DIVISION 4
MAJOR STRUCTURES

SECTION 400
TEMPORARY STRUCTURES

400-1 DESCRIPTION.

Furnish any design calculations and drawings that are required; furnish members and deck materials for structures, and any other materials that are necessary; erect, maintain, remove and dispose of temporary structures required for the maintenance of pedestrian, highway, and other traffic. Approaches to temporary structures are not a part of this work.

Construct temporary structures in accordance with the requirements of the plans, this section of the specifications, any other section of the specifications pertaining to the construction of any part of the structure, and any applicable special provisions.

Maintain traffic over the temporary structure in accordance with Division 11.

400-2 MATERIALS.

Use materials for temporary structures that conform to the requirements of Division 10 of these specifications or previously used materials conforming to the requirements of these specifications. Obtain approval for the use of materials not covered by Division 10 prior to their use. The use of untreated timber is allowed unless otherwise required.

400-3 PLANS.

(A) Furnishing Plans:

Use the project plans for the structure furnished by the Department or submit a design in accordance with Subarticle 400-3(B)

Design the structure when the project plans furnished by the Department do not include detail plans for the structure. For all Contractor designs furnish one set of design calculations and 11 sets of detail drawings of the structure in accordance with Subarticle 400-3(B).

Submit detail drawings and design calculations for temporary structures for review and comment prior to beginning work. Do not perform any work until the detail drawings are reviewed and accepted. Acceptance of such drawings does not relieve the Contractor of any responsibility for safely and continuously maintaining traffic.

(B) Design Requirements for Contractor Furnished Drawings:

Provide temporary structures of such carrying capacity, dimensions, grades, and alignment as required by the plans and special provisions, or as directed. Design temporary structures carrying highway and pedestrian traffic in accordance with the AASHTO "Standard Specifications for Highway Bridges". Have a North Carolina Registered Professional Engineer design and detail the temporary structure and construct the temporary structure in accordance with this design.

Indicate on the plans the specifications for the materials used in the temporary structure.

400-4 CONSTRUCTION REQUIREMENTS.

Construct and maintain temporary structures to adequately and safely carry traffic during the entire period for which they are required.

Remove and dispose of the temporary structures after they are no longer required in accordance with Article 402-2.

Upon removal of the temporary structure, all material furnished by the Contractor for use in this structure is the property of the Contractor unless otherwise provided in the special provisions.

Remove temporary piling to the streambed level or to 1 foot (0.3 m) below existing ground.

400-5 COMPENSATION.

The price and payment below will be full compensation for all items required to provide temporary structures including but not limited to those items contained in Article 400-1.

The work covered by this section will be paid for at the contract lump sum price for "Construction, Maintenance, and Removal of Temporary Structure at Sta. _____".

Payment will be made under:

Construction, Maintenance, and Removal of
Temporary Structure at Sta. ____ .....Lump Sum

SECTION 402
REMOVAL OF EXISTING STRUCTURES

402-1 DESCRIPTION.

Excavate as necessary to remove the structure; dismantle, salvage, and stockpile materials and components of the structure and preserve those portions that should remain intact, and dispose of waste and debris.

Maintain traffic over the existing structure in accordance with Division 11 unless otherwise stipulated by the plans or special provisions. Comply with the posted load limits of the existing structure. The maintenance of the existing structure, if required, is performed by State forces.

402-2 REMOVAL OF EXISTING STRUCTURE.

(A) General:

Use approved methods and operations for removal of structures. Upon removal, all materials are the property of the Contractor unless otherwise indicated on the plans or in the special provisions. Dispose of waste and debris from the structures in accordance with Section 802.

Perform removal operations while preventing damage to adjacent property. Protect new construction during blasting or other operations necessary for the removal of the existing structure.

Unless otherwise required by the plans or special provisions, remove substructures down to the streambed or 1 foot (0.3 m) below the natural ground surface. Remove the substructure as necessary to avoid interference with construction of the proposed structure.

Prevent erosion of soil and silting of rivers, streams, lakes, reservoirs, water impoundment, ground surfaces, or other property. Do not deposit excavated materials and do not construct earth dikes or other temporary earth structures in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff. Limit the use of equipment in any body of water to those operations that are impossible or impractical to perform in any other way, and control them as to minimize erosion and siltation. Do not drop components of structures into any body of water. Remove existing bridges over water by sawing or other non-shattering methods. Submit, and await approval for, a plan for bridge demolition for

these bridges prior to beginning removal. Remove any component of a structure from the water so as to minimize siltation.

(B) Requirements for Materials Which Remain the Property of the Department:

Pile materials salvaged from the structure neatly on the right of way at locations as directed.

Do not use any materials, either temporarily or permanently, which are removed from the structure unless so permitted by the plans or special provisions.

Remove structural materials carefully without damage.

Do not use explosives to remove concrete floor slabs from steel superstructures that remain the property of the Department.

(C) Requirements for Partial Removal:

Perform partial removal true to the lines indicated on the plans. Submit, and await approval for, a plan for partial removal of bridges prior to beginning removal. Do not remove concrete by blasting or other method that may cause damage to the concrete or reinforcement that is used in the completed structure.

Use equipment and methods to remove portions of a concrete structure undergoing widening which are sufficient to obtain plan lines and slopes without undue spalling at edges of the concrete. Do not use an iron ball or pile hammer to remove portions of a concrete structure undergoing widening.

402-3 COMPENSATION.

The price and payment below will be full compensation for all items required to remove temporary structures including but not limited to those items contained in Article 402-1.

When the contract includes the item of "Removal of Existing Structure at Sta. _____", the work of removing the structure will be paid for at the contract lump sum price for this item.

Payment will be made under:

Removal of Existing Structure at Sta._____.....Lump Sum

SECTION 410
FOUNDATION EXCAVATION

410-1 DESCRIPTION.

Excavate any material as necessary for the construction of foundations, end bent caps, and pile encasements for bridges, retaining walls of reinforced concrete or reinforced masonry, arch culverts, and box culverts without floor slabs in accordance with the plans, these specifications, or as directed. Clear and grub, excavate, perform exploratory drilling at footings to a depth not to exceed 5 feet (1.5 m), blast, drain and divert water, bail, and pump. Provide and remove bracing, shoring, sheeting, cribbing, and cofferdams; provide concrete foundation seals when not shown in the plans, substructure scour protection, subsurface drainage, drawings; and backfill, haul, and dispose of materials.

Do not deposit excavated materials or construct earth dikes or other temporary earth structures in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff. As an exception to the above, obtain written approval for the use of confined earth materials in cofferdams for structure foundations.

410-2 MATERIALS.

Refer to Division 10:

Subdrain fine aggregate ..... Article 1044-1
Stone, No. 78M .....Section 1005

410-3 CLEARING AND GRUBBING.

Prior to starting excavation operations at any structure site, clear and grub at the site in accordance with Articles 200-3 and 200-4.

Clear and grub where excavation for foundations is required. At bridge sites, clear the entire width of the right of way beginning at a station 3 feet (1.0 m) back of the beginning extremity of the structure and ending at a station 3 feet (1.0 m) beyond the ending extremity of the structure. Do not clear and grub in areas where excavation is required under another contract in accordance with Section 225 or where construction of the embankment is required in accordance with Section 235.

Dispose of all timber, stumps, and debris in accordance with Article 200-5.

410-4 FOUNDATION EXCAVATION.

Notify the Engineer a sufficient time before beginning the excavation to allow measurements of the undisturbed ground.

Where necessary for safety, slope, shore, brace, or protect by cofferdams the foundation openings in accordance with local and State safety standards. Perform foundation excavation and related work in such sequence that no portion of the structure is endangered by subsequent operations. Adequately protect completed portions of a structure during blasting operations.

In addition to the above requirements, shore any excavation adjacent to a travelway when a theoretical 2:1 slope from the bottom of the excavation on the roadway side intersects the existing ground line closer than five feet (1.5 m) to the existing edge of pavement. Where excavation for foundations or footings is required adjacent to a traveled way, submit the method of shoring, sheeting, or bracing the foundation opening for review and comment before beginning the excavation. Submit one set of design calculations and 7 copies of drawings showing details of the proposed method of excavation protection including step by step installation procedure. Have shoring designed, detailed, and sealed by a North Carolina Registered Professional Engineer. Apply the provisions of Subarticle 410-5(D) to such drawings.

Consider the dimensions and elevations of footings, as shown on the plans as approximate only. The Engineer may order, in writing, such changes in dimensions or elevations of footings as necessary to secure a satisfactory foundation.

Notify the Engineer after excavating each foundation. Do not place concrete prior to obtaining approval for the excavation depth, the character of the foundation, and permission to proceed. Perform drilling as may be required by the Engineer in order to obtain information as to the depth to which the rock or other hard foundation material extends below the bottom of the footing.

Clean all rock or other hard foundation material of all loose material and cut to a firm surface, either level, stepped, or serrated, as directed. Clean out all seams and fill with concrete, mortar, or grout. Remove all loose and disintegrated rock and thin strata. Leave the rock surface in a rough condition to form an adequate key against lateral movement of the footing.

When the footing rests on an excavated surface other than rock, take special care not to disturb the bottom of the excavation until immediately before placing reinforcing steel and concrete. Remove foundation material softened and weakened by exposure and inundation down to sound, solid material before placing steel and concrete.

When using foundation piles, complete the excavation of each pit before driving piles.

When pile driving liquefies the soil, or the bed is otherwise unsuitable as determined by the Engineer, remove the material as required and backfill to the required elevation with an approved granular material. Such work will be paid for as extra work in accordance with Article 104-7.

410-5 COFFERDAMS.

(A) General:

The term cofferdam designates any temporary or removable structure constructed to hold the surrounding earth, water, or both, out of the excavation. It includes timber cribs, any type of sheet piling, removable steel shells, or similar structures, all necessary bracing, and the use of pumping wells or well points for the same purpose. Have cofferdams located in bodies of water designed, detailed, and sealed by a North Carolina Registered Professional Engineer when the distance from the water surface to the bottom of the excavation is 5 feet (1.5 m) or greater.

(B) Construction:

Design and construct cofferdams to adequate depths and heights, safely, and as water-tight as is necessary for the proper performance of the work. Provide interior dimensions of cofferdams as to give sufficient clearance for the construction and inspection of forms and to permit pumping outside the forms. Where a foundation seal is not required by the plans, provide at least 5 feet (1.5 m) of clearance between the proposed edge of footing and inside face of cofferdam when a keyed footing is required and at least 3 feet (0.9 m) when a keyed footing is not required. Right, rest, or enlarge cofferdams that are tilted or moved laterally during the process of sinking to provide the necessary clearance.

Construct cofferdams to protect plastic concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. Do not leave timber or bracing in cofferdams that could extend into the substructure concrete without permission.

(C) Foundation Seals:

Take reasonable measures to dewater cofferdams without the use of a foundation seal unless a foundation seal is shown in the plans for the substructure unit involved.

If in the opinion of the Engineer, after attempting all reasonable measures to provide a dewaterable enclosure, and the cofferdam cannot be dewatered, construct a foundation seal of such dimensions and elevations as deemed necessary by the Engineer. Reasonable measures include, but are not limited to, driving all sheeting to a sufficient depth below plan bottom of footing elevation or else providing a double walled cofferdam lined with clay or other reasonably impervious material. Construct the seal in accordance with Article 420-8 or as required. After dewatering, place the remaining concrete in the dry.

When a foundation seal is not shown in the plans, but a seal is allowed, construct the seal at no cost to the Department, except for the pier column concrete allowance provided in Subarticle 420-21(C).

(D) Drawings:

When required by the plans, special provisions, or Articles 410-4 or 410-5(A), submit for review and comment one copy of design calculations and 7 sets of drawings showing the proposed method of cofferdam construction and other details left open to choice or not fully shown on the plans. The type and clearance of cofferdams, insofar as such details affect the character of the finished work, are subject to the review of the Engineer, but assume responsibility for other details of design and the adequacy of the work.

(E) Removal:

After the completion of the substructure, unless otherwise provided on the plans or in the special provisions, remove cofferdams with all sheeting and bracing to the stream

bed or 1 foot (0.3 m) below existing ground. Take care not to disturb or injure the finished concrete.

410-6 PUMPING.

Perform pumping operations in accordance with Article 414-6.

Do not begin pumping to dewater a sealed cofferdam until the seal sets sufficiently to withstand the hydrostatic pressure, and in no case less than 7 days after placing or such additional length of time as directed.

410-7 PRESERVATION OF CHANNEL.

Unless otherwise required by the plans or special provisions or permitted by the Engineer, do not excavate in stream channels outside of cofferdams. Do not disturb the natural stream bed adjacent to the structure without permission. Backfill any excavation or dredging made at the site of the structure outside of the cofferdam limits to the original ground surface or river bed with approved material.

Remove materials placed within the stream area and leave the stream in its original condition, unless otherwise permitted.

410-8 UTILIZATION OF EXCAVATED MATERIAL.

Utilize suitable excavated material as backfill. Use suitable material that is not required for backfill to form embankments, subgrades, or shoulders. When so utilized, no additional payment will be made for utilization of the material under other pay items or for stockpiling the material for use under other pay items. Furnish disposal areas for excavated unsuitable materials and suitable materials not required in connection with other work included in the contract. Do not place excavated material in a stream or other body of water.

Do not deposit excavated material at any time so as to endanger the partly finished structure, either by direct pressure or indirectly by overloading banks adjacent to the operations, or in any other manner.

410-9 BACKFILLING AND FILLING.

Use approved material for backfill that is free from large or frozen lumps, wood, or other undesirable material. Where there is not an adequate quantity of suitable backfill material available from the excavation, provide suitable backfill material compensated in accordance with Subarticle 410-14(C).

Refill all excavated spaces not filled with permanent work with earth up to the ground surface existing before the excavation. Place backfill to provide adequate drainage as soon as concrete surfaces are finished in accordance with Subarticle 420-18(B) and the concrete is inspected and approved. The Engineer has the authority to suspend all operations until such backfilling is acceptably completed.

Eliminate any slope adjacent to the excavation for abutments, wingwalls, and retaining walls by stepping or serrating to prevent wedge action.

Compact all portions of the backfill that become a part of roadway typical sections or their foundations in accordance with Subarticle 235-4(C). Place all other portions of the backfill in layers not more than 6 inches (150 mm) in depth of loose measure and compact to a density comparable to the adjacent undisturbed material.

Place backfill or embankment material simultaneously insofar as possible to approximately the same elevation on both sides of an abutment, pier, or wall. If conditions require placing backfill or embankment higher on one side, do not place the additional material on the higher side until the concrete develops the minimum specified strength for the class of concrete required for the structure.

Do not place backfill or embankment behind the walls of concrete culverts, abutments of bridges other than rigid frames, or abutments of rigid frame structures until the top slab is placed and has developed the minimum compressive strength required by Article 420-20. Place backfill and embankment simultaneously behind opposite abutments of rigid frames or sidewalls of culverts. Place backfill for abutments of bridges to a minimum elevation of 1 foot (0.3 m) below the bridge seats before setting beams or girders.

Place backfill so as not to cause excess lateral forces against the structure by heavy equipment or from earth masses transmitting pressures caused by earth moving equipment. Place backfill immediately adjacent to the structure by hand operated mechanical tampers. Do not operate heavy earth moving equipment within 10 feet (3 m) of the structure in backfilling operations.

410-10 SUBSURFACE DRAINAGE AT WEEP HOLES.

Place a stone drain consisting of 1 cubic foot (0.03 cubic meters) of No. 78M stone contained in a bag of porous fabric at each weep hole. Place subdrain fine aggregate beneath, around, and over the stone drain so that the stone drain is covered by a layer of subdrain fine aggregate at least 1 foot (0.3 m) thick. Connect all drains with a horizontal drain of subdrain fine aggregate at least 1 foot (0.3 m) square in cross section. In the case of abutments and retaining walls, in addition to the above requirements, place a vertical drain of subdrain fine aggregate at least 1 foot (0.3 m) square in cross section at each weep hole to an elevation 2 feet (0.6 m) below the subgrade or surface of the embankment.

When embankment placement around the structure is part of another contract, the portion of the subsurface drainage system described above, which is located in such embankment, is not considered part of the work of this section.

410-11 SUBSTRUCTURE SCOUR PROTECTION.

Provide substructure scour protection as indicated in the plans. Place the two to six inch (50 to 150 mm) size stone after removing footing formwork and while dewatering the excavation. Place the rip rap stone before removing the cofferdam sheeting, either before or after allowing the excavation to flood. When not using sheeting, place each stone type to the required thickness and extend horizontally to the undisturbed material.

Use two to six inch (50 to 150 mm) size Scour Protection Stone which is hard and durable in nature. While no specific gradation is required, distribute the various sizes of stone reasonably equally within the required size range. Use stone that is essentially cubical in shape.

410-12 BLASTING ADJACENT TO HIGHWAY STRUCTURES.

Conduct blasting operations adjacent to highway structures in accordance with the following requirements.

Submit and await approval of a blasting plan prior to conducting any blasting operation.

Do not conduct blasting operations within 60 feet (18 m) of any structure until the concrete strength reaches 2400 psi (16.5 MPa). After the concrete achieves a strength of 2400 psi (16.5 MPa), limit the maximum peak particle velocity to 4 in./sec. (100 mm/sec.) measured at the closest structure extremity.

For multi-column bents with column heights up to 40 feet (12 m) and a combined span length for the two adjacent spans of 160 feet (49 m) or less, adhere to the following criteria:

1. Do not blast within 6 feet (2 m) without obtaining prior written approval.
2. At distance of 6 to 10 feet (2 to 3 m), do not use a quantity of explosives more than 0.5 pound (0.22 kg) per delay period.

3. From 11 to 60 feet (3.1 to 18 m), use a maximum charge weight per delay of 0.5 pound + 0.5 pound of explosives per foot of distance over 10 feet (0.22 kg + 0.22 kg of explosives per 0.3 m distance over 3 m).

No vibration measurements are required if the above criteria are met. If unable to meet the above criteria, monitor the structure with an engineering seismograph to determine whether the 4 in./sec. (100 mm/sec.) limit is exceeded. If the 4 in./sec. (100 mm/sec.) limit is exceeded, the Engineer will evaluate each subsequent blast, and if deemed necessary, will apply more restrictive controls than those above to prevent damage.

Payment of blasting operations is included in the bid price for Foundation Excavation at the affected substructure unit.

410-13 METHOD OF MEASUREMENT.

(A) Cubic Yard (Cubic Meter) Basis:

Where the contract calls for payment of foundation excavation on a cubic yard (cubic meter) basis, the quantity of foundation excavation to be paid for will be the actual number of cubic yards (cubic meters) of materials, measured in their original position within the limits described below and computed by the average end area method, which are acceptably excavated in accordance with the plans and specifications, or as directed.

The upper limits for measurement are the actual ground surface at the time of starting work, except that where the excavation is performed in cut areas excavated under Section 225 the upper limits are the roadway plan typical section. For keyed footings the upper limits of the keyed section are as shown on the plans. A keyed footing is a footing that is placed without forms for the keyed depth in an excavation whose sides, as near as practicable, are located at the neat line dimensions of the footing and are vertical.

When the foundation material is other than rock, the lower limits for measurement are the elevation of the bottom of footing as established by the plans or as directed. When the foundation material is rock, the lower limits for measurement are the actual rock elevations after the foundation is approved.

As an exception to the lower limits established above, when in the opinion of the Engineer excess excavation is performed due to carelessness or negligence on the part of the Contractor, the Engineer notifies the Contractor of that portion of the excavation which is not measured for payment.

Horizontal limits for measurement are established by vertical planes located 18 inches (450 mm) outside of the neat line dimensions of the footing as established by the plans or directed in writing by the Engineer. For keyed footings the horizontal limits for measurement of the keyed section are established by vertical planes located at the neat line dimensions of the footing as established by the plans or directed in writing.

Measurement includes mud, muck, or similar semi-solid material within the limits described above provided such material is present at the time excavation begins and cannot be drained away or pumped without the use of a jet or nozzle.

No measurement is made of the following excavation, as such excavation is considered incidental to the work covered by this section:

1. Excavation necessary to construct end bent caps and the berm adjacent to the cap.
2. Excavation necessary to construct pile encasement.
3. Excavation outside of the limits described in this subarticle.
4. Excavation necessary from heaving of a foundation due to the driving of piles.
5. Excavation necessary from overbreaks or slides.
6. Mud, muck, or similar semi-solid material which can be drained away or pumped without the use of a jet or nozzle.

7. Excavation made before the Engineer makes measurements of the undisturbed ground.
8. Excavation necessary due to exposure or inundation allowed by the Contractor, or carelessness on the part of the Contractor.

(B) Lump Sum Basis:

Where the contract calls for foundation excavation to be paid for on a lump sum basis, no measurement will be made of any foundation excavation made at such locations.

410-14 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to complete foundation excavation including but not limited to the items listed in Article 410-1.

(A) Cubic Yard (Cubic Meter) Basis:

The quantity of foundation excavation, measured as provided in Subarticle 410-13(A), will be paid for at the contract unit price per cubic yard (cubic meter) for "Foundation Excavation" except as otherwise provided below.

Where the Engineer directs the Contractor in writing to excavate below the original plan elevation of the bottom of the footing, payment for such excavation will be made as follows:

1. For excavation made below the original plan elevation of the bottom of the footing to an elevation 3 feet (1.0 m) below such plan elevation, payment will be made at the contract unit price per cubic yard (cubic meter) for "Foundation Excavation".
2. For excavation made below an elevation 3 feet (1.0 m) below the original plan elevation of the bottom of the footing but not more than 6 feet (2 m) below such plan elevation, payment will be made at 150 percent of the contract unit price per cubic yard (cubic meter) for "Foundation Excavation".
3. For excavation made below an elevation 6 feet (2 m) below the original plan elevation of the bottom of the footing, payment will be made as provided in Article 104-7 for extra work.
4. In areas where piles have been driven, removal of material and backfilling with approved granular material, in accordance with Article 410-4, will be paid for as extra work as provided in Article 104-7.

(B) Lump Sum Basis:

Payment for the work of all foundation excavation at locations where the contract calls for payment on a lump sum basis will be made at the contract lump sum price for "Foundation Excavation for Bent No. _____ at Station _____", except as otherwise provided below.

Where the Engineer directs the Contractor to excavate below the original plan elevation of the bottom of the footing by a distance which is less than 3 feet (1.0 m), the character of the work will not be considered to be materially changed and no additional compensation will be allowed for the foundation excavation at such location.

Where the Engineer directs the Contractor in writing to excavate more than 3 feet (1.0 m) below the original plan elevation of the bottom of the footing, payment for such excavation will be made as provided in Article 104-7 for extra work.

(C) Furnishing and Hauling Backfill Material:

Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material is made as provided in Article 104-7 for extra

work. Placing and compacting such backfill material is not considered as extra work, but is considered incidental to the work covered by this section.

(D) Compensation:

When the Contractor has been directed by the Engineer to drill in the vicinity of a footing to obtain subsurface information, such drilling in excess of a 5 foot (1.5 m) depth will be paid for as provided in Article 104-7 for extra work.

(E) Pay Items:

Payment will be made under:

Foundation Excavation..... Cubic Yard (Cubic Meter)
Foundation Excavation for Bent No. _____ at
Station _____ .....Lump Sum

SECTION 412
UNCLASSIFIED STRUCTURE EXCAVATION

412-1 DESCRIPTION.

Excavate any material not classified as foundation excavation, box culvert excavation, or channel excavation whose removal is required for the construction of bridges, retaining walls of reinforced concrete or reinforced masonry, arch culverts, and box culverts without floor slabs, and which is classified as unclassified structure excavation on the plans, in accordance with the plans and these specifications or as directed. Clear and grub, excavate, blast, brace, shore, provide sheeting and cribbing, backfill, haul, and dispose of materials.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures, in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff.

412-2 CLEARING AND GRUBBING.

Clear and grub all areas where excavation is to be performed in accordance with Articles 200-3 and 200-4.

Dispose of all timber, stumps, and debris in accordance with Article 200-5.

412-3 PRESERVATION OF CHANNEL.

Unless otherwise required by the plans or special provisions, do not excavate in stream channels. Do not disturb the natural stream bed adjacent to the structure without permission.

Do not place material in a stream without approval. Remove materials placed within the stream area and leave the stream in its original condition, unless otherwise permitted.

412-4 UTILIZATION OF EXCAVATED MATERIAL.

Use and place suitable excavated material in accordance with the requirements of Articles 410-8 and 410-9.

Notify the Engineer a sufficient time before beginning the excavation so that measurements may be taken of the undisturbed ground.

412-5 METHOD OF MEASUREMENT.

The quantity of excavation to be paid for is the actual number of cubic yards (cubic meters) of materials, measured in their original position and computed by the average end area method, which is acceptably excavated in accordance with the plans and

specifications or as directed by the Engineer. Original cross sections for the determination of excavation quantities are taken before any excavation is done.

No measurement is made of any materials excavated outside of the limits shown on the plans or directed in writing by the Engineer, or any materials excavated before the Engineer makes measurements of the undisturbed ground.

412-6 BASIS OF PAYMENT.

The price and payment below will be full compensation for all items required to complete unclassified structure excavation including but not limited to those items contained in Article 412-1.

The quantity of excavation, measured as provided for in Article 412-5, will be paid for at the contract unit price per cubic yard (cubic meter) for "Unclassified Structure Excavation".

Payment will be made under:

Unclassified Structure Excavation ..... Cubic Yard (Cubic Meter)

SECTION 414
BOX CULVERT EXCAVATION

414-1 DESCRIPTION.

Excavate all material necessary for the construction of box culverts with floor slabs in accordance with the plans and these specifications or as directed. Clear and grub, excavate, blast, drain and divert water, bail, pump, brace, shore, provide sheeting, cribbing, cofferdams, culvert foundation conditioning, subsurface drainage and drawings; backfill, haul, and dispose of materials.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff. As an exception to the above, obtain written approval for the use of confined earth materials in cofferdams for structure foundations.

414-2 MATERIALS.

Refer to Division 10:

Subdrain fine aggregate ..... Article 1044-1
Stone, No. 78M .....Section 1005
Foundation Conditioning Material.....Section 1016

414-3 CLEARING AND GRUBBING.

Prior to excavating operations at any structure site, clear and grub at the site in accordance with Articles 200-3 and 200-4 and dispose of all timber, stumps, and debris in accordance with Article 200-5.

414-4 FOUNDATION EXCAVATION.

Notify the Engineer a sufficient time before beginning the excavation so that measurements may be taken of the undisturbed ground if desired by the Engineer. Do not disturb the existing ground at the culvert site without permission.

Where necessary for safety, slope, shore, brace, or protect by cofferdams the foundation openings in accordance with local and State safety standards. Perform foundation excavation and related work in such sequence that no portion of the culvert will be endangered by subsequent operations. Protect completed portions of a culvert from blasting.

Where excavation for foundations or footings is required adjacent to a traveled way, await approval for the method of shoring, sheeting, or bracing the foundation opening before beginning the excavation. Submit 5 copies of drawings showing details of the proposed method of excavation protection. Apply the provisions of Subarticle 410-5(D) to such drawings.

Remove and dispose of boulders, vegetative matter, and any other objectionable material.

Notify the Engineer after excavating each foundation. Do not place any concrete until obtaining approval of the excavation depth, the character of the foundation material and permission to proceed.

Take special care not to disturb the bottom of the excavation until immediately before placing reinforcing steel and concrete.

414-5 CONDITIONING CULVERT FOUNDATION.

Excavate to a depth as directed below the bottom of the barrel or wing footing and replace the excavated material with foundation conditioning material.

When the foundation material beneath a portion of the barrel or wing footing is rock or incompressible material, and softer material is beneath the remainder of the barrel or wing footing, excavate the rock material within the neat lines of the barrel or footing to a depth of 12 inches (300 mm) below the bottom of the barrel and footings and backfill with foundation conditioning material.

Use Class VI, Select Material foundation conditioning material as defined in Section 1016.

414-6 PUMPING.

Pump from the interior of any foundation enclosure in such a manner as to preclude the possibility of the movement of water over or through any fresh concrete. Do not pump while placing concrete, or for a period of at least 24 hours thereafter, unless done from a suitable sump separated from the concrete work by a substantially water-tight wall.

414-7 UTILIZATION OF EXCAVATED MATERIAL.

Use suitable excavated material in accordance with Article 410-8.

414-8 BACKFILLING AND FILLING.

As soon as practical after completing the box culvert, place the backfill and redirect the stream through the culvert.

Use approved material for backfill that is free from large or frozen lumps, wood, or other undesirable material. Where there is not an adequate quantity of suitable backfill material available from culvert excavation, provide suitable backfill material compensated as provided in Subarticle 410-14(C).

Eliminate any excavated slope adjacent to backfill areas by stepping or serrating to prevent wedge action.

Compact all portions of the backfill that become a part of roadway typical sections or their foundations in accordance with Subarticle 235-4(C). Place all other portions of the backfill in layers not more than 6 inches (150 mm) in depth of loose measure and compact to a density comparable to the adjacent undisturbed material. Refill all excavated spaces not filled with permanent work with earth up to the ground surface existing before the excavation.

Do not place backfill or embankment behind the walls of culverts until after placing the top slab and allowing development of the minimum compressive strength required by Article 420-20.

Place backfill or embankment material simultaneously insofar as possible to approximately the same elevation on both sides of the culvert and do not carry it to an elevation higher than 1 foot (0.3 m) above the top of footing or bottom slab until the concrete develops the minimum required strength for the class of concrete used.

414-9 SUBSURFACE DRAINAGE AT WEEP HOLES.

Place subsurface drainage in accordance with Article 410-10.

414-10 METHOD OF MEASUREMENT.

(A) General:

No measurement is made of any work covered by this section except for the work of conditioning culvert foundation.

(B) Conditioning Culvert Foundation:

When conditioning culvert foundation is performed in accordance with Article 414-5, the quantity of conditioning culvert foundation to be paid for is the number of tons (metric tons) of foundation conditioning material which is placed within the established limits.

The number of tons (metric tons) of material is determined by weighing the material in trucks in accordance with the provisions of Article 106-7. No deduction is made for any moisture contained in the material at the time of weighing.

414-11 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to complete box culvert excavation including but not limited to those items contained in Article 414-1.

(A) Excavation:

Excavation for box culverts, constructed in accordance with the plans and contract provisions, will be paid for at the contract lump sum price for "Culvert Excavation, Sta. _____". No measurement for payment will be made for this pay item, and no adjustment in the contract lump sum price will be made unless the size, length, elevation, or location of the culvert is revised.

In the event of a revision in the size, length, elevation, or location of the culvert, such revision will be considered an alteration of plans or details of construction in accordance with Article 104-3.

(B) Conditioning Culvert Foundation:

The quantity of conditioning culvert foundation, measured as provided in Subarticle 414-10(B), will be paid for at the contract unit price per ton (metric ton) for "Foundation Conditioning Material, Box Culvert". Such price and payment will be full compensation for all excavation made below the bottom of the barrel and wing footings in addition to furnishing, hauling, and placing the foundation conditioning material.

(C) Furnishing and Hauling Backfill Material:

Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material is made as provided in Article 104-7 for extra work. Placing and compacting such backfill material is not considered extra work, but is considered incidental to the work covered by this section.

(D) Pay Items:

Payment will be made under:

Culvert Excavation, Sta. _____.....Lump Sum
Foundation Conditioning Material, Box Culvert ..... Ton (Metric Ton)

SECTION 416
CHANNEL EXCAVATION

416-1 DESCRIPTION.

Excavate any material outside of the pay limits of foundation excavation, unclassified structure excavation, or box culvert excavation, which is classified as channel excavation in the plans. Place suitable excavated material as directed, drain and divert water, pump, blast, haul, dispose of materials, and backfill.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures in rivers, streams, or impoundment or so near to such waters that they are carried into any river, stream, or impoundment by stream flow or surface runoff.

416-2 CONSTRUCTION REQUIREMENTS.

Notify the Engineer a sufficient time before beginning the excavation so that measurements may be taken of the undisturbed ground. Do not disturb the existing ground without permission.

Remove and dispose of boulders, vegetative material, and any other objectionable material.

Use and place suitable excavated material in accordance with the requirements of Articles 410-8 and 410-9.

416-3 METHOD OF MEASUREMENT.

(A) Cubic Yard (Cubic Meter) Basis:

Where the contract calls for payment of channel excavation on a cubic yard (cubic meter) basis, the quantity of channel excavation to be paid for is the actual number of cubic yards (cubic meters) of materials, measured in their original position within the limits described below and computed by the average end area method, which are acceptably excavated in accordance with the plans and specifications, or as directed.

The upper limits for measurement are the actual ground surface at the time of starting work.

The lower limits for measurement are established by the plans or as directed in writing.

No measurement is made of the following excavation:

1. Mud, muck, or similar semi-solid material which can be drained away or pumped without the use of a jet or nozzle.
2. Excavation before the Engineer makes measurements of the undisturbed ground.
3. Excavation which is within the pay limits of other excavation.
4. Excavation which is outside of the limits shown on the plans or as directed in writing.

(B) Exceptions:

No measurement is made of any channel excavation where the item "Channel Excavation" is not included in the contract.

416-4 BASIS OF PAYMENT.

The price and payment below will be full compensation for all items required to complete channel excavation including but not limited to those items contained in Article 416-1.

(A) Cubic Yard (Cubic Meter) Basis:

The quantity of channel excavation, measured as provided for in Subarticle 416-3(A), will be paid for at the contract unit price per cubic yard (cubic meter) for "Channel Excavation".

(B) Exceptions:

Where the item of "Channel Excavation" is not included in the contract, there will be no direct payment for the work covered by this section.

Payment at the contract unit or lump sum prices for the various items in the contract will be full compensation for the work covered by this section.

(C) Pay Items:

When provided for in the contract, payment will be made under:

Channel Excavation ..... Cubic Yard (Cubic Meter)

SECTION 420
CONCRETE STRUCTURES

420-1 DESCRIPTION.

Construct cast-in-place concrete structures and the cast-in-place concrete portions of composite structures in conformity with the lines, grades, and dimensions shown on the plans and as specified in these specifications. Furnish and place concrete, joint filler and sealer, curing agents, deck drains, expansion anchors, and any other material; erect and remove all falsework and forms; protect concrete in wind, rain, low humidity, high temperatures, or other unfavorable weather; construct joints and weep holes; finish and cure concrete; protect concrete from rust stains; and groove bridge floors. For reinforced concrete deck slabs, in addition to the above, furnish and place reinforcing steel and bridge scuppers; and design, furnish, erect, and remove all bridge deck forms including any appurtenances required by the Engineer to stabilize exterior girders during overhang construction.

420-2 MATERIALS.

Refer to Division 10:

Portland cement concrete .....Section 1000
Curing agents .....Section 1026
Joint fillers ..... Article 1028-1
Joint sealers ..... Article 1028-2
Deck drains ..... Article 1054-3
Expansion anchors ..... Article 1074-1
Metal stay-in-place forms ..... Article 1074-12

420-3 FALSEWORK AND FORMS.

(A) General:

Submit 8 sets of detailed drawings for falsework or forms for bridge superstructure and other components as required by the plans or special provisions for review, comments and acceptance before beginning construction of the falsework or forms. This review does not relieve the Contractor of full responsibility for the safety, alignment, quality, or finish of the work.

Design falsework and forms to carry the full loads upon them, including a dead load of 150 pounds per cubic foot (23.5 kN per cubic meter) for concrete, loads caused by equipment and personnel, and for lateral pressures resulting from rate of pours, setting

times, and effects of vibration on the concrete, so that the finished concrete surface conforms to the proper dimensions and contours and has an even appearance.

Use lumber and other material for forms and falsework that is sound and in good condition.

Set falsework and forms to give the correct elevation shown on the drawings making proper allowance for shrinkage, deflections, and settlement, and maintain true to lines and grades designated until the concrete sufficiently hardens.

Where falsework or forms appear to be unsatisfactorily built in any respect either before or during placing of concrete, the Engineer will order the work stopped until the defects are acceptably corrected.

Keep the falsework and forms in place after placing of concrete for the periods specified in Article 420-17. Remove falsework and forms in an acceptable manner. Do not leave forms or falsework permanently in place without written approval.

Provide a means, satisfactory to the Engineer, to check any settlement or deflection that may occur during the placing of concrete in the various portions of the work.

(B) Falsework:

Build falsework on foundations of sufficient strength to carry the applied loads without appreciable settlement. Support falsework that cannot be founded on solid footings on ample falsework piling.

Use an acceptable method to compensate for shrinkage, deflection, and settlement. Use jacks in order to readily effect adjustment, if necessary, before or during placing of concrete, if required by the Engineer.

(C) Forms:

(1) General:

Use forms made of wood or steel except where other materials are specified by the plans or special provisions or accepted by the Engineer.

(2) Wood Forms:

Build forms mortar-tight of material sufficient in strength with ample studding, walling, and bracing to effectively prevent any appreciable horizontal and/or vertical deflection.

Provide forms with interior dimensions such that the finished concrete is of the form and dimensions shown on the plans.

Line forms, except for surfaces permanently in contact with earth fill, with plywood or other approved material. Provide a lining with a smooth and uniform texture and of such thickness and rigidity that a concrete surface of uniform texture and even appearance results. Provide joints between form liners that are mortar tight and even and maintain to prevent the opening of joints due to the shrinkage of the lumber.

Fillet forms at all sharp corners unless otherwise noted on the plans. Mill wood chamfer strips from straight grained lumber and surface on all sides.

Give forms for all projections a bevel or draft to insure easy removal.

At all times, maintain the shape, strength, rigidity, watertightness, and surface smoothness of reused forms. Resize any warped or bulged lumber before reusing. Do not reuse any forms that are unsatisfactory in any respect. Do not use plywood sheets showing torn grain, worn edges, patches or holes from previous use, or other defects that impair the texture of concrete surfaces exposed to view.

Maintain an acceptable alignment and no broken edges on all chamfer strips.

Thoroughly clean forms previously used of all dirt, mortar, and foreign material before reusing. Before placing concrete in forms to be removed, thoroughly coat all inside surfaces of the forms with commercial quality form oil or other equivalent coating which permits the ready release of the forms and does not discolor the concrete.

Construct or install metal spacers or anchorages, required within the forms for their support or to hold them in correct alignment and location, in such a way that the metal work can be removed to a depth of at least 1 inch (25 mm) from the exposed surface of the concrete without injury to such surface by spalling or otherwise. Limit the diameter to not greater than 1½ times its depth for the recess formed in the concrete. Cut back all such metal devices in exposed surfaces, upon removal of the forms, to a depth of at least 1 inch (25 mm) from the face of the concrete. Carefully fill cavities produced by the removal of metal devices with cement mortar of the same mix used in the body of the work immediately upon removal of the forms, and leave the surface smooth, even, and as nearly uniform in color as possible. As an option, break off flush with the concrete surface those metal devices with cross sectional area not exceeding 0.05 square inches (32 square mm) on surfaces permanently in contact with earth fill.

Do not weld metal devices to either reinforcing steel or structural steel that is a permanent part of the structure without written approval.

(3) Steel Forms:

Apply the provisions of Subarticle 420-3(C)(2) in regards to design, mortar tightness, filleted corners, beveled projections, bracing, alignment, texture and evenness of appearance of the resulting concrete surface, removal, re-use, and oiling to steel forms. Use steel for forms of such thickness that the forms remain true to shape. Counter-sink bolt and rivet heads. Design clamps, pins, or other connecting devices to hold the forms rigidly together and allow removal without injury to the concrete. Do not use steel forms that do not present a smooth surface or line up properly. Exercise care to keep steel forms free from rust, grease, or other foreign matter that will tend to discolor the concrete.

(D) Forms for Concrete Bridge Decks:

In addition to the requirements of Subarticles 420-3(C)(1) through 420-3(C)(3), the following requirements apply to falsework and forms used to construct reinforced concrete bridge decks on girders. Furnish all materials, labor, equipment and incidentals necessary for the proper installation of falsework and forms for concrete bridge deck slabs.

For prestressed girder spans, the plans for the concrete deck slab are detailed for the use of a cast-in-place slab using either precast prestressed concrete panels or fabricated metal stay-in-place forms; however, as an option, construct a cast-in-place slab using removable forms. If noted on the plans, the option is available to use metal stay-in-place forms in lieu of precast prestressed concrete panels.

For structural steel spans, plans for the concrete deck slab are detailed for the use of metal stay-in-place forms; however, as an option, construct a cast-in-place slab using removable forms. Do not use precast prestressed concrete panels on structural steel spans.

If using a form system other than that detailed on the plans, do so at no additional cost to the Department. Changes in slab design to accommodate the use of optional forms are the responsibility of the Contractor. Submit these changes for review and approval. Prior to using optional forms, submit two sets of prints of detailed checked plans of the system and checked design calculations for the composite slab complying to the latest AASHTO Standard Specifications and Highway Design Branch Structure Design Manual. After the drawings are reviewed and, if necessary, the corrections made, submit reproducible drawings of the deck system to become the revised contract plans. Ensure that the size of the sheets used for the drawings is 22" x 34" (560 x 864 mm). Ensure that the plans and

design calculations are checked and sealed by a North Carolina Registered Professional Engineer.

Unless otherwise shown on the plans, use the same forming system for all of the same type superstructure spans within the bridge. Construct the slab overhang from the exterior girder to the outside edge of superstructure using removable forms.

(1) Precast Prestressed Concrete Panels:

Prestressed concrete panels are subject to the requirements for prestressed concrete members as specified in Section 1078, the plans, and these specifications.

Design prestressed panels subject to review by the Engineer. Prior to using prestressed panels, submit 7 sets, including one reproducible set, of detailed plans of the panels for review. Submit with the checked plans 1 set of checked design calculations for the panels complying with the latest AASHTO Standard Specifications, requirements detailed herein, and the contract plans. Have the plans and design calculations checked and sealed by a North Carolina Registered Professional Engineer. If corrections to the drawings are necessary, submit 1 set of corrected reproducible drawings. Use a plan sheet size of 22" x 34" (560 mm x 864 mm). The drawings become part of the contract plans.

Design the prestressed concrete panels in accordance with the following criteria:

1. Design details to provide a mating surface joint or a draft not exceeding 1/8 inch (3 mm) resulting in a joint that is closed at the top and a maximum of 1/4 inch (6 mm) open at bottom of panel. Detail the joints filled with grout or other methods approved by the Engineer to prevent leakage of the concrete. Place a chamfer or fillet, with a 3/4 inch (19 mm) horizontal width, along the top edges of the panel parallel with the prestressed girder.
2. Design panels to support the dead load of the panel, reinforcement, plastic concrete and a 50 pounds per square foot (2.4 kPa) construction load. Design the panel and slab acting compositely to support design live loads and dead loads acting on the composite section. Include in the design dead load acting on the composite section an additional load of 20 pounds per square foot (1.0 kPa) for a future asphalt wearing surface. For bridges up to 44 feet (13.5 m) in width distribute equally to all deck panels superimposed dead loads for such permanent bridge items as barrier rails, medians or any dead load which is applied after the deck is cast. In the case of bridges over 44 feet (13.5 m) wide, distribute these loads equally to the first 2 1/2 panels adjacent to each side of the load.
3. The design span of the prestressed concrete panel is the clear distance between edges of girders plus 2 inches (50 mm) measured parallel to the panel edges.
4. Limit tension in the precompressed tensile zone to 424 psi (2.92 MPa) unless the contract plans require 0 psi (0 MPa) tension.

(2) Fabricated Metal Stay-In-Place Forms:

Furnish metal stay-in-place forms with closed tapered ends to form the concrete deck slabs as shown on the contract plans. Submit 8 copies of complete fabrication and erection drawings for review, comments and acceptance. Indicate on these plans the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets and a clear indication of locations of form supports. Do not fabricate the forming material until drawings are accepted.

Design metal stay-in-place forms in accordance with the following criteria:

1. Accommodate the dead load of the form, reinforcement and the plastic concrete, including the additional weight of concrete due to the deflection of the metal forms, plus 50 pounds per square foot (2.4 kPa) for construction loads. Do not

allow the unit working stress in the steel sheet to exceed 72.5% of the specified minimum yield strength of the material furnished nor 36 ksi (250 MPa).

2. Limit the horizontal leg of the support angle to 3 inches (75 mm). Design the support angle as a cantilever.
3. Limit the deflection under the weight of the forms, the plastic concrete and reinforcement to 1/180 of the form span or 1/2 inch (13 mm) whichever is less; however, do not design for a total loading less than 120 pounds per square foot (5.7 kPa).
4. Base the permissible form camber on the actual dead load condition. Do not use camber to compensate for deflection in excess of the foregoing limits.
5. The design span of the form sheets is the clear distance between edges of beam or girder flanges minus 2 inches (50 mm) measured parallel to the form flutes. Design and provide form sheets with a length at least the design span of the forms.
6. Compute physical design properties in accordance with requirements of the American Iron and Steel Institute "Specification for the Design of Cold-Formed Steel Structural Members" latest published edition.
7. Provide a minimum concrete cover of 1 1/4 inches (30 mm) clear above metal stay-in-place form to the bottom mat of reinforcement.
8. Maintain the plan dimensions of both layers of primary deck reinforcement from the top of the concrete deck.
9. Do not weld to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.

Do not unload or handle fabricated metal stay-in-place forming materials in such a manner as to damage or alter the configuration of the forms. Replace damaged materials at no additional cost to the Department.

Store fabricated metal stay-in-place forms that are stored at the project site at least 4 inches (100 mm) above the ground on platforms, skids or other suitable supports and protect against corrosion and damage from any source.

Install all forms in accordance with detailed fabrication plans submitted to the Engineer for review. Clearly indicate on the fabrication plans the locations where the forms are supported by steel beam flanges subject to tensile stresses. Do not weld to the flanges within these locations. Do not allow form sheets to rest directly on the top of the beam or girder. Securely fasten sheets to form supports with a minimum bearing length of 1 inch (25 mm) at each end. Center sheets between the form supports. Place form supports in direct contact with the flange of girder or beam. Make all attachments by permissible welds, bolts, clips or other approved means. Weld in accordance with Article 1072-20 of the Standard Specifications, except 1/8 inch (3 mm) fillet welds are permitted.

In the areas where the form sheets lap, securely fasten the form sheets to one another by screws at a maximum spacing of 18 inches (460 mm). Securely attach the ends of the form sheets to support angles with screws at a maximum spacing of 18 inches (460 mm).

Where the galvanized coating is damaged on any exposed form metal, thoroughly clean, wire brush, then paint with two coats of zinc oxide zinc dust primer, Federal Specification TT-P-64ld, Type II, no color added, to the satisfaction of the Engineer. Minor heat discoloration in areas of welds is not considered damage and does not require the above repair.

Locate transverse construction joints at the bottom of a flute and field drill 1/4 inch (6 mm) weep holes at not more than 12 inches (300 mm) on center along the line of the joint.

Use a saw for all cuts. Do not flame cut forms.

420-4 REINFORCEMENT.

Furnish and place reinforcement as shown on the plans and in accordance with the provisions of Section 425.

420-5 PLACING CONCRETE.

Do not place concrete until the depth of the excavation, character of the foundation material, adequacy of the forms and falsework, placement of reinforcement and other embedded items are inspected and approved. Do not place concrete without an Inspector present.

Place concrete in daylight or obtain approval for an adequate lighting system for construction and inspection of the work.

In preparation for the placing of concrete, remove all sawdust, chips, and other construction debris and extraneous matter from the interior of forms. Remove hardened concrete and foreign matter from tools, screeds, and conveying equipment.

Make sure that the concrete temperature at the time of placing in the forms is not less than 50° F (10° C), nor more than 95° F (35° C), except where other temperatures are required by Articles 420-8, 420-9, and 420-15.

Do not use concrete that does not reach its final position in the forms within the time stipulated in Subarticle 1000-4(E).

Thoroughly clean and wet surfaces, other than foundation surfaces, immediately before placing concrete to facilitate bonding to those surfaces.

Regulate the placement of concrete so that the pressures caused by the wet concrete do not exceed those used in the design of the forms.

Thoroughly work the external surface of all concrete during the placing by means of approved tools. During the placing of concrete, take care to use methods of compaction that result in a surface of even texture free from voids, water, or air pockets, and that force the coarse aggregate away from the forms in order to leave a mortar surface.

Place concrete so as to avoid segregation of the materials and the displacement of the reinforcement.

Equip chutes on steep slopes with baffle boards or provide chutes in short lengths that reverse the direction of movement.

Use all chutes, troughs, and pipes made from suitable materials other than aluminum and keep them clean and free from coating of hardened concrete by thoroughly flushing with water after each run. Discharge the water used for flushing clear of the structure.

Confine concrete dropped more than 5 feet (1.5 meters) by closed chutes or pipes, except in walls of box culverts or retaining walls unless otherwise directed.

Take care to fill each part of the form by depositing the concrete as near to its final position as possible. Work the coarse aggregate back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, do not jar the forms and do not place strain on the projecting reinforcement or other items embedded in the concrete.

Compact all concrete required to be vibrated by means of approved high frequency internal vibrators or other approved type of vibrators immediately after depositing concrete in the forms. In all cases, have available at least 2 vibrators in good operating condition

and 2 sources of power at the site of any structure in which more than 25 cubic yards (19 cubic meters) of concrete is required. Do not attach or hold the vibrators against the forms or the reinforcing steel. When vibrating concrete containing epoxy coated reinforcing steel, use a vibrator with a protective rubber head as approved by the Engineer. Vibrate with care and in such a manner to avoid displacement of reinforcement, ducts, or other embedded elements. Vibrate in the appropriate location, manner, and duration to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water to flush to the surface. When placing concrete to a depth in excess of 12 inches (300 mm) and containing one or more horizontal layers of reinforcing steel, place the concrete in horizontal layers not more than 12 inches (300 mm) thick. Place and compact each layer before the preceding layer takes initial set such that there is no surface of separation between layers. Do not taper layers of concrete in wedge-shaped slopes but instead place them with reasonably square ends and level tops.

If placing additional concrete against hardened concrete, take care to remove all laitance and to roughen the surfaces of the concrete to ensure that fresh concrete is deposited upon sound concrete surfaces and an acceptable bond is obtained. Thoroughly wet the existing concrete for a minimum of 2 hours before placing additional concrete.

Deposit and compact so as to form a compact, dense, impervious concrete of uniform texture which shows smooth faces on exposed surfaces. Repair, remove, and replace in whole or in part as directed and at no additional cost to the Department, any section of concrete found to be porous, cracked, plastered, or otherwise defective.

Protect beams and girders during concreting operations. Remove any concrete that gets on beams or girders immediately by an approved method to restore the surface to the specified condition.

420-6 PUMPING CONCRETE.

Placement of concrete by pumping is permitted only when approved. Use and locate suitable pumping equipment that is adequate in capacity for the work and so that no vibrations result which might damage freshly placed concrete. Do not use pumping equipment, including the conduit system, which contains any aluminum or aluminum alloy that comes in contact with the concrete.

Waste all grout used to lubricate the inner surfaces of the conduit system.

Pump so that a continuous stream of concrete without air pockets is delivered. After pumping is complete, eject any concrete usable in the work and remaining in the pipeline, in such a manner that there is no contamination of the concrete or separation of the ingredients.

Take samples of concrete for test purposes from the discharge end of the conduit system unless otherwise permitted.

420-7 SLUMP TESTS.

The slump of the concrete is determined in accordance with AASHTO T119.

When a slump test is made and the results of the test exceed the specified maximum, a check test is made immediately from the same batch or truck load of concrete. If the average of the 2 test results exceeds the specified maximum slump, the batch or truck load that contains the batch is rejected.

420-8 FOUNDATION SEALS FOR COFFERDAMS.

For each substructure unit where a foundation seal is required in the plans, construct a cofferdam of sufficient horizontal and vertical dimensions to cast the seal as designed and detailed, or as directed. Have the cofferdam designed, detailed, and sealed by a North Carolina Registered Professional Engineer. Construct the cofferdam in accordance with plans prepared by such engineer. Furnish 7 copies of the plans and 1 copy of the design

calculations for review, comment and acceptance prior to beginning construction of the cofferdam. Where a foundation seal is not required by the plans, but is allowed by the Engineer, obtain approval of the cofferdam before placing the foundation seal.

Use a heavy duty digging type clamshell and air lift or other approved equipment as necessary to excavate from within the cofferdam to obtain a satisfactory foundation. Blasting is allowed if approved by the Engineer. For consideration of blasting inside or adjacent to cofferdams, submit a professionally prepared drilling, loading, and detonating plan for review at least 3 weeks prior to the work. If installing bracing inside the cofferdam before completing excavation, make sure the bracing does not restrict excavation operations adjacent to cofferdam walls. Remove overburden trapped in sheet piling corrugations by water jets or other means. Perform the final excavation by air lift to clean the foundation just prior to casting the seal.

Do not pump to lower the water elevation inside the cofferdam to facilitate excavation or driving piles.

Engage a competent diver or divers to inspect the excavated area within the cofferdam to assure complete removal of all overburden from sheet piling corrugations and bottom of excavation. Notify the Engineer after cleaning the excavated area so that it may be inspected by Department divers. If found acceptable, proceed with casting the seal. If Department divers find the excavated area unacceptable and later inspections are necessary, reimburse the Department for the cost of all underwater inspections excluding the first inspection.

Construct the foundation seal by placing Class S concrete under water by means of a tremie or tremies, consisting of a watertight steel pipe having a diameter of at least 10 inches (250 mm) with a hopper at the top. Use watertight screw connections or flanged connections fitted with gaskets for couplings in tremie pipes. Equip the tremie with a watertight plug on the lower end to permit lowering of the empty pipe to the point of deposit without water entering the pipe. Support the tremies so as to permit proper filling of the hopper and so that slowly raising the tremie starts concrete flow and quickly lowering the tremie reduces or stops flow. Submit details for supporting, raising, and lowering the tremie for review at least 3 weeks prior to placing concrete.

Base the number and spacing of tremies used upon the size of seal. Unless otherwise permitted or required in the plans, use at least one tremie for each 400 square feet (37 square meters) or fraction thereof of the horizontal cross-section of the foundation seal. Locate the tremies such that the area covered by each tremie is approximately equal. When using more than one tremie, place concrete alternately or concurrently in each tremie such that the concrete surface remains as nearly horizontal as practical at all times.

Place concrete under water in such a way so that cement is not washed out of the mix. Do not vibrate or agitate the concrete. Do not allow concrete to fall through water. After initially filling the tremie, keep the lower end embedded in previously placed concrete until the pour is complete. When concrete is deposited in the hopper, slowly raise the tremie to start flow and lower to reduce or stop flow when concrete reaches the bottom of the hopper.

To assure that the lower end of tremie is not raised above the concrete surface, mark the tremie pipe in feet (tenths of a meter) from the lower end to above the water surface. Take periodic soundings of the concrete surface to determine elevation of the concrete with respect to the end of the tremie.

Provide a continuous flow of concrete until the work is complete. Produce a seal that is monolithic and homogeneous. Determine by soundings when to stop placing concrete by using elevation references set at several points around the cofferdam.

At the time of placing, make sure that the temperature of Class S concrete is not less than 40°F (4°C) or more than 75°F (24°C). Do not deposit concrete under water when water temperature is less than 35°F (2°C) at the water surface.

Do not dewater the cofferdam until at least 7 days after placing concrete. After dewatering the cofferdam, clean the seal surface of all scum, laitance, and sediment to expose good sound concrete. Remove concrete peaks within the footing limits such that there is not more than 2 feet (0.6 m) difference in elevation between the highest and lowest concrete surface. Excavate a trench in the concrete adjacent to cofferdam sheeting to collect and divert seepage water to a suitable sump outside the footing limits. Remove this water during placement of footing concrete so that there is no running or standing water within or immediately adjacent to footing forms.

After removing cofferdam sheeting, vertical faces of the foundation seal are inspected by Department divers. Should honeycomb, cracks, crevices, or other defects be evident, the Engineer determines acceptability of the foundation seal. Should the seal be considered unacceptable, repair the defects in a manner acceptable to the Engineer at no cost to the Department.

420-9 PLACING CONCRETE IN COLD WEATHER.

(A) General:

Do not place concrete when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35°F (2°C) without permission. When such permission is granted, uniformly heat the aggregates and/or water to a temperature not higher than 150°F (65°C). Place the concrete when the temperature of the heated concrete is not less than 55°F (12°C) and not more than 80°F (27°C).

Use aggregates that are free of ice, frost, and frozen particles. Do not place concrete on frozen foundation material.

Protect all concrete by means of heated enclosures or by insulation whenever any of the following conditions occur:

1. The concrete is placed when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35°F (2°C).
2. The air temperature, measured at the location of the freshly placed concrete in the shade away from artificial heat, is below 35°F (2°C) and the concrete has not yet attained an age of 72 hours or an age of 48 hours when using high-early strength portland cement concrete. If the mix contains fly ash or ground granulated blast furnace slag, protect the concrete for 7 days.

Provide and place at directed locations a sufficient number of maximum-minimum recording thermometers to provide an accurate record of the temperature surrounding the concrete during the entire protection period.

Assume all risks connected with the placing of concrete under the cold weather conditions referred to herein. Permission given to place concrete when the temperature is below 35°F (2°C) and the subsequent protection of the concrete as required herein does not relieve the Contractor in any way of the responsibility for obtaining the required results.

(B) Heated Enclosures:

Immediately enclose portland cement concrete that is placed when the air temperature is below 35°F (2°C), and portland cement concrete that has not yet attained an age of 72 hours before the air temperature falls below 35°F (2°C), with a housing consisting of canvas or other approved material supported by an open framework or with an equally satisfactory housing. Maintain the air surrounding the concrete at a temperature of not less than 50°F (10°C) nor more than 90°F (32°C) for the remainder of the 72 hour period. Apply these same requirements to high-early-strength portland cement concrete

except reduce the 72 hour period to 48 hours. Do not begin these time periods until completing manipulation of each separate mass of concrete.

Provide such heating apparatus as stoves, salamanders, or steam equipment, and the necessary fuel. When using dry heat, provide means of preventing loss of moisture from the concrete.

(C) Insulation:

As an alternate to the heated enclosure specified in Subarticle 420-9(B), use insulated forms or insulation meeting all requirements of this Subarticle to protect concrete. Use insulation under the same conditions that require heated enclosures. Place the insulation on the concrete as soon as initial set permits.

When using insulation for cold weather protection, batch concrete for sections 12 inches (300 mm) or less in thickness or diameter as outlined below. Use Type III portland cement without any increase in cement content, or use Type I or II portland cement with the cement content increased to 1.80 barrels per cubic yard (2.4 barrels per cubic meter). When the mix includes fly ash, use a mix containing 572 lbs. per cubic yard (340 kg per cubic meter) of cement and a minimum of 172 lbs. per cubic yard (102 kg per cubic meter) of fly ash. When the mix includes ground granulated blast furnace slag, use a mix containing 465 lbs. per cubic yard (276 kg per cubic meter) of cement and 250 lbs. per cubic yard (148 kg per cubic meter) of ground granulated blast furnace slag.

Use insulated materials with a minimum thickness of 1 inch (25 mm). Insulate overhang forms both on the outside vertical faces and on the underside with a 1 inch (25 mm) minimum thickness of either rigid or blanket type insulation. Use insulating materials which provide a minimum system R value of 4.0 in the up mode as determined by ASTM C-236 with a 15 mph (24.1 km per hour) wind over the cold side of the material and a minimum differential of 50°F (10°C). Furnish results of tests conducted in accordance with ASTM C-236 by an acceptable commercial testing laboratory for review, comments and acceptance. Obtain such acceptance prior to use of the material. Face or cover insulating blankets, top and bottom, with polyethylene or similar waterproofing material meeting the test requirements of Article 1026-3 except for the length and color requirements. Place blankets on the concrete in such a manner that they form a waterproof surface for the protected concrete. Do not use blankets with rips and tears in the waterproofing material unless acceptably repaired. When the anticipated low temperature expected during the protection period is less than 10°F (-12°C), provide 2 inches (50 mm) of insulation. Overlap blanket insulation mats at the edges by at least 6 inches (150 mm). Tightly butt rigid type insulation sheets together and seal. Take particular care to provide effective protection of curbs, corners, and around protruding reinforcing steel.

Should the air under the insulation fall below 50°F (10°C) during the protection period, immediately cover the concrete with canvas and framework or other satisfactory housing and apply heat uniformly at a rate such that the air surrounding the concrete is not less than 50°F (10°C) for the remainder of the protection period.

In the event that insulating materials are removed from the concrete prior to the expiration of the curing period, cure the concrete for the remainder of the period in accordance with Article 420-16.

420-10 CONSTRUCTION JOINTS.

Provide construction joints only where located on the plans or shown in the placing schedule, unless otherwise approved in writing.

Place the concrete in each integral part of the structure continuously. Do not commence work on any such part unless the concrete supply, forces, and equipment are sufficient to complete the part without interruption in the placing of the concrete.

In case of emergency, make construction joints or remove the concrete as directed.

Make construction joints without keys, except when required on the plans. Rough float surfaces of fresh concrete at horizontal construction joints sufficiently to thoroughly consolidate the concrete at the surface.

After placing concrete to the construction joint and before placing fresh concrete, thoroughly clean the entire surface of horizontal construction joints of surface laitance, curing compound, and other materials foreign to the concrete. Clean vertical construction joints of curing compound and other materials foreign to the concrete.

Thoroughly clean and wet concrete surfaces immediately before placing additional concrete in order to facilitate bonding.

420-11 WIDENING EXISTING STRUCTURES.

Where plans call for widening existing concrete structures, or otherwise require bonding new concrete to old, remove portions of the existing structures as indicated on the plans.

When extending an existing culvert, remove the following portions of the existing culvert: the portions that interfere with the proposed extension, headwalls only as necessary to clear proposed subgrade by a minimum of 18 inches (460 mm), and wingwalls in such a manner that square surfaces the full thickness of the new sidewalls are provided for bonding new concrete to old. Cut existing wingwall reinforcing steel off flush with the concrete surface.

Thoroughly roughen, clean of loose material, and wet connecting surfaces of the old concrete for a minimum of 2 hours before placing new concrete.

420-12 EXPANSION JOINTS.

(A) General:

Locate and construct all joints as shown on the plans.

Chamfer or edge the edges of joints as shown on the plans or as directed.

Immediately after removing the forms, inspect the expansion joint carefully. Neatly remove any concrete or mortar in the joint.

(B) Filled Joints:

Use cork, bituminous fiber, neoprene, or rubber meeting the requirements of Article 1028-1 in all expansion joint material. Use an optional second layer to obtain the required thickness, when a thickness of more than 1 inch (25 mm) is required.

Cut the joint filler to the same shape and size as the area to be covered except cut it 1/2 inch (13 mm) below any surface that is exposed to view in the finished work. As an option, cut the joint filler the same size and shape as that of the adjoining surfaces, and neatly cut back the material 1/2 inch (13 mm) on the surfaces that are exposed to view after the concrete hardens. Cut the joint filler out of as few pieces as practicable and, except as noted above, completely fill the space provided. Fasten the pieces in any one joint together in an approved manner. Do not use loose fitting or open joints between sections of filler or between filler and forms. Do not use joints made up with small strips. Place two-ply roofing felt over all joints in the filler material in vertical expansion joints below top of curbs. Place the felt on the side of the joint adjacent to the new pour.

Seal all joints as called for on the plans.

Make sure that joints that are sealed with hot-poured rubber asphalt joint sealer are dry and cleaned by brush blast cleaning immediately before sealing. Brush blast cleaning consists of sand blasting with the nozzle held at approximately a 45° angle to the surface and continuously kept in motion to minimize cutting of the surface. Perform brush blast

cleaning so as to provide a firm, clean joint surface free of curing compound, loose material, and any foreign matter.

Use equipment for heating hot-poured rubber asphalt joint sealer that is suitable for the purpose. Do not use direct heating. Heat the joint sealer in a kettle or tank constructed as a double boiler, and fill the space between the inner and outer shells with oil, asphalt, or other material for heat transfer. Provide positive temperature control. Other acceptable methods of indirect heating are allowed as permitted by the Engineer.

420-13 DRAINS IN WALLS AND CULVERTS.

Construct drain holes and weep holes in abutment walls, wing walls, retaining walls, and the exterior walls of culverts as shown on the plans unless otherwise directed, and backfill in accordance with the provisions of Articles 410-9 and 410-10.

Cover drain holes and weep holes at the back face of the wall with hardware cloth of commercial quality, approximately 4 mesh (6 mm openings), of aluminum or galvanized steel wire.

420-14 ANCHOR BOLTS AND BEARING AREAS.

(A) Anchor Bolts:

Accurately set all necessary anchor bolts in piers, abutments, or pedestals either while placing concrete, in formed holes, or in holes cored or drilled after the concrete sets.

If set in the concrete, position the bolts by means of templates and rigidly hold in position while placing the concrete.

Form holes by inserting in the fresh concrete oiled wooden plugs, metal pipe sleeves, or other approved devices, and withdrawing them after the concrete partially sets. Provide holes formed in this manner which are at least 4 inches (100 mm) in diameter.

Core holes at least 1 inch (25 mm) larger in diameter than the bolt used. Use approved equipment for coring concrete. Do not use impact tools. Place reinforcing steel to provide adequate space to core bolt holes without cutting the reinforcing steel.

During freezing conditions, protect anchor bolt holes from water accumulation at all times.

Bond the anchors with a non-shrink portland cement grout or a grout made with epoxy resin. Completely fill the holes with grout. Use any pre-approved non-shrink composition compatible with the concrete.

(B) Bearing Areas:

Finish bridge seat bearing areas to a true level plane to not vary perceptibly from a straightedge placed in any direction across the area.

Place bearing plates in accordance with the provisions of Article 440-6.

420-15 PLACING AND FINISHING BRIDGE FLOORS.

(A) Placing Concrete:

Unless otherwise noted on the plans, use Class AA cast-in-place concrete conforming to the requirements of Section 1000.

Place concrete in accordance with these specifications. Properly vibrate concrete to avoid honeycomb and voids. Have pouring sequences, procedures and mixes approved by the Engineer.

For metal stay-in-place forms, do not place concrete on the forms to a depth greater than 12 inches (300 mm) above the top of the forms. Do not drop concrete more than 3 feet (1 m) above the top of the forms, beams or girder. Discharge the concrete directly over the beams or girders.

Keep the top surface of prestressed concrete panels clean. Thoroughly inspect panels prior to placement of the concrete cast-in-place slab. Remove any foreign matter, oil, grease or other contaminants either with a high pressure water blast or sand blast. Saturate the top surface of the prestressed concrete panels by thoroughly wetting the top surface with water for a minimum of 2 hours before placing the cast-in-place concrete slab. Do not allow the wetted panel surface to dry before cast-in-place concrete slab placement. Remove all puddles and ponds of water from the surface of the panels and top of girder flanges before placing the cast-in-place concrete slab.

Obtain a smooth riding surface of uniform texture, true to the required grade and cross section, on all bridge roadway floors.

Do not place concrete in bridge floors until the Engineer is satisfied that adequate personnel and equipment are present to deliver, place, spread, finish, and cure the concrete within the scheduled time; that experienced finishing machine operators and concrete finishers are employed to finish the floor; and that weather protective equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use. During the period between April 15 and October 15, begin placing concrete in bridge floors as early as practical in order that the concreting operations are accomplished during the cooler hours when forms, beams, and reinforcing steel are at ambient air temperatures.

Unless otherwise permitted, set the rate of concrete placement and use a set retarder such that the concrete remains workable until the entire operation of placing, screeding, rescreeding, surface testing, and corrective measures where necessary are complete. Use of a set retarder is waived when conditions clearly indicate it is not needed.

Place concrete in the deck when the concrete temperature at the time of placement is not less than 50°F (10°C), nor more than 90°F (32°C), except where other temperatures are required by Article 420-9.

Place concrete at a minimum rate of 35 cubic yards per hour (25 cubic meters per hour).

Place and firmly secure supports for screeds or finishing machines before beginning placement of concrete. Set supports to elevations necessary to obtain a bridge roadway floor true to the required grade and cross section, and make allowance for anticipated settlement. Use supports of a type that upon installation, no springing or deflection occurs under the weight of the finishing equipment. Locate the supports such that finishing equipment operates without interruption over the entire bridge floor.

Immediately prior to placing bridge floor concrete, check all falsework and make all necessary adjustments. Provide suitable means such as telltales to permit ready measurement by the Engineer of deflection as it occurs. Do not adjust the profile grade-line for any of the forming types used, unless permitted.

On continuous steel beam or girder spans, cast the concrete in the order shown on the plans. On simple spans, and for any section between construction joints for continuous spans, place the concrete in the floor slab by beginning at the end and working along the roadway or by beginning at the side and working across the roadway. Use approved screeds, screed supports, and screeding methods.

(B) Finishing:

Unless otherwise specified or permitted, use mechanically operated longitudinal or transverse screeds for finishing bridge floor concrete. Do not use vibratory screeds unless specifically approved. Use readily adjustable screeds with sufficient rigidity and width to strike-off the concrete surface at the required grade. Do not use aluminum strike-off elements of screeds and hand tools used for finishing concrete.

Furnish personnel and equipment necessary to verify the screed adjustment and operation prior to beginning concrete placement.

Unless otherwise permitted, do not use longitudinal screeds for pours greater than 85 feet (26 m) in length. Place sufficient concrete ahead of the screeded area to assure all dead load deflection occurs before final screeding.

When using a transverse screed on a span with a skew angle less than 75 degrees or more than 105 degrees, orient and operate the truss or beam supporting the strike-off mechanism parallel to the skew. Position the strike-off parallel to the centerline of bridge, and make the leading edge of concrete placement parallel to the skew. If approved, operate at a reduced skew angle on very wide or heavily skewed spans where the distance between screed supports exceeds 100 feet (30 m).

Orient and operate transverse screeds used on spans with skew angles between 75 degrees and 105 degrees parallel to the skew or perpendicular to the centerline of bridge.

Prior to placing concrete, verify the adjustment and operation of the screed as directed by operating the screed over the entire area and across all end bulkheads. Check the floor thickness and cover over reinforcing steel shown on the plans, and make adjustments as necessary.

During the screeding operation, keep an adequate supply of concrete ahead of the screed and maintain a slight excess immediately in front of the screed. Operate the screed to obtain a substantially uniform surface finish over the entire bridge floor. Do not allow workmen to walk on the concrete after screeding. Use a minimum of 2 approved work bridges to provide adequate access to the work for the purpose of finishing, testing, straightedging, making corrections, fogging, applying curing medium, and for other operations requiring access to the bridge floor. Support the work bridges outside the limits of concrete placement.

The Engineer makes random depth checks of floor thickness and cover over reinforcing steel over the entire placement area and directly behind the screed in the fresh concrete. If depth checks indicate variations from plan dimensions in excess of 1/2 inch (13 mm), take corrective action immediately.

Immediately following the screed and while the concrete is still workable, test the floor surface for irregularities with a 10 foot (3 m) straightedge. Test by holding the straightedge in successive positions parallel to the centerline of bridge and in contact with the floor surface. Test the surface approximately 18 inches (460 mm) from the curb line, at the centerline of each lane, and at the centerline of 2 lane bridges. Advance along the bridge in stages of not more than 1/2 the length of straightedge. Test the surface transversely at the ends, quarter points, and center of the span as well as other locations as directed.

Immediately correct areas showing depressions or high spots of more than 1/8 inch in 10 feet (3 mm in 3 m) by filling depressions with fresh concrete or by striking off high spots. Make corrections with hand tools or a combination of hand tools and rescreeding. Do not use the straightedge as a finishing tool. Give surfaces adjacent to expansion joints special attention to assure they meet the required smoothness.

Provide on the site fogging equipment which is capable of applying water to the concrete in the form of a fine fog mist in sufficient quantity to curb the effects of rapid evaporation of mixing water from the concrete on the bridge floor resulting from wind, high temperature, or low humidity, or a combination of these factors. Do not apply the moisture from the nozzle under pressure directly upon the concrete and do not allow it to accumulate on the surface in a quantity sufficient to cause a flow or wash the surface. Maintain responsibility for determining when to apply the fog mist; however, also apply it when directed.

Keep readily available on site an adequate supply of suitable coverings that will protect the surface of the freshly placed bridge floor from rain. After the water sheen disappears from the surface and before the concrete becomes non-plastic, finish the surface of the floor further by burlap dragging, fine bristle brooming, belting, or other acceptable method which produces an acceptable uniform texture.

Cure the concrete in accordance with Article 420-16, except do not use the Membrane Curing Compound Method. Prior to reaching initial set, place a curing medium consisting of burlap under polyethylene sheets or another approved material on the deck and keep moist for a minimum of 7 curing days. Wet the burlap or other approved curing medium prior to placing on the deck. Apply water to the curing medium through soaker hoses or another approved method. Apply water in amounts to keep the medium moist but do not allow the water to flow or pond on the deck.

After curing the concrete, test the finished surface by means of an approved rolling straightedge designed, constructed, and adjusted to accurately indicate or mark all floor areas which deviate from a plane surface by more than 1/8 inch in 10 feet (3 mm in 3 m). Remove all high areas in the hardened surface in excess of 1/8 inch in 10 feet (3 mm in 3 m) with an approved grinding or cutting machine. Where variations are such that the corrections will extend below the limits of the top layer of grout, seal the corrected surface with an approved sealing agent as required. If approved, correct low areas in an acceptable manner. Produce corrected areas that have a rough, uniform texture and present neat patterns. In all cases, maintain a minimum of 2 inches (50 mm) of concrete cover over reinforcement.

Unless otherwise indicated on the plans, groove bridge floors. Produce grooves that are perpendicular to the centerline of bridge. Do not start grooving until final straightedging and, when necessary, acceptable corrective measures are complete. Cut grooves into the hardened concrete using a mechanical saw device which leaves rectangular grooves 1/8 inch (3 mm) wide and 3/16 inch (5 mm) deep. Produce grooves that have a center to center spacing of 3/4 inch (19 mm). Do not groove the floor surface within 18 inches (460 mm) of the gutter lines and 2 inches (50 mm) of expansion joints or elastomeric concrete in expansion joint blockouts. On skewed bridges, ungrooved triangular areas adjacent to the joint are permitted, provided the distance from the centerline joint to the nearest groove, as measured parallel to the centerline of roadway, does not exceed 18 inches (460 mm). Between expansion joints on horizontally curved bridges, periodically adjust the grooving operation such that adjacent grooves are separated by no more than 3 inches (75 mm) along the outer radius of the bridge floor.

Continuously remove all slurry or other residue resulting from the grooving operation from the bridge floor by vacuum pick-up or other approved methods. Prevent slurry from flowing into floor drains or onto the ground or body of water under the bridge. Dispose of all residue off the project.

(C) Inspection:

The Engineer observes all phases of the construction of the bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement and vibration; and finishing of the bridge deck.

After the deck concrete is in place for a minimum period of 2 days, test the concrete for soundness and bonding of the metal stay-in-place forms by sounding with a hammer as directed. For a minimum of 50% of the individual form panels, as selected by the Engineer, hammer test over the entire area of the panel. If areas of doubtful soundness are disclosed by this procedure, remove the forms from such areas for visual inspection after the pour attains a minimum compressive strength of 2400 psi (16.5 MPa). Remove the stay-in-place forms at no additional cost to the Department.

At locations where sections of the forms are removed, do not replace the forms, but repair the adjacent metal forms and supports to present a neat appearance and assure their satisfactory retention. As soon as the forms are removed, allow the Engineer to examine for cavities, honeycombing and other defects. If irregularities are found, and in the opinion of the Engineer these irregularities do not justify rejection of the work, repair the concrete as directed. If the concrete where the forms are removed is unsatisfactory, remove additional forms, as necessary, to inspect and repair the slab. Modify the methods of construction as required to obtain satisfactory concrete in the slabs. Remove and repair all unsatisfactory concrete as directed.

Provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection procedures.

420-16 CURING CONCRETE.

(A) General:

Unless otherwise specified in the special provisions, use any of the following methods except for membrane curing compounds on bridge floors unless permitted in conjunction with the polyethylene sheeting method. Advise the Engineer in advance of the proposed method. Have all material, equipment, and labor necessary to promptly apply the curing on the site before placing any concrete. Cure all patches in accordance with this article. Improperly cured concrete is considered defective.

When used in this article, curing temperature is defined as the atmospheric temperature taken in the shade away from artificial heat, with the exception that it is the temperature surrounding the concrete where the concrete is protected in accordance with Article 420-9.

A curing day is defined as any consecutive 24 hour period, beginning when the manipulation of each separate mass is complete, during which the air temperature adjacent to the mass does not fall below 40°F (4°C).

After placing the concrete, cure it for a period of 7 full curing days.

Take all reasonable precautions to prevent plastic shrinkage cracking of the concrete, including the provision of wind screens, fogging, application of an approved temporary liquid moisture barrier, or the early application of temporary wet coverings to minimize moisture loss.

Repair, remove, or replace as directed concrete containing plastic shrinkage cracks at no cost to the Department.

(B) Water Method:

Keep the concrete continuously wet by the application of water for a minimum period of 7 curing days after placing the concrete.

When using cotton mats, rugs, carpets, or earth or sand blankets to retain the moisture, keep the entire surface of the concrete damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with the curing medium. Do not apply the moisture from the nozzle under pressure directly upon the concrete and do not allow it to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface. At the expiration of the curing period, clear the concrete surfaces of all curing mediums.

(C) Membrane Curing Compound Method:

Spray the entire surface of the concrete uniformly with a wax-free, resin-base curing compound conforming to the requirements of Article 1026-2. Use clear curing compound to which a fugitive dye is added for color contrast on bridge superstructures and substructures, and on retaining walls. Use either white pigmented or clear curing compound on culverts.

Apply the membrane curing compound after the surface finishing is complete, and immediately after the free surface moisture disappears. During the finishing period, protect the concrete by applying water with the fogging equipment specified in Subarticle 420-16(B).

Seal the surface with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the manufacturer or as directed, but not less than 1 gallon per 150 square feet (1 liter per 3.7 square meters) of area on surfaces other than bridge approach slabs. On bridge approach slabs, apply the curing compound at a minimum rate of 1 gallon per 100 square feet (1 liter per 2.5 square meters) of area.

At the time of use, thoroughly mix the compound with the pigment uniformly dispersed throughout the vehicle. If the application of the compound does not result in satisfactory coverage, stop the method and begin water curing, as set out above, until the cause of the defective work is corrected.

At locations where the coating shows discontinuities, pinholes, or other defects, or if rain falls on the newly coated surface before the film dries sufficiently to resist damage, apply an additional coat of the compound at the same rate specified herein immediately after the rain stops.

Completely remove any curing compound adhering to a surface to which new concrete is to be bonded by sandblasting, steel wire brushes, bush hammers, or other approved means.

Protect the concrete surfaces to which the compound is applied from abrasion or other damage that results in perforation of the membrane film for 7 curing days after placing the concrete. If the film of membrane compound is damaged or removed before the expiration of 7 curing days, immediately cure the exposed concrete by the water method until the expiration of the 7 curing days or until applying additional curing compound.

In the event that the application of curing compound is delayed, immediately start applying water as provided in Subarticle 420-16(B) and continue until resuming or starting application of the compound.

(D) Polyethylene Sheeting Method:

Wet the exposed finished surface of concrete with water, using a nozzle that so atomizes the flow to form a mist and not a spray, until the concrete sets, after which place the white opaque polyethylene sheeting. Continue curing for 7 curing days after the concrete is placed. If the sheeting is damaged or removed before the expiration of 7 curing days, immediately cure the exposed concrete by the water method until placing additional sheeting or until after 7 curing days.

Use sheeting which provides a complete continuous cover of the entire concrete surface. Lap the sheets a minimum of 12 inches (300 mm) and securely weigh down or cement them together in such a manner as to provide a waterproof joint.

If any portion of the sheets is broken or damaged before the expiration of the curing period, immediately repair the broken or damaged portions with new sheets properly secured in place.

Do not use sections of sheeting damaged to such an extent as to render them unfit for curing the concrete.

(E) Forms-in-Place Method:

As an option, cure surfaces of concrete by retaining the forms in place for a minimum period of 7 curing days after placing the concrete.

If electing to leave forms in place for a part of the curing period and using one of the other methods of curing included in this article for the remainder of the curing period, keep the concrete surfaces wet during transition between curing methods.

420-17 REMOVAL OF FORMS AND FALSEWORK.

Do not remove forms and falsework for the portions of structures listed in Table 420-1 until the concrete attains the compressive strength shown, as evidenced by nondestructive test methods approved in writing or by conducting compressive strength tests in accordance with AASHTO T22 and T23. Furnish approved equipment used for nondestructive tests.

TABLE 420-1
MINIMUM CONCRETE STRENGTH FOR
REMOVAL OF FORMS AND FALSEWORK

Portion of Structure	Minimum Compressive Strength, psi (MPa)
Floor slabs and overhangs for beam and girder bridges	3,000 (20.7)
Arch culverts, top slabs and walls of box Culverts, caps and struts of sub-structures, bent diaphragms, and other members subject to dead load bending	2,400 (16.5)
Walls 10 feet (3 m) or more in height	2,400 (16.5)

Do not remove forms for ornamental work, railing, parapets, walls less than 10 feet (3 m) in height, and vertical surfaces that do not carry loads, until at least 12 hours after casting the concrete.

Remove forms for inside curb faces on bridge superstructures any time after 3 hours if the concrete is set sufficiently to permit form removal without damage to the curbs.

Do not remove forms used for insulation before the expiration of the minimum protective period required in Article 420-9.

Do not remove formwork for bent diaphragms until after casting deck concrete and allowing the concrete to attain a strength of 2,400 psi (16.5 MPa). As an option, to remove support from bent diaphragms prior to casting deck concrete, submit for approval a method to prevent the possibility of bent diaphragms slipping downward.

When removing forms prior to the end of the required curing period, use other curing methods to complete the required curing. When removing forms from underneath slabs prior to the end of the curing period, complete the curing in accordance with the requirements of Subarticle 420-16(C).

420-18 SURFACE FINISH.

(A) General:

Finish all concrete as required by this article except for bridge floors. Use the type of finish called for in Subarticles 420-18(B) through 420-18(D), except where the plans or special provisions call for a Class 1 or Class 2 surface finish.

(B) Ordinary Surface Finish:

Apply ordinary surface finish to all formed concrete surfaces either as a final finish or preparatory to a higher class finish. On surfaces backfilled or otherwise covered, or enclosed surfaces, the removal of fins and form marks, the rubbing of grouted areas to a uniform color, and the removal of stains and discoloration, is not required. Use an ordinary surface finish, unless otherwise required, as final finish on all surfaces.

During the placing of concrete, take care to use methods of compaction that result in a surface of even texture free from voids, water, or air pockets, and that the coarse aggregate is forced away from the forms in order to leave a mortar surface.

Immediately after removing the forms, clean and fill with grout all pockets, depressions, honeycombs and other defects as directed. Remove all form ties or metal spacers to a depth of at least 1 inch (25 mm) below the surface of the concrete then clean and fill the resulting holes or depressions with grout. As an option, break off flush with the concrete surface those metal devices with exposed cross sectional area not exceeding 0.05 square inches (32 square mm) on surfaces permanently in contact with earth fill. Unless otherwise required, remove fins and other projections flush with the concrete surface. Remove stains and discoloration.

Use grout for patching which contains cement and fine aggregate from the same sources and in the same proportions as used in the concrete. Cure the grout in accordance with Article 420-16. After the grout has thoroughly hardened, rub the surface with a carborundum stone as required to match the texture and color of the adjacent concrete.

(C) Unformed Surfaces Not Subjected to Wear:

Finish all unformed surfaces not subjected to wear by placing an excess of material in the forms and removing or striking off such excess with a wooden template, forcing the coarse aggregate below the mortar surface. Do not use mortar topping for concrete railing caps and other surfaces falling under this classification.

Obtain the final finish for caps and railing in one of the following ways:

1. Brush Finish: After striking off the concrete as described above, have skilled and experienced concrete finishers thoroughly work and float the surface with a wooden, canvas, or cork float. Before this last finish sets, lightly stroke the surface with a fine brush to remove the surface cement film, leaving a fine grained, smooth, but sanded texture.
2. Float Finish: Finish the surface with a rough carpet float or other suitable device leaving the surface even, but distinctly sandy or pebbled in texture.

(D) Sidewalk, Islands, or Stairways on Bridges:

Strike off and compact fresh concrete until a layer of mortar is brought to the surface. Finish the surface to grade and cross section with a float, trowel smooth, and finish with a broom. If water is necessary, apply it to the surface immediately in advance of brooming. Broom transverse to the line of traffic.

(E) Class 1 Surface Finish:

In addition to the requirements of Subarticle 420-18(B), as soon as the pointing sets sufficiently to permit, thoroughly wet the entire surface with a brush and rub with a coarse carborundum stone or other equally good abrasive, bringing the surface to a paste. Continue rubbing to remove all form marks and projections, producing a smooth dense surface without pits or irregularities.

Carefully spread or brush uniformly over the entire surface the material ground to a paste by rubbing and allowing it to take a reset. After rubbing, cure the surface for a period of 7 curing days. Obtain the final finish by thoroughly rubbing with a fine carborundum stone or other equally good abrasive. Continue this rubbing until the entire surface is of a smooth texture and uniform color.

(F) Class 2 Surface Finish:

In addition to the requirements of Subarticle 420-18(B), after the pointing sets sufficiently to permit, thoroughly wet and rub the entire surface with a coarse carborundum stone or other equally good abrasive to bring the surface to a smooth texture and remove all form marks. Finish the paste formed by rubbing as described above by carefully

stroking with a clean brush, or spread it uniformly over the surface and allow it to take a "reset", then finish it by floating with a canvas, carpet-faced, or cork float; or rub down with dry burlap.

420-19 PROTECTION OF SUBSTRUCTURE CONCRETE FROM RUST STAINS.

In order to prevent unpainted structural steel from staining substructure concrete, protect all final exposed areas of the concrete from rust stains until casting the bridge floor and sealing the expansion joints. Use an approved method for protecting the concrete.

In lieu of the above, allow the unpainted structural steel to stain the concrete and, after completing the bridge floors, remove the stains by approved methods and cleaning agents.

420-20 PLACING LOAD ON STRUCTURE MEMBERS.

Do not place beams or girders on concrete substructures until the concrete in the substructure develops a minimum compressive strength of 2,400 psi (16.5 MPa).

In addition to the requirements of Article 410-9, do not place backfill or fill for retaining walls, abutments, piers, wing walls, or other structures that will retain material to an elevation higher on one side than the other until the concrete develops the minimum specified strength for the class of concrete required for the structure.

Do not carry backfill for arch culverts and box culverts to an elevation higher than 1 foot (0.3 m) above the top of footing or bottom slab until the concrete develops the minimum specified strength for the class of concrete required for the culvert.

Adhere to the following time and strength requirements for erection of forms and construction of superimposed bridge substructure elements:

1. Wait a minimum of 12 hours between placing footing or drilled pier concrete and erecting column forms.
2. Wait a minimum of 24 hours between placing footing or drilled pier concrete and placing column concrete.
3. Wait a minimum of 72 hours between placing column concrete and beginning erection of cap forms or until column concrete attains a compressive strength of at least 1,500 psi (10.3 MPa).
4. Wait a minimum of 96 hours between placing column concrete and placing cap concrete or until column concrete attains a compressive strength of at least 2,000 psi (13.8 MPa).

Do not place vehicles or construction equipment on a bridge deck until the deck concrete develops the minimum specified 28 day compressive strength and attains an age of at least 14 curing days. Construction equipment is allowed on bridge approach slabs after the slab concrete develops a compressive strength of at least 3,000 psi (20.7 MPa) and attains an age of at least 7 curing days. A curing day is defined in Subarticle 420-16(A).

Provide evidence that the minimum compressive strengths referred to above are satisfied by nondestructive test methods approved in writing or by compressive strength tests made in accordance with AASHTO T22 and T23. Furnish approved equipment for use in nondestructive tests.

Do not place construction equipment, materials, or other construction loads on any part of the structure without permission. Submit 7 copies of the proposed plans for placing construction loads on the structure for review, comments and acceptance.

Do not abruptly start or stop concrete trucks on bridge deck. Do not mix concrete in the truck while on the deck. While placing concrete barrier rail or parapet, do not place any equipment on the deck except one concrete truck. Allow concrete barrier rail and

parapet to attain a compressive strength of 3000 psi (20.7 MPa) prior to placing any other traffic on the deck.

Do not operate heavy equipment over any box culvert until properly backfilling with a minimum cover of 3 feet (1 m).

420-21 METHOD OF MEASUREMENT.

(A) General:

The quantity of concrete to be paid for is the number of cubic yards (cubic meters) of each class which is incorporated into the completed and accepted structure except as indicated below. The number of cubic yards (cubic meters) of concrete is computed from the dimensions shown on the plans or from revised dimensions authorized by the Engineer. When the foundation material is rock, the number of cubic yards (cubic meters) of footing concrete is computed by the average end area method using the lower limits established for foundation excavation. The volume of concrete displaced by piles other than steel piles is not included in the quantity to be paid for.

(B) Foundation Seal Shown in the Plans:

(1) General:

When a foundation seal is shown in the plans, all concrete is measured in accordance with Subarticle 420-21(A) except for seal concrete and footing concrete.

(2) Seal Concrete:

The number of cubic yards (cubic meters) of seal concrete is computed by the average end area method from measurements within the limits described below.

The horizontal limits for measurement are defined by vertical planes coinciding with the neat line dimensions of the seal shown on the plans.

The upper limits for measurement are the top of seal elevations determined after all laitance and concrete peaks are removed as directed. However, no measurement is made for concrete more than an average of 6 inches (150 mm) above the top of seal elevation shown on the plans or above the revised top of seal elevation authorized due to redesign.

When the seal is supported on rock foundation, the lower limits for measurement are the actual rock elevations determined by soundings after the foundation is approved.

When the seal is supported on a foundation other than rock, the lower limits for measurement are the bottom of seal elevation shown on the plans or the revised bottom of seal elevation authorized due to redesign. However, a tolerance of not more than an average of 6 inches (150 mm) over-excavation is allowed. Soundings are taken by the Engineer to determine the actual lower limits of excavation.

(3) Footing Concrete:

The number of cubic yards (cubic meters) of footing concrete is computed by the average end area method from dimensions shown on the plans or from revised dimensions authorized by the Engineer due to redesign. However, a tolerance of not more than an average of 6 inches (150 mm) additional thickness is allowed for irregularities in the top surface of the seal.

(C) Foundation Seal Not Shown in the Plans:

(1) General:

When a foundation seal is not shown in the plans but is allowed by the Engineer, all concrete is measured in accordance with Subarticle 420-21(A) except as otherwise provided in this subarticle.

(2) Seal Concrete:

Measurement and payment is not made of any seal concrete.

(3) Footing Concrete:

The number of cubic yards (cubic meters) of footing concrete to be paid for is the same quantity that would have been measured for payment if a foundation seal had not been placed.

(4) Pier Column Concrete:

The number of cubic yards (cubic meters) of pier column concrete to be paid for is the same quantity that would have been measured for payment if the bottom of the footing had been located at the elevation of the bottom of the approved foundation seal.

(D) Grooving Bridge Floors:

The quantity of grooving bridge floors to be paid for is the actual number of square feet (square meters) shown on the plans for "Grooving Bridge Floors". Where the plans are revised, the quantity to be paid for is the quantity shown on the revised plans.

(E) Reinforced Concrete Deck Slab:

The quantity of reinforced concrete deck slab is paid by the number of square feet (square meters) of reinforced concrete deck slab as provided on the plans.

The plan quantity is determined from the horizontal surface area using the nominal dimensions and configuration shown in the Layout Sketch for computing surface area as shown on the plans. The transverse dimension is out to out of slab including raised median and/or sidewalk sections. Diaphragms are considered as a portion of the slab. When required by the plans, curtain walls, raised medians, sidewalks, pavement brackets, end posts, sign mounts, luminaire brackets and any other concrete appurtenances, expansion joint material, etc. are also considered a part of this item. Concrete Barrier Rail (including curved end blocks for the concrete barrier rail, when used) is not considered a part of this item.

For structural steel spans, the quantities of concrete and reinforcing steel shown on the plans are based on a metal stay-in-place forming method. These quantities include amounts for 1 inch (25 mm) additional concrete due to the corrugation of the metal forms, concrete diaphragms and, when required by the plans, curtain walls, pavement brackets, end posts, raised medians, sidewalks and other required attachments based on the profile grade and plan camber of the girders.

For prestressed concrete girder spans, the quantities of concrete and reinforcing steel shown on the plans are based on the forming method detailed on the plans. These quantities include concrete diaphragms, and, when required by the plans, curtain walls, pavement brackets, end posts, raised medians, sidewalks, and other required attachments based on the profile grade and plan camber of girders. The quantities also include either cast-in-place slab concrete when the plans are detailed for the prestressed concrete panel forming method or amounts for 1 inch (25 mm) additional concrete due to the corrugation of the metal forms when the plans are detailed for the fabricated metal stay-in-place form forming method and based on the profile grade and plan camber of the girders.

No measurement is made for concrete or reinforcing steel due to a variation in camber of the girders from the plan camber or for additional quantities required by optional methods of forming.

420-22 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to construct concrete structures including but not limited to those items contained in Article 420-1.

The quantity of concrete, measured as provided in Article 420-21, will be paid for at the contract unit price per cubic yard (cubic meter) for "Class _____ Concrete".

The quantity of grooving bridge floors, determined as provided in Subarticle 420-21(D), will be paid for at the contract unit price per square foot (square meter) for "Grooving Bridge Floors".

The quantity of reinforced concrete deck slab, determined as provided in Subarticle 420-21(E), will be paid for at the contract unit price per square foot (square meter) for “Reinforced Concrete Deck Slab”.

Payment will be made under:

Class _____Concrete..... Cubic Yard (Cubic Meter)
Grooving Bridge Floors .....Square Foot (Square Meter)
Reinforced Concrete Deck Slab.....Square Foot (Square Meter)

SECTION 422
BRIDGE APPROACH SLABS

422-1 DESCRIPTION.

Construct reinforced concrete slabs at bridge approaches, including subgrade, base course, curbs and sidewalks; furnish and place temporary slope drainage systems and subsurface drainage systems; remove existing pavement or approach slab; furnish and place concrete, reinforcing steel, joint filler, sealer and other materials; and finish, tine, and cure concrete.

Construct the approach slabs before constructing concrete barrier rails or sidewalks.

422-2 MATERIALS.

Refer to Division 10:

Portland cement concrete .....Section 1000
Curing agents .....Section 1026
Joint filler ..... Article 1028-1
Joint sealer ..... Article 1028-2
Reinforcing steel .....Section 1070
Subdrain fine aggregate ..... Article 1044-1
Stone, No. 78M .....Section 1005
Aggregate base course .....Articles 1010-1 through 1010-4
Corrugated aluminum alloy pipe ..... Article 1032-2
Corrugated steel pipe ..... Article 1032-3
Corrugated polyethylene (PE) pipe ..... Article 1044-6

422-3 CONSTRUCTION METHODS.

Place a stone drain consisting of 1 cubic foot (0.03 cubic meters) of No. 78M stone contained in a porous fabric bag at each pipe drain located in the end bent cap or abutment and tie it securely. Place subdrain fine aggregate in conjunction with the stone drain as shown on the plans.

Place and compact the subdrain fine aggregate in accordance with Article 410-10.

Construct the subgrade in accordance with Section 500.

Construct the aggregate base course in accordance with Section 520.

Construct the asphalt concrete base course in accordance with Section 630.

Apply the provisions of Section 420 to all concrete except as otherwise provided herein. Use class AA concrete.

Finish and groove the reinforced concrete bridge approach slabs in accordance with the requirements of Article 420-15, except do not groove the approach slabs when grooving the bridge floor is not required.

When grooving is not required, apply a tined surface texture to the approach slabs before the concrete becomes non-plastic. Produce the surface texture perpendicular to the bridge centerline with a broom or comb having a single row of tines which produce grooves spaced at intervals of approximately 1/2 inch (13 mm). Produce grooves in the hardened surface which are approximately 1/8 inch (3 mm) in width and 3/16 inch (5 mm) in depth.

Cure bridge approach slabs in accordance with the requirements of Article 420-16 applicable to bridge floors, except do not cure with the clear membrane curing compound.

Temporarily cover or fill the opening in the joint at the end bent until installation of the joint seal. Make sure that the covering or filler provides for drainage off the bridge floor and keeps debris out of the joint and off the end bent cap.

Shape the concrete curb to match the face of the barrier rail. Do not place the curb within the limits shown on the plans until after sawing the joint at the end bent. Give the concrete a light broom finish with brush marks parallel to the curb.

When shown on the plans, construct sidewalks on bridge approach slabs in accordance with plan details. Do not construct sidewalks until sawing the joint at the end bent. Finish the concrete in accordance with Subarticle 420-18(D).

Include in the temporary slope drainage system the earth ditch block, erosion resistant surface material, Class B stone for erosion control, and the pipe. Locate it as shown on the plans.

Use either corrugated polyethylene (PE), corrugated steel, or corrugated aluminum alloy for the temporary drainage pipe. Do not use perforated pipe. Provide temporary pipe of sufficient length for complete drainage away from the roadway embankment.

Backfill the approach slabs as soon as practical to prevent erosion adjacent to the slab.

422-4 COMPENSATION.

The price and payment below will be full compensation for all items required to construct bridge approach slabs including but not limited to those items contained in Article 422-1.

All work covered by this section except for grooving bridge approach slabs will be paid for at the contract lump sum price for "Bridge Approach Slabs, Sta. _____".

Grooving bridge approach slabs will be paid for at the contract unit price per square foot (square meter) for "Grooving Bridge Floors" as provided in Article 420-22.

Payment will be made under:

Bridge Approach Slabs, Sta. ____ .....Lump Sum

SECTION 425
FABRICATING AND PLACING REINFORCEMENT

425-1 DESCRIPTION.

Furnish, fabricate, and place steel reinforcement other than wire mesh reinforcement, including all related materials such as tie wire, separators, wire bar supports, and other material for fastening the reinforcing steel in place; galvanize and/or coat where required; and fabricate, cut, bend, place, and splice the reinforcement in conformity with the shape

and dimensions shown on the plans and as specified in these specifications. Provide epoxy coated reinforcing steel where indicated on the plans.

425-2 MATERIALS.

Refer to Division 10:

Steel bar reinforcement ..... Article 1070-2
Wire mesh reinforcement ..... Article 1070-3
Reinforcing wire ..... Article 1070-3
Wire bar supports ..... Article 1070-4
Epoxy Coated Reinforcing Steel ..... Article 1070-8
Spiral Column Reinforcing Steel ..... Article 1070-9
Epoxy Coated Spiral Column Reinforcing Steel ..... Article 1070-9

425-3 PROTECTION OF MATERIALS.

Protect steel reinforcement at all times from damage and make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil, or other foreign materials at the time of placement in the work.

Store epoxy coated reinforcing steel bars at the project site a minimum of 1 foot (0.3 m) above the ground on wooden or padded supports placed 10 feet (3 m) apart, and completely cover with an opaque cloth, canvas, or woven fiber reinforced polyethylene white tarp. Do not use solid plastic sheeting. Cover the bars such that adequate ventilation is provided to prevent condensation from forming on the material during storage, and completely protect the bars from direct sunlight. Do not allow water to pond under the epoxy coated reinforcing steel.

Store epoxy coated bars as close as possible to their final location in the structure to prevent coating damage from unnecessary handling.

Do not store epoxy coated bars at the project site from one construction season until the following construction season unless stored in a waterproof enclosure.

425-4 PLACING AND FASTENING.

Accurately place reinforcement as shown on the plans and secure firmly in position by wiring at intersections and using metal bar supports, precast mortar blocks, or other approved devices of sufficient strength and location to resist distortion.

Tie reinforcing bars at all intersections except where spacing is less than 1 foot (0.3 m) in both the longitudinal and transverse directions, in which case tie at alternate intersections, as an option. Securely tie each intersection of vertical reinforcing steel and spiral reinforcement for drilled piers. Use plastic or epoxy coated spiral spacers with epoxy coated spiral column reinforcing steel.

Provide wire bar supports for reinforcing steel in accordance with Article 1070-4 of the proper height to provide the distance from the forms and the proper spacing between rows of steel as indicated on the plans. When required by the plans, epoxy coat bar supports in accordance with Article 1070-8. Provide rust-proofed supporting legs for wire bar supports that rest on the forms as provided in Article 1070-4. When providing rust proofing by plastic protection, make sure that the dipped plastic coating or premolded plastic tips are intact on each bar support leg while concrete is placed.

Precast blocks, of approved shape and dimensions, for holding vertical reinforcement in position from 1:2 mortar or concrete of the same mix used in the member being cast. Cure precast blocks in accordance with the provisions of Article 420-16 for the water method or the polyethylene sheeting method. To hold vertical bars in position, use precast blocks which have embedded wires extending from the block a sufficient distance to tie to the bar.

Roll mesh reinforcement flat before placing concrete, unless otherwise shown on the plans. Hold mesh reinforcement firmly in place against vertical and transverse movement by acceptable means.

Weld reinforcing steel in accordance with the American Welding Society's "Reinforcing Steel Welding Code AWS D1.4" and only where required in the plans or special provisions. Obtain written approval for additional welding. Do not use tack welds unless approved.

Exercise extreme care when transporting, handling, placing and tying epoxy coated reinforcing steel to prevent damage to the coating.

Immediately before placing epoxy coated reinforcing steel bars in the forms, visually inspect each bar for coating damage. Ensure that all coating damaged by any cause is satisfactorily repaired, including hairline cracks and that each bar, including bar ends, is completely encapsulated in epoxy coating or patching material at the time of concrete placement. Make coating repairs as described in Section 1070-8(K) with material specified in Section 1070-8(C). Do not coat more than 5 percent of surface area on each bar with patching material including patching due to damage to the coating by the coater, fabricator, transporter, or contractor. The patching limits do not include holiday repairs, overspray and coated ends of bars.

Do not expose epoxy coated reinforcing steel to the weather for more than 30 days after placing in the forms. If the concrete is not placed within 30 days, cover the epoxy coated reinforcing steel as required by Article 425-3.

Do not place reinforcement while placing concrete in the member involved.

Place, allow inspection, and obtain approval for reinforcement in any member before placing concrete.

425-5 SPLICING.

Furnish all reinforcement in the full lengths indicated on the plans.

Do not splice bars without written approval except where shown on the plans.

Provide splice lengths as shown on the plans.

Overlap sheets of mesh with each other sufficiently to maintain a uniform strength and securely fastened to each other at the ends and edges. Lap at least the dimension of 1 mesh.

425-6 METHOD OF MEASUREMENT.

The quantity of reinforcing steel to be paid for is the number of pounds (kilograms) of steel bar reinforcement, reinforcing wire, and plain rods shown on the plans as being necessary to complete the work. The quantity of spiral reinforcing steel paid for is the number of pounds (kilograms) of spiral column reinforcing shown on the plans as being necessary to complete the work. Where the plans are revised, the quantity to be paid for is the quantity shown on the revised plans. Where directed to deviate from the plans in such a manner to change the quantities of steel bar reinforcement, reinforcing wire, and plain rods necessary to complete the project, the quantity shown on the plans is increased or decreased by the theoretical computed weight of reinforcing steel or spiral column reinforcing steel added or subtracted by the change.

425-7 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to fabricate and place reinforcement including but not limited to those items contained in Article 425-1.

The quantity of reinforcing steel, determined as provided in Article 425-6, will be paid for at the contract unit price per pound (kilogram) for "Reinforcing Steel". The quantity of

spiral reinforcing steel determined as provided in Article 425-6 will be paid for at the contract unit price per pound (kilogram) for “Spiral Column Reinforcing Steel”. The quantity of reinforcing steel or spiral column reinforcing steel shown on the plans is an estimate based on the theoretical computed weight of the steel necessary to complete the work, and will be used for pay purposes. No revision in this pay quantity nor any adjustment in the contract unit price for "Reinforcing Steel" or “Spiral Column Reinforcing Steel” will be made except where revisions in the plans affect the quantity of reinforcing steel or spiral column reinforcing steel necessary to complete the work or where an error has been found in the estimate of steel shown on the plans.

In the event that the elevation of the top of a footing is raised by a distance not exceeding 3 feet (1 m), and the reinforcing steel or spiral column reinforcing steel for the substructure unit has been fabricated before the elevation was raised, no decrease in the quantity of steel to be paid for will be made from the theoretical weight of steel shown on the plans for the original substructure unit. Under the above circumstances the provisions of Article 109-6 will not apply as the steel not used in the work shall remain the property of the Contractor and payment for such steel will be made as provided above. No separate payment will be made for the cost of cutting off reinforcing steel or spiral column reinforcing steel as payment at the contract unit price per pound (kilogram) for the item of "Reinforcing Steel" or “Spiral Column Reinforcing Steel” will be full compensation for cutting the steel.

There will be no direct payment for reinforcing steel when the basis of payment or compensation clause applicable to a particular section of the specifications states that payment at the contract unit or lump sum prices for the work covered by such section will be full compensation for furnishing and placing reinforcing steel.

No separate payment will be made for the work of furnishing and placing wire mesh reinforcement as payment at the contract unit price for the item or items covering the structure containing the mesh reinforcement will be full compensation for such work.

Payment will be made under:

Reinforcing Steel ..... Pound (Kilogram)
Epoxy Coated Reinforcing Steel..... Pound (Kilogram)
Spiral Column Reinforcing Steel ..... Pound (Kilogram)
Epoxy Coated Spiral Column Reinforcing Steel ..... Pound (Kilogram)

SECTION 430
ERECTING PRESTRESSED CONCRETE MEMBERS

430-1 DESCRIPTION.

Furnish and erect precast-prestressed concrete bridge members other than piling. Furnish, galvanize, place, and paint, as applicable, bearing components, anchor bolts, diaphragm bars, washers, nuts, structural and reinforcing steel, miscellaneous hardware, paint, bearing assemblies, and all other materials; handle, transport, and store materials; furnish erection drawings; paint; set bearings and anchorage; grout, and erect and install the bridge members and all other items necessary to complete the erection in accordance with the requirements of the plans and specifications.

When used in this section, the term "prestressed concrete" refers to precast, pretensioned, prestressed concrete.

430-2 MATERIALS.

Refer to Division 10:

Precast-prestressed members .....Section 1078

Plain steel bars, threaded ends ..... Article 1074-2
Structural steel .....Section 1072
Reinforcing steel .....Section 1070
Organic zinc repair paint ..... Article 1080-9
Bearing plate assemblies ..... Article 1072-5
Elastomeric Bearings ..... Article 1079-2

430-3 HANDLING AND STORAGE.

Take special care in handling, transporting, and storing prestressed members. Members damaged while handled or transported are rejectable unless repaired to the satisfaction of the Engineer.

Handle members at the bearings or at pick-up points designated on the plans unless using other methods approved in writing.

Transport prestressed concrete bridge girders in a horizontal upright position. Locate points of support and directions with respect to the girder approximately the same during transportation and storage as when the member is in the final position within the structure.

430-4 METHODS AND EQUIPMENT.

Use methods and equipment to install prestressed members that result in satisfactory installation.

430-5 BEARINGS AND ANCHORAGES.

Supply preformed bearing pads and elastomeric bearings, when required by the plans, meeting the requirements of Section 1079.

Set steel sole plates level in exact position with full and even bearing on the bearing pad.

Accurately set anchor bolts in accordance with the provisions of Subarticle 420-14(A).

When welding the sole plate to the embedded plate in the girder, use temperature indicating wax pens, or other suitable means, to ensure that the temperature of the sole plate does not exceed 300°F (149°C). Temperatures above this may damage the elastomer.

Prior to welding, grind the galvanized surface of the portion of the embedded plate and sole plate that require welding. After welding, repair damaged galvanized surfaces in accordance with Article 1076-6.

430-6 ERECTION AND INSTALLATION.

Erect prestressed concrete members by methods that satisfy the handling requirements specified in Article 430-3.

Perform field welding in accordance with Article 1072-20 only when required on the plans.

When indicated on the plans, recess the ends of tie rods used in intermediate diaphragms of prestressed concrete girders. Fill these recesses with an approved non-metallic, non-shrink grout in a workmanlike manner to match the neat lines of the girders.

When concrete is cast in contact with prestressed members, thoroughly clean and wet the surface of the member which contacts the fresh concrete for a minimum of 2 hours just prior to casting the fresh concrete.

After casting and finishing all concrete, thoroughly clean the prestressed members.

When erecting prestressed cored slabs, place the 1/2 inch (12.7 mm) diameter transverse post tensioning strands and tension to 30,000 pounds (130 kN) in each span. Grease the transverse strands and place in a non-corrosive 1/2 inch (12.7 mm) diameter, 1/16 inch (1.6 mm) minimum wall thickness black polyethylene pipe meeting the requirements of ASTM D2239. Do not apply grease or extend the pipe in the area of the

recesses at the ends of the tensioning strands where grout is applied. After tensioning the 1/2 inch (12.7 mm) diameter transverse strand in a span and before placing any equipment, material or barrier rail on the span, fill the shear key, dowel holes, and recesses at the ends of transverse strands with an approved non-metallic, non-shrink grout and cure for 3 days minimum, and until the grout reaches a compressive strength of 3000 psi (20.7 MPa).

After tensioning and curing, obtain approval prior to placing material and equipment on the cored slab spans. Support cranes or other equipment exceeding the legal load limit on mats. Submit for review a detailed drawing for the mats that are intended for use on the cored slabs. Provide a complete description of the equipment that is intended for placement on the mats. Supply and construct mats at no additional cost to the Department.

430-7 PAINTING.

Clean, by hand or with power tools, and paint with 2 coats of organic zinc repair paint all ungalvanized steel surfaces, such as tie rod ends, not encased in concrete in accordance with Section 442. Provide a minimum dry thickness of each coat of paint of 1.5 mils (0.04 mm).

430-8 METHOD OF MEASUREMENT.

The quantity of prestressed concrete girders to be paid for is the number of linear feet (linear meters) of prestressed concrete girders estimated on the plans as being necessary to complete the project. The quantity of prestressed concrete cored slabs to be paid for is the number of linear feet (linear meters) of prestressed concrete cored slabs estimated on the plans as being necessary to complete the project.

430-9 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to erect prestressed concrete members including but not limited to those items contained in Article 430-1.

The quantity of prestressed concrete girders, determined as provided in Article 430-8, will be paid for at the contract unit price per linear foot (linear meter) for "_____ Inch (mm) Prestressed Concrete Girders".

The quantity of prestressed concrete cored slabs, determined as provided in Article 430-8, will be paid for at the contract unit price per linear foot (linear meter) for "3'-0" x 1'-__" (914 mm x __ mm) Prestressed Concrete Cored Slabs".

The elastomeric bearings will be paid for at the lump sum price for "Elastomeric Bearings".

Payment will be made under:

__" (mm) Prestressed Concrete Girders ..... Linear Foot (Linear Meter)

3'-0" x 1'- __" (914 mm x __ mm) Prestressed

Concrete Cored Slabs..... Linear Foot (Linear Meter)

Elastomeric Bearings .....Lump Sum

SECTION 440
STEEL STRUCTURES

440-1 DESCRIPTION.

Construct steel structures and steel structure portions of composite structures in conformity with the lines, grades, and dimensions shown on the plans and as specified in these specifications.

Furnish, fabricate, galvanize, deliver, place, erect, clean, shop paint, and field paint structural metals and all other materials; furnish, erect, and remove falsework; set bearings and anchorage; weld; and furnish all materials for and assemble all structural joints.

Structural metals include structural steels, metallic electrodes, steel forgings and castings, gray iron and malleable iron castings, drain pipes, and any incidental metal construction. Perform the above in conformity with the plans and these specifications.

Before starting work, inform the Engineer as to the proposed method of erection.

440-2 MATERIALS AND FABRICATION.

Refer to Division 10:

Structural steel .....Section 1072
Steel pipe ..... Article 1074-5
Welded stud shear connectors ..... Article 1072-8
High strength bolts, nuts, washers, and direct tension indicators ..... Article 1072-7
Preformed bearing pads. ..... Article 1079-1
Anchor bolts ..... Article 1072-6
Bearing plate assemblies ..... Article 1072-5
Organic zinc repair paint ..... Article 1080-9
Elastomeric Bearings ..... Article 1079-2

440-3 DRAWINGS.

Submit prints of checked structural steel shop drawings and changes thereto, including shipping diagrams that do not conform to Figure 1072-1, for review, comments, acceptance and distribution as follows:

1. Submit 2 sets for review and comments on all steel structures. After review, submit 7 sets for acceptance and distribution.
2. Submit 5 sets for review and comments for all bridges carrying railroad traffic. After review, submit 9 sets for acceptance and distribution.
3. Furnish any additional sets as requested.

The Engineer does not check shop drawings except to ascertain general compliance with the design and the specifications. Thoroughly check all shop drawings in all respects. Acceptance of shop drawings by the Engineer does not relieve the Contractor of responsibility for the accuracy of these drawings, or for the proper fit of all shop and field connections and anchors.

The maximum size of prints for shop drawings is 22" x 34" (560 x 864 mm) including borders with at least 1 inch (25 mm) at the left edge of the sheet. Provide shop drawings on any medium provided they are legible and are reproducible. Upon completion of the project, furnish one complete set of 22" x 34" (560 x 864 mm) reproducible shop drawings that represent the as built condition of the structural steel including all accepted changes. These drawings will become the property of the Department.

Have all changes on shop drawings after acceptance and distribution reviewed and accepted and furnish a record of such changes.

440-4 HANDLING AND STORING MATERIALS.

Move, handle, and store all structural steel, in the shop, field and while being transported, so that the metal and any coating is not damaged and is kept clean and free of all foreign material such as grease, oil, concrete splatter, chalk marks, crayon marks, and dirt. Natural oxidation of the steel is not considered foreign matter.

Store materials on blocking above the ground and keep it clean and properly drained. Haul and place girders and beams upright and make sure they are shored. Support long members, such as columns and chords, on blocking placed near enough together to prevent injury from deflection.

440-5 FALSEWORK.

Properly design, construct and maintain the falsework for the loads to which it is subjected. Prepare and submit 8 sets of falsework drawings, if required, for review, comments and acceptance. Acceptance of these drawings is not considered as relieving the Contractor of any responsibility.

440-6 BEARINGS AND ANCHORAGES.

Supply preformed bearing pads and elastomeric bearings, as required by the plans, meeting the requirements of Section 1079.

Set steel masonry plates level in exact position with full and even bearing on the preformed bearing pad.

Accurately set anchor bolts in accordance with the provisions of Subarticle 420-14(A).

Make sure that the location of anchors and setting of bearings take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom flange due to dead load after setting, so that at mean temperature and under dead load the bearings are in a vertical position and anchor bolts at expansion bearings center in their slots. Mean temperature is 60°F (16°C) unless otherwise stipulated on the plans. Do not restrict full and free movement of the superstructure at the movable bearings by improperly setting or adjusting bearings or anchor bolts and nuts.

440-7 STRAIGHTENING BENT MATERIAL.

Straighten bent material as approved and in accordance with Article 1072-12.

440-8 FIELD ERECTION.

Report immediately any error in the shop fabrication, or deformation resulting from handling and transporting, which prevents the proper assembling and fitting up of parts by more than the moderate use of drift pins or by more than a moderate amount of reaming, chipping, or cutting. Correct errors in the presence of the Engineer by approved methods.

Do not perform hammering which injures or distorts the members.

Limit the drifting during assembly to only that needed to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes require enlarging to admit the bolts, ream or correct them by approved methods. Do not enlarge the holes more than 1/16 inch (2 mm) over the nominal size hole called for without written approval.

Before assembling the members, clean and dry to touch all bearing surfaces and permanently contacting surfaces.

For bolted splices and field connections, fill one half of the holes with bolts and cylindrical erection pins (half bolts and half pins) before placing permanent fasteners. For continuous units, pin and bolt all beam and girder splices and bring the splices to the correct elevations before permanently fastening. For bolted connections use fit-up bolts and optional shipping bolts with the same nominal diameter as the permanent fasteners, and use cylindrical erection pins which are 1/32 inch (1 mm) larger. Use permanent bolts as fit-up bolts if desired.

Use temporary bolts, including but not limited to shipping and fit-up bolts, supplied with square or hexagon heads and square or hexagon nuts. The use of hexagon head temporary bolts and nuts is allowed, but paint both the head and nut with a durable yellow paint prior to installation.

Do not reuse permanent bolts for final installation unless the nut is easily turned onto the bolt for the full threaded length by hand and without use of tools.

The use of erection bolts for field welded joints is allowed. Use erection bolts that are galvanized when the finish paint is applied in the structural steel fabrication shop and meet the requirements of AASHTO M164 (M164M). Supplement these bolts with clamps

as necessary to meet the AWS Specifications. Where unpainted AASHTO M270 Grade 50W (M270 Grade 345W) structural steel is used, use erection bolts meeting the requirements of AASHTO M164 (M164M) for Type 3 bolts.

After field welding the connection, leave the erection bolt in place with at least the minimum bolt tension shown in Table 440-1. Use holes that are 3/16 inch (5 mm) larger than the nominal erection bolt diameter.

440-9 FIELD WELDING.

Perform field welding only when called for on the plans and in accordance with Article 1072-20.

Remove paint or galvanizing at the location of field welds by blast cleaning (SSPC SP-6 finish), or hand (SSPC SP-2 finish) or power tool cleaning (SSPC SP-3 finish) just prior to welding. Clean sufficiently to prevent contamination of the weld by the paint.

440-10 CONNECTIONS USING HIGH STRENGTH BOLTS.

(A) General:

This article covers the assembly of structural joints using plain or galvanized high strength carbon steel bolts with suitable nuts and washers tightened to a high tension. Use bolt holes that conform to the requirements of Article 1072-18.

Protect bolts, nuts, and washers from moisture during storage and so that they show no signs of rust at the time of installation.

Make sure that plain bolts, nuts, and washers have a thin coat of lubricant at the time of installation.

Apply beeswax, stick paraffin or other approved lubricant to the threads of galvanized bolts just prior to installing the bolts.

Use bolt, nut and washer (when required) combinations from the same rotational-capacity lot.

Perform the rotational capacity test described in Section 1072-7(D4) on each rotational-capacity lot prior to the start of bolt installation. Use hardened steel washers as required by the test.

(B) Bolted Parts:

Make sure that the slope of surfaces of bolted parts in contact with the bolt head and nut does not exceed 1:20 with respect to a plane normal to the bolt axis. Make sure bolted parts fit solidly together when assembled and are not separated by gaskets or any other interposed compressible material. Provide contact surfaces, including those adjacent to the bolt heads, nuts, or washers, that are free of scale, dirt, burrs, oil, lacquer, loose rust, rust inhibitor, other foreign material, and other defects that prevent solid seating of the parts.

(C) Installation:

(1) Bolt Tensions:

Tighten each fastener to provide at least the minimum bolt tension shown in Table 440-1. Tighten fasteners by the turn-of-nut tightening method, with direct tension indicators in accordance with Subarticle 440-10(C)(6), or if permitted, by the use of load indicating bolts as provided in Subarticle 440-10(C)(4).

TABLE 440-1
REQUIRED BOLT TENSION

Bolt Size, Inches	Minimum Bolt Tension in Pounds
1/2	12,050
5/8	19,200
3/4	28,400
7/8	39,250
1	51,500
1 l/8	56,450
1 1/4	71,700
1 3/8	85,450
1 1/2	104,000
Bolt Size, Metric Bolt	**Minimum Bolt Tension in KiloNewtons**
(M16)	(94)
(M20)	(147)
(M22)	(182)
(M24)	(212)
(M27)	(275)
(M30)	(337)
(M36)	(490)

If necessary because of bolt entering and wrench operation clearances, tighten by turning the bolt while preventing the nut from rotating. Use impact wrenches, if necessary, with adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

(2) Washers:

Make sure all fasteners have a hardened washer under the element (nut or bolt head) turned in tightening. Use galvanized washers when galvanized nuts and bolts are required. As an exception to the above, use special washers for oversize, short-slotted, and long-slotted holes in accordance with Subarticle 1072-18(H).

Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, use a smooth beveled washer to compensate for the lack of parallelism.

(3) Turn-of-Nut Tightening:

When using the turn-of-nut method to provide the required bolt tension, first provide enough bolts in a "snug tight" condition to bring the parts of the joint into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, place bolts in any remaining holes in the connection and bring to snug tightness. After bringing all bolts in a connection to snug tightness, match mark each nut, bolt shank, and the structural base metal wih a line of white ink or paint that is not water soluble. Additionally, mark the structural base metal to indicate the applicable amount of nut rotation specified in Table 440-2. Tighten all bolts in the joint additionally by the applicable amount of nut rotation specified in Table 440-2, progressing systematically from the most rigid part of the joint to its free edges. During this operation do not allow rotation of the part not turned by the wrench. To ensure compliance with this article, keep the match mark on the bolt shank and the initial mark on the structural base metal aligned. Additionally, tighten to align the match mark on the nut and the mark representing the specified amount of nut rotation.

TABLE 440-2

NUT ROTATION [a] FROM SNUG TIGHT CONDITION

Bolt Length As measured from Underside of head to extreme end of point)	Disposition of Outer Faces of Bolted Parts		
	Both Faces Normal to Bolt Axis	One Face Normal to Bolt Axis and Other Face Sloped Not More Than 1:20 (bevel washer not used)	Both Faces Sloped Not More Than 1:20 From Normal to Bolt Axis (bevel washers not used)
Up to and Including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 Diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 Diameters but not exceeding 12 diameters [b]	2/3 turn	5/6 turn	1 turn

a Applicable to coarse thread heavy hex structural bolts of all sizes and lengths up to 12 diameters, and heavy hex semi-finished nuts. Nut rotation is relative to the bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

b When bolt lengths exceed 12 diameters, the required rotation must be determined by actual tests in a suitable tension device simulating the actual conditions.

(4) Load Indicating Bolts:

Tightening by use of a load indicating bolt system is permitted provided it can be demonstrated by an accurate direct measurement procedure that the bolt is tightened in accordance with Table 440-1. Tighten by approved methods and procedures.

(5) Galvanized High Strength Bolts:

Use mechanically galvanized high strength bolts in all bolted connections for painted structural steel.

Install galvanized high strength bolts carefully so that shop painted surfaces are not scarred or otherwise damaged.

Repair galvanized surfaces that are abraded or damaged by thoroughly wire brushing the damaged area and removing all loose and cracked coating, after which give the cleaned area 2 coats of organic zinc repair paint.

(6) Direct Tension Indicators:

Supply direct tension indicators in accordance with the requirements of ASTM F959, Article 1072-7, and the manufacturer's recommendations.

Install the direct tension indicators in strict compliance with the manufacturer's written instructions.

Furnish to the Engineer a copy of the manufacturer's instructions for installing the direct tension indicators along with at least one metal feeler gage for each container of direct tension indicators shipped before beginning installation.

Make sure that the lot number on the containers of direct tension indicators is for the same lot number tested as indicated on the test documents.

Furnish to the Engineer three samples of load indicating washers from each lot number, each size and type for tests and two each of the metal feeler gages required for performing the tests.

Install the direct tension indicator under the bolt head. If it is necessary to install the direct tension indicator under the nut, or if the bolt head must be turned, install additional hardened washers in accordance with the manufacturer's instructions.

Provide a tension indicating device on the project for determining the tension imposed on a fastener when the protrusions on direct tension indicator are properly compressed.

Test 3 samples from each lot of direct tension indicators in the presence of the Engineer. Achieve a minimum bolt tension of 5% greater than that required by Table 440-1 of Article 440-10.

Do not substitute direct tension indicators for hardened steel washers required with short slotted or oversized holes. If desired, use direct tension indicators in conjunction with hardened steel washers.

Install direct tension indicators initially to a snug tight condition as specified in Subarticle 440-10(C)(3). After initial tightening, fully tighten as recommended by the manufacturer, beginning at the most rigid part of the joint and continuing toward its free edges.

For tightening fasteners containing direct tension indicators, use a clean and lubricated wrench of type and capacity recommended by the manufacturer. Maintain air supply and hoses in good condition and provide air pressure of at least 100 psi (690 kPa) at the wrench.

Heat structural steel as required for corrections in the vicinity of fasteners before installing fasteners or direct tension indicators.

When tightening the fasteners, ensure that the part of the fastener being restrained from turning does not rotate during the tightening process. Ensure that no portion of the direct tension indicator protrusions is accidentally partially flattened before installing in the structural steel joints.

Do not reuse direct tension indicators. If it is necessary to loosen a bolt previously tensioned, discard and replace the direct tension indicator.

(D) Inspection:

Allow the Engineer the opportunity to observe installation of bolts to determine that the selected tightening procedure is properly used. The Engineer determines when bolts are properly tightened and in the case of direct tension indicator bolts that the correct indication of tension is achieved. Where the turn-of-nut method is used, each bolt is inspected visually for the correct relationship between the match marks on the nut and the bolt shank. Bolts installed by the turn-of-nut method may reach tensions above the value given in Table 440-1 but this is not a cause for rejection. After properly tightening bolts, make sure that the end of the bolt is flush with or extended beyond the outer face of the nut.

Do not begin painting in the area of tightened bolts until after bolt inspection is complete.

In addition to inspecting the match mark relationship with the turn-of-nut method, use the following inspection procedure unless the plans or special provisions require a more extensive or different inspection procedure:

As directed, furnish and use, in the presence of the Engineer, or allow the Engineer to use an inspection torque wrench, calibrated as follows:

At least once each working day, place 3 calibration sample bolts of the same grade, size, representative length, and conditions as those under inspection in a tension indicating calibration device. Furnish a tension indicating calibration device certified by the Materials and Tests Unit within 6 calendar months prior to testing the bolts under inspection, to be in good working order and to provide accuracy within plus or minus 10 percent for the range of loads between 25,000 and 40,000 pounds (110 and 180 kN). Place a washer under the part turned in tightening for each bolt if washers are so used in the structure. If no washer is used make sure that the material abutting the part turned is the same as that used in the structure.

Tighten each calibration sample bolt in the calibration device by any convenient means to an initial condition equal to 15 percent of the required tension and then to the minimum tension specified in Table 440-1. Then apply the inspecting wrench to the tightened bolt and determine the torque necessary to turn the nut or head 5 degrees (approximately 1 inch at 12 inch [25 mm at 300 mm] radius) in the tightening direction. Use the average torque measured in the tests of 3 bolts as the job inspecting torque.

Use the inspection wrench to inspect bolts, represented by the calibration sample bolts, which are tightened in the structure by applying in the tightening direction the job inspecting torque to 10 percent of the bolts, but not less than 2 bolts, selected at random in each connection. If no nut or bolt head turns by this application of the job inspecting torque, the connection is acceptable as properly tightened. If any nut or bolt head turns by the application of the job inspecting torque, apply this torque to all bolts in the connection. Tighten and reinspect all bolts whose nut or head turns by the job inspecting torque. Alternatively, retighten all the bolts in the connection and resubmit the connection for the specified inspection.

When using direct tension indicators, proper tension of bolts is inspected by the Engineer by inserting a 0.005 inch (0.125 mm) thickness feeler gage into the openings between adjacent flattened protrusions of the direct tension indicator. Proper tension is obtained when the number of spaces for which the gage is refused is equal to or greater than the value shown in Table 440-3.

TABLE 440-3
Direct Tension Indicator Gap Refusal

Number of Spaces in Washer	Number of Spaces Gage is Refused*
4	2
5	3
6	3
7	4

* The gage must be refused in all spaces when the direct tension indicator is used under the turned element.

When using direct tension indicators, do not tighten bolts to a no visible gap condition.

Inspections of direct tension indicator installations are made by the Engineer by the use of the metal feeler gauges provided by the Contractor. At least 10%, but no less than two of the bolts in each connection are inspected with feeler gauges. Additionally, all remaining bolts in each connection are visually inspected for proper tightening.

440-11 PAINTING.

Clean and paint iron and steel surfaces in accordance with Section 442.

Repair all abraded or damaged galvanized surfaces in accordance with Article 1076-6.

440-12 SURFACE PREPARATION AND PROTECTION OF WEATHERING STEEL.

Shop clean girders to a SSPC SP-6 finish. After fabrication, shop clean all other structural steel remaining in the unpainted condition in the completed structure in accordance with Subarticle 442-8(B), except blast clean contact surfaces and to 1 inch (25 mm) beyond contact surfaces in the plane of contact of high strength bolted joints to a SSPC SP-6 finish. Provide a contact surface condition in accordance with Subarticle 440-10(B) at the time of bolt installation.

Protect the structural steel during concreting and any other operations that are particularly hazardous with respect to soiling the steel. Remove any foreign matter which gets on the steel as soon as possible by either solvent cleaning, hand tool cleaning, power tool cleaning, blast cleaning, or a combination thereof, as necessary to restore the surfaces to the specified condition.

440-13 COMPENSATION.

The prices and payments below will be full compensation for all items required to construct steel structures including but not limited to those items contained in Article 440-1.

Structural steel will be paid for at the contract lump sum price for "Approximately _____Pounds (Kilograms) Structural Steel". The approximate quantity shown in the contract pay item is an estimate based on the computed weight of the structural steel necessary to complete the work. No measurement for payment will be made for this pay item, and no adjustment in the contract lump sum price will be made for any variation from the approximate quantity shown except for revisions in the plans which affect the quantity of structural steel necessary to complete the work.

When revisions in the plans have been made which affect the quantities of structural steel, adjustments in compensation will be made by supplemental agreement.

When the contract includes the item of "Painting of Structural Steel", all work of painting except for shop painting will be paid for as provided in Article 442-13 and payment for shop painting will be included in the contract lump sum price for "Approximately _____Pounds (Kilograms) Structural Steel". When the contract does not include the item of "Painting of Structural Steel", payment at the contract lump sum price for "Approximately _____Pounds (Kilograms) Structural Steel" will be full compensation for both shop and field painting.

Elastomeric bearings will be paid for as provided in Article 430-9.

Payment will be made under:

Approximately _____Pounds (Kilograms) Structural Steel .....Lump Sum

SECTION 442
PAINTING STEEL STRUCTURES

442-1 DESCRIPTION.

Paint steel structures and properly prepare metal surfaces; apply, protect, and dry paint coatings; protect pedestrian, vehicular, water, or other traffic upon or underneath the structure; protect all portions of the structure and adjacent work against disfigurement by splatters, splashes, overspray, and smirches of paint or of paint materials; apply paint in the shop and field; and furnish blast cleaning equipment, paint spraying equipment, brushes, rollers, paint cleaning abrasives, cleaning solvents, tools, tackle, scaffolding, labor, and any other materials, hand or power tools, inspection equipment, and personal protective and safety equipment necessary for the entire work.

442-2 MATERIALS.

Refer to Division 10:

Paint and paint materials .....Section 1080

442-3 PROTECTION OF WORK.

Protect all parts of the structure against disfigurement by splatters, splashes, overspray, and smirches of paint or of paint materials. Assume responsibility for any damage or disfigurement caused by operations to vehicles, persons, or property, including plants and animals; and provide protective measures to prevent such damage.

Thoroughly clean and restore any surface or surfaces disfigured by splatter, overspray, splashes, smirches, etc., to its original condition.

Restore any damaged structure or surface to its original condition.

If traffic causes dust considered by the Engineer to be detrimental to the work, sprinkle dust producing areas with water or dust palliative and take any other necessary precautions to prevent the accumulation of dust and dirt on freshly painted surfaces.

442-4 ACCESS TO THE WORK.

Provide safe and convenient access to all parts of the work in accordance with Section 105-11.

442-5 APPLICATION CONDITIONS.

Unless the paint manufacturer's application instructions are more restrictive, obtain written permission to apply paint when the temperature of the air or metal is below 50°F (10°C), when freezing weather is forecast during the drying period, or when the metal is hot enough to cause the paint to blister or produce a porous paint film. Also, do not apply paint or perform any surface preparation when the air is misty; in the rain, snow, or fog, or when the steel surface temperature is less than 5°F (3°C) above the dew point, or as directed.

Provide adequate and safe storage for all paint and equipment. Do not expose paint materials to rain, excessive condensation, long periods of direct sunlight, or temperatures above 110°F (43°C) or below 40°F (4°C). Follow the manufacturer's storage requirements if more restrictive than the above requirements.

Replace paint damaged by any cause at no cost to the Department.

442-6 MIXING PAINT.

Mix paint in accordance with the manufacturer's instructions and Article 1080-1.

442-7 PAINT SYSTEMS.

Include in the system surface preparation, shop painting, and/or field painting. Use all paints and solvents for shop and field application which are produced by the same manufacturer.

Use approved/qualified paint products found in Section 1080. Apply the paint system required by the plans and at the film thickness indicated below. Coating thickness in excess of the maximum dry film thickness is acceptable as long as the coating is free of visible defects (runs, sags, cracking, lifting, etc.).

SYSTEM 1 INORGANIC ZINC (IOZ) PRIMER AND ACRYLIC TOP COATS

Coat	Material	Mils (mm) Dry/Wet Film Thickness	
		Min	Max
Primer	1080-7 IOZ	3.0 (0.075) DFT	5.0 (0.125) DFT
Intermediate	1080-12 Brown	2.0 (0.050) DFT	4.0 (0.100) DFT
Stripe	1080-12 White	4.0 (0.100) WFT	7.0 (0.175) WFT
Topcoat	1080-12 Gray	3.0 (0.075) DFT	5.0 (0.125) DFT
Total		8.0 (0.200) DFT	14.0 (0.350) DFT

Apply System 1 to non-weathering steel surfaces cleaned to an SSPC SP-10 finish. Shop painting consists of applying only the primer. Apply two field coats of acrylic paint over all structural steel surfaces except as otherwise specified after erection. Completely cure the inorganic zinc primer to meet the requirements of ASTM D4752 before top coating. Ensure that the Elcometer Adhesion of the zinc primer is no less than 400 psi (2.75 MPa) when tested in accordance with ASTM D4541. If bubbling occurs during the application of the first field coat, apply a mist coat of brown paint to prevent further bubbling. Ensure that the Tape Adhesion of the cured system is no less than 3A when tested in accordance with ASTM D3359.

SYSTEM 2 INORGANIC ZINC (IOZ) PRIMER AND COAL TAR EPOXY TOP COATS

Coat	Material	Mils (mm) Dry/Wet Film Thickness	
		Min	Max
Primer	1080-7 IOZ	3.0 (0.075) DFT	5.0 (0.125) DFT
Intermediate	1080-8 Red	8.0 (0.200) DFT	12.0 (0.300) DFT
Topcoat	1080-8 Black	8.0 (0.200) DFT	12.0 (0.300) DFT
Total		19.0 (0.475) DFT	NA

Apply System 2 on non-weathering steel surfaces cleaned to an SSPC SP-10 finish. Shop painting consists of painting with a primer, and two coats of coal tar epoxy paint over all structural steel surfaces except as otherwise specified. Completely cure the inorganic zinc primer to meet the requirements of the ASTM D4752 solvent rub test before top coating. Ensure that the Elcometer Adhesion of the zinc primer is no less than 400 psi (2.75 MPa) before top coating when tested in accordance with ASTM D4541. Apply the finish coat when the first coat of coal tar epoxy is still tacky. Ensure that the Elcometer Adhesion of the cured system is no less than 400 psi (2.75 MPa) when tested in accordance with ASTM D4541.

SYSTEM 3 ACRYLIC PRIMER AND TOP COATS

Coat	Material	Mils (mm) Dry/Wet Film Thickness	
		Min	Max
Primer	1080-12 Brown	2.0 (0.050) DFT	4.0 (0.100) DFT
Intermediate	1080-12 White	2.0 (0.050) DFT	4.0 (0.100) DFT
Stripe	1080-12 Brown	4.0 (0.100) WFT	7.0 (0.175) WFT
Topcoat	1080-12 Green	2.0 (0.050) DFT	4.0 (0.100) DFT
Topcoat	1080-12 Gray	2.0 (0.050) DFT	4.0 (0.100) DFT
Total		8.0 (0.200) DFT	16.0 (0.400) DFT

Apply System 3 in the field or shop to non-weathering steel surfaces cleaned to an SSPC SP-6 finish. Painting consists of painting with two primer coats, a stripe coat and two finish coats over all structural steel surfaces except as otherwise specified. Provide a curing period for the first primer coat of paint of at least 24 hours. Ensure that the Tape Adhesion of the cured system is no less than 3A when tested in accordance with ASTM D3359.

SYSTEM 4 ACRYLIC PRIMER AND TOP COATS FOR WEATHERING STEEL

Coat	Material	Mils (mm) Dry/Wet Film Thickness	
		Min	Max
Primer	1080-12 Brown	2.0 (0.050) DFT	4.0 (0.100) DFT
Intermediate	1080-12 White	3.0 (0.075) DFT	5.0 (0.125) DFT
Stripe	1080-12 Brown	4.0 (0.100) WFT	7.0 (0.175) WFT
Topcoat	1080-12 Brown	2.0 (0.050) DFT	4.0 (0.100) DFT
Total		7.0 (0.175) DFT	13.0 (0.325) DFT

Apply System 4 to weathering steel surfaces cleaned to an SSPC SP-6 finish. Shop painting consists of applying all primer and finish paints at the ends of beams or girders within a distance of 1 1/2 times the depth of the beam or girder at the bearing except as otherwise specified. Provide a curing period for the first primer coat of paint of at least 24 hours. Ensure that the Tape Adhesion of the cured system is no less than 3A when tested in accordance with ASTM D3359.

SYSTEM 5 OIL/ALKYD PRIMER AND ALKYD TOP COATS

Coat	Material	Mils (mm) Dry/Wet Film Thickness	
		Min	Max
Spot Primer	1080-5 Red +	1.5 (0.038) DFT	3.0 (0.075) DFT
Primer	1080-5 Red	1.5 (0.038) DFT	3.0 (0.075) DFT
Stripe	1080-5 Red +	3.0 (0.075) WFT	5.0 (0.125) WFT
Topcoat	1080-6 Gray +	2.0 (0.050) DFT	4.0 (0.100) DFT
Topcoat	1080-6 Gray	2.0 (0.050) DFT	4.0 (0.100) DFT
Total		7.0 (0.175) DFT	14.0 (0.350) DFT

Apply System 5 in the field overcoating old oil/alkyd paint systems. Painting consists of two primer coats (one on spots which have been cleaned to an SSPC SP-3 finish) and the other over the repairs and the old paint. If applying System 5 to new structural steel, apply the first prime coat in the shop and apply the remaining coats after erecting the steel and placing all concrete. Apply a stripe coat of primer and two finish coats over all structural steel surfaces except as otherwise specified. Provide a curing period for the first primer coat of at least 24 hours. The "+" indicates the addition of an approved tinting pigment to achieve a color difference. Ensure that the Tape Adhesion of the cured system in the areas of spot repairs, is no less than 3A when tested in accordance with ASTM D3359.

442-8 SURFACE PREPARATION.

(A) Blast Cleaning:

Use a blast profile which is 1.0 to 3.0 mils (0.025 to 0.075 mm) and angular. The degree of cleaning required is indicated under the specified paint system. Unless otherwise specified, clean all other steel surfaces to be coated or metallized to meet SSPC SP-10. Clean weathering steel surfaces to be painted to achieve a SSPC SP-6 finish.

Blast clean by centrifugal or forced air blasters. When using forced air blasters, use blast nozzles with a minimum 5/16" (8 mm) orifice and operate at no less than 100 psi (690 kPa) when measured with a needle gage at the nozzle. Use dry blasting for all blast cleaning. Select a size or grade of abrasive that provides the specified finish and profile meeting the requirements of Section 1080-15.

Perform blast cleaning operations in such a manner that no damage is done to partially or entirely completed portions of the work

After blasting, brush the surface with clean brushes made of hair, bristle, or fiber; blow off with compressed air, or clean by vacuum so that any traces of blast products from the surface and any abrasive from pockets and corners are removed.

Use compressed air for nozzle blasting that is free of detrimental amounts of water or oil. Provide adequate separators and traps.

Examine the blast cleaned surface for any traces of oil, grease, or smudges deposited in the cleaning operations. If present, remove them by an approved method. Have the degree of cleanliness and profile approved prior to painting.

When blast cleaning structures open to traffic or over traffic, provide suitable protective enclosures to prevent damage to public and private property.

When blast cleaning near bridge machinery, seal all journals, bearings, motors, and moving parts against entry of abrasive dust before blast cleaning.

Unless otherwise authorized, prime or treat blast cleaned surfaces to be painted no later than 8 hours after blast cleaning is complete. Reclean the cleaned surfaces that contain rust or are contaminated with foreign material before painting or bolting.

(B) Hand or Power Tool Cleaning:

Thoroughly remove loose paint, rust, scale, dirt, oil, grease, and other detrimental substances by hand cleaning (SSPC-SP2), power tool cleaning (SSPC-SP3), or any combination of these methods. Hand cleaning includes the use of metal brushes, grinders, sanders, or any approved combination of these tools. Use bristle or wood fiber brushes to remove loose dust.

442-9 APPLICATION OF PAINT.

(A) General:

Unless otherwise permitted, apply all paint by spraying, except apply the stripe coat by brush or roller. The use of a brush or roller is permitted to make minor repairs to the primer.

Make sure that the applicator has a current copy of the paint manufacturer's application instructions, along with Material Safety Data Sheets for each paint; and furnish 2 copies to the Engineer. Unless otherwise required herein, apply in accordance with the manufacturer's instructions.

Do not start applying paint until the paint materials are approved.

Both Shop and Field applicators are required to conduct and document quality control inspection of the painting, including measurements of temperature, dew point, surface profile, and paint thickness. Make sure that the paint applicator has the Engineer’s pre-approved procedure for repair of all damage and defects.

The Engineer approves all paint thinning activities. The paint products specified in Section 1080 do not require thinning when applied under normal conditions. Obtain written approval for any thinning necessitated by weather conditions or other causes. Only those thinners approved by the paint manufacturer as described in the application instructions are permitted.

Paint in a neat and workmanlike manner. Apply the paint so as to provide a tight film of the specified thickness, well bonded to the metal or previously applied paint, and free of laps, streaks, sags, or other defects.

Make sure each coat of paint is in a proper state of cure or dryness before applying the succeeding coat. Where necessary, clean each coat of paint in accordance with Subarticle 442-8(B).

When a stripe coat is required, apply a 2 inch (50 mm) stripe by brush or roller to all exposed edges of steel before applying the finish coat. Locate the edge or corner in the approximate center of the paint stripe.

(B) Spray Application:

Use equipment for spray application of paint that is suitable for the intended purpose, capable of properly atomizing the paint, and equipped with suitable pressure regulators and gages. Use air caps, nozzles, and needles recommended by the manufacturer of the equipment for the material being sprayed. Keep the equipment in satisfactory condition to permit proper paint application. In closed or recirculating paint spray systems where gas under pressure is used over the liquid, use an inert gas, such as nitrogen.

Provide and drain periodically during operations, adequately sized traps or separators to remove oil and water from the compressed air. Make sure that the air from the spray gun impinging against the surface shows no water or oil.

Use an agitated spray pot. Adjust the agitator or stirring rod to reach within 2 inches (50 mm) of the bottom of the spray pot and be in motion at all times during paint application. Provide sufficient motion to keep the paint well mixed.

Apply paint in a uniform layer, with overlapping at the edge of the spray pattern. Adjust the spray pattern so that the paint is deposited uniformly.

442-10 SHOP PAINTING.

(A) General:

Shop painting is the painting of structural steel in an enclosed shop or plant before shipment to the site of erection. The work in this section applies to previously uncoated steel and includes the proper preparation of the metal surfaces and the application, protection, and cure/drying of coatings. Complete all shop fabrication, including welding and attachment of shear connectors, before painting is started.

(B) Painted Areas:

(1) Do not paint the following surfaces:

- Bearing assemblies, plates, etc. called for as galvanized or metallized.
- Areas where field welding is to be performed.
- Outside surfaces of splice plates (Systems 3 and 5 only).
- Plate surfaces contacting elastomeric bearing pads
- Contact surfaces with blockouts for bolted connections on curved girder bridges and beam and girder splices (Systems 3 and 5 only). In the areas of these blockouts, extend the finish paint no closer than 2 inches (50 mm) nor more than 3 inches (75 mm) from the edges of contact surfaces in bolted connections. Ensure that the primer paint is clearly visible around these areas when the structural steel is assembled. The same offset dimensions are required for finish paint at field welds, measured from the proposed location of the field weld.

(2) Areas where paint is not required and overspray is permitted include:

- Bolt holes.
- Shear connectors and top surface of top flange.

(3) Clean and paint stiffener clips and other inaccessible areas on a best effort basis. Such areas are those that contain enclosed surfaces, the majority of which are not visible.

(4) Apply a stripe coat on all corners and raised welds.

(5) Provide a shop certification by American Institute Steel Construction (AISC) Sophisticated Paint Endorsement (SPE) or Society of Protective Coatings (SSPC)

Qualification Procedure Three (QP3) when the quantity is greater than 1500 square feet (140 square meters) of painted steel.

(6) Provide a repair procedure for all damage and defects for approval before painting.

(7) Paint erection marks for the field identification of members and weight marks upon surface areas previously painted with a shop coat. Do not load material for shipment until the paint is thoroughly dry, and in any case not less than 24 hours after applying the paint.

(C) Definitions:

- A **Corner** is defined as the intersection of two surfaces that are not in the same plane.
- **Inaccessible areas** are partially or completely enclosed surfaces, the majority of which are not visible without the use of special devices such as mirrors.
- A **Sharp Edge** is a corner on a steel section that terminates in a point or edge and appears able to cut human flesh.
- A **Stripe Coat** is an additional coat of paint applied to the edges, outside corners, and areas difficult to coat by spray before or after a full coat is applied to the surface. The stripe coat is intended to give those areas sufficient film build and coverage to resist corrosion.

(D) Surface Preparation

The requirements of Article 442-8 apply to surface preparation of steel surfaces in the shop. Abrasive Cleanliness: Check abrasives daily for contaminants or as otherwise directed by the Engineer. Verify that abrasive material meets the cleanliness requirements of SSPC AB1 or SSPC AB2 depending on the abrasive material used.

The following items are required as a part of preparation and cleaning:

a) Corner Condition: Bevel corners to an approximate 1/16” (2 mm) chamfer if the included angle is less than 90 degrees.

b) Surface Irregularities: Remove slivers, hackles, tears and projection of blast cleaned steel. Restore the profile in areas larger than one (1) square foot (0.09 square meters).

c) Weld Spatter: Remove excessive weld spatter and all loose weld spatter. Tightly adherent weld spatter is allowed unless it is sharp. Flatten sharp weld spatter.

d) Bolts: Shop installed galvanized bolts on which the coating is disturbed or distressed during shop cleaning is of no concern as long as the coating system is applied over them. If necessary, after installation, clean shop installed black bolts in accordance with SSPC Surface Preparation 1 Solvent Cleaning. Blast clean or otherwise clean by an approved alternative method the bolts before shop priming.

442-11 FIELD PAINTING.

Field painting is conducted after erection, or when damage to a shop applied coating system is repaired, or when steel is otherwise painted outside an enclosed shop environment.

Obtain written permission from the Engineer to apply field coats of paint between December 1 of one year and May 1 of the following year inclusive. Do not apply any coating below 32°F (0°C) or when a temperature of 32°F (0°C) or below is predicted during the drying and curing period of the paint. Do not apply any coating above or below the manufacturers recommended application temperatures or during a period when an ambient temperature outside the recommended range is predicted during the drying and

curing period of the paint. Obtain written approval for suitable enclosures if wishing to use such enclosures during adverse weather conditions. Use enclosures that control atmospheric conditions artificially inside within limits suitable for painting during the painting operation and until the paint is dry/cured or until weather conditions permit its exposure in the open.

Do not apply paint in rain, fog or when wind velocity is continuously greater than 10 miles per hour (16 kilometers per hour). Harsh environments may necessitate re-cleaning during or between paint applications.

Touch-up of shop painted non-weathering steel consists of painting with primer and finish paint over all the previously uncoated exposed metal surfaces. When the repair area exceeds one square foot (0.09 square meters), clean, prime, and topcoat damaged areas in accordance with Article 442-8(A). Otherwise clean, prime, and topcoat damaged areas in accordance with Article 442-8(B). For systems with shop applied topcoats, apply an additional field appearance coat of finish paint to the outside surface of all exterior beams on non-weathering steel bridges over highways and navigable waterways.

When an appearance coat of finish paint is required, paint the portion of galvanized high strength bolts on the outside face of exterior beams or girders with primer and appearance coat of the finish paint. Apply the primer to the galvanized high strength bolts by brush so that the primer is not applied to the adjacent finish paint.

At the location of field welds, satisfactorily remove all paint or galvanizing by blast cleaning, or hand or power tool cleaning just prior to welding. Clean sufficiently to prevent contamination of the weld by the paint.

Final acceptance by the engineer will be after erection of the structure, when the final coat has been applied, and all repairs effected.

Clean all contaminants such as soil, concrete, weld splatter, grease, or any other deleterious material from the steel or shop coated surfaces before any painting operations begin. Harsh environments may necessitate re-cleaning during or between paint applications.

442-12 INSPECTION

Ensure that the coating applicator maintains a daily quality control record. The information required in the record is listed on Materials and Tests Form M&T-928. Maintain quality control data in a log and format approved by the Engineer. Enter data on a daily or immediate basis as coating activities are conducted. Ensure that the applicator's quality control representative signs and dates each entry.

Apply all coatings in accordance with SSPC PA1. Repair all coating defects or nonconformities in accordance with SSPC PA1. Make repairs to the topcoat with a uniform gloss and color on visible surfaces. The engineer makes the final decision concerning uniformity and appearance.

442-13 REPAINTING OF EXISTING STEEL STRUCTURES.

Repaint existing steel structures in accordance with Sections 442-1 through 442-12 and the provisions of this section.

(A) Pollution Control:

During field painting operations, utilize all necessary precautions to prevent dispersion of surface preparation debris, paint, or any other material outside the work area due to wind or any other reason.

(B) Hazardous Paint Removal:

Should the existing paint system include toxic substances such as red lead oxide which is considered hazardous if improperly removed, furnish a containment and spill control plan for surface preparation and painting operations and await review and approval

of said plan before beginning work. This plan must meet or exceed the requirements of Class 3 in accordance with SSPC Guide 6I.

Monitor air quality. Any visible emissions outside the containment structure or air quality monitoring results exceeding the permissible OSHA action level is justification for suspension of the work. Monitor air quality at random locations within 1 to 5 feet (0.3 to 1.5 m) from the enclosure in accordance with NIOSH Method 7082.

Immediately collect and retain any spilled dust or paint debris in approved containers. Should a spill result in soil or water contamination, take all necessary actions to remediate the site to its original state.

Waste Handling:

Treat and consider all paint debris generated during the work as hazardous waste.

Collect debris from surface preparation operations in bulk dumpsters or other suitable metal containers approved by the Waste Disposer and Engineer.

Permanently identify each container with a date and identification number. At the end of the work shift, collect all debris generated for that day in the container. No subsequent work is permitted until all debris is properly collected and stored. Store the containers in a fenced or otherwise secured area in an approved location to prevent damage or vandalism.

Clean and dispose of any incidental materials or equipment that are contaminated as the result of work activities on the project.

Waste Disposal: Dispose of waste in accordance with North Carolina's Hazardous Waste Rules 15A NCAC 13A.

(C) Health and Safety Responsibility:

In addition to the requirements of Article 105-11 “Inspection of Work”, Section 106 “Control of Material”, and Section 107 “Legal Relations and Responsibility to Public”, provide effective engineering and work practice controls to insure adequate protection.

Prior to beginning work, certify to the Engineer that all personnel involved with lead paint removal operations (including rigging and material handling personnel) are properly trained and understand the applicable parts of EPA 40 CFR Part 745 and OSHA Standards 29 CFR 1910 and 29 CFR 1926 including any amendments in force at the time of this contract.

442-14 COMPENSATION.

The price and payment below will be full compensation for all items required to paint steel structures including but not limited to those items contained in Article 442-1.

(A) No Direct Payment:

When the contract does not include the item of "Painting of Structural Steel", there will be no direct payment for the work covered by this section.

(B) Direct Payment:

When the contract includes the item of "Painting of Structural Steel", all work covered by this section except for shop painting will be paid for at the contract lump sum price for this item. Payment at the contract lump sum price for "Approximately _____ Pounds (Kilograms) Structural Steel" will be full compensation for the work of shop painting.

(C) Payment:

When provided for in the contract, payment will be made under:

Painting of Structural Steel .....Lump Sum
Pollution Control.....Lump Sum

SECTION 445
TIMBER STRUCTURES

445-1 DESCRIPTION.

Construct timber structures as indicated on the plans in conformity with the lines, profile grades, dimensions, and design shown, and in compliance with the requirements of these specifications. Furnish and erect all timber, fasteners, hardware, and other materials, preservative treatment, and falsework; paint.

445-2 MATERIALS.

Refer to Division 10:

Untreated timber and lumber ..... Article 1082-1
Treated timber and lumber ..... Article 1082-2
Structural steel .....Section 1072
Hardware ..... Article 1074-3
Paint .....Section 1080

445-3 CONSTRUCTION METHODS.

(A) Handling and Storing Materials:

Store lumber and timber in piles at the site unless immediately placing in the structure. Neatly pile structural timber on blocking above the ground and protect it from the sun when necessary to prevent warping. Open-stack untreated timber at least 12 inches (300 mm) above the ground surface, stacked to shed water and prevent warping, and protected from the weather by suitable covering.

Neatly stack all lumber and timber with ends exposed and handle in a manner that will avoid injury or breakage. Handle treated timber with rope slings. Do not use cant hooks, peaveys, or other sharp instruments in handling treated timber.

Clear the ground of weeds and rubbish under and in the vicinity of all material stacks.

(B) Workmanship:

Make all framing true and exact. Drive nails and spikes with just sufficient force to set the heads flush with the surface of the wood.

Perform all cutting, framing, and boring of treated timber before treatment insofar as is practicable. In waters infested with marine borers, avoid cutting below high water.

Thoroughly swab all cuts and abrasions, after trimming carefully, with at least 2 coats of the same preservative used in the treatment of timber. Where creosote is used, make sure it is hot.

Treat all holes bored after treatment in an acceptable manner.

(C) Holes for Bolts, Dowels, Rods, and Lag Screws:

Bore holes for round drift bolts and dowels with a bit 1/16 inch (2 mm) less in diameter than the bolt or dowel used. Make the diameter of holes for square drift bolts or dowels equal to the least dimension of the bolt or dowel.

Bore holes for machine bolts with a bit the same diameter as the bolt.

Bore holes for rods with a bit 1/16 inch (2 mm) greater in diameter than the rod.

Bore holes for screws with a bit not larger than the body of the screw at the base of the thread.

Countersink whenever smooth faces are required.

(D) Bolts and Washers:

Use a washer of the size and type required by the plans under all bolt heads and nuts that would otherwise come in contact with wood.

Burr all bolt threads after the nuts are finally tightened.

(E) Framing:

Accurately cut and frame all lumber and timber to a close fit in such a manner that the joints will have even bearing over the entire contact surface. Do not shim in making joints, and do not use open joints.

(F) Framed Bents:

Bed mud sills firmly and evenly in solid material. Provide full, even bearing for sills on the pedestals, mud sills, or piles. Frame posts true and provide full bearing on pedestals, sills, and caps.

(G) Caps:

Place timber caps to secure an even and uniform bearing over the tops of the supporting post or piles and to secure an even alignment of their ends.

(H) Bracing:

Properly align bents before placing bracing. Provide bracing of sufficient length to provide a minimum distance of 8 inches (200 mm) between the outside bolt and the end of the brace.

(I) Stringers:

Place stringers in position with the better edge placed down.

(J) Wheel Guard and Railing:

Accurately frame and align wheel guards and railings.

(K) Flooring:

(1) Plank Floors:

Construct single plank floors of a single thickness of plank supported by stringers or joists. Securely spike each plank to each joist or nailing strip. Carefully grade the planks as to thickness and lay so that no adjacent planks vary in thickness by more than 1/16 inch (2 mm).

(2) Two Ply Floors:

Construct two ply timber floors of 2 layers of flooring supported on stringers or joists. Lay the top course either diagonally or parallel to the center line of roadway, as required by the plans, and securely fasten each floor piece to the lower course. Stagger joints at least 3 feet (1 m). If placing the top flooring parallel to the center line of the roadway, take care to securely fasten the ends of the flooring.

(3) Laminated or Strip Floors:

Place the strips of flooring on edge parallel to the bents, and securely fasten to the adjacent strips with spikes of the length shown on the plans. Toe-nail or otherwise fasten the strips to the stringers.

445-4 METHOD OF MEASUREMENT.

The quantity of structural timber to be paid for is the number of thousand feet board measure (cubic meters) of timber that is actually incorporated in and becomes a part of the completed and accepted structure. Measurement is based on the nominal timber sizes and the lengths shown on the plans or designated by the Engineer.

445-5 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to construct timber structures including but not limited to those items contained in Article 445-1.

The quantity of structural timber, measured as provided in Article 445-4, will be paid for at the contract unit price per thousand feet board measure (cubic meters) for "Untreated Structural Timber" or "Treated Structural Timber".

Payment will be made under:

Untreated Structural Timber .....Thousand Feet Board Measure (Cubic Meters)
Treated Structural Timber .....Thousand Feet Board Measure (Cubic Meters)

SECTION 450
BEARING PILES

450-1 DESCRIPTION.

Furnish and drive untreated timber, treated timber, prestressed concrete, steel, and cast-in-place concrete bearing piles as indicated on the plans, as directed, in conformity with these specifications and to the required bearing and penetration. Furnish pile shells, collars, hardware, concrete, reinforcing steel, and all other materials; furnish all equipment; clear and grub as necessary; drive piles vertically or on a batter; jet piles; cut off, splice, and build up piles; place concrete and reinforcing steel; construct pile trestles; furnish and place temporary bracing; remove any natural obstruction; wrap, bolt, or fasten timber fender piles; and abandon, remove, replace, and redrive piles as necessary.

450-2 MATERIALS.

Refer to Division 10:

Untreated timber piles ..... Article 1084-1
Treated timber piles ..... Article 1084-2
Prestressed concrete piles .....Section 1078
Steel piles ..... Article 1084-3
Steel pile shells ..... Article 1084-4
Portland cement concrete .....Section 1000

450-3 PREPARATION FOR DRIVING.

(A) Excavation:

Completely excavate the foundation before driving piles in the foundation. Dispose of loose or displaced material resulting from pile driving, augering, or jetting as provided in Article 410-8.

(B) Clearing and Grubbing:

Where clearing and grubbing is not complete at the structure site, clear and grub the site of the work in accordance with Article 410-3.

(C) Driving Piles Through Embankment:

Do not drive piles until the embankment is placed to plan typical section and subgrade elevation for a horizontal distance from any pile of 50 feet (15 m) or such greater distance as is directed except where fill slopes are within 50 feet (15 m) of a pile.

Drive steel piles through embankment regardless of embankment height unless otherwise required by the plans.

Drive concrete piles through embankment when the height of embankment is less than 10 feet (3 m). When the height of embankment is between 10 and 25 feet (3 and 7.6 m) inclusive, auger to the bottom of the embankment before driving piles. When the height of the embankment is greater than 25 feet (7.6 m), auger through the embankment for a distance of 25 feet (7.6 m) before driving piles except where a greater distance is required by the plans or special provisions. Provide a hole with a diameter 2 inches to 6 inches (50 to 150 mm) greater than the diameter or square dimension of the pile. After driving the pile, fill the annular space around the pile to the surface of the embankment with dry sand or pea gravel. As an exception to the above, no augering is required where the embankment is composed of cohesionless soil as determined by the Engineer.

Dispose of material resulting from augering holes as provided for in Article 410-8.

450-4 DETERMINATION OF PILE LENGTH.

The estimated lengths of piles shown on the plans and in the itemized proposal are for bid purposes only. Determine pile lengths and furnish piling of sufficient length to obtain the penetration and bearing value required and to extend into the cap or footing block as indicated on the plans. As an option and at no cost to the Department, drive test piles, make borings, or make such other investigations as may be necessary to determine the required pile lengths.

As an exception to the above, when specified in the special provisions the Engineer determines the required length of the piles.

450-5 TEST PILES.

As an option, locate and cut off driven test piles used in determining the lengths of piles, as a part of the completed structure, provided that such test piles conform to the specifications and are driven in the presence of the Engineer.

Where test piles are shown on the plans, provide piles that conform to the specifications and locate as shown on the plans or otherwise directed.

Drive test piles with the same type and capacity of equipment that is used for driving piles called for on the plans.

Remove test piles which are not incorporated in the completed structure to at least 2 feet (0.6 m) below the surface of the ground or the stream bed, and backfill the remaining hole with earth or other suitable material.

450-6 DRIVING EQUIPMENT.

Drive bearing piles with approved driving equipment either steam, air, or diesel hammers, or a combination of water jets and hammers. Use drop hammers only with written permission.

Submit for approval the specifications for the proposed pile driving hammer, cap block, and cushioning material. Submit this information at least 40 working days prior to driving piles.

Unless otherwise permitted, use pile hammers that develop sufficient energy to drive the piles at a penetration rate of not less than 1/8 inch (3 mm) per blow at the required bearing value. Make sure that the total energy per blow developed by the hammer, as determined by the Engineer, is not less than 1 foot-pound for each pound of weight (30 J for each kilogram) driven, but in no case less than 7,000 foot-pounds per blow

(9,500 J per blow). As an exception to the above, use pile hammers for driving concrete piles weighing more than 25,000 pounds (11,340 kg) that develop a total energy per blow in foot-pounds of at least 25,000 + 0.6 (Weight of pile--25,000) (in joules of at least 35,000 + 0.6 [mass of pile – 35,000]).

When drop hammers are permitted, use hammers that weigh at least 3,000 pounds (1,360 kg) and are equipped with leads and hoisting equipment. Do not allow the fall of the hammer to exceed 10 feet (3 m).

Operate steam, air, or diesel hammers at the length of stroke and number of blows per minute required by the Engineer.

Provide plant and equipment for steam hammers with sufficient capacity to maintain at the hammer, under working conditions, the volume and pressure specified by the manufacturer. Equip the plant and equipment with accurate pressure gauges that are easily accessible.

Use striking parts of air and steam hammers which weigh at least 1/3 the weight of the drive head and pile, with a minimum weight of 2,750 pounds (1,250 kg).

Equip open-end (single acting) diesel hammers with a scale (jump stick) extending above the ram cylinder, to permit the Engineer to visually determine hammer stroke at all times during pile driving operations.

Equip closed-end (double acting) diesel hammers with a calibrated bounce chamber pressure gauge, in good working order, mounted near ground level and easily read by the Engineer. Also, provide a chart or graph equating bounce chamber pressure to equivalent energy for the closed-end diesel hammer used. Submit this chart or graph along with the hammer specifications required above.

When approved, and as an option, supply and operate one or more water jets and pumps, or furnish the necessary augering apparatus to auger holes no greater than the diameter of the pile to the proper depth and drive the piles therein. Submit for approval details of the proposed jetting or augering equipment and procedures. If using jets, withdraw the jets at least 5 feet (1.5 m) before reaching the required penetration and drive the pile with the hammer to secure the final penetration and full bearing. If setting a pile in an augered hole, drive it sufficiently to fix the point firmly and secure full bearing. Do not use jets for installing piles in embankments.

Do not use followers or underwater hammers for driving piles without written permission. When using a follower or underwater hammer, furnish 1 pile in each bent or footing long enough to permit driving without a follower or underwater hammer.

Protect and hold pile heads in position by approved driving heads. Make sure that the driving head closely fits the top of the pile and extends down the sides of the pile a sufficient distance to hold the pile in position. Protect the heads of concrete and timber piles from direct impact by a cushion and driving block. Provide collars or bands to protect timber piles against splitting or brooming where required.

450-7 ACCURACY OF DRIVING.

Drive piles so that the axial alignment is within ¼ inch per foot (20 mm per m) from the vertical or batter shown on the plans. Horizontally, keep the pile within 3 inches (75 mm) of the plan location longitudinally and transversely. Maintain pile embedment in the pile cap or footing to within 3 inches (75 mm) more or 2 inches (50 mm) less than that required by the plans. No additional payment is made for increased footing dimensions necessary due to piles driven out of position.

450-8 CONSTRUCTION REQUIREMENTS.

(A) General:

Unless otherwise approved or directed, do not drive piles within 50 feet (15 m) of cast-in-place concrete until the concrete attains an age of at least 3 curing days.

Drive piles to the required bearing capacity in a continuous operation unless stopped due to insufficient length or other emergencies. After the pile driving operation stops, operate the hammer a sufficient number of blows to overcome the force of built up friction before resuming normal record keeping and checking final bearing.

Redrive any pile raised or moved laterally by the driving of adjacent piles.

(B) Timber Piles:

Store and handle timber piles by methods that do not injure the pile. Take care to avoid breaking the surface of creosoted piles. Do not use cant-hooks, dogs, or pike-poles. Give cuts or breaks in the surface of creosoted piles 3 brush coats of hot creosote oil and impregnate bolt holes with hot creosote oil by means of an approved bolt hole treater.

Use pile points as required for timber piles where indicated on the plans. Fabricate pile points from steel and fasten securely to the pile. Shape the points to provide even, uniform bearing on the pile point. Submit 7 copies of the proposed pile point and attachment details for acceptance prior to use.

Cut off the tops of all piles at the elevation shown on the plans. Except where a cast-in-place concrete cap or footing is constructed, cut off piles to a plane that provides true bearing on every pile without the use of shims. Withdraw any pile damaged during driving operations or driven out of its proper location or below the cut-off grade and replace with a new pile, or otherwise correct as directed.

Thoroughly brush-coat the sawn surface of all creosoted and untreated piles not encased in concrete with 3 applications of approved hot creosote and then cover with a coat of approved hot roofing pitch or other approved hot bituminous material. Place a sheet of galvanized iron or approved aluminum upon each pile head, bend it down over the sides of the pile, neatly trim, and firmly secure to the pile with large headed galvanized roofing nails. Use sheets of iron which are 24 gage (0.635 mm thick), and 24 inches by 24 inches (600 x 600 mm) in size. If using aluminum, make sure it is the same size as specified for galvanized iron sheets and has a minimum thickness of 0.032 inches (0.8 mm).

(C) Prestressed Concrete Piles:

Handle, transport, and store prestressed concrete piles by methods that do not injure the pile and support the piles at the pick-up points shown on the plans or along their full length. Replace piles damaged in handling or driving unless they are repaired to an acceptable condition.

When driving or cutting off piles below the elevation shown on the plans, build up the pile section to the plan elevation as shown on the plans unless otherwise directed.

Cut off piles not driven to grade perpendicular to the axis of the pile by means that do not result in spalling or other damage to the pile.

(D) Steel Piles:

Handle and store steel piles by methods that do not injure the pile. Store the piles above ground upon platforms, blocks, or other supports and keep the piles free from dirt, grease, and other foreign matter, and protect insofar as is practicable from corrosion.

Do not paint steel piles unless called for on the plans.

Use pile points for steel piles where indicated on the plans. Use cast steel pile points conforming to the requirements of AASHTO M103 (M103M). Weld pile points to

the pile as recommended by the manufacturer but make sure that the length of weld is at least twice the width of flange.

Cut off piles at the required elevations along a plane normal to the axis of the pile. Use approved methods for cutting off piles.

Use welded butt splices for steel piles as shown on the plans. Weld in accordance with the requirements of Article 1072-20. Do not use more than 3 pieces (2 splices) of steel pile in making up one full length pile.

(E) Cast-in-Place Concrete Piles:

Use cast-in-place concrete piles by driving steel shells permanently to the required bearing value and penetration and filling with concrete. Provide steel shells of sufficient strength and rigidity to permit driving, to prevent distortion caused by soil pressures or by the driving of adjacent piles, until filling with concrete. Use shells that are sufficiently watertight to exclude water.

After driving and prior to placing reinforcing steel and concrete therein, examine the steel shells for collapse or reduced diameter at any point. Any shell that is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value is subject to rejection. Remove and replace rejected shells, or drive a new shell adjacent to the rejected shell. Fill rejected shells that cannot be removed with concrete to an elevation one foot (0.3 m) below the elevation of the bottom of the footing and cut off the shell at that point. When driving a shell to replace a rejected shell, enlarge the footing as necessary to accommodate the pile.

Make sure that the shells are clean and free of water before placing reinforcing steel and concrete.

Have available at all times a suitable light for inspecting the entire length of the shells before placing reinforcing steel and concrete.

Place reinforcement in accordance with Section 425, the plans, and special provisions.

Use Class A concrete filling for cast-in-place piles. Do not place concrete until all driving within a radius of 15 feet (4.6 m) is complete, nor until all the shells for any one bent are completely driven. If this is not possible, discontinue all driving within the above limits until the concrete in the last pile cast sets at least 7 days.

Place concrete in accordance with Section 420 and compact by mechanical vibration. Ensure that the concrete filling for cast-in-place concrete piles is dense and homogeneous, and that the pile is completely filled up to cut-off elevation.

Do not paint steel pile shells unless called for on the plans.

Cut off steel pile shells at the required elevations along a plane normal to the axis of the pile. Use approved methods for cutting off pile shells.

Weld butt splices for steel pile shells as shown on the plans. Weld in accordance with the requirements of Article 1072-20. Do not use more than 3 pieces (2 splices) of steel pile shells in making up one full length pile.

450-9 BEARING VALUE AND PENETRATION.

Drive piles to a bearing capacity of not less than the design loading shown on the plans and, unless otherwise directed, penetrate at least 10 feet (3 m) into natural ground when a tip elevation is not indicated. When a tip elevation is indicated, drive piles to a bearing capacity of not less than the design loading shown on the plans and also penetrate at least to the specified tip elevation, unless otherwise permitted in writing.

Natural ground within an area of new embankment is defined as the bottom of the embankment or bottom of footing, whichever is lower.

The bearing capacity of a driven pile is determined by the Engineer from the wave equation analysis of ultimate capacity with a safety factor of 2, using approved driving equipment.

Drive piles, as directed, to computed bearing capacities greater than the minimum required on the plans when the character of the soil penetrated; or the distribution, size, and lengths of the piles involved; or other conditions of driving affect the reliability of driven piles.

In case water jets are permitted in connection with the driving, the bearing capacity is determined by formula based on the penetration obtained by driving after the jets are withdrawn.

450-10 METHOD OF MEASUREMENT.

The quantity of piles to be paid for is the actual number of linear feet (linear meters) of piles that are incorporated into the completed and accepted structure. Measurement is made by measuring the pile before it is driven and then subtracting the length of any portion of the pile that is cut off. In the case of prestressed concrete piles that are built up, measurement includes the number of linear feet (linear meters) added to the original pile length by the build-up.

The quantity of pile points to be paid for is the actual number of pile points that are incorporated into the completed and accepted structure.

No measurement is made of any piles driven in falsework or used in bracing, or which are rejected.

450-11 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to provide bearing piles including but not limited to those items contained in Article 450-1.

(A) General:

The quantities of piles, measured as provided in Article 450-10, will be paid for at the contract unit prices per linear foot (linear meter) for "Untreated Timber Piles", "Treated Timber Piles", "_____ Inch (mm) Prestressed Concrete Piles", "_____ Steel Piles", or "Cast-in-Place Concrete Piles".

The quantity of pile points, measured as provided in Article 450-10, will be paid for at the contract unit price each for "Steel Pile Points".

(B) Cutting Off Piles:

No payment will be made for cutting off any pile except as otherwise provided below.

When the Engineer has determined the length of piles to be furnished and driven, and a prestressed concrete pile has been cut off to either shorten the pile or to provide for building up the pile to a longer length, payment for cutting off each pile will be made at an amount equal to the contract unit price per linear foot (meter) for furnishing and driving the pile which has been cut off.

After driving steel piles to the specified bearing, as an option, drive the piles to grade in lieu of cutting off the piles provided the additional length of the pile driven does not exceed 5 feet (1.5 m). If driving the piles to grade, the additional length of pile will be paid for at the contract unit price per linear foot (linear meter) for "_____ Steel Piles". No additional compensation will be made for cutting off piles.

(C) Pile Cut-Offs:

When the Contractor has been responsible for determining pile lengths, no payment will be made for any portion of a pile that has been cut off.

When the Engineer has determined the length of piles to be furnished and driven, the Department will reimburse the Contractor for pile cut-offs as provided below; however, the cut-offs will remain the property of the Contractor. In the case of prestressed concrete piles, steel piles, steel shells for cast-in-place piles, and treated timber piles, payment for pile cut-offs will be made at the actual verified cost per linear foot (linear meter) delivered at the project site, less any discount allowed on the invoice, but with no percentage added. As an exception to the above, no payment will be made for any treated timber pile cut-off which is 2 feet (0.6 m) or less in length.

No payment will be made for pile cut-offs when untreated timber piles are used.

(D) Pay Items:

Payment will be made under:

Untreated Timber Piles ..... Linear Foot (Linear Meter)
Treated Timber Piles ..... Linear Foot (Linear Meter)
__" (mm) Prestressed Concrete Piles ..... Linear Foot (Linear Meter)
_____Steel Piles ..... Linear Foot (Linear Meter)
Cast-in-Place Concrete Piles ..... Linear Foot (Linear Meter)
Steel Pile Points ..... Each

SECTION 452
SHEET PILES

452-1 DESCRIPTION.

Furnish and drive untreated timber, treated timber, steel, and prestressed concrete sheet piles as shown on the plans, which are left in place so that they become a part of the completed work, all in conformity with the requirements shown on the plans or in these specifications. Furnish collars, hardware, and all other materials and equipment; clear and grub as necessary; jet, cut off, splice, and build up piles; furnish and place temporary bracing; remove any obstruction; and remove, replace, and correct piles.

452-2 MATERIALS.

Refer to Division 10:

Untreated timber sheet piles ..... Article 1084-6
Treated timber sheet piles ..... Article 1084-7
Prestressed concrete sheet piles ..... Section 1078
Steel sheet piles ..... Article 1084-8

452-3 DRIVING EQUIPMENT.

Drive sheet piles with steam, air, diesel, or gravity hammer, or a combination of water jets and hammer. Have all driving equipment approved.

452-4 ACCURACY OF DRIVING.

Drive piles to a tolerance of not more than 1/8 inch per foot (10 mm per meter) from the vertical.

452-5 CONSTRUCTION REQUIREMENTS.

(A) General:

Keep piles moving during driving operations by continuous operation of the hammer, except when interrupted by an emergency.

(B) Timber Piles:

Store and handle timber piles by methods that do not injure the pile. Take care to avoid breaking the surface of treated piles, and do not use cant-hooks, dogs, or pike-poles. Repair cuts or breaks in the surface of treated piles as directed and impregnate bolt holes with an approved preservative by means of an approved bolt hole treater.

Cut off the tops of all piles to a true plane at the elevation shown on the plans. Cut off piles that support timber caps or grillage work to an exact plane so that true bearing is obtained on every pile without the use of shims. Withdraw any pile damaged during driving operations or driven out of its proper location or below the cut-off grade and replace with a new pile, or otherwise correct as directed.

Correct all piles displaced by the driving of adjacent piles.

Thoroughly brush-coat the heads of all treated piles not encased in concrete with 3 applications of approved preservative after cutting off the piles.

(C) Prestressed Concrete Piles:

Handle, transport, and store prestressed concrete piles by methods that do not injure the pile. Support the piles while handling, transporting, and storing as shown on the plans or along their full length. Replace piles damaged in handling or driving unless satisfactory repairs are made and accepted.

Cut off piles not driven to grade as directed by means that do not result in spalling or other damage to the pile.

(D) Steel Piles:

Handle and store steel piles by methods that do not injure the pile. Store the piles above ground upon platforms, blocking, or other supports. Keep the piles free from dirt, grease, and other foreign matter, and protect them insofar as is practicable from corrosion.

Do not paint steel piles unless called for on the plans.

Cut off piles with approved methods at the required elevations as directed.

452-6 PENETRATION.

Ensure that piles penetrate a sufficient depth to place the tip of the pile at the tip elevation shown on the plans or as directed.

452-7 METHOD OF MEASUREMENT.

The quantity of sheet piles to be paid for is the number of square feet (square meters) of sheet pile wall completed and accepted. In determining this quantity, the wall length used in the computation is the wall length shown on the plans and the wall height is the length of sheet piles called for on the plans used in constructing the wall.

452-8 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to provide sheet piles including but not limited to those items contained in Article 452-1.

The quantities of sheet piles, measured as provided in Article 452-7, will be paid for at the contract unit prices per square foot (square meter) for "_____ Inch (mm) x_____ Inch (mm) Untreated Timber Sheet Piles", "_____ Inch (mm) x _____ Inch (mm) Treated Timber Sheet Piles", "_____ Inch (mm) x _____ Inch (mm) Prestressed Concrete Sheet Piles", or "_____ Steel Sheet Piles".

If sheet piles are not indicated on the plans but are found necessary during construction and are required by the Engineer, payment for such sheet piles will be made at the unit price included in the contract for sheet piles of the same type and size intended for

use at other locations. If the contract does not include such a unit price, payment for the sheet piles will be made as provided in Article 104-7 for extra work.

Payment will be made under:

__" (mm) x __" (mm) Untreated Timber Sheet Piles .....Square Foot (Square Meter)
__" (mm) x __" (mm) Treated Timber Sheet Piles .....Square Foot (Square Meter)
__" (mm) x __" (mm) Prestressed Concrete Sheet Piles .....Square Foot (Square Meter)
_____ Steel Sheet Piles .....Square Foot (Square Meter)

SECTION 454
WATERPROOFING AND DAMPPROOFING

454-1 DESCRIPTION.

Waterproof or dampproof concrete surfaces in accordance with the provisions of these specifications for the particular method of waterproofing or dampproofing called for on the plans. Furnish and apply all asphalt, tar, fabric, asphalt plank, and any other materials.

454-2 MATERIALS.

Refer to Division 10:

Asphalt primer ..... Subarticle 1020-9(A)
Asphalt binder .....Subarticle 1020-9(B)
Cut-back asphalt .....Subarticle 1020-9(C)
Tar ..... Subarticle 1020-9(D)
Woven cotton fabric ..... Subarticle 1020-9(F)
Plain asphalt plank .....Subarticle 1020-9(E)

454-3 METHOD A WATERPROOFING.

(A) General:

Method A waterproofing consists of one coat of asphalt primer, and 3 mop coats of hot asphalt cement with 2 layers of cotton fabric alternating between the mop coats.

(B) Preparation of Surface:

Ensure that concrete surfaces are dry, reasonably smooth, and free from projections or holes which are capable of puncturing the membrane. Immediately before applying the waterproofing, thoroughly clean the surface of dust and loose materials.

Make sure that the concrete is at least 14 days old for Class A concrete, at least 10 days old for Class AA Concrete, or at least 7 days old for high early strength concrete, before beginning waterproofing. Do not waterproof in wet weather nor when the temperature is below 35°F (2°C), without permission.

(C) Application:

Give waterproofed surfaces a thorough coat of asphalt primer, and allow it to set thoroughly before applying the first mop coat. If directed, thin the primer to a suitable brushing consistency with an approved volatile solvent. Heat the asphalt cement for the mop coat to a temperature of not less than 300°F (149°C), and frequently stir to avoid local overheating. Equip the heating kettles with thermometers.

Begin the waterproofing at the low point of the surface.

Use a half width first strip of fabric; and a full width second strip. Lap the full width of the first strip. Make the third and each succeeding strip full width and lap so that there are 2 layers of fabric at all points with laps not less than 2 inches (50 mm) wide. Make sure that the end laps are at least 12 inches (300 mm).

Beginning at the low point of the surface, mop a section about 20 inches (500 mm) wide and the full length of the surface with hot asphalt cement. Immediately roll the first strip of fabric into the asphalt cement and press into place to eliminate all air bubbles and to provide a firm bond to the surface. Mop this strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric with hot asphalt binder and roll a full width of the fabric into this cement, completely covering the first strip, and press into place. Mop this second strip and an adjacent section of the concrete surface with hot asphalt cement and place the third strip of fabric to lap the first strip not less than 2 inches (50 mm). Continue this process until the entire surface is covered, each strip of fabric lapping at least 2 inches (50 mm) over the second preceding strip. Give the entire surface a final mopping of hot asphalt cement.

Mop on concrete to completely cover the surface sufficiently heavy on cloth to completely conceal the weave. Use at least 12 gallons of asphalt on horizontal surfaces for each 100 square feet (5 liters for each square meter) of finished work, and at least 15 gallons (6 liters) on vertical surfaces. Perform the work so that, at the close of a day's work, all laid cloth receives the final mopping of asphalt. Thoroughly seal down all laps.

(D) Special Requirements:

At the edges of the membrane and at any points punctured by such appurtenances as drains or pipes, make suitable provisions to prevent water from getting between the waterproofing and the waterproofed surface.

Place all membrane flashing at curbs and against girders, spandrel walls, etc., with separate sheets of membrane lapping the main membrane not less than 12 inches (300 mm). Closely seal flashing with either a metal counter-flashing or by embedding the upper edges of the flashing in a groove poured full of joint filler.

Provide expansion joints, both horizontal and vertical, with water stops and premolded joint filler as called for on the plans. Seal expansion joints in the face adjacent to the membrane bituminous material. Carry the membrane continuously across all expansion joints.

At the ends of the structure carry the membrane well down on the abutments and make suitable provisions for all movement.

(E) Repairs:

Repair any damage that occurs as directed. Repair by patching when permitted. Extend the first ply of the patch at least 12 inches (300 mm) beyond the outermost damaged portion of the membrane and extend the second ply at least 3 inches (75 mm) beyond the first.

(F) Backfilling:

Do not backfill without permission and until the final mop coat thoroughly hardens. Place backfill in such a manner that the waterproofing is not damaged.

454-4 METHOD B WATERPROOFING.

(A) General:

Method B waterproofing consists of Method A waterproofing over which a protection course of plain asphalt plank of the thickness required by the plans is placed.

(B) Plain Asphalt Plank Protection Course:

Cover the entire surface of the membrane with the asphalt plank. Before laying, remove all surplus talc or other powder from the plank with a stiff brush or broom. Lay each piece in a mopping of hot asphalt binder. Coat the edge and end of pieces in place with hot asphalt binder before placing the next piece. Crowd each plank tightly against the adjacent plank to provide a uniform smooth surface without open cracks or spaces. Use

whole planks, in regular, straight courses, except as necessary to make closures and trim around openings and obstructions. Carefully cut closing and trimming pieces to size.

(C) Backfilling:

Do not backfill without permission. Place backfill in such a manner that the waterproofing is not damaged.

454-5 METHOD C DAMPPROOFING.

(A) General:

Method C dampproofing consists of 5 absorptive coats of tar, Grade RT-1, and one seal coat of tar, Grade RTCB-5.

(B) Preparation of Surface:

Make sure that the surfaces are dry. Immediately before applying the first dampproofing coat, thoroughly clean the surfaces of dust and loose material. Permit the concrete to dry for a period of at least 5 days after the expiration of the curing period before dampproofing.

(C) Application:

Give the concrete surfaces 5 coats of tar, Grade RT-1. Apply the tar cold with a suitable brush and let each coat absorb before applying the succeeding coat. After absorption of the fifth coat of tar, apply a seal coat of tar, Grade RTCB-5, at a temperature of about 80°F (27°C) and thoroughly brush into all surfaces. Do not apply any coat when the preceding coat is damp or during any time that the surface is exposed to any moisture. Allow the seal coat to set for at least 4 days, or as long as necessary to harden, before allowing any load to come against it.

454-6 METHOD D DAMPPROOFING.

(A) General:

Method D dampproofing consists of 2 coats of cutback asphalt, Grade RC-250, or tar, Grade RT-6.

(B) Preparation of Surface:

Make sure the surfaces are dry. Immediately before applying the first dampproofing coat, thoroughly clean the surfaces of dust and loose materials. Permit the concrete to cure for a period of at least 14 days for Class A concrete, at least 10 days for Class AA concrete, or 7 days for high early strength concrete, before dampproofing.

(C) Application:

Give the concrete surfaces 2 applications of cut-back asphalt, Grade RC-250, or tar, Grade RT-6. Apply the asphalt or tar by means of suitable brushes to secure uniform and thorough applications. Do not apply the second coat of asphalt or tar until the first coat thoroughly sets. Do not apply dampproofing during any time that the surface is exposed to any moisture. Make sure that the temperature of the asphalt or tar is such that uniform and thorough application is obtained. Do not backfill until the second coat thoroughly sets.

454-7 METHOD OF MEASUREMENT.

The quantity of waterproofing and dampproofing to be paid for is the actual number of square yards (square meters) of surface which is waterproofed and dampproofed. In measuring this quantity, measurement is made along the actual surface that is to be waterproofed or dampproofed before the waterproofing or dampproofing is applied.

454-8 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to waterproof and dampproof including but not limited to those items contained in Article 454-1.

The quantity of waterproofing and dampproofing, measured as provided in Article 454-7, will be paid for at the contract unit prices per square yard (square meter) for "Method _____ Waterproofing" or "Method _____ Dampproofing".

Payment will be made under:

Method _____ Waterproofing ..... Square Yard (Square Meter)
Method _____ Dampproofing ..... Square Yard (Square Meter)

SECTION 460
BRIDGE RAILING

460-1 DESCRIPTION.

Furnish and place metal, pipe, or concrete barrier bridge railing in accordance with the requirements of these specifications and as shown on the plans. Furnish posts, rail bars, pipe fittings, hardware, paint, concrete, reinforcing steel, admixtures, forms, falsework and all other materials; galvanize; paint; fabricate and erect rail; and place, finish, and cure concrete.

460-2 MATERIALS.

Refer to Division 10:

Portland cement concrete .....Section 1000
Steel bar reinforcement ..... Article 1070-2
Aluminum rail ..... Article 1074-4
Galvanized steel rail ..... Article 1074-4
Pipe rail ..... Article 1074-5
Paint .....Section 1080
Epoxy Coated Reinforcing Steel..... Article 1070-8

460-3 CONSTRUCTION METHODS.

Adhere to the construction load limitations of Article 420-20 while placing concrete for all bridge rails.

(A) Metal Rail:

Use either aluminum or galvanized steel rail, but use the same material on all structures on the project on which metal rail is required.

Use shims if necessary to obtain correct post alignment.

Drive aluminum rivets cold. Thoroughly coat the base of aluminum rail post, closure plates, shims, or any other aluminum surface in contact with concrete with an approved aluminum impregnated caulking compound.

(B) Pipe Rail:

Give galvanized pipe rail one field coat of organic zinc repair paint, of minimum wet thickness of 1.5 mils (0.038 mm), after erection in accordance with the requirements of Section 442 unless otherwise required in the special provisions.

(C) Concrete Barrier Rails:

This Subarticle applies to the construction of concrete barrier rail, median barrier rail and concrete parapet, referred to collectively as concrete barrier rails in this Subarticle.

Plans for the concrete barrier rails are detailed for slip-formed cast-in-place concrete. Unless otherwise noted, construct concrete barrier rails detailed on the plans using conventional forms or by slip-forming using an approved self-propelled extrusion machine. Except as noted herein, construct in accordance with the requirements of Section 420.

Construct joints in the barrier rails at the locations and of the type shown on the plans.

Construct concrete barrier rails to the shape, line, grade, and dimensions shown on the plans except that when slip-forming rails, either radius or chamfer the corners. Check slip-formed rail concrete directly behind the extrusion machine using successive overlapping applications of the 10 foot (3 m) straightedge. Correct high and low areas while the concrete is still workable. Limit horizontal and vertical deviation from plan line and grade to no more than 1/4 inch in 10 feet (6 mm in 3 m).

Provide sufficient internal vibrators to consolidate the concrete along the faces of forms and adjacent to joints. Consolidate the concrete by internal vibration in one pass of the extrusion machine. Produce a dense and homogeneous barrier free of voids and honeycomb with minimum hand finishing. Coordinate concrete delivery and placement to provide uniform progress while minimizing stopping and starting of the extrusion machine.

When plans require horizontal deck drains through the barrier rails, use drain couplings with slip-formed rails.

Correct all exposed surfaces that are not satisfactory to the Engineer as to uniformity of color and texture or because of excessive patching as required. Give the roadway face of barrier rails constructed using conventional forms a Class 2 surface finish in accordance with Subarticle 420-18(F). Use a broom finish on the roadway face of slip-formed barrier rails.

460-4 METHOD OF MEASUREMENT.

(A) Metal Rail:

The quantity of metal rail to be paid for is the actual number of linear feet (linear meters) of metal rail, measured along the top bar of the rail, which is completed and accepted.

(B) Pipe Rail:

The quantity of pipe rail to be paid for is the actual number of linear feet (linear meters) of pipe rail, measured along the top pipe of the installed pipe rail, which is completed and accepted.

(C) Concrete Barrier Rails:

The quantity of concrete barrier rail to be paid for is the number of linear feet (linear meters) of concrete barrier rail provided on the plans for “Concrete Barrier Rail”. The quantity of concrete median barrier to be paid for is the number of linear feet (linear meters) of concrete median barrier provided on the plans for “Concrete Median Barrier”. The quantity of concrete parapet to be paid for is the number of linear feet (linear meters) of concrete parapet provided on the plans for “Concrete Parapet”. Where the plans are revised, the quantity to be paid for is the quantity shown on the revised plans. Reinforcing steel and Class AA concrete contained in the concrete barrier rails is listed in the “Bill of Material for Concrete Barrier Rail”, the “Bill of Material for Median Barrier”, or the “Bill of Material for Concrete Parapet” on the plans, and no separate measurement or payment is made for these quantities, unless otherwise noted on the plans.

460-5 BASIS OF PAYMENT.

The prices and payments below will be full compensation for all items required to provide bridge railing including but not limited to those items contained in Article 460-1.

(A) Metal Rail:

The quantities of metal rail, measured as provided in Subarticle 460-4(A), will be paid for at the contract unit prices per linear foot (linear meter) for "_____ Bar Metal Rail".

(B) Pipe Rail:

The quantities of pipe rail, measured as provided in Subarticle 460-4(B), will be paid for at the contract unit price per linear foot (linear meter) for "_____ Inch (mm) Galvanized Steel Pipe Rail".

(C) Concrete Barrier Rails:

The quantity of concrete barrier rails, as provided in Subarticle 460-4(C), will be paid for at the contract unit price per linear foot (linear meter) for "Concrete Barrier Rail", "Concrete Median Barrier", or "_____x_____Concrete Parapet".

(D) Pay Items:

Payment will be made under:

____ Bar Metal Rail	Linear Foot (Linear Meter)
__" (mm) Galvanized Steel Pipe Rail	Linear Foot (Linear Meter)
Concrete Barrier Rail	Linear Foot (Linear Meter)
Concrete Median Barrier	Linear Foot (Linear Meter)
____ x ____ Concrete Parapet	Linear Foot (Linear Meter)

SECTION 462
SLOPE PROTECTION

462-1 DESCRIPTION.

Construct slope protection under the ends of bridges or at other locations in accordance with details shown on the plans and the requirements of these specifications. Excavate and backfill; and furnish and place concrete, reinforcement, concrete block, grout, stone, and other materials. Unless otherwise noted on the plans, use either cast-in-place reinforced concrete, concrete block, or stone slope protection. Do not use stone slope protection at railroad grade separation bridges or on end bent slopes steeper than 2:1. Use the same option at both ends of an individual bridge.

462-2 MATERIALS.

Refer to Division 10:

Portland cement concrete	Section 1000
Curing agents	Section 1026
Joint fillers	Article 1028-1
Wire mesh reinforcement	Article 1070-3
Concrete paving block	Article 1040-3
Grout	Article 1040-9
Herbicide	Article 1060-13

462-3 CONSTRUCTION METHODS.

Immediately before placing the paving, properly shape and firmly compact the slope so that it conforms to the required lines and grades.

Construct cast-in-place concrete slope protection in accordance with Section 420, except as otherwise provided herein. Use Class B concrete. Finish concrete as provided below. Furnish and place reinforcement as shown on the plans and in accordance with the provisions of Section 425. After placing the concrete for one section, strike it off to plan grade and finish to a dense and uniform surface.

For concrete block slope protection lay concrete paving blocks in horizontal courses. Grout all joints. Provide nominal joint widths of 3/4 inch (19 mm), with a minimum width of 1/2 inch (13 mm) and a maximum width of 1 1/4 inches (32 mm).

Provide a reasonably smooth and uniform surface for the finished slope protection that does not vary more than 1/2 inch in a distance of 10 feet (13 mm in 3 m).

Do not place backfill adjacent to cast-in-place slope protection at any one end bent until each individual section of paving at the end bent cures for 3 or more curing days as defined in Subarticle 420-16(A). However, place backfill no later than 5 calendar days after the last section of concrete paving placed at the end bent cures for 3 curing days. Compact all backfill to a degree comparable to the adjacent undisturbed material.

Place backfill adjacent to concrete block slope protection no later than 8 calendar days after completing the block paving.

Use stone for slope protection that is hard and durable in nature and ranges in size from 2 to 6 inches (50 to 150 mm). No specific gradation is required; however, use various sizes of stone that are reasonably equally distributed within the required size range and are essentially cubical in shape.

Make sure that the condition of the slope and the method of placement are such that there is partial embedment of the pieces of stone in contact with the slope. Do not allow stone adjacent to concrete to project more than 3 inches (75 mm) above the concrete surface.

Treat all areas of the slope with slope protection with a herbicide. Apply at the rate of 8 pounds of herbicide in 100 gallons of water per acre (9 kg in 935 liters of water per hectare) unless otherwise directed. Apply the herbicide immediately prior to placing the stone. Confine the application to the area where stone is placed. If the slope is dry, lightly water it after application to ensure herbicide contact with the soil particles.

462-4 METHOD OF MEASUREMENT.

The quantity of slope protection to be paid for is the actual number of square yards (square meters) of slope protection, measured along the top surface of the paving, which is completed and accepted.

462-5 BASIS OF PAYMENT.

The price and payment below will be full compensation for all items required to provide slope protection including but not limited to those items contained in Article 462-1.

The quantities of slope protection, measured as provided in Article 462-4, will be paid for at the contract unit price per square yard (square meter) for "_____ Inch (mm) Slope Protection".

Payment will be made under:

__" (mm) Slope Protection..... Square Yard (Square Meter)

NOTES