WEST VIRGINIA
DIVISION OF HIGHWAYS

DIVISION 600
INCIDENTAL
CONSTRUCTION

CONSTRUCTION
MANUAL

2002

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Section 601

STRUCTURAL CONCRETE

601.1 GENERAL REQUIREMENTS

The performance of concrete structures depends primarily on the quality achieved in producing, placing, consolidating, and finishing the mix. Although adequate designs may ultimately be specified for structural elements, misunderstood or misapplied specifications and the use of poor construction techniques and improper equipment operation can greatly affect quality. Section 601 of the **Standard Specifications** defines the requirements for structural concrete work and the method of measurement for payment. The following Section presents specific WVDOH policies, procedures, and additional clarification.

601.1.1 Description of Work

The Contractor is responsible for controlling the quality of materials and work incorporated in the structure. Before the project begins, become thoroughly familiar with the details of the Contract Plans and Specifications, Special Provisions, required Contractor submittals, and the specific orders of work. The Project Engineer/Supervisor and, as assigned, the Project Inspector are responsible for assessing the acceptability of material and work based on the Contract provisions.

601.1.2 Material Considerations

601.1.2.1 Source Approvals, Laboratory Numbers, and Certifications

Many types of materials are required for structural concrete work, including:

1. Portland cement;
2. water;
3. aggregates;
4. admixtures and additives
5. reinforcing steel;
6. formwork, falsework, and framework; and
7. curing and protective coating materials.

Before work begins, check that each material conforms to the requirements specified in Section 601.2 of the **Standard Specifications**, and reject and require removal of all non-conforming material. Source approvals, laboratory numbers, and Certificates of Compliance must be obtained in accordance with Division policies and procedures before materials are incorporated in the work. Verify that required approvals and certifications have been obtained, and document all laboratory numbers and quantities on the Inspector's Daily Report. The Contractor is responsible for notifying the Project Engineer/Supervisor of any changes in the source or type of materials.

601.1.2.2 Classes of Structural Concrete

The classes of structural concrete required for the project will be designated on the Contract Plans. Substitution of a higher class of concrete at no additional cost to the Division is permitted with prior approval from the Project Engineer/Supervisor. Typical applications of structural concrete classes are as follows:

1. Class A**.** Class A is generally used for railing, cribbing, precast shapes, steel grid floors, and filler.

2. Class K. Class K is used for sidewalks, parapets, decks, and median barriers, where they are a part of the superstructure.

3. Class B. Class B is used in beams, girders, roadway sidewalks, columns, hammerhead piers, arch rings, ties and spandrel walls,

rigid frames, box culverts, heavily reinforced abutments, retaining walls, footings, pedestals, and other areas not specifically class designated.

4. Class C. Class C is used in massive footings and pedestals, massive pier shafts, gravity walls and, in general, for non-reinforced or lightly reinforced concrete applications.

5. Class D. Class D concrete is used in unformed and non-reinforced concrete applications such as for backfilling of excavated pockets or voids on which footings are to be located.

6. Class H. Class H concrete shall be used for bridge decks when designated in the plans.

Where a structural concrete class requires modification, the designation, as specified on the Contract Plans, will have the following context:

1. Modified. Where a concrete class is designated "Modified," the concrete class will have an increased design strength requirement.

2. Architectural. Where the concrete class is designated "Architectural," additional formwork conforming to the requirements of Section 601.8.10 of the **Standard Specifications** will be required.

601.1.2.3 Structural Concrete Mix Materials

Become familiar with the physical characteristics of acceptable materials, and check for signs of segregation, intermingling, contamination, and breakage. Segregation is common and typically begins with improper handling. Serious segregation is grounds for rejection. Before production, check component materials for acceptability and verify source approvals, laboratory numbers, and certifications (see Section 601.1.2.1). To facilitate quality control, the structural concrete mix and its component materials should be supplied from the same source for a given concrete class and project. Consider the following additional guidelines:

1. Cement. Portland cement will be shipped from pretested and approved bins at the mill or distribution terminal. Pay particular attention to the length of time cement is stored. Storage periods longer than 90 days typically require retesting.

2. Bulk Storage. Check that bulk materials are stored in weatherproof bins. Also check that different materials and materials from different sources are stored separately.

3. Pozzolanic Additives. Ensure that pozzolanic additives are shipped from Division-approved sources. Pozzolanic additives typically should not be used in blended hydraulic cement.

4. Siliceous Sand. Unless otherwise directed, siliceous sand will be used as fine aggregate in bridge deck wearing surfaces. Verify compliance of material type and storage.

5. Air-Entraining Admixture. All classes of structural concrete are required to be air entrained. Ensure that the proper type of admixture is provided.

6. Water-Reducing Admixtures. Where used, verify that water-reducing admixtures are of the required type. Do not permit the use of water-reducing admixtures in conjunction with water-reducing retarders.

601.1.2.4 Formwork and Falsework Materials

Materials for formwork, falsework, and framework must be of sufficient rigidity to prevent settlement and distortion due to the pressure of concrete and other loads incidental to construction. Verify that all formwork materials comply with the provisions of the Contract by obtaining the appropriate shipping documents. Formwork materials must be in good repair and

of the required type and size for the project. Consider the following guidelines:

1. Form Lumber. Pay particular attention to the condition of form lumber. The faces of form panels must be dressed for the type of surface required. Lumber that is too dry will swell when it absorbs rainwater and the moisture from plastic concrete. Lumber that is too green or unseasoned will shrink and warp causing joints to open, difficulties in alignment, and uneven surfaces to develop.

2. Reuse of Form Lumber. Contractors frequently reuse wooden form panels. Split, frayed, and delaminated panels are unacceptable, and their reuse should not be permitted. Where panels are acceptable for reuse, verify that the Contractor cuts the sides and ends to provide a tight joint, thoroughly cleans the contact faces, and reapplies a fresh coat of release agent. Unless form liners are used, it is generally not good construction practice to mix new and old form panels, because doing so will usually result in a non-uniform surface texture.

3. Form Liners. Where form liners are used, verify that they are of an approved material type and surface finish before installation.

4. Steel Tie Rods. Check that steel tie rods and ancillary fasteners comply with the requirements of the Contract Plans and Specifications.

5. Steel Formwork. Rust-stained steel forms are unacceptable. Reject the use of bent, misaligned, pitted, rusted or otherwise damaged forms. Check that the proper type of bolts, rivets, clamps, and pins are provided to rigidly secure the formwork without damaging the concrete when the forms are removed. Bolts and rivet heads typically must be countersunk.

6. Stay-in-Place Forms. Where stay-in-place forms are used for bridge decks, verify that the forms comply with the Contractor's Fabrication Drawings. Stay-in-place forms must be galvanized and crimped. Reject the use of damaged forms.

7. Architectural Formwork. Review plans and specification requirements for specialized materials and/or items of work.

8. Release Agent. The release agent will be from a Division-approved source and must not bond with or stain concrete nor impede subsequent repairs, wetting, or curing of the finished concrete surface. Where steel forms are used, the release agent must be a rust inhibitor. Upon receipt of the manufacturer's literature from the Contractor, ensure that the manufacturer has certified that the release agent complies with the governing regulations on the use of volatile organic compounds.

601.1.3 Quality Control/Quality Assurance Considerations

601.1.3.1 Quality Control Plan

The Contractor is responsible for developing a Quality Control Plan in conformance with the requirements of MP 601.03.50. The Quality Control Plan should be submitted to the Project Engineer/Supervisor at the Pre-Construction Conference. Before work begins, verify that the Project Engineer/Supervisor has reviewed and accepted the Quality Control Plan.

During the project, verify that the Contractor operates within the Quality Control Plan and that the Contractor provides the necessary equipment and personnel for quality control. Check that at least one certified Portland Cement Concrete Technician is provided to direct the required field inspection, sampling, and testing duties and that such duties are performed by certified Portland Cement Concrete Inspectors. See Section 705 for additional information.

601.1.3.2 Quality Acceptance

The Project Engineer/Supervisor and Project Inspectors, as assigned, are responsible for quality acceptance. Use Section 601.4.4 and Table 601.3.1A of the **Standard Specifications** to evaluate acceptability based on compressive strength. The Contractor's quality control samples and tests may be used for acceptance, if previously authorized by the Project Engineer/Supervisor. Where nonconforming concrete is permitted to remain in place, remember to adjust payment based on the specified adjustment factor; otherwise, enforce the Contract provisions with respected to correcting the work. As needed, the Project Engineer/Supervisor may rely on other tests to further evaluate the acceptability of the work.

601.1.3.3 QC/QA Sampling and Testing

Quality control and quality assurance sampling and testing methods will be performed as specified in Section 601.4.1 of the **Standard Specifications** for sampling plastic concrete and aggregate materials, sieve and moisture analyses, and tests for slump, entrained air, unit weight, yield, and compressive strength. Note that slump tests should be delayed for approximately three to five minutes after mixing, when volumetric batching or continuous mixing processes are used. See Section 703 for additional information on sampling and testing.

601.1.4 Structural Concrete Mix Design

Before production begins, check that the Project Engineer/Supervisor has received and accepted the Contractor's Mix Design. The Mix Design will be developed in accordance with MP 711.03.23 and will document the mix proportions, including admixtures, that are necessary to meet the properties specified for the designated concrete class.

Concrete class and design strength will be designated on the Contract Plans. Pay particular attention to compressive strength requirements. If a "Modified" concrete class is designated, refer to the plans and special provisions.

During the project, verify that concrete production conforms to the Mix Design, and immediately notify the Project Engineer/ Supervisor of any suspected changes in materials. The Contractor is responsible for resubmitting a revised Mix Design if material type or source has been changed.

601.1.5 Formwork and Falsework Plans

601.1.5.1 General Considerations

The Contractor is responsible for the design and construction of all formwork, falsework, and framework. Unless otherwise stipulated for items such as stay-in-place and architectural formwork, the Contractor is generally not required to submit plans for formwork (refer to the plans and specifications when the submittal of drawings and/or calculations are required).

601.1.5.2 Stay-in-Place Forms for Bridge Decks

The Contractor will design the bridge deck forming system in conformance with the minimum requirements of Section 601.8.9 of the **Standard Specifications**, including form material, form sheet gage, design loads, unit working stresses, span lengths, deflections, and forming system changes. The Contractor will submit to the Division detailed Fabrication Drawings, which must be stamped by a West Virginia Professional Engineer. The Project Engineer/Supervisor will review the Fabrication Drawings for compliance with Contract requirements (e.g., PE stamp, service life of forms). The Project Inspector should become thoroughly familiar with the details of the drawings prior to the start of work.

601.1.6 Pour Sequence Plan for Concrete Structures

The Project Engineer/Supervisor will review the contract plans for pour sequence details.

601.1.7 Weather Considerations and Protection of Concrete

601.1.7.1 Requirements for Cold-Weather Concreting

When structural concrete work will occur during cold weather, verify that the Contractor has adequately addressed the requirements for cold-weather concreting. Enforce the Contract provisions for cold-weather concreting when the temperature of the plastic concrete falls below 55°F (13°C). Under such cases, the Contractor must provide adequate means of maintaining mix temperature between 50°F (10°C) and 85°F (30°C). Check that the mixing water and/or aggregates are properly and uniformly heated; however, do not permit heating above 150°F (65°C), because this will promote a false set of the concrete. Do not permit heating methods that will alter air entrainment, the use of live steam to heat the aggregates, nor the use of calcium chloride in the mix.

When the ambient temperature is expected to fall below 30°F (-1°C), check that the Contractor provides suitable means to maintain the concrete surface temperature between 50°F (10°C) and 90°F (32°C). Insulated forms, enclosures, heaters, and blanket coverings are generally used for this purpose. The concrete surface must be maintained above 35°F (2°C) during the curing period. Monitor the surface temperature for compliance, and record the readings on the Inspector's Daily Report. Do not count days on which the surface temperature falls below 50°F (10°C) as curing days. Where frost damage is evident, enforce the Contract provisions with respect to removal and replacement. Consider additional measures such as insulated forms, enclosures, heaters, straw blanketing or tarpaulins.

Special care must be taken to prevent overheating of the concrete, especially during seasons when the air temperature fluctuates greatly from day to day. Venting must be provided in the cold-weather protection to accommodate these rises in temperature. Additionally, after the curing period, ensure that the cold-weather protection is removed in such a manner that will not allow the temperature of the concrete surface to fall more than 20°F (11°C) in a 24 hour period.

601.1.7.2 Requirements for Hot-Weather Concreting

When structural concrete work is to be performed during hot weather, the Contractor is responsible for submitting a Hot-Weather Concreting Plan at the Pre-Construction Conference. The Plan must illustrate that the pour of the bridge deck will occur during days when it is most likely that the ambient temperature will be less than 85°F (30°C).

When the ambient temperature reaches 85°F (30°C), enforce the Contract provisions for hot-weather concreting. Monitor the temperature of the plastic concrete frequently. When the plastic concrete reaches 85°F (30°C), verify that the elapsed time between the introduction of water and the mix discharge does not exceed 1 hour. Concrete tends to set quickly during hot weather. When the temperature of the plastic concrete reaches 90°F (32°C), verify the proper use of retarders or cooling of the mix. The introduction of crushed or flaked ice in the mixing water or mixer is acceptable, as long as the water proportion in the mix is properly adjusted. Note that aggregates must be maintained in a saturated, surface-dry condition. Under no circumstance allow the Contractor to place concrete that exceeds 90°F (32°C) after mixing.

Hot, dry, and windy conditions tend to remove moisture from the concrete surface faster than it can be replaced by normal bleeding, which causes shrinkage cracking. This issue is especially important during the first 24 hours of curing. During hot-weather concreting, verify the application of curing material immediately after finishing. The concrete surface must be maintained in a moist condition throughout the entire curing period.

601.1.7.3 Concreting During Inclement Weather

Before the project starts, check that the Contractor is sufficiently prepared to protect the exposed surfaces of unhardened concrete from the effects of rain and running water. The washing effect of sudden showers and downpours will remove the cement component from these surfaces. If rain is imminent, inform the Contractor to halt work and immediately cover exposed unhardened surfaces. The finishing operation can continue as follows:

1. Brief Showers. If the shower is brief, the Contractor should immediately remove the protective covering to finish the surface.

2. Continuous Showers. During a continuous shower, the Contractor must repeatedly roll back the protective covering approximately 3 ft. (1 m) at a time, finish the surface, and replace the covering without marring the finished surface.

As soon as practical, inspect the surface for defects, and immediately inform the Contractor of any needed repairs. Note your findings and directives to the Contractor on the Inspector's Daily Report.

601.1.8 Preparation for Emergency Stoppage of Work

Ensure that the Contractor is adequately prepared to provide for emergency interruptions in the work. Construction joint locations should be planned well in advance of the concrete placement operation, and material for bulkheads and keyways should be readily available during the work.

As practical, individual sections of the structure should be completed without interruption; however, where work must be stopped, a construction joint should be provided. This prevents the formation of cold joints. If wall construction must be stopped before the forms are completely filled, verify that straight wood strips are nailed to the inside of forms to provide a neat line at the top edge of the concrete. Arches should be constructed according to the schedule on the Contract Plans, or as otherwise directed by the Bridge Engineer.

During construction, ensure that telltales are properly monitored by the Contractor to ensure that unacceptable movement or shifting of forms does not occur. Where unacceptable movement is observed, immediately inform the Contractor and Project Engineer/Supervisor. Appropriate corrective action must be taken.

601.2 MIX PRODUCTION AND HAULING

601.2.1 Overview

Proper inspection of production and hauling methods and equipment cannot be overemphasized. It is key to producing a quality structure. Project Inspectors in charge of production and acceptance must fully appreciate the linear nature of the project – from raw component materials to the final structure. Quality greatly depends on the attention given during each step. No amount of extra effort at the structure can compensate for errors and omissions at the mix site.

Before production, verify that production facilities have been properly inspected and certified by the Division. Become familiar with the equipment and operation, and check for obvious signs of unacceptable use or mechanical

condition. Verify that systematic and regular checks are conducted in accordance with WVDOH policy. Do not adjust production settings, scales, or meter proportioning equipment, because these tasks are the Contractor's responsibility.

601.2.2 Stockpiles and Material Bins

See Section 401.4.2.3 for information on proper aggregate stockpiling techniques. Check that bins are compartmentalized to positively separate different aggregate materials without spillage, intermingling, or contamination. Verify that a rapid means of sampling is provided as the aggregate passes from storage bin to weigh hopper or to conveyor feed. Ensure that bulk cement and fly ash, where used, are stored in separate bins that will prevent contamination and wetting. Dark clumps of cement material are a sign of previous wetting and may be grounds for rejection.

601.2.3 Aggregate Moisture Considerations

The Mix Design assumes latent moisture, so aggregates must be maintained in a saturated surface-dry condition. Excessively dry conditions may warrant wetting at night and sprinkling during the day, but the storage facility must be capable of draining the excess water. Verify that moisture tests are conducted as specified, and require additional testing as conditions warrant. Such monitoring is critical to maintaining the water-cement ratio within tolerance.

601.2.4 Scales and Automated Weighing Devices

Where bulk cement is used, ensure that a separate weigh hopper and scale are provided to proportion the cement material. Verify that the hopper is sealed to prevent dusting. Check that the discharge chute is maintained free of clogs and leaks and is not suspended from the weigh hopper.

Check all scales for proper certification, calibration, and accuracy. Ensure that the Contractor provides the required test weights. See Section 708.1 for additional information on checking batch proportioning scales. Where batch plants are equipped to proportion aggregate and bulk cement materials by means of automatic weighing devices, check to ensure they are of an approved type, properly calibrated, and in good working order.

601.2.5 Water and Admixture Dispensers

Verify that water proportioning devices have been properly checked and calibrated (i.e., by volume or weight). Such devices must be capable of proportioning water to within 1% of the actual quantity required for each batch. See Section 708.2.2 for additional information.

Verify that admixture dispensers are of an approved type and provide a positive, automatic method of proportioning the admixture solution. See Section 708.2.3 for information on checking the accuracy of admixture dispensers.

601.2.6 Concrete Mixers and Agitators

Depending on the type of production method, many types of mixers and agitators may be used, including site and central mixers, volumetric mixers, truck mixers, truck agitators, and non-agitator trucks. Where central mixers are used, ensure they are equipped with a properly calibrated mix timer and discharge locking system. If the device fails, it is permissible to manually control the batch mixing period while repairs are being made. Verify that mixers, regardless of type, are cleaned at suitable intervals. Check pickup and throw-over blades for unacceptable wear, and enforce the Contract provisions with respect to repair and replacement. See Section 501.2.4.2 for addi-

tional information on mixer performance and maintenance.

601.2.7 Ready-Mix Concrete

Ready-mixed concrete will be either central-mixed, truck-mixed, or shrink-mixed as specified in the Contract and defined in Section 601.7 of the **Standard Specifications**. Note that shrink-mixed concrete is partially mixed in a central plant and then a truck mixer is used to finish the mixing (i.e., in transit to or at the job site). Shrink-mixed concrete is generally only permitted if expressly provided for in the Contract.

601.2.8 Volumetric Batch and Continuous Mixing Operations

Concrete produced in volumetric batching and continuous mixing operations is permitted for incidental construction items; however, it is not permitted for use in bridge, box culvert, pavement, and retaining wall construction.

601.2.9 Concrete Hauling Operations

Where truck mixers or agitators are used for transport, pay particular attention to haul time. The maximum elapsed time at discharge, after the cement is introduced to the aggregate, is 1.5 hours. Use 1 hour, maximum, where the concrete temperature exceeds 85°F (30°C). Where a truck mixer is the only means provided for mixing, verify that the mixing operation begins within 1 hour of adding the cement. Pay particular attention to evidence of segregation. Segregation will cause honeycombing, rock pockets, and shrinkage cracks. Reject non-conforming batches. Upon delivery of each batch, check the accompanying Form 411A (i.e., batch ticket) for complete and accurate information. Update the Inspector's Daily Report, and retain all batch tickets for the project files.

601.3 MIX PROPORTIONING AND ADJUSTMENT

601.3.1 Characteristics of Plastic Concrete

Structural concrete is considered to be in the plastic state during the period from when water is introduced to the cement during mixing to just before the concrete begins to set. Two concrete characteristics need to be closely monitored during this period: consistency and workability, which are discussed in the following Sections.

601.3.1.1 Concrete Consistency

Consistency of plastic concrete is a measure of the ability of a concrete mix to flow sluggishly without crumbling or segregating. It is usually specified and measured in inches (millimeters) of slump. Consistency requirements differ from application to application. For example, the consistency of a concrete mix required for a massive but lightly reinforced concrete structure will differ significantly from that required for a heavily reinforced concrete structure that is to be placed in formwork, which is difficult to access. Consistency should be uniform from batch to batch; otherwise, the water content will vary throughout the concrete in the structure. This non-uniform distribution of water will create an uneven surface finish and shrinkage cracking, especially on dry, hot, and windy days. Proper control over mix consistency and the timely curing of the concrete will usually minimize these problems.

601.3.1.2 Concrete Workability

Workability is a subjective rating that reflects the ease or difficulty of placing, consolidating, forming, and finishing a concrete mix. It is influenced by aggregate type and gradation, mix proportioning, air entrainment, and consistency. Workability greatly affects the quality of the finished concrete surface and, ultimately, its acceptability. Concrete that is difficult to work

with will invariably cause defects in the finished surface.

601.3.1.3 Segregation and Bleeding

Plastic concrete can segregate and bleed, which are undesirable conditions. A well-proportioned mix should be homogeneous with all components uniformly distributed as the concrete hardens. Segregation occurs when the coarse aggregate separates from the mortar (i.e., fine aggregate, cement, water) and can be caused by a poorly proportioned mix, improper handling and placing techniques, and excessive vibration during consolidation. Bleeding is the appearance of excess quantities of mix water on the finished surface of bridge decks and other horizontal surfaces and is caused by the use of too much water in a poorly proportioned mix. The mix water is forced to the surface as the heavier components settle. This bleeding problem can be exacerbated by excessive vibration during consolidation. Bleeding will weaken the concrete surface if finishing is not delayed until the bleed water has depleted. A lower water-cement ratio and the use of entrained air in the mix will virtually eliminate bleeding, as long as the mix is not overly vibrated.

601.3.2 Characteristics of Hardened Concrete

601.3.2.1 Compressive Strength of Concrete

Different classes of structural concrete will be designated for different applications, and each concrete class will have a minimum compressive strength requirement. Compressive strength is a primary indicator of acceptability; however, it is not the only factor that should be considered. It is measured by breaking 28-day old concrete test specimens under a compressive load. The compressive strength of concrete is primarily affected by water-cement ratio and curing method. A relatively low water-cement ratio will produce a relatively high-strength concrete. The converse is also true.

601.3.2.2 Wear Resistance of Concrete Surfaces

A wear-resistant concrete is needed for structural elements such as bridge decks, which are normally subjected to wear by studded tires, chains, cinders, and other abrasive materials. The degree of wear resistance is directly related to the compressive strength of the concrete. The higher the compressive strength, the greater its wear resistance will be.

601.3.2.3 Concrete Durability

A durable concrete will resist scaling and spalling, which are detrimental conditions caused by freeze-thaw cycles and de-icing chemicals. Experience and research has shown that concrete durability has a greater influence than compressive strength in mitigating scaling and spalling. High-strength concrete with a low water-cement ratio will not necessarily result in a durable concrete. To provide a durable concrete, the mix must incorporate the specified total air content (i.e., entrapped plus entrained), no more than the maximum specified water-cement ratio, and no less than the minimum specified cement content.

601.3.2.4 Permeability of Concrete

Permeability must be considered where structural concrete will be exposed to water, such as in piers, abutments, bridge decks, box culverts, and retaining walls. Concrete used in such applications must be relatively watertight (i.e., less permeable). To ensure a watertight concrete, the mix must incorporate the specified water-cement ratio and total air content.

601.3.3 Field Testing and Concrete Mix Adjustments

During the project, ensure that the Contractor proportions aggregate, cement, water, and admixture materials in compliance with the Mix

Design. It is good inspection practice to become familiar with the Mix Design, including control charts, mix proportions, and methods of determining scale weights and batch quantities. Note that scales and proportioning equipment must be inspected and certified before the operation begins.

601.3.3.1 Field Laboratory

Prior to production, verify that the Contractor has provided and furnished the field laboratory as required by Section 501.5.1 of the **Standard Specifications**. See Section 501.2.6.1 for additional guidance.

601.3.3.2 Adjusting Concrete Mix Consistency

Uniform consistency is necessary for the proper placement and consolidation of structural concrete. Use Table 601.3.2 in the **Standard Specifications** to check that concrete consistency is uniformly maintained for the structure. Superplasticizers (e.g., Type F, Type G) are frequently used to improve consistency. Where used, obtain from the Contractor the required Statement of Compliance from the admixture manufacturer. Verify that the quantity of superplasticizer used per batch (i.e., field or batch plant) does not exceed that recommended by the manufacturer. Check the speed and time of mixing superplasticized concrete for conformance to specified requirements. Under no circumstance allow slump to exceed 8 inches (200 mm). After mixing, perform the required acceptance tests (e.g., slump, air content, compressive strength). Document the results in the Inspector's Daily Report.

601.3.3.3 Adding Water to Concrete Batches

The addition of water to a batch is generally not permitted; however, where truck mixers are used, there may be instances where water needs to be added to adjust concrete consistency. In such cases, verify that at least 20 additional drum revolutions at mixing speed is performed before the concrete is discharged. Reject concrete batches that fail to meet specified consistency requirements.

601.3.3.4 Adjusting Air Content in Concrete Batches

Check entrained air of batches at the point of placement based on the specified schedule for measurement. Ensure that immediate corrective adjustments are made to the batching process if entrained air is not within plus or minus 2.5% of the target value (see Table 601.3.1 **Standard Specifications)**. Greater than 3.0% is grounds for rejection. Where truck mixers are used, acceptance will be based on the criteria and conditions established in the Contract.

601.3.3.5 Adjusting Concrete Mix Yield

Immediately after consistency and entrained air have been established, determine the average unit weight and actual yield as specified. Ensure that the design mix is adjusted and maintained to correspond to the theoretical yield. As work progresses, make yield checks in the manner prescribed to ensure it is maintained within the required tolerance. If needed, enforce the Contract provisions to adjust other design mix proportions to maintain the concrete in a plastic, workable mix with suitable finishing characteristics. Do not allow changes in the brands or sources of component materials without prior approval from the Project Engineer/Supervisor.

601.3.3.6 Adjusting "Total Solids A" in Concrete Batches

Check that the combined grading of coarse aggregate, fine aggregate, and cement used in the structural concrete conforms to the design mix "Total Solids A" plus or minus the allowable tolerance specified in Table 601.3.2.4

of the **Standard Specifications**. Verify that the Contractor determines the grading of total solids at the specified frequency. Enforce the provisions of the Contract with respect to halting production and requiring proper corrective action if the moving average of test results is not within allowable tolerance.

601.4 PRE-POUR OPERATIONS

601.4.1 Formwork and Falsework

601.4.1.1 General Considerations

Formwork and supporting falsework for structural concrete projects must provide a mortartight enclosure that will minimize distortion due to the pressures, loads, and vibrations generated during the operation. Consider the following guidelines:

1. Chamfer Strips. If untreated, the corners of forms will produce sharp, weak edges on structural concrete members. Additionally, it is difficult for the concrete to completely fill the corners of forms, which results in non-uniform edges and corners. To minimize such defects, the corners of forms must be beveled, filleted, and chamfered. Where chamfer strips are used, check to ensure that the strip is of the required size. In addition, verify that forms are filleted where required and that they are provided with a bevel or draft at projections for easy removal.

2. Cleanouts. Where needed, check that the Contractor provides a suitable means of cleaning extraneous material from the bottom of formwork. This is especially important where forms are used for deep, narrow structural members. To facilitate removal of dirt and debris, the bottom of the formwork is usually provided with a removable panel or window. The bottoms of forms must be cleaned and inspected prior to the concrete pour.

3. Welding Considerations. Where welding is required, verify that welder's have been certified in accordance with the provisions of the Contract. Under no circumstance allow the welding of form ties, form supports, or screed rail supports to the beams.

4. Falsework Considerations. Elevated horizontal structural members such as beams, roof slabs for box culverts, and some bridge decks will be supported by falsework. The Contractor is responsible for the design and construction of all falsework (see Section 601.1.5). Falsework must be sufficiently rigid to support the concrete without appreciable settlement or deformation of the forms. Vertical posts are generally used to support joists and formwork. Each post will be set on a piece of timber called a mudsill. To prevent settlement, the area of the mudsill must be of sufficient size to ensure adequate bearing support from the soil. Verify that jacks and wedges are used to maintain form elevation and permit form removal without damaging the structure. Periodically observe the Contractor's tell-tales for obvious signs of unacceptable settlement or movement and, as needed, require immediate corrective action.

601.4.1.2 Beam and Arch Formwork

The formwork and framework for beams and arches must accommodate the tendency of the form and the final structural member to sag at the center of its span. This tendency to sag occurs both during the pour, due to the weight of the plastic concrete, and after the form has been removed, due to the weight of the structural member itself (i.e., dead load deflection). To offset this tendency to sag, the framework provided at the center of the span must elevate the form higher than its intended final elevation. This treatment is called cambering. The framework will generally consist of supports, strike wedges, sand boxes, and jacks. Where vertical post supports are used, verify that they are

placed on mudsills of sufficient size to minimize settlement.

The amount of cambering must be sufficient to offset the dead load deflection of the member once the forms have been removed. In addition, the framework that the Contractor uses to provide the cambering must be constructed to allow the gradual removal of the center supports. This will allow the hardened beam or arch member to change its shape slowly, thus minimizing sudden stresses and strains in the structural member. The Contractor's Formwork Plan will provide cambering and formwork removal details, including structural data and analyses (see Section 601.1.5). If the Contractor's methods are questionable, immediately notify the Project Engineer/Supervisor.

601.4.1.3 Bridge Deck Formwork

It is important to carefully monitor all bridge deck construction phases, including: installation and fastening of forms; placement and fastening of reinforcing bars; and delivery, placement, consolidation, and finishing of the concrete. Unless otherwise directed, stay-in-place fabricated metal forms will be used to construct all interior bays of beams in concrete bridge decks. Removable forms will be used for overhangs and where longitudinal expansion joints are located between stringers.

Check that stay-in-place forms are installed in compliance with the Contractor's Fabrication Plans (see Section 601.1.5). Verify that the forms are securely fastened to their supports and that the length of bearing at each end is at least 1″ (25 mm). Check form supports to ensure they are placed in direct contact with the flange of stringers or floor beams and that the bolts and clip attachments are secure. Do not walk on forms until they have been securely fastened. Do not allow welding of form supports to the tops of flanges. Check for damage to the forms' galvanized coating and required repair work where needed, and ensure that the forms do not interfere with transverse joints and weep holes, where provided.

Just prior to concrete placement, verify the location of each abutment and pier, check the horizontal and vertical clearance at various points along the structure, and check form alignment and grade for compliance, especially the grade lines for parapets, wheel guards, "V" grooving, and other exposed edges. These checks are generally performed using a surveying transit and level, stringline, tape rule, and plumb bob. "Eyeing in" is acceptable for minor adjustments to grade lines. Check the camber provided for beams and arches. If the amount of camber is not shown on the Plans, contact the Project Engineer/Supervisor for assistance. Pay particular attention to the method of forming deck overhang areas beyond outside girders. These areas are extremely critical due to their cantilever construction. The Contractor is responsible for all overhang calculations and calculations for determining jack size and spacing. If discrepancies are found, notify the Project Engineer/Supervisor.

601.4.1.4 Architectural Formwork

Architectural formwork will be used where designated on the Contract Plans for cast-in-place structural concrete. Check for misaligned forms, open joints, and work that is not level or out of plumb, and verify that openings, offsets, keyways, recesses, chamfers, blocking, screeds, and bulkheads are provided where required. Enforce the Contract provisions with respect to needed corrections. In general, architectural formwork should be assembled so that it can be removed without damaging the exposed concrete surface.

During assembly, check that panels are solidly butted together and that backup material is provided to minimize mortar leaks and the creation of fins. In addition, unless otherwise designated, verify that forms are assembled to provide sharp, clean corners with no visible

edges or offsets and that chamfered corners are provided where specified.

Where the interior of formwork will be inaccessible, verify that the Contractor provides temporary form openings so that the bottom of the formwork can be cleaned and inspected before the concrete pour. The location of these openings should be inconspicuous.

The drilling of form panels is typically required to accommodate form ties. Observe this operation to ensure that panels are drilled from the contact side. Any splintering of the contact side will appear in the exposed face of the concrete once the forms are removed. In addition, check that the diameter of the drilled hole matches that of the form tie. If too large, mortar leaks will occur, and if too small, the tie will need to be driven through the panel, which will generally splinter the panel.

601.4.1.5 Formwork for Concrete Walls

Forms for concrete walls are generally supported by studs and wales, with form panels for the faces of the wall being separated at the proper distance by metal tie rods and wooden spreaders. The tie rods remain within the concrete; however, the spreaders must be removed during the pour. The protruding ends of the rods will be cut off after the concrete has hardened. Where cut, check that any damage to the concrete surface has been properly repaired.

601.4.1.6 Formwork for Parapet Walls and Median Barriers

Contractors will typically use slip forming for structural concrete items such as parapet walls and median barriers. Where slip forming is used, pay particular attention to the joint construction operation. Unless otherwise directed, joints may be either formed or sawed. The joint spacing will be designated on the Contract Plans. Where joints are sawed, review the requirements of Section 601.8.8 of the **Standard Specifications**. The timing of initial sawing must be sufficient to prevent uncontrolled cracking. In addition, check compliance of joint width, depth and length along the face, and verify the proper sealing and installation of back-up material.

601.4.1.7 Form Cleaning

Once the forms have been erected but before the reinforcing steel is placed, check to ensure that all extraneous dirt and debris have been removed from the bottoms of forms. The surfaces of forms should be cleaned and soaked with a steam jet or a stream of hot water. During cold weather, monitor the inside of forms for ice formation.

601.4.1.8 Application of Release Agent

To break the bond between concrete and formwork, check that form surfaces are thoroughly coated with an approved release agent. This operation must be performed before the reinforcing steel is placed. If the release agent is spilled or sprayed on reinforcing steel, require cleaning of the reinforcing steel prior to pouring the concrete. The method and rate of application should be in conformance with that recommended by the manufacturer. Form surfaces that are not coated with release agent should be thoroughly wetted.

601.4.2 Placement of Reinforcing Steel

Check the size, location, spacing, and clearance of reinforcing steel for conformance to the requirements of the Contract Plans. Pay particular attention to the method of tying and fastening. Ensure that the minimum concrete cover requirements are not exceeded.

Great care should be exercised in ascertaining that the reinforcing steel is properly located, spaced, and tied. Pay particular attention to bar bending details and the placement of bent bars to ensure that the required slab depth and specified

minimum concrete cover at ends, edges, and the top and bottom of the slab are provided. In addition, closely examine reinforcing steel just prior to concrete placement for signs of damage to epoxy coating and any material on the bars that would prevent the proper bonding of the concrete to the steel. Require repair or restoration work where required.

For bridge decks constructed with stay-in-place formwork, check that the bottom layer of reinforcing bars are placed at least 1″ (25 mm) from the bottom of the deck slab. Also check that the distance from the bottom layer of reinforcing bars to the top of the deck slab does not exceed that shown on the Contract Plans.

601.4.3 Inspection of Embedded Fixtures

The Project Inspector should make certain that all embedded fixtures are in their correct position and solidly fastened. If wood inserts are used, they must be soaked in water for at least 24 hours prior to being placed in the forms. After all reinforcing steel has been placed, check that the tubes or inserts required for weep holes have not been displaced. Ensure that all required drainage has been properly installed and that no water will be trapped after the structure has been completed.

601.4.4 Joint Considerations

601.4.4.1 Expansion Joints

Each expansion joint must be located as shown on the Contract Plans. The joint must be straight and at right angles to the forms, and care must be taken to prevent concrete from bridging the space left for expansion and contraction. Sliding joints should be lubricated to ensure movement after the concrete has hardened. Where a bridge deck is constructed with a concrete wearing surface, ensure that the expansion joints in the wearing surface are installed at the same location as the joints in the deck slab, curbs, and wheel guards.

601.4.4.2 Construction Joints

A roughened concrete surface at a construction joint does not provide sufficient bonding. Therefore, dowel bars and keyways are required. Verify that the dimensions and placement of keyway forms and dowel bars conform to the requirements of the Contract Plans. Horizontal or vertical construction joints must be constructed in accordance with the requirements of Section 601 of the **Standard Specifications**. Where a vertical joint is constructed on an exposed face, verify that a chamfered strip is placed where the bulkhead meets the form face. This will enhance appearance and prevent concrete spalling.

An unexpected delay in the placement of the concrete may necessitate the installation of a construction joint. In such cases, the Project Engineer/Supervisor is responsible for approving the location of the joint. Depending on the approved location, the Contractor may be required to remove previously placed concrete. Carefully observe the installation operation to ensure that the new concrete will properly bond with the old concrete. To achieve a positive bond, verify that the Contractor thoroughly cleans the stub ends of reinforcing bars that extend through the joints, thoroughly clean the surface of hardened concrete with a stiff wire brush to expose the aggregate and remove foreign material and laitance, and moistens the hardened concrete just prior to placing the new concrete.

601.4.5 General Equipment Inspection

Verify that the Contractor has on hand all equipment necessary for the concrete placement operation. Pay particular attention to the acceptability of the type, quantity, and condition of the equipment. Tools for spreading the concrete must have handles long enough to reach all parts of the forms, and the vibrators must be checked to ensure they meet specified requirements and are in good working condition.

Extra vibrators must be on hand in the event of equipment failure.

Unless otherwise specified, concrete for bridge decks will be placed and finished using a self-propelled machine equipped with automated controls. Prior to placement, verify that the Project Engineer/Supervisor has reviewed and accepted the Contractor's proposed equipment and that the equipment has been properly calibrated and checked during dry runs.

601.4.6 Screed Rail and Screed Inspection

The Project Inspector must pay particular attention to how the Contractor sets the elevations of screed rails and end dams. As the concrete is placed, the beams and girders supporting the deck will deflect; and, unless the Contractor takes this deflection into account, the deck surface will deviate from the required profile and produce a non-uniform slab thickness and rough riding surface. The Contract Plans will provide grade elevations at various locations along the profile to account for this deflection. These elevations must be used when setting screed rail elevations to ensure that sufficient camber is provided in the slab. The tops of stringers are generally used as a baseline.

Screed rails should be held in place by fixed supports that are adjustable for height and easily removed after screeding. The supports should be located in a staggered arrangement (i.e., the supports on one side of the roadway should coincide with the midpoints of spaces between the supports on the other side). The spacing between supports should generally not exceed 5′ (1.5 m) to adequately support the load of the finishing machine without bending the rails.

To check the camber in the screed rails, use a surveyor's level to obtain elevation readings at various points along the top of the rail. Plot these points on an exaggerated vertical scale to verify that they lie on a smooth curve at the proper grade. Ensure that any high or low points are properly adjusted to correct grade. Additional checks can be made by sighting along the top of the rail.

Check all screeding surfaces for straightness and proper cross section. If the finishing machine will ride above the pavement surface, check the screeds in the down position to ensure they are adjusted to the proper profile and cross section.

When the bridge is on a heavy skew angle, consider setting the machine parallel to the skew and refer to the manufacturer's specifications.

601.4.7 End Dam and Bulkhead Inspection

End dams must be secured firmly to maintain proper elevation and to ensure that the check plate will remain parallel with the roadway surface during concrete placement.

Stretch a stringline from the stake to the point on the stringer, ensuring that the stringline is at or parallel above grade at both points.

Compare the grade and alignment of the expansion plate with that of the stringline. Enforce the provisions of the Contract with respect to any needed adjustments.

If the deck is to be poured in sections, ensure that bulkheads are readily available. Check bulkheads for proper fit and dimensions.

601.4.8 Inspecting Height of Reinforcing Steel

After screed rails, end dams and bulk heads are set, the Project Inspector should check the height of reinforcing steel and all clearances between the screed and the reinforcing steel by means of a dry run.

601.5 PLACEMENT AND CONSOLIDATION OPERATIONS

Pay particular attention to evidence of mix segregation and displacement of reinforcing

steel during the pour and require immediate corrective action. Also watch for any unnecessary jarring of forms or movement of projecting reinforcing steel. In multi-stage pours, ensure that all laitance is removed from the surface of the previous pour and that reinforcing bars are cleaned of all splatter. The top surface of plastic concrete in the formwork must be kept nearly level.

601.5.1 Mix Segregation

Segregation of the coarse aggregate will cause honeycombing of the concrete surface, rock pockets, and shrinkage cracks to occur. Pay particular attention to the method used to place and consolidate the concrete. Allowing the mix to fall from an excessive height and excessively vibrating the concrete during consolidation promotes mix segregation.

601.5.2 Use of Chutes and Troughs

Do not permit concrete to be dropped from a distance greater than 5′ (1.5 m) without the use of a tremie, elephant trunk, closed chute, or pipe. Do not allow the use of aluminum chutes or troughs. A chemical reaction between the aluminum and lime materials will cause an uncontrolled increase in entrained air, which will reduce concrete strength.

If concrete is placed using a steeply sloped chute, verify the proper use of baffling at the discharge end of the chute. The baffle should be designed to direct the concrete straight down to minimize segregation.

A chute must have a rounded metal bottom that is clean and smooth on the inside. If the concrete will not move on its own, it must be pushed down the chute with shovels. Extra water should never be added to the concrete mix for the purpose of making it slide down the chute. After each run, ensure that water is used to flush out and discharge residual material outside the formwork.

601.5.3 Pumping of Concrete

If the Contractor chooses to use equipment to pump the concrete into position, emphasize to the Contractor that the specified slump must be maintained and that adding excessive water to the mix for the purpose of facilitating pumping is unacceptable. Prior to pumping the concrete mix, ensure that the Contractor lubricates the line.

601.5.4 Protection of Reinforcing Steel

Where concrete is placed in deep formwork, care must be exercised to protect the reinforcing steel above the elevation of placement from movement and concrete splatter. This is especially important where a structural element is placed in sections one on top of the other. Mortar that splashes and dries on the bars that are to be covered by a subsequent pour will inhibit the concrete from bonding with the steel. The use of tremies, elephant trunks, or windows in the formwork are generally used to minimize bar movement and splatter.

601.5.5 Placement of Concrete in Bridge Deck Formwork

To minimize problems during placement and finishing of a bridge deck and to ensure a smooth riding surface, concrete that is delivered to the site must be uniform in composition, workability and consistency. Variations in any of these factors may produce undulations in the surface during the screeding operation. There should be a small amount of concrete on the surface that is to be struck off by the finishing screed. Too much of a roll or too stiff of a mix in front of the finishing screed will produce a high spot, and too little of a roll will produce a low spot. The use of manual labor to continually adjust the amount of concrete rolled in front of the finishing screed is undesirable.

Where stay-in-place forms are used, concrete must completely fill the forms and be vibrated

sufficiently to ensure consolidation without producing honeycomb or voids at construction joints, expansion joints, flutes, or the ends of the form sheets. During placement, ensure that the concrete is properly vibrated around reinforcing steel, joints, and in the corners of forms. Vibrating screeds will not accomplish this task. Require corrective adjustments to the operation or to the concrete mix if any of these conditions become problematic.

To facilitate finishing under hot, dry, and windy conditions, the Project Engineer/Supervisor may authorize the use of a compressed-air fog spray. Water must never be sprinkled, thrown, or brushed onto the surface of the plastic concrete for the purpose of finishing. This will weaken the wearing surface of the deck slab. Monitor this operation closely.

If the Contract Plans call for a deck pouring sequence requiring construction joints, the sequence must be followed precisely to account for beam deflection. Note that the first batch placed in a section between construction joints must be maintained in its plastic state until the last batch for the section has been poured. During hot weather, a retarder that conforms with the contract specifications is generally added to the mix for this purpose.

601.5.6 Placement of Concrete in Architectural Formwork

Immediately before the concrete is placed, verify that the Contractor has performed a final check of the lines, elevations, and stability of the erected formwork and completed any needed adjustments. During the pour, ensure that the Contractor monitors forms and supports, using telltales or other suitable means, and takes immediate action to correct any undesirable movement. Watch for mortar leaks.

601.5.7 Placement of Concrete in Parapets

Slip forming is generally used for concrete parapets and median barriers. Where forms are used, concrete should be placed in the same manner as required for other structural elements. The concrete in the parapet must be spaded or vibrated to ensure a uniform surface texture.

601.5.8 Placement of Concrete Under Water

It is sometimes necessary to place concrete under water; however, an adjusted concrete mix and special placement techniques must be employed. The pumping operation itself may create a flow of water within the forms. In such cases, temporarily discontinue the pumping operation. Verify that a tremie or closed-bottom dump bucket is used to deposit the concrete in a compact mass in its final position.

601.5.9 Vibration and Consolidation of Concrete

Fresh concrete must be spaded and vibrated to force coarse aggregate away from the surface of the forms and allow entrapped air and free water to come to the surface. The Project Inspector is responsible for checking that approved spades and mechanical vibrators are provided and that the proper consolidation techniques are being employed.

601.5.9.1 Spading Considerations

A spade is typically used to push coarse aggregate away from the form and to remove air bubbles that would show up later as shallow holes on the concrete surface. If the proper quantity of mix water is used and the concrete is mixed, placed, and spaded properly, very little free water will bleed to the surface.

Excessive bleed water must be removed from the surface; and if it becomes problematic, the mix may need adjusting (e.g., reducing mix

water, adjusting aggregate gradation). If bleed water is allowed to remain on the surface, a scum of thin soupy mortar (i.e., laitance) will form. If allowed to harden, this laitance will produce a very weak surface finish that will wear and spall easily. To prevent laitance from forming, the Contractor should overfill the forms and strike off the excess mix after bleeding has stopped.

Where plywood forms are used, or where pressed-wood or metal liners are used with ordinary lumber, the forms often are so tight that it is difficult to remove air bubbles by spading. In such cases, extra care must be taken to place and thoroughly vibrate the concrete in shallow lifts.

601.5.9.2 Use of Vibrators

After concrete is placed in the formwork, it must be properly and thoroughly consolidated. The purpose of using vibrators is to temporarily liquefy the concrete so that entrapped air and water can bleed from the surface. Internal spud vibrators that have a vibrating spud at the end of a long flexible shaft are generally used for this purpose. See Section 501.4.3 for acceptable types and frequency and amplitude settings.

Pay particular attention to the operation of spud vibrators. The spuds must be worked around all reinforcing steel, joints, and angles of forms without coming into direct contact with these features, and the spud must not be left in place too long or dragged through the mix; otherwise, the mix will segregate. When air bubbles stop coming to the surface of the concrete and the surface of the mix around the spud starts to look shiny, the spud should be pulled out and moved to a new position approximately 24″ (600 mm) away. Proper vibration should change the appearance of the surface of the mix for about 18″ (450 mm) in all directions around the spud. Once hardened, the surface of the concrete will have a smooth appearance if the mix is properly vibrated in the forms.

Vibration produces great pressure on forms, and the form material must be sufficiently strong to withstand this additional pressure. When a thin wall section is filled with stiff concrete and the concrete is vibrated, the pressure on the forms may be high enough to spread the forms apart. On a high wall, the rate of concrete placement, measured in terms of rise of concrete per hour, should be monitored as directed by the Project Engineer/Supervisor.

601.6 FINISHING AND CURING OPERATIONS

601.6.1 Form Removal

The Project Inspector must check the method of removing forms to ensure that the concrete is not weakened or damaged in any way. Special care should be used in removing arch forms or forms from the bottoms of beams. These forms should be removed slowly and carefully to prevent sudden unbalanced loads that could damage the concrete or weaken the bond between the concrete and the steel reinforcement.

601.6.1.1 Compressive Strength Considerations

Table 601.8.7 of the **Standard Specifications** presents the minimum compressive strength criteria for removing formwork and falsework and for constructing superimposed structural concrete elements. Any alternate method may be submitted by the Contractor for review. Check that the Contractor makes and monitors compressive test specimens to maintain the operation within specified limits. Otherwise, damage and overstressing of concrete elements may occur.

601.6.1.2 Raising Column Forms

Column forms must not be raised prior to the concrete column achieving the minimum compressive strength criteria presented in Table

601.8.7 of the **Standard Specifications**. After the forms are raised, holes or voids in the surface of the column must be filled with cement mortar in accordance with specified requirements. If a serious defect is found, the Project Inspector should bring the condition to the attention of the Project Engineer/Supervisor.

601.6.1.3 Stay-in-Place Bridge Deck Forms

The Division requires sections of stay-in-pace bridge deck forms to be removed for visual inspection and evidence of acceptability. The Project Engineer/Supervisor will select the times and locations for form removal. To check concrete soundness and bonding, the Project Engineer/Supervisor will also perform sounding tests at the frequency and locations specified in the Contract and, where suspect, may require additional sections to be removed.

If cavities, honeycombing, or other defects are found that, in the opinion of the Project Engineer/Supervisor, do not warrant replacement, ensure that the concrete surface is repaired and finished in accordance with the requirements for a Class 1 – Ordinary Surface Finish. If rejection is warranted, form sections will be removed, as needed, to properly repair the bridge deck, and immediate adjustments will be made to the Contractor's operations. Where forms have been removed, inspect adjacent forms and supports to ensure that they have not been damaged. Forms that have been removed do not need replaced.

601.6.1.4 Removal of Architectural Formwork

During form removal, check to ensure that crush plates are used where needed to prevent damage to the final concrete surface. Do not allow workers to hammer or pry the final concrete surface for the purpose of removing forms.

601.6.2 Removal of Form Ties

Holes left by the removal of form ties should be packed with mortar having the same proportions of cement and sand as the mortar of the concrete. The mortar should be tamped into the holes and kept moist on the surface until the concrete has cured.

601.6.3 Plugging Holes for Anchor Bolts

Where anchor bolts are required in a bridge seat, the Contract Plans will show where the holes will be located. In cold weather, if the holes are left open, the concrete may be damaged if they fill with water and freeze. If placement of the anchor bolts is to be delayed until cold weather arrives, all water must be removed from the holes and they must be tightly sealed preferably with rubber stoppers. If wooden stoppers or plugs are used, they must be waterproofed by being heated in metal paraffin until no air bubbles rise to the surface and the pores of the wood are sealed with wax.

601.6.4 Finishing Concrete Surfaces

Concrete surfaces must be given a finish, as required by the Contact Plans and Specification. Bearing areas of concrete surfaces of substructures, upon which column bases, bearing shoes of girders and trusses, and similar parts will be placed, must be built to provide full and uniform bearing at plan elevation.

601.6.4.1 Classes of Concrete Surface Finish

Bridge parapets, wingwalls, and headwalls are generally given a Class 2 – Rubbed Finish; however, if the Contractor elects to use the optional Class 1 – Ordinary Surface Finish, ensure that the supplemental wood-float rubbing is performed as specified. Other concrete surfaces, including concrete classes designated as architectural, will receive a Class 1 – Ordinary Surface Finish. Horizontal surfaces,

other than bridge decks, will receive a Class 6 – Float Finish. Bridge decks will be finished as defined in Section 601.11 of the **Standard Specifications**.

601.6.4.2 Bridge Deck Surface Finishing

The finishing machine or vibrating screed should be moved at a slow, uniform rate. The screed should always be carrying a uniform roll of concrete across its full width. The distance from the surface to the top of the reinforcing steel and the depth of the slab should be checked frequently. In general, the addition of water to assist in finishing concrete is undesirable, because it tends to weaken the concrete wearing surface. However, the Division recognizes that hot, dry, and windy conditions may promote rapid drying and shrinkage cracking. In such cases, an atomized mist may be used to minimize rapid evaporation of surface during the final finishing operation.

After screeding and consolidating the concrete, the screed rails and their supports must be removed without disturbing the concrete surface. Holes left after their removal must be filled with fresh concrete, and not with mortar or the concrete screeded off the surface. Check the surface trueness of the plastic concrete for acceptability using the Contractor-provided straightedge and the procedures defined in the contract specifications. Require high or low areas not within tolerance to be immediately repaired. After the initial straightedge testing and repair work have been completed, the surface should be smoothed with a lute or smoothing float and retested with a straightedge as specified. Ensure that the finished surface is free from observable departures from the straightedge. The final finishing operation should be delayed only long enough to allow the concrete to bleed, shrink, and begin to set.

After the secondary straightedging, check that the surface of the concrete is given a groove finish that meets the specified pattern and dimensions. Pay particular attention to the timing of the grooving operation. Excessive raveling will occur when the concrete is too dry and the mortar will flow back into the grooves when the concrete is too wet. To facilitate drainage, ensure that the 12″ (300 mm) width immediately adjacent to the curbline is left untextured. After curing, use a rolling straightedge to further test surface trueness for compliance. Where high spots are found, the Project Engineer/Supervisor will make the final determination as to the disposition and method of repair or replacement of the area. After the final surface finishing is completed, ensure that an approved curing material is applied to the slab as soon as practical without marring the textured surface.

When the Contract Plans designate the placement of a specialized concrete overlay on a newly placed concrete bridge deck, as defined in Section 679 of the **Standard Specifications**, check to ensure that the surface of the newly placed concrete bridge deck is intentionally roughened. The surface shall be raked and roughened to provide a surface profile that will facilitate the bond of the specialized concrete overlay. Floating should be minimized to avoid the formation of bleed water on the surface.

601.6.5 Concrete Curing Operation

601.6.5.1 Importance of Curing

The final strength and durability of concrete depends primarily on how it is allowed to cure. If the concrete is maintained warm and moist, hydration of the cement takes place, and the cement and water form a gel which fills the voids between aggregates. The gel will eventually harden into a substance that will bind the aggregate particles together. This action of gel formation and hardening generates heat and is accelerated when the freshly mixed concrete is warm. If the concrete is maintained at a temperature of between 50°F (10°C) and 85°F (30°C), the strength of the concrete will continue to increase for many days. The first few hours and days of curing are the most critical. Unless

the concrete is allowed to fully cure, it not only will lack strength but also will exhibit other serious defects.

601.6.5.2 Curing Period

Verify that the Contractor cures the structural concrete as defined in Section 601.12 of the **Standard Specifications**. It is important that the concrete surface be maintained completely and continuously moist during the curing period. Class K concrete must be cured for at least 7 days, but all other concrete classes may be cured from 3 to 7 days. However, the Project Engineer/Supervisor must authorize the use of any curing period less than 7 days. Prior to curing, check that the curing materials conform to the requirements of the Contract provisions. The application of burlap and water is required for concrete bridge decks. If the Project Engineer/Supervisor has approved the use of an impervious membrane, ensure that the surface finish has been inspected and approved before application. The concrete must be in a saturated, surface-dry condition. In addition, check the rate of application and number of coats for conformance. Check for streaking and membrane damage and, where needed, require immediate corrective action. If the curing material must be removed for the purpose of finishing, ensure that the Contractor restores the covering as soon as practical. See Section 601.1.7 for additional information on cold- and hot-weather curing.

601.6.5.3 Use of Linseed Oil

When the concrete is at least 14 days old, check that the specified linseed oil mixture is sprayed on the entire top surface of bridge decks, approach slabs, medians, sidewalks (i.e., both top and curb face), and the inside faces of parapets. Prior to application, check temperature requirements for conformance and verify that the surface to be treated is dry and properly cleaned. In addition, ensure that the Contractor shields or masks hand rails from overspray. Verify the rate of application and number of coats for compliance. Caution is advised as the linseed oil mixture is flammable, and the treatment is susceptible to damage from rain. All pedestrian and vehicular traffic are prohibited on the structure during the drying period.

601.6.5.4 Use of Epoxy Resin Coating

Verify that the top surface of abutment bridge seats, including drainage areas, and the adjacent bottom 6″ (150 mm) of the backwall and the top surface of pier caps are properly treated with the specified epoxy resin protective coating. Check that the surfaces to be treated are dry and properly cleaned, and verify conformance with specified requirements for age of concrete, temperature, rate and method of application, and number and timing of coats.

601.7 RECORDS AND DAILY REPORTS

The types of records that must be maintained for structural concrete work are very similar to those required for concrete pavement work (see Section 501.7). Ensure that the appropriate attachments are completed and attached to the Inspector’s Daily Report.

Section 602

REINFORCING STEEL

602.1 GENERAL REQUIREMENTS

602.1.1 Description of Work

Concrete material is strong in compression but weak in tension. To offset this weakness, concrete structures are reinforced with properly placed deformed steel bars or welded wire fabric. In general, the Project Inspector is responsible for verifying that the Contractor has furnished and placed the reinforcing steel in the manner prescribed by the Contract Plans and Specifications. See the **Standard Specifications** for the method of measurement for payment.

602.1.2 Material Considerations

The Project Inspector must inspect all reinforcing steel (e.g., deformed steel bars, epoxy-coated rebars, welded wire fabric) delivered to the job site for compliance with the type, size, quantity, and material requirements of the Contract Plans and Specifications. Note that the use of rail-steel is not permitted in bridge decks or parapets. Document laboratory numbers on the Inspector's Daily Report and retain all shipping documents in the project file.

602.1.2.1 Rebar Designations

Reinforcing bars (rebars) are round in cross section, but their surfaces are deformed to improve bonding with the concrete material. In the English system of measurement, rebars are designated with a number that represents how many eighths of an inch are in the bar's nominal diameter. For example, a No. 8 bar would have a nominal diameter of 1″. In the metric system, rebars are designated with a number that represents the bar's nominal diameter. For example, a No. 25 bar would have a nominal diameter of 25 mm. The weight (mass) per unit length of reinforcing bars are provided in the **Standard Specifications**, either pounds per foot or kilograms per meter based on the required system of units. Note that the cross-sectional areas specified for standard English and metric rebar sizes differ, and there does not exist a one-to-one correlation between the two.

602.1.2.2 Storage and Handling

Verify that reinforcing steel is stored above ground on well-drained platforms, skids, or other supports and sorted and labeled with identification tags based on their respective type and size. Prior to acceptance, ensure that the reinforcing steel is free of defects such as cracks and laminations. A thin film of rust or mill scale that cannot be removed by rubbing with burlap is not detrimental and considered acceptable; however, any loose rust or scale must be removed before the steel is placed. Reject all non-conforming material.

602.1.2.3 Epoxy-Coated Rebars

In addition to the guidance provided in Section 602.1.2.2, verify that epoxy-coated rebars are handled without damaging the epoxy coating, especially at contact areas. Verify that a suitable means of banding is used to prevent damage to the coating (e.g., padding). Ensure that all bundles of coated rebars are lifted using a spreader bar with multiple supports to prevent coating damage from bar-to-bar abrasion caused by sags in the bundles. Do not permit the rebars to be dragged or dropped.

If epoxy-coated bars will be stored or placed without concrete cover for a period greater than 90 days, verify that the bars are adequately

covered to prevent damage to the epoxy coating caused by ultraviolet rays and atmospheric elements. When bars are covered, ensure that adequate ventilation is provided to prevent accumulation of moisture.

Enforce the provisions of the Contract with respect to repairing damage to the epoxy coating. Upon delivery of the first shipment of epoxy-coated rebars, the supplier must furnish the epoxy patching material for touch-up and repair work. The patching material must meet specified requirements as evidenced on the shipping documents.

602.1.3 Order Lists and Bar Bending Considerations

Ensure that the Contractor has furnished the order list and bar bending diagrams, if required by the Project Engineer/Supervisor. These documents are for informational purposes only, and acceptance does not relieve the Contractor of the responsibility for accurately complying with the Contract. Reinforcing bars will be cold bent in the shop, and unless otherwise specified, the Contractor should not be permitted to bend bars in the field.

602.2 INSPECTION DURING CONSTRUCTION

602.2.1 General Requirements

The Project Inspector must check that the specified type, size, and dimensioned shape of reinforcing steel is positioned, supported, and fastened as designated on the Contract Plans. Such criteria is design dependent and is especially important in thin slabs, because a slight change in the criteria can significantly reduce the load carrying capacity of the concrete member. The support and fastening system must not damage steel nor allow it to move during placement of the concrete. Concrete must not be placed until the reinforcing steel has been inspected and accepted; and prior to any deck pour, an independent check of bar spacing and clearance is required.

602.2.2 Supports and Ties

Special attention should be given to the manner in which the reinforcing steel is supported and tied. Verify that bar chairs, mortar blocks, or other acceptable supports are provided to prevent the bars from sagging during concrete placement. Where concrete is laid directly on earth or gravel, the reinforcing steel should not be supported by chairs, because the chairs will tend to sink into the soft underlying material and allow the bars to move. In such cases, ensure that the bars are supported by concrete blocks, as specified. Verify that the bars are securely tied. Bars are generally tied at all intersections, except that alternate intersections may be tied where bar spacing is less than 12″ (300 mm) in each direction. For the layer of bars closest to the surface, ensure that the wires are knotted on the side away from the form face to minimize the appearance of rust stains through the finished concrete surface. The final mat of reinforcing steel should be firm and secure.

602.2.3 Splicing Considerations

The Project Inspector should remember that bar splicing is a design element. This is a primary reason why it is important that the Contractor furnish all reinforcing steel in the lengths and shapes designated on the Contract Plans. During the design phase of the project, the designer of the reinforced concrete element will locate bar splices where the reinforced concrete will undergo low tensile stress. The location and details of these splices (e.g., length of lap, staggering) will be designated on the Contract Plans. Bar splicing that is not called for on the Contract Plans requires written approval by the Project Engineer/Supervisor. If the Project Engineer/Supervisor approves a splice that is not designated on the Contract Plans, ensure that the bars are lapped at least 30 bar diameters, unless otherwise directed. For example, if two No. 8

(No. 25) bars are spliced together, the minimum required length of lap will be 30″ (750 mm). Pay particular attention to compliance of the staggered layout of individual splices. Consider the following guidelines:

1. Wire Ties. Where the use of wire ties has been approved for fastening splices, verify that at least three wire ties are used across the entire length of lap.

2. Mechanical Splice Connectors. Where the use of mechanical connectors has been approved for fastening splices, verify that the connectors are furnished and installed as directed by the Project Engineer/Supervisor. Mechanical splices must be capable of withstanding up to 125% of the yield strength of the steel bar in either tension or compression.

3. Bar Welding. Welding of bar splices is generally not permitted, unless designated on the Contract Plans or otherwise authorized in writing by the Project Engineer/Supervisor. If permitted, ensure that the work is performed by a welder who is certified for the type of welding required. The welding must comply with the current specifications of the American Welding Society, D 1.4, and the weld must develop an ultimate strength equal to or greater than that of the steel bars. During the welding operation, inspect compliance of the weld type, size, and length and ensure that the bars have not been burned or made smaller by the weld. Never allow a weld to be cooled by running water.

602.2.4 Bar Clearance

Frequently check the bar clearance from form faces and the tops and bottoms of slabs. Supports and ties must not allow the bars to move during concrete placement. Bar clearance is a design element, which also helps to protect the steel from water and excessive heat. Where bars are spliced, a clear distance of at least 1″(25 mm) must be provided between each pair of lapped bars and the adjacent bar. The clear distance to the form should be at least 2″ (50 mm).

602.2.5 Installation of Epoxy-Coated Rebars

The installation of epoxy-coated reinforcing bars requires special treatment so that the epoxy coating is not damaged during the process. Verify that epoxy-coated bars are placed on plastic or plastic-coated wire supports, and that the bars are fastened with specially fabricated plastic or plastic-coated wire ties. Any visible damage to the epoxy coating must be repaired prior to the placement of the concrete. Patching of damaged areas must be performed in accordance with the patching material manufacturer's recommendations.

602.2.6 Protection of Steel During Prolonged Exposure

If the ends of reinforcing bars or dowels will remain exposed to the elements for more than two months, the Project Inspector must ensure that the Contractor applies a very thin coat of cement paste to the surface of the exposed steel. This coating must be removed by lightly tapping with a hammer or other tool not more than one week before the placement of the concrete.

602.2.7 Cleaning of Bars

Just before the concrete is poured, ensure that the surfaces of the reinforcing steel are cleaned of foreign coatings such as loose scale or rust, oil, grease, paint, form release agent, curing compound, mud, dirt, or weak dried mortar. This will ensure that a positive bond between steel and concrete is achieved.

602.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for ensuring that the Contractor furnishes and places the reinforcing steel in conformance with the requirements of the Contract Plans and Specifications. Before work begins, it is good inspection practice to become familiar with the Contract Plans and Specifications and the inspection guidance presented in Sections 601.1 and 601.2. During inspection, record the following information on the appropriate attachment to the Inspector's Daily Report:

1. structure number and location;

2. weather conditions;

3. types of bars placed (e.g., epoxy coated bars, uncoated bars, welded wire fabric);

4. bar size, weight (mass) per unit length, length, number placed, and total weight (mass);

5. signatures of Project Inspector and quantity checker;

6. inspection notes (see Section 602.1 and Section 602.2);

7. notes on any deviations from the Contract Plans; and

8. supporting sketches, including actual measurements.

Section 603

PRESTRESSED CONCRETE MEMBERS

603.1 GENERAL REQUIREMENTS

603.1.1 Description of Work

603.1.1.1 Overview

Prestressed concrete members differ from conventionally reinforced concrete members in that the member is constructed using high-strength concrete and then compressed before loading by tensioning internal high-strength steel bars or high-strength stranded wires, thus minimizing the tension in the structural member. This allows the use of minimal concrete material and provides for a lighter weight member that can span a longer distance. In general, the Project Engineer/Supervisor and, as directed, the Project Inspector will ensure that the Contractor manufactures, handles, stores, transports, and erects precast/prestressed concrete members in conformance with the requirements of the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

603.1.1.2 Pretensioning/Posttensioning

There are two basic types of prestressed concrete members. The prestressing force may be applied before the concrete is placed or after the concrete has cured. Consider the following:

1. Pretensioning. Pretensioning is the method of applying the prestressing force before placing the concrete in the forms. The bars or wire strands are anchored by a continuous bond throughout the length of the structural element.

2. Posttensioning. Posttensioning is the method of applying the prestressing force after the concrete has cured. In post-tensioning, the bars or wire strands are mechanically anchored at each end of the member.

In either type, the prestressing steel may be high-strength reinforcing bars, single wires, or twisted strands of wire rope.

603.1.1.3 Creep and Camber

Creep is the shortening of a girder after it is prestressed. The actual shortening is very small and occurs rapidly, tapering off over a period of about two months. Because the prestressing force is applied eccentrically, a noticeable uplift, or camber, will occur, which is anticipated during design. However, if the girder cambers beyond specified limits, corrective action may be necessary.

603.1.1.4 Precast Girders

Precast girders are fabricated on a flat surface at the precasting yard and shipped to the site for erection, which is similar to steel girders. The girders will camber when the prestressing force is applied. Be aware that girder age and storage conditions can produce additional camber that may render the girder unacceptable.

603.1.1.5 Cast-In-Place Girders

Concrete box and "T" girders are typically cast-in-place and posttensioned in the field. During production, galvanized rigid ducts are cast into the girder webs. Once cured, the wire stands are pulled through the ducts to prestress the member. Because these girders are produced in the field, the forms and falsework must account for deflections due to dead load and prestressing.

603.1.1.6 Segmental Construction

Precast or cast-in-place posttensioned segmental structures are generally long in span with limited access area, thus requiring gantries or heavy cranes for construction and erection. Bars, wire strands, or a combination of both may be used to impart the prestressing force in segmental members.

In precast applications, the members are match cast to produce a bridge that conforms to the required geometry, but the prestressing is performed in the field. Contrary to conventional girders, segmental members must accommodate both heavy construction and final service loads, and special construction techniques are employed to provide stability. It is therefore important to thoroughly study the Contract Plans and working drawings. If the Contract Plans designate the prestressing force required only for the final service load, the working drawings must define the force needed to accommodate both construction and service loads. Note that superstructure camber has already been developed in member segments during match casting but may be adjusted between segments with shims during erection.

603.1.2 Material Considerations

Prior to beginning the work, ensure that all materials for the work conform to the requirements of Section 603.2.1 of the **Standard Specifications**. Many materials will be required, including concrete mix materials, reinforcing and prestressing steel, joint fillers and sealants, bearing pads, steel bolts and nuts, and concrete sealants and grouts. During the project, record laboratory numbers on the Inspector's Daily Report and retain all shipping documents.

603.1.3 Working Drawings

Before work begins, the Contractor is required to submit detailed shop drawings and erection drawings for review by the Project Engineer/ Supervisor. Shop drawings will provide detailed dimensions and sizes of all component and miscellaneous parts of the structure, and erection drawings will address the following details:

1. method, phasing, and sequence of erection;
2. details of all falsework bents, bracing, guys, and dead-men;
3. forming and bracing details to prevent beam and stringer distortion where the deck overhang exceeds 30″ (760 mm);
4. member details, including weight (mass) of members and location of lifting points;
5. lifting devices, crane capacities, and locations of cranes and barges; and
6. design calculations, which must sealed by a Registered Professional Engineer.

The Project Engineer/Supervisor will review the working drawings to ensure that the Contractor has fulfilled the specified requirements. Note that acceptance of the working drawings in no way alleviates the Contractor's responsibility for accurately complying with the requirements of the Contract. Before production, the Project Inspector should become familiar with the working drawings to ensure that the Contractor complies with the proposed methods and details of fabricating and erecting the structure.

603.1.4 Manufacturer Certification

The Contractor is responsible for submitting a request for manufacturer approval at least three weeks prior to production. The request will define the plant facilities, materials, and production methods. The plant must demonstrate proper certification from the Precast/Prestressed Concrete Institute (PCI). Before production, ensure that the plant has been certified in accordance with the requirements of Section 603.3.1 of the **Standard Specifications**.

603.1.5 Equipment Inspection

Check the acceptability of all equipment, tools, and machinery that will be used for the work. Ensure that prestressing jacks and monitoring instruments have been properly calibrated, or recalibrated, in the manner specified and that the certified calibration charts have been furnished by an independent laboratory. Note that the use of portable pretensioning beds is not permitted. Check the forms and casting beds for acceptability; however, acceptance does not relieve the Contractor of the responsibility for accurately complying with the requirements of the Contract.

603.1.6 Quality Control Program/Supervisor

The Contractor is responsible for ensuring that the manufacturer's quality control program is submitted to the Project Engineer/Supervisor at least 30 days prior to production. Before production, ensure that the quality control program has been accepted, as specified. The use of independent laboratories will be as defined in the Contract. In addition, verify that the Contractor has provided at least one PCI Level II certified technician to supervise the work.

603.1.7 Safety Precautions

The prestressing and erection operation can be very hazardous. Both Division and Contractor personnel are both responsible for providing and maintaining a safe working environment. The Contractor is specifically responsible for taking precautionary measures to prevent injuries to personnel due to the breakage of strands or failure of anchorage devices during the tensioning operation. Division personnel are required to abide by all safety rules established at the site. The protection provided must allow the Division personnel to perform normal inspection duties.

603.2 PRESTRESSED MEMBER FABRICATION INSPECTION

The Project Inspector shall review the prestressed members and their documentation to determine if all required repair work was completed prior to final acceptance.

603.2.1 Preparation of Formwork

Verify that the formwork is of the proper type and size and is adequately cleaned and prepared. If posttensioned members are being fabricated, pay particular attention to how ducts are formed; check for leaks; and verify that grouting ports and vents will remain accessible and free of concrete.

603.2.2 Placement of Reinforcement and Prestressing Steel

Check that all reinforcing steel is properly placed. Ensure that the prestressing steel is installed in the forms, or in the posttensioning ducts, in accordance with the working drawings. The steel strands must be held securely in place by the jacks and end anchors. Where the steel strands or tendons are draped, ensure that they are not kinked or abraded at bends. Pay particular attention to the minimum criteria specified for concrete cover, splicing, and lapping. If a release agent is used, do not allow the compound to contaminate the steel strands. This cannot be overemphasized.

603.2.3 Prestressing Operation

603.2.3.1 Overview

The Project Inspector is responsible for ensuring that the Contractor furnishes calibrated jacking equipment and continually monitors the jacking force as it is applied to the steel strands. Carefully review the sequence of operations with the Contractor, and be concerned with safety. Stay

away from the back of jacks and dead-end anchorages during the prestressing operation.

In typical prestressing (i.e., pretensioning) operations, the forms and steel strands will be prepared and placed as specified, and the steel strands will be preloaded to develop 10% of the final prestress load. Note that records of the jacking force and strand elongation will be maintained throughout the operation. The members are then cast, typically in a continuous line, and the steel strands will loaded to 100% of the prestress force. The concrete will then be placed and allowed to cure. When the concrete reaches minimum compressive strength, as evidenced by test cylinders, the forms will be removed and the steel strands will be disconnected from the jacks and anchors in an order that will minimize undesirable eccentric forces in the members. Do not permit anchors to be release until the concrete has attained its minimum compressive strength.

603.2.3.2 Monitoring Jacking Force and Strand Elongation

Hydraulic jacks or rams are typically used to generate the force necessary to place the steel strands in tension and prestress the concrete members. Use the following procedures to monitor jacking force and strand elongation:

1. Record Strand Elongation. As the jacking force is applied, the steel strands will elongate. Refer to the Contract Plans and Specifications for elongation details and requirements.

2. Establish Measurement Benchmark. Mark a strand in a tendon approximately 10″ (250 mm) from the end of the ram. Make sure that the reference point selected on the ram is a part that does not move. A permanent black felt tip marker may be used to mark the strand.

3. Monitor Jacking Force. The hydraulic equipment will be furnished with a calibration curve that should be used to convert pressure gauge readings to an equivalent jacking force. Review and retain the specified calibration records in the project files. Gauge readings are typically within ±2 % of actual pressures in the hydraulic equipment. Using the calibration curve, monitor the gauge as the jacking force approaches the full jacking force required.

4. Check Strand Elongation. When the full jacking force has been reached, measure the distance between the reference point and the mark on the steel strand (see Step #2). The measured strand elongation, less the dead end anchor set, should be equal to or greater than the actual strand elongation. If not, carefully check the calculations and measurements to verify that the strand elongation is actually short.

5. Acceptability. If the measured strand elongation varies more than 5% from the actual strand elongation established in Step #1 or the measurements are erratic, examine the prestressing operation for possible problems. If the problem cannot be explained or resolved, contact the Project Engineer/ Supervisor for assistance. Do not permit the protruding strands to be cut until the problem has been properly addressed and strand elongation has been verified.

6. Breakage of Wires. During the prestressing operation, the breakage of individual wires may occur. This is common and acceptable as long as the broken wires represent less than 2% of the total area of the strand. Recurring failures may indicate a symptomatic problem that will need to be immediately addressed. Require strand replacement based on the provisions of the Contract.

603.2.4 Concrete Production and Hauling

Concrete for all prestressed members must be produced in accordance with Section 603.6 of

the **Standard Specifications** or as otherwise provided for in the plans.

603.2.5 Concrete Placement and Consolidation

Verify that a suitable means is used to place the concrete in its final position in the forms without segregating the mix. Observe the operation to ensure that the concrete is worked under and around the prestressing steel. Verify that the concrete is properly vibrated. Internal vibrators should be pushed in and pulled out slowly and only long enough to remove the air without segregating the mix. Do not allow internal vibrators to come into contact with the forms or the prestressing steel.

603.2.6 Curing and Finishing

Verify that the prestressed concrete members and test cylinders are properly cured. Many options are available to the Contractor, including:

1. water curing,
2. wet mat curing,
3. saturated cover curing,
4. water spray curing,
5. accelerated curing,
6. low-pressure steam curing, and
7. radiant heat curing.

The proposed method must be reviewed for acceptability by the Project Engineer/Supervisor before the operation begins. Once accepted, review the method's material, equipment, moisture, temperature, curing period and procedural requirements. During the operation, ensure compliance with the approved method and pay particular attention to the results of compressive strength tests. Halt production and reject members for inadequate curing based on the provisions of the Contract. After curing, verify that the members are given the proper surface finish. In general, surfaces should be smooth and even without spalling, damage, or honeycomb.

603.2.7 Dimensional Tolerance and Defects

Acceptance of prestressed members at the manufacturing site should be considered tentative, because the Contractor is responsible for handling, storing, transporting, and erecting the members without damage.

Check the prestressed concrete members for unacceptable defects and breakage, and ensure that honeycomb areas and voids are properly patched and cured. Pay particular attention to the criteria specified for evaluating cracks. In general, members with cracks that are wider than 16 mils (0.4 mm) should be rejected, unless otherwise approved by the Project Engineer/ Supervisor. Cracks with a width less than 16 mils (0.4 mm) may be repaired as specified, unless the member is rejected for some other defect. Check the dimensional tolerance of the members for acceptability based on the criteria specified for "I" beams, bulb "T" beams, box beams, plank beams, and deck panels. Note that the specified tolerances only represent the limits at which construction becomes unacceptable, not the sole criteria for acceptance.

603.3 STORAGE AND HANDLING CONSIDERATIONS

The Contractor is responsible for handling, storing, transporting, and erecting prestressed members without damage. After fabrication, verify that the prestressed members are handled and stored in the upright position without causing torsion, warps, cracks, or other damage. Vacuum lifters, cables lifts attached to lifting points near the ends of the member, or other acceptable means should be used. Block supports for storage of similar members should be located at the same distance from each end of the members to ensure camber uniformity. Stacks should not exceed two members high.

Reject damaged members based on the provisions of the Contract.

During erection, verify that the Contractor provides acceptable means of protecting traffic against falling objects (e.g., nets, flooring), and ensure that the members are installed and, where required, posttensioned in accordance with the working drawings and within specified tolerance. Check that dowel bar and lifting bolt holes are properly filled with non-shrink grout.

603.4 RECORDS AND DAILY REPORTS

The Project Engineer/Supervisor and the Project Inspectors in charge of the work are responsible for recording in Daily Reports all information (e.g., observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Project Engineer/Supervisor will maintain the project's Supervisor's Daily Reports, and the Project Inspector in charge of the work will maintain a daily record of events in the Inspector's Daily Report. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Many claims and lawsuits have been settled based on such documentation. Attempting to reconstruct events later without written notes or test data is frustrating and often leads to claims. Use the Division's Form 442, and pertinent attachments, to prepare the Supervisor's and Inspector's Daily Reports. If in doubt as to whether or not information is important or beneficial, record it.

Section 604

PIPE CULVERTS

604.1 GENERAL REQUIREMENTS

604.1.1 Description of Work

When Item 604 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor constructs or reconstructs the pipe culverts in accordance with Section 604 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

604.1.2 Adverse Impacts of Water

Without a drainage system, water can cause many problems on a highway facility. When compacted soils become saturated, they become very weak and unstable. Water that is allowed to infiltrate and freeze within the underlying strata loosens the compacted material and raises the pavement structure. Once thawed, traffic reconsolidates the material and causes the pavement to break and potholes to form. Embankments that become saturated settle unevenly and become prone to sliding. They are also prone to erosion. In addition, some soils and rocks tend to swell when saturated and, unless removed or well drained during construction, will cause the pavement to raise.

604.1.3 Purpose of Highway Drainage Systems

To minimize the adverse impacts of water, a drainage system must be integrated in the design of the highway facility. This drainage system typically includes an interconnecting system of slopes, open ditches, and buried pipes of various types, sizes, and shapes. The drainage system is designed and constructed to:

1. prevent water from saturating and weakening the soils in highway cuts and embankments;

2. prevent water from infiltrating the pavement base and subbase;

3. intercept and carry away surface and underground water that reaches the roadway prism; and

4. carry away, as quickly as practical, the water that falls on the pavement surface.

Buried pipe culverts must function both hydraulically and structurally. They will be designed not only to accommodate the design flow of water but also to support the pressures of the surrounding soil and the design loads above them. Open ditches will be designed for both water flow and roadside safety.

604.1.4 Features of Highway Drainage Systems

The Contractor should install the features of a highway drainage system, including temporary features, as soon as practical during the project. This helps to lower the water table; prevent water from infiltrating, saturating, and eroding soil materials, and minimize construction delays. See Section 642 for additional information on erosion and sedimentation control. The following sections briefly describe the primary features of a highway drainage system.

604.1.4.1 Cross Slopes

The pavement surface is typically crowned or superelevated and the shoulders are typically

sloped to allow falling rain and melting snow to quickly runoff the roadway surface.

604.1.4.2 Ditches and Inlets

The features that intercept and carry surface runoff away from the highway facility include side ditches, curbs, gutters, inlets, and other similar features. On high embankments, curbs are generally provided to intercept water that flows down the side slopes, and paved channels or "scupper ditches" are provided to channel this water without eroding the earthwork. In deep cuts, ditches are generally constructed along the top of each side slope and down the face of the slopes for the same purpose.

604.1.4.3 Culverts

A culvert is an opening under the roadway with a clear span or sum of spans of 20′ (6 m) or less. A larger span is classified as a bridge. Culverts are typically placed at low points in the profile of the natural ground and at intervals along long grades to carry water under the roadway, but may also be installed to accommodate the passage of pedestrians and animals. A culvert with a rectangular opening is called a box culvert, which may be either precast or cast-in-place reinforced Portland cement concrete. A culvert with a round, arch, or elliptical shape is called a pipe culvert. Both pipe and box culverts may be constructed with more than one opening. These configurations are called "multiple culverts." The type, size, number, and location of culverts will be designated on the Contract Plans and will depend on many factors such as purpose, water acidity, soil type, overhead load, surrounding soil pressure, cost, and the likelihood of the culvert material being eroded by sand or gravel in the water it carries. Prior to beginning the work, verify that all culvert materials are shipped from pre-approved DOH sources and comply with the requirements of Section 604.2 of the **Standard Specifications**. Document laboratory numbers on the Inspector's Daily Report. Consider the following attributes of culverts:

1. Culvert Shapes. The required shape of the culvert (e.g., round, arch, elliptical, box) will depend on the design application. Pipe culvert may be either round, arch, or elliptical in cross section. Box culverts will be either square or rectangular in shape.

2. Culvert Materials. Pipe culverts may be constructed of many different types of materials including: steel, structural steel, stainless steel, aluminum, polyethylene, acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), clay, reinforced plastic mortar (RPMP), and fiberglass reinforcement (FRP). Box culverts are typically precast, reinforced concrete sections, but may be either non-reinforced or cast-in-place depending on the design application.

3. Sheet Thickness, Corrugations, and Perforations. Sheet thickness for metal pipe will be designated on the Contract Plans. Depending on the design application, pipe culverts may also be either corrugated or perforated. The type and size of corrugations will be specified in the Contract.

4. Coating and Paving. Pipe culverts may be galvanized, coated with bituminous material, lined with clay, or fiber bonded. The flowline (i.e., invert) or the entire inside of the pipe may need to be paved prior to installation. Water will not flow as easily through corrugated metal pipe as it will through a pipe with a smooth inner surface, because of the rough surface provided by the ridges and furrows of the corrugated material. To increase the water carrying capacity, the diameter of the culvert must be increased or the corrugations filled with an approved paving material (e.g., a mixture of asphalt and stone dust). If the corrugations in only the lower part of the pipe are filled, the pipe is said to have a paved invert or flowline. If the corrugations are filled all the

way around the pipe, the culvert it is said to be fully paved.

5. End Sections. Pay particular attention to the type and shape of end section specified for the culvert (e.g., safety slope end section).

6. Structural Plate Pipe and Pipe Arch. Structural plate pipe and pipe arch culverts are typically prefabricated plate components that have to be assembled in the field.

7. Backfill Material. The Contractor is responsible for the quality control of backfill material. Gradation acceptance for backfill material will be on the basis of the Contractor's written certification with attached test results.

8. Miscellaneous Materials. Many other types of materials also may be required, including field paving materials, pipe joint and joint sealer materials, gaskets, and bedding. Ensure that these materials conform to the requirements of the Contract.

All pipe culverts must be pretested and shipped to the job site from pre-approved DOH sources. The Project Inspector must make sure that the type and size of the pipe delivered to each culvert location conform to the requirements of the Contract. Document laboratory numbers from the shipping documents on the Inspector's Daily Report.

604.1.4.4 Outlet Ditches and Channels

Water that is collected by the drainage system will eventually be carried by large outlet ditches or channels to a stream, enclosed body of water, or natural watercourse. Where an outlet ditch must be placed on a steep grade, the sides and bottom of the ditch will typically be lined with broken stone, called riprap or dumped rock, to prevent the soil from being washed away. If the water will flow very rapidly over highly erodible soils, the sides and bottom of the ditch may warrant paving with asphaltic concrete or Portland cement concrete.

604.1.5 Field Adjustments

The drainage system design on the Contract Plans is generally based on survey data taken long before the clearing and grubbing work begins. Because conditions uncovered during construction may differ from those originally considered. the type, size, and location of drainage features actually required to meet field conditions may differ from that incorporated in the original design. Project Inspectors must keep this in mind and begin studying drainage conditions early and throughout the project. If a modification to the original design is suspected, immediately notify the Project Engineer/ Supervisor.

After the rough grading is completed, carefully inspect the need for additional drainage features. For example, if water is found to eroding sections of shoulder or the side slopes of embankments, additional edge drains should be considered. Where the natural ground slopes toward a cut or an embankment, ditches may be needed at the top of the cut or at the toe of the embankment. Additional drainage may be needed in the median to prevent ponding. To prevent washing of silty soil into drainage ditches at the side of the road, it also may be necessary to make the slope of a cut or fill flatter than that shown on the Contract Plans. In all such cases, discuss possible solutions with the Project Engineer/Supervisor.

On projects that do not provide grade lines, especially on minor jobs and rehabilitation projects, field adjustment is common. It is important that Project Inspectors use common sense when assessing needed adjustments. For example, make certain that culverts are placed at low points and that the outfall is within the right-of-way. Perform field verification of all drainage features after installation. The use of energy dissipaters may be required, especially where excessive surcharges are expected.

604.2 INSPECTION GUIDELINES

604.2.1 Overview

As soon as practical after installation of drainage features, check them carefully for proper functionality. Any necessary corrections must be made prior to paving work. Verify that each culvert is in proper working order and that no adjustments or replacements are necessary because of plugging up, settlement, or crushing. If inspection shows that conditions have changed since the structure was built, notify the Project Engineer/Supervisor. Keep a complete record of all culverts locations, types, and sizes, with sketches that show inlet and outlet flowline elevations, on the Inspector's Daily Report. All outlets should be referenced on the As-Built Plans so that they can be easily located by maintenance forces.

604.2.2 Culvert Placement

604.2.2.1 General

Before a roadway is built, water flowing over the natural ground will follow drainage channels at low points along its surface. When an embankment is built across a natural channel, water from rain or melting snow will pond, unless it can flow through the embankment. For this reason, it is usually necessary to provide a culvert through the embankment at every natural drainage channel. Drainage-relief culverts are used where the ground or roadway grade slopes in the same direction for a great distance.

604.2.2.2 Small Streams

Where a culvert is to carry water from a small stream through an embankment, the centerline of the culvert is typically placed near the centerline of the stream. In addition, the bottom elevation of the culvert should be about the same elevation as the stream bed. Natural drainage channels should be used as much as practical. Changing the course of a stream could result in property owner claims for damages due to flooding or intercepting too much water. The size, location, and grade of each culvert must be constructed as defined in the Contract, unless field conditions warrant adjustment. If an adjustment in location or elevation appears warranted, immediately notify the Project Engineer/Supervisor.

604.2.2.3 Culvert Skew

Where a culvert is provided at a natural drainage channel or where a drainage-relief culvert is required for road grades of less than 3%, the culvert is generally set at right angles to the roadway centerline; otherwise, the culvert will be skewed. Culverts are skewed to allow rapidly flowing water to more readily enter the culvert inlet. Drainage-relief culverts installed along road grades that are greater than 3% typically will be skewed at an angle of 15° to 45° with the roadway centerline. The degree of skew will be designated on the Contract Plans. In addition, the culvert will typically be set at approximately the same grade of the ditch that feeds the inlet.

604.2.2.4 Culvert Grade

Before embankment construction begins near a culvert location, discuss the type, size, location, and grade of the culvert with the Project Engineer/Supervisor, and obtain approval of all details and adjustments. At the discretion of the Project Engineer/Supervisor, the flowline grade may be altered from that shown on the Contract Plans. The flowline, or invert, of a culvert is the line along the lowest points of its inside surface. The grade of the culvert is the grade of its flowline, which will be designated on the Contract Plans. During construction, the flowline elevation should be set and periodically checked at each cross-section along the culvert's profile. Consider the following guidelines:

1. Siltation. The grade of the culvert should not be so flat as to cause pipe siltation.

2. Inlet Elevation. The elevation of the flowline at a culvert's inlet should be set low enough to meet both of the following requirements:

   a. surface water must be carried away rapidly to prevent flooding adjacent land; and

   b. water from underdrains must be able to drain without backing up when the culvert is running full.

3. Outlet Elevation. The elevation of the flowline at a culvert's outlet should be set as close as practical to the existing ground. Less excavation will then be required for the outfall ditch, and the cost of maintenance will be less. In addition, where no endwall is provided at the outlet, the culvert should extend at least 2′ (600 mm) beyond the toe of the embankment; and the embankment slope may need to be treated with slope paving, a spillway, or a rock dispersion pad to prevent erosion.

604.2.2.5 Marking Culvert Location

Several techniques can be used to perform mark culvert location, including batter boards and stringlines, offset grade stakes, and laser technology. A common procedure is as follows:

1. Stakes are set along the centerline of the roadway at intervals of 25′ (7.5 m) to 50′ (15 m) for 200′ (60 m) on each side of the proposed location of the pipe.

2. From each centerline stake, the distance from the roadway centerline to the planned outer edge of the shoulder is measured in each direction at right angles to the roadway, and long stakes are set along these shoulder lines.

3. The toe of the slope is determined at right angle measurement to the centerline station where the ends of the pipe will be located.

A stringline can also be used to set and control flowline elevation. A mark is made on each stake either at the elevation of the flowline or at a certain uniform distance above or below the flowline elevation. The stringline, passing through these marks, is pulled tight and secured in position on the stakes. If the stringline is not at the elevation of the flowline, the distance above or below the flowline must be marked on the stakes.

604.2.3 Pipe Trenches

604.2.3.1 Trench Excavation

A culvert should never be installed by simply laying it on the natural ground and piling the fill material against and over the pipe. Every pipe culvert must be laid in a trench; because, the ability of the pipe, especially corrugated metal pipe, to support the load at its top depends on the support provided by the pressure of the compacted soil along its sides. Where a pipe is laid in a trench dug in compacted ground or embankment material and the void in the trench on each side of the pipe is backfilled and compacted, the resistance of the pipe to crushing is greatly increased. A trench should only be wide enough to allow room for compacting the backfill around the lower half (i.e., haunches) of the pipe.

In general, the width of the trench should not be less than that required for making proper joints and compacting the backfill, and the trench must be deep enough to permit the top of the pipe to be at least 2′ (600 mm) below the top of the trench. Trench excavation depends primarily on the type and size of the culvert being installed. Use Section 604.4 of the **Standard Specifications** and the Standard Detail Books for trench excavation requirements.

Trench excavation should always start at the low end, and the bottom of the excavation should be maintained even and sloped so that the trench will drain during construction. Where the trench will not drain naturally, a narrow ditch should be

dug along one side to lead the water to a sump from which it may be removed by a pump. Ensure that any unsatisfactory foundation material is removed and replace with suitable material to a depth specified by the Project Engineer. If the bottom of the trench becomes soft and muddy, it may be best to undercut (i.e., dig below the normal grade) and backfill with granular material or earth selected from excavation. Only enough granular material to make a firm bottom should be used. Otherwise, water may run beneath and undermine the pipe. Where a Type F Trench is specified, verify it is in conformance with the **Standard Detailed Drawings**.

604.2.3.2 Safety Considerations

Unless alternative methods such as laybacks or trench boxes are used, the sides of trenches must be securely held by shoring and bracing where trenches are excavated in material other than rock. Shoring and bracing is especially important where heavy construction equipment will be operated near the trench or where material thrown out of the trench is piled on one side. The spoil bank formed by the soil removed from the trench should be trimmed back from the edge of the trench. The weight of the soil in the spoil bank tends to overload the sides of the trench and may cause slides or cave-ins. When specified in the Contract, shoring and bracing will be designed by the Contractor and the plans will be signed and stamped by the Contractor's registered Profession Engineer.

604.2.3.3 Pipe Bedding

All pipe must be properly bedded on a firm foundation. The bottom of the trench, for a specified distance on each side of the pipe centerline, must be shaped with a template to fit the curve of the pipe being laid with proper camber provided for flexible pipe. Where bell-and-spigot pipe is used, check that holes are properly dug in the trench to accommodate the barrels and allow the pipe to be in full contact with the foundation. The pipe must be supported uniformly along its entire length. Small pockets of unstable material in the bottom of the trench should be removed and replaced with suitable material. In most instances, the type of bedding to be used will be noted on the Contract Plans. Flexible pipe should generally be bedded so that the groove formed in the bottom of the trench has a width between one-half and three-fourths of the diameter of the pipe. If a bedding class is not specified, the requirements for Class B bedding will apply as defined in the **Standard Specifications**. Consider the following additional guidelines:

1. Concrete Cradle (Class A Bedding). Class A bedding consists of a continuous concrete cradle conforming to the details of the Contract Plans. The suggested method of providing a concrete cradle is as follows:

   a. The cradle below the lowest point on the pipe should be made of a concrete mix having a very stiff, dry consistency.

   b. The concrete should be placed before the pipe is placed in the trench, and the surface of the concrete should be brought accurately to the grade for the bottom of the pipe. If bell-and-spigot pipe is used, the surface of the concrete should be at the grade of the line through the bottoms of the bells. Looped wires may be placed in the concrete before it hardens and later used to tie the pipe in position.

   c. After the concrete below the pipe sets hard enough to be worked on, the pipe should be laid in its correct position on the concrete.

   d. Fairly wet concrete should be used to complete the cradle or to encase the pipe.

2. Class C Bedding. Class C bedding shall be used in accordance with details shown on the plans.

3. Natural Ground Preparation. Where pipe is to be supported by natural ground, the trench bottom must be fine-graded to the proper grade, camber, and shape so that the pipe will bed properly. The use of a grade stick is highly recommended. The grade stick should have a nail driven into it at a distance from its lower end that is equal to the distance from the stringline to the flowline of the pipe plus the thickness of the pipe shell. The point in the bottom of the trench directly under the stringline, which is at the centerline of the trench, should be brought to the proper grade by measuring vertically from the stringline to the trench bottom with the grade stick. Grading should start at the outlet end of the trench so that the trench will drain properly during construction.

604.2.3.4 Placement Considerations

Various methods are used for lowering pipe into the trench. Mechanical equipment must be used for large pipe sections. Rigid pipe sections are typically lifted using hairpin-shaped hooks that can be inserted in the opening of the section or in special lifting holes or eye connectors. This allows each section to be lifted and set into proper position without damage. Note that bell-and-spigot pipe sections must be laid with the bell end upstream, and the laying operation must start at the downstream end of the trench. Each section should be pointed in the proper direction before it is lowered in the trench. Where pipes with a paved invert are being installed, ensure that the pipe is laid with the paving material at the bottom. Where reinforced concrete oval pipe is being laid, verify that the "top" label is uppermost.

Where flexible pipe is placed in the trench, it should be lowered properly. If a section of pipe is dropped, dents may be produced in some of the ridges, or some of the zinc spelter used for galvanizing the steel or some of the asphalt coating may be knocked off. If the protective coating is knocked off a small area, the bare metal at that place must be painted with approved asphalt furnished for the purpose by the manufacturer of the pipe. The manufacturer's directions for applying the asphalt must be followed. Before lowering the pipe in the trench, flexible pipe should be turned so that the lengthwise lap is at one side. This lap should never be at the top or bottom. If the pipe has a paved invert, it should be turned so that the invert paving is down and the center of the paving is exactly on the centerline of the groove in the bed.

604.2.3.5 Joining Pipe Sections

Bell-and-spigot joints are generally used for small sizes of concrete or clay pipe, and large sizes of concrete pipe usually have tongue-and-groove joints. Because bell-and-spigot pipe is laid with the bell end upstream and laying it started at the downstream end of the trench, the spigot end of the section being set in place must be inserted in the bell of the section previously placed. The methods used in joining sections of tongue-and-groove and bell-and-spigot pipe should be such that the ends of the sections are fully entered and the inner surfaces are reasonably flush and even. Unless otherwise specified on the Contract Plans, joints for rigid pipe will be made with:

1. Portland cement mortar or grout,
2. flexible water tight gaskets,
3. bituminous plastic cement,
4. oakum and mortar,
5. oakum and joint compound,
6. vitrified clay pipe joints,
7. hot poured mineral filler joint sealer, or
8. by a combination of these types.

Mortar joints in bell-and-spigot and tongue-and-groove pipes will be made by plastering up to the quarter point with joint mortar before the succeeding joint is placed. The consistency of the mortar should be sufficient to maintain proper invert grade. Mortar should be made in small batches, and mortar that has set over 30 minutes should be discarded. Old mortar must never be softened by mixing in more water, as it

will not attain full strength when hardened. Air-entrained cement should be used in joint mortar, because it makes the mortar more workable. Lime should not be added to the mortar, as lime-cement mortar will not last well underground. Care should be taken to suitably cover completed mortar joints to protect against rapid drying.

Where flexible pipe is used, the shipping lengths of sections must be jointed in place within the trench by means of connecting bands of corrugated metal. Most connections are made with standard bands, each of which is one piece. Two-piece bands are used for larger pipe sizes and in deep trenches where the joint could not be made easily with a standard band. To join two sections of flexible pipe with a standard band, the opened band is first slipped over the end of the pipe section already laid. The end of the next section is then set about 0.75″ (20 mm) from the pipe in place, and the band is tightened. The ridges and furrows of the band must match those of the two sections of pipe. A galvanized band without an asphalt coating should be tapped with a mallet or hammer while the bolts are being tightened. This will remove the slack and provide a tight fit. A tight joint cannot be made on large pipe by just tapping the band and tightening the bolts. A chain or cable must be placed around the band and cinched so that the band will be tightly pulled together.

604.2.3.6 Inspection of Pipe In Place

All pipe must be inspected in place before backfilling of the trench is started. Joints in large pipes should be inspected from within the pipe to make certain that they are properly filled. Any damaged joints should be repaired. Any section of pipe that has been critically cracked or broken should be taken out and replaced. At the end of each day, the trench with no pipe in it should be blocked off by a temporary dam or tight bulkhead located a short distance beyond the end of the pipe. The end of the pipe should not be blocked, because water filling the trench would then float the pipe and break the joints. Frequent observation of concrete pipe culverts should be made following the initial placement of the structure through the completion of the roadway fill and pavement. These frequent inspections throughout the building of the project should establish the point at which damage occurs, if any, and also the extent of the Contractor's responsibility.

604.2.4 Rigid Pipe Culverts

604.2.4.1 Material Inspection

Pipe should be checked upon arrival to make certain that each section is of the proper type and size to be used. The sections must be shipped from a pre-approved DOH source. As soon as it is unloaded, inspect sections of pipe for defects and record the laboratory number from the shipping documents in the Inspector's Daily Report. If a defect is found, notify the Project Engineer/Supervisor. Pipe also must be inspected after placement to ensure that sections were laid properly and not damaged by rough handling.

604.2.4.2 Handling Considerations

Check that pipe sections are handled properly. If the method used causes damage, caution the Contractor and enforce the provisions of the Contract with respect to repairs or replacement. Pipe sections must be lowered carefully and not dumped or dropped from the truck to the ground. The pipe may be lowered by crane or rolled down an inclined ramp. In general, pipe culverts should be rolled, not dragged, from one location to another. If pipe must be rolled over rocky or stony ground, planking should be used.

604.2.5 Flexible Pipe Culverts

604.2.5.1 Material Inspection

The inspection of flexible pipe will be as outlined in Section 604.2.4.1.

604.2.5.2 Handling Considerations

Flexible pipe must meet all the requirements of the **Standard Specifications** when it is in place in the trench. The Project Inspector must make sure that the pipe is handled and stored properly. Flexible pipe should never be dropped to the ground or into the trench. Asphalt-coated pipe must never be dragged over the ground. It is good practice to store asphalt-coated pipe on planks or timbers so that dirt and small stones will not be pressed into the coating. Each piece of pipe with a paved invert should be turned so that the paved part is down. In hot weather, sections of asphalt-coated pipe should be stored in a shady place, or covered with light-colored tarpaulins, so that heat from the sun will not cause the asphalt coating to flow out of place.

604.2.5.3 Strutting Considerations

Where flexible pipe is to be used under a high embankment, it must be elongated vertically (i.e., its height must be made greater than its width). This procedure serves the following purposes: the pipe will be stronger, and it will look round after the weight of the fill has flattened it.

Flexible pipe may be elongated at the manufacturing plant or in the field. If performed at the plant, which is preferred, wire ties are placed horizontally across the pipe to pull in the sides and push the top and bottom further apart. However, conditions may require that the pipe be elongated in the field by inserting vertical wooden struts at intervals between a wooden cap at the top of the pipe and a wooden sill at its bottom. When strutting is removed, the bituminous pavement, if damaged, should be repaired with bituminous material conforming to the requirements of the **Standard Specifications**.

Struts should be examined each day from the time the depth of the fill above the top of the pipe exceeds 5′ (1.5 m) until the embankment is completed and thoroughly compacted. If there is no sign that the top cap or the bottom sill in the pipe is about to bend, or that the corrugations in the pipe are being crushed, the struts are usually left in place until the project is completed. Whenever any sign of such bending or crushing is noticed, the wedges at the ends of the struts should be loosened. If necessary, the struts should be removed. Tied pipe must be watched carefully while the backfill is being placed. If there is any sign that the ties are denting or damaging the pipe, the ties should be cut.

604.2.6 Backfilling and Compaction

The Project Inspector must ensure that the pipe has been properly laid, inspected for damage, and approved prior to beginning the backfilling operation, which must be performed as specified in Section 604.8 of the **Standard Specifications**. Pay particular attention to the quality control testing and density acceptance requirements. The use of flowable fill must be approved by the Project Engineer. Check that the granular backfill material conforms to specified requirements and is free of muck, large stones, lumps, and debris so that uniform compaction can be achieved.

Do not permit the use of bulldozer or other bladed equipment to place backfill. Mechanical equipment with buckets is permitted. To obtain uniform pressure around the pipe, the backfill material must be placed in approximately 6″ (150-mm) layers and thoroughly compacted. Mechanical tampers are normally used. The compacted layers should generally not exceed 4″ (100 mm). Water should be added as needed to bring the material to optimum moisture content for maximum consolidation. To avoid displacing or unduly stressing the pipe, verify that backfilling is performed equally on both sides of the pipe simultaneously. Special care should be given to tamping material under the haunches of the pipe. Excessive compactive effort under the haunches may raise the pipe above the intended grade.

The compacted backfill should extend at least to the top of the trench. For pipe 60″ (1500 mm) or greater in diameter that is not in a trench condition, the compacted backfill should extend 2′ (0.6 m) above the top of the pipe. All field personnel should be cautioned to carefully observe the few feet of fill placed directly over the pipe to prevent the incorporation of any large rocks in this area. Heavy equipment can maneuver rock into this critical area. Pipe culverts should be adequately protected from damage before heavy equipment is operated near or over them. Water can sometimes be used to facilitate the settlement of granular backfills but it should never be used where conditions are such that liquid or semiliquid pressure may be developed within the berm area.

Timber braces and sheathing must be raised or removed as the trench is filled, but enough timbering should always be left in place to keep the trench safe. If uprights are left in place until the trench has been backfilled, the voids left when they are pulled out should be filled with dry sand. A piece of board should be used to push the sand into the hole and to compact the sand.

If there is any sign of trouble with elongated pipe, and the struts or ties do not interfere too much with the flow of water, the struts or ties should be left in the culvert until the embankment has been completed and has had time to settle. After struts and ties have been removed from a pipe that has been elongated, the vertical diameter of the inside of the pipe, including the thickness of any paving, should not be less than the nominal diameter by more than 1%. Also, the vertical diameter of the inside of any piece 20′ (6 m) long should not vary by more than 2″ (50 mm). The removal of struts and ties should always be checked during final inspection.

Upon completion of the installation, perform a final inspection for reasonably close compliance with staking details, specification conformance, and fulfillment of the purpose for which the culvert was planned.

604.2.7 Structural Plate Pipe, Pipe Arches, and Plate Arches

604.2.7.1 Preliminary Studies

Detailed instructions for erecting structural plate pipe will be shipped with the material. Obtain a copy of these instructions from the Contractor and study them carefully. In addition, consider the guidelines in these sections. Prior to beginning the work, perform a check measurement to ensure that the design length will be sufficient to fit plan grade and alignment.

604.2.7.2 Pipe Bedding

The width of bedding for structural plate pipes need not exceed the width of the bottom plates. The 15% overall height requirements for bedding will not apply except when the pipe is first assembled and then placed in the trench. Where pipe is laid on existing ground, special care must be taken to ensure full uniform support along the barrel of the pipe.

604.2.7.3 Pipe Assembly

Assembly of the structural plate pipe should be started at the upstream end. The bottom plates are lapped and offset. Bolt holes near the center should be lined up, and the bolts should be inserted and nuts fastened as soon as each plate is set. The longer bolts are used at points where three plates overlap. The longest bolts are used first to draw the plates together, and these bolts are then replaced with standard bolts. After enough bottom plates are connected, the side plates just above them are added and held in place with a few bolts. The additional side plates and top plates are then assembled. When all plates are in position, any missing bolts should be installed and the nuts snugged. Nuts should be tightened uniformly, those at the upstream end being adjusted first. After all nuts have been tightened, they should be retightened. This adjustment may be started at either end. Use the turn-of-nut method and the manufacturer's

recommendations to inspect the tightness of nuts.

A structural plate pipe arch is assembled in much the same manner as a structural plate pipe. The work is begun at the upstream end. After the base angles have been placed, the lowest side plates are set on them. Some other side plates and some top plates are then fastened in place with a few bolts on which the nuts are snugged but not tightened. Next, the remaining side plates and the top plates of one complete ring of the arch should be bolted into place. At this time, just enough bolts should be used to hold the plates in place, and the nuts should not be tightened securely. Drift pins will be helpful in matching the bolt holes, and temporary props can be used to help hold the plates in place until connections can be made. After one complete arch is in place, the next set of plates is assembled. Plates should be overlapped by one corrugation. After all the arch sections are in placed, all bolts and nuts should be installed. Then the nuts should be progressively tightened and retightened, as described for structural plate pipe.

If the assembly procedures are not strictly followed when field assembling structural plate pipes and arches, rotation or spiraling of the barrel of the unit will usually result. Once this condition starts, it becomes worse as succeeding sections are assembled, causing the arch and invert to rotate out of position. This condition weakens the load carrying capacity of the structural plate pipe or arch, necessitating complete removal or removal to a point where a rotation is within acceptable limits, at which point correction plates must be installed. This removal or correction results in unnecessary delays to construction of the project.

604.2.7.4 Strutting Considerations

A round structural plate pipe is strutted in much the same way as flexible pipe (see Section 604.2.5.3). A crosspiece of soft wood should be used between each vertical strut and the top sills, so that the pipe can compress slightly under heavy loads. The vertical elongation should be not less than 4% nor more than 6%. Struts of the specified length and sizes should be inserted progressively from one end of the pipe to the other. Jacks are required to elongate heavy gauge structural plate pipe. A structural plate pipe arch should not be strutted. However, props may be required while the embankment material is being placed, to make sure that the full vertical height is maintained.

604.2.7.5 Field Paving of Invert

Paving the lower part (i.e., invert) of a structural plate pipe is generally required to improve the flow and prevent wear by sand and gravel that is carried through the pipe during periods of rapid flow. The surface to be field paved should be thoroughly cleaned and dried, and the priming material must be sufficiently applied with a brush or a mop to coat the surface and fill all seams and joints. All other details are provided in Section 604.9 of the **Standard Specifications**.

604.2.8 Jacking and Tunneling

When jacking or tunneling is designated on the Contract Plans or approved by the Project Engineer/Supervisor, the Project Inspector is responsible for ensuring compliance with Section 604.11 of the **Standard Specifications**. Any departure from the specifications must be approved in writing by the Project Engineer/ Supervisor. This procedure is applicable to either reinforced concrete or corrugated metal pipe. The Contractor is responsible for ensuring that the strength of the pipe can adequately withstand the jacking force. Pay particular attention to requirements for approach trench, pipe guides and collars, jacking equipment, and the allowable tolerance of deviation from plan alignment and grade. The jacking operation should be performed on a 24-hour basis to prevent the pipe from “freezing” in place. Lubrication may be required. Verify that joining

of sections and backfilling are performed as specified.

604.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Reports all information (e.g., laboratory numbers from shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report, Inspector's Pipe Culvert Worksheet, and Inspector's Small Drainage Structures Worksheet, as appropriate. If in doubt as to whether or not information is important or beneficial, record it.

Section 605

MANHOLES AND INLETS

605.1 GENERAL REQUIREMENTS

605.1.1 Description of Work

Section 605 of the **Standard Specifications** governs the material and construction requirements for manholes and inlets. Unless the type is specifically designated, these items, or portions thereof, may be precast or cast-in-place. See Section 601 for information on reinforced concrete structures and bridge decks and Section 602 for information on reinforcing steel. When Item 605 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor installs or adjusts manholes and inlets in accordance with Section 605 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

605.1.2 Curbs, Gutters, Inlets, and Catch Basins

In urban areas and some cut sections in rural locations, curbs or combination curbs and gutters are generally provided to intercept and carry surface water to inlets and catch basins, which empty into storm sewers. Such facilities are typically constructed of Portland cement concrete or asphaltic concrete.

605.1.3 Storm Sewers

A storm sewer is typically provided to rapidly carry away the water that falls on, or runs onto, a city street or other paved area. Water from the paved surface enters the storm sewer through inlets or catch basins that are placed in the gutter section. To prevent the storm sewer from being filled with dirt or trash that is washed from the paved surface, a catch basin, which is constructed with a void just below the pipe intake, is provided to store this material. Once in operation, the catch basins must be periodically cleaned to prevent this void from overflowing and allowing the material to be washed into the storm sewer. Manholes are placed along a storm sewer to allow access from the street to inspect the pipes for any necessary cleaning. A headwall of concrete or masonry is constructed at the outlet end of a storm sewer to hold the pipe firmly in place and to prevent erosion around the pipe.

605.1.4 Materials Considerations

Many different types of materials will be needed for manhole and inlet work. Component materials of manholes and inlets will be sampled, tested, and approved prior to the start of their manufacture and inspected and labeled at the manufacturing plant in accordance with MP 700.00.01 and Section 605.2 of the **Standard Specifications**. Upon delivery, check that manholes, inlets, catch basins, covers, frames, grates, and other related materials are shipped from pre-approved DOH sources and document laboratory numbers from the shipping documents in the Inspector's Daily Report.

605.2 INSPECTION GUIDELINES

Prior to starting work on manholes and inlets, review the Contract. Verify existing drainage conditions, and check that the structures are staked at the proper location and elevation. Consider the following:

1. Safety Considerations. Review safety requirements for trenching operations and confined space entry. Do not enter manholes, inlets, or

other confined spaces without taking the proper safety precautions. Check the excavation operation for compliance.

2. Precast Structures. Upon delivery of precast structures, verify that they are shipped from an approved DOH source with accompanying shipping documents. Check the type and dimensions of precast items for conformance. Where applicable, check the spacing of stair rungs for compliance. Pay particular attention to defects and damage that may have occurred during shipping.

3. Cast-in-Place Structures. Where cast-in-place structures are used, check forms and reinforcing steel for proper condition and dimension.

4. Flowline Elevation. Regularly check the elevation of the pipe invert.

5. Manholes. Verify that manholes are used at each change of grade line. A smooth flowline must be provided between manholes and pipes. Check that a good union with pipes is achieved. Where precast sections are used, check that neat joints are constructed. Verify the proper use of brick and mortar to make field adjustments.

6. Inlets. Check for proper dimension, formwork, concrete placement, and curing. Where slot inlets are specified, use the Inspector's Slot Inlet Worksheet during inspection.

7. Weep Holes. Verify that weep holes are installed in the sidewalls of inlets to properly drain the subsurface material. Weep holes are approximately 4″ (100 mm) in diameter and are located at or below the subgrade elevation. Check that loose rock is placed around the outside of the structure at the openings to prevent excessive backfill material from passing through the weep holes.

8. Backfill. Check the backfill material and the backfill and compaction operations for conformance.

9. Cleaning. Do not permit the Contractor to store materials or hand tools in inlets or catch basins. Verify that all drainage structures are cleaned of any debris prior to accepting the work.

10. Frames and Grates. Check the setting and bedding or casting of metal frames for compliance. Check grates for acceptability with respect to type, dimension, orientation, and galvanization. The grate should set in the frame without rocking.

11. Manhole Covers. Check the type and dimension of manhole covers for compliance. Where located within pavements, check the slope and elevation of covers.

12. Mortar/Grouting. Verify that any needed mortar repairs and grouting around pipe are properly performed.

13. Grade Adjustment. When grade adjustment of existing structures is specified, check that existing frames are removed and reconstructed and adjustment rings are used, where appropriate.

605.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Reports all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Inspector's

Slot Inlet Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 606

UNDERDRAINS

606.1 GENERAL REQUIREMENTS

606.1.1 Description of Work

Depending on the design application, subsurface drainage may include items such as underdrain pipe, blind drains, aggregate filled engineering fabric, free draining base trenches, underdrain outlet pipes, and pavement edge drains. Pavement edge drains are typically installed parallel to and near the edge of the pavement to intercept subsurface water that seeps through the pavement surface courses. In general, underdrains are installed to:

1. intercept springs and lower the elevation of the groundwater table below the subgrade;

2. intercept subsurface water from the backslope before it seeps into the subgrade;

3. intercept subsurface water that may cause slides on the side slope of a cut; and

4. correct base failures due to seepage of subsurface water.

Where Item 606 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor installs the underdrains in accordance with Section 606 of the **Standard Specifications**. The type, size, and location of underdrains will be designated on the Contract Plans. Where field adjustments are required, they must be approved by the Project Engineer/ Supervisor. See the **Standard Specifications** for the method of measurement for payment.

606.1.2 Design Location

The location of underdrains is usually determined from a soils investigation prior to plan preparation. The locations will be designated on the Contract Plans by stationing. A quantity will typically be specified with a notation that the underdrain material is to be used as directed by the Project Engineer/ Supervisor. Changes in design location or the selection of additional locations must be approved by the Project Engineer/Supervisor and documented in writing. At the earliest practical date after construction begins, a survey should be made to determine where underdrains are required.

606.1.3 Field Adjustment

After clearing and grubbing, during grading, and before embankment construction is started, the Project Inspector should look for signs of seepage, springs, and slides, and notify the Project Engineer/Supervisor to determine if underdrains are required. Water seepage often occurs during the spring thaw and after heavy rains. The use of test pits and trenches should be considered to locate the source of seepage, especially in the subgrade. Underdrains must be located at low points to properly collect and remove subsurface water. Pay particular attention to signs of seepage in bench cuts. For underdrains to function properly in slide areas, the loose material must be removed and the underdrains installed above the slide area. It may be necessary to use deep trenches at these locations.

606.1.4 Material Considerations

Check that all pipe for underdrains and edge drains, sand and gravel filter material, and engineering fabric that are delivered to the job site conform to the requirements of Section 606.2 of the **Standard Specifications** with

respect to type, size, class, and gradation. Pay particular attention to allowable substitutions. Verify that materials are shipped from pre-approved DOH sources, and document laboratory numbers on the Inspector's Daily Report from the shipping documents.

606.2 INSPECTION GUIDELINES

Prior to installation, study the details of the Contract Plans, **Standard Specifications**, and **Standard Detailed Drawings** for the types of underdrains to be installed. The installation of underdrains should be performed as soon as grade is achieved, so that the subgrade is not softened and the base course is not weakened by subsurface water.

606.2.1 Protection of Underdrains

It is very important to ensure that underdrains are properly installed and adequately protected during construction. If an underdrain clogs or becomes damaged during construction, cleaning and repair work is expensive and not easily performed. If left in this state of disrepair, the subsurface water will saturate the subgrade and promote pavement failure in that area. Once installed, the underdrain must be protected from contamination by mud and sediments and from damage by heavy equipment until the overlying subgrade material can be placed. Pay particular attention to the use of heavy equipment over underdrains, and require adequate protection from damage.

606.2.2 Staking and Adjustments

Check the location and elevation of staking for conformance. Be alert for adjustments to underdrain locations that may be performed to enhance the functionality of the system.

606.2.3 Trenching and Bedding

Check the grade and dimensions of trenching for compliance. Perform grade checks regularly. Verify that the proper type of bedding material is placed to the proper depth in the bottom of the trench and that underdrain pipe, where used, is firmly embedded in the material.

606.2.4 Pipe Placement

Perforated underdrain pipe must be placed with the perforations down, so that the water table can be lowered as much as practical. Perforated underdrain pipe must be laid so that there are an equal number of perforations on both sides of the pipe's invert. Check for proper joining of flexible pipe sections. To permit the entry of water, non-perforated and rigid pipe must be laid with open joints, with the bell and groove end upgrade, and wrapped with engineering fabric. Check for tearing, folds, and wrinkles in the fabric. Ensure that the upgrade end of underdrain pipe is plugged to prevent entry of soil material. The installation of underdrain pipe must be inspected and approved prior to placement of the filter material.

606.2.5 Aggregate Filter Material

The aggregate filter material for an underdrain must be clean, handled, and protected so that mud or muck does not foul the material during construction. Check that the aggregate filter material is of the specified type, placed over the underdrain pipe to the required height, and covered with sand as specified. Where pipe is being covered, pay particular attention to any unacceptable movement of the pipe.

606.2.6 Backfilling

It is important to prevent surface water from infiltrating the underdrain trench. For this reason, the top of the trench should be sealed with a firmly tamped layer of impervious

material, such as clay soil. Surface water not only overloads the underdrain but also tends to wash fine soil particles into the aggregate filter material. Pay particular attention to the quality control testing and acceptance criteria of the backfill material, and verify that the placement and compaction of backfill layers are in accordance with specified requirements. Do not permit bulldozers or other bladed equipment to be used for backfilling.

606.2.7 Junction and Spring Boxes

Verify that underdrain junction boxes are installed as designated on the Contract Plans. Check the dimensions and elevations of spring boxes for conformance where specified. Backfilling of junction and spring boxes is similar to that required for underdrains.

606.2.8 Outlet Pipe and Slope Walls

The purpose of the outlet pipe is to carry away the subsurface water intercepted by the underdrain, not to collect more ground water. Therefore, the outlet pipe should be firmly joined and non-perforated or, if perforated, oriented with perforations in the upward direction. The outlet pipe is placed in a trench and backfilled. Aggregate filter material is not required. Backfilling is similar to that required for underdrains. Verify that each outlet pipe is marked with a stake and referenced on the As-Built Plans. During construction and just before final inspection, check the outlet pipe of each drain to make certain it is open. Slope walls, or pup walls, are small headwalls used for outlet pipes. Precast slope walls are permitted as long as the slope of the wall matches the side slope. Do not permit the adjustment of the side slope to match that of the wall. Check that slope walls are constructed to the dimensions and elevations designated on the **Standard Detailed Drawings**.

606.2.9 Edge Drains

Prefabricated pavement edge drains are typically installed parallel to and near the edge of the pavement to intercept subsurface water that seeps through the pavement surface courses. Verify that trenching, pipe placement and splicing, backfilling and compaction, and the location and installation of outlet pipe and slope walls are in compliance with the requirements of the **Standard Specifications** and as designated on the Contract Plans.

606.2.10 Blind Drains

A blind drain is an underdrain without perforated pipe that is constructed by excavating a trench to the specified depth and width and partly filling with pervious aggregate. Verify that the installation of blind drains is performed as specified in the **Standard Specifications** and in accordance with the **Standard Detailed Drawings**.

606.2.11 Aggregate Filled Fabric Underdrain

An aggregate filled fabric underdrain consists of a trench filled with porous aggregate that is enclosed with filter fabric. The purpose of the filter fabric is to prevent soil from clogging the aggregate. Pay particular attention to the placement and lapping requirements of the fabric. Tears, folds, and wrinkles in the fabric are unacceptable. Verify that this type of underdrain is constructed as specified in the **Standard Specifications** and in accordance with the Contract Plans.

606.2.12 Free Draining Base Trench

Where free draining base trenches are specified, check that they are in installed as specified in the **Standard Specifications** and in accordance with the Contract Plans. Pay particular attention to the acceptability of trenching, placement and lapping of engineering fabric, bedding and

placement of perforated pipe, aggregate backfill, and the location and treatment of outlet pipes and slope walls.

606.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 607

GUARDRAIL

607.1 GENERAL REQUIREMENTS

607.1.1 Description of Work

Section 607 of the **Standard Specifications** governs the material and construction requirements for guardrail. When Item 607 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor sets, resets, or removes and stores guardrail in accordance with Section 607 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

607.1.2 Types of Guardrail

Where guardrail is warranted, it is installed to prevent errant vehicles from leaving the traveled way and moving into fixed objects, steep slide slopes, and opposing traffic. Different types of designs exist to address specific conditions. The types of guardrail that are typically specified include Type 1 – Galvanized Steel Deep Beam Type Guardrail and Type 5 – Galvanized Steel Double-Faced Guardrail (Deep Beam Type). Both Type 1 and Type 5 are classified as follows, which will be specified in the pay item and designated on the Contract Plans:

1. Class I. Class I guardrail has a 6′-3″ (1905 mm) post spacing with blockouts.

2. Class II. Class II guardrail has a 12′-6″ (3810 mm) post spacing with blockouts.

3. Class III. Class III guardrail has a 12′-6″ (3810 mm) post spacing without blockouts.

4. Class IV. Class IV guardrail has a 3′-1.5″ (952 mm) post spacing without blockouts.

5. Class V. Class V guardrail has a 3′-1.5″ (952 mm) post spacing with blockouts.

6. Modified Cut Slope Terminal. A modified cut slope terminal consists extra long guardrail posts, an additional W-beam guardrail section placed as the bottom beam, and standard guardrail cut slope terminal components.

607.1.3 Material Considerations

Materials for guardrail must conform to the requirements specified in Section 607.2 of the **Standard Specifications**. Check the type of rail system for conformance, including rail sections, hardware, and posts. Verify that new materials are shipped from pre-approved DOH sources, and document laboratory numbers on the Inspector's Daily Report from the shipping documents. When removal and/or resetting or storage is specified, pay particular attention to damaged materials and storage methods, and know the disposition of all salvable materials.

607.2 INSPECTION GUIDELINES

Consider the following guidelines when inspecting guardrail installation:

1. Staking. Verify stake locations. Check lateral offset, longitudinal length, termini location, post spacing, rail curvature, parabolic flares, and trench width, where applicable.

2. Guardrail Post Installation. Unless designated otherwise, guardrail posts may be driven in place, set in dug holes, or set on a concrete base. Check post spacing, elevation, and alignment regularly. Where posts are driven, watch for irregular movement,

possibly indicating an underground obstruction. Check driven posts for damage (e.g., distortion, burring). Where posts are set in dug holes, watch for overdrilling and require backfilling and compaction as needed to adjust depth and provide a firm foundation. After setting, verify that backfill material is placed and compacted in layers around posts. Check that all posts are set firm and plumb and that they are within tolerance of the required alignment and elevation.

3. Installation of Rail Sections. Check that all fittings and metal plates are securely placed in the correct position. Check that rail sections are properly lapped in a smooth, continuous installation. Check that all bolts are drawn tight. Check the rail height and rail face (i.e., with respect to lateral offset and alignment) for conformance and any needed adjustment.

4. Terminals and Transitions. Pay particular attention to the construction details for end treatments, median terminals, and rail transitions (e.g., post type, post spacing, number of rail sections, lapping direction, splices, method of connecting, fastener type, reflector tab location). Specialized hardware and designs are commonly used at these locations and require close inspection prior to acceptance.

5. Traffic Considerations. Where the facility will be maintained open to traffic, it is good construction practice for the installation of rail sections to closely follow the installation of guardrail posts. At the end of the workday, check to ensure that the termini of exposed rail sections are treated as specified.

607.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Inspector's Guardrail Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 608

RIGHT-OF-WAY FENCE

608.1 GENERAL REQUIREMENTS

608.1.1 Description of Work

Right-of-way fences and gates are generally placed within the WVDOH right-of-way. When Item 608 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor installs right-of-way fences and gates in accordance with Section 608 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

608.1.2 Material Considerations

Materials for right-of-way fence must conform to the requirements specified in Section 608.2 of the **Standard Specifications**. Many different types of materials may be required, including:

1. barbed wire, chain link, and woven wire fence fabric;
2. steel posts, post braces, gate frames, and gates;
3. pressure treated wood posts, braces, and preservative treatment;
4. zinc primer and aluminum paint;
5. concrete and forms for footers; and
6. miscellaneous hardware and fittings.

The Contractor will indicate at the Pre-construction Conference the type of post that will be used throughout the project. Know the required type of fencing and gates. Check materials for conformance with respect to type, size, and schedule. Check the weight, length, and coating of steel posts and the preservative treatment, straightness, and size of wood posts for acceptability. Verify that materials are shipped from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report. Reject materials that have been damaged during storage and handling.

608.2 INSPECTION GUIDELINES

Regularly check line, grade, and post spacing, and consider the following guidelines during the installation of right-of-way fencing:

1. Agreements. Activities are generally confined to the area adjacent to the right-of-way fence. As needed, verify the Contractor has obtained agreements with property owners of adjacent private property. Check right-of-way agreements for any special fencing requirements.

2. Temporary Fence. Verify if temporary fence is required (e.g., livestock stock control, pedestrian safety, wetlands protection). Electric fencing may be required for livestock protection and plastic fencing may be required around vegetation that is to be protected.

3. Staking. Check that the staked alignment is approximately 12″ (300 mm) inside WVDOH right-of-way, unless otherwise specified, and that the post spacing is properly marked.

4. Clearing, Grubbing, Trenching, and Hole Excavation. Verify that clearing, grubbing, trenching, and post hole excavation is properly performed. Pay particular attention to the lines, grades, and dimensions specified in the **Standard Specifications** and designated on the Contract Plans.

5. Posts. Check that posts are set at the specified depth, elevation, orientation, and spacing. Verify that metal posts are set to face the correct direction. Pay particular attention to the requirements of posts that are set in rock.

6. Corner and Line Brace Posts. Check for properly located corner and line brace posts. Verify that line braces have been installed where needed for grade changes. Ensure that junctions with existing fencing is properly performed.

7. Concrete Footers. Check that concrete footers are formed, poured, graded to drain, and cured as specified. Concrete must be allowed to set sufficiently around posts and braces. Verify that the concrete has been permitted to gain the required strength before the fabric or wire is stretched.

8. Wire/Fabric. Know which side of the post the fence fabric or wire is to be installed. Check that the fence fabric or wire is properly stretched and fastened.

9. Electrical Grounds. Check conformance of the installation of electrical grounds.

10. Painting. Verify that fence materials are painted or touched up as specified.

11. Advertising Signs. Ensure that no advertising tags or signs are placed on fencing or within the right-of-way.

608.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Inspector's Right-of-Way Fence Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 609

SIDEWALKS

609.1 GENERAL REQUIREMENTS

609.1.1 Description of Work

Section 609 of the **Standard Specifications** governs the material and construction requirements for Portland cement concrete sidewalks. When Item 609 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 609 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

609.1.2 Material and Equipment Considerations

Verify that the concrete mix components and proportions, preformed, expansion joint filler, bed course material, and joint sealing materials comply with the requirements of Section 609.2 of the **Standard Specifications**. Check that the concrete complies with the specified class and that the mix design has been approved. Ensure that the specified sampling and testing requirements are met. Where reinforcing steel is required, check to ensure that the reinforcement is of the proper type and size. Check the type, number, and condition of equipment that will be used to place, consolidate, finish, and cure concrete. Where forms are used, ensure that they are in good condition and of the proper type and dimension. Where slipforming is used, check the slipforming equipment for acceptability. Ensure that the Contractor has adequate materials on hand to properly cure and, as needed, protect the concrete during cold weather. As applicable, verify that materials are shipped from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

609.2 INSPECTION GUIDELINES

Portland cement concrete sidewalks will be constructed on a solid foundation, typically bed course material, that has been properly graded and compacted. Consider the following guidelines during inspection:

1. Subgrade. Check the cross-slope, elevation, and alignment of the subgrade for compliance. Where bed course material is required, ensure that the required type and depth of material is properly placed, shaped, and compacted. Check for soft spots, and enforce the Contract provisions with respect to needed repairs. Ensure that all unsuitable material is removed and replace with suitable material. Do not permit construction on a frozen base. Freeze-thaw cycles tend to loosen a compacted base. Recheck base density after freezing and thawing. Verify that the subgrade is tested by means of a template.

2. Curb Ramps. Review the location and construction details of curb ramps that are designated in the Contract. Pay particular attention to the slope and surface finishing requirements of curb ramps. A textured surface finish is typically required, and field adjustments may be needed to meet slope requirements. Review the locations of drainage structures to ensure that no new drainage structures are aligned with curb ramps.

3. Forms. Where forms are used, check that they are set to the proper line and elevation with respect to grade stakes and that they are firmly staked into position. Pay particular attention to how forms are set with respect to locations of inlet sections, curb ramps,

and driveways, and require adjustments where needed. Ensure that forms are set to accommodate drainage. Prior to placement of concrete, verify that forms are treated with an approved release agent.

4. Reinforcement. Where reinforcing steel is required, check spacing, clearance, and supports for acceptability.

5. Moistening of Foundation. Ensure that the foundation has been thoroughly moistened before the placement of concrete.

6. Placement and Consolidation. Check for the proper placement and consolidation of concrete. Where slipforming is used, check that the grade has been trimmed to the correct line, cross-slope, and elevation. Check grade stakes, grade line, and electronic controls for proper adjustment, including locations of inlet sections, curb ramps, and driveways. Regularly check alignment, elevation, and cross-slope during slipforming, and ensure that the extruded section conforms to typical section, especially the pan (i.e., spill or catch).

7. Joints. Check that transverse expansion joints and saw cuts are located and constructed properly. Joint types and locations should match those in adjacent concrete. Ensure that approved expansion material is placed to full depth in the joint reservoir. Verify that edging is performed where required.

8. Finishing. Verify that the concrete sidewalk is struck off, vibrated, troweled, broomed, edged, and jointed as specified. Check the acceptability of the surface finish. Pay particular attention to texturing requirements (e.g., curb ramps). The finishing operation ideally should be accomplished without the use of additional water.

9. Curing. Verify that concrete is properly cured for the specified curing period. Where curing compound is used, check that it is of an approved type and that the rate and time of application are acceptable. Ensure that the Contactor complies with the provisions for concrete protection during cold weather.

10. Protection. Verify that the Contractor protects the sidewalk for the specified time period. Traffic will be permitted on the sidewalk at the discretion of the Project Engineer/Supervisor.

11. Form Removal and Backfill. Form removal and backfill must not be started until the concrete has reached sufficient strength to withstand damage. Ensure the edges are adequately shouldered. Watch for damage to the concrete during the backfill operation.

609.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 610

CURBS, COMBINATION CURBS AND GUTTERS, AND MEDIANS

610.1 GENERAL REQUIREMENTS

610.1.1 Description of Work

Section 610 of the **Standard Specifications** governs the material and construction requirements for constructing or resetting plain concrete curbing, integral concrete curbing, combination concrete curb and gutter, reflective concrete curbing, asphalt curbing, and medians. When Item 610 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 610 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

610.1.2 Material Considerations

Many different types of materials are required for work under Item 610. Prior to beginning the work, verify that all materials conform to the requirements of Section 610.2 of the **Standard Specifications**. Check materials that are shipped from pre-approved DOH sources, and document their laboratory numbers from the shipping documents on the Inspector's Daily Report. Know the concrete class and mix requirements for any concrete work to be performed, especially for reflective concrete curbing. For asphalt work, verify the laboratory number assigned to the Contractor's approved Job-Mix Formula. Pay particular attention to quality control sampling and testing requirements for asphalt content and gradation and verify that they are maintained within allowable tolerance.

610.2 INSPECTION GUIDELINES

610.2.1 Concrete Curbs and Medians

Consider the following inspection guidelines for plain concrete curbing, integral concrete curbing, combination concrete curb and gutter, and medians:

1. Foundation. Check the alignment, grade, width, and depth of the excavated foundation for acceptability. Ensure that any unsuitable material is removed and replaced with suitable material. If bed course material is specified, check the width and depth for compliance. The foundation must be thoroughly compacted.

2. Concrete Forms. Forms for concrete work may be either wood or metal. Check forms for acceptability. The forms must be clean, free of damage and warps, and set to the proper grade, alignment, and depth. Once installed, verify that the forms are firmly braced and secured.

3. Concrete Placement and Finishing. Just prior to concrete placement, the foundation should be moistened and the forms cleaned and oiled. Check concrete placement and vibration for compliance. Ensure that drainage openings are provided at the required size and elevation. Slip forming is permitted if the work is not required to be integral with or tied to a concrete pavement. If used, check that the track is set to the proper line and grade, the slip form provides the proper cross-section, and the mix consistency does not allow the formed concrete to slump.

4. Joints. Check section lengths for compliance. Where the work will be abutting concrete pavement, sections should match contraction and expansion joints. Check joint intervals and width for compliance, and ensure that joints are properly filled with joint sealing material or preformed expansion joint filler, as appropriate.

5. Curing. Verify that the concrete is maintained moist for the specified curing period. Check that the Contractor's method of curing complies with specified requirements.

6. Form Removal. Forms should generally not be removed for the first 24 hours. When removed, pay particular attention to any damage to the work and require repairs based on the provisions of the Contract. Once removed, verify that the Contract finishes the exposed faces of the concrete as specified. Plastering will not be permitted.

7. Backfilling. Check that the voids in front and back of the work are properly backfilled and thoroughly tamped.

8. Reflective Concrete Curbing. Where reflective concrete curbing is specified, pay particular attention to the specified reflective mortar mix and application methods. If the entire curb is not constructed of the mix, check that the exposed curb face is treated with the mix within the specified time period. Watch for unacceptable discoloration and the need for repairs.

9. Resetting Curb. Where curbing is reset, ensure the Contractor carefully removes, cleans, and stores the curbing to be reset. Require replacement if damaged. Verify that the curbing is reset on a firm foundation true to the required line and grade. Cutting and fitting may be required. Pay particular attention to the specified maximum joint widths and the requirements for end dressing and preformed expansion joint fillers. Once reset, verify that voids in front and back of the curb are backfilled and thoroughly tamped.

610.2.2 Asphalt Curbing

Consider the following guidelines during the inspection of asphalt curing:

1. Equipment & Tools. Asphalt curbing is constructed using a self-propelled curbing machine or paver with a curb attachment. Check the acceptability of the machine and ensure that the formed curb is uniform in texture, shape, and density. Also, verify that the Contractor has on hand necessary hand tools and equipment for the work.

2. Foundation. Where excavation is required, verify that the foundation is the proper alignment and grade and is thoroughly tamped. If laid on a fresh laid asphalt surface, check that the surface is cleaned prior to curbing. If laid on an aged concrete or asphalt base, ensure that the surface is thoroughly swept, cleaned, dried, and tacked prior to curbing. Check the rate of application of tack and watch for overspray.

3. Mix Placement. Check the asphalt mix temperature for compliance. Hand placement and forming is permitted for short inaccessible sections and sections with short radii. Do not allow curbing to be placed during inclement weather or below the specified minimum ambient temperature.

4. Joints. The asphalt curbing operation is generally continuous so that joints are eliminated. However, where joints are required after the operation is halted, verify that the contact surface of previously laid curb is coated with hot asphalt material prior to restarting.

5. Curing and Painting. Once placed, the curbing must be protected from traffic until the heat in the mix dissipates and the curb hardens. The curb should then be painted

with a coat of emulsified asphalt as specified to prevent moisture absorption.

610.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Reports all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 611

PRECAST CONCRETE TRAFFIC DIVIDERS

611.1 GENERAL REQUIREMENTS

611.1.1 Description of Work

Section 611 of the **Standard Specifications** governs the material and construction requirements for precast concrete traffic dividers. When Item 611 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 611 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

611.1.2 Material Considerations

Inspect the material upon arrival. Verify that precast concrete traffic dividers, joint sealer, and joint mortar conform to the requirements specified in Section 611.2 of the **Standard Specifications**. Ensure that the proper type, height, and shape of traffic dividers are supplied from a pre-approved DOH source, and document laboratory numbers from the shipping documents on the Inspector's Daily Report. Do not accept damaged dividers.

611.2 INSPECTION GUIDELINES

Review the Contract Plans and consider the following when inspecting the installation of precast concrete traffic dividers:

1. Foundation. Where excavation is required, check the depth, width, and alignment for compliance. Ensure that the foundation is compacted to density and brought to the required grade. Where placed in conjunction with an asphalt pavement project, the dividers should not be placed until the pavement is placed and compacted. Where placed in conjunction with a concrete pavement project, verify that an opening of the required size is formed into the pavement surface to accept the base of the divider.

2. Placement. Prior to placement, verify that the pavement surface is swept or flushed clean of sand and stone. During placement, regularly check the alignment and connections for acceptability. A straightedge should be used to check alignment of the face in the longitudinal direction. Corrections should be made where out of tolerance. Check that sections are attached per construction details. Once installed, the opening remaining between the pavement surface and the traffic dividers should be filled with joint mortar or joint sealer, as specified.

3. Guardrail Transitions. Pay particular attention to the construction details for end treatments, median terminals, and rail transitions (e.g., post type, post spacing, number of rail sections, lapping direction, splices, method of connecting, fastener type, reflector tab location). Specialized hardware and designs are commonly used at these critical locations and require close inspection prior to acceptance.

4. Lifting Holes. Verify that lifting holes in the dividers are properly filled and sealed as specified.

5. Protection. The Contractor is responsible for maintaining the traffic dividers free of defects and damage. Require removal or replacement based on the provisions of the Contract.

611.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 612

TUNNEL LINER PLATE

612.1 GENERAL REQUIREMENTS

612.1.1 Description of Work

Section 612 of the **Standard Specifications** governs the material and construction requirements for tunnel liner plate. When Item 612 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 612 of the **Standard Specifications** and as designated on the Contract Plans. See **Standard Specifications** for the method of measurement for payment.

612.1.2 Material Considerations

Inspect all materials for conformance to the requirements specified in Section 612.2 of the **Standard Specifications**. Check that applicable materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents. Check that the high-strength bolts and nuts provided comply with specified requirements in terms of ASTM specification, diameter for application, length, and coarse threading. The hardware will be either galvanized or cadmium plated. Field paving material will be Class B concrete, and grout will be Portland cement and sand proportioned for field conditions.

612.2 INSPECTION GUIDELINES

The tunneling and lining operation may begin at either end. During the prosecution of the work, consider the following inspection guidelines:

1. Shop Drawings. The Contractor is responsible for furnishing shop drawings showing typical sections and plate and connection details. Plates should be marked to correspond to the shop drawings. The Contractor is also responsible for providing an experienced Superintendent to oversee this work.

2. Shaft Excavation. If may be necessary to excavate a shaft to reach grade for the tunnel. If so, check the dimensions of the shaft for conformance and ensure that it is sheeted and shored as specified.

3. Tunneling. Verify that the mucking operation does not outpace the installation of the liner plates and that the spoil is disposed of properly. If unstable soils are encountered, jacking type shields should be installed. Verify that a bulkhead is provided at the construction face at the end of each working day.

4. Alignment and Grade. Regularly check that the alignment and grade is maintained within specified tolerance. The use of laser technology is a quick and efficient method for performing this task. Once out of tolerance, it is difficult to correct.

5. Grouting. Verify that grouting is performed to fill the void between the tunnel excavation and the liner plates. Grouting should be performed daily after the installation of the liner plates.

6. Field Paving. Once the liner plates are in place, verify that the tunnel liner is field paved as specified.

612.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all

information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 614

PILING WALLS

614.1 GENERAL REQUIREMENTS

614.1.1 Description of Work

Section 614 of the **Standard Specifications** governs the material and construction requirements for piling walls. In general, this work involves constructing and tying a piling wall directly into an existing stable slope by placing steel piles in predrilled holes and then grouting, backfilling, and lagging the piles. The exposed steel is then painted. When Item 614 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 614 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

614.1.2 Material Considerations

Inspect all materials for conformance to Section 614.2 of the **Standard Specifications**. Check that materials are supplied from pre-approved DOH sources, and document laboratory numbers on the Inspector's Daily Report. Pay particular attention to the size, type, and grade of steel piles and timber lagging. The quality control of concrete and grout is the Contractor's responsibility as designated in Materials Procedure MP 601.03.50. The Quality Control Plan and the type of corrosion protection will be submitted to the Project Engineer/Supervisor for review at the Preconstruction Conference.

614.2 INSPECTION GUIDELINES

Prior to beginning the work, the Contractor, Project Engineer/Supervisor, and Project Inspector will conduct a site review to verify the limits of the pile wall. During construction, consider the following guidelines:

1. Staking. Check that the location of the piles have been properly staked. The center of the piles should be within 1″ (25 mm) of the locations designated on the Contract Plans.

2. Drilling. Drilled holes are required. Check the hole depth for compliance. The hole depth depends on the minimum length of pile embedment in the bedrock. The estimated pile length and depth to bedrock will be shown on the piling profile. Deviations in depth greater than 2.5′ (0.8 m) require approval by the Project Engineer/ Supervisor. Watch the bit alignment during drilling. The bit may deflect along sloping bedrock layers. Alignment can be easily verified using a plumb bob. Check the minimum diameter of the hole for compliance. Temporary casing of holes may be needed. Ensure that the excavated material is disposed of properly.

3. Pile Installation. In general, the piles should be installed without driving, unless an obstacle is encountered. During installation, check that the pile doe not rotate and that its final orientation is within specified tolerance. Once installed, check that the elevation of the top of the pile is within specified tolerance. If splicing is required, verify compliance of the use of butt welds and splice plates.

4. Painting. Check that the surface of the piles from the top down to approximately 2′ (0.6 m) below the anticipated grout line is properly clean and painted.

5. Grouting. Prior to grouting, check to ensure the hole is pumped free of water and cleaned

of loose soil and debris. Verify that concrete or grout, as specified in Section 614.5 of the **Standard Specifications**, is placed in the bottom of the hole up to the bottom of the lagging. Vibration is not required. This is a continuous operation that should be performed on a daily basis as piles are installed.

6. Lagging and Backfilling. Ensure that lagging of the type and size specified is installed between the piles and that backfilling and restoration of the plan roadway template is performed. Ensure that lagging extends below the original ground line.

614.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 615

STEEL STRUCTURES

615.1 GENERAL REQUIREMENTS

615.1.1 Description of Work

Section 615 of the **Standard Specifications** governs the material, fabrication, assembly, and erection requirements for steel structures. The inspection of steel structures requires a great deal of coordination, attention to detail, and a thorough working knowledge of the Contract documents. These documents include, but are not limited to: **Standard Specifications**, **Special Provisions**; **ASTM Material and Testing Specifications**; **AASHTO Standard Specifications for Bridges**; **AISC Steel Construction Manual**; **ANSI/AASHTO/AWS Bridge Welding Code D1.5**; and the Contractor's Working Drawings and Quality Control Plan. Prior to the start of work, review this documentation and become familiar with the responsibilities of WVDOH and Contractor inspection personnel; quality control sampling and testing requirements; fabrication, assembly, and erection details; welding and painting requirements; dimensional tolerances; and the acceptance criteria specified in the Contract. See the **Standard Specifications** for the method of measurement for payment.

615.1.2 Working Drawings

The following working drawings will be reviewed by the Project Engineer/Supervisor for strength and detail only, not dimensions:

1. Shop Drawings. The Contractor is responsible for submitting detailed shop drawings to the Engineer for review. These drawings will include the State project number, Federal project number, bridge name and number, Contractor's name, fabricator's name and the detail of all structural components and miscellaneous parts, including: material identification, dimensions, sizes, and plate rolling direction.

2. Erection Drawings. The Contractor is responsible for submitting erection drawings to the Project Engineer/Supervisor for review. These drawings will include the proposed method of erection, including: details of all falsework bents, bracings, guys, dead-men, lifting devices, and attachments to bridge members; sequence of erection; location of cranes and barges, crane capacities, location of lifting points, and weights of members. Erection drawings must be sealed by a West Virginia Registered Professional Engineer.

3. Camber Diagrams. The fabricator is responsible for submitting camber diagrams to the Project Engineer/Supervisor for review. These drawings will include the preassembled camber for various structural members, as defined in the **Standard Specifications**.

615.2 FIELD INSPECTION GUIDELINES

615.2.1 Inspection Upon Delivery

Structural materials and fabricated members must be inspected upon delivery and during field assembly and erection. Accept only members that bear the WVDOH stamp of acceptance or are delivered with approved evidence of inspection. Immediately notify the Project Engineer/Supervisor of any members that have not been previously inspected and accepted. Pay particular attention to the following:

1. Storage and Handling. Girders, beams, and other structural members must be handled

carefully to prevent damage, and they must be stored above ground on level platforms or skids to keep them free from dirt and grease. Pay particular attention to how members are lifted and supported. Workers must not be permitted to fasten chains or cable hooks to girder stiffeners, diaphragm connectors, or gusset plates when lifted. Long, non-cambered structural members must be laid flat on supports that are placed fairly close together. Cambered members must be stored so that the proper camber will be maintained. As practical, like members should be stored together and lined up so that errors of length can be easily detected. Check girders and beams for deflection, cracked welds, bends, twists, kinks, and dents. If such damage is found, notify the Project Engineer/Supervisor to ensure that the problem will been satisfactorily addressed. Verify that girders and beams are stored upright and shored and that long members are placed to prevent damage by deflection. Do not allow bent or damaged steel members to be incorporated in the work without prior approval by the Project Engineer/Supervisor.

2. Damaged Members. If the Project Engineer/ Supervisor discovers bent members, notify the Design Engineer. All approved repairs are to be visually inspected. If fractures are suspected, magnetic particle and dye penetration testing may be required for verification.

3. Match Marking. Check match marks on members to ensure that they are arranged, assembled, and erected based on the Contractor's erection diagram.

4. Coating Damage. Watch for damage to shop coating caused by mishandling. As needed, require the Contractor to repair the work.

The Project Inspector must maintain a record in the Inspector's Daily Report of each shipment of steel, including the date on which the shipment was received, the number of pieces of each type, laboratory numbers, shipping documents and the invoice weight.

615.2.2 Falsework

Falsework for steel structures is entirely the Contractor's responsibility. The Contractor is responsible for submitting erection drawings as discussed in Section 615.1.2. These drawings must be designed and sealed by a West Virginia Registered Professional Engineer. The Project Engineer/Supervisor and the Project Inspector should not discuss the acceptability of the erection drawings with the Contractor. If, however, the Project Inspector notices noncompliance with the erection drawings (e.g., temporary struts or ties that are improperly located) or that falsework is distorting flanges or webs of structural members, immediately notify the Contractor and Project Engineer/Supervisor for corrective action.

615.2.3 Bearings and Expansion Devices

615.2.3.1 Bridge Expansion and Contraction

A typical bridge has a fixed end and an expansion end. At the fixed end, the superstructure cannot move. At the expansion end, the superstructure can expand and contract a limited distance along its span during fluctuations in temperature and loading. The expansion device, at the expansion end, and the bearings, on which the superstructure rests, are installed to accommodate this movement.

615.2.3.2 Bearing Devices

Many different types of bearing devices are available, including rockers, rollers, and elastomeric bearings. Elastomeric bearings are generally used in structures to level the structure, support the vertical loads of structural members, and isolate specific movements (i.e., longitudinal, transverse, rotational). Stringent quality control governs the manufacture of these

devices. Elastomeric bearings may be classified as either laminated (i.e., reinforced with laminate sheeting) or plain (i.e., non reinforced). Leveling pads are generally not laminated. Fabrication differs with each bearing type and includes component materials such as elastomeric materials, laminate sheeting materials, adhesives, sealing pots, pistons, and anchor bolts. Note that lubricants are not used in bearing devices. Depending on the application and thickness required, some elastomeric bearings may be designated as either laminated or plain and may require a sole plate, radius plate, or an upper and lower sliding element. Other elastomeric bearings are fabricated to accommodate vertical loads and horizontal movement (i.e., longitudinal, transverse, rotational) due to factors such as thermal expansion and contraction, camber changes, and the creep and shrink of structural members. These devices include the following types of designs:

1. Fixed Bearings. Fixed bearing designs accommodate rotation but not longitudinal or transverse movements.

2. Guided Expansion Bearings. Guided expansion bearings accommodate rotational and longitudinal movements but restrict movement in the transverse direction.

3. Non-Guided Expansion Bearings. Non-guided expansion bearings accommodate rotational, longitudinal, and transverse movements.

4. Pot Bearings. Pot bearings are equipped with a piston and may be designated as either guided or non-guided based on the need to accommodate or restrict horizontal movement.

5. Disc Bearings. Disc bearings are equipped with an elastomeric rotational disc and may be designated as either guided or non-guided based on the need to accommodate or restrict movement.

Prior to fabricating these types of elastomeric bearings, the Contractor should submit shop drawings, design calculations, and load data to the Design Engineer. Review these drawings to become familiar with the storage, handling, and installation procedures (e.g., alignment, offset) and the method of protecting the bearings during welding and painting of the structure. If required by the plans, verify that the Contractor has notified the manufacturer of the bearing to make available a representative to guide and inspect initial installation.

615.2.3.3 Expansion Devices

The concrete back wall should not be built until all superstructure steel and the concrete deck have been placed. At the fixed end, a bearing is installed that will inhibit movement of the deck. At the expansion end, a fairly wide space is left between the deck slab and the back wall, and a bearing is installed that will allow the end of the deck to easily slide toward or away from the back wall. For expansion devices that have been strapped as a unit, spacing must be allowed relative to temperature as specified in the plans before the concrete is placed in the back wall. Any straps across the joint must be removed as soon as the concrete is strong enough to hold the seat angle in position. If they are not removed promptly, movement of the end of the deck slab will cause failure of the anchorage in the back wall.

615.2.3.4 Installation and Adjustment

After the falsework has been removed and the superstructure is bearing its full dead load, bearings and expansion devices must be checked for proper adjustment. The method and amount of adjustment depends on the ambient temperature, the type of device, and the manufacturer's recommendations. At 68ºF (20ºC), the bearings should be nearly centered or vertical, and the anchor bolts of expansion devices should be nearly centered in their slotted holes. If the ambient temperature is higher or lower than 68ºF (20ºC) when these devices are set, they must be adjusted off-center or at an angle from vertical in the proper direction along

the span. The magnitude of adjustment depends on the coefficient of expansion. This coefficient is assumed to be 0.0000067 inch of movement/inch of span/degree Fahrenheit from 68ºF (0.00001206 millimeter of movement/ millimeter of span/degree Centigrade from 20ºC). Adjustments should be made while the steel has a uniform temperature.

For example, if the ambient temperature is 85ºF (29.44ºC) and the span is 90′ (27.432 m), the change in span length (i.e., expansion) would be: 0.0000067 • 1080″ • 17ºF = 0.123″ = 1/8″ (0.00001206 • 27,432 mm • 9.44ºC = 3.125 mm = 3 mm). The steel would be 1/8″ (3 mm) longer at 85ºF (29.44ºC) than at 68ºF (20ºC). To allow for this difference, each device would be initially set so that it is centered or vertical and then would be shifted or angled away from the span a distance of 1/8″ (3 mm). The allowable tolerance of adjustment is ± 1/16″ (± 1.5 mm).

615.2.3.5 Inspection Guidelines

Pay particular attention to the location and setting of bearing devices, expansion devices, rockers, rollers, and anchor bolts. Check that anchor bolts are set in either concrete or grout as specified. Verify proper adjustment to accommodate temperature variation and lengthening of the bottom flange under dead load. Check that movement is not hindered by anchor bolts, nuts, or other obstructions. Consider the following guidelines:

1. Anchor Bolts. Holes for anchor bolts must be at least 1″ (25 mm) deeper than the mortared-in part of the bolt and must be thoroughly cleaned with compressed air. A template should be used to ensure the right bolt spacing. Anchor bolts must be vertical, and each bolt should be set with about 1″ of thread above the nut. Non-shrink grout should be rodded around each bolt and left undisturbed and covered with wet burlap for several days.

2. Concrete Surface/Bearing Seat. Check to ensure that the concrete surface and bearing seat are within tolerance of the required elevation and horizontal or superelevated plane. Verify that the concrete surface is clean and free of cracks. Do not accept grout pads unless previously authorized by the Project Engineer/Supervisor. Check bearing seats for irregularities and proper elevation. If the bearing seat is not properly cleaned and prepared to match the pad surface, the edge of the pad will be loaded sufficiently to cause premature failure of the device. Do not permit elastomeric bearing pads to be used for leveling purposes.

3. Installation and Adjustment. Bearing devices must be set level at right angles to the length of the member it supports, in exact position, with full and even bearing on the masonry. It is essential that the final bearing elevation be checked for compliance. Bearing devices must be in alignment with each other. Check to ensure that sole plates are positioned to the correct grade and superelvation and are in full contact with the bottom flange of the girder. Check the bearing alignment for conformance with the Contract Plans. Verify proper adjustment for temperature, post tensioning, and shrinkage. Watch for interference between anchor bolts and the upper part of the bearing device.

4. Protection of Bearings. Where welding is performed in proximity to non-metallic bearing pads, check for the proper use of wax pencils to monitor the heat generated and prevent damage to the pads. Where the structure is painted, verify protection from overspray and contamination.

5. Metal Railing Considerations. At a location where a rail crosses an expansion joint, provision must be made to allow free movement of the rail section as expansion and contraction of the structure occurs. When provision for this movement is made by means of metal sleeves that are fitted inside hollow rail members, the sleeves should be welded in place on the downgrade side of the joint. Any bends or dips in a railing are easily detected. Care must be

taken to ensure that all posts and rails are set to a uniform line and grade.

6. Final Check. Perform a final check of the bearing devices and require corrective work based on the provisions of the Contract. Following completion of the superstructure, inspect the installation and alignment of each device in the presence of the Contractor. Obtain written certification from the Contractor and manufacturer's representative when required by the plans or specifications that the installation of bearing devices have been correctly installed.

615.2.4 Field Welding Considerations

615.2.4.1 General Welding Procedure

Steel members must be set in the proper position and held securely in place during welding to prevent bending or twisting. The method of securing must not interfere with the welding. The surfaces of the members to be welded should be cleaned thoroughly for a distance of not less than 1″ (25 mm) beyond the edges of the weld on all sides. When two pieces of steel are to be butt-welded, the ends of the pieces must usually be beveled, and rough edges should be made smooth.

615.2.4.2 Quality Welds

A finished dependable weld of good workmanship should have the following properties:

1. a reasonably uniform cross-section with a flat or slightly bulging face and a fairly smooth surface;

2. reasonably straight edges flowing into the base metal;

3. a well-defined crater approximately 1/16″ (1.5 mm) deep;

4. a surface with ridges or ripples spaced closely and uniformly; and

5. a bright surface of uniform color after it has been cleaned with a wire brush.

615.2.4.3 Defective Welds

Common defects in welds and their causes and remedies are as follows:

1. Overlap. Overlap, the term used when the edge of the weld is loose and extends over the base metal, is caused by poor fusion. If the overlap is very small and if the weld need not have its full strength, the weld may be accepted. If the overlap is large or if the full strength of the weld is needed, the weld should be removed and a new weld made.

2. Undercutting. Undercutting is evidenced by not having enough electrode metal. The weld should be thoroughly cleaned and built up to standard size with additional weld metal.

3. Shallow Craters. Shallow craters are caused by not getting enough penetration. Unless the weld is for sealing purposes only, it should be removed and a new weld made.

4. Pits and Pockets. Pits, porosity, and gas pockets are caused by improper procedure. The weld should be removed and a new weld made.

5. Inclusions. Slag and oxide inclusions are caused by improper procedure. Unless the weld is for sealing purposes only, it should be removed and a new weld made.

6. Spatters. If spatters are large and scattered over a wide area, they are caused by the use of an arc that is too long or by poor fusion without enough penetration. The weld should be thoroughly checked, and if there is any doubt about the quality of the weld, the weld should be removed and a new weld made.

7. Irregular Ridge Spacing. Irregular spacing of ridges is caused by variation in the speed of welding. The weld may be accepted unless the arc has been jumped forward so as to leave a space with not enough penetration. Such a fault may be corrected by increasing the length of the weld.

615.2.4.4 Inspection Guidelines

Field welding is only permitted where designated on the Contract Plans or as authorized by the Project Engineer/Supervisor. The Contractor must submit the welding procedure to the Materials Control, Soils and Testing Division for approval. Where permitted, each weld should be inspected after the slag has been removed. The Project Inspector must mark each weld that has been inspected and approved in such a manner that it can be easily identified. Consider the following additional guidelines:

1. Welder Certification. Only a welder who has current certification with the West Virginia Division of Highways will be allowed to weld structural members. Notify the Project Engineer/Supervisor of any welder who constantly makes undersized welds or whose workmanship is poor.

2. Size and Length. The size and length of each fillet weld must be compared with the dimensions shown on the Plans. The size or length may be slightly oversize or slightly longer than specified.

3. Joint Width. Where joints are to be field welded, ensure that they are drawn tightly together before welding. If not, the opening may be large enough to allow the weld to pass between the members and tack to the flange under the joint. These welds appear normal on the surface, are difficult to visually detect, and may cause significant damage to the structure (e.g., fatigue cracks produced by stress risers).

4. Stay-in-Place Forms. Where stay-in-place deck forms are installed, do not allow welding or striking of arcs on the flanges of structural steel members.

615.2.5 Assembly and Erection Considerations

615.2.5.1 Positioning Steel Members

The Project Inspector should make certain that all members are placed in the proper positions, and that main supporting members are in correct vertical and horizontal alignment. The marks painted on the steel for identifying pieces should agree with those shown on the erection drawings, and careful attention should be given to match marks at connections. The Project Inspector should recheck the relative positions of bearing connections in the substructure and superstructure just before the steel is put in place. Bearing surfaces and other contact surfaces must be checked to see that they are clean and free from dirt, grease, or rust. After the structural steel has been erected, the Project Inspector should check the bearings to be sure that each bearing part makes full contact.

615.2.5.2 Drift Pins and Temporary Bolts

Before splicing is begun, the members are usually held together by drift pins and temporary erection bolts. The Project Inspector must make certain that these temporary connections are made in accordance with the requirements of the **Standard Specifications**. Members to be spliced together must be held in their correct position so that the connection can be made properly. Drift pins of the proper size are usually installed first in a few sets of holes, to bring the parts into their proper relative position and to keep the holes in alignment. Bolts of the specified size are inserted into other sets of holes and tightened, to hold the members in contact until the first few bolts are installed. Then the drift pins and temporary bolts are removed, and the splice is completed.

615.2.5.3 Allowable Connection Adjustments

Steel should fit together with little distortion or strain. A slight adjustment with drift pins is to be expected. If the holes are too far out of place, a workman should not be allowed to force the parts into position with drift pins. Improper use of drift pins may damage the material around the holes and will prestress the members. Striking a member with a heavy sledge hammer should not be allowed.

In most structures, a reasonable amount of reaming and drilling to match up holes is allowable. However, no reaming should be allowed in a splice in a main tension member of a truss, unless specific permission is obtained from the Project Engineer/Supervisor.

Any error which cannot be corrected by light drifting, a moderate amount of reaming and drilling, should be reported to the Project Engineer/Supervisor. The proposed method of correcting the fault must be approved by the Project Engineer/Supervisor obtained before the method is used.

Checks and any necessary corrections should be made as the work progresses. Also, before the members are connected permanently, the Project Inspector should check the work again to make sure that all members are aligned properly and set to the required camber. This final checking should prevent any poor alignment from being built into the final structure.

615.2.5.4 High-Strength Bolts

After the members have been drawn together tightly by temporary bolts, the Contractor may tighten high-strength bolts to the required tension by using the turn-of-the-nut method, as defined in the **Standard Specifications**. During the use of the turn-of-the-nut method, the nut on each permanent bolt is first turned so that it is snug tight and then given additional rotation to final tension, as defined in the **Standard Specifications**.

Each connection should be checked by the Project Inspector immediately upon completion, because of the tendency of the bolts to freeze. See Section 615.5.6.4 of the **Standard Specifications**, rotational capacity test records, and turn-of-the-nut test records.

615.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report, Inspector's High Strength Fastener Worksheet, and Rotational Capacity Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 616

PILING

616.1 GENERAL REQUIREMENTS

616.1.1 Description of Work

Section 616 of the **Standard Specifications** governs the material and construction requirements for driving various types of piles. When Item 616 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 616 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

616.1.2 Material Considerations

Inspect the material upon arrival at the job site. Verify that steel bearing piles (H piles), splices, steel pile points, and precast and prestressed concrete pile materials conform to the requirements of Section 616.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report. Do not accept damaged materials.

616.1.2.1 Steel Piles

The steel pile types that are typically used in foundation applications include structural steel shapes, steel pipe, and steel shell piles. The Contract Plans will designate the types required. Upon delivery, review the mill test reports to ensure that the heat numbers on the piles correspond to the those on the reports. Also check and document conformance with respect to pile condition, material grade, length, and cross-sectional shape. Steel H-shaped beams are the most commonly used. It is important to verify that the piles are of the type and size designated on the Contract Plans.

616.1.2.2 Concrete Piles

Concrete piles must be inspected at the fabrication plant by WVDOH inspection personnel. Acceptance may be based on a pre-approved WVDOH source. Concrete piles must be handled carefully to prevent damage. Piles up to 25′ (7.5 m) long may be picked up by attaching the lifting hook a distance from the top of the pile equal to approximately one-third of pile's length. Longer piles should be picked up using two or more points. Check for cracks and spalls upon delivery.

616.1.2.3 Timber Piles

Timber piles should be checked for soundness, straightness, and the minimum and maximum specified dimensions. Verify that all outer bark and at least 80% of inner bark has been removed before driving. Check the pile tip and pile butt to ensure that they have been cut square with the longitudinal axis of the pile. Where soil conditions cause driving difficulties, a timber pile must be pointed and shod with a metal shoe. If metal shoes are required, verify that they are of an approved type and firmly attached to the pile.

616.1.2.4 Pile Tips

Pile tips are used to protect the driving end of a pile and as a cutting edge, especially in rocky soil. Where their use is specified, check pile tips and fastening details for compliance. Ensure that closure plates, driving points, and connection welds do not project beyond the perimeter of

pile tips. This is especially important where steel pipe piles, steel shell piles, and timber piles are used.

616.1.2.5 Concrete

Concrete is generally used to fill the interior of steel pipe and steel shell piles after they are driven and their interior cleaned of debris and water. Where specified, check the concrete class for conformance.

616.2 INSPECTION GUIDELINES

616.2.1 Overview

Piles are load-bearing members made of concrete, steel, timber, or a combination of these materials. They are usually used in locations where the surface soil is too weak or too compressible to provide adequate support for a structure. In such a place, piles are used to transfer loads from the structure to stronger underlying layers of soil or rock. In a few cases, piles may be used to resist lateral forces, or anchor piles may be used to resist the effect of a force causing uplift.

Structural steel shapes are typically used as foundation piles. These piles are driven vertically or near vertically into natural ground to help support the structure and minimize settlement. Without a solid foundation, the attention given to constructing a quality structure is meaningless. As such, the Project Inspector must thoroughly and competently inspect the foundation piling provided for structures.

Many types of piles are available for foundation designs, and each design will differ based on the specific conditions at the site. The Contract Plans will designate criteria such as pile type, number, length, horizontal arrangement, orientation (i.e., plumb, batter), and driving specifications such as design load, driving energy, depth, and number of blows. Each pile that is driven to specification will provide a bearing capacity that will support a fraction of the structure's total load (i.e., design load). The pile's bearing capacity results from a combination of resistant forces, including the surface friction between the pile and natural ground and the bearing pressure of the pile tip on the substrata material (e.g., bedrock). Once driven, the pile should not settle under it's design load.

Although it is equally important to check items such as pile type, location, and orientation, it is paramount to continuously inspect the driving operation with respect to the number of blows each pile receives. The decision to continue or halt the operation must be made quickly. If driving is stopped too soon, the pile will not have developed the required bearing capacity to resist the design load, and the structure may eventually settle due to a lack of support. If overdriven, the pile may incur structural damage, increasing the chance that the foundation will settle or otherwise fail at the location of the damaged pile. It is important to note that the Project Engineer/Supervisor is responsible for determining the acceptability of the pile with respect to its load bearing capacity. The procedures, methods, and criteria by which this determination is made will be specified in the Contract. In making this determination, the Project Inspector is only responsible for assisting the Project Engineer, as directed.

616.2.2 Pre-Driving Considerations

616.2.2.1 Contract Documents

Know the requirements of the job. Review the **Standard Specifications** and Contract Plans with respect to equipment requirements and pile type, length, location, orientation, driving depth, theoretical refusal, bearing capacity, and cut-off elevation. Know the splicing, capping, and painting requirements.

616.2.2.2 Staking and Utilities

Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the

operation begins. Check to ensure that all pile locations have been properly staked in accordance with the Contract Plans.

616.2.2.3 Excavation and Embankments

Where excavation or embankment construction is required, check the plan dimensions, depth, and height for compliance. Unless otherwise directed, excavation and embankment construction must be completed and accepted prior to driving foundation piles.

616.2.2.4 Welder Certification

As needed for splice work, ensure that welders are prequalified for the work. Check each welder's certificate of qualification from the West Virginia Division of Highways. Ensure that the document complies with the minimum period of satisfactory performance for the type of welding to be performed. Retain a copy of all certificates of qualification.

616.2.3 Equipment Considerations

616.2.3.1 Selection and Acceptance

Various types of drop hammers and power hammers are available for driving piles. They are generally operated by steam, diesel-oil combustion, or compressed air. Power hammers may be single acting or double acting. Energy-rating data for pile drivers can be obtained from the manufacturer of the equipment. Equipment selection depends on the type and size of piles to be driven. More than one type of driver may be required for the project.

Before pile driving is started, the Contractor shall provide written certification to the Engineer that the pile hammer, air compressor and air valves have been inspected and found to be in good working condition.

616.2.3.2 Drop Hammers

A drop hammer may be used for driving steel or timber piles. However, a drop hammer cannot be used for driving concrete piles, unless authorized by the Project Engineer/Supervisor.

1. Hammer Weight. The hammer should weigh at least as much as the combined weight of the driving head and the pile. Obtain the actual hammer weight from the Contractor and make sure it meets the minimum specified requirements. As needed, use a certified scale to weigh the hammer and pile cap.

2. Hammer Drop. Hammer drop should not exceed 15′ (4.5 m) for steel and timber piles and 8′ (2.4 m) for concrete piles. Greater drops, especially when a relatively heavy hammer is used, may injure the pile. The use of a relatively heavy hammer and lower fall will usually result in greater pile penetration per blow with less injury to the pile, because there is a greater blow rate and less chance for the soil to compact around the pile between blows. This is especially important in hard ground.

3. Hoisting Line. The hoisting line for a drop hammer must be mounted on a rotating drum that can turn freely for the full length of the hammer drop, and the line must be slack during the fall. If there is any drag of the cable, adjustment will be necessary.

616.2.3.3 Power Hammers

Study the manufacturer's literature and become familiar with the operating characteristics of the power hammer. Ensure that the equipment is in good working order and properly adjusted for the specified rating (e.g., energy per blow, blows per minute).

The weight of the ram must bear the proper relation to the weight of the pile, and the ram must have the proper speed when it hits the pile.

The ram not only must strike the pile with enough energy to overcome the inertia of the pile and the resistance of the soil, but also must be heavy enough to avoid the loss of too much energy during the impact. There will be a great loss of energy if the ram causes damage to the top of the pile. As a general rule, piles should be driven with the heaviest available ram that can be used to obtain the greatest penetration without causing serious damage to the pile. Some manufacturers do not recommend the use of a ram that weighs less than one-fourth the weight of the pile.

For the first few piles, carefully watch the performance of the hammer. When adjusted properly, it should move through its full stroke for the required number of blows per minute. It is important to note that the pressure gage on the air compressor may not indicate the pressure delivered to the ram, due to leaks in valves, rings, bushings, and hoses. For this reason, compressors should be able to furnish 25% greater air pressure than that required at the ram. Nearly all manufacturer's literature specify number of plows per minute based on a mean effective air pressure of 80 psi (550 kPa). Refer to the Appendix of this **Manual** for sample pile hammer specifications.

Once started, the driving of a pile should be continuous. If stopped for a short period of time, the soil becomes compacted and increases frictional resistance around the pile and may cause pile damage when driving is resumed.

616.2.3.4 Pile Caps and Driving Heads

A pile cap must be used on all concrete piles. Pile caps or collars should be used on timber piles to avoid damage to the top of the pile. A driving head should be used on steel piles when driving conditions cause damage to the pile. Where a driving head is required, verify compliance with the manufacturer's recommendations. Hammer cushions and striker plates are typically used to ensure uniform driving behavior and minimize damage to the pile. Where required, verify conformance with respect to type and size. Extra pile cushions and striker plates should be on hand so that, if damaged, they can be quickly replaced.

616.2.3.5 Pile Driving Leads

Leads are required for all pile driving operations. Pile driving leads are used to guide the movement of the hammer, thus ensuring the pile receives a concentric impact with each blow. It is essential that the fall of the hammer be in line with the pile; otherwise the head of the pile may be severely damaged, the hammer may be damaged, the energy of the hammer may be reduced, or the pile may change direction. Leads must be straight, true, rigid, and so constructed that free movement of the hammer is provided. The lead channels should be greased to prevent the hammer from sticking. Leads must be held in position by guys or stiff bracing to ensure support of the pile during the driving operation. The stiffness of the leads is an important factor in holding the pile in line, and this requirement must not be overlooked. The leads should be long enough to accommodate, at a minimum, the pile length and the length of the hammer. It is generally good practice to use a somewhat longer length as a contingency.

616.2.4 Pile Driving Considerations

616.2.4.1 Pile Preparation

Before the pile is lifted to the leads, stretch a tape along the pile and place keel marks along its entire length at 1′ (0.3 m) intervals. From just below the anticipated depth of penetration to the top of the pile, the intervals of the marks should be every 1″ (25 mm). At least every fifth mark should be numbered to show the distance from the pile tip.

616.2.4.2 Pile Location and Orientation

Depending on the design requirement, the pile may need to be driven on a batter, or slope. The

amount of batter will be designated on the Contract Plans. If a pile is to be driven on a batter, the leads and the path of the hammer must be set to the required batter. After the pile has been placed in the leads but before driving is started, the tip of the pile must be carefully placed in the correct location and orientation. As needed, a template should be used as a guide. Verify that the pile is set within tolerance of its designated location. Also, check the pile alignment for deviation from allowable tolerance. Where structural steel shapes are used, verify that flanges are oriented as designated on the Contract Plans.

If a pile for a bridge pier or abutment is found to be out-of-tolerance, give the Contractor the option of driving an offset pile or pulling and re-driving the original pile. If the Contractor elects to drive an offset pile, it must be driven where the greater center-to-center spacing occurs. For example, an offset pile would not be required where the center-to-center spacing is less than the plan measurement. This procedure should be used as a guide when minor errors occur. Sound engineering judgment should be applied in selecting the location of offset piling. Complicated situations should be referred to the Engineering Division. For trestle bents, the Contractor will be required to pull and re-drive piles that exceed the ± 1.5″ (± 40 mm) tolerance. The cost of the offset pile and the cost of any pile that is pulled and re-driven will be borne entirely by the Contractor.

616.2.4.3 Water Jetting

Water jets are commonly used to aid the driving of piles. Concrete piles should never be driven without water jets, unless otherwise approved in writing by the project Engineer/Supervisor. The jet of water should be started as soon as the tip of the pile is set in position and before driving begins. The jet pipe should be placed close to the pile. As the soil is softened and washed away by the water, the pile should sink under the weight of the hammer. If not, light hammer taps should be used. The jet should be raised from time to time, and the hammer should be used without the jet to permit the penetration per blow to be determined. Just before the proper elevation is reached, the jet pipe should be pulled out and the pile should be driven to solid bearing by the hammer alone.

616.2.4.4 Pile Penetration

When driving first begins, the hammer should strike relatively light blows. After the pile has been driven approximately 3′ (1 m) into the ground, all guy lines and braces should be tightened, and the alignment of the pile should be checked before driving is continued at specification. During the operation, carefully monitor the location and alignment of each pile. Piles must be driven to virtual refusal into natural ground until the penetration per blow is at the specified limit. Penetration readings should be recorded often so that rate of penetration at various depths will be known. If the driving becomes difficult or if the pile begins to rebound, place 1″ (25 mm) marks on the pile and carefully monitor the penetrations per blow. Form 422 must be completed for each pile that is driven. Where piles are driven for bridge piers or abutments, Form 423 also must be competed and attached to Form 422. Complete these forms as soon as practical after the data is obtained. Completion instructions are on the back of each form.

616.2.4.5 Precautions and Driving Difficulties

The following are precautions and common difficulties that are encountered during the driving of piles:

1. Springing/Bouncing. Watch for pile springing and hammer bouncing. Springing can occur where spliced members are not properly aligned, the pile head is not squared properly, or the pile and hammer are misaligned. Bouncing can occur where the pile has reached the point of virtual refusal, a hammer of insufficient weight is used, or too much

steam or air pressure is used in double-acting hammers.

2. Changes in Direction. Watch the pile as it is driven for sudden changes in direction. This is a good indication that the pile has failed below the ground due to an obstacle. Near vertical rock strata can also contribute to this problem. In such cases, contact the Project Engineer/Supervisor for assistance. Corrective action may be necessary.

3. Sudden Changes in Penetration. Monitor the pile for sudden changes in penetration between blows. This usually indicates that the pile has failed or an unusually soft subsurface strata has been encountered. Sudden disappearance of the pile confirms the presence of a cavern or large void. In such cases, contact the Project Engineer/ Supervisor for assistance. Corrective action may be necessary.

4. Boulders/Rock Strata. Where a pile is driven in an area known to have boulders or varying rock strata, as indicated by boring logs, carefully monitor the operation for a sudden decease in the pile's penetration per blow. Such a rapid change can cause binding and an actual break in the pile. Care must be taken to avoid overdriving the pile. Contact the Project Engineer/Supervisor for assistance. Pre-drilling may be required.

5. Adjacent Piles. Where piles are driven close together into a layer of soft material below firmer soil, the driving of the piles tends to build up pressure in the soft layer. If the pressure becomes high enough, driving more piles will cause piles that have already been driven to push up. Such piles have little or no bearing value; and, if not corrected, serious settlement of a structure can occur. The elevation of the top of each pile in a footer should be determined just after the pile has been driven, and each elevation should be compared with the elevation of the corresponding pile after the driving of the whole group has been completed. Piles raised by the driving of nearby piles should be re-driven until the proper penetration per blow is obtained. No pile should be driven within 15′ (4.5 m) of a cast-in-place concrete pile until the concrete has fully cured.

6. Embankment Considerations. When an abutment is to be supported on an embankment and piles must be driven into the embankment, compaction of the embankment material to meet specified requirements can make penetration difficult. To prevent damage to the piles, pre-drilling may be necessary. In such cases, the uses of water jets is not permitted.

616.2.4.6 Cutting and Splicing Considerations

If a pile has been driven and accepted, but its top is above the elevation shown on the Contract Plans, it may be cut off square with its longitudinal axis. Steel piles and steel reinforcing bars in cast-in-place concrete piles should be cut off with a gas torch.

On a trestle bent where the cut-offs of the several piles in the bent are on an inclined plane, because of skew or superelevation, special care must be taken in establishing the correct elevation and slope for each cut-off. The elevation will be determined by the location of the pile with respect to the reference line and the amount of superelevation. Each pile should be cut off so that there will be full and uniform bearing between the piles and the cap and so that the top of the cap will be at the correct elevation.

If a pile is found to be too short, or one has been cut off too low, it may be extended or rebuilt as approved by the Project Engineer/Supervisor. The Project Inspector must make sure that the work is performed in accordance with the **Standard Specifications**. Careful inspection is particularly important in the case of a precast reinforced concrete pile. The old concrete must be removed to expose the steel reinforcing bars, but care must be taken not to damage the reinforcing steel. The old and new bars must be

lapped; and the new concrete must be properly placed, cured, and finished.

616.2.5 Cast-In-Place Piles

Cast-in-place piles consist primarily of a steel shell or steel pipe with a closed lower end that is driven into the ground to the required depth and filled with concrete or reinforced concrete of a specified class. Check that the steel shell or steel pipe complies with specified requirements, and carefully monitor the driving operation to ensure that it is driven to the proper depth without damage. Before the concrete is placed, check that mud and water are removed from the bottom of the pipe. Also, inspect the inside of the pipe for dents or bulges that would appreciably reduce the diameter of the concrete. Under cold weather conditions, it will be necessary to remove frost from the ground around the pipe by applying heat. During the pour, the concrete should be vibrated after each 2′ (0.6 m) layer of concrete is placed in the pipe. The spud of the vibrator should be lowered slowly through the layer of new concrete to a depth of approximately 1′ (0.3 m) into the layer below. After the spud has been left at this lowest position for approximately 5 seconds, it should be raised slowly until it reaches the top of the new concrete. The final pile surface should be struck off and cured by an approved method.

616.2.6 Foundation Piles

A foundation column is constructed of reinforced concrete and should rest on good rock or other firm material. The form for such a column is a thin steel shell that is drawn up as the concrete hardens. The shell may be provided in sections, but the bottom section of each shell must be placed in a pit that is excavated below the surrounding ground.

The Project Inspector must make sure that the bottom of each shell for a foundation column is in the correct position, and that the sections of the shell are aligned properly. Steel reinforcing bars of the required length must be set in the shell before any concrete is placed. The steel bars should extend above the top of the column at least to the height shown or specified for the lapping of bars.

Before any concrete is placed, the shell should be inspected for damage, and necessary steps should be taken to make it ready for receiving the concrete. Placing of the concrete, especially in the lower sections, must be carefully monitored by the Project Inspector. The Project Inspector should make sure that each shell has the full diameter, and that the shell is solidly filled with concrete. The concrete must be vibrated and cured properly.

616.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 617

RAILINGS

617.1 GENERAL REQUIREMENTS

617.1.1 Description of Work

Section 617 of the **Standard Specifications** governs the material and construction requirements for installing pipe railing, ferrous metal railing, and aluminum railing on a bridge, wall, or other structure. When Item 617 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 617 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

617.1.2 Material Considerations

Inspect the material upon arrival at the job site. Verify that all railing materials, elastomeric pads, grout, and other required materials conform to the requirements specified in Section 617.2 of the **Standard Specifications**. Ensure that materials are supplied from a pre-approved DOH source, and document laboratory numbers from the shipping documents on the Inspector's Daily Report. Do not accept damaged materials.

617.2 INSPECTION GUIDELINES

Section 617 of the **Standard Specifications** governs the criteria that should be used when inspecting railing installation. Consider the following additional guidelines:

1. Contract Documents. Review the Contract Plans and Specifications. Pay particular attention to the type and limits of railing, material requirements, and fastening details (e.g., hardware and bracket locations). Check if the Contractor is required to submit working drawings. If applicable, review the working drawings and become familiar with the fastening details.

2. Posts/Rail Installation. Check posts for proper location, alignment, and plumb tolerance. Check that the rails are rigidly braced and secured and that connections are tight and free of rattle and noticeable deflection. Check for proper installation and grouting of anchor bolts.

3. Fastening/Welding Considerations. Check to ensure that bolts are long enough to extend beyond nuts and that the thread extensions are oriented away from pedestrian and bicycle traffic (i.e., the smooth, round heads of carriage bolts will face pedestrians). Where welding is required, verify conformance with specified requirements. If timber members are used, the bolts should be recessed. Check hand and rub rails for projections, and require immediate correction.

4. Electrolytic Isolation. Where dissimilar metals come into contact with each other, electrolytic isolation may be designated. If specified, verify the proper installation of electrolytic isolation where designated on the Contract Plans.

5. Painting. Where designated for non-galvanized pipe and steel railing, verify that the railing is properly prepared and painted with the designated color.

6. Final Inspection. After construction, ensure that all welds are ground smooth. Watch for burs and sharp edges from cutting, punching, drilling, and tapping and require rounding where needed. Check to ensure

that any coating damage is properly repaired.

617.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 619

WATERPROOFING

619.1 GENERAL REQUIREMENTS

619.1.1 Description of Work

Section 619 of the **Standard Specifications** governs the material and construction requirements for waterproofing concrete retaining walls, abutments, and earth-filled arches, either in the form of dampproofing or waterproofing membrane. When Item 619 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 619 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

619.1.2 Materials Considerations

Inspect all materials upon arrival at the job site. Verify that all primers, agents, membranes, fabrics, joint sealers, and other required materials conform to the requirements specified in Section 619.2 of the **Standard Specifications**. Ensure that materials are supplied from a pre-approved DOH source, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

619.2 INSPECTION GUIDELINES

619.2.1 Dampproofing

Where designated on the Contract Plans, dampproofing of concrete surfaces will be governed by Section 619 of the **Standard Specifications**. Consider the following additional guidelines:

1. Contract Documents. Review the Contract Plans and Specifications. Pay particular attention to the limits of treatment, type of material required, sampling and testing requirements, and the method and sequence of operation.

2. Weather Considerations. Know the limitations of application with respect to inclement weather, surface moisture, and temperature.

3. Concrete Curing. Check to ensure that the concrete has been cured before application of the treatment.

4. Surface Preparation. Before the treatment is applied, check to ensure that the concrete surface has been thoroughly cleaned and prepared as specified.

5. Primer Application. Verify conformance with respect to limits, method, number of coats, and rate of application.

6. Asphalt Dampproofing Application. Verify conformance with respect to timing, method, rate of application, and location.

7. Final Inspection. After the asphalt dampproofing has been applied, check for discoloring of concrete surfaces beyond the designated limits of treatment, and require the Contractor to properly clean the marred surfaces.

619.2.2 Waterproofing Membrane

Section 619 of the **Standard Specifications** governs the criteria that should be used when inspecting waterproofing membrane. Consider the following additional guidelines:

1. Contract Documents. Review the Contract Plans and Specifications. Pay particular

attention to the limits of treatment, type of waterproofing designated, sampling and testing requirements, and the method and sequence of operation.

2. Weather Considerations. Know the limitations of application with respect to inclement weather, surface moisture, and surface and ambient temperatures. Pay particular attention to required drying periods.

3. Concrete Curing. Check to ensure that the age of the concrete complies with specified limits before application of the treatment.

4. Surface Preparation. Before the treatment is applied, check to ensure that the concrete surface has been properly prepared. Pay particular attention to the limits of cleaning (e.g., approach slabs, height of curb above asphalt overlay, height of bridge rail above deck, sidewalks), sequence, timing, and methods (e.g., sand blasting, shot blasting, power washing, sweeping). Where waterproofing membrane is designated, verify that rough surface areas that could puncture or create air pockets in the membrane have been corrected.

5. Primer Application. Where waterproofing membrane is designated, verify the limits (e.g., height of curb above asphalt overlay) and application rate for conformance with specified requirements.

6. Placement of Reinforced Membrane. Where designated, verify that reinforced membrane is properly placed. Check that the membrane is not placed too soon after primer application. Check the limits of placement (e.g., height of curb above asphalt overlay). Ensure that the membrane directs runoff toward curbs and drains. Watch for wrinkles and air bubbles, and enforce the Contract provisions with respect to repairing such defects. Pay particular attention to flashing and priming requirements where membrane is placed near expansion joints and drain pipes.

7. Placement of Elastomeric Membrane. Where elastomeric membrane is designated, check the limits of treatment and rate and thickness of application for compliance. If unacceptable, halt the work and require immediate adjustment.

8. Placement of Protective Covering. Protective covering is required where waterproofing membrane is designated. Do not permit any more membrane to be applied that can be properly covered in the same work day. Pay particular attention to the limits of covering and the required treatment of overlaps and joints.

9. Concrete Sealant Application. For protection, a respirator should be worn during the inspection of work involving concrete sealer. Verify the limits of treatment (e.g., height on bridge rails above bridge deck) and the application rate for conformance. Pay particular attention to mishandling and overspray of sealant material, and require immediate corrective action.

10. Final Inspection. Ensure that all corrective work to damaged waterproofing is completed as soon as practical. Immediately after the treatment has been inspected and accepted, notify the Contractor in writing of such approval and that the protective course can be placed. The protective course should be placed immediately upon receipt of the notification. After an protective course has been placed over waterproofing membrane, coordinate with the Project Engineer/ Supervisor for final inspection. It may be necessary to test the effectiveness of the waterproofing system under the protective course. Where such testing is performed and the results fail to meet specified acceptance criteria, enforce the provisions of the Contract with respect to removal and replacement. Once final inspection has been completed, provide the Contractor with written notification of acceptance.

619.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 621

STEEL GRID FLOORING

621.1 GENERAL REQUIREMENTS

621.1.1 Description of Work

Section 621 of the **Standard Specifications** governs the material and construction requirements for open or concrete filled steel grid flooring. When Item 621 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 621 of the **Standard Specifications** and as designated on the Contract Plans. See the AASHTO publication **Standard Specifications for Highway Bridges** for additional information. See the **Standard Specifications** for the method of measurement for payment.

621.1.2 Materials Considerations

Inspect all materials upon arrival at the job site. Verify that all steel and concrete conform to the requirements specified in Section 621.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

621.1.3 Working Drawings

Before fabrication and installation, the Contractor is required to submit shop and assembly drawings to the Engineer for review. Review these drawings and become familiar with the details of the work.

621.2 INSPECTION GUIDELINES

Section 619 of the **Standard Specifications** governs the criteria that should be used when inspecting steel grid flooring. Pay particular attention to the requirements for:

1. arrangement of sections,
2. camber,
3. field assembly,
4. connection to supports,
5. welding,
6. concrete filler, and
7. painting.

Unless otherwise specified, an expansion dam should be placed and connected before an adjacent grid is installed. Where trimming is necessary, saw cutting should be used, not flame cutting. Welding grids to the upper flange of stringers may cause a sag in the stringers. The Project Inspector should take an elevation reading at the top of the upper flange of the stringer at its center span just before the grid is placed. Another reading should be taken at the same point after the grid has been welded in place. If a sag is evident, notify the Project Engineer/Supervisor.

621.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that

occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 623

PNEUMATICALLY APPLIED MORTAR

623.1 GENERAL REQUIREMENTS

623.1.1 Description of Work

Section 623 of the **Standard Specifications** governs the material and construction requirements for applying pneumatically applied mortar, or shotcrete. When Item 623 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 623 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

623.1.2 Materials Considerations

Inspect all materials upon arrival at the job site. Verify that the shotcrete and reinforcing steel, as applicable, conform to the requirements specified in Section 623.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

623.2 INSPECTION GUIDELINES

Section 623 of the **Standard Specifications** governs the criteria that should be used when inspecting pneumatically applied mortar. Pay particular attention to the requirements for:

1. proportioning and mixing,
2. surface preparation,
3. reinforcing for concrete repairs,
4. reinforcement for structural steel,
5. shotcrete thickness,
6. joint and form requirements, and
7. finishing and curing.

Shotcrete is applied to many types of surfaces for various reasons, including:

1. repairing concrete structures,
2. providing a protective covering for steel members,
3. providing a finishing coat on concrete and masonry surfaces,
4. pointing joints in masonry, and
5. minimizing deterioration of shale surfaces.

The mortar mix for shotcrete uses air-entrained cement, and the application equipment must be capable of applying the mix uniformly from a mixing nozzle with such speed that nearly all of the mortar will stick to the surface to be covered. Little to no mortar should rebound from the surface. Where steel beams and columns are to be treated, welded wire fabric is first secured to the steel members in the desired shape. The fabric will not be in contact with the steel member; rather, it will be approximately 0.75″ (20 mm) away form the members surface. If a thick covering of shotcrete is needed to build up part of a structure, more than one layer of reinforcement may be necessary.

A surface to be covered with shotcrete must be clean. Shotcrete is applied in thin layers. The equipment for applying the shotcrete should be adjusted so that the moisture content of the mortar, the pressure at the nozzle, and the speed of the stream shot from the nozzle conform to specified requirements. Adjustments must be approved by the Project Engineer/Supervisor and be made before the final coat of mortar is applied. If it is necessary to hold the nozzle so close to the surface to be coated that too much material rebounds at the specified pressure, the

pressure should be reduced. After the final coat, a curing compound is typically applied to the shotcrete. Caution should be used when shotcrete is being applied near surfaces that are not to be coated to prevent material that rebounds from marring the surface. Shotcrete may be applied in cold weather with written permission of the Project Engineer/Supervisor; however, heating equipment, housing, and other protection must be provided.

623.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 625

DRILLED CAISSON FOUNDATIONS

625.1 GENERAL REQUIREMENTS

625.1.1 Description of Work

Section 625 of the **Standard Specifications** governs the material and construction requirements for drilled caisson foundations. When Item 625 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 625 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

625.1.2 Materials Considerations

Inspect all materials upon arrival at the job site. Verify that concrete, reinforcement, casing, and other required materials conform to the requirements specified in Section 625.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

625.2 INSPECTION GUIDELINES

Caissons are relatively large-diameter, underground columns of reinforced concrete that are constructed in pre-drilled holes to provide foundation support for structures. They are designed to transfer and distribute structural loads to underlying support strata or bedrock (i.e., an end-bearing design). In general, caisson construction consists of drilling a hole at a designated location, depth, and diameter; constructing and placing a cage of reinforcing steel; and placing and finishing concrete to the elevation required by the foundation details of the Contract Plans. Consider the following inspection guidelines:

625.2.1 Preliminary Considerations

Prior to the construction of caissons, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract Plans and Specifications with respect to the requirements for drilling equipment, materials for reinforcing steel and concrete, and caisson location, depth, diameter, and elevation. Pay particular attention to the operation sequence and dewatering requirements.

2. Caisson Location/Utilities. Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that all caisson locations have been properly staked in accordance with the Contract Plans.

3. Boring Log/Geological Reports. Review the boring log and geological reports. Become familiar with the appearance of the type of material anticipated at the depth of the bearing strata. On many projects, the Contract Documents require the Contractor to perform pre-installation core holes. See Section 625.5 of the **Standard Specifications**.

4. Equipment. Verify that a heavy-duty drilling rig in good operating condition is provided for the work. The rig must be capable of drilling to the required depth and penetrating the underlying bearing material or bedrock.

5. Blasting. The use of explosives for caisson construction is generally not permitted.

6. Materials. Check to ensure that the type of reinforcing steel and class of concrete conforms to specified requirements. Where steel casing is required, verify conformance with respect to wall thickness, strength, diameter, and condition.

7. Alternative Methods. If methods other than those discussed in this Section are proposed, verify that the Project Engineer/Supervisor has reviewed the Contractor's step-by-step procedures prior to beginning the operation, and ensure that the Contractor performs the work as proposed.

625.2.2 Drilling Operation

Where holes are drilled for caissons, consider the following:

1. Location. Check the location of the center of the shaft to ensure it is within allowable tolerance from that designated on the Contract Plans.

2. Depth of Embedment. The designated bottom elevation is an approximation only, which may be revised by the Project Engineer/Supervisor to ensure proper load bearing capacity. Document the depth drilled into the target bearing strata, and compare the excavated material with geological information to ensure that adequate bearing material has been reached.

3. Diameter/Sides. Check the hole diameter and sides to ensure compliance to size, vertical orientation, and allowable tolerance. This may be accomplished during the mini-CID inspection device. Where caving is encountered, halt the operation until the situation can be evaluated and corrected. Contact the Project Engineer/Supervisor for assistance. Protective steel casing may be needed.

4. Excavated Material/Cleaning. Verify that excavated material is disposed of properly. Check to ensure that the hole is dewatered and cleaned of all loose material. The Inspector should verify that the bottom of the hole is clean and flat. If dewatering is not practical, the provisions of the Contract with respect to placing concrete under water will govern. If it is necessary to enter the hole for inspection purposes, ensure that the Contractor provides steel shoring, proper ventilation, electric lighting, and a suitable means of access.

5. Protective Covers. Once the hole has been accepted, verify that protective covering is installed to prevent persons and materials from falling into the hole.

6. Shale/Rock Considerations. Where a caisson is to be socketed into shale or rock, the reinforcing cage, support system, and concrete must be placed within the specified time limit after drilling. If the limit is exceeded, require the Contractor to drill the specified additional depth into the shale just prior to placement of the concrete, and verify that the reinforcement cage is adjusted to the new depth.

625.2.3 Caisson Reinforcement/Steel Casing

Caisson reinforcement generally consists of a single-unit cage of reinforcing steel. The cage must be inspected prior to being placed into the drilled hole. Consider the following:

1. Cage Construction. Inspect the cage for proper bar size, spacing, and fastening. Check the cage height and diameter for conformance. Where required, verify that splices are reviewed by the Project Engineer/Supervisor. Document the number of splices.

2. Steel Casing. Where designated or as directed, ensure that the proper size of steel casing is

installed and properly oiled prior to placement of the cage, support system, and concrete.

3. Installation Timing. After the hole and cage have been inspected, the cage and support system must be installed in the hole just prior to pouring concrete. If the concrete is not immediately poured, require removal of the cage, re-inspect the hole for loose material, and check the surface condition of the steel for acceptability. Where required by the plans or specifications, Crosshole Sonic Logging (CSL) may be used. See Section 625.2.6 of the **Standard Specifications**.

4. Support System. A support system must be provided so that the cage does not sit on the bottom nor lean against the wall of the hole. Check bottom and side clearances. Check conformance with respect to the number and interval of spacers along the length of the cage. Verify that the support system does not rack or skew the cage, and require additional steel as needed to stiffen the cage.

625.2.4 Concrete Placement

Acceptability of the placement method used for concrete will depend on whether or not the hole is considered dry or wet. Just prior to placement, check the depth of water at the bottom of the hole. If the depth, without pumping, is less than approximately 2″ (50 mm), the hole may be considered dry for the purpose of method approval. Otherwise, the hole should be considered wet. Consider the following guidelines:

1. Dry-Hole Placement. Where the hole is dry, the concrete may be poured continuously in a free fall from the surface with the use of a hopper or approved device. Check to ensure that the concrete does not hit the reinforcing cage nor the sides of the hole on the way down.

2. Wet-Hole Placement. For wet holes, the Project Engineer/Supervisor must review the proposed method of placement. See Section 625.5.4 of the **Standard Specifications**.

3. Steel Casing. Unless otherwise designated or directed, the steel casing will be removed from the caisson. Where removal is impractical or will cause damage to the caisson, contact the Project Engineer/ Supervisor for assistance. It may be necessary to leave the steel casing in place. In such cases, ensure that the top of the casing is cut by an approved method to the designated elevation. Ensure that additional concrete is placed, and monitor the elevation of the reinforcing cage and final caisson surface for compliance. Reject the caisson if movement or settlement exceeds specified limits.

4. Key Construction. Where designated on the Contract Plans, verify compliance of the key constructed at the top of the caisson.

5. Concrete Curing. Check that the top surface of the concrete is properly cured. Pay particular attention to the curing material and curing period used.

6. Adjacent Construction. Where work for foundation piles, excavation, or caissons is to be performed adjacent to the freshly poured caisson, check compliance with respect to minimum lateral clearance and compressive strength requirements.

7. Final Inspection. After the caisson has been constructed, check the top elevation of the caisson for compliance to that designated on the Contract Plans. Verify that the projecting reinforcing steel is in the correct location and properly cleaned of mortar. See Section 625.2.6 of the **Standard Specifications** regarding requirements for CSL testing where required by the plans or specifications.

625.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers from the shipping documents, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 626

RETAINING WALL SYSTEMS

626.1 GENERAL REQUIREMENTS

626.1.1 Description of Work

Section 626 of the **Standard Specifications** governs the design, material, and construction requirements for cast-in-place reinforced concrete or mechanically stabilized earth retaining wall systems. When Item 626 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 626 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

626.1.2 Materials Considerations

Inspect all materials upon arrival at the job site. Verify that all materials conform to the requirements specified in Section 626.5 of the **Standard Specifications**. Ensure that system materials are supplied with shipping documents or from pre-approved DOH sources, as appropriate. Document laboratory numbers on the Inspector's Daily Report. Pay particular attention to the requirements for concrete mix design, modular block production, reinforcement, geosynthetics, select granular backfill, quality control sampling and testing, and acceptance.

626.1.3 Design Submittals

The Contractor is responsible for submitting detailed design and construction plans for the wall design selected and approved by the Division. The design will be based on the criteria defined in Section 626.3 of the **Standard Specifications**.

626.2 INSPECTION GUIDELINES

Section 626 of the **Standard Specifications** governs the criteria that should be used when inspecting retaining wall systems. Pay particular attention to the requirements for foundation preparation, erection, and placement of backfill material for mechanically stabilized earth walls and the requirements for architectural formwork for cast-in-place reinforced concrete walls.

626.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 631

ELECTRICAL WORK

631.1 GENERAL REQUIREMENTS

631.1.1 Description of Work

Section 631 of the **Standard Specifications** governs the material and construction requirements for electrical work. When Item 631 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 631 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

631.1.2 Materials Considerations

Inspect all materials upon arrival at the job site. Verify that all materials conform to the requirements specified in Section 631.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

631.2 INSPECTION GUIDELINES

Section 631 of the **Standard Specifications** governs the criteria that should be used when inspecting electrical work. The Project Inspector needs to verify that all workmanship for electrical work on WVDOH projects is performed in accordance with the Contract Plans, the current edition of the **National Electric Code**, and the governing local requirements.

631.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 636

MAINTAINING TRAFFIC

636.1 GENERAL REQUIREMENTS

636.1.1 Description of Work

Section 636 of the **Standard Specifications** governs the material and construction requirements for maintaining and protecting traffic during construction, protecting construction personnel and the work in progress, and protecting adjacent property from excessive dust. When Item 636 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 636 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

636.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all traffic control devices, flaggers, pilot trucks, signs, temporary pavement marking materials, materials for temporary structures, aggregate for temporary roads. and dust palliatives conform to the requirements specified in Section 636.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping document on the Inspector's Daily Report.

A notarized Letter of Certification from the Contractor for all traffic control items is required.

636.1.3 Traffic Control Plan

636.1.3.1 Content and Purpose

The Division expects the Contractor to implement the Traffic Control Plan that is specified in the Contract. The Traffic Control Plan will address the following:

1. safety and convenience of the traveling public;
2. protection of construction personnel and the work in progress;
3. methods of handling traffic for all phases of construction;
4. temporary structures, temporary roads, and application of dust palliatives;
5. Contractor and subcontractor activities; and
6. schedules, deliveries, and project time restrictions.

The method of handling traffic required for each construction phase will depend on the type of construction to be performed.

636.1.3.2 Revision and Review

If the Contractor desires to implement a Traffic Control Plan different than the one specified, the proposal must be submitted to the Project Engineer/Supervisor for review prior to implementation. The Traffic Control Plan will be reviewed to ensure compliance with the requirements of Section 636 of the **Standard Specifications**, **Standard Detailed Drawings**, and the WVDOH publication **Traffic Control for Street and Highways Construction and**

Maintenance Operations. Methods of handling traffic, specifically, will be evaluated for their adequacy of protecting workers, motorists, pedestrians, and bicyclists during construction. The Traffic Control Plan will also be review as follows:

1. Speed Reductions. As practical, each method of handling traffic in the Traffic Control Plan should allow the facility to operate without reducing the speed of the facility. If a speed reduction is requested, ensure that the proposed reduction is consistent with Division policy and is authorized in writing by the Traffic Engineering Division and the Contract Administration Division.

2. Emergency Vehicle Access. Ensure that the Traffic Control Plan adequately addresses emergency vehicle access.

3. Traffic Control Devices and Flaggers. Do not approve a method of handling traffic that includes unnecessary devices or flaggers. The WVDOH publication **Traffic Control for Street and Highways Construction and Maintenance Operations** and Part 6 of the **Manual of Uniform Traffic Control Devices** specifies the type, number, location, and arrangement of devices and flaggers that are acceptable for use in construction applications. Occasionally, Contractors will propose more devices and flaggers than are warranted, making a false assumption that such practice will provide additional safety. On the contrary, such practice can be a detriment to safety at an additional cost. Too many devices and flaggers can cause confusion, render other control measures ineffective, and exacerbate the hazard potential. If a Contractor insists on using unnecessary traffic control, contact the Traffic Engineering Division and the Contract Administration Division for immediate assistance.

4. Pedestrian and Bicycle Traffic. Verify that the Traffic Control Plan adequately provides for pedestrian, bicycle, and other non-motorized traffic. Check that bicycle and recreational trail detours have been correctly identified and signed.

5. Access and Crossovers. Verify that the Traffic Control Plan provides adequate access for construction and maintenance traffic, including turnaround locations. Ensure that median crossings and crossovers comply with the requirements of the Contract.

6. Restrictive Clearances. Where the Traffic Control Plan includes detours and construction activities at bridge structures, verify that the appropriate signing has been provided and check for restrictive vertical and lateral clearances. If a vertical clearance of less than 16.5′ (5 m) or if a restriction to the normal lane width of 12′ (3.6 m) is necessary, verify that the condition is appropriately signed and notify the Traffic Engineering Division and Contract Administration Division. Include the following information in the body of the message:

   a. "RE: RESTRICTION ALERT,"

   b. highway number,

   c. beginning mile post for the restriction,

   d. ending mile post for the restriction,

   e. direction of travel that is restricted,

   f. restriction description (e.g., vertical, lateral),

   g. beginning date and approximate time of restriction, and

   h. name and phone number of contact for the project restriction.

Note that the ending date of the restriction is an approximation. Although, the restriction will not be removed from the report until notification of the end of the project, an estimate assists permit writers to answer queries about the restriction. Provide the Traffic Engineering Division and

Contract Administration Division with as much advance notice as practical to properly notify permit holders. In addition, notify the Traffic Engineering Division and Contract Administration Division when the restriction may be lifted.

636.1.4 Traffic Control Supervisor

In accordance with Section 636 of the **Standard Specifications**, the Contractor is responsible for providing a Traffic Control Supervisor. Traffic Control Supervisor is a person who will monitor the method and devices used for traffic control during the project. The Traffic Control Supervisor will be thoroughly familiar with the WVDOH publication **Traffic Control for Street and Highways Construction and Maintenance Operations** and will have passed a WVDOH or American Traffic Safety Service Association training course on this subject. After traffic control devices are installed for the active method of handling traffic, the Traffic Control Supervisor will inspect the devices frequently to ensure that they are located and maintained properly and are conveying the proper message for the intended application. The Traffic Control Supervisor will have the authority to take all actions necessary for the safe control of traffic through the work zone. The Contractor is responsible for providing the Project Engineer/ Supervisor with the telephone number of the Traffic Control Supervisor, and approved designee, for use in the event of emergencies or crashes at night or on weekends. The Traffic Control Supervisor is responsible for the following:

1. Communication Responsibilities. The Traffic Control Supervisor will manage traffic control on a 24-hour-per-day basis. The required minimum level of communications include:

    a. Prime Contractor. The Traffic Control Supervisor will communicate with the Prime Contractor to determine what traffic control measures need to be provided by subcontractors and material suppliers.

    b. Local Agencies. The Traffic Control Supervisor will inform local police and fire agencies of any lane closures or delays. Regular updates are required as operations change.

    c. Emergency Contact Numbers. The Traffic Control Supervisor will provide emergency contact numbers of Contractor and WVDOH personnel to local police and fire agencies. This allows the proper project personnel to be notified in case of an emergency on the project during working or non-working hours.

    d. Response Time. During non-working hours, the Traffic Control Supervisor, or approved designee, will respond to the site as soon as practical, desirably within 1 hour of notification.

2. Project Meetings. The Traffic Control Supervisor will attend all project scheduling meetings. This will ensure that the Traffic Control Supervisor is properly informed of the planned operations so that the proper method of handling traffic can be implemented for the new phase of construction. Any conflicts in traffic control between subcontractors should be addressed at project scheduling meetings.

3. Inspection Duties. The Traffic Control Supervisor, or approved designee, will inspect traffic control devices on each calendar day that they are in use, masked, or turned away from traffic. This includes weekends, especially on high-speed, high-volume facilities. These inspections will include at least one nighttime inspection per week. Verify that the proper type and number of are located and arranged as designated for the active method of handling traffic. Check devices for damage, undesirable location, and acceptable visibility. Ensure that lights and flashing beacons are functioning properly. Supervise the cleaning of devices as frequently as necessary to preserve legibility and retroreflectivity. All devices must be cleaned a minimum of once every week.

Although the Project Engineer/Supervisor and Project Inspector indirectly assist the Traffic Control Supervisor, their duties primarily are to ensure that the Traffic Control Plan, methods of handling traffic, and traffic control devices are in conformance with the governing Contract documents.

4. Inspection Diary. The Traffic Control Supervisor is responsible for recording, signing, and dating a daily record of inspections, including a statement that all traffic control devices are clean and properly maintained. Deficiencies should generally be corrected within 24 hours. The diary should contain the following type of information:

   a. date and time of inspection;

   b. project number;

   c. list of flaggers and hours;

   d. uniformed traffic control hours used;

   e. method of handling traffic used;

   f. weather conditions;

   g. interference with normal traffic flow,

   h. detours in use;

   i. work performed by Prime Contractor, subcontractors, or utility companies;

   j. location of flagging stations and flagging hours,

   k. problems encountered and corrections made;

   l. crashes or other incidents involving the traveling public;

   m. types and quantities of traffic control devices used;

   n. maintenance or cleaning performed on the traffic control devices; and

   o. any unusual conditions or problems encountered during the day.

   p. Relief Flagging. The Traffic Control Supervisor should not act as a flagger, except in emergency situations or when it is necessary to relieve the stationed flagger for lunch breaks and rest periods. Relief flagging should be performed only when such action will not interfere with the normal duties of the Traffic Control Supervisor; otherwise, another certified flagger must be provided.

636.1.5 Work Zone Pre-Survey

A Work Zone Pre-Survey is performed to minimize traffic disruption caused by temporary repair work on pavements and bridge decks and to evaluate methods of handling traffic during construction on high-speed, high-volume facilities. A high-speed, high-volume facility is an Interstate highway, APD corridor highway, fully-controlled access highway, or an expressway having a speed limit of 45 mph (70 km/h) or greater. The District Construction Engineer is responsible for initiating the Pre-Survey, which will take place prior to the Contractor's Notice to Proceed. The objectives of the Work Zone Pre-Survey are to:

1. evaluate the structural strength of the existing pavement and its ability to carry the projected traffic loads during construction;

2. evaluate the condition of drainage structures within the construction area;

3. check for any evidence of bridge deterioration; and

4. evaluate the methods of handling traffic for each phase of construction.

Based on the findings of the Work Zone Pre-Survey, the review team will forward recommendations to the Traffic Engineering Division and the Contract Administration Division regarding any needed revisions to the Traffic Control Plan or sequence of construction.

636.1.6 Flagger Certification

All flaggers on WVDOH projects must be certified by passing a WVDOH or American Traffic Safety Service Association training course on this subject. Re-certification is generally required every two years and usually involves reviewing the course manual, viewing a training video, and obtaining a passing score on a proficiency test administered by he proctor. Contact the Contract Administration Division for additional information.

636.2 INSPECTION GUIDELINES

Coordination and advance planning by the Contractor, Project Engineer/Supervisor, Project Inspector, and Traffic Control Supervisor are required to provide for the safe and efficient maintenance and protection of traffic through and adjacent to the work area during construction. A practical effort must be made to reduce hazards and inconvenience to the traveling public and to adequately protect project personnel. Once construction has started, both WVDOH and Contractor personnel must continually monitor the construction area and immediately report potentially hazardous situations for correction. The topic of work zone traffic control will be thoroughly addressed at the Preconstruction Conference and during the Work Zone Pre-Survey. The Project Inspector must record daily in the Inspector's Daily Report and Inspector's Traffic Control Worksheet the implementation and condition of the traffic control provided for the construction operation.

636.2.1 Contract Documents

Check that current versions of the WVDOH publication **Traffic Control for Street and Highways Construction and Maintenance Operations**, FHWA publication **Manual of Uniform Traffic Control Devices**, including up-to-date revisions, Contract Plans, **Standard Specifications**, **Special Provisions**, **Standard Detailed Drawings**, Traffic Control Plans, and detour plan and profile sheets are readily available at the job site. The Traffic Control Supervisor should have their own copy of these documents.

636.2.2 Speed Reduction Verification

Where the method of handling traffic requires a speed reduction, verify that the speed reduction has been authorized by the Traffic Engineering Division. Requirements will be spelled out in contract documents.

636.2.3 Personnel Certification Checks

Ensure that the Traffic Control Supervisor and all flaggers posses the specified WVDOH or American Traffic Safety Services Association certifications. Where applicable, check that certification cards match the person. Know if certifications require renewal during the course of the project.

636.2.4 Emergency Contact Numbers

Verify that 24-hour emergency telephone numbers are provided for the Traffic Control Supervisor and response personnel. Ensure that the appropriate Contractor and WVDOH telephone numbers are posted and provided to local agency dispatchers.

636.2.5 Crash Incident Reporting

For the purpose of assessing needed improvements and to protect WVDOH from claims and law suits, crashes that occur within the construction area must be thoroughly documented on the Supervisor's Daily Report. Ensure that the proper authorities have been contacted. The WVDOH Fatal Crash Review Team and FHWA representatives may need to be contacted. Particularly note on the form any property damage, loss-of-life, or school bus involvement. Also note whether or not the method of handling traffic and traffic control devices were in compliance at the time of the incident. This will be used to assess the likelihood that traffic control was a contributing factor. Any needed corrections to traffic control should be performed immediately. The application of a revised method or the installation of replacement barriers, attenuators, and breakaway sign posts may need to be considered.

636.2.6 Traffic Control Supervisor

Verify that the Traffic Control Supervisor is available, appropriately dressed with reflectorized clothing, and is performing and documenting the required daytime, nighttime, and weekend inspections. Verify that device cleaning and maintenance activities are being properly supervised. Ensure that that any reported traffic control deficiencies have been corrected in a timely manner.

636.2.7 Flaggers and Traffic Directors

The flaggers and traffic director are furnished by the Contractor. Check flaggers for compliance. Verify that flaggers are wearing orange hard hats and vests of the proper type, that the "Stop/Slow" paddles are the correct size and shape, and that the flaggers' clothing and equipment are properly reflectorized for nighttime operations. Check that proper flagging methods are being used. Check that the flaggers are facing and visible to oncoming traffic, the proper distance in advance of the work, and that the flagger stations are properly illuminated during nighttime operations. Note that the flagger and traffic director are separate functions. The traffic director will be an off-duty uniformed police officer in a properly identified police vehicle, who will be positioned in accordance with the method of handling traffic.

636.2.8 Stockpiled Materials

If construction materials are stockpiled, they must not interfere with traffic operations or sight distance. Stockpiled materials must be located so that they will not interfere with traffic through or adjacent to the work area. Stockpiles and construction parking areas must be located a minimum of 30′ (10 m) from the edge of the traveled roadway, unless placed behind an acceptable protective barrier. No materials or equipment should remain on the traveled roadway, median area, or shoulder at the end of the work day.

636.2.9 Traffic Control Devices

Traffic control devices are used to warn the traveling public of hazards, advise them of the proper path through the work zone, delineate areas where they may not operate, and separate them from construction workers. Traffic control devices include:

1. temporary pavement markings;
2. construction signs;
3. drums, cones, and delineators;
4. flashers and warning lights;
5. flashing arrow panels, portable message signs, and changeable message signs;
6. temporary traffic signals and temporary lighting;

7. temporary guardrail, temporary concrete barricades, and impact attenuators; and

8. pilot trucks and shadow vehicles.

Traffic control devices will be installed based on the requirements of the method of handling traffic for the active phase of construction. The traffic control devices installed must be fabricated and placed in accordance with the WVDOH publication **Traffic Control for Street and Highway Construction and Maintenance Operations**. These devices must be installed prior to construction and must remain in place as long as they are warranted; otherwise, they must be removed or obscured.

636.2.9.1 Maintenance of Devices

Temporary traffic control devices are subject to wear during use, storage, shipment, installation, relocation, and removal. A large number of worn devices on a project is unacceptable. Maintenance of traffic control devices includes keeping them in good condition, correct position, and free from being obscured by weeds, brush, trees, materials, and equipment. Assessments should be made while the devices are in storage before use on the project, during initial set up, and periodically during the life of the project. Ensure that all traffic control devices are cleaned, as needed, based on the results of weekly inspections. The Project Engineer/Supervisor or Project Inspector should make at least one nighttime inspection every time a new method of handling traffic is implemented to assess conformance. See the ATSSA publication **Quality Standards For Work Zone Traffic Control Devices** for additional information on maintaining traffic control devices.

636.2.9.2 Pavement Markings

Pavement markings that conflict with the desired traffic movement must be eradicated as soon as practical prior to shifting traffic. Temporary pavement markings that are used to delineate pavement lane and edge lines will be either temporary reflectorized pavement marking tape or reflectorized paint. Temporary raised pavement markers may be used as an alternate to temporary paint or to temporary tape. Check that temporary pavement striping and raised pavement markers are installed consistent with the requirements of the active method of handling traffic, the WVDOH publications **Traffic Control for Street and Highway Construction and Maintenance Operations** and **Sign Fabrication Manual**, and the **Standard Detailed Drawings**.

636.2.9.3 Construction Signing

Inspect construction signing for proper installation and satisfactory condition. Consider the following:

1. Contract Documents. Ensure that signs conform to the active method of handling traffic in the Traffic Control Plan, the WVDOH publications **Traffic Control for Street and Highway Construction and Maintenance Operations** and **Sign Fabrication Manual**, and the **Standard Detailed Drawings**. Pay particularly attention to compliance of size, shape, and color; reflective sheeting; and location.

2. Sign Condition. Check that the signs are clean, legible, and in good repair.

3. Breakaway Bases. Check for required breakaway bases on post mounted signs or proper placement behind protective barrier.

4. Temporary Signs. Check that temporary signs are properly weighted, mounted, and at the correct height.

5. Stored Signs. Signs that are not in use should be properly stored. Check that signs are:

   a. laying flat, including the base;

   b. beyond the shoulder;

c. outside the normal roadside recovery area; and

d. not on landscaped areas or sidewalks.

6. Conflicting Signs. Ensure that conflicting permanent signs are properly masked.

636.2.9.4 Channelizing Devices

Verify that channelizing devices conform to the active method of handling traffic in the Traffic Control Plan, the WVDOH publication **Traffic Control for Street and Highway Construction and Maintenance Operations**, and the **Standard Detailed Drawings**. Pay particular attention to the following:

1. correct dimensions and clean serviceable condition;

2. proper retrorefectorized sheeting or collars;

3. correct placement with proper taper lengths and spacing;

4. proper and functioning warning lights that are set in the correct mode; and

5. weighting by acceptable methods.

636.2.9.5 Flashing Arrows and Message Signs

Ensure that flashing arrow panels, portable message signs, and changeable message signs are in the correct location and functioning properly. Check these devices for:

1. properly working lights in the correct mode and/or message;

2. proper automatic dimming at night; and

3. correct panel size mounted at the correct height.

Note that these devices are located behind the channelizing devices or barriers away from moving traffic in such a manner that their visibility is not reduced or obscured. Check the active method of handling traffic in the Traffic Control Plan for proper location.

636.2.9.6 Temporary Barriers and Guardrail

Check that temporary concrete barriers and temporary guardrail are installed in accordance with the active method of handling traffic, Contract Plans, Standard Detailed Drawings, and **Standard Specifications**. Pay particular attention to the following:

1. location of face of barrier and guardrail;

2. cross section shape and height of barrier and rail;

3. guardrail post spacing, especially at transitions;

4. fixed-object clearance behind face of guardrail;

5. connections between sections;

6. transitions between barrier and guardrail;

7. parabolic flares and end treatments; and

8. the color and retroreflectorization of delineators and sheeting.

Verify the proper removal and resetting of temporary concrete barriers and temporary guardrail when the method of handling traffic changes to accommodate a subsequent construction phase.

636.2.9.7 Impact Attenuators

Ensure that impact attenuators are properly located and installed according to the active method of handling traffic, Contract Plans, **Standard Detailed Drawings**, and **Standard Specifications**. Pay particular attention to the weight, quantity, and type of material placed in

barrels and the provisions for preventing filler material from freezing during cold weather.

636.2.9.8 Pilot Truck and Shadow Vehicles

A pilot truck is a vehicle of the pick-up or jeep type, equipped with a prescribed sign that is mounted on the rear portion of the vehicle to be visible by following motorists. A shadow vehicle is a standard truck equipped with a flashing or rotary yellow beacon and a truck-mounted attenuator mounted on the rear. Verify that the use of pilot trucks and shadow vehicles are in conformance with the active method of handling traffic, Contract Plans, **Standard Detailed Drawings**, and **Standard Specifications**. When work is completed for the day, these vehicles must be relocated behind a positive barrier or off the job site in a safe location off of the traveled roadway.

636.2.10 Temporary Roads and Dust Palliatives

Where temporary roads are called for in the Contract, check to ensure that the surface of the temporary road is maintained with aggregate as specified. In addition, dust palliatives are used on haul roads and other locations on the project to minimize pollution from dust, where dust would create a nuisance to the traveling public or adjacent property owners. During the project, verify compliance with the specified application of dust palliatives.

636.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Inspector's Traffic Control Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 637

WATER

637.1 GENERAL REQUIREMENTS

637.1.1 Description of Work

Section 637 of the **Standard Specifications** governs the material and construction requirements for the use of water in compacting embankments, stabilizing soils, and dust control. When Item 637 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 637 of the **Standard Specifications** and as directed by the Project Engineer/ Supervisor. See the **Standard Specifications** for the method of measurement for payment.

637.1.2 Materials Considerations

Verify that the water is suitable for the intended purpose, as specified in Section 637.2 of the **Standard Specifications**.

637.2 INSPECTION GUIDELINES

Water that is used as a dust palliative is intended to prevent a public nuisance and is to be placed as directed and in the quantities ordered by the Project Engineer/Supervisor. Water is also used during embankment construction and to stabilize soils. Check that the application equipment used is suitable for the intended purpose. In addition, verify the application quantities and timing for conformance.

637.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 639

CONSTRUCTION LAYOUT STAKES

639.1 GENERAL REQUIREMENTS

639.1.1 Description of Work

Section 639 of the **Standard Specifications** governs the material and construction requirements for furnishing, placing, and maintaining construction layout stakes. See the **Standard Specifications** for the method of measurement for payment,

639.1.2 Material Considerations

Verify that the materials and equipment required for construction layout stakes conforms to the requirements of 639 of the **Standard Specifications** and as directed by the Project Engineer/Supervisor. .

639.2 INSPECTION GUIDELINES

639.2.1 Overview

The "stake-out" is the means whereby the Contractor is shown exactly at what points on the ground and to what dimensions the road, its appurtenances, and structures are to be built. Except when there is a stake-out item in the Contract, staking-out is a responsibility of the Division. Staking responsibilities of the Division and Contractor are clarified in Section 105.8 and Section 639 of the **Standard Specifications**. The stake-out work must be performed carefully and accurately, because the Contractor is expected to perform the construction work using this control. For this reason, the stake-out should be started well in advance of the beginning of construction to avoid hurried work that may result in errors. All notes in connection with stake-outs must be maintained in a separate notebook, arranged in an orderly sequence, and indexed. When the stake-out has been completed, the notebook is to be submitted to the Project Engineer/Supervisor for reference.

Before staking is started, the Contract Plans should be checked and the notebooks prepared. A set of Contract Plans should be available for the use of the staking party at all times. Any notation of errors that are found in staking should be made on the Field Plans and in the notebooks. All curve data shown on the Contract Plans should be checked before staking starts.

Due to the many stake-out notes that must be maintained on the project, the notes should be maintained in separate books, such as one book for slope stake notes, one for elevation control stakes, one for right-of-way hubs, one for fine grade notes, etc.

639.2.2 Centerline Stakes

When staking out a project for grading, the first operation is to stake the centerline. The Division will locate and reference the centerline in all cases. Where the centerline of the project is the same as the base line of the location survey, the line may already be staked. In such cases, the stakes should be carefully checked for errors that may interfere with carrying true grades. Corrections of stationing should be made as equalities (i.e., equations), inserted preferably at the PC of the curve.

If the centerline is a "paper location," the actual lengths of tangents may vary from the calculated lengths shown on the Contract Plans, and the stationing should accordingly be corrected with equalities.

The angle of each PI should be checked. If necessary, it should be corrected, and the curve

should accordingly be adjusted to fit the tangents. A change in the required length of a curve should be corrected by an equality at the PT.

References for each point that must be referenced should be checked. Where the references have been destroyed, or where they are likely to be disturbed in the course of construction work, new references for the point should be established so that they may be preserved.

639.2.3 Elevation Control Stakes

With the centerline established, the next operation is the checking of bench marks by the Division. All bench marks must be tied into USGS or suitable reference datum. If it is not feasible to carry the levels through to another bench mark established from the same datum, the circuit should be closed by running an independent line back to the original mark. All bench marks should be used as "turning points," and under no circumstances should the elevation of a bench mark be determined by a "side shot."

A hub with a guard stake must be set on each side of the centerline opposite every 50′ (15-m) station or at every original cross-section station. Elevation control hubs and guard stakes will be set at a convenient distance outside the construction limits so as not to be disturbed during construction operations. The guard stakes will be marked as follows:

1. The station number will be marked on the back of the guard stake.

2. The distance out from the centerline will be marked on the front, which is the side facing the centerline, near the top.

3. The elevation of the top of the hub will be marked, which will be marked on the side facing the centerline and below the distance marking. The distance and elevation markings should be separated by a line drawn across the stake.

Care should be taken to set the marker hubs at right angles to the centerline. When the marker hubs on the elevation control lines have been set, levels should be run over them and over the centerline hubs, and the elevations recorded. The levels will serve as an absolute check on any cross-section, either original or final. In some cases, due to the slope of the ground, it may be necessary to run different sets of levels to obtain centerline elevations and elevations on control stakes on left and right of centerline.

639.2.4 Slope Stakes

Slope stakes, consisting of flat marker stakes, are to be set at the computed actual top (cut) and toe (fill) of the side slopes. The distances to slope stakes should not be scaled from the Contract Plan cross-sections, except for temporary use in an emergency. When computing the distance from the centerline to the top of a slope, widening and superelevation must be taken into consideration. At the same time, the distance to the slope stake from the control hub should be marked on the guard stake at the elevation control hub, so that the slope stake can easily be reset if it should be covered up or disturbed. These notes should be entered in the proper stake-out book.

639.2.5 Right-of-Way and Utility Stakes

639.2.5.1 Staking Right-of-Way During Construction

Hubs should be set at right angles to the centerline of the roadway, on both sides of the roadway, and at all locations where right-of-way changes width. Marker hubs will be driven flush with the ground. During the operation, guard stakes will be driven, the station number will be marked on the back of the guard stake, and the distance from the centerline will be marked on the other side facing the centerline of the roadway. The staking should conform to the right-of-way as shown on the Contract Plans or as modified by executed deeds. Right-of-way

lines for drainage easements and borrow pits should likewise be staked.

639.2.5.2 Utility Right-of-Way Stake-Out

The following procedures will be used to expedite stake-out for right-of-way involving utility companies:

1. The District Construction Engineer will assign adequate survey personnel to perform the designated work and will coordinate the survey with the District Utility Supervisor as to priority and progress of the right-of-way stake-out.

2. The District Construction Engineer will inform the utility company of the completion of the right-of-way stake-out so they can conduct their field review and expedite utility agreements. The District Construction Engineer will then contact the Right-of-Way Division Utility Engineer of the stake-out completion and the utility companies contacted.

3. After sufficient time has elapsed for the utility companies' field review, the District Construction Engineer will contact the involved utility companies and the Right-of-Way Division Utility Engineer to determine if any questions have surfaced that will require additional or correctional right-of-way location work.

4. The District will inform the Contract Administration Division, by letter, when the utility right-of-way stake-out has been satisfactorily completed.

5. The Contract Administration Division will notify the Design Division, by letter, of the completion of this phase of right-of-way stake-out with copies to the Right-of-Way Division and the District.

639.2.6 Roadway Cross-Sections

The original cross-sections should indicate the elevations of the "elevation control hubs" and "centerline hubs." When considerable difference in elevations is noted, a new cross-section should be taken and plotted. Intermediate sections may be necessary at abrupt changes in slope which would affect the earthwork quantities. Each section should be carried well beyond the construction lines. While a section is being taken, rod readings on the tops of the elevation control hubs should be indicated in the notes by the notations "TH," meaning top of hub. Where it appears probable that slides or breakage may occur, the sections should be referenced to the tops of hubs set well outside the probable slide or breakage area, and the corresponding rod readings indicated in the notes as "TH."

639.2.7 Borrow Cross-Sections

Places from which borrow is to be obtained must be cross-sectioned to compute the quantity of material excavated. Where the site for a borrow pit is adjacent to the road, being only a short distance outside the right-of-way line and along a tangent, the road cross-sections may be extended to cover the probable extent of the pit. If the pit is likely to be extremely large, a separate base line which is parallel to the centerline of the road should be established and suitably referenced, preferably by a right-angled tie to the roadway centerline.

Where the site for a borrow pit is not near enough to the road, or where it is adjacent to the road but located along a curve, an independent baseline should be run through the approximate center of the pit, and sufficient cross-sections should be referred to this base line. If the pit is likely to be very large, two or more parallel lines should be referred to this baseline.

Whenever a baseline from which cross-sections are taken is independent of the road centerline, the baseline should be referenced in such a way

that the references will not be disturbed, and so that the line and the stationing on it may be re-established for final sectioning.

A reference stake should be set at each limit of each cross-section taken at a borrow site. Such a stake should be marked to show the station number and distance from the base line so that the Contractor will have some idea of the location of the pit limits.

Where there may be slides, the scheme described for sectioning for the roadway under similar conditions should be used.

639.2.8 Pavement Stakes

639.2.8.1 Hubs on Offset Line

In staking out a pavement project, a single row of hubs is generally set on an offset line at one side of the centerline. If conditions are favorable, offset hubs preferably should be set on the side of the road in which the first lane of paving is to be placed. When it can be performed without inconvenience, or danger of loss of hubs, the offset distance should be the same for all hubs. In such a case, the hubs can be lined directly with the transit, and the distances between them can be measured along the offset line.

If it is found necessary to set the hubs at varying offset distances, or on different sides of the road, the centerline will have to be located first. Each point on the centerline may be marked by means of a nail and flag, and the offset distances can then be measured from these points to locate the hubs.

A hub should be driven nearly flush with the ground and should be protected with a guard stake. Markings for the hub are made on the guard stake. Hubs for pavements should be set at all 50′ (15-m) stations on tangents and at 25′ (7.5-m) intervals on horizontal and vertical curves and at intermediate points if necessary. They should also be set at all curve control points (PC, PT, etc.) and ends of run-offs for superelevated curves. Each hub that is referenced to the centerline should have a tack set in it from which to measure the centerline offset.

639.2.8.2 Levels

After the offset hubs have been set, levels should be run over them. The rod should be read carefully to the nearest hundredth of a foot (meter).

639.2.8.3 Cross-Sections

If the paving contract is on a project which previously has been graded under another contract, new cross-sections should be taken to be used in computing the unclassified excavation involved in subgrade, ditch, and shoulder work. The sections need only be carried as far out on each side as it is probable that such work will be done. Ordinarily, it will be enough to take one or two shots beyond the ditch on the bank in a cut or beyond the outside edge of the shoulder on an embankment.

639.2.8.4 Marking Guard Stakes

Before calculating the grades and marking the guard stakes at the offset hubs, the profile notes should be plotted and examined in connection with the proposed grade line, especially on a project where the paving contract is being done separately from the original grading contract. Frequently, a slight change in grade may be found to give a better “fit” to the ground and thus reduce the quantity of unclassified excavation. The Project Engineer/Supervisor should carefully review any change in grade that may be anticipated and should receive approval from higher authority prior to authorizing such change. Extreme care must be used to establish the grade at an elevation which will assure enough material to properly finish the shoulders without excessive waste or borrow.

In marking the guard stakes, the station number should be marked on the upper part of the side facing the centerline, and the offset distance should be put below it on the same side, the two markings being separated by a line drawn across the stake. The cut or fill should be marked on the back. Hubs at the curve control points should be so identified, also on the face of the stake. The amount of superelevation should be marked on the edge of each stake along a curve or tangent run-off.

639.2.8.5 Stake-Out Book

When the grades have been calculated, they are entered in one of the stake-out books. The cuts and fills are then calculated and marked on the stakes at the offset hubs. When the stake-out has been completed, the book should be left with the Project Engineer/Supervisor for use in checking grades.

639.2.9 Staking Culverts

639.2.9.1 Preliminary Studies for Pipe Culverts

Ordinarily, only a few stakes are needed by the Contractor to set a pipe culvert. Usually, a stake, offset from the centerline of the pipe at each end, and an offset hub are required. If the pipe is long, one or more intermediate stakes may be required. However, when choosing the locations of the stakes and setting them, the Project Engineer/Supervisor must pay careful attention to the required length and skew and other matters.

The angle of the culvert is shown as 90° if at right angles to the centerline, or a certain degree skew from right angles if other than 90°. The skew is written RA or RFS, meaning right ahead or right forward skew, or LA or LPS, meaning left ahead or left forward skew.

The ground must be studied carefully to locate the culvert so that the completed structure will best serve its purpose with a minimum of maintenance. To obtain good results, the inlet and outlet should be in a reasonable direct line with the channel, free from obstruction, and located and protected so as to avoid clogging from fill material.

If feasible, the total length of a pipe culvert should be so chosen that it will not be necessary to cut a standard piece.

639.2.9.2 Placing Stakes for Pipe Culverts

When the skew and length of a pipe culvert has been decided upon, stakes are placed at the points on the ground where the ends of the centerline of the pipe are to be located. Each such stake is marked “End Pipe.” An offset hub is then set plus or minus 10′ (0.3 m) from each end. The offset distance should be adequate to place the stakes well out of the way of construction work, and should be marked on the face of each guard stake. Additional information for pipe culvert stake-out is set forth in Section 604 of this **Manual**.

639.2.9.3 Records for Pipe Culverts

The elevation of the flow line at the inlet and outlet of a pipe culvert, and the grade of the culvert, may be established in relation to the ground by using a Locke level or Wye level. The actual end elevations must be determined and must be marked in the structure book and posted on the Plans.

639.2.9.4 Stakes for Box Culverts

In the case of a box culvert, more details and measurements for construction and, therefore, more stakes, are necessary. The location must be carefully worked out by considering several factors, as explained for locating a pipe culvert. The skew angle of the centerline should be turned with a transit and recorded so that the lines of the headwalls and wings also can be

located at the proper angles. Under no circumstances should the location, skew, or elevation be altered without the approval of proper authorities.

With the centerline established and offset hubs set for future references and checking, the points at the ends of the culvert should be marked on the centerline. At these points, the angles for the lines of the faces of the headwalls should be turned. Offset hubs that are well out of the way of the construction should be set on each side of the work. The inside face, or other required working line, of each of the main walls should be located, and these lines similarly referenced by offset hubs. On these working lines, the intersection points with the lines of the faces of the wingwalls are located, and at those points the angles for the lines of the wingwall faces are turned. Offset hubs are likewise set for the wingwall lines.

All control points, whether on working lines or on offset lines, should be marked with tacks. To avoid confusion, a guard stake should be driven near each hub on an offset line and should be plainly marked to show the offset distance and the point on the structure to which the offset distance refers. Notes and sketches of the stake-out should be maintained in a convenient stake-out book.

639.2.9.5 Other Work for Box Culverts

After all stakes needed for a box culvert have been set, levels should be run over a sufficient number of the stakes to permit the cut or fill to grade to be marked on each of them for convenience. A temporary bench mark may be established for use in checking grades during construction. In the case of a box culvert, the grade to which reference is made is customarily the flow line.

Before excavation for a box culvert is begun, cross sections should be taken from the centerline established for the culvert. Sections should be located at enough points to make an accurate computation of the quantities of structural excavation and unclassified excavation by the methods outlined in this **Manual**.

639.2.10 Staking Bridges

639.2.10.1 Control System

Because of the wide range of variations in Contract Plans for bridges, specific rules of standard methods for the stake-out of bridges in general cannot be established. In the stake-out for a bridge, especially one for crossing a large body of water, a highly precise horizontal control system is necessary. Such a system will make it possible to locate accurately and quickly various widely scattered piers and other component parts of the bridge.

639.2.10.2 Preliminary Checking

Before any definite location is marked or any working elevations are given, it is necessary to check the positions and elevations of several points of the original location survey to which the design was fitted. The purpose of this checking is to make sure that the points were taken accurately and that the design is based upon accurate information. It is especially essential, in the case of a grade separation structure, to check the elevations and alignment of all railroad tracks and structures by comparison with the information shown on the Plans, in order that the clearances will be as designed. As a rule, drawings for a grade separation structure give the layout distances and measurements with references to the intersection of the centerline of the highway and the centerline of the railroad track. Convenient bench marks should be established so that elevations for the work can be determined from them as required.

639.2.10.3 Setting Stakes

As a general method of procedure, the centerline of the bridge is carefully established and referenced. Points at the faces or other working lines of each abutment, and at the axis of each pier or row of footings are located on the bridge centerline, and the angles corresponding to the skew of the bridge are turned at these points. Each line thus located is prolonged to reference points well beyond the area of the work. At each intersection of a face of an abutment and a face of a wing, the wing angle is turned, and the line thus located is referenced.

Ordinarily, a bridge cannot be completely staked out at one time, with no further staking required. It is usually necessary to set stake or marks for new lines at intervals during construction, and to give new grades as the work progresses. For this reason, a transit, level, tape, and leveling rod should be kept at the site of the work so that additional lines and levels can be furnished or checked by the Project Engineer/Supervisor or Project Inspector as needed.

As in any other stake-out, notes should be recorded, and the notebook retained by the Project Engineer/Supervisor or Project Inspector in charge of construction.

639.2.10.4 Checking Stake-Out

Accuracy is more essential in layout out a bridge than in any other stake-out. An error is apt to be much more costly than in other construction.

Because of the possibility of a serious error in the stake-out, no bridge stake-out should be considered satisfactorily completed until an independent check has been made. One method of checking a bridge layout, where curves, tangents to curves, and angles from the tangents must be staked, is to go over the Contract Plans carefully and to compute, and have independently checked, the azimuth of every line involved. Then, if the lines have been located by turning deflection angles, they should be checked by azimuths; or vice versa. The advantage of the azimuth method is that the azimuth of a back sight to the point of beginning from any other point and the accuracy of the intervening work can be readily proved, or errors can be detected, by comparing the measured azimuth with the computed azimuth.

639.2.11 Responsibilities for Staking

For all projects, including structures, the Division will locate and reference the centerline and will establish bench marks along the line of the improvement for the proper layout of the work. The responsibility of the Contractor for stake-out is set forth in 639 of the **Standard Specifications** when this item is called for in the contract.

When Item 639 is not provided for in the Contract, the Project Engineer/Supervisor will generally provide the stake-out that is normally expected from the Contractor in the performance of Item 639. The responsibility of the Engineer in placing these stakes will be limited to the initial placement, and the Contractor will be held responsible for the preservation of these stakes. Additional stakes, such as locating batter boards, additional offset lines, additional right-of-way stakes, etc., will be the responsibility of the Contractor. When Item 639 is not called for in the Contract, the Contractor will cooperate with the Project Engineer/Supervisor in preparing a schedule for stake-out to meet the requirements of the Contractor's work schedule.

When Item 639 is provided in the Contract, it shall be the responsibility of the Project Engineer/Supervisor to require the Contractor to furnish copies of field notes as the work progresses (at least on a weekly basis). These notes will be used in spot checking this item of work. The results of this checking will be recorded in the appropriate Inspector's Daily Report form and the Project Diary.

639.2.12 Final Surveys

639.2.12.1 General

The purpose of the final survey on a project is to determine the quantities of the various items of work for which the Contractor is to receive payment in the final settlement of the Contract. The method of calculating the quantity of each individual item is always made a part of the specifications for the item under the subsection "Method of Measurement."

In determining the final quantity of a pavement, base, or similar item, for which payment is made per square yard or per cubic yard, the final survey usually consists of a measurement of the length along the centerline and upon the surface of the road together with measurements of average widths and separate measurements at turnouts and intersections wherever they are necessary to show all authorized work.

For the determination of the final quantities of unclassified excavation, borrow, and similar items, for which payment is made per cubic yard (cubic meter), it is necessary that final cross-sections be taken.

639.2.12.2 Final Section Locations

The party taking the final cross-sections should have available the notebooks containing notes for the original sections, the stake-out book, and also a set of prints of the original cross-sections as shown on the Contract Plans.

The first step in the procedure of taking final sections, is to reset the centerline of the road or the base line from which the original sections were taken. In order that the "ties" of the final sections with the originals may be accurate, the final sections must be taken from the same points on the reference line as were the originals. That is, a final section must be taken from every point on the line from which an original section was taken.

Special care must be exercised in taking final sections to minimize discrepancies between original and final checks and special attention should be given to the guidelines hereinafter specified.

1. Before starting any final survey, all original centerline and cross section books, all revised centerline books (if revised cross sections were taken), centerline profile and cross-sections should be available.

2. Every effort is to be made to replace centerline to its original location before construction. A check on adjacent topography from original centerline book will help verify final centerline.

3. Before starting cross-sections, a level check must be made on all available benchmarks.

4. Ties from construction bench marks to original marks are to be made if errors show in construction benches.

5. A thorough study must be made of cross sections and templates to determine the limits of construction (i.e., side roads included in the contract but not part of the main project template).

6. On each cross-section, a shot will be taken on old ground at a distance to compare with a distance in the original cross section book. Elevations will be figured at this distance and a check made. If elevations compare within 6″ (150 mm), the cross-section is acceptable. If elevations show a difference greater than 6″ (150 mm), a check of the final section will be made. If the check reveals the original cross-section is in error, a note will be made in the book showing the difference, and marked "Final OK."

7. Profile and all cross-section shots on pavement, including paved or stone shoulders will be taken with a precise level to show a more accurate pavement template, and recorded to 0.01′ (0.01 m).

In the event discrepancies between original and final sections cannot be resolved, these differences should be further investigated.

639.2.12.3 Final Section Measurements

When the points on the reference line have been re-established and marked, levels and measurements are taken and noted substantially as described previously for original cross-sections.

As much care must be used to determine lines at right angles to tangents and radial lines on curves as was used during the original or stake-out surveys. Each final section must be run out on each side of the reference lines far enough to cover all the work and include not less than two readings on original ground (marked "OG" in the section book) beyond the top or toe of a slope. In addition, the sections should always include a rod reading on each elevation control grade stake and on any other stake which may have been set during the original survey or stake-out survey and for which there is a previously determined elevation.

639.2.12.4 Terminal Points

In addition to the notes for the regular sections as described above, notes also should be kept to show the stations of terminal points, sometimes called "apex points" or "zero points of cut or fill," for each side of the road. When entering into a cut, the station of the point where the excavation begins on either the right-hand or left-hand side, as the case may be, should be noted. Similar points should be noted where excavation ends and fill begins.

639.2.12.5 Intermediate Cross-Sections

Cuts or fills on approach roads, earthwork for the removal of slides, and some other authorized widenings may not be measurable by means of cross-sections taken at the regular points. In such a case, the quantity may be measured by means of sections taken at intermediate points, unless cross-sections have been previously taken from an independent base line or the quantity has been measured separately by some other method. When an intermediate final section is taken from the road centerline, the corresponding original section is reconstructed by interpolation. The final sections should be located at whatever intervals may be necessary to include the whole volume, and should also show the terminal points of the extra work being measured. Intermediate sections are useless for purposes other than to show widenings, or narrowings in the final survey, unless original sections were actually made for the same points.

639.2.12.6 Slides

Accurate measurement and computation of the volume of a slide frequently requires that the original sections be extended and that intermediate original sections be taken prior to the beginning of excavation. It may be found necessary, especially if part of the slide is below the road grade, to take sections at times intervening between the original and final surveys to show areas that had to be removed during construction but would have been backfilled at the time of the final survey. Measurements at such intermediate sections should be taken as soon as the work has been completed. Information needed for the purpose, such as the location of nearby reference points and their elevations, should always be at hand. The final sections should be extended to original ground which is well beyond the limits of the excavation, and notes should be made to show the location and extent of all cracks and breaks appearing in the original ground because of the construction.

639.2.12.7 Benches

Benches above the grade of the road will be shown in the final sections. But a bench below grade, which has been excavated for the purpose of removing unstable material or to prevent a fill from slipping must be shown by sections taken

at the time of completion of the bench and before the fill is started. Where a bench is formed at a slide, necessary sections should be taken promptly on completion of the work.

639.2.12.8 Structures

In addition to taking the final cross-sections as just described, the station number of the point at which each pipe or other culvert intersects the road centerline should be noted in the final survey and checked with that given in the structure book. Also, the angle of skew should be measured and recorded. In the final survey, measurements should be taken to permit plotting of a profile over and along the centerline of each pipe or other culvert. This profile should show the distances out and elevations of the headwalls and flowlines, and be extended beyond each end of the culvert to original ground. Such a profile serves as a check on the structure-book measurements, and is of use in planning future extensions of the culvert. When a structure, such as a pipe underdrain, may be so covered up that only one end is visible, the invisible end should be located by the station number and a right-angle offset from the road centerline.

639.2.12.9 Field Checking Elevations of Ties

Final cross-sections must always be checked for errors in elevations before being sent to the office for plotting. For checking, calculations are made for the final elevations of the ties, which consist of the OG's and previously set grade stakes, the positions of which have been plotted on the original sections as shown on the Plans. If the two elevations of each tie agree with reasonable accuracy, no further checking may be necessary. The amount of difference to be allowed at any section will depend on the depth of the excavation or fill at that section. If the two elevations obtained for a tie differ by more than 1′ (0.3 m), the section should be rechecked. However, smaller differences are to be expected on the shallower sections.

639.2.12.10 Field Investigation of Differences

The original and final elevations of the ties may differ for any one of several reasons. If there is an appreciable difference and no error can be found in the calculations, all possible reasons should be investigated in order of their probability. To determine the reason, the condition of the ground should be examined carefully, and special notes should be prepared.

From these notes, a conclusion can be drawn in regard to the probable reason for the changes in elevations, and the section can be reconstructed. Such notes should include evidence of the possibility that slips occurred since the original section was measured, or any other evidence that may indicate the reason for the changes.

An agreement in elevation should never be forced at the expense of the accuracy of the final survey. The final survey party is responsible only for the accuracy of its own survey, and not for that of a previous survey.

639.2.12.11 Miscellaneous Measurements

Channel changes are usually measured by original and final sections taken from the centerline of the road and extended far enough to include the channel. A channel should be sectioned immediately upon completion of excavation work.

A drainage ditch, such as an inlet or outlet at a culvert, is usually measured independently or by sections from an independent base line; the method depends on the size and location of the ditch. It is common practice to include such measurements and the volume computations in the structure book. Diversion ditches above cuts or fills and parallel to the roadway should be shown and measured.

When an excavation below grade is authorized to remove rock in a cut and the space is backfilled with earth or other suitable material, cross sections shall be taken and plotted. Where

there is rock below grade in a cut, the final survey should contain notes showing the stations of the beginning and ending of the rock, in order to permit comparison with other notes obtained by the Project Inspector during construction.

When excavation below grade is authorized for removal of mucky or poor material and the space is backfilled, the excavation should be measured at the time the work is done and independent notes should be made. Such excavation may not be shown by the final survey.

639.2.12.12 Plotting and Compaction

Where practical, the final cross-sections should be plotted on the original sheets which were used for planning or designing purposes, and the original cross-sections should not be re-plotted unless it is absolutely necessary to do so. By using the old sheets, the final sections can be easily compared with the original template sections and areas. For this comparison, errors of plotting or running areas are more readily recognized and checked.

639.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Inspector's Traffic Control Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 642

TEMPORARY POLLUTION CONTROL

642.1 GENERAL REQUIREMENTS

642.1.1 Description of Work

Section 642 of the **Standard Specifications** governs the material and construction requirements for temporary pollution control. When Item 642 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 642 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

642.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 642.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

642.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for temporary pollution control is in conformance with the construction methods and details specified in Section 642 of the **Standard Specifications**. If inspectors are contacted by the WVDEP at the project, any recommended modifications or corrective measures must be addressed immediately.

At the Preconstruction Conference, the Contractor will submit for approval the erosion control plans, including the project waste and borrow sites. These plans shall be approved by the District Construction Engineer and the WVDEP. All permits related to pollution control issues need to be on file at the project. Pay particular attention to the schedule of requirements for each size threshold of erodible area. Construction of permanent drainage facilities as well as performance of other Contract work that will contribute to the control of erosion and siltation will be accomplished at the earliest practical stage during the life of the Contract. Pollutants such as chemicals, fuels, lubricants, bitumen, raw sewage, and other harmful waste will not be discharged into or alongside rivers, streams, impoundments (e.g., lakes, reservoirs, etc.) or into natural or man-made water courses leading thereto. The Contractor will also comply with the applicable regulations of the Department of Natural Resources and other statutes relating to the prevention and abatement of pollution.

See the WVDOH District Environmental Coordinator for information on DEP permit requirements. See the WVDOH **Erosion and Sedimentation Control Manual** for information the Contractor's Erosion and Sedimentation Control Plan, erosion and sedimentation control at waste and borrow sites, seeding and mulching frequencies, and maintenance of in-place erosion control features.

642.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine

and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Erosion Monitoring Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 651

FURNISHING AND PLACING TOPSOIL

651.1 GENERAL REQUIREMENTS

651.1.1 Description of Work

Section 651 of the **Standard Specifications** governs the material and construction requirements for furnishing and placing topsoil. When Item 651 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 651 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

651.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 651.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

651.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for furnishing and placing topsoil is in conformance with the construction methods and details specified in Section 651 of the **Standard Specifications**. Pay particular attention to the location of the topsoil (i.e., on or off right-of-way) and the requirements for stripping, transporting, placing, and manipulating the topsoil.

651.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 652

SEEDING AND MULCHING

652.1 GENERAL REQUIREMENTS

652.1.1 Description of Work

Section 652 of the **Standard Specifications** governs the material and construction requirements for seeding and mulching. When Item 652 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 652 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

652.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 652.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, in concurrence with West Virginia Department of Agriculture laws, rules and regulations, and document laboratory numbers on the Inspector's Daily Report.

652.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for seeding and mulching is in conformance with the construction methods and details specified in Section 652 of the **Standard Specifications**. Watch for Contract provisions regarding State noxious weeds. Pay particular attention to the requirements for seasonal work, area preparation, application methods and rates for mulch and fertilizer, and maintenance requirements.

During dry weather, the mulch application rates, as defined in Section 642 and Section 652 of the **Standard Specifications**, may not provide the necessary moisture retention for seed germination and plant growth. Under these conditions, the Project Engineer/Supervisor may increase the application by 1.5 times the specified rate when using hay, straw, or wood cellulose mulch. No adjustments are necessary when wood chips are used.

652.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 653

VINE AND GROUND COVER PLANTING

653.1 GENERAL REQUIREMENTS

653.1.1 Description of Work

Section 653 of the **Standard Specifications** governs the material and construction requirements for vine and ground cover planting. When Item 653 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 653 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

653.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 653.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources in concurrence with applicable West Virginia Department of Agriculture laws, rules, and regulations, and document laboratory numbers on the Inspector's Daily Report.

653.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for vine and ground cover planting is in conformance with the construction methods and details specified in Section 653 of the **Standard Specifications**. Watch for Contract provisions regarding State noxious weeds. Pay particular attention to the requirements for seasonal work, area preparation, application rates for water, mulch, and fertilizer, and maintenance requirements.

During dry weather, the mulch application rates that are defined in the **Standard Specifications** may not provide the necessary moisture retention for plant growth. Under these conditions, the Project Engineer/Supervisor may increase the application by 1.5 times the specified rate when using hay, straw, or wood cellulose mulch. No adjustments are necessary when wood chips are used.

653.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 654

TREE AND SHRUB PLANTING

654.1 GENERAL REQUIREMENTS

654.1.1 Description of Work

Section 654 of the **Standard Specifications** governs the material and construction requirements for tree and shrub planting. When Item 654 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 654 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

654.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 654.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources in concurrence with applicable West Virginia Department of Agriculture laws, rules, and regulations, and document laboratory numbers on the Inspector's Daily Report.

654.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for tree and shrub planting is in conformance with the construction methods and details specified in Section 654 of the **Standard Specifications**. Watch for Contract provisions regarding State noxious weeds. Pay particular attention to the requirements for seasonal work, area preparation, application rates for water, mulch, and fertilizer, and maintenance requirements.

During dry weather, the mulch application rates that are defined in the **Standard Specifications**, may not provide the necessary moisture retention for plant growth. Under these conditions, the Project Engineer/Supervisor may increase the application by 1.5 times the specified rate when using hay, straw, or wood cellulose mulch. No adjustments are necessary when wood chips are used.

654.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 655

MATTING FOR EROSION CONTROL

655.1 GENERAL REQUIREMENTS

655.1.1 Description of Work

Section 655 of the **Standard Specifications** governs the material and construction requirements for matting for erosion control. When Item 655 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 655 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

655.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 655.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, as applicable, and document laboratory numbers from the shipping document on the Inspector's Daily Report.

655.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for matting for erosion control is in conformance with the construction methods and details specified in Section 655 of the **Standard Specifications**. Pay particular attention to the requirements for area preparation, mat placement method, maintenance, and repair work in accordance with the manufacturer's recommendations.

655.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 656

SEEDLING PLANTING

656.1 GENERAL REQUIREMENTS

656.1.1 Description of Work

Section 656 of the **Standard Specifications** governs the material and construction requirements for seedling planting. When Item 656 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 656 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

656.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 656.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources in concurrence with applicable West Virginia Department of Agriculture laws, rules, and regulations, and document laboratory numbers on the Inspector's Daily Report.

656.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for seedling planting is in conformance with the construction methods and details specified in Section 656 of the **Standard Specifications**. Watch for Contract provisions regarding State noxious weeds. Pay particular attention to the requirements for seasonal work, area preparation, application rates for water, mulch, and fertilizer, and maintenance requirements.

During dry weather, the mulch application rates that are defined in the **Standard Specifications**, may not provide the necessary moisture retention for plant growth. Under these conditions, the Project Engineer/Supervisor may increase the application by 1.5 times the specified rate when using hay, straw, or wood cellulose mulch. No adjustments are necessary when wood chips are used.

656.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 657

ROADSIDE SIGN SUPPORTS

657.1 GENERAL REQUIREMENTS

657.1.1 Description of Work

Section 657 of the **Standard Specifications** governs the material and construction requirements for the fabrication and erection of roadside sign supports that are located outside and not above the shoulder. When Item 657 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 657 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

657.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all structural aluminum and steel supports, bases, and caps; wood posts; and reinforcing steel. concrete, and anchor bolts materials conform to the requirements specified in Section 657.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

657.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for roadside sign supports is in conformance with the construction methods and details specified in Section 657 of the **Standard Specifications**. The work will be in conformance with the FHWA publication **Manual on Uniform Traffic Control Devices for Streets and Highways** and the AASHTO publication **Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals**. Review the shop drawings and know the erection details for the sign support. Verify the proper excavation of the footing. Check that the erection and setting of the post complies with the requirements of the Contract. Ensure that the Contractor properly backfills and field paints the post as specified.

657.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 658

OVERHEAD SIGN STRUCTURES

658.1 GENERAL REQUIREMENTS

658.1.1 Description of Work

Section 658 of the **Standard Specifications** governs the material and construction requirements for the fabrication and erection of overhead bridge, cantilever, and butterfly sign supports. When Item 658 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 658 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

658.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all aluminum, galvanized steel, weathering steel, fasteners, reinforcing steel, anchor bolts, and concrete materials conform to the requirements specified in Section 658.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

658.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for overhead sign structures is in conformance with the construction methods and details specified in Section 658 of the **Standard Specifications**. The work will be in conformance with the FHWA publication **Manual on Uniform Traffic Control Devices for Streets and Highways** and the AASHTO publication **Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals**. Review the Contract Plans and **Standard Detailed Drawings** and know the erection details for the sign support system specified. Verify the proper excavation of the footing. Check that the erection and setting of the post complies with the requirements of the Contract. Bolt installation is to be performed with an hydraulic torque wrench. Bolt torque should be checked using the turn-of-the-nut method. Ensure that a crane is used to support the structure during erection so that the bolts are not overloaded. Pay particular attention to the specified requirements for welding aluminum alloys. Ensure that the Contractor properly backfills the excavation.

658.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 659

SIGN LIGHTING

659.1 GENERAL REQUIREMENTS

659.1.1 Description of Work

Section 659 of the **Standard Specifications** governs the material and construction requirements for sign lighting. When Item 659 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 659 of the **Standard Specifications** and as designated on the Contract Plans. See **Standard Specifications** for the method of measurement for payment.

659.1.2 Materials Considerations

Know the details of the Contractor's equipment list and drawings. Work should not begin until these drawings are reviewed by the Project Engineer/Supervisor. Inspect all materials upon arrival. Verify that all conduit, pull boxes, cable, connectors, poles, enclosures, sign lighting fixtures, and photoelectric controls conform to the requirements specified in Section 659.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

659.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for sign lighting is in conformance with the construction methods and details specified in Section 659 of the **Standard Specifications**, including local laws and ordinances, the **National Electric Code**, and other national criteria, as defined. Verify the proper excavating of the footing. Ensure that any fixture that are to be removed and replaced are performed as specified. Check installation of conduit, pull boxes, luminaires, ballasts, isolating transformers, cables, and grounds for compliance. Check for proper backfilling. Ensure that the electrical service is connected as arranged. Coordinate with the Project Engineer/Supervisor to perform the final field test.

659.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 660

TRAFFIC SIGNALS

660.1 GENERAL REQUIREMENTS

660.1.1 Description of Work

Section 660 of the **Standard Specifications** governs the material and construction requirements for the installation of traffic signals. When Item 660 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 660 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the methods of measurement for payment.

660.1.2 Materials Considerations

Know the details of the Contractor's equipment list and drawings. Work should not begin until these shop drawings are reviewed by the Traffic Engineering Division. Inspect all materials upon arrival. Verify that all signal supports, controllers and cabinets, traffic detectors, signal heads, auxiliary equipment, conduit, junction boxes, messenger cable, and conductors conform to the requirements specified in Section 660.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

660.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for traffic signals is in conformance with the construction methods and details specified in Section 660 of the **Standard Specifications**, the WVDOH publication **Traffic Control for Street and Highway Construction and Maintenance Operations,** local laws and ordinances, **Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals**, **Manual of Uniform Traffic Control Devices**, **National Electric Code**, and other national criteria, as defined. Verify the proper removal of existing signal equipment, if specified. Check the excavation of the footing for compliance. Ensure that loop detectors are installed in accordance with the Contract Plans and **Standard Detailed Drawings**. Verify that the support structure is erected and connected in accordance with Contract Plans. Check the signal head mounting for compliance, paying particular attention to height and viewing angle with respect to a vehicle at the stop bar. Ensure that cabinets are properly located and that messenger cable, conduit, junction boxes, and wiring are installed as specified. Check for proper backfilling. Ensure that the electrical service is connected as arranged. Coordinate with the Project Engineer/Supervisor to perform the final field test.

660.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 661

TRAFFIC SIGNS AND DELINEATORS

661.1 GENERAL REQUIREMENTS

661.1.1 Description of Work

Section 661 of the **Standard Specifications** governs the material and construction requirements for the fabrication and erection of traffic signs and delineators. When Item 661 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 661 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

661.1.2 Materials Considerations

Know the details of the Contractor's shop drawings. Work should not begin until these drawings are reviewed by the Traffic Engineering Division. Inspect all materials upon arrival. Verify that all sheet and extruded aluminum sign panels, structural steel shapes, fastening hardware, sign sheeting and copy, reflectors, and delineators conform to the requirements specified in Section 661.2 and Section 661.3 of the **Standard Specifications**. The criteria for sampling, inspection, and acceptance of signing material is documented in MP 661.02.40. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

661.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for traffic signs and delineators is in conformance with the construction methods and details specified in Section 661 of the **Standard Specifications**, **Sign Fabrication Manual**, **Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals**, **Manual of Uniform Traffic Control Devices**, and **Standard Alphabets for Highway Signs**, as defined. Check that the assembly, erection, and location of the signs are in accordance with the Contract Plans. Pay particular attention to the location requirements for multi-lane roadways. Check delineators for proper type, location, and spacing. Ensure that the Contractor cleans the work area as specified.

661.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 662

ROADWAY LIGHTING

662.1 GENERAL REQUIREMENTS

662.1.1 Description of Work

Section 662 of the **Standard Specifications** governs the material and construction requirements for the fabrication and installation of roadway lighting systems. When Item 662 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 662 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

662.1.2 Materials Considerations

Know the details of the Contractor's shop drawings. Work should not begin until these drawings are reviewed by the Traffic Engineering Division. Inspect all materials upon arrival, including:

1. concrete and reinforcing steel for footers;
2. anchor bolts and breakaway bases;
3. support poles and arms;
4. lowering devices, ring and winch assemblies for high-mast systems:
5. luminaires, lamps, and ballasts;
6. conductors, connectors, conduit, junction boxes, and ground rods; and
7. service cabinets, control stations, and poles.

Verify that all materials conform to the requirements specified in Section 662.2 of the **Standard Specifications**. Check for proper marking, mill test reports, and certifications of support poles and arms. Ensure that the materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

662.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for roadway lighting is in conformance with the construction methods and details specified in Section 662 of the **Standard Specifications**, local laws and ordinances, **Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals**, **National Electric Code**, and other national criteria, as defined. Know the type of lighting system required by the Contract (e.g., roadway, underpass, high-mast, navigation). Check the excavation of the footing for compliance. Pay particular attention to the installation of breakaway bases. Verify that the supports are erected and connected in accordance with the Contract Plans and Specifications. Check the luminaire mounting for compliance, paying particular attention to mounting height and angle for the type to be installed. Ensure that service and control cabinets are properly located and that messenger cable, conduit, junction boxes, wiring, and grounds are installed as specified. Check for proper backfilling. Ensure that the electrical service is connected as arranged. Coordinate with the Project Engineer/Supervisor to perform the final field test.

662.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 663

PAVEMENT MARKINGS

663.1 GENERAL REQUIREMENTS

663.1.1 Description of Work

Section 663 of the **Standard Specifications** governs the material and construction requirements for furnishing and installing pavement markings. When Item 663 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 663 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

663.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all paint, extruded thermoplastic marking material, preformed traffic markings, and raised markers conform to the requirements specified in Section 663.2 of the **Standard Specifications**. Ensure that the materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

663.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for pavement markings is in conformance with the construction methods and details specified in Section 663 of the **Standard Specifications**, Contract Plans, **Standard Detailed Drawings**, and the **Manual on Uniform Traffic Control Devices for Streets and Highways**. Verify that the pavement is properly cleaned and repaired and the proper per-marking codes are applied. Verify the proper application of the markings, including the location, width, length, spacing, and arrangement of all specified edge lines, lane lines, centerlines, barrier lines, channelizing lines, stop and crosswalk lines, stripes, curb markings, island markings, lane arrows, lane letters, and raised markers,

663.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Inspector's Pavement Markings Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 664

TRAFFIC SAFETY DEVICES

664.1 GENERAL REQUIREMENTS

664.1.1 Description of Work

Section 664 of the **Standard Specifications** governs the material and construction requirements for furnishing and installing various types of traffic safety devices. When Item 664 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 664 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

664.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that the proper type and quantity of sand barrels, crash cushions, truck-mounted attenuators, and/or Quad Guard systems have been delivered and conform to the requirements specified in Section 664.2 of the **Standard Specifications**. Ensure that the materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

664.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for traffic safety devices is in conformance with the construction methods and details specified in Section 664 of the **Standard Specifications**. Obtain and review a copy of the manufacturer's installation instructions. Check the location of each device for conformance with the Contract Plans. Verify that each device is installed per manufacturer's recommendations and, as applicable, the **Standard Detailed Drawings**.

664.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 665

PLUGGING GAS, OIL, AND DRILLED WATER WELLS

665.1 GENERAL REQUIREMENTS

665.1.1 Description of Work

Section 665 of the **Standard Specifications** governs the material and construction requirements for plugging gas, oil, and drilled water wells. When Item 665 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 665 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

665.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 665.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

665.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for plugging gas, oil, and drilled water wells is in conformance with the construction methods and details specified in Section 665 of the **Standard Specifications**.

665.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 670

WATERLINE INSTALLATION

670.1 GENERAL REQUIREMENTS

670.1.1 Description of Work

Section 670 of the **Standard Specifications** governs the material and construction requirements for waterline installation. When Item 670 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 670 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement for payment.

670.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 670.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

670.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for waterline installation is in conformance with the construction methods and details specified in Section 670 of the **Standard Specifications**.

670.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 675

SANITARY SEWERS

675.1 GENERAL REQUIREMENTS

675.1.1 Description of Work

Section 675 of the **Standard Specifications** governs the material and construction requirements for sanitary sewers. When Item 675 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 675 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement payment.

675.1.2 Materials Considerations

Inspect all materials upon arrival. Verify that all materials conform to the requirements specified in Section 675.2 of the **Standard Specifications**. Ensure that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

675.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for sanitary sewers is in conformance with the construction methods and details specified in Section 675 of the **Standard Specifications**.

675.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 679

OVERLAYING OF PORTLAND CEMENT CONCRETE BRIDGE DECKS

679.1 GENERAL REQUIREMENTS

679.1.1 Description of Work

Section 679 of the **Standard Specifications** governs the material and construction requirements for furnishing and placing latex modified or microsilica concrete overlays on Portland cement concrete bridge decks. Section 679 also governs the work for the following items:

1. cleaning of bridge decks;
2. bridge deck repairs;
3. cleaning exposed reinforcing steel;
4. supporting and tying reinforcing steel;
5. placing slab reconstruction concrete;
6. abutment backwalls and approach slabs repairs; and
7. hydrodemolition of existing deck surfaces;

When Item 679 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 679 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement payment.

679.1.2 Materials and Equipment Considerations

Latex and microsilica concrete mixes require special designs that require close inspection. Mix designs will be discussed and reviewed at the Pre-Pour Meeting. Test mixes and test slabs will be constructed to ensure compliance. Inspect all materials upon arrival. Verify that aggregate, concrete class and mix proportions, latex and microsilica admixtures, reinforcing steel, bonding grout, and curing materials (e.g., burlap, quilted covers, polyethylene covers, fiber blankets) conform to the requirements specified in Section 679.2 of the **Standard Specifications**. Verify that all equipment complies with specified requirements and is in good working order, including all equipment for cutting, hydrodemolition, blastcleaning, proportioning and mixing, placement and finishing, water flushing, saw cutting, and fogging. Note that an effectiveness demonstration will be required prior to using hydrodemolition equipment.

679.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for overlaying Portland cement concrete bridge decks is in conformance with the construction methods and details specified in Section 679 of the **Standard Specifications**. During the work, check compliance of the following:

1. removal of deck surface;
2. equipment restrictions including load limits and protection of steel;
3. stockpiling, storage, and handling of component materials;
4. surface preparation and wetting;
5. equipment calibration and trial runs;

6. placement limitations and preconditions, including night operations and weather provisions;

7. concrete placement and finishing operation;

8. surface texturing and grooving;

9. straightedge testing; and

10. curing method, time, and temperature.

Verify that defective or damaged work for this type of application is repaired or removed and replaced based on the provisions of the Contract.

679.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers from the shipping documents, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report and Inspector's Latex Worksheet for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.

Section 688

PAINTING STEEL STRUCTURES

688.1 GENERAL REQUIREMENTS

688.1.1 Description of Work

Section 688 of the **Standard Specifications** governs the material and construction requirements for shop painting for new steel structures and field painting of new and existing structures. When Item 688 is specified in the Contract, the Project Inspector is responsible for verifying that the Contractor performs the work in accordance with Section 688 of the **Standard Specifications** and as designated on the Contract Plans. See the **Standard Specifications** for the method of measurement payment.

688.1.2 Materials and Equipment Considerations

Inspect all materials and equipment upon arrival at the job site. Verify that all materials and equipment conform to the requirements specified in Section 688.2 of the **Standard Specifications**. The Contractor and shop fabricator are responsible for submitting a Quality Control Plan based on the requirements of MP 688.02.20. Ensure that that materials are supplied from pre-approved DOH sources, and document laboratory numbers from the shipping documents on the Inspector's Daily Report.

688.1.3 Environmental and Hazard Considerations

Know the requirements specified for environmental protection that are defined in Section 688.3.2.2 and 688.3.3.6 of the **Standard Specifications**. Containment plans for all paint removal will be in accordance with WVDOH publication **Best Management Practices for Containment and Disposal of Waste Materials Generated in Paining Bridges**. Know the precautions that must be in place to protect workers.

688.2 INSPECTION GUIDELINES

The Project Inspector is responsible for ensuring that the work for painting steel structures is in conformance with the construction methods and details specified in Section 688 of the **Standard Specifications**. The cleaning and painting operation must be in conformance with the Contractor's approved Quality Control Plan. Prior to the operation, review the specified weather limitations.

688.2.1 Cleaning Steel Surfaces

Verify that a system is used that allows the steel to be cleaned and inspected just prior to painting. Only as much surface should be cleaned in one day as can be painted on that day. There are two approved methods of cleaning steel: hand cleaning and sand blasting. Oil and grease are removed with an approved cleaner.

688.2.2 Brushing and Rolling

Thorough mixing of the paint before it is applied is essential. A mechanical mixer should be used for stirring the paint. Paint should be spread smoothly and uniformly. Paint should be worked into all corners, joints, and other hard to reach placed. A sheepskin dauber may be used to coat any surface that cannot be reached with a brush. The first field coat is started by applying paint only to such surfaces as rivet heads, bolt heads and nuts, and edges of plates, angles, and other rolled shapes. Then, as soon as this paint has dried thoroughly, the first coat is completed by

painting all surfaces, including those covered previously. Finally, runs are picked up, and the paint is laid off in one direction.

688.2.3 Spray Painting

The paint should be applied in a uniform layer. The pattern to be followed in applying the paint should make it possible to obtain a uniform thickness of not less than the specified mil thickness. There must be some overlapping at the edges of strips covered on successive strokes of the spray gun. The spray gun should be held at right angles and at the correct distance to the surface being painted. Runs and sags must be brushed out right away, or the paint must be removed and the surface repainted.

688.3 RECORDS AND DAILY REPORTS

The Project Inspector is responsible for recording in the Inspector's Daily Report all information (e.g., laboratory numbers, observations, quantity measurements, directives to the Contractor) necessary to accurately document the prosecution and progress of the work, justify payment to the Contractor, and protect the Division from any future claims. See Section 111 for additional information. The Inspector's Daily Report must include all routine and non-routine events that occur during each production day and reflect an unquestionable basis for acceptance or rejection. Use the Division's Form 442 – Inspector's Daily Report for documentation purposes. If in doubt as to whether or not information is important or beneficial, record it.