CDOT Construction Manual

SECTION 500
STRUCTURES

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SECTION 501
STEEL SHEET PILING

501.1 GENERAL

Sheet piling is typically specified in Contracts for applications such as coffer dams and cutoff walls at the base of retaining-wall footings. In such applications, sheet piling provides a tight interlocking bulkhead that restricts the lateral movement of material behind it. The Contract will designate the location, extent, and type of sheet piling required. The primary duty of the Project Inspector is to verify that the Contractor furnishes the correct material and properly drives the sheet piling.

501.2 INSPECTION GUIDELINES

501.2.1 Before Construction

Consider the following guidelines before the pile driving operation begins:

1. Contract Plans and Specifications. Review the Contract with respect to the designated limits of treatment (e.g., location, driving depth, cut-off elevation) and the type of sheet piling. Pay particular attention to splicing, welding, and painting requirements.

2. Types of Sheet Piling. The Contract will designate the type of sheet piling required. Upon delivery, review the Mill Test Reports to ensure that the heat numbers on the sheet piles correspond to those on the reports. Document the width and length of each sheet pile. Where painting is designated in the Contract, check that the sheets are in accordance with the Contract Specifications. Two types of sheet piling may be designated in the Contract. Consider the following:

a. Type I. Where Type I sheet piling is designated, verify that the piling is corrugated, non-galvanized steel sheeting of the interlocking type. Check the material grade, thickness, and section modulus for compliance.

b. Type II. Where Type II sheet piling is designated, check that the material grade and thickness conform to the requirements for steel sheet piling.

501.2.2 During Construction

Consider the following guidelines during the driving of sheet piling:

1. Driving Head. Verify that a driving head is used during the operation. Check for damaged piling and enforce the Contract provisions with respect to pulling and replacing damaged piling.

2. Penetration. Verify conformance of the method used to determine acceptable penetration (e.g., measured depth, refusal).

3. Cut-Off Elevation. Where a sheet extends above the designated cut-off elevation, ensure that it is cut to the required elevation by an approved method. Document the area of cut sheets that are not used at other locations or for splice work.

4. Splicing. Where a standard length of sheet piling must be driven so that its top is below the designated cut-off elevation, verify that additional sheeting is spliced (i.e., cut, installed, and welded) to raise the height of the piling to the required elevation. Check the cutting and welding operation for acceptability. Where multiple splices are needed, ensure that the minimum specified distance between splices is not exceeded. Document the number, width, and length of splices performed and accepted.

SECTION 502
PILING

502.1 GENERAL

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 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).

Although it is equally important to check items such as pile type, location, and orientation, it is paramount to continually inspect the driving operation. 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. 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.

502.2 INSPECTION GUIDELINES

502.2.1 Before Construction

Significant information will need to be documented with respect to pile driving. See Appendix B for an example of a completed Piling Form.

502.2.1.1 Contract Plans and Specifications

Review the Contract with respect to equipment requirements and pile type, length, location, orientation, anticipated driving depth, structural refusal, bearing capacity, and cut-off elevation. Review the splicing, capping, and painting requirements.

502.2.1.2 Pile Location and Utility Considerations

Verify that utility locations have been staked and that any known conflicts have been resolved before the operation begins. Review to ensure that all pile locations have been properly staked in accordance with the Contract.

502.2.1.3 Excavation

Where excavation is required, check the limits of excavation (i.e., plan dimensions and depth) for compliance. Unless otherwise authorized, excavation must be completed and accepted prior to driving foundation piles.

502.2.1.4 Equipment Considerations

Various types and energy ratings of pile drivers are available. 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. Based on the methods and criteria specified in the Contract, the Project Engineer will determine equipment acceptability before delivery to the job site.

This task generally involves analysis and comparison of data supplied by the Contractor and, if questionable, further inspection and testing (e.g., pile driving analyzer). As soon as practical, provide the Contractor with written notification of equipment acceptance or rejection. Verify that the Contractor furnishes the pre-approved equipment and ensure that substitutions are not made during the work. Otherwise, equipment acceptability must be reassessed. Consider the following guidelines:

1. Hammer Cushion/Striker Plate. 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.

2. Pile Driving Head. Where a pile driving head is required, verify compliance with the manufacturer's recommendations.

3. Pile Driving Leads. Pile driving leads are typically 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. Also, check lead alignment to ensure that it does not hinder the movement of the hammer.

4. Followers. Where required, verify the proper use of followers.

502.2.1.5 Material Considerations

Use the following guidelines to inspect materials for the pile driving operation:

1. Pile Types. The pile types that are typically used in foundation applications include structural steel shapes, steel pipe, and steel shell piles. The Contract 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 and that the piles have been manufactured in the United States of America. Also check and document conformance with respect to pile condition, material grade, length, and cross-sectional shape and dimensions.

2. Pile Tips. Where their use is specified, check pile tips and fastening details for compliance.

3. Concrete. Concrete is 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.

502.2.1.6 Test Piles and Pre-Drilling

As designated or directed, test piles will be used to determine the need for pre-drilling. In general, if a test pile is driven to specification without reaching the designated minimum penetration depth and bearing elevation, pre-drilling will be required. Check and record the location, depth, and diameter of all pre-drilled holes. The hole diameter depends on the type and size of pile required. This ensures that the pile will be in an accurate and stable position for driving. If the maximum diameter is exceeded, verify that voids are backfilled as specified.

502.2.1.7 Welder Certification

As needed for splice work, ensure that welders are prequalified for the work. Check each welder's Certificate of Qualification. 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.

502.2.2 During Construction

During the driving of foundation piles, consider the inspection guidelines in the following Sections. See Appendix B for a sample piling form.

502.2.2.1 Pile Location and Direction

Verify that each pile is driven within tolerance of its designated location. Also, check pile alignment (i.e., vertical, batter) for deviation from allowable tolerance. Verify that pile flanges are oriented as designated in the layout of the Contract. 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 surface. In such cases, contact the Staff Bridge Branch for assistance.

502.2.2.2 Hammer Cushion/Striker Plate

As needed during driving, inspect the integrity of cushions and striker plates for compliance. Pay particular attention to the thickness of the material and require replacement based on the minimum specified thickness.

502.2.2.3 Water Jetting

Water jets, where authorized, are used to facilitate pile penetration. Ensure that water jets are removed, as specified, for the final depth of penetration. Once removed, determine average penetration using test blows.

502.2.2.4 Pile Penetration and Bearing Elevation

Piles must be driven to virtual refusal into natural ground so that the elevation of the tip of the pile is at or below the designated bearing elevation. At bridge structures, the bearing elevation of the pile must be below the 500-year scour depth. Check and document pile elevation, number of blows at minimum final penetration, and final depth of the pile. Consider the following guidelines:

1. Adjacent Piles. Where a new pile is being driven, closely monitor the elevation of adjacent piles. In some cases, adjacent piles will tend to “push up.” Ensure that the Contractor re-drives affected piles to the proper bearing elevation.

2. 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 Staff Bridge Branch for assistance.

3. Unusually High Bedrock. Where the designated penetration depth and bearing elevation cannot be obtained without damaging the pile (e.g., encounter with unusually high bedrock), contact the Project Engineer for assistance. Pre-drilling may be required.

4. Springing/Bouncing. Watch for pile springing and hammer bouncing. Springing may occur where spliced members are not properly aligned, the pile head is not squared properly, or the pile and hammer are misaligned. Bouncing may 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.

5. Pile Driving Analyzer. The Project Engineer will determine the number and location of piles to be monitored by a pile driving analyzer. If the Contractor is directed to setup the analyzer and monitor the piles, check and document the number and location of piles that were monitored and the results of the analysis.

502.2.2.5 Cutting of Piles

Ensure that the piles are cut by an approved method and to the correct cut-off elevation. Check that the cuts made at splices are normal to the longitudinal axis of the pile. Document the pile location, the pile's initial length, and the length of pile that was cut. Pay particular attention to the disposition of cut lengths of piles. They may or may not be reused. If reused in field-splice work, document the pile location and the length of pile that was reused.

502.2.2.6 Pile Splicing

For those piles driven deeper than the minimum penetration depth, splicing may be necessary to raise the top of the pile to the correct cut-off elevation. Either commercial splices or field-welded splices may be used. Check for acceptability and document the location, type, and number of all splices. Where commercial splices are used, check that they are of an approved type and fastened in accordance with the manufacturer's recommendations. Thoroughly inspect welding for compliance with respect to welder certification, surface preparation, root opening, welding method, type of weld, number and order of passes, and removal of slag.

502.2.2.7 Filling and Capping of Hollow Piles

After steel pipe, shell piles, and the adjacent piles have been driven and accepted, inspect the inside cavity using the Contractor-supplied lighting system. Pay particular attention to buckling or crushing. Ensure that water and debris are removed from within the pile before the Contractor fills the interior with the designated class of concrete.

502.2.2.8 Pile Damage and Defects

During the driving operation, continually monitor piles for damage and defects, and review the provisions of the Contract with respect to corrective work. Pay particular attention to head damage, internal damage, splice defects, and improper pile location, direction, and final bearing elevation. Contact the Project Engineer and the Staff Bridge Branch as needed for assistance. Defective piles may need to be removed and replaced, or they may be permitted to remain with the provision of another treatment (e.g., new adjacent pile, footing adjustment, additional extension). Note any unusual conditions encountered. Re-inspect all corrective work.

502.2.3 After Construction

Once foundation piles have been driven to specification, verify that the pile tops are cut square. Ensure that all loose material is removed from around the piles before the foundation concrete is poured.

SECTION 503
DRILLED CAISSONS

503.1 GENERAL

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 strata through side shear and end bearing. 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.

503.2 INSPECTION GUIDELINES

503.2.1 Before Construction

Before the construction of drilled caissons, consider the following guidelines:

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

2. Caisson Location/Utilities. Verify that utility locations have been staked. Verify that all caisson locations have been staked in accordance with the Contract.

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.

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

5. 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.

503.2.2 During Construction

503.2.2.1 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 in the Contract.

2. Depth of Embedment. The designated bottom elevation is specified, which may be revised by the Project Engineer 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. Where caving is encountered, halt the operation until the situation can be evaluated and corrected. Protective steel casing may be needed.

4. Excavated Material/Cleaning. Check to ensure that the hole is dewatered and cleaned of all loose material. If dewatering is not practical, the provisions of the Contract with respect to placing concrete under water will govern.

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 Considerations. Where a caisson is to be socketed into shale, 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.

503.2.2.2 Caisson Reinforcement/Steel Casing

Caisson reinforcement will consist 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.

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

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 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.

503.2.2.3 Concrete Placement

Acceptability of the placement method used for concrete will depend on whether 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 two inches, 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 or the sides of the hole on the way down.

2. Wet-Hole Placement. For wet holes, the Project Engineer must review the proposed method of placement. The Contract provisions regarding placement under water will govern. Verify that the hole is dewatered.

3. Vibration Operation. Check the vibration operation for compliance with respect to the minimum depth of concrete consolidation at the top of the caisson.

4. Removal of Water-Diluted Concrete. Where water-diluted concrete has floated to the top of the caisson during the pour, verify that the minimum depth of the top surface is removed and wasted as specified.

5. Steel Casing. Unless otherwise designated or directed, the steel casing shall be removed from the caisson.

6. Concrete Curing. Check that the top surface of the concrete is properly cured.

7. 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.

503.2.3 After Construction

Verify that the projecting reinforcing steel is in the correct location and properly cleaned of mortar.

SECTION 506
RIPRAP, GABIONS, and SLOPE MATTRESS

506.1 GENERAL

Erodible slopes within the right-of-way (e.g., along the banks around bridge structures) are typically treated with an erosion and sedimentation countermeasure. Three types of treatments may be designated: riprap, gabions, or slope mattresses. Riprap is the careful placement of relatively large, angular stone on the erodible slope. Gabions and slope mattresses, used on highly erodible banks, are similar to riprap, except that fabricated wire-cage units containing the graded rock are placed on the slope.

506.2 INSPECTION GUIDELINES

506.2.1 Before Construction

Before construction begins, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract with respect to the location, limits, and type of treatment required. Pay particular attention to the nominal size and material requirements of the stone, depth of treatment, and fabrication details for wire-cage units.

2. Materials. Review the requirements for riprap with respect to nominal size, shape, dimensional ratio, specific gravity, gradation, abrasion resistance, and compressive strength. Visually observe the required material samples from the quarry and site for compliance (i.e., size, angularity, gradation). Where the material is suspect, request laboratory results for verification or require the Contractor to provide the necessary equipment for gradation testing. Where gabions or slope mattresses are designated, check compliance of the tie wire, wire mesh, cages, anchor stakes, and stone material.

3. Surface Preparation/Excavation. Verify the acceptability of the slope after it is prepared, including the bed for gabions and slope mattresses. Check the excavation for the toe or cut-off wall, where required, to ensure that it conforms to the lines designated in the Contract.

506.2.2 During Construction

The following Sections present inspection guidelines that should be considered during the construction of riprap treatments, gabions, and slope mattresses.

506.2.2.1 Riprap Treatment

The stone for riprap is generally placed and spread using a combination of mechanical and hand methods. Check the limits of treatment and depth of stone for compliance. Pay particular attention to the placement of the final surface layer. Regardless of the placement method used, the final surface should appear relatively smooth with interlocking faces of adjacent stones.

506.2.2.2 Gabion Treatment

Gabions are wire cages (i.e., building blocks) that are filled with riprap material, placed, and tied to each other on the slope to provide a larger protective structure. Check the acceptability of the wire cages in terms of dimensions and perimeter edges (i.e., selvedged, bound). Ensure that the stone material is placed in the cages as dense as practical. Verify the units are placed closely together and tied to each other as specified.

506.2.2.3 Slope Mattress Treatment

Slope mattresses are similar to gabions except that the horizontal dimensions of the wire cage are much greater than the depth. Where slope mattresses are specified, verify the proper use of secured diaphragms within the cage. Their use will depend on the unit's

length-to-width ratio. Each diaphragm contains the stone material in smaller cells within the mattress. Prior to filling, check that adjoining surfaces and edges of lids are tied as specified. Verify that each mattress is properly anchored with stakes. Where holes are predrilled for stakes, check the depth for compliance. Where wire cages are pre-fabricated and placed on the slope, ensure that damage to the zinc coating is properly repaired.

506.2.3 After Construction

Walk the treated area and look for obvious signs of improperly placed stone, inadequate depth of stone, and misaligned or untied wire cages.

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SECTION 507
SLOPE AND DITCH PAVING

507.1 GENERAL

Slope and ditch paving is used primarily for erosion and sedimentation control, but it also offers a neater appearance over other treatments, especially on slopes around major structures. Where designated in the Contract, the Project Inspector must ensure compliance as discussed in this Section.

507.2 INSPECTION GUIDELINES

507.2.1 Before Construction

Before slope and ditch paving begins, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract. Pay particular attention to the location, limits, depth, and type of paving required.

2. Materials. The materials required for the work will depend on the type of paving specified. which may include: concrete, reinforcing steel, grout, bituminous material, riprap, and dry rubble. Check the required materials for compliance (e.g., type, class, size, classification, gradation). Where dry rubble is required, do not allow the use of riprap material. The purpose of dry rubble is to provide a natural appearing slope around bridge abutments without introducing a rock slope that is potentially hazardous to the traveling public.

3. Surface Preparation/Excavation. Ensure that the area to be treated is properly prepared. Check the toe or cut-off wall excavation for compliance. Where unsuitable soil material is encountered, it may be necessary to replace the material. The paving slope may need to be adjusted in the field to properly match the ditch line. This may occur where a road on steep grade traverses under a structure or

where rough terrain does not permit a smooth transition with approach fill. Note that the paving slope designated in the Contract is the maximum allowed, and any required field adjustment must be in the direction of providing a flatter slope.

507.2.2 During Construction

Use the guidelines in the following Sections to inspect slope and ditch paving construction.

507.2.2.1 Concrete Paving

Where concrete slope and ditch paving is specified, check the mixing and placement of concrete for conformance. To enforce the Contract provisions for slip-form and hand placement methods, pay particular attention to the designated paving thickness and that which is proposed by the Contractor. Where required, check the acceptability of forms and the placement of reinforcing steel. Monitor the depth of paving for compliance, and ensure that expansion joint materials, where required, are placed at the proper thickness and location. Verify compliance with requirements for cold-weather paving, curing method and material, surface moisture, and curing period.

507.2.2.2 Dry-Rubble Paving

Riprap is not allowable where dry-rubble slope and ditch paving is specified. Check that larger stones are placed on the lower course. Verify compliance of joint location and treatment, total paving thickness, and the appearance of the final surface. Pay particular attention to oversize stones and protrusions that could present a safety hazard, and require immediate corrective action.

507.2.2.3 Grouted-Rubble Paving

Where grouted-rubble slope and ditch paving is specified, check the placement of the stone for acceptability. Inspect the joints prior to grouting and require cleaning as needed to remove soil and debris. Ensure that the elapsed time between grout mixing and placement does not exceed specified limits. Do not permit grouting during freezing weather. Check that all joints are properly grouted and that the grout is kept moist for the required curing period. This is especially important during hot, dry, and windy conditions. Verify that the final surface is swept to expose the faces of the rock without removing grout from the joints.

507.2.2.4 Grouted-Riprap Paving

Where grouted-riprap slope and ditch paving is specified, verify that the riprap material is properly placed. Where required, check weep holes with respect to bedding, pipe, geotextile fabric, and rock cover. Ensure that the elapsed time between mixing and placement of concrete mortar does not exceed specified limits, and do not permit mortar to be applied during freezing weather. Verify the use of pencil vibrators between rocks, and inspect mortar penetration for acceptability. Verify that the top layer of exposed rock is properly cleaned and the required height above the mortar. Check to ensure that the concrete mortar is properly finished and cured.

507.2.2.5 Bituminous Paving

Where bituminous slope and ditch paving is specified, check to ensure that the bituminous material is placed and compacted to the cross-section designated in the Contract. Verify that a fog coat is applied at the specified rate to the final surface.

507.2.3 After Construction

After construction, ensure that excavated areas that were not paved are properly backfilled with acceptable material and tamped to the level of the original ground.

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SECTION 508
TIMBER STRUCTURES

508.1 GENERAL

The requirements for timber structures, as well as portions of other structures that are timber, are governed by the provisions specified in Section 508 of the *Standard Specifications*.

508.2 INSPECTION GUIDELINES

508.2.1 Before Construction

Before beginning work that involves treated and untreated timber members, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract. Pay particular attention to material requirements and designations for timber grade, working stress, and preservative treatments. Know where and how specific timber members are to be arranged, fastened, primed, and painted.

2. Timber Members. Upon delivery, inspect the timber members to ensure that they are grade-marked by a grading agency certified by the American Lumber Standards Committee. As needed, reference the *Lumber Inspection Agency Certification Grade Verification Guidelines* contained in Appendix D. Check the Certificate of Inspection to ensure that it designates the correct destination and project.

3. Fasteners/Incidental Materials. Fasteners that are typically used in timber construction include bolts, washers, nuts, drift pins, dowels, nails, and screws. Check compliance with respect to the type and size of materials required. Pay particular attention to thread length and galvanization requirements.

4. Shop Drawings. Bridges made from timber require shop drawings to be submitted. The Project Engineer will send the drawings to the Staff Bridge Branch for processing according to Section 105.2.3.

508.2.2 During Construction

Consider the following guidelines during the inspection of work involving treated and untreated timber members:

1. Field Cuts/Drilled Holes. Unless otherwise directed, treated timber should not be cut in the field. However, where it is necessary to cut or drill treated timber, ensure that the Contractor properly applies the required preservative treatment to the exposed timber.

2. Construction Details. Check compliance of the following items with respect to type, size, location, grain orientation, clearance, and fastening details:

   - bracing and framing;
   - piling and posts;
   - bulkheads, longitudinal X-braces, trusses, and bent timbers;
   - treated fill pieces and dapping;
   - sills and caps, including sheet metal and burlap caps;
   - hot asphalt swabbing;
   - joints, blocking, and shimming;
   - stringers, floor planks, laminated flooring; and
   - handrails and handrail posts.

3. Bolts/Bolt Holes. Check the diameter of drilled holes for the type of bolt specified, and ensure that the correct type and number of washers are used.

4. Painting. Where designated in the Contract, check that wood and metal surfaces are properly cleaned, prepared, primed, and painted.

5. Structure Number. Check to ensure that the structure number is placed as designated in the details of the Contract.

508.2.3 After Construction

Perform a final review of the timber structure for obvious errors and omissions, and require immediate corrective action based on the provisions of the Contract.

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SECTION 509
STEEL STRUCTURES

509.1 GENERAL

The work for steel structures, as designated in the Contract, will be governed by Section 509 of the *Standard Specifications*.

509.2 INSPECTION GUIDELINES

509.2.1 Before Construction

Many different activities must be performed before construction begins. Consider the following guidelines:

1. Contract Plans and Specifications. 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, the following:

    - *CDOT Standard Specifications*;
    - *Standard Special Provisions*;
    - *Project Special Provisions*;
    - *ASTM Material and Testing Specifications*;
    - *AASHTO Material and Testing Specifications*;
    - *AASHTO Standard Specifications for Bridges*;
    - *AISC Steel Construction Manual*;
    - *Bridge Welding Code ANSI/AASHTO/AWS D1.5*;
    - Shop Drawings; and
    - Quality Control Plan.

Prior to the start of work, review this documentation and become familiar with the responsibilities of CDOT and Contractor inspection personnel; material sampling and testing requirements; fabrication, assembly, and erection details; welding and painting requirements; and the acceptance criteria specified in the Contract.

2. Storage. Do not allow bent or damaged steel members to be incorporated in the work without prior review by the Project Engineer.

3. Shop Drawings. Shop drawings are required for all steel structures governed under Section 509 of the *Standard Specifications*. Review the drawings and become familiar with the types and locations of steel and fasteners required, member identification and marking system, rolling orientation designations, types and location of welds, and the location, extent, and criteria for non-destructive tests.

509.2.2 During Construction

Consider the following guidelines during field assembly and erection:

1. Material Inspection, Delivery, and Erection. Watch for materials and work that have not been previously inspected and documented on the Form 193. Pay particular attention to the following:

    a. Straightening. Straightening of bent members, check to ensure the process does not fracture or damage the member. Visually inspect members immediately after straightening and, if fractures are suspected, use magnetic particle and dye penetration testing for verification.

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

c. Coating Damage. Watch for damage to shop coating (e.g., galvanization, paint) caused by mishandling upon delivery and during erection, and require the Contractor to make immediate repairs.

2. Falsework Considerations. Where falsework is required, verify conformance with subsection 601.11 of the *Standard Specifications*.

3. Bearings and Bearing Seats. Where bearing devices are designated for steel structures, see Section 512.

4. Field Welding Considerations. Field welding is only permitted where designated in the Contract or with written permission from the Staff Bridge Branch.

5. Bolt Installation and Inspection. The Staff Bridge Pre-Inspection unit will perform rotational capacity tests of all bolts on the project before installation. The Project Engineer will notify the Staff Bridge Pre-Inspection unit no less than 72 hours before installation. Connections must be drawn tightly together. All bolts in the connection must be installed before final tightening of the connection. Once the connection is complete, check bolts for proper tension, as specified.

6. Field Cleaning and Painting. After inspection and acceptance of erection work, verify that surfaces to be field painted are properly cleaned. Self-weathering steel will be cleaned but not painted to promote development of a uniform coat of rust. Ensure that a prime coat is applied to all uncoated surfaces to be painted, including damaged shop painted surfaces. Once the prime coat has cured, verify that the top coat is applied in the manner specified. Pay particular attention to the mishandling of painting materials, and enforce the Contract provisions with respect to mitigating environmental contamination.

509.2.3 After Construction

Upon completing the steel structure, consider the following guidelines:

1. Removal of Supports. Check that all blocking, supports, and falsework are removed without damaging the structure.

2. Final Appearance. Check the fit and appearance of diaphragms, transverse bracing, field splices, and floor beam connections.

3. Damaged Coating. Verify repair of galvanized units on which the spelter coating has been burned by welding or damaged during erection.

4. Structure Number. Verify that the number stenciled on the structure is correct and placed in the proper location.

SECTION 510
STRUCTURAL PLATE STRUCTURES

510.1 GENERAL

Structural plate pipes are typically used in culvert and bridge applications. Depending on the particular needs of the application, the plates will be fabricated from steel or aluminum alloy and assembled to form an arch, elliptical, or circular pipe. To obtain full design strength, this type of structure depends primarily on the specified tensioning of bolts and backfill placement.

510.2 INSPECTION GUIDELINES

510.2.1 Before Construction

Before work begins, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract. Pay particular attention to the location, type and size of structure, excavation and flow line, assembly method and sequence, and material requirements. The type of material (steel or aluminum) will be determined at the Preconstruction Conference.

2. Materials. Check structural plates for conformance with applicable material specifications for steel and aluminum alloy.

3. Manufacturer/Fabricator Certificates. Verify that the Contractor has furnished the appropriate Certificates of Compliance. Also check that the manufacturer has furnished the required data sheets.

4. Field Coating. Where designated in the Contract, check the application of field coating with respect to the material used, application method, rate of application, and number of coats applied.

5. Damaged Coating. Plates delivered with broken or bruised spelter coating shall be repaired in accordance with subsection 707.09 of the *Standard Specifications*.

510.2.2 During Construction

Consider the following guidelines during the work involving structural plate pipes:

1. Excavation. Check the width and depth of excavation (e.g., trenching) for conformance to the lines and grades designated in the Contract. Ensure the embankment has been completed to a height 0.3 of the rise above the flow line or 0.3 of the diameter of the structure before excavation. Check the bedding of the flow line for compliance paying particular attention to oversize rocks and rock protrusions.

2. Test Pits. Verify compliance of test-pit excavation with respect to the required number, location, and depth below the flow line. Where unsuitable foundation material is encountered, ensure that the material is removed to the minimum specified depth below the flow line and backfilled with suitable material.

3. Field Cutting. Where plates are cut to form skewed or sloped ends, check the angle of the cut for compliance. Ensure that the cut plates are numbered or match-marked as required.

4. Spelter Coating. Verify that damage to spelter coating caused by field cutting or welding is properly repaired in accordance with subsection 707.09 of the *Standard Specifications*.

5. Assembly. Watch for correct sequencing of plate assembly. Check to ensure that thicker invert plates are placed in the proper position. Check longitudinal and circumferential seams, joint staggering, and bolt connections for compliance with specified requirements. Require the Contractor to demonstrate that bolts have been tightened to within the specified range. After complete assembly but before backfilling, check all bolts for proper torque. After backfilling, perform spot checks to verify that uniform bolt tension has not been lost due to backfilling or vibratory

compaction equipment. If the structure is assembled in other than its final location and is to be set in place after erection, all bolts must be tightened to specification requirements before lifting.

6. Circular Pipe Distortion. Prior to backfilling, check to ensure circular pipes are elongated (i.e., distorted) and properly set with respect to the elongated axis.

7. Backfilling. Check that backfilling complies with the details of the Contract. Watch for damage to the pipe and require immediate correction. Pay particular attention to the progression of the backfill operation. The height of the backfill on each side of the structure should progress equally in uniform compacted layers. This will minimize uneven lateral stresses on the structure.

510.2.3 After Construction

After assembly and backfilling, check the dimensions of the final cross-section (e.g., diameter, span and rise) and the grade of the flow line for conformance. Check to ensure that adequate earth cover has been placed and compacted before allowing heavy equipment traffic to operate over the structure.

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SECTION 512
BEARING DEVICES

512.1 GENERAL

Bearing devices are used in structures to allow movement (i.e., longitudinal, transverse, rotational) due to such factors as temperature change, post tensioning, and girder rotation.

512.2 INSPECTION GUIDELINES

512.2.1 Before Construction

Before work involving the installation of bearing devices begins, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract. Pay particular attention to the location and types of bearing devices required. Know the certification and installation requirements for each type of bearing to be installed.

2. Inspection Upon Delivery. Upon delivery, verify compliance with the required certification documentation. Retain all written certifications and applicable Certificates of Compliance in the permanent project files. Check the documentation to ensure that the bearings have been delivered to the correct location and are the proper type for the structure. Check that each bearing is properly packaged to prevent damage and contamination. Verify that bearing components are marked where required. Reject bearings that fail to meet these delivery requirements.

512.2.2 During Construction

Consider the following guidelines during the installation of bearing devices:

1. 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.

2. Installation/Adjustment. Check to ensure that sole plates are positioned to the correct grade and superelevation and are in full contact with the bottom flange of the girder. Check the bearing alignment for conformance with the Contract. Verify proper adjustment for temperature, post tensioning, and shrinkage. Watch for interference between anchor bolts and the upper part of the bearing device.

3. Type III – Special Considerations. Verify that Type III masonry plates are set on the proper sheeting where monolithic cap seats are used. Ensure that a representative of the manufacturer of the Type III bearing is present to provide guidance during installation and to assist with inspection.

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.

512.2.3 After Construction

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 Type III device in the presence of the Contractor and the manufacturer's representative. Obtain written certification from the Contractor and manufacturer's representative that the installation of all Type III bearing devices have been correctly installed.

SECTION 514
PEDESTRIAN AND BIKEWAY RAILING

514.1 GENERAL

Pedestrian and bikeway railing is typically designated for pedestrian walkways and bikeways, including those combined with bridge rails across structures. Depending on the particular needs of the application, different designs and materials may be specified, including steel and timber.

514.2 INSPECTION GUIDELINES

514.2.1 Before Construction

Before work involving pedestrian and bikeway railing begins, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract. Pay particular attention to the type and limits of railing, material requirements, and fastening details (e.g., hardware and bracket locations).

2. Materials. Check that the type of railing delivered conforms to specified quantity, dimensional, and material requirements. In general, timber will be governed by Section 508, and steel by Section 509 of the *Standard Specifications*. For pipe railing, verify the coating (e.g., black, galvanized) and threaded and slip fittings for compliance. For steel tube railing, verify compliance of the steel tubes, plates, bars, fastening hardware, zinc coating, and prefabrication welding. For timber railing, verify that the correct fastening hardware has been delivered, and check that the timber members are pressure treated as specified. Upon delivery, verify the destination and project from the Certificate of Inspection, and inspect the timber members to ensure that they are properly grade-marked (see Section 508.2.1).

3. Working Drawings. Check that the Contractor has submitted the required working drawings. Review the working drawings and become familiar with the fastening details.

514.2.2 During Construction

Consider the following guidelines during the installation of pedestrian and bikeway railing:

1. 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.

2. 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. For timber members, verify that bolts are recessed as required. Check hand and rub rails for projections, and require immediate correction.

3. Electrolytic Isolation. Where dissimilar metals come into contact with each other, electrolytic isolation will be designated in the Contract. Verify the proper installation of electrolytic isolation.

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

514.2.3 After Construction

After construction, ensure that all welds are ground smooth. Watch for burrs and sharp edges from cutting, punching, drilling, and tapping and ensure rounding where required. Check to ensure that paint and galvanization damage is properly repaired.

SECTION 515
WATERPROOF MEMBRANE

515.1 GENERAL

Waterproofing treatments (e.g., reinforced and elastomeric membranes, concrete sealer) are typically applied to concrete bridge decks. Concrete sealer is applied to bridge decks that will not receive an asphalt wearing course. Waterproofing membrane is applied to bridge decks that will receive an asphalt wearing course. The treatment is applied just prior to placement of the asphalt overlay. This minimizes potential damage to the treatment during construction.

515.2 INSPECTION GUIDELINES

515.2.1 Before Construction

Before the waterproofing treatment is applied, consider the following guidelines:

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

2. Materials. Check the materials (e.g., membrane, sealer, primer) at the site to ensure they conform to the type designated for the project. Verify and retain applicable Certificates of Compliance. Verify compliance with sampling and testing requirements, and document test results.

3. 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.

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

5. 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., bridge deck, 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.

515.2.2 During Construction

Consider the following guidelines during the application of waterproofing treatments:

1. Primer Application. If a primer is specified, verify the limits (e.g., height of curb above asphalt overlay) and application rate for conformance with specified requirements.

2. Placement of Reinforced Membrane. 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 is overlapped in such a manner that a shingling effect will be achieved that 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 joints and drain pipes.

3. Placement of Elastomeric Membrane. Where elastomeric membrane is designated, check the limits of treatment and rate and thickness of application for compliance.

4. Placement of Protective Covering. Where protective covering is designated, do not permit any more membrane to be placed than 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.

5. Concrete Sealant Application. Contractor and CDOT personnel should follow the manufacturer's safety recommendations when applying concrete sealant. For protection, wear the Contractor-supplied respirators 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.

515.2.3 After Construction

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 asphalt overlay can be placed. If the Contractor does not immediately place the overlay, it must be inspected again prior to paving.

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SECTION 516
DAMPPROOFING

516.1 GENERAL

Where designated in the Contract, dampproofing of concrete surfaces will be governed by Section 516 of the *Standard Specifications*.

516.2 INSPECTION GUIDELINES

516.2.1 Before Construction

Before the dampproofing is begun, consider the following guidelines:

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

2. Materials. Check primer and asphalt dampproofing materials to ensure they conform to the type designated for the project. Verify and retain applicable Certificates of Compliance. Verify compliance with sampling and testing requirements, and document test results.

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

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

5. Surface Preparation. Before the treatment is applied, check to ensure that the concrete surface has been thoroughly cleaned.

516.2.2 During Construction

Consider the following guidelines during the application of dampproofing treatment:

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

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

516.2.3 After Construction

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.

SECTION 517
WATERPROOFING

517.1 GENERAL

Where designated in the Contract, waterproofing of concrete surfaces will be governed by Section 517 of the *Standard Specifications*.

517.2 INSPECTION GUIDELINES

517.2.1 Before Construction

Before the waterproofing treatment is applied, consider the following guidelines:

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

2. Materials. Check the materials (e.g., asphalt primer, asphalt mop coat, woven cotton fabric) at the site to ensure they conform to the type designated for the project. Verify and retain applicable Certificates of Compliance. Verify compliance with sampling and testing requirements, and document test results. Pay particular attention to the method and temperature required for heating asphalt materials.

3. 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.

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

5. Surface Preparation. Check that the concrete surface has been thoroughly cleaned. Verify that rough surface areas that could puncture or create air pockets in the treatment have been corrected.

517.2.2 During Construction

Consider the following guidelines during the application of the waterproofing treatment:

1. Primer Application. Verify the limits and method of primer application for conformance with specified requirements.

2. Mop Coat Application. Check that mop coat is applied at the specified locations and application rate.

3. Fabric Placement. Verify that the fabric is overlapped so that water will run over, not against, the laps. Check the lap width for conformance and that the laps are treated with mop coat. Watch for wrinkles and air bubbles and required immediate correction. Verify the application of mop coat over the entire surface of the fabric. Check to ensure this process is repeated as specified. Do not allow any more fabric to be applied that can be properly covered and sealed with mop coat in the same workday.

517.2.3 After Construction

After the waterproofing has been applied, check for areas that may allow water to infiltrate, such as improper overlaps and punctured fabric. Require immediate correction of any such defects.

SECTION 518
WATERSTOPS AND EXPANSION JOINTS

518.1 GENERAL

The installation of waterstops, expansion joints, and end dams is governed by Section 518 of the *Standard Specifications*. Expansion joint devices must not allow water to seep through the superstructure slab.

518.2 INSPECTION GUIDELINES

518.2.1 Before Construction

Before work involving the installation of waterstops, expansion joints, and end dams begins, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract. Pay particular attention to the installation details, material testing and certification requirements, and the locations, types, and sizes of devices required. The Contractor will provide the manufacturer and model number of the designated devices at the Preconstruction Conference.

2. Materials. Check devices and component materials to ensure they conform to the quantity, size, and type designated for the project. Verify compliance with sampling and testing requirements. The manufacturing plant and testing facility may be inspected for compliance by the Staff Bridge Pre-Inspection Unit. Ensure that the Project Engineer has accepted devices before they are installed. Verify and retain the manufacturer's written certification and applicable Certificates of Compliance.

3. Working Drawings/Shop Drawings. Do not accept working drawings or shop drawings that do not include the manufacturer's installation instructions. Review the drawings and become familiar with the component designations and

installation details (e.g., center beams and support bars of modular expansion devices).

4. Manufacturer's Literature. Review the required manufacturer's installation literature to become familiar with the materials, components, adjustment settings, and installation details of the designated devices.

5. Manufacturer's Representative. Installation of expansion devices relies heavily on manufacturer's assistance and guidance. Ensure that the Contractor has properly notified the manufacturer of the need to provide a qualified representative during installation. Inspection certification will be required.

6. Joint Opening Preparation. Check the joint opening for proper alignment, grade and dimensions and that the opening has been properly cleaned and prepared.

518.2.2 During Construction

518.2.2.1 Waterstops

Where waterstops are installed, verify proper installation. Ensure that the material is properly cut and spliced to prevent buckling and distortion. Check the position and shape for acceptability.

518.2.2.2 Asphaltic Expansion Devices

Where asphaltic expansion devices are installed, ensure that a qualified manufacturer's representative is on site during installation of the device. Verify with the representative that the device is being installed in accordance with the manufacturer's literature. Check conformance of the final thickness and grade.

518.2.2.3 Elastomeric Expansion Devices

Where elastomeric expansion devices are installed, ensure that a qualified manufacturer representative is on site during installation. Verify with the representative that the device is being installed in accordance with the working drawings and the manufacturer's literature. The Contractor shall set the joint opening in accordance with the temperature chart in the Contract Plans. Check that the device is properly set, supported, and secured. Where Portland cement concrete end dams are designated, verify the proper use of pressure injected grout and compliance with temperature and curing limitations. Verify that uncoated metal surfaces are properly cleaned and maintained. Check the final joint opening, grade, and elevation for conformance. Once installed, test the expansion joint for evidence of water seepage. If the test fails, require immediate correction, and retest the joint.

518.2.2.4 Modular Expansion Devices

Where modular expansion devices are installed, ensure that a qualified manufacturer representative is on site during installation of the device. Verify with the representative that the device is being installed in accordance with the shop drawings and the manufacturer's literature. The Contractor shall set the joint opening in accordance with the temperature chart in the Contract Plans. Verify that the maximum time between setting the joint opening and placement of the concrete is not exceeded, and measure and document the structure temperature as specified. Check for unacceptable bends or kinks and, if found, require replacement. Verify that recess openings in the deck and curb are properly primed with grout, filled with concrete, and finished. Ensure that uncoated metal surfaces are properly cleaned and maintained. Visually inspect concrete anchorages for conformance, and perform the hammer test as specified. Require replacement if the hammer test fails. Check the final joint opening, grade, and elevation for conformance. Once installed, test the expansion joint for evidence of water seepage. If the test fails, require immediate correction, and retest the joint.

518.2.2.5 Elastomeric Concrete End Dams

Verify proper installation based on assistance and guidance provided by the qualified manufacturer's representative. Enforce the provisions of the Contract with respect to corrective work.

518.2.3 After Construction

Obtain written certification (i.e., signed and dated) from the Contractor and the qualified manufacturer representative that the expansion devices and end dams designated for the project have been installed correctly.