

## SECTION 400 PAVEMENTS

### SECTION 401 PLANT MIX PAVEMENTS-GENERAL

#### DESCRIPTION

**401.01** These specifications include general requirements that are applicable to all types of hot mix asphalts irrespective of gradation of aggregate, kind and quantity of asphalt cement, or pavement use. Deviations from these general requirements will be indicated in the specific requirements for each type.

This work consists of one or more courses of bituminous mixture constructed on a prepared foundation in accordance with these specifications and the specific requirements of the type under contract, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established.

#### MATERIALS

**401.02 Composition of Mixtures.** The bituminous plant mix shall be composed of a mixture of aggregate, filler or additives if required and approved, asphalt cement, and reclaimed material if permitted and used.

- (a) *Mix Design.* The Contractor shall submit the following to the Engineer:
- (1) A proposed hot mix asphalt mix design prepared in accordance with Colorado Procedure 52, including a proposed job-mix gradation for each mixture required by the Contract which shall be wholly within the Master Range Table in Section 703 before the tolerances shown in Section 401 are applied. The weight of lime shall be included in the total weight of the material passing the 75  $\mu\text{m}$  (No. 200) sieve.
  - (2) The name of the refinery supplying the asphalt cement and the source of the anti-stripping additive.
  - (3) A sufficient quantity of each aggregate for the Department to perform the tests specified in Section 2.2.1 of CP 52.

The Contractor's proposed job-mix formula for each hot mix asphalt grading will be tested by the Department utilizing materials actually produced and stockpiled for use on the project.

The Department will process one asphalt design mix for each pavement grading at no charge to the Contractor. The Contractor will be assessed a charge of \$3,000 for testing and evaluating each additional design mix submitted by the Contractor.

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The job-mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size, a single percentage of asphalt cement to be added to the aggregate, and a single temperature for the mixture at the discharge point of the plant.

When Laboratory tests indicate that a proposed job-mix formula complies with the specifications as revised for the project, a Form 43 shall be executed between the Engineer and the Contractor to establish the job-mix formula.

- (b) *Mixtures Furnished to the Project.* After the job-mix formula is established, all mixtures furnished for the project shall conform thereto within the ranges of tolerances listed in Table 401-1

**Table 401-1**

Asphalt Content	±0.3%
Asphalt Recycling Agent	±0.2%
Temperature of Mixture When Discharged from Mixer	±20 °F
<sup>1</sup> Hot Mix Asphalt - Item 403	
<sup>2</sup> Passing the 9.5 mm ( <sup>3</sup> / <sub>8</sub> inch) and larger sieves	± 6%
<sup>2</sup> Passing the 4.75 mm (No. 4) and 2.36 mm (No. 8 sieves)	± 5%
<sup>2</sup> Passing the 600 µm (No. 30) sieve	± 4%
<sup>2</sup> Passing the 75 µm (No. 200) sieve	± 2%
<sup>1</sup> When 100% passing is designated, there shall be no tolerance. When 90-100% passing is designated, 90% shall be the minimum; no tolerance shall be used.	
<sup>2</sup> These tolerances apply to the Contractor's Quality Control Testing.	

The job-mix formula for each mixture shall be in effect unless modified in writing on Form 43.

Should a change in sources of materials be made, a new job-mix formula shall be established before the new material is used. This new job-mix formula shall be in effect until modified by the Engineer. Requests made in writing by the Contractor for changes in the job-mix formula will be considered. The job-mix formula may be changed by the Engineer if the change will produce a mixture of equal or better quality and will:

- (1) Permit better utilization of available material, or
- (2) Result in a saving in cost to the Department through an adjustment in unit price.

Tests for cleanliness, abrasion loss, and percent of fractured faces will be made on representative samples of aggregate taken during production or from the stockpiles.

Hot mix asphalt (HMA) will be tested for moisture susceptibility by the Department in accordance with Table 401-2. If a sample fails to meet the criteria

shown in Table 401-2, the Contractor shall take corrective action before being permitted to continue production. If proper corrective action cannot be readily determined, the Engineer will suspend the use of such material until Laboratory tests indicate that the corrective measures taken by the Contractor will provide material that is in compliance.

If one or more samples fail to meet the requirements of Table 401-2, material from the area represented by the failing sample will be evaluated as follows:

If the area represented by the failing sample contains 2000 tons of the new pavement or less, then the result for the failing sample shall be considered a lot of one and will be evaluated according to the formulas and procedures in subsection 105.03.

If the area represented by the failing sample contains more than 2000 tons of the new pavement, then the material from the area represented by the failing sample will be sampled and tested according to the following method:

Pavement samples for possible moisture susceptibility testing will be taken at a minimum frequency of once every 2000 tons throughout the project. The Engineer will observe the sampling, take possession of the samples, and retain these samples for possible testing. Sample size shall be a minimum of 20 pounds. If a 10,000 ton sample fails then the four 2000 ton samples from the area represented by that failing 10,000 ton sample will be tested for moisture susceptibility. The 10,000 ton result and the four 2,000 ton results will be considered a lot of five and will be evaluated according to the formulas and procedures in subsection 105.03. If less than four retained samples are on hand because the 10,000 ton sample represents less than 8000 tons of hot mix asphalt, the price adjustment will be based on the test results from the retained samples on hand plus the test result from the 10,000 ton sample.

For the above evaluation the "F" factor used in calculating P factors shall be 2.5. The P value shall be applied to price of the HMA item. If asphalt cement is not paid for separately the price reduction shall be multiplied by 0.60. Lottman P values will not be combined with Pay Factors for other elements determined in accordance with QC/QA specifications.

**Table 401-2**

<b>Grading</b>	<b>Test Procedure</b>	<b>Minimum Test Result</b>	<b>Sampling Frequency</b>
All Gradings	CP L-5109 Method B	70	One per 10,000 tons or fraction thereof (minimum)

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**401.03 Aggregates.** Aggregates shall meet the applicable requirements of Section 703 - Aggregates.

**401.04 Mineral Filler.** Mineral filler shall meet the requirements of subsection 703.06.

**401.05 Hydrated Lime.** Hydrated lime shall meet the requirements of subsection 712.03.

**401.06 Asphalt Cements.** The type and grade of asphalt cement will be specified in the Contract.

The asphalt cement shall meet the applicable requirements of Section 702-Asphalt Cements.

### CONSTRUCTION REQUIREMENTS

**401.07 Weather Limitations and Placement Temperatures.** Hot mix asphalt shall be placed only on properly prepared unfrozen surfaces which are free of water, snow, and ice. The hot mix asphalt shall be placed only when both the air and surface temperatures equal or exceed the temperatures specified in Table 401-3 and the Engineer determines that the weather conditions permit the pavement to be properly placed and compacted.

**Table 401-3  
PLACEMENT TEMPERATURE LIMITATIONS IN °F**

Compacted Layer Thickness in inches	Minimum Surface and Air Temperature °F	
	Top Layer	Layers Below Top Layer
<1½	60	50
1½ - <3	50	40
3 or more	45	35

Note: Air temperature is taken in the shade. Surface is defined as the existing base on which the new pavement is to be placed.

If the temperature falls below the minimum air or surface temperatures, paving shall stop.

The Contractor shall schedule the work so that no planed or recycled surface is left without resurfacing for more than ten calendar days during the period specified in Table 401-4, below. The Contractor shall immediately place a temporary hot mix asphalt layer on any surface that has been planed or recycled and can not be resurfaced in accordance with the above temperature requirements within ten calendar days after being planed or recycled. The minimum thickness of the temporary hot mix asphalt layer shall be 2 inches. The Contractor shall perform the quality control required to assure adequate quality of the hot mix asphalt used in the temporary layer. All applicable pavement

markings shall be applied to the temporary layer surface. The Contractor shall maintain the temporary layer for the entire period that it is open to traffic. Distress which affects the ride, safety, or serviceability of the temporary layer shall be immediately corrected to the satisfaction of the Engineer. The temporary hot mix asphalt layer shall be removed when work resumes.

**Table 401-4**  
**PERIODS REQUIRING OVERLAY OF TREATED SURFACES**

Location by Elevation	Period During Which Planed or Recycled Surfaces Must be Overlaid within Ten Days
All areas below and including 7000 feet	October 1 to March 1
All areas above 7000 feet up to and including 8500 feet	September 5 to April 1
All areas above 8500 feet	August 20 to May 15

**401.08 Bituminous Mixing Plant.** The bituminous mixing plant shall be capable of producing a uniform material, have adequate capacity, and be maintained in good mechanical condition. Defective parts shall be replaced or repaired immediately if they adversely affect the proper functioning of the plant or plant units, or adversely affect the quality of the hot bituminous plant mix.

Dust, smoke, or other contaminants shall be controlled at the plant site to meet all air quality requirements in accordance with subsections 107.01 and 107.24.

Acceptable safety equipment shall be provided by the Contractor to accommodate sampling and testing.

Hot bituminous plant mix shall not be stored longer than nine hours, unless additional protective measures are used and approved.

When hot bituminous plant mix is obtained from a commercial plant, the Contractor shall make arrangements for approved laboratory facilities at the plant site for testing hot bituminous paving mixtures. The plant laboratory shall meet the requirements of subsection 620.04.

**401.09 Hauling Equipment.** Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds thinly coated with a minimum amount of paraffin oil, lime solution, or other approved release agent. Petroleum distillates such as kerosene or fuel oil will not be permitted. Each truck shall have a cover of canvas or other suitable material to protect the mixture from the weather.

**401.10 Bituminous Pavers.** Self-propelled bituminous pavers shall be provided and equipped with an activated screed assembly, heated if necessary, capable of spreading and finishing the bituminous plant mix material in lane widths applicable to the typical

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section and thicknesses shown in the Contract. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of asphalt plant mix material in widths shown in the Contract.

The paver's receiving hopper shall have sufficient capacity for a uniform spreading operation and shall have an automatic distribution system that will place the mixture uniformly in front of the screed.

The screed or strike-off assembly shall produce the specified finished surface without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with uniform and continuous laying of the mixture. Stop and go operations of the paver shall be avoided.

The bituminous paver shall be equipped with a means of preventing the segregation of the coarse aggregate particles from the remainder of the bituminous plant mix when that mix is carried from the paver hopper back to the paver augers. The means and methods used shall be approved by the paver manufacturer and may consist of chain curtains, deflector plates, or other such devices and any combination of these.

The following specific requirements shall apply to the identified bituminous pavers:

- (1) Blaw-Knox bituminous pavers shall be equipped with the Blaw-Knox Materials Management Kit (MMK).
- (2) Cedarapids bituminous pavers shall be those that were manufactured in 1989 or later.
- (3) Caterpillar bituminous pavers shall be equipped with deflector plates as identified in the December 2000 Service Magazine entitled "New Asphalt Deflector Kit {6630, 6631, 6640}".

Prior to the start of using the paver for placing plant mix, the Contractor shall submit for approval a full description in writing of the means and methodologies that will be used to prevent bituminous paver segregation. Use of the paver shall not commence prior to receiving approval from the Engineer.

The Contractor shall supply a Certificate of Compliance that verifies that the approved means and methods used to prevent bituminous paver segregation have been implemented on all pavers used on the project.

Pavers shall be equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, and maintaining the screed at the specified longitudinal grade and transverse slope. The sensor shall be constructed to operate from either or both sides of the paver and shall be capable of working with the following devices:

- (1) Ski-type device at least 30 feet in length.
- (2) Short ski or short shoe.
- (3) At least 5,000 feet of control line and stakes.

The type or types of devices to be furnished shall be as provided in the Contract.

The controls shall be capable of maintaining the screed at the specified transverse slope within plus or minus 0.1 percent.

Manual operation will be permitted for constructing irregularly shaped and minor areas.

If the automatic controls fail or malfunction the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained.

If the Contractor fails to obtain and maintain the specified surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

Placement of hot mix asphalt on a waterproofed bridge deck shall be accomplished with equipment that will not damage the membrane or protective covering.

**401.11 Tack Coat.** When ordered by the Engineer or specified in the Contract, a tack coat shall be applied between pavement courses and paid for in accordance with Section 407.

**401.12 Surface Conditioning.** Irregularities in the existing pavement or base shall be brought to uniform grade and cross section.

Prior to placing tack coat and beginning overlay work, the surface to be tack coated shall be swept to remove accumulations of loose gravel and debris.

Bituminous plant mix shall be placed only on properly constructed surfaces that are free from substances that would adversely affect the pavement quality.

Contact surfaces of curbing, gutters, manholes, and other structures shall be painted with a uniform coating of asphalt cement prior to placing bituminous mixture against them.

**401.13 Preparation of Asphalt Cement.** The asphalt cement shall be heated to the specified temperature without local overheating and shall be continuously supplied to the mixer at a uniform temperature within the specified range.

**401.14 Preparation of Aggregates.** Heating and drying of the aggregates shall be accomplished without damaging the aggregate.

When hydrated lime is used it shall be added to the aggregate in accordance with one of the following methods:

- (1) *Lime Slurry Added to Aggregate.* The hydrated lime shall be added to the aggregate in the form of a slurry and then thoroughly mixed in an approved pugmill. The slurry shall contain a minimum of 70 percent water by weight.

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- (2) *Dry Lime Added to Wet Aggregate.* The dry hydrated lime shall be added to aggregate wetted a minimum of 2 percent above the surface saturated dry condition (SSD) of the blended aggregate as shown on the Form 43, and then thoroughly mixed in an approved pugmill. The Engineer will not require the Contractor to go above 5 percent total moisture, although the Contractor may elect to do so if the added water is necessary to meet the minimum Lottman specification (See Table 401-2.).

The lime-aggregate mixture may be fed directly into the hot plant after mixing or it may be stockpiled for not more than 90 days before introduction into the plant for mixing with the asphalt cement. The hydrated lime may be added to different sized aggregates and stockpiled, by adding 75 percent of the lime to the aggregate passing the 4.75 mm (No. 4) sieve and 25 percent to the aggregate retained on the 4.75 mm (No. 4) sieve.

In order to ensure the required lime and water quantities are introduced, lime and water feed for lime operation shall have control systems that change introduction rates in conjunction with changes in plant mix production. The control systems shall be documented in the Contractor's QC Plan.

When a test for aggregate percent moisture falls below the required minimum, the Contractor will receive a warning. When two consecutive tests for aggregate percent moisture fall below the required minimum, a follow up test will immediately be performed. A failure on the follow up test will result in suspension of work. Production will remain suspended until the source of the problem is identified and corrected. Each time production is suspended, corrective actions shall be proposed in writing by the Contractor and approved in writing by the Engineer before production may resume.

**401.15 Mixing.** The dried aggregates and asphalt shall be combined in the mixer in the quantities required to meet the job-mix formula.

The materials shall be mixed until the aggregate is completely and uniformly coated, and the asphalt is uniformly distributed throughout the aggregate.

The minimum temperature of the mixture when discharged from the mixer and when delivered for use shall be as shown in Table 401-5:

**Table 401-5**

<b>Asphalt Grade</b>	<b>Minimum Mix Discharge Temperature, °F*</b>	<b>Minimum Delivered Mix Temperature, °F**</b>
PG 58-28	275	235
PG 64-22	290	235
PG 76-28	320	280
PG 64-28	320	280
PG 58-34	300	280
* The maximum mix discharge temperature shall not exceed the minimum discharge temperature by more than 30 °F .		
** Delivered mix temperature shall be measured behind the paver screed.		

Hot-mix asphalt mixture shall be produced at the lowest temperature within the specified temperature range that produces a workable mix and provides for uniform coating of aggregates (95 percent minimum in accordance with AASHTO T 195), and that allows the required compaction to be achieved.

Storing or holding of asphalt mixture will be permitted provided the characteristics of the mixture are not altered. If storing or holding of the mixture causes segregation, excessive heat loss, or adversely affects the quality of the finished product, corrective action shall be taken. Unsuitable mixture shall be disposed of at the Contractor's expense.

When placing hot bituminous mixture over bridge decks covered by waterproofing membrane, the minimum temperature of the mixture when rolling operations begin shall be 250 °F. The job-mix formula temperature may be increased up to 30 °F to obtain this temperature.

**401.16 Spreading and Finishing.** Bituminous pavers shall be used to distribute the mixture to the established grade and required thickness over the entire width or partial width as practicable.

The longitudinal joint in both a new pavement and an overlay pavement layer shall offset the joint in the layer immediately below by 6 inches. In every pavement layer, the joints shall not be constructed in the wheel paths. The Contractor shall submit a longitudinal joint and pavement marking plan three days prior to the Pre-Paving Conference. The plan shall show the location and configuration of the proposed longitudinal joints and pavement markings, and shall detail the methods to be used to field establish a control line. The Contractor shall use a continuous string line to delineate every longitudinal joint during paving operations. All exposed string line shall be picked up and disposed of at the end of each day's paving. Paving shall not commence until the plan has been approved in writing by the Engineer. The joints in the top layer of pavement shall be located as follows unless otherwise approved in writing by the Engineer:

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- (1) For 2-lane roadways, offset 6 to 12 inches from the center of pavement and from the outside edge of travel lanes.
- (2) For roadways of more than 2 lanes, offset 6 to 12 inches from lane lines and outside edge of travel lanes.

Longitudinal joints shall not cross the centerline, lane line, or edge line unless approved by the Engineer.

Where paving operations are on the present traveled roadway, the Contractor shall arrange paving operations so there will be no exposed longitudinal joints between adjacent travel lanes at the end of a day's run. With the approval of the Engineer, the Contractor may leave an exposed longitudinal joint conforming to the following:

- (1) When the thickness of the pavement course being placed is 1.5 inches or less a vertical exposed longitudinal joint may be constructed.
- (2) When the thickness of the pavement course being placed is greater than 1.5 inches the joint shall be constructed according to one of the following:
  - (i) The entire joint shall be tapered 3:1 or flatter. A Taper steeper than 3:1 shall be considered vertical.
  - (ii) The top portion of the longitudinal joint may be vertical. The vertical portion shall be a maximum of 1.5 vertical inches. The remainder of the joint, below the vertical portion, shall be tapered 3:1 or flatter.

On areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be dumped, spread, raked, screeded, and luted by hand tools to the required compacted thickness and grades.

Production of the mixture shall be maintained so pavers can be used in echelon to place the wearing course in adjacent lanes.

The bituminous mixture shall be transported and placed on the roadway without segregation. All segregated areas behind the paver shall be removed immediately upon discovery. The segregated material shall be replaced with specification material before the initial rolling has taken place. If more than 50 square feet of segregated pavement is ordered removed and replaced in any continuous 500 linear feet of paver width laydown, operations shall be discontinued until the source of the segregation has been found and corrected.

If at any time, the Engineer observes segregated areas of pavement, he will notify the Contractor immediately.

After rolling, segregated areas will be delineated by the Engineer and evaluated as follows:

- (1) The Engineer will delineate the segregated areas to be evaluated and inform the Contractor of the location and extent of these areas within two calendar days, excluding weekends and holidays, of placement.
- (2) In each segregated area or group of areas to be evaluated, the Contractor shall take five 10 inch cores at random locations designated by the Engineer. In accordance with CP 75, the Contractor shall also take five 10 inch cores at random locations designated by the Engineer in non-segregated pavement adjacent to the segregated area. These cores shall be within 30 feet of the boundary of the segregated area and in the newly placed pavement. The coring shall be in the presence of the Engineer and the Engineer will take immediate possession of the cores. The Contractor may take additional cores at the Contractor's expense.
- (3) Gradation of the aggregate of the cores will be determined by CDOT in accordance with CP 46.
- (4) The core aggregate gradations from the segregated area will be compared to the core aggregate gradations of the corresponding non-segregated area.
- (5) Two key sieves of the core gradations from the segregated area will be compared to the core gradations from the corresponding non-segregated area to determine the difference. If differences for both key sieves exceed the allowable difference specified in the table below, the area is segregated.

**Table for Segregation Determination**

<b>Mix Grading</b>	<b>Key Sieves</b>	<b>Allowable Difference, %</b>
SX	2.36 mm (#8), 4.75 mm (#4)	9
S	2.36 mm (#8), 4.75 mm (#4)	9

- (6) Segregated areas in the top lift shall be removed and replaced, full lane width, at the Contractor's expense. The Engineer may approve a method equivalent to remove and replace that results in a non-segregated top lift. Segregated areas in lifts below the top lift, that are smaller than 50 square feet per 100 linear feet of lane width, will be corrected by the Contractor at the Contractor's expense in a manner acceptable to the Engineer. Segregated areas larger than 50 square feet per 100 linear feet of lane width in any lift shall be removed and replaced, full lane width, by the Contractor at the Contractor's expense.

If the area is determined to be segregated, the coring will be at the expense of the Contractor. If the area is determined to be non-segregated, the Engineer shall reimburse the Contractor \$2,000 for obtaining the ten cores.

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**401.17 Compaction.** The hot mix asphalt shall be compacted by rolling. Both steel wheel and pneumatic tire rollers will be required. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and be continuous until the required density is obtained. When the mixture contains unmodified asphalt cement (PG 58-28 or PG 64-22) or modified (PG 58-34), and the surface temperature falls below 185 °F, further compaction effort shall not be applied unless approved. If the mixture contains modified asphalt cement (PG 76-28 or PG 64-28) and the surface temperature falls below 230 °F, further compaction effort shall not be applied unless approved.

All roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted during surface course final rolling and will not be permitted on any rolling on bridge decks covered with waterproofing membrane.

Pavement shall be compacted to a density of 92 to 96 percent of the maximum theoretical density, determined according to CP 51. Field density determinations will be made in accordance with CP 44 or 81.

The longitudinal joints shall be compacted to a target density of 92 percent of the maximum specific gravity. The tolerance shall be  $\pm 4$  percent. Maximum specific gravity will be that shown on the Form 43 for the asphalt mix used in construction of the joint. If two Forms 43 apply to the joint material, the average of the maximum specific gravities shown on the Forms 43 will be used. Density (percent relative compaction) will be determined in accordance with Colorado Procedure 44.

The Contractor shall obtain one 6 inch diameter core at a random location within each longitudinal joint sampling section for determination of the joint density. The Contractor shall drill the cores at the location directed by the Engineer and in the presence of the Engineer. The Engineer will take possession of the cores for testing. The Contractor may take additional cores at the expense of the Contractor. Coring locations shall be centered on the line where the joint between the two adjacent lifts abut at the surface. Core holes shall be repaired by the Contractor using materials and methods approved by the Engineer.

Incentive or disincentive payment determined for joint density in accordance with subsection 105.05 will apply to the HMA on each side of the joint. If a layer of pavement has joints constructed on both sides, incentive or disincentive payment for each of those joints will apply to one half of the pavement between joints.

Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be immediately removed and replaced with fresh hot mixture, and compacted to conform with the surrounding area.

The Contractor shall construct a compaction pavement test section (CTS) for each job mix for which 2000 or more tons are required for the project. The CTS will be used to evaluate the number of rollers and the most effective combination of rollers and rolling patterns for achieving the specified densities. Factors to be considered include, but are not limited to, the following:

- (1) Number, size, and type of rollers.
- (2) Amplitude, frequency, size and speed of vibratory rollers.
- (3) Size, speed, and tire pressure of rubber tire rollers.
- (4) Temperature of mixture being compacted.
- (5) Roller patterns.

The CTS shall be constructed according to the following procedures:

The CTS shall be constructed to provide the nominal layer thickness specified. The first 500 tons of hot hot mix asphalt on the project location shall constitute the CTS. The production and placement rates of the CTS shall closely approximate the anticipated production and placement rates for the remainder of the Contract.

Compaction of the CTS shall commence immediately after the hot hot mix asphalt has been spread, and shall be continuous and uniform over the entire CTS. For the CTS, compaction shall continue until no discernible increase in density is obtained by additional compactive efforts. All compaction shall be completed before the surface temperature of the mixture drops below 185 °F.

Approved types of rollers shall be used to achieve the specified density. The Contractor shall determine what methods and procedures are to be used for the compaction operation. The compaction methods and procedures shall be used uniformly over the entire last 200 tons. The Contractor shall record the following information and a copy of this data shall be furnished to the Engineer.

- (1) Type, size, amplitude, frequency, and speed of roller.
- (2) Tire pressure for rubber tire rollers, and whether the pass for vibratory rollers is vibratory or static.
- (3) Surface temperature of mixture behind the laydown machine and subsequent temperatures and densities after each roller pass.
- (4) Sequence and distance from laydown machine for each roller, and number of passes of each roller to obtain specified density.

Two sets of random cores shall be taken within the last 200 tons of the CTS. Each set shall consist of a minimum of seven random corings. The locations of these cores shall be such that one set can serve as a duplicate of the other. One set of these cores shall be immediately submitted to the Engineer. This set will be used for determining acceptance of the CTS and determining density correction factors for nuclear density equipment. Densities of the random samples will be determined by cores according to CP 44. Density correction factors for nuclear density equipment will be

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determined according to CP 81. Coring shall be performed under CDOT observation. Coring will not be measured and paid for separately but shall be included in the work.

The CTS meets requirements if the Quality Level of the random samples is greater than or equal to 75. The Quality Level will be determined according to CP 71. Once constructed and accepted, the CTS shall remain in place and become part of the hot mix asphalt on the project.

When the Quality level is less than 75 the Contractor shall construct an additional test section, utilizing different rollers, or roller positions, or roller patterns as required. A written proposal detailing the changes in methods and procedures that will be used to obtain density is to be submitted to the Engineer for review before constructing the additional test section.

If the Quality Level of a CTS is less than 75 and greater than or equal to 44, the Engineer may accept the material at a reduced price in accordance with Section 105.

If the Quality Level of a CTS is less than 44, the Engineer may:

- (1) Require complete removal and replacement with specification material at the Contractor's expense.
- (2) Where the finished product is found to be capable of performing the intended purpose and the value of the finished product is not affected, as determined by the Engineer, permit the Contractor to leave the material in place with a pay factor, but not more than 75 percent of the bid price.

Each CTS shall be 500 tons. If in-place densities of the CTS, as determined by nuclear density equipment prior to determining density of the cores, meet the CTS density requirements, the Contractor may begin production paving and continue to place hot mix bituminous pavement under the following conditions:

- (1) The period during which the Contractor continues to pave without test results from cores shall not exceed one working day.
- (2) Construction proceeds at the Contractor's risk. If correlation with the cores reveals that the densities do not meet the CTS requirements, the hot mix bituminous pavement placed subsequently will be subject to price reduction or removal and replacement.

After production paving work has begun, a new CTS shall be constructed when a change in the compaction process is implemented. A new CTS may be required for different layers of pavement. Each additional CTS shall be constructed as specified herein, and shall be sampled, tested and accepted or rejected as described herein.

All additional costs associated with construction of the CTS shall be at the Contractor's expense. The hot mix asphalt (HMA) placed in the CTS will be paid for in accordance with subsection 401.22, at the contract price for the HMA mixture.

**401.18 Joints.** Placing of the HMA paving shall be continuous, and rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. A coat of asphalt cement shall be applied to contact surfaces of all joints just before additional mixture is placed against the previously compacted material. Location and configuration of longitudinal joints shall be in accordance with subsection 401.16.

**401.19 Pavement Samples.** The Engineer may take samples of the compacted pavement at random locations on the project for testing. Where samples have been taken, new material shall be placed and compacted by the Contractor to conform with the surrounding area.

**401.20 Surface Smoothness.** The roadway surface smoothness shall be tested in accordance with subsection 105.07. If not specified otherwise on the plans, the roadway surface shall be subject to inches per mile requirements for Category I, Rural Interstate Highway, in accordance with Table 105-6.

When the Contract specifies that the smoothness of an asphalt pavement is to be based on the Percentage of Improvement, the Contractor may still choose to use pavement smoothness based on inches per mile. The Contractor shall notify the Engineer in writing at least three working days prior to commencing of paving operation regarding the decision to change from Percentage of Improvement to inches per mile.

### **METHOD OF MEASUREMENT**

**401.21** Hot mix asphalt and asphalt cement will be measured by the ton. Batch weights will not be permitted as a method of measurement. The tonnage shall be the weight used in the accepted pavement. Deduction will not be made for the weight of asphalt cement in the mixture.

### **BASIS OF PAYMENT**

**401.22** All work performed and measured as described above will be paid for as provided in the respective sections for each type specified.

If there is no pay item for asphalt cement of the type specified it will not be measured and paid for separately but shall be included in the work.

Water used in the mixing plant, in accordance with subsection 401.14, to bring the lime-aggregate mixture to approved moisture content will not be measured and paid for separately but shall be included in the work.

Facilities for testing hot bituminous plant mix at the site of the commercial plant will not be paid for separately, but shall be included in the work.

When asphalt cement is a separate pay item, the amount of asphalt cement contained in reclaimed asphalt pavement (RAP) material will not be measured or paid for but shall be included in the work.

401.22

Coring for longitudinal joint density testing, core hole repair and associated expenses will not be paid for separately but shall be included in the work. Traffic control for this work will be paid for in accordance with the contract.

All costs of the temporary hot mix asphalt layer required according to subsection 401.07, maintenance and removal of the temporary pavement layer, temporary pavement marking, and traffic control will not be paid for separately, but shall be included in the work.

## **SECTION 403 HOT MIX ASPHALT**

### **DESCRIPTION**

**403.01** This work consists of constructing one or more courses of hot mix asphalt (HMA) pavement on a prepared base in accordance with these specifications, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established.

The HMA pavement shall be composed of a mixture of aggregate, filler if required, and asphalt cement.

Hot Mix Asphalt (Patching) consists of those quantities required for the replacement of unstable corrugated areas in the existing pavement, pipe trenches, areas removed for curb & gutter forms, areas between the curb & gutter or sidewalk and the existing paved parking lots, and areas designated on the plans. These quantities will be restricted to small areas which require hand placement methods and where conventional paving equipment can not be utilized.

### **MATERIALS**

**403.02** The materials shall conform to the requirements of subsections 401.02 through 401.06.

### **CONSTRUCTION REQUIREMENTS**

**403.03** The construction requirements shall be as prescribed in subsections 401.07 through 401.20.

Areas to be patched shall be excavated and squared to a neat line, leaving the sides of the excavation vertical. Prior to placement of the patch the exposed sides of the existing pavement shall be thoroughly coated with Emulsified Asphalt (slow-setting). Hot mix asphalt shall then be placed and compacted in succeeding layers not to exceed 3 inches in depth.

### **METHOD OF MEASUREMENT**

**403.04** Hot mix asphalt will be measured as prescribed in subsection 401.21.

### **BASIS OF PAYMENT**

**403.05** The accepted quantities of hot mix asphalt will be paid for in accordance with subsection 401.22, at the contract unit price per ton for the bituminous mixture.

Payment will be made under:

403.05

<b>Pay Item</b>	<b>Pay Unit</b>
Hot Mix Asphalt (Grading__)	Ton
Hot Mix Asphalt (Grading__) (Asphalt)	Ton
Hot Mix Asphalt (Patching)(Asphalt)	Ton

Aggregate, asphalt cement, asphalt recycling agent, additives, hydrated lime, and all other work necessary to complete each hot mix asphalt item will not be paid for separately but shall be included in the unit price bid.

Excavation, preparation, and tack coat of areas to be patched will not be measured and paid for separately, but shall be included in the work.

**SECTION 405  
HEATING AND SCARIFYING  
TREATMENT**

**DESCRIPTION**

**405.01** This work consists of recycling the top portion of the existing bituminous pavement as shown in the Contract, by cleaning, heating, scarifying, redistributing, re-leveling, compacting, and rejuvenating the existing bituminous material.

**MATERIALS**

**405.02** Asphalt rejuvenating agent shall meet the requirements of subsection 702.04.

**CONSTRUCTION REQUIREMENTS**

**405.03** Weather limitations shall be as provided in subsection 401.07. Prior to commencing heating and scarifying operations, the pavement shall be cleaned of all loose material. Power brooms shall be supplemented by hand brooming and use of other tools as required to bring the surface to a clean, suitable condition free of deleterious material.

Equipment used to heat and scarify the bituminous surface shall meet the following requirements:

- (1) Capable of uniformly applying heat under totally insulated, enclosed hoods to produce radiant heat.
- (2) Self-propelled and capable of scarifying to the depth specified.
- (3) Capable of covering a minimum of 750 square yards per hour while heating the existing surface to the extent that it will be remixed by the scarifiers to a depth not less than specified.

The heating operation shall extend at least 4 inches beyond the width of scarifying on both sides. When a pass is made adjacent to a previously placed mat, the longitudinal seam shall extend at least 2 inches into the previously placed mat. The temperature of the scarified material shall be between 200 and 300 °F when measured immediately behind the scarifier. The scarified material shall be distributed and leveled by a paving machine. The paving machine shall be capable of screeding the full width of the scarified material to produce a uniform cross section as shown in the Contract.

While the scarified material is still hot and before it is placed by the paving machine, an application of asphalt rejuvenating agent shall be applied as specified.

The bituminous surface shall be compacted immediately after it has been distributed and leveled, and while it is still workable. Two rollers shall be used to compact the scarified material. A steel wheel roller shall be used first to provide breakdown rolling, followed by a pneumatic tire roller with a minimum weight of 12 tons, to complete compaction to 92 to 96 percent of maximum theoretical density. When the mixture surface temperature falls below 165 °F, no further compaction effort shall be

405.03

done unless approved. A minimum of 24 hours shall elapse before a bituminous pavement overlay is applied to the scarified pavement.

The weight per cubic foot of the existing bituminous surface shall be determined in accordance with AASHTO T 166. Scarification depth will be acceptable when the moving average of a minimum of three consecutive random tests per hour indicates that the required amount per square foot, based on the weight per cubic foot of the existing bituminous surface, has been scarified. Testing shall be performed by the Contractor in lots of three per hour, or as often as necessary to maintain process control.

The longitudinal surface smoothness of the roadway prior to and after heating and scarifying shall be tested in accordance with subsection 105.07(c).

#### **METHOD OF MEASUREMENT**

**405.04** Heating and scarifying treatment will be measured by the square yard of work completed and accepted.

#### **BASIS OF PAYMENT**

**405.05** The accepted quantities of heating and scarifying treatment will be paid at the contract unit price per square yard for heating and scarifying treatment, and shall include cleaning, heating, scarifying, redistributing, re-leveling, and compacting the existing bituminous surfacing.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Heating and Scarifying Treatment	Square Yard

Asphalt rejuvenating agent will be measured and paid for in accordance with Section 411.

**SECTION 406**  
**COLD BITUMINOUS PAVEMENT (RECYCLE)**

**DESCRIPTION**

**406.01** This work consists of pulverizing the existing bituminous surfacing to the depth shown on the plans, mixing a recycling agent and water, if required, with the pulverized material, then spreading and compacting the mixed material.

**MATERIALS**

**406.02** The recycling agent shall be either a high float emulsified asphalt (polymerized) or emulsified recycling agent meeting the requirements of subsection 702.03.

The pulverized material shall meet the following gradation requirements:

Sieve Size	Percent Passing
31.5 mm (1¼ inch)	100
25.0 mm (1 inch)	90-100

The sealing emulsion shall be high float emulsion (diluted), emulsified asphalt (SS), or approved equal.

**CONSTRUCTION REQUIREMENTS**

**406.03** Weather Limitations. Daily recycling operations shall not begin until the atmospheric temperature is 55 °F and rising. Recycling operations shall be discontinued when the temperature is 60 °F and falling. Recycling operations shall not be performed when the weather is foggy or rainy, or when weather conditions are such that the proper mixing, spreading, compacting, and curing of the recycled material cannot be accomplished. Cold recycled pavement damaged by precipitation shall be reprocessed or repaired by methods approved by the Engineer, at the Contractor's expense.

The construction of cold recycled pavement will not be allowed from September 16 through May 14 unless otherwise approved. The Contractor's Progress Schedule shall show the methods to be used to comply with this requirement.

**406.04 Milling.** The existing bituminous surfacing shall be cold recycled in a manner that does not disturb the underlying material in the existing roadway.

Adjacent recycling passes shall overlap at the longitudinal joint a minimum of 4 inches.

The beginning of each day's recycling operation shall overlap the end of the preceding recycling operation a minimum of 100 feet unless otherwise directed.

Any fillet of fine, pulverized material which forms adjacent to a vertical face shall be removed prior to spreading the mixed material, except that such fillet adjacent to existing pavement which will be removed by a subsequent overlapping milling operation need not be removed. Vertical cuts in the roadway shall not be left overnight.

406.05

**406.05 Mixing.** When commencing recycling operations, the recycling agent shall be applied to the pulverized material at the initial design rate determined by the Materials Laboratory, based on samples obtained by the Department prior to construction. The exact application rate of the recycling agent will be determined and may be varied as required by existing pavement conditions. An allowable tolerance of plus or minus 0.2 percent of the initial design rate or directed rate of application shall be maintained at all times.

A representative of the recycling agent supplier shall be present on the project during recycling operations until an acceptable production sequence is established as determined by the Engineer.

The Contractor may add water to the pulverized material to facilitate uniform mixing with the recycling agent. Water may be added prior to or concurrently with the recycling agent, provided that this water does not adversely affect the recycling agent.

**406.06 Spreading.** Recycling and placing recycled material shall be at a rate sufficient to provide continuous operation of the paving machine. If paving operations result in being excessively behind or in excessive stopping of the paving machine, as determined by the Engineer, recycling operations shall be suspended. Recycling may resume when the Contractor can synchronize the rate of recycling with the capacity of the paving machine.

If segregation occurs behind the paver, the Contractor shall make changes in equipment, operations, or both to eliminate the segregation.

**406.07 Compacting and Finishing.** After the recycled material has been spread, traffic, including Contractor's equipment, shall not be allowed on the recycled material until it starts its initial break as determined by the Engineer. However, if precipitation is imminent, compaction may proceed to seal the surface from additional moisture.

Initial rolling shall be performed with one or more pneumatic tire rollers and be continued until no displacement is observed. Final rolling to eliminate pneumatic tire marks and achieve the required density shall be done by steel wheel rollers either in static or vibratory mode. The use of vibratory rollers shall be approved by the Engineer. If rollers are used in the vibratory mode, vibration shall be at low amplitudes to prevent transverse cracks.

The recycled material shall be compacted to a minimum of 100 percent of the density of a laboratory specimen compacted in accordance with CP 53. If the area tested fails to meet the required density, the area shall be reworked until it attains 100 percent compaction. The frequency of density testing for project acceptance will be one per 5000 square yards. The Engineer will perform one CP 53 for calculation of the percent relative compaction with each field density taken.

Rollers shall not be started or stopped on uncompacted recycled material. Rolling shall be accomplished so that starting and stopping will be on previously compacted cold recycled pavement or existing pavement.

Any type of rolling that results in cracking, movement, or other types of pavement distress shall be discontinued until the problem is resolved.

After the recycled material has been compacted, traffic, including the Contractor's equipment, shall not be permitted on the cold recycled pavement for at least two hours, unless otherwise approved.

Before placing the sealing emulsion or hot mix asphalt overlay, the cold recycled pavement shall be allowed to cure until the free moisture is reduced to 1 percent free moisture or less, by total weight of mix. Free moisture will be measured according to CP 57. After the free moisture content of the cold recycled pavement has reached the acceptable level, the hot mix asphalt overlay or sealing emulsion, if required, shall be placed. However, unless otherwise approved by the Engineer, the cold recycled pavement shall be covered with a minimum thickness of 2 inches of hot mix asphalt within ten calendar days after it is laid and compacted. The sealing emulsion, if required, shall be applied to the surface at an approximate rate of 0.025 to 0.10 gallons per square yard. The sealing emulsion shall be applied when the Engineer determines that it is necessary to prevent raveling (progressive separation of aggregate particles).

Damage caused by the Contractor to the cold recycled pavement shall be repaired at Contractor's expense, as directed, prior to placing any hot bituminous surfacing. Soft areas that are not caused by the Contractor or weather, shall also be repaired prior to placing the hot mix asphalt.

**406.08 Recycling Train.** The Contractor shall furnish a self-propelled machine capable of pulverizing the existing bituminous surfacing to the depth shown on the plans, in one pass. The machine shall have a minimum rotor cutting width of 12 feet. The rotor cutting width selected for the project shall allow for the longitudinal joint to be offset from the longitudinal joint of the layer placed above by at least 6 inches. The longitudinal joint shall not fall in the wheel path. The machine shall have standard automatic depth controls, and maintain a constant cutting depth. The machine shall also have screening and crushing capabilities to reduce or remove oversize particles prior to mixing with recycling agent. Oversize particles shall be reduced to size by crushing.

The machine shall perform continuous weight measurement of the pulverized material interlocked with the recycling agent metering device so the required recycling agent content will be maintained. Positive means shall be provided for calibrating the weight measurement device and the recycling agent metering device.

A positive displacement pump, capable of accurately metering the required quantity of recycling agent at rates as low as 4 gallons per minute, shall be used to apply the recycling agent. The interlock system shall allow addition of the recycling agent only

406.08

when pulverized material is present in the mixing chamber. Each mixing machine shall be equipped with a meter capable of registering the rate of flow and the total amount of recycling agent introduced into the mixed material.

The recycling agent shall be applied through a separate mixing machine capable of mixing the pulverized material and the recycling agent to a homogeneous mixture, and placing the mixture in a windrow. The mixture shall be placed in a windrow in a manner that prevents segregation.

**406.09 Paver.** The recycled material shall be placed with a self-propelled bituminous paver meeting the requirements of subsection 401.10, except that the screed shall not be heated. The mixed material shall be spread in one continuous pass, without segregation, to the lines and grades established on the plans.

When a pick-up machine is used to feed the windrow into the paver hopper, the pick-up machine shall be capable of picking up the entire windrow to the underlying materials.

**406.10 Compactors.** Rollers shall be steel wheel, pneumatic tire, vibratory or combination of these types. The number and weight of rollers shall be sufficient to obtain the required compaction while the recycled material is in a workable condition, except that each pneumatic tire roller shall be 30 tons minimum weight.

**406.11 Smoothness.** The longitudinal surface smoothness of the roadway prior to and after cold recycling shall be tested in accordance with subsection 105.07(c).

### METHOD OF MEASUREMENT

**406.12** In-place cold recycled pavement will be measured by the square yard of paved surface actually recycled, complete in place and accepted.

Repair of cold recycled pavement will be measured by the square yard of paved surface repaired and accepted.

### BASIS OF PAYMENT

**406.13** The accepted quantity of in-place cold recycled pavement will be paid for at the contract unit price per square yard.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Cold Bituminous Pavement (Recycle)	Square Yard
Repair of Cold Bituminous Pavement (Recycle)	Square Yard

Bituminous materials will be measured and paid for in accordance with Section 411.

406.13

Water will not be measured and paid for separately, but shall be included in the work.

Repair of cold recycled pavement damaged by the Contractor or by weather will not be measured and paid for separately, but shall be included in the work.

Overlaps of preceding recycling operations will not be measured and paid for separately, but shall be included in the work.

407.01

**SECTION 407  
PRIME COAT, TACK COAT, AND  
REJUVENATING AGENT**

**DESCRIPTION**

**407.01** This work consists of preparing and treating an existing surface with bituminous material, and blotter material if required, in accordance with these specifications and in conformity with the lines shown on the plans or established.

**MATERIALS**

**407.02 Bituminous Material.** The type and grade of bituminous material for prime and tack coating will be specified in the Contract.

The bituminous material for all coatings shall meet the applicable requirements of Section 702. The bituminous material for prime and tack coating may be conditionally accepted at the source. The rejuvenating agent shall be accepted before loading into the distributor.

**407.03 Blotter Material.** Blotter material for prime coating shall consist of aggregate base course conforming to the requirements specified for base course aggregate on the project.

Blotter material for rejuvenating agent shall consist of dry, gritty sand conforming to the fine aggregate gradation of Table 703-2, or as approved.

Blotter material may be accepted in the stockpile at the source or at the roadway prior to placement.

**CONSTRUCTION REQUIREMENTS**

**407.04 Weather Limitations.** Prime coat and tack coat shall not be applied under the following conditions:

- (1) When the surface is wet.
- (2) When weather conditions would prevent the proper construction of the prime or tack coat.

**407.05 Equipment.** The Contractor shall provide equipment for heating and uniformly applying bituminous material and blotter material.

The distributor and equipment shall be capable of uniformly distributing bituminous material at even temperature and uniform pressure on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard. The allowable variation from any specified rate shall not exceed plus or minus 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be

equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

The distributor for rejuvenating agent shall also be equipped with the following:

- (1) Heating facilities with controls to reach a temperature of 130 °F.
- (2) Circulating system to maintain proper mixture of the rejuvenating agent.

**407.06 Preparation of Surface.** Preparation of the surface to be treated shall include all work necessary to provide a smooth, dry, uniform surface. The work shall include patching, brooming, shaping to required grade and section, compaction, and removal of unstable corrugated areas.

The edges of existing pavements which are to be adjacent to new pavement shall be cleaned to permit the adhesion of bituminous materials.

**407.07 Application of Bituminous Material.** Bituminous material shall be applied by a pressure distributor in a uniform and continuous spread. When traffic is maintained, not more than ½ of the width of the section shall be treated in one application, or sufficient width shall be left to adequately handle traffic. Care shall be taken so the application of bituminous material at the junctions of spreads is not in excess of the specified quantity. Excess bituminous material shall be removed or distributed as directed. Skipped areas or deficiencies shall be corrected. Bituminous material shall not be placed on any surface where traffic will travel on the freshly applied material.

The rate of application, temperatures, and areas to be treated shall be approved prior to application of the coating.

**407.08 Application of Blotter Material.** If, after the application of the prime coat or rejuvenating agent the bituminous material fails to penetrate and the roadway must be used by traffic, blotter material shall be spread in the quantity required to absorb excess bituminous material.

## **METHOD OF MEASUREMENT AND BASIS OF PAYMENT**

**407.09** Bituminous material will be measured and paid for in accordance with Section 411.

Blotter material will not be measured and paid for separately but shall be included in the work.

Payment for patching will be made at the contract unit price for the various items used for patching.

408.01

## **SECTION 408 JOINT AND CRACK SEALANT**

### **DESCRIPTION**

**408.01** This work consists of furnishing and placing an approved hot poured joint and crack sealant in properly prepared cracks in asphalt pavements. Cracks with a width greater than  $\frac{1}{8}$  inch and less than 1 inch are to be filled with this material.

### **MATERIALS**

**408.02** Materials for hot poured joint and crack sealant shall meet the requirements of subsection 702.06.

Using a mixture of different manufacturers' brands or different types of sealant is prohibited.

### **CONSTRUCTION REQUIREMENTS**

**408.03** Immediately before applying hot poured joint and crack sealant, the cracks shall be cleaned of loose and foreign matter to a depth approximately twice the crack width. Cleaning shall be performed using a hot compressed air lance. This lance shall be used to dry and warm the adjacent asphalt immediately prior to sealing. Direct flame dryers shall not be used.

These Cracks shall be filled with hot poured joint and crack sealant flush with the pavement surface. Immediately following the filling of the crack, excess sealant shall be leveled off at the wearing surface by squeegee, a shoe attached to the applicator wand, or other suitable means approved by the Engineer. The squeegeed material shall be centered on the cracks and shall not exceed 3 inches in width or  $\frac{1}{16}$  inch in depth.

The sealant material shall be heated and applied according to the manufacturer's recommendations. The equipment for heating the material shall be an indirect heating type double boiler using oil or other heat transfer medium and shall be capable of constant agitation. The heating equipment shall be capable of controlling the sealant material temperature within the manufacturer's recommended temperature range and shall be equipped with a calibrated thermometer capable of  $\pm 5$  °F accuracy from 200 to 600 °F. This thermometer shall be located so the Engineer can safely check the temperature of the sealant material. Overheating of the sealant material will not be permitted.

The face of the crack shall be surface dry and the air and pavement temperatures shall both be at least 40 °F and rising at the time of sealant application.

Sealant material picked up or pulled out after being placed shall be replaced at the Contractor's expense. The Contractor shall have blotter material available on the project in the event it is required to prevent tracking or pulling. If required, blotter material shall be approved by the Engineer and placed at the Contractor's expense.

**METHOD OF MEASUREMENT**

**408.04** Hot poured joint and crack sealant will be measured by the ton of material used. The Engineer may require the weighing of equipment for determination of actual quantities of material used.

**BASIS OF PAYMENT**

**408.05** The accepted quantities will be paid for at the contract unit price per ton.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Hot Poured Joint and Crack Sealant	Ton

All materials, equipment, and costs incidental to the preparation of the surface prior to application of the hot poured joint and crack sealant will not be paid for separately, but shall be included in the work.

409.01

## **SECTION 409 SEAL COAT**

### **DESCRIPTION**

**409.01** This work consists of furnishing and applying bituminous material and cover coat material on an existing surface, in accordance with these specifications and in conformity with the lines shown on the plans or established. When rejuvenating agent or emulsified asphalt is used as a fog seal, cover coat material will not be required.

### **MATERIALS**

**409.02 Bituminous Material.** Emulsified asphalt shall be polymerized rapid set emulsified asphalt conforming to the requirements of subsection 702.03 for either CRS-2P or HFRS-2P.

Rejuvenating agent shall conform to the requirements of subsection 702.04.

**409.03 Cover Coat Material.** Cover coat material shall meet the requirements of subsection 703.05 for the type specified. The material will be accepted at the spreader.

### **CONSTRUCTION REQUIREMENTS**

**409.04 Weather Limitations.** Bituminous material shall not be applied on a damp surface, when either the air or pavement surface temperature is below 70 °F, or when weather conditions would prevent the proper construction of the seal coat.

**409.05 Equipment.** The following equipment or its equivalent shall be used:

- (1) Bituminous distributor and equipment shall be capable of uniformly distributing bituminous material at even temperature and uniform pressure on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard. The allowable variation from any specified rate shall not exceed plus or minus 0.02 gallon per square yard. The distributor's spreading capabilities shall be computer controlled or it shall be calibrated to conform to the distributor manufacturer's procedure prior to applying the emulsified asphalt. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. Distributors shall be equipped with an automatic heater capable of maintaining the bituminous material at the manufacturer's recommended application temperature or at 140 °F, whichever is higher.
- (2) A rotary power broom.
- (3) A minimum of two pneumatic tire rollers, which weigh at least 10 tons each.
- (4) One self-propelled aggregate spreader of approved design supported by at least four wheels equipped with pneumatic tires on two axles. The aggregate spreader shall be capable of applying the larger cover coat material to the surface ahead of the smaller cover coat material and shall have positive controls so the required

quantity of material is deposited uniformly over the full width of the bituminous material. Other types of aggregate spreaders may be used provided they accomplish equivalent results and are approved.

**409.06 Preparation of Surface.** The entire surface that is to receive a seal coat shall be cleaned of loose sand, dust, rock, mud, and all other debris that could prevent proper adhesion of the bituminous coating. The cleaning shall be accomplished by power broom, scraping, blading, or other approved measures. Seal coating operations shall not be started until the surface is approved.

**409.07 Applying Bituminous Material.** Bituminous material shall be applied by a pressure distributor in a uniform, continuous spread and within the temperature range specified. The distributor's spreading capability shall be computer controlled or calibrated to conform to the distributor manufacturer's procedure prior to applying the emulsified asphalt. If streaking occurs, the distributor operation shall be stopped immediately until the cause is determined and corrected. Streaking is alternating, narrow, longitudinal areas of excessive and then insufficient quantities of bituminous material. The quantity of bituminous material per square yard may vary from the rate shown in the Contract, as directed. A strip of building paper, at least 3 feet in width and with a length equal to that of the spray bar of the distributor plus 1 foot, shall be used at the beginning of each spread. If the distributor does not have a positive cut-off, the paper shall be used at the end of each spread. The paper shall be removed and disposed of in a satisfactory manner. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Skipped areas and deficiencies shall be corrected. Junctions of spreads shall be carefully made to assure a smooth riding surface.

The length of spread of bituminous material shall not be in excess of the area which trucks loaded with cover coat material can immediately cover.

The spread of bituminous material shall not be more than 6 inches wider than the width covered by the cover coat material from the spreading device. Under no circumstances shall operations proceed so bituminous material will be allowed to chill, set up, dry, or otherwise impair retention of the cover coat.

The distributor shall be parked so that bituminous material will not drip on the surface of the traveled way.

**409.08 Application of Cover Coat Material.** Immediately following the application of the bituminous material, cover coat material shall be spread in quantities as designated. The spreading rate may vary from the rate shown in the Contract when approved. Spreading shall be accomplished so the tires of the trucks or aggregate spreader do not contact the uncovered and newly applied bituminous material.

If directed, the cover coat material shall be moistened with water prior to spreading, to eliminate or reduce the dust coating of the aggregate. If cover coat material is lightweight aggregate it shall be moistened with water prior to spreading.

409.08

Immediately after the cover coat material is spread, deficient areas shall be covered with additional material. Rolling shall begin immediately behind the spreader and shall continue until three complete coverages are obtained. Rolling shall be completed the same day the bituminous material and cover coat materials are applied.

The completed roadway surface shall be lightly broomed the following morning to remove any excess material, without removing any imbedded material. The Contractor shall conduct additional brooming if so directed.

A fog seal shall be applied at the rate of 0.1 gallon per square yard of diluted emulsion when directed. The emulsion shall be diluted with water at the rate of 50 percent water and 50 percent emulsion. The application rate and the dilution rate may be changed by the Engineer.

**METHOD OF MEASUREMENT**

**409.09** Seal coat will be measured by the number of tons or cubic yards of the designated type of cover coat aggregate.

**BASIS OF PAYMENT**

**409.10** The accepted quantities of seal coat will be paid for at the contract price per ton or cubic yard for cover coat material.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Cover Coat Material (Type___)	Ton
Cover Coat Material (Type__) (Lightweight)	Cubic Yard

Bituminous materials, including the bituminous material used for fog seal, will be measured and paid for in accordance with Section 411.

## **SECTION 411 BITUMINOUS MATERIALS**

### **DESCRIPTION**

**411.01** This work consists of furnishing bituminous materials of all types and the application of these materials in accordance with these specifications and details shown on the plans.

### **MATERIALS**

**411.02** All bituminous materials shall conform to the requirements of Section 702.

The type and grade of bituminous material will be specified in the Contract. The grade may be changed one step by the Engineer at no change in unit price except as provided for under subsection 104.02.

### **CONSTRUCTION REQUIREMENTS**

**411.03** Bituminous materials shall be fortified when required by the Contract with an additive of an approved type. Additive shall be uniformly blended with bituminous materials at the refinery, or through an approved in-line blender as specified in the Contract.

Asphaltic application methods which result in the discoloration of concrete structures, concrete curbs, and concrete gutters will not be permitted. Coatings shall be applied so as to cause the least inconvenience to traffic and to permit one-way traffic. Traffic will be permitted to travel on fresh bituminous material when it can be accomplished without pickup or tracking of the bituminous material.

Asphaltic materials used as fuel or lubricant shall be stored separately.

Emulsified asphalt for tack coat shall be diluted before use as shown in the Contract or as directed.

### **METHOD OF MEASUREMENT**

**411.04** Asphalt cement will be measured by the ton by one of the following methods as determined by the Engineer:

- (1) The pay quantity of asphalt cement will be determined by multiplying the total accepted tons of paving mix by the weighted average of all asphalt content percentages obtained from the field acceptance tests for that item, or
- (2) The pay quantity of asphalt cement will be determined from the invoices for the asphalt cement delivered to the job corrected by tank stabs.

Emulsified asphalt and liquid asphaltic materials will be measured by the gallon.

The pay quantity for emulsified asphalt shall be the number of gallons before dilution with water.

411.04

Concentrated asphalt rejuvenating agent will be measured by the gallon before any water is added.

**BASIS OF PAYMENT**

**411.05** The accepted quantities, measured as provided above, will be paid for at the contract unit price per ton or gallon as the case may be, for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Asphalt Cement (___)	Ton
Emulsified Asphalt (___)	Gallon
Liquid Asphaltic Material (___)	Gallon
Asphalt Rejuvenating Agent	Gallon
Recycling Agent	Gallon

High float emulsified asphalt (polymerized) or emulsified recycling agent used in Item 406, Cold Bituminous Pavement (Recycle) will be paid for by the gallon under the pay item Recycling Agent.

Water used to dilute emulsified asphalt or asphalt rejuvenating agent will not be paid for separately but shall be included in the work.

**SECTION 412  
PORTLAND CEMENT  
CONCRETE PAVEMENT**

**DESCRIPTION**

**412.01** This work consists of constructing a pavement composed of portland cement concrete on a prepared subgrade or base course in accordance with these specifications and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established.

**MATERIALS**

**412.02** Materials shall meet the requirements of the following subsections:

Fine Aggregate	703.01
Coarse Aggregate	703.02
Portland Cement	701.01
Fly Ash	701.02
Water	712.01
Air Entraining Admixtures	711.02
Joint Sealant with Backer Rod	705.01
Curing Materials	711.01
Reinforcing Steel	709.01
Chemical Admixtures	711.03
Dowel Bars and Tie Bars	709.03

**CONSTRUCTION REQUIREMENTS**

**412.03 Classification.** Concrete shall conform to the requirements for Class P concrete as specified in Section 601, unless it is fast track concrete pavement, which shall conform to the requirements for Class E concrete as specified in Section 601. When the Engineer has determined that the quantity of concrete pavement is too small to make the use of mechanical equipment practical, the Contractor will be permitted to use AASHTO M 43 Size 57 or 67 aggregate in lieu of the coarse aggregate specified in Section 601.

**412.04 Proportioning.** Proportioning shall conform to the requirements of subsection 601.05.

**412.05 Batching.** Batching shall conform to the requirements of subsection 601.06.

The Contractor shall provide a Quality Control Plan (QCP) to minimize voids in the concrete pavement, such as clay balls, mud balls and other deleterious materials. It shall also identify the Contractor's method for ensuring that the provisions of the QCP are met. This QCP shall be submitted to the Engineer at the Preconstruction Conference. Paving operations shall not begin until the Engineer has approved the

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QCP. This QCP shall identify and address issues affecting the quality of aggregates incorporated into the concrete mix including but not limited to:

- (1) Washing aggregates.
- (2) Inspection at the pits, plants and aggregate storage areas.
- (3) Base or floor of pits, plants and aggregate storage areas.
- (4) Inspection of truck beds.
- (5) Methods and frequency of aggregate testing.
- (6) Training of operators, haulers and inspectors in regards to aggregate quality.
- (7) Plant site selection and layout.
- (8) Grizzlies and screens on conveyors.
- (9) Stabilization of haul roads and construction accesses.

When the Engineer determines that any element of the approved QCP is not being implemented, the paving shall stop, the cause shall be identified and corrected by the Contractor before paving operations resume.

**412.06 Mixing.** Mixing shall conform to the requirements of subsection 601.07.

**412.07 Equipment.** Equipment and tools shall be capable of handling materials, performing the work, producing a product of specified quality, and shall be approved. The equipment shall be at the job site sufficiently ahead of the start of paving operations to be examined and approved.

- (a) *Hauling Equipment.* Concrete may be hauled and placed with nonagitator equipment. Bodies of nonagitating equipment shall be smooth, mortar tight containers, and shall be capable of discharging the concrete at a controlled rate without segregation.
- (b) *Consolidating and Finishing Equipment.* Concrete shall be spread, struck-off and finished by mechanical equipment, either from fixed forms or by slip form method, unless otherwise permitted.

Consolidation shall be accomplished by vibrators for the full width of the concrete paving slabs. The vibrators shall be the internal type meeting the following requirements:

An electronic monitoring device displaying the operating frequency of each individual internal vibrator shall be required for mainline pavement exceeding 600 feet in length. The monitoring device shall have a readout display near the operator's controls visible to the paver operator and to the Engineer. It shall operate continuously while paving, and shall display all vibrator frequencies with manual or automatic sequencing among all individual vibrators. If a vibrator monitor fails to function properly, a hand held device may be used until the monitor is repaired. The Contractor shall measure the vibrations of each vibrator at least once an hour. The vibrator monitor repair must be made within 48 hours.

The depth of penetration into the concrete pavement slab of internal vibrators shall be between the surface and mid slab and passing above any reinforcing steel. An operating position locking device shall be provided so that no part of the vibrating unit can be lowered to the extent that it will come in contact with reinforcing steel or tie bars while paving.

Vibrators shall have a minimum eccentric diameter of 1 $\frac{3}{4}$  inches or as approved by the Engineer. Horizontal spacing of vibrators shall not exceed the manufacturer's recommendations, and shall not exceed 18 inches from center to center. The longitudinal axis of the vibrator body shall be mounted approximately parallel to the direction of paving. Vibrators shall meet or exceed the following specifications at manufacturers design frequency of 10,000 VPM:

- (1) Amplitude (peak to peak) 0.070 inch
- (2) Centrifuge force 1200 pounds

Within the frequency range, the Contractor shall adjust the frequency to provide optimum consolidation for the mix and placement conditions.

If any vibrator ceases to function properly, the paving operation shall be stopped immediately and not resumed until the faulty vibrator has been repaired or replaced. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies by means of vibrators inserted in the concrete. Vibrators shall not come in contact with or cause displacement of the joint load transfer devices, subgrade, or side forms and shall not interfere with placement of reinforcing steel.

Any variation from the above method must have prior written approval from the Engineer. The Contractor's documentation shall include evidence that the proposed method of consolidation will provide equal or better consolidation than the method described above.

- (c) *Tining Equipment.* When longitudinal tining is required, the concrete pavement shall be longitudinally tined with a metal device with a single row of tines. The tines shall be of such dimensions as to produce grooves parallel with the centerline of the road in accordance with the dimensions specified in subsection 412.12(d). The tining machine shall be mechanically operated and shall cover the full pavement width in a single pass at a uniform speed and depth. Longitudinal tining shall be accomplished by equipment with horizontal and vertical controls to ensure straight, uniform grooves. Hand tining will be allowed on irregular areas or areas inaccessible to the tining machine. Hand tining shall consist of creating uniform grooves placed parallel with the centerline of the road.
- (d) *Concrete Saw.* When sawed joints are required, the Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at a rate that will control cracking. The

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Contractor shall provide at least one standby concrete saw in good working order at all times. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job during concrete placement.

Wastewater generated from concrete saw operations shall be contained and disposed of in accordance with subsection 107.25.

- (e) *Test Bridge.* The Contractor shall furnish a movable bridge that conforms to subsection 601.15(g) for use by the Department.

**412.08 Preparation of Subgrade.** After the roadbed has been graded and compacted, the subgrade shall be trimmed to the correct elevation and slope. For slip form paving, the elevation and slope of the trimmer shall be automatically controlled from outside reference lines established for this purpose. The trimmed subgrade shall extend at least 2 feet beyond each edge of the proposed concrete pavement when forms are used and at least 1 foot outside the track width of finishing, curing, and tining equipment for slip form operations. Any work required beyond the planned roadbed necessary to support the Contractor's paving equipment or hauling vehicles, will not be paid for separately, but shall be included in the work.

The subbase or base course shall be brought to the specified cross section. High areas shall be trimmed to the proper elevation. Low areas in untreated bases may be filled and compacted to a condition similar to that of the surrounding grade, or filled with concrete integral with the pavement. Low areas in treated bases shall be filled with concrete integral with the pavement. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.

Untreated subgrade or base course shall be uniformly moist during concrete placement. If it becomes too dry, the untreated subgrade or base course shall be sprinkled without forming mud or pools of water.

**412.09 Limitations of Placing Concrete.** Limitations on the placing of concrete shall conform to subsections 601.12 (b) and (c), and 412.15.

**412.10 Placing Concrete.** The concrete shall be uniformly deposited on the grade in such a manner as to require as little rehandling as possible. Concrete for areas which contain load transfer devices shall not be dumped directly from the hauling vehicles onto the grade. Concrete shall be placed by an approved placer spreader machine. Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the discharge is well centered on the joint assembly. Necessary hand spreading shall be done with Shovels, not rakes. Workers shall not walk-in freshly mixed concrete with footwear coated with earth or foreign substances. All footprints in the fresh concrete shall be vibrated and finished flush with the adjacent surface.

Construction equipment other than standard paving equipment will not be allowed to handle plastic concrete in advance of the paver in the roadway without approval.

Where concrete is placed adjacent to a newly constructed lane of pavement with the concrete paving equipment operating on the newly constructed pavement, the concrete shall have attained a minimum compressive strength of 2000 psi prior to commencing paving. Determination that the concrete has reached 2000 psi shall not relieve the Contractor of the responsibility for protecting the pavement.

Any concrete or foreign materials that falls on or is worked into the surface of a completed slab shall be removed immediately.

Following placement, the concrete shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans or established.

**412.11 Test Specimens.** The Contractor shall furnish the concrete necessary for casting test cylinders and performing air and slump tests.

**412.12 Finishing.** The sequence of operations shall be strike-off and consolidation, floating, and final surface finish.

The Contractor shall not add water to the surface of the concrete to assist in finishing operations.

The surface shall be finished to a uniform texture, true to grade and cross section, and free from porous areas. When the finishing machine (either form or slip form) or hand finishing method, leaves a surface that is not acceptable, the operation shall stop and corrective action shall be taken. Inability of the finish machine to provide an acceptable surface finish, after corrective action, will be cause for requiring replacement of the finish machine.

Wastewater generated from concrete finishing operations shall be contained and disposed of in accordance with subsection 107.25.

- (a) *Hand Finishing.* Unless otherwise specified, hand finishing methods will be permitted only under the following conditions. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs. Narrow widths or areas of irregular dimensions, or where operation of the mechanical equipment is impractical, may be finished by hand methods.

Hand finished concrete shall be struck off and screeded with a portable screed that is at least 2 feet longer than the maximum width of the slab to be struck off. It shall be sufficiently rigid to retain its shape. Concrete shall be thoroughly consolidated by hand vibrators.

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- (b) *Floating.* Hand floating will be permitted only as specified in subsection 412.12(a) above. Floats made of aluminum shall not be used.
- (c) *Final Finish.* For the final finish a strip of plastic turf shall be dragged longitudinally over the full width of pavement after a strip of burlap or other approved fabric has been dragged longitudinally over the full width of pavement to produce a uniform surface of gritty texture.

The plastic turf drag shall be made of material at least 3 feet wide and be maintained in such a condition that the resultant surface finish is of uniform appearance and reasonably free from grooves over  $\frac{1}{16}$  inch in depth. Where more than one layer of burlap drag is used, the bottom layer shall be approximately 6 inches wider than the layer above. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags installed.

- (d) *Tining and Stationing.* Where posted speeds are 40 mph or higher, the surface shall be given a longitudinal metal tine finish immediately following turf drag. Tining is not required where posted speeds are less than 40 mph. Tining shall produce grooves of  $\frac{1}{8}$  inch by  $\frac{1}{8}$  inch spaced  $\frac{3}{4}$  inch apart and parallel to the longitudinal joint. Longitudinal tining shall stop at the edge of travel lanes. Tining devices shall be maintained clean and free from encrusted mortar and debris to ensure uniform groove dimensions. The tining finish shall not be performed too early whereby the grooves may close up.

Before paving the Contractor shall provide in writing a tining plan showing tining locations and describing methods that will be used for hand tining. Paving shall not commence until the Engineer has approved the tining plan in writing.

The tining grooves shall be neat in appearance, parallel with the longitudinal joint, uniform in depth and in accordance with what is shown in the plans and these specifications. Any time that the tining grooves do not meet these requirements, the concrete paving operation shall be immediately stopped and shall not resume until the problem has been resolved.

Stationing shall be stamped into the outside edge of the pavement, as shown on the plans.

**412.13 Joints.** Joints shall be constructed of the type, dimensions, and at locations required by the Contract.

Immediately after sawing, the sawed joints shall be flushed with water to remove any saw residue, and the saw residue shall be completely removed from the surface of the pavement. This residue shall be removed by approved methods.

All equipment other than saws shall be kept off the pavement until the sawing and sealing are complete.

After the proper curing period, the sawed joint shall be thoroughly cleaned and immediately sealed in accordance with subsection 412.18.

- (a) *Construction Joints.* Construction joints shall be slightly tooled while the concrete is plastic and later sawed to the dimensions specified in the Contract. The tooling shall not exceed the width of the sawed joint at any point.

In the event tie bars cannot or are not placed in plastic state concrete, then the tie bars shall be placed according to the following minimum requirements:

Holes with a diameter  $\frac{1}{8}$  inch greater than the required bar diameter shall be drilled laterally into the hardened concrete slabs at one half the slab depth, 30 inches on center, 15 to 16 inches deep. Each hole shall be cleaned out with compressed air using a wand attachment that fits into the hole and is long enough to reach to the back of the hole. Each hole shall be brushed out with a stiff bristled cylindrical brush that is at least  $\frac{1}{4}$  inch larger than the diameter of the hole. Each hole shall be blown out with compressed air a second time using a wand attachment that fits into the hole and is long enough to reach to the back of the hole. Each hole shall be blown out until there is no longer any evidence of dust, debris or loose material in the hole.

An approved epoxy shall be used and installed according to the manufacturer's instructions. Epoxy shall be placed in the back of each hole with an applicator that will reach the end of the drilled hole. A sufficient amount of epoxy shall be placed in each hole to insure that the bar will be completely covered with epoxy. Epoxy shall be placed on the bar before inserting the bar into the hole. The bar shall be inserted into the hole using a twisting motion to facilitate covering the bar and the inside surface of the hole with epoxy minimizing voids or air pockets.

When tie bars are placed in plastic state concrete or drilled and epoxied into a construction joint, and if required by the Engineer, the Contractor shall demonstrate by testing at least 15 of the tie bars that the average bar pullout resistance is at least 11,250 pounds with slippage of  $\frac{1}{16}$  inch or less. If two or more tie bars do not meet the required pullout resistance, then another 15 tie bars shall be tested. If any of the second 15 do not meet the required pullout resistance, then all remaining tie bars shall be tested. The Contractor shall perform additional pullout tests and take corrective action when and as directed. All steps taken to test bars, and to correct, repair or replace failed tie bars and the surrounding failed area shall be at the Contractor's expense. Concrete strength shall be at least 2500 psi before testing. The procedure and apparatus for performing pullout testing shall be as approved.

1. *Longitudinal Construction Joints.* Keyways and epoxy coated, deformed steel tie bars shall be placed as specified in the Contract. Tie bars shall be placed perpendicular to the longitudinal joint by an approved method.

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When adjacent lanes of pavement are constructed separately, tie bars may be bent at right angles against the edge of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed. In lieu of bent tie bars, approved two piece connectors may be used. If the coating of epoxy coated tie bars is damaged, the bars shall be repainted with epoxy paint prior to placement of concrete.

2. *Transverse Construction Joints.* Transverse construction joints shall be constructed as specified in the Contract. Transverse construction joints shall be constructed when the concrete placement is interrupted for more than 30 minutes and initial set is imminent. No transverse joint shall be constructed within 2 feet of another transverse joint. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 2 feet long, the concrete back to the preceding joint shall be removed and the bulkhead placed in accordance with the requirements for a standard transverse contraction joint.

Transverse construction joints shall be placed at the end of each day's placement.

- (b) *Weakened Plane Joints.* Weakened plane joints shall be spaced and skewed as specified in the Contract and formed by sawing. The time of sawing shall be determined by the Contractor to prevent random cracking, and raveling from the sawing. The time will depend upon weather conditions, temperature, and other factors affecting the setting of concrete. If uncontrolled cracking occurs during or prior to joint sawing, the Contractor shall move the sawing operation ahead and, if necessary, add additional sawing units to eliminate uncontrolled cracking.

1. *Longitudinal Weakened Plane Joints.* Epoxy coated deformed steel tie bars shall be inserted into the plastic state concrete after the auger. In the event the tie bars are placed behind the machine paving mold, vibration will be required during placement. Other methods of bar placement may be acceptable if the Contractor can demonstrate satisfactory performance of the alternate method. Proposals of alternate methods or additional costs associated with other methods shall be at the Contractor's expense. Tie bars shall be placed according to a method approved by the Engineer. The Contractor shall, when requested by the Engineer, expose the bars while the concrete is still plastic to verify the tie bar's final location. The cost and repair of the concrete will not be measured and paid for separately, but shall be included in the item of work. Should the tie bars be found to be closer than 1 inch to the bottom of the sawed joint, or closer than 2 inches to the bottom of the slab, or if the spacing between tie bars is found to be greater than 32 inches, the Contractor shall cease paving operations until it can be successfully demonstrated that the required tolerances can be met. The weakened plane joint shall then be made by sawing in hardened concrete in accordance with the plan details.

2. *Transverse Weakened Plane Joints.* When dowel bars are specified in the Contract, they shall be installed within the tolerances and of the size, grade, and spacing specified. The center of the dowel assembly or the insertion location shall be marked on both sides of the pavement slab for reference in sawing the joint. Dowel bars shall be furnished in a rigid welded assembly or, when the Contractor demonstrates that the placement can be made within required tolerances, placed by a dowel insertion machine. Dowel insertion machine may be used only with written permission from the Engineer. The rigid assembly shall be fabricated from number 1/0 wire or heavier with vertical support wires every 1 foot. Assembly shall be securely fastened to the subbase and constructed to firmly hold all the dowel bars at T/2 depth, parallel to each other and to the pavement grade and alignment. See standard plan M-412-1 for schematic describing the measurement of each tolerance. Dowel placement tolerances are:

Horizontal = 1 inch,  
 Horizontal translation = 2 inches,  
 Horizontal Skew =  $\frac{3}{8}$  inch,  
 Vertical =  $\frac{1}{4}$  inch,  
 Vertical Skew =  $\frac{3}{8}$  inch.

When concrete shoulders or widenings are constructed subsequent to the driving lanes, transverse weakened plane joints shall immediately be formed in the plastic concrete of these widenings to create an extension of the existing transverse joint. This tooled joint shall be formed in such a manner that it controls the cracking and shall be sawed and sealed in accordance with the above requirements.

- (c) *Expansion Joints.* Preformed joint filler expansion joints shall be constructed at all existing or proposed structures and features projecting through, into, or against the pavement and at other locations specified in the Contract.

**412.14 Curing.** Immediately after the finishing operations have been completed the entire surface, including tined grooves and exposed sides of the newly placed concrete, shall be sprayed uniformly with an impervious membrane curing compound. The impervious membrane curing compound shall meet the requirements of AASHTO M 148, Type 2 and shall be volatile organic content (VOC) compliant. The concrete shall not be left exposed for more than 30 minutes before being covered with curing compound. Failure to cover the surface of the concrete within 30 minutes shall be cause for immediate suspension of the paving operations.

Curing compound shall be applied under pressure by mechanical sprayers at the rate of not less than 1 gallon per 150 square feet of pavement surface. Curing compound may be applied in two passes, one forward and one backward. The spraying equipment shall be fully atomized, equipped with a tank agitator, and a wind guard. During application, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle and the compound shall be stirred

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continuously by effective mechanical means. Hand spraying of irregular widths or shapes and surfaces exposed by removal of forms will be permitted. Curing compounds shall not be applied to the inside faces of joints to be sealed.

Should the curing film become damaged from any cause, within 72 hours after application, the damaged portions shall be repaired immediately with additional compound.

The sides of pavement slabs shall be immediately sprayed with curing compound when the forms are removed.

In addition, for Class E concrete, curing blankets with a minimum R-value of 0.5 shall be provided and shall be placed as soon as they can be placed without marring the surface.

**412.15 Cold Weather Concrete Paving.** The Contractor is responsible for the strength and quality of the concrete placed during cold weather. Before starting paving operations, the Contractor shall be prepared to protect the concrete from freezing. Maturity meters, to monitor and record time and pavement temperature, shall be installed at the time of placement when the air temperature is expected to fall below 40 °F during the next three days or as requested by the Engineer when the air temperature is expected to fall below 45 °F during the next three days. The Contractor shall maintain the temperature of the pavement at or above 40 °F until the pavement has attained a compressive strength of at least 2000 psi. The compressive strength of the concrete shall be determined by the use of maturity meters. Three maturity meters shall be used for each day's concrete paving operations. One maturity meter shall be placed in the final 15 feet of paving, and the two other maturity meters shall be placed at locations designated by the Engineer. The maturity meters shall remain in place until the concrete has attained a compressive strength of 2000 psi. The maturity meter probes shall be located on the outside edge of the slab, at least 1 foot and not more than 2 feet from the edge. Each maturity meter shall be capable of recording the time and temperature at three depths, ½ inch below the surface, mid slab and ½ inch above the bottom of the pavement.

The Contractor shall develop maturity relationships for each mix placed during the cold weather conditions described above in accordance with ASTM C 1074 with the following additions or modifications:

- (1) The cylinders used to establish the compressive strength vs. maturity relationship shall be cast and cured in the field in conditions similar to the project.
- (2) These cylinders shall be tested in pairs at times which yield compressive strengths where three sets are at or below 2000 psi and one is above 2000 psi.
- (3) Testing to determine datum temperature or activation energy will not be required.
- (4) A test slab shall be cast at the same time and location as the cylinders. The test slab shall have a length and width of 6 feet and a thickness equal to the

pavement design thickness. Slab maturity will be determined with two probes located in the slab approximately 1 foot and 2 feet from the edge. The test slab shall be cured and protected in the same manner as that being used on the project.

The development of the maturity relationship and maturity determination of the test slab is part of the trial mix and shall be submitted to the Engineer prior to cold weather concrete paving.

The Contractor shall provide the maturity meters and all necessary wires and connectors. The Contractor shall be responsible for the placement, protection and maintenance of the maturity meters and wires. Locations where the maturity meters are placed shall be protected in the same manner as the rest of the concrete pavement.

The following procedures shall be followed if the temperature of the concrete pavement falls below 32 °F before the concrete reaches 2000 psi:

- (1) The Contractor will take cores at locations designated by the Engineer.
- (2) The Engineer will take immediate possession of the cores and submit the cores to a petrographer for examination in accordance with ASTM C 856.
- (3) All costs associated with coring, transmittal of cores, and petrographic examination shall be borne by the Contractor regardless of the outcome of the petrographic examination.
- (4) Pavement damaged by frost as determined by the petrographic examination, shall be removed and replaced at the Contractor's expense.

**412.16 Repair of Defective Concrete Pavement.** Defective concrete pavement shall be repaired or replaced at the Contractor's expense. This corrective work shall be accomplished prior to joint sealing and final smoothness measurement. Defective concrete pavement replaced after smoothness measurement shall be retested for final smoothness. The Contractor's corrective work plan shall be approved prior to performing the work.

When necessary, the extent of defects will be determined by the inspection of cores drilled at the Contractor's expense.

Pavement slabs with any of the following conditions shall be removed and replaced:

- (1) Pavement slabs in driving lanes containing one or more cracks through the full depth of the slab that separate the slab into two or more parts. If the Contractor can demonstrate that the crack was caused by factors beyond the Contractor's control, the Contractor will be reimbursed the costs to remove and replace the slab.
- (2) Pavement slabs containing honeycombed areas.
- (3) Pavement slabs containing an extreme void as defined below.
- (4) Pavement slabs containing more than one void greater in depth than half the pavement thickness.

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- (5) Pavement slabs containing a cumulative surface area of moderate and severe voids, as defined below, greater than one percent of the slab's total area.
- (6) Pavement slabs containing 20 or more severe voids as defined below.

A void is a defect in a slab caused by air pockets, clay balls, clumps of sand, cement or reinforcing fibers caused by incomplete mixing or foreign materials such as cans, rags, bottles, etc. The defect will be considered a moderate void when the largest dimension, either height, width or length is at least ½ inch but no more than 2 inches. The defect will be considered a severe void when the largest dimension, either height, width or length is greater than 2 inches. The defect will be considered an extreme void when the largest dimension, either height, width or length is greater than the thickness of the pavement.

When the Engineer determines that voids are at an unacceptable level, the paving shall stop, and the cause shall be identified and corrected by the Contractor before paving operations are allowed to resume.

Concrete slabs that are determined by the Engineer to be acceptable if repaired shall have voids filled using materials from the Department's Approved Products List and methods approved by the Engineer.

When portions of concrete pavement are removed and replaced, the portion removed shall be the full width of the lane and length of the affected slab. Slabs with cracks penetrating the full depth of pavement shall be removed as required above. Cracks that penetrate partial depth may, with the written approval of the Engineer, be epoxy injected using materials from the Department's Approved Products List and methods approved by the Engineer.

Joints and cracks that are spalled shall be repaired as follows:

- (1) A saw cut at least 1 inch outside the spalled area and to a minimum depth of 2 inches shall be made parallel to the joint or crack.
- (2) The concrete between the saw cut and the joint or crack shall be chipped out to solid concrete to a minimum depth of 2 inches.
- (3) The cavity formed shall be thoroughly cleaned.
- (4) A prime coat of epoxy-resin binder shall be applied to the dry, cleaned surface on all sides of the cavity, except the face of the joint or crack. The prime coat shall be applied by scrubbing prime coat material into the surface with a stiff bristle brush.
- (5) Placement of portland cement concrete or epoxy-resin concrete shall immediately follow the application of the prime coat.

If the spalled area, to be repaired, abuts a working joint or a working crack which penetrates the full depth of the pavement, an insert or other bond-breaking medium shall be used to maintain the working joint or crack during the repair work.

**412.17 Surface Smoothness.** The roadway surface smoothness shall be tested in accordance with subsection 105.07. If not specified otherwise on the plans, the

roadway surface shall be subject to inches per mile requirements for Category I, Rural Interstate Highway, in accordance with Table 105-6.

**412.18 Sealing joints.** Before installation of the backer rod or sealant, the following shall be completed:

- (1) Repair of defective pavement slabs and repair and proper curing of cracks or spalls in accordance with subsection 412.16.
- (2) Corrective work for tining.
- (3) Corrective work for pavement smoothness in accordance with subsection 105.07.

A copy of the manufacturer's recommendations pertaining to the storage, heating and application of the sealant shall be submitted to the Engineer prior to commencing work. These recommendations shall be adhered to by the Contractor, with such exceptions as required by these specifications.

The Contractor shall cut the transverse and longitudinal joints to the width and depth required. The cut shall be made with a power drive saw equipped with diamond blades. The residue from sawing shall be removed from the pavement by the Contractor. The material shall be removed at the time of the sawing operation. Any damage to the concrete pavement such as spalling or fracturing shall be repaired by the Contractor as directed by the Engineer at no cost to the project. Sawing residue shall be immediately removed from all joints.

Cleaning, repairing, and proper curing of all spalls, fractures, breaks, and voids in the concrete surface of the joints shall be accomplished prior to installing the backer rod material or joint sealant.

The backer rod shall be placed in such a manner that the grade for the proper depth of the seal material is maintained.

The Contractor shall thoroughly clean the joint and adjacent pavement for a width of at least 1 inch on each side of the joint of all scale, dirt, dust, residue, and other foreign material that will prevent bonding of the joint sealant. This operation is to be accomplished by sandblasting or jet water-blasting on the same day as the joint sealing operation.

Immediately prior to the placement of backer rod material and sealant, the joints shall be cleaned using a minimum of 100 psi of compressed air. Work shall be stopped when and if it is found that there is oil or moisture in the compressed air. Work shall not resume until oil and moisture are removed from the compressed air.

Sealant shall not be placed unless the surfaces of the joint and the pavement are dry, and the weather is dry. Joint sealing will not be allowed when the air or surface temperature falls below 50 °F. Manufacturer's recommendations shall be followed if a higher temperature is recommended. Sealant shall not be placed prior to expiration of the sealant manufacturer's recommended concrete pavement curing period, if any.

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| The Contractor shall not place the sealant if there is dust, moisture, oil, or foreign material on that portion of the concrete that is to receive the backer rod or sealant.

The Contractor shall prevent smearing of the joint sealant material onto the concrete pavement driving surface. Smearred joint sealant shall be removed from the pavement before it is opened to traffic.

Sealing shall be completed before opening the pavement to traffic, unless otherwise specified or approved.

**412.19 Construction by Form Method.** Straight side forms shall be made of a metal having a thickness of not less than  $\frac{7}{32}$  inch and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth equal to or greater than the specified edge thickness of the concrete, without horizontal joint, and a base width equal to or greater than the depth of the forms. Top surface of the forms shall be set flush with the proposed concrete surface. Flexible or curved forms of proper radius shall be used for curves of 100 feet radius or less. Flexible or curved forms shall be of a design acceptable to the Engineer. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than  $\frac{2}{3}$  the height of the form. Forms with battered top surfaces, and forms that are bent, twisted, or broken shall not be used. Repaired forms shall not be used until inspected and approved. Built-up forms shall not be used except where the total area of the pavement, of any specified thickness, on the project is less than 2000 square yards. The top face of the form shall not vary from a true plane by more than  $\frac{1}{8}$  inch in 10 feet, and the vertical leg shall not vary more than  $\frac{1}{4}$  inch from vertical. The forms shall contain provisions for locking the ends of abutting form sections together tightly, and for secure setting.

Forms for bridge approach slabs or for pavement areas with irregular dimensions shall be made of metal or straight, sound timber. Forms shall be free from warp and of sufficient strength to resist springing out of shape. Forms shall be staked securely to line and grade to the satisfaction of the Engineer. All mortar and dirt shall be removed from the forms.

- (a) *Setting Forms.* The foundation under the forms shall be compacted true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. The roadbed shall be prepared in accordance with subsection 412.08; however, where the grade at the form line is found to be below specified grade it shall be filled and thoroughly compacted to specified grade with granular material in lifts of  $\frac{1}{2}$  inch or less. Imperfections or variations above grade shall be corrected by tamping or by trimming as necessary.

Forms shall be set sufficiently in advance of concrete placement to provide time for the Engineer to check the line and grade and allow a continuous concrete placement operation. Forms shall be staked in place and free from play or movement in any direction. The forms shall not deviate from true line by more

than ¼ inch at any point. No excessive settlement or springing of the forms under the finish machine will be tolerated. Forms shall be cleaned and coated with a form release agent or oiled prior to placement of concrete.

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before concrete placement. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

- (b) *Removing Forms.* Unless otherwise provided, forms shall not be removed from freshly placed concrete until the concrete is strong enough to withstand damage when the forms are removed. After the forms have been removed, the sides of the slab shall be cured in accordance with subsection 412.14.

**412.20 Construction by Slip Form Method.** The subgrade shall be completed in accordance with subsection 412.08 and then checked and approved by the Engineer before installation of load transfer units, if required, and placement of concrete. Concrete shall not be placed on a subgrade that has not been approved. If any traffic uses the finished subgrade, the grade shall be checked and corrected immediately before placement of the concrete.

The concrete shall be finished with an approved, self propelled slip form paver capable of spreading, consolidating, screeding, and finishing the freshly placed concrete with one pass of the paver. The paver shall be capable of providing a dense and homogeneous pavement with an even texture and no porous areas, and to the slope and elevation specified. The alignment and elevation of the paver shall be automatically controlled from outside reference lines established to obtain a smooth alignment and profile.

For mainline paving of Pavement Smoothness Category I roadways, as defined in Table 105-6 all slip form paving shall be accomplished by a machine capable of paving at least a 24 feet minimum width as recommended by the equipment manufacturer.

- (a) *Stabilized Bases.* The Contractor is responsible for irregularities in the stabilized base and payment will not be made for overruns in concrete quantities if extra concrete is used to correct the irregularities.
- (b) *Concrete Pavement Overlays.* Trimming will not be required. The Contractor shall place a bond breaker, if specified in the Contract, before placing the concrete. Payment will be made for irregularities under pay item of Furnish Concrete Pavement.

The Contractor shall furnish a machine to develop and establish a profile grade for the new pavement. The method used will be by dual slope laser mounted on a 30 foot ski. The Engineer may approve an alternative method of establishing the profile grade, if the Contractor demonstrates that equal or superior results will be achieved by the alternative method.

412.21

**412.21 Determining Pavement Thickness.** The Contractor shall perform the process control (PC) testing for pavement thickness. A process control testing plan shall be submitted and must be approved prior to the start of paving. This PC testing plan shall include determining the thickness of freshly finished concrete pavement at a minimum frequency of one measurement per 1250 linear feet of each traffic lane. All shoulders 8 feet or greater in width shall be tested as a separate traffic lane. Shoulders less than 8 feet wide shall be included in the adjacent lane. Areas such as sections of mainline pavement that are less than 1250 linear feet long, intersections, entrances, crossovers, ramps, etc., shall be grouped into units of 1000 square feet or remaining fraction thereof. A minimum of one random measurement shall be taken in each unit.

The Engineer may inspect the Contractor's PC tests at any time during the paving operations. Approval and inspection of the Contractor's PC plan and operations does not constitute acceptance of the pavement thickness, and does not relieve the Contractor of the responsibility for providing the required hardened pavement cores for project acceptance testing. The Contractor shall provide daily written reports to the Engineer listing the results of the day's PC thickness measurements.

Project acceptance (PA) testing will be the responsibility of the Engineer. PA testing consists of determining pavement thickness by measuring the length of cores taken by the Contractor from the hardened pavement as outlined below. Acceptance of the pavement thickness and price adjustment for deficient thickness will be based on project acceptance tests.

The Engineer will designate the time and location of the coring and will be present during the coring operation. The Contractor shall obtain 4 inch or 6 inch nominal diameter cores from the hardened pavement that are suitable for measuring in accordance with AASHTO T 148. When the cores are removed from the pavement, the Engineer will take possession and determine their length in accordance with AASHTO T 148.

The lower tolerance limit ( $T_L$ ) for pavement thickness shall be Plan Thickness (PT) minus 0.4 inches. This  $T_L$  shall be used in the formulas in Section 105 for Incentive and Disincentive Payments (I/DP), Quality Levels (QL) and Pay Factor (PF) determinations. Any pavement thickness test value that exceeds the PT by more than 1.0 inch shall be assigned a value of PT + 1.0 inch for the purpose of calculating the QL, PF and I/DP.

Coring frequency shall be in accordance with subsection 106.06. Core locations shall be determined by a random procedure so that each area has a randomly selected coring location. One core will be taken at each location.

Where the new portland cement concrete pavement overlays an existing roadway, cores for measuring pavement thickness shall be determined by a stratified random procedure in the longitudinal direction and by the point of minimum required thickness in the lateral direction as shown in the plans. If existing field conditions show a condition where the point of minimum thickness in the lateral direction as

shown in the plans is not appropriate, the Contractor shall identify the location and extent of the area to the Engineer at least 24 hours before paving. The Engineer may exclude this area from pavement thickness measurements for incentive and disincentive payments.

Pavement thickness tests will be evaluated in accordance with subsection 105.06.

Additional cores will be taken at the direction of the Engineer as follows:

- (1) One additional core at the location of each process control (PC) test that is less than  $T_L$  but greater than PT minus 1.0 inch. If the length of the additional core is greater than  $T_L$ , no additional actions will be taken and the original randomly selected acceptance test core will be used to compute I/DP for the process that includes this material.
- (2) If the additional core or any randomly selected core is less than  $T_L$  but greater than PT minus 1.0 inch, the area represented by this core shall become a separate process and this core will not be used to compute an I/DP. Four additional randomly selected cores will be taken within the area represented by this core. The four additional cores will be used to compute an I/DP in accordance with Section 105. Cores taken at locations not randomly determined, such as process control cores will not be used to compute I/DP.
- (3) When the measurement of any core is less than PT (Plan Thickness) minus 1.0 inch, whether randomly located or not, the area represented by this core shall become a separate process and this core will not be used to compute an I/DP. The actual thickness of the pavement in this area will be determined by taking exploratory cores. Cores shall be taken at intervals of 15 feet or less, parallel to the centerline in each direction from the affected location until two consecutive cores are found in each direction which are not less than PT minus 1.0 inch.

Pavement areas found to be less than PT minus 1.0 inch shall be removed and replaced at the Contractor's expense. Exploratory cores taken at the Contractor's expense will be used to determine the extent of deficient pavement for pavement removal.

When the removal and replacement have been completed, four additional randomly selected cores will be taken within the area represented by this core. The four additional cores will be used to compute an I/DP in accordance with subsection 105.06. Exploratory cores will not be used to compute I/DP.

The Contractor shall repair all core holes by filling them with an approved non-shrink high strength grout.

**412.22 Opening to Traffic.** The Engineer will determine when the pavement shall be opened to traffic; otherwise the pavement shall not be opened to traffic until 14 days

412.22

after the concrete was placed or the concrete has achieved a compressive strength of 3000 psi. Prior to opening the pavement to traffic the roadway shall be cleaned, as approved.

Pavements placed with Class E concrete may be opened to traffic when the concrete has reached a maturity value that indicates the concrete has a compressive strength of at least 2500 psi as determined by ASTM C 1074 as modified in subsection 601.05.

### METHOD OF MEASUREMENT

**412.23** The quantities of Concrete Pavement, and Place Concrete Pavement to be paid for under these items will be the number of square yards completed and accepted. The width for measurement will be the width of the pavement shown on the typical cross section of the plans, including additional widening where called for, or as otherwise directed by the Engineer in writing. The length will be measured horizontally along the centerline of each roadway or ramp.

The quantity of Furnish Concrete Pavement to be paid for under this item will be the number of cubic yards of concrete delivered and accepted. The concrete volume will be based on batch weights of the concrete converted to volumes by use of the conversion factor developed with the specific mix design. Quantities of concrete that are wasted, spilled, or used as a result of excessive thickness shall be deducted from the pay quantity. Excessive thickness shall be considered any thickness in excess of ½ inch greater than the specified depth that continues for a length of 200 feet or more. Yield shall be determined in accordance with AASHTO T 121. Where concrete is paid for by cubic yard batched, the pay quantities for all concrete produced with a relative yield less than 0.99 shall be corrected in accordance with the following formula:

Corrected cubic yards = (cubic yards batched) • (relative yield)

Reinforcement other than dowels, tie bars and other joint material, will be measured by the pound.

### BASIS OF PAYMENT

**412.24**

(a) *General.* The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Concrete Pavement ( __ Inch)	Square Yard
Place Concrete Pavement	Square Yard
Furnish Concrete Pavement	Cubic Yard

The price per square yard of Concrete Pavement shall be full compensation for furnishing and placing all materials, including any dowels, tie bars, joint materials, tining, sawing, finishing, and rumble strips.

The price per square yard for Place Concrete Pavement shall include everything included in the pay item, Concrete Pavement, except furnishing concrete.

The price per Cubic Yard for Furnish Concrete Pavement shall be full compensation for furnishing the concrete to the project site.

Reinforcing steel will be measured and paid for in accordance with Section 602.

Furnishing, installing, and monitoring vibrators and vibrator monitoring device will not be measured and paid for separately, but shall be included in the work for Concrete Pavement.

Incentive and Disincentive Payments (I/DP) will not be made on interim estimates. I/DP will be made when the concrete pavement or a major phase of the concrete pavement has been completed and all the data for computing the I/DP is available.

Furnishing, calibrating and use of maturity meters, wire and other appurtenances including the molding, curing and breaking of cylinders for calibration and placement of calibration slabs will not be measured and paid for separately, but shall be included in the work.

- (b) Where the pavement thickness is more than Plan Thickness (PT) minus 1.0 inch, I/DP for the element of pavement thickness will be applied to the contract unit price in accordance with subsections 105.06 and 412.21. I/DP for other elements will be applied to the contract unit in accordance with Section 105.

Adjustments in payment because of deviations in air content will be in accordance with subsection 601.17 using \$100.00 per cu. yd. for the unit bid price.

420.01

## **SECTION 420 GEOSYNTHETICS**

### **DESCRIPTION**

**420.01** This work consists of furnishing and installing geotextiles and geomembranes for paving, impervious lining, erosion control, drainage, separators and landscape weed barrier.

### **MATERIALS**

**420.02** Geotextiles and geomembranes shall meet the applicable requirements of subsection 712.08 for the use intended. Geotextiles for erosion control for drainage\_or for separators may be either Class A or Class B if the class is not specified on the plans.

Asphalt cement binder for the paving geotextile shall be the same grade as the asphalt cement used for Item 403.

Paving geotextile shall conform to the requirements of Table 712-6 in subsection 712.08.

### **CONSTRUCTION REQUIREMENTS**

**420.03** Areas on which the geosynthetic is to be placed shall have a uniform slope, be reasonably smooth, free from mounds and windrows, and free of any debris or projections which could damage the material.

Riprap or cobbles placed on the geosynthetic shall not be dropped from a free fall greater than 3 feet. The cushion layer or initial layer of riprap may require careful placement without free fall to avoid geosynthetic damage. Geosynthetics damaged or displaced before or during placement of overlying layers shall be replaced or repaired in accordance with the requirements of this section and to the satisfaction of the Engineer, at the Contractor's expense.

**420.04 Paving.** The areas to be treated shall be as designated on the plans. The pavement surface shall be broomed clean immediately prior to beginning the crack reduction geotextile treatment using a self-propelled power broom.

The asphalt cement binder shall be applied to the pavement surface at the rate of approximately 0.25 gallon per square yard. The exact application rate shall be as recommended by the geotextile manufacturer, and at a temperature of 300 to 350 °F. Paving geotextile shall be applied, in accordance with the manufacturer's recommendations, immediately after the application of asphalt cement binder.

Construction equipment, including dump trucks, shall not make sudden stops or starts or sharp turning movements on the geotextile. Dump trucks shall not park on the geotextile prior to dumping into the asphalt paver.

Traffic shall be kept off all newly placed binder and geotextile material until the bituminous surface has been placed.

The minimum temperature of the hot mix asphalt at the time compaction begins shall be 250 °F.

The Contractor shall make arrangements with the geotextile supplier to have a technician, skilled in this paving geotextile work, present at the project site during this work to give any technical assistance needed.

**420.05 Impervious Lining.** Geomembranes for lining shall be loosely laid (not stretched) to avoid any rupture of the lining. If field lap joints are necessary, the joints shall be formed by lapping the edges of panels in accordance with the manufacturer's recommendations. The contact surfaces of the panels shall be cleaned to remove all dirt, dust, and other foreign materials. Sufficient cold-applied vinyl to vinyl bonding adhesive shall be applied to the contact surfaces in the joint area and the two surfaces pressed together immediately. Wrinkles in the joints shall be smoothed out.

Necessary repairs to the geomembrane shall be patched using the geomembrane material itself and cold-applied vinyl to vinyl bonding adhesive. The bonding adhesive shall be applied to the contact surfaces of both the patch and the lining to be repaired and the two surfaces pressed together immediately. Any wrinkles in the repair joints shall be smoothed out.

**420.06 Erosion Control and Drainage.** Geotextiles for erosion control or drainage shall be loosely laid (not stretched) with the roll direction the same as the anticipated water flow, and in a manner that avoids any rupture of the cloth. The geotextile may be anchored in place with securing pins at 3 foot spacing along but not closer than 2 inches to all edges and to the extent necessary to prevent displacement. When shown on the plans, erosion control geotextile may be held in place using 6 inches of clean embankment with a minimum 6 inch trench at the top of the slope. Overlaps shall be at least 12 inches on slopes 3:1 and flatter, and at least 24 inches on slopes steeper than 3:1. Laps shall be made with the uphill layer on top. Sewn seams in accordance with the manufacturer's recommendations may be used in place of overlaps. Full rolls shall be used whenever possible in order to minimize the number of roll end laps. Lengths and widths of individual sheets shall be at the Contractor's option.

**420.07 Geotextile Separator.** The geotextile shall be unrolled as smoothly as possible on the prepared subgrade in the direction of construction traffic. The geotextile shall be placed by machinery or by hand labor. The geotextile shall not be dragged across the subgrade. Wrinkles and folds in the geotextile (not associated with roadway curves) shall be removed by stretching and staking as required. The geotextile may be held in place prior to placement of cover by pins, staples or piles of fill or rock. On curves, the geotextile may be folded to conform to the curve. The fold or overlap shall be in the direction of construction and held in place as prescribed above. Adjacent geotextile rolls shall be overlapped in the direction of subbase placement using the guidelines in Table 420-1. Before covering, the condition of the geotextile will be inspected by the Engineer to determine that no holes, rips or other defects exist. If any defects are observed, the section of the geotextile containing the

420.07

defect shall be repaired by placing a new layer of geotextile extending beyond the defect in all directions a minimum distance equal to the overlap shown in Table 420-1. Alternatively, the defective section may be replaced.

Either sewn seams or overlaps (unsewn seams) shall be used in construction. The widths of the overlaps shall conform to Table 420-1. Sewn seams shall be in accordance with the manufacturer's recommendations.

The first lift of cover material shall be end-dumped or spread over the geotextile from the edges of the geotextile. The height of the dumped pile shall be limited to avoid local bearing capacity failures. The first lift of cover material shall be graded to a 12 inch thickness or to top of grade whichever is less and compacted. Equipment shall not be on the treated area with less than the minimum thickness of compacted cover material over the geotextile. Small dozer equipment or front end loader shall be used to spread the cover material.

Construction vehicles shall be limited in size and weight such that rutting in the initial lift is no deeper than 3 inches. If rut depths exceed 3 inches, the Contractor shall use a smaller size and weight of construction vehicles. Ruts shall be filled in with cover material.

Compaction of lifts shall be accomplished without damaging the geotextile.

Construction equipment shall not make turns on the first lift of cover material.

**Table 420-1  
MINIMUM REQUIRED OVERLAP**

<b>Subgrade Strength_R-Value</b>	<b>Overlap Width (Unsewn Seam) Inches</b>
5 - 10	30
10 - 20	24
>20	18

**420.08 Landscape Weed Barrier.** Landscaped and mulched areas to be covered by geotextile shall be brought to finish grade below the depth of the mulch material shown on the plans. All soil preparation shall be completed prior to geotextile application.

The geotextile shall be rolled directly onto prepared soil in the direction of water flow. The geotextile shall be applied loosely without stretching. The top edge of the geotextile shall be buried in a 6 inch check slot at the top of the slope and stapled. When specified, metal landscape border shall be placed adjacent to check slot on the uphill side, so as not to puncture the geotextile.

Where one roll of geotextile ends and a second roll begins, the upslope piece shall be brought over the start of the second roll and overlapped in accordance with the

manufacturer’s recommendation. Where two or more widths of geotextile are applied side by side, they shall be overlapped in accordance with the manufacturer’s recommendation. Staples shall be inserted at a 2 foot spacing along the outer edges of the geotextile where a metal border is not used.

In level planting beds, geotextile shall be secured under metal landscape border by extending the geotextile 6 inches beyond the metal landscape border and driving stakes through the geotextile.

**METHOD OF MEASUREMENT**

**420.09** Geomembranes and geotextiles will be measured by the square yard of surface area covered, complete in place.

**BASIS OF PAYMENT**

**420.10** The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Geomembrane	Square Yard
Geotextile (Erosion Control)(Class___)	Square Yard
Geotextile (Drainage)(Class___)	Square Yard
Geotextile (Weed Barrier)	Square Yard
Geotextile (Paving)	Square Yard
Geotextile (Separator)(Class___)	Square Yard

Securing pins, staples, adhesives, sewn seams, asphalt cement, brooming, skilled technician, and other work and materials necessary for placement will not be measured and paid for separately but shall be included in the work.



420.10



## **SECTION 500 STRUCTURES**

### **SECTION 501 STEEL SHEET PILING**

#### **DESCRIPTION**

**501.01** This work consists of furnishing and driving corrugated steel sheeting or steel sheet piling in accordance with these specifications and in conformity to the lines and grades shown on the plans or established.

#### **MATERIALS**

**501.02** Type I steel sheet piling shall be used where shown on the plans and shall be a corrugated steel sheeting nongalvanized interlocking type, at least 8 gage in thickness with a minimum section modulus of 1.300 cubic inches per unit of 12 inches in width. Steel sheeting shall conform to ASTM A 857, Grade 36 for 7 gage or 8 gage steel, Grade 30 for heavier gages. The sides for each piece of sheeting shall be furnished with an interlock that is continuous for the full length of the sheeting. The interlock shall have an opening of sufficient width to allow free slippage of the adjoining sheet.

**501.03** Type II steel sheet piling shall be of the type and weight shown on the plans and shall conform to the requirements of AASHTO M 202 or AASHTO M 270, Grade 50.

#### **CONSTRUCTION REQUIREMENTS**

**501.04** Steel sheet piling shall be driven to form a tight bulkhead. A driving head shall be used and any piling which does not provide a tight bulkhead shall be pulled and replaced at the Contractor's expense.

Steel sheet piling that is full length as shown on the plans and is required to be driven below the specified cut-off elevation shall be spliced with additional steel sheet piling with a full penetration butt weld. Splicing will be limited to three per pile sheet. A splice shall not be less than 3 feet from another splice on the same pile.

Welding shall conform to the applicable requirements of ANSI/AWS D 1.1.

Where specified on the plans, sheet piling shall be painted as described in subsection 509.24.

#### **METHOD OF MEASUREMENT**

**501.05** Steel sheet piling will be measured by the square foot, complete in place and accepted, to cut-off elevation. Each approved splice will be measured as an additional 3 square feet of sheet pile.

501.05

The area of sheet piling cut-off to be measured will be those random areas of sheet piling which result from cutting off the tops of driven sheet piling and not used in the work.

**BASIS OF PAYMENT**

**501.06** The accepted quantities of steel sheet piling will be paid for at the contract unit price per square foot of each type used.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Steel Sheet Piling (Type__)	Square Foot

Sheet piling cut-offs 10 square feet or less in area will be paid for at the contract unit price less 20 percent. These cut-offs shall become the property of the Contractor.

Sheet pile cut-offs greater than 10 square feet will not be paid for.

## SECTION 502 PILING

### DESCRIPTION

**502.01** This work consists of furnishing and driving all types of piling shown in the Contract, other than sheet piling, in accordance with these specifications. Each pile shall be installed at the location and to the elevation, penetration, and bearing shown on the plans or established.

### MATERIALS

**502.02 Steel Piling.** Structural steel shapes used as piling shall conform to the requirements of AASHTO M 270 Grade 36.

Steel pipe shall conform to the requirements of ASTM A 252, Grade 2. Closure ends shall conform to the requirements of AASHTO M 270 Grade 36.

Steel shell piles shall conform to the requirements of AISI C 1010 or C 1015 steel.

Closure plates, driving points and their connecting welds shall not project beyond the perimeter of the pile tip for steel pipe and steel shell piles.

Commercial driving points may be used for end bearing piles. All steel pipe piles and steel shell piles shall be filled with Class B concrete conforming to subsection 601.02.

Steel piling may be ordered in plan lengths or in 30 to 60 foot lengths.

### CONSTRUCTION REQUIREMENTS

**502.03 Pile Driving Equipment.**

- (a) *Pile Hammers.* Steam, air, diesel, or hydraulic impact hammers may be used to drive all types of piles. Vibratory or gravity hammers shall not be used to drive bearing piles.
1. For steam, air, and diesel hammers, a minimum manufacturer's rated energy as shown in Table 502-1 shall be used.

**Table 502-1**

Pile Size	Area (Square Inches)	Minimum Energy (Foot-Pounds)
HP 10x42	12.4	26,000
HP 10x57	16.8	26,000
HP 12x53	15.5	26,000
HP 12x74	21.8	42,000
HP 14x89	26.1	52,000
HP 14x117	34.4	68,000

502.03

The rated energy of the hammer shall not be greater than 2500 foot-pounds per square inch of unit area.

If more than one size of piling is designated in the Contract, the Contractor shall provide the necessary hammer or hammers to meet these requirements for all sizes of piles used.

2. Hydraulic hammers may be substituted for steam, air, and diesel hammers. The minimum energy requirement for hydraulic hammers shall be 40 percent of the value specified in Table 502-1. The maximum impact energy of hydraulic hammers shall be adjusted to not exceed 1000 foot-pounds per square inch of pile unit area.
  3. When designated in the Contract, a hammer with a rated energy determined by the Wave Equation Analysis Program (WEAP) shall be used. When the WEAP is used in the design phase of a project, a range of acceptable hammer energies will be included in the Contract.
- (b) *Hammer Cushion.* All impact pile driving equipment except hydraulic hammers shall be equipped with a suitable hammer cushion to prevent damage to the hammer or piles and to insure uniform driving behavior. Wood, wire rope, and asbestos cushion material shall not be used. A striker plate as recommended by the hammer manufacturer shall be used. The hammer cushion may be inspected by the Engineer at anytime during progress of the work. Any hammer cushion whose thickness is reduced by 10 percent or more of the original thickness shall be replaced at the Contractor's expense before driving is permitted to continue.
- (c) *Pile Driving Head.* Appropriate driving heads, mandrels, or other devices shall be provided in accordance with the manufacturer's recommendations.
- (d) *Leads.* Pile driving leads shall be constructed in a manner that affords the pile hammer freedom of movement while maintaining alignment of the pile hammer and the pile to insure concentric impact for each blow. Leads may be either fixed or swinging. Swinging leads shall be fitted with a pile gate at the bottom of the leads.
- (e) *Followers.* Followers shall be used only when specified on the plans or approved in writing by the Engineer.

**502.04 Approval of Pile Driving Equipment.** All pile driving equipment discussed in subsection 502.03 shall be approved by the Engineer prior to delivery to the site. Approval will be based upon pile driving equipment data, such as rated energy, impact energy, or striking ram weight, which the Contractor shall submit. When the equipment is of questionable adequacy, the WEAP will be used to determine approval.

If the Contract includes hammers determined by subsection 502.03(a)3., the Contractor will be notified of the acceptance or rejection of the driving system within ten calendar days of the Engineer's receipt of the pile and driving equipment data. The

approval criteria for wave equation analysis will consist of (1) the pile stress at the required ultimate pile capacity and (2) pile driveability.

The driving stresses in the pile indicated by the Wave Equation Analysis shall not exceed 90 percent of the yield stress of the steel.

Once approved, changes in the pile driving equipment shall not be made without additional approval, and will be considered only after the Contractor has submitted the necessary information for a revised Wave Equation Analysis. The approval process outlined above shall be applied to the revised driving equipment.

All pile hammers delivered to the job site which the Engineer determines, either by observation or by pile driving analyzer, are not in good working condition will be rejected.

**502.05 Driving Piles.** Foundation piles shall not be driven until the excavation is complete unless authorized by the Engineer. After driving is complete, all loose and displaced material shall be removed from around the piling before pouring any concrete.

Piles shall be driven with a variation of not more than  $\frac{1}{4}$  inch per foot from the vertical or from the batter shown in the Contract. Foundation piles shall not be out of the position shown in the Contract more than 6 inches after driving.

A minimum pile penetration of 10 feet in natural ground is required for all piles. This requirement may be waived by the Engineer if the subsurface material at the pile tip location is bedrock or other acceptable bearing material provided that the bearing elevation is below scour depth.

If a minimum pile tip elevation is specified in the Contract, all piles shall be driven to or below this elevation unless otherwise approved in writing. If the pile cannot be driven to the minimum tip elevation, the Engineer will determine if predrilling is required. Any predrilling not required by the Contract and ordered by the Engineer will be paid for in accordance with subsection 109.04. The depth of the predrilling will be determined by the Engineer.

Piles shall be driven to virtual refusal in natural ground at or below the estimated tip elevations specified on the plans. Virtual refusal is defined as a penetration of 1 inch or less for the final ten blows unless modified by the Engineer based on the pile driving analyzer results as described below. If virtual refusal has been reached in natural ground and piles have not been driven to the estimated tip elevation but have been driven below minimum tip elevation, the Engineer may order the driving to be continued for 40 additional blows.

Water jets may be used in conjunction with the hammer to obtain the specified penetration only with approval. The last 3 feet of penetration shall be obtained by driving without the use of water jets. Test blows to determine average penetration shall be applied after the jets have been removed. The use of water jets will not modify any of the requirements of this section.

502.05

The Engineer may monitor the pile driving by using a Pile Driving Analyzer (PDA) to determine the condition of the pile, the efficiency of the hammer and the static bearing capacity of the piles, and to verify or modify the pile driving criteria specified in this Section. Modifications may include relaxing or stiffening the refusal criteria. The monitoring will be conducted by the Engineer. It is estimated that the Engineer will need approximately one hour per pile to install the PDA measurement equipment. Not more than two piles per project will be monitored unless specified in the Contract. All necessary work performed by the Contractor associated with the dynamic monitoring will not be paid for separately but shall be included in the work. If the Engineer requests additional piles to be monitored, or requests the Contractor to monitor the pile or piles, all necessary time required and work performed by the Contractor will be paid for in accordance with subsection 109.04.

**502.06 Drilling Holes to Facilitate Pile Driving.** Holes to facilitate pile driving shall be drilled at all locations shown on the plans and to elevations shown.

When test piles are shown on the plans they shall be used to determine if drilling holes to facilitate pile driving is required.

If the test pile or piles do not reach the estimated tip elevation as specified in subsection 502.05, holes shall be drilled to facilitate pile driving.

If the test pile or piles reach the estimated tip elevation shown on the plans and develop the required bearing capacity as determined in subsection 502.05, drilling holes will not be required and the remainder of the piles shall be driven in the normal manner.

The drilling of holes shall be done in such manner that the piling will stand accurately positioned as shown on the plans.

The diameter of the drilled holes and the material used to fill oversize holes shall be as stipulated herein unless otherwise designated on the plans.

The minimum diameter of the drilled holes shall be 1 inch larger than the outside diameter of steel pipe piles. The minimum diameter of the drilled holes shall be 2 inches larger than the web depth for H piles.

The maximum diameter of the drilled holes shall be 2 inches larger than the minimum diameter specified above. If the maximum diameter of the drilled hole is exceeded due to sloughing, drifting, over-drilling, or other causes, the void area between the driven pile and the edge of the hole shall be filled with sand or pea gravel at the Contractor's expense.

The Engineer will determine if shooting holes with explosives or redesign is necessary when piles cannot be driven or holes drilled.

**502.07 Capping Piles.** Steel pipe or shell piles will be inspected after all adjacent piles within a 5 foot radius have been driven. The Contractor shall supply suitable

lights for the inspection of the insides of these piles. Water or other foreign material shall be removed and the pipe or shell shall be filled with concrete.

The tops of all steel piles shall be cut off square and embedded in the concrete as shown on the plans.

**502.08 Extensions and Splices.** There will not be a limit placed on the number of splices allowed for steel piles; however, payment will be limited to two splices per pile.

Steel piling shall be spliced with a square-groove butt-joint weld using a  $\frac{1}{8}$  inch root opening. Weld deposition on pipe piles shall be made in two separate passes around the outside perimeter of the pile. Weld deposition on steel "H" piles shall be made in two passes. The first pass shall be made from one side of the part being welded and shall penetrate one-half the thickness of the member. The second pass shall be made on the side opposite from the first. For both types of piles, the slag left by the first pass shall be completely removed before making the second pass. All cuts at splices are to be made normal to the longitudinal axis of the pile. The cut-off portion may be driven to start the next pile or it may be welded to previously driven piles to provide the necessary extension length. Splices must be authorized.

Welding shall conform to the applicable requirements of ANSI/AWS D1.1.

Welders shall be prequalified in accordance with the standard qualification procedure of the American Welding Society. The Engineer may consider a welder qualified when the Welders' Certificate states that the welder has been doing satisfactory welding of the required type within a one year period previous to the subject work. A certification shall be submitted for each welder and for each project, stating the name of the welder, the name and title of the person who conducted the examination, the kind of specimens, the positions of welds, the results of the tests and the date of the examination. Such certification of pre-qualification may also be accepted as proof that a welder on field welding is qualified, if the Contractor who submits it is properly staffed and equipped to conduct such an examination or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose.

Approved commercial splices may be used as an alternate for welded splices.

**502.09 Defective Piling.** Piles damaged in driving by reasons of internal defects or improper driving; driven out of their proper location; or driven below the elevation specified on the plans without approval shall be corrected at the Contractor's expense by one of the following approved methods:

- (1) The pile shall be withdrawn and replaced by a new, and if necessary, longer pile.
- (2) A second pile shall be driven adjacent to the defective pile.
- (3) The pile shall be spliced or built up.
- (4) A sufficient portion of the footing shall be extended to properly embed the pile.

All piles pushed up by the driving of adjacent piles shall be driven down again.

502.10

**502.10 Pile Tips.** Pile tips shall be placed on piles when shown on the plans. Pile tips and details for fastening tips to piles shall be in accordance with the plans or approved. If difficult driving conditions are encountered, the Engineer may order the Contractor to furnish and attach pile tips even though tips are not required by the plans. In that event, the tips will be paid for in accordance with subsection 109.04.

**502.11 Painting Steel Piles.** The exposed portion of steel piles not embedded in concrete, including 2 feet below the stream bed or ground line, shall be painted as described in Section 509.

### METHOD OF MEASUREMENT

**502.12** Piling will be measured by the linear foot in place. Measurement shall be from the tip to the cut-off elevation.

The length of pile cut-off to be measured will be those random lengths of piling which result from cutting off the tops of driven piles and which are not used in the work.

Where piling is driven to within 1 foot of the elevation of cut-off, butt ends will be included in the length measured for piling actually driven.

Measurement of splices will be limited to two per steel pile, except when extra splices are ordered.

Splices for piles will be measured as additional length of pile. The additional length for each splice will be as follows: steel "H" piles, 3 linear feet; steel pipe piles, 3 linear feet.

Pile tips and end closure plates for steel pipe piles will be measured by the actual number used.

Drilled holes to facilitate pile driving will be measured by the linear foot, to the nearest foot.

### BASIS OF PAYMENT

**502.13** The accepted quantities will be paid for at the contract unit price per unit of measurement for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Steel Piling (size)	Linear Foot
Steel Pipe Piling (size)	Linear Foot
Steel Shell Piling (size)	Linear Foot
Drilling Hole to Facilitate Pile Driving	Linear Foot
End Plate	Each
Pile Tip	Each

502.13

Steel cut-offs 10 feet or less in length will be paid for at the contract unit price less 20 percent. These cut-offs shall become the property of the Contractor.

Pile cut-offs greater than the above specified lengths will not be paid for.

Authorized jetting, blasting, or other work necessary to obtain the specified penetration of piles will be paid for in accordance with subsection 104.03.

Concrete used to fill steel pipe will not be measured and paid for separately, but shall be included in the work.

503.01

## **SECTION 503 DRILLED CAISSONS**

### **DESCRIPTION**

**503.01** This work consists of drilling holes and placing reinforcing steel and concrete in the drilled holes in accordance with these specifications and in conformity with the lines and grades on the plans or established.

### **MATERIALS**

**503.02** Concrete shall be Class BZ or as specified in the Contract, and shall conform to the requirements of Section 601.

Reinforcing steel shall conform to the requirements of Section 602.

### **CONSTRUCTION REQUIREMENTS**

**503.03 Drilled Holes.** Caisson excavation shall be performed by heavy duty drilling rigs suitable for penetrating the cobbles, boulders, and bedrock to the required depths. Blasting will not be allowed.

The top of the caissons shall be the elevation shown on the plans. The elevations of the bottom of the caissons shown on the plans are approximate only and may be revised by the Engineer depending on the conditions encountered. The minimum embedment length into bedrock shall be as shown on the plans. Materials resulting from drilling shall be disposed of by the Contractor.

The maximum permissible variation of the center axis of any shaft at the top from its plan location shall be the greater of 3 inches or  $\frac{1}{24}$  of the shaft diameter. Caissons shall not be out of plumb more than three percent of their length. If a drilled hole does not meet these requirements, it shall be reamed or redrilled as required to bring it to the proper alignment, or drilled an additional distance, as approved by the Engineer. Additional concrete required as a result of these measures shall be provided at the Contractor's expense.

The excavation shall be protected with a suitable cover which will prevent persons or materials from falling into the hole.

When caving conditions are encountered, drilling shall be discontinued until the construction method used will prevent excessive caving.

**503.04 Cleaning and Inspection.** Holes shall be pumped free of water, cleaned of the loose material, and inspected by the Engineer. A drilled hole may be entered for inspection when deemed necessary by the Engineer, but only when a protective casing is in place. The Contractor shall provide fresh air ventilation, electric lights, suitable means of access, the protective casing, and shall assist the Engineer, as directed, in making the required inspection of the drilled excavation and foundation material.

**503.05 Reinforcing Steel.** After a hole has been inspected and approved, the reinforcing steel shall be installed and the concrete placed as soon as possible.

The required reinforcing steel cage for the drilled caisson shall be completely assembled and placed as a unit for the full length of the caisson immediately prior to the placing of any concrete. If concrete placement does not immediately follow the cage placement, the Engineer may order the steel to be removed from the excavation so that the integrity of the excavation, including the presence of loose material in the bottom of the hole, and the surface condition of the reinforcing steel may be determined by inspection.

The reinforcing steel cage shall be supported from the top during the placement of the concrete to achieve the clearances shown on the plans. Setting the cage on the bottom of the hole will not be permitted. The support system shall be concentric to prevent racking and displacement of the cage. Approved spacers shall be provided at intervals not to exceed 10 feet along the cage to insure concentric positioning for the entire length of the cage; a minimum of three spacers shall be provided at each spacing interval. Additional reinforcement may be added to stiffen the cage at the Contractor's option and expense.

**503.06 Steel Casing.** If casings are used, they shall be steel of ample thickness and strength to withstand distortion due to handling, the internal pressure of fresh concrete, and the external pressure of the surrounding soil and ground water, and shall be watertight. The inside diameter of the casing shall be equal to or larger than the caisson dimensions shown on the plans. The use of casings larger than the diameter of the caissons shown on the plans must have prior approval from the Engineer. Additional concrete required due to the use of oversize casings shall be provided at the Contractor's expense.

Casings shall be removed unless otherwise designated on the plans. Casings shall be removed in a manner such that voids between the excavation and the casing will be completely filled with fresh concrete. The removal method shall prevent the intrusion of water, sloughing of the excavation, displacement of the reinforcing steel, and lifting of the concrete. The casing removal shall be performed in a manner that minimizes the displacement of the concrete from its initial placement point. If the casing is stuck and can't be removed without damaging the hole, it may be cut off and left in place with the Engineer's approval, or other remedial measures taken as approved. The top elevation of the reinforcing steel cage shall be checked before and after the casing removal. Upward movement in excess of 2 inches or downward movement in excess of 6 inches of the reinforcing steel cage will be cause for rejection of the caisson. Concrete settlement in the caisson will be determined by measuring the top surface of the concrete: (1) immediately after the casing is removed and additional concrete poured to the desired elevation; and, (2) at least four hours later. Concrete settlements in excess of  $\frac{1}{2}$  of the caisson diameter will also be cause for rejection of the caisson.

503.07

**503.07 Concrete.** For any portion of the caisson socketed in shale, if the concrete is not placed within four hours of drilling, the Contractor shall drill into the bedrock an additional  $\frac{1}{3}$  of the specified penetration prior to placing the concrete. The reinforcing cage shall extend to the new tip elevation.

Foundation piling shall not be driven nor excavation performed within a radius of 20 feet, nor additional caissons drilled within a clear distance of 3 feet, of concrete that has not attained a compressive strength of at least 1500 psi as determined by the Engineer.

Other construction methods, such as slurry displacement, may be used, if approved. The procedure for step-by-step construction shall be approved prior to beginning the work.

Concrete for each drilled caisson shall be placed in one continuous pour. Concrete may be placed in a dry hole by free-drop from the surface provided that a hopper or other approved device is used to force the concrete to drop straight down without hitting the sides of the hole or any reinforcing steel before striking the bottom. A drilled hole may be considered dry at the time of concrete placement if, without dewatering, the water depth at the bottom of the hole is not in excess of 2 inches.

Where an excavation cannot be practically dewatered for the placement of concrete, the Engineer may authorize a portion of the concrete to be placed under water in accordance with subsection 601.12(f). Concrete placed below water shall be limited to a height sufficient to seal the excavation and to withstand hydrostatic pressure. Immediately following the placement of this sealing concrete, the remaining portion of the hole shall be dewatered and the remainder of the concrete shall be placed. Concrete within the top 5 feet of the caisson shall be vibrated during placement. The layer of water-diluted concrete which has been floated to the top during placement shall be removed to the depth directed by the Engineer and wasted. The removed layer shall not be less than 4 inches thick. Only that concrete which meets specification requirements shall remain as part of the caisson.

Immediately following the concrete placement and the casing removal, the projecting reinforcing steel shall be thoroughly cleaned to remove accumulations of splashed mortar. This work shall be completed before the concrete takes its initial set. Care shall be taken when cleaning the reinforcing steel to prevent damage to or breakage of the concrete-steel bond.

#### **METHOD OF MEASUREMENT**

**503.08** Drilled caisson will be measured by the linear foot from the elevation shown on the plans to the bottom of the hole as drilled.

Each approved splice of the reinforcing cage for additional length of caisson will be measured as  $\frac{1}{2}$  linear foot of additional length of drilled caisson.

**BASIS OF PAYMENT**

**503.09** The unit price of drilled caissons shall be full compensation for making all excavations; hauling and disposal of excavated material; performing all necessary pumping; furnishing and placing required concrete and reinforcement steel, including the reinforcement projecting above the tops of the caissons necessary for splicing; all backfilling; removing casings; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work. No extra payment will be made for casing left in place.

- (a) *Payment.* The accepted quantities for drilled caissons will be paid for at the Contract unit price per linear foot except for price adjustments allowed in (b) below.  
Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Drilled Caisson (___Inch)	Linear Foot

- (b) *Price Adjustments.* When the Engineer orders holes to be drilled to a lower elevation than shown on the plans, compensation for additional depth will be as follows:

<b>Additional Length</b>	<b>Compensation</b>
0 to 5 feet	Contract Unit Price
Over 5 feet to 15 feet	Contract Unit Price Plus 15%
Over 15 feet	As provided in subsection 109.04

Additional compensation will not be paid for the portions of a caisson that are extended due to the Contractor’s method of operation, as determined by the Engineer.

504.01

## SECTION 504 CRIBBING

### DESCRIPTION

**504.01** This work consists of the construction of steel, concrete or timber cribbing in accordance with these specifications, and in conformity with the design or type, lines and grades shown on the plans or established.

### MATERIALS

**504.02** Backfill shall be of the type designated on the plans and shall conform to Section 206. All cribbing members of the same type and size shall be interchangeable without any modification.

- (a) *Steel Cribbing.* Material used in steel cribbing shall conform to the requirements of AASHTO M 218.
- (b) *Concrete Cribbing.* Concrete shall be Class B and conform to the requirements of Section 601. Reinforcing steel shall conform to the requirements of Section 602.

Forms for concrete cribbing shall be true to line, and built of metal, plywood, or dressed lumber. A 3/4 inch chamfer strip shall be used in all corners. Forms shall be watertight and shall remain in place at least 24 hours after the concrete has been placed.

The concrete placement shall be continuous. Acceptable methods of vibration or compaction of the concrete shall be used.

Backfilling around cribbing shall not be started until concrete test cylinders show a compressive strength of at least 80 percent of the required 28 day compressive strength. In lieu of test cylinders, the concrete shall be allowed to set for at least 14 days at a minimum temperature of 60 °F or 21 days at a minimum temperature of 40 °F.

- (c) *Timber Cribbing.* Timber cribbing shall meet the requirements of AASHTO LRFR Bridge Design Specifications, Section 8. When treatment with preservatives is required, it shall be done in accordance with subsection 508.03. The preservative shall be as noted on the plans and the treatment shall be for "Soil Contact." Inspection will be done in accordance with subsection 508.04.

### CONSTRUCTION REQUIREMENTS

**504.03** Construction requirements for timber cribbing shall conform to the applicable requirements of Section 508.

The foundation shall be firm and must be approved by the Engineer before construction of walls is commenced. Members that are damaged during installation shall be replaced at the Contractor's expense.

Filling of cribbing interior shall be placed in loose layers not exceeding 6 inches in thickness and shall be thoroughly tamped into place. Backfilling behind cribbing shall conform to Section 206 and shall progress with, but not ahead of, the filling of the interior of the cribbing. A layer of rock or stone spalls shall be laid against concrete or timber cribbing in advance of backfilling to prevent loss of backfill material through openings.

**METHOD OF MEASUREMENT**

**504.04** Crib walls of the various types and designs will be measured by the number of square feet of facial area.

**BASIS OF PAYMENT**

**504.05** The accepted quantities of cribbing will be paid for at the contract unit price per square foot of facial area for the items listed below that appear in the bid schedule.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Concrete Cribbing (Design__)	Square Foot
Steel Cribbing (Design__)	Square Foot
Timber Cribbing (Type__)	Square Foot

Structure excavation and structure backfill will be measured and paid for in accordance with Section 206.

Subsurface drains, if required, will be measured and paid for in accordance with Section 605 or subsection 104.03.

506.01

**SECTION 506  
RIPRAP**

**DESCRIPTION**

**506.01** This work consists of the construction of riprap in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

**MATERIALS**

**506.02** Riprap shall consist of hard, dense, durable stone, angular in shape and resistant to weathering. Rounded stone or boulders shall not be used as riprap material. The stone shall have a specific gravity of at least 2.5. Each piece shall have its greatest dimension not greater than three times its least dimension.

Material used for riprap may be approved by the Engineer if, by visual inspection, the rock is determined to be sound and durable. The Engineer may require the Contractor to furnish laboratory results if, in the Engineer's opinion, the material is marginal or unacceptable. At the request of the Engineer, the Contractor shall furnish laboratory test results indicating that the material meets the requirements for abrasion resistance or compressive strength as indicated in Table 506-1.

**Table 506-1**

<b>Test Description</b>	<b>Test Method</b>	<b>Specification Requirement</b>
Abrasion Resistance by Los Angeles Machine	ASTM C 535	50% Loss, max.
Unconfined Compressive Strength of Drilled Core Specimen	AASHTO T 24	2500 psi, min.

Riprap shall conform to the gradation requirements given in Table 506-2.

**Table 506-2**

Pay Item		% of Material Smaller Than Typical Stone <sup>2</sup>	Typical Stone Dimensions <sup>3</sup> (Inches)	Typical Stone Weight <sup>4</sup> (Pounds)
	Stone Size d50 <sup>1</sup> (Inches)			
Riprap	6	70-100	12	85
		50-70	9	35
		35-50	6	10
		2-10	2	0.4
Riprap	9	70-100	15	160
		50-70	12	85
		35-50	9	35
		2-10	3	1.3
Riprap	12	70-100	21	440
		50-70	18	275
		35-50	12	85
		2-10	4	3
Riprap	18	100	30	1280
		50-70	24	650
		35-50	18	275
		2-10	6	10
Riprap	24	100	42	3500
		0-70	33	1700
		35-50	24	650
		2-10	9	35

<sup>1</sup>d50 = nominal stone size  
<sup>2</sup>based on typical rock mass  
<sup>3</sup>equivalent spherical diameter  
<sup>4</sup>based on a specific gravity = 2.5

Nominal stone size and total thickness of the riprap shall be as shown on the plans.

Control of gradation will be by visual inspection. The Contractor shall provide two samples of rock at least 5 tons each, meeting the gradation specified. One sample shall be provided at the construction site and may be a part of the finished riprap covering. The other sample shall be provided at the quarry.

These samples will be used as a reference for judging the gradation of the riprap supplied. When it is determined necessary, conformance of the gradation will be verified by dumping and checking the gradation of two random truck loads of stone. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided at the Contractor's expense.

### **CONSTRUCTION REQUIREMENTS**

**506.03** Stones with typical stone dimensions that are equal to d50 and larger shall be placed at the top surface with faces and shapes matched to minimize voids and form as

506.03

smooth a surface as practical. Dumping and backhoe placement alone is not sufficient to ensure a properly interlocked system. The material may be machine-placed and then arranged as necessary by use of gradall with multi-prong gapple device or by hand to interlock and form a substantial bond.

Excavation for toe or cut-off walls shall be made to the neat lines of the wall. Allowance will not be made for work outside the neat lines.

### **METHOD OF MEASUREMENT**

**506.04** Riprap of the sizes specified in the Contract will be measured by the ton or by the cubic yard. Cubic yards will be by the method of average end areas based on dimensions shown on the plans or ordered.

### **BASIS OF PAYMENT**

**506.05** The accepted quantities of riprap will be paid for at the contract unit price per cubic yard or per ton.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Riprap (___ inch)	Cubic Yard or Ton

Structure excavation will be measured and paid for in accordance with Section 206.

## **RIPRAP (GABIONS) AND SLOPE MATTRESS**

### **DESCRIPTION**

**506.06** This work consists of the construction of riprap in wire mesh gabions and in wire mesh slope mattresses in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

### **MATERIALS**

**506.07** The wire, wire mesh, cages, anchor stakes and riprap shall conform to subsection 712.09.

### **CONSTRUCTION REQUIREMENTS**

**506.08 Gabions and Slope Mattresses.** Gabions and slope mattresses shall be placed to conform with the plan details. Riprap material shall be placed in close contact in the unit so that maximum fill is obtained. The units may be filled by machine with sufficient hand work to accomplish requirements of this specification.

Where the length of the unit exceeds its horizontal width the gabion is to be equally divided by diaphragms, of the same mesh and gauge as the body, into cells whose length does not exceed the horizontal width. The unit shall be furnished with the

necessary diaphragms secured in proper position on the base section in such a manner that no additional tying at this juncture will be necessary.

- (a) *Gabions.* All perimeter edges of gabions are to be securely selvedged or bound so that the joints formed by tying the selvedges have approximately the same strength as the body of the mesh.

The gabion bed shall be excavated to the width, line, and grade as staked by the Engineer. The gabions shall be founded on this bed and laid to the lines and dimensions required.

Excavation for toe or cut-off walls shall be made to the neat lines of the wall.

All gabion units shall be tied together each to its neighbor along all contacting edges in order to form a continuous connecting structure.

- (b) *Slope Mattresses.* Slope mattresses shall be filled with angular or fractured stone. Rounded boulders will not be permitted. Before the mattress units are filled, the longitudinal and lateral edge surfaces of adjoining units shall be tightly connected by means of wire ties placed every 4 inches or by a spiral tie having a complete loop every 4 inches. The lid edges of each unit shall be connected in a similar manner to adjacent units. The slope mattress shall be anchored as shown on the plans.

The Contractor shall determine whether the holes for the soil anchor stakes are to be drilled or whether the stakes may be driven. Care shall be taken to avoid drilling holes to a greater depth than is necessary to place the top of the finished stake slightly above the top of the finished mattress.

The Contractor will be allowed to assemble, partially fill, and tie together mattress-units on the subgrade provided they can be placed on the slope without abrading the zinc coating on the wire mattress or permanently distorting the shape of the mattress in transporting and installing the units on the slope. All prefabrication procedures shall be subject to approval.

### **METHOD OF MEASUREMENT**

**506.09** The quantity to be measured under this item will be the number of cubic yards of riprap required to fill the gabions and slope mattresses in accordance with the dimensions shown on the plans, or ordered.

### **BASIS OF PAYMENT**

**506.10** The accepted quantity measured as provided above will be paid for at the contract unit price per cubic yard for "Riprap (Gabions)" or "Slope Mattress" as the case may be.

Payment will be made under:

506.10

<b>Pay Item</b>	<b>Pay Unit</b>
Riprap (Gabions)	Cubic Yard
Slope Mattress	Cubic Yard

Structure excavation and structure backfill will be measured and paid for in accordance with Section 206.

## SECTION 507 SLOPE AND DITCH PAVING

### DESCRIPTION

**507.01** This work consists of the construction of slope and ditch paving in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

### MATERIALS

**507.02 Concrete Slope and Ditch Paving.** Concrete shall conform to the requirements of Section 601. Concrete shall be Class B or as shown on the plans. Reinforcement, when required, shall conform to the requirements of Section 602. Preformed joint filler shall conform to AASHTO M 213.

**507.03 Dry Rubble Slope and Ditch Paving.** Stone shall conform to the material requirements of subsection 506.02. Size of stone and total thickness of paving shall be as shown on the plans.

**507.04 Grouted Rubble Slope and Ditch Paving.** Stone shall conform to the material requirements of subsection 506.02. Size of stone and total thickness of paving shall be as shown on the plans.

Mortar shall consist of one part portland cement and three parts of fine aggregate by volume thoroughly mixed with as much water as is necessary to obtain the required consistency. Materials shall meet the requirements specified in the following subsections:

Portland Cement	701.01
Fine Aggregate	703.01
Water	712.01

Mortar shall be used within 45 minutes after mixing and shall not be retempered. Class B concrete, conforming to the requirements of Section 601, may be substituted for mortar.

**507.05 Grouted Riprap Slope and Ditch Paving.** Concrete mortar for grouted riprap slope and ditch paving shall meet the requirements of Section 601 with the following exceptions:

Field Compressive Strength (28 days) (Not a specification requirement)	2000 psi
Cement Content	560 lbs./cu. yd.
Air Content	6-9%
Slump, AASHTO Designation T-119	5-9 inches
Fine Aggregate, AASHTO M-6	70%
Coarse Aggregate, AASHTO M-43	30%, 2.36 mm (No. 8)
Polypropylene Fibers (1" fiber length or equivalent)	1.5 lbs./cu. yd.

507.05

Riprap stone shall conform to the quality requirements of subsection 506.02 and the classification and gradation requirements specified in the following table:

**Table 507-1  
CLASSIFICATION AND GRADATION OF ROCK  
FOR GROUTED RIPRAP**

<b>Riprap Designation</b>	<b>Percent Smaller Than Given Size By Weight</b>	<b>Intermediate Rock Dimension, Inch</b>
d50 = 24" (Type HG)	100	30
	50 - 70	24
	0 - 5	18
d50 = 18" (Type MG)	70 - 100	21
	50 - 70	18
	0 - 5	12

**507.06 Bituminous Slope and Ditch Paving.** The mixture used shall conform to the requirements for the bituminous pavement used on the project.

### CONSTRUCTION REQUIREMENTS

**507.07** Paving thickness shall be as specified on the plans. In ditch construction, the excavated areas adjacent to the paving which are not occupied by the paving shall be refilled to the level of original ground with acceptable material and thoroughly tamped.

Excavation for toe or cut-off walls shall be made to the neat lines of the wall. Allowance will not be made for work outside the neat lines.

**507.08 Concrete Slope and Ditch Paving.** Concrete shall be mixed, placed and cured in accordance with Section 601. Reinforcement, when required, shall be in accordance with Section 602.

Unsuitable soil shall be removed and replaced with a suitable soil as designated by the Engineer.

Where the thickness of concrete lined ditch as shown on the plans is less than 4 inches, this concrete slope and ditch paving shall be installed with slip-form machine, except for the following:

- (1) Where it is deemed impossible to construct the ditch lining by the slip-form method, the lining shall be hand formed and the thickness shall be at least 1 inch greater than the thickness shown on the plans.
- (2) The Contractor may use hand method of placement in lieu of the slip-form method, provided the thickness of this hand-placed lining is at least 1 inch greater than the thickness shown on the plans.

Where the thickness of concrete lined ditch as shown on the plans is 4 inches or greater, the Contractor will be permitted to place the material with a slip-form machine or by hand method.

**507.09 Dry Rubble Slope and Ditch Paving.** Stones shall be placed with close joints which shall be broken to minimize straight construction joints. The stones shall be placed to give the appearance of plating the fill slope.

Larger stones shall be placed on the lower courses. Open joints shall be filled with spalls.

Oversize stones and protrusions that present a safety hazard will not be permitted.

**507.10 Grouted Rubble Slope and Ditch Paving.** Stones shall be laid as specified in subsection 507.09, with care to prevent earth and sand filling the joints. Joints shall be filled with grout from bottom to top and the surfaces swept with a stiff broom.

Grouting shall not be done in freezing weather. In hot, dry weather the work shall be protected and kept moist for at least three days after grouting, or clear membrane curing compound may be used.

**507.11 Grouted Riprap Slope and Ditch Paving.** All placement of concrete mortar shall be in conformance with subsection 601.12 with the following exceptions:

- (1) All concrete mortar shall be delivered by means of a low pressure (less than 10 psi) grout pump using a 2 inch diameter nozzle.
- (2) Full depth penetration of the concrete mortar into the riprap shall be required. To achieve this a pencil vibrator shall be used.
- (3) The top 6 inches of the rock layer shall be left exposed.
- (4) After placement, all exposed rocks shall be cleaned with a wet broom.
- (5) All concrete mortar between rocks shall be finished with a broom finish.
- (6) Weep holes constructed of 1½ inch or 2 inch PVC pipe shall be installed when required by the Engineer. The PVC pipe shall be cut flush with the surrounding grout. To alleviate plugging, the PVC pipe shall be pushed into the bedding, or if bedding is not required, under the rock layer. The PVC pipe shall be wrapped in a coarse geotextile fabric filled with 1½ inch rock.
- (7) All concrete mortar shall be sprayed with a clear liquid membrane curing compound as specified in subsection 601.13(b).
- (8) Cold weather curing shall be in accordance with subsection 601.13(d).

**507.12 Bituminous Slope and Ditch Paving.** The bituminous mixture shall be properly shaped to the required cross section and thoroughly compacted.

A fog coat shall be placed on the exposed surfaces of the paving at the rate of approximately 0.1 gallon per square yard. Material for fog coat shall be Emulsified Asphalt (CSS-1) or as designated.

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**METHOD OF MEASUREMENT**

**507.13** Bituminous slope and ditch paving will be measured by the ton and shall include asphalt. Slope and ditch paving of the other various types will be measured by the cubic yard by the method of average end areas based on dimensions shown on the plans or ordered.

When the plans call for concrete lined ditch less than 4 inches thick but the actual thickness placed is greater than the plan thickness, measurement and payment will be made only for the thickness shown on the plans.

**BASIS OF PAYMENT**

**507.14** The accepted quantities will be paid for at the contract unit price for the various items below that appear in the bid schedule.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Concrete Slope and Ditch Paving	Cubic Yard
Concrete Slope and Ditch Paving (Reinforced)	Cubic Yard
Dry Rubble Slope and Ditch Paving	Cubic Yard
Grouted Rubble Slope and Ditch Paving	Cubic Yard
Grouted Riprap Slope and Ditch Paving	Cubic Yard
Bituminous Slope and Ditch Paving (Asphalt)	Ton

Structure excavation will be measured and paid for in accordance with Section 206.

Fog coat and asphalt required for bituminous slope and ditch paving will not be measured and paid for separately but shall be included in the work.

Mortar or concrete used for grout in grouted rubble slope and ditch paving will not be measured and paid for separately but shall be included in the work.

Payment for Grouted Riprap Slope and Ditch Paving will be full compensation for all work and materials required to complete the item.

## **SECTION 508 TIMBER STRUCTURES**

### **DESCRIPTION**

**508.01** This work consists of the construction of timber structures and timber portions of other structures in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

### **MATERIALS**

**508.02** Sawn lumber and timber shall conform to AASHTO M 168. Timber shall be Douglas Fir of the coast region or Southern Yellow Pine. "Native" timber may be used when noted on the plans. "Native" timber shall be Red Cedar, Douglas Fir of the inland region, Lodgepole Pine, Ponderosa Pine, Spruce, as listed and described in AASHTO M 168, or any other native wood specifically approved for the intended purpose. All timber shall be of the grade or shall meet the working stresses shown on the plans. Timber used in non-structural applications, whose working stresses are not shown on the plans, shall be graded to produce a working stress of 1000 pounds per square inch on the extreme fibers when subjected to bending and 800 pounds per square inch when subjected to compression parallel to the grain. Material of equal or greater stress values may be used.

All lumber shall be manufactured in accordance with Product Standard 20-70 as published by the Department of Commerce, and shall be grade-marked by a grading agency or have an accompanying certificate from a grading agency. The grading agency shall be certified by the Board of Review of the American Lumber Standards Committee.

**508.03 Treated Timber.** Preservative treatment shall be by the empty cell method whenever practicable. The preservative to be used shall be as specified on the plans. The preservatives and entire treatment process shall be as described in AASHTO M 133. Treatment with chromated copper arsenate will not be permitted.

**508.04 Inspection.** All timber furnished shall be covered by a certificate of inspection issued by an approved inspection agency. Inspection approval shall be marked on each piece. The destination of the material and the project to which it is being shipped shall be shown on the certificate. The Department reserves the right to re-examine the timber at its destination and to reject any material not conforming to specification requirements.

Shop drawings shall be submitted in accordance with subsection 105.02 for all major structures and for other structures when specified.

The Department may provide an inspector at the treating plant for material quality review and inspection of the treatment process for treated timber. The plant shall notify the Engineer sufficiently in advance of time of treating so that inspection may be arranged.

508.05

**508.05 Hardware.** Hardware shall include all bolts with necessary nuts and washers, timber connectors, drift pins, dowels, nails, screws, spikes, metal pile protectors, steel anchor plates and all other metal fastenings as shown on the plans. Bolts shall conform to the requirements of Section 509. Bolts over 12 inches long shall be threaded at least 4 inches. Drift bolts, spikes, boat spikes and other spikes shall be wrought iron or steel. Washers shall be standard cast iron ogee or malleable cast washers. Timber connectors and common nails shall be of the type and size specified on the plans. All hardware, except timber connectors and common nails, shall be galvanized in accordance with AASHTO M 232 or cadmium plated in accordance with AASHTO M 299.

### CONSTRUCTION REQUIREMENTS

**508.06** Timber for the various portions of the structure shall be treated or untreated as stipulated on the plans.

Treated timbers shall not be sized or trimmed in the field, except when ordered. The Contractor shall not make temporary use of treated timber. All pieces that have been field cut shall be thoroughly brushed or treated with three coats of preservative applied at a temperature of between 180 and 190 °F.

Untreated stringer ends shall be separated at least ½ inch and shall be secured to the timber on which they rest.

Sway bracing shall be securely bolted to piling or post and caps as shown on the plans. Treated filling pieces shall be used in lieu of framing or dapping to bring bracing into a plane. Bulkheads, where required, shall be full size timber. Posts for framed bents shall be of the proper length for their position and provide an even bearing on cap and sill. All untreated caps shall be sized over the piles or posts to a uniform thickness and even bearing on piles or posts. Caps shall be within ¼ inch of nominal depth before treatment and may be surfaced on the vertical grain face.

Before the timber capping is placed, a No. 20 gage galvanized sheet metal cap shall be placed on each pile in accordance with the plans. In lieu of the sheet metal cap, three layers of heavy burlap may be used. Each layer of burlap shall be cut square to a dimension of 12 inches greater than the diameter of the pile head and shall be thoroughly swabbed with hot asphalt. The overhanging ends shall be turned down and secured to the pile with galvanized wire. The entire wrapping shall then be swabbed with a heavy application of hot asphalt.

Longitudinal X-braces shall be properly framed and secured to piles or posts. Truss and bent timbers shall be cut and framed in such manner that they will have even bearing over the entire contact surface of the joint. Blocking or shimming will not be allowed in making joints. Open joints will not be accepted. Stringers shall not be more than ¼ inch off nominal size, before treatment.

Floors shall be constructed as shown on the plans. The plank shall be secured to each stringer with two 7 inch spikes. Half inch cracks between planks shall be left in plain plank floors without surfacing. Laminated floors shall be secured as shown on the plans.

**508.07 Holes and Bolts.** All holes bored shall be thoroughly treated with three coats of preservative applied at a temperature of between 180 and 190 °F. Holes drilled for drift bolts shall be  $\frac{1}{32}$  inch smaller than the diameter of the bolt. All other holes shall be bored to such size as to ensure a snug fit. Unless otherwise designated, all bolts shall be provided with two ogee washers.

**508.08 Painting.** All paint shall conform to the requirements of Section 708. Timber to be painted shall be surfaced on four sides and shall be cleaned immediately preceding painting.

New timber to be painted shall receive one coat of primer. "White Wood Primer" shall be used when the surface is to be finished with "Outside White Paint." For "Exterior Black Paint," the specification paint shall be thinned by adding one part linseed oil and one part turpentine to eight parts paint for use as a primer.

The surfaces of all untreated timber to be painted shall be primed with one coat of primer immediately after the material is delivered to the project. Unless otherwise designated, pieces shall be primed as specified for the finish coat of paint, or "White Wood Primer" shall be used when additional painting is not required. Untreated timber will not require additional priming.

All handrails and handrail posts shall be of untreated timber and shall be painted as described hereafter. Contact surfaces shall receive the primer and one coat of paint before placing handrailing.

Parts specified herein, parts shown on the plans, and all exposed non-galvanized iron and steel shall, after the prime coat, be given two coats of the specified paint, which shall be thoroughly brushed in. Paint shall be applied only to thoroughly dry surfaces. All previous coats shall have thoroughly dried before subsequent coats are to be applied. Portions to be painted above the wheelguards or top wales shall be painted white and those portions below the wheel-guards or top wales to be painted shall be painted black.

**508.09 Structure Number.** The location, letters, figures, and paint used for stenciling shall be in accordance with the plan details.

### **METHOD OF MEASUREMENT**

**508.10** Timber will be measured by the thousand feet board measure [MFBM] actually incorporated in the structure, and shall include hardware unless otherwise designated on the plans.

### **BASIS OF PAYMENT**

**508.11** The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

508.11

<b>Pay Item</b>	<b>Pay Unit</b>
Untreated Timber	MFBM
Treated Timber	MFBM

Structure excavation and structure backfill will be measured and paid for in accordance with Section 206.

Timber piling will be measured and paid for in accordance with Section 502.