Chapter 8 - Structures

2-801 New Construction

Bridge construction requires close cooperation between the contractor and Chief Inspector. A bridge design must meet the conditions unique to a specific site. It is especially important for the contractor to understand the desires of the Department in regard to the design as well as the finished product.

2-801A Storage/Staging of Materials and Equipment on Structures

The Federal Highway Administration issued an advisory to all State Highway Departments in the summer of 2007 asking for review of current practices for the stockpiling of materials and the staging of construction equipment on bridges under construction. The Office of Construction reviewed this advisory and in coordination with the offices of Design, Bridge Safety, Maintenance, and Federal Highway. As a result, the Load Restriction Specification, Article 1.07.05 was revised. It should appear as a special provision in all future projects until it can be incorporated into a Supplemental to the 816.

Designers are being directed to add notes to their structure plans to indicate the allowable load for existing structures and the proposed structure, if applicable. When a structure is not posted, the contractors will be allowed to stockpile material and store construction equipment, when the maximum weight of equipment or material stored in each 12 foot wide travel lane of any given span shall be limited to 750 pounds per linear foot combined with a 20,000 pound concentrated load located anywhere within the subject lane. If these notes do not appear on the plan sheets, the Office of Bridge Safety shall be contacted immediately by the Project Engineer to determine the allowable load for the existing structure and the project’s designer for the proposed structure.

The operation of standard construction equipment for the rehabilitation and/or reconstruction of a structure do not fall under this guideline. The existing structure and proposed structure should have been reviewed for typical construction loadings. Any specific restriction will appear as a note on the plan. The Project Engineer should touch base with the designer after a thorough plan review to discuss loading restrictions, especially if:

- The structure has a pin and hanger assembly
- Load Restrictions are posted
- The bridge has been classified to have a specific structural problem awaiting repair
- The bridge is a steel arch truss structure

If anticipated storage of equipment or material exceeds the above provision, then the Contractor shall submit his proposal of storage, supported by calculations stamped by a Professional Engineer registered in the State of Connecticut, to the Engineer for approval 14 days prior to the storage operation. All submittals shall include a detailed description of the material/equipment to be stored, the quantity of storage if it is stockpiled materials, the storage location, gross weight with supporting calculations if applicable, anticipated duration of storage, and any environmental, safety, or traffic protection that may be required. The storage location on the structure shall be clearly defined in the field. If structures are in a state of staged construction or demolition, additional structural analysis may be required prior to authorization of storage. It is noted that operations associated with structural steel demolition and erection will follow their respective specifications.
All inspectors should be aware of load restrictions associated with the Department’s roadway and bridge construction. In accordance with State Statute 14-269:

- This statute will apply to any four-wheeled motor vehicle equipped with pneumatic tires which is engaged in construction work or in supplying or transporting materials or equipment for public or private construction projects and which is operating upon a highway or bridge within twenty-five miles of such construction project.
- No such motor vehicle may be operated upon any highway or bridge if its gross weight, including its load, exceeds forty thousand pounds.
- No such four-axle motor vehicle may be operated upon any highway or bridge if its gross weight, including its load, exceeds seventy-three thousand pounds.
- Any person who violates the provisions of subsection (b) or (d) of this section shall be subject to the penalties set forth in subsection (f) of section 14-267a.

Inspectors are cautioned that permitted equipment should not be moved or restaged without prior review with District staff to determine if any permit modifications are required on the part of the Contractor. This includes, but is not limited to, crossing an existing or newly constructed structure.

2-802 Chief Inspector's Duties

The Chief Inspector ensures that the bridge is constructed in accordance with the plans, contract documents and specifications. The work usually requires the assistance of others, such as survey parties, testing personnel, soils engineers, etc. The Inspector should request needed assistance through the Project Engineer.

Upon being assigned to a bridge project, the Inspector must make a careful study of the plans and become thoroughly familiar with the proposed work. All dimensions and elevations shown on the plans must be checked and verified for correctness and conformity. The Inspector checks the steel requirements of the plans against the approved shop drawings. The Inspector should also check the quantities for discrepancies.

Bridge plans should show all dimensions and details necessary to complete the construction or to enable the contractor to prepare necessary working drawings. In the case of Department-designed structures, shop drawings are submitted for approval by the various suppliers to the Department. In the case of consultant-designed structures, the Department sends the shop drawings to the consultant for approval. The approved plans are returned to the Inspector through the Project Engineer.

The Inspector reviews the contractor's proposed methods of construction for cofferdams, shoring, bracing and form work; and if, in the judgment of the Inspector, there is any doubt as to the adequacy of the proposed methods, the Inspector should immediately notify the Project Engineer.

The Inspector should understand the methods to be used by the contractor to construct the bridge and must be knowledgeable about the contractor's schedule of operations. Although the contractor must execute the work in accordance with the plans and to the lines and grades established by the Department, the Inspector must check and be thoroughly familiar with all aspects of the construction to guard against possible errors and omissions.

The Inspector checks any work that is ready for inspection as well as any operations in progress that affect the quality of the work. The Inspector should immediately point out to the contractor's representative any errors detected so that they may be corrected without delay. If the Inspector encounters an aspect of the proposed construction on the plans or in the contract documents that may not satisfactorily accommodate actual field conditions, the matter should be promptly discussed with the Project Engineer.
The Inspector is responsible for determining all quantities for payment. The Inspector makes or arranges to make all field measurements necessary for the accurate computation of the quantities.

2-803 Changes

The contractor may request changes in the plans or contract provisions regarding construction methods, materials, or procedures. Requests are made by the contractor (not by a subcontractor) to the Assistant District Engineer who requests a final review by Design, if deemed necessary. Typically, Design sends its comments directly to the Assistant District Engineer, with a copy of the comments to the Manager of Construction Operations.

2-804 Shop Drawings

Before fabricating any material, the contractor must submit shop drawings to the Engineer for approval. The drawings must include erection plans, material lists, and material designated for project use, such as:

- reinforcing steel
- anchorage details for rail attachments at the ends of bridge parapets
- structural steel
- pretensioned concrete beams and deck units
- post-tensioned concrete superstructures
- post-tensioned pier caps
- concrete for structures (including remain-in-place forms, if applicable)
- “modular” expansion joints
- mechanical/electrical components of movable bridges
- elastomeric compression seals
- bearings
- bridge scuppers
- pipe for bridge drainage
- stain protection
- metal bridge rail
- open steel sidewalk grating
- granite facing
- illumination

In addition to bridge items, shop drawings are required for precast retaining walls, side-mounted sign supports, bridge-mounted sign supports, and tubular and truss sign supports.
The drawings are submitted to the designer, except for side-mounted sign-support drawings. They are submitted to the Office of Traffic Engineering. Regardless, a copy of the letter of transmittal is sent to the District. The Inspector should maintain a shop drawing log to track approvals and notify the Project Engineer if approvals are not timely.

2-805 Manufacturer's Supervision

The Specifications for a number of bridge structure items require a representative or technical adviser of the manufacturer to be present at the installation to give the aid and instruction needed to obtain satisfactory results.

The following list indicates the items that currently require a manufacturer's representative to be present at the time of installation:

- Portland Cement Concrete—Joint Seals for Structures—Type “A” Joint Seal only
- Class Concrete (Post Tensioned Superstructure)—Epoxy Bonding Compound
- Epoxy Coal-Tar Delineation for Bridges
- Elastomeric Expansion Device
- Modular Expansion Joint
- Post-Tensioning of Superstructure
- Post-Tensioning Pier Cap
- Epoxy Bonding Compound – Chemical Anchors
- Amine-Epoxy Surface Coating
- Amine-Epoxy Skin Patch
- Amine-Epoxy Finishing Patch
- Remove Concrete Nosing and Curb
- Membrane Waterproofing
- Pot or Disc Bearings
- Epoxy Injection Crack Repair
- Some types of Precast Retaining Walls
- Some field-applied bridge coatings

Because this list will change, the specifications of the individual projects should be reviewed to determine what other items may require a representative of the manufacturer to be present at the time of the construction.

2-806 Cofferdams and Underwater Concrete

Cofferdams are covered in Article 2.04 of the Standard Specifications. They must be constructed to protect uncured concrete and masonry from water damage and foundations from erosion.
If cofferdams are required, the contractor must submit drawings prepared and sealed by an engineer licensed in Connecticut, along with a complete description of the process for construction of the cofferdam. The drawings and description are reviewed, and comments are offered by the Department. The furnishing of the plans and methods does not relieve the contractor of any responsibility for the safety of the work or for the successful completion of the project.

2-807 Foundation Seals

If the foundation cannot be dewatered, the Engineer may require the construction of a concrete foundation seal. A sketch is shown in Figure 2-8.1. Tremie concrete is normally used. The contractor must submit drawings and a detailed description of the process for review and approval before placing the seal. If a mud wave is created during the placement of the tremie seal, the displaced material is removed to preserve the full foundation cross section specified in the contract documents.

After the seal has been placed, the foundation is pumped out, and the footing is placed in the dry. If weighted cribs are employed and the crib weight is used to overcome a part of the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys are provided to transfer the entire weight of the crib into the tremie concrete. If a tremie concrete seal is placed, the cofferdam must be vented or ported at the low-water level as directed.
2-808 Pumping

During the placement of concrete or masonry and for 24 hours after placement, pumping must be done from a sump located outside the horizontal limits and below the elevation of the work being placed. Pumping to dewater a sealed cofferdam must not begin until the seal has set sufficiently to withstand the hydrostatic pressure.

Refer to Sections 2-111A and 2-111B for information pertaining to environmental considerations for handling water and dewatering of cofferdams.

2-809 Removal of Cofferdams or Cribs

Cofferdams or cribs are removed by the contractor after the completion of the substructure and without damage to the substructure. No part of the cofferdams or cribs that extend into the substructure may be left in place without written permission from the Engineer. Any damage to the substructure will be repaired by and paid for by the contractor.

2-810 Stability of Foundation

The contractor is responsible for stabilizing the foundation area such that the concrete footing can be constructed in the dry and in its proper location.

2-811 Excavation

Structure excavation definitions are found in Article 2.03 of the Standard Specifications. The Inspector must be familiar with Article 1.07.07 and the latest edition of OSHA Publication 2207.

Cofferdams and pumping necessary for the completion of the work must be properly located and be constructed with adequate interior horizontal dimensions and structural adequacy to properly perform all required work incidental to the construction.

The elevation of the bottom of a footing, as shown on the plans, may be varied by the Engineer to secure a satisfactory foundation. If rock is encountered, accurate cross sections must be taken before any cofferdams are installed or excavation work is performed, and after the excavation work has been satisfactorily completed.

If foundation piles are not used and excavation to suitable bearing must be made below the planned bottom of the foundation, the additional excavated spaces under the substructure units are to be filled with concrete, the footing elevation lowered, or the footing deepened as specified in the contract documents or as directed by the Engineer. Rock foundations that are to receive footing concrete must have a rough finish. If excavation to suitable bearing for box culverts must be made below the planned bottom of the foundation, additional excavated spaces under the barrels are backfilled with select backfill. The spaces under the wing-wall footings are filled by lowering the footing elevation or deepening the footing.

Structure excavation for footings may be increased by not more than 2 ft. (600 mm) and remain within the scope of the excavation item. Quantity changes resulting from dimension variations exceeding 2 ft. (600 mm) are to be paid for in accordance with the Standard Specifications. Permission to increase the size of the footing must be requested from the Engineer.
2-812 Tying New Concrete to Existing Concrete

If portions of an existing structure are used in the new structure, the new structure is tied to the existing one.

If existing concrete is removed, the existing reinforcement steel to be incorporated in the final structure should be straightened and cleaned. The contractor is required to submit a straightening procedure in writing for approval. Care must be taken not to damage the bars. All existing reinforcing steel extending into an area of epoxy-coated reinforcing steel must be sandblast-cleaned and epoxy-coated.

If the existing, exposed reinforcement has lost 20 percent or more of its original cross-sectional area, it must be replaced. A new bar of the same diameter is provided and placed so as to have the minimum required lap at each end of the new bar. If the required bar lap is available, the deficient bar is used as a dowel. If the required bar lap is not available (or too much concrete would need to be removed to obtain the required lap), a welded or approved mechanical splice is used.

If dowel bars are required to tie new concrete into an existing structure, the dowel holes will be at least the diameter of the dowel bar plus ½ in. (13 mm). Dowel-bar hole sizes are different for epoxy-grouted bars than for cementitious-grouted bars. The Inspector should be aware of the manufacturer's requirements and recommendations. Depth of embedment is as shown on the plans.

2-813 Foundations

The design of a structure foundation involves various dead loads, live loads, site limitations and restrictions, the relationship of the structure to the adjacent roadways, roadway geometry (both over and under the structure), stream flow and alignment, and the type and support capacity of the soils. The Engineer must be notified immediately if there are questions as to the ability of the underlying material to support the structure or if the existing conditions differ from those shown on the borings or on the plans.

The elevation of the bottom of the footing specified in the contract documents can be considered an approximation. During construction, any changes in dimensions or elevations of footings to secure a satisfactory foundation must be reviewed and approved by the design engineer.

Prior to the completion of excavation for a bridge footing, box culvert, or structural plate pipe, the Inspector will notify the Project Engineer so that the Project Engineer or a designated assistant may examine the foundation before any concrete is placed. Footings for structures must be constructed on suitable foundations, and no concrete may be placed or foundation piles driven until the foundations are approved by the Engineer.

There are three common types of foundations:

- spread footings
- foundations seated in rock
- pile-supported foundations

2-813A Spread Footings

Spread footings usually are used if the bearing capacity of the soil at the site is adequate to support the structure. Generally, spread footings are the most economical type of foundation. Granular fill is usually needed to provide for uniform load transfer from the footing to the existing ground and/or to establish a level bearing area. The granular fill must be carefully placed and thoroughly compacted in layers on a shaped and graded foundation area, as shown on the plans.
To provide for uniform load transfer from the structure, through the footing, to the existing ground, the structure should be constructed on undisturbed soil. Faces of footings are placed plumb against undisturbed material, rock, sheeting, shoring, or forms. If the excavation does not stand plumb, the contractor must furnish and install sheeting, shoring, or forms as required. OSHA requirements for support of embankments in excavations must be met. If specified in the contract documents, sheeting used to construct spread footings must be left in place and cut off below finished grade to the depth shown in the plans. If not specified, the sheeting may be removed.

The design of sheeting and shoring is the responsibility of the contractor. If the material retained by the sheeting and shoring is greater than 6 ft. (1.8 m) high, the detail, procedure, and computations must be submitted to the Department for approval. The submittal must be sealed by an engineer, licensed in Connecticut and experienced in this type of work.

Forms used for footings must be removed, and any void between the footing and the embankment must be backfilled with suitable material. The material is compacted to not less than 95 percent of its maximum density. Foundation concrete must be used for this backfill if footings are submerged. Working drawings for forms used for footings are not required.

In certain instances, subsurface soils require preconsolidation using a superimposed load, or surcharge. If a superimposed load is to be installed over a granular fill in place, the granular fill should be placed about 6 in. (150 mm) higher than the proposed elevation of the footing. The additional depth of material provides for a settlement allowance and facilitates the placement of the footing on a firm, uncontaminated granular base (after removal of the surcharge and any excess granular fill).

2-813B  Foundations Seated in Rock

Foundations for structures in rock-cut locations are usually supported by a modified concrete spread footing that is constructed on rock. Special care must be taken in excavating the rock to the limit prescribed on the plans to avoid excessive fracturing of the rock that reduces its bearing capacity. This could result in a reduction of the stability of the structure.

Rock or other hard foundation material is cleaned of loose material and cut to a firm surface, either level or stepped, as directed by the Engineer. All seams or crevices are cleaned out and grouted. All loose and disintegrated rock and thin strata are removed.

The Inspector must maintain a record of the elevations of the bottoms of all drill holes and a sketch of their locations if ledge rock is removed to reach foundation grade. The data become part of the project records. The contractor should be cautioned that payment for structure excavation rock will not be made for depths greater than 6 in. (150 mm) below the plan grade or approved revised plan grade. Refer to Article 2.03 of the Standard Specifications.

2-813C  Pile Supported Foundations

If the existing soils cannot satisfactorily support a structure, foundation support is provided by piles or caissons. The piles may be end bearing or friction type:

- End-bearing piles usually are steel pipe piles or steel H-piles that are driven to refusal with an approved hammer. Prior to driving end-bearing piles, soil borings are studied, and the soil types above the rock are evaluated for elevation and driving resistance. Hard pan, till or decomposed rock often overlie satisfactory rock. High pile-driving resistance [high blows per foot (meter)] should not be mistaken for refusal.
Friction piles may be steel H- or pipe piles, or precast or cast-in-place concrete piles. Friction piles often are driven to a prescribed tip elevation or blow-count resistance. The criteria are based upon soil testing, test-pile driving resistance results, and pile-load test results.

**Figure 2-8.2 Piles**

H-, precast, and cast-in-place piles are shown in Figure 2-8.2.

The type of pile specified must be driven in accordance with the current Standard Specifications and based upon the specific recommendations of the Soils and Foundations Division. The Inspector must notify the Project Engineer of the date set for driving test piles sufficiently in advance of the actual operation to arrange to have the Soils and Foundations Engineer or designer present. Test piles are driven with the same equipment and by the same methods to be used for the piles of the permanent structure, because appreciable differences in hammer types, weights, and drop result in differences in penetration and bearing.

The depth of penetration and the length of piling for structures are usually determined by driving test piles. The contract documents specify the test-pile locations, minimum penetrations and bearing values, and estimated tip elevations. The contractor uses the information to order and drive the test piling. Then the actual, safe bearing value of the test piling is determined by load testing.
Some project's Special Provisions call for the contractor to hold off on ordering the pile lengths for the job until after data from driving the test pile has been analyzed.

2-813C.1 Load Test

Load tests are covered in Article 7.02.03-10 of the Standard Specifications, “Determination of Bearing Values of Piles.” The load-test setup, the measuring system, the loading device, the loading procedure, the frequency of measuring the movement of piles, and the recordkeeping must conform to the contract documents.

The contractor must submit drawings and computations to the Engineer showing all details of the proposed pile load-test setup and must obtain the Engineer's approval prior to starting the work. The submittal includes the method of applying the load, the reaction frame and reaction pile configuration, if used, and the placement and support of measuring devices.

At each load test location, the Engineer provides driving criteria for the test pile. The pile is driven and load tested to the test load specified in the contract documents or as directed by the Engineer. If the pile fails to achieve the required capacity, a contingent load test is performed on a second test pile. This pile may be located adjacent to the initial test pile and driven according to revised driving criteria provided by the Engineer. The Engineer may elect to have the contractor redrive piles that do not meet the required penetration resistance.

If, at any stage during the test, the Engineer detects malfunctioning of any apparatus furnished by the contractor, the load being eccentrically applied, or the anchor piles yielding, the Engineer will order the test abandoned, and the contractor will replace it with another test at no additional cost to the State. The contractor must have an employee present at the site at all times during the performance of the test to maintain the required load.

After the test piles are driven, and the pile load tests, if any, are performed, the Soils and Foundations Engineer or consultant designer will promptly analyze the data and furnish the Assistant District Engineer with a list of recommended order lengths for the piles in that locality. If these lengths appear proper, the Project Engineer will use them to make up an order list to the contractor for pile lengths to be furnished by the contractor. The Department is responsible for determining required pile length.

2-813C.2 Driving Plan

The contractor must submit a plan of the pile-driving method to the Engineer, including type of hammer, for approval prior to driving any piling.

2-813C.3 Equipment

The size of the hammer must be appropriate for the type and size of the piles and the driving conditions. The hammer to be used must be approved by the Soils and Foundations Engineer. The Inspector should refer to Article 7.02.03-5 of the Standard Specifications.

The hammer to be used for driving permanent piles must be the same hammer that was used to drive the test piles. If the contractor changes hammers, the contractor must drive additional test piles at his expense before driving the permanent piles, even if the energy ratings of the hammers are identical.

Hammers are to be operated at speeds recommended by the manufacturer for the bearing value specified. The manufacturer's manual for the hammer employed must be available to the Engineer at the project site.

If the required penetration is not obtained by the use of a hammer complying with the requirements, a heavier hammer, jetting, spudding, or a combination of these methods may be used to obtain the required penetration. The Inspector must be aware that hammers delivering an energy that the Engineer considers detrimental to the piles will not be used.
Diesel hammers and vibratory methods for driving piles, other than prestressed concrete piles, are permitted subject to the restrictions in the applicable Standard Specifications.

Pile-driver leads are used for driving all piles unless otherwise permitted by the Engineer. The contractor must drive the piles within the tolerance as specified without injury to the piles. Any leads that do not produce satisfactory end results in the driving of piling are to be removed from the work.

Long piles and battered piles may require guides and additional support to prevent excessive bending or buckling under the hammer blow. Piles must be held in place and aligned by templates or other means approved by the Engineer.

2-813C.4 Driving

In pile-driving operations, the Inspector must be aware of a number of circumstances that may cause driving resistance to be falsely indicated.

- If using a pile hammer that is too light, a considerable amount of the energy is absorbed by inertia of the pile instead of being available for driving.
- The stroke of the hammer may be shorter than needed and should always be checked.
- Slowing down some types of single-acting hammers by the operator will reduce the stroke by several inches (millimeters).
- Resetting the slide bar on a hammer will create back pressure and will ultimately reduce the penetration of the pile under each blow.
- Soft wood placed in the cushion pad will absorb energy, falsely indicating resistance.
- Reduction of speed in a double-acting hammer will reduce the energy of the hammer.

If piling must penetrate strata that resist driving, the contractor must auger or drill holes through the strata. The size of the auger or drill may not be larger than the nominal diameter of a round pile or the minimum diameter of a circle in which an H-pile fits and must meet with the approval of the Engineer before use. After the hole is completed, the pile is inserted and dry sand is used to completely fill any voids between the pile and the walls of the hole. Driving is then completed, after which any remaining voids are completely filled with dry sand.

Once driving a pile has begun, it must be kept continuous except for splicing. A temporary halt in driving a pile may allow the pile to “set”. It may be necessary to continue driving the halted pile for a distance of several feet (meters) before resistance returns to what it was before the stoppage.

If splicing is necessary, it should be performed before approaching the estimated tip elevation. If splicing steel H-piles or shells for cast-in-place concrete piles is necessary, the piles or shells must be spliced as specified in the contract documents by electric arc welding conforming to the American Welding Society (AWS) Structural Welding Code for the full periphery. The number of splices permitted should be compatible with driving conditions at the site and the standard lengths of piling produced by manufacturer.

A pile may become overstressed during driving. If a pile is founded on rock, it becomes a column and additional driving cannot increase its bearing value, but it may seriously damage the pile by brooming, fracturing, or shearing. When the resistance to driving is increased to near the design resistance, smaller increments should be used to check penetration. They will aid the Inspector in ascertaining the number of blows required for each foot (meter) of penetration, the total driving length, and the elevation of the tip of the pile.

Disposition of pile cutoffs is covered by Article 7.02.03-14 of the Standard Specifications or by the project special provisions.
2-813C.5 Tolerances

Piles are driven to the following tolerances:

- **General.** Foundation piles should not be driven out of the position specified in the contract documents by more than 6 in. (150 mm) in any direction regardless of the length of piles. Variation from the vertical or from the batter should not be more than ¼ in./ft. (20 mm/m).

- **H-Piles.** Rotation of the pile in excess of 25 degrees from the planned axis is not permitted.

- **Bents.** Piles must be driven so that the cap may be placed in its proper location.

2-813C.6 Unacceptable Piles

Any pile that does not conform to the contract documents is corrected at the contractor’s expense by one of the following methods or by other methods approved by the Engineer:

- The pile is withdrawn and replaced by a new pile.

- A second pile is driven adjacent to the unacceptable pile.

- The pile is spliced or built up.

- A sufficient portion of the footing is extended to properly embed the pile.

2-813C.7 Reporting

An accurate and complete record should be kept of each driven pile for substantiating the length driven, driving resistance, and tip elevation. The records are kept on Form CON-87 which can be found in the Approved Forms folder.

2-814 Formwork

The contractor is responsible for assuring that forms are adequate. If there is reason to believe that the formwork is inadequate to support pressures from plastic concrete, the Inspector should consult with the Project Engineer and immediately notify the contractor of the concern.

Forms must be fabricated and erected to accurate measurements and lines, and with tight joints, by experienced and capable carpenters, and they must be thoroughly finished and braced. Used lumber must be cleaned before it is reused. Plywood must be free of broken edges and other damage that affect the exposed surface. All defects, including penetrations, ply delaminations, and holes, are plugged and finished flush with the surfaces of the forms. All forms are oiled with clear form oil before use.

Sufficient ties and spreaders should be provided to properly align the forms. Sufficient bracing must be provided to hold the forms in their proper positions while the concrete is being placed. Metal ties and anchors used to hold the forms in alignment and location must be constructed so that the metal can be removed to a depth of at least 1 in. (25 mm) from the surface of the concrete without damage to the concrete. All cavities should be filled with an approved mortar or non-shrink grout. Spreaders are removed when the concrete reaches their level.
The contractor establishes string lines or other suitable means for checking the alignment of the forms during and after concrete is placed. The Inspector must check for alignment and grade before, during, and after the placement of the concrete. The Inspector personally checks established string lines and requires the contractor to assign a competent foreman to check and adjust the alignment of the forms during the concreting operations. The Inspector must closely observe all corners and walers to ensure that any movement during the placement of concrete is brought to the contractor's attention. The contractor must realign and strengthen the forms or halt the placement of concrete until the possibility of form movement or failure is eliminated.

2-815 Reinforcement

Reinforcement is covered in Article 6.02 of the Standard Specifications.

2-815A Plan Dimensions

All plan dimensions related to reinforcing steel are out-to-out measurements. Spacing is measured center to center.

2-815B Cutting and Bending

Reinforcement bars are cut and bent at the mill or shop to the shapes specified in the contract documents before shipment to the job site. Reinforcement bars must not be bent in the field except to correct errors, damage by handling and shipping, or minor omissions in shop bending.

2-815C Storage

Bundles of reinforcing bars are stored at the site on suitable blocking or platforms sufficiently high to keep them free from vegetation growth, accumulations of dirt, oil, or other foreign material. Blocking must be sufficiently close to avoid bending and distortion of the bars. Any distortion of the bars or damage to epoxy coating must be corrected as directed by the Engineer at the expense of the contractor.

Rebar can only be stored on the existing bridge if its weight has been reviewed as noted in Section 2-801A.

2-815D Installation

Longitudinal and transverse bars must be properly located relative to each other. An adequate number of approved metal chairs or suitable precast mortar blocks are used to support reinforcement at the proper elevations. However, reinforcing bars must not be supported by chairs, stand-offs, blocks or other methods against formed surfaces that will be exposed in the completed structure. In addition, no bars are to be cut and spliced for reasons of expediting the installation unless otherwise permitted. All splice lap lengths must be the proper length and in the proper location.

The Inspector must check that the required quantity of reinforcing steel is properly installed and that it is securely fastened so that it remains in position during the placement and consolidation of the concrete. The reinforcing bars must not become displaced or untied during concrete placement operations.
If metal chairs are used to support the reinforcement, there is a tendency for the chair legs to be exposed when the forms are stripped. A part of the chair may protrude beyond the surface of the concrete, where it is susceptible to corrosion. This can be eliminated by using precast mortar blocks to space the steel from the form, as shown in Figure 2-8.3. However, when this method is used, the concrete must be carefully vibrated to avoid honeycombing or the formation of voids around the mortar blocks. The Inspector must not allow the use of wooden blocks for the support of reinforcing steel.

**2-815E Splicing**

In lapped splices, reinforcement bars are placed in contact and wired together. Bars in beams, girders, walls, columns, footings, slabs, and haunches are lapped 24 diameters. Bars in the upper section of beams and girders are lapped 35 diameters if there is more than 12 in. (300 mm) of concrete under the bars. Mechanical and welded splices are allowed if in the plans or authorized in writing by the Project Engineer. Refer to Section 10 of the AASHTO Standard Specifications for Highway Bridges.

Dowel-bar splicing systems may be designated for stage construction, as indicated on the plans. The contractor may elect to use these in certain situations; the required approval is made by the Engineer.

![Figure 2-8.3 Mortar Block](image-url)
2-815F Epoxy Coating for Bars

The Inspector must be familiar with the special provisions for the epoxy coating for reinforcement bars and the touch-up for repair furnished by the manufacturer. Flame cutting of coated bars is not permitted.

A final visual inspection of epoxy-coated steel at the construction site should be made by the Inspector after the steel is in place, immediately prior to placing the concrete. Areas designated by the Inspector that require repair should be patched with epoxy. No concrete may be placed on a patched area until the patching material has cured for one hour. The contractor must allow the Inspector sufficient time after the reinforcement and forms are in place to conduct the inspection.

2-816 Concrete

2-816A Concrete Mix

The Inspector must become thoroughly familiar with Article 6.01 of the Standard Specifications. This Article contains the requirements for mixing, transporting, placing, and curing concrete. All sources of supply are approved by the Central Laboratory annually and are available on request from the District. Mix design information and approved vendors can also be accessed from the SiteManager Terminal Server files.

One of the first duties of the Inspector is to obtain an approved concrete-mix formula from the Central Laboratory for the anticipated suppliers of concrete. The Laboratory tests and approves the operation of each concrete plant and the materials. They also design the standard concrete mixes. The contractor may use the standard concrete mixes or submit a nonstandard mix design. If the contractor submits a nonstandard design, the Inspector assures that it is forwarded to the Laboratory with sufficient lead time to allow for approval prior to placing concrete.

Requests for material tests for fine and coarse aggregate must be submitted by the Inspector to the District Laboratory in accordance with the frequency for acceptance and requirements identified in the current ConnDOT “Schedule of Minimum Requirements for Sampling Materials for Test.”

The concrete tickets must be signed by the Inspector. The Inspector also will enter the time and weather conditions.

2-816B Sampling and Quality Control

2-816B.1 Sampling

The following procedures should be used for sampling concrete:

- **Truck Mixer.** The samples, including slump, air entrainment, cylinders, etc., are taken at three or more regular intervals during continuous concrete placement. The Inspector can increase the frequency if a change in the mix is apparent. The samples must not be taken at the very beginning or very end of the distribution. The same procedure is used for trucks delivering central-mix concrete. For truck-mixed concrete, the mixer capacity, the number of revolutions at mixing speed, and other checks are recorded on each load ticket at the time a test specimen is made.

  - Any one of the following should be sufficient cause for rejection:
    - the mixing revolutions exceed 100
    - the concrete is not discharged within 1 hour from the time the truck is loaded
    - the air content or slump is not within specified range
• Stationary Mixer. The concrete sample should be taken after approximately one-half of the batch is discharged. If a chute arrangement is used, samples may be taken by diverting the concrete discharge stream completely until a sufficient amount of material is acquired. If the concrete is discharged directly into a concrete bucket, the discharge should be stopped after approximately one-half of the material is discharged, and the required amount of concrete removed from the top of the bucket. The sample should be put in a wheelbarrow. A hand bucket can be used if a wheelbarrow is not available.

2-816B.2 Testing

After sampling, whether from trucks or stationary mixers, the concrete is moved to a safe area where the necessary tests can be completed. At the site where tests and specimens are to be made, the Inspector remixes the concrete with a shovel to ensure uniformity. If buckets are used, the material is dumped on a flat, level surface, such as a piece of plywood, and remixed. After remixing, the concrete is covered to prevent loss of moisture.

The first tests to be made are the slump test and the air entrainment test. If either the slump or air test does not meet Department requirements, the load should be rejected or adjusted. The concrete plant and the inspector at the plant must be notified of the action. If the tests are satisfactory, specimens should be made.

Test cylinders should be molded by placing the fresh concrete in the standard mold in three layers, each approximately one-third of the volume of the mold. Each layer is rodded with twenty-five strokes of the rod. The strokes are distributed in a uniform manner over the cross section of the mold and should penetrate into the underlying layer by 1 in. (25 mm). The bottom layer is rodded throughout its depth. After the top layer is rodded, the surface of the concrete should be finished to a true plane. Care must be taken in moving and transporting cylinders after their initial set.

After curing for twenty-four hours, the specimen is removed from the mold and properly cured. Curing methods and locations should duplicate those of the actual structure. Care should be exercised during curing to make sure specimens are not damaged. Arrangements must be made by the Inspector to have Laboratory personnel test the specimens.

If slump and air are satisfactory and specimens have been molded, the information obtained is reported on the cylinder card MAT-29, using SiteManager or the paper form for non-SiteManager projects. The Inspectors make a minimum of three cylinders for each unit placed. The cylinders should be numbered “1, 1a, 1b;” “2, 2a, 2b;” etc. The location represented by each sample should be clearly noted.

Concrete slump and air tests are made periodically throughout the placement to ensure proper mix consistency. The procedures for making slump tests and air tests are described in Sections 2-723C and 2-733A within Volume 2, Chapter 7, “Concrete Pavements.”

The AASHTO and ASTM methods for air entrainment determination, slump testing and molding of test specimens all require a round, straight steel rod, about 5/8 in. (16 mm) in diameter and approximately 24 in. (610 mm) in length, with one end rounded to a hemispherical tip. Unless the operator exercises care, a great deal of damage can be done to the air meter, base plates, or the cylinder forms by this steel rod.

2-816C Placement

Concrete can be structurally unsound if not correctly placed, consolidated and cured, even if the right materials and mixing methods are used. The Inspector must assure that placement is in strict compliance with Article 6.01.03-8 of the Specifications.
All foreign material, such as wood chips, paper, wire, dirt, water, mud, etc., must be removed from the forms before the start of a concrete operation.

Concrete should be deposited as close as practicable to its final position. Concrete segregates if it is allowed to run or fall freely or is worked over a long distance. If concrete must be moved a long distance, use concrete hoppers and trucks. Over-vibration will not be permitted. The result is poor-quality, low-durability concrete with subsequent porosity, premature scaling and disintegration.

Vibrators are used to consolidate concrete—never to spread it. Over-vibration or the incorrect use of the vibrator causes separation of concrete materials. The vibrator should penetrate the entire depth of the layer of concrete being placed but not be allowed to remain in the same spot too long. Ten seconds is about the maximum period necessary to consolidate one area. Usually, less time is needed.

The vibrating head should not be allowed to lie idling in freshly placed concrete or against reinforcing bars that protrude from fresh concrete. The vibrator should not be operated against reinforcing steel that projects into concrete that has not reached its initial set.

### 2-816D Construction Joints

Construction joints are to be placed only at the locations shown on the plans or at locations approved by the Engineer. The Inspector may authorize placement of a construction joint if a section cannot be completed as planned because of an emergency (such as a plant breakdown). The contractor must request permission from the Engineer to place a construction joint if there is no emergency and the joint was not authorized previously.

A joint must be vertical or horizontal, regardless of the reason for the joint. It must be perpendicular to the line of greatest stress and located where shear is lowest. The lines of the joint must be straight and true. For a horizontal joint, edging strips are used to control the lines of the joint. If a vertical construction or expansion joint is located in a structure, 1 in. (13mm) beveled chamfer strips are placed on both sides of the joint to control the line and prevent spalling or ragged edges. A construction joint with a keyway is shown in Figure 2-8.4.

**Figure 2-8.4 Construction Joint**
2-816E Placing Concrete in Cold Weather

Cold weather procedures are used from October 15 to April 15, unless the Engineer directs otherwise. The procedures are covered in Article 6.01.03-12 of the Standard Specifications. The Inspector must be sure that the heating apparatus is adequate. The contractor must not allow hot spots to develop that might cause premature drying or damage of the material. The contractor must provide a sufficient number of maximum/minimum recording thermometers to record temperatures in each concrete placement undergoing cold-weather protection. There is no additional compensation for the use of heating equipment or for the maintenance of proper curing moisture.

The temperature of the concrete must be no less than 60 °F (16 °C) when placed in the forms. The temperature surrounding the structure must be kept above 60 °F (16 °C) for five days after placement, above 40 °F (5 °C) for an additional nine days, and then gradually lowered to the ambient air temperature. Mixing water must be heated, but its temperature cannot exceed 150 °F (65 °C). If aggregate is heated, its temperature must be between 50 °F (10 °C) and 100 °F (37 °C). The Engineer may vary the temperatures for the mix, water, or aggregate in extreme weather.

The contractor must have tarpaulins, insulating devices, and other suitable materials at the site to enclose or protect all portions of the concrete requiring protection. Materials should be stored close to where they will be used and, after the concrete is placed, installed as rapidly as possible to keep exposure to cold weather to a minimum. The spaces to be heated must be completely enclosed, and the temperature must be kept at required levels by the use of heaters approved by the Engineer.

Before placing concrete, the Inspector should ensure that the air temperature in the forms and the reinforcing steel is at or above the specified temperature. The temperature must be maintained throughout the entire concrete placement operation.

After the concrete is placed in the forms, daily temperature readings are taken by the Inspector to ensure that necessary temperatures are maintained. A record must be kept of these readings on the Inspector's Report. A thermocouple probe and thermometer can assist the Inspector in obtaining readings and improving the accuracy of the representative temperature of the concrete.

The curing period for all structural concrete requiring cold-weather protection must conform to the cold-weather protection period except if the normal curing period is longer. The concrete must be covered after the initial set. Proper curing moisture must be maintained at all times.

2-816F Curing

Curing is covered under Article 6.01.03-19 of the Standard Specifications, “Curing Concrete”.

Proper curing improves the three most desirable characteristics of concrete: strength, water tightness, and durability. There should not be a tendency to neglect the curing of concrete walls, abutments, piers, and other features of a structure where forms may be stripped early.

The strength of concrete is increased about 50 percent by keeping it damp the first seven days instead of allowing it to dry out rapidly. Moist curing is an aid to producing watertight concrete. As the cement paste hydrates, additional solid matter is formed, filling in spaces between the cement particles. The more complete the hydration process, the denser the concrete. In addition, moist curing improves the durability of concrete and prevents checking and dusting.

Liquid membrane-forming curing must not be used for bridges. Some of the methods that may be used are described below.

- **Flooding.** Units of structures that will be below water in the completed structure—bottom slabs of culverts, footings, struts, etc.—may be gradually flooded when approved by the Engineer after the concrete is 12 hours old. The temperature of this water should be maintained at 35 °F (2° C) or above for the specified curing time.
• **Burlap.** Two layers of burlap must be used. Successive strips of burlap are overlapped a minimum of 6 in. (150 mm). The second burlap layer is placed not less than 45 degrees to the first layer, or in lieu of this, the 6 in. (150-mm) overlap of the second layer may be placed midway between that of the first layer. The material must be thoroughly saturated by immersion in curing water for at least 24 hours prior to placement and must be kept saturated throughout the time specified for curing.

• **White Opaque Polyethylene Backed Non-woven Fabric.** One layer of white opaque polyethylene backed fabric must be used. Successive strips are overlapped a minimum of 6 in. (150 mm) The material must be thoroughly saturated by immersion in curing water for at least 24 hours prior to placement and will be kept saturated throughout the time specified for curing.

• **Cotton Mats.** One layer of cotton mat material is used and must be kept thoroughly saturated with curing water prior to placement and throughout the time specified for curing. The material must be kept in tight contact with the concrete.

• **White Opaque Burlap Polyethylene Sheeting or White Opaque Polyethylene Film.** The white opaque burlap polyethylene sheeting is placed on no less than one layer of wet burlap with the burlap side of the sheeting facing down. White opaque polyethylene film, if used, is placed on no less than two layers of wet burlap. Only one layer of cotton mats is required in any usage. The materials may only be used on top of the wet burlap or cotton mats if the surfaces are unobstructed, flat and reasonably level.

Adjacent mats or sheets must be lapped no less than 12 in. (300 mm). The ends are brought down around the sides of the concrete being cured and securely fastened to make an air-tight seal.

The white opaque burlap polyethylene sheeting or the white opaque polyethylene film must remain in place for the same length of time as required for burlap or cotton mats. The protective coverings need not be wetted down. However, the covered burlap or cotton mats must be kept wet for the period specified.

### 2-816G Finishing Concrete Surfaces

The Inspector should refer to Article 6.01.03-21 of the *Standard Specifications*, “Surface Finish”.

Immediately following the removal of forms, all fins and irregular projections must be removed from all surfaces, except from those that are not to be exposed or not to be waterproofed. On all surfaces, broken corners or edges and any cavities must be thoroughly cleaned and, after having been kept moist, are carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished. Any excess mortar at the surface of the concrete must be removed. The mortar patches are to be cured. Construction and expansion joints in the completed work must be carefully tooled and cleaned. Joint filler is exposed for its full length with clean and true edges. Resulting surfaces must be true and uniform.

The *Specifications* contain a table of finishes that indicate the type of finish to use by structure component. The components are finished with either a float, grout clean-down, or rubbed finish as described in the *Specifications*.

### 2-816G1 Horizontal Surfaces

All upper horizontal surfaces, such as the tops of parapets, copings, and bridge seats, must be finished by placing an excess of concrete material in the forms and striking it off even with a wood template. Tops of handrail (posts and caps), headwalls, parapets, wingwalls, and barriers are steel troweled to a smooth, dense surface.

The bridge seat bearing areas of the substructure masonry must be finished to the elevations shown on the contract documents. The contractor will check the elevation of each bearing area prior to finishing ensuring conformance with
the plans. Each area must be checked for level in all directions using a spirit level, and adjustments must be made prior to the setting of the concrete. The area is steel troweled to a dense, flat surface. Bearing areas that are not flat after final finishing must be ground to achieve an acceptable surface. A bearing area is not accepted if it is at an elevation below that of the surrounding masonry.

2-816G.2 Sidewalks and Safety Curbs

The concrete should be struck off with an approved screed to the elevation and slope specified in the contract documents. It must be wood-floated to give a uniformly gritty surface free from depressions or high spots. The joints must then be edged with the appropriate edging tool. Curbs are stripped and finished as soon as possible.

2-816G.3 Culvert Slabs

The tops of culvert slabs that are not part of the roadway and invert slabs must be screeded either by hand or machine and have a float finish. The allowable surface tolerance must be within \( \frac{1}{4} \) in. (6 mm) of the grade specified in the contract documents. Inverts of culverts having a span of less than 10 ft. (3 m) need not be straightedged.

2-817 Superstructures

2-817A Steel Bridges

Steel bridges are usually designed with steel superstructures constructed of structural steel and concrete. Their substructures are usually constructed of concrete. Further design-related definitions and information can be found in the ConnDOT Bridge Design Manual and the Department's Steel Construction Manual.

Figure 2-8.5 Shear Connectors
There are two types of steel superstructures: composite and non-composite. In a non-composite steel-beam bridge with a reinforced concrete deck, each beam carries the dead and live load transmitted to it by the concrete slab. In a composite bridge, shear connectors are welded to the beams, so that after the concrete slab is placed, the slab and the beams act together as composite sections to carry the loads. A sketch of shear connectors is shown in Figure 2-8.5.

2-817B Box Girders

Steel and post-tensioned concrete box girders are now in use. Stay-in-place forms are generally not allowed for building concrete decks on box girders.

2-817C Temporary Bridges

The construction of a temporary bridge may be included in the project, usually as part of stage construction. The contractor is responsible for the design of a temporary bridge according to the contract specifications. On complex projects, the Department will provide a temporary bridge design on the plans. Shop drawings are always submitted to the Department by the contractor for review.

2-817D Prestressed Bridges

Prestressed concrete superstructure units of various shapes have been adopted for use as economical bridge-deck components. The more common prestressed units and types are:

- **Standard Prestressed Concrete Slabs.** These are hollow, rectangular concrete units with central, longitudinal voids. A unit may serve as both girder and deck surface for simple-span structures, although a bituminous or cementitious wearing surface may be applied. Normally, they are not used for spans over 65 feet (20 meters) in length.

- **Standard Prestressed Concrete Box Beams.** These are similar in shape to standard prestressed-concrete slabs but usually are deeper, used for spans up to 105 feet (32 meters). They can be covered with a bituminous or cementitious wearing surface.

- **Standard Prestressed Concrete Girders.** These are I-shaped units used primarily as girders that normally are used with conventionally reinforced concrete decks. The span limit is 120 feet (37 meters).

- **Precast Reinforced Concrete Arch.** Each unit is a concrete arch constructed of three sided, reinforced, monolithically precast sections with open ends of the size as shown on the plans. The units are tied together with transverse strands that are post-tensioned as directed by the Designer.

2-817D.1 Strength

The strength of the concrete in the superstructure units must be as shown on the plans, as defined by the following:

\[
f'_{c} \text{— the required 28-day compressive strength.}
\]

\[
f'_{c_1} \text{— the required compressive strength at the time the strands are detensioned.}
\]
2-817D.2 Camber

Camber is defined as the slight arch or convex curvature provided in beams to compensate for dead-load deflection. The camber of the prestressed superstructure units when delivered to the job site should approximate the value of the estimated camber. The estimated camber is computed on the basis that the superstructure units are detensioned at the prestress plant when the concrete has attained the required compressive strength ($f_{ci}$), as shown on the contract plans. Too great a camber can result from the introduction of an excessive prestress force, but usually it is caused by detensioning the superstructure units before the required concrete strength ($f_{ci}$) has been reached. If the camber is excessive (over or under by approximately 50 percent of the estimated camber), the Inspector should notify the Assistant District Engineer.

2-817D.3 Bearing Areas

The Inspector must check the bottom of each superstructure unit at both bearing areas for trueness of plane surface. The check is done before the superstructure unit is erected to ensure uniform bearing between the superstructure unit and the elastomeric bearing pads. The bearing surface of the bottom of a superstructure unit must lie in a plane that is parallel to the plane passing through the top of the bearing pads. The allowable deviation from a true plane is ±1/16 in. (±1.5mm), as specified in the Manual for Inspection of Prestressed Concrete presented by the joint AASHTO-PCI Committee.

2-817D.4 Unacceptable Units

The Laboratory notifies the supplier of all unacceptable units delivered to the site. Copies of the notifications are sent to the appropriate District Office. Field inspectors must ensure that the beams delivered to the site are found acceptable by the Laboratory. If the beams are delivered to the site and have not been accepted at the plant by the Laboratory, the beams must be rejected and returned to the supplier. Out-of-tolerance beams must not be accepted on site, regardless of any understanding that remedial corrections will be performed in the field.

2-817E Anchor Bolts and Bearings

Anchor bolts and bearing assemblies must be accurately positioned or set prior to placing concrete for the bridge seat. Anchor bolts must be set in formed holes in accordance with details and dimensions shown on the plans. The space around the anchorage material is completely filled with nonshrink, nonstaining grout. The work is done as noted on the plans or as ordered by the Engineer.

Frequently, the provision for anchor bolts becomes a part of the superstructure work. In such instances, it is not advisable to drill holes for the anchor bolts. The positioning of anchor bolts must be performed before the substructure concrete is placed. Because there is very little room for adjustment, the anchor-bolt layout must be accurate. The bolt holes must be in the correct locations and perpendicular to the plane of the bridge seat.

The layout procedure is as follows:

- After forms are constructed for the concrete substructure, the centerline of the bridge is located for the abutments and piers.
- The centerline of bearing is located for the first abutment. The angle between the centerline of the bridge and the centerline of bearing is checked to see that it is exactly as planned. Any discrepancy must be corrected by adjusting the centerline of bearing.
• The distance is checked between the centerlines of bearing for the first abutment and the second abutment or pier, applying corrections for temperature and measuring tape sag. After the correct distance between the centerlines of bearing is established, an adjusted centerline of bearing is located on the second abutment or pier. The centerlines of bearing for the remaining piers or abutments are located in a similar manner.

• For each abutment and pier, the centerline of the girder and the centerline of the anchor bolts are permanently located. The lines are used to determine the position of the anchor bolts and to set the masonry plates.

• After the anchor-bolt holes are cast into the concrete and the bearing is prepared, each masonry plate is marked with the centerline of the girder. The centerline of the anchor bolts is marked on the bearing seat. The plate is set so that the marks on the plate coincide with the marks on the bearing seat.

The anchor bolt positions must be adjusted to accommodate expansion of the girders. Rockers will be tilted toward the abutment if the temperature is above the mean temperature indicated on the plans and away from the abutment if the temperature is below the mean temperature indicated on the plans.

2-817F Elastomeric Bearing Pads

The purpose of the elastomeric bearing pad is to transmit the superstructure loads to the substructure and to accommodate the expansion, contraction, and horizontal movements of the superstructure. This should be accomplished without slippage between the superstructure and the elastomeric bearing pad or between the elastomeric pad and the substructure. A sketch of an elastomeric bearing pad assembly is shown in Figure 2-8.6.

2-817F.1 Materials

The dimensions of the pads must be as shown on the plans, with allowable tolerance indicated in the specifications. The two most critical dimensions are the taper of the pad, or pad thickness if no taper is required, and the location of the laminae, if a laminated pad is specified. The taper (or thickness) of the pad must be correct to obtain uniform bearing between the pad and the superstructure unit, resulting in uniform stresses within the pad.

The laminae within the pad, if present, have the effect of dividing the pad into a series of pads. Therefore, the distance between laminae is equivalent to the thickness of each “internal pad” and must be of the proper dimension. The Materials Laboratory cuts the sample pad to determine the location of the steel laminae. The position of the laminae can also be determined after the superstructure unit has been set on the pad. The weight of the superstructure unit will produce a series of bulges on the side of the pad. The valleys, or the portions of the side that do not bulge, indicate the positions of the laminae. The required position of the laminae will be as shown on the plans, with the allowable tolerances stated in the specifications. No part of the laminae may be exposed.
2-817F.2 Bearing Area

Unless otherwise stated in the specifications or plans, the elastomeric bearing pad is set on a prepared concrete seat. The seat must be level and at the elevation shown on the plans, and it may not vary from a true plane by more than 1/16 in. (1.5 mm) over the entire surface on which the elastomeric bearing pad is to rest. Normally, no grout will be used to level the seat. If shims are needed, elastomeric shims will be used prior to installation of the elastomeric bearing pad.

When the elastomeric pads are used without masonry bearing plates, the masonry bearing surfaces must be ground to remove all laitance before the application of the adhesive. The surfaces of the concrete bearing areas that will be in contact with the bearing pads and the full contact area of the bearing pad will be coated with the epoxy adhesive. After the adhesive is applied and the pads are set in place, blocking or other approved mechanical methods may be used to secure the pads in their final position until the adhesive sets up.

2-817F.3 Installation

The pads and abutting surfaces must be given a final cleaning to assure that they are free from all dust, dirt, oil, grease, moisture, and other foreign substances. Cleaning may be done with an approved solvent that is compatible with the adhesive. The adhesive must be mixed and applied in conformance with the manufacturer's recommendations.

Surface temperatures and predicted ambient air temperature for the next four hours must be 50 °F (10 C) or higher at the time of application, unless otherwise specified in the contract documents or recommended by the epoxy adhesive manufacturer and approved by the Engineer.

After application of full dead load, there must be uniform bearing between the superstructure unit and the elastomeric bearing pad and between the bearing pad and the concrete seat, uniform deflection of the pad, and no tearing of the elastomer.
2-817F.4 Nonconforming Work

Any deviation from the above, or any nonconformance to the requirements of the plans or specifications, must be reported immediately to the Project Engineer. Refer to Section 1-325 for usage of Non-Compliance Notices.

2-817G Pot Bearings or Disc Bearings

Pot or disc bearings must provide for rotation in all directions. Expansion bearings have sliding surfaces of polytetrafluoroethylene (PTFE) to accommodate expansion and, thus, sliding in the directions indicated on the contract plans. A sketch of a pot bearing is in Figure 2-8.7.

![Figure 2-8.7 Pot Bearing](image)

The Inspector must be aware of possible problems during normal use of the bearings:

- The bearing may be subjected to rotation beyond its capacity during installation.
- The electrical ground may be attached to the bearing, causing current to travel through the bearing or causing arcing of the ring against the side of the pot.
- Paint may be applied inadvertently to PTFE or stainless steel surfaces. The surfaces are intended to slip against each other. The paint impedes the movement.
- Duct tape or such, used to secure the bearing during transportation, may be left in place between the teflon and stainless steel surfaces.
- Bearings may be handled and stored improperly. They can easily be contaminated with foreign material.
- The pot bearing may “ooze” after loading.

As with all fabricated structural steel, the contractor must submit shop drawings to the Engineer for approval before fabrication of any bearing. The contractor is responsible for coordinating the work between the bearing manufacturer and the subcontractor installing the bearings. Pot bearings are preassembled in the fabricator's shop before shipping to the job site. They should not be disassembled in the field.
Before installing the bearing, the contractor certifies to the Engineer that an experienced representative of the bearing manufacturer will be available to the contractor at the site to give aid and instruction. The bearings must be placed at the predetermined location at the time of structural steel erection or, in the case of cast-in-place concrete superstructures, before the superstructure is cast. All temporary restraints are removed as directed by the bearing manufacturer.

Expansion bearings are adjusted from the normally aligned position to allow for the ambient temperature at the time of erection or casting. In addition, the bearings are adjusted horizontally on the anchor plates to properly fit the steel superstructure members being erected. After all adjustments and at the approval of the Engineer, the bearings are welded to the anchor plate.

2-817H Expansion Dams

In setting expansion dams, the length of the expansion dam on the plans is adjusted for the difference between the existing temperature and the mean temperature indicated on the plans. The following formulas are used:

\[
T = \text{mean temperature indicated on the plans in degrees Fahrenheit (Celsius)}
\]

\[
E = \text{existing temperature in degrees Fahrenheit (Celsius)}
\]

\[
L = \text{length of the structure contributing to expansion in inches (millimeters)}
\]

When the temperature is above T, the steel expands. The increase in the length of the girder because of the difference in temperature is:

\[
0.000 011 6 \times (E - T) \times L \quad (0.000 006 5 \times (E - T) \times L)
\]

If the other end of the girder is fixed, existing expansion space should be set smaller than that shown on the plans by subtracting the calculation result. If the other end of the girder is free to expand or contract, the existing expansion space is smaller by one-half of the calculation result.

When the temperature is below T, the steel contracts. The decrease in the length because of the difference in temperature is:

\[
0.000 011 6 \times (T - E) \times L \quad (0.000 006 5 \times (T - E) \times L)
\]

If the other end of the girder is fixed, the existing expansion space should be set larger than that shown on the plans by adding the calculation result. If the other end of the girder is free to expand or contract, the existing expansion space is set larger by one-half of the calculation result.

If the mean temperature is not indicated on the plans, T is assumed to be 50 °F (10 °C).
A rocker setting is shown in Figure 2-8.8.

It is important to remember that a further allowance must be made for the increase in length of beam that may be produced by reduction in camber resulting from the application of dead load. In addition, an allowance for concrete creep must be made for cast-in-place concrete boxes.
2-817I Steel Erection

Article 6.03 of the Standard Specifications must be thoroughly reviewed by the Inspector prior to erecting any steel. It is very important that steel erection proceed in accordance with the approved procedure. Any deviation in crane size or lifting locations should not be permitted. All details of the erection of steel members must be discussed in the approved erection plan.

When structural steel is being erected, it is very important that diaphragms are installed and bolted as girders are placed—to stabilize the girders and prevent accidents. The Inspector must not allow work to be stopped for the day until all erected beams are stabilized by the proper installation of diaphragms and keeper blocks if necessary. The Inspector must never permit unbraced steel to be left overnight.

2-817J Shear Connectors

Shear connectors must be the diameter and height specified on the plans and must be installed in accordance with the prescribed spacing on the top flange of steel girders. Shear-connector samples of the type described on the plans must be submitted for testing and approval well in advance of the anticipated use. The Inspector may refer to Article 5.08.03 of the Standard Specifications for field testing procedures.

2-817K Welding

Welding is a critical function in the construction of steel bridges and requires constant diligence of the Inspector. The Inspector must thoroughly review the Standard Specifications Article 6.03.03-6, “Welding,” AASHTO and American Welding Society (AWS) codes, and the ConnDOT Steel Construction Manual.

Field welding must be performed by the shielded metal arc method, unless otherwise permitted by written consent of the Assistant District Engineer. Welding will not begin until all welding procedures are submitted by the contractor and accepted by the Department.

2-817K.1 Welder Qualifications

To work on the project, either in the field or shop, a welder (1) must possess a valid Department welding card and (2) must have welded on a Department project or on a project acceptable to the Department within 12 months. The Chief Inspector must personally inspect and copy each welder's card before he begins work on the project. The welder's identity must be verified by a positive means of identification (driver license, etc.).

The welder is required to requalify through examination if he cannot produce a suitably approved welding certificate, dated not more than 12 months previously, from a welding agency acceptable to the Engineer. Examinations are at the expense of the individuals and are given at independent testing agencies approved by the Laboratory. The Laboratory issues the welding card.

2-817K.2 Inspection

The contractor is required to employ a Certified Welding Inspector with a DOT welding certificate to perform fabrication-and-erection or verification inspection of the work for conformance with all applicable codes.
The Inspector must be equipped with a welder's mask to inspect a weld while it is being executed. In executing a weld, the molten metal forms a pool, and in observing this pool the Inspector can detect the presence of foreign matter such as slag, water, grease, paint, or other substances that impair the density or structure of the weld. A Certified Welding Inspector can observe the depth of penetration into the base metal.

Before any field welding is started, the structure must be adjusted to the correct grade and alignment, and provision must be made to prevent distortion during welding. All surfaces to be welded must be free of paint or primed as specified in the Standard Specifications Article 6.03.03-37, “Shop Painting,” and must be thoroughly cleaned. The edges of plates and sections to be welded will be tightly closed by service bolting, clamping, or other approved methods.

2-817K.3 Weld Quality

Proper current, voltage, and welding speed are necessary to make a good weld, and varying from normal in any of these factors affects the quality of the weld. Figure 2-8.9 shows various combinations of current, voltage and welding speed and the results that can be expected.

<table>
<thead>
<tr>
<th>Current</th>
<th>Voltage</th>
<th>Speed</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Smooth contour, uniform cross section with slightly convex face, straight edges, ripples spaced closely and uniformly</td>
</tr>
<tr>
<td>Low</td>
<td>Normal</td>
<td>Normal</td>
<td>Shallow, poorly defined crater, poor fusion</td>
</tr>
<tr>
<td>High</td>
<td>Normal</td>
<td>Normal</td>
<td>Shallow, poorly defined crater, poor fusion, no pronounced overlap</td>
</tr>
<tr>
<td>Normal</td>
<td>Low</td>
<td>Normal</td>
<td>Penetration small, fusion poor, porous weld.</td>
</tr>
<tr>
<td>Normal</td>
<td>High</td>
<td>Normal</td>
<td>Fusion poor, bead wide with large splatters</td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Low</td>
<td>Fusion fair, bead wide and overlapping, penetration good</td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>High</td>
<td>Fusion fair, insufficient deposit of weld material</td>
</tr>
</tbody>
</table>

2-817K.4 Defective Welds

After the weld has cooled and the slag has been removed, it must be cleaned with a wire brush. Common defects in the weld that the Inspector should detect are treated in the following manner:

- **Overlap.** If the edge of the weld metal is loose and protrudes over the base metal, poor fusion is indicated. The weld is cut out, and a new weld is made.

- **Undercutting.** There is an insufficient deposit of weld metal, or the base metal is necked down. The weld is cleaned and built up to standard by depositing weld metal.

- **Shallow Craters.** Poor penetration is indicated. Unless the weld is for sealing purposes only, the weld is cut out, and a new weld is made.
• **Pits, Porosity and Gas Pockets.** The weld is cut out, and a new weld is made.

• **Irregular Spacing of Ripples.** This is not harmful unless an exceptionally wide space occurs, causing a weak spot. If full strength is important, the length of the weld is increased.

The sizes and lengths of all fillet welds are checked against the plans. A weld slightly larger or longer than specified is acceptable, but the weld may not be smaller or shorter than specified. Any questions may be directed to the Materials Testing Laboratory.

The Inspector must ensure that the welder makes consistently satisfactory welds. If the welds appear to be of inferior quality, the Inspector notifies the Laboratory for review by an AWS Certified Welding Inspector employed by the Laboratory. For welders who perform satisfactory work, the Inspector must sign and date the welder's card.

### 2-817L Bolted Connections

Bolted connections are not to be used unless shown on the plans. The bolts must be of the size and type specified and must be installed in accordance with Article 6.03.03-19 of the Standard Specifications. It is important that sample bolts are taken to assure quality and approval and to ensure that the bolts are not foreign made. Bolt manufacturers can be identified by the markings on the head. Bolts should be checked for adequate torque. In some cases, load-indicating washers can be used and inspected according to the manufacturer.

### 2-817M Utility or Conduit Installation

Utility installations covered by contract items must be installed as shown on the plans.

Steel conduits usually are placed within the parapet area of a bridge deck. They must be continuous, extend to the proper height above the top surface of the parapet at roadway lighting unit locations, extend from the wingwalls the proper distance below the proposed roadway surface, and be satisfactorily capped. Adequate provision must be made for the temperature movements of the structure by installing expansion sleeves where directed and especially at the expansion joints of the structure. All conduits must be bent in an approved bending device to the radii limits prescribed in the electrical code.

### 2-817N Bridge Deck Procedures

Article 6.01.03-9, “Concrete for Bridge Decks,” of the Standard Specifications requires the contractor to submit plans for deck screeds, grades, and concrete placement methods and sequences. The plan is reviewed by the Inspector.

#### 2-817N.1 Grades, Formwork and Screed Rails

The contractor may elect to screed a concrete deck slab either longitudinally or transversely, depending on the way deemed best for the size of the deck.

As a rule, the camber noted on the plans refers to the amount of camber required in the beam to offset the deflection due to the dead load to be carried by the beam plus the weight of the beam itself. The amount of camber to remain in the completed slab varies with the length of the span. In addition, screed settings are affected if the bridge is on a vertical curve.
After grades are computed for the predetermined reference points, the deflections and the amount of camber desired are applied to the computed grades to give a working grade. The working grade is used to build the forms and to set the adjustable screed.

Immediately after the steel erection is completed, elevations are taken on the beams at the reference points. No significant dead load (including deck forms) may be placed on any beam until all elevations of the steel are taken. It is recommended on larger bridges that survey elevations be taken as soon as possible, at a fairly constant temperature. Although deflections and camber are significant to design, the deck thickness is the critical element in the field. The deck thickness, as computed from the horizontal and vertical geometry of the roadway, should not be less than the thickness specified on the plans.

The beam elevations are then subtracted from the working grade, and the difference between the two should be marked on the beams in inches (millimeters). It is advisable to do the marking with something durable, such as paint, as the reference markings are used for constructing the slab forms and setting the screed. After the screed is set and necessary adjustments are made, the slab is ready to be placed. Unless it is accidently displaced, no further adjustment of the screed is necessary, as allowances for deflection and camber are made in computing the working grade.

Additional deflection allowances may be noted for structural sidewalk, safety walk, parapet or median components, and the proper deflection allowances must be made in the grades of the formwork.

On bridges with a horizontal curvature, forms between reference points are checked radially to the base line, not necessarily perpendicular to the girders.

Particular attention must be given to the location and grade of the parapet rustication and chamfer strips. The plan details covering reductions in the depth of the rustication strips and parapet coping chamfer at sign-support bases or luminaire bases merit careful review and consideration.

The lack of sufficient concrete cover over deck reinforcement is a major cause of premature deck deterioration. Thus, it is necessary that bridge decks be constructed in strict conformity with plan dimensions, and sufficient care must be taken to ensure that the clear cover over the reinforcement is as shown on the plans and within allowable tolerances. The Inspector should verify compliance with plan dimensions by an adequate number of measurements of the reinforcing bar locations before placing concrete. The epoxy-coated bars used in the deck must be checked for nicks, cutoffs, etc., and touched up properly in the field. This should ensure continuous protection of the steel to prevent rust.

2-817N.2 Placing Concrete

Unless otherwise specified in the contract documents, Class F concrete must be used for bridge decks. The air content of the placed concrete must be maintained within the limits specified to provide for durability. Deck concrete generally is placed with concrete buckets, pumps, or conveyors. The manner of placement and finishing is very similar to that for concrete pavement. See Volume 2, Chapter Seven, "Concrete Pavements."

The Inspector must be completely familiar with the deck concrete placement sequence as shown on the plans. Generally, placement sequences are provided for multi-span continuous-beam bridges. If the contractor wishes to modify the sequence from that shown on the plans, a written request must be submitted to the Engineer for approval prior to placement of any concrete. The placement sequence is critical to the construction of the bridge and the loading of the superstructure, particularly if the beams are skewed from the substructure. It is also important to consider the structural stability of the bridge during the unbalanced loading that occurs during placement of the deck concrete.

If the deck placement will occur over a fairly long time in a continuous operation, set retarders should be used in a modified concrete-mix design to allow finishing of the surface.
If practicable, placing operations commence at the lowest exterior grade point of the structure. The concrete must be spread evenly in layers, thoroughly vibrated—especially around haunches, fillets, rustication strips and shear connector devices—brought to the final grade as established by the screed rails, and finished by an approved mechanical finisher.

The machine-struck surface will be smoothed with an approved lute, straightedged, and textured with a broom drag. The surface may not vary more than 1/8 in. (3 mm) if checked with a 10 ft. (3 m) straightedge. The broom finish for decks is omitted if a waterproof membrane is applied.

The grade at the curb line should be true to prevent water from standing along the curbs. Workers should not be allowed to walk in the concrete after it has been screeded; suitable bridges must be provided to gain access to the various parts of the work. Screed rails or supports for screed rails may not be placed in the roadway area, unless specifically outlined on the plan or as directed by the Engineer.

The Inspector must assure that the concrete pump hoses or pipes are primed throughout with a lubricating grout. Approximately 5 gallons for every 50 feet (1.25 liters for every meter) of hose is needed to properly coat the inside surface. When almost all the priming grout is pumped out of the receiving hopper, the first load of deck concrete may be discharged into the hopper. Then pumping can proceed slowly until the excess grout and water are removed, and the true mix is flowing.

At the outlet end of the hose, the pipe must be located high enough above the form so that the mix can be distributed easily, but not so high as to permit a free fall that leads to segregation. Concrete should not be allowed to drop more than 3 ft. (1 m) from the chute to the form or to the previously deposited concrete.

The Inspector should keep a number of basic requirements in mind:

- The concrete hauler must discharge directly into the receiving hopper.
- An adequate supply of clean water is necessary for flushing out the cylinder system, and provision must be made for disposal of the flushed water.
- Proper mix design is essential.
- If pumping downhill, the pump should have a certain resistance to work before the pipeline reaches the downward incline. This resistance can be provided by going uphill for a few feet (meters) before turning downward.
- Weather can affect pumping performance. In hot weather, pipe exposed to the sun can be covered with wet burlap.
- A contingency plan should be available to complete the concrete placement in case of equipment breakdown.
- The pumping operation can commence at the farthest point from the pump and work toward the pump.

2-817N.3 Finishing

All exposed external surfaces of structural concrete are finished as prescribed in the Specifications. Deck surfaces receive a broom finish unless a waterproof membrane is to be applied. The top surfaces of safety walks and parapets receive a float finish.

If specified in the contract documents, the deck grooving operation will start after the bridge deck slab has been cured and has attained the minimum compressive strength specified. The bridge deck must be grooved perpendicular to the centerline of the roadway.

The grooves may be cut using a mechanical saw device that leaves grooves 1/8 in. (3 mm) wide, 3/16 in. ± 1/16 in. (5mm ± 1.5 mm) deep, and variably spaced from 5/8 in. (16 mm) to 7/8 in. (22 mm) apart. The grooves may extend across the slab to within 1 ft. (300 mm) of the gutter lines. All residue resulting from grooving operations must be
removed from all surfaces in an environmentally accepted manner. All surfaces will be left in a washed, clean condition.

### 2-8170 Joints

#### Figure 2-8.10 Poured Joint Seal

A sketch of a poured joint seal is in Figure 2-8.10. The joint sealers for structures should be as noted on the plans or as required by the special provisions.

The Inspector must be thoroughly familiar with any joint sealer used. As with other coating systems, a data sheet comes in the box containing the cans of sealer. This data sheet provides the type of information that is needed by the Inspector. The data pertain to only the particular brand being used. Without the data, the Inspector has no way of making a proper inspection unless thoroughly familiar with the brand of sealer from experience. Also of equal importance in sealing joints with any material is the use of a proper bond breaker and backup material. The wrong choice of bond breaker, backup material, or both can mean failure of the joint even though the sealant and workmanship are the highest quality.

The bond breaker must exhibit the following characteristics:

- It must prevent bond between itself and the sealant.
- It must have extremely low tear strength.

Backup materials for joint sealants must do the following:

- control the depth of sealant in the joint
- serve as a supporting medium

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**2-8170.1 Sealants**

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- It must prevent bond between itself and the sealant.
- It must have extremely low tear strength.

Backup materials for joint sealants must do the following:

- control the depth of sealant in the joint
- serve as a supporting medium
• be nonabsorbent or relatively nonabsorbent

• have the ability to be compressed by changing volume rather than shape

2-8170.2 Expansion Joint Material

Expansion joint material delivered to the bridge site should be stored under cover on platforms above the surface of the ground. It must be protected at all times from damage, and when placed it must be free from dirt, oil, grease, or other foreign substances. All welding will conform to AWS unless otherwise specified in the contract documents. No expansion joint material may be installed prior to approval by the Engineer of all material and installation methods.

The preformed material will consist of the longest length possible with a minimum of joints. Lengths less than 4 ft. (1.2m) must be one piece. The material is cut to a clean, true edge with a sharp tool. Care will be taken to insure straight lines at the joint.

When installing the seal, the contractor must not use any type of equipment that will damage the seal. If the seal is damaged during installation, the contractor must remove and replace the seal at the contractor's expense.

2-8170.3 Systems and Devices

The transverse compression seals will be one piece for the entire length of the roadway joint. Shop or field splices in the seal are prohibited. Compression seals for longitudinal bridge joints will consist of the longest piece practicable.

Lubricant adhesives must be applied in conformance with the manufacturer's recommendations. If the seal is stretched more than five percent, the contractor will reinstall the seal as directed by the Engineer.

• Elastomeric Concrete Strip or Box Seal Expansion Joint System. This system consists of all necessary reinforcing and hold-down bars, and the elastomeric concrete that holds the strip or box seal. An adhesive lubricant will be used to install the strip seal in the steel intrusions. See Figure 2-8.11. Prefabricated Strip Seal Expansion Joint Device. This device consists of a prefabricated elastomeric strip seal gland inserted in steel extrusions. The steel extrusions are welded to steel plates that are fastened to existing finger plates with welded studs. It is set in place with elastomeric concrete. See Figure 2-8.12.
2-817P  Protective Surface Treatment Compounds

If coating materials are used for surface treatments to curb, sidewalk, medians, parapets or any other part of a structure subjected to roadway salts, the Inspector must become familiar with the characteristics of the material well in advance of its application. As contracts normally allow a choice of equivalent brands of materials, the Inspector must be aware of the contractor's choice and retain a data sheet from the vendor for the material.
The data sheet provides information on the following:

- description of epoxy
- advantages
- properties
- effect of material temperature
- effect of curing temperature
- coverage
- how to prepare and use
- limitations
- safety

Because of the critical nature of the material and the factors limiting its use, as well as the factors that may be detrimental to the resultant quality, the Inspector must make every effort to ensure proper preparation and application.

### 2-818 Bridge Rehabilitation

The storage and load restriction instructions outlined in Sections 2-801A and 2-801B should be thoroughly reviewed and applied to all bridge rehabilitation projects. Special attention should be focused on staged construction where loads from temporary precast barrier curb will affect the structure for potentially long periods of time.

### 2-818A General

Bridge rehabilitation requires a design-construction approach by the Department and close attention to the details of rehabilitation construction. In addition, as new materials are introduced into the construction industry, the focus on proper preparation, handling, and application of materials becomes more and more important to the success of rehabilitation efforts.

Bridge rehabilitation may involve the repair of or the removal and replacement of bridge decks, the repair of substructure components, the cleaning or replacement of bearings, the strengthening of structural steel members, the repair and protection of the bridge utility conduits and supports, the paving or overlaying of bridge decks, and the proper disposal of all construction debris.

Once the work is underway, the extent or limits of deterioration may be greater than anticipated. As the construction progresses, the Inspector may encounter site conditions very different from those shown in the contract documents. The changed conditions require reevaluation of the design, project goals and objectives, and available budget.

### 2-818B Utilities

During any rehabilitation construction project, the Inspector must ensure that the contractor is aware of existing utility services (including water, telephone, gas, electrical, and cable) that are located on the bridge or in the bridge parapets.
As a first order of work, preliminary measurements, sketches and photographs of the locations of all existing utilities are documented jointly by the contractor, the Inspector, and the utility company representative. The Inspector inspects the visible utility components to ensure they are in good condition and meet current requirements. If there is any question concerning the condition or serviceability of the existing utilities, the Inspector should contact the Project Engineer.

To avoid unnecessary delays and costs, it is important that utility companies be advised well in advance of any construction that may affect their facilities. This contact occurs during design and pre-construction phases of the work. Inspectors must contact each affected utility company or their designated representative at the beginning of the project and advise them of the pending work.

All existing utilities must be protected against damage during construction, and in nearly all cases uninterrupted service must be maintained.

### 2-818C Bridge Deck Repair

The repair of deteriorated bridge decks requires:

- removing the existing bituminous concrete wearing surface and membrane (if present)
- locating and marking the deteriorated areas
- removing the deteriorated concrete
- patching the areas
- installing a waterproofing membrane to the deck surface
- overlaying or patching the deck with a new bituminous concrete wearing surface

![Figure 2-8.13 Bridge Deck Repair](image-url)
installing joints and joint seals

Figure 2-8.13 shows a typical bridge deck repair.

2-818C.1 Removal of Bituminous Wearing Surface

Before removal operations begin, the contractor will submit a list of the equipment to be used and the removal methods for approval of the Engineer.

The contractor removes the existing bituminous wearing surface, using approved means, to completely expose the underlying concrete deck. Damage caused by the contractor is repaired at the sole expense of the contractor. The usual methods of removal are with a backhoe or front-end loader or by milling. Vibratory scarifiers may be used but must be approved before use. Vibratory scarifiers are not allowed on:

- bridge deck spans that are supported with pin and hanger assemblies
- bridges with load restrictions (posted)
- bridges that have been classified to have a specific structural problem awaiting repair

If construction is performed during off-peak hours and traffic uses the roadway at other times, the Inspector should ensure that the contractor installs temporary pavement markings prior to allowing normal traffic to resume. The roadway should be swept clean of construction debris, and all deck areas that may ravel under traffic are temporarily repaired. Smooth transitions should be provided between the abutting approach pavement and the deck. It is preferable to have the transition ramps milled during pavement removal.

If milling of the transition areas is not possible, the Inspector should have the contractor install bituminous concrete ramping from the areas where bituminous concrete was removed to the existing pavement. The preferred taper for ramps is 1:50 or flatter. No longitudinal joint (drop-off) is allowed between lanes.

For overlays up to 2 in. (50 mm) thick, longitudinal-joint ramping may be allowed by the Inspector. For thicker overlays, ramping is not allowed, and the pavement removal will most likely need to be restricted to milling from curb to curb to avoid drop-offs.

2-818C.2 Location and Marking of Deteriorated Areas

The general areas of deterioration are indicated on the plans and are approximate. The actual limits of work are determined in the field.

Before any existing concrete is removed from the structural slab, the contractor should provide the Inspector unobstructed access to the bridge deck. During this time, the Inspector performs an inspection of the structural slab and designates areas where concrete removal is required.

The method currently used to outline the actual deteriorated areas is called “chaining” or “rattling.” A piece of heavy machine chain, 8 or 10 ft. (2.5 to 3 m) long, is held in one hand and snaked back and forth over the surface of the pavement in an S-curve pattern. The sound made by the chain on the concrete surface changes if it passes over a deteriorated or delaminated area. Practice enables the Inspector to accurately define the limits of removal. The limits of the deteriorated areas are outlined with paint as the chaining procedure progresses. Smaller areas close together may be combined into one larger area. For the final determination of the limits of removal, all limit lines must be straight with 90-degree corners.
If, during the chaining process, the Inspector finds an excessive amount of deteriorating concrete, the Inspector should alert the Project Engineer. The Project Engineer, in consultation with Design, will make a cost analysis of patching the deck (versus installing a new deck) before any deck repairs are made.

2-818C.3 Removal of Deteriorated Concrete

Deteriorated concrete may be removed by pneumatic hammer or hydrodemolition methods. The contract documents will specify the removal methods. The contractor will not perform any repair work without prior approval of the Inspector of location, limits, and type of repair.

If the removal of deteriorated concrete extends to a depth of more than one-half of the total bridge deck thickness (mid-depth between the mats of reinforcing steel), then all remaining concrete within the outline of the patch must be removed, and the deck will be repaired for its full thickness.

2-818C.3a Protective Shields

The contractor must protect the public against injury and damage from demolition operations when removing portions of existing bridge-deck slabs. If deck removal is performed over or near roadways, railroads, or waterways, the contractor must furnish and erect temporary protective shields to prevent any material or debris from entering the areas.

The protective shields must be approved by the Inspector. Flooring and siding can have no cracks or openings through which material particles may pass. The shields must be able to support 150 lbs/ft.² (730 kg/m²) over their entire area, in addition to their own weight.

A minimum underclearance of 14.5 ft. (4.4 m) must be maintained over the roadway pavement and shoulders. No portion of the shield, including connection devices, may encroach on this underclearance. If less than 16.0 ft. (4.9 m) of underclearance is provided, the contractor must furnish and erect signs indicating the exact minimum underclearance. In addition, the Chief Inspector must inform the supervisor of Motor Transport Services Unit of the reduction in vertical clearance. See Section 1-108 “Change in Travelway Clearances and Bridge Capacity Ratings”. The signs and their locations must be approved by the Inspector. They must be removed when the original underclearance is restored and will become the property of the contractor.

After the Engineer determines that the protective shields have served their purpose, they will be removed and become the property of the contractor.

2-818C.3b Removal by Pneumatic Hammer

The outline of each removal area must be saw cut to a depth of ½ in. (13 mm) with an approved power saw capable of making straight cuts. If sawing is impossible or impractical, the areas may be outlined by chisel or other approved means. If reinforcing steel is encountered within the saw cut, the depth of cut will be adjusted back to ½ in. (13 mm) after the shallow steel is passed.

Deteriorated concrete is removed by pneumatic hammers approved by the Engineer. The weights of the hammers may not exceed 30 lbs. (14 kg). A 15 lb. (7 kg) (maximum) chipping hammer is used for removing concrete below the top mat of reinforcing steel. Care must be taken not to damage the reinforcing steel in any way. Pneumatic hammers may not be placed in direct contact with reinforcing steel. If overbreakage of the concrete saw-cut edge results in a featheredge, the featheredge is resawed to create the required vertical edge.
The minimum depth of concrete removal is 1 in. (25 mm). The required depth of removal is determined by inspection of the fractured aggregate over the entire removal area. If the large aggregate fractures—instead of “popping out” (losing its bond with the cement matrix)—the concrete is sound. Care must be taken to remove fillets from the corners of intersecting removal limit lines. All intersecting removal lines should be squared.

If reinforcing steel is surrounded by deteriorated concrete, has at least one-half of its surface area exposed, or has less than 1 in. (25 mm) of cover, the depth of concrete removal must not be less than ¾ in. (19 mm) below the bottom of the steel.

If the existing reinforcement bar is damaged or corroded, it must be cut out and replaced with new reinforcement bar. New reinforcement bar is attached beneath existing reinforcement bar with a minimum lap conforming to the plans or as directed by the Inspector. Reinforcing steel that is to be left in place is cleaned of all concrete. Small concrete fragments may have to be removed with hand tools.

The concrete surface and reinforcing steel that will receive patching material must be blast-cleaned of loose particles, foreign matter, and any rust, oil, solvent, grease, dust, dirt, or bitumen just prior to patching.

**2-818C.3c Removal by Hydrodemolition**

Hydrodemolition usually is employed if the total surface area of the bridge deck is to be replaced. Hydrodemolition removal can be used for selective patches instead of removal by pneumatic hammer.

At least two weeks prior to the planned initiation of hydrodemolition operations, the contractor must submit to the Inspector for approval a comprehensive plan for the containment, filtration and disposal of hydrodemolition runoff water and concrete debris. The plan must ensure that all concrete debris will be removed from hydrodemolition runoff water prior to its release to the environment.

All hydrodemolition equipment should be capable of selectively removing spalled, delaminated, or otherwise deteriorated concrete and cleaning the existing reinforcing steel of all rust and corrosion products by use of high-velocity water jets acting under continuous automatic control.

The depth of concrete removal must be at least ¾ in. (19 mm) below the top reinforcing mat but may be such as to include all spalled, delaminated, or otherwise deteriorated concrete. The Inspector may require that a test area be used by the contractor to establish the depth of concrete removal and the desired hydrodemolition machine settings. The Inspector will be the sole determiner of what constitutes deteriorated concrete, using sounding methods or other evaluation measures at his discretion.

All loose concrete debris must be removed within one hour following the initiation of hydrodemolition in a patch area. Debris removal is followed by flushing the existing concrete bonding surface with water to completely remove all traces of concrete debris and cement residue that may prevent bonding. Rebonding of new concrete to the surface of the remaining sound concrete will be enhanced by the use of an approved bonding compound. If it is not convenient to clean and flush the patch area within one hour, all steel reinforcement and concrete bonding surfaces will be cleaned subsequently by high-pressure water blasting at a nozzle pressure not less than 7000 psi (48,000 kPa) with a volume sufficient to completely remove all rebonded debris and laitance.

All deteriorated concrete is removed by hydrodemolition methods, except that pneumatic hammers may be used, if approved by the Inspector, in the following cases:

- small areas within larger areas designated for hydrodemolition that are not accessible to hydrodemolition equipment
- the removal of any remaining thin concrete ridges or “shadows” directly beneath reinforcing bars
if necessary to achieve required clearance around lap splices in the repair of deteriorated or damaged reinforcing steel.

The weight of the pneumatic hammers may not exceed 30 lbs. (14 kg) for concrete removal above the top reinforcing steel and 15 lbs. (7 kg) for concrete removal below the top reinforcing steel. If pneumatic hammers are used, the minimum depth of removal will be not more than 1 in. (25 mm) shallower than any adjacent hydrodemolished deck excavation.

If the existing reinforcing steel is damaged or corroded, it must be cut out and replaced with new reinforcing steel of the same size. Sound reinforcing steel damaged during concrete removal must be repaired or replaced by the contractor at his expense, as directed by the Inspector. New steel will be attached beneath or beside existing steel with a minimum splice length as indicated on the plans or as directed by the Engineer. The concrete will be removed to a minimum depth of ¾ in. (19 mm) below the new steel.

2-818C.4 Patching

The patch product and mix are indicated in the special provisions. Products that may be specified are:

- Class F concrete
- latex modified concrete
- gypsum Portland cement

Mixing and placing concrete should be prohibited unless the ambient temperature is greater than 35°F (2°C) and rising. All mixing must be accomplished by means of a standard drum-type portable mixer. A continuous-type mobile mixer may be used if permitted by the Engineer. The total mix must be limited to the quantity that can be mixed and placed in 15 minutes.

The Inspector should not allow the contractor to patch any more than can set up by the time normal traffic patterns must be restored. The contractor may not remove more deck material than can be replaced by the time normal traffic patterns must be restored. Use of steel deck plates to cover unrepaired areas prior to making the patch is not allowed by the Department.

2-818C.4a Preparations

The concrete surface and reinforcing steel to receive patching material is blast-cleanced followed by air-blasting to remove all loose particles and dust. All blasting operations are performed using techniques approved by the Engineer, taking care to protect all pedestrians, traffic, and adjacent property. The concrete surface to be patched is dampened, and all free water must be removed.

If less than one-half of the surface area of the reinforcement is exposed after removal of deteriorated concrete, the reinforcement is coated with an approved epoxy bonding compound. The epoxy bonding compound is mixed and applied in strict accordance with the manufacturer's instructions. The steel surface is sandblasted and must be absolutely dry. Promptly after mixing, a single coat of epoxy material is applied to the partially exposed reinforcement, with minimum coverage of 20 mils thickness.

The Inspector will observe the underside of the bridge deck for pop-outs caused by the removal of deteriorated concrete. The surface area of pop-outs must be coated with epoxy resin if ordered by the Inspector. The concrete surface and exposed reinforcing steel, if any, that is to receive the coating material must be cleaned of all loose or powder-like rust, oil, dust, dirt, loose particles, and other bond-inhibiting matter just prior to coating for delamination.
2-818C.4b Spreading and Finishing

The concrete mix is spread evenly and compacted to a level slightly above the pavement surface. Vibration must be used to thoroughly consolidate the concrete and fill the entire patch area. If practicable, internal vibration is used if concrete is removed below the reinforcing steel. Hand tamping can be used to consolidate concrete in smaller patches, including pop-outs.

It is preferred that vibrating screeds be used for strike-off and consolidation. After the mix is placed and compacted, the vibrating screed is drawn over the surface. It must move at a uniform speed without stopping to finish the surface smooth and even with the adjacent concrete. The surface is float finished. Mixes requiring fast-setting gypsum portland cement set in a short time. All of the finishing operations must take place before initial set.

2-818C.4c Testing

The Inspector will make test cylinders. The dimensions, type of cylinder mold and number of cylinders is standard but may be increased by the Engineer under some circumstances.

2-818C.4d Unacceptable Work

The finished surface profile should not vary more than 1/8 inch in 10 feet (3 mm in 3 m) in any direction. High areas must be ground. Sags require removal of the concrete to a depth of ¾ in. (19 mm) and repatching. Curing of the patched areas must be in accordance with the Specifications.

Cured patches that have a hollow sound when chain-dragged or tapped (indicating delamination) will be replaced by the contractor at the contractor's expense.

2-818C.4e Opening To Traffic

Traffic is not allowed on any areas where the contractor has placed and finished concrete until the material has reached a minimum of 1800 psi (12,500 kPa). It is anticipated that this will occur in 2 to 3 days for portland cement and 1½ to 3 hours for gypsum cement mixes.

2-818C.5 Waterproofing Membrane

Installation of waterproofing membrane is covered under Article 7.07 of the Standard Specifications. In addition, the manufacturer's recommendations must be followed.

There are various types of membrane waterproofing. Some of the most frequently used products are:

- woven glass fabric
- Royston Bridge Membrane No. 10A (membrane waterproofing)
- Protecto Wrap M-400A (membrane waterproofing)
- heavy-duty bituthene (membrane waterproofing)
Design generally will specify woven glass fabric if the bridge deck is on a grade or adjacent to an intersection where vehicles will be braking or making turning movements. If a contractor requests a material substitution for this item, the Inspector must first check with the bridge designer prior to granting approval. The primers for all products must be diluted with acceptable solvents.

2-818C.6 Placement of Bituminous Concrete Wearing Surface

Application of the paved wearing surface is subject to the requirements for bituminous concrete paving, found in Volume 2, Chapter 6, “Bituminous Pavements”. A fine mix (SF) is used, and care must be taken that the membrane is not punctured or damaged in any way during placement of the wearing surface.

2-818C.7 Bridge Deck Joints

There are numerous types of bridge deck joints. The repair procedures for the joints on all bridge projects are detailed in the contract documents. In many cases, the design may require the replacement of the existing type of joint with a superior type of joint. A contractor may request a substitution for the type of joint specified. The bridge designer must approve all substitutions.

2-818D Structural Steel Inspection

Some of the more common defects and repairs involve the following:

- corrosion
- cracking
- fire damage
- collision damage

Structural steel repairs vary according to the location of deterioration, type of structure, element being repaired, and extent of deterioration. Repairs may include reinforcement of existing members, temporary support of existing members, limitation of load, replacement of members, and stress relief in members. The requirements for each type of repair are detailed in the contract documents.

As with other structural members, an in-depth inspection must first be conducted to review the repairs shown on the plans for strengthening structural steel beams and girders. The following must be evaluated:

- extent and location of damage
- extent and location of repairs
- presence of cracking
- limits of collision or fire damage
- fatigue stress damage
- remaining structural capacity
Steel-strengthening construction must include environmental considerations, as well.

The existence of fracture-critical members requires the Inspector to closely scrutinize the condition of each member and to fully understand and comply with the sequence of construction. In addition to specific defects, the Inspector must consider such information as material, age, capacity, and loading. Each of these affects the economics involved in deciding whether to repair or replace a member.

Inspectors should be aware that the proposed repairs are based on the findings of a condition survey of the structure that was conducted prior to the start of design. The survey may have been conducted several years ago. The survey may not accurately detail all parts of the structure that need to be repaired. The Inspector must be alert for differing conditions that may require changing the repair methods, materials, or limits.

### 2-818E Jacking

Jacking of structural steel beams and concrete substructures is necessary if temporary support of an element is needed to make repairs. Jacking usually serves to remove the loads from the permanent members. Typically, temporary jacking members are stressed higher than permanent bridge structural members. This is done because the loads are for a short duration. Thus, it is crucial that the members be sized, fabricated, and erected exactly according to the plans.

#### 2-818E.1 Jacks and Beams

Jacks with a higher capacity than those listed in the plans may be allowed, but the contractor is responsible for monitoring the jack load to ensure the safety of the structure. The jack system must be equipped with a gauge to directly read the jack force in pounds or kips (newtons or kilonewtons) or shall be accompanied by a chart with which the dial reading can be converted into pounds (newtons). Direct reading gauges are preferred.

The contractor may use alternative jacking beams to those specified on the plans. The alternatives must be approved by the Engineer. The alternative beams must comply with the following restrictions:

- They must be in new condition.
- The section modulus and web area must be equal to or greater than those of the jacking beams shown on the plans.
- If the connection detail or the stiffener-plate details are changed, the contractor will submit detailed calculations to the Engineer for approval. These calculations will be stamped by an engineer licensed in Connecticut.

Jacking beams must be set level, unless indicated otherwise on the plans. In no instance will the contractor be allowed to chip away the concrete end diaphragms to achieve a level jacking beam.

Areas under the jacks should be thoroughly cleaned to provide a flat, clean jacking surface. Jacking surfaces that are not level or have slightly deteriorated concrete areas will be repaired to a flat, level surface with cast-in-place concrete, as specified in the contract. Test cylinders are required for the concrete mix used for bearing pedestal repairs. The existing beams will not be lowered in place until the concrete achieves 3000 psi (21 MPa) minimum strength.

#### 2-818E.2 Welding and Repairs

All field welding is done by the shielded metal arc process. All requirements of the specifications must be adhered to, except that the requirements for radiographic and ultrasonic inspection will be waived if a visual inspection by the Inspector indicates that the welds are satisfactory. The exception applies only to structural steel that is erected for a temporary installation.
If necessary, cast-in-place concrete repairs are used to restore the jack locations to full capacity prior to the jacking. If deteriorated concrete extends on both sides of the beam that requires jacking, one side will be repaired completely before the repair to the other side is started. Both sides must be repaired before the beam can be jacked. The contractor will wait a minimum of 72 hours and until the repaired concrete obtains a minimum compressive strength of 3000 psi (21 MPa) before the jacking operation begins.

2-818E.3 Operations

The Inspector must check all pertinent dimensions and requirements, as set forth on the plans, to ensure that all pertinent stipulations are met before commencement of the actual jacking. The Inspector must be present during all jacking operations. Jacking assemblies, frames and grillages must be inspected daily while in service. All members, connections, foundations, footings, bracing, and jacks must be inspected for alignment, orientation, and trueness. Frequently, elevations and survey measurements are required to monitor the structure for movement.

An existing bearing may not be raised more than 1/8 in. (3 mm) higher than its as-built elevation, unless otherwise indicated on the plans. The maximum jacking forces shown on the plans will not be exceeded. The jack hydraulics may not be used to support the load after jacking. However, the contractor has the option of using a jack with a locking nut or cribbing blocks instead of the support scheme indicated on the plans.

It is the contractor's sole responsibility to use the correct scheme and jack capacity corresponding to the particular bearing being repaired. Damage of the existing structure resulting from the contractor's misuse of the jacking scheme must be repaired by the contractor to the complete satisfaction of the Engineer, at the contractor's expense.

Any existing bearing assemblies that will be reused, areas of paint that are damaged, and any new steel that, according to the plans, remains in place must be sandblasted in accordance with SSPC-SP10 and painted.

2-818F Repair of Cover Plate Welds

Cover plates are added to the bottom flanges of rolled beams to strengthen the members. Generally, cover plates are welded to the flange, but they may be riveted or bolted. The critical inspection area on a welded cover-plated beam is located at the end of the cover plate where the weld is transverse to the length of the beam. If the weld is not transverse to the bottom flange, it may end near the end of the cover plate. The Inspector must investigate these areas for cracking.

The contractor cleans the welds at the ends of beam cover plates, as indicated on the plans. Surfaces to be cleaned must be blast cleaned in strict conformance with provisions of SSPC-SP10 to “Near White”.

After the welds are cleaned, the designer and Inspector conduct an inspection. They decide which locations will be peened and which locations will be repaired. Repairs are completed in accordance with the plans.

Cover plate welds are peened to the limits shown on the plans. Peening is performed using a pneumatic hammer and is continued until the weld toe becomes smooth. The depth of indentation due to peening must be approximately 1/32 to 1/16 in. (1 to 3 mm). The Inspector will direct the contractor to peen a test area to demonstrate his methods and results. Areas repaired by peening are painted in accordance with specifications contained in the contract documents.

If a crack is observed, a bolted repair is made as shown in the contract documents.

If any defect is observed by the Inspector, but is not specified for repairs on the plans, the Engineer should be notified immediately.
2-818G Inspection of Structural Steel Cross Section

The failures at expansion joints on bridge decks are caused by deterioration and section loss to bridge girders from the chlorides used for snow and ice control. Some of the affected areas are at the bearings, ends of the girders, and behind the end diaphragms.

If the Inspector suspects that there is section loss, the Inspector must contact the Project Engineer, who requests Bridge Safety to provide a D-meter. The D-meter determines the thickness of the structural members. After determining the thickness of the members, the information is sent to Design to determine if a repair is necessary. Design provides corrective repair plans and procedures to the Assistant District Engineer. The Inspector ensures that both the Engineer's procedures and Article 6.03.03 of the Standard Specifications are followed.

2-818H Heat Straightening Structural Members

If a structural member is injured through neglect by the contractor, the Inspector should request a repair procedure from the contractor. The procedure is sent to Design for review and approval. Design provides the approved methods to the Assistant District Engineer.

Heat straightening is a unique method that is used with jacking, blocking, and supplemental supports to correct member misalignment caused by impact. Not all damaged members can be heat straightened. Some members cannot be straightened due to the extent of damage. For others, heat straightening may cause additional damage to the member, reducing member capacity. A member can be heat straightened only once at any one location on the member.

Generally, a member is considered adequately straightened if it is returned to line, grade, and shape within ½ in. (13 mm). Temporary support must be provided for beams while they are being heat straightened.

The Inspector will be satisfied that the repair work is implemented correctly by using the submitted and approved procedures and Article 6.03.03 of the Standard Specifications. The Inspector should be familiar with the special provisions, as heat straightening is a specialty repair, with explicit procedures and details.

2-818I Removal of Existing Bridge Decks

Removing existing bridge decks consists of removing and disposing of all materials above the top of the stringers for the width and length of the bridge superstructure. The work is performed in accordance with specifications or as ordered by the Engineer.

2-818I.1 Protective Shields

Prior to any work on the structure, the Inspector should become familiar with the special provisions and plans to determine if protective shields are necessary. If work is to be performed above traveled ways, railroads and water, the contractor is required to provide protective shields to prevent any dust, debris, concrete, form work, paint, or tools from falling onto the area below the structure or onto adjacent traffic lanes.

If protective shields are necessary, the contractor is required to submit the details of the protective shields, consisting of design calculations and working drawings, signed and sealed by an engineer who is licensed in Connecticut. The material is given to the Project engineer, who will review and approved the details only as to the methods of erection and as to whether the proposed installations provide the levels of protection required at the various locations.
If the existing structural steel will be used in the finished structure and the contractor elects to support the protective shields from the steel, all connections must be made by means of clamps or other approved devices. Drilling holes in the existing steel work or welding to the steel work for this purpose is prohibited.

### 2-818I.2 Operations

Before removal operations begin, the outlines of the top flanges or cover plates of all stringers and floor beams are drawn on the bridge deck, and 1 in. (25 mm) diameter pilot holes are made outside the lines to confirm the location of the steel.

Prior to removing the existing slabs, the contractor must take elevations at locations along the bottom of the bottom flange or top of the top flange by removing small sections of slabs over the stringers. Pilot holes are used at mid-span, quarter points of all stringers, and other points if necessary. Maximum spacing of the elevations is 25 ft. (7.5 m). After removing the deck, the contractor must take a new set of elevations at the same points and determine the superstructure rebound. The rebound values are used, instead of dead-load deflections, to establish grade controls and the finished top of the concrete deck that is true to planned line and grade. For bridge decks constructed with a longitudinal construction joint between stringers, diaphragms between the stringers may not be disconnected unless specified in the contract documents.

On continuous bridges, the contractor's proposed sequence of deck removal should address uplift at the ends of continuous spans.

If damage results from the contractor's operations, the removal operation must be modified, and the damaged items must be repaired or replaced by the contractor in a manner acceptable to the Engineer at the contractor's expense.

### 2-818J Substructure Repairs

Generally, the Inspector will encounter only concrete repairs to bridge substructures. In the rare case that a structure is constructed with steel substructure elements, inspection of repairs is performed in the same manner as inspection of structural steel strengthening.

Several materials are currently available for concrete substructure repairs. These include:

- cement-based mortar or concrete
- nonshrink quick-setting mortar
- epoxy mortar
- resin-based polymer concrete
- cement-based polymer concrete
- pneumatically applied mortar

Factors to be considered in selecting concrete repair materials include:

- size
- location
- general function of the member
Material selection is influenced by:

- compatibility of the material with the existing concrete
- environmental considerations, including aesthetics
- cost effectiveness
- expected service life
- availability of the material
- familiarity of contractors with the material

### 2-818K Deteriorated Concrete Removal

It is important that the Inspector accurately and completely define the limits and extent of concrete to be removed. The limits and extent of deteriorated concrete removal are very important for two reasons. The first is integrity of the repaired element. The repaired element must work as a monolithic mass, and thus, compatibility of materials is important. The second is the safety of the structure to support dead and live load. If a portion of concrete is removed from an element, it no longer has the same capacity to support load. Even if the concrete is restored, it does not carry the load carried by the corresponding portion of removed concrete prior to deterioration. In any case, the Inspector must work with the designer to maintain structural safety of the concrete substructure during repairs.

If the Inspector determines that there is excessive deterioration of a portion of a substructure element, the Project Engineer should be alerted. The Project Engineer contacts Design to request a structural analysis. It may be detrimental to the safety and integrity of the bridge to remove all of the deteriorated concrete at one time.

The Inspector must limit the extent of removal of concrete from the overhang on the piers, on bridge seats, and especially around bearing pads. If there is extensive removal of concrete in these areas, the Project Engineer must be contacted. The Project Engineer will contact Design to request a structural analysis.

It may be necessary to design temporary supports to carry the loads while repairs proceed.

### 2-818L Repair Materials

Portland cement concrete should be used for patching if possible. If the area to be patched is horizontal, larger than approximately 4 sq. ft. (0.37 m²) and is at least 1 in. (25 mm) deep, Class S concrete should be used. Class S superplasticized concrete currently is the preferred product for surface repairs that are less than 1 in. (25 mm) but limited to Class S aggregate size [3/8 in. (10 mm)] deep. The Inspector should become familiar with the specifications for Class S concrete before the contractor performs any repairs.

### 2-818M General Repair Requirements

If an existing deteriorated concrete element does not have sufficient concrete cover over the reinforcing steel, the area is repaired and built out to gain additional cover and protection of the reinforcing steel. The build-out may also make placement of the concrete easier.
All concrete patches must be mechanically anchored to the existing concrete either by encasement of existing reinforcement or by using drilled anchoring devices attached to the existing concrete.

2-818N Shotcrete

Shotcrete may be recommended for application, if many various-size repairs are needed and the repairs are on vertical or overhead surfaces. Shotcrete, also known as pneumatically applied mortar, is a specialty product that must be placed and cured correctly. Pneumatically applied mortar must have a minimum 28-day compressive strength of 3500 to 5000 psi (25 to 35 MPa).

2-818N.1 Equipment

All shotcrete equipment must be capable of thoroughly mixing all material used and must be calibrated. The mixer must be self-cleaning and capable of discharging all mixed material without any carry-over from one batch to the next. Mixing equipment must be cleaned at least once a day.

The air compressor should have a capacity sufficient to maintain a supply of clean, dry air adequate to provide the required nozzle velocity for all parts of the work, while simultaneously operating a blow pipe for cleaning away rebound. The air and water pressure must be constant and not pulsate.

2-818N.2 Preparatory Work

The contractor will contain all blast waste and loose concrete and promptly remove it to an approved disposal site. Blast waste and loose concrete must be kept out of waterways.

The deteriorated areas of concrete must be removed to sound concrete with a 30 lb. (14-kg) (maximum) chipping hammer to a minimum depth of 1 in. (25 mm) behind the reinforcement steel.

After the Engineer has determined that the cavity surface is sound, it must be sandblasted. Just prior to mortar application, all surfaces will be thoroughly cleaned, followed by wetting and damp drying.

If sound concrete is encountered before the reinforcement steel is exposed then the sound concrete is removed to a depth of 1 in. (25 mm) behind the existing reinforcement steel. If sound concrete is found within 3 ½ in. (90 mm) of the proposed finished surface, the removal operation stops, and additional No. 4 (No. 13M) reinforcing bars are doweled at 12 in. (300 mm) center to center horizontally and vertically, 2 in. (50 mm) clear of the proposed finished surface. Doweling details are as directed by the Engineer.

All exposed existing reinforcement steel that is incorporated in the new work is sandblasted to a near-white finish to remove all rust, dirt, scale, and loose concrete. All deteriorated reinforcing bars that have lost 20 percent or more of their original dimension must be cut out, and new bars are welded in their place. Dual bars of equivalent or greater section may be used. New reinforcement steel is welded to existing reinforcement steel as specified in the contract documents. The Engineer decides whether reinforcement steel is to be reused or replaced.

All areas to be repaired are reinforced with wire mesh, in addition to the reinforcement steel.

For anchoring reinforcement to masonry surfaces, expansion bolts not less than 3/8 in. (10 mm) in diameter are set into drilled holes, or plain round No. 4 (No. 13M) bars are set in approved dry-packed mortar, tightly driven into drilled holes. Drilled holes should not be less than 3 in. (75 mm) deep. All bolts or bars must be set in solid masonry (not in mortar, joints, or cracks) and must have heads or hooks on their outer ends. If approved by the Engineer, wire-mesh reinforcement can be wired to existing reinforcement without the use of expansion bolts.
2-818N.3 Application

The cement and sand must be uniformly dry-mixed in a batch-mixing machine. Material that has not been applied within one hour after being mixed must be discarded. After the materials are dry-mixed and before being charged into the placing machine, the mixture must be passed through a 3/8 in. (10 mm) screen.

Each layer is built up by several passes of the nozzle over the working area. The mixture must emerge from the nozzle in a steady, uninterrupted flow. If the flow becomes intermittent, it must be directed away from the work until it becomes constant. The nozzle must be held perpendicular to the application surface, at the distance from the surface to get the best results for the conditions. When shooting through reinforcement, the nozzle must be held at a slight angle from perpendicular to permit better encasement.

The application of the mixture to vertical surfaces begins at the bottom. The first layer should, at least, completely embed the reinforcement.

Rebound may not be worked back into the construction, and it must not be salvaged and included in later batches. Rebound and overspray may not be allowed to fall into waterways and will become the property of the contractor, who can dispose of this material at the contractor's own expense in an approved disposal site.

If a layer of pneumatically applied mortar is to be covered by a succeeding layer, it will first be allowed to take its initial set. Then all laitance, loose material, and rebound must be removed by brooming. Laitance that has been allowed to take final set is removed by sandblasting, and the surface is cleaned with an air-water jet. In addition, the surface will be sounded by the Inspector with a hammer for hollow-sounding areas resulting from rebound pockets or lack of bond.

The area of repair on existing structures must be finished to match the existing structure.

2-818O Copolymer Cementitious Mortar

If other methods and materials for patching are not satisfactory, copolymer cementitious mortar should be used. The copolymer should be used for shallow patches; the maximum thickness per layer may not exceed the manufacturer's recommendation. This product has proved somewhat difficult for some contractors, but there are sufficiently satisfactory installations to continue its use.

The minimum mortar thickness should be 1/8 in. (3 mm), and the maximum thickness should be 1 in. (25 mm). The mortar may not be specified for individual patches that exceed approximately 4 sq. ft. (0.4 m²) of surface area.

The contractor should obtain the services of a technical adviser to assist the Engineer and the contractor during the work. The adviser must be a qualified representative of the manufacturer, approved by the Engineer, and at the work site prior to mixing the components.

For all repairs, the specification requirements regarding surface preparation, mix application, and cure must be adhered to for the work to be successfully accomplished.

2-818P Crack Repair by Epoxy Injection

Epoxy injection as a means of repairing cracks will not correct the cause of the cracking. This is because epoxy resins used for injection are, like concrete, generally unable to resist tension forces. Once the cause of the cracking is corrected by other repair means, epoxy injection can rebond the concrete element into a composite member, seal the concrete to preclude moisture penetration, and reduce reinforcing steel corrosion potential.
The Inspector must be careful when injecting an abutment, because if the crack is completely through the abutment, the epoxy may be injected into the soil behind the abutment.

The Inspector, in cooperation with the designer, determines the scope and extent of the epoxy injection contract work. The Inspector must be familiar with the epoxy-injection contract documents and the types of cracks that are designated to be repaired. Injection of all cracks, regardless of crack width, is not necessary. The Inspector must have a clear understanding, developed during an initial structure inspection, of the size and limits of cracks to be injected. After determining the intent of the designer, the Inspector directs the contractor accordingly.

The contractor will not perform any repair work without prior approval of the Inspector as to location, limits, and method of injection. Contractors must be prequalified specifically for epoxy injection.

2-819 Painting

In the last several years, painting of new and existing bridges and structures has become technically complex. Cleaning and painting is no longer simply the removal of the existing coatings, application of primer coats, and application of top coats. Management of blast residue—including containment, transport and disposal—is very important to both the Department and environment.

Recent developments in the protective-coating industry, research, and contractor prequalification programs of the Steel Structures Painting Council (SSPC), as well as proactive, strict environmental rules and regulations, place significant limitations on painting. The developments also provide powerful tools to the Inspector in performing his work.

References available to the Inspector include SSPC-VIS-1 and SSPC “Good Painting Practices,” as well as Article 6.03.03-23 through -38 of the Standard Specifications. Volume 2, Chapter One, “Environmental Protection,” includes general information about waste generated by painting structural steel.

2-819A Preconstruction Requirements

2-819A.1 Debris and Material Storage

Information concerning the surface-preparation debris-storage containers and their storage-site locations must be submitted to the Inspector for review and approval. Storage sites must not present a hazard to traffic and must be located in areas that are properly drained. The storage containers must be in conformance with the specifications. Volume 2, Chapter One, “Environmental Protection,” includes additional information on debris and material storage.

The contractor must supply the location of the storage facility for the paint for approval by the Engineer. This facility must comply with the latest OSHA regulations, to provide protection from the elements and ensure that the paint is not subjected to temperatures outside the manufacturer's recommended extremes. It is desirable that the storage facility be in proximity to the work site and be accessible to the Inspector at all times. The contractor is fully responsible for storage at all times.

The Inspector will contact the Office of Research and Materials to determine if the manufacturer of the coating system is on the approved supplier and manufacturer list. Prior to beginning any painting, the contractor must provide the Inspector with the manufacturer's technical data sheet and application instructions for the coating system being used.

2-819A.2 Containment System Plan

The contractor will prepare a Cleaning Containment System Plan for the capture, containment, collection and storage of the waste generated by the work. The containment system must be capable of containing blast residue generated by the work.
If required by the contract documents, the contractor will submit plans and details for the recovery system for recycling blast material used for blast cleaning; a written compliance program for worker protection; and an industrial hygienist's plan of action indicating procedures for monitoring air, soil, and water. The action plan will include the type of equipment, approximate location of monitors, and test samples for each bridge site.

Within 14 days after receiving award and prior to beginning work at each bridge, the contractor will submit working drawings of the proposed containment system. The contractor must also submit the design of the systems to be employed, including an analysis of the load that will be added to the existing structure by the containment system and blast waste. The load analysis must be performed and stamped by a licensed engineer having a minimum of five years of experience in bridge design. The analysis will assure that the system will not induce a load on the bridge that will create an overstress condition or otherwise affect the structural integrity of the bridge. The containment system or equipment will not encroach upon the minimum bridge clearances. The Inspector must ensure that the contractor's operations are at all times in conformance with the approved Cleaning Containment System Plan.

2-819A.3 Containment Meeting

Prior to the start of paint removal operations, a meeting will be held with the contractor, painting subcontractor, inspection staff, and District supervisor to review the containment requirements, plans, and monitoring process, as well as the need for strict adherence to the containment and collection requirements. The contractor must prepare a remedial action plan to address the potential of a containment or collection failure. The Inspector will advise the contractor that noncompliance in this area could result in the painting firm being found in default of the contract.

2-819B Equipment

The contractor should provide the following equipment. The equipment should be new and for the exclusive use of the Engineer to inspect the contractor's cleaning and painting operations.

- **PTC Surface-Temperature Thermometer.** The range should be from 0 to 150 °F (-18 to 66 °C). Use to record the surface temperature of the steel.

- **Psychron 566 Psychrometer.** It should include two sets of batteries. Use to record the relative humidity at the work site.

- **Spring Micrometer for Coatings.** Use to measure Testex tape to determine the surface profile of the steel.

- **Testex Press-O-Film Replica Tape—Extra Coarse (1.5 to 4.5 mils).** One roll (100 pieces) should be provided for each bridge span. Use to measure surface profile after steel is blast cleaned. The extra coarse tape is used as specified. Remove the wax paper from the tape, and place it emulsion side down on the blasted surface. Rub the mylar vigorously with the blunt burnishing tool provided until the mylar turns uniformly gray. Remove the tape, and place it between the anvils of a spring micrometer. The micrometer reading, after subtracting Textex tape thickness, represents the profile.

The following references and equipment can be reviewed at or obtained from the District Office:

- **Respirator.** Each Inspector must be properly fitted and instructed on proper use. The respirator must be worn at all times while on the project during surface cleaning and painting operations.

- **Safety Glasses, Disposable Coveralls, Gloves.**

- **SSPC-VIS 1-89.** This is a book of color prints illustrating the desired surface condition standards for various degrees of abrasive blast cleaning over mill scale and various rust grades of structural steel. It may be desirable to prepare blast test panels for reference throughout the project.
• **Inspection Mirror**. Use to view locations that are not readily accessible to ensure proper cleaning and coating applications.

• **Wet-Film Thickness Gauge**. Use to approximate the amount of coating applied while wet to help ensure that the proper dry-film thickness results. The gauge is placed squarely and firmly on the wet surface immediately after the coating application. Remove the gauge and note the highest step covered by the coating. The wet-film thickness lies between this step and the next uncoated step.

• **Magnetic Pull-Off Dry-Film Thickness Gauge**. Used to obtain nondestructive measurements of non-magnetic coatings applied to a ferrous metal surface. The gauge must be calibrated with metallic shims, provided with the gauge, prior, during and after use. To operate, hold the gauge firmly to the surface, then turn the dial forward until the magnet is in solid contact with the surface to be measured. The dial is slowly and evenly turned back until the magnet breaks contact with the surface. The coating thickness is read as the number on the scale that lines up with the hairline on the instrument.

• **Tooke Gauge**. Use only if specified to measure the dry-film thickness of the coatings, using a 50× microscope in conjunction with a microscopic incision made through the coating. However, this is a destructive test, and any areas where this is used must be repaired. Make a reference benchmark on the coating surface with a felt-tip pen. Then make an incision with one of the cutting tips through the coating down to the substrate at the location of the benchmark. The proper tip must be used, based on the anticipated thickness of the total coating:
  - 10× tip: 0–3 mils coating thickness
  - 2× tip: 3–20 mils coating thickness
  - 1× tip: 20–50 mils coating thickness

  View the incision with the microscope. Line up the reticle of the microscope across the incision and count the number of divisions for each coat. The determination of the coating thickness is interpreted as follows: each division is equivalent to 1.0 mil if the 1× tip is used; 0.5 mils if the 2× tip is used; and 0.1 if the 10× tip is used. The thickness reading is the average of readings obtained across the length of the incision.

**2-819C Containment Enclosures**

Surface-preparation (abrasive blast-cleaning) operations are allowed only within containment enclosures approved by the Inspector. If, during surface preparation, the containment enclosure allows debris to escape, work must be stopped until the enclosure is repaired to the Inspector’s satisfaction. Any debris that escapes from the enclosure must be cleaned up by the contractor immediately.

The following apply to the containment requirements on all projects for which paint removal operations are planned:

• All seams on containment enclosures must be lapped a minimum of 2 feet (0.6 meters).

• All seams must be tied off at intervals not to exceed 1 foot (300 mm).

• All attachments to bridge parapets and the undersides of bridge decks must be sealed to prevent the escape of fugitive dust.

• The area between beams beneath the bridge deck must be enclosed with a solid bulkhead and sealed to prevent the escape of fugitive dust.

• All tarpaulins used on containment enclosures must be impervious.
2-819D Air Pressure in Containment Enclosures

SSPC “Guide 61” and project specifications require the average negative pressure in a containment enclosure to be 0.03 in. (0.8 mm) of water relative to the ambient pressure. The negative pressure is monitored with a magnehelic gauge. A magnehelic gauge consists of a pressure gauge and two flexible tubes. The tubes are placed at two locations, and the gauge measures the difference in pressure between them.

Initial pressure readings are taken when the containment system is complete and all ventilation systems are running. The readings should be verified every five working days. Additional readings should be taken if problems occur and after any changes are made to the containment system. The contractor’s dust collectors are equipped with a magnehelic gauge that measures the difference between the dirty and clean sides of the filters. The Inspector should monitor the readings to help identify problems or changes to the system.

To use the gauge, feed one tube to the outside of the containment. Use the other tube to take readings within the enclosure. Visually divide the enclosure into equal volumes, none of which should be larger than 10 x 10 x 12 ft. (3 × 3 × 3.5 m). Stack the volumes for enclosures that are higher than 12 ft. (3.5 m). Take readings at the center of each volume. No reading can be less than the 0-.03 in. (0.8 mm) required. Record the readings and calculate the average.

If the results do not meet the specifications, notify the contractor and repeat the readings. Take a minimum of five readings. To meet the specifications, no more than two readings can be below 0.03 in. (0.8 mm), no reading can be 0.00 in (0.0 mm), and the average of the readings must be 0.03 in. (0.8 mm) or greater. If the results are still not acceptable, the contractor must shut down the operation and make corrections. No blasting is allowed until after the corrections are completed.

2-819E Surface Preparation

Surfaces must be prepared as specified in the SSPC specifications, the contract specifications, and Article 6.03.03 of the Standard Specifications and as indicated by the results of the sample blast test panels. The cleaning methods are described below.

- Only recyclable blast materials may be used.
- Solvent cleaning is used to remove foreign matter such as oil, grease, soil, and other contaminants from steel or galvanized surfaces. Solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods approved by the Engineer are used as specified in SSPC-SP 1, “Solvent Cleaning”. Soap steam cleaning must be used in cleaning steel grids that are open, decks and walkways, and machinery areas of drawbridges. Contaminated solvent must be removed before it evaporates by wiping or rinsing with clean solvents to prevent a film of contaminants from remaining on the surface.
- Hand-tool cleaning is used to remove loose mill scale, loose rust, and loose paint from steel surfaces. Non-mechanical brushing, sanding, chipping, scraping, or other hand-impact methods conforming to SSPC-SP 2, “Hand Tool Cleaning” must be used.
- Brush-off blast or power-tool cleaning conforming to SSPC-SP 7, “Brush-Off Blast Cleaning,” is used to remove loose mill scale, loose rust, and loose paint from steel surfaces. Power wire brushes, impact tools, grinders, sanders, or any combination of these tools must conform to SSPC-SP 3, “Power Tool Cleaning,” and must be approved.
- Abrasive blast cleaning is used to remove mill scale, rust, rust scale, paint or other foreign matter from steel surfaces. Sand or steel grit abrasive propelled through nozzles or centrifugal wheels producing a surface conforming to SSPC-SP 10, “Near-White Blast Cleaning” must be used only after approval. The end surface condition must conform to near white. Abrasives should be dry and free of oils, grease and other harmful materials, such as lead dust, at the time of use.
Regardless of the method used for cleaning, the contractor will comply with the specifications and the manufacturer's recommendations. As a minimum, the contractor should feather the edges of remaining old paint so that the repainted surface has a reasonably smooth appearance. Heavy rust and pack rust must be removed by a combination of cleaning procedures, such as hand chipping (using chipping hammers or scaling hammers), brush-off blast cleaning, power tool cleaning, etc., without scarring the steel. Oil and grease must be removed by solvent cleaning. Prior to blast cleaning, all surfaces are washed with a pressure washer capable of 2000 psi (13.8 MPa) maximum pressure at the nozzle using potable water to remove dust, dirt, debris, and salt contaminants. Paint removed during washing operations must be contained and collected.

The minimum height of the steel-surface profile after cleaning is 2 to 3 mils and should be uniform. The Inspector must verify the profile height with Testex Replica Tape, extra-coarse. The used tape is included with the project records.

2-819F Waste Disposal

At the end of each work day, the contractor must haul the waste material away from the bridge site to the approved temporary storage site. The storage site must be capable of preventing the migration of the lead-contaminated abrasive into the environment. The storage area must provide protection from vandalism and unauthorized access by the general public. The waste may not remain at the temporary storage site longer than 90 days.

The testing of the surface preparation debris for classification as “contaminated” or “hazardous” and the disposal of it will be in accordance with the contract requirements. The Inspector must ensure that material that tests as hazardous is transported to a proper disposal site and that the necessary documentation is provided to assure proper disposal. The Inspector should require a signed manifest to ensure that the material has been delivered. Additional information about the procedures for hazardous-waste disposal is in Volume 2, Chapter One, “Environmental Protection”.

The Environmental Compliance Unit or DEP may be contacted to answer questions, to provide assistance, and to obtain details on the proper handling, storage, containment, and transportation of hazardous materials.

2-819G Coatings Inspection

Coating system product sampling, testing and approval must be in accordance with the contract requirements. The Inspector should have all relevant technical data sheets (TDSs) and may require the contractor to schedule a meeting with the technical adviser employed by the coating manufacturer to establish the correct application for the materials being used.

2-819H Materials

Thin skins formed in a paint container must be cut loose and discarded. Material that is livered, gelled, thick skinned, or questionable may not be used unless reapproved by the Inspector. Waste chemical solutions, oil rags and other waste must be removed daily. All necessary precautionary measures must be taken to ensure that workers and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing, and application of materials. Materials may not be used beyond their pot life. The Inspector should refer to the TDS for the materials being used.
2-819I Weather

Paint may not be applied if the ambient air temperature is below 40 °F (5 °C), the air is misty, or conditions are otherwise unsatisfactory for the work. The relative humidity should be below 85 percent. The paint must not be applied to damp or frozen surfaces. Paint operations may be stopped by the Inspector during winds up to 20 mph (32 km/h). Paint operations will stop if the wind velocity exceeds 20 mph (32 km/h) unless otherwise approved by the Inspector. The Inspector should refer to the TDS for other conditions that may apply to the material.

2-819J General Requirements

The contractor will schedule operations so that all cleaned surfaces are painted immediately, not to exceed 24 hours after cleaning. If rust bloom appears or the air or steel temperature falls below 5 °F (2.5 °C) above the dew point after cleaning and prior to application of the primer coat, the contractor must reclean the affected areas to the satisfaction of the Inspector.

If it is suspected that moisture is condensing on the surface, a well-defined area of the surface may be lightly moistened with a damp cloth and observed. If the dampness evaporates and decreases in 15 minutes, the surface is considered satisfactory for the application of paint. If fresh paint is damaged by the elements, the paint must be replaced or repaired by the contractor at no additional cost to the Department.

The contractor may begin painting operations after the Inspector has reviewed and approved the cleaned surfaces. All surfaces to be painted will be sound, properly cleaned, and thoroughly dry. The Inspector will review the proficiency of the applicator prior to beginning the full-scale painting operation. A test panel may be prepared as required by the Inspector.

2-819K Coating New Steel

The primer coat is applied in the shop as recommended by the manufacturer in a single application employing multiple-spray passes. The specified coating film thickness must be applied to all surfaces to be painted, except a light dust coating is applied to the areas of field welding and to the top and both edges of the top flange where steel stud shear developers are attached.

Except for shop coat touch-ups, steel that will be exposed to view in the completed structure must not be painted until all concrete has been placed. The contractor must protect concrete from being stained by painting operations. Damaged concrete surfaces must be restored to the originally intended color without damage to the concrete.

Bolts for field assembly may not be shop coated. After field welding and prior to applying the intermediate or tie coat, these bolts, field weld areas, and rusted or damaged areas will be brush-off blast or power-tool cleaned or abrasive-blast cleaned if required. The primer coat must be applied on these areas the same day that they are cleaned. Primer paint stained from rusted bolts is wiped before the following coats are applied.

The primer is applied from agitated containers. All touch-ups must have the same dry-film thickness as the coat being repaired but may be applied by brush. Organic zinc primer may be used to touch up the primer coat.

2-819L Coating Existing Steel

All paint must be properly mixed and applied as specified by the manufacturer, except that all painting is applied by brush unless otherwise approved by the Inspector. Roller application may be used on the finish coat. Spray painting is permitted provided the location and method of application has been approved by the Inspector. However, all areas...
adjacent to machinery or mechanical components, etc., are painted by brush application only. All dry spray and runs must be removed prior to the application of the succeeding coat. Surfaces inaccessible for painting by regular means will have the paint applied by sheepskin daubers or by other means necessary to ensure coverage at the proper coating thickness. Thinning of paint is prohibited.

The Inspector notifies the Bridge Safety and Evaluation Section, Office of Engineering, in writing of any cracks or section loss that have been detected during the cleaning operation. The Structural Deficiency Report form, shown in Figure 2-8.14, is used for the notification. The Inspector must ensure that all foreign materials loosened by the blast cleaning are completely removed prior to the painting operations.

The steel will be kept dust free during painting operations, and care must be taken to protect newly coated surfaces from cleaning operations. If an area that was cleaned or painted becomes soiled, contaminated or rusted, the area is recleaned to the specified condition and completely recoated at no additional cost to the Department.

2-819M Defective Work

The contractor is responsible for the satisfactory application of paint. During the contract warranty period, paint must be removed, and the steel must be thoroughly cleaned and repainted at no additional cost to the Department under any of the following conditions:

- rusting occurs
- any paint coat lifts, blisters or wrinkles
- any paint coat shows evidence of having been applied under unfavorable conditions
- the workmanship is poor
- impure or unauthorized paint is used

The painting may be deemed unsatisfactory for other reasons, as well.

2-819N Stenciling

When the final coat of paint is dry, the contractor stencils a legend on the structure indicating the type of paint used in each coat and the month and year in which each application was completed. The stencil must be applied with black paint inside a fascia stringer near the abutment at a location selected by the Inspector.

2-819O Paint Storage

The inspector must be familiar with and the contractor must adhere to the coating manufacturer's recommendations for storage. Paints and thinners will be stored in well-ventilated areas and not subject to excessive heat, open flames, electrical discharge, or direct sunlight. Materials susceptible to damage by low temperatures must be stored in heated areas if necessary. All materials will be used on a rotating stock basis and remain closed until used. Paints that cannot be stirred to attain normal consistency may not be used. Paints that are not in actual use will be stored in tightly covered containers at not less than an ambient temperature of 45 °F (7 °C). Containers used for storage of coatings must be maintained in a clean condition, free of foreign materials and residue.
2-819P  Health and Safety

The Department has initiated special contract requirements for the implementation of a Lead Health Protection Program (LHPP) where work tasks pose a serious airborne lead exposure risk. The contract requirements for each project must be thoroughly understood and complied with. All Inspectors assigned to painting projects, who will be subjected to the airborne lead exposure risks, are required to participate in the LHPP specified in the contract.

The Department has an agreement with the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) for assisting the Department with compliance with federal lead regulations to prevent excessive employee exposure to lead.

2-819Q  Reporting

Inspectors on painting projects will make out Daily Work Reports (DWRs) and the following special reports:

- **Structural Deficiency Report.** It is shown in Figure 2-8.14. Structural deficiencies noted during the inspection of the work, not included in the scope of the contract requirements, are reported by phone to the Bridge Safety and Evaluation Section and then followed with the formal submission of a completed Deficiency Report.

- **Daily Containment Inspection Report.** See Figures 2-8.15a and b. The report is completed each day and at each bridge site where the contractor is performing surface preparation. The Inspector covering the cleaning operations prepares the form and attaches it to the daily IR. In addition, the Project Engineer should both review the painting operations at least two times per month to verify compliance and use the form to prepare a report on the findings. The District Environmental Coordinator, whenever visiting a project with an active painting operation, reviews the operation and prepares a report using the form. The Project Engineer and District Records Examiner, when reviewing the project records, monitor the form's completion and use.

- **Daily Bridge Painting Quality Control Inspection Report.** The Report is shown in Figure 2-8.16. The report is completed daily as a supplement to the Inspector's Daily Report.

- **Bridge Paint Inspection Checklist.** The Report is shown in Figures 2-8.17a and b. The report is completed daily as a supplement to the Inspector's Daily Work Report.
Figure 2-8.14 Structural Deficiency Report

Structural Deficiency Report

Location: ____________________________________________

Bridge Number: ______________________________________

Span: _______________________________________________

Girder / Beam / Diaphragm affected (circle one)

Problem and Location: __________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

Prepared By: ___________________________________________ Date: __________
## Daily Containment Inspection Report

**Town:** ____________________________  
**Date:** ____________________________

**Project No.:** ____________________________  
**Weather:** ____________________________

**Painting Contractor/Subcontractor:** ____________________________  
**Temperature:** ____________________________

**Bridge Number:** ____________________________  
**Wind Condition:** ____________________________

**Bridge Location:** ____________________________  
None ___ Light (0-16) ___

**Specified Containment Level:** ____________________________  
Moderate (16-32) ___ Strong (>32) ___

**Crossing Feature:**  
Secondary Roadway ___ Expressway ___
Wetland ___ Watercourse ___

### Containment Parameters

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<th>No</th>
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<tr>
<td>Impervious Tarps</td>
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<tr>
<td>Seam Lap</td>
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<td></td>
</tr>
<tr>
<td>300 mm Max. Tie-offs</td>
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<td></td>
</tr>
<tr>
<td>Bulkheads Between Beams</td>
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<td></td>
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<tr>
<td>Parapet Attachment</td>
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<td></td>
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<tr>
<td>Continuously Sealed</td>
<td></td>
<td></td>
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<tr>
<td>Impervious floor/deck</td>
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<td></td>
</tr>
<tr>
<td>Holes in Containment</td>
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<tr>
<td>Sealed Entryway</td>
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<tr>
<td>Airlock</td>
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<tr>
<td>Overlap</td>
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<tr>
<td>Open Seam</td>
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<td>Cable</td>
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<tr>
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<tr>
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</tr>
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</tr>
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<td>Exhaust Dust Filtration</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>10-15 min/day</td>
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<td></td>
</tr>
<tr>
<td>&gt;15 min/day</td>
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### Figure 2-8.15b Daily Containment Inspection Report (continued)

**Daily Containment Inspection Report**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Type</th>
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<tbody>
<tr>
<td>Vacuum Collection Available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recyclable Shot Used</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debris Collected Daily</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Containers Staged on</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impervious Surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Containers Covered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Containers Properly Labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Debris Outside</td>
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<td></td>
</tr>
<tr>
<td>Containment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was It Cleaned Up?</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Storage Containers</td>
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<td></td>
</tr>
<tr>
<td>Number</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Directives issued to Contractor:

Compliance:

Remarks:
Figure 2-8.16 Daily Bridge Painting Quality Control Inspection Report

Daily Bridge Painting Quality Control
Inspection Report

Date: ________________ Project No.: ________________ Bridge No.: ________________
Location of Work: ____________________________________________________________
Time Started: ________________ Time Completed: __________________________________
Contractor: ___________________________ Inspector: ____________________________

Method of Verification
Ambient Conditions and Time Taken
Dry Bulb: ________________________________________________________________
Wet Bulb: ________________________________________________________________
Relative Humidity: ___________________________ Dew Point: ____________________
Surface Temperature: _______________________________________________________

Surface Preparation
Degree of Cleaning Specified: ______________________________________________
Degree of Cleaning Achieved: ______________________________________________
Method: ___________________________ Type of Abrasive: _______________________
Coating Materials: __________________________________________________________
Batch No.: ________________ Mfg. Date: ________________ Shelf Life: ______________
Thinner Type: ___________________________ Amount: __________________________
Application: ___________________________ Type of Equipment: __________________
Wet Film Thickness: _______________________________________________________
Location of Reading: _______________________________________________________
Dry Film Thickness: _______________________________________________________ Location of Reading: ___________________________

Hazardous/Contaminated Debris
Drums/Containers: ___________________________ Labeled: Yes _____ No _____
Comment: ___________________________________________________________________
Figure 2-8.17a  Bridge Paint Inspection Checklist

**Bridge Paint Inspection Checklist**

Date: ________________________  Inspector: ________________________

Bridge No.: ________________________

1. Specified Coating System:

<table>
<thead>
<tr>
<th>Coating Manufacturer</th>
<th>Supplied Material</th>
<th>Specified D. E. T.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer (i.e. Organic Zinc)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate (i.e. Epoxy Mastic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finish (i.e. Aliphatic Urethane)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Required Reference Material at the site, 1 copy each:
   - Coating Manufacturer’s Product Data Sheet
   - Bridge Paint Specification
   - Surface Preparation Specification

3. Environmental Conditions: To be obtained a minimum of every three (3) hours. When a reading is close
   to the minimum or maximum specified condition, then readings must be
   obtained every twenty minutes until that particular condition improves or
   fails.

<table>
<thead>
<tr>
<th>Specified</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temperature</td>
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</tr>
<tr>
<td>Steel Surface Temperature</td>
<td></td>
</tr>
<tr>
<td>Coating Material Temperature</td>
<td></td>
</tr>
<tr>
<td>Dry Bulb Thermometer Temp</td>
<td></td>
</tr>
<tr>
<td>Wet Bulb Thermometer Temp</td>
<td></td>
</tr>
<tr>
<td>Relative Humidity</td>
<td></td>
</tr>
<tr>
<td>Dew Point</td>
<td></td>
</tr>
</tbody>
</table>

4. Surface Preparation: Cleaning Specified (i.e. SSPC-SP-10):

   Adjacent Surfaces Protected: Yes ____  No ____

   Containment Enclosure: Yes  No

   Cleaning Achieved: ________________________

   If blast cleaning, type of abrasive used and size: ________________________

   Dust and residue removed prior to coating application: Yes ____  No ____
Bridge Paint Inspection Checklist

5. Application: Method Utilized (Spray, Brush, Roller): ________________________________

Volatile Organic Compounds (V.O.C.) Content as supplied: ___________________________ kg/L

If thinned, how much thinner in liters of thinner per liter of paint? ______________________

V.O.C. Content after thinning: _________________________________ kg/L

Note: Coating Manufacturers Technical Service Department can assist.
V.O.C. content is determined by ASTM D3960.

Wet Film Thickness = W.F.T.  
1 μm = 0.000 001 m
Dry Film Thickness = D.F.T.
Percent of Solids by Volume of Coating = V.S. (i.e. 53% = 0.53)
Volume percent of thinner added = T (i.e. 0.25 liters per 4 liters = 0.25/4 = 0.0625)

\[
\text{Required W.F.T.} = \frac{\text{Specified D.F.T.} \ (1.0 + T)}{\text{V.S.}}
\]

Sample: 150 μm = \( \frac{75 \mu m \ (1.0 + 0.0625)}{0.53} \)

Coating Induction Time if required: _______________________________________________

Time between coats: _________________________________________________________

Primed before rust back: Yes _____ No _____

6. Semi-Final Inspection:

Coating System D.F.T.: Specified ____________ Actual ____________

Defects for Correction—Low D.F.T., Sags, Runs, Splatters: _______________________

Corrective Action: ___________________________________________________________ 

7. Final Inspection:  Review Checklist

Visual Inspection

Acceptance/Rejection