

**VDOT GOVERNANCE DOCUMENT**

**CONSTRUCTION MANUAL**

**CONSTRUCTION DIVISION**

**REVISED MAY 2016**



**VIRGINIA  
DEPARTMENT OF TRANSPORTATION**

# 2005 Construction Manual



## **Introduction**

This Manual has been prepared to inform and assist construction inspection personnel in the performance of their duties and in the documentation of project activities. This is not a specification document and its content is not legally binding upon any Department contract and should be recognized as a guide only. References to certain sections of the Specifications appear throughout in order to relate certain inspection activities to an applicable Specification.

Recognizing that any manual of this type must undergo continuous revisions, each recipient is requested to submit suggested changes through appropriate channels to the Scheduling and Contract Division. Approved changes, additions, or deletions will be issued as the need arises. Each recipient of the Manual is responsible for keeping the contents of their copy up to date.

This Construction Manual is presented with the sincere belief that it will aid in maintaining the high quality construction standards which have been established over the years by the Department.

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# **GENERAL**

## **COUNTY, CITY AND TOWN CODES**

The Commonwealth of Virginia was originally sub-divided into 100 counties. A coding system has been developed in which the counties are given a 2 digit number from 00 to 99, and cities and towns have a 3 digit number from 100 to 350. This coding system is used to identify counties, cities, and towns in the project numbers. Counties are grouped together into Districts according to their geographical location.

### **There are Nine Districts**

1. Bristol
2. Salem
3. Lynchburg
4. Richmond
5. Hampton Roads
6. Fredericksburg
7. Culpeper
8. Staunton
9. Northern Virginia

## COUNTIES

<b>County Code</b>	<b>County</b>	<b>District</b>
00	Arlington	Northern Virginia
01	Accomack	Hampton Roads
02	Albemarle	Culpeper
03	Alleghany	Staunton
04	Amelia	Richmond
05	Amherst	Lynchburg
06	Appomattox	Lynchburg
07	Augusta	Staunton
08	Bath	Staunton
09	Bedford	Salem
10	Bland	Bristol
11	Botetourt	Salem
12	Brunswick	Richmond
13	Buchanan	Bristol
14	Buckingham	Lynchburg
15	Campbell	Lynchburg
16	Caroline	Fredericksburg
17	Carroll	Salem
18	Charles City	Richmond
19	Charlotte	Lynchburg
20	Chesterfield	Richmond
21	Clarke	Staunton
22	Craig	Salem
23	Culpeper	Culpeper
24	Cumberland	Lynchburg
25	Dickenson	Bristol
26	Dinwiddie	Richmond
28	Essex	Fredericksburg
29	Fairfax	Northern Virginia
30	Fauquier	Culpeper
31	Floyd	Salem
32	Fluvanna	Culpeper
33	Franklin	Salem
34	Frederick	Staunton
35	Giles	Salem
36	Gloucester	Fredericksburg
37	Goochland	Richmond
38	Grayson	Bristol
39	Greene	Culpeper
40	Greensville	Hampton Roads
41	Halifax	Lynchburg
42	Hanover	Richmond



43	Henrico	Richmond
44	Henry	Salem
45	Highland	Staunton
46	Isle of Wight	Hampton Roads
47	James City	Hampton Roads
48	King George	Fredericksburg
49	King & Queen	Fredericksburg
50	King William	Fredericksburg
51	Lancaster	Fredericksburg
52	Lee	Bristol
53	Loudoun	Northern Virginia
54	Louisa	Culpeper
55	Lunenburg	Richmond
56	Madison	Culpeper
57	Mathews	Fredericksburg
58	Mecklenburg	Richmond
59	Middlesex	Fredericksburg
60	Montgomery	Salem
62	Nelson	Lynchburg
63	New Kent	Richmond
65	Northampton	Hampton Roads
66	Northumberland	Fredericksburg
67	Nottoway	Richmond
68	Orange	Culpeper
69	Page	Staunton
70	Patrick	Salem
71	Pittsylvania	Lynchburg
72	Powhatan	Richmond
73	Prince Edward	Lynchburg
74	Prince George	Richmond
76	Prince William	Northern Virginia
77	Pulaski	Salem
78	Rappahannock	Culpeper
79	Richmond	Fredericksburg
80	Roanoke	Salem
81	Rockbridge	Staunton
82	Rockingham	Staunton
83	Russell	Bristol
84	Scott	Bristol
85	Shenandoah	Staunton
86	Smyth	Bristol
87	Southampton	Hampton Roads
88	Spotsylvania	Fredericksburg
89	Stafford	Fredericksburg
90	Surry	Hampton Roads
91	Sussex	Hampton Roads

92	Tazewell	Bristol
93	Warren	Staunton
95	Washington	Bristol
96	Westmoreland	Fredericksburg
97	Wise	Bristol
98	Wythe	Bristol
99	York	Hampton Roads

## CITIES AND TOWNS

<b>County Code</b>	<b>City or Town Code</b>	<b>City or Town</b>	<b>District</b>
95	140	Abingdon	Bristol
01	160	Accomack	Hampton Roads
12	161	Alberta	Richmond
00	100	Alexandria	Northern Virginia
15	162	Altavista	Lynchburg
05	163	Amherst	Lynchburg
97	164	Appalachia	Bristol
06	165	Appomattox	Lynchburg
42	166	Ashland	Richmond
09	141	Bedford	Salem
01	167	Belle Haven	Hampton Roads
21	168	Berryville	Staunton
97	101	Big Stone Gap	Bristol
60	150	Blacksburg	Salem
67	142	Blackstone	Richmond
01	169	Bloxom	Hampton Roads
92	143	Bluefield	Bristol
33	170	Boones Mill	Salem
16	171	Bowling Green	Fredericksburg
21	172	Boyce	Staunton
58	173	Boydton	Richmond
87	174	Boykins	Hampton Roads
87	175	Branchville	Hampton Roads
82	176	Bridgewater	Staunton
95	102	Bristol	Bristol
82	177	Broadway	Staunton
12	178	Brodnax	Richmond
58	178	Brodnax	Richmond
15	179	Brookneal	Lynchburg
11	180	Buchanan	Salem
81	103	Buena Vista	Staunton
67	181	Burkeville	Richmond
65	182	Cape Charles	Hampton Roads
87	183	Capron	Hampton Roads
92	184	Cedar Bluff	Bristol
19	185	Charlotte C.H.	Lynchburg
02	104	Charlottesville	Culpeper
58	186	Chase City	Richmond
71	187	Chatham	Lynchburg
65	188	Cheriton	Hampton Roads
64	131	Chesapeake	Hampton Roads
86	189	Chilhowie	Bristol

01	190	Chincoteague	Hampton Roads
60	154	Christiansburg	Salem
90	191	Claremont	Hampton Roads
58	192	Clarksville	Richmond
83	193	Cleveland	Bristol
29	194	Clifton	Northern Virginia
03	105	Clifton Forge	Staunton
84	195	Clinchport	Bristol
25	196	Clintwood	Bristol
41	197	Clover	Lynchburg
97	198	Coeburn	Bristol
96	199	Colonial Beach	Fredericksburg
20	106	Colonial Heights	Richmond
32	200	Columbia	Culpeper
87	201	Courtland	Hampton Roads
03	107	Covington	Staunton
07	202	Craigsville	Staunton
67	203	Crewe	Richmond
23	204	Culpeper	Culpeper
95	205	Damascus	Bristol
71	108	Danville	Lynchburg
82	206	Dayton	Staunton
90	207	Dendron	Hampton Roads
14	208	Dillwyn	Lynchburg
19	209	Drakes Branch	Lynchburg
77	210	Dublin	Salem
84	211	Duffield	Bristol
76	212	Dumfries	Northern Virginia
84	213	Dungannon	Bristol
65	214	Eastville	Hampton Roads
85	215	Edinburg	Staunton
82	216	Elkton	Staunton
40	109	Emporia	Hampton Roads
65	217	Exmore	Hampton Roads
29	151	Fairfax	Northern Virginia
29	110	Falls Church	Northern Virginia
73	144	Farmville	Lynchburg
11	218	Fincastle	Salem
31	219	Floyd	Salem
87	145	Franklin	Hampton Roads
88	111	Fredericksburg	Fredericksburg
38	220	Fries	Bristol
93	112	Front Royal	Staunton
17	113	Galax	Salem
84	221	Gate City	Bristol
95	222	Glade Spring	Bristol

81	223	Glasgow	Staunton
35	224	Glen Lyn	Salem
68	225	Gordonsville	Culpeper
81	226	Goshen	Staunton
71	227	Gretna	Lynchburg
82	228	Grottoes	Staunton
07	228	Grottoes	Staunton
13	229	Grundy	Bristol
41	230	Halifax	Lynchburg
01	231	Hallwood	Hampton Roads
53	232	Hamilton	Northern Virginia
27	114	Hampton	Hampton Roads
82	115	Harrisonburg	Staunton
76	233	Haymarket	Culpeper
25	234	Haysi	Bristol
29	235	Herndon	Northern Virginia
53	236	Hillsboro	Northern Virginia
17	237	Hillsville	Salem
61	238	Holland	Hampton Roads
83	239	Honaker	Bristol
74	116	Hopewell	Richmond
71	331	Hurt	Lynchburg
38	240	Independence	Bristol
03	241	Iron Gate	Staunton
51	242	Irvington	Fredericksburg
87	243	Ivor	Hampton Roads
91	244	Jarrett	Hampton Roads
40	244	Jarratt	Hampton Roads
52	245	Jonesville	Bristol
01	246	Keller	Hampton Roads
55	247	Kenbridge	Richmond
19	248	Keysville	Lynchburg
51	249	Kilmarnock	Fredericksburg
66	249	Kilmarnock	Fredericksburg
58	250	LaCrosse	Richmond
12	251	Lawrenceville	Richmond
83	252	Lebanon	Bristol
53	253	Leesburg	Northern Virginia
81	117	Lexington	Staunton
54	254	Louisa	Culpeper
53	255	Lovettsville	Northern Virginia
69	159	Luray	Staunton
15	118	Lynchburg	Lynchburg
56	256	Madison	Culpeper
76	155	Manassas	Northern Virginia
76	152	Manassas Park	Northern Virginia

86	119	Marion	Bristol
44	120	Martinsville	Salem
26	257	McKenney	Richmond
01	258	Melfa	Hampton Roads
53	259	Middleburg	Northern Virginia
34	260	Middletown	Staunton
54	261	Mineral	Culpeper
45	262	Monterey	Staunton
96	263	Montross	Fredericksburg
82	264	Mt. Crawford	Staunton
85	265	Mt. Jackson	Staunton
35	266	Narrows	Salem
65	267	Nassawadox	Hampton Roads
22	268	New Castle	Salem
85	269	New Market	Staunton
94	121	Newport News	Hampton Roads
87	270	Newsoms	Hampton Roads
84	271	Nickelsville	Bristol
64	122	Norfolk	Hampton Roads
97	146	Norton	Bristol
76	272	Occoquan	Northern Virginia
01	273	Onancock	Hampton Roads
01	274	Onley	Hampton Roads
68	275	Orange	Culpeper
01	276	Painter	Hampton Roads
06	277	Pamplin City	Lynchburg
73	277	Pamplin City	Lynchburg
01	278	Parksley	Hampton Roads
35	279	Pearisburg	Salem
35	280	Pembroke	Salem
52	281	Pennington Gap	Bristol
26	123	Petersburg	Richmond
19	282	Phenix	Lynchburg
92	283	Pocahontas	Bristol
99	147	Poquoson	Hampton Roads
16	284	Port Royal	Fredericksburg
64	124	Portsmouth	Hampton Roads
97	285	Pound	Bristol
77	125	Pulaski	Salem
53	286	Purcellville	Northern Virginia
76	287	Quantico	Northern Virginia
60	126	Radford	Salem
30	288	Remington	Culpeper
35	289	Rich Creek	Salem
92	148	Richlands	Bristol
20	127	Richmond	Richmond

44	290	Ridgeway	Salem
80	128	Roanoke	Salem
33	157	Rocky Mount	Salem
53	291	Round Hill	Northern Virginia
98	292	Rural Retreat	Bristol
52	293	Saint Charles	Bristol
97	294	Saint Paul	Bristol
80	129	Salem	Salem
86	295	Saltville	Bristol
95	295	Saltville	Bristol
01	296	Saxis	Hampton Roads
41	297	Scottsburg	Lynchburg
02	298	Scottsville	Culpeper
32	298	Scottsville	Culpeper
69	299	Shenandoah	Staunton
46	300	Smithfield	Hampton Roads
41	130	South Boston	Lynchburg
58	301	South Hill	Richmond
39	302	Standardsville	Culpeper
69	303	Stanley	Staunton
07	132	Staunton	Staunton
34	304	Stephens City	Staunton
91	305	Stony Creek	Hampton Roads
85	306	Strasburg	Staunton
70	307	Stuart	Salem
90	308	Surry	Hampton Roads
01	309	Tangier	Hampton Roads
28	310	Tappahannock	Fredericksburg
92	158	Tazewell	Bristol
30	311	The Plains	Culpeper
82	312	Timberville	Staunton
85	313	Toms Brook	Staunton
38	314	Troutdale	Bristol
11	315	Troutville	Salem
59	316	Urbanna	Fredericksburg
55	317	Victoria	Richmond
29	153	Vienna	Northern Virginia
80	149	Vinton	Salem
41	318	Virgilina	Lynchburg
75	134	Virginia Beach	Hampton Roads
01	319	Wachapreague	Hampton Roads
91	320	Wakefield	Hampton Roads
30	156	Warrenton	Culpeper
79	321	Warsaw	Fredericksburg
78	322	Washington	Culpeper
91	323	Waverly	Hampton Roads

07	136	Waynesboro	Staunton
84	324	Weber City	Bristol
50	325	West Point	Fredericksburg
51	327	White Stone	Fredericksburg
47	137	Williamsburg	Hampton Roads
46	328	Windsor	Hampton Roads
97	329	Wise	Bristol
85	330	Woodstock	Staunton
98	139	Wytheville	Bristol



## **FIELD ORGANIZATION OF THE DEPARTMENT**

The field organization of the Department is divided into nine districts. Each district is directed by a District Administrator who is aided by two or more District Engineers and a staff, consisting of engineers, technicians, maintenance, and administrative personnel. The District Engineers and the staff are assigned specific responsibilities associated with the construction and maintenance of highways located within the boundaries of the district. The districts are sub-divided into three to six residencies which include one to four counties, depending upon size, road mileage and other factors.

The District Construction Management organization includes the Area Construction Engineers, Construction Managers, Contract Administrators, and Inspectors. The District Construction Engineer is responsible to the District Administrator for the oversight of all construction and maintenance projects in the District and has the responsibility of determining that all construction and maintenance projects are being constructed in compliance with the plans and Specifications. Through delegated representatives, the District Construction Engineer provides the necessary guidance and instruction to the Project Inspectors to achieve this end. The Area Construction Engineer periodically inspects the project and verifies the project records. The Area Construction Engineer's verifications are noted in the project records. At the completion of the project the Area Construction Engineer or duly authorized representative, inspects the Contractor's work and notes any unfinished items. When the work is completed the Area Construction Engineer, acting under the authority of the Chief Engineer, accepts the project.

# **Area Construction Engineer**

## **Distinguishing Features of this Position**

The Area Construction Engineer leads and guides construction inspection staff and managers to achieve district contract goals for safety, quality, schedule, and budgeting for construction and maintenance contracts. Provide direction, leadership, and professional engineering advice to CM's and inspectors and serve as responsible charge engineer for highway construction functions.

## **Examples of Duties of this Position**

- (1) Evaluate project development process to ensure they adequately address constructability and bidability issues prior to advertisement of project. Review plans and contract special provisions prior to beginning construction work.
- (2) Manage contract construction budgets for all assigned projects to meet performance goals. Coordinate with FHWA in the preparation and review of work orders, NOIs, and claims to validate necessity of work and level of federal participation.
- (3) Conduct on-site field visits to ensure all elements of design and construction are within scope of contract and within established standards and specifications.
- (4) Manage VDOT and consultant resources and partner with contractors to facilitate on-time completion of projects. Review, coordinate and schedule projects and monitor progress throughout construction phase. Work to resolve issues that may delay projects through partnering with all stakeholders.
- (5) Provide leadership in dispute resolution; perform analyses and lead negotiations.
- (6) Manage and facilitate contract and construction quality improvement. Conduct follow-up CQIP review for all correctable non-compliant questions from original review within 2 weeks of original review. Sign and distribute report to DCE, CQIP Manager and inspector of original review and project staff.
- (7) Interpret plans, schedule, and contract requirements. Provide technical advice and decision to contractors, design and field staff in consultation with Engineer of Records / others. Conduct meetings with engineering and construction groups to address project issues and maintain consistency.
- (8) Conduct on-site field visits and document findings to appropriate parties; perform follow-up assessments to evaluate implementation effectiveness.
- (9) Discuss inspection needs with CM's and authorize assignments of Inspectors to projects, to ensure adequate inspection coverage.
- (10) Checks and approves records of work performed for final cost determination such

as work books and monthly estimates.

- (11) Manage and ensure the training of CM's and Inspectors, evaluates performance, and recommends promotions and transfers.

# **Construction Manager**

## **Distinguishing Features of this Position**

The Construction Manager supervises the inspection activities on a group of highway projects. This work involves responsibility for making assignments, supervising, and providing technical advice to Inspectors. Emphasis is placed on the application of a broad knowledge of field testing and inspection techniques to assure that the quality of workmanship and materials conform with plans and Specifications and that construction is progressing in accordance with the terms of the contract. Discussions are held with Contractors and Inspectors and decisions are made in the field to resolve problems requiring interpretations of Specifications and plans. Construction Managers serve as liaison between the field and the District office to keep the Area Construction Engineer abreast of the progress and problems on construction projects. Supervision is received from the Area Construction Engineer through periodic discussions and the review of reports.

## **Examples of Duties of this Position**

- (1) Determines inspection needs and assigns Inspectors to projects to ensure adequate inspection coverage; instructs subordinates on inspection techniques and field testing methods.
- (2) Interprets contract requirements for subordinates and contractors through the analysis of plans and Specifications.
- (3) Investigates complaints from landowners arising out of conflicts between construction and right-of-way agreements.
- (4) Prepares correspondence and non-routine reports relative to the status of a project.
- (5) Reviews monthly progress estimates and brings discrepancies to the attention of Inspectors; checks and approves records of work performed for final cost determination such as work books and monthly estimates.
- (6) Maintains a perspective overview regarding federal, state, and local laws regulating construction procedures, safety practices and working conditions.
- (7) Inspects work in progress, to assure that methods, materials, and equipment conform to approved standards.
- (8) Supervises the training of Inspectors, evaluates performance, and recommends promotions and transfers.

# **Inspector Senior**

## **Distinguishing Features of this Position**

The Inspector Senior monitors and performs all types of inspection work on both complex and routine highway projects, or acts as a specialist and advisor to other Inspectors on certain phases of the work requiring specialized talent and experience. Assignments are of an independent nature and include responsibility for inspecting and monitoring the inspection work on a complex project.

The Inspector Senior is responsible for assigning assistant Inspectors in a manner which will assure that all phases of the work will be given adequate inspection.

Supervision is received from the Construction Manager or Area Construction Engineer by periodic visits and reviews of records and reports. The Inspector's authority is limited in that changes in plans and Specifications requested or recommended must be reviewed and approved by a Construction Manager or Area Construction Engineer to whom authority has been delegated.

## **Examples of Duties of this Position**

- (1) Inspects all phases of work on a project and advises the Contractor's superintendent or other representative of necessary action to ensure conformance with plans, Specifications and the contract.
- (2) Inspects grading projects, paving projects, demolition projects, special design bridge projects, signal projects, signing projects, utility projects and special projects.
- (3) Reviews the performance of assistant Inspectors daily; advising them as necessary.
- (4) Answers questions from assistant Inspectors and the Contractor concerning contract requirements and their application.
- (5) Reviews the "Inspector's Daily Reports" for preparation of entries for the project diaries, as built plans, materials books, and work books.
- (6) Prepares or checks construction progress reports and monthly progress estimates; makes necessary corrections and forwards them to the Construction Manager or the Area Construction Engineer.
- (7) Performs occasionally any or all of the duties of an assistant Inspector when required by volume of work.
- (8) Monitors training of Inspectors assigned to the project.

# **Inspector**

## **Distinguishing Features of this Position**

The Inspector inspects phases of construction on a complex highway construction project under the supervision of a Senior Inspector or independently inspects a routine highway construction project. Assignments are of an independent or subordinate nature, depending on the scope or complexity of the project, and are made by the Construction Manager or Area Construction Engineer. The work is distinguished from the trainee level by the requirements for relatively independent decisions, actions, and relationships in dealing with Contractors or the public. Training and supervision of trainees are responsibilities of the position.

Supervision is generally received from the Construction Manager or the Area Construction Engineer. Considerable freedom of action is allowed and specific instructions are required only as a result of changes in plans and Specifications, nonconformance by a Contractor, or questions raised by the Inspector.

## **Examples of Duties of this Position**

- (1) Inspects assigned phases of work on a project and makes official contact with Contractor's superintendent or other representative to ensure conformance with plans, Specifications and other contract documents.
- (2) Frequently checks line, grade and dimensions of roadways and structures with an engineer's level and theodolite and advises the Contractor of any discrepancies.
- (3) Checks method of construction where specific methods are stated and requires action to correct any variance in methods employed.
- (4) Ascertains that warning or directional signs are erected and maintained for the safety and convenience of employees and the public, keeping in mind commercial and private entrances and traffic flow.
- (5) Prepares or reviews the "Inspector's Daily Reports" for preparation of entries for the project diaries, as built plans, materials books, and other end of contract documents.
- (6) Records or monitors the recording of materials received, showing quantities estimated to be required, and quantities received, used and tested.
- (7) Checks materials, or materials documents, to make sure they have been tested, or performs routine physical tests and analysis on sample materials on the job, sends additional samples to the District or Central Office laboratories for verification of results.

- (8) Prepares or checks weekly and monthly project progress reports, giving physical progress and percent of total work completed, currently and cumulatively.
- (9) Maintains accurate project records.

# **Inspector Trainee**

## **Distinguishing Features of this Position**

The Inspector Trainee performs daily assigned inspection tasks in a training capacity preparatory to assuming the duties of an Inspector. Assignments follow a plan of on-the-job training, the primary purpose of which is to provide experienced inspection personnel for future highway projects. The work includes measuring, testing, and checking materials, methods, and installations to ensure conformance by the Contractor with the plans, specifications, and the contract. Supervisory control is intensive initially, but is progressively decreased as knowledge of the work increases.

## **Examples of Duties of this Position**

- (1) Inspects excavations, drainage structures, road surfaces and structures to compare the work performed with plans and Specifications, conferring frequently with higher level Inspectors or engineering personnel to clarify or interpret details.
- (2) Checks elevations against reference points using a hand level or wye level. Prepares routine reports and records involving the application of basic geometric and trigonometric principles. Learn use of level and transit survey instruments.
- (3) Prepares an "Inspector's Daily Report" which includes the details of the Contractor's work activities and lists the location of work, materials, equipment, and labor forces used.
- (4) Becomes familiar with plans, Specifications, standards and related material when not occupied with regular assignments or whenever so directed by higher level Inspectors.
- (5) Advises Contractor's supervisory personnel of necessary actions to conform to plans and Specifications.
- (6) Assist in preparing project records.



## **FEDERAL HIGHWAY ADMINISTRATION AND UNITED STATES DEPARTMENT OF TRANSPORTATION**

On highway projects for which part of the money is furnished by the Federal Government, the terms of federal participation are set forth in an agreement between the Department and the Federal Highway Administration (FHWA). Such an agreement provides that the work is to be performed in accordance with predetermined standards embodied in the plans and Specifications, in other approved standard drawings, and in any special provisions necessitated by conditions peculiar to the project.

The contract for the project is awarded by the State with the concurrence of the FHWA. Administration of the contract is a function of the Department and its Engineers and Inspectors. However, Engineers from the FHWA may make inspections of Federal-aid projects at times selected by them.

The relationship between the FHWA and the Department does not directly involve the Contractor. FHWA representatives inspect the project for the purpose of reviewing the adequacy of the Department's inspection procedure as evidenced by the prosecution of the work in accordance with the commitments contained in the State-Federal Agreement. The FHWA's representative has neither the responsibility nor the authority to deal directly with the Contractor. The FHWA's representative should be advised of important developments and changes affecting the prosecution of the work during routine visits to the project or as necessitated by conditions.

# ETHICAL CONDUCT

## Integrity

Absolute integrity on the part of Department personnel is essential if public confidence in the Department is to be maintained. Integrity embraces everything that touches a person's ability to do his job: resourcefulness, decisiveness, adaptability, stability, moral courage and tenacity.

Employees of the Department must be guided in their actions by the highest of ethical standards. Information gained through association with the Department may not be used for personal profit or gain, nor may normal business associations with Contractors be used to the personal advantage of an employee.

An employee of the Department is subject to dismissal if they accept gifts or gratuities from anyone doing business with the Department. The term "gifts and gratuities" includes, but is not limited to, monies, credits, discounts, seasonal or special occasion presents (Christmas, birthday, weddings, etc.), edibles, drinks, household appliances and furnishings, clothing, loans of goods or money, tickets to sporting events or theaters, transportation, vacations, travel or hotel expenses, and any form of entertainment.

No employee of the Department shall engage in any transactions involving property owned or controlled directly or indirectly by the Commonwealth or the Department for personal profit, gain, or convenience.

No employee shall engage in any outside employment or business without first submitting a request for authority to participate in such off duty activities to their Division Administrator or District Administrator.

Any action of unethical conduct by Contractor personnel should be reported immediately to the Construction Manager.

## Hatch Act

By virtue of the use of Federal-aid Funds for highway construction by the Department, employees are subject to provisions of the Hatch Act, a Federal Law concerning political activity. A portion is quoted below:

### *Title 5 (Section 118K) HATCH ACT*

"No officer or employee of any State or local agency whose principal employment is in connection with any activity which is financed in whole or in part by loans or grants made by the United States or by any Federal agency shall (1) use his official authority or influence for the purpose of interfering with an election or a nomination for office, or coerce, attempt to coerce, command, or advise any other such officer or employee to pay,

lend or contribute any part of his salary or compensation or anything else of value to any party, committee, organization, agency, or person for political purposes. No such official or employee shall take any active part in political purposes. No such official or employee shall take any active part in political management or in political campaigns. All such persons shall retain the right to vote as they may choose and to express their opinions on all political subjects and candidates."

# **PUBLIC RELATIONS**

## **General**

Courtesy and consideration are necessary in all contacts with the public because the entire Department is judged by the actions of its employees. Although employees may not obligate the Department to any course of action or any expense without due authorization, they should always be as tactful and helpful as conditions permit. The media of communication with the public are many: newspapers, radio, television, service clubs, Chambers of Commerce, city and county officials, and direct contact with individuals.

The Inspector is not authorized to release official information to any news media. The Inspector should tactfully refer such queries to the Construction Manager. As the authorized representative of the Department, the Construction Manager may or may not release the information. The Construction Manager may refer the matter to the Public Affairs Office. In either case, the media should get the most factual information available.

In dealing with residents along the project, the Project Inspector must endeavor to maintain friendly relations. Frequently, requests will be made on which he will not have authority to act. In such case the Inspector must make every effort not to offend people making these requests. The Inspector should advise such parties that they will discuss such matters with their Construction Manager. After doing so, the Inspector should personally take the answer back to the interested persons. If the answer or solution offered does not satisfy the resident, then such person may be referred to the Inspector's supervisor.

## **Contractor-Inspector Relations**

A good Contractor-Inspector relationship can be maintained if these suggestions are considered:

- (1) Treat the Contractor fairly and impartially.
- (2) Study the Contractor's viewpoint and be friendly but impersonal. Do not put yourself under obligation to the Contractor.
- (3) Be ready to advise the Contractor when requested, but do not make snap decisions.
- (4) Issue all instructions only to the Contractor or the Contractor's representative.
- (5) Write and retain copies of specific instructions given.
- (6) Discuss the Contractor's schedule and coordinate inspection with such schedule.

(7) Do not be arbitrary or become involved in pointless argument with the Contractor or other personnel regarding matters not related to the work.

## **GENERAL PROVISIONS**

# **GENERAL PROVISIONS**

## **Award and Execution of Contracts**

After bids are read and tabulated, the successful bidder is determined. This involves checking all unit prices, quantities, and extensions to determine if any errors have been made by the bidder. These tabulations are submitted along with the Engineer's estimate to the Chief Engineer, who recommends to the Board that they be either awarded or rejected. The bid of the lowest responsible bidder must generally be within the tolerance of the Engineer's estimate.

After receiving Board approval on State or certification acceptance projects, the contract is awarded. On Federal oversight projects, FHWA concurrence is required before award. At the time of execution of the contract, the successful bidder shall furnish a performance and payment bond.

The contract is then executed by the Department and a copy is distributed to the Contractor, the surety, the various Department offices, and to FHWA and municipalities, when applicable.

The District Administrator notifies the Contractor to proceed with the work. This is done as soon as possible in order to give the Contractor the full advantage of the contract time limit.

## **Pre-Construction Conference**

As soon as possible after the project has been awarded, the Construction Manager is to arrange a conference with the Contractor and interested parties for the purpose of reviewing construction details, proposed schedules, and utility coordination. Prior to this meeting, the Area Construction Engineer, Construction Manager and Project Inspector should have studied the plans and Special Provisions and made a field inspection of the project so that they will be well informed as to contract requirements and existing conditions.

Among those who may be included in the conference are the following:

1. Representatives of the District Office, such as the Structure and Bridge Engineer, Traffic Engineer, Utilities Engineer, Materials Engineer, Environmental Manager, Contract Manager and the Civil Rights Manager.
2. Area Construction Engineer and principal assistants, including the Project Inspector.
3. The Contractor and principal personnel.

4. Representatives of the utilities involved.
5. Municipal or County Representatives, if involved.
6. Railroad officials, if applicable, and any other interested parties involved.

On projects involving railroads, railroad officials require a minimum of two weeks notice prior to the date of the pre-construction conference.

Among the subjects to be discussed at the conference are the following:

1. Contractor's proposed sequence of construction, operating schedules, computation of workday charges, time schedule, and completion date requirements.
2. Work to be sublet, stipulations to be included in the subcontract agreements, insofar as progress of the job and work to be done, Engineer-Contractor relations and responsibility towards subcontractors, authorized representatives.
3. Labor provisions, necessary posters, Engineer's inspection, and investigating procedures with regard to labor requirements.
4. Legal relations and responsibilities; cooperation with utility owners, the public, and other Contractors; licenses and permits in connection with execution of the work, local ordinances.
5. Special requirements and unusual conditions, conflicts and problems anticipated clarification of construction details and Specification requirements, procedures for assessment of time.
6. Coordination and the scheduling of work between the Contractor and the various utility companies.
7. Inspection procedures, notification to the Engineer of material orders, furnishing samples and the time and place of testing and accepting materials, field office, storage and use of materials.
8. Haul road requirements; location and scheduling of bypass construction, crossroad closures and access facilities; general responsibilities with regard to traffic convenience.
9. Employee and public safety, sanitary provisions.
10. Appointment of the project safety officer(s) for administration of the Construction zone safety requirements and procedures.



11. Delegation of authority by the Contractor and the Engineer, lines of communication, equipment and personnel.
12. A list of suppliers should be furnished the Engineer indicating where the Contractor proposes to obtain materials for the project.
13. Pertinent outlines of the Federal Labor Compliance Regulations.
14. Civil Rights and DBE/WBE or MBE requirements.
15. Review of requirements for Contractor's notice of intent to file a claim.
16. Environmental concerns to include applicable permits, compliance with environmental laws and Contractor's responsibilities.
17. The Contractor Performance Evaluation (CPE) process shall be discussed with the Contractor in detail at the Pre-Construction Meeting. Discussion should include the various reports which includes the questions the Contractor will be scored on, appeals process and frequency of reports. For any Subcontractor not present at the Preconstruction Meeting, the Contractor shall be responsible to inform them of the CPE Process.

## **Progress Schedule and Plan of Operations**

After notice of award the Contractor shall attend a scheduling conference with the Engineer to develop a schedule in the form of a general outline of the Contractor's work plan. The Contractor shall also attend a preconstruction conference called by the Engineer at which time the Contractor's planned or contemplated operations will be discussed. The scheduling conference and the preconstruction conference may be held separately or simultaneously.

Within 15 days after the preconstruction conference, the Contractor shall submit a detailed schedule covering the next six weeks of construction. The Contractor shall submit an updated six week schedule every two weeks until the working schedule is submitted for the remainder of the project.

Within 45 days after the preconstruction conference, the Contractor shall submit to the Engineer for approval, a working schedule for the remainder of the project showing the sequence and interdependence of activities required for completion of the work, the date on which he will commence work and the contemplated dates for completing items of work. The working schedule should include diagrams, bar charts, and tabular schedule report showing start and finish dates. Intermediate completion milestones shall be indicated and critical activities to accomplish those milestones shall be shown. The diagram shall clearly depict the order, interdependence, and duration for each activity. The critical path shall also be depicted. The diagram shall be neatly lettered and legibly drawn. A written narrative of the working schedule shall be submitted and describe each

element shown. The narrative shall list the Contractor's work days per week, holidays, number of shifts per day, and number of hours per shift.

It is incumbent upon the Department to expeditiously provide usable facilities for the public in keeping with timing commitments made during public hearings and to affected municipalities and organizations.

Timely completion is also essential to the project because the cost to the Department for the administration of the contract including engineering, inspection, and supervision will increase as time required to complete the work is increased.

Evaluation of progress is made by comparing the actual work completed to date with the Contractor's anticipated progress shown on the latest accepted schedule.

The progress schedule indicates the amount of work to be performed within given time periods as percentages of the contract dollar value. The progress schedule provides a means of measuring the Contractor's progress throughout the life of the project. Early detection of deficient progress is critical to preventing or mitigating delays in project completion. The Project Inspector should be alert to detect delays or lack of progress on the project. Such delays should be brought to the attention of the Contractor and the Construction Manager. This will help prevent the Contractor's progress from becoming deficient to the extent of removal from the bidders list.

Form C-13, Contractors' Progress Schedule for Construction Projects, or similar Contractor generated form, is to be used if Special Provisions do not specify an earnings schedule.

Schedules are to be submitted by the Contractor to the Area Construction Engineer.

The Area Construction Engineer is to review the schedules to determine if the planned rate of work is sufficient to complete the contract within the time allotted and to see that the progress proposed for the completion of each item or group is realistic.

## **SECTION 104 – SCOPE OF WORK**

### **Section 104.04 Maintenance During Construction**

Project maintenance as used herein relates more to the prosecution of work which could adversely affect traffic than maintenance of traffic itself. It is intended that the Contractor actively prosecute operations to the timely completion of that work. As an example, the Contractor should not close a section of road to traffic until he is prepared to begin work on that specific portion of road. In addition and whenever practicable, connections with other roads and entrances should be kept in a condition which allows for the safe and reasonably comfortable passage of vehicles. This may require stage construction of entrances and roadway in order to provide such continual passage as noted in Section 104.04(e).

#### **Section 104.04(d) Delays**

The Specifications state in part that “Two-way traffic shall be maintained at all times, unless otherwise approved. The Contractor shall not stop traffic without permission.”

Providing for the uninterrupted flow of traffic during construction may involve careful sequencing and scheduling of the work and other measures either described in the contract or required in the form of a plan developed by the Contractor for Department approval. Every reasonable effort should be made at the field inspection stage to recognize the need for and to develop plans to accommodate closures. Such planning should be reflected in special provisions or plans for handling traffic or in describing the sequence of construction.

In the event a contract does not include specific language permitting temporary closures and they are found to be necessary during construction, closure should only be permitted upon the approval of the District Administrator. In addition, any closure on an Interstate route should be concurred with by FHWA.

There are certain operations over existing roadways which, because of the potential hazard to motorists, necessitates the temporary or momentary closing of all lanes over which such work is to occur. The planning of such closures must be thorough in order to minimize the length of time motorists are delayed. Such planning should include, but is not limited to, the following considerations:

1. Development of a satisfactory plan for minimizing the time involved in performance of the overhead work, such as erecting structural members in units of two members with diaphragm connected for stability, thus eliminating the delay involved in bracing or tying off each member; or, in the case of continuous steel members, the construction of temporary bents on which the sections can be supported during the performance of field splices.
2. Scheduling temporary closures during off-peak traffic periods.

3. Providing an adequate number of signs, barricades, and flaggers to safely execute the closure.
4. Mobilizing all materials, equipment, and personnel at the site prior to the closure.
5. Detours should be carefully selected and reviewed with the Regional Traffic Engineer as well as with local municipalities involved.

As a general rule, State roads are not to be closed for more than 10 minutes during any single closure. Closures of more than 10 minutes should be handled by detour unless the detour travel time will exceed the period of closure.

When closures are specifically permitted in the contract or approved during construction, the Public Affairs Office is to be advised by the Construction Manager in sufficient time for the public to be properly forewarned.

Appropriate State or local police should be informed and their presence requested during the closure of roadways involving high-speed or high-density traffic.

#### **Section 104.04(e) Connections and Entrances**

By law, all property owners adjacent to a project are guaranteed access to their property unless restricted by limited access laws. The Specifications place the responsibility upon the Contractor for furnishing and maintaining connections and entrances during construction.

Connections and entrances are not to be disturbed by the Contractor until necessary. The Inspector and the Contractor should keep in mind the effects of wet weather. All disturbed connections and entrances are to be maintained in such a manner that surface water will drain away from the area. Connections and entrances are to be maintained in a passable condition throughout the construction period. Permanent surfacing should be placed as soon as practicable whenever a connection or entrance can be completed to line and grade in a continuous operation. However, temporary stabilization or surfacing may be required whenever the connection or entrance must be constructed in stages.

When an entrance is replaced, the new entrance should be as good as or better than the entrance that existed prior to construction. Confer with the property owner prior to replacement and discuss the proposed entrance with the property owner in the presence of the Contractor's representative. The Inspector should point out to the landowner where the new entrance will be located, the approximate grade, and the manner in which the grade will be transitioned along the roadway. In the event the explanation of the location does not agree with the understanding stated by the landowner, the Inspector should simply state a request will be made of superiors to re-check the location as shown on the construction plans. The Inspector must not assume the responsibility to agree to changes requested by the landowner.

An entrance should be rebuilt as far back beyond the right-of-way line as it was disturbed. In some cases, grading beyond the right-of-way lines may be necessary to eliminate a steep grade. An adequate amount of stone must be placed on the new driveway entrance or mailbox turnouts. This may be the difference between good and poor relations with the property owner throughout the duration of the project. All entrances are to be inspected by the Area Construction Engineer or appointed representative together with the Project Inspector and the District Right-of-Way Agent prior to completion of the project.

#### **Section 104.04(f) Grading Operations**

Contractor's proposed construction methods on projects should be carefully reviewed to ensure that the vertical clearance of grade separation structures is not temporarily reduced below 14'-2" during construction, unless such reduction is unavoidable. The Department of Motor Vehicles' Permit Manual allows the issuance of blanket permits for vehicle heights up to and including 14'-0". Holders of these blanket permits are seriously affected when the vertical clearance of a structure is temporarily or permanently reduced below 14'-2". Any temporary reduction in vertical clearance of grade separation structures will require notification in accordance with Department policies.

#### **Section 104.05(a) Signs**

The Contractor is required to maintain existing permanent traffic control signs for the life of the project within the project limits, which includes any removal, relocating, installation and/or reinstallation and storage of signs, as determined by the Engineer.

#### **Section 104.06 Cleanup**

General housekeeping must be a continuous process throughout the construction project in the interest of safety and appearance.

Before a project is finally accepted, the Project Inspector and staff must ascertain that the Contractor has complied with the contract requirements and that the following items have been completed according to the Specifications:

1. Trash, construction debris and other waste materials have been removed and disposed of in an acceptable manner.
2. Drainage ditches and live streams have been cleared of masonry and other construction debris.
3. Drainage structures and culverts are clean and free from obstructions.
4. Proper drainage achieved on pavement surfaces, paved gutters, deck slabs, bridge seats, etc.

5. Mailboxes, turnouts, entrances, etc. disturbed by construction have been satisfactorily replaced.
6. Property drainage claims settled.
7. Concrete surfaces given specified finishes, including smoothness and texture.
8. Disturbed ground surface restored to original lines or graded in accordance with plans.
9. Adjacent property, utility lines, fences, etc. damaged during construction have been repaired.
10. Finished surfaces that have been marred have been touched up.
11. Shoulders and side slopes of fills have been dressed and sloped to drain.
12. General appearance of the project is neat and orderly.
13. Borrow pits, disposal areas, quarries, storage areas and all areas occupied by the Contractor shall be cleaned of all rubbish, excess material, and temporary structures.

## **SECTION 105 – CONTROL OF WORK**

### **Section 105.02 Plans and Working Drawings**

Shop drawings submitted for review shall be identified by the complete project and job designation numbers and items or component materials shall be identified by the specific contract item number and the Specification reference indicated in the contract. Work should not be performed nor materials ordered prior to the review of submittals except at the Contractor's risk.

The Inspector or Construction Manager shall insure that a Professional Engineer's certification is included on shop drawing submittals for lighting and traffic control items as noted in Section 105.02 of the Specifications.

All shop drawings should be reviewed and returned to the Contractor within 30 days from the date of receipt or 45 days if a railroad, municipality, or other entity as noted in the contract or on the plans is involved in review of specific shop drawings. In addition some items may be submitted in accordance with the "Pre-Approved Traffic Control Device Listing."

The Inspector or Construction Manager should state a return due date on all shop drawings submittals forwarded for review by designers, consultants, municipalities, allowing sufficient time to comply with the 30 or 45 day return.

If any shop drawings are returned late to the Contractor, the Inspector should note in the project dairy the reason for delay and if the delay will have any impact on the Contractor's project schedule.

### **Section 105.03 Conformity with Plans and Specifications**

It is the responsibility of the Inspector to inspect the work for conformity with the plans, Specifications and Special Provisions. Tolerances for many Specification requirements are given in the Specifications or Special Provisions; however, experience and good judgment (common sense) are needed to properly apply the Specifications in order to produce the desired results.

No Specification can cover all situations; however, the Specifications are intended to cover most situations and circumstances, and deviations from the Specifications should not be common. Inspectors should seek the advice and approval of the Area Construction Engineer in cases where deviations may be necessary.

On the other hand, there are occasions where the specified tolerances may be met, but the work should be rejected. A classic example would be grade at top of earthwork. Section 303.05(a) establishes a tolerance of 0.10 foot above or below theoretical grade. However, if deviations from theoretical grade occur abruptly or in such proximity as to be readily discernible, the work should not be accepted until the Contractor has

reconstructed or otherwise corrected the affected area to conform to the specified tolerance in such a manner as to provide a smooth riding surface.

## **Section 105.05 Coordination of Plans, Standard Drawings, Specifications, Supplemental Specifications, Special Provisions, and Special Provision Copied Notes**

The Contract documents are intended to be complementary to each other, but occasionally one may contradict another. Should a contradiction be observed, the following order of priority shall apply:

1. Special Provision Copied Notes
2. Special Provisions
3. Plans
4. Supplemental Specifications
5. *Road and Bridge Specifications*
6. Calculated dimensions
7. Scaled dimensions

## **Section 105.11 Authority and Duties of Inspector**

Authorities and duties of the Inspectors are as outlined in the "Field Organization of the Department." It is not the responsibility or within the authority of the Inspector to act as a Foreman or Superintendent for the Contractor or to give instructions to employees of the Contractor. Section 105.06 requires the Contractor to provide a competent Superintendent on the project. The Inspector is to communicate on matters related to the project with the Superintendent.

Inspection Services Performed By Consultants - The Department utilizes Consultants for the performance of specific inspection services in accordance with contract agreements. The Project Inspector should note pertinent information pertaining to these services in the project records so that the Consultant's billings can be verified and approved for payment.

## **Section 105.13 Removal of Unacceptable and Unauthorized Work**

In almost every instance in which an important component of the contracted work is rejected, we can expect the Contractor to question the basis for the rejection. Before



reordering replacement material, the Contractor wants to be reasonably certain that our decision to "reject" is justified.

No one is expected to be an expert in the evaluation of the many materials which we use; therefore, it behooves the individual, whether they be serving in an inspector or engineer capacity at the project level, to call upon the appropriate "specialist" in the Department to render a decision of confirmation or to call upon someone else who is otherwise able to offer a satisfactory explanation for the condition(s) which prompted the initial decision to reject the material.

We cannot afford the luxury of acting solely on our own judgment in the rejection of materials or workmanship involving large sums of money and many manhours of labor. The authority we have been given to "reject" is tempered with responsibility to fully evaluate that which is in question. Further, since time is important to both parties of the contract, we have the added responsibility to be prompt in seeking confirmation of our judgment.

The above procedure or philosophy naturally does not apply to materials or workmanship which is obviously improper, defective, or not as specified. Examples include: Incorrect size bars or location of bends in reinforcing steel, broken pipe, un-approved substitutions involving the type of material specified, rejection of "perishable" items such as hydraulic cement concrete which fails under test to conform to the specified requirements and which also fails under re-test.

Whenever it does become necessary to reject material or workmanship, field personnel should not become involved in suggesting or directing what course of action the Contractor should or must follow. Section 105.13 states in part: "Unacceptable work shall be remedied or removed immediately and replaced in an acceptable manner at the Contractor's expense except that, the Engineer may accept the work at reduced price when such acceptance is considered to be in the best interest of the public." Hence, there are at least two courses of action open to the Contractor (and perhaps more). The Contractor should be given an opportunity to decide and propose the course of action to the Department for our consideration without having been unduly influenced at the outset. It may be that the only practical solution is to remove the work, but don't be guilty of jumping to this conclusion. At the outset, simply tell the Contractor that the work is unacceptable and that, after reviewing the possible alternatives, the Department is to be advised of what the Contractor proposes to do to correct the deficiency.

## **Section 105.15 Acceptance**

**Partial Acceptance:** If at any time during the prosecution of the project the Contractor completes a unit or portion of the project, such as a structure, an interchange, slopes, pavement, or a section of a roadway, in its entirety, he may ask the Engineer to make final inspection of such work. If the Engineer finds upon inspection that the work conforms to the requirements of the Contract and that acceptance is in the interest of the public, he may accept the work as being completed, and the Contractor will be relieved of

further responsibility for the work as specified in Section 107.16. Partial acceptance shall in no way void or alter any terms of the Contract.

If any damage attributable to causes beyond the control of the Contractor is sustained by the accepted unit or portion of the project, the Engineer may authorize the Contractor to make necessary repairs. In the absence of contract prices covering the items of repair, the work will be paid for in accordance with the requirements of Section 109.05.

**Final Acceptance:** Upon receipt of written notice from the Contractor of presumptive completion of the entire project, the Engineer will make an inspection. If all construction provided for and contemplated by the contract is found completed to his satisfaction, the inspection will constitute the final inspection and the Engineer will make the final acceptance. The Contractor will be notified by letter of such acceptance within five days of such inspection. A copy of the acceptance letter is to be transmitted to the Scheduling and Contract Division. In addition to the acceptance letter, the Contractor is to be provided a copy of the Form C-5 issued for the starting and completion of contract work.

Other involved parties, such as FHWA or cities, should perform their inspection at the same time as the Area Construction Engineer, if not prior.

## **Section 105.16 Submission and Disposition of Claims**

Due to the sensitive nature of potential claims and the documentation and procedures required for handling of same, a *Claims Manual* has been assembled. Please refer to the *Claims Manual* for instruction and guidance.

## SECTION 106 – CONTROL OF MATERIAL

### General

Most materials are sampled, tested, and approved for use prior to shipment to the project. Such approval is given subject to the provision that the material will not be detrimentally altered during shipping, storage, handling, and inclusion in the work.

Specified requirements governing the sampling and testing of materials are outlined in the *Manual of Instructions - Materials Division*. The Inspector should be familiar with the Materials Manual and pertinent instructional memoranda issued by the Materials Division.

Materials arriving on the project with evidence of inspection (stamp, seal, or certification) should be visually inspected, particularly for signs of contamination, segregation, structural damage and other physical impairments which could have resulted from the handling operations. The Inspector should always act promptly upon the results of visual inspection of materials. The following courses of action are to be taken:

1. Accept material that bears proper evidence of inspection and that passes visual inspection.
2. Suspend the use of material that bears proper evidence of inspection but does not pass visual examination. Obvious defects in the material should be rejected immediately by the Inspector. If there is a doubt about the acceptance of the material, the Project Inspector should immediately notify the Construction Manager and the District Materials Engineer of the action taken and request their assistance in making a more adequate evaluation of the material to establish the basis for acceptance or rejection. The Inspector is to record in the diary all actions and decisions made and those who assisted in making the final determination. Make sure that the Contractor's representative is promptly informed of the final determination.
3. Reject material that bears evidence of inspection but, based upon visual examination, is not in close conformity with Specification requirements.
4. Promptly sample and submit for tests those materials that arrive on the project and do not bear evidence of inspection unless the item, according to the *Manual of Instructions - Materials Division*, may be accepted on the basis of visual inspection or by certification of test results.
5. Take the necessary action to ensure that all guaranties or warranties normally furnished by manufacturers or which may be required in the contract, including those covering signal equipment, are furnished or assigned to the Department by the Contractor, in writing. Such guaranties or warranties must include necessary information to identify, by serial number or other

appropriate means, the items being guaranteed or warranted. This may necessitate the Contractor requiring an additional copy of the invoice from the supplier in the event the guaranty or warranty is on the back of same. The guaranties and warranties are to be maintained in the project file.

### **Section 106.03 Local Material Sources (Pits and Quarries)**

The Contractor is required to submit to the Engineer for approval a detailed sketch showing the approximate boundaries of the proposed borrow pit, quarry, or disposal areas, and the direction of flow of water on and away from the area affected. The Contractor must also submit in writing, a plan to minimize erosion and siltation of nearby streams or natural drainage areas, and to provide for the restoration of the disturbed areas. The proposed sites are to be reviewed with the District Environmental Manager before approval.

In order for the Department and its Contractors to operate within the provisions of the Surface Mining Act and the specific waiver provided for pits and quarries operating to produce materials exclusively for highway projects, it is necessary that appropriate notification be made. The District Administrator or his appointed representative is to furnish the following information:

- a. Name of Contractor or company operating the pit or quarry.
- b. Name and address of official who is in charge of the operation.
- c. Project number(s) of the project(s) for which the material is being furnished.
- d. The location of the pit or quarry - sufficiently detailed to pinpoint on a county or city map.

This information is to be forwarded to:

Department of Mines, Minerals and Energy  
Division of Mineral Mining  
P.O. Box 3727  
Charlottesville, Virginia 22903

Borrow pits and quarry sites are to be concealed from view of the completed roadway and any existing public roadway by selecting an out of sight area, by providing screening between the site and the roadway, or by other use of the site after the removal of the material.

Upon receipt of approval, the Inspector should contact the Survey Party Supervisor and request the borrow pit site to be cross sectioned. A diagram of the borrow pit is to be shown in the slope stake notebook, giving the designation number of the pit, property owner's name, property lines, a definite location distance from centerline of the road and a tie-in with definite stations, if possible. The diagram should also show the property referenced base line, base line bearing, and property or county separator lines. This

applies both to staking out and taking of finals. All references to the base line and bench marks are to be so placed that they will be entirely outside of the area likely to be disturbed by the operation in and around the borrow pit.

The borrow pit area should be cleared, grubbed and topsoil removed before cross sections are taken. This will define the area in which the Contractor intends to work and eliminate the possibility of not having the intended work area covered by cross sections. Once the pit has been opened and any unsuitable material is encountered, this material should be stockpiled separate from the topsoil stockpile.

Cross sections are taken at sufficient intervals to cover all breaks in the ground and insure accurate computations of quantities. In the event a borrow pit covers two or more properties, all property lines shall be clearly shown in the cross section notes and on the diagrammatic sketch, in order that the amount of material removed from each property can be determined.

The Contractor is responsible for erosion and sediment control and restoration of the borrow pit, quarry site or disposal area. During operations, the Contractor shall at all times have a person certified as an Erosion and Sediment Control Contractor by the Department of Conservation & Recreation (DCR) present. The Contractor's certified representative shall be responsible for ensuring adherence to all applicable DCR requirements.

The Contractor's approved plan may include the continued use of the quarry site or disposal area beyond the date of final acceptance. However, any restoration work done after the acceptance of the project will be performed at the Contractor's expense. Any plan for continued use of the site beyond the life of the project must be in accordance with Sec. 106.03 and in full compliance with applicable State Mining Laws.

## **Section 106.05 Rights for and Use of Materials Found on the Project**

The Specifications give the Contractor the right to use in the construction, material found in the excavation. For example, if the Contractor finds material in a cut that can be used as subbase material, he is allowed to use such excavation as subbase material. The Contractor is not required to use this material as embankment material. When excavated, this material should be paid for at the contract unit price for excavation and when placed as subbase material, this material should also be paid for at the contract unit price for subbase material. However, the Contractor must furnish, at no cost to the Department, suitable embankment material to replace the regular excavation used as subbase material.

The Contractor will not be permitted to sell material secured within the right-of-way unless the contract provides for the Contractor to retain ownership of salvageable material. Such violations should be brought to the immediate attention of the Construction Manager.

## **Section 106.08 Storing Materials**

All materials should be stored in such a manner as to be readily accessible for inspection and protected from damage which would lessen their quality or fitness for the work. This would include damage due to weather or the introduction of deleterious materials.

The Inspector should insure that the Contractor does not store equipment or materials within traffic clear zones, even for short periods of time, unless such storage has been approved and adequate protection provided.

Written permission, with a clause not to hold the Department responsible for any damage that may occur, must be furnished prior to storage of any material on private property. At the completion of the use of the property, the Contractor must furnish a signed release from the property owner.

## **SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC**

### **Storm Water Pollution Prevention (SWPP) Plan**

The Storm Water Pollution Prevention (SWPP) Plan, also referred to as the Erosion and Sediment Control (ESC) Plan, Storm Water Management (SWM) Plan and related Road and Bridge Specifications and Standards contained within all contract documents, are required for all land-disturbing activity of 10,000 square feet or greater (2,500 square feet or greater in Tidewater Virginia).

The Contractor is responsible for the installation, maintenance, inspection, and ensuring the functionality of all erosion and sediment control measures on a daily basis and all other stormwater and pollutant runoff control measures identified within the plans, specifications, permits, and contract documents.

The Contractor shall take all reasonable steps to minimize or prevent any stormwater or non-stormwater discharge, which has a reasonable likelihood of adversely affecting human health, public and/or private properties.

The Contractor shall develop erosion and sediment control plan(s) and stormwater management plan(s) for submission and acceptance by the Engineer prior to usage of any support facilities, off-site borrow and disposal areas, construction materials or equipment storage areas, and other industrial storm water discharge directly related to the construction process.

The Contractor is responsible for conducting inspections in accordance with the requirements of Section 107.14(a). The Contractor and/or Subcontractor shall document such inspections by completion of form C-107 (a) and (b) (Construction Runoff Control Inspection Form and Continuation Sheet) in strict accordance with directions contained within the form.

The Contractor shall not discharge into state waters sewage, industrial wastes, other wastes, or any noxious or deleterious substances or otherwise alter the physical, chemical, or biological properties of state waters and make them detrimental to the public health, animal or aquatic life, the use of such waters for domestic or industrial consumption, for recreation or for other uses.

The Contractor shall quickly notify the Engineer upon the discovery of or potential of any unauthorized, unusual, extraordinary, or non-compliant discharge from the construction activity, but in any case not later than 24 hours after said discovery.

The Contractor shall submit to the Engineer within 5 days of the discovery of the discharge a written report describing details of the discharge to include its volume, location, cause, and any apparent or potential effects on private and/or public properties

or endangerment to public health, as well as steps being taken to eliminate the discharge. A completed form C-107 (a) and (b) shall be used for such reports.

### **Contractor SWPP Plans**

The Contractor shall provide SWPP Plans that document the location and description of potential pollutant sources such as vehicle fueling, storage of fertilizers or chemicals, sanitary waste facilities, construction and waste materials etc. prior to any such pollutant sources being brought onto the project site. Such documentation shall include a description of the controls to reduce, prevent, and control pollutants from these sources including spill prevention and response. The Contractor shall submit such documentation in accordance with Section 107.14(b)1 to the Engineer and, thereby, immediately becoming a component of the project SWPP Plan and subject to all corresponding requirements contained therein.

### **Changes and Deficiencies**

The Contractor shall report to the Engineer when any planned physical alterations or additions are made to the construction activity or deficiencies in the project plans or contract documents are discovered that could significantly change the nature or increase the quantity of the storm water pollutants discharged from the construction activity.

## **Section 107.08 Railway-Highway Provisions**

In the event that construction work is to be performed in close proximity to railway facilities, the Inspector should be thoroughly familiar with the requirements of the railway provisions contained in the contract and this section of the Specifications. Particular care should be exercised in regard to rail traffic safety.

Section 107.08 of the Specifications expressly prohibits entrance onto or over railroad right-of-way unless a flagman or watchman is present. A particular area of concern centers on the incidental swinging of construction materials or equipment, even momentarily, over railroad right-of-way when no flagman or watchman is present. Department inspection personnel as well as Contractor personnel should be alert to the potential for equipment or construction failure which may not be on railroad right-of-way, but close enough in proximity to effect damage or delays to the railway.

Department inspection personnel should carefully review construction scheduling and sequencing with the Contractor to minimize, if not avoid, time consuming and costly delays. Scheduling should be such that work in proximity to the railroad is continuously prosecuted once started so that the recall of flagmen to the project is minimized.

## **Section 107.10 Barricades and Warning Signs**

The Inspector should be thoroughly familiar with the requirements of Sections 104.04, 107.10, 512, the *Work Area Protection Manual* and the project special provisions in



regard to the Contractor's responsibility to maintain channelizing devices and warning signs during construction.

The Contractor must take reasonable precautions for the security of Department furnished signs; however, the Contractor should not be held responsible for the damage or loss of signs by causes beyond his control, when such signs are being properly utilized or stored. Negligent exposure and abusive handling of signs is a concern, especially in light of the number of signs furnished by the Department. The unnecessary exposure of signs left along side the roadway when no longer needed and the careless handling and storage of signs which result in damage or loss would be considered negligence on the part of the Contractor and, consequently, the Contractor would be required to make restitution for such damages and losses.

Although the Contractor is not responsible for loss or damage beyond his control, it is still incumbent upon the Contractor to notify the Department immediately of such loss or damage in order for an evaluation to be made. In the event signs are not being properly cared for, the Contractor should be advised of his responsibility in accordance with contract requirements.

The Contractor is to erect, maintain, and relocate, as deemed necessary by the Engineer, signs furnished by the Department for use within the limits of the projects. In addition, the Contractor is to furnish, erect, and maintain all other traffic control devices unless otherwise stated.

Existing signs should not be removed unless the sign is to be re-erected at a more appropriate location, or the sign message is no longer applicable or the message is adequately conveyed on another sign that has been erected in the vicinity. This should be determined by the Project Inspector, with the assistance of a representative of District Traffic Engineering. The Project Safety Officer and Project Inspector should constantly re-evaluate the signing of the project as the work progresses.

Temporary signs and channelizing devices are frequently struck by vehicles and equipment or blown down by high wind. Be on constant alert for such conditions and bring them to the immediate attention of the Contractor. Particular attention should also be paid to insure that signs and traffic control devices are promptly removed when no longer needed. Serious hazards are created when signs such as "Flagger Ahead" and "Detour" are left in place when the message is no longer applicable.

The legibility and effectiveness of many signs and channelizing devices located on construction projects are extremely poor because of the presence of heavy coatings of wheel splash and dust. The "maintenance" required of the Contractor in Section 107.10 and the *Work Area Protection Manual* includes the cleaning and replacement, if deemed necessary by the Inspector, of signs and channelizing devices as frequently as necessary to keep the sign message legible and the channelizing devices in proper condition to function as designed.

The District Traffic Engineer should be called upon to assist in the evaluation of signing and channelizing devices of projects as needed.

## **Section 107.11 Use of Explosives**

Blasting operations should always be conducted under careful, competent supervision to prevent damage to adjacent property and injury to persons. The location and size of the area in which blasting is to be done and the strength of the charges set therein will determine, to a great extent, the procedure required.

Explosives must be stored in a secure manner in compliance with federal, state, local law and ordinances.

The Contractor is responsible for notifying property and utility owners having a structure above or below ground in the area of the proposed charge. Such notification does not relieve the Contractor of responsibility should damage occur.

Blasting areas must be properly signed to inform all persons of the potential danger and to insure that all mobile radio units and cellular phones are turned off when in the immediate vicinity of explosive charges. The effectiveness of the signs is reduced and the public is unnecessarily inconvenienced if these signs remain in place permanently. The Contractor should display the signs immediately before the explosive charges are placed, and then cover or remove the signs after the charge is set off.

All wells and springs that might be affected by the blasting operation should be checked prior to and after the blasting operation and the results noted in the Project Diary.

The Inspector should observe the blasting operation and warn the Contractor of any anticipated damage of which he is aware. However, the Contractor is solely responsible for all damages caused by the blasting operation. A complete record of any damage and the resulting corrective measures should be included in the Project Diary.

Entries in the Project Diary should also include the time the charge was set off and the location of the charge.

The day to day information concerning the type and amount of explosive, number and average depth of holes, including the location and detonation time for each charge, is to be secured from the Contractor and made a part of the project records. This information should be compiled for all blasting related to the project in any way.

## **Section 107.14 Environmental Stipulations**

### **Erosion and Siltation Control**

The Inspector shall be very familiar with the requirements of this section of the Specifications, the standard plan sheet on erosion control and The *Manual On Erosion and Sedimentation Control* which should be on every project.

The Contractor must adhere to the requirements of all environmental permits issued for the project. The Contractor must exercise every reasonable precaution throughout the duration of the project to prevent siltation of rivers, streams, and impoundments (lakes, reservoirs). Some preventive measures are listed below:

1. Construct permanent drainage facilities and other contract work as soon as possible in conjunction with earthwork operations.
2. Shape top of earthwork and construct berms along edges of fills.
3. Provide drains to carry off rainwater and ground water from cuts and embankments located in vicinity of streams and rivers. Care must be taken to keep loose material from washing into drainage areas, streams, and rivers.
4. Install siltation dams shown on plans and check with Construction Manager as to whether others are needed.
5. Equipment should be allowed only in streams where channel changes or other contract work make this necessary. Frequent crossing of live streams with construction equipment is not permitted. Temporary bridges or other structures are to be used when equipment will be crossing frequently.
6. Review the Contractor's approved erosion and siltation control plan and call attention to deficiencies.
7. Temporary control measures require the attention of the Contractor to ensure their proper function. Some items to watch are; cleaning silt basins, replacing straw bales, cleaning out behind bales, checking barriers to see that no water is washing under or around them.
8. Seeding should progress as closely behind the construction activities as possible and temporary seeding should be employed where needed in accordance with Section 603 herein.
9. Material excavated from channels should be placed so as to prevent its re-entry into the stream. Protective devices should be employed to assure that erosive material will not be washed into the stream in case of heavy rain.

10. Cofferdams and causeways should be constructed of non-erodible material and continually maintained to prevent siltation.
11. The project should be reviewed continually by the Project Inspector along with the Construction Manager and Contractor's Representative to evaluate control measures and to see if any additional measures are needed.

## **Pollution**

Every effort should be made to prevent or minimize pollution, whether air, water, or noise pollution, as a result of construction activities. The Inspector should be familiar with the local ordinances and contract requirements in this regard.

The contract may have a general permit issued by the Corp of Engineers stating how work adjacent to or in bodies of water is to be performed. It is very important that the Contractor adheres to the restrictions and guidelines established in the permit. If noncompliance is discovered by the Corp of Engineers the project may be shut down and the Department may receive severe fines and penalties for noncompliance.

## **SECTION 108 – PROSECUTION AND PROGRESS OF WORK**

### **Section 108.09 Determination and Extension of Contract Time Limit**

On fixed date projects when the contract is not executed within 60 calendar days after the opening of bids, and such delay is not the fault of the Contractor, the Contract time limit is to be extended by the number of days beyond 60 days to contract execution . The day on which bids are opened will be the first day of the 60-day period.

Section 108.02 of the current Specifications declares the Notice to Proceed to be the date of contract execution, unless otherwise indicated in the Contract. This section also requires the Contractor to notify the Engineer in writing at least 24 hours prior to the date on which he intends to begin work.

Weather: Detailed diary entries must be kept in order to accurately substantiate the effect upon the work of all individual weather events which occur throughout the life of the project.

Unforeseen Conditions: The Contractor must bear the cost associated with loss of time (delays) caused by weather events to the extent described in the Specifications as well as for delays caused by his own negligence, lack of planning, poor supervision, incompetent personnel, inadequate coordination of the work or equipment breakdowns. However, the Department agrees to consider granting extensions of time for delays which occur “due to unforeseen causes beyond the control of and without the fault or negligence of the Contractor.” Alterations in plans or character of work resulting in substantial increases, strikes affecting the delay of materials, delayed utility adjustments to be performed by the utility owner and national or international disasters (wars, floods, etc.) are a few examples of delays considered to be beyond the control of the Contractor. The Contractor does have the responsibility to make every reasonable effort to make up for these delays and thus to complete the work on time.

The following action should be taken upon the first indication that the Contractor will be delayed as a result of a cause beyond his control:

1. The Inspector should notify the Construction Manager or the Area Construction Engineer and report the cause for the delay.
2. A discussion should be held with the Contractor and the Area Construction Engineer level for the purpose of establishing the extent of the delay.
3. The Area Construction Engineer should discuss the details of the delay with the Federal Highway Administration Area Engineer in all instances in which (FO) Federal funds are involved.

4. Upon completion of these discussions, the Area Construction Engineer should immediately make a recommendation regarding the delay to the District Administrator (or Designee), or if authorized, the Area Construction Engineer should make the decision on what, if any, time extension to allow. (In this case, steps 5 and 6 do not apply)
5. The District Administrator (or Designee) should then review the Area Construction Engineer's recommendation, together with all supporting evidence relative to the delay.
6. The District Administrator (or Designee), upon evaluating the recommendation will notify the Area Construction Engineer as to the appropriate time extension to be allowed.

In the event there is a disagreement between the Department and the Contractor as to the appropriate and proper adjustment in the fixed time completion date, adjustment will be made in accordance with what is considered by the Department to be a fair and equitable adjustment, recognizing the Contractor's right to file claim for the adjustment up to 60 days after the final estimate is paid by the Department.

A shutdown form should be prepared and submitted when, in the judgment of the Inspector, a shutdown is justified. The following guidelines should be used in determining the justification for a shutdown:

#### **Suspension of Work Due to Fault of Contractor**

Suspension of work due to the fault or negligence of the Contractor is not considered to be "shutdowns" and no extension of contract time is to be allowed. Such suspensions are to be handled by letter and Form C-12 should not be distributed.

## **SECTION 109 - MEASUREMENT AND PAYMENT**

### **Section 109.01 Measurement of Quantities**

#### **Scales**

The sealing of scales shall be performed by the Department of Agriculture and Consumer Services, Division of Weights and Measures as outlined in the *Manual of Instructions - Materials Division*, Section 107.

The scale owner, whether it be the material producer, supplier, or Contractor, is responsible for requesting Division of Weights and Measures to seal his scales at least 10 days prior to the anticipated date of operation or seal expiration date. When the scales require servicing, the scale owner will be responsible for obtaining an approved scale repair person or manufacturer's representative to perform such service prior to inspection by Division of Weights and Measures. If Division of Weights and Measures cannot test and approve the scales prior to the anticipated date of use or the seal expiration date, Division of Weights and Measures will advise the scale owner of such and, if so requested, will advise the District Materials Engineer. The District Materials Engineer may authorize the temporary use of the scales.

When the District Materials Engineer receives the repair person's signed "Scales Inspection and Service Report" indicating that the scales conform to the applicable requirements, and Division of Weights and Measures advises that it cannot inspect the scales prior to the anticipated date of use or seal expiration date, then the scale owner may request temporary approval from the District Materials Engineer to use the scales. If the scales are determined to be satisfactory for use and upon receipt of verbal approval from the District Administrator, the District Materials Engineer will then notify the scale owner in writing that the scales have been temporarily approved for a period of time not to exceed 30 calendar days. The scales must be inspected and sealed by the Division of Weights and Measures during the 30 day period.

If the inspection by Division of Weights and Measures reveals that the scales are not functioning properly and if the necessary repairs or adjustments cannot be made by the scale repair person immediately, the District Materials Engineer will then notify the scale owner by phone and confirm by letter that the scales have been taken out of service for state work until properly repaired and then sealed by Division of Weights and Measures. No additional temporary approval will be given.

#### **Accuracy of Measurement for Payment**

The day to day field quantities should be measured, computed, or otherwise tabulated to one digit beyond that accuracy necessary for final quantities. Final quantities are to be measured or computed in the appropriate units and to the accuracy stated in the "Post Construction Manual."

## **Section 109.05 Extra and Force Account Work**

Occasionally, on contract projects, it becomes necessary to perform extra work or work not included in the contract. If the Department and the Contractor are not in agreement on the amount to be paid for the work, the Engineer may set up a unit price or may require the work to be performed on a Force Account basis. Under Force Account provisions, the Department pays up to allowable costs of the Contractor's equipment and labor necessary to do the work. The Contractor is compensated for the work on the basis of records kept by the Inspector and the invoices for materials.

Form C-115, Contract Force Account Authorization must be submitted and approval obtained prior to commencement of work. The District Administrator has the authority to approve authorizations within the project budget. The Inspector should be familiar with Form C-115 and be able to furnish the pertinent information. Information should include a brief but complete description of the work to be performed, a definite location by station numbers, a listing of all anticipated classifications of labor and rate for each classification, a listing of materials and equipment to be used, giving the weekly and hourly rates. Notation should be made on Form C-115 for any equipment not covered by the current "Blue Book" and for which rates have been agreed upon based on prevailing area rates or those being paid by the Contractor at the time of the authorization. A statement is to be prepared which sets forth reasons for the extra work. When necessary, a detailed explanation should be included in the letter of transmittal.

Force Account work is paid for in accordance with the Specifications. The Project Inspector should keep accurate daily records of the work as it is accomplished. At the end of each day the Contractor's representative and the Inspector should compare records of the work performed. This record is to be submitted in duplicate to the Contractor's representative weekly for signature on Form C-116. The Construction Manager and the Contractor each receive one signed copy.

All bills for materials used must be properly supported by copies of the invoices for the materials received on the job. Freight costs and taxes are considered to be part of the cost of the material used on Force Account work.

Payrolls for labor on Force Account work are required and must show the name of the employee, job classification, the rate of pay actually paid by the Contractor, the dates on which the work was performed and the number of hours worked daily by each employee on Force Account.

Bills for equipment used on Force Account must show the number of hours each piece of equipment worked each day, the dates on which the work was performed, and sufficient description of the equipment so that the rate of pay can be determined. The rate of pay for equipment must not exceed applicable rate established in Section 109.05 of the Specifications.



At the conclusion of the work, the entire Force Account charge is to be summarized. The Contractor must furnish invoices, payrolls, freight bills, etc. to support the charges.

All documentation records are to be furnished to the District for final cost verification. District cost verification is to be part of the Final Review operation and should be accomplished immediately following the completion of each Force Account authorization. Verification of such costs is ultimately the responsibility of the District Administrator.

## **Work Orders**

Unforeseen conditions may arise during the prosecution of the work which will necessitate extra work which was not contemplated and was not included in the contract. When such conditions arise, the Project Inspector, Construction Manager, and Area Construction Engineer should examine the situation and determine the need for a Work Order.

Procedures established in Construction Directive Memorandum CD 2006-02, Contract Change Management: Work Orders, Force Accounts, and Contract Expenditures, must be followed.

Once the need for a change has been recognized, a decision should be obtained promptly and the Contractor advised immediately so that he may begin planning his work accordingly and preparing his work order price. Accordingly, the following policy and procedures are hereby established.

1. After the need for a work order or force account has been determined and prior to obtaining the Contractor's agreement to the work order or force account, the District Administrator is to ascertain that adequate funds to finance the work are appropriated. In negotiating work orders, any time extension necessary is to be agreed upon by the Department and the Contractor and such time set forth in the respective work order. Also, when the cost of the work is to be paid for in part or entirely from sources other than State or Federal-Aid project funds, the sources and percent of participation are to be clearly shown on the work order. If a municipality is participating in the cost, they should be apprised of the need and cost of the work.
2. The Area Construction Engineer is to inform the FHWA Area or District Engineer of all impending work orders on Federal Oversight projects, including the need for performing the work along with an assessment of the unit prices obtained from the Contractor as well as any time extension. A concerted effort is to be made at this time to obtain FHWA concurrence in the work, unit prices, and time extension. The FHWA representative's position concerning the work is to be recorded by the Construction Manager in the project records showing the date of discussion and name of the representative with whom discussed.

3. The District Administrator or his designee may approve work orders within the project budget.
4. Prior to authorizing work on Federal Oversight projects at the District level, the FHWA must have made a firm commitment for approving the work, including the unit prices. In the event the FHWA representative concurs in the need but not the prices obtained, and it is necessary that the work be performed immediately, the District Administrator may authorize proceeding with the work
5. Work orders, except on Federal Oversight projects, which are approved by the District Administrator do not require additional signatures of approval and are to be distributed by the District Office. The original Form C-10 and one copy of all pertinent support documentation including the Contractor's cost breakdown, are to be sent to the Scheduling and Contract Division for Central Office distribution.
6. Work orders on Federal Oversight projects require formal approval by the FHWA. The original Form C-10 and two copies of all pertinent support documentation including the Contractor's cost breakdown, are to be submitted to the FHWA for approval.
7. Work orders exceeding the project budget must be approved by the Central Office prior to proceeding with the work. The original and one copy of Form C-10 and one copy of all pertinent support documentation, including the Contractor's cost breakdown, are to be submitted to the Scheduling and Contract Division. Notification of approval will be relayed to the District by e-mail and copies of the approved Form C-10 will then be furnished by transmittal to the District for distribution. As soon as the District Office receives e-mail approval, the District is to either notify the Contractor directly or notify the Construction Manager and have his office notify the Contractor by telephone that he may proceed with the work. A record is to be made of the time and date of the telephone conversation and to whom the release was relayed by telephone.

The Project Inspector should be familiar with Form C-10 for work order providing the following information:

1. Full description of work - "What do you want to do?"
2. Location of proposed work - "Where are you going to do this work?"
3. Necessity for work - "Why is the work necessary?" Make this explanation detailed and complete. Remember that the Work Order will have to be approved by personnel who may be unfamiliar with the details of the project. They must understand the reason for the work.
4. Estimate of quantities and costs broken down by project (showing unit prices).

5. Time extension - The Contractor and Construction Manager should agree on time extension and this is to be shown on the Form C-10.

After the preliminary draft of the Work Order is complete, it is submitted to the Construction Manager for recommendations.

The Construction Manager then routes the Work Order through the proper channels as established in Construction Directive Memorandum CD 2006-2 for approval. The Contractor will not be allowed to begin the work detailed in the Work Order until the work order is approved.

When it becomes necessary to perform additional work for which reasonable prices cannot be secured from the Contractor, the Engineer may determine the price or the work will then have to be performed by force account.

## **Section 109.06 Eliminated Items**

There are times when various items of the contract are eliminated or materially changed. When the Contractor has purchased material for such items prior to notification that the item has been changed or eliminated, the Department may purchase this material from the Contractor if requested to do so.

**It is especially important that the Contractor be notified in writing as soon as possible if items are being eliminated which require project specific materials to be fabricated, constructed, or manufactured such as sign structures, reinforcing steel, drop inlets, structural steel, etc.** Prompt written notification will increase the potential for minimizing the costs associated with an eliminated item.

Written notification to the Contractor is not necessary for minor underruns of items where some portion of the contract quantity will be eliminated and there are no fabricated, constructed, or manufactured project specific materials involved. Examples would be underruns of aggregate material, excavation, paved ditch, flaggers, etc. However, if the entire quantity of an item is being eliminated or if a “significant change” underrun of a major item will occur, written notification should be made to the Contractor.

Payment to the Contractor for materials, when purchased by the Department, will be limited to the Contractor's cost for the material and freight cost. Costs incurred by the Contractor's forces to deliver the material to a VDOT storage site may be paid as well. Material and freight costs must be evidenced by invoices to the Contractor from the supplier and carrier, and other applicable associated costs must be adequately supported; however, no additional compensation will be made for overhead or anticipated profit.

Procedures for payment are as follows:

If the Contractor performs any work necessary for the installation of an eliminated item prior to written notification of the elimination being provided to the Contractor, then the Department should compensate the Contractor for the actual cost of any work performed for the installation of the eliminated item. A Work Order should be prepared to document the amount of the compensation and to authorize the payment of the compensation.

If the Contractor has already purchased materials for use in the eliminated item prior to written notification of the elimination being provided to the Contractor, then the Department should compensate the Contractor for the materials unless the Contractor elects to retain the materials for his own use elsewhere.

If the Contractor elects to be compensated for already purchased materials and cannot return them to the supplier, the District Administrator (or designee) must decide if the Department wants to take ownership of the materials or if the Department wants the contractor to retain and dispose of the materials. This decision should be based on the potential for use of the materials by the Department for other purposes. The Department should only take ownership of materials and place them in inventory if there is a very high probability that the materials can be used by the Department for other purposes.

If the Department chooses to take ownership of the materials, the Contractor should be compensated for the actual cost of the materials including freight and taxes, as evidenced by invoice. A Work Order should be prepared to document the amount of the compensation and to authorize the payment of the compensation.

If the Department chooses to have the Contractor remove and dispose of the materials from the right of way and/or any property adjacent to the project that he does not own or control, then the Contractor should be compensated for the actual cost of the materials (or any restocking fees if the materials are returned to the supplier), freight, taxes, and any disposal costs, as evidenced by invoice. A Work Order should be prepared to document the amount of the compensation and to authorize the payment of the compensation.

In most cases, any compensation costs paid to the Contractor for eliminated items should be charged to the established UPC charge source for the project. If the contract has Federal funding, all costs associated with eliminated items should be charged as non-participating unless otherwise approved by the FHWA. If the Department has decided to take ownership of the materials, then the charge for the cost of the materials can be redistributed to an appropriate inventory funding source by journal voucher.

## **Section 109.07 Partial Payments**

Partial payments are made once each month for work performed and materials furnished. Lump sum items not covered by specific payment provisions require judgment to determine the degree of completeness and hence the amount of the partial payment. The following guide may be used to determine the amount which should be paid in partial payments.

**1. Sign items**

One-third of the contract unit price for the sign support may be paid when foundations are complete, two-thirds of the contract unit price when the sign support is in place and 100 percent of the contract price will be paid when the remainder of the installation has been completed.

**2. Select material, subbase, and base material (aggregate-type material)**

The quantity of material in the various stages of completion on the road should be estimated and an equitable quantity paid for at the contract price. Seventy-five percent of the estimated quantity of material placed will be paid for at the contract price when the material is placed on the road prior to compaction. (The delivered material has a certain value and a partial payment maybe made for it.)

When questionable material is being placed or extenuating circumstances are involved, the quantity for which partial payment is made should be reduced.

**3. Drop inlets and other items paid on a complete unit basis**

Partial payments may be allowed on these items on a percentage basis. For instance, 6 drop inlets may be approximately 50 percent complete; therefore, a partial payment can be made in the amount for 3 complete inlets.

**4. Landscaping**

On planting projects, the Inspector may allow 25 percent of the cost of each plant upon completion of digging and backfilling the hole with topsoil.

**Withholding of Estimate**

The Department may withhold payment of the Contractor's monthly progress estimate for the Contractor's failure to comply with contract requirements for submission of:

1. Payrolls
2. Form C-28 - Hourly Rates Paid by Contractor
3. Contractor's Progress or Earning Schedule
4. Contractor's Plan of Operation
5. Form C-57 - Contractor's Monthly E.E.O. Report
6. Minority Contracting/Procurement/Supplier Activity Report
7. Form C-62 - Contractor's Semi-annual Training Report
8. And for unresolved property damage claims

With the exception of requirements concerning the progress schedule and the plan of operation, the Department's policy concerning the withholding of estimates due to late submission of documentation is to be as follows:

1. The Contractor is to be allowed a one estimate "grace period." In effect, payment will not be withheld unless initial or subsequent submissions are 30 or more days delinquent.
2. The Contractor is to be given a courtesy telephone call as close as possible to the original due date advising of the late documentation.
3. If, during the course of a contract a particular contractor is continually late with submittals, he may be advised in writing (copy to appropriate Quality Construction Engineer) that the policy concerning "grace periods" and "courtesy calls" is being rescinded and that future estimates will be withheld in strict accordance with the governing specifications or provisions.
4. In the event that the late forms or payrolls are those of a subcontractor, it may be necessary to withhold a portion of the monthly estimate. If the Contractor provides documentation of his efforts to obtain the late forms or payrolls from the subcontractor, then only work performed by that subcontractor shall be withheld from payment on the monthly estimate until the forms or payrolls are submitted.

In any instance in which it becomes necessary to withhold payment of an estimate, the Contractor is to be advised, in writing, that payment is being withheld; the reason(s) for withholding payment and that payment cannot be released until such time as the specified requirement(s) has been met. After the Contractor has complied with the specified requirement(s), the estimate is to be immediately submitted to the Fiscal Division for processing. In the case where a portion of an estimate has been withheld due to late forms for payrolls by a subcontractor, that portion withheld shall be paid on the next estimate following receipt of the forms or payrolls.

When it is necessary to withhold payment, the Contractor must be notified in writing of the action being taken and the reasons for such action.

After the Contractor has complied with the contract requirements, the withheld estimate may be processed

If the Contractor's Monthly Estimate is not to be withheld for noncompliance, then every effort for timely payment should be made. Furthermore, Contractor's Monthly Estimate should clear the District Office within 8 working days after the estimate closing date.

The Department will deduct an amount equivalent to 5 percent of the monthly progress estimate on all unbonded contracts and will retain such monies until final payment is made in accordance with the requirements of Section 109.09. The balance less all previous partial payments will be vouchered for payment. After 50 percent of the total contract value has

been completed and 5 percent has been retained on this amount, the Department will make the remaining partial payments in full provided the Contractor is maintaining a satisfactory rate of progress. *Total contract value* will be considered to mean the original amount of the contract except when the contract is increased or decreased by more than 20 percent, in which case, the adjusted total will be considered as the total contract value. The Department will not deduct retainage on bonded contracts provided the Contractor achieves and maintains a satisfactory rate of progress.

If the Contractor's progress falls more than 10 percent behind the latest approved progress schedule on either a bonded or unbonded contract, the Contractor may be notified that if the next monthly progress estimate shows a delinquency of more than 10 percent, progress will be considered unsatisfactory and 5 percent retainage will be withheld each month the Contractor is behind the progress schedule by more than 10 percent.

When the percentage of time used exceeds the percentage of work completed by more than 10 percent, the Contractor may be notified that if the next monthly progress estimate shows a delinquency of more than 10 percent, progress will be considered unsatisfactory and 5 percent retainage will be withheld on either bonded or unbonded contracts for each month the percentage of time used exceeds the percentage of work completed by more than 10 percent.

On bonded contracts, when the Engineer determines that the Contractor's progress is considered satisfactory in accordance with these requirements, the 5 percent retainage previously withheld because of unsatisfactory progress will be released in the next monthly progress estimate and the remaining monthly progress estimates payments will be made in full provided satisfactory progress continues to be made. The Department will continue to deduct 5 percent retainage on unbonded contracts as provided for herein.

## **Section 109.08 Payment for Material on Hand**

Prior to payment for material on hand, the Contractor must make a written request to the Department specifying the material for which payment is requested. The request should include invoices or bills from the supplier and certification or evidence of testing and approval as applicable. A copy of such letter must be in the project files.

Each month the Contractor must provide a certified inventory of materials on hand for which payment has been requested, on Forms C-22.

No payment for material on hand will be made on the estimate if the Contractor has not provided the certified inventory.

## **Section 109.09 - Final Payment**

The final estimate is due for payment within 90 days after acceptance of the project. To accomplish this, it is essential that all project notebooks be completed and turned in at the

earliest date possible. As structures and other construction items on which separate books are maintained, and completed, the Project Inspector should finalize these books and turn them in to the Construction Manager for review. The Construction Manager will then give the books to the Area Construction Engineer for review. The books will then be forwarded to the District Office for checking by appropriate Sections within the District. All project books and records are to be turned in to the District within 10 calendar days after acceptance of the project.

The Construction Manager is to make the projects "As Built" plans available to the survey party at the earliest possible time so that an on-the-ground spot check of measurements shown therein may be made in sufficient detail to enable the Survey Party to verify the "As Built" plans. The Survey Party's check will be an independent operation from that of the Inspector.

In order that the final survey may be completed as soon as possible, the Survey Party may begin the survey prior to acceptance of the project as various features of the work are completed; therefore, the Project Inspector should advise the Construction Manager as various features of the work, including structures, have been completed to the extent that the final survey may be started.

The complete final data should be submitted to the Scheduling and Contract Division by the District as soon as the final is completed, but not less than 10 days prior to the due date for payment. The Department may withhold final payment due to the Contractor's delay in fulfilling the contract such as: dressing and seeding of borrow pits and disposal areas, resolving property damage claims, submitting or correcting data forms and payrolls. However, certifications regarding payment will not be a prerequisite to the issuance of final payment on contracts that require a payment bond. The Contractor should be reminded that a delay in final payment caused by any action on his part will extend the 90 day time limit accordingly.



## **SECTION 110 - MISCELLANEOUS PROVISIONS**

### **Section 110.01 Common Carrier Rates**

This section of the specification provides for additional compensation to the Contractor or for a credit to the Department, as the case may be, as a result of changes in common carrier rates and taxes by public authority during the life of the project.

The request from the Contractor for additional compensation as a result of increased rates is to be accompanied with a statement from the local common carrier or petroleum tank truck carrier to the effect that the rates were changed on a certain date. This statement must include the rates prior to the change and the rates after the change. The Contractor is to submit receipted bills to the Construction Manager covering the increase. These bills are to be thoroughly checked by the field offices and payment included in the next progress estimate covering the additional freight. If the information is not available at the time the progress estimate is made up, it may be included in the final.

Rail freight rates are controlled by public authority and any properly documented request may be authorized for payment by the District. Truck haulers, however, are not generally covered under the provisions of this section. Therefore, any claim for increased common carrier rates for truck haulers submitted by Contractors in accordance with Section 110.01 of the Specifications must be accompanied by the following:

The name of the hauler.

Origin and destination of the shipment.

Information concerning the contract between the Contractor or supplier and the hauler, such as the establishment of the rate structure and provisions for adjustment.

Each claim should be transmitted to the Scheduling and Contract Division.

Any increase as a result of common carrier rate change is not to be considered as progress and no extension of time is to be granted as a result thereof.

### **Section 110.02 Labor and Wages**

It is a requirement of all highway contracts that Federal and State labor regulations be observed throughout the prosecution of the work. Inspectors should have a good working knowledge of these regulations in order to evaluate compliance by the Contractor. This section will provide further explanation of the regulations affecting labor.

Enforcement of Labor Provisions - Since labor regulations are as much a part of the contract as the performance of the work itself, the Department has the responsibility to assure itself that such regulations are observed throughout the life of the contract.

Routine checks should be made for compliance with labor regulations and records prepared to document the results. Checks should be made upon the following:

**1. Posters**

The required posters and wage rates must be posted as required in the Specifications.

**2. Interviews of Contractor's Employees**

To ensure compliance on Federal-aid projects, Project Personnel will conduct random, on-the-job interviews with several employees of the Contractor to determine the actual wages being paid, and whether the employee is properly classified in the work he is doing. The first interviews should be performed within the first 30 days after the contractor has fully mobilized. Subsequent interviews should be performed no less than semi-annually and when new work crews are assigned to the project. The results of the interviews by the Project Personnel are to be recorded in the project diary. Payrolls for that week are to be checked to see that the figures obtained during the interview were reported correctly. This should be recorded in the diary.

**3. Statement of Compliance - Form C-56**

The Contractor and Subcontractors are required to submit with the payroll a Weekly Statement of Compliance, Form C-56 (WH-348) on Federal-aid projects. This affidavit relates to Anti-Kickback regulations, the Davis Bacon Act, Work Hours Act and Fringe Benefits and is required throughout the course of the work.

**4. Payrolls**

On Federal-aid contracts, the Contractor and approved Subcontractors must submit a copy of their weekly payroll to the Project Inspector within two weeks after the pay period ends. Additional copies may be obtained on mutual agreement with the Contractor. All approved Subcontractors' payrolls must be forwarded through the prime Contractor to the Project Inspector and each must bear certification that it has been reviewed by the prime Contractor. Each Contractor and Subcontractor payroll is to be checked by the Project Inspector at such frequency as to assure that conformance with wage provisions of the contract is attained. The first two payrolls received from the Contractor and each Subcontractor on a project are to be thoroughly checked to ensure their correctness. Discretion should be used to determine the need for checking any further successive payrolls, dependent upon the number of errors found in the initial checks. Upon determining that the Contractor or Subcontractor, as applicable, is complying with the wage regulations of the contract, subsequent payrolls need only be checked on a periodic basis with such frequency as to

ensure continued compliance; however, it should be ascertained that each subsequent payroll contains the required statement of compliance.

Following are guidelines to clarify payroll requirements on Federal Aid projects when contractors rent another contractor's equipment with operator and the renting of equipment with operator from an equipment service company:

1. Rental of another contractor's equipment with operator: The equipment operator must be shown on the contractor's or approved subcontractor's payroll and paid by the contractor or subcontractor for whom the operator worked.
2. Rental of equipment with operator from a bonafide equipment service company: The equipment service company is NOT considered a subcontractor. The operator must be shown on a certified payroll. This payroll can be the contractor's or approved subcontractor's payroll. It is satisfactory to accept certified payrolls from the equipment service company.

## **5. Payroll Information**

Payrolls must contain the following information:

- a) The employee's full name, address and Social Security Number (the employee's full name and Social Security Number need only appear on the first payroll on which his name appears. The employee's address need only appear on the first payroll unless a change of address necessitates a submittal to reflect the new address.)
- b) A code in the name column to identify minority or non-minority employees. FHWA recommends:
  1. B = Black
  2. H = Hispanic
  3. I = American Indian or Alaskan Native
  4. A = Asian or Pacific Islander
  5. O = Other
- c) The employee's classification as listed on the posted predetermined minimum wage rate schedule.
- d) The employee's basic hourly wage rate and where applicable, the overtime hourly wage rate. The payroll should indicate separately the amounts of employee and employer contributions to fringe benefit funds and programs. Any fringe benefits paid to the employee in cash must be so indicated on the payroll. It is suggested that the straight-time basic rate and cash in lieu of fringes be separately stated in the hourly rate column, thus \$6.25/.80.

- e) The employee's daily and weekly hours worked in each classification including actual overtime hours worked.
- f) Itemized deductions made (all deductions not required by law must be authorized by the employee).
- g) Net wages paid.

## **6. Corrections**

If it is found that the payroll has discrepancies, such discrepancies should be called to the attention of the Contractor(s) and corrections made promptly. The original payroll submitted should NOT, under any circumstances, be returned to the Contractor. Corrections are to be made by supplemental payrolls prepared and submitted in the same manner as the original. Under certain conditions copies of canceled checks may be required as evidence of payment to affected employees.

## **7. Other Requirements**

Payrolls not submitted within two weeks from the end of a pay period are to be considered "late." A delinquency of three weeks or more in the submission of payrolls by either the prime or any subcontractor will be sufficient cause to withhold payment of any monthly or semi-final progress estimate. No further payments will be made until payroll submissions are brought within the prescribed submission time. No monthly or semi-final progress estimate is to be withheld for payment due to payroll discrepancies such as clerical errors.

## **8. Violations**

Violation of the labor requirements regarding wages is a serious matter. The Inspector is to report any complaints of violation of the labor standards to the Construction Manager for further investigation.

## **9. Determining Wage Classification**

In checking payrolls and hearing complaints with regard to wage difficulties, the Inspector will be confronted with the problem of determining the actual classification in which an employee is working. Seldom is the solution clear-cut nor has the Inspector authority to determine definitely the classification in which the Contractor's employee belongs. For example, the Inspector does not have sufficient information to distinguish between the duties of a carpenter's helper and those of a carpenter. When a wage dispute arises, the Inspector should observe the man's work and then consult the Construction Manager for assistance in resolving the dispute.

## **10. Convict Labor On Federal-Aid Projects**

Between the time of the award of the contract and acceptance of a Federal-aid project, convict labor supervised by VDOT personnel is not to be used within the project limits. Any instance in which convicts are observed working within the limits of a construction project should be called to the attention of the Construction Manager immediately. Inmates paroled to Contractors under State or Federal work release programs may be employed.

## **Section 110.03 Equal Employment Opportunity**

### **Equal Employment Opportunity Actions and Documentations**

- (1) Project EEO File to be documented with the following data:
  - a) Name and address of Contractor:
    - Project No.
    - Contract Amount - \$
    - Date Work Started
    - Estimated Peak Employment Date:
  - b) Obtain and file a copy of EEO policy statement formally adopted by the Contractor.
  - c) Determine and place on file the name of the Contractor's designated EEO Officer and what position of authority the EEO Officer holds with the contracting firm.
- (2) Project Inspector should determine if Contractor practices the following (Contractor should provide back-up data for project files):
  - a. Dissemination of Policy:
    1. Staff - All supervisory personnel should be indoctrinated with and practice the Contractor's EEO policy.
    2. Orientation - All new staff members that are authorized to hire, supervise, promote, and discharge employees are indoctrinated with the EEO policy.
    3. Meetings - Not less than every six months the EEO officer should conduct a meeting to review and explain EEO policy and its implementation.

4. Notices - All notices and poster (Executive Order 11246) setting forth Contractor's EEO policy are placed on bulletin boards that are readily accessible to employees and prospective employees.
- b. Recruitment:
1. Advertisements by Contractor for employees shall use the quotation "An Equal Employment Opportunity Employer."
  2. Contractor should recruit minorities and females, and document contacts made with State employment agencies, schools, colleges, and minority and female group organizations.
  3. Encourage present employees to refer minority and female group members for employment.
- c. Personnel Actions:
1. Ensure that job site personnel are not discriminated against as far as working conditions and employee facilities.
  2. Payroll should reflect no discrimination in wage practices for each classification.
  3. Administration of discrimination complaints - document nature of complaint and final disposition.
- d. Training and Promotion:
1. As the work force demands, training programs should be implemented, i.e., pre-apprenticeship, apprenticeship, and on the job training, to increase the skills of minority group employees.
  2. All current and new employees should be made aware of available training programs.
- e. Unions:
- If Contractor relies wholly or partially upon unions as a source for work force, then the union agreement should have an EEO clause in regard to employment and training.
- f. Subcontracting:

Contractor shall try to use minority group subcontractors or subcontractors with meaningful minority group representation. Subcontractors are required to comply with the Contractor's contract obligations.

g. Records and Reports:

1. Number of minority group members in each classification.
  2. Progress or efforts to hire or train minorities through unions.
  3. Progress or efforts to hire minorities through newspaper ads, minority group organizations, and U.S. or State employment services.
  4. Progress or efforts in contracting minority group subcontractors or material suppliers.
  5. Contractor and Subcontractor must submit Form C-57, due each month for the first three months of construction and every July thereafter, indicating the number of minority and non-minority group employees in each work classification.
  6. Contractors and Subcontractors should be reminded at the pre-construction conference of their obligation to submit a Form CC-257 on a monthly basis directly to the applicable Office of Federal Contract Compliance Programs (OFCCP) if they have any Federal-aid projects.
- (3) Project Inspectors will maintain a file to indicate the following information on projects which include Trainees on Construction Projects:
- a) Selected work classification for which training is to be provided.
  - b) Completed Trainee Enrollment Form.
  - c) Record of Trainee status (includes hours of training accomplished each week with cumulated total).
  - d) Certificate of completion or reason not completed.

Form C-67, Weekly Trainee Report, was developed for use on non-Federal-aid projects which have Special Provisions for Trainees as a part of the Contract documents. In the event training is provided in accordance with the Special Provision during a week, each Contractor (prime or sub) providing the training is to complete Form C-67 for the week, sign in the appropriate space and submit same to the Project Inspector in triplicate.

After the Inspector determines that the information is correct, to the best of his knowledge, his signature is to be affixed in the appropriate space. The original of Form C-67 is to be transmitted to the District Office, one copy is to be furnished the Contractor and the other copy maintained on the project by the Inspector.

Contractors may elect to use Form C-67 on Federal-aid projects; however, it will still be necessary that trainees be shown on weekly payrolls.

## **Section 110.04 Use of Disadvantaged and Minority Business Enterprises (DBE and MBE)**

This section provides for the utilization of disadvantaged (DBE) firms on federal aid contracts and minority (MBE) firms on non-federal aid contracts. Achievable DBE requirements are established on federal aid contracts and achievable MBE potential achievements are established on non-federal aid contracts. VDOT's project personnel are responsible for assuring that DBE/MBE firms are actually used to perform the designated work, and that their work meets the guidelines established for performance of a commercially useful function in order for credit to be allowed.

On federal aid contracts with DBE requirements established, the prime Contractor is required to submit a progress schedule that also shows DBE participation, which is to be checked against Form C-111 in the contract. Copies of the actual subcontract with each DBE must be submitted no later than seven (7) days prior to the Notice to Proceed. The Contractor's progress in using DBEs is to be checked against the progress schedule and the latest Form C-111 by comparison with the current Form C-63.

Forms C-63 and C-63A must be submitted by the prime for each applicable subcontractor for each month in which participation occurs and verification is available on federal aid projects. On state funded projects, the prime must submit Forms C-63 and C-63A at the end of the project. Verification is to be made from Form C-63A or copies of canceled checks with appropriate identifying notations.

If substitute or additional DBE/MBE firms are to be used, their certification status is to be checked to assure it is current at the time their names are submitted. Before such participation can be shown on Form C-63, either a revised Form C-111, including a properly executed Form C-63A (federal) or Form C-61A, including a properly executed Form C-63A (non-federal) must be submitted. This form must show the current status of ALL commitments, not just those to be added.

Project personnel are responsible for completing Schedule "B" for all DBE/MBEs who perform work on a VDOT project and for actively participating in any compliance reviews that may be scheduled.

The final inspection letter must indicate whether or not the Contractor has met the DBE project goal. If the DBE goal has not been achieved, the Contractor is to be advised of possible sanctions and the right of appeal.



The level of effort by the Contractor in meeting or exceeding the DBE requirements or the MBE potential achievements on the contract or their attempts to do so; or, their efforts in soliciting appropriate involvement if no requirement or potential achievement is established, will be a relevant factor in determining the Contractor's performance rating for future prequalification.

## **Section 110.05 Construction Safety and Health Standards**

The Department's policy is to keep informed of Virginia's Safety Code and the Occupational Safety and Health Administration Standards (OSHA), abide by the Codes and Standards, and cooperate fully with the Federal OSHA Inspectors and State Department of Labor and Industry in having the Contractor perform his operations in compliance with said rules and regulations.

NOTE: Virginia's Safety Code can differ in some instances but can be no less stringent than the OSHA Standards.

By having a thorough knowledge of the Safety Rules and Regulations, we will be better equipped to call unsafe practices to the Contractor's attention and perhaps prevent accidents that could cause serious injury or death. This knowledge will also make us better qualified to exercise the authority given the Engineer in Section 105.01 of the Specifications to suspend work on projects, when necessary, due to unsafe practices. Serious violations noted by Department personnel should be called to the Contractor's immediate attention. If the Contractor does not take prompt and proper action, then these violations should be promptly reported through the Construction Manager to the Virginia Department of Labor and Industry so that they can take the necessary action to ensure compliance. The Department's personnel are required to adhere to these same safety standards and regulations. A good rule to follow is "Stay Alert to Stay Alive."

## **Section 110.06 Bulletin Boards and the Posting of Official Notices**

### **Required Notices and Posters**

Highway construction contracts partially or fully financed by Federal-aid provide that certain information be displayed in a conspicuous place on the project so that interested persons may become acquainted with labor regulations. This information is to be displayed on two readily accessible, weatherproof bulletin boards erected within project limits (not inside the Inspector's or Contractor's office) and maintained by the Contractor until completion of the project.

### **Fraud Poster - Form C-58**

On all Federal Interstate, Appalachian, Primary, Urban, and Secondary Projects, Form C-58 is to be posted in at least two places on the project and one location is to be selected where it is most likely to be seen by the Contractor's personnel. This poster is NOT to be placed on the inside of the Inspector's or Contractor's office. The information presented on the "Fraud Poster" is in regard to the "Anti-Kickback" Act and provides spaces at the bottom for the name of persons to whom violations are to be reported.

### **Wage Rates Information Poster - Form C-59 and Wage Rates**

On all Federal-aid projects, the "Wage Rate Information" poster, Form C-59, is to be posted in at least two places on the project with one location being where it is most likely to be seen by the Contractor's personnel. Attached to the bottom of this poster should be a copy of the predetermined minimum wage rates assigned to the project. Additional rates established shall be added to all posters on the project as soon as they have been approved. The name of the State Highway representative is to be shown in space provided on the poster as indicated below:

**CONSTRUCTION MANAGER  
VDOT  
ADDRESS**

In addition, Contractors are required to post the prescribed equal opportunity posters on all Federal-aid projects.

The following equal opportunity posters are to be posted:

- (1) Executive Order No. 11246 as amended by Executive Order 11375 (Form C-60)
- (2) "Equal Opportunity is the Law" - GPO: 1966 0-218-692
- (3) Contractor's and Subcontractors' "Equal Employment Opportunity Policy" statement.

# **MATERIALS**

## SECTION 200 – MATERIALS

### General

It is the responsibility of the Project Inspector to assure that all materials incorporated into the work have been tested and approved or are covered by acceptable certification as applicable. Requirements and procedures for testing and acceptance are as specified in Section 200 of the Specifications and as outlined in the *Manual of Instructions-Materials Division*. Materials Division personnel normally test materials at the source. Also, certain outside agencies test materials at the source for the Department.

The project file should contain test reports or certifications to cover all materials received on the project except those accepted on the basis of "visual inspection." Generally such test reports should have been received within 2 weeks after receipt of the material. Materials occasionally arrive on a project with specific identification that indicates the material has been tested and approved (stamp, seal, etc.); however, close visual inspection indicates that the material, in fact, does not conform to Specifications. When such a situation develops, the following procedure should be followed:

The Inspector refuses or rejects the use of a material.

It should be noted here that the rejection of a material on a visual basis may not always be completely valid; for example, an Inspector may feel that a specification aggregate is either out of gradation specification or contaminated; however, these factors may not be determined without the benefit of a retest. In these situations the Inspector should contact the District Materials Engineer for assistance.

In other instances, however, visual inspection might completely suffice for the rejection of the material since the material is unquestionably altered. A classic example of this would be a broken section of concrete pipe.

The Inspector should then advise the Area Construction Engineer of the situation and the District Materials Engineer should be immediately notified.

The District Materials Engineer will then investigate and provide a retest if necessary, such a retest directed toward proper evaluation of the true character of the material. The Inspector will then properly document the situation by recording the developments in the project diary.

The Inspector should ensure that a Source of Materials Form C-25 has been submitted by the Contractor and forwarded to the District Materials Engineer. The Source of Materials should include all materials to be incorporated into the project. In the event of changed conditions, work orders or substitutions by the Contractor, updated Sources of Materials will be required for any material not previously submitted. The C-25 must clearly show

the specifications/certifications necessary to evaluate materials utilized as part of the work order. Upon return from the Materials Division, the Inspector should post a copy and ensure that the materials received on the project are from the sources and suppliers that have been approved. The Inspector should pay special attention to the testing requirements established by the Materials Division in the right column of Form C-25. The Inspector should refer to Section 200 of the *Manual of Instruction-Materials Division* for minimum acceptance sampling requirements.

The Contractor may request to substitute other material for that specified. The Contractor must submit with such request certain documentary proof in accordance with Section 200.02 of the Specifications. Written approval of the request must be in the project file prior to allowing the use of substitute materials.

## **Inspector Certifications**

Inspectors are required to be certified by the Materials Division in Asphalt Field, Concrete Field, Soils and Aggregate Compaction, Pavement Marking and Nuclear Safety. Certification training can be scheduled through the District Materials Engineer. Once certified, it is the Inspector's responsibility to maintain the required certifications.

## **Minimum Acceptance Sampling Requirements**

Minimum Acceptance Sampling requirements are located in Section 200 of the *Manual of Instructions-Materials Division*. Sampling rates given are the minimum required under ideal conditions. When conditions are otherwise, the number of samples and tests should be established as is necessary to attain the uniformity and level of workmanship intended by the specifications.

The initial testing frequency should be established by the Engineer at a substantially greater frequency than the minimum required, until the Engineer is satisfied that the type of material and the Contractor's equipment and methods can consistently produce a finished product well within the specifications. At this point, the frequency of testing should be gradually reduced until the minimum frequency is reached. If failing tests are noted, the frequency of testing should be increased until the material and workmanship are found to be within the specifications.

## **Density Testing Requirements**

The proper density of soils and aggregate used in the construction of pavement structures is critical to the performance of those structures. Inspectors must ensure conformance with the requirements established in the *Manual of Instructions-Materials Division*.

Specific requirements are found in the following section of the *Manual of Instructions-Materials Division*:

**Embankments** -Section 300 of the *Manual of Instructions-Materials Division*

**Aggregate Base, Subbase and Select Material Courses**-Section 300 of the *Manual of Instructions-Materials Division*

**Aggregate Shoulder Material**-Section 300 of the *Manual of Instructions-Materials Division*

**Backfill for Pipe and Box Culverts**-Section 300 of the *Manual of Instructions-Materials Division*

**Backfill for Abutments, Gravity and Cantilever Retaining Walls**-Section 300 of the *Manual of Instructions-Materials Division*

**Mechanically Stabilized Earth Walls**-Section 300 of the *Manual of Instructions-Materials Division*

**Asphalt Concrete Base Course**-Section 500 of the *Manual of Instructions-Materials Division*

**Asphalt Concrete Intermediate and Surface Courses**-Section 500 of the *Manual of Instructions-Materials Division*

## **Materials Division Intranet/Internet Links**

To access the *Manual of Instructions – Materials Division*, Approved List of Materials, *Virginia Test Methods* or Materials Division forms click on the following link:

[http://www.virginiadot.org/business/resources/Materials/Approved\\_Lists.pdf](http://www.virginiadot.org/business/resources/Materials/Approved_Lists.pdf)

To access the Materials Division Welder Certification Database the following link is provided: <http://insidevdot/C12/Materials/Lists/Tool%20Kit/AllItems.aspx>

# **ROADWAY CONSTRUCTION**

## **SECTION 301 – CLEARING AND GRUBBING**

### **Excavation Areas**

All trees, undergrowth, stumps, etc., except those trees and shrubs designated to remain in place, shall be cleared and grubbed. The choice of equipment is left to the Contractor as long as the equipment will perform the work in a safe and satisfactory manner. However, there may be limitations to this choice of equipment as may be required by contract specifications for noise control or by local ordinances.

In the event of the discovery of prehistoric ruins, Indian or "early settler" sites, burial grounds, relics, fossils, meteorites or other articles of archeological and paleontological interest during the prosecution of the contract, work must be immediately suspended at the site. The Inspector should notify the Construction Manager or Area Construction Engineer who in turn will contact the Environmental Engineer at the Central Office and advise him of the site's location. Preserve the plot until the site has been evaluated. The intention of the Department is to preserve all items of a historical value found during construction.

Private or public property adjacent to the right-of-way, and all natural growth and improvements thereon, must be continually protected from damage by equipment and construction operations. When or where such damage is done by the Contractor's equipment and operation, it shall be his sole responsibility to rebuild, repair, or make good such damage or injury at his expense. The manner in which a Contractor preserves and protects such property should be of his selection as long as it is reasonable and consistent with good construction practice. The Inspector should refrain from directing how this should be accomplished unless it is specifically covered by the plans or Specifications. However, the Inspector should document all efforts to prevent the Contractor from damaging private property.

Trees and shrubs which will not interfere with the use of a highway and its drainage system are often selected to remain in place for their scenic, historical, environmental, or other value. Precautionary measures must be taken to protect selected trees from damage during all phases of construction. Branches of trees extending over the roadbed are to be trimmed to give a clear height of at least 20 feet above the roadway surface.

### **Embankment Areas**

All trees and undergrowth are to be cleared and grubbed as noted on the plans or in the Specifications. In some areas the trees and any existing stumps need not be grubbed out but cut off as close to natural ground as practicable and left in place. This is normally allowed only in areas where the undisturbed stumps will be a minimum depth below the subgrade or side slopes of the embankment as set forth by the Specifications.



## **Disposal of Combustible Materials**

Burning of combustible materials is governed by the laws and regulations of the State. Highway construction is particularly affected by the regulations of the Department of Environmental Quality and the Department of Forestry. For areas in or adjacent to national forests, the regulations of the National Forest Service are also applicable.

Inspectors should ensure that the Contractor does not burn any materials such as rubber tires, asphaltic materials, crankcase oil, impregnated wood, or other rubber or petroleum based materials.

The Contractor shall never be permitted to burn toxic or hazardous materials or containers for such materials.

Open burning permitted does not exempt or excuse the Contractor from the consequences, liability, damages, or injuries which may result from such conduct, nor does it excuse or exempt the Contractor from complying with all applicable laws, ordinances, regulations, and orders of the governmental entities having jurisdiction.

The Contractor should make a reasonable effort to minimize the amount of material that is burned. Such efforts shall include, but are not limited to, the removal of pulpwood, sawlogs, and firewood.

The material to be burned shall consist of brush, stumps and similar land clearing refuse generated at the site and shall not include demolition material or any refuse brought in from other sites.

The burning shall be attended at all times.

## **Disposal of Material Outside the Right-Of-Way**

The Contractor may dispose of all or part of clearing debris or other surplus material outside the right-of-way. This is permitted if the Contractor secures approval from the Engineer and complies with the requirements of Section 106.04. The Contractor must fulfill the terms of his approved plan regardless of property owner's willingness to accept a lesser restoration effort.

## **Disposal of Firewood**

Trees, limbs and other timber having a diameter of 3" and greater will not be burned, buried or otherwise wasted, and shall be disposed of as saw logs, pulpwood, firewood or other usable material or if designated on plans or Right of Way Agreements as reserved by the property owner, and will be cut in specified lengths and piled where designated.

Brush, limbs, and root mat less than 3" in diameter will be utilized to form brush silt barriers. Any material not needed to form silt barriers may then be disposed of or burned as permitted by the specifications and local ordinances.

## **Measurement and Payment**

Payment for clearing and grubbing is based on a lump sum, acre, or unit basis as stated in the contract.

When the lump sum unit of measurement is specified, the actual area need not be recorded unless the construction limits are changed and the area to be cleared and grubbed is altered by more than the limit specified in the contract. Otherwise, enter a Note in the Project Diary which reads as follows: "Clearing and Grubbing was performed in accordance with the plans and is to be paid for on a lump sum basis - 100%."

When the "lump sum" area is altered by more than the limit specified in the contract, the dimensions of the additional areas actually cleared and grubbed are to be measured, the boundaries shown with respect to stationing and centerline, and the area computations shown in the Project Diary.

When payment is on a lump sum basis, the Project Diary should contain an estimate of the actual area cleared or grubbed and payment on the monthly progress estimates will be based on the percent the total area cleared and grubbed to date. When payment is on an acre or unit basis, accurate measurements, and computations for the amount of work performed must be shown in the Project Diary.

## **Inspector's Checklist**

1. Is the clearing and grubbing confined to the construction limits?
2. Are all items that are within 5 feet of the top of the earthwork directly beneath the pavement structure and shoulders being removed?
3. Are trees and other vegetation disposed of properly?

## SECTION 302 – DRAINAGE STRUCTURES

### General

Excavation should be adequate to accommodate the structure to be installed and should provide sufficient working space and room for forms and bracing if required. The trench for a culvert should be prepared according to the applicable Safety Standards.

All lines should be cleaned periodically, especially after a prolonged wet spell. Materials such as silt, gravel, and debris, should not be allowed to accumulate in the pipe to such an extent that the material threatens to halt the flow of water. Silt and larger material may be removed by the use of drag type equipment. High pressure water may be used only when the necessary precautions have been taken to prevent and control the siltation and erosion of drainage areas.

### Foundation and Bedding

It is essential that the foundation beneath the structure be firm, but not unyielding, and uniform throughout the length of the installation. If the structure is to be placed on two different types of material or entirely on rock, the Project Inspector should have the condition examined to see if special precautions need to be taken.

The *Road and Bridge Standards* governing the installation of pipe culverts and storm sewers specify 4 inches of bedding under all types of pipe on normal earth foundations. Bedding material is specified for several reasons:

1. Provides exploration which could reveal the presence of boulders or rock pinnacles which would otherwise lay undetected immediately beneath the pipe.
2. The use of a granular backfill material immediately beneath the pipe serves to block the intrusion of silty clay or other small particles which would be carried into the pipe at the joints.
3. The bedding material assists in maintaining uniform support for the pipe throughout its length.
4. The use of selected bedding material facilitates the proper shaping of the foundation.

The *Road and Bridge Standards* require the removal of rock or unyielding material beneath the pipe for a minimum of 1/2-inch per foot of fill height. In order to determine if this criteria is satisfied, it is necessary to probe or determine the profile of the unyielding material, boulders or rock pinnacles. It is the Contractor's responsibility to do this on all sizes of pipe; except for routine entrance or crossover pipe involving 12 through 30 inch diameter pipe unless the fill height exceeds 15 feet.

Local material is to be used for replacement of unsuitable or unyielding material, unless suitable local material absolutely is not available or accessible. Acceptable local materials include coarse sand, sandy loam, and sandy gravels. Materials which contain a high percentage of fines such as clay and silt soils are unacceptable because of the poor supporting capacity in wet environments. The Project Inspector should refer any doubts about the acceptability of local bedding material to the Area Construction Engineer.

The 4-inch layer of bedding material may be eliminated or reduced in depth under entrance pipe as directed by the Engineer, depending upon the type of material encountered. However, bedding will be used as shown on the standard drawings under all entrance pipe situated in live streams or where the foundation material is weak or unyielding.

On all cross drainage culverts in which the foundation must be undercut to remove unsuitable or unyielding material, local material is to be used to backfill up to within approximately 8 inches of the bottom of the pipe, provided the material is such that its supporting capacity will not be appreciably reduced when it becomes wet and providing the material is free from unyielding material larger than 4 inches.

It is important that the foundation bedding be properly shaped before the pipe is placed.

## **Pipe Installation**

Many different procedures are used to establish the grade in the bottom of the trench. When checking the flow line grade, be sure to hold the grade rod in a vertical position. All pipes should be inspected prior to backfilling the trench.

The joints of all rigid pipe must be sealed in accordance with the Section 302 of the Specifications. Check all lines over 36 inches in diameter after backfilling. Joints that have become unsealed should be resealed with approved materials from the inside.

Corrugated metal pipe culverts should normally be laid with separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides.

## **Backfill**

Backfilling should be accomplished in accordance with the *Road and Bridge Standards*. The pipe should be uniformly backfilled and compacted on both sides in order to avoid a buildup of the load on the pipe as the fill settles and also to minimize the settlement of the pavement directly over the pipe. An adequate number of compaction tests are to be performed at pipe and box culverts to properly evaluate the density obtained in those areas.

## **Method of Measurement**

The Inspector's diary entries for pipe installation should include the length of each joint, number of joints and location of line with respect to stationing. When partial sections of pipe are used to make a closure, each partial section is to be measured along the flow line to the nearest tenth (1/10) of a linear foot.

Payment for pipe culverts will be based on the actual length used and will include backfill material as indicated in the *Road and Bridge Standards*.

## **Inspector's Checklist for Pipe**

1. Is the trench excavated to the required depth?
2. Did the Contractor explore the foundation?
3. Is the pipe obtained from the source indicated on the approved Form C-25 Source of Materials and does it have the required stamp or certifications?
4. Was the pipe unloaded, stored, and moved in such a way that it was not damaged?
5. Is the pipe of the correct gage or strength?
6. Is the culvert placed so as to best meet field conditions and is the pipe long enough?
7. Are the proper invert and outfall elevations established?
8. Is the Contractor shaping the pipe bedding properly?
9. Is the pipe installed with tight joints and properly installed joint material?
10. Is the Contractor backfilling the trench using four inch compacted lifts?
11. Does the density of each lift meet the minimum requirements?
12. Is the pipe protected against heavy construction loads?

## **Box Culverts**

Concrete box culverts are to be constructed in accordance with the plans, Standard Drawings, Section 404 and other applicable sections of the Specifications.

**Location of Structure:**

The Inspector should check on location as to stationing, barrel length compared to roadway cross section, skew and flow lines and check survey stake-out in accordance with current survey manual.

Invert elevations in relation to finished streambed should also be verified.

**Excavation and Foundation Exploration**

Secure the data necessary to compute minor structure excavation quantities.

The Contractor and Inspector should explore the adequacy of the sub-foundation in accordance with Section 401. Foundation material should be uniform for the entire length of the structure. Where unsuitable materials, rock or combinations of rock and soil are encountered, special treatment may be needed. In these instances, notify the Area Construction Engineer.

Minor structure excavation will be measured and computed in accordance with Section 303 of the Specifications.

The Inspector should check Contractor's plan for bypass of drainage water.

**Forming**

Form dimensions must be checked to ensure dimensions are in accordance with the plans or Standard Drawings. Forms must be well built, with tight joints and smooth surfaces.

Forms must be oiled or wetted before use.

**Reinforcing Steel**

Certain box culvert reinforcing bars (such as: J, J-1, K and L bars) are designated on the Standard Plans for the BC series to be placed alternately. In general, the sets of each of these bars have the same spacing. In a few instances the design does not permit making these spacings the same. For all cases, the Typical Section shows these bars as alternating with each other. Where spacings differ and it is obviously not possible to obtain true alternation, it is intended that the independent spacings be adhered to and adjusted only to the extent that clearances between any two adjacent bars will be 1 1/2 times the specified maximum size of coarse aggregate, but not less than 1 1/2 inches in order to provide for proper placement of the concrete.

## **Mixing and Placing Concrete**

Concrete must be accurately batched and delivered in accordance with the applicable Specifications.

Required finishing tools must be on hand.

Reinforcing steel must be secured in proper position before concrete placement.

Be sure all spacers are removed and accounted for.

Finish concrete to neatlines. Prohibit the use of free water during finishing of concrete.

Provide the proper curing environment for fresh concrete.

Oversee the making of test cylinders if the Contractor plans early form removal or to backfill the culvert before the prescribed time has elapsed.

If curing compound is used, be sure it is thoroughly mixed and properly applied. Curing compound must not be used on surfaces that are to be abutted with additional concrete.

## **Removal of Forms**

### **Box Culvert Header Forms Removal**

It will be satisfactory to permit the removal of the header form in box culvert construction and the placement of concrete in the adjoining sections after a delay of not less than 12 hours (measured from the end of the concreting operation to the beginning of the removal of the header form), provided a sectional type header form is used that will permit its removal without disturbing the reinforcing steel protruding from the previous placement and provided the appropriate precautions are taken to prevent the application of load or force on protruding bars. A work bridge should be used over the protruding bars in floor and top slabs to prevent workers from stepping upon such bars and thereby causing injury to the “green” concrete in which the bars are embedded.

In the event the protruding bars cannot be properly protected, the header form shall remain in place not less than two days or until the concrete has attained at least 30 percent of the design compressive strength.

The Contractor may remove forms by curing time requirements or cylinder break requirements.

Require tie-bar holes and minor honeycomb to be patched as soon as possible after form removal.

## **Backfilling**

Use suitable material at proper moisture content.

Place in layers conforming to the Specification requirements.

Compact each layer thoroughly.

Backfill both sides of culvert or arch at same time.

Run compaction tests on every third lift at random locations or more often as practicable.

## **Records**

Concrete and reinforcing steel is normally paid for by plan quantities in accordance with Section 109. Accurate records of concrete, reinforcing steel, etc, placed, should be kept in the event the Contractor disputes the plan quantities.

## **Inspector's Checklist for Box Culverts**

1. Is the Contractor's mix design approved?
2. Is the Contractor prepared to furnish the concrete at an adequate rate?
3. Is the equipment necessary to perform all tests and to make test cylinders at the site?
4. Are all the test results and other information entered on the Forms TL-28?
5. Is the Contractor's placing and finishing equipment free from dirt and accumulations of hardened concrete?
6. Do the mixing, delivery and placement times conform to Specification requirements?
7. Are the form dimensions correct and is the bracing adequate?
8. Are the forms clean? All sawdust, dirt and other foreign material including ponded water must be removed.
9. Are the forms oiled or thoroughly wetted?
10. Do forms for exposed surfaces have an approved liner?
11. Do the metal ties or anchorages within the forms conform to the Specifications?
12. Do the dimensions and location of all chamfer strips agree with the plans?



13. Are all keyways formed correctly?
14. Are all embedded fixtures such as pipe sleeves, conduits and weep holes positioned correctly and attached to prevent movement when concrete is placed?
15. Does the condition and position of the reinforcing steel conform to the specifications?
16. Is the joint filler material of proper type and correctly positioned?
17. Are pile heads clean and properly prepared?
18. Are foundation and form elevations correct?
19. Are water stops installed properly?
20. Has contractor stakeout been checked and does this match current grade and stream bed elevations for correct length of box culvert and wing height?
21. If box culvert is to be stage constructed, has reinforcing steel been checked for correct lap length?

## **SECTION 303 - EXCAVATION AND EARTHWORK**

### **Description**

One of the most critical stages of roadway construction is the foundation on which the roadway is to be constructed. The use of proper suitable material cannot be over emphasized. The use of proper erosion control measures is important during the earthwork phase of roadway construction.

### **Erosion and Siltation Control**

Prior to performing land disturbing operations the proper erosion and siltation control measures need to be taken. The Inspector must first verify that the Contractor has been qualified by the Department of Conservation and Recreation (DCR). This DCR certified person must be on the job site during all land disturbing activities.

Erosion and siltation control devices are to be installed in accordance with the plans, Specifications and the Department of Conservation and Recreation Erosion and Sedimentation Control Handbook.

The Inspector must ensure that the Contractor maintains erosion and siltation control devices during the life of the project. The entire project is to be inspected for deficiencies after each rainfall and at least daily during periods of prolonged rainfall. Corrective actions are to be taken immediately. They should also be checked daily to see if they are properly located for effectiveness.

Sediments are to be removed when the wet storage capacity has reached 50 percent.

Geotextile fabric that has decomposed or becomes ineffective but is still needed shall be replaced. Temporary erosion and sediment control devices shall be removed within 30 days after final site stabilization.

### **Earth Berms and Slope Drains**

The top of temporary earth berms are to be shaped to allow runoff of rainwater and constructed and compacted along the top edges of embankment to intercept runoff rainwater. Temporary slopes drains are used to intercept runoff and shall be securely fastened when installed. Slope drains must be capable of being shortened or lengthened.

### **Incremental Seeding**

Cut and fill slopes shall be shaped as required and seeded as the work progresses. Seed and mulch shall be applied as specified in Section 603 in the following sequence:

1. Slopes with a vertical height of 20 feet or more shall be seeded in 3 equal increments. Slopes with a vertical height of more than 75 feet shall be seeded in 25-foot increments.
2. Slopes with a vertical height of less than 20 feet but more than 5 feet shall be seeded in 2 equal increments.
3. Slopes with a vertical height of 5 feet or less may be seeded in one operation.

Seeding operations are to begin within 48 hours of achieving the appropriate grade or when grading operations are not to resume for more than 15 days.

### **Check Dams**

Check dams must be installed at 25-foot intervals below the outfall end of drainage structures, unless otherwise indicated on the plans.

Straw check dams are not to be installed in streams and shall only be installed where shown on the plans to create settlement pools. Settlement pools are to be cleaned regularly as needed. Removed material should be deposited in a location where it will not re-enter the stream or drainage way.

### **Baled Straw Silt Barriers**

Baled straw silt barriers may be used instead of temporary filter barriers with the approval of the Engineer in non-critical areas.

### **Temporary Silt Fences, Geotextile Fabric Silt Fences, and Filter Barriers**

**Temporary Silt Fences:** Fences shall be installed as shown on the plans and as directed by the Engineer. Fabric shall be extra strength and posts shall be spaced not more than 6 feet apart. Posts shall be inclined toward the silt load area at least 2 degrees but not more than 20 degrees. Fabric shall be firmly secured to the posts. Fabric shall be entrenched into the ground at least 4 inches. Fabric may be spliced only at posts and with an overlap of at least 6 inches. The top of fabric shall be installed with a 1 inch tuck or reinforced top section. The height of the silt fence shall be 36 inches.

**Geotextile Fabric Silt Barriers:** Existing fences or brush barriers used along the downhill side of toes of slope or below pipe culverts shall have standard strength geotextile fabric attached at locations shown on the plans. The fabric shall be entrenched at least 4 inches and the top shall have a 1 inch tuck or be reinforced.

Brush barriers are installed prior to major earth disturbing operations and must be trimmed so as not to puncture fabric. Fabric is to be installed to the brush barrier and horizontal and vertical splices shall have a 6 inch overlap.

**Temporary Filter Barriers:** Barriers consist of standard strength fabric or 10 ounce burlap and are secured to posts spaced not more than 3 feet apart and driven at least 12 inches into the ground. At least 3 supports shall be used. The fabric shall be entrenched at least 4 inches and the top shall have a 1 inch tuck or be reinforced. The height shall be at least 15 inches but not more than 18 inches.

## Definitions of Terms

**Regular Excavation** - Removal of all materials as necessary within the construction limits as defined below.

1. Cut Sections

All material down to a point one foot below either the elevation of the top of earthwork or the elevation of unsuitable material shown on the plans.

2. Fill Sections

(a) Fill height less than 5 feet - All material down to a point one foot below (1) the bottom of rootmat or topsoil, (2) unsuitable material shown on plans or (3) original ground if no topsoil or root mat is present and no unsuitable material is shown on plans.

(b) Fill height greater than 5 feet - All material down to a point one foot below either the original ground or the elevation of unsuitable material as shown on the plans.

**Undercut Excavation** - The removal of unsuitable material below the regular excavation limits as defined above, or below the limits of normal excavation for minor structures less than 48" span.

**Unsuitable Material** - Material deemed to be unfit for incorporation into the work due to poor bearing capacity, excessive moisture, or other reasons. Unsuitable material may be designated on the plans or encountered during construction. Removal of unsuitable material is to be measured as regular excavation or undercut as defined above or as minor structure excavation.

**Borrow Excavation** - Suitable material from sources outside the project typical sections used primarily for embankments. Borrow is generally measured at the source by cross sections.

**Select Borrow** - Borrow material having specified physical characteristics such as specified CBR values.

**Embankment** - A structure of soil, broken rock, or soil aggregate between the embankment foundation and the subgrade, commonly referred to as "fill."

**Minor Structure Excavation** - The removal of material below original ground level for the purpose of placing or constructing a culvert, drop inlet or other minor structure.

**Special Minor Structure Excavation** - Minor structure excavation specified as such on the plans and contract for separate payment because of unusual conditions which may require special equipment or procedures.

### **Regular Excavation**

Regular excavation normally includes all materials encountered regardless of their nature or the manner in which they must be removed. The Inspector should ascertain from the plans which quantities are designated “plan quantities” and which quantities require measurement.

Generally all excavation which conforms to the project typical sections will be included in the “plan quantities.” Topsoil stripped from cut areas is generally included in the plan quantities. Removal of unsuitable material, not shown on plans, stripping of topsoil and rootmat in fill sections, and excavation of side ditches will usually require measurement (Inspector should compute the quantity removed by the average-end-area method). Such measurements and computations for all measured excavation must be included in the project records.

The rounding of the top of the cut slope is customarily shown on the plans. Although the radius of this curve is specified, the curve may be modified to meet local conditions and benefit the control of erosion. The radius of rounding throughout the length of the cut slope may also be modified to advantage by using a longer radius as the height of the cut decreases.

### **Borrow Excavation and Select Borrow**

Borrow must be obtained from approved sources and should not be placed until authorized by the Engineer. The suitability of the material source must be approved by the Materials Division. Generally, the amount of borrow is measured in its original position. Survey cross-sections at the source before and after the operations should be taken and the quantity of material computed from these measurements.

### **Undercut Excavation**

Undercut excavation, when not a bid item but authorized by the Engineer, will be paid for at twice the unit price per cubic yard for regular excavation.

In certain instances a bid item for undercut excavation will be included in the contract. Whenever this occurs, all undercut excavation encountered, irrespective of whether or not

such material is shown on the plans, will be paid for at the unit price bid for undercut excavation, NOT at twice the unit price for regular excavation.

### **Minor Structure Excavation**

Excavation for culverts having spans or openings of less than 48 inches will be included in the cost of the culvert therefore no measurement will be made. However, excavation of rock or unsuitable material which falls below the lower theoretical slab or culvert thickness or below the normal foundation excavation plane, whichever is the greater depth, will be measured and paid for as undercut excavation according to Section 303 Measurement and Payment.

Excavation for culverts having spans of 48" or greater and excavation for minor structures is measured for payment as minor structure excavation. The limits of payment are vertical planes up to 18" outside the neat lines of the culvert, the original groundline or regular excavation payline, whichever is lower and the lower excavation limit for normal earth foundations or the bottom of the lower theoretical slab, whichever is the lower. If unsuitable material is encountered below the normal excavation limits then its removal, as necessary, is to be paid for as minor structure excavation and so noted.

Excavation for wingwalls, end walls, and end sections for pipe and box culverts of 48" or larger diameter will not be measured. Payment for such excavation will be based on the ratio of the plan area of all wingwalls, end walls, or end sections to the plan area of the culvert barrel. The width of the barrel will be the normal span or opening of the pipe or box culvert, and the length of the barrel will be from out to out of the culvert. The wall thickness and the 18" outside of the neatlines of the culvert will not be included in computing the ratio shown on the plans.

The excavation quantity for the barrel section (measured from out to out of the culvert and including wall thickness and the 18" outside the two major plan view dimensions or the width in accordance with Standard PB-1 from the neatline of the barrel) is to be increased by the ratio shown on the plans to give the total cubic yards of minor structure excavation.

When the length of the culvert barrel changes by 10 percent or more from the plan length, the Inspector is to re-compute the ratio to the nearest whole percent and show the calculations in the project records with the appropriate culvert.

### **Removal of Unsuitable Materials**

Unsuitable material may be encountered either above or below the finished grade line. All unsuitable material must be removed and disposed of legally. Sometimes material which is designated as unsuitable on the plans is found to be suitable during construction because the moisture content may have changed since the material was initially tested. If it is above the normal grade line, then such material should be used in embankments in lieu of borrow. If such material is below the normal grade line but designated to be

removed, then it should be left and the Inspector should immediately notify the Area Construction Engineer and request an on site review of the material.

The method of measurement and payment for removal of unsuitable material will depend upon where it is encountered and whether it is designated on the plans as unsuitable material.

## **Embankments**

### **Earth Embankments**

Prior to the construction of an embankment, the area that will serve as its foundation should be carefully inspected. All areas of questionable supporting capacity should be given special attention. The presence of soft or very wet conditions may suggest the need for removal of certain unsuitable materials, installation of underdrain facilities to remove spring or seepage water, or merely the need for aeration to dry the material. Conditions of this type should always be called to the attention of the Construction Manager.

Embankments to be placed over swampy areas, composed of materials which will not support the weight of the hauling equipment, may be constructed by end-dumping successive loads in a uniformly distributed layer and of a thickness capable of supporting the hauling equipment while placing subsequent layers. The use of compacting equipment will not be required on this initial layer; however, the remainder of the embankment is to be constructed in layers and compacted in accordance with the Specifications. The initial layer should have an adequate thickness to develop a working platform or mat. If the initial layer is too thin, water will seep upward into the compacted layers through shear cracks in the mat.

In constructing embankments on slopes steeper than 4:1, particular attention should be given to obtaining a good interlock between the sloping foundation and the new embankment. All vegetation should be removed to prevent the formation of slippage planes. Proper interlock between the surfaces can usually be provided by “benching” the existing slope.

When embankments are placed over an existing roadway, the surface should be scarified to such a degree that ample bond will be assured between the existing surface and the embankment. When the existing surface is bituminous concrete or hydraulic cement concrete, Section 510 of the Specifications will also govern.

### **Hauling, Spreading and Shaping:**

Prior to beginning the construction of an embankment, the limits of construction should be clearly outlined by construction stakes. The Inspector should check a sufficient number of stakes placed either by the Contractor or the Department’s survey party to be reasonably sure of their accuracy. The use of this system of checks will reduce the

chances for error in embankment widths and heights. Corrective measures are difficult and costly.

Washes, holes and other low areas in the embankment foundations should be filled and compacted prior to beginning the construction of the first lift of embankment. The first lift should begin in the low areas with the intent of eventually providing an embankment layer approximately parallel to the finished grade. As the earth materials are being dumped and spread, large roots, and other objectionable materials must be removed, unless they are outside the areas beneath the roadbed.

The selection of the equipment used to haul excavation is left to the Contractor's option; however, it must conform to the requirements of Section 105.14. Material may be spread with the hauling equipment or it may be spread by the use of blade graders, bulldozers or other equipment.

Hauling over fills should not be confined to the same path or track but should be spread out over the entire width of the embankment to avoid ruts and to insure uniform compaction.

Localized "soft spots" will ruin the ability of the fill to support a roadway. Loaded equipment will often indicate these "soft spots" in compacted layers. The Inspector should watch the material under the tires of the loaded equipment. If the material "pumps" when the equipment passes over it, that particular spot should be investigated and if necessary scarified and recompactd or removed and replaced.

At the end of each working day, the surface of the embankment should be graded to allow runoff of rain water. Then, if a shower occurs during the night or the following morning, water will not be trapped on top of the fill. The fill will dry out quickly, enabling the Contractor to resume his operations. However, the Project Inspector is reminded of the provisions of Section 107.14, wherein the Contractor is required to take special precautions to prevent the siltation of our water resources (rivers, streams, and impoundments).

#### **Layer Thickness:**

The Specifications restrict the depth of soil which can be placed in a single layer in an effort to ensure adequate and uniform compaction throughout each layer.

#### **Moisture Content:**

Every soil has a particular moisture content, known as optimum moisture, at which that soil can be compacted to its maximum density. Therefore, the success of compaction operations is dependent to a large extent on proper moisture control. If the proper amount of moisture is uniformly distributed throughout the embankment layer, rarely will there be any difficulty in obtaining satisfactory compaction.



### **Earth Embankment Compaction:**

In-place density tests for checking compaction should be made using the specified equipment and procedures outlined in the *Manual of Instructions - Materials Division*.

## **Rock Embankments**

### **Placing:**

The construction methods for placing rock embankments will depend upon the size of the boulders or stone and the quantities involved. Ordinarily, rock embankments are constructed in layers extending over the full width of the roadway, with the layer thickness conforming to the requirements of the applicable Specifications. By exercising skill in handling, the coarse and fine materials can usually be distributed so that voids between the larger pieces will be filled with small pieces and earth to make the embankments as dense as possible.

When material is placed in the fill by the end-dumping method, each load should be dumped on top of the previous layer and pushed into place. Allowing material to roll into place by dumping over the edge of completed work shall not be permitted. Oversize pieces of rock, not suitable for placement in a given layer should be reduced to proper dimensions or moved to a portion of the fill where large rock can be satisfactorily used.

### **Compaction:**

When rock is present in the embankment material in considerable proportions, moisture control procedures are of little benefit and density tests for checking compaction are not considered feasible. When it is not possible to properly perform meaningful tests due to high rock content, this fact is to be noted on the appropriate report of field densities.

## **Hydraulic Embankment**

There will be occasions where it may be desirable to obtain embankment material from sources under or adjacent to water. When the material selected for embankment use is beyond the reach of dragline equipment and located below the water table (river, swamp, or lake bed), excavation and movement of the material can be done efficiently by hydraulic dredging. Even if the material is not covered by water but is adjacent to it, dredging equipment may prove very competitive with other types of excavation equipment. The dredge pump draws water and suspended material through a pipe line to the point of discharge. Some materials can be excavated by suction alone, but the tougher, more cohesive materials require agitation or cutting to loosen and stir them prior to pickup by the suction intake.

Frequently, the embankment foundation area contains an overburden of muck or unsuitable material which must be removed prior to placement of the excavated material. If job site conditions permit, this may be handled by the same equipment that will be used

to excavate and place the embankment material. Suitable disposal areas must be provided for all unsuitable material removed from the embankment and borrow source areas.

Selection of material from within the area to be excavated must be given the same careful attention as if it were from a surface borrow source. All unsuitable material should be removed from the proposed work area before the embankment material is excavated. During production, the material being discharged on the embankment area should be observed for contamination by abnormal amounts of unsuitable material. Material such as clay balls in sand, has a tendency to settle out in the vicinity of the discharge and form a pocket of undesirable material which can produce instability. Such material should be removed prior to the completion of the work.

The embankment material is usually pumped through the pipe system directly to the embankment site where it is shaped and compacted by a bulldozer or other suitable equipment. The applicable Specifications will describe the manner of spreading, manipulating, and compacting the material.

The Inspector should not permit a hydraulic fill to be placed over a portion of fill already placed by conventional methods. The hydraulic fill material may over saturate the existing material necessitating removal and replacement of the entire fill.

The yardage of borrow material placed by the hydraulic method is determined from cross sections of the material in its final position.

## **Disposal of Surplus Materials**

It may be determined during the grading of a project that the required excavation will yield more suitable material than can be placed in the embankment. Generally, embankment construction should be completed before any suitable material is wasted. In any event, calculations should always be made to ensure that the remaining excavation is sufficient to complete the embankments prior to wasting material. Material should not be wasted until authorized in writing by the Engineer or his authorized representative. Usually, surplus material can be used to flatten slopes or fill medians to provide for greater safety.

## **Tolerances**

Finished grade of subgrade shall be within 1/10<sup>th</sup> foot of the theoretical grade.

Slopes shall not deviate from the theoretical grade by more than 0.5 foot.

## **Inspector's Checklist**

1. Does the Contractor have a person who has a current Department of Conservation and Recreation Erosion and Sediment Control Contractor certification on the project while installing Erosion and Siltation Control Devices and conducting land disturbance operations?
2. Are all Erosion and Siltation Control devices being installed or constructed as required?
3. Are Erosion and Siltation Control devices being maintained as required?
4. Is the Contractor stripping topsoil only over an area that is to be actively worked within 15 days?
5. Is incremental seeding being performed as specified?
6. Is the roadway being graded in such a manner as to provide proper drainage?
7. Are grading operations limited to only the area necessary to perform the work?
8. Is excavation for structures accomplished to suitable foundation?
9. If unsuitable material shown on the plans was found to be suitable, is it being used in embankments instead of borrow?
10. Is backfill material being placed in layers not more than 6 inches, loose, and compacted?
11. Is embankment material being placed on both sides of structures simultaneously?
12. Is surplus material being used to flatten slopes if possible?
13. Are existing slopes being benched to receive embankment material?
14. Is embankment material being rolled to the outside of the fill and compacted at + / - 20 percent of optimum moisture content and compacted to 95 percent of theoretical maximum density?
15. Is the finished grade of the top of the earthwork and slopes being constructed within the specified tolerances?

## **SECTION 304 – CONSTRUCTING DENSITY CONTROL STRIPS**

### **General**

Density Control Strips are sections of a pavement structure that are used to determine the target density required for that particular course of the structure. Materials used to construct the control strips must be from the same source and of the same type as those to be used in constructing the remainder of the course. Compaction equipment must be of sufficient size and weight to obtain uniform density throughout the depth of the layer being compacted.

One control strip shall be constructed at the beginning of each roadway and shoulder course and for each lift in each course. Additional control strips will be required if there is a change in the source of the material being used or if there is a significant change in the composition of the material from the same source. The Inspector should divide the project into control strips and tests sections to define areas represented by each series of tests. Specific requirements for the size of control strips and test sections can be found in Virginia Tests Methods–010. (<http://virginiadot.org/business/materials-download-docs.asp>) This website also has the necessary forms to be used to record the information and determine the Control Strip Density.

Control strips must be constructed using the same methods to be used for the remainder of the course. Rolling of the control strip must continue until no appreciable increase in density is obtained by additional passes of the roller.

Upon completion of the rolling, the average density of the control strip will be determined by ten tests taken randomly within the control strip using a nuclear density gauge.

Each control strip shall remain in place and become a section of the completed roadway.

### **Tolerances**

If the average density of a test section does not conform to the requirements below, the entire test section must be re-compacted or re-worked until the required density is obtained. If an individual test within the test section does not conform to the requirements, the entire area represented by that test must be re-compacted or re-worked until the required density is obtained.

### **Roadways**

The density for each test section is evaluated based on five tests performed at random sites within the test section. The average density for each test section must be at least 98

percent of the average density obtained in the control strip. Each individual test within a test section must be at least 95 percent of the average density obtained in the control strip.

### **Aggregate Shoulders**

The density for each test section is evaluated based on five tests performed at random sites within the test section. The average density for each test section must be 95 +/- 2 percent of the average density obtained in the control strip. Each individual test within the test section must be 95 +/- 5 percent of the density obtained in the control strip.

### **Asphalt Shoulders**

The density for each test section is evaluated based on five tests performed at random sites within the test section. The average density for each test section must be at least 98 percent of the average density obtained in the control strip. Each individual test within the test section must be at least 95 percent of the density obtained in the control strip.

## SECTION 305 – SUBGRADE AND SHOULDERS

### Shaping and Compacting the Subgrade

The subgrade is the earth surface upon which the pavement structure or shoulder is constructed. It is most important that the subgrade be constructed of the best available materials with particular emphasis being placed on the subgrade in fill sections. The Inspector should see that satisfactory materials are placed during all stages of the grading operation. Any soft, unstable, or unsuitable material encountered in cuts or fills is to be removed and replaced with satisfactory material. Measurement of unsuitable material removed in subgrade preparation should be accomplished by taking measurements before the excavation is backfilled.

The method and rate of testing shoulder materials are specified in the *Manual of Instructions - Materials Division*.

Standard Shoulder Design and Slope - Most of the shoulder slopes in the *Book of Standards* are self-explanatory. The term “7 percent algebraic differences” (7% Alg. Diff.) may be more easily understood by the following example:

Find the difference in elevation between the left edge of pavement (LEP) and the right edge of pavement (REP). This can be determined from the plans or from actual field measurements and computations.

(LEP) 310.08'  
(REP) 309.12'  
Difference 0.96'

Divide this difference by the width of pavement (24') to determine the rate of superelevation.

$\frac{0.96'}{24'} = 0.04 \text{ ft./ft. or } 4\%$

Subtract the rate of pavement superelevation from 7%.

0.07            7%  
-0.04   or   -4%  
0.03            3%

The slope of the shoulder on the high side (LEP) should be 0.03 ft./ft. (sloping downward 3 hundredths of a foot per foot of width).

Shoulders should have a pleasing appearance to the eye. Sometimes, these precise standards will require minor adjustment to maintain a pleasing appearance. Major

adjustments indicate an error. Do not make major adjustments without checking the grades and calculations.

## **Finishing Subgrade**

At times, a small amount of additional material must be added so that the surface can be graded to plan elevation. The existing surface should be scarified before any additional material is placed. This prevents planing and slippage between the two layers. The subgrade should be recompacted according to the requirements of the Specifications.

After the subgrade preparation has been completed, it should be thoroughly checked by using a level, string line, crown board, or other means to determine that the subgrade is within Specification tolerance and conforms to the typical cross-section.

## **Shoulders**

Water tends to collect under both asphalt and hydraulic cement concrete pavements, especially at sag points in the vertical grade. Cross drainage through the shoulder must be provided. Care must be taken to avoid contaminating the subbase or base course under the shoulder areas with lime, cement or excessive fines, or to over compact such areas and thus block cross drainage. Occasionally, it will be necessary to install drains at intervals through the shoulders to accommodate the amount of water which collects just beneath the pavement.

### **A. Prime Coat**

A prime coat, if required should be applied on the base shoulder course using the materials and rate of application specified prior to the placement of asphalt concrete. The base should be cleared of all mud, dirt, dust, and caked or loosened material prior to the application of the prime coat.

### **B. Asphalt Surface Treatment**

Asphalt surface treatment work is described in Section 313.

### **C. Asphalt Concrete Shoulder**

Asphalt concrete used for the shoulder surface should be summarized separately in the project records but combined with like items on the project estimate. Keep the same records for this operation that you would keep for any asphalt paving operation. Since the pay item is in tons, the Inspector should assure himself that the material is placed at the proper rate.

## **Method of Payment**

Payment for material placed in shoulders is based on the contract price for the individual items that comprise the shoulder.

## **Inspector's Checklist**

1. Is the subgrade scarified 6 inches deep for a distance of 2 feet beyond the proposed edge of pavement?
2. Is suitable material used?
3. Is the subgrade compacted to 100 percent density?
4. Is the subgrade within plus or minus 20 percent of optimum moisture?
5. Is the aggregate shoulder material compacted within plus or minus 2 percentage points of optimum moisture to the required density?



## **SECTION 306 – LIME STABILIZATION**

### **Description**

Lime Stabilization consists of stabilizing unsuitable roadbed material (clay type soils in particular) by the addition of lime. The amount of lime necessary for stabilization will be determined by laboratory tests of samples of the soil to be treated. The rate of lime to be applied will be specified on the plans or directed by the Engineer. The depth and width of treatment will be designated on the plans.

### **Placement Limitations**

Lime stabilization shall not be permitted when aggregate or the surface on which the course is to be placed is frozen. Manipulation shall not be started until the surface is free from mud and frost and the temperature is at least 40 degrees Fahrenheit.

### **Preparation of Roadbed**

The subgrade should be properly constructed and conditioned before any lime is applied. All soft spots, ruts, and grade deficiencies should be corrected by removing, replacing or regrading. Sufficient drains should be cut through windrowed material on the shoulders at the end of the work day to drain the roadbed.

The prepared roadbed should be scarified to the depth and width required for stabilization as indicated on the plans.

### **Application of Lime**

Lime is usually delivered to the project in self-unloading truck transports. Each truck shipment must have the weight of lime certified on public scales or the weight of lime must be determined on a set of approved scales furnished by the Contractor. It is essential that the weight of lime be known prior to its use.

Lime must be distributed with a reasonable degree of uniformity. Dry lime must not be spread when the wind will cause an excessive loss, or when blowing lime becomes objectionable. In distributing lime, a uniform speed of the vehicle must be maintained and care exercised to secure a small lapping of the longitudinal strips.

Frequent checks on the rate of application must be made. The actual area of spread for each shipment should be compared with the theoretical area of spread as determined from the specified rate. The two areas should not differ appreciably.

When the slurry method of application is used, lime and water are mixed and applied through spray bars from tank trucks equipped with agitating equipment to keep the lime in suspension. The proportion of the lime-water slurry depends upon the required percent of lime, the optimum moisture content of the soil or base material, and the field moisture content in the soil at the time of application.

Care should be exercised to avoid exceeding the optimum moisture content of the soil. Drying back to allowable moisture content can be very slow and time consuming.

Lime should not be spread on more area than can be satisfactorily mixed within the time limit specified. This requirement is necessary to prevent loss of lime to wind or rain. The spreading operation should be well coordinated with the mixing and sealing operations. When the application of lime is extended too far in advance of the other operations, moisture and density control procedures are complicated by the gradual change in physical properties of the lime treated mixture.

## **Mixing**

Generally, the same mixing procedure is used for both the dry method and the slurry method of application. The lime must be mixed with the soil, brought to the proper moisture content, and left to age before the final mixing. While aging, the mixture should be placed in a windrow or spread over the roadbed and the surface sealed with a steel wheel or pneumatic-tire roller. Care should be taken during initial mixing to manipulate lime to the proper depth and width in order that the moist clay lumps will be in contact with the lime during the curing period.

## **Compaction and Finishing**

The compaction and finishing of lime treated material should be governed by the applicable Specifications.

Due to variations in soil conditions, the Inspector should run a proctor test prior to the final compaction tests. A new proctor test should be made when the soil conditions visually change, when the compaction test results vary appreciably or according to instructions by the District Materials Engineer.

Fluffing is usually associated with the lack of curing, particularly during hot weather. The surface should be kept moist during the curing period, but repeated flooding of the surface should be avoided. The loss of stability in the top 1/4" to 3/4" of the lime stabilized course is usually attributed to the removal of lime by repeated flooding or excessive manipulation of the surface.

## **Protection and Curing**

Construction equipment, except for sprinkling equipment, and private vehicles should be prohibited from traveling over the lime stabilized roadbed until completion of the curing period or application of the next course. The Contractor is required to moist cure the lime stabilized roadbed for 7 days after final grading and compaction. During the ensuing curing period, the Contractor may place the next course. However, if the Contractor does not place the next course by the end of the curing period, the Contractor may have to place an asphalt cover material at the application rates specified on the plans at no additional cost to the Department.

## **Method of Measurement**

Lime stabilization is measured and paid for by tons of lime or fly ash, square yards of manipulation and cubic yards or tons of aggregate material.

Sufficient test coverage for the amount of lime used should be included in the project records.

Entries in the diary should include the location of the work, the number of square yards processed, the amount of lime received and used, instructions given to the Contractor, and any unusual conditions or items of interest.

## **Inspector's Checklist**

1. Is the surface free of mud and frost, and the temperature at least 40 degree F prior to starting manipulation?
2. Is the roadbed scarified to the proper depth and width?
3. Is the application rate as shown on the plans?
4. Is the equipment used applying the lime at a uniform rate?
5. Is the lime and water properly mixed and the surface sealed by rollers?
6. Is the material compacted to the required density?
7. Is the material protected and properly cured?

## **SECTION 307 - HYDRAULIC CEMENT STABILIZATION**

### **Description**

Certain types of soil may be strengthened by the addition of cement. The increase in strength makes it possible to substitute this mixture for granular subbases and bases. This form of stabilization is commonly known as "soil cement."

The cement may be added to existing material in place. This is usually done using a self-propelled or self-powered machine. The material in place is scarified, cement and water added, and then mixed by the same machine in one pass. Other machines may be utilized that require a separate pass for each operation.

If the central plant method of adding cement is used, the material is mixed with the cement in a pugmill, then the blended material is hauled to the roadway. This method is used when cement is mixed with granular subbase or base material.

The Superintendent and the Project Inspector should discuss the construction procedure prior to starting the actual operation. This discussion should include methods for controlling traffic, the method of pulverizing the soil, distributing water, mixing, shaping, compacting, and curing the layer.

The Inspector is to inspect all equipment the Contractor intends to employ in his operation. Equipment should be in proper working order before the Contractor begins.

### **Weather Limitations**

Hydraulic Cement stabilization is not permitted when the aggregate or surface on which it is to be placed is frozen. Manipulation operations will not be started until the air temperature is 40 degrees Fahrenheit in the shade and rising. When the material may be exposed to freezing temperatures within 24 hours of curing, the Contractor shall protect the stabilized material from freezing for 7 days or place the next course within 4 hours of completion of the operation.

### **Materials**

Cement must conform to the requirements of Section 214 of the Specifications.

Water should be free from substances deleterious to the hardening of soil cement. Only water conforming to the requirements of Section 216 of the Specifications is to be used. Water approved for drinking may be accepted without further test.

## **Preparation of Existing Surface**

The Contractor is not required to compact the roadbed to the required density until after it is stabilized. Prior to the application of cement, the roadbed is to be graded to the approximate lines of the cross sections. Any low, soft, or yielding areas are to be corrected. The surface is to be firm enough to support the construction equipment and in condition that the required compaction can be obtained.

## **Application**

### **1. Mixed in Place Method**

The cement is to be placed on the soil in such quantities that the specified cement content for the layer is obtained when mixing has been completed. The amount of cement required per square yard should be computed and the actual rate being applied should be checked continuously. The most accurate method of calculating the rate of application is by comparing the desired area of spread with the actual area of spread.

Immediately after the soil and cement have been mixed, water is to be added and mixed sufficiently to bring the soil to optimum moisture content. Sufficient equipment should be available to complete the wetting and mixing of the layer within the time specified. If more than one pass of the mixer is required, at least one pass should be made before water is added.

Tests should be continuously taken on the wetted mixture to insure that the desired moisture is incorporated into the mixture. Soil-cement that has the proper moisture content will make a firm cast when squeezed in the hand. If the cast falls apart, more water is needed. If there is excess moisture, it will show up on the palm of your hand. After all mixing water has been applied, mixing must continue until a uniform mixture of soil, cement, and water has been obtained.

### **2. Central Plant Method**

The most common type of central mixer is the pugmill, consisting of revolving blades or paddles on a shaft. There may be one or two shafts in the mixer, depending on its capacity. The mixer is charged from the top and discharged through the bottom in batch mixing, and charged at one end and discharged at the other in continuous mixing. The proportioning of material is controlled by batch weights or volumes in batch mixing and by adjustable gate openings in continuous mixing.

Not more than 60 minutes shall elapse from the time mixing starts until the start of compaction.

## **Compacting and Finishing**

During and after compaction, the surface of the layer is to be shaped to required lines, grade and cross sections. All roller imprints and other marks made by equipment are to be removed. The moisture content of the material must be maintained at optimum during finishing operations by lightly sprinkling the surface.

## **Construction Joints**

Each day's operation shall tie into the section placed the previous day. This shall be done by re-mixing approximately 2 feet of the previously placed section. An amount of 50 percent of the required cement shall be placed in these sections.

When a completed section remains undisturbed for more than 24 hours, a transverse construction joint shall be cut in the completed section to form an approximately vertical face.

## **Protecting and Curing**

After the treated course has been compacted as specified, it is to be cured and protected in accordance with the Specifications. Various interpretations have been given to this Section of the Specifications; however, the intent is that during the first 7 days after the stabilization is placed, the Contractor has the option of curing by application of any of the following:

- (1) The next course
- (2) Moisture
- (3) Asphalt Cover material
- (4) Other approved cover material

The next course must be in place or asphalt cover material applied on or before the eighth day.

The most desirable method of curing is by application of the next course immediately after depth and density have been approved. This eliminates the necessity for moist curing and asphalt cover material.

In the event the next course is placed within 7 days after stabilization, the asphalt material specified on the plans for curing is to be eliminated from the Contract. In the event the next course is not placed within 7 days, the liquid asphalt material specified on the plans may need to be applied. Liquid asphalt used for curing will not be measured for separate payment.

## **Method of Measurement**

Entries in the Project Diary must include the location of the work, the amount of cement received and used, the number of square yards stabilized, and any instructions given to the Contractor.

Hydraulic Cement Stabilization is measured and paid for by tons of hydraulic cement, square yards of manipulation and cubic yards or tons of aggregate material.

Sufficient test coverage for the amount of hydraulic cement used should be included in the project records.

## **Inspector's Checklist**

1. Is the roadbed prepared to the required grade?
2. Is cement stabilization performed in accordance with the weather limitations?
3. Does the Contractor protect the stabilized material if freezing is expected during the first 24 hours of curing?
4. Is the roadbed properly scarified prior to placement of the cement?
5. Is the cement uniformly applied at the required application rate?
6. Is optimum moisture maintained?
7. Does compaction start within 60 minutes of the start of mixing at the plant?
8. Is the stabilized material compacted to the required density?
9. Are construction joints installed as required?
10. Is the stabilized section properly protected?

## **SECTION 308 - SUBBASE COURSE**

### **Description**

The subbase course consists of furnishing and placing one or more courses of mineral aggregate on a prepared subgrade. The purpose of the subbase course is:

1. To provide a free draining material.
2. To provide a frost resistant material on which to support other base or surface courses.
3. To prevent pumping of underlying soils.
4. To distribute traffic wheel loads transmitted to the embankment.

The designed thickness and width of the subbase course shown on the plans are dependent upon the geographic location, soil conditions and anticipated traffic.

### **Construction Methods**

The subgrade should be checked in accordance with Section 305 prior to placing of subbase material.

The subbase material must be placed on the roadway by means of an approved mechanical spreader.

If the total depth of material is more than 6 inches, the material is to be placed in 2 or more equal layers and compacted. The maximum depth in any one lift is not to exceed 6 inches unless vibrating or other type of approved compaction equipment is used. In this case, the depth may be increased to 10 inches compacted, if approved by the Area Construction Engineer.

The Inspector should check the grade and the shape of the finished surface. This can be performed in one of several ways.

The string line method is applicable when distances are not so great that the sag of the line is excessive. First, mark the correct grades on stakes situated on the edges of the work. Stretch a string line taut between the stakes and raise the string in the center the same amount that the center of the plan cross section is crowned. The vertical distance between the string and the actual grade will be the same at all points if the cross section is correct.



These checks should be made at the roadway centerline, each travel lane centerline, and edges of pavement, at each Station (every 30 meters for Metric projects). If checks indicate that the surface is out of tolerance, more frequent checks should be made.

## **Method of Measurement**

Material will be paid for on a tonnage or cubic yard basis. The Inspector should ascertain that sufficient weigh tickets and evidence of testing or test reports have been received before making payment. A partial payment of 75% may be made if the material has been placed but not shaped and compacted. When the material is paid for by the ton, the weigh tickets and corresponding TL-102A are to be maintained in the project records.

## **Inspector's Checklist**

1. Is the material placed on subgrade using an aggregate spreader as specified?
2. Is the subbase course compacted at specified moisture?
3. Is the subbase surface scarified, reshaped and re-compacted if the surface became uneven or distorted?
4. If the thickness is deficient, does the Contractor scarify the subbase prior to adding more material?
5. Does the depth of the subbase course meet the tolerances of the plan depth?

## **SECTION 309 - AGGREGATE BASE COURSE**

### **Materials**

Unless specifically waived by special provisions, all base material is to be mixed in a pugmill before being spread on the road. This requirement includes pit material that will conform to the Department's grading requirements in place. Pugmill mixing of material produces a more uniform material.

### **Sampling and Testing**

Sampling and testing of aggregate base material is generally performed at the pugmill. Plant sampling requirements are explained further in the *Manual of Instructions - Materials Division*.

If material remains exposed, it may become contaminated. This includes such contaminants as mud from truck tires. Material thought to be contaminated should be retested. If the retest proves the material to be contaminated, it should be removed and replaced at the Contractor's expense.

### **Construction Methods**

#### **A. Placing**

Prior to placing aggregate material, the course upon which the material is to be placed should be carefully examined. Soft spots, ruts, and grade deficiencies should be corrected by removing, replacing, or regrading material where necessary. The Contractor should direct his hauling activity so that truck traffic is distributed over the entire width of the surface and not concentrated in one area.

The material should be placed according to the requirements of the Specifications. The aggregate is not to be dumped in piles, but is to be spread by use of spreaders. Precautions should be taken to avoid segregation; that is, the large stone separating from the fine portions. When segregation occurs, the Contractor must remove and replace the aggregate material or remix the material to conform to the requirements of the Specifications.

The maximum thickness of material which may be placed in one layer is limited to 6 inches compacted, unless approved by the Engineer. If vibratory compaction equipment is used, the thickness of the layers may be increased with the approval of the Area Construction Engineer. If the specified thickness of the base course exceeds the maximum layer which can be effectively compacted in one spread, the course is to be constructed in at least two equal layers.

It is very important that the moisture content of the material be at or near optimum, at the time the aggregate is spread and compacted. Water added to the surface aids only the material near the surface. The material at the bottom of the layer does not receive the additional moisture; therefore, ultimate compaction will be less at that level.

The Inspector must perform density and moisture tests in accordance with the Manual of Instructions - Materials Division and Section 200 of this Manual.

## **B. Checking Grade**

The final inspection operation of aggregate base course construction is to check grade and the shape of the finished surface. This can be performed in one of several ways.

The string line method is applicable when distances are not so great that the sag of the line is excessive. First, mark the correct grades on stakes situated on the edges of the work. Stretch a string line taut between the stakes and raise the string in the center the same amount that the center of the plan cross section is crowned. The vertical distance between the string and the actual grade will be the same at all points if the cross section is correct.

These checks should be made at the roadway centerline, each travel lane centerline, and edges of pavement, at each Station (every 30 meters for Metric projects). If checks indicate that the surface is out of tolerance, more frequent checks should be made.

## **Method of Measurement**

The weigh tickets and corresponding TL-102As are to be maintained as part of the project records. Payment is to be made by tonnage or cubic yards, as specified.

## **Inspector's Checklist**

1. Is material visually inspected for segregation when delivered to the project?
2. Is the material placed on a properly graded and compacted course?
3. Is the material placed using an approved aggregate spreader?
4. Is the material placed in layers that meet the requirements of the Specifications?
5. Is the material shaped to the proper grade?
6. Is the material placed and compacted at optimum moisture?
7. Are weigh tickets, Forms TL-102As and density reports filed as part of the project records?

## **SECTION 310 – TACK COAT**

### **Description**

A tack coat consists of applying an asphalt material, usually at a specified rate per square yard, upon an existing pavement surface to ensure a thorough bond between the old and new courses. Tack coats are used primarily in connection with asphalt pavements and are most important in helping to prevent slippage or pushing of the new surface under the strain of daily traffic.

There are certain conditions for which the use of tack will be beneficial; however, tack should not be used indiscriminately nor should it be applied in excessive quantities. Tack coat is usually needed: (1) when overlaying existing hydraulic cement concrete pavement; (2) when the existing asphalt course has been allowed to become dirty; and (3) when the existing asphalt course has been used by traffic. The Inspector should consider the conditions which produce a need for tack and use such material only where needed.

Tack coats should be applied over the surface evenly in a thin mist or fog. A very light coverage is adequate. Too much tack will cause slippage rather than adhesion between the two layers. Excessive tack will also bleed and cause flushing at the surface along construction joints.

The Contractor should be cautioned against applying tack coats too far in advance of the placement of the next layer or course. If this is allowed, the tack coat will collect a film of dust and result in poor adhesion.

### **Method of Measurement**

Tack coat will not be considered for separate payment unless specified in the contract as a pay item.

### **Inspector's Checklist**

1. Does the type and grade of liquid asphalt comply with the contract requirements?
2. Is the liquid asphalt heated to the required temperature?
3. Does the Contractor take precautions to avoid splattering adjacent items?
4. Are the vertical surfaces of adjacent pavements cleaned properly?
5. Is the liquid asphalt applied at the specified rate per square yard?

## **SECTION 311 - PRIME COAT**

### **Description**

A prime coat consists of applying a liquid asphalt material, usually at a specified rate per square yard, directly upon the surface of a base or foundation course which is to receive some type of asphalt wearing surface. Its purpose is to penetrate the existing surface, to coat and bond any loose mineral particles to the surface, to provide a dust-free surface for subsequent asphalt applications and to promote adhesion between the existing surface and any superimposed course.

The preparation of the surface prior to priming is important. The surface should be graded and compacted in accordance with the plans and Specifications. Best results are obtained when the existing material is neither too wet nor too dry. When the course is too dry, the prime will "ball up." A good practice is to moisten the existing surface about an hour prior to priming. This will normally ensure that a sufficient amount of moisture is present for good penetration.

It is not always necessary to apply the prime at the rate shown on the plans. The exact rate should be determined by local experience in the area. If the prime puddles or runs, the rate of application should be decreased. If the coverage is spotty or not complete, the rate of application should be increased. Uniform, complete coverage is important. Lean spots should be sprayed with additional prime. Sand cover material can be used to blot up the excess prime from "fat spots."

When the prime has sufficiently penetrated the subgrade, the asphalt courses can be placed. Sufficient penetration can be judged by stepping on the primed area. If no prime "picks up" or sticks to the soles of the shoes, the overlying course may be placed. When the prime sticks to the soles of the shoes, further time should be allowed for penetration and evaporation of the emulsion agent.

Inspectors should be especially conscious of the wind during priming operations. Minute globules of prime will drift in the wind, causing damage to property. Although such damage is the Contractor's responsibility, the Inspector should "encourage" the Contractor to take appropriate precautions to avoid property damage, and halt any operation which is causing property damage until appropriate preventive measures are employed.

### **Materials**

The Inspector should be sure the liquid asphalt material has been tested and approved for use. There are various ways to do this. One is to visually inspect the distributor being loaded from a tested source; another is to remove an approved seal from the distributor.

Contractor personnel may remove an approved seal from a storage tank or tank car and hand carry it to the Inspector only if the tank car arrives after normal working hours.

If there is no visual evidence of testing, the Inspector should take a field sample and submit it to the District Materials Laboratory for testing as directed by the *Manual of Instructions - Materials Division*. The asphalt material should not be used until the sample has been tested and approved.

The Inspector should be aware of the proper place to take a sample from a distributor. The most representative sample can be taken by dipping a container through a manhole. The sample is not normally taken from the hand hose since material collects in the hose which is not representative of the material in the tank. However, if the Inspector elects to take the sample from the hand hose, the valve should be held open for the material to flow for a short period of time before sampling. Only then can the Inspector be assured that the material obtained is a representative sample.

## **Construction**

All equipment proposed for use must be inspected for compliance with the requirements of the applicable Specifications. The Inspector should be cautioned that final approval or disapproval must be based on end results.

The inspection, calibration, or adjustment of the major parts of asphalt distributors are discussed below; however, all adjustments found necessary are to be performed by the Contractor and not by the Inspector.

### **Asphalt Material Distributor**

#### **A. Tank:**

The tank consists of an insulated shell with flues, a thermometer, baffle or surge plates, a manhole and an overflow pipe. The capacities of distributor tanks vary considerably. All distributors are equipped with a float-type gauge and a measuring stick for determining the amount of material in the tank. The measuring stick should be marked in increments of not more than 10 gallons.

#### **B. Heating System:**

The heating system consists of one or two burners and an equal number of heating flues. Each burner fires directly into a flue which transfers heat to the asphalt material. The heating system should be checked to make certain that it is capable of maintaining the asphalt material at the desired application temperature. When being heated, the asphalt material must be circulated. Care should be taken that the application temperature of the material is not exceeded.

### C. Circulating System:

The circulating system consists of a pump and lines passing through the distributor tank to the spray bar and to the hand spray. The pump should be checked to make certain that it is capable of circulating the asphalt material through the tank and the spray bar and developing and maintaining a constant, uniform pressure along the entire length of the spray bar so that an equal amount of material will be sprayed from each nozzle without atomizing the asphalt material or emitting a distorted fan.

The control for the valve system, by which the discharge of asphalt material from the nozzles is regulated, should be inspected and adjusted as found necessary. There should be no slack in the linkage from the control to the valve system so that all of the nozzles will be completely closed immediately when the control is operated. The pump tachometer or pressure gauge, which registers the pump discharge, should be checked for accuracy.

### D. Spray bar:

In order to ensure that the spray bar is in proper working condition, the following inspections and adjustments must be made:

#### 1. Nozzles:

Spray nozzles should be removed from the spray bar, cleaned, and examined for size, wear, and damage to the edges of the nozzle opening. Uniform distribution of the asphalt material depends on the nozzles being in good condition and being the proper size. Usually, the smallest size nozzle available for a distributor will provide the most uniform distribution. The nozzles should be set so that the slots make the angle with the spray bar recommended by the manufacturer of the distributor.

#### 2. Spray Bar Height:

The height of the spray bar should be set so that the exact number of laps of asphalt material desired will be obtained. The height for a double lap can be determined by closing every other nozzle, operating the distributor at the proper speed or pressure, and raising or lowering the spray bar by not more than one half of an inch at a time until it is determined by visual observation that exactly one single lap of material is being applied. When the closed nozzles are opened, a double lap of material will be applied. For a triple lap, close the second and third, fifth and sixth, etc., nozzles and follow the above procedure.

## **Measurement and Payment**

- A. The final "pay" quantity of liquid asphalt material will be the quantity of gallons shown on the delivery tickets for full loads distributed, plus the converted quantities for partial loads. (Correction factors based on material at 60<sup>0</sup> F can be found in the *Manual of Instructions - Materials Division*.)
- B. Records for documentation should include the following:
  - 1. Test reports covering liquid asphalt material.
  - 2. Test reports on cover aggregate used.
  - 3. Delivery tickets of liquid asphalt material used.
  - 4. TL-102 weigh sheets and certified delivery tickets for cover aggregate used.

## **Inspector's Checklist**

- 1. Does the cover material conform to the Specification requirements for aggregate material?
- 2. Are temperature limitations adhered to if asphalt is used as a cover material?
- 3. Is the surface to be primed shaped to the required grade and section, free from ruts, corrugations, segregated material or other irregularities; and uniformly compacted?
- 4. Is the prime protected from traffic until the asphalt penetrated?



## **SECTION 312 - SEAL COAT**

### **Description**

A seal coat consists of applying a liquid asphalt material, at a specified rate per square yard, upon an existing surface and immediately placing a single, uniform application of cover aggregate on the liquid asphalt material. The cover aggregate is then promptly embedded in the asphalt material by rolling. Seal coats are used to lengthen the service life of an existing pavement surface by waterproofing, slightly increasing its strength, and improving the skid resisting texture of the surface.

### **Materials**

Aggregate will be tested and approved at the source as part of the Department's Quality Assurance program. The Inspector should ensure that the necessary Forms TL-102A indicate the material has been tested. If the material has been shipped without being tested, the Inspector should reject the material.

The Inspector should inspect each load of coarse aggregate visually for cleanliness and segregation even though the material is being delivered from tested stock. Extremely dirty, dusty, or dry stone should not be. Dust prevents proper adherence between the liquid asphalt material and the aggregate.

Liquid Asphalt must conform to the requirements of Section 210. If necessary during construction, the viscosity may be changed one grade by the Engineer at no change to the contract price.

### **Weather Limitations**

An important factor which must be considered when constructing penetration type surfaces is the weather. Construction operations should not proceed when the existing surface is wet, when it is foggy, raining, or threatening rain, or when the air temperature is below 50°F or the surface temperature is below 70°F.

### **Equipment**

A minimum of one rubber-tired roller is required to be used on seal coat construction. The pneumatic tires "knead" the surface which produces a tighter (more dense, waterproof) surface. The gross load of the roller should be adjustable to apply 200-350 pounds per inch of rolling width.

The exact load per inch of rolling width is determined from information furnished by the manufacturer of the equipment. Since the unit load transmitted varies with tire pressure, the exact tire pressure should be known before referring to the manufacturer's

informational guide or handbook. Generally, a nine-wheel pneumatic-tire roller with a gross load of 6-10 tons will apply a load of 200-350 pounds per inch of rolling width. This loading is based on a tire pressure of 90 psi.

## **Construction Methods**

The construction operations are of the utmost importance in asphalt penetration work. Even the most precise design will be of no value if the construction operations are not properly performed, such as:

### **A. Cleaning the Surface**

The existing surface should be thoroughly cleaned with a rotary power broom or other means necessary to remove dirt and dust. Failure to do so will cause a lack of adhesion between the liquid asphalt and the aggregate.

### **B. Traffic Control**

Traffic control is essential to the construction of penetration type surface. Traffic must be controlled in such a manner that interruption and damage to the work will be avoided, that construction personnel will be protected and that the traffic itself will be protected from hazards created by the construction operations.

### **C. Application of Asphalt Material**

Asphalt materials cool rapidly; therefore, the distribution of the material should be coordinated with the spreading of the cover aggregate. The time lapse between the distribution of the asphalt material and the application of the cover aggregate should be kept to an absolute minimum in order to obtain greater wetting action and hence better bond with the aggregate.

The transverse joints on seal coats and on surface treatments should be carefully made so that they will not be rough and unsightly. This can be done successfully by starting and stopping each application of asphalt material and cover aggregate on a sheet of building paper. The longitudinal joints for seal coats and surface treatments which are not placed to the full width of the roadway in a single pass should also be carefully controlled. Since it is not practical to use building paper on these joints, it is considered better to have a slight buildup due to overlapping the adjacent passes than to have a gap in the surface.

### **D. Application of Cover Aggregate**

The application of the cover aggregate should be scheduled so that the time lapse before the asphalt material is covered will be the absolute minimum. This is particularly important when emulsions are being used as these quickly lose their adhesive qualities. Asphalt emulsions should normally be covered within 2

minutes after application. Care should be exercised in the spreading of the aggregate so that it is spread to a uniform depth of approximately one particle thickness. Since excess aggregate will not adhere to the asphalt material, the rate of application should be carefully evaluated. The desired uniform rate of application can be obtained by using an aggregate spreader. If the spreader has been properly adjusted and operated at constant speed, seldom should there be a reason for spreading any cover aggregate by hand.

In order to spot check the rate at which aggregate material is being applied, the following measurements and calculations should be made:

The weight of aggregate (pounds) on a truck is divided by the area (square feet) of roadway surface covered by that truck load. The weight of aggregate on a truck is given on the weigh ticket and the area of the surface covered is obtained by multiplying the length of spread by the width of spread measured to the nearest even foot. Divide the answer by 9 to convert pounds per square foot to pounds per square yard. Appreciable deviations from the specified rate of application should be brought to the immediate attention of the Contractor.

#### **E. Rolling**

The rolling operation should immediately follow the application of the aggregate material in order to embed the particles while the liquid asphalt material is still soft and tacky. The operation should begin at the outside edge of the surface and progress toward the center. Rolling should be discontinued when the asphalt material has set or hardened.

#### **F. Excess Cover Aggregate**

When placing seal coats and surface treatments in half widths, the loose aggregate should be removed from along the longitudinal joint before the adjacent lane is surfaced.

Usually there will be some loose aggregate particles on a new surface after the rolling operation has been completed. It is recommended that this loose aggregate be broomed off in the cool part of the morning when the asphalt material is hard and the bonded aggregate particles will not be disturbed.

## **Project Records**

The project records for seal coats should include as a minimum:

1. The date of application.
2. The quantities of materials received.

3. The quantities of material used.
4. The beginning and ending station numbers for each application.
5. The quantity and type of liquid asphalt material used and the application temperature.
6. Delivery tickets, weigh tickets and corresponding TL-102A(s).
7. Sufficient test report coverage for materials used.

## **Basis of Payment**

Seal coats are to be measured in gallons of liquid asphalt and tons of cover material applied.

## **Inspector's Checklist**

1. Is the surface cleaned properly prior to placement of the liquid asphalt?
2. Is building paper used at the beginning of each spread?
3. Is the specified rate of application of liquid asphalt and cover material maintained?
4. Is the cover material applied immediately following the liquid asphalt?
5. Is the rolling operation begun immediately following the application of the cover material?
6. Is traffic controlled in such a manner as to not damage the surface?

## **SECTION 313 - ASPHALT SURFACE TREATMENT**

### **General**

A single course surface treatment is similar to seal coat except that it is usually applied to a prepared non-asphaltic base for the purpose of waterproofing the wearing surface.

### **Materials**

Asphalt shall conform to the applicable requirements of Section 210. Asphalt may be changed one viscosity grade by the Engineer during construction.

Cover material shall conform to the applicable requirements of Sections 202 and 203. Coarse aggregate shall be a minimum Grade B. Lightweight aggregate shall conform to the requirements of Section 206. Cover material shall not be hauled directly from a washing plant for immediate use in the work.

### **Procedures**

Asphalt surface treatment consists of applying one or more seal coats or a prime coat followed by one or more seal coats. The Contractor shall have a certified Asphalt Paving Technician present during the paving operation.

Penetration courses shall not be placed when surfaces are wet, when the air temperature is below 50 degrees F, or when the surface temperature is below 70 degrees F. The surface temperature shall be measured prior to placement. The Contractor is responsible for furnishing a properly calibrated infrared instrument for this purpose.

The prime coat shall be permitted to cure prior to the next application of asphalt.

During the period between application of the prime coat and the seal coat, the primed surface shall be kept in repair. Holes, ravels, and areas deficient in primer shall be patched and repaired with asphalt-treated materials by penetration methods or other approved procedures.

The application rates of asphalt surface treatment materials will be furnished to the Contractor by the Department. The Inspector should verify that the Contractor is applying the materials at the correct rate by measuring the length and width and comparing the square yardage against material delivery tickets.

As soon as the final layer is placed, controlled traffic may be permitted thereon.

### **Inspector's Checklist**

1. Does the Contractor have a certified Asphalt Paving Technician on the project?

2. Are weather and surface conditions as required?
3. Is the spread of asphalt no more than 6 inches wider than the width of cover material being applied?
4. Is the temperature of the asphalt maintained between 160 and 175 degrees during application?
5. Is each application of asphalt immediately followed by an application of cover material?
6. Are the application rates of the asphalt and cover material as specified?
7. Is the rolling started immediately following the application of the cover material?
8. Is excess material lightly broomed of the wearing surface as required?

## **SECTION 315 - ASPHALT CONCRETE PAVEMENT**

### **Description**

The various mixtures used by the Department are designated as follows:

The "SM" (surface) mixes are placed as the course upon which traffic rides.

The "IM" (intermediate) mixes can be used as the surface course but are generally used immediately beneath the surface course and directly above the base course. They are also referred to as "binder" courses.

The "BM" (base) mixes are placed as the initial asphalt course which typically lies directly above the subbase or subgrade.

The "C" (curb) mixes are used for asphalt curbing work.

The Contractor designs the job mix based on the Department's Specifications. The job mix is then submitted to the District Materials Engineer for approval and will be approved or disapproved, based on the recommendation of the Materials Division. The Contractor must secure the Department's approval of the job mix formula for each type of asphalt concrete in the contract prior to being used. An approved job mix formula for the mix specified should be a part of the project records prior to beginning work on the course in which that mix is to be used.

At the start of production of a mix not previously used on a state roadway, the Contractor shall place 100 to 300 tons or up to one day's production as directed by the Engineer at an approved site (may be project site) so the Engineer can examine the mixing plant's process control, the Contractor's placement procedures, surface appearance, of the mix compaction patterns of the Contractor's roller(s) and correlation of the nuclear density device.

### **Placement Limitations**

An important factor which must be considered when constructing asphalt concrete courses is the weather.

Asphalt concrete mixtures shall not be placed when weather or surface conditions are such that the material cannot be properly handled, finished or compacted. The surface upon which asphalt mixtures are to be placed shall be free of puddled water and the base temperature shall conform to the following:

- (a) When the base temperature is above 80 degrees F, mixture laydown will be permitted at any temperature conforming to the limits of Section 211.

- (b) When the base temperature is between 35 degrees F and 80 degrees F, the Nomograph, Table III-2, shall be used to determine the minimum laydown temperature of the asphalt concrete mixes. At no time should the minimum base and laydown temperatures be less than the following:

<b>Mix Designation</b>	<b>Minimum Base Temperature</b>	<b>Minimum Laydown Temperature</b>
A	40 <sup>0</sup> F	250 <sup>0</sup> F
D	50 <sup>0</sup> F	270 <sup>0</sup> F
E	50 <sup>0</sup> F	290 <sup>0</sup> F
M	50 <sup>0</sup> F	290 <sup>0</sup> F
S	50 <sup>0</sup> F	290 <sup>0</sup> F
All Base Mixes	35 <sup>0</sup> F	250 <sup>0</sup> F

The temperatures of the asphalt concrete material and the overlaid base course are critical factors in the life and durability of a thin layered asphalt concrete course. The nomograph in Figure III-2, Cold Weather Paving Limitations, correlates the surface temperature of the base material, the depth (in pounds per square yard) of the asphalt concrete course and the minimum laydown temperature of the asphalt concrete material.

Asphalt base courses average 115 pounds per square yard per inch of depth. Asphalt intermediate courses average 112 pounds per square yard per inch of depth. Asphalt surface courses average 110 pounds per square yard per inch of depth. The exact weight of the material for the individual project may be obtained from the District Materials Engineer.

The following example may be helpful in understanding the application of the nomograph:

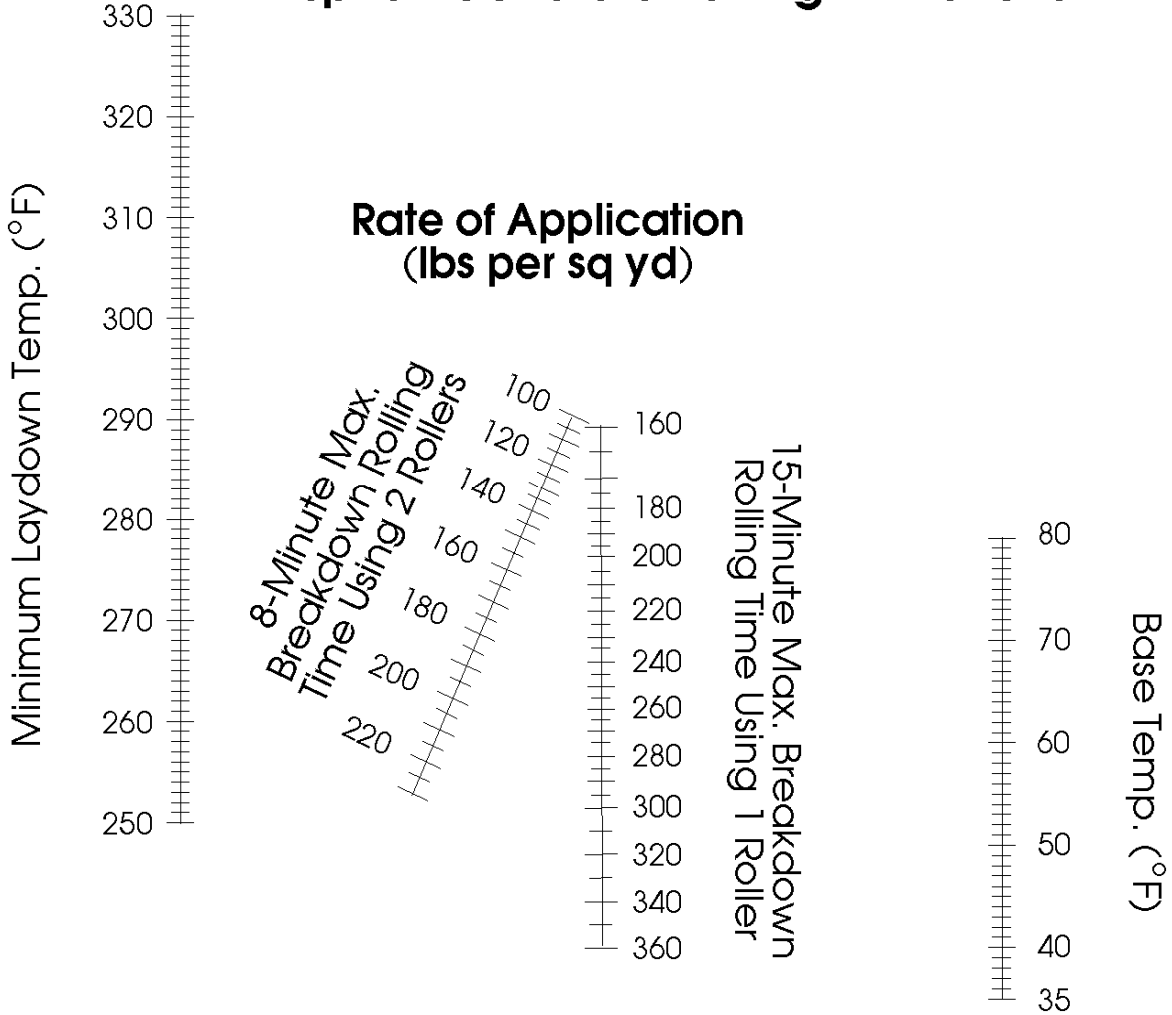
The rate of application of asphalt surface course is 165 pounds per square yard (1 1/2" depth). Two rollers are used and the base temperature is found to be 52° F. A straightedge is placed on the nomograph to intersect 52° F on the base temperature scale, 165 on the 8 minute-two roller scale and the minimum laydown temperature is found (at the point of intersection with the straightedge) to be 288° F.



**TABLE III-2**

**Cold Weather Paving Limitations**

**Asphalt Concrete Paving Limitations**



Note: Intermediate and base courses which are placed at rates of application which exceed the application rates shown in Table III-2 shall conform to the requirements for the maximum application rate shown for 8 minute and 15 minute compaction rolling as per number of rollers used.

## **Equipment**

The Inspector should make an inspection of the Contractor's paving equipment, checking the condition and adjustment of the component parts. By making this inspection prior to beginning paving operations, obvious deficiencies in the condition of the equipment may be discovered and corrected (by the Contractor), thus avoiding delays once the work is underway. The Inspector should realize that the finished product is the best indicator of equipment suitability and performance.

### **Hauling Equipment**

Trucks used for hauling asphalt concrete should be inspected for tight, clean, smooth metal bodies. A tarpaulin, in good condition, is to be used to cover the hot material. The tarpaulin prevents a cold crust from forming on top of the load. To be effective, the tarpaulin should be secured at both ends of the truck body.

Prior to loading, each truck body should be sprayed with a thin coat of aliphatic hydrocarbon invert emulsion release agent, lime solution or other approved material to prevent the mixture from adhering thereto; however, too much oil or solution will puddle and is detrimental to the asphalt concrete. Only a thin film is necessary. Excess oil or solution should be drained off by tilting the bed before the truck is loaded.

Truck drivers should stop slightly short of the paver when backing up to empty their load. This assures that the paver is in motion when it contacts the truck. If the truck bumps the paver, the shock will be transferred to the finished surface through the screed. Any contact between the body of the truck and the paver will be reflected in the texture of the finished pavement. Contact between a truck and a paver should occur only at the push rollers. Insist that the Contractor correct the cause for any contact at other points.

The Contractor should arrange his hauling operation so that each load of material arrives on the project at fairly constant intervals. During long waits, the screed of the paver settles into the mat and leaves depressions. Consequently, the uniform delivery of materials is a contributing factor in the construction of a smooth riding surface.

### **Asphalt Concrete Paving Machines**

The Inspector should familiarize himself with the mechanical features of all machinery used on the project, so that an intelligent appraisal of the condition and adjustment of each machine may be made. Handbooks of operating instructions are available from each manufacturer, in which various adjustments and operating details are shown.

## **Rollers**

Steel wheel rollers should be checked to determine that the wheels are capable of rolling in a true plane. The steering and driving mechanism of all rollers must be free of excessive play or backlash and the motor and driving transmission free from oil leaks. Each roller should be fitted with a water tank connected to spray bars and mats on each wheel. The wetting mats should be checked for excessive wear and the spray bars checked for proper operation. The drive wheel should be located in the front of the roller.

Pneumatic-tire rollers must be equipped with smooth tires in good condition and of equal size, ply, and inflation. Tire pressures and loading of the roller may be varied to give ground contact pressures desirable. All wheels should roll true, without wobble or creep.

## **Miscellaneous Tools**

A check should be made to see that the Contractor has available on the project an adequate supply of asphalt rakes, lutes, shovels, brooms, straightedge and other small tools. The Contractor is to be properly equipped with portable channelization devices, cones or other means of protecting the freshly laid mixture from damage by traffic.

## **Conditioning of Existing Surface**

The paving sequence should be considered and agreed upon by the Inspector and the Contractor prior to actual construction. Once agreed upon, the sequence should not be changed without good reason. The best surface is usually obtained when the pavement is constructed with a minimum of interruptions.

Prior to beginning the paving operation, the Inspector should thoroughly check the surface on which the paving material is to be placed. If the surface is:

### **A. Soil**

The underlying material should be primed with low viscosity asphalt which should be allowed to penetrate the soil. The grade of asphalt will be designated on the typical section of the plans. The priming operation is described in Section 311.

When asphalt concrete to be placed has a total thickness of 4 inches or more, priming with asphalt material will not be required on aggregate subbase or base material.

### **B. Existing Hydraulic Cement Concrete Pavement**

Prior to placement of asphalt concrete, longitudinal and transverse joints and cracks in hydraulic cement concrete shall be sealed by the application of an approved joint sealing compound.

### **C. Hydraulic Cement Concrete Base**

This pavement should be prepared in accordance with Section 316 of the Specifications. The concrete base should be allowed to cure until the concrete has achieved the required modulus of rupture.

In the absence of beam tests, the overlay is not to be placed until 14 days after the concrete is placed. Once the concrete base has attained the specified strength or age, an asphalt tack should be sprayed thereon before placing the asphalt concrete overlay. Tack coat operations are described in Section 310.

The pavement should be cleaned thoroughly before the tack material is applied to remove all dust, dirt. Such deleterious materials reduce the adhesion of the tack. Although not required by the Specifications, a rotary power broom appears to do the best job and is probably the most economical tool for this purpose.

Tack material shall be uniformly applied with a pressure distributor.

### **D. Existing Asphalt Concrete Pavements**

The method to be used in the repair of existing pavements will usually be specified. In many cases the cause for failure in the existing pavement is due to a failure in the base. Corrective measures will differ according to the type and condition of the supporting materials and the severity of the distress in the pavement.

Potholes should be filled and compacted before spreading the first course. If the hole is filled while laying the first course, problems will be encountered while rolling. First, the compactive effort of the roller might not reach the full depth of the hole. Second, the roller will try to "shove" asphalt in front of the roller over the hole.

Where deviations in the pavement are severe, a leveling course should be placed prior to laying the surface course. The contract will usually call for a leveling course where such is felt necessary at the time of the field inspection.

Contact surfaces of curbing, gutters, manholes, and other structures projecting into or abutting the pavement and cold joints of asphalt shall be painted with a thick, uniform coating of asphalt prior to placement of asphalt mixture.

## **Spreading and Finishing**

The Inspector should visually inspect each truck load of asphalt mixture for uniformity and make an occasional check on the temperature of the mixture being delivered. The requirements for the temperature of the mixture at the time of placing are stated in placing limitations of the Specifications and this Manual.

The use of any haul truck whose frame comes in contact with the paving machine or which bears down on the paving machine when dumping the mixture will not be permitted. The result of either or both of these conditions will be a rough surface.

To begin paving operations, the screed should be heated to the proper temperature and the grade controls set to construct the transverse joint. Do not change unless necessary.

As the paver proceeds, the grade or thickness control device must be adjusted to give the spread required by the plans. As continuity of operations is essential to securing a good pavement surface, the speed of the paver should be regulated by the plant's production. By observing the surface texture behind the machine and checking the surface texture with a straightedge, a malfunction in the paver or non-uniformity of mixture may be detected. The Inspector must insist on prompt action to locate and correct any trouble that occurs. Some of the most common difficulties encountered, together with possible causes, are listed below:

**A. Wavy Surface (Short Choppy Waves)**

Worn or poorly adjusted tracks or drive chains; truck driver setting brakes too tightly; excessive paving machine speed; push rollers not operating freely; or some material may be falling in front of the paver.

**B. Wavy Surface (Long Waves)**

Excessive variation in amount of mix carried in the auger box ahead of tampers or screed; rolling too early; roller operation too fast; over-controlling screed.

**C. Excessively Open Surface Texture**

Improper adjustment of tamper bar; improper speed of tamper bar; screed plate rough or galled; excessive paving machine speed.

**D. Varying Surface Texture**

Insufficient mixing; overmixing; overheating of mixture; dry mixing period too long; segregation of mix in trucks; worn or damaged screed plate.

**E. Bleeding Patches on Surface**

Asphalt concrete not uniformly mixed; excessive moisture in mix.

**F. Irregular Rough Spots in Pavement**

Roller standing on fresh surface; abrupt reversing of roller; truck backing into paver; poor workmanship at transverse joints.

The pavement edge shall be marked by a string line or guide line placed far enough ahead of the paver to maintain continuity. The line should be secured at intervals such that it is held taut without sagging. Check the alignment of the guide line to be certain that the correct alignment, width, and elevation of the pavement will be assured.

The Contractor should be encouraged to maintain a constant height of material in front of the screed. Large variations in the height of the material affect the thickness of the finished surface. Uniform delivery of materials will minimize this problem.

When the paving machine is equipped with an automatic grade control unit, it is essential that the paving crew and Inspector be thoroughly familiar with its operations and adjustments. When this unit malfunctions, it tends to compound its errors; therefore, the paver must be stopped immediately, the pavement corrected and the malfunction located and corrected before proceeding with paving operations. Essentially the automatic grade control unit divorces the screed from the upward and downward movement of the floating arms which attach the screed to the machine, and transfers this control to the unit equipped with a sensor element which travels on a rigidly set control guide line.

The Specifications limit the thickness of asphalt concrete which may be placed in a single lift or layer. Limiting the depth of application improves the likelihood that the course will have the desired strength and stability. The depth limitations should not be exceeded, except with the approval of the Area Construction Engineer.

If the plan thickness specified in a course exceeds the total amount that may be placed in one layer, two or more layers may be required to place the entire course. Good construction practices dictate that the layers in a course be of approximately equal thickness.

The best basis for making an adjustment in the rate of material being laid is to measure the distance traveled by a paver while spreading a truck load of material. The actual application rate can be computed even more accurately if the determination is based upon the spread of more than one truck. A comparison between the actual and the plan tonnage spread in a given area is a good basis for

controlling all asphalt operations. Since there is a natural tendency to place more than the specified rate, the Inspector should maintain a good check on the actual weight per square yard placed.

### **1) Longitudinal Joints**

When a pavement lane is constructed in more than one strip, each longitudinal joint should be offset from each underlying joint by approximately 6 inches; however, the longitudinal joint in the surface course is to be located at lane lines. The screed should overlap the previously laid lane to ensure enough material to completely fill the joint.

When matching the edge of a previously laid section of pavement, the screed of the paver should overlap the existing edge from one to two inches and the thickness control should be adjusted to leave the material slightly higher than the previously laid section of pavement. Overlapping this edge will force more than enough material into this area so that the joint is completely filled and moisture proof. The height of the material above the previously laid edge of pavement should be adjusted so that when the longitudinal joint is properly compacted, the pavement will be uniform in cross-section within the tolerances specified.

### **2) Transverse Joints**

Transverse joints should be constructed in such a manner as to provide a smooth riding surface. The edge of existing joint should be cut back until it is perpendicular to the edge of the pavement and vertical. The previous course should be completely exposed to the joint.

A good construction procedure is to place blocks between the screed unit and the existing surface when beginning operations at a transverse joint. This ensures that the thickness of a new mat will be slightly higher than the existing surface. If the screed is allowed to "pull off" the existing pavement, the thickness of the new pavement will be low when compacted.

The Inspector's routine duties include the verification of weigh tickets and the control of the location and length of spread of each load; however, the principal duty is to ensure that the pavement is constructed to the correct grade and cross-section set forth in the plans, and with a uniform surface texture and smooth riding surface. To achieve these results, the Inspector must continually check the surface on which the pavement is to be placed, the mixture in the trucks, surface texture behind the machine, and rolling operation. The Inspector must also evaluate the finished surface using a straightedge and string line for proper crown and smoothness.

Paving in tandem and squaring-up at the end of each work day has been the general practice of the Department to providing a hazard free travel way for the general public.

Although, consideration may be given to eliminating squaring-up at the end of each work day if the following requirements are met:

1. Uneven roadway signing is used to advise the public.
2. The difference in elevation of adjacent lanes must not exceed 1 1/2 inches compacted.
3. Temporary pavement marking is provided on a daily basis when needed.

Safety and convenience of the traveling public is of utmost importance; therefore, the proximity of the ends of adjacent lanes should not be so close as to cause abrupt maneuvers of vehicles when changing lanes. Additional consideration should be given to type of traffic, speed, and potential problems such as ponding water.

## **Compaction**

Rolling of the longitudinal joint should be done immediately behind the paving operations. The rolling operation should follow the paver as closely as possible without cracking the mat or having the mix pick up on the roller wheels. Rolling should continue until the required density is achieved. The finish rolling should be completed while the material is still workable enough for removal of any roller marks.

The roller wheels should be kept moist with only enough water to avoid picking up the material. Rollers should move at a slow but uniform speed with drive roll or wheels nearest the paver. Changes in direction should be effected gradually and rollers allowed to roll or slowly brake to a complete stop before reversing. When rollers are parked on the pavement they should be parked at a 45-degree angle with the centerline so that subsequent rolling operations will remove any depressions resulting from the parked rollers.

When the nuclear field density testing method is used to determine proper compaction, control strips are to be constructed in accordance with the provisions of Section 304. The District Materials personnel should be notified if assistance is needed.

## **Details of Inspection**

Some of the more important details of inspection and corresponding corrective action for construction of hot-mix asphalt concrete pavements are listed below:

- A. Check condition and adjustment of paving machines and rollers.
- B. See that traffic control is organized and functioning properly; make sure required signs are in place.



- C. Check application of tack coat; be certain adjoining surfaces such as gutter, curbs, manholes, are properly tacked. All surfaces should be clean before tack is applied. Tack coats should be applied evenly over the pavement surface.
- D. Examine pavement base, see that required patching and pre-leveling is done; make check on paving depths or spread before paving begins.
- E. See that paver guide lines are set properly.
- F. Check transverse joint for smoothness and appearance.
- G. Watch trucks dumping into paver hopper for adverse effect on paver operation. Each truck should empty completely and material should not accumulate in corners.
- H. Check temperature of the mixture.
- I. Maintain constant inspection of mat behind paver for signs of roughness or non-uniformity of mixture.
- J. See that longitudinal joints are raked and compacted properly.
- K. Make frequent checks of the spread.
- L. Watch rolling operations; see that best rolling sequence is used to fit conditions; watch for excessive speed of rollers. Check to assure that the desired pavement contour is being achieved.
- M. Inspectors should ensure that the finished grade elevations and design cross slopes are within specified tolerances. The finished grade elevations should be checked at the roadway centerline, each travel lane centerline, edge of pavement, and edge of shoulder at each Station (every 30 meters for Metric projects). If checks indicate that the surface is out of tolerance, more frequent checks should be made.
- N. Keep records of truckloads used each day.
- O. Make sure the project is in good order before you leave at the end of the day; check warning lights, channelizing device. Drive through or approach the work and attempt to view the situation through the eyes of an out-of-state motorist who is totally unfamiliar with the route and construction work being performed.

Records for Documentation Should Include:

- A. All weigh tickets must be checked by the Project Inspector. Numbering each ticket will help maintain the trucks in the proper sequence.

All delivery tickets should include: (1) name of Contractor; (2) project number(s) (3) date; (4) truck identification number; (5) load number; (6) type of material and (7) net weight.

- B. Any portion of a load not used must be returned to the plant and weighed. The weighmaster should record the corrected weight on Form TL-102a and notify the Project Inspector. The Inspector should record the weight of material returned on the appropriate delivery ticket.
- C. A record of the temperature checks taken on the project.
- D. A copy of the approved mix design.
- E. Copy of depth measurements recorded from cores, and density reports.

## **Inspector's Checklist**

1. Do the trucks hauling asphalt have tight, clean, smooth metal bodies?
2. Are trucks equipped with operable backup alarms?
3. Are the trucks hauling asphalt equipped with the proper cover to protect the mixture?
4. Does the asphalt paver produce a finished surface as required?
5. Do the rollers leave the surface in an acceptable condition?
6. Are the weather and surface conditions during placement of the asphalt mixture as required?
7. Are the minimum laydown temperatures as specified?
8. Are intermediate and base courses exceeding the application rate given in Table III-2 placed as specified?
9. Has the surface of existing pavement or base that is irregular been corrected as required?
10. Have longitudinal and transverse cracks in hydraulic cement concrete been sealed prior to placement of asphalt?
11. Have all contact surfaces and cold joints of asphalt been painted as required prior to asphalt placement?
12. Is a tack or prime coat of asphalt applied as specified?

13. Are asphalt cutbacks or emulsions applied and allowed to form a tacky residue prior to the application of the paving mixture?
14. Is tack or prime coats which have been damaged or contaminated been repaired prior to placing the paving mixture?
15. Have irregularities in the existing surface that would result in a compacted thickness of over 3 inches been repaired as specified?
16. Has a continuous line been placed and maintained to control pavement width and alignment?
17. Has the longitudinal joint of each layer been offset approximately 6 inches or as specified?
18. Is the certified Asphalt Concrete Paving Technician inspecting and straight edging each layer as required prior to compaction?
19. Are the specified rates and depth adhered to when placing asphalt concrete base, intermediate and surface course?
20. Does rolling begin immediately after placement and continue until the mixture is thoroughly and uniformly compacted?
21. Are there sufficient rollers to obtain the required compaction of the mixture?
22. Has the rolling of the mixture been accomplished as required by the Specifications?
23. In areas not accessible to rollers, has the material been compacted as required?
24. Are the edges of the pavement surface true curves or tangents as required?
25. Are the surfaces of the compacted courses protected until the material has cooled sufficiently to support traffic without marring?
26. Does the density of the compacted course meet the requirements as specified?
27. Did the Contractor furnish and operate a nuclear density gage, which had been calibrated within the previous 12 months by an approved calibration service, in accordance with the requirements of this section?
28. Has a control strip been constructed for each roadway, shoulder course, and each lift of each course as required?

29. Have the required number of density tests been taken by the Contractor on specified courses?
30. Have the rollers continued until roller marks are eliminated and the required density has been obtained?
31. Has a transverse joint been cut on the previous run as specified?
32. Has a brush coat of asphalt been applied to transverse joints as directed?
33. Have joints adjacent to curbs, gutters, or adjoining pavement been set up to a height sufficient to receive full compression under the rollers?
34. Has the Contractor cut the testing samples and replaced the material as required?
35. Has the Contractor taken corrective actions to fix surface areas out of tolerance prior to determining the pavement thickness?
36. Does the thickness of the base course meet the requirements?

## **SECTION 316 - HYDRAULIC CEMENT CONCRETE PAVEMENT**

### **Description**

The construction of concrete pavement is a highly mechanized operation which requires inspection of a vast quantity of material and a working knowledge of numerous types of equipment. Inspectors assigned to this work should be thoroughly familiar with the Specifications, Special Provisions, construction details, and sequence of operations. Prior to the start of paving work, a meeting should be held between the Contractor's supervisory personnel and the Project Inspector to discuss the sequence of operations.

### **Materials**

The Inspector must be familiar with the source and type of aggregate intended for use, mix proportions, moisture content determination, method of determining scale weights, batching equipment, tests and reports. A review of the Manual of Instructions - Materials Division and the Study Guide for the Hydraulic Cement Concrete Certifications School will be helpful.

All sources supplying concrete to the Department shall be required to have present during the batching operations, a Certified Concrete Batcher or a Certified Concrete Technician. A Certified Concrete Batcher is that person who actually performs the batching operation. He shall never initiate adjustments and will be permitted to implement adjustments only at the direction of the Certified Concrete Technician, unless his certification carries this special authorization. A Certified Concrete Technician is that person who is capable of performing adjustments in the proportioning of materials used to produce the specified concrete, should such adjustments prove necessary. Certification shall be by the Department, awarded upon satisfactory completion of an examination.

The concrete producer shall so plan his batching operations so that delays do not occur due to the absence of certified personnel. In cases of emergency, the concrete producer shall have readily available for service a Certified Concrete Batcher or a Certified Concrete Technician to replace the regular personnel assigned to these jobs. Should cases of extreme emergency arise during actual batching operations, this requirement will be temporarily waived by the Engineer in order to complete the placing of concrete on the portion or section of a structure involved. Additional batching operations shall not be initiated until the services of a Certified Concrete Batcher and Certified Concrete Technician have been obtained.

The Project Inspector will never assume by act or word the responsibility of batch control adjustments, calculations, or the setting of dials, gages, scales, and meters.

## Equipment

Equipment plays an important role in concrete paving. The Inspector should familiarize himself with the mechanical features of all machinery used on the project so that an intelligent appraisal of the condition and adjustment of each machine can be made. Handbooks of operation instructions are available from equipment manufacturers which explain various adjustments and operating procedures.

In the event the manufacturer's instructions for an individual piece of equipment differ from the procedure outlined herein, comply with the manufacturer's instructions. All paving machinery should be correctly adjusted within the first 100 feet of operation. Examine each machine's performance carefully and require adjustments as soon as the need for such is indicated. Continued use of an unsatisfactory piece of equipment can only result in an excessive amount of corrective work.

Equipment that rides on forms should have a scraper that will keep the top of the forms and the wheels clean of concrete.

**Placing Reinforcing Steel for Continuously Reinforced Pavement:** At each location where five or more consecutive days will elapse between placement operations, a "leave out" joint shall be installed as detailed on the plans. Longitudinal bars shall be positioned in the finished pavement within  $\pm 1/2$  inch of the specified vertical position and  $\pm 1$  inch of the specified horizontal position with a cover of at least 2 inches.

Pre-bent deformed tie bars, Grade 40 or 60, may be used in the joint between the mainline and ramp pavement to facilitate the use of the slipform paver. Bars shall be pre-bent with equipment designed especially for fabricating 90-degree bends in 5/8-inch deformed bars without damage to the bars. Side forms of the slipform paver shall be designed in a manner so that the pre-bent tie bars can be inserted in an appropriate slot and will pass between the edge of the pavement and the inside face of the trailing forms as the paver advances.

When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be vibrated and struck off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly on the concrete, after which the top layer of concrete shall be placed, struck off, and screeded. Any portion of the bottom layer of concrete that has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or placed by approved mechanical or vibratory means in fresh concrete after spreading.

Reinforcing steel shall be straight, and its surface condition shall conform to the requirements of Section 406.

## Setting Forms

Forms should be checked to ensure that they are straight, clean, and oiled; the face is perpendicular to the base, flanges are not bent; and locking devices are in proper working order.

The subgrade on which forms are to rest is to be cut true to grade, usually from a reference string line. When forms are set, they are to be firmly supported for their full lengths.

Pins must be adequate in length to avoid perceptible movement by equipment and locked. Locking devices must be properly fastened. Width between the edges of pavement must be set correctly. After forms are set, it is advisable to sight along the top of the forms to detect obvious deviations in grade or alignment.

## Conditioning of Subgrade or Subbase Course

After forms are set or track path cut for slip form paving, the fine grade should be checked. If the base is low, material should be added and recompact in accordance with the Specifications. The Inspector should check the grade by measuring down to the subgrade from a taut string or wire across the forms at random intervals. Loose material often accumulates at the inside edge of the forms. Any loose material found here should be removed. The slab thickness is most often checked at the edges, so the depth should be double checked here. The thickness of a concrete slab affects the final payment for such work and most Contractors appreciate a close check.

The moisture condition of the subbase should also be checked. If the subbase is too dry, water needed for hydration of cement will be "pulled out" of the concrete. The subgrade should be uniformly moist, but not muddy, at the time the concrete is placed.

Final tests and depth checks for the subgrade or base course should be completed by the Materials Section prior to the start of the paving operation as outlined in the Manual of Instructions - Materials Division.

**Placing Concrete** - Regardless of whether concrete is mixed in site mixers, stationary mixers, or truck mixers, it is the responsibility of the job site Inspector to determine that it is properly mixed and meets Specification requirements for slump, air content, uniformity, and desired workability at the time of discharge into the spreader or forms. The Inspector at a paving mixer must see that dry batches are delivered in the proper manner and condition and are dumped in the skip without loss of materials and should check to see that the skip empties all material into the mixer without waste. The mixer is to be regulated so that some water flows into the drum in advance of cement and aggregate and shall continue to flow for a specified period after all the cement and aggregates are in the drum. Proper blending of ingredients is important for proper mixing.

The Specifications regulate the amount of time that can elapse between the introduction of cement to the mix and discharge of the mix. These maximum time limits apply to concrete delivered in both agitating and non-agitating type trucks.

Concrete must be placed on the subgrade in such a manner as to prevent segregation and to require a minimum of redistribution (additional movement). Paving mixer buckets are best discharged while still in motion moving away from the paver. Concrete dumped in piles causes non-uniformity of consolidation and additional strain on the forms and spreader. This, in turn, will probably cause increased finishing work to obtain a good riding surface. When it is necessary to spread concrete by hand, it should be done with a shovel instead of a rake or similar tool. Vibrators should never be used to move concrete. Extreme caution must be employed when placing concrete around joint assemblies, dowels, expansion joints to avoid displacement of these items.

Normally, the mixing and placing of concrete pavement should be discontinued when the ambient air temperature is below 40<sup>0</sup> F. When concrete is mixed and placed at temperatures lower than those noted above, it should be produced, delivered and finished in a manner to provide for a minimum loss of heat. Finished concrete must be cured and protected in a manner that will protect it during the period in which it is susceptible to frost and freeze damage.

In cold weather, the Contractor is required to cover pavement with insulating material to prevent the slab from freezing. The surface temperature of the concrete is required to be kept above 40°F for the first 72 hours. The blanketing material must be kept in place an additional 48 hours in the event freezing air temperatures are expected to continue.

Hot, dry or windy conditions cause rapid surface drying, rapid temperature changes and undesirable high temperatures in the concrete during the early stages of hardening. Such condition(s) often cause the loss of moisture from the pavement surface faster than it can be replaced by normal bleeding thereby causing plastic shrinkage cracks to form. It may be necessary under extreme conditions to cool the mixing water and aggregate stockpiles in order to lower the temperature of the concrete. In any event, the curing medium must be applied at the earliest possible time.

Prior to the start of paving operations, the Inspector should check to see that the Contractor has sufficient material on hand, such as burlap, polyethylene sheeting or other approved material, to properly protect the pavement surface in case of rain. Sudden showers which might occur during paving operations or immediately after finishing operations, require the exposed surface of the fresh concrete to be covered to prevent washing the cement particles out of the surface. Mixing and placing of concrete should cease immediately in the event of rain.

If rain continues only for a short period, the protective covering may be removed and finishing completed. In case the rain continues, finishing may be accomplished by



rolling back a few feet of protective cover at a time and replacing it immediately after finishing.

## **Concrete Pavement - Slip Form Method**

The Contractor may elect to use the slip form method of paving in lieu of the conventional form type method. Prior to beginning slip form operations, the base material must be uniformly compacted and free from irregularities.

Special attention must be given to the track path of the slip form paving equipment. Some slip form pavers use the track path as the profile grade. The track path is normally located on the edge of the base material. In this case, the supporting material must be compacted and graded to match the plan profile grade.

The tracks of the slip form paving equipment must not be allowed to run over concrete spills or other material. Such obstructions, if left unattended, will bring about irregularities in the concrete finish. Spills and other material in the track path are to be removed.

The Contractor may elect to use a control guide wire (string line) for both roadway alignment and profile grade. The Inspector should spot check the control guide wire from the fine grade hubs. The control guide wire should be taut, free from obstructions and without measurable sag between supports. A final check of the control guide wire is to be made prior to paving by sighting along the wire for irregularities.

The concrete should be of such consistency that it can be spread, consolidated, and finished in a single pass without appreciable slumping of the outer edges. Edge slump can be compensated for by slightly tapering the trailing forms in a front-to-back convergence such that the concrete will be extruded upward. However, the consistency of the concrete is an extremely important control in slip form paving. An ideal concrete slump is 1 1/2 to 2 inches.

The method of installing headers is to be reviewed with the Contractor's representative prior to the paving operation. Special techniques are necessary for the placement of additional reinforcement and maintaining the proper profile grade. The Contractor should plan the concrete delivery in such a manner that the header can be placed opposite a finish grade hub.

Caution should be taken to avoid paving when rain is imminent. A sudden shower can produce serious consequences in the quality of the paving texture.

## **Test Specimens**

The Manual of Instructions - Materials Division outlines the procedures that apply to concrete test beams.

## **Strike-Off of Concrete and Placement of Reinforcement**

The concrete spreader should be adjusted so that concrete is struck off uniformly across the entire width of spread.

When wire mesh is used, the mesh may be placed by means of two layer construction of the concrete or by the use of an approved placing machine which vibrates the reinforcement into proper position after full thickness of concrete is placed. When mesh is placed by means of two layer construction no more than 30 minutes is to elapse before placing the top layer of concrete. If an approved placing machine is used, it must be checked for proper adjustment to assure that all reinforcement is positioned at the proper depth and that it does not move out of position during the remaining finishing operations. A continual check should be maintained for the location of reinforcement regardless of the method of installation.

When wire mesh, bar mat, or continuous reinforcement is required, it should be stored off the ground in a manner that will avoid damage and be kept clean. Wire mesh and reinforcing steel are to be free from dirt, oil, paint, grease and excessive rust at the time the concrete is placed.

## **Joints**

### **Dowel Supporting Assemblies**

When dowel supporting assemblies are required for transverse joints, they must be laid out and marked in such a manner that the exact centerline of the assembly can be reestablished. Generally, they are held in correct position by the use of metal stakes or pins that are left in the base material. It is very important that all dowels in a dowel assembly be parallel to each other and form a straight line. If not, a "locked joint" will result; a condition in which the normal expansion and contraction movement designed to occur at the joint is prevented from occurring.

Prior to placement, dowel assemblies should be visually inspected. Occasionally, metal burrs will be found that will create a locked joint if placed in the concrete. These burrs are the result of the shearing operation at the manufacturer's plant. The assembly can be used once these burrs are removed by filing, grinding or otherwise corrected.

The free end of all dowel assemblies should be painted with an approved coating material or tar paint. In addition, before placing, the free end of the bars should be coated with asphalt or other approved lubricant. Dowel caps are required for the free end of all expansion joints. The spacing of all joints should be in accordance with the requirements of the plans, Standards, and Specifications.

## **Tiebars**

Tiebars installed across the centerline should be parallel to the surface and installed as shown in the Standards. Unless an approved mechanical device, operating immediately behind the spreader or behind the strike off of a slip form paver, is used for the installation, the tiebars must be installed ahead of placing the concrete and held securely in position.

## **Tie Bolts**

Tie bolts used for multiple lane paving must be placed in proper position on the face of the roadway forms, as shown in the Standards.

## **Sawing**

The time for sawing will vary with weather and atmospheric conditions as well as the hardness of the coarse aggregate. Slight raveling is not objectionable and generally is an indication that sawing is being done at the proper time. Joints must be sawed over the exact center of load transfer devices and perpendicular to the surface. If sawing is not performed at the proper time, random or uncontrolled cracks will occur.

## **Final Strike-Off, Consolidation and Finishing**

Immediately after spreading, the concrete should be screeded and consolidated by means of approved mechanical finishing and vibrating equipment.

The purpose of the finishing machine is to not only provide some additional consolidation of the concrete, but also to produce a reasonably smooth, plane surface at the elevation and cross section specified.

When the spreader and finishing machine are in proper adjustment, there will be a uniform roll of concrete in front of each screed. The roll in front of the first screed should be larger than the roll in front of the back screed. The roll of concrete in front of the back screed should be sufficient (about as large as a man's wrist) to provide a uniform surface. If an excess of concrete is being carried forward in front of the screeds, it will tend to float or lift the machine off the forms. In addition, there will be "surging" behind the screed to complicate the proper function of the trailing equipment. As the work progresses, the tilt and speed of the screeds may need to be adjusted to adapt to the particular mix being used, to eliminate tearing, and to control the amount of surge. With stiff, harsh mixes, the screed's oscillating speed should normally be rapid with a long stroke and slow forward speed. With more fluid mixes, the screed action should be decreased, both in speed and length of stroke with the forward speed increased. The number of screedings will be determined by field conditions. Excess screedings should be avoided since it tends to result in undesirable quantities of low-strength mortar on the surface. The finishing machine wheels and the top of the forms should be kept clean at all times.

Vibrators, which may be attached to the back of the spreader, the front of the finishing machine, or on a separate carrier, must conform to the Specifications and be mounted in such a manner that they will not come in contact with reinforcement, subgrade, or forms. The entire width of the pavement must be thoroughly vibrated in a manner that will be effective for the full depth. All vibration should be controlled by the forward movement of the spreader so that vibration automatically ceases when the forward movement of the spreader is stopped.

After consolidating and screeding, the concrete is to be floated to remove irregularities left by previous operations and by shrinkage. This operation may be done by the use of longitudinal or a transverse float. The time of floating will depend on field conditions.

Floating should be held to a minimum during the period when the worst bleeding is occurring in order to avoid the over dispersion of cement particles in the surface paste. The longitudinal float should be operated so that the entire surface area is covered at least twice. This is accomplished by overlapping the previous transverse pass by one half the length of the float. Excessive floating should be avoided. If excessive cutting or filling is required, the equipment should be checked and necessary adjustments made to eliminate the condition. When operating properly, the longitudinal float should carry a small roll of concrete along all but approximately the rear 2 feet of its length.

When the transverse float is used, the time of operation must be adjusted to field conditions. This will be similar to the requirements for using a longitudinal float. The screed or screeds working ahead of the transverse float should carry a uniform roll of concrete so that the transverse float will leave a smooth uniform surface free of screed marks with a minimum of surging.

Regardless of the type of float used, a continuous operation at a uniform rate of speed is necessary for obtaining the most desirable finished product.

Normally, the addition of water to the surface to facilitate finishing is not permitted; however, the practice of wetting the surfaces of the finishing equipment with a fine mist spray is acceptable provided large droplets of water are not conveyed directly to the concrete surface.

## **Station Numbers and Dates**

**Stenciling Station Numbers and Dates** - Before concrete takes its final set and after finishing operations are completed, the Contractor shall stencil station numbers and dates into the pavement in accordance with the standard drawings. The dies for numbering and dating will be furnished by and remain the property of the Department. Dies or numerals lost or damaged by the Contractor shall be replaced at his expense.

## **Curing**

The "curing of concrete" is the operation which is performed to assist the cement hydration process to take place in such a manner that the concrete will be strong, durable and reasonably impervious. The natural tendency is for the water present on or near the surface to evaporate and thus cause a cessation of the hydration process. When conditions of low humidity, high wind, high temperatures, or combinations of the aforementioned occur, the rate of evaporation can take place almost as rapidly as if a giant blotter were to be placed on the surface.

When the rate of evaporation at the surface exceeds the rate at which water escapes (bleeds) to the surface, plastic shrinkage cracking is likely to occur. If such cracks extend down through the full depth of pavement, the structural capacity of the pavement is lost. Rain water and deicing chemicals will gain entry through the cracks and cause rapid deterioration of the pavement through freeze and thaw action.

The ability of an approved curing material to prevent the escape of moisture from the concrete is related primarily to the promptness and completeness of the application. Curing material must be applied as soon as practicable after the surface has been textured.

### **Liquid Membrane**

Curing compound is to be applied uniformly at the specified rate. Frequent checks should be made of the quantity used in relation to surface area to insure proper rate of application. Since white pigment particles will settle out of solution, all curing compound must be mixed thoroughly before and while it is used. Should the curing agent be damaged by rain or other causes, the pavement should be immediately covered by an additional application of curing compound.

### **Surface Test**

As soon as possible after concrete has set, the surface should be checked with a straightedge or other specified device. All irregularities varying by more than the Specification requirements should be corrected with an approved cutting tool. The Inspector should consult with the Area Construction Engineer before ordering surface corrections.

### **Removing Forms**

Side forms should not be removed from freshly placed concrete until the concrete has set for the specified time. The concrete should be hardened to the extent that spalling or

other damage will not occur. Immediately upon removal of forms, any honeycomb must be patched and the edges of pavement cured in an approved manner.

## **Sealing Joints**

Joints, whether sawed or formed, must be cleaned and surface dry at the time of sealing. The sealing of joints with approved material should be completed prior to opening the pavement to any traffic including the Contractor's equipment.

## **Protection of Pavement**

The edges and the surface of the pavement should be protected against damage by the public, and the Contractor's forces and equipment. The Contractor should be warned of the advisability of posting watchmen along sections of newly placed concrete in order to discourage acts of malicious vandalism until the concrete has attained sufficient set.

## **Checking Finished Grade and Cross Slope**

Inspectors should ensure that the finished grade elevations and design cross slopes are within specified tolerances. The finished grade elevations should be checked at the roadway centerline, each travel lane centerline, edge of pavement, and edge of shoulder at each Station (every 30 meters for Metric projects). If checks indicate that the surface is out of tolerance, more frequent checks should be made.

## **Tolerance in Pavement Thickness**

Prior to final acceptance, the Materials Division will core the pavement to determine the actual thickness. The thickness will be determined by the average caliper measurement specified in Section 316 of the Specifications.

If pavement thickness is not within the allowable tolerance, deductions for deficient pavement will be made in accordance with the specified method of adjusting unit price. However, the adjusted unit price for deficiencies need not appear on the monthly progress estimate unless specified instructions to do so are issued by the District Office.

## **Basis of Payment**

Normally, pavement is measured in square yards. The width for calculations may be taken from the typical cross sections. The length should be measured horizontally along the centerline of pavement.

All paving records and reports should be kept current and complete. The project records must include sufficient test reports or certifications to cover the material used:

1. Wire mesh.

2. Steel reinforcing bars.
3. Tie bars.
4. Dowel assemblies.
5. Expansion joint material.
6. Joint sealing material.
7. Curing compounds or materials.
8. Other materials for which test are required.

The following information should be included in the "Inspector's Daily Report."

1. The amount of concrete received and used. If a batch or load of concrete is wasted or rejected, then a reason should be noted on the appropriate ticket and in the "Inspector's Daily Report."
2. Stations between which pavement was placed and the number of square yards placed.
3. Record of Test Beams made or broken as outlined in the Manual of Instructions - Materials Division.
4. Contractor's labor and equipment.
5. Concrete pavement curing temperature ranges
6. The location of any joints which are not placed according to plans.

A field paving book is to be maintained for the daily paving train tests and measurements. The following tests and checks are to be located by time and station and initialed by the Inspector:

1. Air content test.
2. Consistency test.
3. Concrete and air temperatures.
4. Reinforcement cover checks.
5. Pavement depth checks.

When not in use in the field, the field paving book should be stored with the project records.

## **Inspector's Checklist**

1. Does the Contractor have a Certified Concrete Field Technician present during placement of pavement?
2. Is the concrete sufficiently cohesive to prevent detrimental sloughing of the edges when the slip form method is used?
3. Does the Contractor have sufficient equipment and tools to place and finish the concrete pavement as required?
4. Does the Contractor have sufficient equipment on hand to protect the concrete from freezing?
5. Do the forms and bulkheads meet the requirements of this section?
6. Do the vibrators being used meet the requirements of this section?
7. Does the surface of the concrete base course meet the requirements when tested under a 10 foot straightedge and also have a heavy broomed texture?
8. Are "leave out" joints installed when required and as detailed on the plans?
9. Are the side forms of the slip form paver designed so that tie bars can be placed as specified?
10. Have the forms been pinned sufficiently and locked in place to hold line and grade as required?
11. Prior to concrete placement, are the forms cleaned and oiled?
12. Is the alignment and grade of the forms checked and corrected as required by the Contractor?
13. Is the concrete placed and finished in accordance with this section?
14. Has the concrete in an adjoining lane attained the strength requirements before mechanical equipment is operated on it?
15. If random or uncontrolled cracking occurs, have concrete joints or slabs been repaired as specified?



16. Are the deformed tie bars and longitudinal joints installed as specified?
17. Are approved devices used to form the joints and the groove sealed with joint material as required?
18. Are saw cut joints in accordance with the requirements of this section?
19. Are transverse expansion joints properly formed and sealed with filler placed at the proper grade and elevation?
20. Are transverse contraction joints installed as specified?
21. Are the plain dowels held in place as required?
22. Is the free end of each dowel treated as specified?
23. Are isolation joints formed for structures in the pavement as required?
24. Is concrete mechanically vibrated to prevent voids and segregation?
25. Does the riding surface have a gritty texture and is it grooved as required?
26. Is the surface and sides of the pavement sprayed uniformly with curing compound which is continuously and effectively agitated during application?
27. Is the PE film being used for curing the type specified for the time of the year?
28. Has the Contractor maintained the surface temperature of the concrete as specified?
29. Is the curing material placed as early as possible in hot, low humidity or windy weather?
30. Is the paved riding surface in compliance with the requirements of this section?
31. Are the forms left in place for the required time before removal?
32. Are major honeycombed areas removed and replaced?
33. Are all joints thoroughly cleaned and sealed prior to opening the pavement to traffic?
34. Is the joint for hot-poured, or silicone sealer sealed only if the air temperature is at least 40 degrees F.?
35. Is the hot-poured sealer material stirred during heating and prevented from bonding to the filler as specified?

36. Is the sealer applied and tooled to form a recess as specified?
37. Is the contractor protecting the pavement from the effects of rain and all traffic as specified?
38. Does the pavement meet the thickness tolerance?

# **BRIDGES AND STRUCTURES**

## **SECTION 401 - STRUCTURE EXCAVATION**

### **Description**

Foundations are a very important part of bridge construction. If the underlying soil will not support the design loads, damaging settlements or overturning may result. For this reason, the Inspector should pay particular attention to the type and condition of material encountered during excavation. The materials encountered should be compared with the substrata shown on the plans. Significant variations should be reported to the Area Construction Engineer.

During excavation, nearby buildings, utilities, sloping ground surfaces, or other substructure elements may be damaged. While inspecting such operations, be mindful of the possibility that it may become necessary to modify adjacent slopes or to support the sides of the excavation, thereby preventing damage to adjoining property; however, this is the Contractor's responsibility. Bring the possibility of property damage to the Contractor's attention, leave the necessary corrective measures to his initiative and document such notification in the Inspector's Daily Report.

### **Preparation of Foundations For Footings**

Stability is the key to a good foundation. Generally, dense sands or gravels have the desired stability. Clays may be acceptable. However, muck and soft clays should be removed.

Rock, if sound, will provide a satisfactory foundation. Sedimentary types of rock may have voids and should be investigated by probing, sounding or drilling before any concrete is placed. Rock surfaces upon which concrete is to be placed should be relatively level. When sloping rock is encountered at or near footing elevation, the rock should be stepped or serrated.

Not only rock, but all foundation materials must be thoroughly examined. If there occurs a large difference in the types of soil or combination of soil and rock within a footing, advise the Area Construction Engineer. Abnormal conditions encountered during excavation are to be noted in detail in the diary along with a description of the physical characteristics of the material upon which the footing is placed. Normally, the Area Construction Engineer is to examine and approve all foundations prior to the placing of concrete in footings. The name of the person approving the foundation and the date of approval should be noted in the diary.

Ground water is often encountered above the desired foundation elevation. This water must be prevented from saturating the foundation soils. One way of preventing saturation is by constructing sumps in the excavation. These serve as receptacles for excess water and expedite pumping operations. All sumps should be located outside the footing forms. In addition, other precautions may have to be taken to ensure that water flow will not

wash cement from freshly placed concrete. Water from foundations is not to be pumped directly back into the stream.

Before the Contractor can begin work on, over, or under Railway property, approval must be obtained. The Contractor must submit to the Department his plan of operations for shoring, sheeting, or cofferdaming for construction of pier foundations and other excavation adjacent to the railway tracks. The Contractor may be required to show information in sufficient detail so that his design can be easily checked or may be required to submit his design calculations. This information should be submitted to the District Administrator for review and subsequently submit the Contractor's plan directly to the Railway for their approval.

## **Cofferdams and Shoring**

A cofferdam is a structure, generally of a temporary nature, constructed for the purpose of keeping water and earth out of the excavation area. Normally a cofferdam is placed before excavation begins. A simple type of cofferdam is a box-like enclosure of sheet piling within which the excavation is made, pumped dry, and the foundation constructed.

When an underwater foundation must be constructed in the dry, a layer of concrete may be used to seal the bottom of the cofferdam. In this situation, a layer of concrete is deposited within the cofferdam by means of a tremie. After the concrete has cured, the water inside the cofferdam is pumped out. The weight of the concrete seal resists the pressure created by the water on the outside of the cofferdam and prevents water from entering. Once the cofferdam is pumped out, the area can be cleaned and the footing constructed.

Cofferdams must be of sufficient size to accommodate the necessary form work, drainage details such as sumps, clearance for batter piles, and clearance for minor deviations that occur in the installation of the walls.

Shoring refers to temporary support of the sides of an excavation and must conform to the Federal OSHA Standards and Virginia OSHA Standards. It is a wall type structure constructed of wood or steel and is installed as the excavation proceeds. Although the Contractor is responsible for the adequacy of shoring used, any seemingly unsafe condition should be brought to the attention of the Contractor and the Area Construction Engineer.

## **Backfill Material**

The key to a stable backfill is the use of good materials and proper placement techniques. Intermittent inspection is essential to the obtainment of a properly constructed backfill.

The best materials for backfill are well graded broken stone, gravel, and sand. They drain well and their behavior is predictable. Generally, silty sands, silts, and clays are poor backfill materials because they drain slowly, resist compaction, shrink when dry and swell when wet. Poor materials lead to undesirable settlements and exert excessive pressures against the walls or abutments of the structure. Seek the cooperation of the Contractor in selecting and using the best material available for backfill. Generally, the material excavated will be accepted for backfilling. If there is reason to believe such material is not acceptable, consult the Area Construction Engineer for a decision. Suitable material may be available elsewhere on the project. Refer to the plans, special provisions, Standards and Specifications for the specific requirements for backfill material.

## **Placement**

The importance of proper placement of backfill material cannot be overemphasized. Care should be given to the sequence and method of placing.

Backfill material must be placed in 6 inch layers, loose, and compacted at 20 +/- percent of optimum moisture to 95 percent of the theoretical maximum density. As backfilling progresses, lifts in front of and behind structures must be placed and compacted at the same elevations. A sufficient number of compaction tests should be taken to assure the Department that the backfill is placed in accordance with the contract requirements.

Backfill shall not be placed against abutments or wingwalls until concrete has been in place for 14 days, or until 93 percent of the 28-day design compressive strength has been obtained. Because of this requirement, the open excavation around structures is occasionally allowed to stand for a lengthy period of time before backfill material is placed. In such instances rain water and ground seepage may collect in the excavation and reduce the stability of the foundation soils; therefore, the Contractor should take adequate precautions for drainage or pumping of sumps. The Inspector should impress upon the Contractor the importance of prompt backfilling and make every effort to see that open excavation around structures is kept dry until backfilled. Backfill shall be placed no later than 30 days after the placement of concrete.

## **Backfilling Weepholes**

Weepholes permit water to escape from the backside of an abutment or wall. If water is trapped and allowed to accumulate behind the wall, the abutment will be subject to high thrust type forces. Weepholes should be kept clear of all obstructions when the backfill is placed and remain clear after the backfill is complete.

Two inch crusher run is to be used to backfill around the back of weepholes. The material shall be placed 18 inches behind the entrance to the holes, 18 inches above the bottom of the holes and 18 inches laterally on each side of the holes. Place filter cloth or mesh at weepholes.

## **Records**

The project records are to include the following field information and calculations:

1. Original ground level notes including sketch indicating location of irregularities.
2. The actual elevation of the footing bottom.
3. The actual horizontal dimensions of the excavated area. (Pay quantity is to include the actual material excavated limited to 18 inches outside of footing neatlines.)
4. When the footing is to be keyed into rock, record the actual dimensions of the excavated area.
5. The vertical limits of excavation are from the bottom cross sections of the footing to the original ground cross sections. When structure excavation is in a fill area, excavation above the original ground will not be included for payment. When footing is on piles, fill to top of footing and excavate to bottom. Pay to top of footing in this case.
6. Structure excavation calculations.
7. Date, name and title of person who approved the foundation.

## **Inspector's Checklist**

1. Is an area staked off 18 inches around the neatlines of the footing and record original ground elevations, including irregularities, prior to excavation operations?
2. Does the Inspector verify the Contractor's layout of excavation area?
3. Does the Contractor install the required erosion and siltation control devices?
4. Does the Contractor verify the need for cofferdams or shoring to retain the embankment in compliance with applicable safety codes during excavation?
5. Does the Inspector check the plans for the bottom elevation of the footing and notify the Contractor not to exceed this elevation?
6. Does the Contractor examine the foundation for proper location, dimensions, grade and stability? The Contractor is to explore at least five feet below the contemplated foundation elevation. Usually, three to five drilled holes or rod soundings are sufficient to determine the adequacy of the sub-foundation. Note location of exploration in project records.

7. Does the Inspector notify the Area Construction Engineer and/or District Bridge Engineer for inspection and approval of foundation?
8. Does the Inspector record foundation irregularities and computed excavation quantities?
9. Is the foundation cleaned of loose materials prior to placement of concrete?
10. Are the concrete strength requirements met prior to form removal and subsequent backfill?
11. Is the backfill placed in uniform lifts and compacted properly?
12. Has the material used for backfill been approved by the Engineer?



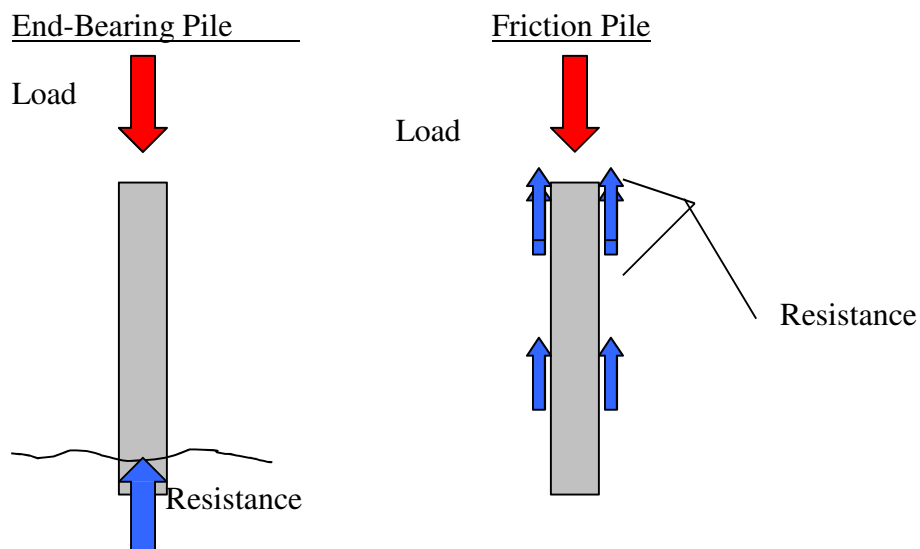
## SECTION 403 – BEARING PILES

### Description

When the near-surface soil or rock is too weak to support the load of a structure plus the load to be carried by a structure by means of a spread footing, deep foundations are typically used to transfer the load to deeper soil or rock that is capable of providing adequate support. The most common type of deep foundation system used by VDOT is driven piles. Driven piles can be classified generally as either end-bearing piles or friction piles.

**End-bearing piles** transfer the load from the head of the pile directly to a competent stratum (such as bedrock) located near the tip (bottom) of the pile. End-bearing piles are generally driven to refusal (either “practical” refusal or “absolute” refusal), the definitions of which are provided in the Specifications, and discussed later in this Section. “Refusal” in the general sense can be considered the point beyond which it is not possible to achieve further penetration without excessive driving and possibly pile damage. Steel H-piles are generally used when end-bearing piles are required. Often a pile tip (or point) is used to help prevent tip damage as the pile passes through cobbles or boulders and as the tip of the pile reaches the bearing stratum.

**Friction piles** transmit the foundation load to the ground by means of frictional resistance that develops along the sides (shaft) of the pile as the pile is driven into the ground. It should be noted that all piles have both an end-bearing capacity and a frictional (shaft) capacity. A pile is classified as either an end-bearing pile or a friction pile based on the predominant manner in which the pile carries the load. The most common types of friction piles used are prestressed concrete piles; however, timber piles and cast-in-place piles are occasionally used. Friction piles are not usually driven to refusal, but rather they are driven to the depth (penetration) at which the required capacity is reached. A pile is considered to have reached the required capacity when a certain “driving criteria” has been attained.



The term “driving criteria” will be used throughout the remainder of this Section instead of the previous term “blow count.” Driving criteria is the driving resistance (blow count) that is observed under the action of a specific hammer operating at a specific stroke. It is important to remember that reporting a “blow count” by itself is basically meaningless. The blow count should always be accompanied, at a minimum, by the hammer stroke that was observed during the occurrence of that blow count. For example, if it has been determined that the driving criteria for a specific hammer for a project is determined to be a minimum of 20 blows per foot (bpf) under a minimum hammer stroke of 7 ft. If the driving resistance is observed to be 20 bpf under a hammer stroke of 8 ft., the driving criteria have been satisfied, and the pile will likely be acceptable. On the other hand, if the driving resistance is observed to be 20 bpf under a hammer stroke of 5 ft., the driving criteria have not been satisfied, and the pile is not acceptable. Additional pile penetration will be required. The driving criteria depend on several factors, many of which will change throughout the course of a project.

The selection of pile type is left to the judgment of the Engineer who designed the foundation and is based on various design considerations. If, however, there are any questions or concerns that, based on field observations, may adversely affect the type of pile indicated on the plans, contact the Area Construction Engineer. It is possible that the designers were not aware of these conditions when designing the foundations. The Area Construction Engineer should contact the District Bridge Engineer for direction regarding this issue.

Prior to beginning pile driving work, the Inspector should review the anticipated work plan with the Contractor. He/she should be sure that the Contractor is fully aware of all pertinent Specifications, Special Provisions, and the notes on the plans. This kind of communication will help reduce conflicts and misunderstandings that may occur between the Contractor and the Inspector.

## **Suitability of Foundation**

During foundation excavation work, it might be determined that piles are not required under a portion of (or the entire) foundation. If so, explore the bearing layer according to the Specifications and submit the findings to the Area Construction Engineer. The Area Construction Engineer should contact the District Bridge Engineer for direction regarding this condition.

## **Test Piles vs. Production Piles**

Pile driving usually involves the placement of two types of piles: test piles and production piles. Not all projects require that test piles be driven. Projects that utilize steel H-piles as end-bearing piles may not have test piles. If test piles are required on a project, their quantity and location will be clearly indicated on the plans. Test piles are installed prior to production piles and are used to establish the driving criteria and, in the case of prestressed concrete piles and timber piles, pile lengths for the Contractor’s order

list. After installation, the test piles are usually incorporated into the foundation as production piles, provided they were not damaged during placement.

When driving tests are required, the Contractor shall install the test pile with the same equipment and in the same manner that he plans to install the subsequent production piles. The Inspector should carefully monitor the installation of the test piles. Subsequent production piles that appear to drive significantly different than the test piles should be brought to the attention of the Area Construction Engineer, as this might be an indication of a problem.

## **Order Lists**

When precast (prestressed) piles or timber piles are being used, the Contractor is required to submit an order list to the Engineer for review and approval prior to placing an order with the pile supplier. This order list is usually developed after the test piles are driven, and the Contractor feels that he has a good estimate of the pile length required for the project. On most projects, the required pile lengths will vary from one substructure unit to another. In many cases, the pile lengths approved by the Engineer will be slightly longer than the embedment indicated during the test pile work, in order to have some contingency length in case subsurface conditions change unexpectedly between test pile locations.

## **Methods Used to Estimate Bearing Pile Bearing Capacities**

- a) **Loading Tests:** When required, a load test involves the incremental application of a static load to the top of a pile (usually a test pile) and the measurement of the movement of the pile as the load is applied. The maximum load applied to the pile is usually 200% to 300% of the load required for design, unless failure of the pile occurs first. This test is usually a compressive load test; however, uplift (tensile) and lateral load tests can be also performed. The apparatus required to perform this test usually involves a large reaction beam held in position by several reaction piles located adjacent to the test pile. A hydraulic jack is used to apply the load, and a load cell is used to measure the load. Dial gauges, wire-and-mirror gauges and survey points are generally used to measure the movement at the top of the pile under the applied load. In some cases, if measurements of pile deflection at various points along the length of the pile are required, telltale gauges might be used. Telltale gauges consist of vertical rods that extend to particular locations within the pile. The movement of these rods can be measured as the load is being applied to the pile.

The Inspector is responsible for completing Form C-4 Pile Loading Test Data and recording all load test data, as well as all pertinent observations and occurrences during the test. The completed form should be submitted to the Area Construction Engineer and District Bridge Engineer for review.

The load test is typically used only on large projects, particularly those on which the design capacities of the piles are higher than usual.

- b) **Pile Driving Analyzer (PDA):** While the load test is performed on a pile after it has been fully driven into the ground, the PDA (also referred to as Dynamic Pile Test) is a test that is performed on a pile (usually a test pile) during its installation into the ground. Before pile driving begins, strain gauges and accelerometers are attached near the top of the pile. Wires connect these gauges to a computer located nearby. As the pile is driven into the ground, the PDA is able to measure numerous parameters and estimate several important values, including the static capacity of the pile, the driving stresses that occur within the pile, the performance of the hammer, and possible pile damage. This work is performed by one of the companies on the Department’s list of approved PDA firms.

For friction piles, after the test pile is initially driven, the Contractor is usually required to wait a minimum of five days, after which a restrrike is usually required. The reason for this requirement is that the capacity of a friction pile changes over time. In other words, the process of driving a pile into the ground causes tremendous changes within the soil that surrounds the pile and the water within the soil. Over time, these changes gradually reach some condition of equilibrium, and it is this long-term equilibrium condition that we want to measure. The PDA is used during the restrrike of the pile as well.

- c) **Driving Formulas:** These formulas are found in the Specifications and should be used with extreme caution. These are approximate relationships that have a wide margin for error. However, if neither load tests nor PDA are indicated on the project, they can be used to establish driving criteria (also referred to as the “blow count required for safe bearing”). The formulas shown in the Specifications are shown below, rewritten in a slightly different format:

For single-acting steam hammers: 
$$C = \frac{12(P)}{(2WH) - 0.1(P)}$$

For double-acting steam hammers: 
$$C = \frac{12(P)}{2H(W+Ap) - 0.1(P)}$$

For gravity hammers: 
$$C = \frac{12(P)}{2(WH) - P}$$

For diesel hammers: 
$$C = \frac{12(P)}{1.6(E) - 0.1(P)}$$

Where:

- C** = blow count required for safe bearing, in blows per foot (bpf)
- P** = theoretical safe bearing capacity of the pile, (pounds)
- W** = weight of striking parts of hammer (ram weight), (pounds)
- H** = height of hammer fall, or stroke, (feet). For double-acting hammers, this might be referred to as equivalent stroke.
- A** = area of piston, (square inches)
- p** = steam pressure at the hammer, (psi)
- E** = equivalent energy, (foot-pounds)

**Example:** – Friction Pile

Using the appropriate driving formula given above, determine the driving criteria to be recorded on the “Required Blow Count” table of Form C-1 Pile Driving Record for the following situation:

- Hammer: ICE 70-S open-ended diesel hammer.
- Ram Weight: 7000 lbs.
- Stroke Range: 4.0 ft. to 10.0 ft.
- Pile: 24-inch prestressed concrete pile.
- Design Capacity: 84 tons.

**Solution:**

During the initial test pile phase of the project, it was observed that, for this particular hammer at this particular site, the observed hammer stroke varied from 5 ft. (for the weakest soil layers) to 8 ft. (for the strongest soil layers). Therefore, the driving criterion for each stroke within this range needs to be determined.

Using the following equation, a table can be developed.

$$C = \frac{12(P)}{1.6(E) - 0.1(P)}$$

Stroke, (ft.)	Ram Weight (lbs.)	Energy, E (ft.-lbs.)	C (bpf)
5	7000	35,000	51
6	7000	42,000	40
7	7000	49,000	33
8	7000	56,000	28

The “C” values shown in the table correspond to the “blow count” that is required for safe bearing for each of the stroke values noted. To complete the table on Form C-1, practical and absolute refusal must be calculated for each stroke. Recalling the definitions of practical and absolute refusal, the table on Form C-1 would be filled out as follows:

<b>STROKE</b>	<b>5 ft.</b>	<b>6 ft.</b>	<b>7 ft.</b>	<b>8 ft.</b>
Bearing (bpf)	51	40	33	28
Practical Refusal (bpf)	102	80	66	56
Absolute Refusal (bpi)	17	13	11	9

This table should be completed prior to production pile driving. For each of the given strokes, the Inspector can easily determine the three criteria under which pile driving can be terminated. For example, if the hammer is operating at a stroke of 6 ft., the Contractor can terminate pile driving if at least 40 bpf occurs for three consecutive feet, **or** at least 80 bpf is maintained for one foot, **or** at least 13 bpi is maintained for one inch.

These criteria were based solely on the driving equation. If PDA had been used on the project instead, the driving criteria would likely have been much different. PDA is a far superior method for establishing driving criteria. If PDA is used, the driving criteria will be provided to the Inspector by the District Bridge Office.

## **Glossary of Terms**

**Leads:** The leads, which are supported by a crane, are the framework that is used to support the pile and the hammer and to keep them in proper position during pile driving.

**Helmet:** (Also called the drive head, bonnet, anvil block, or pile cap) The helmet, which is usually made of steel, is designed to help distribute the hammer blows evenly across the top of the pile. It is important that the helmet fit the pile correctly.

**Template:** A template is a temporary steel frame that is mounted on the ground, or the bottom of a river or stream, and is used as a guide to ensure that the pile is placed in proper position.

**Hammer:** The hammer is composed of numerous parts, including the ram, anvil base, striker plate and capblock. The different hammers types are:

**Pile Cushion:** For pre-stressed concrete piles, a pile cushion is placed between the helmet and the pile. The pile cushion, which is typically made up of layers of plywood, is used to help cushion the impact from the hammer. It helps reduce the damage to the pile head and helps reduce driving stresses within the pile. (Do not confuse pile cushion with hammer cushion. The hammer cushion (sometimes called the capblock or cushion block) is a device contained within the hammer assembly.)

**Ram:** The ram is the part of the hammer that drives the pile. It basically is the moving part (striking part) of the hammer. **The manner in which**

**the ram is raised and lowered is the main feature that distinguishes the different hammer types.**

**Stroke:** The stroke is the distance over which the ram travels as it falls (from the highest point to the lowest point). If the ram freefalls by gravity, the stroke is the actual distance of the fall. However, if the ram is “pushed” downward as it travels downward, an equivalent freefall stroke must be determined.

**Energy:** There are numerous ways to refer to the energy (or equivalent energy) that a hammer imparts to a pile. The simplest way is to state that energy is equal to the weight of the ram multiplied by the hammer stroke [ $E = (W)(H)$ ]. This relationship is only applicable to drop hammers and single-acting hammers, not for double-acting hammers. For double-acting hammers, an equivalent free fall stroke must be determined based on the pressure that is built-up within the bounce chamber of the hammer. The Contractor should provide the Inspector with information that correlates bounce chamber pressure to equivalent freefall stroke. For double-acting hammers, the energy is considered “equivalent” energy because it is calculated using the equivalent freefall stroke [Equivalent Energy =  $(W)(\text{Equivalent } H)$ ]. A list of pile hammers is provided at the end of this Section.

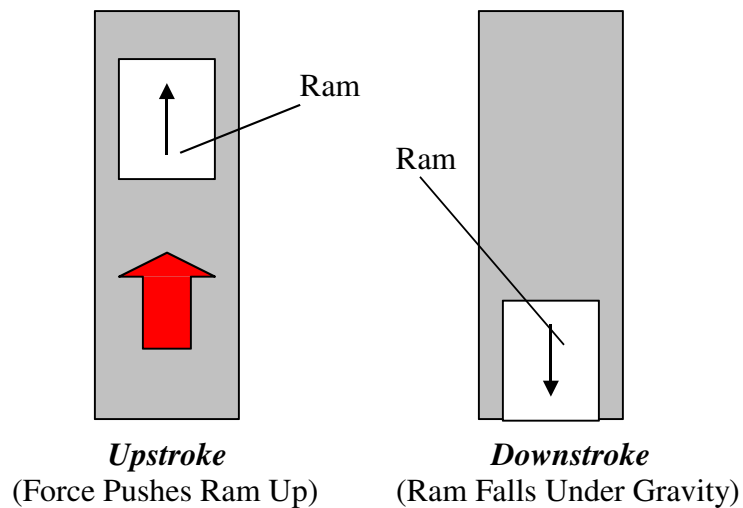
The previous two references to energy (E and Equivalent E) are the terms used in the driving formulas previously presented. It should be noted that these values do not represent the energy that actually reaches the pile. There are numerous losses of energy that occur during each stroke of the hammer. These losses include the friction that the ram experiences as it travels downward and the losses that occur as the impact energy passes from the ram (through the hammer cushion, the helmet and pile cushion) to the top of the pile. The numbers (0.1 and 1.0) in the driving formulas represent an attempt to account for these energy losses. On projects where PDA is used, the measured energy will be significantly lower than the energy that is computed by multiplying W and H, because the PDA is measuring the energy that actually reaches the gauges mounted near the top of the pile.

**Drop Hammer:** This type of hammer, sometimes called a gravity hammer, involves raising a weight (ram) by a cable and allowing the weight to freefall, striking the pile. This type of hammer is rarely used nowadays, primarily because it is an inefficient method of driving piles. Additionally, if great care is not used, there is a high risk that this type of hammer will overstress the pile causing damage during driving. The drop hammer should only be used for low capacity piles and only with approval of the Engineer.

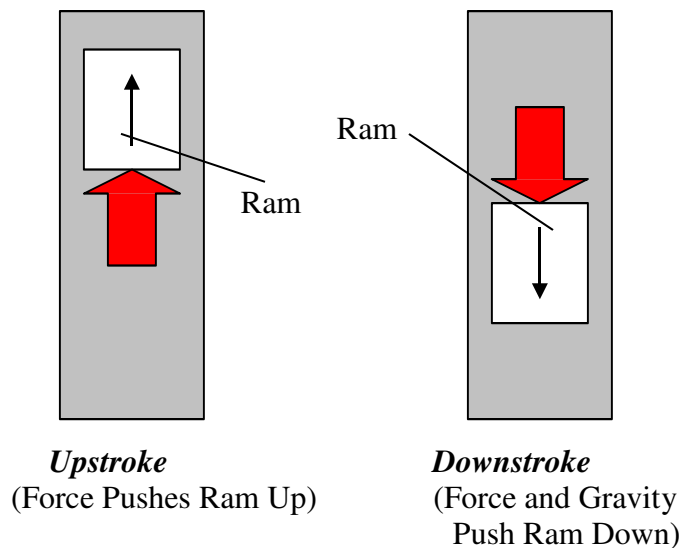
## Single-Acting vs. Double-Acting Hammers:

The term “single-acting” refers to the fact that the ram is only pushed upward by some force; once the ram reaches the highest point of the stroke, it will be allowed to freefall by gravity until it impacts the pile. The term “double-acting” means that the ram is pushed upward by some force, and the ram is pushed downward by some force (in addition to the force of gravity).

### Single-Acting Hammer



### Double-Acting Hammer





**Single-Acting, Air/Steam Hammer:**

Upstroke – Caused by the pressure of compressed air or steam acting on the bottom of the ram.

Downstroke – Caused only by gravity.

**Double-Acting, Air/Steam Hammer:**

Upstroke – Caused by the pressure of compressed air or steam acting on the bottom of the ram.

Downstroke – Caused by gravity **and** the pressure of compressed air or steam acting on top of the ram.

**Differential-Acting, Air/Steam Hammer:**

A special type of double-acting air/steam hammer that incorporates the use of pistons having two different diameters connected to the ram.

**Single-Acting Diesel – Also known as an Open-Ended Diesel Hammer.**

Upstroke – Caused by the explosion of diesel gas.

Downstroke – Caused only by gravity.

**Double-Acting Diesel – Also known as a Closed-Ended Diesel Hammer.**

Upstroke – Caused by the explosion of diesel gas.

Downstroke – As the ram moves upward, it compresses air in the upper portion (closed portion) of the hammer, called the bounce chamber. Once enough pressure builds up to stop the upward travel of the ram, the ram is pushed downward by the built-up pressure, as well as by gravity.

**Single-Acting Hydraulic Hammer: \***

Upstroke – Caused by an external hydraulic power source.

Downstroke - Caused only by gravity.

**Double-Acting Hydraulic Hammer: \***

Upstroke – Caused by an external hydraulic power source.

Downstroke – Caused hydraulic pressure and gravity.

\* (Note that hydraulic hammers can be thought of simply as special types of air/steam hammers. For both hydraulic hammers and air/steam hammers, the most important aspect to remember is that some external power source (be it steam, air, or hydraulic fluid) is used to move the ram.)

**Soil Set-up (Or Soil Freeze):**

The process of driving a large friction pile into the ground causes significant soil displacement and disturbance. As a result, the soil's shear strength can be reduced dramatically during driving and for some period of time after driving. This phenomenon is related to an increase in pore water pressure that occurs within the soil. As time passes, the excess pore water pressures dissipate, and the soil surrounding the pile appears to get stronger than it was during pile driving (it appears to "freeze").

**Design Pile Capacity:**

The design pile capacity (also called allowable pile capacity, or the theoretical safe bearing capacity of the pile) is the maximum load that will be placed on the pile by the structure and live loads, as calculated by the designers. This is the capacity that is shown on the plans.

**Ultimate Pile Capacity:**

Ultimate pile capacity is the maximum load that a pile can carry. This is the load under which a pile would fail (failure is defined generally as plunging into the ground or settling excessively). In order for the pile to be acceptable, the ultimate capacity must be significantly greater than the design capacity listed on the plans.

**Factor of Safety:**

The ratio of ultimate pile capacity to the design pile capacity. The minimum required factor of safety will vary between 1.9 and 3.5, depending on the level of construction control is used during the test pile work. For example, if PDA is used to monitor driving, the factor of safety required by the Special Provisions is usually 2.25. However, if driving formulas are used, the required factor of safety increases to 3.5 (since the driving formulas are far less accurate than PDA).

**Bearing:**

The term "bearing" is used to describe the minimum driving criteria that must be observed to determine that a friction pile has reached the required bearing capacity. The "bearing" blow count must be maintained for three consecutive feet of driving. (End-bearing piles are never driven to "bearing"; they are always driven to either practical refusal or absolute refusal.)

**Practical Refusal:**

As defined in the Specifications, practical refusal is twice the blow count required for bearing, maintained for one foot.

**Absolute Refusal:**

As defined in the Specifications, absolute refusal is four times the blow count required for safe bearing, maintained for one inch.

## Estimating the Stroke

It is very important that the hammer stroke be estimated as accurately as possible, at least to the nearest one-foot (preferably to the nearest half-foot).

Single-acting air/steam hammers and single-acting hydraulic hammers utilize a constant stroke depending on the available stroke settings. For example, the ICE 160-SH is a single-acting, hydraulic hammer that has a maximum stroke of 4 ft. With this hammer, the Contractor can set the stroke to operate at 1 ft., 2 ft., 3 ft., or 4 ft. (full stroke). If the Contractor chooses for some reason to set the hammer to operate at half stroke, the stroke will always be 2 ft. for that hammer. During pile driving, if the Contractor increases to full stroke, the stroke will always be 4 ft. For these hammers, recording the stroke is usually a simple matter.

Diesel hammers operate differently than air/steam and hydraulic hammers. Diesel hammers have several different fuel settings that correspond to various magnitudes of fuel combustion. These fuel settings are not absolutely linked to a specific stroke. For diesel hammers, the stroke that is achieved during driving is directly related to the resistance provided by the soil. In other words, for a given fuel setting, the stroke will tend to increase as the pile penetrates into harder/stiffer ground. Conversely, as the driving resistance decreases (meaning the pile is penetrating into looser/softer ground), the stroke will tend to decrease.

The hammer stroke can be estimated or measured during pile driving using the following methods:

**Visual Methods:** For drop hammers and single-acting hammers, the stroke can usually be estimated by simply observing the ram. When an open-ended diesel hammer is operating, the top of the ram often extends above the top of the hammer (out of the open end) at the high point of each stroke. Sometimes the stroke can be determined by viewing this part of the ram relative to the leads. In some cases, the end of the ram has rings that provide an estimate of the stroke as the ram extends out of the top of the hammer.

For double-acting hammers, the Contractor must provide a bounce chamber pressure gauge and provide the relationship between bounce chamber pressure and equivalent

freefall stroke. For example, for a certain hammer model, if the bounce chamber pressure is say 12 psi, the equivalent freefall stroke might be 6 ft.

**Timed Methods:** For single-acting diesel hammers operating continuously, it is possible to measure the time that it takes the hammer to strike the pile 10 times, and use this number to estimate stroke using the following equation:

$$H = 0.0402 (T)^2 - 0.3$$

Where:            H = stroke (ft.)  
                      T = Time (seconds) for 10 hammer blows

For example, if a single-acting diesel hammer (operating continuously) is being used, and it takes 12 seconds for the pile to be struck 10 times, the stroke is about 5.5 ft.

**Note that this equation is only valid for single-acting diesel hammers; it is not applicable to double-acting diesel hammers.**

Some Inspectors might be concerned that, in order to use the timed method, he/she might not be able to record the blow count that is occurring during that interval of driving. Because obtaining stroke information is so important, it is acceptable to miss a blow count every so often during the time at which the Inspector is checking the stroke. For instance, for every 5 ft. to 7 ft. of pile driven, the driving record might have a blank in the blow count column, but it would have a value in the stroke column.

**Saximeter:** A saximeter operates on the same principle as the one described above; the saximeter calculates stroke by measuring the time between blows.

**Bounce Chamber Pressure:** For closed-ended hammers, none of the previous methods for estimating the stroke are appropriate, since the ram is not freefalling on the downstroke. In these cases, a bounce chamber pressure gauge must be used to estimate an equivalent freefall stroke. The Contractor should provide the Inspector with information that relates the bounce chamber pressure to the equivalent freefall stroke.

## Preparation Prior to Pile Driving

Prior to pile driving operations, the Inspector should do the following:

1. Download Forms C-1 and C-4 from <FILE:\\0501coconst\public\FORMS>
2. Become familiar with the type, size, and location of piles that are being used on the project. Pay particular attention to the quantity and estimate lengths indicated at each substructure unit on the plans, because these are the lengths that the designers estimated would be necessary to support the load. Any significant

deviation in estimated pile length should be brought to the attention of the Area Construction Engineer and the District Bridge Engineer.

3. If prestressed concrete piles or timber piles are used, obtain a copy of the Contractor's Pile Order List. Confirm that the production piles (size and length) provided by the Contractor meet the requirements of the order list.
4. Examine the tips (bottom) of each pile to confirm that the appropriate tip (point) has been used per the requirements of the plans and Specifications.
5. Confirm that the pile has been marked in one-foot increments so the Inspector can determine when the driving criteria have been satisfied. For sections of pile that will be left exposed above the ground surface, remove these marks if they detract from the appearance of the pile.
6. Confirm that the Contractor will be lifting the pile from the ground and placing it into the leads in an appropriate manner. This is particularly important for prestressed concrete piles. The prestressed pile standard sheet in the plans indicates the number and locations of pile pick-up points, and it is very important that the Contractor adhere to these requirements. Concrete piles can be damaged if not lifted correctly, and this damage is usually not easily detected because of the prestressing force within the pile will tend to close small cracks that may develop.
7. Position every pile as shown on the plans. The Contractor is responsible for pile layouts, and the Inspector is responsible for checking these layouts.
8. Confirm that the pile is oriented correctly (either plumb or battered). If battered, confirm that the Contractor is installing the pile at the correct batter.
9. Confirm that the Contractor is using a hammer that meets the minimum energy and ram weight requirements that are indicated in the Specifications, listed on the plans, and the requirements of the Special Provisions.

## **Observations During Pile Driving**

1. Record the blow count and stroke.
2. Record all noteworthy occurrences, including pile rebound.
3. Never overdrive a pile that has attained the driving criteria, unless directed to do so by the District Bridge Engineer. In some cases, a minimum pile tip elevation must be reached. In some cases, if driving becomes excessive, the District Bridge Engineer may direct or approve preboring or jetting to enable the pile to reach a certain tip elevation.

4. If a pile refuses at a tip elevation that is higher than expected, this might be an indication that an obstruction was encountered (boulder, debris, etc.). A pile that bears on such an obstruction might not be able to carry the required load, and the Area Construction Engineer should be contacted.
5. When driving concrete piles, the pile cushion should be examined regularly to determine that it still meets the requirements of the Specifications.

## **Additional Considerations**

### **Preboring**

In some cases, the Contractor is required to prebore prior to pile installation. Preboring involves drilling a hole with an auger throughout a portion of the depth necessary for penetration. When friction piles are to be placed through newly constructed embankment fill, preboring must be performed through the fill, after which the pile is placed into the prebored hole and driven to the required capacity. Preboring operations (other than through embankment fills) that are not specified on the plans should be allowed only if authorized by the District Bridge Engineer.

### **Jetting**

Jetting is another method that is sometimes used to facilitate pile penetration, particular projects located in the coastal region. Jetting involves the use of high-pressure water or air that flushes away the soil adjacent to the pile. In most cases, jetting is only used to help the pile pass through a certain stratum that it could not pass by driving alone; it is rarely used during the entire pile installation. Jetting is most effective in loose to medium dense granular soils.

Jetting is not advised for friction piles because the jetting process reduces the piles frictional capacity. Recently, environmental regulations have restricted the locations at which jetting can be used. As with preboring not called out on the plans, jetting should only be allowed if authorized by the District Bridge Engineer.

### **Unusual Driving**

An apparent increase (or an apparent decrease) in the driving resistance may indicate that a pile has been broken or, in the case of cast-in-place piles, the shell may have collapsed. This occurrence should be recorded and immediately brought to the attention of the Area Construction Engineer. Each case will have to be evaluated as to whether remedial actions are required.

When driving steel shells for cast-in-place concrete piles, check adjacent piles that have been previously installed for possible shell collapse or damage as subsequent piles are driven in the group. To the extent practical, all driving of the shells of cast-in-place piles shall be completed for a given substructure unit prior to concrete being placed in any of

the piles. Driving shall not be performed within a 15-foot radius of freshly placed concrete until the concrete has been in place for at least 7 days.

### **Accuracy of Driving**

The Inspector should check the alignment of all piles (vertical and battered) prior to driving, when the pile is placed within the leads. Vertical piles should be checked with a carpenter's level, and battered piles should be checked with a template and carpenter's level. When battered piles are required, the leads should be battered at the same angle as the pile.

Piles shall not be driven with a variation of more than  $\frac{1}{4}$  inch per foot from vertical or the batter specified. This tolerance should be checked immediately after the pile has been fully driven into the ground.

Once pile driving operations begin, the Contractor and Inspector should periodically check that the position and alignment of the pile are within tolerance. Piles have a tendency to change position and direction once driving begins. Periodic checking may allow the Contractor to make adjustments that can correct the position or alignment of a pile that is beginning to deviate from its planned location and orientation.

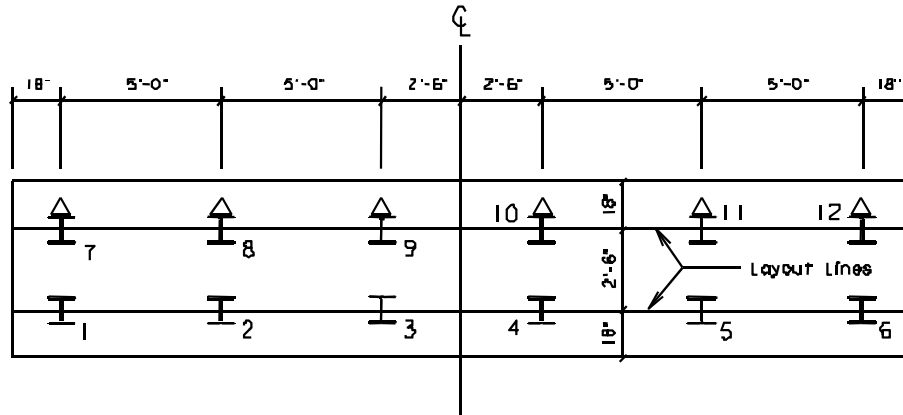
After the piles are driven, the Inspector must make the following three checks to help ensure that the piles meet the Specifications:

1. Each pile must be no more than  $\frac{1}{4}$  inch per foot from vertical or the batter specified on the plans (or as directed by the Engineer). This check is made immediately after the pile is driven.
2. Each pile must be within the position tolerance as described in the Specifications for that particular type of pile. This check is usually made after all piles within a section of footing have been driven.
3. All piles under a separate footing or an individually constructed unit are considered as a group and must conform to the center of gravity (C.G.) tolerances described in the Specifications.

The following sketches, Determination of Center of Gravity of Pile Group, show a typical steel pile layout for a bridge abutment. The upper sketch shows the locations of the piles as indicated on the plans. The lower sketch shows the piles locations after they were driven into the ground.

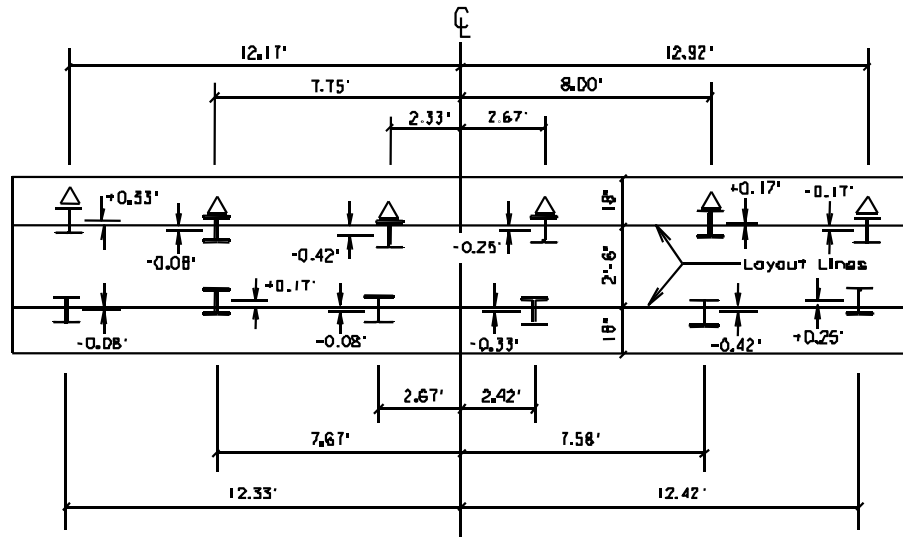
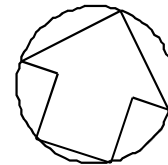
Since this foundation consists of steel piles supporting an abutment, each individual pile must be within 6 inches of plan location. All piles satisfy this requirement.

### DETERMINATION OF CENTER OF GRAVITY OF PILE GROUP



PLAN PILE LAYOUT

△ denotes battered piles



ACTUAL LOCATIONS OF DRIVEN PILES

### ATTACHMENT "B"



With respect to the required tolerance of the center of gravity (C.G.) of the pile group, the Specifications state that the C.G. of the group shall be either 3% of the distance between the extremes or 1½ inches, whichever is greater. “Extremes” is defined as the distance between the centerlines of the outermost rows of piles. The distance between centerlines of the outermost rows is 2½ ft., and 3% of 2½ ft. is 0.075 ft., or 0.9 inches. Since 1½ inches is greater than 0.9 inches, the C.G. of the group (after driving) must be less than 1½ inches from the C.G. of the pile group as planned.

The Specifications indicate that the C.G. of the group must be checked along the long axis of the footing, which in this case, runs parallel to the face of the abutment. The actual pile locations are shown on the lower. Any pile that deviates to the north of the pile layout line was arbitrarily designated with a positive (+) distance, and any pile that deviates to the south of the layout line was arbitrarily assigned with a negative (-) distance.

In order to find to location of the C.G., add the distances by which each pile deviates from its plan location (keeping track of the signs), then divide by the number piles.

<b>Pile No.</b>	<b>Deviation Distance</b>
1	-0.08 ft.
2	+0.17 ft.
3	-0.08 ft.
4	-0.33 ft.
5	-0.42 ft.
6	+0.25 ft.
7	+0.33 ft.
8	-0.08 ft.
9	-0.42 ft.
10	-0.25 ft.
11	+0.17 ft.
12	-0.17 ft.
<b>Total</b>	<b>-0.91 ft.</b>

Dividing -0.91 ft. by 12 (number of piles) equals -0.076 ft. (or -0.91 inches). The minus sign simply indicates the direction in which the actual center of gravity deviates from the plan center of gravity (in this case, minus means “south”), and is of little importance here. Since the absolute value of the deviation (0.91 inches) is less than 1½ inches, the C.G. of the group is within tolerance.

The Inspector need not show the computations for the C.G. of the pile group in the diary if such computations are kept with the pile driving record. However, a note must appear in the project diary indicating that the pile group is within the required tolerance.

The center of gravity for a pile group under a column pier footing would be figured in a similar manner about both major axes.

## **Inspector's Checklist**

1. Has the Contractor submitted the Pile and Driving Equipment Data Form for each hammer and pile type?
2. Were driving tests completed prior to the Contractor submitting his/her pile order list?
3. Do the lengths of piles match the order list?
4. Are the piles being handled and stored on-site properly?
5. Is the location of each pile verified prior to and after driving?
6. Is Form C-1 being completed for each pile driven?
7. Has the center of gravity (C.G.) for each pile group been checked?
8. Are all piles driven to the required capacity?
9. Are all splices performed in accordance with the Specifications?
10. Has the Contractor performed loading tests as required?
11. Has Form C-4 Pile Loading Test Data been completed and submitted to the Area Construction Engineer and District Bridge Engineer?
12. Are steel pile shells checked after driving to determine if distortion or collapsing of the piles has occurred?
13. Is the correct reinforcing steel properly installed in the pile shells?

## Hammer List

<i>Manufacturer</i>	<i>Model</i>	<i>Max. Energy (kip-feet)</i>	<i>Ram Weight (kips)</i>	<i>Type of Hammer</i>	<i>Max. Stroke (feet)</i>	<i>Min. Stroke (feet)</i>
DELMAG	D 5	8.23	1.10	OED	7.48	4.03
DELMAG	D 8-22	17.60	1.76	OED	10.00	5.33
DELMAG	D 12	23.59	2.75	OED	8.58	5.35
DELMAG	D 15	28.31	3.30	OED	8.58	4.03
DELMAG	D 16-32	39.25	3.52	OED	11.15	5.35
DELMAG	D 22	40.61	4.91	OED	8.27	4.03
DELMAG	D 22-02	48.50	4.85	OED	10.00	5.35
DELMAG	D 22-13	48.50	4.85	OED	10.00	5.35
DELMAG	D 22-23	51.26	4.85	OED	10.57	6.30
DELMAG	D 25-32	61.49	5.51	OED	11.16	6.83
DELMAG	D 30	59.60	6.60	OED	9.03	4.03
DELMAG	D 30-02	66.00	6.60	OED	10.00	5.35
DELMAG	D 30-13	66.00	6.60	OED	10.00	5.35
DELMAG	D 30-23	73.66	6.60	OED	11.16	6.83
DELMAG	D 30-32	73.66	6.60	OED	11.16	6.83
DELMAG	D 36	83.82	7.93	OED	10.57	5.18
DELMAG	D 36-02	83.82	7.93	OED	10.57	5.18
DELMAG	D 36-13	83.82	7.93	OED	10.57	5.18
DELMAG	D 36-23	88.50	7.93	OED	11.16	6.83
DELMAG	D 36-32	88.50	7.93	OED	11.16	6.83
DELMAG	D 44	90.44	9.50	OED	9.52	4.64
DELMAG	D 46	107.18	10.14	OED	10.57	5.18
DELMAG	D 46-02	107.18	10.14	OED	10.57	5.18
DELMAG	D 46-13	96.53	10.14	OED	9.52	5.15
DELMAG	D 46-23	107.18	10.14	OED	10.57	6.56
DELMAG	D 46-32	113.16	10.14	OED	11.16	7.15
DELMAG	D 55	124.53	11.86	OED	10.50	6.56
DELMAG	D 62-02	152.45	13.66	OED	11.16	5.58
DELMAG	D 62-12	152.45	13.66	OED	11.16	5.81
DELMAG	D 62-22	152.45	13.66	OED	11.16	5.81
DELMAG	D 80-12	186.24	17.62	OED	10.57	7.15
DELMAG	D 80-23	196.64	17.62	OED	11.16	7.15
DELMAG	D 100-13	299.85	23.61	OED	12.70	7.15
DELMAG	D 6-32	10.50	1.32	OED	7.94	3.30
DELMAG	D 12-32	31.33	2.82	OED	11.11	3.30
DELMAG	D 19-32	42.40	4.00	OED	10.60	3.30
DELMAG	D 200-42	492.04	44.09	OED	11.16	0.00
FEC	FEC 1200	22.50	2.75	OED	8.18	3.70
FEC	FEC 1500	27.09	3.30	OED	8.21	3.70
FEC	FEC 2500	50.00	5.50	OED	9.09	3.70
FEC	FEC 2800	55.99	6.16	OED	9.09	3.70
FEC	FEC 3000	63.03	6.60	OED	9.55	3.70
FEC	FEC 3400	73.00	7.48	OED	9.76	3.70
MITSUBISHI	M 14	25.25	2.97	OED	8.50	4.00
MITSUBISHI	MH 15	28.14	3.31	OED	8.50	4.00
MITSUBISHI	M 23	43.01	5.06	OED	8.50	4.00
MITSUBISHI	MH 25	46.84	5.51	OED	8.50	4.00
MITSUBISHI	M 33	61.71	7.26	OED	8.50	4.00
MITSUBISHI	MH 35	65.62	7.72	OED	8.50	4.00

<i>Manufacturer</i>	<i>Model</i>	<i>Max. Energy (kip-feet)</i>	<i>Ram Weight (kips)</i>	<i>Type of Hammer</i>	<i>Max. Stroke (feet)</i>	<i>Min. Stroke (feet)</i>
mitsubishi	M 43	80.41	9.46	OED	8.50	4.00
mitsubishi	MH 45	85.43	10.05	OED	8.50	4.00
mitsubishi	MH 72B	135.15	15.90	OED	8.50	4.00
mitsubishi	MH 80B	149.60	17.60	OED	8.50	4.00
LINKBELT	LB 180	8.10	1.73	CED	4.68	1.92
LINKBELT	LB 312	15.02	3.86	CED	3.89	1.73
LINKBELT	LB 440	18.20	4.00	CED	4.55	1.49
LINKBELT	LB 520	26.31	5.07	CED	5.19	2.66
LINKBELT	LB 660	51.63	7.57	CED	6.82	2.48
KOBE	K 13	25.43	2.87	OED	8.86	4.60
KOBE	K22-Est	45.35	4.85	OED	9.35	4.26
KOBE	K 25	51.52	5.51	OED	9.35	4.26
KOBE	K 35	72.18	7.72	OED	9.35	4.11
KOBE	K 45	92.75	9.92	OED	9.35	3.93
KOBE	KB 60	130.18	13.23	OED	9.84	4.00
KOBE	KB 80	173.58	17.64	OED	9.84	4.00
ICE	180	8.13	1.73	CED	4.70	1.92
ICE	422	23.12	4.00	CED	5.78	1.97
ICE	440	18.56	4.00	CED	4.64	1.48
ICE	520	30.37	5.07	CED	5.99	2.66
ICE	640	40.62	6.00	CED	6.77	3.60
ICE	660	51.63	7.57	CED	6.82	2.48
ICE	1070	72.60	10.00	CED	7.26	3.13
ICE	30-S	22.50	3.00	OED	7.50	3.00
ICE	40-S	40.00	4.00	OED	10.00	4.00
ICE	42-S	42.00	4.09	OED	10.27	4.00
ICE	60-S	72.94	7.00	OED	10.42	4.00
ICE	70-S	70.00	7.00	OED	10.00	4.00
ICE	80-S	99.36	8.00	OED	12.42	4.00
ICE	90-S	90.00	9.00	OED	10.00	4.00
ICE	100-S	120.00	10.00	OED	12.00	4.00
ICE	120-S	149.04	12.00	OED	12.42	4.00
ICE	200-S	100.00	20.00	OED	5.00	2.00
ICE	205-S	210.00	20.00	OED	10.50	4.00
ICE	120S-16	198.40	16.00	OED	12.40	4.00
ICE	110-SH	37.72	11.50	ECH	3.28	0.00
ICE	115-SH	37.95	11.50	ECH	3.30	1.00
ICE	160-SH	64.00	16.00	ECH	4.00	1.00
MKT 20	DE333020	20.00	2.00	OED	10.00	0.00
MKT 30	DE333020	28.00	2.80	OED	10.00	0.00
MKT 33	DE333020	33.00	3.30	OED	10.00	0.00
MKT 40	DE333020	40.00	4.00	OED	10.00	0.00
MKT	DE 10	15.30	1.70	OED	9.00	0.00
MKT	DE 20	16.00	2.00	OED	8.00	0.00
MKT	DE 30	22.40	2.80	OED	8.00	0.00
MKT	DA35B SA	23.80	2.80	OED	8.50	0.00
MKT	DE 30B	23.80	2.80	OED	8.50	0.00
MKT	DA 35B	21.00	2.80	CED	7.50	0.00
MKT	DA 45	30.72	4.00	CED	7.68	0.00
MKT	DE 40	32.00	4.00	OED	8.00	0.00
MKT	DE 42/35	42.00	4.20	OED	10.00	0.00

<i>Manufacturer</i>	<i>Model</i>	<i>Max. Energy (kip-feet)</i>	<i>Ram Weight (kips)</i>	<i>Type of Hammer</i>	<i>Max. Stroke (feet)</i>	<i>Min. Stroke (feet)</i>
MKT	DE 50C	50.00	5.00	OED	10.00	0.00
MKT	DE 70C	70.00	7.00	OED	10.00	0.00
MKT	DE 50B	42.50	5.00	OED	8.50	0.00
MKT	DA55B SA	40.00	5.00	OED	8.00	0.00
MKT	DA 55B	38.20	5.00	CED	7.64	0.00
MKT	DE 70B	59.50	7.00	OED	8.50	0.00
MKT 50	DE70/50B	50.00	5.00	OED	10.00	0.00
MKT 70	DE70/50B	70.00	7.00	OED	10.00	0.00
MKT 110	DE110150	110.00	11.00	OED	10.00	0.00
MKT 150	DE110150	150.00	15.00	OED	10.00	0.00
MKT	DA 35C	21.00	2.80	CED	7.50	0.00
MKT	DA 55C	38.20	5.00	CED	7.64	0.00
CONMACO	C 50	15.00	5.00	ECH	3.00	0.00
CONMACO	C 65	19.50	6.50	ECH	3.00	0.00
CONMACO	C 550	25.00	5.00	ECH	5.00	0.00
CONMACO	C 565	32.50	6.50	ECH	5.00	0.00
CONMACO	C 80	26.00	8.00	ECH	3.25	0.00
CONMACO	C 100	32.50	10.00	ECH	3.25	0.00
CONMACO	C 115	37.38	11.50	ECH	3.25	0.00
CONMACO	C 80E5	40.00	8.00	ECH	5.00	0.00
CONMACO	C 100E5	50.00	10.00	ECH	5.00	0.00
CONMACO	C 115E5	57.50	11.50	ECH	5.00	0.00
CONMACO	C 125E5	62.50	12.50	ECH	5.00	0.00
CONMACO	C 140	42.00	14.00	ECH	3.00	0.00
CONMACO	C 160	48.75	16.25	ECH	3.00	0.00
CONMACO	C 200	60.00	20.00	ECH	3.00	0.00
CONMACO	C 300	90.00	30.00	ECH	3.00	0.00
CONMACO	C 5200	100.00	20.00	ECH	5.00	0.00
CONMACO	C 5300	150.00	30.00	ECH	5.00	0.00
CONMACO	C 5450	225.00	45.00	ECH	5.00	0.00
CONMACO	C 5700	350.00	70.00	ECH	5.00	0.00
CONMACO	C 6850	510.00	85.00	ECH	6.00	0.00
CONMACO	C 160	51.78	17.26	ECH	3.00	0.00
VULCAN	VUL V12	27.11	2.76	OED	9.84	5.58
VULCAN	VUL V18	39.05	3.97	OED	9.84	5.58
VULCAN	VUL V25	57.88	5.51	OED	10.50	5.58
VULCAN	VUL 01	15.00	5.00	ECH	3.00	3.00
VULCAN	VUL 02	7.26	3.00	ECH	2.42	2.42
VULCAN	VUL 06	19.50	6.50	ECH	3.00	3.00
VULCAN	VUL 08	26.00	8.00	ECH	3.25	3.25
VULCAN	VUL 010	32.50	10.00	ECH	3.25	3.25
VULCAN	VUL 012	39.00	12.00	ECH	3.25	3.25
VULCAN	VUL 014	42.00	14.00	ECH	3.00	3.00
VULCAN	VUL 016	48.75	16.25	ECH	3.00	3.00
VULCAN	VUL 020	60.00	20.00	ECH	3.00	3.00
VULCAN	VUL 030	90.00	30.00	ECH	3.00	3.00
VULCAN	VUL 040	120.00	40.00	ECH	3.00	3.00
VULCAN	VUL 060	180.00	60.00	ECH	3.00	3.00
VULCAN	VUL 30C	7.26	3.00	ECH	2.42	0.00
VULCAN	VUL 50C	15.10	5.00	ECH	3.02	1.36
VULCAN	VUL 65C	19.18	6.50	ECH	2.95	0.00

<i>Manufacturer</i>	<i>Model</i>	<i>Max. Energy (kip-feet)</i>	<i>Ram Weight (kips)</i>	<i>Type of Hammer</i>	<i>Max. Stroke (feet)</i>	<i>Min. Stroke (feet)</i>
VULCAN	VUL 65CA	19.57	6.50	ECH	3.01	1.38
VULCAN	VUL 80C	24.48	8.00	ECH	3.06	1.38
VULCAN	VUL 85C	25.99	8.52	ECH	3.05	0.00
VULCAN	VUL 100C	32.90	10.00	ECH	3.29	3.29
VULCAN	VUL 140C	35.98	14.00	ECH	2.57	0.00
VULCAN	VUL 200C	50.20	20.00	ECH	2.51	1.29
VULCAN	VUL 400C	113.60	40.00	ECH	2.84	1.38
VULCAN	VUL 600C	179.16	60.00	ECH	2.99	1.50
VULCAN	VUL 320	60.00	20.00	ECH	3.00	0.00
VULCAN	VUL 330	90.00	30.00	ECH	3.00	0.00
VULCAN	VUL 340	120.00	40.00	ECH	3.00	0.00
VULCAN	VUL 360	180.00	60.00	ECH	3.00	0.00
VULCAN	VUL 505	25.00	5.00	ECH	5.00	0.00
VULCAN	VUL 506	32.50	6.50	ECH	5.00	0.00
VULCAN	VUL 508	40.00	8.00	ECH	5.00	0.00
VULCAN	VUL 510	50.00	10.00	ECH	5.00	0.00
VULCAN	VUL 512	60.00	12.00	ECH	5.00	5.00
VULCAN	VUL 520	100.00	20.00	ECH	5.00	0.00
VULCAN	VUL 530	150.00	30.00	ECH	5.00	0.00
VULCAN	VUL 540	200.00	40.90	ECH	4.89	0.00
VULCAN	VUL 560	300.00	62.50	ECH	4.80	0.00
VULCAN	VUL 3100	300.00	100.00	ECH	3.00	0.00
VULCAN	VUL 5100	500.00	100.00	ECH	5.00	0.00
VULCAN	VUL 5150	750.00	150.00	ECH	5.00	0.00
VULCAN	VUL 6300	1800.00	300.00	ECH	6.00	0.00
RAYMOND	R 1	15.00	5.00	ECH	3.00	0.00
RAYMOND	R 15	19.50	6.50	ECH	3.00	0.00
RAYMOND	R 65C	19.50	6.50	ECH	3.00	0.00
RAYMOND	R 65CH	19.50	6.50	ECH	3.00	0.00
RAYMOND	R 0	24.38	7.50	ECH	3.25	0.00
RAYMOND	R 80C	24.48	8.00	ECH	3.06	0.00
RAYMOND	R 80CH	24.48	8.00	ECH	3.06	0.00
RAYMOND	R 2/0	32.50	10.00	ECH	3.25	0.00
RAYMOND	R 3/0	40.63	12.50	ECH	3.25	0.00
RAYMOND	R 150C	48.75	15.00	ECH	3.25	0.00
RAYMOND	R 4/0	48.75	15.00	ECH	3.25	0.00
RAYMOND	R 5/0	56.88	17.50	ECH	3.25	0.00
RAYMOND	R 30X	75.00	30.00	ECH	2.50	0.00
RAYMOND	R 8/0	81.25	25.00	ECH	3.25	0.00
RAYMOND	R 40X	100.00	40.00	ECH	2.50	0.00
RAYMOND	R 60X	150.00	60.00	ECH	2.50	0.00
MENCK	MH 68	49.18	7.72	ECH	6.37	0.00
MENCK	MH 96	69.43	11.02	ECH	6.30	0.00
MENCK	MH 145	104.80	16.53	ECH	6.34	0.00
MENCK	MH 195	141.12	22.05	ECH	6.40	0.00
MENCK	MHU 220	159.07	25.13	ECH	6.33	0.00
MENCK	MHU 400	289.55	50.71	ECH	5.71	0.00
MENCK	MHU 600	433.64	77.16	ECH	5.62	0.00
MENCK	MHU 1000	737.70	126.97	ECH	5.81	0.00
MENCK	MHU 1700	1228.87	207.23	ECH	5.93	0.00
MENCK	MHU 2100	1547.59	255.80	ECH	6.05	0.00

<i>Manufacturer</i>	<i>Model</i>	<i>Max. Energy (kip-feet)</i>	<i>Ram Weight (kips)</i>	<i>Type of Hammer</i>	<i>Max. Stroke (feet)</i>	<i>Min. Stroke (feet)</i>
MENCK	MHU 3000	2171.65	363.76	ECH	5.97	0.00
MENCK	MRBS 500	45.07	11.02	ECH	4.09	0.00
MENCK	MRBS 750	67.77	16.53	ECH	4.10	0.00
MENCK	MRBS 850	93.28	18.96	ECH	4.92	0.00
MENCK	MRBS1100	123.43	24.25	ECH	5.09	0.00
MENCK	MRBS1502	135.59	33.07	ECH	4.10	0.00
MENCK	MRBS1800	189.81	38.58	ECH	4.92	0.00
MENCK	MRBS2500	262.11	63.93	ECH	4.10	0.00
MENCK	MRBS2502	225.95	55.11	ECH	4.10	0.00
MENCK	MRBS2504	225.95	55.11	ECH	4.10	0.00
MENCK	MRBS3000	325.36	66.13	ECH	4.92	0.00
MENCK	MRBS3900	513.34	86.86	ECH	5.91	0.00
MENCK	MRBS4600	498.94	101.41	ECH	4.92	0.00
MENCK	MRBS5000	542.33	110.23	ECH	4.92	0.00
MENCK	MRBS6000	759.23	132.27	ECH	5.74	0.00
MENCK	MRBS7000	631.40	154.00	ECH	4.10	0.00
MENCK	MRBS8000	867.74	176.37	ECH	4.92	0.00
MENCK	MRBS8800	954.53	194.01	ECH	4.92	0.00
MENCK	MBS12500	1581.83	275.58	ECH	5.74	0.00
MENCK	MHF5-5	38.69	11.02	ECH	3.51	0.00
MENCK	MHF5-6	46.43	13.23	ECH	3.51	0.00
MENCK	MHF5-7	54.17	15.43	ECH	3.51	0.00
MENCK	MHF5-8	61.91	17.64	ECH	3.51	0.00
MENCK	MHF5-9	69.65	19.84	ECH	3.51	0.00
MENCK	MHF5-10	77.39	22.04	ECH	3.51	0.00
MENCK	MHF5-11	85.13	24.25	ECH	3.51	0.00
MENCK	MHF5-12	92.87	26.45	ECH	3.51	0.00
MENCK	MHF3-3	24.76	7.05	ECH	3.51	0.00
MENCK	MHF3-4	30.96	8.82	ECH	3.51	0.00
MENCK	MHF3-5	38.69	11.02	ECH	3.51	0.00
MENCK	MHF3-6	46.43	13.23	ECH	3.51	0.00
MENCK	MHF3-7	54.17	15.43	ECH	3.51	0.00
MENCK	MHF10-15	124.73	33.06	ECH	3.77	0.00
MENCK	MHF10-20	166.27	44.07	ECH	3.77	0.00
MENCK	MHUT 200	147.38	26.46	ECH	5.57	0.00
MENCK	MHUT 400	295.12	52.70	ECH	5.60	0.00
MENCK	MHUT 500	405.75	66.13	ECH	6.14	0.00
MENCK	MHUT700U	516.13	92.83	ECH	5.56	0.00
MENCK	MHUT700A	619.18	92.83	ECH	6.67	0.00
MENCK	MHUT1000	736.91	132.30	ECH	5.57	0.00
MKT	No. 5	1.00	0.2	ECH	5.00	0.00
MKT	No. 6	2.50	0.40	ECH	6.25	0.00
MKT	No. 7	4.15	0.80	ECH	5.19	0.00
MKT	9B3	8.75	1.60	ECH	5.47	0.00
MKT	10B3	13.11	3.00	ECH	4.37	0.00
MKT	C5-Air	14.20	5.00	ECH	2.84	0.00
MKT	C5-Steam	16.20	5.00	ECH	3.24	0.00
MKT	S-5	16.25	5.00	ECH	3.25	0.00
MKT	11B3	19.15	5.00	ECH	3.83	0.00
MKT	C826 Steam	24.40	8.00	ECH	3.05	0.00
MKT	C826 Air	21.20	8.00	ECH	2.65	0.00

<i>Manufacturer</i>	<i>Model</i>	<i>Max. Energy (kip-feet)</i>	<i>Ram Weight (kips)</i>	<i>Type of Hammer</i>	<i>Max. Stroke (feet)</i>	<i>Min. Stroke (feet)</i>
MKT	S-8	26.00	8.00	ECH	3.25	0.00
MKT	MS-350	30.80	7.72	ECH	3.99	0.00
MKT	S 10	32.50	10.00	ECH	3.25	0.00
MKT	S 14	37.52	14.00	ECH	2.68	0.00
MKT	MS 500	44.00	11.00	ECH	4.00	0.00
MKT	S 20	60.00	20.00	ECH	3.00	0.00
IHC Hydh	S 35	25.81	7.27	ECH	3.55	0.00
IHC Hydh	S 40	30.36	5.51	ECH	5.51	0.00
IHC Hydh	S 60	44.26	13.23	ECH	3.35	0.00
IHC Hydh	S 70	51.65	7.72	ECH	6.69	0.00
IHC Hydh	S 90	66.36	9.92	ECH	6.69	0.00
IHC Hydh	S 200	147.18	22.00	ECH	6.69	0.00
IHC Hydh	S 250	184.64	27.60	ECH	6.69	0.00
IHC Hydh	S 280	206.51	29.80	ECH	6.93	0.00
IHC Hydh	S 400	294.60	44.30	ECH	6.65	0.00
IHC Hydh	S 500	368.30	55.30	ECH	6.66	0.00
IHC Hydh	S 800	589.85	81.57	ECH	7.23	0.00
IHC Hydh	S 1000	737.26	101.41	ECH	7.27	0.00
IHC Hydh	S 1600	1177.80	156.00	ECH	7.55	0.00
IHC Hydh	S 2300	1694.97	226.60	ECH	7.48	0.00
IHC Hydh	S 3000	2210.12	332.00	ECH	6.66	0.00
IHC Hydh	SC 30	22.13	3.64	ECH	6.08	0.00
IHC Hydh	SC 40	29.48	5.51	ECH	5.35	0.00
IHC Hydh	SC 60	44.24	7.72	ECH	5.73	0.00
IHC Hydh	SC 80	58.90	11.24	ECH	5.24	0.00
IHC Hydh	SC 110	77.42	15.21	ECH	5.09	0.00
IHC Hydh	SC 150	103.31	24.25	ECH	4.26	0.00
IHC Hydh	SC 200	151.00	30.20	ECH	5.00	0.00
IHC Hydh	SC 250	176.97	39.24	ECH	4.51	0.00
HERA	1250	25.34	2.81	OED	9.02	4.92
HERA	1500	30.41	3.37	OED	9.02	4.92
HERA	2500	50.69	5.62	OED	9.02	4.92
HERA	2800	56.77	6.29	OED	9.02	4.92
HERA	3500	70.96	7.87	OED	9.02	4.92
HERA	5000	101.37	11.24	OED	9.02	4.92
HERA	5700	115.57	12.81	OED	9.02	4.92
HERA	6200	125.70	13.93	OED	9.02	4.92
HERA	7500	152.06	16.85	OED	9.02	4.92
HERA	8800	178.42	19.78	OED	9.02	4.92
FAIRCHILD	F-45	45.00	15.00	ECH	3.00	0.00
FAIRCHILD	F-32	32.55	10.85	ECH	3.00	0.00
BSP	HH 1.5	16.25	3.30	ECH	4.92	0.00
BSP	HH 3	26.02	6.61	ECH	3.94	0.00
BSP	HH 5	43.37	11.02	ECH	3.94	0.00
BSP	HH 7	60.78	15.43	ECH	3.94	0.00
BSP	HH 8	69.50	17.64	ECH	3.94	0.00
BSP	HH 9	78.17	19.84	ECH	3.94	0.00
BSP	HH 11-1.2	95.54	24.25	ECH	3.94	0.00
BSP	HH 14-1.2	121.59	30.86	ECH	3.94	0.00
BSP	HH 16-1.2	138.87	35.27	ECH	3.94	0.00
BSP	HH 20	173.58	44.09	ECH	3.94	0.00



<i>Manufacturer</i>	<i>Model</i>	<i>Max. Energy (kip-feet)</i>	<i>Ram Weight (kips)</i>	<i>Type of Hammer</i>	<i>Max. Stroke (feet)</i>	<i>Min. Stroke (feet)</i>
BSP	HH 20S	173.58	44.09	ECH	3.94	0.00
BSP	HA 30	260.37	66.13	ECH	3.94	0.00
BSP	HA 40	347.16	88.18	ECH	3.94	0.00
BSP	HH 11-1.5	119.31	24.25	ECH	4.92	0.00
BSP	HH 14-1.5	151.83	30.86	ECH	4.92	0.00
BSP	HH 16-1.5	173.54	35.27	ECH	4.92	0.00
BERMINGHAMMER	B23	22.99	2.80	CED	8.21	0.00
BERMINGHAMMER	B200	18.00	2.00	OED	9.00	0.00
BERMINGHAMMER	B225	29.25	3.00	OED	9.75	0.00
BERMINGHAMMER	B300	40.31	3.75	OED	10.75	0.00
BERMINGHAMMER	B400	53.75	5.00	OED	10.75	0.00
BERMINGHAMMER	B300 M	40.31	3.75	OED	10.75	0.00
BERMINGHAMMER	B400 M	53.75	5.00	OED	10.75	0.00
BERMINGHAMMER	B400 4.8	43.20	4.80	OED	9.00	5.00
BERMINGHAMMER	B400 5.0	45.00	5.00	OED	9.00	5.00
BERMINGHAMMER	B23 5	22.99	2.80	CED	8.21	0.00
BERMINGHAMMER	B2505	26.25	2.50	OED	10.50	0.00
BERMINGHAMMER	B350 5	47.20	4.00	OED	11.80	0.00
BERMINGHAMMER	B400 5	59.00	5.00	OED	11.80	0.00
BERMINGHAMMER	B450 5	77.88	6.60	OED	11.80	0.00
BERMINGHAMMER	B500 5	92.04	7.80	OED	11.80	0.00
BERMINGHAMMER	B550 5	106.20	9.00	OED	11.80	0.00
BERMINGHAMMER	B550 C	88.00	11.00	OED	8.00	0.00
BERMINGHAMMER	B2005	21.00	2.00	OED	10.50	0.00
BERMINGHAMMER	B2505	35.40	3.00	OED	11.80	0.00
JUNTTAN	HHK 3	26.55	6.62	ECH	4.01	0.00
JUNTTAN	HHK 4	35.37	8.82	ECH	4.01	0.00
JUNTTAN	HHK 5	44.23	11.03	ECH	4.01	0.00
JUNTTAN	HHK 6	53.05	13.23	ECH	4.01	0.00
JUNTTAN	HHK 7	61.91	15.44	ECH	4.01	0.00
JUNTTAN	HHK 10	88.42	22.05	ECH	4.01	0.00
JUNTTAN	HHK 12	106.10	26.46	ECH	4.01	0.00
JUNTTAN	HHK 14	123.79	30.87	ECH	4.01	0.00
JUNTTAN	HHK 5A	44.12	11.02	ECH	4.00	0.00
JUNTTAN	HHK 7A	61.77	15.43	ECH	4.00	0.00
JUNTTAN	HHK 9A	79.42	19.84	ECH	4.00	0.00
JUNTTAN	HHK 12A	104.15	26.45	ECH	3.94	0.00
JUNTTAN	HHK 14A	121.51	30.86	ECH	3.94	0.00
JUNTTAN	HHK 16A	138.87	35.27	ECH	3.94	0.00
JUNTTAN	HHK 18A	156.22	39.68	ECH	3.94	0.00
HPSI	110	44.00	11.00	ECH	4.00	0.00
HPSI	150	60.00	15.00	ECH	4.00	0.00
HPSI	154	61.60	15.40	ECH	4.00	0.00
HPSI	200	80.00	20.00	ECH	4.00	0.00
HPSI	225	90.00	22.50	ECH	4.00	0.00
HPSI	650	32.50	6.50	ECH	5.00	0.00
HPSI	1000	50.00	10.00	ECH	5.00	0.00
HPSI	1605	83.00	16.60	ECH	5.00	0.00
HPSI	2005	95.10	19.02	ECH	5.00	0.00
HPSI	3005	154.32	30.86	ECH	5.00	0.00
HPSI	3505	176.32	35.26	ECH	5.00	0.00

<i>Manufacturer</i>	<i>Model</i>	<i>Max. Energy (kip-feet)</i>	<i>Ram Weight (kips)</i>	<i>Type of Hammer</i>	<i>Max. Stroke (feet)</i>	<i>Min. Stroke (feet)</i>
UDDCOMB	H2H	16.62	4.40	ECH	3.77	0.49
UDDCOMB	H3H	24.88	6.60	ECH	3.77	0.50
UDDCOMB	H4H	33.18	8.80	ECH	3.77	0.50
UDDCOMB	H5H	41.47	11.00	ECH	3.77	0.50
UDDCOMB	H6H	49.76	13.20	ECH	3.77	0.50
UDDCOMB	H8H	82.19	17.60	ECH	4.67	0.50
UDDCOMB	H10H	86.88	22.05	ECH	3.94	0.50
DAWSON	HPH 1200	8.65	2.29	ECH	3.77	0.00
DAWSON	HPH 2400	17.32	4.19	ECH	4.13	0.00
BANUT	3 Tonnes	17.34	6.61	ECH	2.62	0.00
BANUT	4 Tonnes	23.14	8.82	ECH	2.62	0.00
BANUT	5 Tonnes	28.92	11.02	ECH	2.62	0.00
BANUT	6 Tonnes	34.72	13.23	ECH	2.62	0.00
BANUT	7 Tonnes	40.49	15.43	ECH	2.62	0.00
APE	D 19-32	44.41	4.19	OED	10.60	3.30
APE	D 30-32	70.07	6.61	OED	10.60	6.83
APE	D 36-32	84.06	7.93	OED	10.60	6.83
APE	D 46-32	107.48	10.14	OED	10.60	7.15
APE	D 62-22	161.46	13.66	OED	11.82	5.81
APE	D 80-23	196.99	17.62	OED	11.18	7.15
APE	D 100-13	246.30	22.03	OED	11.18	7.15
DKH	PH-5	43.40	11.02	ECH	3.94	0.00
DKH	PH-7	60.75	15.43	ECH	3.94	0.00
DKH	PH-7S	60.75	15.43	ECH	3.94	0.00
DKH	PH-10	86.79	22.04	ECH	3.94	0.00
DKH	PH-13	112.83	28.66	ECH	3.94	0.00
DKH	PH-20	216.98	44.09	ECH	4.92	0.00
DKH	PH-30	325.47	66.13	ECH	4.92	0.00
DKH	PH-40	433.96	88.18	ECH	4.92	0.00

## **SECTION 404 - HYDRAULIC CEMENT CONCRETE OPERATIONS**

### **General**

Prior to placement of Hydraulic Cement Concrete, the Inspector must verify that a current mix design is on file for the class of concrete to be used. Concrete should be visually inspected to ensure it is mixed properly. The Inspector should then refer to Table II-17 of the Specifications to determine the minimum and maximum allowable air content and consistency (slump). The Inspector should also verify that the temperature of the concrete is within the limits specified. Attention must be paid to the batch time versus the placement time to ensure the concrete is placed within the maximum allowable time range for the temperature of the concrete. Concrete that does not meet the Specifications will be rejected and removed from the project.

### **Materials**

After checking all equipment to be used, the Inspector should make those periodic checks necessary to ensure that all materials used are within the Specifications limits and that the concrete conforms to the requirements of the structure design.

### **Forms**

Bridge decks shall be constructed in such a manner that the actual thickness is not less than the design thickness and not more than 1/2 inch more than the design thickness.

Before placing concrete, forms must be completely checked for conformance with the plans and Specifications, and all irregularities corrected. Forms should also be checked for ease of removal without injury to the concrete.

Inspectors should verify the dimensions of the forms, proper placement of reinforcing steel and proper location of chamfer strips.

### **Placement and Consolidation**

During the placement of concrete, the Inspector must check the consistency of the concrete and methods of spreading and consolidation. Forms are to be closely inspected for leaks, and when discovered, must be caulked immediately.

### **Construction Joints**

Construction joints are to be made only where located on the plans, unless otherwise specified or approved by the Engineer.

Unless otherwise specified, construction joints adjacent to earth fill are to be protected by dampproofing applied for a distance of 3 inches on each side of the joint throughout the length of the joint. This practice is intended for construction joints placed in reinforced abutments and thin wall sections of box culverts. An approved waterstop is to be used in visually exposed areas.

A construction joint may be placed at the junction between a footing and an abutment or column, although such joints are not generally detailed on the plans.

## **Bonding Construction Joints**

When placing fresh concrete against that which already has set, the old concrete is to be thoroughly cleaned, roughened, and saturated before placing the new concrete.

Shear keys or inclined reinforcement are to be used as specified to tie various sections together.

An epoxy bonding compound (Type EP-4) is to be applied to the face of the construction joint in bridge decks immediately preceding the placement of adjoining concrete unless otherwise specified.

## **Removal of Forms and Construction of Superimposed Elements**

The Specifications regulate the minimum time that concrete forms must remain in place and the time that must elapse before structural steel or prestressed members may be erected. This time is based on days when the temperature is above 40<sup>0</sup> F in the shade. If the Contractor desires, test cylinders can be made according to accepted practice and cured in the same manner as the structure. The results of strength tests performed on the test cylinders will determine when the concrete forms can be removed. Particular care should be taken to see that bridge decks are not loaded with construction equipment prior to the attainment of the design strength.

## **Curing of Concrete**

The Contractor shall perform evaporation rate testing prior to placement of the concrete. The proper curing of concrete requires the proper control of four major factors: Humidity, temperature, wind and protection against disturbance. The concrete is to be cured under conditions of humidity, temperature, and wind that will produce a uniform hydration of the cement. Concrete may be satisfactorily cured by either a moisture application system or by the uniform application of an acceptable curing compound membrane. Do not permit the use of curing compound if an overlay will be required for additional surfacing.

## **Bridge Deck Curing**

Bridge deck concrete shall be moist cured with white polyethylene sheeting with or without the use of wet burlap. The concrete shall be maintained in a moist condition by fogging after screeding and until covered with the white polyethylene sheeting. The concrete surface shall stay wet under the white polyethylene sheeting until the end of the moist-curing period. The moist-curing period shall be for at least 7 days and until 70 percent concrete strength ( $f'_c$ ) is achieved. The initial temperature of the outermost surfaces of the concrete mass shall be above 50 degrees F for at least 72 hours and above 32 degrees F until the completion of the moist-curing period. When the white polyethylene sheeting is removed, burlap (if used) shall be removed also. White pigmented curing compound shall be applied at the rate of 100 to 150 square feet per gallon while the surface of the concrete deck is damp and free of standing water. Bridge deck overlay concrete shall be cured in accordance with the requirements of Section 412 of the Specifications.

## **Protection of Concrete**

The Contractor is to make every reasonable effort to protect the concrete from rain or rapid drying conditions. The concrete surface is not to be walked upon or disturbed for a minimum of 24 hours. When open-flame heaters are used in the vicinity of combustible concrete formwork, a watchman is to be provided by the Contractor.

## **Hot Weather Concrete Placement**

Hot weather can have many adverse effects on concrete. Some effects of hot weather on fresh concrete include an increased water demand, an increased rate of slump, an increased rate of setting, an increased tendency for plastic shrinkage cracking and an increased rate in controlling entrained air content. Some effects of hot weather on hardened concrete include a decreased 28-day strength, an increased tendency for drying shrinkage and thermal cracking, decreased durability, greater variability of surface appearance, an increased potential for reinforcing steel corrosion, and increased permeability. All of these effects can compromise the strength and durability of the concrete.

Several precautions can limit the damaging effects of hot weather on concrete. The mixing water can be kept cool, or ice should be used. Do not add water at the project site to compensate for a loss in slump. Prior to placement, cool all handling equipment by wetting them with cool water. Mist forms, reinforcing steel and subgrade with cool water immediately prior to placement. The hours of placement can be limited to the cooler hours of the day. Placement at night allows for the concrete to attain its primary set before the heat of the next day. Avoid delays during placement. Following placement, sunscreens can be erected to control the surface temperature. Adequate curing is critical. Continuous moist curing should begin as soon as surfaces are finished and should continue for at least 24 hours.

## Expansion and Fixed Joints

### A. Open and Filled Joints

All joints should be made by the insertion and subsequent removal of a wood strip or other material. A common tendency of concrete finishers is to plaster over the wooden strip when finishing the joint. Proper attention should be directed to this very important detail. The edges of all joints should be tooled to a radius of 1/4" unless otherwise specified.

Joints are often damaged by construction traffic. Steel wheeled rollers and other construction equipment can cause spalls at the edges of unprotected joints. Once broken, these edges can never be satisfactorily repaired. Joints should be kept clean and free of dirt, pebbles and other incompressible materials in order that the openings may partially close during expansion of adjoining units of concrete.

All joints are to be completely cleaned immediately prior to filling and sealing. Remove water and other material that may have collected in the joint. The Specifications outline the proper procedure to follow when sealing a joint. Poured or extruded joint sealers are to be installed slightly lower than the deck surface (1/4" to 3/8") so that traffic does not damage the joint material. Only tested and approved joint materials are to be used.

### B. Steel Joints

Joint openings are given on bridge plans for a design temperature of 60° F. Should the joint be set at a temperature other than 60° F, a correction must be applied to the width of the opening. The coefficient of expansion for steel is 0.0000065 (unit per unit of length) per degree Fahrenheit. For example, a joint opening is given as 1 1/2" at 60° F and the sum of the distances each side of this joint to the fixed ends in adjacent spans are 165 feet. Assume the temperature to be 95° F at the time when this joint is positioned. The correction to be made to this opening would be found by multiplying the difference in degrees temperature times the length of the bridge between fixed bearing times the coefficient of expansion of steel. That is  $(95^\circ - 60^\circ) \times 165' \times 0.0000065$  per degree equals  $35 \times 165' \times 0.0000065$  per degree Fahrenheit equals 0.038' which equals 0.456" which equals 7/16 inch. This correction should be deducted from the plan opening. Likewise, if the temperature at which the joint is positioned is lower than that specified on the plans, the correction should be added to the joint opening to give the specified opening at the plan temperature.

When positioning the rocker assembly under steel beams, the same temperature corrections are to be used to compute the position of the arm. A standard temperature at which the arm must be vertical will be specified on the plans. All calculations are to be based on this standard temperature.

## **Bearing Areas**

It is absolutely essential that bridge seats, (that is the bearing areas of the beams and bearing plates), be in strict compliance with the Specifications to avoid failures that may arise from the load being concentrated on only a portion of the pad. Bridge seat bearing areas shall be finished plane and level and shall not deviate more than 1/16 inch from plane or more than 1/32 inch per foot from level or from the slope specified on the plans.

Precautions should be taken during the construction of bridge seats to ensure that they are within Specification tolerance. Prior to setting the beams, the bridge seats should be rechecked and deviations corrected if necessary, by grinding and the use of an epoxy mortar.

Metal bearing plates and the bottoms of prefabricated beams, which are to bear on elastomeric pads, must be coated with an approved epoxy adhesive and surfaced with an approved grit. Bridge seats are to be finished to an equivalent roughness.

The intent regarding bridge seats is that a normal floated surface will afford the required roughness (texture). However, in the event the surface was given a slick troweled finish or in the event the seat had to be ground down or built up and such corrective work resulted in a slick surface, the seats would then have to be coated with epoxy and grit in the same manner in which the bearing plates and bottoms of prefabricated beams were coated.

The differential height between each bridge seat is more critical than the elevation of each seat. This is one of the factors that determine the bolster thickness of concrete in the deck and the ease in erection of structural steel members. Once the elevation of one seat is established in the field, that seat should be used as a bench mark for establishing the remaining seats for that pier or abutment.

A sufficient number of depth probes must be taken while the concrete is still plastic to determine the actual thickness of the bridge deck. A minimum of twelve probes should be taken (more on long spans or in unusual conditions). The points to be probed are to be selected at random and recorded in the project records; however, depth probes are not to be taken over beams with the bolster thickness subtracted from this depth to obtain the apparent depth. When corrugated metal deck forms are used, the Inspector should exercise special care to insure that the depth probes are actually taken and measured from the top of the corrugations.

## **Finishing Concrete Surfaces**

### **A. Class 2, Rubbed Finish**

The face form for bridge deck sidewalks and brush curbs should be removed as soon as the concrete will stand without support of the form and the concrete rubbed prior to initial setting.

For other concrete surfaces requiring a rubbed finish, rubbing should begin as soon as possible after the forms are removed. The surfaces must be thoroughly saturated with water for at least 3 hours immediately prior to rubbing and kept saturated during the rubbing operations.

A common tendency is to use too much mortar in the rubbing operation. The excess mortar washes or chips off soon after construction, resulting in an unsightly appearance. Permit the use of only enough mortar to fill the voids on the surface.

## **B. Class 6, Bridge Deck Finish**

The Specifications require the Contractor to provide access "for the purpose of finishing, straight edging, making corrections, and for other operations requiring access to the surface of the deck before grooving the deck surface." This access is provided by a separate work bridge. The start of bridge deck placement should not be approved until all necessary equipment is available and assurance has been obtained from the Contractor that he will utilize such equipment as specified.

The ability to straightedge accurately is primarily based on practice and intuition. It is not by any means an exact science. Before attempting any straightedging, check the straightedge to be certain it is straight. Light straightedges warp and wear easily. To make them totally warp resistant would add too much weight to the straightedge.

When checking a straightedge, lay it on a flat surface with the edge that will be used to check the concrete facing up. Using three blocks of equal thickness, place one of these on each end of the straightedge. Stretch a string line taut and rest it on top of the blocks. If the straightedge is straight, the third block should just clear the space between the edge and the line at any point along the edge.

If the block will not slip between the line and the straightedge, there is a hump at that location. If there is space between the block and the line, there is a sag in the straightedge at that location. After you are assured the straightedge is straight, the straightedge operation can begin.

Sweep the area to be checked so that it is free of dirt or other debris. Next, set the straightedge on the surface, let it rest naturally, step back and carefully evaluate the surface. Check the surface for high and low areas.



Move the straightedge forward one-half the length of the straightedge. Evaluate the surface at this location, taking into account the information obtained from previous laps. Repeat this procedure until the desired distance is traversed.

It is important to straightedge the entire deck when checking for compliance with straightedge requirements. An erroneous conclusion can be obtained by setting the straightedge down one time. A series of laps is necessary to secure conclusive information.

Where possible, straightedging should be performed in the presence of the District Bridge Engineer, Area Construction Engineer, and a representative of the Contractor.

Do not attempt to define the limits of an area needing correction. You need only to mark the location of areas which are out of tolerance. The Contractor makes his own checks as he progresses with the corrective work. He should check and, if necessary, regrind an increasingly larger area. This procedure should be repeated until the surface is within tolerance.

Low areas are not to be corrected until viewed by the District Bridge Engineer.

## **Inspector's Checklist**

1. Does the Inspector check the concrete temperature, air content, slump, batch time/placement time prior to placement of the concrete?
2. Is the concrete placed in such a manner that segregation was minimized?
3. Do all chutes and troughs conform to the Specifications?
4. Does the distance that concrete was dropped conform to the Specifications?
5. Is the concrete deposited as near as possible to its final position?
6. Do the Contractor's vibratory procedures conform to the Specifications?
7. Is the concrete placed in continuous horizontal layers?
8. Are the Specifications adhered to when the operation was temporarily discontinued?
9. Do the reinforcing steel and the anchor bolts maintain their position during placement of the concrete?
10. Are the curing materials approved prior to use?
11. If used, is curing compound applied at the specified rate?

12. Where liquid membrane seal was selected, are the contents of the container thoroughly agitated before any portion is drawn off for use?
13. In cold weather, does the Contractor make provisions to maintain the temperature of the curing concrete within the specified limits?
14. Are the correct number of probes taken and recorded in the project diary for computing overdepths within the ½” construction tolerance?
15. Are approved plans for in place deck forms used and followed?
16. Has a dry run of the screed and form elevations of the deck been checked?

## **SECTION 405 - PRESTRESSED CONCRETE**

### **Description**

Prestressed members normally used by the Department are: I-beams, box beams, flat slab type members and concrete piles. I-beams are used to support conventional deck slab type construction. Box beams and flat type members are laid side by side to form the deck but are generally waterproofed and overlaid with a bituminous or latex concrete riding surface. Concrete piles are used as friction piles for structure supports, particularly over navigable waters.

Ordinarily, I-beams are designated by types. Type I is 28" high; Type II is 36" high; Type III is 45" high; Type IV is 54" high. Prestressed slabs and box beams are rectangular cross sections. In addition, both may have hollow centers or voids which decrease the dead weight of the members.

### **Handling, Storage and Erection**

It is essential that all prestressed concrete items be picked up only at their predetermined pick-up points. Prestressed concrete items can be seriously damaged internally if handled incorrectly.

Prestressed concrete beams are to be stored on a firm base, in a plumb position and braced to prevent overturning. Supports must be placed in the immediate vicinity of the bearing areas (not less than 6", nor more than 2/3 the height of the beam, from the end).

After erection, concrete beams must sit flush on their bearing pads and be in acceptable vertical alignment. The Inspector can check the vertical alignment of the beam, at the bearing areas, with a plumb bob and rule. The Contractor must maintain acceptable vertical alignment when pouring struts, diaphragms and the deck slab. Acceptable vertical alignment for prestressed concrete beams as interpreted from the Specifications is  $\pm 1/8"$  per foot of beam height.

### **Tolerances**

Sufficient spot checks are to be made to ascertain that each prestressed member conforms to the plans, Specifications and special provisions before being erected. Ordinarily, beams and piles are inspected, approved for use and stamped VDOT by the plant inspector before they are shipped. However, the job site Inspector is to check for obvious discrepancies. The following inspection checks pertain to prestressed beams and prestressed piles:

Inspect the unit for cracks. Short hairline cracks or slight chipping caused by movement of the concrete with respect to the casting forms are to be expected. Occasionally small horizontal cracks appear at the ends of the beams, but these

are also acceptable. However, cracks that can be traced continuously around the member should be questioned because these cracks probably extend through the entire section. These and other apparent major faults, may affect the structural integrity of the member, are to be brought to the prompt attention of the Area Construction Engineer.

All bearing areas are to be plane and level unless otherwise specified. Where required by Specifications, due to gradients or vertical curves, epoxy sand wedges are cast on each beam. The casting operation leaves the bearing areas smooth. Epoxy and grit must be applied to the smooth bearing areas to create the desired texture. If this was not done at the plant, it will be necessary to perform this operation on the job site before erection.

Pin positions and the location of all dowels are to conform to the plans.

Camber should be checked. This can be done with a level and a rod or with a very taut string line. Make checks along the bottom surface of the member.

Sweep should be determined by holding a taut string line on the concave side of a member at the ends. Once the string is taut the amount of curvature can be measured with a rule.

## **Inspector's Checklist**

1. Are prestressed concrete units visually inspected for defects when delivered?
2. Is the camber verified to be correct?
3. Are prestressed concrete piles driven only after 7 days and attaining the minimum design strength?
4. Are prestress units handled and supported properly?
5. Are bearing surfaces parallel to the bottom surface of the unit or as specified on the plans?
6. Do prestressed units meet the tolerances as specified in Section 405?
7. Is waterproofing performed if required by the plans?
8. Is the beam bearing 100% on bearing pads?
9. Does inspector have approved shop drawings for pre-stressed items?
10. Have shop drawings as required been approved by District Bridge Engineer and used for construction and erection of pre-stressed members?

## **SECTION 406 – REINFORCING STEEL**

### **Description**

Reinforcing steel is placed in concrete to resist such stresses as those due to flexure, tension, compression, and temperature.

Generally, the number of the bar indicates its diameter in increments of 1/8". A No. 8 bar has a nominal diameter of 1"; a No. 5 bar is 5/8" diameter, etc.

### **Protection of Material**

All reinforcing steel stored on the project should be off the ground and epoxy coated reinforcing steel must be covered to protect it from the weather. Equipment should never be allowed to "run over" reinforcing steel.

Particular attention should be given to the handling of epoxy-coated bars. Allowable repairs should be made in accordance with the Specifications.

As the bars are removed from storage, they should be inspected. The following conditions determine the criteria for using bars that have rusted:

1. The light rust coating (usually brown to light red in color) that initially appears on steel is of no serious consequence and can be safely disregarded.
2. Further development of the rusting process leads to a thick scale (dark red in color). This scale, if it is tight, is not detrimental to bond and may be used in concrete. It would be well at this point, however, to observe and to determine whether or not the flake, in fact, is tight and not loose.
3. Further development in the rusting process produces loose, flaky, scaling rust which can be detrimental to the bond between the concrete and the reinforcing steel. If this condition occurs, the steel is to be cleaned before use in the concrete. This cleaning operation can be accomplished either by brushing with burlap and steel brushes or sandblasting. Reinforcing steel bars which have lost their cross-sectional area during cleaning are not to be used.

### **Placing and Fastening**

Evidence of inspection does not minimize the Inspector's responsibility to examine the fabricator's work and to reject reinforcing steel which does not closely conform to plan or approved details. Sufficient spot checks are to be made of reinforcing steel to verify that the bars conform to plan dimensions and that all bends conform to the bending diagram. This check is to be made as soon as practical after the reinforcing steel arrives on the

project and prior to placement in the forms. This will allow the Contractor maximum time to correct any deficiencies.

Once assembled, the mats or individual bars are to be inspected for proper positioning. This is especially critical in bridge decks due to the relatively thin slab. Consequently, 1/4" tolerance is allowed in the vertical placement of a bar from its plan position. Keep in mind that vertical spacing of bars is considerably more critical than horizontal spacing.

Slab bolster and chair type bar supports are to be placed in sufficient quantity so as to properly support the reinforcing steel mats and not to exceed an average spacing of 4'-0" in each direction. Additional bar supports may be required beneath temporary walkways. When stay in place forms are used, all bar supports are to be firmly supported and located in a manner which will ensure that vertical alignment is not lost due to dislocation of supports.

Bar supports come in many configurations and materials. Stainless steel or galvanized supports may be accepted by letter of certification from the manufacturer or supplier which certifies that the bar supports conform to the applicable material and coating requirements specified in this section of the Specifications. When it is determined that testing of the supports is necessary, one (1) support sample per type and manufacturer is to be sent to the Materials Division.

“Standees” (A reinforcing bar support with bent legs resting on the lower mat of bars), used to support the top mat of steel in deck slabs and slab spans may be used as follows:

On simple slab spans where the top mat of steel is considered temperature steel, not main reinforcement, “standees” may be used provided they hold the reinforcing steel to the requirements of Section 406.03 of the Specifications. The use of “standees” will not be permitted for the top mat of steel on any continuous slab spans. Each standee shall be firmly tied to the lower mat to prevent slippage.

## **Splicing and Lapping**

Reinforcement shall be furnished in full lengths as indicated on the plans. Except where shown on the plans, splicing bars will not be permitted without the written approval of the Engineer. Splices shall be as far apart as possible.

Bars shall be lapped at least 30 bar diameters to make the splice. In lapped splices, bars shall be placed in contact and wired together. Mechanical butt splicing will be permitted at longitudinal joints in deck slabs and other locations shown on the plans provided the mechanical connection develops in tension or compression, as required, at least 125 percent of the specified yield strength of the bar. Reinforcing steel shall be welded only if specified on the plans. Welding shall be in accordance with the requirements of Section 407 of the Specifications.

Laps for sheets of welded wire fabric or bar mat reinforcement shall be at least one mesh in width.

## **Inspector's Checklist**

1. Are samples sent to Materials Division and test reports on file?
2. Is material stored as specified?
3. Do the size dimensions, bends, and hooks of all reinforcing bars conform to the reinforcing bar schedules shown on the plans?
4. Is the surface condition free of loose mill scale, flaky rust, dirt, oil or other coatings that would inhibit concrete bond.
5. Is epoxy coated reinforcing steel being used where required?
6. Is epoxy coating intact and free of defects?
7. Is epoxy coated steel left in sun light more than 30 days without covering?
8. Was reinforcing steel tied as specified?
9. Was reinforcing steel supported as specified?
10. Was reinforcing steel placed as specified?
11. Were splices and laps made as specified?
12. Did spacing, location and edge clearances of all reinforcing bar mats conform to the plans and Specifications?

## SECTION 407 - STEEL STRUCTURES

### Materials

When structural steel arrives on the project, sufficient spot checks are to be conducted to verify that all material bears evidence of test, conforms to the shop drawings and is not damaged. Study the match marks on the stringers and diaphragms and compare these to the shop drawings. This might eliminate some misunderstanding during erection.

### Shop Drawings

Complete shop drawings of all structural steel girders and beams, bearing assemblies and anchorage devices must be submitted by the Contractor for review by the Department. A copy of shop drawings which have been reviewed by the Structure and Bridge Office are to be included in the project files. The Inspector should also review these drawings when they arrive and check them against the contract for obvious discrepancies. If discrepancies are found, they are to be brought to the prompt attention of the Area Construction Engineer.

### Welds

Welding is the art and science of joining two pieces of metal by establishing a metallurgical bond between them. There are numerous welding processes which accomplish this; however, this discussion is limited to manual shielded metal-arc welding, since this is the process used almost exclusively by field welders.

The mechanical process of arc welding is that an electric arc is concentrated on the edges of two pieces of metal to be jointed. This electric arc generates heat in the magnitude of 6000<sup>0</sup> F and melts the metal. The electric arc is introduced to the metal through an electrode which also melts. The metal, commonly referred to as the base metal, and electrode form a molten pool and as the electric arc moves on, this pool solidifies and the metallurgical bond is established.

In joining two pieces of metal, we speak of a welded joint. These joints are either designated as a fillet weld or groove weld. Many refer to a groove weld as a butt weld. Welding of these joints may be performed in four positions; flat, horizontal, vertical or overhead.

**Welder Qualification** - The most important factor is the welder. All welders must be qualified in accordance with the American Welding Society's standards and their qualifications verified by the Materials Division. Prior to a welder performing work on a project, the Contractor must submit to the Inspector a copy of the welder's certificate of qualification, and also a certificate stating that the welder has not exceeded any period of three months since the date of qualification without performing satisfactory welding in the required process. These documents are to be forwarded to the structural steel section



of the Materials Division to be reviewed to determine the validity of the documents before welding is performed. The pertinent information pertaining to the welder's certification is to be recorded in the project diary.

In order to expedite the approval process of certification documents for field welding, the following procedure is to be followed:

- 1) Upon receipt of the documents, the Project Inspector is to contact, by phone, the district representative previously designated by the District Administrator as being responsible for review of welding documents.
- 2) In the event the welder has been approved on another project in the District, the district representative can give immediate approval.
- 3) If the welder has not been previously approved in the District, the district representative is to contact, by phone, the structural steel section and then advise the Inspector by phone accordingly.
- 4) Upon receipt of verbal approval from the district

There are many types of qualification tests which may be conducted and each test permits a welder to make certain types of welds. Tests will vary in that the following variables must be considered: type of joint welded; thickness of test plates; electrode used in welding the sample; and position of test plates. The structural steel section, in reviewing the welder's certificate, will determine from the test taken, the type of joints that the welder is qualified to perform, thickness of metal qualified to weld, positions that he is qualified to weld, and the electrodes that may be used. The Inspector should ensure the Contractor is qualified to perform the type of weld required.

Electrodes - Welding electrodes used in structural welding must conform to current Specifications. The Materials Division maintains and distributes to all Inspectors a list of all acceptable electrodes which may be used without evidence of test. Electrodes must be kept in a dry location. Electrodes which become damp must not be used. The classification of all electrodes will be shown on the container and also each individual electrode will have the classification marked near the grip end of the core wire.

Electrodes have a chemical coating on the core wire. As the electrode melts, this coating forms a slag on top of the molten metal which protects the metal from the surrounding air. The air contains oxygen and nitrogen, and if these two elements are allowed to combine with the molten metal, the weld is weakened by being porous and brittle. The slag also prevents the molten metal from solidifying representative, the Inspector is to advise the Contractor and welding (by the Certified Welder) may proceed.

The certification documents are to be submitted in accordance with the procedure established in the Manual of Instructions, Materials Division. Written approval for documentation of records will follow through normal channels.

The chemistry of the coating, which forms the slag, adds alloying ingredients to the molten metal, giving the weld certain physical properties which are desirable.

Preparation of Material - Surfaces and edges to be welded must be smooth, uniform and free from fins, tears, cracks and other defects which would adversely affect the quality or strength of the weld. Surfaces to be welded and surfaces adjacent to a weld must also be free from loose scale, slag, rust, grease, moisture, or other material that will prevent proper welding.

Inspection of Welds - Satisfactory welds exhibit a generally uniform cross section with a flat or slightly convex face. The surface should have a contour that is relatively even and smooth. The edges of the weld should be reasonably straight.

Defects which reduce the structural quality of a weld include undersize weld, insufficient throat, excessive convexity, excessive undercut, overlap and insufficient slag.

The detailed requirements set forth in the Specifications are intended to apply to main member welds and to other designed welds whose quality is critical to the structural capacity or performance of the structure. Fillet welds and pile splice welds are generally not critically designated and visual inspection of such welds is normally satisfactory.

Shop welds are normally evaluated at the fabrication shop as a part of the structural steel inspection and performed under the administrative supervision of the Materials Division. Inspection reports are distributed and handled in the same manner as other test reports.

Request for inspection of critically designed field welds, as well as request to resolve the need for detailed inspection of welds, should be reviewed by the appropriate member of the district staff (the District Bridge Engineer or the District Materials Engineer). The district office will be responsible for scheduling all detailed field weld inspection work. Arrangements are to be made by contacting the structural steel section of the Materials Division located in the Central Office (Elko). The Materials Division will make all necessary contacts with the inspection agency or personnel authorized to perform the inspection of field welds.

Information which should accompany the request for field weld inspection includes: (1) project and location, (2) amount and type of weld to be inspected, (3) location of the welds in the structure, (4) type of electrical current available at construction site, (5) location of nearest water source, (6) telephone number of the Inspector's office, and (7) date inspection is desired.

A copy of the AASHTO/AWS Bridge Welding Code D1.5 may be obtained from the District Office.

## Drifting of Holes

If bolt holes are only slightly out of alignment, drift pins may be used to align the members. If the holes are out of alignment to such extent that forcing the drift pins would damage the metal surrounding the hole, they should be drilled or reamed in accordance with the Specifications. Any fabrication error that cannot be corrected by a slight amount of drifting, drilling, or reaming is cause for rejection.

Heavy sledge hammering or other severe forcing of parts to bring them into alignment should not be permitted. The making of cuts or adjustments with oxyacetylene torch is not to be permitted without written approval of the Engineer.

## High-Strength Bolts

Contact surfaces of all plates are to be free from burrs, rust buildup, oil or any other material that would prevent the intimate contact of metal surfaces. Any such defect or material found to be present is to be removed prior to beginning the bolting operation.

Make certain that bolts, nuts and washers are identifiable as being of the specified quality and approved for use. Bolts from only one manufacturer will be allowed on any one structure, unless otherwise approved, due to shipping problems. The following table is to assist the Inspector in identifying the proper bolt dimensions.

Nominal Bolt Size	Bolt Dimensions, in inches			Nut Dimensions, in inches	
	Heavy Hexagon Structural Bolts			Heavy Semi-finished Hexagon Nuts	
	Width across flats	Height	Thread Length	Width across flats	Height
1/2	7/8	5/16	1	7/8	31/64
5/8	1-1/16	25/64	1-1/4	1-1/16	39/64
3/4	1-1/4	15/32	1-3/8	1-1/4	47/64
7/8	1-7/16	35/64	1-1/2	1-7/16	55/64
1	1-5/8	39/64	1-3/4	1-5/8	63/64
1-1/8	1-13/16	11/16	2	1-13/16	1-7/64
1-1/4	2	25/32	2	2	1-7/32
1-3/8	2-3/16	27/32	2-1/4	2-3/16	1-11/32
1-1/2	2-3/8	15/16	2-1/4	2-3/8	1-15/32

A washer is to be used under the nut or the bolt head, whichever is the element turned in tightening the fastener.

The Specifications require that every structural bolt be tightened to a minimum tension based on its diameter. Wrenches that are used to tighten bolts measure torque. The

relationship between torque and tension varies with field conditions; therefore, the wrench must be calibrated at least once each day.

Proper calibration is determined by using a device called a "bolt tension calibrator" which is to be provided by the Contractor. At least three bolts are to be tightened in the calibrator to the torque necessary to produce the necessary tension. If a torque wrench is calibrated, note this reading and use it as the "job inspecting torque." If a power wrench is used, adjust it so that it "impacts" at a torque that will produce a 5 percent greater tension in the bolt than minimum. New, clean bolts are to be used in the calibration tests.

The Specifications outline the inspection procedure for each connection. Visually inspect the bases of the nut and the bolt in each connection tightened with a power wrench. If their edges are either panned or burred, the Inspector can assume that the connection is tight.

When tightening either a bolt or a nut, care should be exercised to ensure that the element not being turned is prevented from rotating, as this will give an incorrect reading. A hand wrench can be used to hold the element which is to remain stationary.

High-strength bolts, nuts and washers are accepted for use on the project by a "Certificate of Compliance" as outlined in the Manual of Instructions - Materials Division. The Inspector's copy of the Certificate of Compliance is to be maintained with the project records and recorded in the materials book.

## **Alignment at Bearings and Transverse Connections**

The end bearing stiffeners of the steel beam or girder is to be in true vertical alignment (unless otherwise called for on the plans). Prior to erection, the Inspector can use a framing square to check the vertical alignment of the girder or beam with respect to the bearing plate. After erection, the Inspector can use a plumb bob and rule to determine conformance. The Inspector must ascertain that the structural steel base plate has made full contact with the bearing assembly and is seated evenly throughout the bearing area.

## **Handling and Storing Materials**

Structural steel beams and girders are to be stored off the ground in a properly drained area and braced against overturning in an up-right position. All other stored materials must also be stored off the ground and kept clean.

## **Inspector's Checklist**

1. Has the Contractor submitted working drawings for review by the Engineer of all structural steel, bearing assemblies, and anchorage devices?
2. Do the working drawings specifically identify each piece other than ASTM A36 steel?

3. Do welders have current certifications for the types of welds being made?
4. Do bolts, nuts, and washers meet Specifications?
5. Are bolts identified as required?
6. Are bolts tensioned as required?
7. Is tightness of bolt checked?
8. Does the welding show quality workmanship?
9. Does the Contractor keep welding rods in a hot box?
10. Do the welding electrodes used in structural welding conform to the approved list?
11. Is the surface of the welds relatively even, smooth, and of the required size?
12. Is the welding being performed to avoid undercut?
13. Has welding only been performed in locations as noted on the plans or as approved by the Engineer?
14. Have welds that do not conform to the specifications been repaired or removed and replaced or the entire piece rejected?
15. Are the bolt holes no more than 1/16 inch larger than the nominal bolt size?
16. Have the burrs on the outside of the bolt holes been removed?
17. Is field flame cutting of structural steel units not done?
18. Are the structural steel stud shear connectors the size and spacing as shown on the plans?
19. Do the shear connectors project 2 inches above the bottom of the deck slab and 3 inches below the plane of the top of the deck slab?
20. Has each unit been identified with an erection mark?
21. Has the Contractor furnished the materials order shipping statement and erection diagrams?

22. Were bolt tensioning devices and complete bolt assemblies tested with an approved tension indicating device at the start of construction and on a periodic basis as determined by the Engineer?
23. Does the Contractor test calibrated wrenches daily or as directed by the Engineer?

## **SECTION 410 – RAILINGS AND PARAPETS**

### **Description**

The object of railing and parapet, in addition to its functional purpose, is to produce a pleasing, finished appearance for bridges, wing walls, retaining walls, etc. Where metal railing is to be used, the bridge deck or parapet wall is to be prepared to receive the railing by having proper surface and alignment of the contact areas. The location of expansion joints in bridge railing, or parapet, or median barriers should coincide with the location of expansion joints in the bridge deck.

### **Metal Railing**

Corrosion at the base of the posts is a critical problem with metal railings. Proper drainage and surface protection for the metal should be provided. For aluminum posts on concrete, it is important that the base be sealed to prevent contact of the aluminum metal with the concrete. The base of the aluminum post is usually separated from the concrete by the use of an aluminum pigmented caulking compound or approved gasket.

Aluminum tubing, which has black carbon streaks after erection, is to be cleaned to remove the streaks so far as possible. The tubes are to be turned so that the least amount of streaks remaining is visible from the traffic side of the parapet wall.

When field welding of railing or support brackets is indicated, approved electrodes and procedures are to be used to produce joints of satisfactory appearance. Finishing by grinding may be needed for exposed parts of the railing.

### **Concrete Railing and Parapet**

Special care should be exercised by the Contractor to maintain the proper alignment of all chamfer strips. This, more than any other single factor, determines the finished appearance of the railing and parapet. The Inspector must verify that chamfer strips are built into the formwork as required.

The Inspector must also verify that the reinforcing steel is placed as indicated on the plans and that the height and width of the railing or parapet is correct prior to placement of the concrete.

Proper consolidation of the concrete is important to eliminate possible honeycombing.

The concrete must be cured using specified methods and forms should be removed only after the specified time.

After removal of the forms, the proper finish needs to be applied as specified.

## **Method of Measurement**

Metal and concrete railings (when listed as separate pay items) are to be measured along the centerline of the top rail (between the extremities of each railing) to the nearest 1/10 foot for the entire superstructure. Concrete parapets are to be measured along the face of parapet, from out to out and to the nearest 1/10 foot.

## **Inspector's Checklist**

1. Are railings and parapets constructed at the proper height?
2. Are metal railings constructed in accordance with the Specification?
3. Are metal railings or metal parapets grounded properly?
4. Are concrete railings, median barriers and parapets given a Class I finish?
5. Is reinforcing steel placed as specified?
6. Are chamfer strips placed as required?
7. Are construction and expansion joints constructed as required?
8. Is there sufficient clearance of reinforced steel to edge of concrete?



# **SECTION 411 - PROTECTIVE COATING OF METAL IN STRUCTURES**

## **General**

Due to environmental concerns, particular attention should be given to Section 411. Existing metal structures that are to be coated may contain hazardous materials.

Each structure will be properly classified on the plans so the Contractor and Inspector will be aware of any coatings which may contain hazardous material.

Type A structures do not contain hazardous materials, therefore an expendable, nondusting, silica-free abrasive can be used and the residue contained, however we do not treat it as a potential hazardous residue.

Type B structures may contain hazardous materials and must be treated as such.

Prior to beginning work on structures that may contain hazardous material, the Office of Employee Health and Safety is to be contacted so that affected Inspectors may get a health screening.

The District Environmental Manager should be contacted to answer questions, provide assistance and to obtain details on the proper handling, storage, containment, and transportation of hazardous materials.

## **Materials**

Coatings shall conform to the requirements of Section 231.

Only potable water may be used in cleaning operations.

Abrasives used in cleaning operations shall be one of the following:

1. Expendable abrasives which shall be selected from the Department's approved products list.
2. Recyclable abrasives which are newly manufactured or re-manufactured steel.

## **Certifications**

The Inspector must verify that the Contractor has the certifications required to perform the work. The Contractor is required to submit proof of certification prior to performing the work.

# Procedures

## Surface Preparation

Inspectors must ensure that surfaces to be coated are free from rust, loose or brittle paint, chalking, oil, grease, salt, dirt, or other substances that would prevent proper adhesion of the paint.

## Application of Coating

The Contractor shall conform to the requirements of SSPC-PA 1 for applications of coatings. Coatings must not be applied prior to proper surface preparation. Areas that had previously been prepared properly, but became soiled, contaminated, or rusted must be re-cleaned prior to application of coatings.

Coating shall not be applied under conditions shown below, unless recommended by the manufacturer and approved by the Engineer. Without manufacturer's recommendation and the approval of the Engineer, coatings shall not be applied when:

1. air, coating, or metal temperature is below 40 degrees F
2. air, coating, or metal temperature is expected to fall below 40 degrees F before the coating has cured
3. snow, sleet, or rain is falling
4. moisture is visible on metal
5. humidity is above 85 percent
6. the temperature of the steel or metal surface to be coated may cause blistering as indicated in the manufacturer's product data sheet
7. the steel surface temperature is less than 5 degrees F above the dew point or is expected to fall to that point before the coating has dried or cured, and
8. in no case shall System W as shown in the Table below be applied unless the air, steel surface and material temperature is above and maintained above 50 degrees F and rising.

Prior to application of coatings, the surface shall be dry. Coatings shall be applied in a neat and orderly manner by brushing, rolling, or spraying as recommended by the manufacturer. However, rollers, daubers, or sheepskins shall not be used to apply zinc-rich coatings.

Zinc-rich coatings may be applied by brush, limited to isolated areas of 1 square foot or less.

Application of coating shall provide a tight film of specified uniform thickness well bonded to metal or underlying coating, including crevices and corners, and shall be free from laps, streaks, sags, runs, overspray, dryspray, shadow-through, skips, excessive film build-up, mud cracking, misses, and other defects.

Beam edges, bolts, washers, and nuts shall receive a stripe coat prior to the full coat application. If a multi-coat system is being applied, beam edges, bolts, and nuts shall be striped prior to each coat except that a stripe coat will not be required for a zinc-rich primer. Stripe coatings shall dry or cure to touch before overcoating.

Deficient, impaired, or damaged areas of each coat shall be repaired using material from the Department's approved systems list.

Successive coatings shall not be applied until each preceding coat has dried and cured in accordance with the requirements of the manufacturer's recommendations and has been approved by the Engineer. Coatings shall be applied in accordance with the requirements of following table:

### COATING SYSTEMS

System	Coat	Coating	Min. Dry Film Thickness (DFT) (mil)
A	Primer	No. 1	2.0
	Intermediate	No. 8, Federal No. 595-20219	2.5
	Finish	No. 8, color as specified	2.5
B	Primer	Zinc-rich (from approved systems list)	
	Intermediate		
	Finish		
F	Primer	No. 14	5.0
	Finish	No. 14	5.0
W	Primer	No. 101 Federal No.595-30045	2.0-4.0
	Intermediate	No. 102, White	2.0-4.0
	Finish	No. 103*	2.0-4.0**

\* Color as specified. If not specified, color shall be Federal No. 595-26307.

\*\* DFT shall be no less than specified thickness; however it shall completely cover the intermediate coat.

### **Quality Control**

Inspector must measure the dry-film thickness of the coating with a Tooke gage when the thickness of previous coatings is not known. When the thickness of previous coatings is known a magnetic dry-film thickness gage is to be used. An adhesion test should be performed.

The Contractor is responsible for repairing test areas at no additional cost.

### **Contractor's Record Keeping**

Section 411 specifies the requirements for the Contractor to maintain daily records. The Inspector should be familiar with the requirements specified.

## **Environmental Protection**

### **Environmental Plan**

The Contractor has a responsibility to protect the public and the environment from leaded paint and hazardous material resulting from preparation operations.

If surface preparation operations are required, the Contractor is required to submit a detailed site-specific environmental plan for review. Once the plan is approved, the Inspector must ensure the Contractor is in compliance with the plan.

### **Monitoring**

The Inspector must perform continuous visual inspections of containment structures, dust collectors and abrasive recycling equipment to detect any emissions into the unconfined space.

Perimeter air monitoring shall be performed as stated in the environmental plan. Should emissions exceed the limits established in Section 411, the Contractor is required to notify the Inspector immediately and operations are to be halted until corrective actions are implemented.

### **Storage and Disposal of Waste Material**

Section 411 contains very specific instructions for storage requirements of waste material. The Inspector needs to be familiar with these requirements and ensure that they are adhered to by the Contractor. The Contractor will not be permitted to store hazardous material on Department property.

## **Health and Safety Plan**

The Contractor shall prepare a worker health and safety plan. This plan is to be prepared and approved by a Certified Industrial Hygienist currently certified by the American Board of Industrial Hygiene or by a SSPC QP-2 Supervisor/Competent Person.

These plans shall not be submitted to the Engineer for approval, but shall be submitted for the Engineer's review and record. After project award but not less than three weeks prior to commencing operations, the worker health and safety plan shall be submitted to the Engineer.

In no case shall the Contractor be allowed to begin work prior to the Engineer's receipt and review of a satisfactorily complete plan.

The CIH or SSPC QP-2 Supervisor/Competent Person providing plan approval or a qualified designated representative shall be present during start-up, surface preparation periods and as needed during removal operations throughout the duration of the project to ensure the provisions of the worker safety and health plans are properly implemented.

At completion of the project, the CIH or SSPC QP-2 Supervisor/Competent Person shall submit a written statement of certification for the Engineer's record, complete with all revisions including notations of any areas of non-compliance and corrective actions taken, that the worker health plans fully complied with all regulations and that the plans were fully implemented.

## **Inspector's Checklist**

1. Did the Contractor submit proof of the required certification prior to beginning work?
2. If a containment structure was erected, was the structure certified by a Professional Engineer licensed in the Commonwealth of Virginia?
3. Are all surfaces prepared as specified?
4. Did the Contractor contain all solid and liquid waste during surface preparation?
5. Is the coating operation done in accordance with Section 411?
6. Are all surfaces dry prior to coating operations?
7. Has the coating material been tested and approved?
8. Is the coating applied at the specified thickness?
9. Are preceding coats dried or cured and approved by the Engineer prior to subsequent coats being applied?

10. Does the Contractor maintain daily records as specified?
11. Is waste material stored and disposed of as specified?
12. Did the Contractor submit the required worker health and safety plan?
13. Did the Contractor submit the required compliance certification at the end of the operation?

## **SECTION 412 – WIDENING, REPAIRING, AND RECONSTRUCTING EXISTING STRUCTURES**

### **Description**

On a regular basis, bridges are repaired and reconstructed to prolong the life of the structure and widened to meet current needs and requirements. There are various types of repairs that can be made to the substructure and superstructure. Inspectors should become familiar with the requirements for the various types of repairs specified in Section 412 of the Specifications when assigned to a project in which widening, repairing, or reconstructing existing structures are involved.

### **Procedures**

#### **General**

Concrete structures are repaired by removing and replacing deteriorated concrete, thoroughly cleaning concrete and reinforcing steel to remain, and replacing reinforcing steel if necessary. Cleaning can be performed by sand blasting, water blasting or other approved methods to remove concrete, rust, oil and other foreign materials that will prevent achieving a bond with the new concrete. Epoxy coated reinforcing steel is not to be cleaned by sandblasting.

Areas to be repaired should be sawcut to a depth of 1 inch. Deteriorated concrete should be removed using hand tools or pneumatic hammers weighing 30 pounds or less. Pneumatic hammers should be angled toward the area to be removed to prevent damage to concrete that is to remain. Care should be taken to ensure the existing reinforcing steel is not damaged.

When existing reinforcing steel has lost  $\frac{1}{4}$  or more of its original cross section, it shall be lapped with new bars of the same size and shape. News bars must lap the existing bars 30 times the diameter of the bars on each side of the damaged portion.

Where new concrete is to be placed against existing concrete, dowels at least  $\frac{3}{4}$  inch in diameter are to be installed at no more than 2 feet 6 inch center to center. The dowels should be installed perpendicular to the existing concrete by drilling and grouting.

### **Bridge Superstructure Repairs**

**Type A milling** consists of milling the surface of a bridge deck to a depth of  $\frac{1}{2}$  inch. Equipment must be capable of removing  $\frac{1}{2}$  inch of concrete uniformly in one pass. Power hand tools will be needed to work around reinforcing steel and in confined areas.

**Type A patching** consists of repairing the deck surface or milled area to a depth that will not expose the reinforcing steel.

**Type B patching** consists of repairing the deck or milled area to a depth of at least 1 inch below the top mat of reinforcing steel.

**Type C patching** consists of repairing the full depth of the deck. For full depth repairs of 3 square feet or less, forms may be suspended from the reinforcing steel. For larger areas, blocking must be used to support the forms.

**Epoxy-mortar patching** is accomplished the same as Type A patching except the depth is up to and including  $\frac{3}{4}$  inch. Surfaces need to be dry and primed with neat epoxy just prior to placing the mortar. The surface is to be sprinkled with sand before the epoxy sets or sandblasted just prior to placement of the seal to ensure bonding.

**Crack repairs** are done by V-grooving structural and dormant cracks to a depth of  $\frac{1}{2}$  inch and blown clean. The groove is then filled with neat epoxy. If latex patches are to be made, the Contractor may brush latex into the groove if the patches are done monolithically.

**Concrete superstructure surface repairs** include repairs to raised medians, median barriers, beams, diaphragms, parapets, posts, rails, curbs, and sidewalks. These surface repairs are to be made with Type B patches. When the patches are 2 inches thick or more, welded wire fabric is needed. The fabric is to be tied to the reinforcing steel if possible. If not possible, expansion bolts are to be installed and the fabric tied to the bolts.

**Joint opening repairs** and reconstruction are accomplished by removing concrete, repairing or replacing reinforcing steel, cleaning exposed surfaces and re-casting the joint with hydraulic cement concrete.

## **Bridge Deck Overlay Repairs**

Prior to placing a bridge deck overlay all deck repair concrete must attain at least 93 percent of the minimum designed compressive strength.

The Inspector is to ensure that existing expansion joints and dams are maintained through the overlay. This is accomplished by installing a bulkhead the same width as the existing joint and installed to the proposed grade and profile.

If major delays occur during placement of the overlay, a construction dam or bulkhead is to be installed. For delays of 1 hour or less, the Inspector must ensure that the end of the placement is protected from drying.



## **Latex or Silica Fume Overlay**

Within 24 hours immediately prior to placing the overlay, the entire deck surface is to be thoroughly cleaned. The edge of the previously placed adjacent overlay shall also be cleaned.

For at least 1 hour prior to placing the overlay, the deck is to be soaked with water. An effective method is to cover the soaked deck with plastic to hold in the moisture. Standing water must be removed prior to placing the overlay.

Overlays are to be placed only when the temperature is 50 degrees F and rising. If the temperature is above 85 degrees F, the Engineer may require the overlay to be placed at night or in the early morning hours.

Mixers for latex hydraulic cement concrete are either batch mixers or automatic mobile continuous mixers. They must conform to the requirements of Section 217 of the Specifications. The Contractor shall perform yield tests on these mixers prior to placement of the overlay. Mixers for silica fume concrete shall be truck mixers that conform to Section 217.

The thickness of the overlay shall be at least 1 ¼ inch. The Contractor may use the overlay for Type A, B, or C patches or joint and crack repairs, if these repairs are placed monolithically with the overlay.

Prior to placing the overlay, the latex or silica fume concrete is to be brushed over the surface of the existing deck. The paste from the latex or silica fume acts as a bonding agent. The Inspector should ensure that the deck and adjacent vertical surfaces are coated. This coating must be applied directly ahead of the overlay placement to ensure that the coating does not become dry prior to the overlay placement. Excess aggregate from the coating operation must be removed prior to placement of the overlay.

The evaporation rate of surface moisture must be strictly controlled to prevent surface cracking. If the evaporation rate exceeds 0.05 pounds per square foot per hour, measures need to be taken to control the evaporation rate. One effective method is to increase the relative humidity at the surface by fogging.

The surface of latex and silica fume overlays must be protected from drying or cracking by placing wet burlap on the overlay. This needs to be accomplished immediately following screeding of the overlay.

Latex and silica fume overlays are to be measured and paid for by the square yard for the thickness specified in the contract documents.

## Bridge Substructure Repairs

Concrete substructure surface repairs are made using Type B patching along with welded wire fabric. Prior to jacking and blocking beams, the Contractor must submit his method of jacking and blocking to the Area Construction Engineer for approval. Unless approved in writing by the Engineer, structures supported on jacks will not be subjected to traffic loadings.

### Shotcrete

When shotcrete is used, repairs shall be done in accordance with the requirements of Concrete Superstructure Surface Repairs and Bridge Substructure Repairs.

Two classes of Shotcrete are as follows:

**Class A** - Class A shotcrete shall contain a minimum of 658 pounds of cementitious material per cubic yard. Class A shotcrete shall have a minimum compressive strength of 5000 pounds per square inch at 28 days. Class A Shotcrete is reinforced with either steel or synthetic fibers. When steel fibers are used, the minimum fiber content shall be 60 pounds per cubic yard. When synthetic fibers are used, the minimum fiber content shall be 6 3/4 pounds per cubic yard. The minimum thickness of Class A shotcrete cover over reinforcing steel shall be 2 inches except in transition areas where shotcrete is feathered to existing concrete with less than 2 inches of cover or where patches are made on existing concrete with less than 2 inches of cover over reinforcing steel.

**Class B** - Class B Shotcrete shall contain a minimum of 635 pounds of cementitious material per cubic yard. Class B shotcrete shall have a minimum compressive strength of 4000 pounds per square inch at 28 days. The minimum thickness of Class B shotcrete cover over reinforcing steel shall be 2 inches except in transition areas where shotcrete is feathered to existing concrete with less than 2 inches of cover or where patches are made on existing concrete with less than 2 inches of cover over reinforcing steel. Where shotcrete containing silica fume is used, the minimum cover over reinforcing steel shall be 1½ inches.

The Inspector should verify that the Contractor has an approved mix design and performance test data with the Engineer's approval on file.

**Wet Process:** Shotcrete subject to freezing and thawing shall contain an air content of 7.0 percent  $\pm$  1.5 percent as delivered to the job site. The materials for wet process shotcrete shall be mixed in accordance with the requirements of Section 217 and applied within 90 minutes after batching.

**Dry Process:** Solid ingredients for dry-mix shotcrete shall be predampened as needed and mixed in a batch type or continuous mixer. Most of the mixing water shall be added at the

nozzle. Dry-mix shotcrete material shall be applied within 45 minutes after batching or pre-dampening.

### **Equipment and Personnel**

Prior to starting the work, the Inspector must verify that equipment used to deliver shotcrete has been approved for use by the Engineer. The equipment shall be capable of discharging the shotcrete mixture in a continuously smooth stream of uniformly mixed ingredients. Air added at the nozzle shall be free from oil or other contaminants, and the air pressure shall be capable of maintaining sufficient nozzle velocity to all parts of the work.

Prior to starting the work, the Inspector is to verify that the nozzleman and supervisors are qualified as stated in Section 412 of the Specifications.

### **Surface Preparation**

The Inspector should ensure that the perimeter of all areas where concrete is removed shall be tapered at approximately a 45-degree angle, except that the outer edges of all areas removed by chipping shall be sawcut perpendicular to the surface to a minimum depth of 1/2 inch to prevent featheredging unless otherwise approved by the Engineer.

Earth surfaces shall be trimmed to line and grade and shall have adequate support to prevent displacement during shotcrete placement. Shotcrete shall not be placed on an earth surface that is frozen, spongy, or subject to free running water at the time of the application of shotcrete. Active seeps, drips, and flowing water shall be controlled by installation of suitable drain systems such that water pressure does not build behind shotcrete linings. Excessive loss of mixing water from the Shotcrete must be prevented. This shall be accomplished by one of the following procedures:

1. Wet the soil prior to the time of gunning to the extent that it is damp but with no visible free water on the surface. Puddling, ponding, or freestanding water shall be eliminated from areas to be shotcreted.
2. As an alternative or when specified, install a moisture barrier system to inhibit the movement of moisture from the newly placed shotcrete into the earth. Wrinkling and folding of moisture barrier will not be permitted.

Rock surfaces shall be free of loose material, debris, chips, mud, dirt, and other foreign matter. The Inspector should verify that surfaces are damp at the time of gunning, and there is no puddling, ponding, or freestanding water.

Wood forms which are to be removed after use shall have a form release agent applied to prevent the absorption of moisture and inhibit the bond between shotcrete and the form.

## **Application**

Shotcrete shall have a temperature of at least 50 degrees F but not more than 85 degrees F during application. The ambient and surface temperature shall be 50 degrees F and rising. At ambient air temperatures above 85 degrees F the Engineer may require placement to be made at night or during early morning hours.

Shotcrete to be applied to uneven and previously repaired surfaces shall first be applied to any deep hole, deeply excavated sections, corners, or areas where rebound cannot escape or be blown free. The thickness of the shotcrete layer shall be such that no sloughing, sagging, tearing, or debonding will occur. Existing concrete shall be sandblasted within 24 hours of application and the surface shall be damp just prior to application.

Where a layer of shotcrete is to be covered by a succeeding layer, it shall be first allowed to develop its initial set. Then all loose, uneven, or excess material, glaze, and rebound shall be removed by brooming, scraping, or other means. Any surface deposits that take a final set shall be removed by sandblasting, and the surface cleaned with an air-water blast from the nozzle. Curing compounds shall not be applied to surfaces that will be covered by an additional layer of shotcrete.

Shooting wires, ground wires, or other devices acceptable to the Engineer shall be used to control the line, grade, and thickness of the shotcrete.

During the shotcrete application, the nozzle shall be held perpendicular to, and when possible, 3 to 5 feet away from the receiving surface and rotated steadily in series of small oval or circular patterns. Whenever possible, sections shall be gunned in one layer to the full design thickness. However, for multiple layers of reinforcement, gunning of one layer of shotcrete may be required for each layer of reinforcement.

When encasing reinforcement, the nozzle shall be held closer than normal and at a slight upward angle. The mixture may be wetter than normal, but not so wet that sloughing behind the reinforcement will occur.

Vertical surfaces shall be gunned starting at the bottom. Rebound or previously expended material shall not be incorporated in the applied layer, and all such material shall be removed from the surface and work area prior to final set and before placement of shotcrete on adjacent surfaces. Shotcrete shall not be placed if drying or stiffening of the mixture is occurring.

## **Finishing**

Prior to the initial set, the shotcrete surface shall be scraped or cut with a trowel or metal template to obtain an even and aesthetically acceptable appearance. The final finishing shall be with a wet sponge unless otherwise specified. Trowel or float smoothing will not be allowed.

## **Curing**

After gunning, the surfaces of shotcrete shall be protected from drying or cracking. When necessary, fogging shall be used prior to the application of moist curing or a curing compound. Shotcrete shall be moist cured for a period of at least 7 days or cured using a curing compound conforming to the requirements of Section 220. The rate of application shall be not less than 1 gallon of curing compound per 100 square feet of surface. The color of the curing compound shall be approximately that of the existing concrete.

## **Quality Assurance and Testing**

Preconstruction testing may be waived by the Engineer if it can be shown that the crew to be used is qualified and that the mixture has been successfully used in similar work.

Test panels 24 inches by 24 inches by 4 inches deep containing steel reinforcement representative of that to be used on the project shall be prepared. Each crew shall gun two test panels with the mix design to be used on the project and for each gunning orientation to be encountered on the job. Panels will be cured in the field in the same manner as the structure for 1 day and transported to the laboratory, where curing shall be continued until time of testing. For shotcrete jobs of less than 200 square feet, the Contractor shall cut one of the test panels with a trowel or a metal template before the initial set, in the presence of the Engineer, to check visually for possible voids under the reinforcement. For larger jobs where specific evidence of good encasement of reinforcing bars is needed, the Contractor shall cut cores from the test panels after the concrete has hardened for at least 3 days. Cores shall be cut through the steel.

The second panels for all jobs shall be used to determine the compressive strength of the applied shotcrete. Cores shall be 2 inches to 4 inches in diameter and shall be taken between the reinforcement and tested by the Department at the specified age in accordance with the requirements of ASTM C42.

In-place shotcrete shall be of uniform quality and free from segregation, honeycombing, sand pockets, sand lenses, sagging, dry patches, overspray, rebound, or incomplete encasement of reinforcement. It shall also be free from delamination, cracking, or single voids with dimensions in excess of 1/4 inch.

The Contractor shall remove and replace or correct defective shotcrete to the satisfaction of the Engineer.

For compressive strength tests, one test panel shall be prepared for each day's production or for each 200 square feet of shotcreting by each crew using the same ingredients and gunning orientation as the shotcrete applied to the job. These panels shall be cured and delivered to the designated testing laboratory as earlier specified in this section.

## Inspector's Checklist

1. Is cleaning performed by sandblasting, waterblasting, or other approved methods in order to remove concrete or other materials detrimental to achieving a bond?
2. Are areas to be repaired outlined with saw cuts to a depth of at least 1 inch or that which will clear the top of reinforcing steel?
3. Is all the loose and unsound material removed using hand tools or pneumatic hammers weighing 30 pounds or less and worked at an angle of 45 to 60 degrees to the plane of the concrete surface being removed?
4. Is exposed reinforcing bars being cleaned, with sandblasting not done on epoxy coated steel?
5. Are reinforcing bars that have lost 1/4 or more of their original cross-sectional area repaired in accordance with this section?
6. Is dust and debris removed by blowing with compressed air or by hosing with water?
7. Are dowels or expansion bolts provided when joining new and existing concrete?
8. Is superstructure surface repair performed in accordance with Type B patching?
9. When concrete surface repairs are made, is a cover of at least 2 inches maintained over all reinforcing steel, expansion bolts, and welded wire fabric, except in transition areas, at patches less than 2" in depth over existing concrete?
10. Has the deck repair concrete attained 93% of the minimum design compressive strength before overlays are placed?
11. Is vehicular traffic not allowed on the bridge until the overlay obtains a compressive strength of 3,500 psi?
12. Is the end of the overlay placement protected from drying during delays of 1 hour or less?
13. Within 24 hours immediately preceding the beginning of latex or silica fume concrete overlay, is the entire surface to be overlaid thoroughly cleaned?
14. Is the surface to be overlaid continuously and thoroughly water soaked for at least 1 hour prior to overlay placement?
15. Is overlay placed only when the ambient air temperature is 50 degrees F and rising?

16. Is a thorough, even coating of latex concrete or silica fume brushed onto the prepared surface prior to overlay placement?
17. Are measures taken to reduce the rate of evaporation if the rate exceeds 0.05 lb/sq ft/hr during placement?
18. Is the latex concrete surface cured through prompt application of wet burlap, covered with polyethylene, and kept continuously moist for the initial 48 hour curing period, followed by 48 hours of air curing?
19. Is concrete removed to a depth as specified on the plans or as directed by the Engineer?
20. Did the Contractor submit a method of jacking and blocking beams for seat repair for the Engineer's approval?
21. Was written approval obtained from the Engineer prior to subjecting structures supported on jacks to traffic loadings?
22. Is the minimum thickness of Class A, Class B, or shotcrete containing silica fume as specified for cover over reinforcing steel?
23. Is shotcrete delivery equipment approved by the Engineer prior to commencement of the work?
24. Is gunning of test panels required for approval of inexperienced nozzle men or supervisors?
25. Do temperature requirements and application methods conform to the requirements of this section?
26. Is initial and final finishing performed as specified?
27. Are test panels for compressive strength and for preconstruction testing, if required, prepared as specified?
28. Have sufficient measurements been taken and recorded to facilitate payment for the repair performed?

## SECTION 414 - RIPRAP

### General

Since channel changes usually alter the hydraulic characteristics of a stream, riprap is frequently specified to protect property and roadways from erosion. When riprap is specified, the type and location will be specified on the plans.

The Project Inspector is to visually examine the slope upon which the plans designate riprap is to be placed. If the slope material appears coarser than the bedding aggregate specified, then the Project Inspector is to contact the District Materials Engineer, through normal channels, for a more detailed investigation to determine the actual need for the bedding. If the slope is comprised of solid rock or closely consolidated boulders whose soundness, size, and weight equal or exceed the Specifications for the proposed riprap, then the riprap may be deleted by the District Materials Engineer.

The Materials Division or the hydraulic section of the Location and Design Division will be available to assist in establishing the need and proper field location for riprap. The plans show the general location but the definite limits must be determined based on field inspections.

Eddy currents often develop at the terminal ends of riprap. These terminals should be tied into some existing undisturbed features such as a boulder or rock outcrop. The alignment of riprap should conform as nearly as possible to the existing alignment of the stream. Any sharp change in alignment causes changes in the characteristic flow of the stream and can increase the rate of erosion at some point along the stream or river.

The following table may be used as a guide to approximate certain rock dimensions to equivalent weights. This table is not to be used for acceptance or rejection of riprap material.

<b>Weight</b>	<b>Height</b>	<b>Mean Spherical Diameter</b>	<b>Rectangular Shape Length</b>
50 lbs.	0.5'	0.8'	1.4'
100 lbs.	0.6'	1.1'	1.75'
150 lbs.	0.67'	1.3'	2.0'
300 lbs.	0.9'	1.6'	2.6'
500 lbs.	1.0'	1.9'	3.0'
1000 lbs.	1.25'	2.2'	3.7'
1500 lbs.	1.5'	2.6'	4.7'
2000 lbs.	1.8'	2.75'	5.4'
2 tons	2.0'	3.6'	6.0'
3 tons	2.3'	4.0'	6.9'
4 tons	2.5'	4.5'	7.6'
10 tons	3.3'	6.1'	10.0'



It is essential for Project Inspectors to ensure that Contractors furnish and place the class of dry riprap specified on the plans. To avoid project delays and minimize material rejections the following procedures have been developed with the producers.

The classes of dry riprap shall be as follows:

1. **Class I:** Stones shall weigh between 50 and 150 pounds each. At least 60 percent shall weigh more than 100 pounds, and approximately 10 percent may weigh 50 pounds or less.
2. **Class II:** Stones shall weigh between 150 pounds to 500 pounds each. At least 50 percent shall weigh more than 300 pounds, and approximately 10 percent may weigh 150 pounds or less.
3. **Class III:** Stones shall weigh from 500 pounds to 1,500 pounds each. At least 50 percent shall weigh more than 900 pounds, and approximately 10 percent may weigh less than 500 pounds.
4. **Class AI:** Stones shall weigh between 25 and 75 pounds each, except that approximately 10 percent may weigh 25 pounds or less and 10 percent may weigh 75 to 100 pounds.

## **Stockpiled Dry Riprap**

The Inspector is to verify the size and acceptability of the material at the quarry prior to shipment.

Dry Riprap to be shipped as it is produced

The Inspector is to establish by visual inspection with the Contractor and the producer the size and percentages required to meet the Department's Specifications.

The Contractor should furnish a sample of the minimum to maximum size riprap at the project work site to be used for visual comparison of riprap delivered to the project and a sample should be maintained at the quarry for the producers benefit. When necessary, the Inspector may request assistance from the District Material Engineer to visit the quarry and establish the size and percentages of dry riprap.

## Procedures

**Grading:** The Inspector should verify that the slope to receive the riprap has been graded to within 6 inches of the lines shown on the plans. Riprap or bedding shall not be placed until the prepared base has been approved by the Inspector.

**Bedding:** Riprap bedding is placed on the embankment to form a backing for riprap. Bedding shall be spread uniformly on the prepared base. Compaction of the bedding material will not be required, but material shall be finished to a reasonably even surface, free from mounds or depressions.

When geotextile bedding material is required, the entire perimeter of the material shall be turned down and buried at least 9 inches for anchorage. Adjacent strips of material shall run only up and down the slope and shall overlap at least 18 inches. Geotextile bedding material shall not be used on slopes greater than 1:1. Damaged material shall be replaced or repaired with a patch of the same material overlapping the damaged area by at least 18 inches on all sides. Material shall be placed loosely so that positioning riprap will not stretch or tear it.

**Placing stones:** Riprap shall be placed on the embankment as soon as practicable after bedding has been finished, but no later than 15 days.

Riprap shall be placed to its full course thickness in one operation and in a manner to avoid displacing underlying material. Riprap stone shall not be dropped onto fabric from a height greater than 1 foot. Smaller-sized material shall not be dropped onto fabric from a height greater than 3 feet. Larger stones shall be reasonably well distributed. Hand placing may be required to the extent necessary to secure the results specified and form uniform slopes.

A tolerance of  $\pm 1/4$  of the thickness of the maximum-size stone from the lines and grades shown on the plans will be allowed in the finished surface.

Placing riprap by dumping into chutes or similar methods likely to cause segregation of the various sizes will not be permitted.

## Mortared Riprap

Stone shall be the same size as specified for dry riprap, Class II, and shall be selected to secure fairly large, flat-surfaced stones that will produce a true and even surface with a minimum of voids.

Stones shall be placed first and roughly arranged in close contact, with the larger stones placed near the base of the slope. Spaces between larger stones shall be filled with stones of suitable size, leaving the surface reasonably smooth and tight and conforming to the contour required.

As each larger stone is placed, it shall be surrounded by fresh mortar, and adjacent stones shall be shoved into contact. After larger stones are in place, spaces or openings between them shall be filled with mortar, and smaller stones shall then be placed by shoving them into position, forcing excess mortar to the surface, ensuring that each stone is carefully and firmly bedded laterally.

## **Grouted Riprap**

Grout shall consist of 1 part hydraulic cement and 3 parts sand, thoroughly mixed with water to produce grout having a thick, creamy consistency.

Stones shall be of the same sizes and placed in the same manner as specified for dry riprap, Class I. Care shall be taken during placing to keep earth or sand from filling spaces between stones. After stones are in place, spaces between them shall be filled with grout from bottom to top and the surface swept with a stiff broom. Riprap shall not be grouted in freezing weather. In hot, dry weather, the work shall be protected from sunlight and kept moist for at least 3 days after grouting by the use of saturated burlap.

## **Inspector's Checklist**

1. Is all vegetation removed from the slope prior to placement of the riprap?
2. Is the slope graded as required?
3. Is geotextile fabric installed properly if required?
4. Is riprap of the gradation specified?
5. Is riprap keyed into existing toe of fill or stream bed as shown on plans or as directed by the Engineer?

## **SECTION 415 – CONCRETE SLOPE PROTECTION**

### **General**

The plans may require concrete slope protection to be constructed with pre-cast blocks or "cast-in-place" concrete slabs. When blocks are required, the joints between the blocks are filled with mortar. In the case of cast-in-place slabs, all joints are ordinary construction butt joints. Horizontal joints to be continuous on the face of the slope with vertical joints being staggered perpendicular to the horizontal joint.

Slope protection requires the firm support of bedding material, although it has the structural strength to "bridge over" small local voids. Adequate drains must be provided to prevent an uplift force from frost action and from the pressure of water trapped behind the slope.

A 2 inch bedding of Grade B sand may be specified as bedding material beneath the slope protection. Weep holes may be formed in the concrete to provide drainage.

Cast-in-place slope protection is used more often than the block type. All slabs are reinforced and tied together with woven wire fabric. If the slabs are to have the necessary rigidity and durability, the wire fabric must be positioned at mid depth of the slab. Frequently, the weight of the fresh concrete pushes the wire below mid depth and the workers neglect to reposition it accurately. Considerable attention must be given to this very important detail.

The Contractor may elect to place slope protection in alternate horizontal or vertical strips and score the perpendicular joints with a jointing tool in lieu of placing the concrete in alternate blocks.

If the slope protection is for a roadway grade separation rather than a bridge over a stream, examine the grading plans for ditch line elevations. The ditch line elevations on the roadway plans should agree with those of the slope protection on the bridge plans. Any differences are to be brought to the attention of the Construction Manager.

Finally, check the layout of slope protection in the field. All slope protection is to extend along the slope for a sufficient distance to catch storm water dripping from the outer edges of the deck. A slight amount of additional concrete here will eliminate a serious erosion (maintenance) problem.

### **Method of Measurement**

The actual field dimensions (measured to the nearest tenth of a linear foot), pertinent calculations and detailed sketches necessary to determine the actual area of the slope protection (rounded to the nearest square yard per abutment), are to be recorded in the

project records. If an individual protruding fixture has an area greater than 9 square feet, that area is to be deducted from the total area of the slope protection.

## **Inspector's Checklist**

1. Is the subgrade constructed properly?
2. Is the 2 inch bedding material placed properly?
3. Are blocks laid with continuous horizontal joints and staggered joints extending up and down the slope?
4. Are all joints filled with mortar?
5. Is cast in place edging placed as specified?
6. Is the toe of slope protection in alignment with proposed and/or existing ditch?

## **SECTION 419 - BRIDGE CONDUIT SYSTEMS AND LIGHTING SYSTEMS**

### **Description**

As soon as practicable, the Inspector should carefully study the plans, Specifications and Special Provisions and become familiar with the requirements therein. Layouts should be checked to determine any omissions or necessary changes.

### **Materials**

Electrical materials are to conform to Section 238 and must be approved for use by test report or certification prior to payment. Occasionally, plans will specify a manufacturer's brand name, model number, and state "or equal." If the Contractor elects to order an "equal," he is to submit pertinent details (drawings and manufacturer's specifications) to the Area Construction Engineer for review and approval prior to ordering such materials.

### **Installation**

Installation is to be performed in accordance with Section 700. Conduit is generally installed in conjunction with the reinforcing steel and is to be placed so as not to interfere with the proper location of the steel. Conduit should be secured in place to avoid dislocation or damage which would affect installation of wiring.

Conduit that has been crushed, kinked, or in any way deformed is not to be used in the work. During installation, conduit is to be kept free of dirt or other objectionable material. After installation, there should be no obstructions in the conduit that will hinder the "pulling" of electrical conductors.

The location of the conduit "runs" shown on the plans is for the purpose of circuitry and bidding only. During construction it may be advantageous to alter or change the runs somewhat to avoid obstacles unforeseen during design stages.

Conduit field cuts are to be made with a pipe cutter with the ends square. When metal conduit is properly joined, the ends are butted tightly together. Periodically, the Inspector should test the couplings with a wrench to see that the joints are made up tight.

Field cuts in non-metallic conduit are also to be made square. Couplings should be checked to ensure that the proper gaskets are installed correctly and that the joint is tight.

Conduit is to be equipped with expansion and deflection fittings which coincide with bridge joints. Sufficient slack is to be left in conductors to allow for movement of bridge sections. When a bonded system is required, care should be exercised to ensure continuity of the system by flexible bond across moveable fittings. Where non-metallic

conduit is used, the system is bonded internally with a bare copper wire no smaller than No. 6.

## **Inspector's Checklist**

1. Are materials tested and certified as specified?
2. Did the Contractor notify the Engineer at least 48 hours prior to energizing the electrical system?
3. Are all required conduits, expansion and deflection fittings and electrical items installed as specified?
4. Are all joints made up tight?
5. Are all conduit runs clear of obstructions after installation?

## **INCIDENTAL CONSTRUCTION**



## SECTION 501 – UNDERDRAINS

### Description

The locations of underdrains are usually determined by soils investigations prior to completion of the plans or during grading operations. Underdrains are placed to lower the water table or to intercept and dispose of water seeping into the roadway from backslopes or other sources outside of the roadbed. Changes in design location, elimination of underdrains, or the selection of additional locations should be made by the Area Construction Engineer or District Materials representative and documented in the project diary.

### Installation

Underdrains should be placed with their perforations down or as directed by the Engineer. Non perforated pipe should be used for outlets or crossdrains. Non perforated pipe need not be backfilled with granular material. Blind drains are often installed, in which case the pipe is omitted, and the water is lowered by the use of free draining material.

Inspectors should verify that geotextile drainage fabric is installed and lapped properly. The designated area shall be cleared of debris prior to fabric installation. Large holes shall be filled with sandy, coarse material, and sharp contours and rises shall be leveled. Adjacent strips of geotextile drainage fabric shall be overlapped at least 12 inches. If fabric is torn or punctured, it shall be repaired with the same type of fabric.

Inspectors should also verify that the correct type of aggregate is placed as shown in Section 108 of the *Road and Bridge Standards*.

Semi-round underdrain pipe is to be installed with the rounded section down. Wherever the depth of trench is modified for any reason to a depth less than normally specified, ABS or PVC pipe is not to be allowed.

For underdrain outlets non-perforated pipe shall be placed in the trench with sections securely joined. After pipe installation has been approved by the Engineer, the trench shall be backfilled with aggregate material in layers not more than 6 inches in depth and thoroughly compacted.

Installation of EW-12 Endwalls and outlet markers shall be in accordance with Section 101 of the *Road and Bridge Standards*.

### Method of Measurement

Underdrains of all types are to be measured to the nearest linear foot for each line.

## **Inspector's Checklist**

1. Are all cuts checked for springs and seepage after heavy rains?
2. Are trenches excavated to the proper depth and width?
3. Is non-perforated pipe used for outlets?
4. Are the upgrade ends of pipes adequately capped or plugged?
5. Are pipe joints checked to ensure tight connections?
6. Is the pipe placed and bedded in accordance with applicable Specifications and Standards?
7. Are all special problems pertaining to drainage brought to the attention of the Area Construction Engineer?
8. Is an adequate number of outlets provided for all underdrains? Are outlets so located that there is no chance of water backing into underdrains during heavy storms?
9. Are all pipe outlets checked to ensure they had not been crushed or displaced during construction?
10. Are all outlets checked after periods of heavy rainfall to ensure that they were flowing freely.
11. Did the Contractor place markers at outlet end of all underdrain installations?
12. Is extra depth installation over 4 feet adjusted for pay in accordance with Section 501?

## **SECTION 502 – INCIDENTAL CONCRETE ITEMS**

### **General**

Incidental concrete items include paved ditches, paved flumes, curbs, gutters, combination curbs and gutters, bridge drainage aprons, concrete median barriers, median strips, sign islands and directional island curbs.

These items are shown on the plans by the designer in locations and in quantities based on the field data he has available. Additions or deletions may be necessary to suit conditions on the project. As soon as practical, the Project Inspector should review the project with the Area Construction Engineer for any necessary changes.

### **Procedures**

Areas should be excavated to the proper grade and thoroughly compacted.

All forms must be straight, free from warp and be of sufficient construction to allow for concrete placement without shifting. Forms should also be free of foreign matter and oiled prior to placement of concrete. If the forms do not meet the requirements of the Specifications, they should be rejected by the Inspector, and the Contractor should be required to provide forms that are acceptable. It is suggested that a small mark be placed on forms that do not meet Specification requirements to assist in identifying unacceptable forms.

Inspectors should verify that forms are set to the correct grade and check the horizontal and vertical alignment prior to placement of concrete. The alignment of all forms is to be smooth and pleasing to the eye. The longer the form line the easier it is to detect and remove minor irregularities. The value of "eyeballing" to detect obvious mistakes and minor irregularities cannot be overemphasized.

The foundation material must be uniformly compacted and shaped to the correct elevation. The gravel or crushed stone particles that collect along the inside edges of the forms are to be removed. The presence of this loose material may lead someone to incorrectly conclude that the concrete lacks proper depth (when they observe the sides of the concrete section after removal of the forms). The Inspector should ensure the subgrade is thoroughly moistened prior to placement of concrete.

The Contractor should straightedge the flow line of gutters and paved ditches while the concrete is still workable, and remove any sags or knots that would prohibit the proper drainage or appear unsightly. Concrete placed adjacent to forms is to be vibrated or hand spaded to eliminate honeycomb.

The completed curb should be backfilled as soon as practical after construction. Storm water should not be allowed to accumulate behind the curb, as it may saturate the

pavement structure. Care should be taken to ensure compaction of the backfill does not cause damage to the concrete.

The Contractor may request to use slip-form equipment for placing incidental concrete items. Approval to slip-form is contingent upon the quality, shape, and alignment of the test section produced.

Inspectors should verify that transverse joints for crack control are provided at the following locations:

1. at approximately 20 foot intervals
2. at the gutter where the curb and gutter tie to the gutter apron of drop inlets
3. when time elapsing between consecutive concrete placement exceeds 45 minutes
4. where no section shall be less than 6 feet in length

Crack control joints may be formed by using one of the following methods:

1. removable 1/8 inch thick templates
2. scoring or sawing to a depth not less than 3/4" inch when using a curbing machine
3. approved "leave in" type inserts

Expansion joints shall be formed at approximately 100 foot intervals, at all radii points at concrete entrances and curb returns and at locations no less than 6 feet and no more than 10 feet from drop inlets.

Edges of concrete shall be rounded to a 1/4 inch radius. Exposed surfaces immediately adjacent to the roadway are to be given a light broom finish. Concrete median barriers are to be given a Class I finish. Paved ditches and flumes are to be given a course or roughened finish.

The proper curing of concrete requires the proper control of four major factors: Humidity, temperature, wind and protection against disturbance. The concrete is to be cured under conditions of humidity, temperature, and wind that will produce a uniform hydration of the cement. Concrete may be satisfactorily cured by either a moisture application system or by the uniform application of an acceptable curing compound membrane. Do not permit the use of curing compound if an overlay will be required for additional surfacing.

The Contractor is to make every reasonable effort to protect the concrete from rain or rapid drying conditions. The concrete surface is not to be walked upon or disturbed for a minimum of 24 hours. When open-flame heaters are used in the vicinity of combustible concrete formwork, a watchman is to be provided by the Contractor.

Asphalt Concrete curbs shall be placed on a dry, clean surface. Immediately prior to placement of the curb, a tack coat shall be applied at a rate of 0.05 to 0.15 gallon per square yard. Asphalt Concrete curbs should be placed by a self-propelled automatic curb machine, except that short section or radii may be placed by other methods with approval of the Engineer.

Asphalt Concrete paved ditches shall be placed and compacted so as to provide a smooth, uniform, and dense texture.

Concrete median barrier shall be constructed with a tolerance of 1/2" inch for overall depth and width, 1/4 inch for width of the upper portion, and 1/4 inch per 10 feet for horizontal alignment.

Concrete median barriers should be backfilled and compacted in 6 inch layers to required elevation. The barrier should be backfilled as soon as the concrete curing time has elapsed.

## **Inspector's Checklist**

1. Is the foundation compacted to the proper density?
2. Are the dimensions correct in accordance with the plans or applicable standard?
3. Are forms free of warp and braced to prevent movement or deflection during concrete placement?
4. Are forms placed in the proper location and to the correct grade?
5. Are the front and back slopes of paved ditches checked?
6. Is loose material removed from within the forms?
7. Is the proper size re-bar installed?
8. Does the re-bar have the required clearance from the forms?
9. Is the concrete vibrated during placement?
10. Are edges rounded to a 1/4 inch radius?
11. Are transverse crack control joints provided at the correct locations?

12. Are the joints formed to the correct depth using an approved method?
13. Are expansion joints placed in the correct location?
14. Are exposed surfaces given the appropriate finish?
15. Are there irregularities that would hinder the drainage flow?
16. Are sections of concrete the minimum required length?
17. Is the concrete cured and protected properly?
18. Is integral curb placed with 45 minutes of slab placement?
19. Are curb, gutter, and combination curb and gutter backfilled and properly compacted within 3 to 7 days?
20. Is 0.05 to 0.15 gallons per square yard of tack applied to the surface prior to placement of asphalt concrete curb?
21. Are concrete median barrier dimensions verified?
22. Is concrete median barrier properly backfilled and compacted?

## **SECTION 503 – RIGHT-OF-WAY MONUMENTS**

### **General**

Right-of-way monuments are to be set accurately in accordance with instructions in the *Road and Bridge Standards* and should be checked by the Inspector to ensure the location is as called for on the plans. The Right-of-way monuments should be thoroughly compacted in such a manner as to not displace the monument. When the plan location of a monument falls within an entrance or yard where its presence would be unsightly or create a hazard, they may be set with the top flush with the ground. Where monuments are set flush with the ground the Inspector is to reference their location (except at P.C.'s and P.T.'s). This information is to be forwarded through normal channels to the Right-of-Way Division in the Central Office.

Right-of-way monuments shall conform to the requirements of Section 219 of the Specifications and shall be installed in accordance with Section 503 of the Road and Bridge Standards.

### **Method of Measurement**

Right-of way monuments are to be measured in units of each, complete-in-place, and paid for at the contract unit price per each. Payment is to include excavating, backfilling and compacting.

## **SECTION 504 – SIDEWALKS, STEPS AND HANDRAILS**

### **Sidewalks**

Sidewalks can be constructed with either hydraulic cement concrete or asphalt concrete. The location of sidewalks should be verified by the Inspector prior to excavation. After excavation, unsuitable material should be removed and the foundation graded to the proper elevation and thoroughly compacted.

Forms should be free of warp and free of foreign material. Forms must be sufficiently braced to prevent deflection or movement during placement of concrete.

When hydraulic cement concrete is used, the foundation should be thoroughly moistened and the forms oiled prior to placement of concrete.

Class A3 concrete should be used for the construction of sidewalks. Outside edges and joints should have a radius of ¼-inch.

Sidewalks should be finished using a hand float and light trowel marks removed with a light brooming.

Transverse expansion joints are to be constructed at approximately 100 - foot intervals. Slabs should be at least 3 feet in length and be separated by preformed joint filler extending from the bottom of the slab to ¼ inch below the top of the slab.

The slab between expansion joints should be divided into 5 foot sections and separated by transverse control joints formed by tooling. When obstructions, except for drop inlets, penetrate the sidewalk, construction joints should be formed around those obstructions. These joints are to be constructed using ¼ inch preformed joint material.

Where sidewalks are adjacent to curb, the expansion joints in the sidewalk and curb should coincide.

Sidewalks should not be open to pedestrian traffic for 5 days and not open to vehicular traffic for 14 days or until the minimum design strength had been achieved.

When liquid membrane curing compound is used, heavy concentrations should not be allowed.

When asphalt concrete is used, a 4 inch layer of No. 8 aggregate bedding shall be placed and thoroughly compacted. Asphalt concrete may be placed in one or more layers, dependant on the depth required. Asphalt concrete should be accomplished using a hand operated or power roller of sufficient weight to achieve the necessary density. Hand tamping is only permitted in areas inaccessible to the roller.



Hydraulic cement concrete sidewalks should be measured and paid for by the square yard for the depth indicated in the contract. Obstructions within the limits of the sidewalk that is greater than 1 S.Y. shall be deducted from the measurement.

Asphalt concrete sidewalk is to be paid by the ton of asphalt material. Bedding material is to be paid for by the ton or cubic yard at the contract unit price.

## **Steps**

Hydraulic cement concrete steps are to be constructed in accordance with the plans or Section 601 of the *Road and Bridge Standards*.

A light broom finish should be given to the tread portion of the steps.

Inspectors should pay special attention to the placement of reinforcing steel to ensure the correct size bars are being used and the proper bends have been made.

Hydraulic cement concrete steps should be measured in cubic yards of concrete and pounds of reinforcing steel used.

To determine the necessity for handrails, refer to Section 601.01 of the *Road and Bridge Standards*.

## **Handrails**

Handrails are constructed using standard weight pipe for rails and extra strong pipe for posts. All metal rails, posts, and fittings shall be galvanized.

Handrail may be constructed using standard fittings or by welding. If joints are welded, all exposed joints shall be finished smooth by grinding or filing.

Handrails are to be constructed in accordance with Section 605 and 601 of the *Road and Bridge Standards*.

Handrails are to be measured in linear feet along the top rail and paid for at the contract unit price.

## **Inspector's Checklist**

1. Is the pre-formed joint material tested and is it ½ inch thick?
2. Are foundations properly compacted and loose material removed?
3. Is geo-textile fabric overlapped at 12 inches?

4. Are forms straight, cleaned, oiled, and braced strongly enough to withstand the concrete placement without movement?
5. Is the foundation thoroughly moistened prior to concrete placement?
6. Is concrete screeded in such a manner as to prevent honeycombing?
7. Do outside edges of the slab and joints have a  $\frac{1}{4}$  inch radius?
8. Are transverse expansion joints constructed at 100 foot intervals and filled with  $\frac{1}{2}$  inch joint filler extending to  $\frac{1}{4}$  inch below the top surface of the slab?
9. Are slabs at least 3 feet in length?
10. Are construction joints and transverse control joints constructed where required?
11. Do expansion joints in the sidewalk and adjacent curb coincide?
12. Is the slab properly cured and protected?
13. If placing an Asphalt Concrete sidewalk, is No. 8 aggregate placed in 4 inch layers and thoroughly compacted?
14. Are the treads of steps finished with a lightly broomed texture?
15. Are all exposed welds on handrails filed or grinded to create a neat appearance?
16. Are handrails installed in accordance with Sections 601 and 605 of the Road and Bridge Standards?

## **SECTION 505 – GUARDRAIL AND MEDIAN BARRIER**

### **General**

As soon as practical after grading operations have been completed, the Inspector, Construction Manager, Area Construction Engineer, District Traffic Engineer, and the Federal Highway Administration's Area Engineer (Federal oversight only) should review the designed location of guardrail and end sections to determine if any changes to the designed location are required prior to installation. The Inspector should also try to have the guardrail installation foreman attend.

The Inspector should verify that the Contractor has a trained installer on the project that has successfully completed the Guard Rail Installation, Inspection, and Repair Training (GRIT) and has a current Verification of Qualification card.

The edge of pavement should be established in order to align the guardrail posts. Generally, the holes for concrete or wood posts are auger dug, while steel posts are driven, however, all post may be driven providing the equipment used is capable of installing the post without damaging them. After the posts have been placed in auger dug holes, the space around the post shall be backfilled and well compacted. Posts shall be set plumb (check this with a carpenter's level), spaced in accordance with the standards and the top of the posts set to the design elevations. The rails should lap in the direction of vehicular travel.

The Inspector should verify that the Contractor has contacted Miss Utility to investigate for the presence of underground utility conduits, pipelines, or other covered items before any posts are driven. Also, in areas of Department owned equipment, signals, lighting, changeable message signs, cameras, or roadway antennas, the Contractor shall not drive any post without first contacting the District Traffic Engineering Section and allowing them to locate their equipment. The appropriate utility company or the Engineer is to be immediately notified by the Contractor if their underground utilities are damaged due to construction.

For additional information and guidance the Inspector should use the following web site:

<http://www.extranet.vdot.state.va.us/locdes/GRIT/main.htm>

### **Method of Measurement**

The Inspector is to measure and record in the project diary the length of each line of guardrail and median barrier measured to the nearest linear foot from center to center of the end posts. A copy of all required Certificates of Compliance as outlined in the *Manual of Instruction - Materials Division* is to be placed in the project records upon receipt.

## Inspector's Checklist

1. Does the Contractor have a trained installer on project during installation that has a current certification of training from a GRIT course?
2. Does the Inspector verify that all materials delivered were as specified on the Source of Material?
3. Does the Inspector check the condition of the materials delivered to ensure there were no defects?
4. Does the Inspector review the plans to verify the location of the guardrail was as designed?
5. Does the Inspector verify the Contractor's staked location of the guardrail by Station and distance from Edge of Pavement to be in conformance with the plans or as agreed to at a guardrail field review meeting?
6. Are there any obvious physical reasons that the guardrail should not be installed as designed? If so, are the Construction Manager, Area Construction Engineer, Project Manager, District Traffic Engineer, Project Designer and FHWA Area Engineer (Federal oversight only) requested to review the site?
7. Are GR-6 terminal sections properly buried into cut slopes and are proper flair rates employed in the installation?
8. Is the site preparation in accordance with the *Road and Bridge Standards* and checked by the Inspector?
9. Does the Contractor maintain the proper post spacing as determined by the applicable *Road and Bridge Standards*?
10. Does the Contractor drive steel posts by a method that did not damage them?
11. Are wood posts sawed to the dimensions on the plans?
12. Did the Inspector check VDOT's Approved NCHRP 350 Products List for verification of manufactured products being installed?
13. Does the Inspector verify that proprietary terminals are installed in accordance with the manufacturer's specifications?
14. Does the Inspector receive a copy of the FHWA approval letter on proprietary terminals that were being installed?
15. If reusing guardrail, is it inspected to determine if it is suitable for reuse?

16. Does the Inspector verify the proper blockouts are being installed?
17. Does the Inspector verify that wood timber blockouts are properly toe-nailed?
18. Are guardrail delineators installed correctly and match the edge line colors?
19. Are anchor assemblies installed correctly?
20. Are post holes properly backfilled to grade?
21. Does the Inspector verify the height of the guardrail above the edge of pavement to be in compliance with the applicable *Road and Bridge Standards*?
22. Does the Inspector verify that all bolts are installed and adequately tightened?
23. Does the Inspector verify that guardrail sections are lapped in the correct direction?
24. Does the Inspector check for damage to adjacent pavement structures caused by Guardrail installation?
25. Is only one kind of post and blockout allowed in a single run?
26. Is guardrail kept clean during application of fertilizer, lime, tack coats, primer, or other materials?
27. If weak post and strong post systems are connected, is the transition section properly installed?
28. Are shoulder widths and slopes adequate for guardrail installations?
29. Are deflection areas clear of fixed objects?
30. Is the correct fixed object attachments used at bridge/box culvert locations?

## SECTION 507 – FENCES

### Construction Methods

In the erection of limited access fences, the post is to be set on the highway side of the right-of-way line and, as a general rule, the wire is to be placed on the off side of the right-of-way, thus placing the wire approximately along the right of way line. Where fencing is being erected for the landowner, the post will be on the landowner's side of the right-of-way line with the wire on the road side of the property along the right-of-way line.

Inspectors should check the Contractor's layout of brace units to ascertain that the units meet the criteria of the Specifications and *Road and Bridge Standards*. Additional brace units installed by the Contractor for breaks in horizontal or vertical alignment exceeding those specified in the *Road and Bridge Standards* will not be paid for.

When fencing through a wooded area, it is the Contractor's responsibility to remove such underbrush, etc., as may be required to place the fence on the right-of-way line. In some instances the limited access fence line may not conform to the right-of-way line. In these instances, the fence is to be erected along the line shown on the plans for fence location. It will be satisfactory to make slight adjustments in the location of the fence in order to save large trees that fall directly on the right-of-way line. If the fence is a limited access fence, then it is to be curved in and located on the right-of-way so as to save the tree. If the fence is being erected for the landowner, then it should be curved or located on the landowner's property so as to save the tree.

Woven wire farm fence has different sized openings. The smallest openings are to be placed at the bottom. This will discourage small animals from crawling through the fence.

Splicing is permitted only at the post unless a splice is provided which will develop a strength comparable to the strength of the wire. If the Contractor requests permission to splice fence wire between posts, forward the request to the Area Construction Engineer. Include full information, such as the manufacturer's literature on the splicing device and a sample.

A common inspection practice is to pull on a fence to determine if it is taut. Don't do this any more than necessary for each time the fence is pulled, it is loosened slightly. The result of repeated checking is a loose fence that will need tightening. Climbing over a fence should not be allowed as this also tends to loosen the fence.

All materials incorporated in the fence are to be tested and approved as outlined in the *Manual of Instruction - Materials Division*.

Inspectors should refer to Section 502 of the *Road and Bridge Standards* for installation details and additional information.

All metal fencing is to be grounded in accordance with the *Road and Bridge Standards*.

## **Method of Measurement**

Fencing is measured between end posts or gate posts along the top of fence for each continuous run of fabric including that fabric necessary for line and corner braces but not through gates. Gates are measured in units of each which includes all fabric and fittings. Line and corner braces are measured in units of each in addition to the payment for fence fabric. Standard fence is to be measured to the nearest linear foot and chain link fence is to be measured to the nearest one tenth of a linear foot.

## **Inspector's Checklist**

1. Did the Contractor properly locate the fence line as shown on the plans?
2. Are all fencing materials tested and approved?
3. Are wooden posts that are sawed in the field been re-treated with 3 heavy coats of preservative used to treat the posts?
4. Are posts placed at least 3 feet in the ground, or 18 inches if rock was encountered?
5. When metal posts are set in concrete footings, is the concrete cured for a minimum of 7 days (14 days if average air temperature is below 50 degrees) prior to being disturbed?
6. Is the wire stretched taut and securely fastened to the posts?
7. Is spacing between braces a maximum of 500 feet?
8. Are gates located as shown on the plans?
9. Are metal fences properly grounded?

## **SECTION 508 – DEMOLITION OF PAVEMENT AND OBSCURING ROADWAY**

### **Description**

Demolition of pavement pertains to the breaking-up and removal of the hydraulic cement concrete or asphalt concrete pavement structures including the surface, base, and cement stabilized courses.

Obscuring of old roadway is the scarifying, plowing, harrowing and shaping of the old roadway outside of the limits of new construction. The restored area is then prepared to receive vegetation.

### **Method of Measurement**

Demolition of existing pavement structure is measured to the nearest tenth of a linear foot and computed to the nearest square yard.

Obscuring of old roadway is measured to the nearest linear foot, with the area computed in units of 1000 square feet, and then rounded to the nearest 1/10 unit for payment.



## **SECTION 509 – PATCHING HYDRAULIC CEMENT CONCRETE PAVEMENT**

### **Description**

Patching hydraulic cement concrete pavement consists of removal of the existing hydraulic cement concrete pavement, removal of unsuitable subbase material and replacing pavement with high-early strength hydraulic cement concrete.

Patching of hydraulic cement concrete pavement is accomplished using Class A-3 paving concrete, except that the compressive strength must be at least 3000 pounds per square inch within 24 hours.

Where the existing joint dowel assembly is to be removed, the existing concrete shall be saw cut and removed at least one foot on each side of the transverse joints. Saw cuts shall not extend into adjacent slabs unless that slab is to be repaired. Saw cuts extending beyond the patch shall be sealed with an approved material.

Unsuitable subbase material is to be removed and replaced prior to patching.

The foundation should be thoroughly cleaned and moistened prior to placing concrete.

Existing concrete pavement shall not be removed if it will result in the concrete being placed when the air temperature is below 55 degrees.

As soon as the concrete is placed and prior to the initial set, the patch and adjacent pavement should be tested with a 10 foot straightedge. Irregularities greater than ¼ inch in 10 feet shall be corrected.

After the concrete patch has been textured, concrete shall be covered with wet burlap and poly film. If the air temperature is expected to be below 65 degrees during the curing period, an insulated blanket shall be placed over the poly film.

### **Method of Measurement**

Patching of hydraulic cement concrete pavement is measured and paid in square yards of pavement surface area.

### **Inspector's Checklist**

1. Did the Contractor remove all defective pavement prior to placing new pavement?
2. Where existing joint dowel assemblies are to be replaced, is the existing concrete saw cut and removed for one foot on each side of the transverse joint?

3. Is subgrade under removed concrete dressed and compacted?
4. Do saw cuts extend into adjacent sections of pavement to remain?
5. Are temperature requirements adhered to?
6. Is joint material and reinforcing steel properly placed?

## **SECTION 511 – ALLAYING DUST**

### **General**

Allaying of dust is to be performed as a pay item when the control of dust is necessary for the protection and comfort of motorists or area residents regardless of whether the dust is created on the project or on a haul road leading to the project.

Large "overruns" in the number of truck hours of allaying dust can be avoided by giving more attention to the completion of certain areas of the project before other areas are disturbed. Your attention is directed to the provisions of Section 108.05 entitled Limitation of Operations.

Applying water or calcium chloride to embankment or other materials or pavement courses to achieve compaction or as required by other sections of the Specifications as construction methods will not be paid for as allaying dust. These operations can be identified and separated from regular allaying operations by the timing of the application with regard to compactive rolling of the layer or course. Some Sections of the Specifications which require this treatment and in which this treatment may be an included item are: 303, 305, 306, 307, 309, 310 and 321.

### **Inspector's Checklist**

1. Does the Inspector check on dusty areas, especially in populated areas and be alert to dust which may create a hazard for motorists on nearby roadways?
2. Does the Contractor have a 1000 gallon minimum capacity water truck on the project at all times?
3. Does the Contractor exceed the 30 minute maximum loading time for payment per 1000 gallons of water?

## SECTION 512 – MAINTAINING TRAFFIC

### General

The maintenance of traffic through construction projects is very important. Construction operations may inconvenience people who live along the right-of-way as well as those who must travel through a project built under traffic. Anything the Inspector can do to minimize this annoyance will improve public relations.

The Engineer should require the Contractor to erect the necessary guardrail or barriers at hazardous locations as soon as practicable rather than waiting until the final stages of the project; or he should require the Contractor to erect a suitable temporary barrier service at such locations.

The Specifications require the Contractor to maintain traffic in such a manner as to provide safe, unobstructed and convenient passage of the public through the construction project at all times. Section 104.04(e) further requires that two-way traffic be maintained at all times, unless otherwise approved. To properly administer these requirements, the following policy has been established:

1. If the average daily traffic count is less than 2000 vehicles per day and it is determined that allowance for one way traffic is absolutely necessary, the duration of one way traffic should be limited to short periods of time and, as a rule, should never be permitted over night. The area over which the one-way traffic is permitted must be stabilized and flaggers or other traffic controls must be provided to properly regulate traffic in accordance with Section 104.04. Delays to traffic must not exceed 10 minutes.
2. If the average daily traffic count is in excess of 2000 vehicles per day, one-way traffic should not be permitted.

Maintenance of traffic over temporary detours that are constructed by the Contractor should be the same as that required over the project except that considerable judgment will be necessary in the determining the type surface that must be provided when the type detour is not specified on the plans. Careful attention should be given to the stabilization and surfacing of detours and the following criteria may be used as a guide:

1. All detours should be stabilized. When the traffic count is less than 1000 vehicles per day, surface treatment will not be necessary except in certain situations, such as use extending over a long period of time.
2. If the traffic count is in excess of 1000 vehicles per day, the detour should be surface treated or asphalt concrete paved except in those instances where it will only be in use for a short period of time in order to place a pipe, etc., or where the new road location is tying into short sections of the old road.

3. Where the traffic count is considerably higher than 1000 vehicles per day, surface treatment or asphalt concrete surface may be necessary even though the period of use is anticipated to be short.

Regardless of the type surface provided, the detour must be maintained in a uniformly smooth condition at all times so as to provide for the safe, unobstructed and convenient passage of traffic.

Inspectors should ensure that the Contractor adheres to the Sequence of Construction for Maintenance of Traffic as shown on the plans.

When specified on the plans or required by the Engineer, measurement of the various materials used in stabilization and surface treatment for maintenance of traffic should be in accordance with the applicable Section of the Specification for the materials used. Payment should be made at the unit prices bid in the contract for each material.

Prior to opening a detour, the Contractor should notify all Emergency Services agencies, i.e. local fire, rescue and police departments. Such notification should be given to insure that emergency vehicles will be aware of any impending dangers and, if necessary, reroute around the construction area.

The Specifications require TMA, PCMS, arrow board, portable stands, warning lights, flags, paddles and channelization devices for traffic control to be furnished by the Contractor. Their use and installation shall conform to the applicable section of the Specifications, *NCHRP 350 Standards and the Work Area Protection Manual*. Construction signs will either be furnished by the Department or by the Contractor, depending on the contract.

The use of flashers for the purpose of delineation is contrary to the recommended use of such devices as set forth in the *Manual on Uniform Traffic Control Devices*. Flashers should be reserved for use as advance warning devices and for marking severe or unexpected hazards located in or alongside the roadway and should not be used for routine delineation.

Delineation of a temporary roadway that is poorly defined should be accomplished by using reflectorized road edge delineators, channelization devices or other reflectorized devices. Where lights are required for delineation, steadily burning yellow lights should be used. For example, steadily burning lights should be used to delineate extreme changes in horizontal alignment.

Improper signing can create dangerous conditions, thereby causing accidents. Area Construction Engineer, Construction Managers and Project Inspectors have the authority to determine the signing of construction projects. However, they should rely heavily on the advice of the District Traffic Engineer and the Work Zone Safety Coordinator.

Inspectors should perform a review of projects which affect traffic using the Work Zone Safety Checklist (Form # TE-97001) at least once a week. At a minimum every second weekly review should be performed at night. Additional reviews are necessary after a change in the traffic pattern or severe weather conditions.

The Inspector should constantly evaluate the signing of the project in light of the Contractor's operation. Modifications may be needed to insure safety. Knowing when signs are no longer required is just as important as knowing when they are required. The effectiveness of all signs is reduced if one sign is left up after the need for it passes. This leads drivers to believe they can ignore construction signs. When signs are not needed the Contractor should be required to remove them from the roadway.

The Inspector should ensure the Contractor maintains all signs in a satisfactory condition. Cleaning will be needed periodically to improve their visibility. Regulatory signs, such as black-on-white speed limit signs, are enforceable when authorized and placed on construction projects. To be correct and enforceable, these signs must conform to the standards for regulatory signs and be erected in accordance with State laws. The District Traffic Engineer has the authority to determine the speed limit within the project limits. Police may be asked to enforce these signs.

Inappropriate use of the sign C-29, "Danger Dynamiting - turn off two way radio while passing through this project", can be very annoying. Emergency services such as police, fire, etc. have a lengthy plan of action to follow if they must turn off their radios. It is inconsiderate to ask this needlessly. The appropriate time to display the sign is from the time the Contractor begins placing powder charges until after the explosive is set off. The Contractor should be encouraged to designate one man to display and remove these signs.

The Project Inspector should review the condition of the project at least twice daily, once in the morning and again before leaving the project in the evening. The Inspector should be certain such items as barrier services, warning lights, signs, channelization devices, and other traffic devices are clean and visible in the proper location and are effective. Any unusual situations which may require signs should be brought to the attention of the Construction Manager. Any irregularities or defects in the operation of detour items or the detour surface should be brought to the Contractor's attention for prompt correction.

The public's impression of a project is greatly influenced by its flaggers. When flaggers are neat, courteous and efficient, the public will accept inconvenience of construction with little question. A rude, discourteous, or lazy flagger will create a potentially dangerous condition, especially if the public thinks he can be ignored. Flaggers are required to speak English when performing flagger duties. Flaggers are required to be properly attired when directing traffic (see *Work Area Protection Manual*). This includes the Contractor's forces as well as the Department's. Above all, flaggers must be familiar with the proper procedures of directing traffic, as shown in the *Work Area Protection Manual*.

Sign paddles shall be used to direct traffic as outlined in Section 104.04 of the Specifications and this manual. Flags shall be limited to use by a Traffic Spotter or emergency use only. Hard hats, pocket handkerchiefs, articles of clothing, trash can lids, etc. are not proper flags.

The Contractor shall keep all parked equipment, stored materials, employee vehicles, etc, either behind guardrail and median barrier or outside the clear zone area throughout the project limits. The clear zone will vary with field conditions and is defined in *Location and Design Instructional and Information Memorandum*. Any equipment parked behind the guardrail must be beyond the deflection zone of the guardrail.

## **Inspector's Checklist**

1. Does the Contractor locate construction signs in accordance with the Work Area Protection Manual?
2. Are posts installed in accordance with the Standards?
3. Are signs placed at the correct height above the edge of pavement?
4. Are the correct types of signs and sign stands being used?
5. If signs on posts are covered, are delineators installed on the posts?
6. Is the detour properly delineated?
7. Does the contractor install the proper taper for lane closures?
8. Are flaggers certified and properly attired?
9. Are the correct channelizing devices being used?
10. Are channelizing devices spaced correctly?
11. Is the Work Zone Safety Checklist (Form # TE-97001) being used at least once a week?
12. Is the Inspector documenting when traffic is disrupted?

## **Construction Pavement Markings**

Caution should be used in the application of construction pavement markings. Improper markings lead to confusion and create a serious safety hazard.

The Inspector should check to make sure that the Contractor has submitted a source of material list and the origin of shipment. The source is to be approved prior to the shipment of the material. The Inspector is to see that the proper types of markings are being used in the right location for the sequence of construction being performed.

The Inspector should verify that the Contractor has a certified pavement marking technician on the project during the installation of pavement markings. The Inspector also should be certified.

Inspectors should verify that the air and surface temperatures are in accordance with the manufacturer's recommendation for placement. Inspectors should also verify that the surface is clean and dry.

The Contractor should pre-mark the roadway prior to installing pavement markings and the Inspector should verify that the markings are in the correct location.

Type D tape (removable, can be peeled up by hand) may be used on all finished surfaces and in areas where the traffic pattern will change before the surface is overlaid. Type E, removable black tape may be used for covering existing markings in construction zones. Type F, Class I or II, can be used on asphalt concrete or hydraulic cement concrete.

The reuse of pavement marking tape for maintenance of traffic is questionable due to wear and handling of the material. Prior to allowing a Contractor to use salvaged pavement marking tape, the material shall be recertified by the manufacturer for compliance with the requirements of Section 246 of the Specifications.

Inspector should keep constant check to insure that the construction pavement markings are properly maintained and that the reflectivity of the markings is visible at night under normal driving conditions (3 skip lines should be visible from a standard car's low beam lights).

The Contractor's certified pavement marking technician must furnish the Inspector a Form C-85, Contractor's Daily Log and Quality Control Report, at the end of each day that pavement marking is performed. The Inspector should verify that the form is complete and the quantities are accurate. The Form C-85 is the test report for the pavement markings and markers placed that day.

See *Manual of Instruction-Materials Division* for additional information concerning acceptance of Pavement Marking Materials and Markers.

See Section 704 – Pavement Markings and Markers for application procedures.

## **Construction Pavement Markers**

Raised temporary pavement markers are typically used in work zones and are used in conjunction with construction pavement markings to further delineate traffic flow. Raised



temporary pavement markers are glued to the roadway with either bitumen or epoxy adhesive.

When used in lane shifts and transition areas, the markers should be installed on 20 foot centers. When required in other areas, they should be installed on 40 foot centers in accordance with Section 512.03 (k) of the Specifications.

Markers should be located between and in alignment with skip lines or alongside solid lines. Where double lines separate traffic, two-way markers should be installed beside each line.

Temporary raised pavement markers needing replacement shall be replaced by the Contractor at no additional cost to the Department, except when the need for replacement was caused by Department maintenance operations, such as snow removal.

## **Impact Attenuators**

Temporary Impact Attenuator Units (regardless of condition) shall not be allowed as a substitute for a permanent installation. Doing so would expose the Department to increased liability.

A letter of NCHRP 350 certification and Manufacturer's installation recommendations shall be furnished by the Contractor before impact attenuators are installed.

## **Temporary Signalization**

Prior to installing temporary signalization, the Contractor must submit a plan for installing and maintaining signals that depicts the Contractor's intent for maintaining traffic flows. This shall include timing and sequencing of the signals. The Inspector should not allow the Contractor to proceed with the installation until the plan is approved by the Regional Traffic Engineer.

Signalization is to be installed as per Section 703 of the Specifications and the applicable details in the *Road and Bridge Standards*.

The Contractor may use new, salvaged, or refurbished materials unless the materials are to become the property of the Department. The Inspector should review the contract documents to determine if the materials are to be turned over to the Department.

Portable Traffic Signal Equipment will be allowed for temporary one-way bridge signals, and then only when specified in the pay item.

## **Traffic Barrier Service**

When used, traffic barrier service must be of sufficient length to protect the work zone and traffic. A letter of NCHRP 350 certification shall be supplied to the Inspector before Traffic Barrier service is installed, or a letter submitted that the barrier service proposed is on the Department's pre-approved list.

If the Contractor does not remove the barrier service after written notification is given, one or more of the following actions may be taken:

1. Remove the affected quantity of barrier from the monthly progress estimate
2. Withhold monthly progress estimate in accordance with Section 109.07.
3. Remove barrier service with State Forces after written notification in accordance with Section 104.04

Delineators are to be installed on temporary barrier service in work zones. Each delineator must have a minimum of 7 square inches of reflective surface. The surface to which the delineators are to be affixed to shall be thoroughly cleaned and must be dry prior to installation. Delineators must be mounted 25 inches above the roadway and spaced on 80 foot centers.

Barrier vertical panels are required on temporary barrier service in accordance with the requirements in the *Work Area Protection Manual*.

A Type A flashing light is required on top of the barrier at the breakpoint for the transition.

Barrier delineators, vertical panels, and Type A flashing lights are incidental to the barrier service and are to be included in the payment for barrier service.

## **Inspector's Checklist**

1. Do the materials listed on the approved Source of Material Form match the materials used?
2. Does the Contractor have a certified pavement marking technician on site?
3. Is the pavement to be striped clean and free of moisture?
4. Does the Contractor properly pre-mark the area to be striped?
5. Is the material approved for use and have the proper certifications?
6. Are the correct amount of beads used?
7. Are pavement markings applied at the right thickness and width?

8. Are pavement markers applied with the correct spacing?
9. Is the correct type of adhesive used to apply pavement markers?
10. Are pavement markings protected from traffic until dry?
11. Does the Contractor give the Inspector a Form C-85, Contractor's Daily Log and Quality Control Report for the work performed each day?

## **SECTION 515 – PLANING PAVEMENT**

### **General**

Pavement planing shall be accomplished with equipment capable of milling and removing the millings from the surface in a continuous operation. Equipment must be capable of milling a minimum depth of 2 inches on flexible pavements and ½ inch on rigid pavements.

Milling and planing equipment must have a self-contained watering system to control dust and fine particles.

All high spots and irregularities must be removed.

Pavement millings shall be disposed of by the Contractor.

### **Method of Measurement**

Planing will be measured and paid by the square yard per inch of depth.

### **Inspector's Checklist**

1. Does the planing equipment have a self-contained watering system?
2. Is the pavement planed to the correct depth?
3. Are all irregularities and high spots removed?

## **SECTION 516 – DEMOLITION OF BUILDINGS AND CLEARING PARCELS**

The District Right-of-Way Manager will advise, in writing, the Area Construction Engineer of the buildings to be released to the Contractor for demolition. The Inspector is to make a visual survey of the project to see if the released buildings are still in place and keep records on items removed by the Contractor.

Some structures may be designated as containing hazardous materials, such as asbestos, which will have to be removed before demolishing the structure. Inspectors should obtain copies of the Asbestos Inspection Reports and consult with the District Environmental Manager.

The Inspector shall review the plans and special provisions for structures having hazardous materials and proceed in accordance with special provisions.

All utilities are to be disconnected before demolishing the structure. It is important that these services be disconnected at the "street," not at the end of the service line. The Contractor is to make the necessary arrangements with the utility companies.

The Contractor may be permitted to occupy a building, scheduled for demolition, for project use with written permission from the Engineer.

Parcels to be cleared will be identified on the plans and may include items off the right-of-way but within easement limits. All items to be cleared from parcels may not be shown; however, such items as those listed in Section 516 of the Specifications are to be cleared as indicated therein.

Section 516.02(b) of the Specifications states that the Contractor will be notified in writing when buildings are ready for demolition. The Project Inspector is to have a copy of the written notification releasing the buildings to the Contractor prior to such buildings being demolished and shown on the monthly voucher for payment. During preparation of the final voucher, a final check is to be made to determine that all buildings being paid for as demolition items were released to the contractor in writing.

Wells shall be closed in accordance with State Department of Health Private Well Regulations, Department of Environmental Quality, and all local jurisdictions.

### **Measurement and Payment**

Demolition of buildings and Clearing of Parcels are to be paid as lump sum. Closing of Wells is to be paid for in units of each.

## **SECTION 519 - SOUND BARRIER WALLS**

### **Procedures**

Piles shall be driven in accordance with the requirements of Section 403 except that the tolerance for the position of a single steel H-pile shall be  $\pm 1/2$  inch. Piles for sound barrier walls shall not be driven on Saturdays, Sundays, or holidays or between 4:30 P.M. and 8:00 A.M. on other days. The portion of posts from the finished grade to the bottom end and the portion of the H-pile lapped with posts shall be painted with asphalt mastic after splicing. Voids between posts and piles created by the use of shims for plumbing posts shall be caulked prior to the application of asphalt mastic.

Joints and connections shall be secured so as to be structurally sound with no visible openings for sound transmission and shall not be a secondary source of noise attributable to vibration. The top face of the sound barrier wall shall be aligned to maintain a continuous appearance and shall not deviate from true alignment by more than  $1/2$  inch in 10 feet.

When precast panels are supported by a concrete foundation, shimming of panels may be required for proper alignment. Shimming methods and materials are to be submitted to the Engineer for approval prior to shimming.

Disturbed areas shall be graded and seeded in accordance with the requirements of Section 603.

### **Precast Sound Barrier Wall**

Absorptive and reflective precast concrete panels and concrete post footings shall be constructed in accordance with the requirements of Section 404 or 405, except that patching of panels will not be allowed. Panels having deficiencies such as cracking, crazing, scaling, efflorescence or segregation; or panels having mottling of pigment, stain or finish will be rejected. The roadway side of the panel shall have a rustic board, fractured fin or other finish as specified, and the property side of the panel shall have a fuzzy raked or other finish as specified on plans. In addition, the color of the wall shall be approved by the Engineer. Disturbed areas shall be graded to maintain proper drainage, and shall be seeded in accordance with the requirements of Section 603.

### **Metal Sound Barrier Wall**

The Contractor shall submit to the Engineer five copies of certifications from an independent testing laboratory certifying that the design of the sound barrier wall panel will provide the minimum sound transmission loss specified herein.

The Contractor may furnish the galvanized post and girts with the protective color-coating system specified for panels, thereby eliminating the related flashing covering, provided posts and girts conceal threads of bolts and screws.

The Contractor may furnish fixed bolted connections in lieu of welded connections provided he submits load calculations for the specific bolted connections and uses a safety factor of at least 3. Self-drilling screws may be used for locations where forces from the facial wind load will cause the shaft of the self- drilling screw to be in shear and not in tension.

Cut, marred, or scratched surfaces shall be repaired in accordance with the manufacturer's recommendations.

## **Method of Measurement**

Sound barrier walls will be measured in square feet of surface from the finished grade to the sound attenuation line shown on the plans and from end to end of the wall, complete-in-place.

## **Inspector's Checklist**

1. Do soundwall materials conform to the requirements of this section?
2. Are H-piles for sound barriers driven within a +/- 1/2 inch tolerance and in accordance with the section on bearing piles?
3. Is the portion of the post below finished grade and portions of the H-pile lapped with the post painted with asphalt mastic after splicing and are voids caulked prior to painting?
4. Are joints and connections secured so as to be structurally sound with no visible openings, and so as to transmit no noise through vibration?
5. Does the alignment of the top face of the wall not deviate more than 1/2 inch in 10 feet?
6. Is the bottom panel properly supported in accordance with the plans?
7. Are disturbed areas graded and seeded in accordance with the section on Seeding?
8. Are sound barrier walls constructed in accordance with the plans, Special Provisions and Section 519?

## **ROADSIDE DEVELOPMENT**



## **SECTION 601 – SELECTIVE TREE REMOVAL, TRIMMING, AND CLEANUP**

### **General**

With the approval of the Engineer or District Environmental Manager certain trees may be removed to lessen maintenance work and, at the same time, attain a variety of scenic effects. Undesirable trees may be removed to benefit the growth of more beneficial trees. A dense stand may be thinned to this advantage. The desired results of selective tree removal are natural scenery and orderly appearance. The results may be more natural and pleasing than from new plantings.

The Contractor will first remove the dead trees along with those designated as unwanted. Other trees to be removed for scenic effect should be marked. A clear understanding of the effect desired will eliminate the need for returning to select additional trees for removal.

When herbicidal spraying of stumps is authorized, the material is to be mixed and applied according to the manufacturer's recommendations on the label. Exposed wood and tops of roots are to be sprayed liberally.

When spraying herbicide, extreme caution is to be taken to spray areas only when wind is not blowing to avoid damaging nearby crops and trees. Also, there are certain types of grass seed that will be killed when herbicide spray is used. A note is usually on plans as to the type of seed which will be affected. If not, check with the Construction Manager or the District Environmental Manager.

Flowering trees (dogwood or evergreens such as holly and cedar) should not be disturbed. Shrubs such as wild azaleas should also be left. These species are designated by State law as desirable. The Inspector should learn to identify them.

Fruit trees should never be left in the median or in any area designated for selective thinning. Left to grow wild without the benefit of chemical spraying they will become diseased. This disease may be communicated to nearby orchards and damage marketable produce.

### **Measurement and Payment**

Selective Tree Removal, Trimming and Cleanup will be measured in acres and paid to the nearest 1/10<sup>th</sup> acre at the Contract unit price per acre.

## **SECTION 602 - TOPSOIL**

### **General**

Topsoil is to be stripped (within limits of construction) and stockpiled within the right-of-way unless its presence will interfere with the orderly prosecution of the work. Topsoil should first be used from stockpiles located on private property. Any surplus topsoil remaining on private property after completion of the project topsoiling operations is to be moved by the Contractor onto the right-of-way and stockpiled, shaped and seeded as directed by the Engineer. Topsoil stored within the right-of-way will be available after the acceptance of the project for maintenance, erosion control, or use on landscape projects.

Class A topsoil is stripped from land within the right-of-way limits. Class B topsoil is secured from a source outside the project's limits. Generally, Class A topsoil will be designated on all contracts. Class B topsoil may or may not be designated.

### **Construction Methods**

#### **Preparation of Subsoil**

It is important that the subsoil be properly prepared before placing the topsoil. The most basic and important detail is to properly prepare the slopes. Slopes that have been horizontally grooved shall not be loosened.

Generally, subsoil that is mostly sand or gravel should be scarified to a depth of about 2 inches before placing topsoil over it. This type of scarification makes the slope more resistant to erosion.

#### **Handling and Placing Topsoil**

Topsoil should not be handled when it is so wet that it will become densely compacted during its placement. Prior to placement of topsoil, the Inspector is to ascertain that there is no unauthorized change in kind or source of material.

#### **Depth**

Depth of topsoil may be determined by digging test holes at frequent enough intervals to assure that the minimum required depth shown on the plans is being placed.

#### **Seeding**

Areas receiving topsoil shall be seeded within 15 days after placement of topsoil.

## **Method of Measurement**

The unit of measurement for topsoil is acres. Surface measurements (to the nearest linear foot) are necessary to determine the number of acres topsoiled (computed to the nearest 1/10 acre). Deduct the areas of such items as paved ditch from these calculations. Section 109.01 of the Specifications describes surface measurements and defines the allowable deductions. Individual fixtures with a surface area of 9 square feet or less will not be deducted.

## **SECTION 603 - SEEDING**

### **Description**

All varieties of seed delivered to the project must be in separate bags and accompanied by a certification. This affidavit should certify the lot number, number of pounds, percent germination, percent purity, percent weed seed, variety and kinds. All tests are to be conducted within the 6 month period prior to the season during which the seed is to be used. Prior to use, the inspector is to check to ascertain that the percent germination, percent purity, and percent weed seed conform with the plans and shall note such verification in the project diary.

Seeding materials stored on the job are to be protected from moisture, heat, and rodents. Kerosene and herbicides are also detrimental to germination and are not to be stored in the immediate vicinity of the seed. Seed contaminated by improper storage is not to be used.

The seed mixture will be shown on the plans. The Inspector should verify that the proper mixture is being used. The Inspector will document regular seeding (which includes mulch) or overseeding (which does not include mulch).

### **Procedures**

#### **Drainage**

Good drainage is essential to the successful growth of grasses. Depressions in the surface of slopes which will collect water are to be corrected prior to seeding.

#### **Application of Lime**

Liming is always a separate operation, prior to the application of seed or fertilizer. Regardless of the method used, limed areas must be "worked in" before other materials are applied. Lime must not be placed when the wind is so strong as to blow the lime away from the construction area because the rate of application may not be in conformance with the Specifications. The Contractor should be advised to change his construction method or stop the lime operation until weather conditions are more favorable.

#### **Fertilizer**

When urea formaldehyde is used, check the bag labels to ascertain that the product is 38% nitrogen (slow release) and NOT "urea," a 45% nitrogen product.

One gallon of liquid 5-10-5 fertilizer weighs approximately ten pounds.  
One gallon of liquid 10-20-10 fertilizer weighs approximately 11.5 pounds.

The delivery ticket should give the weight per gallon.

The Contractor is required to employ protective measures that will prevent fertilizer and other injurious materials from coming in contact with signs, sign supports, guardrail and posts. Protection will involve the use of coverings or very special care in the application of spray materials in the vicinity of signs, guardrail and other structures.

If the Contractor elects to furnish a fertilizer with a different analysis from that required by Specifications, he shall advise the Engineer in advance and shall specify the appropriate 1-2-1 fertilizer analysis and the rate of application necessary to provide equivalent amounts of nitrogen and similar amounts of phosphorus and potassium. This is permitted by Specifications; however, computation of quantities and method of measurement is to be in accordance with Section 603. The following examples may be helpful in applying an equivalent fertilizer analysis.

Example: When 1500 pounds per acre of 10-20-10 fertilizer is specified, any of the following fertilizer analysis may be used:

Fertilizer Analysis	Fertilizer Conversion Factor	Pounds Per Acre	Pounds of Nutrient		
			N	P205	K20
10-20-10	1.00	1500	150	300	150
5-10-5	0.50	3000	150	300	150
15-30-15	1.50	1000	150	300	150

Example: When 800 pounds per acre of 10-20-10 fertilizer is specified, any of the following fertilizer analysis may be used:

Fertilizer Analysis	Fertilizer Conversion Factor	Pounds Per Acre	Pounds of Nutrient		
			N	P205	K20
10-20-10	1.00	800	80	160	80
5-10-5	0.50	1600	80	160	80
15-30-15	1.50	535	80	160	80

### **Sowing Seed**

The rate of seeding should be checked at the beginning of the seeding operation and frequently thereafter by comparing the area seeded with the measured quantity of seed applied. Seeding and fertilizing are usually accomplished by the hydraulic method since this method is the most economical and efficient. In this method seed and fertilizer are mixed in a tank of water to make a slurry which is agitated and then pumped to a nozzle and sprayed onto the area to be seeded. The slurry must be agitated constantly during seeding operations to prevent separation of the materials and hence the application of an incorrect rate of fertilizer, seed, or mulch. If wood cellulose fiber is used as a mulch, it may be added to the slurry. Straw is applied separately.

Record the amounts of each material, except water, placed in the slurry tank of the hydro-seeder. Mark the place where application of the load starts and where it ends. Measure the area. Simple calculations of the recorded data will provide the amount of each material applied to the area. This is the best way to be sure the desired coverage is achieved.

Areas designated for regular seeding are required to be covered with a mulch. The mulch helps to anchor the seed and to retain moisture in the soil. Mulch may be either hay, straw, or the wood cellulose fiber type. Mulching of overseeded areas is not required. Hay and straw mulch are to be free from noxious weeds as far as possible. It should not be black and must be free from mold. If hay or straw mulch is placed accurately, the rate of application will be approximately 2 tons per acre (approximately 1 to 1 1/2 inches loose depth) with not more than 10% of the area exposed. Hay or straw mulch must be applied within 48 hours after the seeding operation. It may be necessary to "anchor" the mulch to prevent the wind from blowing it away, by either tying it down with twine and stakes or by using an asphalt emulsion or commercial preparations suitable to anchor the mulch in place.

The asphalt is sprayed after the mulch is placed. The rate of application is usually from 1.25 to 0.10 gallons per square yard. Caution should be exercised in spraying the asphalt. If too much asphalt is placed, the seed will not germinate. If the film is too thin, the mulch will not be anchored.

Mulch and asphalt are to be immediately removed from the roadway, pavement shoulders and paved drainage ways. Mulch should not be allowed to clog drainage structures and other drainage ways.

Special commercial mulching materials may be used when approved or specified on the plans.

### **Seeding on Stabilized Shoulders**

If the seeding on shoulders is to be done at the same time as on adjacent areas, they should be seeded in the same manner with the appropriate seed mixture. The surface of the shoulder need only be loosened. Scarification of the shoulder is not desirable due to the stable nature of the surface; however, mulching and anchoring of the mulch is extremely important.

### **Temporary Seeding**

When the grading operation is suspended for more than 15 days, in an area to be re-graded (uncompleted cut slopes, fill slopes and topsoil stockpiles), that area is to be fertilized, seeded and mulched with the mixture specified on the Roadside Development plans for that time of the year, as shown on the plans.

Seed mixture "P" is to be used only on areas that are to be re-graded and for that period of the year specified on the chart. If the finished grade has been completed in an area during the period when seed mixture "P" is required, the mixture from the previous period on the Roadside Development plan is to be used.

Protection from erosion during seasons of the year when temperatures are below 50<sup>0</sup> F is provided entirely by the mulch. The seed will, however, be held in place by the mulch until weather conditions are conducive to seed germination. Thus, a stand of grass will normally develop in the early Spring when conditions may be such that seeding operations cannot be performed.

## **Method of Measurement**

Fertilizer is to be measured in tons. Payment for fertilizer of other than the specified analysis is to be at the adjusted tonnage of equivalent nutrient value. Therefore, to equate used material to payment material, multiply the poundage used by the fertilizer conversion factor and convert to tons. Computations for equivalent fertilizer analysis are to be shown

The amount of lime, fertilizer and seed actually used on the project must be documented. The following procedures are to be followed:

Make spot checks of the Contractor's seeding operations to determine if the rates per acre are being applied as specified on the plans. Ensure that the Contractor makes adjustments as necessary.

Lime - Delivery tickets, signed by the Inspector, from material delivered to the project are to be used as a record. Transfer of excess materials to another project is to be made with the proper forms and recorded in project records.

Fertilizer - Delivery tickets, signed by the Inspector, from materials delivered to the project are to be used as a record with the same procedure as for lime.

Seed - The Inspector will remove the tag from each bag of seed used in the seeding operation and shall indicate the weight on the tag, if not given. When only a portion of a bag is used the tag will remain with the bag until the entire bag is exhausted. The Inspector will document regular seeding or overseeding in the daily diary.

## **SECTION 604-SODDING**

### **General**

Sodding is one operation that requires very close supervision and inspection to be effective.

### **Preparing Sod Beds**

The preparation of the soil where the sod will be placed is critical. Soil on which sod is to be placed shall be graded evenly and smoothly. Lime shall be applied at a rate of approximately 2 tons per acre. Fertilizer shall be applied at a rate of 16.5 pounds of 15-30-15 fertilizer per 1000 square feet.

Following the fertilizer and lime application, the soil shall be cultivated to a depth of 2 to 3 inches and sufficiently watered to moisten the cultivated soil.

### **Placing Sod**

Sod shall not be placed from June 1 to September 1 or when the temperature is below 32 degrees F. Frozen sod shall not be placed, nor shall sod be placed on frozen soil.

Sod shall be hand placed and joints shall fit tightly without overlap. For small openings and gaps, they should be plugged with sod that has been cut to the same size and shape of the openings.

When placed on slopes, sod should be placed starting from the bottom and placed horizontally with the long edges parallel to the contour. If possible, the vertical joints of the sod should be staggered.

When placed on slopes steeper than 2:1 sod shall be anchored using approved methods.

If there are joints that are too small to fill with cut pieces, those joints shall be filled with loamy topsoil.

Sodded areas shall be thoroughly watered and rolled or tamped to press the root system into contact with soil bed.

Sodded areas shall be kept watered to maintain the life and growth until final acceptance of the project.

### **Method of Measurement**

The sodded area is to be measured and paid for to the nearest square yard.



## **SECTION 605 - PLANTING**

### **General**

Proposed planting plans are prepared by the Environmental Division primarily as a guide for locating plants. Questions or proposed changes are to be referred to the District Environmental Manager. It is important that the Inspector examine the plan location of plant material to see that the actual location on the ground is compatible with local conditions, such as, having trees in the proper relation to utility lines or views. Special care should be exercised to avoid placing trees in poorly drained areas.

The Contractor is to stake the location of all plants for the approval of the District Environmental Manager. Adjustments in location may then be made by the Engineer to correct for conditions at the site.

### **Materials**

If a Contractor is unable to furnish the specified kinds or sizes of plants, permission to substitute is to be requested from the Engineer in accordance with the appropriate Specifications.

### **Planting Seasons**

Frozen ground and dry conditions in the nursery or collecting field are unfavorable weather conditions for transplanting. During or following a drought, the plants may not have stored up sufficient moisture to survive transplanting and after planting watering may not be sufficient. Never permit any bare roots to be exposed to the air without protection, such as, moist burlap, mud, or wet peat moss.

The Roadside Development sheets in the plans normally establish the dates for planting. An extension of planting dates in the spring may be granted by the Engineer depending upon the weather conditions.

### **Storage**

It is desirable to discuss the planting schedule with the Contractor before any work is begun. This will verify the placing of orders for the plants and their schedule of deliveries. There should be no laxity about requiring the Contractor to give advance notice of plant deliveries. Delivery tickets prepared by the shipper are to be furnished.

Before any plants are delivered, it should be determined whether a "heeling in" space will be required to store plants temporarily. If required, the trenches are to be opened up to avoid all possible delays when the plants arrive. "Heeling in" trenches should preferably be of lengths and depths to accommodate the shipment unless they can be conveniently

dug concurrently with the "heeling in." The Contractor should open plant bundles and lay out the plants separately, backfill over the roots, compact the soil reasonably well over the roots and watch afterwards for settlements or cracks which would permit air to reach the roots.

## **Planting**

Plants may settle and leave the roots too deep below the surface. A 3-foot ball may settle an inch and a 5-foot ball may settle 2 inches. Allow for such a settlement with large bare root plants and all balled stock. A large proportion of plant losses in heavy soil have been attributed to planting too deep. Roots of bare root plants should be spread in the same position in which they have been growing. The appearance of injured roots is justification for rejection.

Paper or pottery containers of potted plants are to be removed before planting, unless a "grow-through" type of container is used.

**Backfilling:** Wet soil should not be used for backfill because when compacted, the air spaces would be too greatly reduced. It is desirable to backfill half the way, and then fill the pit with water. After the water soaks away, the backfill can be completed. Backfilling should also be carefully done under balled material to prevent air pockets.

A mound of soil around the edge of each pit is generally formed after planting to serve as a cup to hold water during maintenance. Each plant should be thoroughly watered after backfilling.

## **Staking and Guying**

"Staking" is the use of one or more stakes set approximately parallel with the trunk of the tree to support it. "Guying" is supporting trees by three or more wires fastened to stakes. Staking and guying are shown in the Standards.

Staking or guying, where required, must be done immediately after or concurrently with planting operations. This prevents serious damage to the root system of unsupported trees which can result from any swaying of the top due to wind action. The guy wires are to remain in place until the trees are well established.

### **Staking**

The intent of the Specification is that stakes are to be driven so that plant balls are not injured. Single stakes should be placed on the side to the prevailing wind. Double stakes appear best when parallel to the pavement.

## **Guying**

Stakes or deadmen for guys are to be spaced equidistant around the tree. Stakes are to be driven in the ground at such an angle that each stake will be approximately perpendicular to its guy wire. On completion of the installation, all guys should be tight without having used more than half of the possible "take up" of turnbuckles or by driving stakes flush.

## **Pruning**

Pruning is to be accomplished within 48 hours after planting. A major portion of the pruning may be permitted while the plants are heeled in.

Whenever a plant is transplanted, some roots are necessarily lost. A proportionate amount of the top branches should be removed to balance this root loss. Side branches of young trees should be cut back, not thinned out. In general, 1 /3 of the branches should be removed in the process of cutting back and shaping rather than by thinning.

The leaders of single-stemmed trees should never be cut. Most shrubs and some vines may be pruned by removing older canes and intersecting branches only. Others need only heading back for some of the branches.

## **Period of Establishment**

Watering is the most important maintenance item. It should be done as soon as there is any deficiency of rainfall, such as a week without rain, except when the plants are dormant. Excess watering can be injurious; roots kept too wet will show a blue color and give off an odor of decay.

Of next importance is weeding. Weeds affect the moisture supply for the plants. Hand weeding should be done by pulling rather than by cultivating.

Inspection should be made to determine damage by insects or disease. This is particularly important during the last part of May and early June when insects are prevalent.

Guy wires and cables must be kept tight.

## **Guarantee**

Probably no part of the Specifications for planting is subject to a greater range of interpretation than such phrases as "a satisfactory living condition," or "in an unhealthy or badly impaired condition." The Engineer must know what is meant by these phrases in relation to each kind and size of plant in the contract. It is not enough that the plants be alive. If they are not in a healthy growing condition, there will be such evidence as an excess quantity of dead twigs, relatively few and small buds, a scarcity of leaves, small

leaves, or leaves which are not of a healthy color. Dead and rejected plants must be promptly removed from the site.

## **Method of Measurement**

Project records should accurately denote the scope of the daily work and the reason for rejection of any plants. The shipping list furnished by the Contractor or the list accompanying deliveries from the heeling-in ground may be used for determining the type and number of plants received and planted. The list is to be signed by the Inspector and made a part of the project records.

At the end of each day, the number of units satisfactorily planted is to be entered in the project diary.

# **WETLAND MITIGATION CONSTRUCTION**

## **General**

Wetland mitigation construction requires close coordination between the Department's construction and the environmental staffs to ensure that the project goals of creating a successful wetland mitigation site and all permit requirements are met. The Project Inspector will fulfill the daily responsibilities of overseeing the Contractor's construction activities. The Project Inspector will receive technical assistance and direction from the Environmental Representative assigned to the site by the District Environmental Manager. The Environmental Representative will provide technical assistance and direction to the Project Inspector to ensure attaining the goals and objectives of the mitigation site design.

The Special Provisions describe site-specific construction and permit concerns that must be reviewed prior to construction. Another document that should be reviewed prior to construction is the Mitigation Narrative. The Project Inspector should contact the Environmental Representative to review this narrative. Developed to meet permit requirements, the Mitigation Narrative can provide valuable insight into the final site design and a detailed description of the environmental considerations, including key design components, the goals and objectives of the mitigation, intended water source and any design constraints that may affect the success of the site.

**Documentation** – All site reviews by the Environmental Representative during the contract period (including the Establishment Period) will be documented with a Mitigation Site Review Report (EQ-501), which will be immediately provided to the Project Inspector. All key decision points (itemized in Coordination below) will be documented, as appropriate. In the event that the Environmental Representative does not approve of a particular proposal by a Contractor, the Environmental Representative will work with the Contractor **through the Project Inspector** and attempt to resolve any issues in the original proposal that may have prevented approval. A Project Inspector's

Checklist for Wetland Mitigation Sites is included at the end of the section as a guide for use by the Project Inspector and Environmental Representative.

## **Coordination**

The Project Inspector should contact and coordinate with the Environmental Representative regarding the construction of the wetland mitigation site(s) at the following points:

### **Project Showings**

The Environmental Representative will present the general aspects of the wetland mitigation work in the contract and discuss relevant estimated contract quantities, methods of payment, site access, protection areas and other specific considerations or restrictions noted in the contract documents including water quality permits special provisions which potential Contractors should consider in their bid proposals.

### **Pre-Construction Conference**

The Environmental Representative will discuss design details of the wetland mitigation work, and such items as permit requirements, sequence of construction, clearing limits, erosion and siltation control, storm water management, time of year restrictions, sources and handling of materials, site access, grading tolerances, soil amendments, plants and planting materials, planting procedures and seasons, plant establishment period, maintenance, inspections, and basis of work acceptance. The Environmental Representative will also address any technical questions the Contractor may have about the work and consider any proposed changes in the specified nature or sequence of the work. The Project Inspector will schedule a field review of the wetland mitigation site with the Contractor and the Environmental Representative before work begins. This field review will be used to confirm clearing limits for the mitigation work to discuss protection measures for any areas not to be disturbed, and to discuss any other aspect of the work before proceeding. The District Environmental Manager will ensure that flagging is placed as necessary any areas in the vicinity of the work that are to remain undisturbed by construction activities.

### **Source of Materials**

Upon receipt from the Contractor, the Project Inspector will submit the Contractor's proposed sources of materials (Class B Top Soil, organic soil amendments, plants, seeds, and planting materials such as tree shelters, mulch, etc.) to the Environmental Representative for review and approval. (Note: the Contractor's submittal of his proposed list of sources for plant/seed material for wetland mitigation work is generally required by contract note or special provision within three months of the contract award.) Wetland seed providers shall obtain VDOT Green Tag certification, in accordance with

special provisions and VDOT guidelines on nonstandard seeds. Organic amendments must meet specifications and associated laboratory test requirements described in Special Provisions prior to acceptance.

The Environmental Representative may inspect such materials as Class B Top Soil and organic soil amendments, if specified in the contract, at the proposed sources and require laboratory tests of such materials to ensure that contract requirements would be met prior to approving the sources.

### **Commencement of Construction**

The Project Inspector shall send a copy of the Contractor's progress schedule (including revisions) for commencing wetland mitigation work to the Environmental Representative when available. The Environmental Representative will review the staked clearing limits for the mitigation work including construction access, staging, and stockpile areas prior to the Contractor commencing any clearing and grubbing activities. The Project Inspector will also notify the Environmental Representative within two business days of the commencement of earthwork operations in the wetland mitigation site(s).

### **Plan Changes**

The Project Inspector will request the Environmental Representative review and approval of any Contractor proposal that would, by intention or effect, modify the design, project limits, hydrology, drainage, construction sequence, approval points and timing of or requirements for project completion as specified in the contract documents. Prior to implementation, the Project Inspector will secure written approval of the Environmental Representative for any adjustments proposed by the Contractor to the specifications or previously approved procedures, including, but not limited to, changes of grades or construction methods, wetland planting period, planting pattern and density, or plant installation and maintenance procedures. The Environmental Representative will coordinate and review proposed plan changes with the Mitigation Plan Project Manager and with regulatory agencies as necessary prior to approving changes to the plans or Specifications.

### **Requests for Substitutions**

Upon receipt from the Contractor, the Project Inspector will transmit all requests for any substitutions or adjustments to the materials or the sources of the materials to the Environmental Representative for approval before taking any action on the requests.

### **Confirmation of Subgrade Elevations**

The Project Inspector will notify the Environmental Representative when the Contractor completes grading to the sub-grade elevation(s) of the wetland mitigation site. Prior to

allowing any further work such as loosening the sub-grade material (if specified) or backfilling to the final design grade, the Inspector will request the Environmental Representative to review and approve the sub-grade elevation(s) or establish a modification of the sub-grade elevation(s) within two business days. On larger sites (greater than 1 acre), the Project Inspector will notify the Environmental Representative when the first portion of the site reaches the sub-grade elevation to minimize possible re-work.

### **Confirmation of Final Grade**

Upon completion of the final grade of the wetland mitigation site, and before any planting or seeding of the wetland planting area, the Project Inspector will ensure that the Contractor performs an as-built topographic survey confirming that design grades are within specified tolerances, as stated in the design plans or special provisions. The Project Inspector will provide the Environmental Representative with a copy of the survey for the Environmental Representative to secure releases from the regulatory agencies. Following the receipt of the releases, the Environmental Representative will notify the Project Inspector that the Contractor may commence permanent site stabilization with the specified wetland seed mixture, as required by the water quality permit.

### **Disturbances of Approved Final Grades**

The Project Inspector will require the Contractor to avoid the use of equipment that could rut, compact, pollute, or otherwise harm the planting area. Any proposal by the Contractor to use such equipment in the planting area will be reviewed and approved by the Environmental Representative. The Contractor, at no additional cost to the Department, will repair damages to the final grade of the planting area caused by his use of equipment. Any disking or ripping after approval of final grades that is specified in a special provision to reduce soil compaction prior to seeding or planting operations, is not included in this prohibition.

### **Hydrologic Monitoring Devices**

The Inspector will notify the Environmental Representative when the locations of all hydrologic monitoring wells and are staked in accordance with the approved hydrological monitoring plan if installation of these devices is a contract item.

### **Pre-planting Hydrologic Monitoring**

Pre-planting hydrologic monitoring by the Department is required by permit condition and must be conducted during the first three months of the growing season following final grade approval. The Environmental Representative will notify the Project Inspector

when the site has been approved by the regulatory agencies for planting during the following planting season as required by the water quality permit. As noted by contract note or special provision, the regulatory agencies may require additional monitoring to confirm adequate soil moisture before releasing all or portions of the site for the planting.

### **Plant Material Inspection**

The Project Inspector will notify the Environmental Representative at least two business days in advance of delivery of plant materials to the mitigation site. The Environmental Representative will then arrange to inspect the plants prior to installation. Plants in poor condition or otherwise not meeting contract requirements or originating from unapproved sources will generally be rejected. The Project Inspector may submit to the Environmental Representative a request from the Contractor that the Environmental Representative inspect plant materials that have been set aside and designated for use on the wetland mitigation site at previously approved, local sources. Such off-site inspection of plant material may be requested to avoid transport of material to the mitigation site, which may not meet the contract specifications. Should the Environmental Representative agree to inspect material off-site for the convenience of the Contractor, the Environmental Representative reserves the right to be provided with two business days notice prior to actual delivery to the mitigation site and to re-inspect and possibly reject material on-site that does not meet specifications.

### **Planting Inspection**

The Project Inspector will notify the Environmental Representative when the Contractor begins installing plants on the wetland mitigation site and request an inspection of the planting procedures. The Project Inspector will also notify the Environmental Representative when all planting has been completed and request an inspection of the work. When the Environmental Representative is satisfied that the Contractor has performed the planting satisfactorily in the wetland mitigation area, he will provide the Project Inspector with written approval for the commencement of the Plant Establishment Period.

### **Establishment Period**

The Inspector may request assistance at any time during the Establishment Period (normally two years in length) if there are questions about the plantings receiving proper care or required maintenance, or if the Inspector is concerned about any other aspect of the site such as stability of side slopes, wildlife browsing, flooding damage, invasive species, etc. on the site.



### **Final Planting / Mitigation Site Inspection**

At the end of the Establishment Period when the Contractor and the Project Inspector believe the Site is ready, the Project Inspector will request that the Environmental Representative participate in conducting a Final Inspection of the wetland mitigation site. The Environmental Representative will note any discrepancies in the plantings or the maintenance of the site as a whole to the Project Inspector and specify any necessary remedial work by the Contractor in the mitigation area. Upon the Environmental Representative agreement that the Contractor has performed all work in the wetland mitigation area satisfactorily, the Project Inspector may notify the Area Construction Engineer that the mitigation work is complete.

## **INSPECTOR'S CHECKLIST FOR WETLAND MITIGATION SITES**

**Project Number:** \_\_\_\_\_ **Inspector:** \_\_\_\_\_

**Project Location:** \_\_\_\_\_

The Project Inspector overseeing construction of mitigation site(s), will receive technical assistance and direction from the Environmental Representative who is familiar with the design, goals and constraints of the work. The Project Inspector will contact the Environmental Representative at the following points to provide information or to seek technical guidance for the construction of the mitigation site:

- 1. Project Showing, Pre-Construction Conference, and preliminary site review -Request attendance of Environmental Representative when the meetings are scheduled.
- 2. Commencement of Construction - Notify Environmental Representative when a date is established and provide construction schedule.
- 3. Staking of Clearing Limits, including site access, staging and stockpile areas - Notify Environmental Representative when completed.
- 4. Non-Disturbance Areas - Request that any natural or cultural resources not shown on the plans that may be in the vicinity of anticipated construction activities are clearly identified by Environmental Representative with flagging.
- 5. Sub-Grade - Notify Environmental Representative when the Contractor achieves sub-grade elevations. If the site is greater than 1 acre, notify Environmental Representative when the first portion of the site will reach the specified sub-grade elevation before proceeding with filling and grading to final elevations.
- 6. Soil Permeability Tests – When required, provide Environmental Representative with the results of any permeability tests of the sub-grade when testing is specified by special provision.
- 7. Organic Backfill (composted yard waste) - Provide Environmental Representative with laboratory test reports of any specified composted yard waste to be used as an amendment of topsoil for review and approval prior to use.
- 8. Final Grades - Provide Environmental Representative a copy of As-Built Survey when final grading is completed for review and approval. (On larger sites, Environmental Representative may approve phasing of backfilling of sub-grade areas to final grades & As-Built Surveys).

- 9. Seeding and Planting - Notify Environmental Representative when temporary or permanent seeding and planting are scheduled.
- 10. Use of Equipment - Notify Environmental Representative before Contractor is allowed to use any equipment on the final grades that might disturb or compact the planting surfaces.
- 11. Ground Water Monitoring Wells – If wells are to be installed by the Contractor, request Environmental Representative to review the staked locations of wells (based on an approved plan) and notify Environmental Representative when installation of wells is scheduled.
- 12. Plan Changes - Notify Environmental Representative of any proposed adjustments to site design, drainage, the planting scheme or materials so that he/she may review and approve such adjustments prior to implementation.
- 13. Sources of plant and planting materials - Provide Environmental Representative with a copy of the Contractor's proposed sources of plant and planting materials for review and approval.
- 14. Delivery of plant and planting materials - Notify Environmental Representative within two business days of scheduled delivery so the Environmental Representative can arrange to be on site to approve or reject such materials.
- 15. Beginning of Establishment Period - Request Environmental Representative review and approval of the completed planting work to begin the Establishment Period.
- 16. Two-Year Establishment Period - Notify Environmental Representative of any problems or concerns with site conditions, Contractor's care of the wetland planting or maintenance of the mitigation site during the Establishment Period.
- 17. Termination of Establishment Period - Notify the Environmental Representative when the Contractor believes the Establishment Period can be terminated and request the Environmental Representative to participate in a final inspection of the wetland mitigation site.
- 18. Replacements & Corrections – Notify Environmental Representative when the Contractor has completed any required replacements of plant material and request concurrence on termination of the 2- Year Plant Establishment Period.
- 19. Request concurrence from the Environmental Representative that the Contractor has satisfactorily completed any other adjustments or corrections within the site that were identified by the Environmental Representative at the Final Inspection (such as ground stabilization of adjacent areas and removal of E. & S. controls) prior to releasing the Contractor from all contract obligations for the mitigation site.

## **SECTION 606 – SOIL RETENTION COVERINGS**

### **General**

This work shall consist of furnishing and placing protective covering material for soil retention including seed, fertilizer, lime, topsoil and water.

### **Construction**

The Contractor shall apply two inches of topsoil to areas to receive soil retention coverings. Topsoil shall be rolled or tamped before being shaped to match cross sections on the plans. During the shaping operation, a seedbed approximately  $\frac{3}{4}$  inch deep shall be provided.

The Inspector should ensure that stones, roots and other objects are removed from the seedbed prior to installation of the covering.

Seed shall be applied as required in Section 603, except that mulch is not required. Seed, lime and fertilizer must be placed prior to installation of the covering.

The soil retention covering is to be installed in accordance with the Standard Drawings and manufacturers recommendations.

Inspectors should verify that the soil retention coverings are listed on the approved list of materials.

### **Method of Measurement**

Protective coverings and soil retention mats are measured in square yards of area covered and paid for at the contract unit price per square yard. This price shall include complete installation, stapling, shaping of ditches, preparing seedbeds, and applying topsoil, lime, fertilizer, seed and water.

### **Inspector's Checklist**

1. Does the Contractor place 2 inches of topsoil shaped in accordance with the cross sections?
2. Does the Contractor apply seed, fertilizer and lime prior to installing protective covering?
3. Is the soil retention covering installed in accordance with the Standard Drawings and manufacturer's recommendations?

4. Is the protective covering applied in the direction of water flow and lapped a minimum of 6 inches?
5. Does the Contractor bury the top of the anchor slot 6 to 12 inches?
6. Are the staples the proper size and length and placed properly according to the Standard Drawings?
7. Does the Contractor trench in the edges of the coverings a minimum of 6 inches?
8. Does the Contractor water the seeded areas after the covering was installed?

## **SECTION 607 – HERBICIDE SPRAYING**

### **General**

This work consists of spraying an approved herbicide for control of weeds. Handling and application of herbicides is of a critical nature in that the materials are quite toxic and often non-selective as to vegetation killed

The Inspector should consult the District Environmental Manager prior to herbicides being applied and should keep thorough records on all applications of herbicides. The Inspector should ensure that the Contractor takes precautions when spraying, filling or flushing equipment to prevent contamination of streams, lakes, or ponds.

### **Application**

Herbicide shall be applied in accordance with the manufacturer's recommendation. Herbicide shall not be applied when the temperature is above 85 degrees F or below 60 degrees F. Spraying should not be applied when the vegetation is wet, when rain is imminent within 6 hours or when excessively windy.

### **Method of Measurement**

Herbicide spraying is measured in units of 1000 gallons of mixture and is paid at the contract unit price per 1000 gallons.

## **SECTION 608 – MOWING**

### **General**

This work consists of mowing areas as designated by the Engineer. Mowing is important not only for aesthetics but also to control weeds and promote the growth and spread of more desirable grasses. Areas should be mowed to a height no less than 4 inches.

### **Method of Measurement**

When specified as a contract item, mowing is paid for by the hour.

# **TRAFFIC CONTROL DEVICES**



## **SECTION 700 - GENERAL**

### **Description**

This section is for general construction items of work common to signing, signals and lighting.

### **Working Drawings**

The Contractor shall submit seven copies of working drawings and catalog cuts including any design calculations of each item or piece of equipment to be furnished and installed on the project in accordance with Section 105. In lieu of submitting working drawings the Contractor may submit a letter indicating the brands, types, and models of equipment along with bid item numbers and approval numbers for equipment on the Department's "Pre-Approved Traffic Control Device Listing." Working drawing submittals and the listing for pre-approved items are to be forwarded to the Regional Traffic Engineer for review.

### **Procedures**

#### **Grounding**

The Contractor may use NEC approved methods of grounding metal items other than what is shown on the plans or in the Road and Bridge Standards. However, the method shall result in a resistance to ground of no more than 25 ohms.

#### **Foundation**

The Inspector must verify that the staked location of the foundation is correct. After excavation, the Inspector must verify that the base upon which the foundation will be placed is suitable material. Reinforcing steel must be placed and anchored in accordance with the Road and Bridge Standards or the plans.

Concrete foundations are to be constructed as shown in the Road and Bridge Standards, the plans and the working drawings.

The size of the conduit should be checked and the placement should be as shown on the plans, working drawings and Road and Bridge Standards. Ensure the proper placement of anchor bolts to achieve correct alignment and elevation.

The top of the foundation is to be flush when mounted in or adjacent to sidewalks and 4 inches above the ground level in all other areas. The foundation is to be backfilled and compacted as specified.

Concrete foundations must achieve 3000 psi compressive strength prior to erection of any item on them.

### **Erection of Poles, Post and Sign Structures**

The location of all signs, signal, and lighting poles are to be staked by the Contractor and checked by the Engineer and the Inspector before construction. No major location change is to be made without approval of the Regional Traffic Engineer.

Necessary precautions must be taken to reduce damage to galvanized, painted, or finished aluminum surfaces.

Hardware should be checked for compliance with Specifications and shop drawings upon arrival on the project.

Poles are to be installed plumb after installation of their loads. Plumbness may be achieved by the use of nuts and flat washers above and below the base plates, as allowed by the Road and Bridge Standards.

If any pole, structure, or span wire is to be installed within 10 feet of an electrical power line, the Engineer is to be notified immediately and no work is to proceed until advised by the Engineer that it is safe to do so.

Non-corrosive metal identification tags are to be installed and marked as specified.

Poles are to be provided with 3 inch by 5 inch hand holes complete with covers and gaskets. Hand holes are to be attached with non-corrosive tap screws and are to face away from the roadway.

### **Conductor Cables**

Conductor cables in conduit more than 100 feet long shall be installed with the use of an approved lubricant. Bends in conductor cables shall have a bend radius of at least 5 times the diameter of the cable.

Splices in signal and interconnect conductor cables will not be permitted. Splices in lighting conductor cables will be permitted only at accessible locations. Splices in service entrance conductor cable are only permitted for connection to the utility company's service conductor cable.

Termination of cables is permitted only in a master control cabinet, local controller cabinet or a terminal enclosure. Each wire of a cable must be connected to a terminal post.

The Contractor is required to perform a Meggar test on interconnect cables as specified.

Prior to energizing an electrical system, the Contractor is to demonstrate that the system is clear and free from short circuits and unintentional grounds.

Conductor cables are to be marked and identified at accessible locations as specified.

### **Conduit Systems**

Conduits shall be PVC, fiberglass or metal as specified. Ends of conduit that must be field cut shall be reamed smooth. Conduit sections shall be connected with couplings so that the ends will abut squarely inside the coupling. Joint sealing solvent shall be as recommended by the manufacturer of the conduit.

Conduits shall be installed continuous and watertight between outlets and so that moisture will drain properly to junction boxes or drainage tees.

After installation, each conduit is to be tested for obstructions. When conduits are clear of obstructions, empty conduits shall be equipped with pull ropes as specified.

Open ends of unused conduit shall be plugged or capped. Where conduit crosses an expansion joint, conduit shall be provided with an expansion fitting. Metal conduit shall be bonded.

Exposed conduit systems shall not have more than 4 bends between outlets and the angular sum of the bends shall not exceed 360 degrees.

Buried conduit systems shall be installed in straight lines between outlets. When obstructions are encountered, the obstruction shall be bypassed in accordance with the standard drawings. Required bends shall have a radius of at least 5 feet.

When conduit is installed under a roadway and open cutting is not permitted, the conduit shall be installed in a pipe sleeve that has been jacked or bored.

### **Electrical Service**

The electrical service location and date electrical service is needed should be determined early. The request for electrical service should be sent to the Regional Traffic Engineer with the following information as soon as possible:

1. Location of electrical service
2. Voltage and number of phases needed (120/240 single phase, 240/480 single phase, 277/480 three phase etc.)
3. Installation - above or below ground

4. Name of utility company servicing the project area and pole number identified as the power source.
5. Date electrical service is needed.

### **Inspector's Checklist**

1. Does the material meet the requirements as specified?
2. Are working drawings submitted as required?
3. Do ground rounds include a No. 6 bare copper wire and ground wire clamp?
4. Are concrete foundations constructed as required?
5. Did concrete foundation reach the required 3000 psi compressive strength prior to erection of items on them?
6. Is the location of each foundation verified to be correct?
7. Are non-corrosive metal tags attached as specified?
8. Are hand holes provided as specified?
9. Are conduit systems and conductor cables installed as specified?

## **SECTION 701 – TRAFFIC SIGNS**

### **General**

The proper use of traffic signs is critical to ensure the safety of the traveling public. Materials used must conform to the Specifications and proper location and installation must be in accordance with the Manual for Uniform Traffic Control Devices (MUTCD). Inspectors should contact the Regional Traffic Engineer for assistance as needed.

### **Materials**

The Inspector is to ascertain that all materials have been approved for use by test reports or "Certificates of Compliance" and documented in the Materials Notebook. Visual inspection is to be made of the condition of material at time of arrival and for compliance with plans, Specifications, and approved drawings. Should a question arise in regard to acceptability of a material or finished sign, the Inspector is to refer the matter to the Area Construction Engineer for clarification. Substitution of a similar item for the specified or previously approved item is not to be permitted unless specifically authorized in writing by the Engineer.

### **Procedures**

#### **Fabrication**

Sign panels are fabricated using 0.100- inch thick aluminum. The panels must be smooth, flat and free of burrs and splinters.

With few exceptions, reflective sheeting shall be 4 x 4 feet on sign panels 16 square feet or more in area. Joints or laps are not permitted on sign panels less than 16 square feet in area except as allowed by the Specifications.

When more than one width of sheeting is applied to a panel, sheeting edges shall form a vertical butt joint or overlap not more than 3/8 inch. If horizontal joints are used, the bottom edge of the top sheet shall lie over the top of the next lower sheeting with a lap of no more than 3/8 inch.

Legends on each sign face are to be checked upon arrival on the project to ensure correct copy. Checks of letter size and spacing for conformance with shop drawings are to be made before erection. Each sign panel is to be clean when it is erected.

The finished sign shall have no cracks gaps, streaks, wrinkles, blisters, buckles, tears, warps, or discoloration.

#### **Transporting and Storing**

Inspectors should verify that signs are being transported and stored as specified to ensure damage does not occur to the signs prior to installation.

## **Erection**

The Inspector must verify that the clearance for overhead and bridge mounted signs is not less than 19 feet and not more than 21 feet from the bottom of the sign to the roadway crown.

Panels are to be securely fastened to posts or supports and erected plumb. Stud breakage of not more than 10 percent shall be repaired. If breakage exceeds 10 percent, the Inspector must reject the sign panel.

Ground mounted signs are to be installed at a horizontal angle of 93 degrees between the face of the sign and the centerline of the roadway. Vertical and horizontal spacing between signs shall be 1 inch.

Neoprene gaskets 1/16 inch thick are to be used between galvanized steel post clamps and the framing unit.

Damage to reflective sheeting shall be patched or replaced as specified.

## **Method of Measurement**

Sign panels are measured in square feet of surface area. The price includes background sheeting, sign messages and framing units.

## **Inspector's Checklist**

1. Do all materials delivered have Certificates of Compliance or test reports?
2. Are sign panels smooth, flat, correct thickness, degreased and etched, edges straight and smooth, and corner radius true and proper?
3. Are Zee bars the proper size, straight and properly spaced?
4. Does sheeting material have joints, splices, and laps as specified?
5. Are the finished sign panels free from cracks, gaps, streaks, wrinkles, blisters, discoloration, buckles, and warps and have a smooth surface of uniform color?
6. Are all messages and symbols correct and conform to the requirements of the MUTCD?
7. Were signs transported and stored properly?

8. Are signs installed as required?
9. Are signs panels covered as required when installed prior to being needed?

## **SECTION 702 – DELINEATORS**

### **General**

The proper installation of delineators on guardrail, barriers, parapets, railings, and along the roadside is necessary to ensure the safety of the traveling public. Inspectors should refer to the Road and Bridge Standards or the plans for proper placement.

### **Procedures**

Road edge delineators are to be placed as indicated on the plans and on the Standard Drawings. Inspectors should pay particular attention to the distance the delineator is installed from the edge of roadway, the height of the reflector and the spacing.

Delineators installed on guardrail, median barriers and railings must be installed on a clean, dry surface. The Inspector must ensure that loose material and dirt are removed from the surface where the delineator is to be installed.

Delineators installed on barriers shall be installed on top of the barrier wall. Exceptions are when barrier height is greater than 36 inches, barriers with glare screens or handrail attached and barriers in work zones. These delineators shall be installed 25 inches above the roadway and positioned so the vertical plane faces oncoming traffic.

Delineators for guardrail shall be installed on the web of posts. If blockouts are used, the delineator shall be installed on the web of the blockouts.

Delineators on guardrail and barriers are to be installed on 80 foot centers, unless otherwise indicated. When the correct center to center spacing cannot be achieved due to guardrail post spacing, the delineator spacing shall not exceed 80 feet.

### **Method of Measurement**

Road edge delineators are measured in units of each installed. Guardrail, barrier, and railing delineators are considered incidental to the construction of those items and are not measured for separate payment.

### **Inspectors Checklist**

1. Are delineators the same color as the adjacent pavement markings?
2. Are road edge delineators installed at the specified distance from edge of pavement?
3. Are delineators installed at the specified height?
4. Are delineators installed at the specified spacing?



## **SECTION 703 – TRAFFIC SIGNALS**

### **General**

Work under this section consists of furnishing, installing, modifying, relocating, or removing traffic signal equipment. Since this work differs so much from normal roadwork, it is desirable that the Inspector make a special effort to learn the terminology unique to this work and to contact the Regional Traffic Engineer for advice. This knowledge is necessary in order to communicate effectively with the Contractor's personnel.

The Contractor should not be allowed to disturb existing facilities until he is prepared to continuously prosecute the work to completion. When existing signals are to be altered, they should be kept in regular operation as long as practicable. During any "down time" while signals are being modified or replaced, the Contractor is to provide other means of controlling traffic. Once the Contractor begins work on any system, he is responsible for all maintenance for that system until accepted by the Department. This is not intended to hold the Contractor responsible for all costs incurred from damages completely beyond his control.

### **Equipment**

Equipment provided by the Contractor shall be certified by the manufacturer as conforming to the requirements of NEMA TS-1. Controllers are to be furnished completely housed in a waterproof cabinet. The manufacturer's instructions for installing and maintaining the equipment shall be provided by the Contractor.

Inspectors should verify that the manufacturer's certifications and instructions have been furnished.

The Contractor is required to provide at least 15 hours of training to Department personnel in the operation, timing, maintenance, and repair of signal equipment.

### **Prosecution of Work**

Inspectors must ensure that the operation of existing traffic signals is not discontinued without the approval of the Engineer.

The Contractor is responsible for maintaining traffic at all times during installation.

### **Equipment Color**

The color of signal heads shall be Federal Yellow, except the inside of the visors shall be flat black. Backplates and leveling attachments shall be flat black.

## **Mounting Controller Cabinets**

Pole Mounted Controller Cabinets are to be mounted to metal poles using brackets secured by encircling clamps and to wood poles by lag screws and plates bolted through the back of the cabinet.

Ground mounted cabinets are to be installed on concrete foundations.

## **Installing Signal Heads**

When a new or refurbished signal head is installed, the Contractor shall cover the signal head with a durable non-transparent cover and maintain the cover until the signal head is put into operation.

The bottom of the housing of pedestal mounted or bracket mounted signal face adjacent to the pavement shall be at least 8 feet but not more than 15 feet above the sidewalk or the pavement grade at the center of the roadway.

When traffic signal heads are suspended over roadways the lowest point shall be at least 15 feet for mast arm installations and 16 feet for span wire installation above the pavement grade at the center of the roadway. The bottom of the housing shall not be more than 19 feet for either type of installation.

Pedestrian signal heads shall be mounted at least 7 feet but not more than 10 feet above the sidewalk. They shall be orientated in such a manner that they are visible to the pedestrians using the crosswalk.

Backplates shall be attached with bolts, washers and lock nuts or self-tapping screws and washers. For 3 section signal heads, at least 8 bolts or screws are required. For 4 section signal heads, at least 10 bolts or screws are required and 12 bolts or screws for 5 section assemblies.

Illuminated signs used to control right or left turns shall be installed directly over or adjacent to the affected traffic lane. They shall be mounted at the same height as standard traffic signals. When mounted with other traffic control signs or signals, there should be adequate clearance between them so as to prohibit contact.

Detectors are to be installed within 2 feet of the location shown on the plans. Splices in loop or magnetic detector conductors are only allowed in signal junction boxes. Detector and detector lead-in cables are to be installed coiled with enough coiled length to extend 2 feet above the junction box. Detector and detector lead-in cables shall be tagged as specified.

Installation of magnetic detectors shall be in a heavy-wall PVC conduit 3 inches in diameter in a trench cut to 15 inches in depth and surrounded by at least 3 inches of sand.

Magnetic detector circuits are not to be installed in the same cable sheath with conductors carrying signal power.

Slots for inductive loop detectors are sawed into the pavement, cleaned with pressurized water and dried with compressed air before loop conductors are installed and sealed with a Department approved sealer. Loops shall be installed in the presence of the Engineer.

Pedestrian detectors are mounted on supports as shown on the plans. Breakaway connectors must be installed in the hand hole on conductor cables for pedestrian detectors on pedestal poles.

## **Rigging Details**

Overhead span wires are attached to either a 5/8 or 3/4 inch thimbleye, depending upon the diameter of the span wire. Span wires are not to be spliced.

Down guys are used on wood poles and shall be the same type of cable as used in span wires. They are attached in the same manner and same height as span wires. Lateral guys placed over the roadway are to be strung to maintain a vertical clearance of at least 17 feet 6 inches.

## **Testing Equipment**

After energizing signal installations the Contractor is required to demonstrate that the electrical components are in proper working order. Upon completion of the electrical tests the Contractor shall conduct a demonstration test of each signalized intersection for 30 continuous days. If any components need to be replaced or repaired, that portion shall be subject to an additional 30 days of testing.

Testing of traffic signal system master controllers and system coordination shall be conducted after demonstration test of each signalized intersection.

Prior to final acceptance, the Contractor must furnish written certification that the system control equipment has been installed in accordance with the manufacturer's specifications.

## **Method of Measurement**

Span wire, tether wire, and saws cuts are measured in linear feet. Conductor cables are measured in accordance with Section 700. All other components are measured in units of each.

## **Inspector's Checklist**

1. Are traffic signals installed as specified and as on the plans?

2. Are controllers installed in waterproof cabinets?
3. Did the Contractor furnish instructions for installing and maintaining the equipment?
4. Is the minimum vertical clearance maintained?
5. Are backplates installed as specified?
6. Are loop detectors installed within 2 feet of the location shown on the plans?
7. Are slots for loop detectors saw cut, cleaned with pressurized water, and dried with compressed air?
8. Were loops installed in the presence of the Engineer?
9. Is loop sealant installed flush with the finished surface and completely cover the loops?
10. Are pedestrian detectors mounted as shown on the plans and are breakaway connectors installed in the hand holes?
11. Did the Contractor perform the proper tests and demonstrations?
12. Are signal heads that are not in operation properly covered?

## **SECTION 704 – PAVEMENT MARKINGS AND MARKERS**

### **General**

Normally the last item of work on pavement structures is the installation of pavement markings and markers. Yet, the correct installation of these items is very important for the safety of the traveling public.

If there is not a Pavement Marking plan sheet for the project and if the Standards don not address the pavement marking needs, the Inspector should contact the Regional Traffic Engineering Office for assistance.

The Inspector should verify that the Contractor has a certified Pavement Marking Technician on the project prior to installation of pavement markings or markers.

### **Materials**

Pavement marking materials are required to be tracked using an approved inventory tracking system. Inspectors should verify that the Contractor has furnished a certification of such as required in Section 704. A copy of the certified delivery ticket must be given to the Inspector upon delivery of the material.

### **Pavement Markings**

Pavement markings on new roadways are to be installed prior to opening to traffic. On roadways already open to traffic, pavements markings must be installed within the specified time limits. If the Contractor cannot install permanent pavement markings within the specified time limit, Type D construction pavement markings shall be installed within the same timeframe. The cost of installing, maintaining, and removing the construction pavement markings shall be borne by the Contractor.

The location of pavement markings is established by premarking the roadway. The premarking material may be Type D removable tape, chalk, or lumber crayon. Special pavement markings must be made with either chalk or lumber crayons. Premarkings must be of the same general color of the finished markings.

The Contractor is required to perform quality control testing for application thickness and glass bead rate at the beginning of each day and every three hours thereafter. This testing is to be performed in the presence of the Inspector. Testing procedures are outlined in VTM-94.

A daily log (Form C-85) is to be maintained by the Contractor for both temporary and permanent pavement markings. This log is to be completed for each day and delivered to the Inspector at the end of each workday.

The proper type and class of pavement marking needs to be applied as specified. Inspectors need to pay particular attention to the surface temperature at the time of application. The Inspector must ensure that pavement markings are applied in accordance with the tolerances established in Table VII-1.

Solid lines and skip lines shall be installed using Type A or Type B markings as specified.

Crosswalks and stop lines shall be installed using Type B, Class I or IV.

Pavement message markings shall be installed using Type B, Class I, IV, or VI as specified.

The Inspector should ensure that the Contractor is applying pavement markings that have clean and well defined lines, are free of waviness, and are straight on tangent alignment and follow a true arc on curves.

Pavement marking widths shall be within ¼ inch on tangent and ½ inch on curves.

Glass beads shall be applied at the specified rate. Approximately 70 percent of the beads shall be buried in the marking. The remaining 30 percent shall be embedded 50 to 60 percent into the surface of the marking. Beads shall be applied at the following rates:

Type / Class	Rate of Application
Type A markings	6 pounds per gallon of paint
Type B, Class I (Thermoplastic)	7 pounds per 100 square feet
Type B, Class II (Polyester Resin)	8 pounds per gallon of material
Type B, Class III (Epoxy Resin)	25 pounds per gallons of material

The Inspector must ensure the Contractor is using all means necessary to protect traffic from splattering, tracking, and overspray of pavement markings.

## **Pavement Markers**

### **Snow-plowable Raised Pavement Markers**

Snow-plowable raised pavement markers shall be installed when the ambient air temperature is 50 degrees F or higher.

Snow-plowable raised pavement markers are installed by cutting grooves into the pavement at the depth and dimensions recommended by the manufacturer. The Inspector should check to ensure the Contractor is cutting to the correct depth, and that the grooves are being cut parallel to the adjacent pavement marking. The grooves must be cut with a blade matching the diameter of the curvature of the steel casting bottom.

The steel casting is to be bonded into the pavement as recommended by the manufacturer. The bonding material shall be from the Department's approved list of materials.

The nose of the casting must be flush with the pavement surface. The height of the marker shall be installed approximately ½ inch above the pavement surface.

The top of the reflector shall be mounted flush with the top of the casting.

### **Raised Pavement Markers**

Raised Pavement Markers shall be bonded to the pavement using the manufacturer's recommendation. Bonding material shall be from the Department's approved list of materials, except that epoxy shall not be used on asphalt concrete pavements.

### **Method of Measurement**

Pavement Line markings are measured in linear feet of markings applied. Message markings are measured per each for the type of message. Pavement markers are measured in units of each.

### **Inspector's Checklist**

1. Does the Contractor use an approved inventory tracking system and provide copies of certified delivery tickets?
2. Does the Contractor have a certified Pavement Marking Technician present during pavement marking operations?
3. Is premarking accomplished as specified?
4. Is quality control testing performed as specified?
5. Does the Contractor install markings within the specified time limits?
6. Is the Contractor installing the proper color markings in accordance with the Manual for Uniform Traffic Control Devices?
7. Is the Contractor installing markings in accordance with Table VII-1?
8. Did the Contractor maintain and submit to the Inspector Form C-85 for each days work?
9. Is the Contractor protecting traffic from damage due to pavement marking operations?

10. Is the pavement surface dry for 24 hours prior to pavement markings being applied?
11. Are glass beads applied at the specified rate?
12. Are grooves for snow-plowable pavement raised pavement markers cut as specified?
13. Are the noses of snow-plowable raised pavement markers installed flush with the pavement surface?
14. Is the height of snow-plowable pavement raised pavement markers approximately  $\frac{1}{2}$  inch above the pavement surface?



# APPENDIX A

## DEPARTMENT EQUIPMENT

### Engineering Equipment

Inspection on many projects requires the use of engineering instruments such as levels, theodolites, electronic measuring devices or total stations. These instruments are assigned to the District Construction Management staff on construction projects by the District Survey Party Supervisor and reassigned to a particular construction project.

Instruments are to be tested for adjustment at regular intervals. This should be done by performing field tests by the person using the instrument. However, the Project Inspector is charged with the responsibility of seeing that it is done and that the instruments are kept in adjustment. The instrument should never be disassembled or adjusted except by an authorized instrument repairman.

When not in use, instruments should be kept in their respective boxes. Never leave an instrument "set up" unless an employee of the Department is present to protect it. Before climbing a fence or similar obstacle, the instrument should be placed on the other side with the tripod legs spread. Under no circumstances should a boxed instrument be placed in a vehicle so that it can bounce around or overturn.

Instruments, under ordinary circumstances, should be maintained and carried in their original storage boxes. Should circumstances require that an instrument be shipped, it should be clamped on its spindle and paper packed carefully and snugly around it in the box.

The magnetic needle must be kept clamped at all times, except when a compass reading is being taken. After such readings are made and recorded, the needle should immediately be reclamped.

Precaution should be used to ensure that engineering equipment is not exposed to any form of precipitation. If the instrument has been exposed to falling weather, it must be wiped dry as soon as possible, in any event, as soon as brought indoors.

Tripods should be protected from the weather when not in use and the threads protected by using the tripod cap. Instrument boxes should be kept clean and free of dust. Loose objects shall not be stored or transported in instrument boxes.

Engineering instruments and laboratory equipment are delicate, precision equipment. Results are reliable only when instruments and equipment are properly used, handled, and maintained. Remember that instrument and equipment repair work is costly and time consuming.

The Project Inspector is responsible for all instruments assigned to the project. In case of theft or accident caused by negligence or misuse, the person responsible can be assessed the cost of replacement or repairs, unless conclusive evidence is given that the occurrence was unavoidable. For these situations, the Project Inspector must make a written report to the Construction Manager explaining the details as follows:

1. Name of person in charge of instrument and person directly responsible.
2. Location where accident or theft occurred.
3. Cause, give full information.
4. Make and serial number of instrument.
5. Extent of damage.
6. General condition of instrument exclusive of damage.

## **Vehicular Equipment**

An employee should not operate any piece of mechanical or motorized equipment unless familiar with the correct operating procedures. Regulations prohibit any employee from operating any motorized equipment unless he has an approved operator's card for that particular type of equipment. These cards may be secured from the Resident Mechanic.

Any accident involving State equipment and causing personal injury or property damage should be reported to and investigated by the State Police. Insist upon an investigation by the State Police before leaving the scene of an accident.

A "Driver's Report of Equipment Accident" is furnished with every piece of State equipment. These indicate the information the operator must secure if that piece of equipment is involved in an accident. This information should be delivered to the residency office.

Remember that all Department-owned vehicles are public property. You, as an operator, are expected to set a good example by:

1. Observing all traffic laws.
2. Practicing courtesy in driving.
3. Maintaining all safety devices in operating condition.
4. Keeping the vehicle properly serviced and clean.

5. Practicing defensive driving.
6. Abiding by all current Safety Rules.
7. Properly securing the vehicle when unattended.

## **Publications**

Publications are available from the residency and district offices. All inspection personnel should have available the following items:

1. *Road and Bridge Specifications* book.
2. *Road and Bridge Standards, Volumes I and II.*
3. *Construction Manual.*
4. *Inspection Manual*
5. *Manual of Instruction, Materials Division.*
6. *Work Area Protection Manual.*
7. *Erosion and Sedimentation Control Handbook.*
8. *Guard Rail Installation Training Manual.*
9. *Claims Manual*
10. Current Instructional Memorandum.
11. *Post-Construction Manual*
12. *Survey Manual*

## **WEB Sites**

The following web sites are available to assist in the performance of Inspection duties:

1. <http://www.virginiadot.org/business/const/default.asp>
2. <\\Comatapp01\MaterialsNet\Default.htm>
3. [http://www.virginiadot.org/business/resources/const/Inspection\\_Manual.pdf](http://www.virginiadot.org/business/resources/const/Inspection_Manual.pdf)
4. <http://www.extranet.vdot.state.va.us/locdes/GRIT/main.htm>



# APPENDIX B

## TERMS FOR SUBGRADE AND PAVEMENT STRUCTURES

### General

**Subgrade** may consist of:

1. In-place materials.
2. Imported material
3. Hydraulic cement stabilized in-place or imported material.
4. Lime stabilized in-place or imported material.

In contracts that include the construction of the pavement structure, the subgrade must be prepared in conformance with the "Subgrade and Shoulders" section and other appropriate sections of the Specifications governing treated and select materials.

**Subbase** may consist of:

Mineral aggregate.

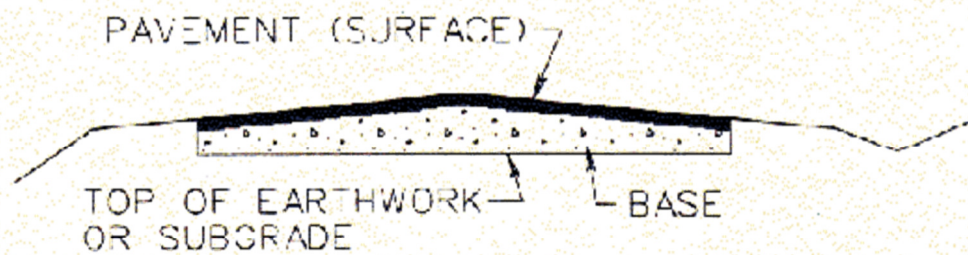
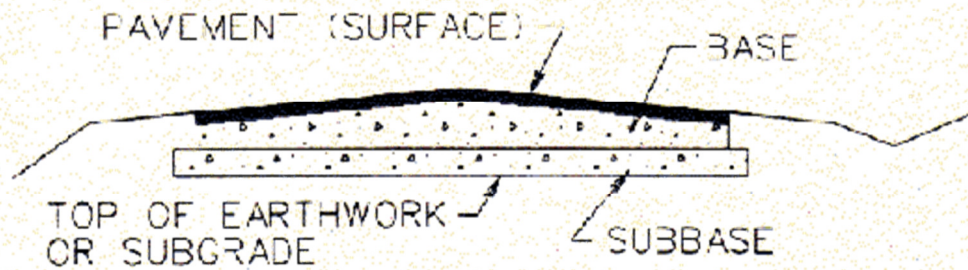
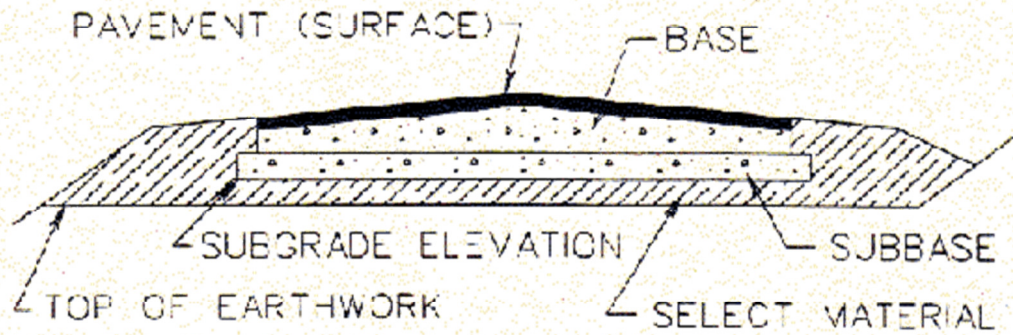
**Base** may consist of:

1. Mineral aggregate.
2. Asphalt cement concrete.
3. Hydraulic cement concrete.

**Pavement surface** may consist of:

1. Asphalt cement concrete.
2. Hydraulic cement concrete.
3. Asphalt surface treatment.
4. Calcium chloride or sodium chloride treatment.

# LOCATION OF SUBGRADE AND PAVEMENT STRUCTURE COURSES



# APPENDIX C

## PROJECT RECORDS

### General

The “keeping” of project records, including the preparation, assembly, and preservation of such records is considered to be one of the most important duties and responsibilities which the Engineer delegates to the Inspector.

Field notes constitute a written record of pertinent information, measurements, and observations regarding the project. They should be kept according to uniform practices. Detailed sketches should be shown on daily diary sheets.

Project diaries and project records are to be reviewed by the Construction Manager, Area Construction Engineer or District Construction Engineer on at least a monthly basis. A record of this review, signed by the reviewer, will be made part of the project records and a summary of the findings of this review shall be made in the project diary.

### Accuracy

Record exactly what was done at the completion of the item rather than depending on memory at a later time. When it is necessary to add data to notes previously prepared, the additional item should be dated and initialed. Always enter notes directly into the record.

### Clarity

Plan your entries so that data can be orderly arranged. Do not make ambiguous statements. Show neatly dimensioned sketches for clarity. Assume that the person who will use your notes has no familiarity with the work.

### Legibility

Use standard symbols and abbreviations to keep notes concise. Use plain lettering to avoid confusion.

### Completeness

Show all pertinent measurements and observations. Use a degree of accuracy consistent with the operation. If in doubt about the need for the data, record it.

## Self Checking

Notes should be so kept that the work can be checked without returning to the field. Persons familiar with the project should be able to verify the accuracy of the work from the information contained in the notes. Use positive controls.

Project records consist of, but not limited to, the following:

1. Copy of the Contract and Special Provisions.
2. A complete set of plans that include the latest revisions.
3. Notice to Proceed, Form C-20.
4. A copy of the "Report of Starting and Completion of Project," Form C-5.
5. A copy of Subletting Requests, Form C-31.
6. A copy of all approved Work Orders, Form C-10.
7. One copy of approved working drawings and shop plans that are required for the project.
8. Copies of all utility plans and agreements when the Project Inspector inspects such work.
9. Inspector's Daily Utility Reports, Form UT-7, for utility and railway work.
10. A copy of the project's correspondences and reports.
11. A copy of the Right-of-Way Agreement between the Commonwealth and the property owners within, and adjacent to, the project limits.
12. Records of work performed under Force Account Specifications, Forms C-115, and C-116.
13. Copies of all shutdowns issued on contracts, Form C-12, and correspondence relative to extensions of time.
14. Electronic Project Diary
15. Source of Materials
16. Materials Test Reports
17. Work Zone Inspection Checklists
18. Materials Invoices / Delivery Tickets
19. Materials Notebook.
20. A complete and accurate file should be kept on the project concerning information pertaining to Equal Opportunity and Form C-67 for on-the-job training by the Contractor.
21. Copy of Form C-79 Summary of Time, Theoretical and other measurements, signed by both the Contractor and the Inspector. Form C-79 is to be printed and signed at least monthly to coincide with the monthly pay voucher. This form may be printed and signed more often as deemed necessary and mutually agreed upon by the Contractor and Inspector.
22. Progress Estimate.
23. Progress Schedule, Working Schedule, Plan of Operations, or CPM.
24. As built plans, if required.
25. Contractor's weekly payroll or payroll roster.
26. copies of CPE annual / final reports signed by the Contractor
27. copies of CPEi reports signed by the Contractor
28. copies of CPEs reports signed by the sub-contractors
29. Form C-107 Construction Runoff Control Inspection Form



## Project Diary

The Project Inspector is required to maintain an electronic diary in Site Manager for each contract. The electronic diary entries will be made daily and must be completed by noon on the following day.

The project diary should contain a day-to-day record of all significant occurrences relating to the project. It must be complete, concise, and accurate. The Project Diary should include the following information:

1. Day of week, month, date of the month and year.
2. Daily weather conditions and temperature range.
3. Record of instructions given to the Contractor. In the event a controversy arises, record all pertinent information.
4. Information relative to the progress of work being done by the Utility Company in moving their facilities (lines, cables, poles, pipes,). Note causes for delay and its effect on the Contractor's progress.
5. Pay items
6. Note any authorized extra work, force account work, etc. being performed and refer to Inspector's Daily Report for detailed information.
7. Any unusual occurrences, resulting in personal injury or property damage, such as damage caused by blasting operations or Contractor's equipment.
8. When physical conditions of the work are encountered that are unusual or are materially different from those expected, record the following information:
  - i. Detailed description of the unusual conditions encountered.
  - ii. An estimate of the net effect the unusual conditions have upon the progress of the work.
  - iii. The increase in the working force required to overcome the unusual conditions encountered.
  - iv. Equipment and materials used and other pertinent information which would be of value should a claim result.
9. If construction progress is not satisfactory, entries in the diary should substantiate this fact. In addition to the information previously listed the diary should include:

10. The actual activities of the Contractor.
11. The rate that the Contractor is performing these operations.
12. The activities that the Contractor could and should be accomplishing but is not.
13. The efforts made at the project level to have the Contractor improve upon his progress.

Note: The opinion of the Inspector is valuable when it is documented by facts. Do not hesitate to list the full particulars in the diary. Seemingly minor details may become important at a later date.

14. Periodic wage rate interviews with Contractor's employees (Laborer, Equipment Operator, etc.,) to determine proper classification and wage rate compliance.
15. Discussions with property owners, official visitors, and the representatives of various utilities, railroads or other governmental agencies should also be entered in the diary.
16. All official phone calls should be recorded.
17. Final disposition of salvageable materials.
18. Welder Certifications - Record the Welder's name, type, and position of weld qualified and certification number.
19. Note any assigned Inspector who is on vacation, sick leave, or on temporary assignment to another project.
20. Summary of findings of Construction Manager's, Area Construction Engineer's or District Construction Engineer's monthly review.

## **Inspector's Daily Report**

Each Inspector is to complete a Daily Work Report (DWR) on the construction activities he/she personally inspects for that day. However, if more than one Inspector is involved in the inspection of a single construction activity, only one need be written for that activity. The DWR does not have to be printed and signed.

The Inspector's daily report is to include the following information:

1. Contractor's working force and equipment used. (The equipment can be listed weekly or monthly if changes are recorded daily.) Note equipment condition if efficiency is affected thereby.

2. Record of locations of pertinent items of work in progress. Description of the work being performed, including quantities of work, the quality of workmanship, difficulties encountered and method of correction, and the results of Inspectors checks or tests.
3. Information as to time, materials, working force and equipment used for authorized extra work, i.e., claims, force account.
4. Material accepted on visual inspection or material rejected.
5. Structural footings information should include:
  - a) Description of the material encountered, such as type of clay, sand, gravel, rock, etc.
  - b) Condition of the foundation, such as firm, soft, level, sloping rock, results of probes.
  - c) Elevation of foundation.
  - d) Date of approval.
  - e) Person approving.
6. Measurements taken as dimensional checks and for determination of pay quantities. Include dimensioned sketch where such will prove helpful in preparing the dairy. Show detailed sketches on daily diary sheet.
7. Notes on the work as required by the Inspection manual.

The Inspector's Daily Reports and the Project Diary should be completed promptly but not later than noon of the following workday.

## **State Force Operations**

Certain items of work such as signs, guardrail, fence, and right-of-way monuments may be designated to be accomplished using State Forces.

To obtain uniformity and insure proper administration and documentation of this work, the following procedures are established:

### **1. Plans**

- a. Items to be handled by State Forces are to be selected at design stage of plan development.

- b. Items to be handled by State Forces are to be summarized on the plans separately from the work to be performed by the contractor.
- 2. FHWA Approval**
- Scheduling and Contract Division obtains approval from FHWA to use State Forces for the construction of the selected items on a participating basis, based upon Total Estimated Cost (TEC).
- 3. Detailed Estimate**
- The detailed estimate is to show State Force Work.
- 4. Diary and Summary**
- a. As these items of work are being performed, the Project Inspector is to make the appropriate entries in the project diary.
  - b. All work performed by State Forces is to be summarized separately from that done by contract and clearly identified as such.
- 5. Cost Keeping Records**
- a. All costs, except engineering, involved in performing the State Force work are to be charged to the project as nonparticipating, Activity 733.
  - b. All engineering costs are to be charged to the applicable engineering activity of the project as participating on Federal-aid projects and as nonparticipating on State financed projects.
  - c. As any item of work by State Forces on an individual section within the contract is completed, Form A-50 (Report of Force Account Work on Federal Projects) is to be completed. The TEC to be used in completing Form A-50 will be that shown on the detailed estimate furnished to the District.
  - d. At the time each Form A-50 is completed, a copy of Form A-11 (Debit and Credit Memorandum) is to be prepared, crediting Activity 733, and debiting Activity 633 of the appropriate project section with a sum equal to that shown on the Form A-50. The costs shown on Form A-11 are to be classified by items and not by labor, materials, and equipment. The TEC to be used in completing Form A-11 will be the same as that price used in preparing Form A-50. The Forms A-50 and A-11 are to be submitted together through the District to the Fiscal Division.

**6. Exceptions**

- a. The procedures outlined in Item 5 c. and d. will not apply to projects financed with 100 percent State funds or for nonparticipating items on Federal-aid projects.
- b. In the event the FHWA approves the financing of State Force work on an actual cost basis for an individual project, separate instructions will be issued on a project by project basis.

# APPENDIX D

## ROAD AND BRIDGE STAKEOUT

### General

Unless otherwise indicated in the contract, all surveying and stakeouts for the successful prosecution of work on the project shall be accomplished by the Contractor. The Contractor shall provide the Department with a record copy of surveying drawings, field notes, and computations prior to using the stakeouts for construction.

The following survey work shall be performed by or under the direct control of a surveyor licensed in Virginia as a Land Surveyor and is experienced in highway construction:

- (1) Right of Way and boundaries affecting property ownership.
- (2) Horizontal and vertical control for bridges, box culverts and other culverts having openings greater than 48 inches.
- (3) Horizontal and vertical control centerlines or baselines for roadways, ramps, loops and connections.

All other surveying work may be performed by or under direct control of the Contractor if experienced in highway construction stakeout.

### Slope Stakes

Slope stakes are set at all even and +50 stations except transitioned curves where they are set on the transition stations not to exceed 50' intervals between slope stakes. A careful examination should be made of the typical cross sections shown on the summary sheet for width of surfacing, width of shoulder and width of ditch, together with the cut and fill slopes or CS standards to be used. Also a careful examination should be made of the summary sheets, plan sheets, and special notes pertaining to staking and construction of the project and the plan cross sections to determine the suggested slope to be used in special cases. The Inspector should make certain that the typical section shown on the bridge plans matches the typical section shown on the roadway plans where grade separations are involved.

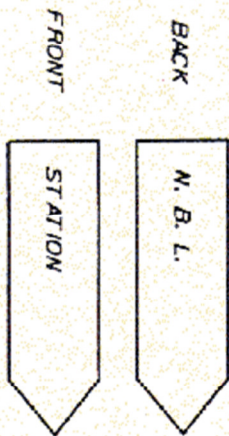
### Fine Grade Stakes

Fine grade or other stakes required for the construction of the project are set as the work progresses. Fine grade stakes are required for all projects on which the plans show a

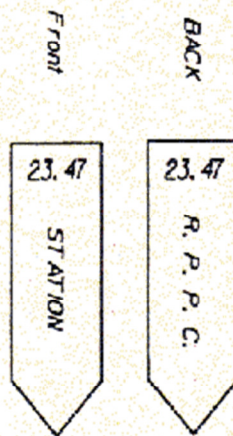
definite grade line or as directed by the Engineer. On tangents the fine grade hubs are set on one side of the roadway with distances and grades referenced to the finished grade on centerline. On curves, fine grade hubs are required on both sides with offsets and grades referenced to the edge of pavement. The Contractor shall ensure survey notes are kept on fine grade stakes. Fine grade stakes should not be placed until they are actually needed.

## **Bridge Stakeouts**

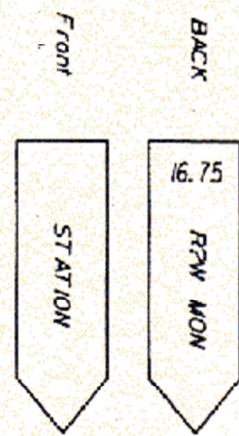
The Contractor sets stakes on the base line of the bridge, where the centerline of all piers and abutments intersect, on either side of the bridge base line, on the centerline of the piers and face of abutments. At least 2 stakes are set on each side of the base line of the bridge on the centerline of the pier or abutment so that if one stake is knocked out, there will still be a stake left in place. The line that is staked for the base line of the bridge is usually the line shown on the bridge plans from which all dimensions are referenced. This may not necessarily be the actual centerline of the bridge, or the centerline of the roadway. The same is true of the piers and abutments. The pier or abutment centerline staked may not be the actual centerline of the piers or abutments, but will be that line shown on the bridge plans from which the dimensions are referenced.



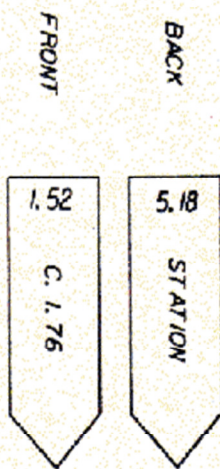
Centerline Stakes



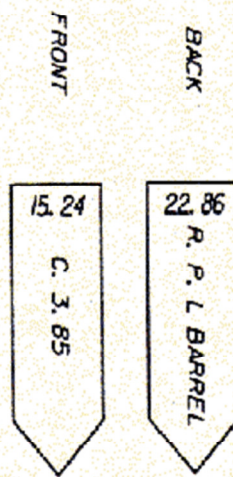
Reference Point Stakes.  
Distance from  $\mathcal{E}$   
shown on each side.



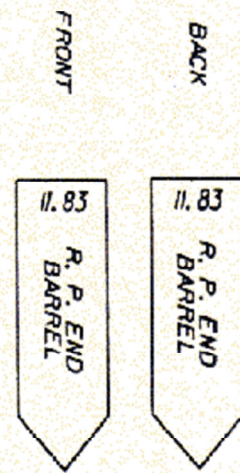
R/W Monument Stakes.  
Distance from  $\mathcal{E}$   
shown on back.



Finish Grade Stakes.  
Cut or fill on front  
with offset and grade  
to edge of pavement  
when on curve and to  
L when on tangent  
station on back and  
offset to  $\mathcal{E}$ .



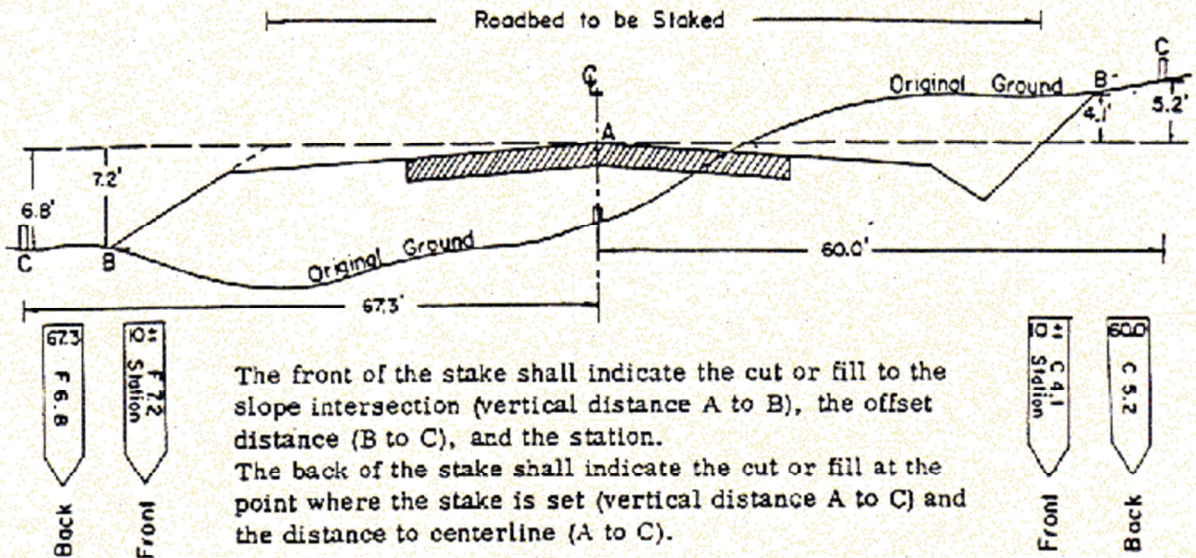
Reference Point Stakes for  
culverts with cut or fill  
on front and distance to end  
of barrel and distance on back  
to  $\mathcal{E}$ .



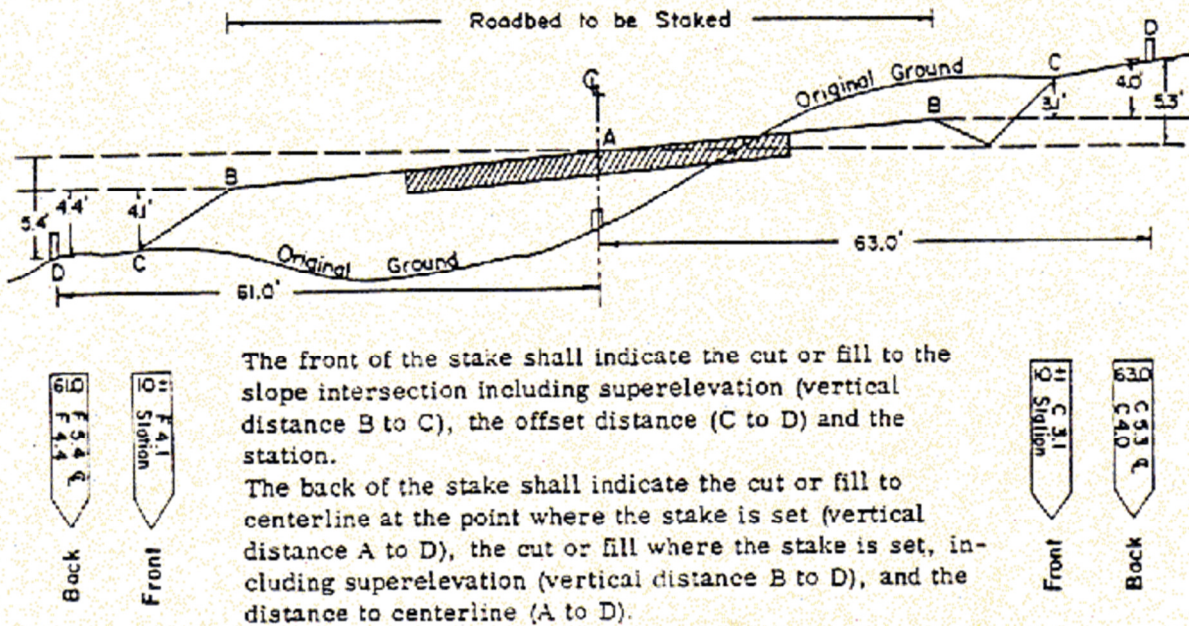
The End of Barrel Reference  
Stakes will show the distance  
to the L of barrel and will  
be marked R. P. END BARREL on  
front and back.



### SLOPE STAKES ON TANGENTS



### SLOPE STAKES ON CURVES



An adequate number of stakes (50 foot intervals or less) should be set to locate the position of the toe of fill (or cut) in front of the two abutments. The objective is to furnish sufficient survey control stakes from which the grading contractor will be able to install abutment embankments "in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans." At grade separations, the location and grade of the ditch lines of the "under-passing" roadway will generally control the location of the toe of the slope. Caution: Be certain to check both the road plans and the bridge plans for proper dimensions, rates of slope and super-elevations.

## **Project Inspector's Responsibilities - Bridge Stakeout**

The Project Inspector is to check all stakes set by the Contractor. The Contractor should be notified immediately if the Inspector discovers a difference in a measured distance or angle during the course of this check.

The Project Inspector is not to set line or grade for the Contractor. However, all stakes set by the Contractor are to be checked by the Project Inspector in a separate and independent survey operation. The Project Inspector is expected to assist the Contractor in his survey work, when requested to do so, but only in an advisory capacity.

The Project Inspector is to check the line, grade, and dimensions of all forms set by the Contractor during the course of the construction work to be certain that the structure is being built in accordance with plans and specifications at all times.

## **Project Inspector's Responsibilities- Box Culvert Stakeout**

The Inspector must verify that box culvert length and invert elevations match existing ground elevations and grade and typical sections shown on the plans. Verification should be performed in accordance with the *Survey Manual*.

## **Use of Instruments**

### **Transit**

Double Centering and doubling angles.

A transit is a very fragile instrument and can unknowingly be out of adjustment. Therefore, the transit should be used in a manner that will eliminate or minimize instrument and human errors. For example, when checking the centerline of a bridge pier, the reference points used should be two that will not necessitate "plunging" or reversing the transit telescope. If this is not possible, the method of "double-centering" should be used. The transit, in this case, is set up on one point, a backsight taken on another, the telescope plunged, and a point checked. The transit should then be revolved about its vertical axis and a second backsight taken, this time with the telescope reversed from its position at the time of the initial sight. The telescope is again plunged and the

point re-checked. Midway between the first point check and the second point check will be the true prolongation of a line between the reference point sighted on and the reference point on which the transit is set up.

Whenever it is required to turn an angle with a transit, it should also be turned using a procedure that will minimize errors, especially human errors. After the initial angle has been turned, the vernier setting should be left unaltered, the instrument turned on its lower motion and a second sight taken. The upper clamp is loosened and the angle turned a second time. The angle now has been doubled. In this way the process is continued for as many times as desired. The vernier reading divided by the number of times the angle was turned will give the correct angle.

All sights taken with a transit should be taken at the intersection of the center horizontal and vertical cross hairs. The transit should be carefully focused on each sight to minimize parallax. This can be checked by sighting through the telescope and moving the eye from side to side. If the cross hairs remain stationary on an object while the eye is being moved, parallax has been corrected.

## **Levels**

Precautions need to be taken while using the level.

The Inspector should set up the tripod in a firm position and assure that it remains like that.

The Inspector should level the instrument before reading and recording each sight and check to see that it remains level periodically as it is being used. A level that is out of adjustment will not be level at all points with a 360 degree arc.

Keep leveling screws firm but not excessively tight.

Keep the backsight and foresight distances as near equal as practical. If the instrument is slightly out of adjustment, this procedure will tend to balance or minimize the error.

If possible, run levels, particularly when long sights are required, when temperatures are not excessive. Heat waves often cause errors in reading the level rod.

Be careful to read the correct even foot and the correct tenth of a foot. These are very common errors.

Avoid the use of un-stationary objects when setting temporary bench marks.

A bench mark (B.M.), either permanent or temporary, is established for elevation control. Bench marks should be verified by running check levels from the succeeding or preceding bench mark as shown on the road plans to the bench mark at the bridge site and then back to the original bench mark.



Where practical, a temporary B.M. should be established on the first pier or abutment bearing seat constructed. Elevations for subsequent pier and abutment bearing formwork should be set to conform with the initial bearing seat constructed. Should the initial elevation be established in slight error, all subsequent elevations set from this elevation will be in error in the same magnitude and direction.

The following note keeping procedure should be used:

Left Page					Right Page		Date	Weather
	(+)		(-)					
Loc.	B.S.	H.I.	F.S.	Elev.	B.M.	Remarks	Redman	WDC
							Instr.	WSX
							Bk. man	RMS
B.M.	6.07	165.08		159.01	159.01	Description of B.M.		
T.P.	2.27	156.44	10.91	154.17				
T.P. <sub>2</sub>	3.11	151.01	8.54	147.90				
B.M. <sub>2</sub>	9.06	156.18	3.89	147.12	147.12	Description of B.M. <sub>2</sub>		
T.P. <sub>3</sub>	6.58	159.40	3.36	152.82				
T.P. <sub>4</sub>	11.37	160.67	10.10	149.30				
B.M. <sub>1</sub>			1.66	159.01	159.01	B.M. <sub>1</sub>		
Checked by		DWN						

## **Chaining**

The act of measuring distances for survey work is known as chaining. The chain is a steel tape which comes in 50, 100, 200, and 300 foot lengths. Chaining is usually done in the horizontal position with the use of a hand level and plumb bobs. Non-horizontal chaining (slope chaining) is employed only when the deviation angle from the horizontal plane can be determined. The true horizontal distance is determined by using the following trigonometric correction formula:

True Horizontal Length = (Slope Length) x (Cosine of Angle)

The following are common errors in chaining distances:

1. Chain not held horizontal - Both ends of the chain should be nearly level but it should be remembered that a 100 foot chain out of level by 1.42 feet will result in an error of 0.01 foot.
2. Variations in temperature - A 100 foot steel chain expands and contracts about 0.01 foot for every 15° F change in temperature. Generally, a chain is standard or 100 feet long at 68° F. For example, if a distance of exactly 100 feet is to be laid off when the temperature is 98° F (30° F higher than standard), the distance actually used on the chain should be 99.98 feet since the chain is 0.02 feet too long due to the temperature change of +30° F.
3. Variations in tension - In a 100 foot steel chain, a change in tension or pull of 3 pounds changes the length of a fully supported chain by 0.001-foot. Care should be taken to exert enough tension to take out any undue sag - usually 15 to 30 pounds of tension.
4. Chain not calibrated to its true length - The chain should be calibrated between two known distance points to determine its true length and proper tension pull.
5. Reading numbers incorrectly, such as a "6" for a "9" - This error can be eliminated by reading the numbers to either side of the one indicating the desired measurement.

## **Checking Plan Dimensions and Elevations**

A thorough review of the designer's plans by both the Contractor's Representative and the Inspector should precede the first construction operation. This review should accomplish two important objectives:

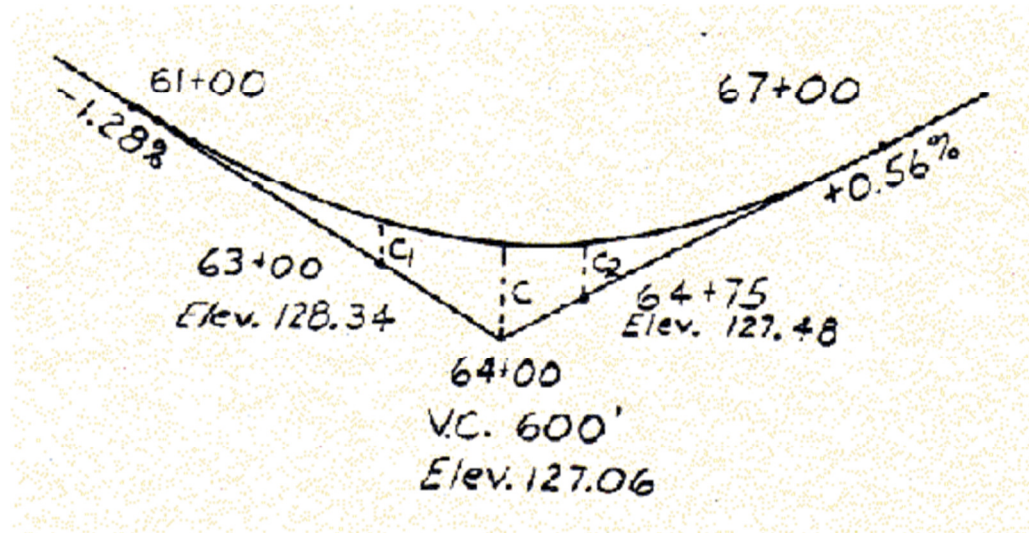
1. Familiarization with plan details.
2. Dimension and elevation check for clarity and relative correctness.

The dimensions and elevations shown on the title sheet of the bridge plans are checked using the plan and profile details shown on the road plans. Since the bridge structure actually represents a sector of the plan and profile for the highway, the alignment and grade for the bridge deck must coincide with the roadway approaches.

Two geometric situations along with the computations necessary for performing station and elevation determinations at any given point on the bridge or roadway centerline are presented in the following examples:

## Vertical Curve

A vertical curve is an arc of a parabola connecting two uniform gradients. The length of curve, the percentages of grade for the two gradients, and the station and elevation for the point of intersection of the two gradients are always shown on the road plans.



Compute the elevations on the tangents for all stations required:

$$\begin{array}{l} \text{Station } 64+00 \\ \text{Station } \underline{63+00} \\ 1+00 = 100 \text{ feet} \end{array}$$

$$\begin{array}{l} \text{Station } 64+75 \\ \text{Station } \underline{64+00} \\ 0+75 = 75 \text{ feet} \end{array}$$

Change in elevation:

$$\frac{1.28\%}{100} \times 100 \text{ feet} = 1.28 \text{ feet}$$

$$\frac{0.56\%}{100} \times 75 \text{ feet} = 0.42 \text{ feet}$$

Therefore, tangent elevations at station

$$\text{Station } 63+00 = 127.06 + 1.28 = 128.34 \text{ feet}$$

$$\text{Station } 64+75 = 127.06 + 0.42 = 127.48 \text{ feet}$$

2. Compute the center offset "c"

$$c = \frac{\text{length of curve in stations} \times (\text{Algebraic difference in grades})}{8}$$

$$c = 6/8 (1.28 + 0.56) = 1.38 \text{ feet}$$

3. Compute intermediate offsets "c"1, "c"2 . . . etc.

$$c_1, c_2, \dots = c \times \frac{(\text{Dist. from closest end of vertical curve})^2}{(\text{half the length of vertical curve})^2}$$

$$c_1 = 1.38 \frac{(200)^2}{(300)^2} = 0.61 \text{ feet} \quad c_2 = 1.38 \frac{(225)^2}{(300)^2} = 0.78 \text{ feet}$$

4. Apply the intermediate offset to the elevation of the tangent to obtain the required elevation on the vertical curve.

$$\text{Elevation on vertical curve at station } 63+00 = 128.34 + 0.61 = 128.95 \text{ feet}$$

$$\text{Elevation on vertical curve at station } 64+75 = 127.48 + 0.78 = 128.26 \text{ feet}$$

5. Compute the station of highest or lowest point on the vertical curve:

Distance from beginning of curve =

$$\frac{(\text{First gradient}) \times (\text{length of vertical curve})}{\text{Algebraic difference in grades}} =$$

$$\frac{(1.28) \times (600)}{(1.28 + 0.56)} = \frac{768.00}{1.84} = 417.39 \text{ feet}$$

Therefore: Station  $(61+00) + (4+17.39) = (65+17.39)$

6. Compute the elevation for the highest or lowest point on the curve:

Use steps (1), (3) and (4) above.

Answer: 128.23 feet

## Circular Curves

The stationing of a centerline progresses around a curve in the same manner as along a tangent. The point where a curve begins is called the P.C. (point of curvature) and where it ends is called the P.T. (point of tangency). The point where the two tangents intersect is called the P.I. (point of intersection).

The distance between two stations on a curve is 100 feet along the arc and somewhat less along the chord. Therefore, the correct chord length must be measured that will result in obtaining a distance equal to 100 feet around the arc. For curves having long radius (2000 feet to infinity), the distance along the arc will be very nearly the same as along the chord. However, for curves having a short radius (less than 2000 feet), the chord length must be corrected. The correct chord length to be used can be found in Table V of a Standard Field Book or by using the formula:

$$\text{Chord Length} = 2 \text{ Radius} \times \text{Sine of deflection angle.}$$

Curves are staked out using a transit and steel tape or "chain" by either of two methods:

1. By turning deflection angles (with the transit set up at the P.C.) from the tangent to the station desired along the curve. The deflection angle can be computed by either of the following formulas:

Deflection angles in degrees =

$$\frac{(\text{Degree of Curve}) \times (\text{Dist. from P.C. to P.O.C.})}{200}$$

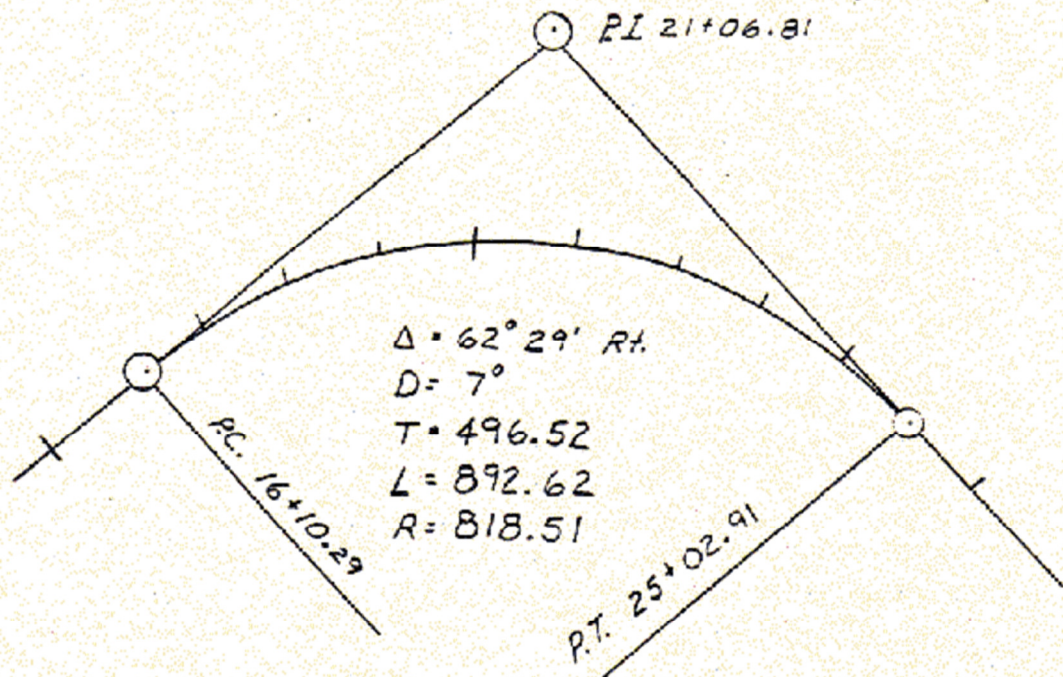


Deflection angle in minutes =

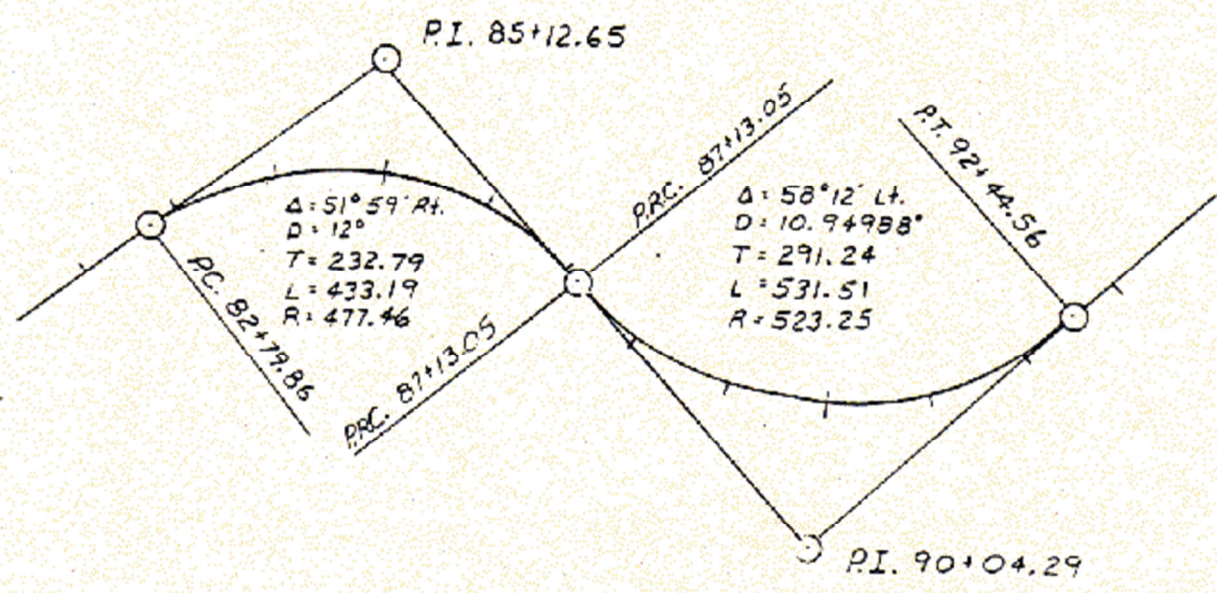
$$0.3 (\text{Degree of Curve}) \times (\text{Dist. from P.C. to P.O.C.})$$

2. By turning deflection angles with the transit set-up at some known point on the curve. The deflection angle is turned from the local tangent to the curve at the point of set-up to any desired point on the curve. The transit can be oriented so that it will read zero on the local tangent to the curve by the following procedure: Back sight at any station on the curve with the vernier set at the difference between the deflection angle of the station sighted on and the deflection angle of the station occupied and set in the same direction as the direction of the curve. When the transit is turned to zero on the vernier, it is oriented to the local tangent to the curve. The deflection angle of each succeeding point on the curve can then be turned by using one of the formulas in step one, except that the distance used is the distance from the set-up point to the point for which the deflection is needed.

## CIRCULAR CURVE



## REVERSE CURVES



MINUTES AND SECONDS TO DECIMALS OF A DEGREE

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	Minutes Seconds	Seconds		Minutes	
1	.01667	.00027	31	.51667	.00861
2	.03333	.00055	32	.53333	.00888
3	.05000	.00083	33	.55000	.00916
4	.06667	.00111	34	.56667	.00944
5	.08333	.00138	35	.58333	.00972
6	.10000	.00166	36	.60000	.01000
7	.11667	.00194	37	.61667	.01027
8	.13333	.00222	38	.63333	.01055
9	.15000	.00250	39	.65000	.01083
10	.16667	.00277	40	.66667	.01111
11	.18333	.00305	41	.68333	.01138
12	.20000	.00333	42	.70000	.01166
13	.21667	.00361	43	.71667	.01194
14	.23333	.00388	44	.73333	.01222
15	.25000	.00416	45	.75000	.01250
16	.26667	.00444	46	.76667	.01277
17	.28333	.00472	47	.78333	.01305
18	.30000	.00500	48	.80000	.01333
19	.31667	.00527	49	.81667	.01361
20	.33333	.00555	50	.83333	.01388
21	.35000	.00583	51	.85000	.01416
22	.36667	.00611	52	.86667	.01444
23	.38333	.00638	53	.88333	.01472
24	.40000	.00666	54	.90000	.01500
25	.41667	.00694	55	.91667	.01527
26	.43333	.00722	56	.93333	.01555
27	.45000	.00750	57	.95000	.01583
28	.46667	.00777	58	.96667	.01611
29	.48333	.00805	59	.98333	.01638
30	.50000	.00833			

---

EXAMPLE: To reduce  $7^{\circ} 13' 23''$  to a decimal of a degree.

$$\begin{aligned}
 7^{\circ} &= 7.00000 \\
 13' &= 0.21667 \\
 23'' &= \underline{0.00638} \\
 &7.22305^{\circ}
 \end{aligned}$$

EXAMPLE: To reduce 8.32139 to degrees, minutes and seconds.

$$8.32139$$

$$\underline{-8.00000} = 8^\circ$$

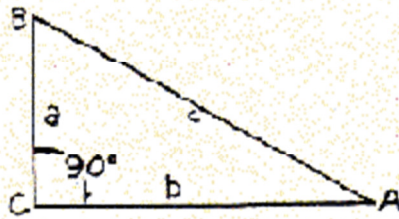
$$0.32139$$

$$\underline{-0.31667} = 19'$$

$$0.00472 = 17''8^\circ 19' 17''$$

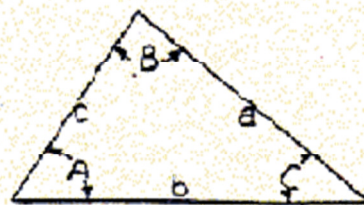
## TRIGONOMETRIC FORMULAE

### RIGHT TRIANGLE



- (1)  $\sin A = \frac{a}{c} = \cos B$
- (2)  $\cos A = \frac{b}{c} = \sin B$
- (3)  $\tan A = \frac{a}{b} = \cot B$
- (4)  $\cot A = \frac{b}{a} = \tan B$
- (5)  $\sec A = \frac{c}{b} = \csc B$
- (6)  $\csc A = \frac{c}{a} = \sec B$
- (7)  $\text{vers } A = 1 - \cos A = 1 - \frac{b}{c}$
- (8)  $\text{exsec } A = \sec A - 1 = \frac{c}{b} - 1$
- (9)  $a = (c+b)(c-b)$
- (10)  $b = (c+a)(c-a)$
- (11)  $c^2 = a^2 + b^2$
- (12)  $\text{Area} = \frac{1}{2}ab$
- (13)  $\text{Area} = \frac{1}{2}ab^2 \tan A$

### OBLIQUE TRIANGLE



- (1) Law of Sines  
(When two angles and the included side are known)  
 $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$
- (2) Law of Tangents  
(When two sides and the included angle are known)  
 $\frac{a+b}{a-b} = \frac{\tan \frac{1}{2}(A+B)}{\tan \frac{1}{2}(A-B)}$
- (3) Law of Cosines  
(When two sides and the included angle are known or when all three sides are known)  
 $a^2 = b^2 + c^2 - 2bc \cos A$   
 $b^2 = a^2 + c^2 - 2ac \cos B$   
 $c^2 = a^2 + b^2 - 2ab \cos C$
- (4) Half-angle formula  
(When all three sides are known)\*  
\*  $s = \frac{1}{2}(a+b+c)$   
 $\sin \frac{1}{2}A = \frac{(s-b)(s-c)}{bc}$
- (5)  $\text{Area} = \frac{1}{2}ab \sin C$   
 $= \frac{1}{2}bc \sin A$   
 $= \frac{1}{2}ac \sin B$

# APPENDIX E

## SAFETY RULES

These rules shall be posted and kept posted in all buildings, shops and storage sheds owned or leased by the Department of Transportation. All employees will abide by these safety rules. Each new employee, hired contract employee, and hired vehicle/equipment operator shall be given a copy of these safety rules and their contents shall be explained to them by their immediate supervisor or VDOT supervisor contact.

### CONSTRUCTION AND MAINTENANCE

1. Hard hats shall be worn by ALL employees while participating in or observing all types of field work when outside of a building or outside of the cab of a vehicle, and by all employees exposed to, participating in or supervising buildings under construction.
2. Regulation respiratory equipment shall be worn by all employees while performing those tasks specified in the Department's Respiratory Protection Program.
3. Adequate eye protection shall be worn by participants and other employees in the proximity of grinding breaking of rock and/or concrete, while using brush chippers, operating chain saws, striking metal against metal or when working in situations where the sight may be in jeopardy. In addition to eye protection, face protection in the form of face shields shall be worn when operating chain saws, feeding chippers, and when pulling brush to a chipper when the chipper is in operation.
4. Safety boots shall be worn by all employees in those positions specified in the Department's Safety Footwear Policy.
5. Safety Vest shall be the minimum high-visibility safety apparel worn by all employees exposed to vehicular traffic and construction equipment as specified in the Virginia Work Area Protection Manual, Section 6D.03.
6. Standards and guidelines of the current Virginia Work Area Protection Manual shall be used when setting, reviewing, and removing traffic controls.
7. All flag persons will be certified according to the Virginia Flagger Certification Program.
8. Seat belts shall be worn by all vehicle/equipment operators as specified in the Department's Seat Belt Policy.
9. Riding on running boards and getting on or off any equipment while the equipment is moving is prohibited. Jumping from truck beds or from equipment when ladders, steps and dismounting devices have been provided is prohibited. Boarding and descending



from equipment shall be done by facing the equipment and by maintaining three-point contact.

10. Vehicles used to transport employees shall have seats firmly secured and adequate for the number of employees to be carried. Under no circumstances shall more employees be transported than can be safely seated. Employees who are in the process of training another employee may, in controlled circumstances, ride for short distances with the permission of supervisory personnel.

11. Only state employees and persons on official state business are allowed to be transported in state vehicles.

12. No person shall be permitted to position themselves under any raised load or between hinge points of equipment without first taking steps to support the load by the placing of a safety bar or blocking.

13. Explosives shall be purchased, transported, stored, used, and disposed of by a Virginia State Certified Blaster in possession of a current criminal history record check and a commercial driver's license with hazardous materials endorsement and a valid physician's certificate. All federal, state, and local regulations pertaining to explosives must be strictly followed.

14. All electrical tools shall be adequately grounded or double insulated. GFCI protection must be installed in accordance with the National Electrical Code (NEC) and current Virginia Occupational Safety and Health (VOSH) regulations of the Department of Labor and Industry (DLI). If extension cords are used, they shall be free of defects and designed for their environment and intended use.

15. Before any employee performs any servicing, maintenance, repairs on any machinery or equipment where the unexpected energizing startup or release of any type of energy could occur and cause injury, the machinery or equipment will be rendered safe to work on either being locked or tagged out. VDOT's policy entitled "Policy for the Control of Hazardous Energy Sources and Electrical Hazards-Lockout and Tagout" will be strictly followed.

16. Only authorized persons in accordance with the VDOT policy entitled "Policy for the Control of Hazardous Energy Sources and Electrical Hazards- Lockout and Tagout" are permitted to do service, maintenance, or repairs on machinery and equipment.

17. No person shall enter a confined space without training, permits and authorization.

18. All new equipment operators are to be examined in accordance with the Asset Management Division's policy (Equipment Section Procedures 3.20- "Authorization to Operate Equipment and Licensure Requirements"). Employees shall be properly instructed in the safety regulations necessary for the safe and efficient operations of equipment and the proper maintenance thereof.

## **GENERAL**

19. Report all personal injuries and equipment accidents to your supervisor immediately.
20. A five-minute safety meeting will be held each morning before the work party departs.
21. Any action such as horseplay on work operations will not be tolerated.
22. In order to promote safer working conditions, good housekeeping will be maintained in all our facilities and work sites.
23. Smoking is prohibited inside all offices, buildings and inside equipment and any vehicles owned or paid for by the state. This includes tractors and backhoes, as well as vehicles that are leased or rented with state funds. The Governor's Executive Order # 41 (2006) on smoking will be in effect.
24. Smoking or the use of a torch, lantern, spark producing device, etc., or any open flame within 50 feet of gasoline or other flammable liquids, is prohibited.
25. Transporting any type of empty, filled or partially filled flammable containers or explosives in the passenger compartment of any vehicle/equipment carrying employees is prohibited.
26. Open fires must not be built within 200 feet of any point where bituminous, flammable or hazardous materials are stored or are being transferred.
27. No open flame shall be used to inspect or examine drums, tank cars or other containers in which bituminous, flammable, or hazardous materials have been stored.
28. The use of gasoline to start a fire or as a cleaning agent is prohibited.
29. Under no circumstances shall equipment motors or engines be operated or started when fuel leaks are present.
30. When welding or assisting in this operation, employees shall use regulation hoods. When cutting or burning metals, approved eye protection shall be used. Welding on tanks, distributors or any other container of bituminous or flammable materials used for transporting or storage shall not be done unless the proper safeguards are taken. All bituminous or flammable material tanks are to have wide open vents while work is being done. Before welding, the container is to be steamed, flushed and ventilated for 48 hours to remove all fumes. Tanks will be checked with explosive meter before welding is performed.



31. Asphalt kettle burners shall be lighted or re-lighted in accordance with the manufacturer's Instructions and shall be operated per the manufactures' instructions for operation and safety.

32. Undermining a soil, sand or gravel pit, a soil, shale or gravel bank, or any other excavation, is prohibited. The provisions of Virginia Occupational Safety & Health regulation (VOSH) 'Excavation Standard, Construction Industry' (16 VAC 25-170-10 et seq.) shall be strictly followed.

33. No employee shall enter waters without wearing an approved water safety device, e.g., U.S. Coast Guard approved life jackets or buoyant work vests. This instruction remains in effect even if a boat is used in the water negotiation process.

34. Fall protection is required:

- When an employee is exposed working at elevated heights of six feet (6) or greater when engaged in construction related activities.
- When doing non-construction related activities at VDOT facilities, fall protection is required when an employee is exposed to heights of four feet (4) or greater. Such fall protection will comply with Virginia Occupational Safety & Health (VOSH) General Industry regulation (1910 Subpart D) "Walking-Working Surfaces."
- When working from the basket of aerial lifts, an employee shall wear a personal fall arrest system (PFAS) with an attached lanyard connected to an approved manufacturer's anchorage point on the equipment. Employees shall not work in the baskets of aerial lifts such as bucket trucks, platform trucks, and other equipment when over the top of moving traffic.

35. **All backing incidents are preventable.** The same attention and awareness required to operate a vehicle in the forward direction must be used when backing a vehicle. Where there is limited sight distance, obstructions, or limited maneuverability, a ground guide or spotter must be used, if available. If a spotter or ground guide is not available, have a **G.O.A.L – Get Out And Look** to avoid a backing incident. When parking a vehicle, pull through parking is preferred or parking in a safe and legal location free of obstructions to avoid backing altogether. In addition, back-in parking of state vehicles should be practiced at all times, unless situations do not allow.