



LOWER ARROYO VENADA BANK STABILIZATION PROJECT

BID & CONTRACT DOCUMENTS

VOLUME 2 of 2: PROJECT SPECIFICATIONS

Southern Sandoval County Arroyo Flood Control Authority

IFB # 2022-03

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The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal as a professional engineer licensed to practice in the state of New Mexico, is affixed below:

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TECHNICAL SPECIFICATION 1510

EXCAVATION, BORROW, AND FILL

Revised 09/16/2021

1510.1 GENERAL

- 1510.1.1 Excavation, borrow, and fill shall consist of all earthwork operations involved in grading and construction in accordance with the plans and specifications, except for excavation and backfill for structures; excavation and backfill for trenching; and any other earthwork operations separately designated.

1510.2 REFERENCES

This section incorporates the following publications by reference:

- | | |
|---------------|-----------------------|
| • ASTM D-1557 | This publication: |
| • ASTM D-422 | • NM APWA Section 201 |
| • ASTM D-4318 | • Tech. Spec. 1513 |
| • ASTM D-6938 | • Tech. Spec. 1514 |

1510.3 MATERIAL CLASSIFICATIONS

1510.3.1 UNSUITABLE MATERIAL

Unsuitable materials shall include all material that contains debris, roots, organic matter, stones or boulders too large to be used in the intended construction, or other materials that are determined by the Engineer to be unsuitable. Otherwise suitable materials which are unsuitable due to excess moisture content will not be classified as unsuitable material unless it cannot be dried by manipulation, aeration or blending with other materials satisfactorily as determined by the Engineer.

Material that is unsuitable for the intended use shall be excavated and removed from the site or otherwise disposed of as approved by the Engineer. Unsuitable material shall be disposed in accordance with environmental requirements and as approved by the Project Manager.

The removal and disposal of such unsuitable material will be paid for as excavation, removal and disposal for the quantities involved.

1510.3.2 FILL MATERIAL

All fill material shall be free of vegetation and debris. Clods or hard lumps of earth of 6 inches in greatest dimension shall be broken up. Fill materials shall be free of



vegetation and debris and contain no rocks larger than 3 inches. All fill and backfill material, including selection and blending of material, shall be subject to approval by the Geotechnical Engineer. All fill material shall conform to the requirements for Structural Fill as outlined below.

1510.3.3 STRUCTURAL FILL AND BACKFILL

Structural fill and backfill shall consist of material excavated from on-site or Borrow Material that meets the requirements described in this section. The blended excavated site soils from within the area will be generally suitable for use as structural fill. Blending of soils shall be considered incidental to the Work and no separate payment will be made for this effort. Gradation of the fill material, as determined in accordance with ASTM D-422, shall be as follows:

Sieve Size (Square Openings)	Percent Passing (by Weight)
3 inch	100
No. 4	60-100
No. 200	5-40

All structural fill shall be blended as necessary to produce a homogeneous material. The plasticity index of the structural fill shall be no greater than 15 when tested in accordance with ASTM D-4318.

1510.3.4 BORROW MATERIAL

Borrow material is defined as material obtained from an approved borrow source to be used as structural fill material for construction. If borrow material is required, the Contractor shall identify a borrow site and tests will be performed to verify compliance of the material with structural fill requirements per this specification. The Contractor shall not import any borrow material prior to verification that material meets the requirements contained herein and he has received approval to import the material by the Owner.

1510.3.5 SURPLUS MATERIAL

The Contractor shall make all arrangements for disposal of surplus material in accordance with environmental requirements and as approved by the Project Manager. If the material is disposed of on-site, the Contractor shall place material in locations as designated by the Owner. Do not remove materials from the project limits without the approval of the Owner. The Contractor shall satisfy himself that there is



sufficient material available for the completion all items requiring fill material before disposing of any indicated surplus material inside or outside of the project area. Any shortage of material caused by premature disposal of surplus material by the Contractor shall be replaced by the Contractor and no payment will be made for such replacement.

1510.4 CONSTRUCTION REQUIREMENTS

1510.4.1 GENERAL

Contractor shall perform necessary clearing, grubbing and stripping in accordance with Section 201 of the Specifications and Supplemental Technical Specification 201, "Clearing and Grubbing", prior to any excavation, grading, or other earthwork operations. Excavation, fill construction and backfill shall be finished to reasonably smooth and uniform surfaces.

All slopes and cuts should be made in accordance with CFR 29 Part 1926 Subpart P, and all other applicable regulations.

1510.4.2 EXCAVATION

Excavation shall consist of the removal of earth involved in grading and construction according to the plans, except other excavations separately designated.

Temporary construction excavations shall be made in accordance with CFR 29 Part 1926 Subpart P, and all other applicable regulations. Surface water shall be routed such that it does not flow down the face of the excavation slopes. Where insufficient space exists for open cut excavations, a shoring system will be required. All required shoring systems shall be considered incidental to the cost of excavation and no additional payment will be made for this item. All excavations shall comply with all applicable safety regulations.

1510.4.3 FILL CONSTRUCTION

Fill construction shall consist of constructing embankments, the placing and compacting of approved material within areas where unsuitable material has been removed; and the placing and compacting of suitable materials in holes, pits, and other depressions.

1510.4.4 PLACING AND COMPACTING

Fill or backfill, consisting of soil approved by the Engineer and/or project's Geotechnical Report, should be placed in controlled compacted layers not exceeding 8 inches (compacted) with approved compaction equipment. All fill material should be blended as necessary to produce a homogeneous fill. The fill should be raised uniformly and should be benched into the native soils. All compaction should be



accomplished to a minimum of 95 percent of maximum dry density. No lifts of high permeability material or material differing substantially from the lift below shall be permitted.

At locations where it would be impractical to use mobile power compacting equipment, fill layers shall be compacted to the specified requirements by any approved method that will obtain the specified compaction.

1510.5 TESTING

- 1510.5.1 Tests for degree of compaction should be determined in accordance with ASTM D-1556 or ASTM D-6938.

Continuous, full time observation and field tests should be conducted during fill and backfill placement by a representative of the Engineer to assist the contractor in evaluating the required degree of compaction. If less than the required compaction is required, additional compaction effort should be made with adjustment of the moisture content as necessary until 95 percent compaction is obtained.

1510.6 MEASUREMENT AND PAYMENT

1510.6.1 EXCAVATION

Payment will be made on the unit price per cubic yard for unclassified excavation as provided in the Unit Price Bid Proposal. Payment will include the cost for all excavation, removal, storage and disposal of unsuitable material, hauling of surplus material to the designated location(s), and hauling of select material within the construction site. No payment will be made for excavation of stockpiled materials, structural excavation of previously placed materials and over depth cuts. No payment will be made for shrink or swell. Excavation beyond the authorized cross section will not be included in measurement or payment.

1510.6.2 BORROW

Borrow material will be measured by the cubic yard in-place after compaction. Field topographic surveys, as described in SSCAFCA Technical Specification 1513 or 1514 "Construction Staking", will be used to determine in-place quantities.

Payment will be made on the unit price per cubic yard for Borrow. Payment will include excavation & haul from Borrow Area, moisture conditioning, required blending of soils, placement, compaction, and other related work.

END OF SECTION



TECHNICAL SPECIFICATION 1511

NPDES COMPLIANCE

Revised 08/21/2020

1512.1 SCOPE OF WORK

The work under this section includes compliance with the U.S. Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES) Regulations for Storm Water Discharges from construction sites. This work consists of implementing and maintaining a plan to control erosion, pollution, sediment and runoff during the construction of the project.

1512.2 MEASUREMENT AND PAYMENT

1511.2.1 UNIT PRICE BID PROPOSALS

For Unit Price Bid Proposals, NPDES Compliance shall be a Lump Sum (LS) item, paid for as follows:

1511.2.1.1 Fifteen (15) percent of the Lump Sum unit price amount shall be paid after the Contractor has completed an EPA Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity Under a NPDES General Permit, Form 3510-9, or a Low Erosivity Waiver (LEW) form, if applicable. A copy of the NOI or LEW form must be delivered to the Owner and the original filed with the EPA. All required erosion control measures sufficient to begin construction must also be in place. This will be defined in the plan specifications and/or the SWPPP.

1511.2.1.2 Payment for an additional sixty percent (60%) of the Lump Sum unit price amount shall be prorated based on the Actual Percent Complete on the Application for Payment as approved by the Architect, Engineer or Landscape Architect. For example, if the Contractor is 20% complete, the contractor can take the 20% (0.2) and multiply it by 60% (0.6) of the Lump Sum unit price amount and receive that portion.

In order to receive payments, the field inspection forms must be sent in with the Application for Payment each month. If there are deficiencies maintaining or implementing the SWPPP and its Best Management Practices (BMPs), the payment will be withheld until the deficiencies are corrected.



1511.2.1.3 The remaining twenty-five (25) percent of the Lump Sum unit price amount will be based on the completion of an EPA Notice of Termination (NOT) of Coverage Under a NPDES General Permit for Storm Water Discharges Associated with Construction Activity and BMP removal. A copy of the NOT must be delivered to the Owner and the original filed with the EPA. BMPs must be removed as defined in the plan specifications or SWPPP. This is done in case there are some BMPs that must remain until final stabilization is met, and that there are no more NPDES concerns for the Contractor.

END OF SECTION



TECHNICAL SPECIFICATION 1512

CONTROL OF STORM WATER AND NUISANCE FLOW

Revised 07/24/2020

1512.1 DESCRIPTION

This work covers the control of storm and nuisance flow water in the vicinity of this project.

1512.2 CONSTRUCTION REQUIREMENTS

All permanent work shall be performed in areas free from water. The CONTRACTOR shall construct and maintain all dikes and drainage ditches necessary for the elimination of water from work areas and shall furnish, install, maintain, and operate all necessary pumping and other dewatering equipment required for dewatering the various work areas. Two (2) types of flow can be expected;

- 1) Continuous or intermittent flow through the main arroyo;
- 2) Local sheet flow from adjacent properties or adjacent streets.

The CONTRACTOR is responsible for adequacy of the scheme or plans, or for furnishing all equipment, labor and materials necessary for dewatering the work areas and breaking up and removing such ice or snow as may have formed or settled in the work area. The CONTRACTOR shall be fully responsible for all dewatering operations, and the cost of all dewatering operations shall be included in the lump sum price for this work. The CONTRACTOR shall also be responsible for removal of any sediment deposited by storm and nuisance water, and the cost of sediment removal work shall be included in the lump sum price for this work.

In the event that storm flow, snowmelt or other water flows overtop the Contractor's diversion method, the Contractor will be responsible for any and all damage, including damage to the existing channel and any damage to new work and is responsible for immediate resolution and repair in a manner acceptable to SSACFCA.

Diversion methods may be by use of sandbag diversion channels, sandbag dams, pumping or piping around or over the work areas, or any method or combination.

1512.3 BASIS OF PAYMENT

The bid item for this effort will be on a Lump Sum (LS) basis. Providing and maintaining the diversion and care of water, regardless of the amount of water actually handled, shall be paid for as follows:



Payment will be made as a percentage of the dollar amount of work completed to date minus the Mobilization bid item.

Pay Item

Control of Storm Water and Nuisance Flow

Pay Unit

LS

END OF SECTION



TECHNICAL SPECIFICATION 1513

CONSTRUCTION STAKING

Revised 09/16/2021

1513.1 DESCRIPTION

This work consists of construction staking lines, grades, and layouts by the Contractor in accordance with the plans and specifications and as directed by the Engineer for the control and completion of the project.

1513.2 MATERIALS

The Contractor shall furnish all stakes, templates, straightedges, surveying equipment and other devices necessary for establishing, checking, marking, and maintaining points, including P.I.'s, P.C.'s, P.T.'s, and lines, grades and layouts. As directed by the Engineer, points shall be referenced so that they may later be re-established.

1513.3 CONSTRUCTION REQUIREMENTS

The Contractor shall be responsible for all control, slope stakes, cut stakes, offset stakes, benchmarks, blue tops or other staking necessary for proper execution of the work, or as requested by the Project Manager, to assure compliance with the plans.

1513.4 CONSTRUCTION SURVEYS

The contractor shall obtain and pay for the services of a Professional Surveyor licensed in the State of New Mexico to perform surveys consisting of the following phases:

Phase 1: A topographic survey, with a contour resolution of 1-ft or greater, to determine the Project Site (including Borrow Area, if applicable) existing ground elevations prior to construction, after clearing and grubbing and after removal of trash and debris. Data collected shall be of sufficient detail, including all breaks in the terrain, to be able to create an original ground digital terrain model (DTM). The Project Site & Borrow Area (if applicable) "original ground" DTM shall be submitted to the Engineer for review and acceptance prior to proceeding with excavation and export of material. Survey data must be sufficient to determine future earthwork quantities.

Phase 2: A topographic survey, with a contour resolution of 1-ft or greater, to determine the Borrow Area (if applicable) finished ground elevations post-construction, after all required



borrow material is removed. Data collected shall be of sufficient detail, including all breaks in the terrain, to be able to create a finished ground digital terrain model (DTM). The Borrow Area “finished ground” DTM shall be submitted to the Engineer for review and acceptance prior to payment for “Borrow” Bid Item. Survey data must be sufficient to determine earthwork quantities.

Phase 3: A topographic survey, with a contour resolution of 1-ft or greater, will be completed for the project site (excluding borrow area) after construction to demonstrate compliance with the design grades, structure elevations, inverts, alignments/profiles, etc. shown on the plan set. Phase 3 Survey will also include the update and completion of as-built survey for the project. It is the responsibility of the contractor to coordinate with the surveyor on a regular basis to provide as-built information to incorporate in the survey.

All surveys must be certified by the Professional Surveyor and include complete documentation. Borrow Area surveys (Phases 1 and 2) must be used by the Professional Surveyor to compute the quantity of excavation, subject to the provisions for measurement in [Technical Specification 1510](#). Volume shall be determined based on the “average end area” computation. All computations of excavation must be submitted to the Engineer in sufficient detail. This submittal shall be such that methods and computations can be fully verified and are subject to approval by the Engineer. The Contractor shall also submit the electronic survey point files, including break lines, in a format compatible with AutoCAD Civil3D such that the Engineer can use the data for verification of cut/fill quantities.

At the end of the Project, the Engineer will transcribe the as-built information provided by the Contractor onto the Record Drawing. The Contractor’s Professional Surveyor will be required to stamp, sign and certify the information shown on the as-built drawings.

1513.5 METHOD OF MEASUREMENT

Submit a construction-staking schedule of values as part of each Pay Application to the Project Manager for approval.

1513.6 BASIS OF PAYMENT

<u>Pay Item</u>	<u>Pay Unit</u>
Construction Staking	Lump Sum

1513.7 SSCAFCA will make partial payments in accordance with the approved construction-staking schedule of values.

END OF SECTION



TECHNICAL SPECIFICATION 1515

REMOVAL OF STRUCTURES & OBSTRUCTIONS

Revised 11/16/2021

1515.1 DESCRIPTION

This work shall consist of removing and disposing of surface and subsurface features to clear the project site for construction. This includes concrete debris, fences, structures, pavements, curb and gutter, sidewalks, buried pipes, and any other items listed within the construction plans. All removal and salvage features included in these items will be designated in the contract.

1515.2 MATERIALS

Suitable materials are those materials which can be compacted to the required embankment densities and meet all other contract requirements for embankment materials. If applicable, the project Geotechnical Report would include this information.

1515.3 CONSTRUCTION REQUIREMENTS

1515.3.1 Suitable Materials

Suitable materials are those materials which can be compacted to the required embankment densities and meet all other contract requirements for embankment materials. If applicable, the project Geotechnical Report would include this information.

1515.3.1.1 Marking of Removal Limits

Prior to work on the site, the Contractor shall establish the right-of-way lines and construction limits confining the removal operations and will designate those surface and subsurface features for removal and those for preservation. The Owner or designee shall be offered the opportunity to review the removal limits before work commences.

1515.3.1.2 Temporary Erosion Control

Ensure all erosion control requirements and all necessary temporary sediment and erosion control protection devices (TESCP), if called for in the contract, are installed prior to initiating removal operations on the construction site. The TESCP items will be paid for under the SWPPP pay item.

1515.3.1.3 Protection of Site Features

The Contractor shall preserve and protect all existing improvements, adjacent property, utilities, and surface or subsurface features not to be removed from injury or damage resulting from their operations. This may require the Contractor to install



temporary signing, temporary fencing, or other temporary features at their cost. Should any damage occur to these site features due to the Contractor's operations, the Owner or designee may withhold payment until the damage is remediated or require the damaged items to be replaced at the Contractor's expense.

1515.3.2 Removal and Salvage Operations

Remove all surface features and subsurface features designated for removal in the contract and dispose of them at a properly permitted disposal site. Provide the Owner or designee with a copy of the written permission from the property owner and copies of any other necessary disposal permits or approvals.

Carefully remove and salvage all surface features and subsurface features designated for salvage in the contract and store and deliver these materials in accordance with the contract requirements. The Contractor shall repair any damage to salvageable items that occurs during their removal, storage, or delivery operations at no cost to the Owner.

Backfill holes created by structure or obstruction removals as per SSCAFCA Standard Specification 1510 with suitable materials, unless the area is within the area of new construction.

1515.3.2.1 Removal of Pavements, Sidewalks, Curb and Gutter

Pavements, sidewalks, and curb and gutter shall be removed to neat saw cut lines as identified in the Contract, and dispose of them off the project site.

1515.3.2.2 Removal of Culverts and Drainage Structures

The Contractor shall sequence the removal of existing culverts and drainage structures so drainage is maintained on the project. This may require installation of temporary drainage features at Contractor's sole cost.

1515.3.2.3 Removal of Sanitary Sewer and Water Utilities

The Contractor shall sequence the removal of existing sanitary sewer and water utilities to minimize the impacts to local businesses and residents. The sequencing of removals shall be coordinated with the City Utilities Department or designee prior to performing removal operations in the field.

1515.3.2.4 Removal of Bridges and Arroyo Features

If the Contract includes the removal of a bridge or feature in an arroyo, remove the existing structures down to the arroyo bottom elevation OR an elevation sufficient to allow for proposed grading, proposed over-excavation, or proposed installation of infrastructure, as shown in the Contract documents.

Remove existing structures outside the arroyo to one (1) foot below ground surface, unless otherwise directed in the Contract.



1515.3.2.5 Removal and/or Salvage of Fencing

If the contract includes removal of fencing materials, remove all fence materials, including posts and post foundations and backfill holes with suitable materials.

If the Contract includes salvaging of fencing materials, place barbed wire into single-strand rolls and minimize the damage to fence posts when pulling them.

1515.3.2.6 Hauling and Stockpiling Salvageable Material

If the Contract requires the Contractor to haul and stockpile salvageable material, load, haul, unload, and stockpile the materials in accordance with the Contract.

Place the salvageable material on blocks or other approved materials and maintain the stockpile area, as directed by the Owner or designee.

1515.3.2.7 Site Appearance

The site shall have a neat and finished appearance when removal operations are finished, except for areas where construction activities are planned.

1515.3.2.8 Disposal

Dispose of all removal items outside the project at a permitted location. If applicable, a disposal plan, including written permission from private property owners used for debris material disposal, shall be submitted to the Owner or designee prior to commencement of disposal activities.

1515.3.2.9 Burying

No burying of any removed debris will be allowed on the project site.

1515.3.2.10 Burning

No burning of any removed debris will be allowed on the project site. In addition, no accumulation of combustible materials shall be stored on the project site near property lines or areas where an unexpected fire could cause damage to existing site features.

1515.4 METHOD OF MEASUREMENT

No measurement will be made for lump sum removal of structures and obstructions.

No measurement of the removal of surfacing will be made if the lump sum basis of payment is used.

Removal of surfacing will be made by the Square Yard if Square Yard basis of payment is used.



1515.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Removal of Structures and Obstructions	Lump Sum
Removal of Surfacing	Lump Sum or Square Yard

Removal of Structures and Obstructions payment shall be considered all-inclusive of the costs of the work including: marking the removal limits; installation of temporary features to protect the site; saw- cutting, removing, and salvaging all items as designated in the Contract; filling depressions associated with the work; providing temporary drainage features associated with the removals; obtaining disposal locations and disposing of debris; and, removing, stockpiling, transporting, and unloading salvaged items.

Removal of Surfacing payment shall be considered all-inclusive of the costs of the work including: removing the surfacing to neat lines; filling depressions associated with the work; providing temporary drainage features associated with the removals; obtaining disposal locations and disposing of debris; and, removing, stockpiling, transporting, and unloading items.

Additional payment for minor removals not specified in the Contract shall not be made.

Unknown buried features not identified in the Contract are not included in this item.

Payments shall be made based on percentage of the pay item completed at the date of monthly Pay Application submittal.

END OF SECTION

SECTION 207: SUBGRADE PREPARATION

207.1 DESCRIPTION

This Work consists of compacting and finishing the Subgrade.

207.2 MATERIALS—Reserved

207.3 CONSTRUCTION REQUIREMENTS

Maximum dry density of all soil types encountered or used will be determined in accordance with AASHTO T 180 (Modified Proctor), Method A or D (TTCP Modified).

The Contractor shall ensure the top two (2) feet of borrow Materials in the finished Subgrade is comprised of Material with the design R-value.

The Contractor shall compact the top six (6) inches of the Roadbed to 95% of maximum density.

The Contractor shall ensure the soil moisture content (at the time of compaction) is from optimum to optimum minus five percent (5%). For soils with a PI of 15 or greater, the Contractor shall ensure the moisture content of the soil at the time of compaction is from optimum moisture to optimum moisture plus four percent (4%).

Field density tests shall be performed in accordance with AASHTO T310 or by other Department approved methods and Section 906, "Minimum Testing Requirements."

207.3.1 Tolerances

The Contractor shall ensure the top surface of the finished Subgrade along centerline shall not vary by more than 0.1 foot above or below established grade and 0.05 foot above or below the typical cross-section measured on the finished surface at right angles to the centerline. The Contractor shall correct all deviations from these tolerances.

207.4 METHOD OF MEASUREMENT

The Department will measure Subgrade preparation using the dimensions shown in the Contract and/or approved modifications.

207.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Subgrade Preparation</i>	Square Yard

207.5.1 Work Included in Payment

The Department will consider the item(s) listed in this section as included in the pay items(s) listed in Section 207.5, "Basis of Payment" and will not measure or pay for them separately:

1. No payment will be made for rehandling or reworking Material to meet moisture and density requirements; and
2. Proof rolling for Unstable Subgrade Stabilization shall be considered Incidental to the Contract and will not be measured or paid for separately.

SECTION 303: BASE COURSE

303.1 DESCRIPTION

This Work consists of providing, hauling, and placing Base Course.

303.1.1 Stockpiling

This Work consists of providing, hauling, and stockpiling Base Course at specified locations.

303.1.2 Removing, Processing, and Placing Base Course

This Work consists of removing, hauling, processing, placing existing Base Course Material.

303.2 MATERIALS

303.2.1 General

Base Course consists of one (1) or more of the following:

1. Crushed stone;
2. Crushed or screened gravel;
3. Caliche;
4. Sand;
5. Recycled Asphalt Pavement (RAP) not to exceed 50%; recycled concrete pavement (RC) not to exceed 75%; and the combined RAP and RC not to exceed 75% by weight;
6. Processed glass aggregate.

Base Course shall not contain organic matter or other Deleterious Materials, including silt and clay balls.

The Department will allow a maximum of ten percent (10%) (by weight) processed glass aggregate, uniformly distributed, in composite Base Course. Processed glass aggregate shall meet physical properties and deleterious substance requirements in accordance with AASHTO M 318.

303.2.2 Aggregate Acceptance

The Department will accept Base Course based on random samples taken by the Department from the Roadway. Unless the Contract specifies otherwise, the Contractor shall produce Material in compliance with Table 303.2.2:1, "Type I Base Course Gradation Band or Table 303.2.2:2, "Type II Base Course Gradation Band" as specified in the Contract and Table 303.2.2:3, "Base Course Physical Properties."

**Table 303.2.2:1
Type I Base Course Gradation Band**

Sieve size	% passing
1.0 inch	100
¾ inch	80--100
No. 4	30-60

Table 303.2.2:1
Type I Base Course Gradation Band

Sieve size	% passing
No. 10	20-45
No. 200	3.0-10.0

Table 303.2.2:2
Type II Base Course Gradation Band

Sieve size	% passing
1.0 inch	100
¾ inch	85-95
No. 4	40-70
No. 10	30-55
No. 200	6.0-15.0

Table 303.2.2:3
Base Course Physical Properties

Property	Specification Limit
Fractured Face ^a	Minimum 50% on Untreated Material
AI ^b	Maximum 35
LL	Maximum 25
PI	Maximum 6

^aMaterials retained on or above the No. 4 sieve shall have at least two (2) Fractured Faces when evaluated in accordance with AASHTO T-335, "Determining the Percentage of Fractured Faces in Coarse Aggregate."

^bMaximum AI of 35 for untreated natural aggregate source when calculated in accordance with Section 910, "AGGREGATE INDEX".

303.3 CONSTRUCTION REQUIREMENTS

303.3.1 Subgrade

The Contractor shall place base course on subgrade prepared in accordance with Section 207, "Subgrade Preparation."

303.3.2 Mixing and Placing

The Contractor shall:

- Place maximum six (6) inch (compacted) lifts, unless specified otherwise.
- Not Place Base Course Material on frozen Subgrade.
- Compact Base Course to at least 96% of maximum density as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified).

The Department will use nuclear testing methods to determine in-place densities in accordance with AASHTO T 310 and TTCP procedures for wet density moisture correction.

303.3.3 Surface Tolerance

The surface tolerance shall not exceed ½ inch within ten (10) feet as verified by the Department. All deviations greater than ½ inch shall be corrected by the Contractor and reverified by the Department.

303.3.4 Plan Base Course and Sub-base Depths

The Department will monitor and record Base Course depth during the placement in accordance with the Department's "Minimum Testing Requirements." If the placed thickness deviates from the requirements by more than minus ½ inch, the Contractor shall add Material and reprocess to correct the deficiency.

303.3.5 Stockpiled Base Course

The Contractor shall stockpile base course material at locations shown on the Plans and prevent segregation of Materials at each stockpile. The Contractor shall maintain each stockpile in accordance with the following requirements:

1. Place stockpiles upon prepared sites;
2. Make stockpiles neat and regular to prevent segregation;
3. Provide enough storage space for each size of aggregate;
4. Prevent contamination (store stockpiles away from vehicular and Equipment traffic);
5. Keep the storage site neat and orderly and keep the stockpiles accessible for sampling; and
6. Acceptance by the Department will be at the final stockpile location.

303.3.6 Removing and Processing Existing Base Course

The Contractor shall:

1. Minimize contamination of Base Course Material when removing it from the Roadway for reuse, and;
2. Meet the requirements as indicated in Section 303.3.2 "Mixing and Placing."

303.3.7 Sampling and Testing

The Contractor and Department shall sample and test the Base Course in accordance with Section 906 "Minimum Testing Requirements" for Base Course. Department personnel may test locations other than the random locations generated for statistical analysis. These tests will not be used for pay factor determination, but may be used to determine Acceptance or rejection of localized Material.

303.3.7.1 Contractor Quality Control

The Contractor shall develop and administer a Quality Control plan that ensures the product meets the requirements of Section 902, "Quality Control." The Contractor shall ensure that the Quality Control plan addresses the following elements:

1. Contractor management and process control personnel,
2. Testing Equipment and lab facilities,
3. Aggregate production,
4. Aggregate quality,
5. Stockpile management,

6. Proportioning,
7. Mixing and processing,
8. Transporting,
9. Placing and spreading,
10. Compaction,
11. Line and grade control, and
12. Criteria for the correction or rejection of unsatisfactory Materials.

The Contractor shall:

1. Provide copies of TTCP wallet cards or certifications for personnel who are responsible for sampling and testing the Base Course.
2. Update the list as required if personnel substitutions are made.
3. Use test results, inspections, and other Quality Control practices to assure the quality of each material source and to control processes for crushing, mixing, proportioning, processing, transporting, placing, spreading, and compacting quality.

303.3.8 Acceptance

The Department will accept Base Course Materials based on samples taken in accordance with the Section 906, "Minimum Testing Requirements" after placement but before compaction. Acceptance will be in accordance with Section 303.2.2, "Aggregate Acceptance" and Section 303.3, "Construction Requirements. If necessary, the Contractor shall re-work the Base Course until all requirements are met at no additional expense to the Department.

303.4 METHOD OF MEASUREMENT

When calculating the square yardage the Department will use the average Base Course width and the station-to-station length along the centerline. The dimensions will show on the typical section of the Plans. When calculating the weight of the material, the Department will deduct the weight of moisture that exceeds the optimum moisture content plus two percent (2%). No additional payment shall be made for the stockpile pad.

303.5 BASIS OF PAYMENT

The Department will pay for the accepted quantities of *Base Course* as determined in Section 303.3.8, "Acceptance."

Pay Item	Pay Unit
<i>Base Course</i>	Cubic Yard or Ton
<i>Base Course _____ inch Depth</i>	Square Yard
<i>Remove, Process and Place Base Course</i>	Square Yard or Ton
<i>Stockpiled Base Course</i>	Cubic Yard or Ton

303.5.1 Work Included in Payment

The Department will consider as included in the payment for the pay item(s) listed in this section and will not measure or pay separately for the following Work:

1. Providing, hauling, placing, and compacting Base Course Material;
2. Stockpiling, if required by contract;

3. Quality Control in accordance with Section 902, "Quality Control;" and
4. Remove, process, and place Base Course, if required by contract.

SECTION 509: PORTLAND CEMENT CONCRETE MIX DESIGNS

509.1 DESCRIPTION

This Work consists of developing, submitting and receiving approval to use Portland Cement Concrete (PCC) mix designs for use on Department Projects.

For the purposes of this Section, the following definitions are used:

1. Supplier: Any individual, partnership, company, firm, corporation, or joint venture that owns the Approved Concrete Mix Design, for concrete that is incorporated into a Department construction Project(s).
2. The terms "mix" and "mixture" are used interchangeably.

509.2 MATERIALS

All Materials shall be in accordance with AASHTO and ASTM methods or other test procedures designated by the Department. The State Materials Bureau is the final authority regarding the interpretation of test procedures.

The certifying laboratory or Private Testing Laboratory (PTL) performing the physical and chemical tests for the Supplier is required to participate in the Cement and Concrete Reference Laboratory (CCRL) proficiency sample and the pozzolan inspection programs.

509.2.1 Reserved

509.2.2 Cementitious Materials

Unless otherwise specified, the Supplier shall use; (1) a combination of Type II, III, or V Portland cement and supplemental cementitious Materials (SCM), (2) Blended cement, or (3) a combination of blended cement and SCM. Supplemental cementitious Materials used in blended cements shall not be used as a replacement of portland cement for mix design purposes.

509.2.2.1 Portland and Blended Cements

Portland cement shall comply with ASTM C150. Types II, III, and V portland cement shall have an alkali content less than 0.60% by mass of alkalis as $\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}$ when determined under AASHTO T 105. Types III and V portland cements shall only be used if specified or authorized by the State Concrete Engineer.

Blended cements shall comply with Type IS (S) – portland blast-furnace slag cement, Type IP (MS) – portland-pozzolan cement, or Type IT – Ternary blended cement as specified in ASTM C595, except:

1. Portland cement used in blended cements shall comply with the requirements listed in 509.2.2.1;
2. Class C fly ash shall not be used in blended cements, unless otherwise approved by the State Concrete Engineer;
3. SCM used in blended cements shall meet the requirements of Section 509.2.2.2, "Supplementary Cementitious Materials;"
4. Maximum SCM content shall not exceed 50%; and
5. Blended cement shall be composed of Type II or V portland cement and SCM produced by one of the following methods:

- 5.1. Intergrinding of portland cement clinker and SCM;
- 5.2. Blending of portland cement and SCM; and
- 5.3. Combination of intergrinding and blending of portland cement and SCM.

509.2.2.2 Supplementary Cementitious Materials

Each SCM shall be in accordance with the following standards and as modified in Table 509.2.2.2:1, "Supplementary Cementitious Material Requirements:"

1. Portland cement used in blended cements shall comply with the requirements listed in Section 509.2.2.1, "Portland and Blended Cements;"
2. Class C and F fly ashes shall comply with the requirements of ASTM C618:
 - 2.1. Class C fly ash shall not be used in concrete exposed to sulfate environments or with "potentially reactive," or "reactive" aggregate;
3. Ultrafine fly ash (UFFA) shall comply with ASTM C618, Class F;
4. Natural or calcined natural pozzolans shall comply with ASTM C618, Class N;
5. Metakaolin shall comply with ASTM C618, Class N;
6. Ground granulated blast furnace slag (GGBFS) shall comply with ASTM C989, Grade 100 or 120; and
7. Silica fume shall comply with ASTM C1240.

**Table 509.2.2.2:1
Supplementary Cementitious Material Requirements**

SCM Type	Material Standard	Properties	Limits		
Coal Fly Ash, and Raw or Calcined Natural Pozzolans	ASTM C618	Class	N	F	C
		Sum of Al_2O_3 , SiO_2 , and Fe_2O_4 , min	75%	85%	50%
		Loss on ignition, max	5.0%	3.0%	3.0%
		Magnesium Oxide (MgO), max	5.0%	5.0%	5.0%
		Sulfur Trioxide (SO_3), max	3.0%	3.0%	3.0%
		Available alkalis as $\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}$, max	1.50%	1.50%	1.50%
		Calcium Oxide (CaO), max	As Approved	8.0%	50%

Table 509.2.2.2:1
Supplementary Cementitious Material Requirements

SCM Type	Material Standard	Properties	Limits
Ultra Fine Fly Ash in addition to the requirements for Class F fly ash	AASHTO M 321	Accelerated Pozzolonic Activity Index,	
		<ul style="list-style-type: none"> 7 day 28 day 	85% 100%
		Particle size distribution	
		<ul style="list-style-type: none"> less than 2.25 μm less than 8.50 μm 	50% 90%
		Fineness, retained on 45 μm wet sieve, max	5.0%
		Moisture content, max	1.0%
Metakaolin	ASTM C618	Silicon dioxide (SiO_2) + aluminum oxide (Al_2O_3), min	92%
		Calcium oxide (CaO), max	1.0%
		Sulfur trioxide (SO_3) max	1.0%
		Loss on ignition, max	1.2%
		Available alkalis as $\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}$, max)	1.5%
		Accelerated Pozzolonic Activity	

**Table 509.2.2.2:1
Supplementary Cementitious Material Requirements**

SCM Type	Material Standard	Properties	Limits
		Index, <ul style="list-style-type: none"> • 7 day • 28 day Fineness, retained on 45 μ m wet sieve, max	85% 95% 5.0%
Silica Fume	ASTM 1240	Reduction in mortar bar expansion when used with cement in the proposed mix design, min	80%

509.2.2.3 Cementitious Materials Source Approval and Acceptance

The Department will approve individual cementitious Materials based upon compliance with the respective ASTM or AASHTO Standard Specifications and the requirements listed in this Section. The following information shall be included with each cementitious Material approval request submittal:

1. Supplier name and address;
2. Manufacturer name and address;
3. Production facility physical address;
4. Material type;
5. Material source/origin;
6. Raw Material source(s);
7. Production procedures;
8. Description of storage facilities;
9. Quality Control program documentation including the following:
 - 9.1. Certifying Laboratory's accreditation and current participation in the ASTM Cement and Concrete Reference Laboratory Program (CCRL);
 - 9.2. Routine sampling and testing frequency; and
 - 9.3. QC program test reports (mill certs) for each lot tested from the previous six (6) months shall be provided upon request from the Department;
10. Cementitious Materials shall be tested and certified for conformance with the respective Material Specifications below:
 - 10.1. Portland cements: ASTM C150 – Standard Specification for Portland Cement; and

- 10.2. Blended cements: ASTM C595 – Standard Specification for Blended Hydraulic Cements;
 - 10.2.1. Portland cements used in manufacturing blended cements: ASTM C150 – Standard Specification for Portland Cement; and
 - 10.2.2. SCM used in manufacturing blended cements: ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; and
- 11. Supplementary Cementitious Materials shall be tested and certified monthly for conformance with the respective Material Specifications listed below:
 - 11.1. Pozzolans: ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete;
 - 11.2. Metakaolins: ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete;
 - 11.3. GGBFS: ASTM C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars; and
 - 11.4. Silica fume: ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.

509.2.2.4 Withdrawal of Source Approval

The State Materials Bureau may withdraw cementitious Material source approval for any of the following reasons:

- 1. A change in Material source or production procedure from that on the original request for approval;
- 2. Failure to comply with Specification requirements;
- 3. The source becomes inactive for a period of three (3) months; or
- 4. The appropriate cementitious Material mill certificates are not received monthly.

509.2.2.5 Packaging

Cementitious Materials shall be packaged with the name brand, the source manufacturing facility, Material type, date of production and lot number. The Supplier shall provide the same information, as well as quantities, on the shipping documents for bulk cementitious Materials deliveries.

509.2.2.6 Storage

Different brands of SCM or cements from different production facilities shall be stored in separate, identifiable storage units provided at the production facilities. Each cementitious Material shall be stored separately.

509.2.3 Aggregates

509.2.3.1 Aggregates Testing

Coarse and fine aggregate shall be tested in accordance with the methods shown in Table 509.2.3.1:1, "Aggregates Test Methods." Concrete mix design approval involving a designated source will remain in effect as long as annual test results for specific gravity, absorption, gradation, and sand equivalent (for fine aggregate only) and annual tests for other requirements (except ASR) demonstrate Material compliance.

**Table 509.2.3.1:1
Aggregates Test Methods**

Method	Aggregate test	Coarse	
		Aggregates	Fine Aggregates
AASHTO T 2	Sampling	Note ^A	Note ^A
AASHTO T 112	Clay lumps, max	2.5%	3.0%
	Soft fragments, max	2.0%	2.0%
	Coal & lignite, max	0.25%	1.0%
AASHTO T 27	Sieve analysis	Note ^B	Note ^{C, D}
AASHTO T 11	Passing No. 200, max	2.0% ^E	3.0% ^E
AASHTO M 6	Fineness modulus	NA	2.3 to 3.1 ^F
AASHTO T 85	Coarse aggregate absorption & specific gravity	Report	NA
AASHTO T 84	Absorption & Specific Gravity of Fine Aggregate	NA	Report
AASHTO T 104	Magnesium sulfate soundness, max	15%	12%
ASTM C131	L.A. Abrasion	40%	NA
ASTM D3744	Aggregate Index, min	25	NA
ASTM D4791 TTCP Modified	Flat and elongated pieces, max	15% ^G	NA
ASTM D5821	Fractured faces, min	Report	NA
AASHTO T 176	Sand equivalent, min	NA	75
ASTM C295	Petrographic analysis	Report	Report
AASHTO T303 or ASTM C1293	Alkali-Silica Reactivity	Report	Report

Notes:

1. Coarse and fine aggregates shall be sampled in accordance with AASTO T 2.
2. See Table 509.2.3.2.3:1 – Coarse Aggregate Gradation Requirements.
3. See Table 509.2.3.3.3:1 – Fine Aggregate Gradation Requirements.
4. The Department will not approve fine aggregate that has more than 45% passing any sieve and retained on the next finer sieve.
5. The Department may Accept coarse and fine aggregates with more than the maximum percent passing the No. 200 sieve if the combined gradation of the coarse and fine aggregate percent passing the No. 200 sieve does not exceed three percent (3.0%).
6. Ensure that Material larger than 3/8 inch contains no more than 15% flat or elongated particles with a 3:1 or greater dimensional ratio in accordance with TTCP. Add the percentage of flat pieces to the percentage of elongated pieces to determine specification compliance. Count pieces that are both flat and elongated only once.

509.2.3.2 Coarse Aggregate

Coarse aggregate shall consist of clean crushed stone, crushed gravel, or natural washed gravel free of trash, debris, organics, and other Deleterious Materials.

509.2.3.2.1 Coarse Aggregate Gradation Requirements

When using the combined gradation procedure in Section 509.2.7.5.1, "Combined Gradation;" coarse aggregate gradation requirements are not required with the exception of tolerance for Material passing the No. 200 sieve found in Table 509.2.3.2.1:1, "Coarse Aggregate Gradation Requirements." Coarse aggregate gradations shall be in accordance with Table 509.2.3.2.1:1, "Coarse Aggregate Gradation Requirements."

Table 509.2.3.2.1:1
Coarse Aggregate Gradation Requirements

Sieve size	% of aggregate passing sieve			
	1.5 in	1.0 in	3/4 in ^A	1/2 in
2.0 inch	100	—	—	—
1.5 inch	95–100	100	—	—
1.0 inch	—	95–100	100	—
3/4 inch	35–70	—	90–100	100
1/2 inch	—	25–60	—	90–100
3/8 inch	10–30	—	20–55	40–70
No. 4	0–5	0–10	0–10	0–15
No. 8	—	0–5	0–5	0–5
No. 200	0.0–2.0	0.0–2.0	0.0–2.0	0.0–2.0

A. Required for Class G gradation.

509.2.3.3 Fine Aggregate

Fine aggregate shall consist of clean and well-graded natural sand, manufactured sand, or combination of both, and free of trash, debris, organics, and other Deleterious Materials.

509.2.3.3.1 Fine Aggregate

When using the combined gradation procedure detailed in Section 509.2.7.5.1, "Combined Gradation;" fine aggregate gradation requirements are not required except for the amount of Material passing the No. 200 sieve which shall be within the tolerance listed within Table 509.2.3.3.1:1, "Fine Aggregate Gradation Requirements."

Fine aggregate shall meet the gradation requirements listed in Table 509.2.3.3.1:1, "Fine Aggregate Gradation Requirements." The gradation requirements represent the limits that the Department will use to determine source Acceptability.

The Supplier shall use a fineness modulus, calculated in accordance with AASHTO M 6, to determine the degree of uniformity between representative samples. If the combined gradation procedure has not been chosen, the Department may reject fine aggregate from designated sources with variation in fineness modulus greater than 0.20 above or below the fineness modulus shown on the approved concrete mix designs. Variations in excess of these tolerances may be cause for rejection.

Table 509.2.3.3.1:1
Fine Aggregate Gradation Requirements

Sieve size	% Passing
3/8 inch	100
No. 4	90–100
No. 8	70–95
No. 16	45–80
No. 30	25–60
No. 50	5–30
No. 100	0–8
No. 200	0.0–3.0

509.2.3.4 Aggregate Alkali-Silica Reactivity

The Supplier shall perform the initial proof-of-reactivity-potential test using standard GCC Type I-II low alkali cement from the GCC Cement plant located at Tijeras, New Mexico. The Department considers aggregates with mean mortar bar expansions of greater than 0.10% at 14 Days when tested in accordance with AASHTO T 303 or ASTM C1260 potentially reactive and those less than 0.10% as non-reactive. Expansions greater than 0.20% are considered "Reactive." If tested using ASTM C1293, the Department will consider aggregate non-reactive if the average expansion at the end of one (1) year is less than 0.04%. Once the State Materials Bureau approved a particular aggregate source is non-reactive, it will not require the source to reevaluate for five (5) years unless concerns arise from possible aggregate source changes.

509.2.3.4.1 ASR Mitigation Evaluation Criteria

If the results of the initial proof-of-potential-reactivity test show the aggregate to be "potentially reactive" or "reactive," the Contractor shall repeat the test procedure using the actual cement, and, if desired, any of the ASR inhibiting SCM and admixtures listed in Table 509.2.3.4.1:1, "Option 2 Mix Designs - ASR Mitigation Requirements." The Department will consider an admixture effective if the mean mortar bar expansion at 14 Days is less than or equal to 0.10%, when tested in accordance with AASHTO T 303 (modified to include SCM) or ASTM C1567. The Supplier shall retest aggregates classified as "potential reactive" or "reactive" for ASR mitigation each time the comprehensive mix evaluation is performed. The Contractor shall report the minimum amount of Class F fly ash, and the minimum amount of ASR inhibiting admixture required to provide a maximum expansion at 14 Days that is less than 0.10%. The SCM required for mitigation shall be reported as a percentage of the cement weight. For Option 2 mix designs, the Contractor shall use ASR inhibiting SCMs or admixtures in accordance with Table 509.2.3.4:1, "Option 2 Mix Designs - ASR Mitigation Requirements," unless it is determined that larger dosages are required to control the expansion.

Table 509.2.3.4:1
Option 2 Mix Designs - ASR Mitigation Requirements

SCM	Minimum SCM Content^{A, B}
Class F	
Binary Blends	20%
Ternary Blends ^C	12%
Blended cement	20%
GGBFS	20%
Silica fume	10%
Lithium nitrate	0.55 gal/yd ³ of solution for each pound of cement sodium equivalent

Table 509.2.3.4:1
Option 2 Mix Designs - ASR Mitigation Requirements

Notes:

1. By total cementitious content.
 2. Or minimum amount required to mitigate ASR expansion, whichever is greater.
 3. 20% combined SCM content or minimum amount required to mitigate ASR expansion, whichever is greater.
-

509.2.4 Admixtures

Admixtures types and brands are required to be on the Department's APL at the time of mix design submission. Air entraining, and chemical, and lithium nitrate admixtures shall not contain more than 0.1% of soluble and insoluble chlorides. Individual admixtures shall be compatible with each other when multiple admixtures are used in a concrete mixture. Admixtures shall be used in compliance with the manufacturer's written instructions.

509.2.4.1 Air Entraining Admixtures

Air-entraining admixtures shall be provided in accordance with ASTM C260.

509.2.4.2 Chemical Admixtures

Any of the following chemical admixtures types as defined by and meeting the requirements of ASTM C494 may be used to facilitate concrete mix design:

1. Type A – Water Reducing;
2. Type B – Retarding;
3. Type D – Water Reducing and Retarding;
4. Type F – Water Reducing, High Range; or
5. Type G – Water Reducing, High Range, and Retarding.

The following admixtures may be used if approved by the State Concrete Engineer:

1. Type C – Accelerating;
2. Type E – Water Reducing and Accelerating; or
3. Type S – Specific Performance.

Any of the following chemical admixtures types as defined by and meeting the requirements of ASTM C1017 may be used to facilitate concrete mix design:

1. Type I – Plasticizing; or
2. Type 2 – Plasticizing and Retarding.

509.2.4.3 Lithium Nitrate Chemical Admixture

Lithium nitrate shall be in an aqueous solution meeting the following:

1. Lithium nitrate as LiNO_3 shall be 30% by weight;
2. Sulfate as SO_4 shall be less than 0.1% (1,000 PPM); and
3. Alkalis as $\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}$ shall be less than 0.1%.

509.2.4.4 Pigment Admixtures for Integrally Colored Concrete

Pigments shall conform to ASTM C979. Pigments shall be lightfast, alkali-resistant, weather resistant, and formulated to give long lasting color to concrete.

509.2.5 Water

Water shall conform to ASTM C1602. Water shall have a pH between 6.0 and 8.5; sulfate or chloride contents shall not exceed 1,000 ppm, and shall be free of oil, silt, clay, organic matter, or other Deleterious Material.

509.2.6 Fiber Reinforcement

If specified, steel fibers shall conform to ASTM A820, and synthetic fibers conform to ASTM C1116.

509.2.7 Portland Cement Concrete Mix Design

Concrete mixtures shall be designed in a PTL approved by the Department, by a Professional Engineer registered in the State of New Mexico with a minimum of three (3) year of experience in testing, proportioning and designing of concrete and is directly responsible for all test results used for design purposes. The laboratory mix design shall only be developed using the proposed Materials.

Only technicians who are currently certified by TTCP - Concrete or ACI Concrete Field Technician, Level I shall determine concrete fresh properties in accordance with the appropriate AASHTO procedures. Laboratories approved by the Department's State Materials Bureau shall determine hardened properties. Technicians performing tests on aggregates and aggregate gradations shall be certified by TTCP or ACI Concrete Laboratory Level I. Those technicians performing strength tests on hardened concrete must be certified as an ACI Level I Laboratory Technician or by TTCP for Compressive Strength Testing of Concrete.

509.2.7.1 Concrete Classifications

The concrete classes listed below shall be used when specified in the Contract:

1. Class A: Structural, cast-in-place sidewalks, curb/gutter, concrete wall barrier, Bridge Substructures;
2. Class AA: Structural, used for cast-in-place structural, Bridge Superstructure, approach slabs, abutments;
3. Class HPD: Structural, used for Bridge decks, concrete paving, concrete paving repair. Additional requirements: combined gradation protocol, shrinkage ASTM C157 less than 0.04% at 28 days;
4. Class F: Slip formed concrete wall barrier, curb/gutter; compressive strength measured at 14 days;
5. Class G: Below grade applications, caissons, drilled piers (part of Bridge Substructure);
6. Class HES (formerly rapid set): High early strength concrete used for rapid repair applications. Early compressive strengths will be determined on a per Project basis. Cement content will be determined by lab trials. Allowable cements: Type II, III and rapid strength cements;
7. Class P (formerly class F-LS): Concrete paving. Mix design shall include compressive strengths in addition to flexural beams in order to develop a correlation curve. Other additional requirements: combined gradation protocol, shrinkage

ASTM C157 less than 0.04% at 28 days; and

8. Special: The Contract Requirements for the individual Project will address mix design and testing requirements.

509.2.7.2 Concrete Class Requirements

Option 1 or Option 2 may be used for mix design development of the Concrete Classes listed in Table 509.2.7.2:1, "Option 1: Concrete Requirements." Mix designs developed using Option 1 shall be approved by the State Concrete Engineer for estimated Project quantities less than those provided in the table below. The Department may consider requests to increase the maximum estimated quantity on a Project specific basis. Mix designs developed using Option 1 do not require ASTM C666 testing, and ASTM C457 hardened air void characteristics.

For Projects with anticipated concrete quantities of 150 CY or less of an individual concrete class, a written request may be submitted to the State Concrete Engineer to issue the a mix design under Section 509.2.7.6.12, "Mixture Design Submittals," bullet 13.3, "Incidental Concrete."

Table 509.2.7.2:1
Option 1: Concrete Requirements

Class	Strength ^A , psi	W:CM Ratio, max	Minimum Cementitious Content, lbs/CY	Maximum Estimated Project, Quantity	Slump ^B , Inches	Air Content ^C , %
A	3,000	0.45	560	1,000 CY	3 - 5"	-
F	3,000 ^D	0.45	575		0.5 - 2"	-
G	3,000	0.44	611		6 - 9"	< 3% ^G
HES	4,000 ^F	0.40	NA	500 CY	Note H	-
P	3,000 ^D and 650 ^E flex	0.35	600	10,000 SY	0.5 - 2"	-
Special	The Contract Requirements for the individual Project will address special mix requirements.					
Notes: <ul style="list-style-type: none">1. Specified strength shall be achieved by 28 days unless otherwise noted.2. As determined by AASHTO T 119.3. Project risk zone requirements apply; see Section 509.2.7.4, "Freeze-Thaw Risk Zones."4. Specified strength shall be achieved by 14 days.5. Specified flexural strength shall be achieved by 28 days.6. Specified strength shall be achieved in 24 hours, and 75% of the specified strength shall be achieved in five (5) hours, unless otherwise stated in the Contract.7. Air entraining admixtures are not allowed.8. Mix design specific for Project specific requirements.						

For Option 1 mix design development, the minimum SCM in concrete shall comply with one of the following:

- Any combination of cement and a minimum of one (1) SCM satisfying Equation 1:

Equation 1:

$$\frac{(25 \times UF) + (12 \times FA) + (6 \times SL)}{MC} \geq X$$

Where:

- UF = silica fume, metakaolin, or UFFA, including the quantity in blended cement, lb/CY.
 FA = Class N natural pozzolan, or Class F fly ash including quantity in blended cement, lb/CY.
 SL = GGBFS, including the quantity in blended cement, lb/CY.
 MC = minimum cementitious content, lb/CY.
 X = 1.8 innocuous aggregate, 3.0 for reactive or potentially reactive aggregates.
- Or
- 25 % Class F fly ash by total weight of cementitious Material.

Option 2 mix designs are required for Project quantities in excess of the maximum quantities provided in Table 509.2.7.2:2, "Option 2: Concrete Requirements."

Table 509.2.7.2:2
Option 2: Concrete Requirements

Class	Compressive Strength ^A , psi	Slump ^B , Inches	Air Content ^C , %
A	3,000	4.5" – 5.5"	-
AA	4,000	4.5" – 5.5"	-
F	3,000 ^D	0.5 - 2"	-
HES	4,000 ^F	-	-
HPD	4,000	4.5" – 5.5"	-
P	3,000 ^D and 650 ^E flex	0.5 - 2"	-
G	3,000	6-9"	< 3% ^G
Special	The Contract Requirements for the individual Project will address special mix requirements.		
Notes:			
1. Min specified strength shall be achieved by 28 days unless otherwise noted.			
2. As determined by AASHTO T 119.			
3. Project risk zone requirements apply; see Section 509.2.7.4, "Freeze-Thaw Risk Zones."			
4. Min specified strength shall be achieved by 14 days.			
5. Min specified average flexural strength shall be achieved by 28 days when tested in accordance with AASHTO T 97.			
6. Min specified strength shall be achieved in 24 hours, and 75% of the specified strength shall be achieved in five (5) hours, unless otherwise stated in the Contract.			
7. Air entraining admixtures are not allowed.			

For both Options 1 and 2, Class G concrete shall have the following characteristics:

1. Minimum cementitious content of at least 611 lb;
2. Maximum water/cementitious ratio no greater than 0.44;
3. Combined gradation;
4. Maximum sized aggregate no greater than 0.75 in;
5. Class G mix designs using aggregates with fractured faces shall include a viscosity modifying admixture.
6. Sand/aggregate ratio between 40% and 42% by total aggregate volume;
7. Maximum air content no greater than three percent (3.0%);
8. No air entrainment agent;
9. Slump range of seven (7.0) inches \pm one (1.0) inch, except when placing under a drilling fluid;
10. Slump range of eight (8.0) inches \pm one (1.0) inch for placement under a drilling fluid; and
11. Adjust admixtures for the job site conditions encountered so that the concrete remains workable and plastic for the two (2) h placement limit.

509.2.7.3 Details for Tables 509.2.7.2:1 & 2, "Concrete Classes for Laboratory Design of Concrete Mixtures"

Tables 509.2.7.2:1 & 2, "Concrete Classes for Laboratory Design of Concrete Mixtures" shall be used for designing concrete mixes. Section 510.3.1.4, "Plastic Properties" shall be used to evaluate concrete delivered to Department Projects.

The Contractor shall use the minimum air content shown below in the Laboratory mix:

1. High Risk Zones: 7.0%
2. Medium Risk Zones: 6.5%
3. Low Risk Zones: 6.0%

All new mix designs shall have a minimum over-design compressive strength of 1,200 psi greater than the specified compressive strength. For Class F and Class P the minimum over-design compressive strength shall be 800 psi greater than the specified design strength unless a lower value is calculated using the greater value from either Equation (1) or Equation (2). Class P over-design flexural strength shall be 15% greater than the specified flexural design strength. For Class P, the minimum average flexural strength for three (3) beams cast in the Laboratory shall be 650 psi at 28 Days, when tested in accordance with AASHTO T 97. Option 1 mix designs shall not be adjust based compressive strength statistical analysis.

For Option 2 mix designs, annually the Supplier shall determine the minimum allowable average compressive strength for approved mix designs with 15 or more compressive strength tests, or for similar mix designs mixing from the same facility with the similar air content and compressive strength, and 15 or more compressive strength tests using one (1) of the following equations. The equation that produces the largest value shall be used to determine the minimum allowable compressive strength.

$$f'_{cr} = f'_c + (1.34 \times k \times s) \quad (1)$$

$$f'_{cr} = f'_c + (2.33 \times k \times s) - 500 \quad (2)$$

Where,

- f'_{cr} Minimum Laboratory compressive strength at the specified age.
- f'_c Specified compressive strength.
- k KK-factor from Table 509.2.7.3:1, "k-Factor for Increasing Standard Deviation," for standard deviation increase if the total number of tests is less than 30, but equal to or greater than 15.
- s Standard deviation for the compressive strength tests submitted of the same specified strength.

Table 509.2.7.3:1
k-Factor for Increasing Standard Deviation

Total number of tests	k-Factor
15	1.16
20	1.08
25	1.03
≥30	1.00

The Department will allow linear interpolation for an intermediate number of tests. A mix that was developed from a history of 15 or more test results from the preceding 24 month period is considered an existing mix. A mix developed without historical test results is considered a new mix.

509.2.7.4 Freeze-Thaw Risk Zones

The concrete mixture shall be designed for use in the freeze-thaw zone in which the Project is located. One (1) freeze/thaw cycle is defined as a Day in which the lowest recorded temperature is equal to or less than 25 °F as recorded on the Western Regional Climate Center database. The web address is www.wrcc.dri.edu. The risk levels are defined as follows:

1. **Low-Risk.** The annual average number of freeze/thaw cycles is equal to or less than 30 cycles per year;
2. **Medium-Risk.** The annual average number of freeze/thaw cycles is greater than 30 but less than or equal to 130 cycles per year; and
3. **High-Risk.** The annual average number of freeze/thaw cycles is greater than 130 cycles per year.

Table 509.2.7.4:1, "Statewide Concrete Risk Zones," shall be used to determine the required risk zone.

Table 509.2.7.4:1
Statewide Concrete Risk Zones

District no.	County name	Station name	Concrete risk zone
1	Dona Ana	(County wide)	Low
1	Grant	(County wide)	Low
1	Hidalgo	(County wide)	Low
1	Luna	(County wide)	Low
1	Sierra	(County wide)	Low
1	Socorro	(County wide)	Medium
2	Chaves	(County wide)	Low

**Table 509.2.7.4:1
Statewide Concrete Risk Zones**

District no.	County name	Station name	Concrete risk zone
2	Curry	(County wide)	Medium
2	De Baca	(County wide)	Medium
2	Eddy	(County wide)	Low
2	Lea	(County wide)	Low
2	Lincoln	(County wide) ^a	Medium
2	Lincoln	Ruidoso	High
2	Otero	(County wide)	Medium
2	Roosevelt	(County wide)	Medium
3	Bernalillo	(County wide) ^a	Medium
3	Bernalillo	Sandia Crest	High
3	Sandoval	(County wide)	Medium
3	Valencia	(County wide)	Medium
4	Colfax	(County wide)	High
4	Guadalupe	(County wide)	Medium
4	Harding	(County wide)	Medium
4	Mora	(County wide)	High
4	Quay	(County wide)	Medium
4	San Miguel	(County wide)	Medium
4	Union	(County wide)	Medium
5	Los Alamos	(County wide)	Medium
5	Rio Arriba	(County wide)	High
5	San Juan	(County wide)	Medium
5	Santa Fe	(County wide)	Medium
5	Taos	(County wide)	High
5	Torrance	(County wide)	Medium
6	Catron	(County wide)	High
6	Cibola	(County wide)	High
6	McKinley	(County wide) ^a	High
6	Sandoval	(County wide)	High

^aExcept as otherwise listed

The minimum allowable air content for mix design submittal purposes is:

1. Six percent (6.0%) for low-risk zones;
2. 6.5% for medium-risk zones; and
3. Seven percent (7.0%) for high-risk zones.

The air content shall be confirmed by the pressure method and the volumetric method in accordance with Section 509.2.7.6, "Mix Design Submittal."

509.2.7.5 PCC Mixture Development

509.2.7.5.1 Combined Gradation

The combined gradation procedure is required for Class F, Class P and Class HPD, and is optional for all other concrete mixes. The aggregates shall be evaluated for concrete mixtures prepared for the combined gradation procedures in accordance with the following:

1. **Coarseness Factor.** Determine the Coarseness Factor in accordance with the following equation:

$$CF = \frac{Q}{Q+I} \times 100 \quad (3)$$

Where,

CF Coarseness Factor.

Q Weight of the aggregate retained on or above the 3/8-inch sieve.

I Weight of the aggregate passing the 3/8 inch sieve, but retained on the No. 8 sieve

2. **Workability Factor.** The weight of the aggregate passing the No. 8 sieve divided by the weight of the combined gradation, represented as a percent.
3. **Mortar Factor.** The volume of the cement, SCMSCM, water, air, other pozzolans, and aggregate passing the No. 8 sieve divided by the volume of the entire concrete mixture, represented as a percent.
4. **Paste Factor.** The volume of the cement, fly ash, water, air, and other pozzolans divided by the volume of the entire concrete mixture, represented as a percent.

When using the combined gradation protocol, aggregates shall be proportioned using a 0.45 power curve to achieve a dense and uniform gradation. Coarse and fine aggregate gradation requirements do not apply. The suggested targets for the Coarseness and Workability Factors for concrete mixtures designed using combined gradation are provided in Table 509.2.7.5.1:1, "Recommended Workability Factor and Coarseness Factor Targets."

Table 509.2.7.5.1:1 Recommended Workability Factor and Coarseness Factor Targets		
Nominal Maximum Aggregate Size	Workability Factor	Coarseness Factor
3/4 inch	32 - 36	65 - 75
1/2 inch	40-42	10-20

509.2.7.5.2 Concrete Mix Design Requirements

The concrete mix design shall be proportioned and designed to meet the following requirements:

1. All concrete mix design submittals shall include compressive strengths for the following specified ages:
 - 1.1 3 days;
 - 1.2 7 days;
 - 1.3 14 days; and
 - 1.4 28 days;
2. For concrete classes developed using Option 2, when examined in accordance with

the ASTM C457 linear traverse method, hardened air void system characteristics with the exception of Class G and Class HES, shall meet the following criteria:

- 2.1 A minimum air content of five percent (5.0%);
- 2.2 A specific surface greater than 600 inches⁻¹; and
- 2.3 A spacing factor less than 0.008 inch;
3. Ensure that concrete complies with Section 509.2.3.4, "Alkali-Silica Reactivity," and Section 509.2.3.4.1, "ASR Mitigation Evaluation Criteria," as determined by the State Materials Bureau;
4. For all concrete classes, chloride ion permeability at 28 Days tested in accordance with ASTM C1202 shall meet the following:
 - 4.1 Less than or equal to 3,000 coulombs for Low-Risk Zones;
 - 4.2 Less than 2,500 coulombs for Medium-Risk Zones; or
 - 4.3 Less than 2,000 coulombs for High-Risk Zones;
5. For structural concrete classes developed using Option 2, the durability index shall be determined from at least one (1) prism tested at 28 Days for 300 cycles, in accordance with ASTM C666, Method A. The mix designs shall have a minimum durability index of:
 - 5.1 80 for Low-Risk Zones;
 - 5.2 85 for Medium-Risk Zones; and
 - 5.3 90 for High-Risk Zones;
6. Cure prisms tested for durability index and chloride ion permeability by bathing in lime saturated water at a temperature of 73.3 °F ± 3.0 °F for the first seven (7) Days followed by 21 Days in lime saturated water at a temperature of 100.0 °F ± 3.0 °F; and
7. The maximum shrinkage value for Class P and HPD concrete mixtures is 0.04% at 28 Days when tested with three (3) inch x four (4) inch x 16 inch prism or three (3) inch x three (3) inch x ten (10) inch prism and cured in a standard cure for the first seven (7) Days. Following the seven (7) Day initial cure, cure in a relative humidity of 50% and test in accordance with AASHTO T 160. The results shall be reported in the "comments" field of the mix design submittal form.

509.2.7.6 Mixture Design Submittals

For standard concrete mix designs, complete electronic copy of the NMDOT *Concrete Mix Design Submittal Form* shall be submitted to the Concrete Unit of the State Materials Bureau for review and approval. Special mix designs and mix designs with Project specific shall be submitted to the Project Manager for review and approval by the State Concrete Engineer.

The following information shall be included in the mix design submittal:

1. Mix design Option;
2. Supplier name;
3. Production facility physical address, telephone number and e-mail address;
4. Production facility NRMCA Certification # and expiration date;
5. PTL's name;
6. The New Mexico registration number of the professional Engineer who is responsible for the concrete mixture design Work;
7. A comprehensive Materials list and the properties of each component, including:

- 7.1. Aggregates:
 - 7.1.1. Source names;
 - 7.1.2. Specific source locations;
 - 7.1.3. For new aggregate sources, a complete ASTM C295 "Petrographic Examination of Aggregates for Concrete" and an ASTM C294, *Constituents of Natural Mineral Aggregates* for both the coarse and fine aggregates after completing processing and manufacturing procedures and the aggregate is ready for use shall be submitted. Include the geologic origin of the Material; perform and certify the analysis using a petrographer previously approved by the Department;
 - 7.1.4. AASHTO T 11 - Soundness loss;
 - 7.1.5. AASHTO T 335 - Percent of Fractured Faces for the coarse aggregate;
 - 7.1.6. Gradations, including AASHTO T 11;
 - 7.1.7. AASHTO T 85 - Bulk saturated surface dry specific gravities;
 - 7.1.8. AASHTO T 96 - Los Angeles wear abrasion;
 - 7.1.9. AASHTO M 6 - Fineness modulus;
 - 7.1.10. AASHTO T 84 - Aggregate absorption;
 - 7.1.11. AASHTO T 152 - Aggregate correction factor;
 - 7.1.12. AASHTO T 176 - Sand equivalent of fine aggregate;
 - 7.1.13. AASHTO T 112 - Clay lumps content; and
 - 7.1.14. AASHTO T 21 - Organic impurity content, including soft fragments, coal and lignite, flat or elongated pieces, and other Deleterious substances;
- 7.2. Cement:
 - 7.2.1. Supplier name;
 - 7.2.2. Specific source name; and
 - 7.2.3. Specific cement type;
- 7.3. SCMSCM:
 - 7.3.1. Supplier name;
 - 7.3.2. Specific source name; and
 - 7.3.3. Specific SCM type;
- 7.4. Blended Cement:
 - 7.4.1. Cement supplier name;
 - 7.4.2. Specific cement source name;
 - 7.4.3. Cement type;
 - 7.4.4. SCM supplier name if different than the cement supplier name;
 - 7.4.5. Specific SCM source name;
 - 7.4.6. Specific SCM type; and
 - 7.4.7. Percent SCM;
8. Concrete mixture proportions; state clearly if submitting request under the combined gradation provisions;
9. Water/cementitious ratios;
10. Type and amount of admixtures; use admixtures on the Department's *Approved Products List*;
11. Water source and location; include pH, available alkalis, and a full chemical

- analysis, if the water source is not a certified NMED public potable water supply;
12. Plastic Concrete Properties:
 - 12.1. Air temperature;
 - 12.2. Concrete temperature;
 - 12.3. Slump; when using super-plasticizer, document the slump before and after addition of the super-plasticizer;
 - 12.4. Unit weight;
 - 12.5. Air content measured in accordance with AASHTO T 152 or AASHTO T 121; and
 - 12.6. When using super-plasticizer, document the measured air content before and after adding the super-plasticizer);
 13. Hardened Concrete Properties:
 - 13.1. New Concrete Mixtures:
 - 13.1.1. Compressive strength tests (the average of three (3) cylinders tested at three (3) Days, seven (7) Days, 14 Days and 28 Days);
 - 13.1.2. Type of fracture of each cylinder;
 - 13.1.3. Flexural strength test results for Class P (average of three (3) beams)
 - 13.1.4. Durability index (for structural mixes only);
 - 13.1.5. Hardened air void analysis (for structural mixes only);
 - 13.1.6. Rapid Chloride Permeability (for structural mixes only); and
 - 13.1.7. Expansion data from AASHTO T 303 or ASTM C1260 or C1567;
 - 13.2. Existing Concrete Mixtures:
 - 13.2.1. Resubmit original mix design, updated aggregate properties, and compressive strength statistical data when available in accordance with Section 509.2.7.6, "Mixture Design Submittals;"
 - 13.3. Incidental Concrete Mix Designs (Only for specific Projects) are concrete mixes intended for Projects that anticipate less than 150 CY of each concrete class. Incidental Mix Designs shall be proportioned in accordance with the Section and shall be approved based on the following:
 - 13.3.1. Compressive strength data (field performance data if using the mix within the previous 24 months, or Laboratory mix performance data not using it in the field); and
 - 13.3.2. Air content, as measured by the pressure method or the volumetric method; when using superplasticizer, show the air content before and after adding superplasticizer.

509.2.7.7 Mixture Design Approval

The Department will require 14 Days to review the submittal packages after receipt by the State Materials Bureau of all required information.

The Department will approve Option 1 mix designs for a period of one (1) year from the date of issuance upon verification of compliance with all requirements. Option 1 designs are required to be fully renewed each year prior to use on NMDOT Projects, or may be resubmitted under Option 2 with the additional testing required for Option 2.

The Department will approve Option 2 mix designs for a period of one (1) year from the date of issuance upon verification of compliance with all requirements. A minimum of 30 Days

before the one (1) year approval expires, the Supplier may request that the mix design be reissued. The Supplier shall provide test reports showing that the mix design met specification requirements during the issue period. Option 2 mix designs may be re-approved for no more than four (4) additional years.

At the discretion of the State Concrete Engineer, a mixture can be adjusted without re-batching by using "cement efficiency" calculations to determine the amount of change to the cement and the total cementitious content that is necessary to achieve the desired level of performance. When this procedure is allowed, the ratio of SCM to cement ratio will remain unchanged, the water content will remain unchanged, and the aggregates will be adjusted without changing the overall gradation to accommodate the changes in volume from changes made to the cement. All changes made by this method shall be approved by the State Concrete Engineer before being implemented in the field.

The approved mix design's constituent Materials shall not be changed without the State Concrete Engineer's written approval. The approved mix design's constituent Materials shall not be changed without the State Concrete Engineer's written approval.

509.2.7.8 Suspension and Revocation of Mix Design Approval

Mix design approval may be suspended by the State Concrete Engineer at any time during the approval period for any of the following reasons:

1. Unauthorized changes to the constituent Materials or proportions;
2. Conditions of the Supplier's Equipment or Quality Control adversely affects the strength or other properties of the concrete;
3. Drop in the statistical averages of the concrete below the minimums required for Acceptance in accordance with Section 510.3.5, "Acceptance;" and
4. Test cores indicate the mix is not performing as designed or is not meeting the specified design strength as determined in accordance with Section 510.3.5.4.1, "Testing Cores."

If a mix design approval is suspended or revoked, it shall not be Accepted for use on any Department construction Project.

In the event that a mix design approval is suspended for reasons 1 or 2, all of the Supplier's mix designs approvals may be suspended until such time that is demonstrated that the root cause for the suspension has been corrected.

The State Concrete Engineer will only consider a request to reinstate an approval after the Contractor has submitted and implemented a comprehensive "Corrective Action Plan" to address and correct the reason(s) for the suspension.

If the "Corrective Action Plan" fails to adequately address and correct the reason(s) for the suspension, the approval may be permanently revoked by the State Concrete Engineer. The mix design will then be required to be resubmitted in its entirety as a new mix design with updated comprehensive testing.

509.3 CONSTRUCTION REQUIREMENTS

Concrete or concrete items shall be constructed in accordance with the section of these Standard Specifications for which the concrete is used.

509.4 METHOD OF MEASUREMENT

The Department will measure concrete or concrete items in accordance with the section of these Standard Specifications for which the concrete is used.

509.5 BASIS OF PAYMENT

The Department will pay for concrete or concrete items in accordance with the section of these Standard Specifications for which the concrete is used.

SECTION 511: CONCRETE STRUCTURES

511.1 DESCRIPTION

This Work consists of constructing concrete box Culverts, headwalls, retaining walls, abutments, bents, piers, slabs, girders, and Incidental Structures requiring the use of concrete, except pre-stressed members.

511.2 MATERIALS

When waterproofing is required by the Contract but a type is not specified, either fluid-applied waterproofing or sheet membrane waterproofing shall be used.

511.2.1 Portland Cement Concrete

The Contractor shall use concrete mixes that have been designed in accordance with Section 509, "Portland Cement Concrete Mix Designs" and approved for use on NMDOT Projects by the State Materials Bureau for the freeze/thaw risk zone in which the Project is located. A higher risk zone concrete may be substituted.

511.2.1.1 Concrete Surface Finishing Materials

For Class 2 Surface Finish, the Contractor may use a thin mortar composed of one (1) part cement and four (4) parts sand passing the No. 16 sieve. The cement used in the thin mortar shall be of the same type and source as that used in freshly placed concrete.

Alternatively, the Contractor may use a prepackaged, polymer modified mortar, designed specifically for concrete surface finishing with a minimum 28 day compressive strength of 2,000 psi per ASTM C109.

511.2.2 Steel Reinforcing

The Contractor shall provide steel reinforcement in accordance with Section 540, "Steel Reinforcement."

511.2.3 Bonding Agent

The Contractor shall use a bonding agent that meets the requirements of ASTM C1059, Type II or C-881 Type V.

511.2.4 Form Release Agent

The Contractor may use form release agents at their discretion. Compatibility must be confirmed in a letter from the Manufacturer of subsequent surface treatments including but not limited to penetrating water repellent treatment, stains, and/or paints. If compatibility cannot be confirmed, form release residue shall be removed per the surface preparation recommendations of the manufacturer of the subsequent product.

When integrally colored concrete is used, the Contractor shall use form release agents that are non-staining and minimize surface imperfections of concrete.

511.2.5 Liquid Applied Evaporation Reducers

Unless otherwise specified in the Contract documents, the Contractor may utilize liquid-applied evaporation reducers to reduce the effects of excessive rate of evaporation at the

surface of plastic concrete. Evaporation reducers shall be commercially available water-based compounds that are specifically designed to form a thin monomolecular film to reduce rapid moisture loss from the concrete surface prior to curing. The product shall be certified to have no adverse effects on the cement hydration process or the concrete and that it reduces surface moisture evaporation from the concrete when performing concrete operations in direct sun, wind, high temperatures, and/or low relative humidity.

511.2.6 Curing Materials

511.2.6.1 Liquid Membrane Forming Compounds

The Contractor shall use Type 1-D or Type 2 liquid membrane-forming concrete curing compounds that comply with ASTM C 309.

When integrally colored concrete is used, the Contractor shall use only curing compounds specifically recommended for use with colored concrete and in accordance with ASTM C309 Type 1.

511.2.6.2 Linseed Oil Emulsion

The Contractor shall not use linseed oil emulsion-curing agent.

511.2.6.3 Sheet Materials for Curing Concrete

The Contractor shall use concrete curing sheet Materials in accordance with AASHTO M 171. The Department will only allow the white reflective type.

511.2.7 Joint Materials

The Contractor shall provide joint filler Material in accordance with AASHTO M213 or AASHTO M153 Type I or IV (no cork).

The Contractor shall provide liquid-applied joint sealant in accordance with Section 452, "Sealing and Resealing Concrete Pavement Joints" at non-Bridge joint locations.

511.2.8 Extruded Polystyrene

The Contractor shall provide extruded polystyrene that complies with ASTM C578 Types X or XII (15 psi), Type IV (25 psi), or Type VII (60 psi). If strength is not shown in the contract, the Contractor shall use Type IV (25 psi). Extruded or expanded polystyrene may be used interchangeably.

511.2.9 Tear-Web Waterstop

Waterstop at the joint between abutment cap and abutment diaphragm shall be tear-web waterstop. The Contractor shall provide a product that meets the requirements of Table 511.2.9:1, "Tear-Web Waterstop Requirements."

**TABLE 511.2.9:1
Tear-Web Waterstop Requirements**

Typical Properties	ASTM Method	Minimum Value
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TABLE 511.2.9:1
Tear-Web Waterstop Requirements

Typical Properties	ASTM Method	Minimum Value
Water Absorption	D-570	0.10%
Tear Resistance, lb/in	D-624	225
Specific Gravity, (+/-0.05)	D-792	1.38
Hardness, Shore A (+/-5, 10 sec. delay)	D-2240	80
Tensile, psi	D-638, Type IV	2000
Elongation %	D-638, Type IV	350
Low Temperature Brittleness @ - 35° F	D-746	No Failure
Stiffness in Flexure, psi	D-747	600
Accelerated Extraction, USACE CRD-C572		
Tensile, psi	D-638, Type IV	1600
Elongation, %	D-638, Type IV	300
Effect of Alkali, USACE CRD-C572		
Weight Change, %	-----	+0.25%, -0.10%
Change in Hardness, Shore A	D-2240	+/-5 points

511.2.10 Sheet Membrane Waterproofing

When specified in the Contract documents, the Contractor shall install waterproof membrane Materials. For this application, the Contractor shall provide flexible, sheet membrane waterproofing Material that is a minimum 50 mil thickness. Compatible surface primers, adhesives and flashings shall be used as recommended by the manufacturer's application instruction. The Material shall meet the requirements of Table 511.2.10:1, "Sheet Membrane Waterproofing Requirements."

TABLE 511.2.10:1
Sheet Membrane Waterproofing Requirements

Typical Properties	ASTM Method	Value
Water Vapor Permeance	ASTM E96	0.05 perms max
Elongation	ASTM D412	300% min
Tensile Strength	ASTM D412	300 psi min
Peel Strength	ASTM D903	8 lbs/in min
Puncture Resistance	ASTM E154	45 lbf min

511.2.11 Fluid-Applied Waterproofing

When specified in the Contract documents, the Contractor shall install cold, fluid-applied waterproof membrane Materials on concrete walls prior to backfill. For this application, the Contractor shall provide seamless rubberized asphalt membrane at a minimum thickness of 30 mils. Compatible surface primers, and joint, crack, and corner treatments shall be used as recommended by the manufacturer's application instruction. The Material shall meet the

requirements of Table 511.2.11:1, "Fluid-Applied Waterproofing Requirements."

TABLE 511.2.11:1
Fluid-Applied Waterproofing Requirements

Typical Properties	ASTM Method	Value
Solids by Weight	ASTM D1644	60% min
Elongation	ASTM D412	300% min
Water Vapor Permeance	ASTM E96	0.1 perms max
Hardness	ASTM C661	60 max

511.2.12 Swellable Hydrophilic Waterstop

Swellable hydrophilic waterstop shall meet the requirements of ASTM D-71, ASTM D-6, and ASTM D-217. The following properties will apply:

1. Specific gravity — ASTM D71: 1.35;
2. Hydrocarbon content — ASTM D4: 47%;
3. Volatile matter — ASTM D6: one percent (1%);
4. Penetration cone in accordance with ASTM D217 at 77 degrees F (25 degrees C): 40 mm; and
5. Service temperature range: -30 to 180 degrees F (-34 to 82 degrees C).

511.3 CONSTRUCTION REQUIREMENTS

511.3.1 Concrete Placement

Concrete shall be placed and tested for compliance with the Project Specifications in accordance with Section 510, "Portland Cement Concrete."

511.3.2 Temporary Works and Falsework

511.3.2.1 Temporary Works

The Contractor shall perform temporary Works in accordance with the current edition of the AASHTO Guide Design Specification for Bridge Temporary Works and the AASHTO Construction Handbook for Bridge Temporary Works.

Although the document contains "Guide Design Specifications," the Contractor shall consider them to have the same importance and standing as a code or a Specification. If the content of the collaboration documents appears permissive with words such as "should," "could," "may," etc., the Contractor shall consider the content to be a requirement unless otherwise approved by the State Bridge Engineer.

In the event of a conflict between a referenced code and this Specification, this Specification will take precedence.

511.3.2.2 Falsework and Falsework Foundations

The Contractor shall construct Structure in accordance with Section 511, "Concrete Structures," and Section 512, "Superstructure Concrete", as applicable.

The Contractor shall design, construct, and maintain falsework and falsework foundation to provide the required strength and rigidity, and to support loads without settlement. The Contractor shall have a professional Engineer licensed in the State of New Mexico design the falsework and its foundation. The design of the falsework and foundation will be required if one (1) or more of the following conditions apply:

1. If the height of the Structure is greater than ten (10) ft (excluding concrete Culverts with bottom slabs);
2. Where the supported span is greater than 15 ft; or
3. Where traffic, other than workmen involved in constructing the Structure, will travel under the falsework.

The Contractor shall place the falsework on an adequate foundation. The maximum foundation bearing pressure is 2,000 pounds per square foot unless a Geotechnical investigation indicates a higher value can be used. The Contractor shall provide methods for measuring settlement or movement of falsework and forms under load. If falsework shows settlement greater than 3/8 inch at the vertical supports, the Contractor shall stop the Work and correct the settlement or movement.

If pilings are used for falsework, the Contractor shall pull or cut off falsework pilings. The Contractor shall ensure the cut-off elevations are one (1) ft below the low water level, natural ground, or bottom of proposed channel.

If required, the Contractor shall submit Plans for falsework to the State Bridge Engineer for approval. The Contractor shall submit proposed changes to existing Structures required for maintenance of traffic to the Project Manager for approval. 30 Days shall be allowed for the initial review. 15 additional Days shall be allowed for each resubmittal.

511.3.3 Form Construction

The Contractor shall make forms mortar tight and sufficiently rigid to prevent deformation due to the pressure of the concrete and other loads incidental to the construction operations, including vibration. The Contractor shall construct and maintain forms to prevent the joints from opening. The Contractor shall construct and maintain forms used on surfaces in public view such that the finished concrete surface will be smooth and of uniform color and texture.

The Contractor shall remove loose dirt, laitance, and miscellaneous debris from the bottom of the forms before placing concrete.

The Contractor shall fillet forms and chamfer them 3/4 inch, unless required otherwise in the Contract, and give them a bevel or draft for easy removal of projections such as girders and copings.

511.3.3.1 Form Lumber

The Contractor shall use lumber that is planed on at least one (1) side and the two (2) edges for exposed concrete surfaces. The Contractor shall place the planed face so that it will be the formed surface for the concrete being placed.

511.3.3.2 Metal Ties

The Contractor shall construct metal ties and anchorages within the forms to permit the removal of a portion of the tie connections without damaging the concrete, and provide at least 1/2 inch depth of cover from the concrete surface.

511.3.3.3 Surface Treatment of Forms

The Contractor shall ensure that forms have been properly wetted before placing concrete.

The Contractor shall use form release agents at their discretion before placing reinforcing steel. The Contractor shall not use form release agents that adhere to or discolor the concrete.

511.3.3.4 Metal Forms

The Contractor shall provide metal forms thick enough to prevent bending and maintain their shape. The Contractor shall use countersunk bolts and rivet heads. The Contractor shall use clamps, pins, and other connecting devices designed to hold forms rigidly together and for removal without damaging the concrete. The Contractor shall use metal forms that have a smooth surface and line up properly.

The Contractor may use metal forms that remain part of the Structure in accordance with the Contract or as approved by the State Bridge Engineer. The Contractor shall use permanent steel Bridge deck forms in accordance with Section 512.3.4.1, "Permanent Steel Deck Forms."

511.3.3.5 Reuse of Forms

The Contractor shall continuously maintain the shape, strength, rigidity, water tightness, and surface smoothness of reused forms. The Contractor shall resize warped or bulged lumber before reusing it.

511.3.4 Temperature and Weather Limitations

The Contractor shall keep the concrete mixture temperature between 50 °F to 90 °F at the time of placement.

511.3.4.1 Cold Weather Concrete

The Contractor shall place cold weather concrete in accordance with ACI 306, "*Cold Weather Concreting*."

If air temperatures are likely to fall below 40 °F during the placement or curing periods, the Contractor shall submit a cold weather concreting and curing plan to the Project Manager for approval by the State Concrete Engineer before concrete placement. The Contractor shall allow 14 Days for review. The Contractor shall ensure that the Plan details the methods and Equipment to maintain the required concrete temperatures over the entire concrete pour area.

Information submitted will include, but not be limited to:

1. Whether or not outside heating sources will be used (and how the exhaust will be vented away from the fresh concrete);
2. Whether or not the rate of surface evaporation is expected to exceed the limitations detailed in Section 511.3.4.3, "Rate of Evaporation Limitations" and measures to be taken;
3. What the target mix temperature will be;
4. How the concrete will be protected from the ambient conditions;
5. Curing methods to be used during and following the protection period;

6. How soon after the placement the protection from the ambient conditions will be implemented;
7. Who will be responsible for insuring that the proper protection from the environment is properly implemented;
8. How the actual temperature of the concrete will be monitored;
 - a. How often will this be checked;
 - b. Who will do the checking;
9. What actions will be taken if the temperatures fall below the target points;
10. Who will be responsible for taking the necessary actions; and
11. Who the contact will be if Department Personnel need to transmit notices or information about the cold weather conditions.

Review and Acceptance of the Cold Weather Concreting and Curing Plan shall not relieve the Contractor from its obligation to perform the Work and provide Materials in strict conformance with the Contract.

The Contractor shall not place concrete directly onto any surface that is less than 40 °F unless otherwise approved by the Project Manager. The Contractor shall not place concrete on frozen ground.

If placing concrete at or below air temperatures of 35 °F, the Contractor shall provide suitable enclosures and heating devices. The Contractor shall vent exhaust from combustion type heating devices outside the placing area so that the exhaust fumes cannot come in contact with the freshly placed concrete.

The Contractor shall ensure the concrete surface temperatures never fall below 45 °F during placement and the first three (3) Days after placing. The Contractor shall not let the surface temperature fall below 40 °F during the next four (4) Days after the initial three (3) Day curing period, or until the in-place strength determined by the *Maturity Method*, in accordance with Section 510.3.5.2, "In-Place Concrete Strength Measurements" indicates that 75% of the design strength is achieved.

The Contractor shall monitor the minimum concrete temperatures at various locations including edges and corners of slabs or other Structures, and check immediately before placing insulating Material over the concrete.

If heating the aggregates or water, the Contractor shall use heating methods and Equipment that can heat the Material uniformly. The Contractor shall not heat the Materials to more than 110 °F. During the heating or mixing process, the Contractor shall not add cement to water and aggregate combinations that are hotter than 90 °F.

511.3.4.2 Hot Weather Concrete

The Contractor shall place hot weather concrete in accordance with ACI 305, "*Hot Weather Concreting*."

Hot weather is any combination of the following conditions that tends to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration or otherwise causing detrimental results: high ambient temperature; high concrete temperature; low relative humidity; wind speed; or solar radiation.

The Contractor shall estimate the rate of evaporation at the surface of the concrete per

Section 511.3.4.3, "Rate of Evaporation Limitations." If the rate of evaporation is anticipated to be greater than 0.2 lb per sq ft per hour, the Contractor shall submit a hot weather concreting and curing Plan to the Project Manager for approval by the State Concrete Engineer before concrete placement. The Contractor shall allow 14 Days for review.

The Contractor's Hot Weather Concreting and Curing Plan shall include measures that shall be taken by the Contractor at their expense and maintained to the satisfaction of the Project Manager to reduce the rate of evaporation during initial cure to within the specified rate. The methods can include but not be limited to following:

1. Erect windbreaks to reduce the wind velocity over the concrete surface;
2. Place concrete during nighttime or early morning hours;
3. Use cool aggregate and mixing water to lower the fresh concrete temperature;
4. Increase the relative humidity at the site with a fog spray; and/or
5. Apply a liquid-applied evaporation reducer.

Review and Acceptance of the Hot Weather Concreting and Curing Plan shall not relieve the Contractor from its obligation to perform the Work and provide Materials in strict conformance with the Contract.

511.3.4.3 Rate of Evaporation Limitations

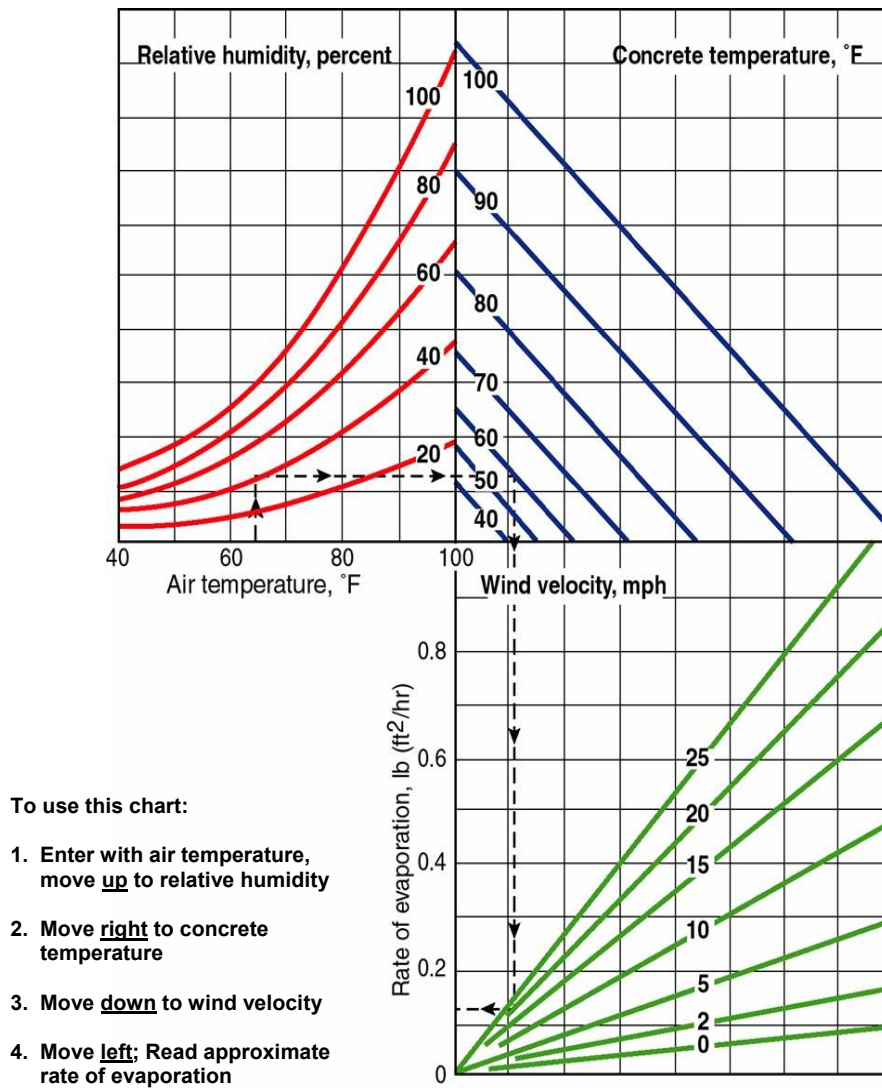
The "Rate of Evaporation Limitations" are detailed in ACI 305 – Hot Weather Concrete. These procedures lessen the potential of plastic-shrinkage cracking in concrete. The "Rate of Evaporation Limitations" apply to Bridge decks, approach slabs, CBC (top and bottom slabs), slipped formed concrete Structures, all PCCP and structural shotcrete. ACI 308 – Guide to Curing Concrete emphasizes that the rate of evaporation limitations can be exceeded in both cold and hot weather and must be addressed in both conditions.

The Contractor shall determine the anticipated rate of evaporation of surface moisture from the concrete by utilizing Figure 511.3.4.3:1, "Surface Evaporation from Concrete." The Contractor shall not place concrete if the anticipated rate of evaporation exceeds 0.20 lb per square foot per hour at the site over any ten (10) minute period, unless measures are taken to prevent excessive moisture loss from the surface of the concrete during initial curing. See Section 511.3.4.2, "Hot Weather Concrete" for Acceptable measures. These measures must be detailed in the Cold Weather Concrete Plan per Section 511.3.4.1, "Cold Weather Concrete" or the Hot Weather Concrete Plan per Section 511.3.4.2, "Hot Weather Concrete."

During the concrete placement, the wind speed, relative humidity and ambient air temperature shall be collected via a computerized weather station that shall be provided and retained by the Contractor. The weather station shall be an automated system that does not require any human support or effort after its initial set-up. The Contractor shall record readings at minimum five (5) minute intervals until the final curing system has been physically applied. Copies of these readings shall be submitted to the Project Manager within 24 hours of the placement. Measurements to determine the Surface Evaporation from the Concrete shall be taken at a height of approximately five (5) feet above the deck for relative humidity and ambient air temperature, and between a height of 20 inches and five (5) feet for wind speed.

For concrete placements that are smaller than ten (10) cubic yards, a handheld anemometer may be used in lieu of a weather station. The handheld anemometer shall be capable of measuring wind speed, humidity and air temperature; and shall be supplied and retained by the Contractor.

Figure 511.3.4.3:1
Surface Evaporation from Concrete (reference ACI 305)



511.3.4.3.1 Wind Break

If a wind break is used, the wind break shall be a minimum height of eight (8) ft - zero (0) inches protecting the Bridge deck, approach slabs, sleeper footings and/or transition slabs (if applicable). All areas of the freshly placed concrete must be protected by the wind break. The nature and type of windbreak to be used shall be approved by the Project Manager prior to placement of any Superstructure concrete.

511.3.4.3.2 Fogging System

If a fogging system is used, a water fog shall be continuously applied over the surface of the freshly placed concrete in such a manner that the entire surface is kept at a relative humidity of 90% or greater and the surface of concrete is kept at an evaporation potential of 0.15 pound/square foot/hour or less, as determined from Figure 511.3.4.3:1, "Surface Evaporation from Concrete." The evaporation potential shall be determined prior to fogging and outside the wind protection, and continuously monitored with evaporation potential measurements taken and recorded at least once every five (5) min throughout the entire placement, and continuing until the concrete curing system has been completely installed. If a wind break and/or fogging are being used, the Contractor shall obtain these readings from the protected area at a height of approximately five (5) feet above the protected concrete.

The area to be fogged shall be the entire area of the freshly placed concrete, which has not had the final finish applied. This fog shall be delivered through a network of nozzles, which are properly spaced to provide a uniform fog at the surface of the concrete. The nozzles used shall be of the type, which atomizes the water so that there are no visually discernible droplets of water. The area of coverage from each nozzle shall overlap all adjacent nozzle coverage by at least one (1) ft. It shall be demonstrated prior to the placement of the concrete that the intended system is capable of delivering the required fogging environment for at least twice the anticipated required time. The Contractor shall not finish or otherwise mix any of the fogging water into the fresh concrete.

The intended system must be properly field tested, and approved by the State Materials Bureau before being used on any Superstructure concrete. Fogging shall continue until the surface is treated with an approved curing method.

511.3.4.3.3 Liquid Applied Evaporation Reducers

If a liquid-applied evaporation reducer is used, it shall be selected from the Departments Approved Products list and must be applied in strict accordance with manufacturer's application instructions.

Liquid applied evaporation reducers are not curing compounds and are not finishing aids. Liquid applied evaporation reducers are to be used to reduce surface evaporation during the initial cure of concrete. Initial cure of concrete typically occurs up to and including bull-floating. Multiple applications of liquid applied evaporation reducer may be required, reference manufacturer's application instructions.

Upon commencing surface finishing (beyond bull-floating), further application of liquid evaporation reducers shall not be allowed (liquid evaporation reducers cannot be used as finishing-aids). The Contractor shall cure concrete after surface finishing in accordance with Section 511.3.9, "Curing."

511.3.5 Concrete Placement

Concrete shall be placed and tested for compliance with the Project Specifications in accordance with Section 510, "Portland Cement Concrete."

The Contractor shall not place concrete until the Project Manager approves the reinforcing steel and forms. The Contractor shall ensure that forms are clean and free of rust, grease, and other Deleterious Material immediately before placing the concrete. The Contractor shall remove wooden form spacers immediately before placing concrete in that area.

The Contractor shall vibrate the concrete during placement to force the coarse aggregate from external surfaces and to bring mortar against the forms to produce a smooth finish significantly free of water, air pockets, and honeycombs.

The Contractor shall place concrete in girders, walls, and other similar Structures in horizontal layers. The Contractor shall ensure that the concrete is not too thick for the vibrator to consolidate and merge it with the previous layer. The Contractor shall not pour concrete layers deeper than two (2) ft.

The Contractor shall not place concrete faster than the rate used for the design of the forms. The Contractor shall adjust the rate for the temperature of the concrete being placed.

511.3.5.1 Chutes and Troughs

The Contractor shall avoid segregation of the Materials and the displacement of the reinforcement when placing the concrete. The Contractor shall use metal or metal-lined open troughs and chutes; the Contractor shall not use aluminum. All tools used for the moving and/or spreading of the concrete shall be square pointed tools. The Contractor shall not use round nose shovels and spreading tools.

Where the Contract requires steep slopes, the Contractor shall equip the chutes with baffle boards or use short lengths that reverse the direction of movement.

The Contractor shall keep chutes, troughs, and pipes clean and free of hardened concrete by thoroughly flushing with water after each pour. The Contractor shall discharge the water used for flushing away from the placed concrete.

The Contractor shall not allow concrete to free fall for more than three (3) ft. For CBC walls and retaining walls that are less than or equal to ten (10) inches thick, maximum free fall heights shall not apply. For CBC walls and retaining walls greater than ten (10) inch thick, concrete may have a free fall of less than nine (9) ft.

The Contractor shall fill each part of the form by placing the concrete as close to the final position as possible. The Contractor shall vibrate the concrete during placement to force the coarse aggregate back from the forms and around the reinforcement without displacing the bars. After the concrete's initial set, the Contractor shall not jar the forms or place strain on the ends of projecting reinforcement.

511.3.5.2 Concrete Pumping

If placing concrete by pumping, the Contractor shall install pumping Equipment so that vibrations resulting from the operation do not damage the concrete being placed. The Contractor shall obtain Project Manager approval before using concrete pumping Equipment.

Before placing the concrete, the Contractor shall clean the Equipment thoroughly. The Contractor shall operate the Equipment so that it pumps a continuous flow of concrete without air pockets and without an appreciable loss of slump or entrained air.

The Contractor shall control the loss of entrained air by one (1) or more of the following methods:

1. Tie the end of the pump hose so that the discharge end is pointing upward, forming a "J" at the end of the hose;
2. Install a series of four (4) consecutive elbows to form a 360° loop;

3. Reduce the diameter of the end of the pump line; or
4. Limit the enclosed angle of the boom arms to an angle of 135° or more.

The Contractor shall make sure that the discharge of the concrete from the pump is as close as possible to the bottom of the structure being placed, but in no case shall it be allowed to drop a distance greater than four (4) feet with the exception of CBC walls where the walls equal to or less than ten (10) inch thick, concrete may have a free fall of less than nine (9) ft.

The Contractor shall not use aluminum pipe. The Contractor shall not add water to the concrete during pumping. If water is added at the pump hopper to clear a clogged pump, the Contractor shall dispose of the concrete in the hopper and the line.

511.3.5.3 Conveyers and Belts

The Contractor may use conveyor belts to transport the concrete from the point of delivery to the point of placement. If using multiple belts, the Contractor shall ensure that the drop from one (1) belt to the next is no greater than 18 inches. At the end of the last belt, the Contractor shall not allow the concrete to free-fall more than four (4) ft. The Contractor shall ensure that the concrete coming off the end of any belt is not being segregated. If segregation occurs, the Contractor shall slow down the speed of the belt until segregation no longer occurs.

511.3.5.4 Placing Concrete Under Water

If placing concrete under water, the Contractor shall submit a mix design and procedure plan to the Project Manager. The Project Manager may require up to 30 Days to approve them. The Contractor shall allow time in the schedule to accommodate this approval process.

511.3.5.5 Vibrating/Consolidation

Unless otherwise directed by the Project Manager, and excluding drilled shafts, the Contractor shall consolidate concrete with suitable mechanical vibrators operating within the concrete. During concrete placement, the Contractor shall keep enough personnel, vibrators, and other tools available to assure adequate consolidation. If necessary, the Contractor shall supplement vibrating with hand spading with suitable tools to assure proper consolidation. If using vibrators, the Contractor shall use procedures in accordance with ACI 309 – Consolidation of Concrete.

The Contractor shall not use a "jitterbug" or any other flat tool that could cause concrete segregation.

The Contractor shall use vibrators that have each been certified within the last 90 Days to provide 8,500 to 12,500 Vpm.

The Contractor shall operate vibrators to consolidate the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. The Contractor shall not use vibrators to make concrete flow or run. The Contractor shall vibrate long enough to accomplish consolidation, but do not vibrate so long to cause segregation or air bubbles. The Contractor shall insert the vibrators vertically into the concrete, and immediately withdraw upward along the same line with the opposite motion. The Contractor shall not drag the vibrator horizontally across the placing area.

When operating vibrators, the Contractor shall avoid contact with reinforcing bars, particularly epoxy coated reinforcing bars or bars that extend into concrete that has taken an

initial set. If vibrating concrete in areas reinforced with epoxy-coated bars, the Contractor shall cover the vibrators with nonmetallic sleeves to prevent damage to the epoxy coating.

511.3.5.6 Sequence of Placement and Application of Load

The Contractor shall not place superimposed loads on or against load carrying members, floor slabs, or retaining walls until the concrete reaches 75% of specified design compressive strength but no less than 2,500 psi, determined in accordance with Section 510.3.5.2, "In-Place Concrete Strength Measurements." Concrete Box Culverts and CBC wingwalls shall not be backfilled until specified design compressive strength has been achieved.

The Contractor shall submit a concrete placement schedule to the Project Manager upon request. The Contractor shall plan and schedule concrete placement to prevent damage to previously placed concrete or to the curing or protection systems of previously placed concrete.

The following applies to concrete placement scheduling:

1. The Contractor may erect reinforcement and formwork for walls, columns, and pier caps 24 h after placement of footings or floor slab concrete. Unless otherwise provided, the Contractor may place concrete columns, walls, and pier caps, 48 h after placement of footing or floor slab concrete;
2. The Contractor shall not set beams or girders, or place Superstructure concrete until Substructure forms have been stripped sufficiently to determine the quality of the concrete;
3. The Contractor shall not place the load of the Superstructure on the Substructure until the Substructure concrete has been in place for at least 14 Days or until in-place strength measured by the Maturity Method indicates that the concrete has attained 75% of the design strength;
4. The Contractor shall ensure that the concrete has achieved sufficient strength as determined by the Maturity Method in accordance with the form design before placing concrete for integral horizontal members, such as pier caps or top slabs;
5. The Contractor shall place the vertical members at least seven (7) Days before mounting friction collars or falsework brackets that will support the weight of horizontal members. The Contractor shall ensure that the vertical members have attained the specified strength before applying loads, unless the Department approves otherwise;
6. The Contractor shall limit monolithic casting of walls and deck slabs of concrete box Culverts to Culverts that are six (6) ft high or less. The Contractor shall construct box Culvert walls higher than six (6) ft in accordance with this subsection; and
7. If the concrete is not gaining strength as expected, the Assistant District Engineer of Construction may extend the waiting periods. The Contractor shall conduct construction operations in a manner that does not damage the previously placed concrete.

511.3.5.7 Supplementary Lighting

The Contractor shall not mix, place, or finish concrete when the natural light is insufficient without using an adequate artificial lighting system, approved by the Project Manager. The Contractor shall test the lighting system at least one (1) Day before placing the concrete to assure that the system will provide sufficient light, without shadows or dark areas for placing, testing and finishing concrete. The Contractor shall ensure that the lights do not create a hazard for traffic on adjacent Roadways or Detours.

511.3.6 Removal of Forms

The Contractor shall not remove the forms until the concrete is strong enough to avoid damage by removing the forms.

If in-place strength tests in accordance with Section 510.3.5.2, "In-Place Concrete Strength Measurements," are not used to control field operations, the Contractor shall remove forms in accordance with Table 511.3.6:1, "Timetable for Removal of Forms," not counting those Days when the temperature is below 40 °F.

Table 511.3.6:1
Timetable for Removal of Forms

Structural component	Minimum time for removal
Bottom of beams	14 Days
Bridge decks ^a	seven (7) Days
Floor slabs	seven (7) Days
CBC Floors	seven (7) Days
CBC Top Slab	seven (7) Days
Walls	24 h
Columns	48 h
Sides of beams	24 h
All other parts	24 h

^aAdditional requirements of Section 512, "Superstructure Concrete," shall apply.

If one (1) of the test methods in Section 510.3.5.2, "In-Place Concrete Strength Measurements," is used to control the field operations, the Contractor may remove forms from the bottom of beams and floor slabs when the concrete reaches 75% of the design compressive strength.

511.3.7 Joints

The Contractor shall make construction joints in concrete Structures in accordance with the Plans, unless otherwise directed or approved by the Project Manager.

If the concrete placement is interrupted and additional construction joints are required, the Contractor shall place the additional joints in planes perpendicular to the principal lines of stress, and at points of minimum shear, as approved by the Project Manager.

511.3.7.1 Keyed Joints

The Contractor shall mechanically bond construction joints with keys formed by beveled strips embedded in the surface of the concrete. The Contractor shall make the keys from 1 3/8 inch to 1 1/2 inch deep. The Contractor shall place the keys centrally within the thickness of the joint. The Contractor shall ensure that the keys have a width that is one-third (1/3) of the depth of the smallest dimension of the joint. The keys do not need to exceed the clear distance between reinforcing mats, or be greater than eight (8) inches. The Contractor shall provide raised keys in accordance with the Plans.

511.3.7.2 Bonding New Concrete to Existing

If bonding new and existing concrete, the Contractor shall retighten the forms before

depositing new concrete on or against the hardened concrete. The Contractor shall roughen the surface of the hardened concrete without loosening the aggregate or damaging the concrete on the surface. The Contractor shall thoroughly clean the surface of foreign matter and laitance.

The Contractor shall utilize a bonding method at the interface between the hardened and fresh concrete. It is Acceptable to utilize an enriched mortar or a bonding agent. When using enriched mortar, the Contractor shall saturate the surface of the concrete and scrub the enriched mortar onto the entire surface with a nylon bristled brush. The Contractor shall place the new concrete before the enriched mortar reaches an initial set. If using a bonding agent, the Contractor shall follow the manufacturer's application instructions. The Contractor shall place the concrete continuously from joint to joint, and finish the face edges of exposed joints in accordance with the Plans.

511.3.7.3 Water Stops and Flashings

The Contractor shall provide and place water stops, and flashings per the Contract documents. The Contractor shall splice or solder water stops and flashings to form continuous watertight joints.

Swellable hydrophilic waterstop shall be installed with two (2) inch minimum concrete cover. Materials shall be installed per manufacturer's installation instructions.

511.3.7.4 Joint Sealing Materials

The Contractor shall install joint sealers in accordance with the manufacturer's recommendations, including surface preparation and the use of primers and backer-rod as required.

511.3.8 Miscellaneous Construction

511.3.8.1 Setting of Bearings

The Contractor shall ensure the surfaces on which metal masonry plates and elastomeric bearing pads will rest are flat and on level planes. If using elastomeric bearing pads, the Contractor shall finish the Bridge seats slightly high and grind to the correct elevation.

If it is necessary to adjust the elevation of a bearing upward, the Contractor shall make the adjustment by placing full size shim plates. If it is necessary to adjust the elevation of a bearing downward, the Contractor shall make the adjustment by diamond grinding to a level plane-bearing surface. The Contractor shall not use grout to level or adjust elevation.

If placing a bearing surface below the level of adjacent concrete, the Contractor shall ensure water drains away from the masonry plate or elastomeric bearing pad.

The Contractor shall finish sections of Bridge seats on abutments or piers on both sides of bearing assemblies to drain, with a slope of from 1/16 inch to 1/8 inch per foot. The Contractor shall correct depressions that retain water.

511.3.8.2 Waterproofing

If required in the Contract, the Contractor shall protect the backsides of abutment backwalls and wingwalls by waterproofing. The Contract shall define the vertical and horizontal limits of the waterproofing. The Material shall be installed in conformance with the manufacturer's application instructions.

511.3.9 Finishing

The Contractor shall perform finishing after removing forms in accordance with the Contract.

511.3.9.1 Exposed Surfaces

The Department considers "exposed surfaces" as surfaces that are not buried in the ground or permanently covered by the fill, or against which the fill is not permanently placed. However, the Department does not consider the inside surfaces of concrete box drainage Culverts and concrete box girders, and the bottom side of concrete Bridge decks as "exposed surfaces."

511.3.9.2 Class 1, Ordinary Surface Finish

The Contractor shall apply a Class 1 finish to exposed surfaces as a final finish or before a Class 2, Rubbed Surface Finish, or a Class 4, Special Surface Finish.

A Class 1 finish includes the removal of rods, bolts, or other form ties to at least 1/2 inch deep from the face of the concrete. The Contractor shall fill tie holes and honeycombs with mortar composed of one (1) part cement and two (2) parts sand; the Contractor shall use the same brand and type of cement as used in the concrete.

The Contractor shall remove objectionable fins, bulges, and projections by rubbing with carborundum bricks or by other methods approved by the Project Manager. If necessary, the Contractor shall clean the entire surface. The Contractor shall keep such surfaces in an Acceptable condition until Final Acceptance of the Work.

The Contractor shall apply a Class 1 finish to surfaces buried in the ground or permanently against the fill, except that form ties may be cut off even with the concrete surface, and fins, minor bulges, projections, stains, and discolorations do not need to be removed.

Unless specified otherwise in the Contract, the Contractor shall apply a Class 1 finish to the front faces of backwalls of abutments, the top surfaces of Bridge seats on piers and abutments, and concrete curtain walls between pier pilings.

The Contractor shall apply a Class 1 finish to the inside surfaces of concrete box drainage Culverts, except as noted in Section 511.3.8.3, "Class 2, Rubbed Surface Finish."

511.3.9.3 Class 2, Rubbed Surface Finish

The Contractor shall apply a Class 2 finish to concrete surfaces generally exposed to public view.

The Contract may specify a Class 4, Special Surface Finish with selected colors, for various components or parts of components. If the Contract specifies a Class 4, Special Surface Finish, the Contractor shall apply a Class 2 finish first, unless otherwise approved by the Project Manager.

A Class 2 finish consists of a Class 1 finish, then thoroughly wetting the surface and applying a mortar.

The Contractor shall apply a thin mortar, in accordance with Section 511.2.1.1, "Concrete

Surface Finishing Materials,” and rub it into holes and pockets in the surface of the concrete. The Contractor shall allow the mortar to remain until it has set sufficiently to prevent removal by subsequent rubbing operations. The Contractor shall rub the surface with a No. 25 to No. 30 carborundum brick, then, rub with burlap to remove excess mortar. If the completed rubbed surface does not look uniform, the Contractor shall make a final finish by wet rubbing with a No. 30 carborundum brick.

The Contractor shall apply Class 2 finish to the following:

1. Outside vertical surfaces of Bridge decks;
2. Outside surfaces of exterior girders, curb and rail posts seen in elevation view;
3. Curb tops, post tops, inside faces of curbs, and faces of hand rails;
4. Exposed surfaces of pier columns and caps;
5. Abutment wingwalls and Bridge seats one (1) ft below final grade;
6. Bridge rehabilitation Projects with existing slope paving;
7. Top surface of slope paving (tops of Bridge seats require only a Class 1 finish);
8. Exposed surfaces of barrier railings on Bridges or concrete box Culverts;
9. Exposed surfaces of miscellaneous concrete Structures extending above Shoulder line grade and inside walls of concrete underpass Structures;
10. Concrete box Culverts used for drainage, on the soffit and streamside faces of headwalls and wingwalls, and for six (6) inches down the back side of wingwalls; and
11. The interiors of sidewalls to one (1) ft back from the face of the Culvert at the tops of the sidewalls, and extending on a 45° line downward and inward.

511.3.9.4 Class 3, Float Finish

The Contractor shall apply a Class 3 finish to upper surfaces not formed, such as tops of walls, headwall, tops of slabs and bottom slabs of box Culverts, copings and Bridge seats, except tops of Bridge decks, Sidewalks, or curbs.

A Class 3 finish consists of placing an excess amount of concrete in the forms and striking off this excess concrete with a template, forcing the coarse aggregate below the surface. After striking off the concrete, the Contractor shall thoroughly work the surface with a wooden, cork, or canvas float without adding water or cement. Before the final finish has set, the Contractor shall use a fine brush to remove surface film and to produce a fine grain, smooth, sanded texture.

511.3.9.5 Class 4, Special Surface Finish

When specified in the Contract documents, the Contractor shall apply a Class 4, Special Surface Finish. The Class 4, Special Surface Finish shall be applied in accordance with Specification Section 548, “Coating of Concrete.”

The Contractor shall apply the Class 4 finish over the Class 2 finish, unless directed otherwise by the Project Manager.

The Contractor shall apply the Class 4 finish consistent with the location requirements of Section 511.3.8.3, “Class 2, Rubbed Surface Finish.” If repairing existing Structures, apply a Class 4 finish to the entire surface of the repaired components.

511.3.10 Curing

The Contractor shall cure all concrete in accordance with ACI 308 – Guide to Curing Concrete. All concrete shall receive a minimum of seven (7) Days of curing treatment. The Contractor shall use curing methods in accordance with Table 511.3.10:1, “Curing of Concrete Structures,” unless the Contract specifies otherwise.

If the Department allows the Contractor to choose the curing method, the Contractor shall obtain the approval of the Project Manager before beginning curing operations.

Table 511.3.10:1
Curing of Concrete Structures

Method designation		Curing method description
Method 1		Water curing
Method 2		Curing compound
Method 3		Form curing
Method 4		Combination of Method 1 and Method 2
Structure description		Curing methods
<u>Top surfaces of:</u>		
Bridge decks ^a		4
Approach slabs		4
Concrete curbs, gutters and	Sidewalks	1 or 2
Pier caps, abutment Bridge seats		1 or 2
Wingwalls and parapet walls		1 or 2
All vertical concrete surfaces that begin in contact with form Materials, including but not limited to:		3
Barrier walls, barrier railing, wingwalls, parapet walls, abutments, box culverts, decks, slabs, curbs, gutters, sidewalks, construction joints		
Elevated horizontal surfaces on the underside of structural elements that begin in contact with temporary form Materials including but not limited to:		3
pier caps, girders, structural slabs		
Slip Formed Concrete elements including but not limited to:		2
Concrete wall barriers, curb, gutter		
All other concrete ^b		1, 2, or 3

^aSee Section 512.3.10.1, “Curing,” for additional curing requirements for Bridge decks.

^bUnless the Contract specifies otherwise.

511.3.10.1 Method 1, Water Curing

The Contractor shall keep the concrete thoroughly and continuously wet and covered for at least seven (7) Days. The Contractor shall place and anchor covers, mats, and sheeting to ensure continuous contact with the concrete surfaces.

The Contractor shall cover concrete slabs as soon as possible with a double layer of clean, wet burlap or cotton mats, or other moisture retaining Material approved by the Project

Manager. The Contractor shall ensure that the moisture retaining Materials lay flat with no wrinkles and that adjacent strips of moisture retaining Materials overlap at least 12 inches. After installation, the Contractor shall soak the moisture retaining Material and add moisture as required to ensure that it is not allowed to become dry for the duration of the specified curing period. The Project Manager will determine the suitability of the moisture retaining Material for reuse, based on the cleanliness and absorptive ability of the Materials.

In addition to the moisture absorptive Material, the Contractor shall install plastic sheeting over the moisture absorptive Material. If the slabs are on grade, the Contractor shall extend the cover Materials at least twice the slab's thickness beyond the edges of the slab, and make sure that the entire exposed surface of the concrete is protected. If the slab is a Bridge deck, the Contractor shall place the cover Materials to fully protect exposed edges and unformed surfaces of the concrete.

The Contractor may temporarily remove the cover from surfaces that require a rubbed finish for finishing, but shall restore the cover as soon as possible.

511.3.10.2 Method 2, Curing Compound

Application of curing compound shall be in accordance with manufacturer's application recommendations.

For slabs, Bridge decks and other flatwork, the Contractor shall apply the curing compound to the fresh concrete as soon after finishing as allowed by the manufacturer.

The Contractor shall thoroughly mix the membrane forming curing compound per the manufacturer's recommendations.

The Contractor shall not apply the curing compound in rainy conditions. The Contractor shall adhere to the thermal limitations as specified by the manufacturer – typically, the product when stored should not be allowed to freeze and should not be applied when the air or concrete temperature is less than 40 degrees Fahrenheit.

The Contractor shall apply the curing compound under pressure with an atomizing-type spray nozzle. The Contractor shall uniformly cover the entire surface area at the rate recommended by the manufacturer or at a rate of at least one (1) gal per 175 ft² whichever rate is greater. The Contractor shall use spray Equipment with enough pressure to force the curing compound to leave the nozzle as a fine mist. If the nozzle becomes plugged, the Contractor shall immediately clear the nozzle before continuing the application. The Contractor shall not continue to spray curing compound through a nozzle that has become plugged or obstructed.

The Contractor shall apply the curing compound by first spraying back and forth in one (1) direction until a uniform covering has been achieved. Then, the Contractor shall spray back and forth in a direction perpendicular to the first application until a second, uniform covering has been achieved. The Contractor shall ensure that the entire curing surface has been uniformly covered with two (2) coatings of curing compound. The Contractor shall not apply the curing compound to exposed reinforcing steel.

The Contractor shall protect all surfaces covered with curing compound for seven (7) Days after application. The Contractor shall provide walkways and mats for workmen, Material, and Equipment.

The Contractor shall not use a curing compound that exhibits separation, segregation, or skimming.

The Contractor shall not apply curing compound to surfaces that will receive a Class 2 or Class 4 finish, unless the Contractor thoroughly cleans the surfaces per the recommendations of the manufacturer of the Class 2 or Class 4 finish product.

511.3.10.3 Method 3, Form Curing

The Contractor shall leave forms in place in accordance with Section 511.3.6, "Removal of Forms." The Contractor shall keep wood forms moist during the curing period and replenish the system with water to maintain a continuously moist condition. The Contractor shall cure exposed surfaces with Methods 1 or 2.

Form removal shall be in accordance with Section 511.3.6, "Removal of Forms." Should forms be removed prior to the specified seven (7) day curing period, the Contractor shall immediately resume curing by Method 2.

For Structures with formed surfaces that require the application of a finish per Section 511.3.8, "Finishing" such as barrier walls, barrier railings on Bridges, wingwalls, or parapets on Bridges or box Culverts, the Contractor shall remove the forms in accordance with Section 511.3.6, "Form Removal," finish the concrete in accordance with Section 511.3.8, "Finishing," and resume curing with Method 2 for the duration of the curing period. The Contractor shall not pause curing for more than two (2) hours.

511.3.10.4 Method 4, Combination of Curing Compound and Water Curing

The Contractor shall apply Method 2 curing compound as soon after finishing as is allowed by the manufacturer.

When the concrete is hard enough that placement loads and burlap or cotton mats can be applied without marring the concrete surface or deformation of structural elements, the Contractor shall apply Method 1 curing directly over the curing compound coated surface.

511.3.10.5 Equipment and Personnel Readiness

The Contractor shall show the Project Manager that curing Material and Equipment (including backup sprayers and mixers) are in working order, at least one (1) Day before concrete placement.

511.3.10.6 Temperature Requirements for Storage and Application

The Contractor shall store curing compounds in protected areas away from weather and extreme temperatures and per the manufacturer's recommendations. The Contractor shall dispose of compounds that have been frozen in storage. The Contractor shall apply curing compounds when the temperature of the compound is between 50 °F and 95 °F.

511.3.10.7 Penetrating Water Repellent Treatment Solution

The Contractor shall saturate the exposed surfaces of the following concrete Structures with a penetrating water repellent treatment in accordance with Section 532, "Penetrating Water Repellent Treatment" for:

1. Bridge wingwalls;
2. Front and side faces of abutment Bridge seats;
3. Front faces of abutments, backwalls and diaphragms;

4. Top surfaces of Bridge seats on piers and abutments;
5. Pier columns, stem walls and vertical surfaces of pier caps;
6. Top and vertical side surfaces of Bridge decks, except in the areas where using epoxy Bridge deck overlays;
7. Top surfaces of concrete approach slabs;
8. Concrete barrier railings;
9. Concrete wall barriers; and
10. Sidewalks, curbs and gutters on Structures.

The Contractor shall extend treatment to at least one (1) ft below the final groundline.

The Contractor shall not treat the underside of pier caps, or side and end surfaces of concrete approach slabs.

511.4 METHOD OF MEASUREMENT

The Department will measure all pay items using the dimensions shown in the Contract or approved modifications.

511.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Structural Concrete, Class _____</i>	Cubic Yard
<i>Structural Concrete, Class _____, _____ inch</i>	Square Yard
<i>Substructure Concrete, Class _____</i>	Cubic Yard

511.5.1 Work Included in Payment

The following Work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

1. Waterstops and flashings;
2. Waterproofing;
3. Premolded and preformed joint fillers;
4. Concrete required to fill overbreakage in excavation when footings or walls are cast against vertical or horizontal faces of excavation;
5. Installation of drains and weep holes;
6. Extruded polystyrene; and
7. Means and methods associated with placement of concrete in hot and cold weather conditions, including but not limited to wind break, fogging systems, and temporary heat.

SECTION 512: SUPERSTRUCTURE CONCRETE

512.1 DESCRIPTION

This Work consists of constructing concrete Bridge decks, reinforced-concrete box-girder Bridges; slab Bridges, slant-leg Bridges, truss Bridges, and other structural configurations requiring the use of Superstructure concrete, also referred to as Class AA or Class HPD (High Performance Deck) concrete.

Cast-in-place concrete placed in Bridges above the bearings will be Class HPD unless otherwise shown in the Contract.

Bridges with integral abutments shall have wingwalls, end diaphragms, and concrete above the bearings constructed of Class HPD concrete.

Approach slabs, transition slabs, integral pier and abutment caps, and Superstructure appurtenances shall be constructed with Class HPD concrete, unless otherwise shown in the Contract.

512.2 MATERIALS

The Contractor shall provide Class HPD concrete in accordance with Sections 509, "Portland Cement Concrete Mix Designs" and 510, "Portland Cement Concrete."

The Contractor shall provide steel reinforcing bars and epoxy-coated steel reinforcing bars in accordance with Section 540, "Steel Reinforcement."

512.3 CONSTRUCTION REQUIREMENTS

Requirements contained in Section 511, "Concrete Structures," will apply unless expressly modified in this Section.

512.3.1 Deck Placement Conference

The Project Manager will hold a Deck Placement Conference three (3) to seven (7) Days before the anticipated deck placement to review the specification requirements and discuss the Contractor's preparations.

The recommended agenda checklist is available from the Bridge Bureau.

512.3.2 Profile Survey of Girders

After placing girders and before setting screeds, the Contractor shall take a profile along each line of girders. If actual top of girder elevations differ significantly (more than a nominal haunch dimension) from those shown on the Plans such that excessive haunches or deficient slab thickness would result, the Contractor shall make appropriate adjustments as directed by the State Bridge Engineer.

512.3.3 Falsework

The Contractor shall design a lateral bracing system to support the deck overhang and to resist the entire torsional load from the deck overhang during construction. Design of lateral bracing system shall be in accordance with the AASHTO *Guide Design Specifications for Bridge Temporary Works*. In the event of a conflict between the referenced *Guide* and this specification, this specification will take precedence.

The screed rails supporting the concrete deck finishing machine shall be supported directly on the center of the bridge girders. The concrete deck overhangs shall be screeded and finished by hand.

The Contractor shall submit the Working Drawings for the lateral bracing system and the design calculations stamped by a NM licensed Professional Engineer with a minimum of five (5) years of structural design and construction experience. Review of the construction bracing by the Department does not relieve the Contractor of responsibility to provide the proper means and methods for successful construction. The lateral resistance of the steel intermediate diaphragms attached to the girders shall not be included in the Contractor's lateral bracing system design. The cost of the lateral bracing system and its design shall be incidental to the cost of the concrete.

The Contractor shall submit Working Drawings and design calculations for the proposed girder bracing system to the Project Manager for approval at least 21 Days before the anticipated placement date. The Contractor shall allow 14 Days for review of re-submitted Working Drawings.

Construction of the lateral bracing system shall be in accordance with the AASHTO *Construction Handbook for Bridge Temporary Works*. In the event of a conflict between the referenced *Handbook* and this specification, this specification will take precedence.

512.3.4 Forms

The Contractor shall use deck forms in accordance with Section 511.3.3, "Form Construction."

512.3.4.1 Permanent Steel Deck Forms

The Contractor shall provide Material and elements for the permanent steel deck form units that are fabricated from steel in accordance with ASTM A 653M (A653) Grade A-3. The Contractor shall provide a Class G 165 coating. The Contractor shall provide form sheets and form supports in accordance with the shop drawings; that are at least 22 gauge and 16 gauge thick, respectively.

The Contractor shall not use permanent steel forms in panels where longitudinal slab construction joints are located between stringers. The Contractor shall provide proper vibration of the concrete to ensure adequate consolidation of concrete.

512.3.4.1.1 Permanent Ventilated Steel Deck Form Design

The Contractor shall design permanent steel forms to support superimposed dead loads of the form, reinforcement, and plastic concrete, plus a live load of 50 pounds per square foot. The Contractor shall use steel ventilated at a minimum rate of 1/2 inch² per square foot.

The Department will not allow the following:

1. Unit working stresses to exceed the lesser of the following:
 - 1.1. 72.5% of the specified minimum yield strength of the Material, or
 - 1.2. 36,000 psi.
2. Maximum deflections under the weight of the plastic concrete, reinforcement, and form, to exceed the lesser of the following:
 - 2.1. 1/240 of the form span, or

2.2. 3/4 inch.

3. A load used to compute the deflection that is less than 120 lb per square foot.

The form span for design and deflection is the clear distance between the flanges of the supporting girders less two (2) inches, measured parallel to the form flutes.

The Contractor shall limit the increase in dead load due to the use of permanent steel deck forms to 15 lb per square foot. If the increase exceeds this limit, show that the additional load will not be detrimental; or strengthen the Structure to accommodate the extra load, at no additional cost to the Department.

The Contractor shall calculate physical design properties in accordance with the current American Iron and Steel Institute Specification for *Design of Cold-Formed Steel Structural Members*.

The Contractor shall design the permanent steel deck forms so that the deck slab laterally supports the steel girder or girder top flanges in compression, except where providing shear connectors.

The Contractor shall provide design calculations to the Project Manager for approval by the State Bridge Engineer 14 Days prior to ordering.

512.3.4.1.2 Permanent Steel Deck Form Installation

The Contractor shall not rest form sheets directly on the top of the stringer or floor beam flanges. The Contractor shall securely fasten sheets to form supports. The Contractor shall use sheets with a minimum bearing length of one (1) inch at each end. The Contractor shall place form supports in direct contact with the flange of stringers or support beams. The Contractor shall make attachments with welds, bolts, clips, or other approved means; the Contractor not weld to girder or beam flanges. All welding must be performed by a certified welder in accordance with the applicable documents and welder qualifications listed in Section 541.3, "Steel Structures; Construction Requirements."

The Contractor shall place bottom reinforcing bars with a minimum cover of one (1) inch. Except in cases where reinforcing bars are not parallel to form corrugations, the Contractor shall center the bars (approximately) in the bottom layer of the main reinforcement over the valleys of the forms when necessary to achieve the minimum concrete cover. The Contractor shall not allow the distance from the top of the slab to the bottom layer of main slab reinforcement to be less than the dimension shown in the Contract.

512.3.5 Placing of Reinforcing Bars

The Contractor shall firmly support reinforcing bars in deck slabs with approved devices spaced at intervals not exceeding 3.3 ft. The Contractor shall securely tie down reinforcing bar mats in Bridge decks to girders and forms to prevent upward movement during concrete placement.

The Contractor shall not allow the spacing between adjacent reinforcement bars to vary more than 1/2 inch from the dimensions shown in the Contract. The Contractor shall place and maintain reinforcement bars within 1/4 inch of the vertical dimensions shown in the Contract. The Contractor shall not allow the concrete cover over the top layers of reinforcement to be less than two (2) inches.

For continuous steel Bridges, the Contractor shall complete the forming and placing of

reinforcing steel and screed rail settings for the entire length of the Bridge before proceeding with any portion of the deck placement, unless otherwise authorized by the State Bridge Engineer.

512.3.6 Preparation for Placing Concrete

512.3.6.1 Support of Finishing Machines

The Contractor shall ensure finishing machines travel on steel rails. The Contractor shall provide pipe for rails with 2 3/8 inch outside diameter and 1 15/16 inch inside or heavier. The Contractor shall firmly support rails on adjustable steel supports. The Contractor shall securely fasten supports in place and do not space them more than 30 inches apart. The Department will not allow the Contractor to weld the supports to top flanges of steel girders or girders, or to the stirrups of concrete girders.

512.3.6.2 Setting of Screed Rails

The Contractor shall set the steel rails for placing and finishing Equipment to finish the deck in accordance with the Contract or as directed by the Project Manager. The Contractor shall make the accuracy of setting the rails consistent with the required tolerances for smoothness. The Contractor shall check elevations and straightness of the rails by survey, straight edging or string lining, and sight by eye.

If supporting the finishing machine over an outside girder, the Contractor shall check edge forms for the deck for vertical alignment and install in accordance with the Contract tolerances for smoothness. The Contractor shall provide rails that extend a sufficient distance beyond both ends of the scheduled length of placement to permit the finishing machine to reach all areas of the concrete placed and to permit off-deck parking of the machine out of the way of the hand finishers. The Contractor shall check the finishing machine setup for correct deck cross sections. The Contractor shall check blockouts for expansion joints for proper depths and widths of openings.

512.3.6.3 Finish Machine Trial Run

At least 24 h before placing concrete, the Contractor shall traverse the finish machine the length of the proposed placement or, if a continuous steel Bridge, for the full length of the Bridge.

The Contractor shall demonstrate that the following performance criteria are met during the trial run:

1. Use of required deck slab thickness, top of deck elevations, and the specified reinforcing bar cover; unless otherwise noted on the Plans, provide cover to the top of the top reinforcing bars of from 2 (two) inches to 2 7/16 inches. When checking the deck slab thickness, top of deck elevations, and cover, allow for deflections of supports resulting from the weight of the concrete;
2. Do not allow screed rails to deflect excessively;
3. The finishing machine is properly adjusted and in good working order; and
4. The finishing machine will properly track over the entire length of the proposed placement, particularly for decks that are curved, super-elevated, or that have a high skew.

512.3.6.4 Work Bridges

The Contractor shall provide one (1) or two (2) transverse Work Bridges for floating, straight edging, and curing operations. The Contractor shall provide Work Bridges that are structurally sound and do not deflect excessively. The Contractor shall test the Work Bridges in place before the deck placement to ensure proper adjustments of wheels, adequate clearances to safety railings, and compliance with other requirements.

512.3.7 Placing of Concrete

The Contractor shall place concrete by pumping or other approved means.

The Contractor shall place concrete close to the final position and to the full thickness of the slab. The Contractor shall place concrete far enough in front of the finishing machine to ensure proper striking off and finishing, generally a distance not greater than 12 ft.

Unless otherwise directed by the Project Manager, the Contractor shall consolidate concrete with suitable mechanical vibrators operating within the concrete. During concrete placement, the Contractor shall keep enough personnel, vibrators, and other tools available to assure adequate consolidation. If necessary, the Contractor shall supplement vibrating with hand spading with suitable tools to assure proper consolidation. If using vibrators, the Contractor shall use procedures in accordance with ACI 309.

The Contractor shall not use a "jitterbug" or any other flat tool that could cause concrete segregation.

The Contractor shall use approved vibrators that can transmit vibration at frequencies up to 10,000 Vpm. The Contractor shall provide vibrators that have each been certified within the last 90 Days to provide 8,000 to 10,000 Vpm.

The Contractor shall operate vibrators to consolidate the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. The Contractor shall not use vibrators to make concrete flow or run. The Contractor shall vibrate long enough to accomplish consolidation, but do not vibrate so long to cause segregation or air bubbles. The Contractor shall insert the vibrators vertically into the concrete, and immediately withdraw upward along the same line with the opposite motion. The Contractor shall not drag the vibrator horizontally across the placing area.

When operating vibrators, the Contractor shall avoid contact with reinforcing bars, particularly epoxy coated reinforcing bars or bars that extend into concrete that has taken an initial set. If vibrating concrete in areas reinforced with epoxy-coated bars, the Contractor shall cover the vibrators with nonmetallic sleeves to prevent damage to the epoxy coating.

If hydraulic fluid, motor oil, dirt, or other Deleterious Material leaks or falls onto the deck, the Contractor shall remove contaminated concrete from the deck before proceeding.

The Contractor shall place concrete for abutment and/or pier diaphragms monolithically with Bridge deck, unless otherwise shown in the Plans.

512.3.7.1 Pumping of Concrete

Before placing concrete, the Contractor shall thoroughly clean the Equipment. The Contractor shall operate the pump to produce a continuous stream of concrete without air pockets and no appreciable loss of slump.

If placing concrete by pumping, the Contractor shall not add water at the concrete entrance hopper. If adding water at the pump hopper to clear a clogged pump, the Contractor

shall remove and dispose of concrete in the hopper and the line.

The Contractor shall obtain the Project Manager's approval of concrete pumping Equipment before use. The Contractor shall provide a backup placement system capable of completing concrete placement to a bulkhead in case of a pump failure. The Contractor shall provide bulkheads that are pre-cut and ready for installation.

The Contractor shall not use aluminum pipe as a conduit for concrete placement.

The Department will test concrete for Acceptance at the discharge end of the pump, and collect samples from concrete placed on the deck.

512.3.7.2 Delays in Deck Placement

The Contractor shall stop placement operations and correct, if one (1) of the following problems occur:

1. A deck-finishing machine fails;
2. Placement operations are not within the specification requirements; or
3. Placement operations are not achieving satisfactory results.

If the concrete placement is Delayed, the Contractor shall stop all other placement operations until the cause of the Delay is corrected.

If the Contractor fails to correct the problem within 45 min (or within 60 min if using a set retardant), the Contractor shall erect a bulkhead parallel to the finishing operations and as close as practical to the location that placement originally stopped. The Contractor shall finish concrete to the bulkhead and discontinue placement operations for the Day. Before deck placement, the Contractor shall cut the bulkhead to length and slot it for reinforcing bars.

For slab Bridges, the Contractor shall install the bulkhead as close to one (1) of a span's quarter points as possible.

If deck placement operations have been suspended and bulkheads installed, the Contractor shall not resume deck construction until after 12 h and after taking adequate corrective measures to ensure concrete mixing, placement, finishing, and curing are performed in accordance with the Contract, as approved by the Assistant District Engineer for Construction in consultation with the State Bridge Engineer.

512.3.7.3 Rate of Evaporation Limitations

The Contractor shall comply with Section 511.3.4.5, "Rate of Evaporation Limitations."

512.3.7.4 Rate of Progress

The Contractor shall provide a rate of progress of Bridge deck placement in accordance with the Contract. If the Contract does not define a rate, the rate of progress will be at least 30 ft per hour over the entire width of the deck, except for slab Bridges, for which the rate will be at least 20 ft per hour.

If the placement includes integral pier or abutment diaphragms, the Contractor shall not include the time required to place the diaphragms in the rate of placement calculations. The Contractor shall include Delays in the placement due to other causes in the calculation of the overall rate of pour.

The Department may reject decks placed at rates slower than specified.

The Project Manager may decrease the rate of placement by 25%, if the following conditions exist:

1. The rate of evaporation is less than 0.08 lb per square foot per hour;
2. The wind velocity on the deck is less than ten (10) mph; and
3. The Contractor is producing an Acceptable finish.

512.3.7.5 Concrete Placement in Girders

Unless otherwise approved by the Assistant District Engineer – Construction, the Contractor shall uniformly deposit concrete in girders the full length of the girder and bring up evenly in horizontal layers not exceeding two (2) ft in depth.

512.3.8 Temperature and Weather Limitations

512.3.8.1 Temperature Requirements

The Contractor shall comply with Section 511.3.4, "Temperature and Weather Limitations."

512.3.8.2 Change in Weather Conditions

The Contractor shall assume the risk of proceeding with deck placement during marginal weather. The Contractor shall repair or remove and replace concrete damaged due to changing weather conditions.

After placement operations have started, if weather conditions change causing evaporation rates to exceed those previously specified or if other adverse weather conditions arise, the Contractor shall immediately place an emergency bulkhead, finish concrete to the bulkhead, and discontinue placement operations for the Day.

The Contractor shall keep Materials available to cover and protect unfinished deck areas and completed deck areas ahead of and behind the finishing machine as the machine moves forward to the bulkhead.

512.3.9 Finishing

The Contractor shall ensure that the rideability, drainage, and surface texture characteristics of finished Bridge deck slabs meet the requirements specified.

The Contractor shall provide deck with smooth transitions at ends of Bridges and across expansion and construction joints. The Contractor shall provide deck that is free draining, with no depressions.

Unless otherwise specified in the Contract or approved in writing by the Assistant District Engineer for Construction, the Contractor shall operate finishing machines with the skew of the Structure. The Contractor shall float and broom the plastic concrete parallel to the finishing operation.

The Contractor shall provide a ten (10) foot long, lightweight, round-bottom, straightedge equipped with a long handle, as approved by the Project Manager.

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

512.3.9.1 Finishing Machine

The Contractor shall finish Bridge deck slabs and approach slabs with approved power driven finishing machines, unless the use of such machines is impractical and the Assistant District Engineer – Construction provides a written waiver.

The Contractor shall use finishing machines with one (1) or more rotating rollers, augers, and vibratory pans providing from 2,500 Vpm to 4,000 Vpm.

512.3.9.2 Finishing of Slab Edges

If an exterior beam or girder supports a finishing machine, the Contractor may hand finish the deck slab between the exterior beam or girder and the edge of the deck slab.

512.3.9.3 Hand Finishing Plan Submittal

The Contractor may finish the concrete deck slabs by hand if the use of a finishing machine is not possible. The Contractor shall submit a hand-finishing plan to the Project Manager for approval before initiating placement operations. The plan will describe the screed arrangement and proposed methods of finishing.

512.3.9.4 Final Finishing Operations

Immediately following the initial finishing operations and while the concrete is still plastic, the Contractor shall test the slab surface for trueness in accordance with Section 512.3.10.2, "Acceptance Criteria," by using the straightedge as a float. The Contractor shall advance the straightedge longitudinally along the slab in successive stages not more than 1/2 the length of the straightedge.

The Contractor shall correct variations in the surface of the slab by striking off projections and filling depressions with freshly mixed concrete. The Contractor shall consolidate and refinish the corrected areas with a long handled float at least three (3) ft in width.

The Contractor may use small hand floats if approved by the Project Manager. The Contractor shall recheck the surface with a straightedge.

During the floating and straight-edging process, the Contractor shall check and ensure that the deck has the proper crown, slope, and grade. The Contractor shall construct deck surfaces in the vicinity of deck drains to slope gently toward the drains.

The Contractor may use a float three (3) ft or greater in width to seal the surface behind the finishing machine.

Final finishing operations will follow the trailing edge of the finishing machine closely, generally, at a distance of 13 ft or less. The Contractor shall not allow more than one (1) h to elapse between the time of placement of concrete on the deck and the completion of final finishing operations.

Unless otherwise specified in the Contract, the Contractor shall apply a broomed finish to the plastic concrete parallel to the finishing operation.

512.3.10 Final Operations

512.3.10.1 Curing

Unless otherwise specified in the Contract, the Contractor shall cure Bridge decks and approach slabs in accordance with Section 511.3.10, "Curing." The Contractor shall ensure forms supporting Bridge decks remain in place for at least seven (7) Days.

512.3.10.2 Acceptance Criteria

The Contractor shall test the smoothness of the completed Roadway surfaces of Bridge decks, approach slabs, and the adjoining 50 ft of approach pavement. After the concrete of Bridge decks, approach slabs, and pavement hardens, the Contractor shall check the entire surface areas with a ten (10) foot straightedge. The Contractor shall hold the straightedge in successive positions parallel to the centerline of the Roadway and in contact with the slab. The Contractor shall advance the straightedge longitudinally along the slab in successive stages no greater than half the length of the straightedge.

The Contractor shall provide a finished surface plane of Bridge decks and approach slabs that do not vary more than 3/16 inch, measured from the bottom of the straightedge. The Contractor shall provide a finished surface of concrete or asphalt approaches that does not vary more than 1/4 inch, measured from the bottom of the straightedge. The Contractor shall plainly mark variations that exceed the allowable values.

The Contractor shall ensure that vertical steps or discontinuities at the ends of Bridges and approach slabs do not exceed 3/16 inch. The Contractor shall place expansion joints below grade, from 1/16 inch to 3/16 inch. The Department will reject expansion joints installed at elevations above the Roadway grade.

The Contractor shall remove smaller discontinuities or high spots greater than 3/16 inch by rubbing with carborundum brick and water. The Contractor shall correct larger areas of deck requiring repair by use of power grinders or similar tools approved by the Project Manager. The Department will not allow the use of a bush hammer or similar tools to remove irregularities. When grinding, the Contractor shall not reduce the concrete cover over the reinforcing steel to less than 1 9/16 inch. If diamond grinding cannot satisfactorily correct portions of decks, the Contractor shall remove and replace them at no additional cost to the Department.

After rubbing and diamond grinding, the Contractor shall restore the curing system on the deck as necessary.

The Assistant District Engineer – Construction may direct the Contractor to remove and replace unacceptable areas under the following conditions, at no additional cost to the Department:

1. The finished deck surface is exceedingly rough;
2. Plastic shrinkage cracking or surface tearing is severe;
3. Serious damage due to any cause occurs over large areas of the deck placement;
or
4. Concrete cover over reinforcing steel is less than required minimum.

512.3.10.3 Grooving of Hardened Concrete

The Contractor shall straightedge and repair the Bridge deck before grooving. The Contractor shall groove the deck after the deck has reached 75% of the design strength.

512.3.10.3.1 Grooving Machine

The Contractor shall groove hardened concrete with diamond blades mounted on a multiblade arbor on a self-propelled machine built for grooving concrete pavements. The Contractor shall provide a grooving machine with the following:

1. A depth control device that detects variations in the concrete surface and adjusts the cutting head height to maintain the specified groove depth; and
2. A device to control alignment.

512.3.10.3.2 Groove Pattern

The Contractor shall groove the Bridge decks, approach slabs and transition slabs parallel to the centerline of the Roadway if Bridge decks abut concrete pavement that is to receive longitudinal grooving, or if specified in the Contract. Otherwise, the Contractor shall cut grooves perpendicular to the centerline of the Roadway.

The Contractor shall begin grooving 18 inches from the gutter line or face of rail and run in a continuous pattern to 18 inches from the opposite gutter line or face of rail. The Contractor may increase the 18 inch dimension on one (1) side of the deck to as much as 27 inches, if the clearance of the grooving machine does not allow a closer approach to the railing.

The Contractor shall provide grooves that begin and end within from two (2) inches to four (4) inches of expansion joints, contraction joints, and ends of the slab.

The Contractor shall lay out the grooving accurately before cutting begins. The Contractor shall provide grooves that are 0.125 inch \pm 0.02 inch wide and from 1/8 inch to 1/4 inch deep.

If using transverse grooving, the Contractor shall space grooves in a random pattern from 1/2 inch to 7/8 inch centers. If using longitudinal grooving, the Contractor shall space grooves from 5/8 inch to 7/8 inch centers.

512.3.10.3.3 Grooving Residue Removal

The Contractor shall continuously remove resulting slurry or residue immediately following grooving operations. The Contractor shall clean the lands and the grooves and leave the surface free of slurry residue and other Deleterious Material.

The Contractor shall remove grooving residue by flushing, vacuuming, or other methods approved by the Project Manager.

512.3.10.4 Penetrating Water Repellent

After finishing, repairing, and machine grooving, the Contractor shall apply a penetrating water repellent treatment to Bridge decks and approach slabs in accordance with Section 532, "Penetrating Water Repellent Treatment."

512.3.11 Superstructure Appurtenances

512.3.11.1 Construction Joints

The Contractor shall make construction joints smooth and true to line, and finish them with an edging tool with a radius of approximately 1/8 inch. If longitudinal construction joints are located off the crown, the Contractor shall provide a finish across the joint that is smooth

and of a slope to provide proper drainage of the deck.

512.3.11.2 Sealing of Construction Joints and Surface Cracks

After grooving and applying the penetrating water repellent, the Contractor shall fill and seal construction joints and cracks that are visible on a dry deck with a resin in accordance with Section 535, "Crack Sealing Using Low-Viscosity, Gravity-Fed Sealers."

The Contractor shall apply resin to joints and cracks that permit the flow of water through the deck thickness as recognized by leaching along the crack or joint lines when viewed from below the deck, as determined by the Project Manager.

512.3.11.3 Sidewalks, Curbs, and Raised Medians on Structures

The Contractor shall thoroughly tamp the concrete in Sidewalks, curbs, and raised Medians on Structures so that a layer of mortar approximately 1/8 inch remains on top of the coarse aggregate. The Contractor shall strike off the surface of the concrete with a strike board to a uniformly smooth surface and float it with an acceptable wood or cork float.

The Contractor shall test the surface of Sidewalks and raised Medians with a ten (10) foot straightedge and ensure the surface does not vary more than 1/4 inch from the bottom of the straightedge.

The Contractor shall give Sidewalks, curbs, and raised Medians a broomed surface finish. After finishing and curing, the Contractor shall give the Sidewalks, curbs, and raised Medians a penetrating water repellent treatment in accordance with Section 532, "Penetrating Water Repellent Treatment."

512.3.11.4 Opening of Bridge Deck and Approach Slabs to Traffic

If it is necessary to open a Roadway to traffic at the earliest possible moment, the Assistant District Engineer for Construction may allow traffic on a Bridge deck or on approach slabs after the seven (7) Day curing period and after cylinders that are field cured in the same environment as the slabs demonstrate the concrete reaches 90% of specified design strength in accordance with Section 510.3.5.2, "In-Place Concrete Strength Measurements."

The Department will allow traffic on the deck before the application of the penetrating water repellent treatment, however; the Contractor shall perform the specified surface preparation procedures before application.

The Contractor shall construct Bridge deck prior to approach and transition slabs; no exceptions. Approach and transition slabs shall be constructed to match grade and elevation of the adjoining Bridge deck as shown in the Project Plans or as directed by the State Bridge Engineer if adjustments are required to match the completed Bridge deck.

512.4 METHOD OF MEASUREMENT

The Department will measure Superstructure concrete using the dimensions shown in the Contract or approved modifications. The pay quantity will not be increased for any additional volume of concrete placed because of the use of metal stay-in-place forms.

512.5 BASIS OF PAYMENT

PAY ITEM	PAY UNIT
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Superstructure Concrete
High Performance Deck (HPD)

Cubic Yard
Cubic Yard

512.5.1 Work Included In Payment

The following Work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

1. All corrective Work;
2. Machine grooving;
3. Construction joint and crack sealing;
4. Formwork and lateral bracing system; and
5. Penetrating Water Repellent Treatment.

SECTION 515: REINFORCED CONCRETE FOR MINOR STRUCTURES

515.1 DESCRIPTION

This Work consists of providing reinforced concrete for minor Structures.

515.2 MATERIALS

The Contractor shall provide Class A concrete with a design compressive strength of at least 3,000 psi in accordance with Section 510, "Portland Cement Concrete."

The Contractor shall provide Grade 40 or 60 reinforcing steel in accordance with Section 540, "Steel Reinforcement." The Department will allow field bending and cutting.

The Contractor shall thread pre-formed hookbolts for the entire depth of embedment, or make hookbolts using reinforcing bar stock.

The Contractor shall provide chemical adhesive for anchoring hookbolts in accordance with Section 522, "Chemical Adhesive Anchors."

515.3 CONSTRUCTION REQUIREMENTS

The Contractor shall construct reinforced concrete for minor Structures in accordance with Section 510, "Portland Cement Concrete," Section 511, "Concrete Structures," and Section 540, "Steel Reinforcement."

The Contractor shall construct collars to fit tightly for joining pipe-to-pipe or pipe-to-box Structures. The Contractor shall ensure concrete plugs at the ends of existing conduits or box openings fit tightly.

The Contractor shall provide bulkheads at the junction of different sized pipes and conduits to prevent leakage of fresh concrete and mortar into the conduit. The Contractor shall remove concrete or mortar that leaks into the conduit. If required to maintain smooth flow conditions within the conduit, the Contractor shall form fillets of fresh concrete to reduce turbulence at conduit junctions.

515.4 METHOD OF MEASUREMENT

The Department will measure reinforced concrete for minor Structures using the dimensions shown in the Contract or approved modifications.

515.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Reinforced Concrete for Minor Structures</i>	Cubic Yard

515.5.1 Work Included In Payment

The following items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

1. Reinforcing steel.
2. Waterstops.
3. Dowels, anchor bolts and hookbolts.

4. Excavation.

SECTION 519: SHOTCRETE

519.1 DESCRIPTION

This Work consists of constructing a pneumatically applied non-structural shotcrete onto rock, soil or structural shotcrete onto formed surfaces in accordance with the Contract and as directed by the Project Manager.

These Specifications refer to premixed cement and aggregate pneumatically applied by suitable Equipment and competent operators.

519.2 MATERIALS

Structural shotcrete shall have a design strength of 4000 psi at 28 Days. If structural shotcrete is required, the Contractor shall use a shotcrete mix that has been designed and proportioned in accordance with Section 509, "Portland Cement Concrete Mix Designs" and complies with the designated hardened properties for the class of concrete required in the specifications. All mix constituents must comply with Table 519.2:1, "Applicable Specification Sections." The Contractor shall determine all hardened properties in accordance with Section 519.2.6, "Acceptance Sampling and Testing."

Non-structural shotcrete shall have a design strength of 3000 psi at 28 Days. If the shotcrete is non-structural, the non-structural shotcrete mix design may be developed in accordance with Section 509, "Portland Cement Concrete Mix Designs" without using the special boxes required in Section 519.2.6, "Acceptance Sampling and Testing."

All shotcrete mix designs must be reviewed and approved by the State Concrete Engineer before being used on NMDOT Projects. The Contractor shall use either wet-mix or dry-mix shotcrete. The Contractor shall reinforce shotcrete in accordance with the Contract.

The Contractor shall provide Materials and perform construction requirements in accordance with the specification sections listed in Table 519.2:1, "Applicable Specification Sections."

Table 519.2:1
Applicable Specification Sections

Material/Construction Requirements	Section
Portland cement	Section 509, "Portland Cement Concrete Mix Designs"
Fly Ash	Section 509, "Portland Cement Concrete Mix Designs"
Pozzolans	Section 509, "Portland Cement Concrete Mix Designs"
Curing Materials and Admixtures	Section 509, "Portland Cement Concrete Mix Designs"
Water	Section 509, "Portland Cement Concrete Mix Designs"
Fine Aggregate	Section 509, "Portland Cement Concrete Mix Designs"
Coarse Aggregate	Section 509, "Portland Cement Concrete Mix Designs"
Neat Cement Grout	Section 521, "Non-Shrink Mortar"

Table 519.2:1
Applicable Specification Sections

Material/Construction Requirements	Section
Bar Reinforcement	Section 540, "Steel Reinforcement"
Welded Wire Fabric	Section 540, "Steel Reinforcement"
Surface evaporation	Section 512, "Superstructure Concrete"

519.2.1 Fine Aggregate Quality Requirements

The Contractor shall provide fine aggregate with the following properties:

1. A soundness Loss of 12 or less when tested in accordance with AASHTO T 104 using magnesium sulfate solution and a test duration of five (5) cycles; and
2. A sand equivalent of at least 75 when tested in accordance with AASHTO T 176.

519.2.2 Fine Aggregate Gradation Requirements

Fine aggregates shall comply with Table 519.2.2:1, "Fine Aggregate Gradation" for either Grading No.1 or Grading No. 2.

Table 519.2.2:1
Fine Aggregate Gradation

Sieve Size, U.S. Standard Square Mesh	Percent by Weight Passing Individual Sieves	
	Grading No.1	Grading No.2
¾ inch (19 mm)	---	---
½ inch (12 mm)	---	100
3/8 inch (10 mm)	100	90 to 100
No. 4 (4.75 mm)	95 to 100	70 to 85
No. 8 (2.4 mm)	80 to 98	50 to 70
No. 16 (1.2 mm)	50 to 85	35 to 55
No. 30 (600 µm)	25 to 60	20 to 35
No. 50 (300 µm)	10 to 30	8 to 20
No. 100 (150 µm)	2 to 10	2 to 10

519.2.3 Water

The Contractor shall use water in the shotcrete mix that is free of elements that could stain the mix and in accordance with Section 509.2.6, "Water."

519.2.4 Anchor Bars

The Contractor shall provide anchors of appropriate size to hold reinforcement in place. The Department will allow maximum anchor spacing of 24 inches on a grid pattern over the entire area for structural applications.

If using "L"-shaped anchors, the Contractor shall use those that consist of No. 5 reinforcement bars (or larger) bent into an "L" shape. The short leg of the "L" will be at least six (6) inches long and the long leg at least two (2) feet long.

519.2.5 Welded Wire Mesh

The Contractor shall provide non-galvanized eight (8) gauge steel with a four (4) inch x four (4) inch mesh (4 x 4-W2.1 x W2.1) in accordance with Section 540, "Steel Reinforcement" for welded wire mesh. For structural applications, the Contractor shall use welded wire mesh in accordance with the Contract and as approved by the State Bridge Engineer. The Contractor shall ensure that all wire mesh has been rigidly fixed in place to prevent rebound when struck by the shotcrete.

519.2.6 Fiber Reinforcement

Synthetic Fibers shall meet the requirements of ASTM C1116.

Steel fibers should meet the requirements set forth in ASTM A820.

519.2.7 Prepackaged Product

For non-structural shotcrete; a pre-mixed and prepackaged concrete product, with or without steel fibers, specifically manufactured as a shotcrete product for on-site mixed shotcrete, may be used if approved by the State Materials Bureau. The Material shall meet the requirements of ASTM C1480 and have a minimum strength of 3,000 psi at 28 Days for non-structural Shotcrete.

519.2.8 Acceptance Sampling and Testing for Structural and non-structural Shotcrete

The Contractor shall apply shotcrete to approved test panels. The Contractor shall orient the spray nozzle to the test panel in the same position as that used on the actual Project. The Contractor shall provide test panels constructed in accordance with the requirements of ASTM C 1140. The Contractor shall use test panels with the following characteristics:

1. Minimum dimensions of 30 inch² x eight (8) inch deep;
2. Constructed from wood and sealed plywood; and
3. 45° sloped sides to allow rebound to escape.

The Contractor shall use at least one (1) pre-construction trial to do the following:

1. Obtain test cores to confirm compliance with the hardened properties of Section 510, "Portland Cement Concrete."
2. For structural Shotcrete only, pre-qualify the proposed nozzle operator and strike-off persons. The Department will not allow nozzle operators and strike-off persons who have not been pre-qualified to apply shotcrete on the Project. Each nozzle operator and strike-off person shall shoot pre-construction test panels in the presence of the Project Manager or designated representative. Each nozzle operator shall have a minimum of the following qualifications:
 - 2.1. Supervisor, at least one (1) year of experience as a shotcrete nozzle operator and at least two (2) years of experience on shotcrete Projects.
 - 2.2. Nozzle operator and delivery Equipment operators, at least one (1) year of apprenticeship on similar applications with the same type of Equipment.
 - 2.3. Nozzle operators shall be ACI Certified Shotcrete Nozzle Operators.

The Contractor shall perform curing, coring, and testing of the shotcrete test panels and specimens at a private testing Laboratory approved by the State Materials Bureau for concrete mix designs.

The Contractor shall provide one half of the test panels with reinforcement and anchors representative of the same size and spacing required in the Contract for the actual Work. The Contractor shall provide the remaining panels with no reinforcement to allow for extraction of shotcrete test cores for compliance testing.

Each nozzle operator proposed for use on the Project shall shoot at least one (1) test panel at each orientation.

The Contractor shall obtain the required number of test cores in accordance with Section 510, "Portland Cement Concrete," from these test panels for testing at the designated ages for the specified performance parameters. The Contractor shall extract a minimum of three (3) four (4) inch diameter cores from locations of intersecting reinforcing steel and mesh to check the adequacy of consolidation of shotcrete around and behind the reinforcement. The Contractor shall take at least one (1) core at an anchor location.

The State Materials Bureau will evaluate the quality of the extracted cores and test panels. If the Department rejects a prequalification test panel, the Contractor shall have the nozzle operator shoot a second test panel. If the Department rejects the second test panel, the Contractor shall not allow the nozzle operator to shoot on the Project until the operator completes an appropriate training program and prepares an acceptable test panel.

The Contractor shall transport test panels in the wooden forms with care to not crack or damage the specimens.

The Contractor shall place the test panels in a moist room in the Laboratory that is maintained at a temperature of $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$, and a relative humidity of $98 \pm$ two percent (2%). After three (3) Days, the Contractor shall remove the test panels from the wooden forms and return them to the moist room until testing time.

519.2.8.1 Production Testing for Structural Shotcrete

The Contractor shall shoot two (2) construction test panels for each nozzle orientation and for each nozzle operator each Day of shotcrete production in the presence of the Project Manager. The Contractor shall shoot one (1) set of panels for each nozzle operator in the morning and one (1) set of panels for each nozzle operator in the afternoon for a full Day's production.

The Contractor shall produce test panels in accordance with ASTM C 1140, a minimum 12 inch² × eight (8) inch deep. The Contractor shall use test panels constructed of wood and sealed plywood with 45° sloped sides to permit escape of rebound. The Contractor shall provide construction test panels that contain no reinforcement or embedments.

The Contractor shall store, handle, and cure construction test panels the same as specified for pre-construction test panels. The Contractor shall prepare test specimens the same as specified for pre-construction test specimens.

The Contractor shall use compressive strength test specimens that are four (4) inch × eight (8) inch cores (length/diameter ratio of 2:1).

The mean compressive strength is acceptable if the average of three (3) cores tested at the specified age is equal to or greater than 85% of the specified strength, with no individual

strength test being less than 75% of the specified strength.

The Contractor shall correct unacceptable shotcrete sections at no additional cost to the Department.

519.3 CONSTRUCTION REQUIREMENTS

519.3.1 Equipment

519.3.1.1 Shotcrete Placing Equipment

The Contractor shall apply wet mix shotcrete with one (1) of the following methods:

1. The "thick-stream" method, which involves the use of a regular concrete pump with air addition at the discharge nozzle to pneumatically apply the shotcrete on the receiving surface. The "thick-stream" method usually uses a two (2) inch to 2 1/2 inch internal diameter delivery hose.
2. The "thin-stream" method, which normally involves the use of a pressurized chamber to pneumatically send the shotcrete down the delivery hose to the receiving surface. The "thin-stream" method normally uses a hose with a maximum 1 1/2 inch internal diameter.

The Contractor shall only use the "thin-stream" method for non-structural shotcrete if pre-construction testing confirms the capability to properly consolidate shotcrete, fully encase reinforcing steel, and produce a Material that meets the required hardened properties.

The Contractor shall use shotcrete delivery Equipment in accordance with ACI 506R and that is capable of delivering a steady stream of uniformly mixed Material to the discharge nozzle at the proper velocity and rate of discharge.

The preferred type of the wet-mix shotcrete delivery system uses positive displacement pumps equipped with hydraulic or mechanically powered pistons (similar to conventional concrete piston pumps), surge-reduction devices, and compressed air added at the discharge nozzle. The Contractor may use pneumatic-feed guns, rotary-type feed guns (similar to dry-mix guns), and peristaltic squeeze-type pumps if the Contractor demonstrates that the guns can produce shotcrete in accordance with the performance requirements and the Project Manager approves.

The Contractor shall carefully monitor the air ring at the nozzle for signs of blockage of individual air holes. If non-uniform discharge of shotcrete becomes apparent, the Contractor shall stop shooting and clean the air ring or take other appropriate corrective actions.

The Contractor shall thoroughly clean the delivery Equipment at the end of each shift. The Contractor shall remove build-up of coatings in the delivery hose and nozzle liner. The Contractor shall regularly inspect the air ring and nozzle and replace as necessary.

519.3.1.2 Auxiliary Shotcrete Equipment

The Contractor shall supply a clean, dry air supply capable of maintaining sufficient nozzle velocity and simultaneous operation of a blow pipe.

The Contractor shall use an air supply system with a moisture and oil trap.

The Contractor shall provide auxiliary shotcrete Equipment, such as air delivery hoses, blow pipes, couplings, admixture dispensers, and fiber feeders, in accordance with the

recommendations of ACI 506R.

519.3.2 Batching and Mixing Shotcrete

519.3.2.1 Wet Mix Process

The Contractor shall batch, mix, and supply wet mix shotcrete using one (1) of the following systems:

1. Central Mixing with transit delivery; or
2. Transit mixing and delivery.

519.3.2.1.1 Central Mixing and Supply

The Contractor shall batch and mix ingredients in accordance with Section 510, "Portland Cement Concrete." The Contractor shall provide inspected transit mixers in accordance with Section 510, "Portland Cement Concrete."

The Contractor may only re-temper the shotcrete once with superplasticizer added directly to the transit mixer during the period of discharge to maintain workability (slump) of shotcrete. The Contractor shall mix the shotcrete for a minimum period of five (5) min at the rated mixing speed after adding the superplasticizer to the transit mixer.

The Contractor shall shoot shotcrete within 90 min of adding mix water to the batch. The Contractor shall use appropriate shotcrete batch sizes per load to meet this requirement.

519.3.2.1.2 Transit Mixing and Supply

The Contractor shall apply central mixing requirements to transit mixing, except add ingredients directly to the transit mixer, not the central mixer. The Contractor shall not charge transit mixers to more than 70% of their rated capacity.

519.3.2.2 Dry Mix Process for Non-Structural Shotcrete

The Contractor shall batch the cement and aggregate by weight directly at the Project site within the tolerances required in Section 510, "Portland Cement Concrete."

The Contractor shall pre-dampen the dry mix before flow into the main hopper and immediately after flow out of the packaging to ensure uniform shotcrete free of dry pockets.

The Contractor shall not use pre-dampened cement/aggregate mixtures that are more than 90 min old or that are unable to produce the specified hardened properties.

519.3.2.3 Batching and Mixing Steel Fibers

The Contractor shall submit the procedure used for adding steel fibers to the shotcrete to the Project Manager for approval. The Contractor shall demonstrate the procedure in the field to the satisfaction of the Project Manager before starting production operations.

If fiber addition takes place at the nozzle, the Contractor shall uniformly distribute fibers throughout the mortar matrix without isolated concentrations (clumping or balling).

If adding fibers to the dry or wet mix during the batching and mixing process, the Contractor shall use a screen with a mesh of from 1 1/2 inch to 2 1/2 inch to prevent fiber balls from entering the shotcrete line. The Department will not require batching through a screen if

the Contractor demonstrates that fiber balls are not forming.

The Contractor shall not add fibers to the dry or wet mix too quickly (so they can be blended with the other ingredients without forming balls or clumps). The Contractor shall use a vibrating screen or sift to pass bulk fibers (that have a tendency to stick) into the mix as individual elements and not as clumps.

519.3.2.4 Preparation and Hardware

519.3.2.4.1 Subsurface Preparation

The Contractor shall locate and remove loose, spalled, deteriorated, and delaminated concrete, stone, or other substrate. The Contractor shall use hammer sounding to locate specific de-laminated areas of concrete or rock. The Contractor shall not damage areas of sound concrete or reinforcing steel during concrete removal operations.

The Contractor shall remove concrete using one (1) or more of the following methods:

1. Chip with light duty pneumatic, or electric, chipping hammers (not to exceed 15 lb).
2. Scarifiers, scabblers or other suitable mechanical means.
3. High-pressure (15,000 psi to 40,000 psi) water jetting. (If using water jetting, do not allow water to collect so that surrounding areas are not contaminated or damaged.)

If the Contractor exposes corroded reinforcing steel, the Contractor shall continue concrete removal until there is a minimum 3/4 inch clearance around the exposed, corroded reinforcing bar. The Contractor shall not damage the bond to adjacent non-exposed reinforcing steel during concrete removal.

The Contractor shall taper the perimeter of removed concrete areas at approximately 45° angles. The Contractor shall sawcut the outer edges of chipped areas to a minimum depth of 3/4 inch to avoid feather edging.

The Contractor shall use abrasive blast cleaning to remove fractured surface concrete and traces of unsound Material or contaminants, such as oil, grease, dirt, slurry or Materials that could interfere with the bond of the freshly placed shotcrete. The Contractor shall apply shotcrete to abrasive blast cleaned areas within 48 h or re-blast them.

The Project Manager may waive the requirement for abrasive blast cleaning where the Contractor performed concrete removal with high-pressure water blasting and the prepared surface is free of residual slurry or other Material detrimental to an Acceptable shotcrete bond.

The Contractor shall install reinforcement in slope blankets that do not contain steel reinforcement. Unless otherwise specified, the reinforcement will consist of No. 4 steel reinforcing bars placed with maximum spacing of 12 inch for vertical and horizontal bars. The Contractor shall rigidly attach this reinforcement to the underlying forms or concrete Structure. The Contractor shall remove dust, debris, or laitance generated by this process in accordance with these abrasive blast cleaning procedures.

519.3.2.4.2 Repair or Replacement of Steel Reinforcement

If the Contractor exposes corroded reinforcing steel during concrete removal, the Contractor shall remove corrosion using abrasive grit blasting.

The Contractor shall remove and replace reinforcing steel displaying deep pitting or loss of more than 20% of cross-sectional area as directed by the Project Manager.

If pitting is isolated, the Contractor shall reinforce the steel by adding appropriately placed reinforcing bars of suitable length (the existing reinforcing steel need not be cut).

519.3.2.4.3 Steel Reinforcement

The Contractor shall use a minimum lap splice length of reinforcing steel that is in accordance with the AASHTO *LRFD Bridge Design Specification*. The Contractor shall place these bars in accordance with ACI 506R, Sections 5.4 and 5.5. In particular, the Contractor shall not bundle bars in lapped splices; place them so the minimum spacing around each bar is three (3) times the maximum aggregate size to allow for proper shotcrete encapsulation.

The Contractor shall tightly secure intersecting reinforcing steel bars to each other using 12 gauge or heavier tie wire and adequately support them to minimize vibration during shotcrete placement.

The Contractor shall place welded wire mesh fabric in accordance with the Contract. The Contractor shall lap sheets of adjoining mesh by at least two (2) spaces in both directions at intersections, and securely fasten.

The Contractor shall fasten mesh to preset or existing anchors and reinforce using 12 gauge or heavier tie wire on a grid not less than 12 inch². The Contractor shall avoid large knots of tie wire that could result in sand pockets and voids during shotcreting.

The Contractor shall provide a minimum clearance of 3/4 inch behind installed reinforcing steel or mesh and existing concrete forms or bare rock.

519.3.2.4.4 Structural Anchors

Unless otherwise specified in the Contract, the Contractor shall place anchor bars (for structural applications) at a maximum spacing of 24 inches on a grid pattern over the entire area.

The Contractor shall provide the types of anchors in accordance with the Contract and either mechanically set or grout, as specified.

The Contractor shall ensure anchors develop the minimum pullout force in accordance with the Contract. The Contractor shall randomly test anchors at a frequency in accordance with the Contract to verify pullout force. The Department will not accept a pull out force less than 150 lb. If anchors fail to meet the minimum acceptable pullout value, the Contractor shall remove and replace immediately and take corrective action. Also, the Contractor shall test the anchors in the same relative location as those that failed. The Project Manager will determine the area for corrective measures.

519.3.2.4.5 Non-Structural Anchors

For non-structural applications (slope blankets, etc.), the Contractor shall install anchor bars at ten (10) foot centers on a grid pattern over the entire area in one (1) inch diameter holes drilled into the rock or soil approximately 24 inches deep.

The Contractor shall completely fill the drilled hole with neat cement grout using a grout tube extending to the bottom of the hole.

The Contractor shall push the anchor bar into the grout-filled hole and center it such that the short leg of the "L"-shaped bar points upward and parallel to the slope and is located

approximately 1 1/2 inches from the rock or soil surface.

519.3.2.4.6 Weep Holes

For slope blankets, the Contractor shall provide weep holes throughout the shotcrete mat on maximum ten (10) foot centers, horizontally and vertically.

The weep hole drains will consist of two (2) inch diameter Schedule 40 PVC slotted drainpipe, two (2) feet in length, placed within predrilled holes and sloped five percent (5%) to drain. The exposed end will extend from one (1) inch to three (3) inch outside the slope.

The Department will not allow pre-drilled holes with diameters larger than three (3) inches.

The Contractor shall install the slotted drainpipe before placing shotcrete. During placement of shotcrete, the Contractor shall protect weep holes and drainpipes against contamination.

519.3.2.4.7 Alignment Control and Cover

The Contractor shall implement alignment control (to establish control over line and grade), and maintain the minimum specified shotcrete thickness and cover of reinforcing steel.

The Contractor shall perform alignment control with shooting wires (also called ground wires), guide strips, depth gauges, or forms. The Contractor shall submit the proposed means of alignment control to the Project Manager for review and approval.

The Contractor shall use shooting wires that are at least "piano wire"—sized high-strength steel wire combined with a turnbuckle and spring coil. The Contractor shall remove shooting wires after completion of shotcreting and screeding operations.

The Contractor shall not let guide strips and forms impede the ability of the nozzle operator to produce uniform, dense, properly consolidated shotcrete. The Contractor shall not use alignment control Material that causes the formation of sand-pockets and voids.

If using depth gauges for alignment control, the Contractor shall space no greater than four (4) ft in a grid pattern. The Contractor shall cut back metal depth gauges to 1/4 inch below the finished surface.

The Contractor shall cover reinforcing steel in accordance with Section 540, "Steel Reinforcement."

519.3.3 Quality Assurance and Quality Control Testing

519.3.3.1 Quality Assurance

The Department will implement a Quality Assurance Program for the shotcrete Work. The program will include the following:

1. Review of Contractor submittals;
2. Review of the approval of Contractor-proposed Materials, supply, Equipment, and crew. In particular, evaluation in the pre-construction testing program of shotcrete nozzle operator and strike-off person proposed for use on the Project; the Department will allow only nozzle operators and strike-off persons approved in writing by the State Materials Bureau to perform Work;

3. Examination and approval (before application of any shotcrete) of areas prepared for shotcreting, including installation of anchors, reinforcement, and alignment control devices;
4. Provision of Inspectors to monitor shotcrete installation and authority to require removal and replacement of defective shotcrete while still plastic;
5. Regular monitoring of Quality Control testing results;
6. Implementation of a program for in-place evaluation and Acceptance or rejection, if test results indicate shotcrete is unacceptable; and
7. Implementation of a program of remedial Work, if the Quality Assurance Program deems it necessary.

519.3.3.2 Quality Control Testing

The Contractor shall provide an independent testing Laboratory to establish and maintain a Quality Control program for the shotcrete Work to ensure compliance with Section 519, "Shotcrete." Such a program will include, but not be limited to, the following:

1. Maintenance of test records for Quality Control operations; and
2. Physical testing in accordance with Section 519.2.6.1, "Production Testing" for the confirmation of compliance with the specified hardened shotcrete properties.

519.3.3.3 Safety and Cleanup

519.3.3.3.1 Preparation

The Contractor shall implement a safety program during preparation for shotcreting to do the following:

1. Protect the structural integrity of structural elements (by shoring or other suitable means) during concrete and reinforcing steel removal operations.
2. Protect personnel from falling debris, blasting grit, and high-pressure water jets during concrete removal processes.

The Contractor shall dispose of debris, blasting grit, and hydro-demolition and water-jetting slurry in accordance with Section 107, "Legal Relations, Environmental Requirements, and Responsibility to the Public."

519.3.3.3.2 Shotcrete Operations

The Contractor shall implement a safety program using hoarding, shrouds, screens, or other appropriate measures to protect personnel and surrounding property from pneumatically applied shotcrete over-spray and rebound Materials during the shotcrete application process.

Personnel working near the shotcreting operation, including nozzle operator, strike-off persons, nozzle operator's helpers, supervisors, and Inspectors, shall wear appropriate protective Equipment. Such Equipment includes, but is not limited to, safety helmet, safety boots, gloves, appropriate clothing, safety glasses with side enclosures, and dust masks.

Nozzle operator's helpers shall keep a supply of water, cloth or towel, and backup safety glasses available for the nozzle operator so satisfactory vision can be maintained during shooting operations. The Contractor shall provide sufficient lighting so the nozzle operator has a clear view of the Work.

The Contractor shall provide readily available eyebaths and wash facilities in the

immediate vicinity of the shotcrete application. The shotcrete crew shall apply appropriate skin protection and adopt Work hygiene to protect against cement or accelerator alkali burn.

The Contractor shall install sufficient lighting and ventilation to provide the nozzle operator and helpers with clear, unhindered view of the shooting area. The Contractor shall terminate Work and adopt corrective measures if, in the opinion of the Project Manager, visibility is unsuitable for the safe application of quality shotcrete.

519.3.4 Shotcrete Application and Finishing

519.3.4.1 Shotcrete Application

The Project Manager will review and approve areas prepared for shotcrete application before application of shotcrete.

The Contractor shall flush surfaces with water at least one (1) hour before application of shotcrete. The Contractor shall allow flushed surfaces to dry back to saturated surface-dry condition before application of shotcrete. If necessary, the Contractor shall use a blowpipe with oil-free compressed air to facilitate removal of surface water. For very porous and dry substrates, the Contractor shall saturate the substrate the Day before shotcreting and then re-wet before shooting as described above.

The Contractor shall apply shotcrete in accordance with ACI 506R, except that if using silica-fume modified shotcrete; the Contractor may apply the full thickness of shotcrete in a single layer. The Contractor shall use the minimum number of layers required to build up the full thickness of shotcrete without sagging, separation, or sloughing. Wherever possible, the Contractor shall apply shotcrete to the full thickness in a single layer.

If using multiple-layer shotcrete construction, the Contractor shall prepare the first layer with one (1) of the following methods before applying a subsequent layer:

1. Broom the stiffening layer with a stiff bristle broom to remove loose Material, rebound, over-spray, or glaze, before the shotcrete attains initial set.
2. If the shotcrete has set, Delay surface preparation at least 24 h, then prepare the surface by sandblasting or high-pressure water blasting to remove loose Material, rebound, hardened over-spray, glaze, or other Material detrimental to good bond.

When successive layers of shotcrete are necessary to build up full shotcrete thickness, the Contractor shall prevent the first layer from drying out with fogging or wetting. The Contractor shall only use curing compound with the approval of the Project Manager. If using a curing compound, the Contractor shall remove it by abrasive blast cleaning or high-pressure water blasting, before application of the next layer of shotcrete. The Contractor shall clean the first layer of shotcrete of surface water and ensure it is in a saturated surface-dry condition when applying the next shotcrete layer.

The Contractor shall exercise care to protect adjacent surfaces from buildup of rebound and over-spray. The Department will not allow rebound and over-spray on the completed Work. The Contractor shall remove rebound and over-spray from surfaces to receive shotcrete while the Material is still plastic, using blowpipes, scrapers, wire brushes, or other suitable tools. The Contractor shall remove hardened rebound and overspray with abrasive blast cleaning, chipping hammers, high-pressure water blasting or other suitable techniques before applying additional shotcrete.

The Contractor shall provide scaffolding or other devices so the nozzle operator and helpers have free, unhindered access to the Work area.

The Contractor shall apply shotcrete from the nozzle in accordance with ACI 506R.

The Contractor shall not apply shotcrete during periods of rain or high wind, unless suitable protection is provided.

The Contractor shall apply shotcrete in accordance with the Contract using shooting wires, depth gauges, guide strips, forms, or other suitable devices. The Contractor shall apply the minimum cover of shotcrete to reinforcing steel in accordance with the Plans. The Contractor shall cut back metal depth gauges to within 1/4 inch of the shotcrete surface, to prevent corrosion staining of the surface.

When applying a 3/8 inch maximum aggregate size shotcrete, the Department will allow a final flash coat layer (1/4 inch to 3/4 inch thick) using 1/4 inch aggregate shotcrete.

519.3.4.2 Shotcrete Finishing

The Contractor shall leave shotcrete in the natural gun finish unless otherwise specified in the Contract.

If the Contract requires finishing, the Contractor shall cut back shotcrete to line and grade using cutting rods, screeds, or other suitable devices. The Contractor shall allow shotcrete to stiffen sufficiently before cutting and trimming, to prevent the formation of tears, cracks, and delaminations. The Contractor shall remove shooting wires on completion of cutting and trimming.

The Contractor shall apply one (1) or more of the following finishes if required:

1. Wood float finish, either as a preliminary finish for other surface treatments, or as a granular texture finish.
2. Rubber float finish, applied to either a flash coat or wood float finish, to produce a finer textured granular finish.
3. Brush finish, a fine hairbrush float finish that leaves a finely textured, sandy finish.
4. Steel trowel finish that leaves a dense, smooth hard finish.

The Contractor shall trim back shotcrete and over-spray from adjacent non-prepared concrete surfaces. The Contractor shall provide the edges of shotcrete repairs with a minimum square saw-cut edge 3/4 inch deep; finish shotcrete up to this edge. The Contractor shall not featheredge shotcrete (including flash coats).

519.3.4.3 Curing and Protection

On completion of finishing, the Contractor shall immediately prevent shotcrete from drying out by fogging or wetting.

If the Contract requires leaving shotcrete with a natural gun finish, the Contractor shall apply curing compounds at twice the application rate normally specified for smooth concrete finishes. The Contractor shall completely remove curing compounds by abrasive blasting or water blasting (with a pressure of 3,000 psi) before application of subsequent sealers.

Once the shotcrete achieves its final set, the Contractor shall keep it continuously moist for at least seven (7) Days. The Contractor shall perform moist curing using one (1) or both of the following procedures:

1. Wrap the elements in wet burlap presoaked in water for 24 h before installation;

wrap the wet burlap in plastic sheet to slow the drying rate of the burlap.

2. Install sprinklers, soaker hoses, or other devices that keep the shotcrete continuously wet. Do not use intermittent wetting procedures that allow the shotcrete to undergo cycles of wetting and drying during the curing period.

519.3.4.4 Hot and Cold Weather Protection

The Contractor shall apply shotcrete during periods of hot and cold weather in accordance with ACI 305R and ACI 306R.

If it is anticipated that shotcrete will be placed when the ambient temperature will fall below 35 °F, a Cold-Weather Shotcrete Plan must be prepared and submitted to the Project Manager at least 30 Days before the intended application. The Cold Weather Shotcreting Plan must be reviewed and approved by the State Concrete Engineer before shotcrete is permitted to be placed at temperatures below 35 °F.

The Contractor shall monitor the Surface Evaporation of the Shotcrete in accordance with Section 512, "Superstructure Concrete." The Contractor shall not proceed with shotcrete application if the average rate of surface evaporation of the shotcrete over any ten (10) minute period exceeds 0.2 lb per square foot per hour, in accordance with Section 512, "Superstructure Concrete." The Contractor shall not allow the prevailing ambient conditions (relative humidity, wind speed, air temperature, and direct exposure to sunlight) to cause either plastic shrinkage or early drying shrinkage cracking.

All cracked Structural shotcrete, regardless of the cause, shall be removed and replaced at no cost to the Department.

Subsequent efforts to prevent further cracking problems shall include, but not be limited to:

1. Rescheduling of the Work to a time when more favorable ambient conditions prevail; and
2. Adopt corrective measures, such as installation of sunscreens, windbreaks, or fogging devices to protect the Work.

During periods of cold weather, shotcreting may only proceed if the substrate to which the shotcrete is applied and the air temperature in contact with the shotcrete surfaces are both above 50 °F.

The Contractor shall maintain the air temperature in contact with the shotcrete surfaces at 60 °F or greater for at least four (4) Days after application of shotcrete. The Contractor shall submit the means of maintaining the air temperature to the Project Manager for approval. The Contractor shall not use unvented heaters.

The Contractor shall apply shotcrete at a temperature of between 50 °F and 90 °F. The Contractor shall use cooler mix temperatures during hot-weather shotcrete operations and warmer mix temperatures during cold-weather shotcrete operations.

519.3.4.5 Inspection and Remedial Work

The Contractor shall sound the surface of the cured shotcrete with a hammer to locate unsound areas.

The Contractor shall provide Equipment, hardware, and means necessary to perform the inspection operations. The inspection accommodations are subject to the approval of the

Project Manager.

The Contractor shall cut out and replace sags or other defects with another layer. If welded wire mesh reinforcement is damaged or destroyed by such repairs, the Contractor shall repair the damaged area by overlapping and tying additional wire mesh in accordance with Subsection 519.3.2.4.3, "Steel Reinforcement."

519.4 METHOD OF MEASUREMENT

The Department will measure shotcrete using the dimensions shown in the Contract or approved modifications.

519.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Structural Shotcrete</i>	Square Yard
<i>Non-structural Shotcrete</i>	Square Yard

519.5.1 Work Included in Payment

The following Work and item(s) will be considered as included in the payment for shotcrete and will not be measured or paid for separately:

1. Reinforcement;
2. Anchors;
3. Slotted pipe;
4. Ties;
5. Test molds;
6. Test samples;
7. Submittals;
8. Boring;
9. Cores; and
10. Grouting.

SECTION 521: NON-SHRINK GROUT

521.1 DESCRIPTION

This Work consists of providing and placing non-shrink grout for use in concrete Structures. Uses of grout include the following:

1. Filling under masonry plates and blockouts between precast members;
2. Bonding cementitious dowel bars in preformed recesses;
3. Filling shear keys between Bridge members; and
4. Other uses as required.

For Concrete Structure surface repairs, see Section 533, "Concrete Structure Repair."

521.2 MATERIALS

The Contractor shall provide prepackaged nonshrink hydraulic-cement grout ("grout") in accordance with Table 521.2:1, "Enriched Mortar Physical Property Requirements." The Contractor shall select the grout from the Department's *Approved Products List*. The grout shall be nonmetallic, water-based and cannot contain chlorides, fluorides, sulfites, nitrates, or gas-forming agents.

Table 521.2:1
Enriched Mortar Physical Property Requirements

Property	ASTM Test	Requirements
Compressive strength, minimum (psi)	C-1107	Stiff
		3 day - 4000
		7 day - 5000
		28 day - 8000
		Flowable
		3 day - 3000
		7 day - 3500
Hardened Grout Height Change	C-827	28 day - 5000
		Maximum 0.6%
Pull-out Strength	E-488	20,000 lbf

The Contractor shall provide water in accordance with Section 509.2.6, "Water."

521.3 CONSTRUCTION REQUIREMENTS

The Contractor shall use non-shrink grout in accordance with the manufacturer's recommendations and instructions regarding proportioning, mixing, maximum water content, application, curing temperatures, and curing conditions. If manufacturer's recommendations conflict with this Section, the manufacturer's recommendations shall govern.

521.3.1 Placing, Finishing, and Curing

The Contractor shall clean concrete areas of loose or Deleterious Material that would prevent a bond between the grout and the base concrete surfaces. The Contractor shall flush

areas with water and let dry to a surface dry condition immediately before placing the grout.

The Contractor shall ensure that the grout completely fills recesses and holes, voids under structural members, and at other specified locations. The Contractor shall screed the Material to the specified level, and finish the surface to the specified texture.

521.3.2 Curing

After placing, the Contractor shall cure surfaces of grout in accordance with the manufacturer's recommendations. If the manufacturer recommendations are not specific, cure surfaces in accordance with Section 511.3.9.1, "Method 1, Water Curing."

521.3.2.1 Temperature Requirements

The Contractor shall place grout when the air temperature is at least 45 °F, but less than 95 °F. The Contractor shall not allow the grout temperature to rise above 85 °F during mixing and placing.

The Contractor shall maintain the temperature of the grout at or above 45 °F during the curing period.

521.3.3 Elapsed Time Before Loading

The Contractor shall not allow loads on grout that has been in place less than 72 hours, or as recommended by the manufacturer, unless otherwise directed by the Project Manager.

521.3.4 Grout Defects

The Contractor shall remove and replace improperly cured or otherwise defective grout.

521.4 METHOD OF MEASUREMENT - Reserved

521.5 BASIS OF PAYMENT

521.5.1 Work Included In Payment

The Department considers providing, placing, and curing of non-shrink grout incidental to the completion of the Work and will not measure or pay for it separately.

SECTION 540: STEEL REINFORCEMENT

540.1 DESCRIPTION

This Work consists of providing and placing steel reinforcement.

540.2 MATERIALS

540.2.1 Bar Reinforcement

The Contractor shall provide deformed bars in accordance with AASHTO M 31, Grade 60, or ASTM A706, Grade 60, at the nominal dimensions in accordance with Table 540.2.1:1, "Nominal Dimensions of Reinforcement." AASHTO M31 Grade 40 may be used for Reinforced Concrete for Minor Structures (Section 515 only).

Table 540.2.1:1
Nominal Dimensions of Reinforcement

Bar size	Nominal Weight (lb/ft)	Diameter (inch)
No. 3	0.376	0.375
No. 4	0.668	0.500
No. 5	1.043	0.625
No. 6	1.502	0.750
No. 7	2.044	0.875
No. 8	2.670	1.000
No. 9	3.400	1.128
No. 10	4.303	1.270
No. 11	5.313	1.410
No. 14	7.650	1.693
No. 18	13.600	2.257

540.2.2 Welded Wire Fabric

The Contractor shall provide welded wire fabric in accordance with AASHTO M 55.

540.2.3 Spiral Reinforcement

The Contractor shall provide spiral reinforcement fabricated from steel bars in accordance with AASHTO M 31, or from cold drawn steel wire in accordance with the AASHTO M 32.

540.2.4 Reinforcing Wire

The Contractor shall provide reinforcing wire in accordance with AASHTO M 32.

540.2.5 Corrosion-resistant and Coated Reinforcing Bars

The Contractor may use one (1) of the following corrosion-resistant or coated reinforcement systems for Bridge decks and other concrete components exposed to weather and Road salts:

1. Epoxy-coated reinforcement in accordance with ASTM A775 and from plants certified by the Concrete Reinforcing Steel Institute (CRSI) for the coating and fabrication process;
2. Deformed stainless steel bars in accordance with ASTM A 955;

3. Stainless steel clad deformed steel bars in accordance with AASHTO M 329;
4. Uncoated low-carbon, chromium, steel bars in accordance with AASHTO MP 18 ; or
5. Hot-dipped galvanized reinforcement in accordance with ASTM A767.

540.2.6 Coating and Patching Materials

The Contractor shall provide the following coating and patching Materials:

1. A fusion-bonded powdered epoxy resin coating Material that meets the requirements of ASTM A 775.
2. A liquid, two (2) part epoxy patching Material formulated to be compatible with the fusion-bonded epoxy powder coating, to repair damaged or uncoated areas. The patch Material shall meet the requirements of ASTM A775 Annex A2.
3. Zinc-rich paint with a minimum 65% zinc content in accordance with ASTM A780 for patching damaged and uncoated areas of hot-dip galvanizing.

540.2.7 Accessories

The Contractor shall provide plastic-coated reinforcing tie wire for tying epoxy-coated reinforcing bars, for deformed stainless steel bars, for stainless steel clad deformed steel bars and for uncoated low-carbon, chromium, steel deformed bars. The Contractor shall provide galvanized, annealed wire ties for galvanized reinforcing bars.

The Contractor shall provide continuous chairs or supports which shall be one (1) of the following types of chairs, supports, and clips:

1. Steel, fully coated with plastic or fusion-bonded epoxy.
2. Galvanized steel, with the cradle and the upper two (2) inches of the chair, support, or clip, coated with fusion-bonded epoxy or plastic.
3. Galvanized metal chairs or other metal supports for reinforcement that contacts the exposed concrete surfaces.
4. Galvanized, painted or epoxy-coated metal chairs or other corrosion resistant metal supports for regular reinforcement.
5. Epoxy coated metal chairs or other corrosion resistant metal supports for epoxy-coated reinforcement.
6. Galvanized sand chairs or other metal supports placed directly on the ground; or
7. Concrete blocks in place of sand chairs or other metal supports placed directly on the ground.

The Contractor shall not use uncoated black (ferrous) steel ties, chairs, supports or clips in direct contact with stainless or galvanized reinforcing.

540.2.8 Certificates of Compliance

The Contractor shall provide Certificates of Compliance to the Project Manager with each reinforcing steel shipment.

The Contractor shall show the Project number, the shipping invoice number, name of the manufacturer, pounds shipped, heat numbers, Laboratory test reports, and grade of steel on the Certificates of Compliance. This requirement is the same for each of the coating/cladding systems and the corrosion-resistant systems.

540.2.9 Epoxy-Coated Reinforcing Bar Certificates of Compliance

The Contractor shall submit evidence that the epoxy-coated reinforcing steel furnished for this Project was produced by a plant that is currently Certified by the CRSI.

The Contractor shall provide the Department's Inspector three (3) copies of a Certificate of Compliance for each shipment of coated bars. The Contractor shall state on the certificate that the samples of the coated bars were tested and that the test results were in accordance with ASTM A 775 and this specification. The Contractor shall show epoxy resin batch numbers on the certificate.

The Contractor shall provide coating test results to the Department for inclusion in final inspection reports.

540.2.10 Epoxy-Coated Reinforcing Coating

Epoxy coating shall be applied by the electrostatic spray method or other organic coating methods that meet the requirements of ASTM A 775.

The Contractor shall provide epoxy coated reinforcing steel that is produced by a plant that is currently Certified by the CRSI.

540.2.11 Hot-Dip Galvanized Reinforcing Bars

The Contractor shall provide hot-dip galvanized reinforcing bars in accordance with ASTM A 767. The Contractor shall galvanize bar after cutting and bending.

540.2.12 Galvanizing Material

The Contractor shall provide galvanizing zinc in accordance with ASTM B6.

540.3 CONSTRUCTION REQUIREMENTS

540.3.1 GENERAL

The Contractor shall measure dimensions from centerline of bar to centerline of bar.

The Contractor shall store all reinforcing bars above ground on platform skids or other supports. Reinforcing shall be kept free from dirt, grease, and other foreign matter. Reinforcing shall be kept free of corrosion as far as practicable.

540.3.1.1 Bar Lists and Bending Diagram

When the Contract documents do not include detail bar lists and bending diagrams, the Contractor shall provide such list and diagrams to the State Bridge Engineer for review and approval. The approval of bar lists and bending diagrams shall in no way relieve the Contractor of responsibility for correctness. The bar lists and bending diagrams shall meet the requirements of the current edition of the Concrete Reinforcing Steel Institute's (CRSI) publication Reinforcing Bar Detailing. The Contractor shall allow 30 Days for review of the submittal.

540.3.1.2 Bundling and Tagging

The Contractor shall tag and mark reinforcement bar shipments in accordance with CRSI's *Code of Standard Practice*.

540.3.1.3 Bar Bending

The Department will allow cold bending around a pin. The Contractor shall not field bend Grade 60 bars, epoxy-coated bars or hot-dip galvanized bars.

Unless otherwise directed, the Contractor shall ensure the bend diameter is in accordance with CRSI Manual of Standard Practice current edition.

540.3.1.4 Splicing

The Contractor shall splice bars only in accordance with the Plans unless otherwise approved by the State Bridge Engineer.

The Contractor shall place and tie bars in lapped splices to maintain minimum reinforcing cover.

The Contractor shall splice spiral reinforcement by lapping. The Contractor shall ensure that laps are at least 48 bar or wire diameters, but not less than one (1) ft with 90° hooks around longitudinal bars at ends.

The Department will allow mechanical couplers for AASHTO M 31, Grade 60, and ASTM A706, Grade 60. Mechanical coupler splice strength must be greater than or equal to 125% of the yield strength of the spliced reinforcing bars and must develop the specified tensile strength of the bars. ACI 318 "Type 2" mechanical couplers meet the above splice strength requirements. The Contractor shall submit coupler type (manufacturer and model number) and certified test results from an approved testing agency showing that the coupler meets these requirements.

If the mechanical couplers are included in the Contract Documents, the method of payment for couplers shall be by the each. If the mechanical couplers are not included in the Contract Documents but are requested for the convenience of the Contractor, payment shall be incidental to the reinforcing bar pay item.

If the mechanical couplers are not included in the Contract documents, the Contractor may submit documentation to the Project Manager for showing where mechanical couplers are proposed to be used. The Contractor shall show splice locations and coupler clearance dimensions in the request and submit before fabricating the reinforcing bars that will be coupled. The Contractor shall allow 14 Days for review and approval of submittals.

Unless otherwise specified, the Contractor shall ensure that welded wire fabric and bar-mat reinforcement overlap is at least one (1) spacing of cross wires plus two (2) inches when measured between the outer-most cross wires of each sheet.

540.3.1.5 Field Cutting

Bars may be cut to length in the field by shearing or sawing. Flame cutting will not be permitted. The ends of coated or clad bars cut in the field shall be patched with suitable patching Material.

540.3.1.5.1 Reinforcing Bar Placement

The Contractor shall place reinforcing bars as shown in the Contract drawings, securely tied in position with wire not smaller than 16 gauge. The Contractor shall carefully place, support and tie reinforcing, and place and consolidate concrete around reinforcing with care to avoid any displacement and damage to the coatings.

The Contractor shall tie all intersections where bar spacing is greater than or equal to one (1) ft in either direction. The Contractor shall tie alternate intersections where bar spacing is less than one (1) ft in either direction.

The Contractor shall use metal spacers, chairs, hangers, and other approved devices to hold the reinforcing bars in position.

When using concrete blocks to support the bottom mat of reinforcement in slabs that are cast on ground, the Contractor shall use dense, rectangular concrete blocks that:

1. Have compressive strength and density equal to or greater than the concrete to be placed;
2. Occupy a small area; and
3. Contain embedded, plastic or epoxy-coated, tie wires for attachment of reinforcement.

The Contractor shall not use wooden spacers or supports.

Tie reinforcing bar mats in Bridge deck and concrete box Culvert slabs to beams and forms to prevent upward movement during concrete placement. The Contractor shall ensure that the space between ties does not exceed ten (10) ft.

540.3.1.5.2 Reinforcing Bar Placement Tolerances

The Contractor shall ensure that the space between adjacent bars does not vary more than the greater of ½ inch or 1 /24 of the spacing dimension shown on the Plans.

Except for slabs cast on the ground, the Contractor shall ensure that the clear cover of reinforcement shall not vary more than the greater of either 1/4 inch or 1/8 of the dimension shown on the Plans.

The Contractor shall ensure that the reinforcement clear cover in slabs cast on the ground does not vary more than minus 1/2 inch from the position shown on the Plans.

540.3.1.6 Cleaning Reinforcing Bars

Before placing concrete, the Contractor shall clean the reinforcing bars of Materials that would reduce or destroy the bond.

540.3.1.7 Welding of Reinforcing Steel

The Contractor shall weld reinforcing steel only if the Contract requires it or if the State Bridge Engineer authorizes it in writing. The Contractor shall weld in accordance with AWS Specification D1.4, Reinforcing Steel Welding Code. Welding of bars other than ASTM A706 is allowed only upon approval of qualified welding procedures for those bars that comply with AWS D1.4. The Contractor shall submit a Welding Procedure Specification, stamped by an AWS certified welding Inspector for each procedure.

Welding reinforcing to other steel added by the Contractor for stiffening, cage alignment, lifting, handling and other Contractor needs shall not be allowed unless called for in the Plans.

540.3.1.8 Concrete Cover Requirements

Concrete cover is the distance from the surface of concrete to the edge of the bar nearest to that surface. If cover dimensions are not specified in the Contract, the Contractor shall use the concrete cover dimensions in accordance with Table 540.3.1.8:1, "Concrete Cover Requirements."

**Table 540.3.1.8:1
Concrete Cover Requirements**

Location	Minimum Cover (inch)
Concrete cast against and permanently exposed to the ground	3
Concrete exposed to the ground or weather	
Principal reinforcement	2
Stirrups, ties and spirals	1 ½
Concrete Bridge slabs	
Top reinforcement	2
Bottom reinforcement	1
Concrete not exposed to weather or in contact with ground	
Principal reinforcement	1 ½
Stirrups, ties and spirals	1
Bar bundles	2 ^a
^a Or equal to the diameter of a single bar of equivalent area, whichever is greater.	

540.3.1.9 Final Inspection

The Contractor shall not place concrete until the Department inspects and accepts the reinforcing steel in place.

Acceptance of the reinforcing steel does not relieve the Contractor of responsibility for the cover and position control of the steel.

540.3.2 Requirements for Epoxy-Coated Reinforcing Bars

540.3.2.1 Storage and Handling of Epoxy-Coated Reinforcing Bars

The Contractor shall transport and store epoxy-coated reinforcing steel on wooden or padded supports. The Contractor shall use devices with padded contact areas to handle epoxy-coated reinforcement bars and prevent bar-to-bar abrasion. The Contractor shall not drop or drag bars or bundles. The Contractor shall use spreader beams and multiple pick points when hoisting bar bundles to prevent sagging. The Contractor shall not store epoxy-coated reinforcing bars in sunlight for more than 30 Days. The Contractor shall use only non-metallic sleeved heads with immersion-type vibrators when placing concrete around epoxy-coated reinforcing.

540.3.2.2 Repair of Damaged Epoxy-Coating

The Contractor shall repair visible damage before shipping. The Contractor shall ensure the total surface area of patched coating Material is not more than one percent (1%) of the total coated area in any one (1) foot section. The Department will reject bars shipped to the Project that show more than one percent (1%) patched coating Material.

The Contractor shall patch sheared ends, cuts and exposed areas promptly before detrimental oxidation occurs. The Contractor shall keep exposed areas free of contaminants before patching.

The Contractor shall patch coating damage before placing concrete. The Contractor shall ensure that the total patched surface area does not exceed two percent (2%) of the coated area in any one (1) foot section. The Department will reject any installed bars with more than two percent (2%) patching.

The Contractor shall apply the patching Material in strict compliance with the manufacturer's instructions. The Contractor shall allow adequate time for the patch to cure before placing concrete over the bars.

540.3.3 Requirements for Galvanized Reinforcing Bars

540.3.3.1 Galvanizing Bent Bars

Where galvanized bars are detailed to be bent or have other types of cold-forming, the bars must be bent before galvanizing.

540.3.3.2 Surface Preparations

The Contractor shall prepare bar surfaces by removing dirt and grease with a hot alkaline solution. The Contractor shall use a diluted solution of sulfuric acid to pickle. The Contractor shall use a solution of zinc ammonium chloride to flux. The Contractor shall ensure that the resulting surface condition is equal to SSPC-SP 10 as described by the SSPC.

540.3.3.3 Thickness of Galvanizing

The Contractor shall ensure that the galvanizing after drying with air, steam or wiping is from three (3) mils to 3.9 mils thick. The Contractor shall determine the thickness with a magnetic thickness gage.

540.3.3.4 Chromating

The Contractor shall treat the galvanized coating with chromate. This prevents a reaction between the bars and fresh Portland cement paste. The Department will allow proprietary chromating treatment solutions of equivalent strength instead of the generic chemical treatment in accordance with ASTM A 767, Section 5.3. Quenching of bent bars or bars to be bent is not allowed. Such bars must be chromated at ambient temperature.

540.3.3.5 Finish and Adherence of Coating

The Contractor shall ensure that the zinc coating is free of bare spots, blisters, flux spots or inclusions, dross, and acid or black spots. The Department will reject bars that stick together after galvanizing. A matte gray finish appearance is not, by itself, a cause for rejection.

The Contractor shall ensure that the coating cannot be removed through normal handling.

540.3.3.6 Installation of Galvanized Reinforcing Bars

The Contractor shall transport and store galvanized bars in a manner to prevent damage to the galvanized coating. All systems for handling galvanized coated bars shall have padded

contact areas. All bundles of bars shall be lifted using spreader beams and multiple pick points or a platform Bridge to prevent bar-to-bar abrasion from sagging in the bar bundle. The bars and bundles shall not be dropped or dragged on the ground, platforms or other bars.

Galvanized reinforcing bars shall not be tied with black steel or left in contact with black steel. Galvanized reinforcing bars shall be left in contact only with galvanized, plastic-coated, or epoxy-coated surfaces.

540.3.3.7 Repair of Damaged Galvanizing

The Contractor shall patch sheared ends, cuts and exposed areas using a zinc-rich paint in accordance with ASTM A780. The Contractor shall prepare the surface to be patched so that it is clean, dry and free of oil, grease and corrosion products. The Contractor shall blast-clean the surface to near-white metal, in accordance with SSPC-SP10. The Contractor shall spray or brush-apply the paint containing the zinc dust as recommended by the manufacturer in one (1) application of as many passes as required to achieve a dry film thickness of four (4) mils as determined using a magnetic or electromagnetic gage.

540.3.4 Repair of Stainless Steel Clad Deformed Steel Bars

The stainless steel clad deformed steel bars shall be shop bent as shown on the Contract documents using tools with non-ferrous surfaces that will not contaminate stainless steel cladding with ferrous particles. All ends of the bars where mild steel core is exposed shall be capped by one (1) of the following methods:

1. Heat shrink cap applied in accordance with the cap manufacturer's instructions.
2. Neoprene cap adhered with silicone or epoxy sealant.
3. Stainless steel cap epoxied in place.
4. Stainless steel seal weld.

No field cutting or bending of stainless steel clad deformed steel bars will be allowed.

540.4 METHOD OF MEASUREMENT

The Department will measure reinforcing bar weight in accordance with Table 540.2.1:1, "Nominal Dimensions of Reinforcement," whether it is black steel, epoxy-coated, galvanized, stainless steel, stainless steel clad, or low-carbon, chrome steel. The computed weights of reinforcing bars will be based on the nominal weights of the bars before application of the epoxy-coating, or galvanizing of the bars. Lap splices shown in the Contract documents shall be included in computing the weight of the bars for payment. For CBC construction, lap splice weight shall be included in computing the weight of the bars for payment when phased construction is required by the Contract documents and when maximum run lengths exceed 60 feet. When lap splices are unscheduled or are made for the convenience of the Contractor and are approved by the Project Manager at locations not shown in the Contract, the extra steel required for lap splices will not be included in computing the weight of the bars for payment. Mechanical couplers that are shown in the Contract documents or are required for construction shall be paid for by "Each." When mechanical couplers are installed for the convenience of the Contractor and are approved by the State Bridge Engineer at locations not shown in the Contract, the mechanical couplers will not be paid for.

540.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Reinforcing Bars, Grade ____	Pound

<i>Epoxy-Coated Reinforcing Bars, Grade ____</i>	Pound
<i>Galvanized Bars, Grade ____</i>	Pound
<i>Uncoated Corrosion Resistant Reinforcing Bars, Grade ____</i>	Pound
<i>Stainless Steel Reinforcing Bars, Grade ____</i>	Pound
<i>Stainless Steel Clad Reinforcing Bars, Grade ____</i>	Pound
<i>Mechanical Couplers</i>	Each

540.5.1 Work Included in Payment

The following Work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

1. Clips, supports, wire, and other Material used for fastening reinforcement;
2. Samples and submittals; and
3. Mechanical couplers and reinforcing bar lap splices that are installed for the convenience of the Contractor.

SECTION 602: SLOPE AND EROSION PROTECTION STRUCTURES

602.1 DESCRIPTION

This Work consists of providing and placing riprap, gabions, revetment mattresses, sacked concrete revetment, concrete block revetment, wrapped rock faces, and other systems on the Embankment slopes and the sides and bottoms of channels, drain outlets, ditches, and other such locations.

602.2 MATERIALS

Unless otherwise specified in the Contract, the Contractor shall provide slope protection Structures as follows:

1. Hexagonal double-twisted wire mesh riprap, gabions, and revetment mattresses; or
2. Welded wire mesh gabions, revetment mattresses, and wrapped rock faces.

The Contractor shall provide galvanized slope protection items in accordance with ASTM A 641. If specified in the Contract, the Contractor shall coat galvanized items with PVC in accordance with Section 602.2.2.9, "PVC Coating."

The Contractor shall provide double-twisted riprap, gabions, and revetment mattresses in accordance with ASTM A 975. The Contractor shall provide welded wire mesh gabions, revetment mattresses, and wrapped rock faces in accordance with ASTM A 974.

602.2.1 Classifications

The Department will classify riprap and gabions in accordance with Table 602.2.1:1, "Riprap Classifications and Gabion Requirements."

The Contractor shall provide riprap with at least 80% of the stones meeting the specified size requirements. The Contractor shall use stones less than the minimum dimensions to fill voids. For riprap Class A, wrapped rock faces, and gabions, the Contractor shall not use stones smaller than the mesh openings.

The Department will classify riprap and gabions in accordance with Table 602.2.1:1 "Riprap Classifications and Gabion Requirements" with the exception of Class D, Derrick Stone. Class D, Derrick Stone will follow the gradation requirements in Table 602.2.1:2 "Gradation Requirements for Class D, Derrick Stone" shown below.

Table 602.2.1:1
Riprap Classifications and Gabion Requirements

Class	Description	Stone volume (ft ³)		Minimum dimension (in) ^a
		Minimum	Maximum	
A	Wire enclosed riprap	1/6	2/3	4
B ^b	Non-enclosed riprap	1	2	6
C ^b	Non-enclosed riprap	2	4	9
E	Grouted riprap	1/3	1	3
F	Grouted riprap	1	2	6
G	Rock plating	—	—	4–8 ^c

Table 602.2.1:1
Riprap Classifications and Gabion Requirements

Class	Description	Stone volume (ft ³)		Minimum dimension (in) ^a
		Minimum	Maximum	
N/A	Wrapped rockfacing	—	—	1
N/A	Gabions	—	—	4–8 ^c

^aMinimum size in the least dimension.

^bClass B and C stone — at least two (2) Fractured Faces.

^c70% to 80% of the stone — at least four (4) inches but not more than eight (8) inches in the smallest dimension. 30 to 20% of the stone — no larger than four (4) inches in any dimension.

Table 602.2.1:2
Gradation Requirements for Class D, Derrick Stone

Class, Description	Percent of Rock Equal or Smaller By Count, D _x	Range of Intermediate Dimension ¹ , (inches)	Range of Rock Weight ² , (pounds)
D, Derrick Stone ³	100	30	5000
	70	24 – 18	1780 – 2500
	40	11 – 14	360 – 500
	20	6 – 8	70 - 100
¹ Intermediate dimension measured as the shortest straight-line distance from one side of the rock or rock particle to the other on the maximum projection plane (plane of rock or rock particle with the largest projected surface area). ² Weights based on a specific gravity of 2.65. ³ Include spalls and rock fragments to provide a stable dense mass.			

602.2.2 Riprap, Gabions, and Revetment Mattresses

602.2.2.1 Stone for Riprap, Gabions, Revetment Mattresses, and Rock Faces

Except for Class G riprap, the Contractor shall provide rocks or rough quarry stone with no more than 60% wear, in accordance with AASHTO T 96. The Contractor shall provide stone with a soundness loss of no more than 21, in accordance with AASHTO T 104 using a magnesium sulfate solution with a five (5)-cycle test duration.

The Contractor shall provide stone for riprap, gabions, revetment mattresses, and rockfaces in accordance with Section 602.2.1, "Classifications."

602.2.2.2 Wire Mesh

The Contractor shall provide non-raveling, double-twisted wire mesh forming hexagons for riprap, gabions, and revetment mattresses in accordance with Section 602.2.2.3, "Pull-Apart Test." The Contractor shall provide non-raveling welded wire mesh for gabions, wrapped rock faces, and revetment mattresses forming squares or rectangles in accordance with ASTM A 974, Section 7, *Material Properties*, except that the strength requirement for mattress joints is 900 lb per foot instead of 600 lb per foot.

602.2.2.2.1 Wire

The Contractor shall provide soft temper wire with a Class 3 zinc coating for constructing wire mesh in accordance with ASTM A 641. The Contractor shall provide 0.120-inch diameter wire for gabions and riprap and 0.087-inch diameter wire for revetment mattresses and wrapped rock faces.

602.2.2.2.2 Mesh Openings

The Contractor shall ensure that mesh openings are uniform and hexagonal. The Contractor shall make mesh openings for riprap and double-twisted gabions approximately 3 1/4 inch × 4 3/4 inch, and for double-twisted revetment mattresses approximately 2 1/2 inch × 3 1/4 inch. The Contractor shall make mesh openings for welded wire mesh gabions approximately three (3) inch × three (3) inch, and for welded wire mesh revetment mattresses and wrapped rock faces approximately 1 1/2 inch × three (3) inch.

602.2.2.2.3 Selvedges

The Contractor shall mechanically selvedge the edges of double-twisted gabions, revetment mattresses, and wrapped rock face, including, end panels and diaphragms. The Contractor shall use a selvedge wire with a diameter of at least 0.150 inch.

602.2.2.2.4 Lacing and Tie Wire

The Contractor shall provide lacing wire for double-twisted gabions, revetment mattresses, and wrapped rock faces with a diameter of at least 0.087 inch. The Contractor shall provide tie wire for double-twisted gabions and revetment mattresses with a diameter of at least 0.087 inch. The Contractor shall provide tie wire for riprap with a diameter of at least 0.120 inch. The Contractor shall provide lacing and tie wire with the same tensile strength and coating as the mesh wire.

602.2.2.2.5 Spiral Binders

The Contractor shall provide spiral binders for welded wire mesh gabions, revetment mattresses, and wrapped rock faces, of the same wire quality as the mesh wire with a diameter of at least 0.106 inch. Unless otherwise approved, the Contractor shall provide spiral binders with a maximum inside diameter of 2 1/2 inches and with a maximum pitch of three (3) inches.

602.2.2.2.6 Alternate Fasteners

The Contractor may use alternative fasteners, such as ring fasteners, with double-twisted wire mesh, and welded wire mesh riprap, gabions, revetment mattresses, and wrapped rock faces, if approved by the Project Manager. The Contractor shall provide wire for alternative fasteners in accordance with Section 602.2.2.2.5, "Spiral Binders."

602.2.2.2.7 Minimum Strength of Fasteners

The Contractor shall use fasteners that provide a minimum strength of 1,400 lb per foot for gabion baskets, and 900 lb per foot for revetment mattresses and wrapped rock faces.

602.2.2.2.8 Approval of Alternative Fasteners

The Contractor shall use a certified Laboratory to test alternative fasteners in accordance with Section 602.2.2.3, "Pull-Apart Test." At least 60 Days before using alternative fasteners, the Contractor shall submit CTRs to the Project Manager verifying that the fasteners meet the pull-apart test requirements.

The Contractor shall provide a description of the fastener, with drawings and photographs showing the number of fasteners required, details of the fasteners, and load capacities. In addition the Contractor shall:

1. Lock and close each interlocking fastener. For gabions, use fasteners in every other opening. For revetment mattresses and wrapped rock faces, use fasteners in every opening; and
2. Close each overlapping ring fastener and overlap ends a minimum of one (1) inch. Provide one (1) ring for each opening.

The Department will allow this fastener for forming individual baskets, but not for interconnecting baskets.

602.2.2.2.9 PVC Coating

The Contractor shall provide PVC coating with an average thickness of 0.0216 inch and a minimum thickness of 0.0150 inch per side. The Contractor shall apply PVC coating over the galvanizing.

The Contractor shall coat the galvanized wire with extruded or fusion bonded PVC Material. Unless otherwise specified, the Contractor shall use a gray or green colored coating. The Contractor shall use a PVC coating that meets the following requirements:

1. Specific gravity of from 1.20 to 1.40, if tested in accordance with ASTM D 792;
2. Abrasion resistance of less than 12% weight loss, if tested in accordance with ASTM D 1242-95A, Method B at 200 cycles, CSI-A Abrader Recording, 80 grit;
3. Brittleness temperature no higher than 15° F, if tested in accordance with ASTM D 746;
4. Tensile strength no less than 2,980 psi for extruded coating, if tested in accordance with ASTM D 412; and no less than 2,275 psi for fusion bonded coating, if tested in accordance with ASTM D 638;
5. Modulus of elasticity no less than 2,700 psi at 100% strain for extruded coating, if tested in accordance with ASTM D 412; and no less than 1,980 psi at 100% strain for fusion bonded coating, if tested in accordance with ASTM D 638;
6. Ultraviolet light exposure for a test period of no less than 3,000 h, using apparatus Type E at 145 °F, if tested in accordance with ASTM G 152; and
7. Salt spray test for a test period of no less than 3,000 h, if tested in accordance with ASTM B 117.

602.2.2.3 Pull-Apart Test

602.2.2.3.1 Sample Preparation

The Contractor shall prepare two (2) identical rectangular panels along a selvedge wire, each about 10 1/2 mesh-openings wide. The Contractor shall attach the two (2) panels along the two (2) selvedge wires using the proposed fastener system. If the Contractor uses alternative fasteners to join two (2) individual gabion baskets, the Contractor shall include two (2) additional selvedge wires (each mechanically wrapped with mesh wires) so that each fastener contains two (2) selvedges and two (2) mesh wires.

602.2.2.3.2 Test Procedures

The Contractor shall mount the joined test panels in a loading machine with grips or

clamps that secure the panels uniformly along the full width. The Contractor shall use grips or clamps designed to transmit only tension forces. The Contractor shall apply the load at a uniform rate of 50.7 lb per second until failure occurs. The Department will define failure as a drop in strength under continuous loading or, when an opening between two (2) joined selvedge wires exceeds two (2) inch. The minimum allowable strength at failure is 1,400 lb per foot for joined gabions; and 900 lb per foot for joined revetment mattresses and wrapped rock face panels.

602.2.2.4 Certification

The Contractor shall submit a certificate, to the Project Manager, stating that the following proposed items meet the requirements of this Specification before their use:

1. Wire mesh;
2. Gabion baskets;
3. Lacing wire;
4. Tie wire; and
5. Approved alternative fastener systems.

602.2.2.5 Stakes

The Contractor shall use steel railroad rails, standard weight galvanized steel pipe, or steel angles for riprap stakes. The Contractor shall use railroad rails with a unit weight of at least 30 lb per yard. The Contractor shall use standard weight galvanized steel pipe with a minimum outside diameter of four (4) inches. The Contractor shall use steel angles that are at least four (4) × four (4) × 3/8 inch.

602.2.2.6 Grout

The Contractor shall provide portland cement, aggregate, and water for grout in accordance with Section 509, "Portland Cement Concrete Mix Designs."

602.2.2.7 Material

The Contractor shall provide geotextile (filter fabric) Class one (1) as per Section 604, "Soil and Drainage Geotextiles."

602.2.3 Sacked Concrete Revetment

The Contractor shall provide sacked concrete revetment from a vendor on the Department's *Approved Products List*. The Contractor shall provide bags of concrete that weigh from 60 lb to 80 lb each, dry weight, and contain from 0.018 yd³ to 0.025 yd³ of concrete. The Contractor shall ensure each bag contains one (1) of the following mixes:

1. One (1) part cement to three (3) parts sand;
2. A mix design in accordance with the Contract; or
3. A mix design approved by the State Materials Bureau.

The Contractor shall provide a concrete mix capable of attaining a minimum compressive strength of 3,500 psi after 28 Days, unless otherwise specified in the Contract. The Contractor shall keep the sacked concrete in dry storage until application.

602.2.3.1 Packaging

The Contractor shall use permeable, biodegradable sacks made of jute, cotton, or scrim-reinforced paper that are capable of holding the sand-cement mix without significant leakage and allowing sufficient water to hydrate the concrete mix.

The Contractor shall provide non-asphaltic, three (3)-layer laminated, polyester-fiber-scrim-reinforced paper sacks. The Contractor shall perforate each of the three (3) layers and offset the perforations to prevent cement leakage.

The Contractor shall use only one (1) type and size of sack throughout the Project, unless otherwise specified in the Contract.

602.2.3.2 Portland Cement

The Contractor shall provide portland cement in accordance with Section 509, "Portland Cement Concrete Mix Designs."

602.2.3.3 Aggregate

The Contractor shall provide fine aggregate in accordance with Section 509, "Portland Cement Concrete Mix Designs."

602.2.3.4 Steel Anchorage

The Contractor shall provide steel staples in accordance with Section 540, "Steel Reinforcement." The Contractor shall use steel staples either epoxy coated in accordance with AASHTO M 284, or galvanized in accordance with ASTM A 153.

602.2.4 Concrete Block Revetment

The Contractor shall provide concrete block revetment products from the Department's *Approved Products List*. The Contractor shall provide concrete block units compatible with the geotextiles being used and with a minimum compressive strength of 3,000 psi, unless otherwise specified in the Contract.

602.3 CONSTRUCTION REQUIREMENTS

602.3.1 General Placement Requirements

The Contractor shall place riprap stones forming a continuous blanket in accordance with the Contract. Unless otherwise specified, the Contractor shall construct rock plating using riprap Class G to minimum thickness of 12 inches. The Contractor shall place stones with the long axis parallel to the toe of the slope, with a stable bearing upon the underlying soil or stones.

The Contractor shall place large stones as close together as possible. The Contractor shall use smaller stones to fill the areas between the larger stones, except when the Contract requires Class E or F (grouted) riprap.

The Contractor shall ensure that the finished riprap surface varies no more than three (3) inches from the specified slope; and derrick stone riprap varies no more than eight (8) inches from the specified slope.

Unless otherwise specified, the Contractor shall place the riprap foundation course in a trench excavated to 24 inches below the toe of the slope of the Embankment or side of channel.

The Contractor shall place a layer of Class 1 geotextile filter fabric between the slope and erosion protection Structures, and the backfill Material.

602.3.1.1 Grouted Riprap Placement

The Contractor shall fill riprap voids with grout to the full riprap thickness. After placing grout, the Contractor shall sweep the riprap surface with a stiff broom.

The Contractor shall protect grout from freezing for at least four (4) Days after placement.

The Contractor shall cure grouted riprap placed in hot, dry weather in accordance with Section 511.3.9, "Curing."

602.3.1.2 Proportioning and Mixing Grout

The Contractor shall use grout that consists of one (1) part portland cement and three (3) parts fine aggregate (by volume). The Contractor shall mix with water to a workable consistency.

602.3.1.3 Class A Riprap Placement

The Contractor shall enclose Class A riprap with wire mesh drawn tightly on all sides. The Contractor may connect wire mesh using approved fasteners or lacing wire. The Contractor shall weave adjacent edges at least once with double loops of lacing wire that is as strong and flexible as the mesh.

The Contractor shall provide continuous lacing as far as possible that passes through each mesh opening. Where splicing is necessary, the Contractor shall overlap the lacing at least 12 inches.

The Contractor shall space galvanized wire ties connecting top and bottom mesh layers approximately 24 inches on centers. The Contractor shall anchor the ties to the bottom wire-fabric layer. The Contractor shall extend the ties through the rock layer and secure to the top wire-fabric layer. The Contractor shall anchor wire-enclosed riprap to slopes with steel stakes driven into the Embankment. The Contractor shall space stakes in accordance with the Contract.

602.3.1.4 Placement of Geotextile

The Contractor shall place Class 1 non-woven geotextile (filter fabric) between the riprap or revetment mattresses and the supporting soil. The Contractor shall ensure that the fabric is in accordance with Section 604, "Soil and Drainage Geotextiles."

602.3.2 Sacked Concrete Revetment Placement

The Contractor shall place sacked concrete revetment within ± 0.2 ft of the specified grade and slope, or as directed by the Project Manager.

The Contractor shall place the foundation course in a trench excavated to 24 inches below the toe of the slope of the Embankment or side of channel. The Contractor shall stagger the sack ends and steel staple anchors of succeeding courses.

The Contractor shall tamp each row of sacks, round out the bags, eliminate wrinkles, minimize voids, and prepare an even surface for the next row.

The Contractor shall obtain the Project Manager's approval of the compaction method prior to backfill and compact soil behind each row of sacks before placing the next row. The Contractor shall not place large stones and jagged objects adjacent to the bags.

The Contractor shall anchor the sacks with steel staples without damaging the sacks.

After placing the sacks, the Contractor shall wet thoroughly and keep moist for at least three (3) Days.

602.3.3 Concrete Block Revetment Placement

The Contractor shall construct concrete block revetment systems in accordance with the manufacturer's recommendations and the Contract.

The Contractor shall remove slope obstructions, and fill voids with approved Material or grade slopes before placing concrete blocks.

602.3.4 Gabions

The Contractor shall supply gabions within \pm five percent (5%) of the manufacturer's stated sizes.

602.3.4.1 Assembly of Gabion Baskets

The Contractor shall fabricate gabions for individual assembly at the construction site.

If a gabion is greater than 1 1/2 times as long as it is wide, the Contractor shall divide the gabion into cells using diaphragms of the same wire mesh as the body of the gabion. The Contractor shall create cells that are no longer than the gabion is wide and anchor diaphragms to the base section of the gabion. The Contractor shall selvages or bind perimeter edges so the joints are as strong as the gabion body. The Contractor shall assemble perimeter edges using approved fasteners or lacing wire. The Contractor shall place fasteners in each mesh opening. The Contractor shall secure lacing wire by double looping through every other mesh opening. The Contractor shall assemble gabions using one (1) of the following:

1. Double looped lacing twice; or
2. Connect with approved fasteners and double looped lacing once.

602.3.4.2 Foundation Preparation

The Contractor shall level and compact the top six (6) in of the gabion foundation to at least 95% of maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified), and to field densities in accordance with AASHTO T 310.

602.3.4.3 Placement of Gabion Baskets

The Contractor shall set assembled, empty baskets into the specified positions and wire each unit to adjacent units along the top and vertical edges before placing stone.

602.3.4.4 Placement of Gabion Stone

The Contractor shall place stone in equal layers of from nine (9) inch to 12 inch. The Contractor shall minimize local deformations by not filling a gabion more than 12 inches higher than an adjacent gabion. The Contractor shall hand place stone at exposed surfaces.

The Contractor shall provide cross-connecting wires on gabions with cells 18 inches or higher. The Contractor shall place cross connecting wires directly above each layer of stone. The Contractor shall equally space and tightly tie two (2) connecting wires in each direction for each layer through two (2) mesh openings at opposite faces of each gabion cell.

The Contractor shall maintain alignment while filling gabions (minimizing voids and bulges, and finishing to a neat square appearance).

After filling, the Contractor shall bend the lid over and tightly bind to the perimeters and diaphragms in accordance with Section 602.3.4.1, "Assembly of Gabion Baskets."

602.3.4.5 Gabion Marking

The Contractor shall mark each gabion in an identifiable manner that clearly indicates its size.

602.3.4.6 Placement of Geotextile

The Contractor shall install Class 1 non-woven geotextile (filter fabric) between gabion baskets and supporting soil, and between gabion baskets and backfill.

602.3.5 Placement of Wrapped Rock Faces

The Contractor shall place wrapped rock faces within ± 0.2 ft of the specified grade and slope.

The Contractor shall place the foundation course 18 inches below the toe of the slope of the Embankment or side of channel.

The Contractor shall place each level of welded wire forms with biaxial geogrid embedded in the rock face in accordance with the Contract, and tensioned with anchor pins to remove slack. The Contractor shall lap the geogrid a minimum of 12 inches at the edges of adjacent panels. The Contractor shall tamp the welded wire form face to eliminate wrinkles, minimize voids, and finish to an even surface.

The Contractor shall backfill and compact behind each welded wire form level before placing the next row. The Contractor shall obtain the Project Manager's approval of the compaction method.

602.4 METHOD OF MEASUREMENT

The Department will measure *Riprap Class___ and Sacked Concrete Revetment* based on the specified thickness and Accepted surface area.

The Department will measure *Concrete Block Revetment* and *Wrapped Rockfacing* based on the Accepted surface area.

The Department will measure *Gabions* and *Revetment Mattresses* based on the specified basket dimensions.

602.5 BASIS OF PAYMENT

Pay Item

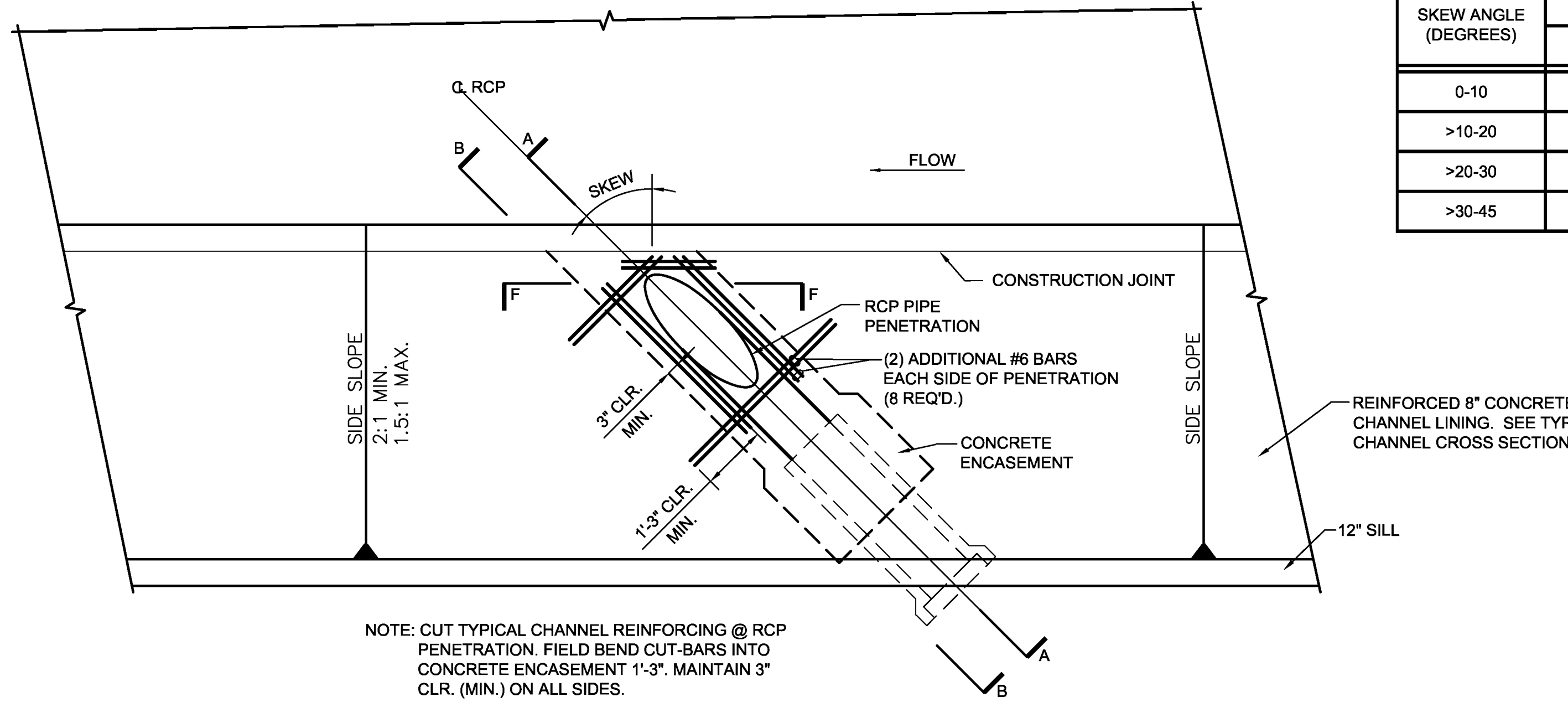
Pay Unit

<i>Riprap Class ____</i>	Cubic Yard
<i>Riprap Class G</i>	Square Yard
<i>Sacked Concrete Revetment</i>	Cubic Yard
<i>Concrete Block Revetment</i>	Square Yard
<i>Gabions</i>	Cubic Yard
<i>Revetment Mattresses</i>	Cubic Yard
<i>Wrapped Rockfacing</i>	Square Yard

602.5.1 Work Included in Payment

The following Work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

1. Excavation, backfilling and disposal of Material required for the placement of slope and erosion protection Structures;
2. Dewatering; and
3. Stakes and steel staples, drainage geotextile(s).



NOTE: CUT TYPICAL CHANNEL REINFORCING @ RCP PENETRATION. FIELD BEND CUT-BARS INTO CONCRETE ENCASEMENT 1'-3". MAINTAIN 3" CLR. (MIN.) ON ALL SIDES.

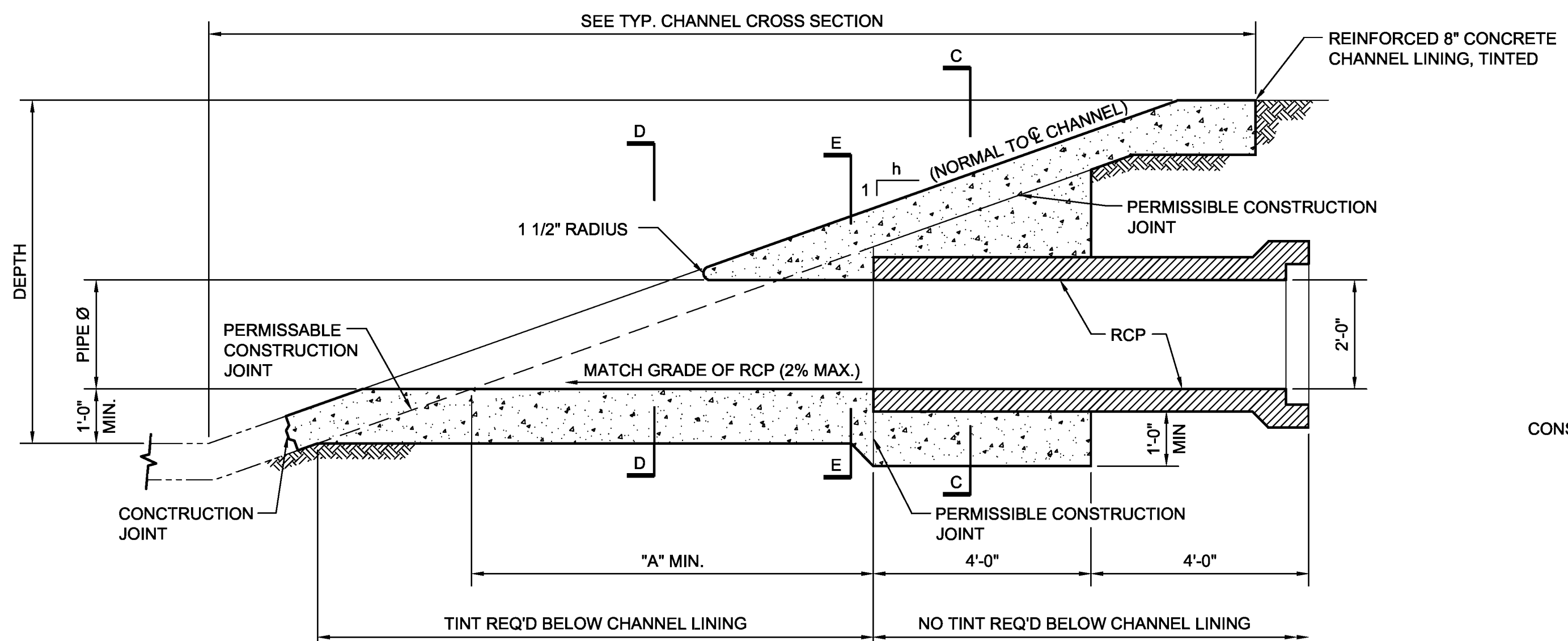
PIPE PENETRATION (PLAN VIEW)
NO SCALE

DIMENSION "A" FOR 1.5:1 SIDE SLOPE								
SKEW ANGLE (DEGREES)	PIPE DIAMETER (INCHES)							
	24	30	36	42	48	54	60	72
0-10	4'-9"	5'-6"	6'-3"	7'-0"	7'-10"	8'-7"	9'-4"	10'-10"
>10-20	4'-11"	5'-8"	6'-5"	7'-3"	8'-1"	8'-11"	9'-8"	11'-3"
>20-30	5'-2"	6'-0"	6'-11"	7'-9"	8'-7"	9'-6"	10'-4"	12'-1"
>30-45	5'-11"	7'-0"	8'-1"	9'-2"	10'-2"	11'-3"	12'-4"	14'-5"

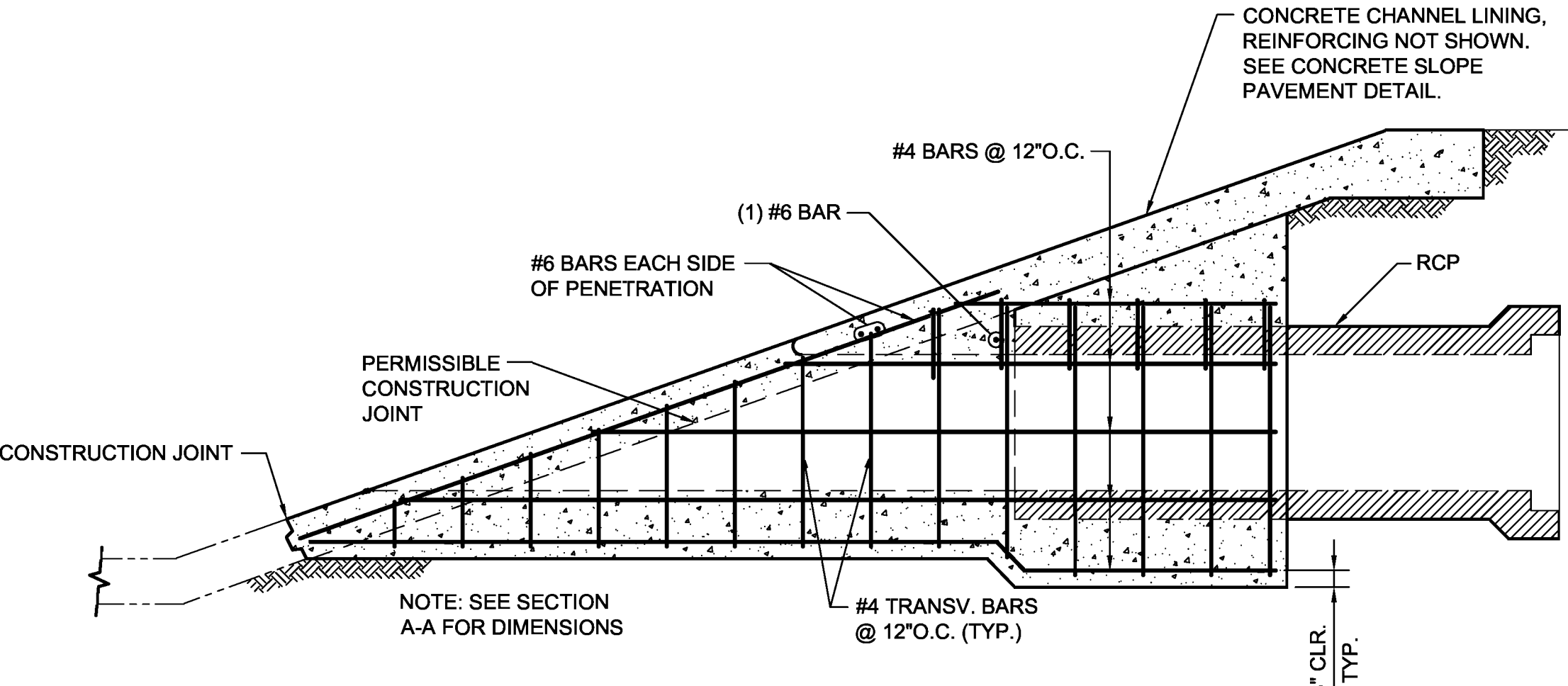
DIMENSION "A" FOR 2:1 SIDE SLOPE								
SKEW ANGLE (DEGREES)	PIPE DIAMETER (INCHES)							
	24	30	36	42	48	54	60	72
0-10	5'-9"	6'-9"	7'-10"	8'-10"	9'-10"	10'-10"	11'-11"	13'-11"
>10-20	5'-11"	7'-0"	8'-1"	9'-2"	10'-3"	11'-3"	12'-4"	14'-6"
>20-30	6'-4"	7'-6"	8'-7"	9'-9"	10'-11"	12'-1"	13'-3"	15'-7"
>30-45	7'-4"	8'-9"	10'-2"	11'-7"	13'-0"	14'-5"	15'-10"	18'-9"

DIMENSION "B"								
PIPE DIAMETER (INCHES)								
24	30	36	42	48	54	60	72	
10"	11"	1'-1"	1'-2"	1'-3"	1'-4"	1'-6"	1'-8"	

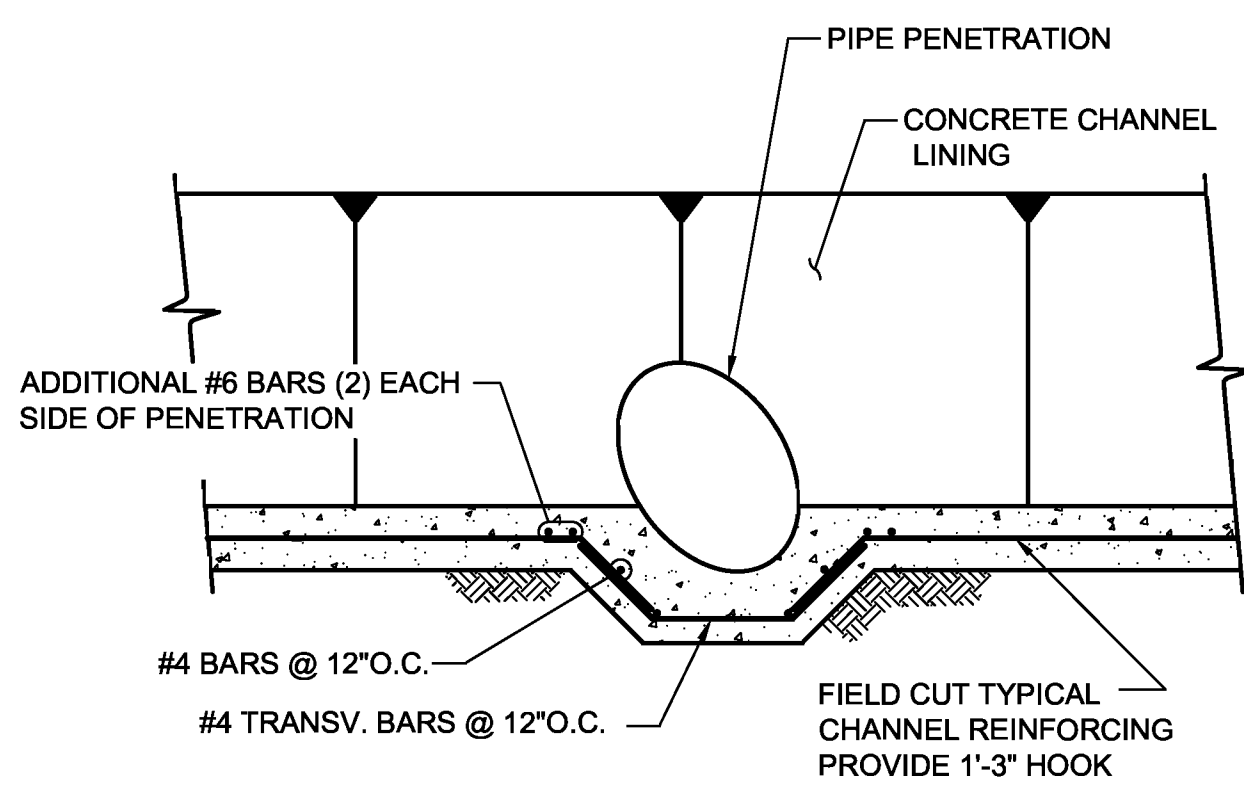
- GENERAL NOTES:**
1. THE PIPE PENETRATION DETAILED HEREIN SHALL BE PAID FOR UNDER LUMP SUM AND SHALL BE COMPENSATION FOR THE PENETRATION COMPLETE AND IN PLACE. INCLUDED IN THIS WORK (BUT NOT LIMITED TO) IS GRADING, SUBGRADE PREPARATION, REINFORCED CONCRETE, CONSTRUCTION JOINTS, CONCRETE PLACEMENT AND FINISHING. NOTE THE MEASUREMENT FOR 8" CHANNEL LINING IS CONTINUOUS AND UNINTERRUPTED AT THE PENETRATION LOCATION.
 2. ALL CULVERT PIPE PLACED UNDER THE CHANNEL LINING OR WITHIN AMAFCA RIGHT-OF-WAY SHALL BE RCP CLASS III MIN.
 3. FOR PIPE PENETRATIONS INTO EXISTING CHANNELS, USE CHANNEL REMOVAL DETAILS FROM AMAFCA STANDARD DRAWING 102.



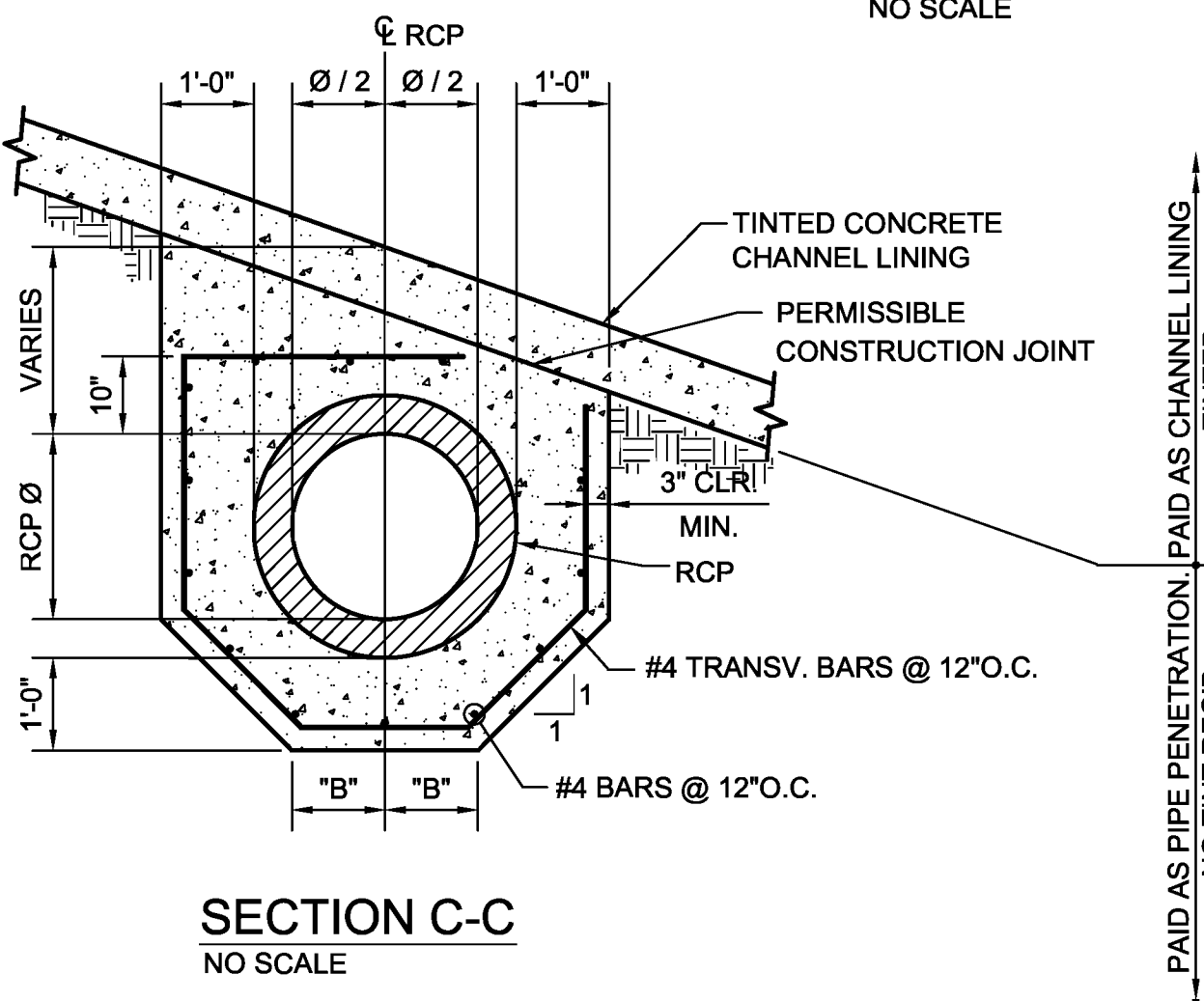
SECTION A-A
NO SCALE



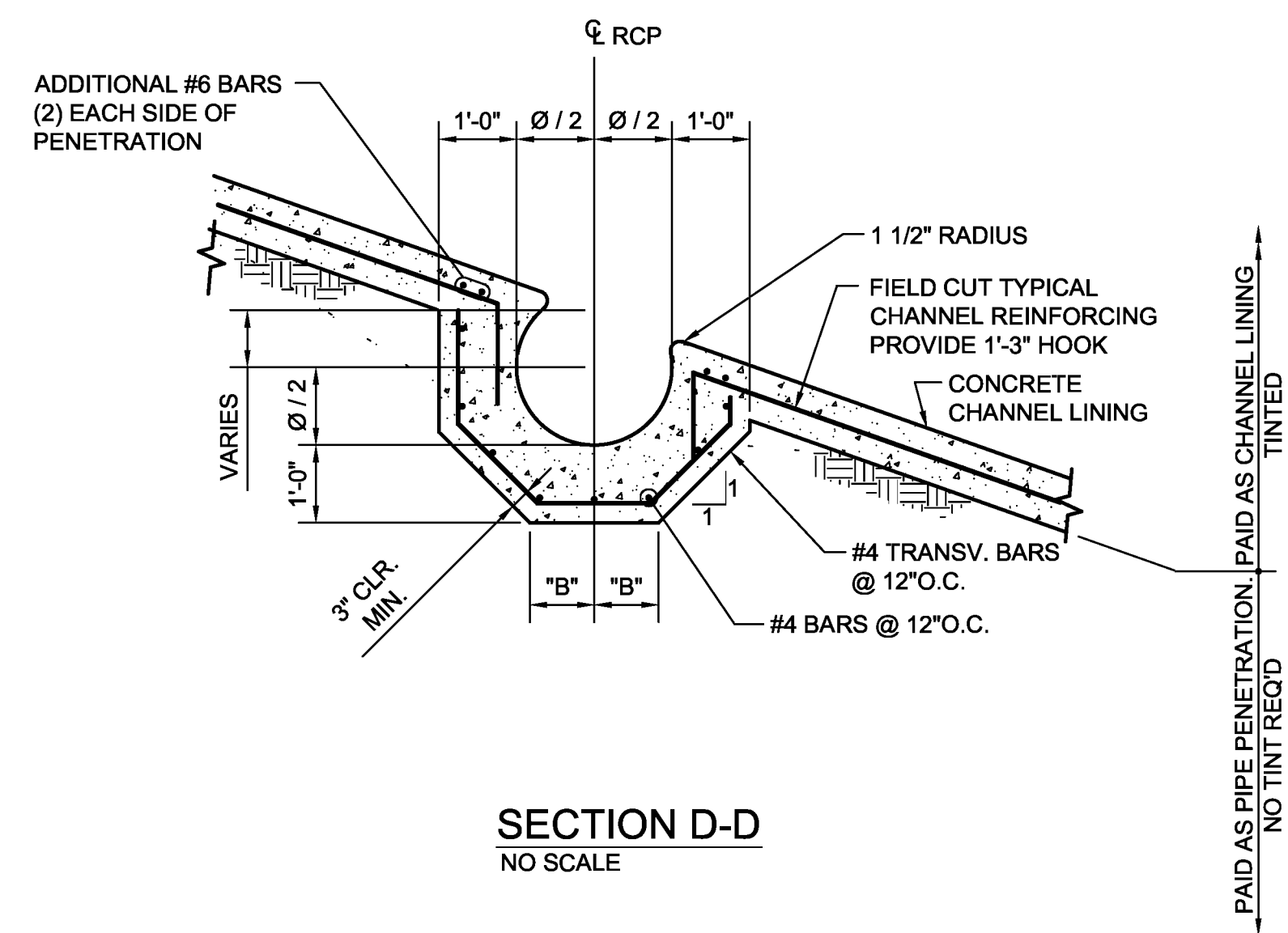
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NO SCALE



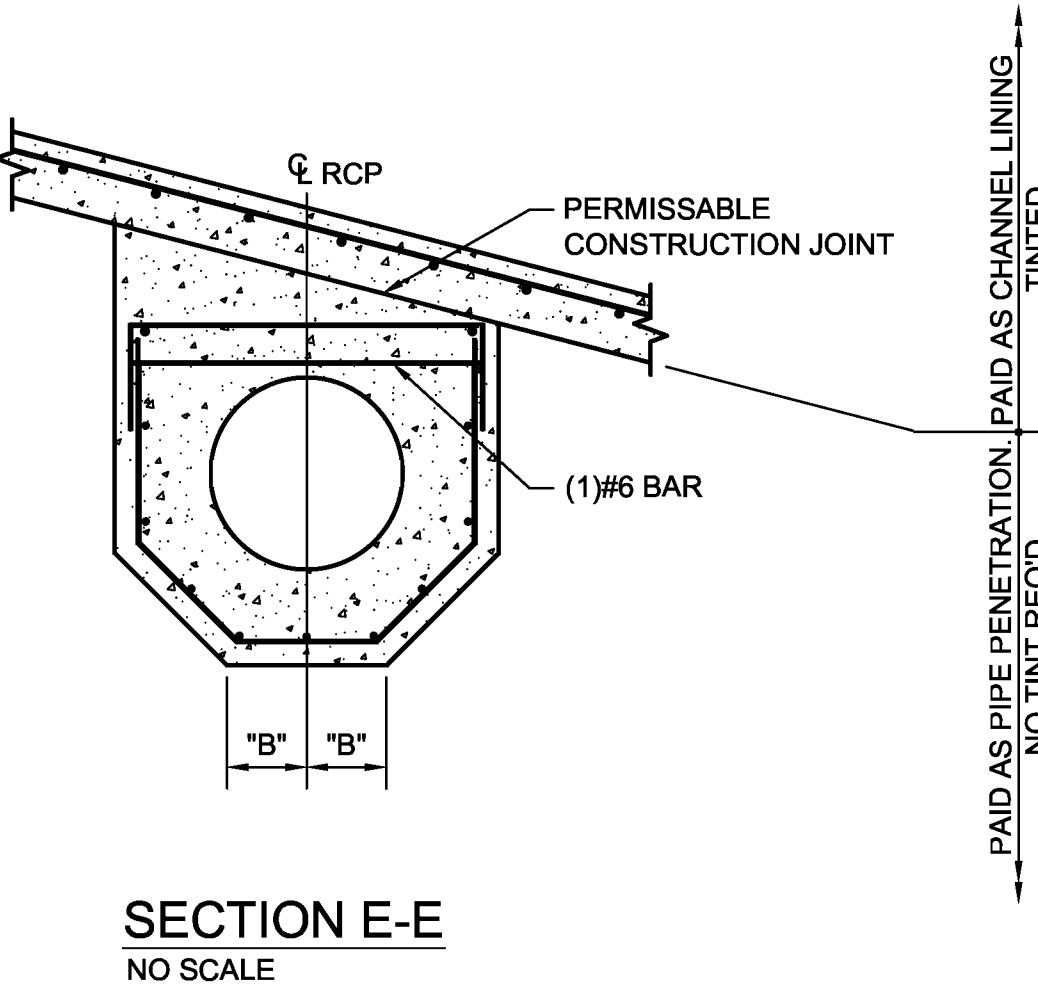
SECTION F-F
NO SCALE



SECTION C-C
NO SCALE



SECTION D-D
NO SCALE



SECTION E-E
NO SCALE

SECTION 101

PORTLAND CEMENT CONCRETE

101.1.1 GENERAL: Portland cement concrete, prestressed concrete, post tensioned concrete, shotcrete, gunite, and light weight structural concrete shall consist of a mixture of Portland cement, aggregates, water, and admixtures, proportioned, batched and delivered as specified herein. All materials and design mixes used in Portland cement concrete, either batched at or delivered to a project shall be certified in accordance with the requirements of Section 13 of these specifications. Each design mix submitted and authorized for use under this Specification shall be identified by a design mix number, unique to that design mix. If either a change in material(s) or material supplier(s) from that specified in the authorized design mix occurs during a project, authorized use of the job mix formula on the project may be canceled as directed by the ENGINEER. A concrete design mix shall not be used on a project without written authorization of the ENGINEER. A design mix, upon request by a concrete supplier, may be authorized by the OWNER for use on OWNER and OWNER-related projects for a period of 14 months from the date of sampling of reference aggregates in the design mix.

101.1.2 For construction and reconstruction projects requiring portland cement concrete continuous placement(s) equal or greater than either 100 cubic yards of concrete per day, the CONTRACTOR shall have a full time portland cement concrete construction supervisor on site to direct the construction operations. The supervisor shall be certified either as an ACI certified Concrete Field Testing Technician Grade I, or the equivalent National Institute for Certification of Engineering Technologies Technician, with Specialty Concrete Work Elements Level I 82001, 82002, and Level II 84002, 84003, 84004, 84010. The supervisor shall be identified by the CONTRACTOR at the preplacement conference and shall be the contact person for the ENGINEER during concrete construction.

101.1.3 Pre-Placement Conference

A Pre-Placement Conference shall be held by the CONTRACTOR, as directed by the ENGINEER, no later than seven (7) calendar days prior to the start of construction for concrete continuous placement(s) equal or greater than either 100 cubic yards of concrete per day. The following meeting agenda/assigned responsibilities shall be accomplished at the conference.

I. ENGINEER/OWNER

- A. Scope of the project.
- B. Identify construction management team and contact telephone numbers.
- C. Review CONTRACT requirements for construction.
- D. Review Quality Assurance Program.

II. CONTRACTOR

A. Review construction schedules.

1. Placement schedules.
 2. Proposed construction schedule for duration of the project.
- #### B. Identify construction personnel and contact telephone numbers.
1. Contractor Staff
 2. Sub-Contractor (s)
 3. Supplier (s)
 4. Safety Manager
- #### C. Present construction placement procedure plans.
1. Equipment Schedule
 2. Concrete Design Mix
 3. Construction methodology
 4. Concrete pumping plan
 5. Traffic Control Plan
 6. Quality Control Plan

III. DISCUSSION AND COMMENT

101.2 REFERENCES

- 101.2.1 American Society for Testing and Materials (Latest Edition) (ASTM)
- C31 Making & Curing of Concrete Test Specimens in the Field
- C33 Specification for Concrete Aggregates
- C39 Test for Compressive Strength of Cylindrical Concrete Specimens
- C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- C78 Test for Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
- C94 Specification for Ready-Mixed Concrete
- C125 Definition of Terms Relating to Concrete and Concrete Aggregates
- C138 Air Content (Gravimetric), Unit Weight, and Yield of Concrete
- C143 Test for Slump of Portland Cement Concrete specification. If required, certification
- C150 Specification for Portland Cement
- C172 Sampling Fresh Concrete
- C173 Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
- C192 Making & Curing of Concrete Test Specimens in the Laboratory
- C227 Test for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar Bar Method)
- C231 Test for Air Content of Freshly Mixed Concrete by the Pressure Method
- C260 Specification for Air Entraining Admixtures for Concrete
- C330 Specification for Lightweight Aggregates for Structural Concrete
- C441 Test for Effectiveness of Mineral Admixtures in

Preventing Excessive Expansion of Concrete Due to Alkali-Aggregate Reaction

C494 Specification for Chemical Admixtures in Concrete

C567 Unit Weight of Structural Lightweight Concrete

C617 Capping Cylindrical Concrete Specimens

C618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

C685 Specification for Concrete Made by Volumetric Batching & Continuous Mixing

C803 Test for Penetration Resistance of Hardened Concrete

C805 Test for Rebound Number of Hardened Concrete

D2419 Sand Equivalent Value of Soils and Fine Aggregates

101.2.2 American Concrete Institute (Latest Editions)

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

ACI 211.2 Standard Practice for Selecting Proportions for Structural Lightweight Concrete

ACI 318-89 Building Code Requirements for Reinforced Concrete

101.2.3 This Specification:

SECTION 337 PORTLAND CEMENT CONCRETE PAVEMENT

SECTION 340 PORTLAND CEMENT CONCRETE CURBS, GUTTERS, WALKS, DRIVEWAYS, ALLEYS, INTERSECTIONS, SLOPE PAVING, AND MEDIAN PAVING

SECTION 346 TEXTURED CONCRETE

SECTION 349 CONCRETE CURING

SECTION 420 TRAFFIC SIGNAL AND STREET LIGHTING CONDUIT, FOUNDATIONS AND PULL BOXES

SECTION 510 CONCRETE STRUCTURES

SECTION 512 PRECAST PRESTRESSED MEMBERS

SECTION 602 PORTLAND CEMENT CONCRETE FOR CHANNEL LINING AND DIKE AND DAM SURFACING

SECTION 701 TRENCHING, EXCAVATION AND BACKFILL

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SECTION 900 SANITARY AND STORM SEWER FACILITIES

SECTION 915 STORM DRAINAGE APPURTENANCES

SECTION 1500 MONUMENTS

101.3 PORTLAND CEMENT

101.3.1 Portland cement to be used or furnished under

this Specification shall comply either with the requirements of ASTM C150, Types I LA, II LA, III LA, and V LA, cements, or as specified herein, in the Supplementary Technical Specifications, Drawings, or as approved by the ENGINEER. The CONTRACTOR shall submit certification of compliance signed by the cement manufacturer, identifying the cement type and source (plant location), stating the Portland cement furnished to the project, and or used in the concrete delivered to the project complies with this Specification. If required, certification of the Portland cement used for each day's concrete placement shall be submitted to the ENGINEER for each type of cement and each design mix used on the project.

101.3.2 Portland cement specified in an authorized design mix shall be of the same source and type for all concrete batched at and/or delivered to a project under the authorized design mix identification number.

101.3.3 When suitable facilities (such as those recommended by the Concrete Plant Manufacturer's Bureau and/or approved by the ENGINEER) are available for handling and weighing bulk cement, such facilities shall be used. Otherwise, the cement shall be delivered in original unopened bags of the Manufacturer and the type of cement plainly marked thereon, each bag to contain 94 pounds (42.6 kg) of cement.

101.3.4 Cement shall be stored in such a manner as to permit ready access for the purpose of inspection and be suitably protected against damage by contamination or moisture. Should any lot of bulk cement delivered to the site show evidence of contamination, the ENGINEER may require that such lot be removed from the site.

101.3.5 Portland cement shall be measured by weight, lbs, (mass, kg) for concrete produced in accordance with the requirements of ASTM C94 and by volume for concrete produced in accordance with the requirements of ASTM C685.

101.4 AGGREGATES:

101.4.1 Aggregates shall comply with the requirements of ASTM C33 and as amended herein, or as specified in the Supplementary Technical Specifications and Drawings, or as approved by the ENGINEER. Aggregates shall be certified to comply with the requirements of this Specification and authorized for use by the ENGINEER before the materials may be incorporated in the construction. Prior to delivery of the aggregates or material containing the aggregates, The CONTRACTOR may be required to furnish samples of the aggregates to the ENGINEER for testing. The CONTRACTOR's daily production aggregate gradations used in concrete shall be submitted to the ENGINEER upon request. Aggregates specified in an authorized design mix shall be of the same source and type for all

concrete batched and delivered under the authorized design mix identification number.

101.4.2 In placing materials in storage or in moving them from storage to the mixer, no method shall be employed which may cause the segregation, degradation, or the combining of materials of different grading which will result in any stockpile not meeting specified requirements.

101.4.3.1 Aggregates supplied under this Specification shall be assumed to be "alkali-silica reactive", ASR. Variance from this position for a particular aggregate source may be authorized by The ENGINEER. Application for a variance may be made to The ENGINEER.

101.4.3.2 An aggregate may be classified non-alkali-silica reactive if, when tested in accordance with ASTM C227, using low alkali cement demonstrates an expansion at one (1) year not greater than 0.05%, and the rate of expansion is negative decreasing, based on test measurements at 1 month, 3 months, 6 months, 9 months, and 15 months, as authorized by the ENGINEER.

101.4.3.3 Portland cement concrete design mixes using non alkali-silica reactive aggregates complying with 101.4.3.2 will not be required to be proportioned with Class F fly ash.

101.4.4.1 Coarse aggregates shall meet the gradation limits as specified in Table 2 of ASTM C33. Fine aggregates shall comply with the gradation requirements of ASTM C33, Section 4, Grading. The sand equivalent of fine aggregate, when tested in accordance with ASTM D2419, Sand Equivalent Value of Soils and Fine Aggregates, shall be greater than 75.

101.4.4.2 The maximum size aggregate shall comply with either these specifications, or the requirements of Table 101.A, or the Supplementary Technical Specifications, or the recommendations of ACI 318-89, paragraph 3.3.2, or as required by the ENGINEER.

101.4.5 Aggregates shall be measured by weight (mass) for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

TABLE 101.A
MAXIMUM SIZE AGGREGATE

	Application	Size, in
I.	Pavement, Sidewalk, Curb and Gutter, Drive Pads, Wheel Chair Ramps, Slab on grade, Foundations, and Structures,	1
II.	Channels, minimum 5% retained on the 1 in sieve	1-1/2

III. High Early Release Concrete, 3/4 minimum 5% retained on the 1/2 in sieve

IV. Stamped, Patterned, Stairs and Steps, minimum 5% retained on the 3/8 in sieve 1/2

V. Formed Concrete

A. 1/5 the narrowest dimension between sides of forms,

B. 1/3 the depth of slab,

C. 3/4 of the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, or prestressing tendons or ducts, or reinforcing and forms.

101.5 WATER

Water used in Portland cement concrete shall be clean and free from injurious amounts of oil, acids, alkalis, salts, organic materials, or other substances that may be deleterious to the concrete or reinforcement. Non-potable water shall not be used unless the requirements of ACI 318.3.4.3.2 are met. Water shall be measured by weight or volume for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

101.6 ADMIXTURES:

101.6.1 Admixtures shall comply with the requirements of this specification. The CONTRACTOR shall submit a certification of compliance signed by the admixture manufacturer, identifying the admixture and its source (plant location), stating the admixture furnished to the project and/or used in the concrete delivered to the project complies with this Specification. Certification laboratory testing of an admixture shall be submitted by the CONTRACTOR to the ENGINEER upon request. Admixtures specified in an authorized design mix shall be of the same source and type for all concrete batched and delivered as defined under a design mix identification number. Admixtures shall be measured accurately by mechanical means into each batch by equipment and in a method approved by the ENGINEER. An admixture shall not be used on a project without authorization by the ENGINEER.

101.6.2 Air-entraining agent, conforming to ASTM C260, shall be measured accurately by mechanical means into each batch by equipment and in a method approved by the ENGINEER. The air-entraining agent used shall not contain more than 0.035% chloride by weight. Air-entrainment content shall comply with the requirements Table 101.B., the Supplementary Technical Specifications, or the recommendations of ACI 318, latest edition.

TABLE 101.B ENTRAINED AIR CONTENT

Nominal Maximum Size Aggregate, in.	Air Content Range, (%)	
	min	max
1 / 2	5.5	8.5
3/4	4.5	7.5
1	4.5	7.5

101.6.3 Chemical admixtures shall conform to either the requirements of ASTM C494, or as specified in the Supplementary Technical Specifications, or as specified by the ENGINEER. Chemical admixtures shall not contain more than 0.035% chloride by weight.

101.6.4.1 Mineral admixtures shall be class "F" fly ash complying with the requirements of ASTM C618 including the requirements of TABLE 4, UNIFORMITY REQUIREMENTS, and the requirements of this Specification.

101.6.4.2 Mineral admixtures, when tested in accordance with ASTM C441, shall conform to the following:

Reduction in expansion @ 14 days, % , min, 65.0
100% Reliability

Mortar expansion @ 14 days, max, % 0.20

Expansion must be less than control sample expansion.

101.6.4.3 The "Reactivity with Cement Alkalis" shall be determined using new Dow Corning glass rod base for aggregate. If a fly ash does not comply with the above requirement using the specified cement type, it may be authorized if the criteria is met using the low alkali Portland cement typically available to the Albuquerque area, as directed by the ENGINEER.

101.6.4.4 Mineral admixtures used or furnished under this Specification shall be certified quarterly, in a calendar year, to comply with this Specification by the supplier. Certification shall include test results and specifications, source and location.

101.6.4.5 Mineral admixtures shall be measured by weight (mass) for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

101.6.5 Accelerating admixtures may be used in Portland cement concrete batched and supplied under this Specification only when approved by the ENGINEER. The accelerating admixture used shall be a non-chloride type. A design mix proportioned with an accelerating admixture shall be submitted as specified in

paragraph 101.8.8. and authorized by the ENGINEER, prior to use on a project.

101.7 PROPORTIONING

101.7.1 Portland cement concrete shall be proportioned in accordance with the requirements of ACI 318, latest edition, Chapter 5, either ACI 211.1 or ACI 211.2 (latest editions), and Table 101.C of this Specification, either field experience or trial mixtures, and the construction placement requirements selected by the CONTRACTOR. The CONTRACTOR shall be solely responsible for the portland cement concrete design mix proportions for concrete either batched at, or delivered to, placed and finished at the site. Certification of a design mix and all component materials, including all formulations of a mix and any and all admixtures which may be used under special construction conditions and environments with that mix to include high range water reducers (super-plasticizer), accelerating admixtures and retarders, and any other admixture, shall comply with the requirements of Section 13 of this Specification.

101.7.1.1 Design mix(es) shall be prepared in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, and operated under the direct supervision of a New Mexico registered Professional Engineer.

101.7.1.2 The testing equipment used in the design development testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration shall be maintained at the laboratory for review by the ENGINEER. A copy of the certifications shall be submitted to the ENGINEER upon request. A portland cement concrete design mix shall not be batched at and/or delivered to a job site without written authorization of the ENGINEER.

101.7.1.3 A design mix shall be prepared under the direct supervision of a New Mexico Registered Professional Engineer.

101.7.2 Portland cement shall be proportioned to comply with the requirements specified in Table 101.C, or as specified in the Supplemental Technical Specifications, or Plans, or as authorized by the ENGINEER.

101.7.3 The mineral admixture Class F fly ash shall be proportioned by weight of cement to provide a fly ash to portland cement ratio not less than 1:4, not less than 20 per cent of the total cementitious material. Portland cement concrete submitted under this Specification shall be proportioned with Class F fly ash, unless a variance is authorized by the ENGINEER.

107.7.4 The water to total cementitious material ratio shall not be greater than specified in Table 101.C, or the maximum determined from a "trial mix" compressive strength vs. water to cementitious ratio curve, defined in accordance with ACI 318, latest edition, Chapter 5. The trial mix compressive strength water to cementitious material ratio curve shall be developed with the target slump at design application maximum, ± 0.75 inches, and the target entrained air content at design application maximum, ± 0.5 per cent, using materials specified in the design submittal. The cementitious material shall be defined as the total weight of portland cement and Class F fly ash in design mix.

101.7.5.1 A design mix submittal shall include but not be limited to the following information, as directed by the ENGINEER.

A. Certification of compliance of the design mix with the requirements of this Specification in accordance with Section 13 of these specifications by the New Mexico Registered Professional Engineer in responsible charge of the design mix development;

B. Certification of compliance of design mix's component materials by a manufacturer/supplier. The certification shall include laboratory test results of companion samples of the component material used in the laboratory prepared design mix, verifying the component materials comply with the specifications. For a mix design based on statistical methods, certification(s) of component materials shall be based on results performed within two (2) months of the submittal date.

C. Plastic characteristics of the design mix to include concrete temperature, slump, entrained air content, wet unit weight, yield and cement factor, reported in English and metric units;

D. Performance characteristics of the hardened concrete to include the compressive strength of all test cylinders averaged for a respective test and the corresponding average compressive strength reported in English units;

E. Compressive strength test (3 cylinder tests each point) shall be reported for each water to cementitious material ratio design mix proportioned at 3, 7, 14 and 28 days laboratory cure normal concrete; and, 1 day, 3 days, 7 days and 28 days laboratory cure for high early release concrete.

F. The "trial mix" compressive strength vs. water to cementitious ratio curve graphically plotted to include the water to cementitious ratio for the proposed design mix. A proposed design mix water to cementitious ratio outside the limits of a trial mix curve shall be rejected.

G. When a proposed design mix is based on statistical

analysis of historical data, certification that the design mix represented by the historical data was batched with the same or similar materials from the same sources as the materials proposed in the design mix shall be included in the submittal. Under this design certification procedure, the proposal shall include a statistical analysis for a period of 12 months prior to sampling aggregates of the characteristics of a) slump, b) entrained air, and c) f'_c @ 28 day compressive strength test. A compressive strength test shall be the average of two (2) cylinders tested at 28 days. An annual average aggregate gradation analysis may be used if the data represents the 12 month period prior to sampling for a design mix. A minimum of three production gradations per month will be required in the data base, as directed by the ENGINEER.

H. Batch proportions for concrete made by Volumetric Batching and Continuous Mixing, ASTM C685, shall include 1) component batch weights, 2) component batch volumes, and 3) gate settings for each type of batching equipment the design mix that may be batched.

J. High Range Water Reducing Admixture(s) (hrwra), Superplasticizers

a. A prescription for use of the hrwra in a design mix shall be provided by the CONTRACTOR to include but not limited to the following

1. Maximum dosage per cubic yard (meter) by standard measure, ozs/yd³;
2. Admixture introduction location (plant or Job site);
3. Minimum mixing after admixture introduction (drum revolution count at mixing speed);
4. Air entrainment dosage adjustment, if required;
5. Base mix water reducing admixture (wra) dosage adjustment, if required;
6. Consistency (slump) targets for before and after admixture introduction;
7. Concrete temperature limitations, if required; and,

b. Laboratory demonstrated performance of the design mix, at the specified maximum admixture dosage, shall be reported, including slump, entrained air content, unit weight, water to cementitious materials ratio, seven (7) and twenty eight (28) day compressive strength (f'_c), and three (3) days and seven (7) day compressive strength (f'_c) for high early release concrete. Submittal compressive strength shall be based on the average value of three cylinders required.

K. Accelerating Admixture(s)

a. A prescription for use of the accelerating admixture in a design mix shall be provided by the CONTRACTOR to include but not limited to the following:

1. Maximum dosage per cubic yard (meter) by standard measure, ozs/yd³;
2. Concrete temperature limitations, if required;
3. Admixture introduction location, plant or project;
4. Restrictions of use in combination with other

- admixtures, as applicable; and,
 - b. Special considerations for mixing, placing, and curing, as applicable.
- L. Color Admixture(s)
- a. A prescription for use of a color admixture in a design mix shall be provided by the CONTRACTOR to include but not limited to the following:
 - 1. Maximum dosage per cubic yard (meter) by standard measure, ozs/yd³;
 - 2. Admixture introduction location, plant or project;
 - 3. Restrictions of use in combination with other admixtures; and
 - b. Special considerations for mixing, placing, and curing, as applicable.
- M. Submittal Format

- a. A standard design mix submittal may include some or all of the above information as directed by the CONTRACTOR to define use as "optional" admixture(s). The standard design mix code would be the same for applications with and without the optional admixture(s)
- b. A specific design mix submittal can be made to include either color, or accelerating, or high range water reducing admixture for use under a specified application only. Separate design mix submittals will be required to include the information specified above.

101.7.5.2 A submittal shall be rejected if it does not include the specified information and samples. A design mix submittal shall be accepted or rejected within ten (10) days of receipt by the ENGINEER.

TABLE 101.C - DESIGN MIX SPECIFICATIONS-PORTLAND CEMENT CONCRETE [1, 2, 3]

Application	Use In Section(s)	$f'c$ @ 28 days psi, min [4]	Entrained Air Range [11]	Slump, Not To Exceed, note [5] inches			Portland Cement min, lbs./yd ³	w:(c+f a) max [7]
				Placement	Nor m	HRWR A		
<u>Interior Concrete</u> (heated areas) Foundations and slab on grade.	510	3,000	(See par.101.7.2)	Hand Place	4	6	423	0.50
<u>Exterior Concrete</u> a) Structure, foundations, slab on grade, steps/stairs; b) sidewalks, drive pads, wheel chair ramps, stamped pattern concrete, curb & gutter, and valley gutter; c) storm drain structures, channels, drop inlets, and manhole bases; d) retaining walls; and, e) miscellaneous concrete.	340, 346, 420, 510, 511, 602 [12,13], 701, 800, and, 1500	3,000	(See par.101.7.2)	Hand Place	4	6	470	0.45
				Slip Formed	2	3		
<u>Pavement</u> For design of PCCP, use MR= 600 lbs/in ² [4]	337	4,000	(See par.101.7.2)	Hand Place	4	6	564	0.40
				Slip Formed	2	3		
<u>Hydraulic Structures</u> Reservoirs	510 and 512	3,500	(See par.101.7.2)	Hand Place	4	7	517	0.40
				Slip Formed	2	3		
<u>Structures</u> Buildings, bridges/bridge decks, and parking structures	500	4,000 [8, 9]	(See par.101.7.2)	Hand Place	4	7	564	0.40
				Slip Formed	2	3		
<u>Sanitary Sewer Facilities</u> Structures, manholes and bases.	900	4,000 [8, 9]	(See par.101.7.2)	Hand Place	4	7	658 [6]	0.40
				Slip Formed	2	3		
<u>High Early Release Concrete</u> fcr= 3,400 lbs/in ² @ release to service [10]	All applications	4,000 @ 7 days	(See par.101.7.2)	Hand Place	4	7	Design	Design
				Slip Formed	2	3		

1. Use of material(s) not defined by this specification must be approved by the ENGINEER.
2. Maximum size aggregate shall comply with the requirements of par. 101. 4.4.2.
3. Portland cement concrete shall be proportioned with Class F fly ash complying with the requirements of 101.6.4, proportioned 1: 4, minimum, fly ash to portland cement, by weight.
4. *MR*-Modulus of Rupture, *f'c*-compressive strength at 28 days.
5. When authorized by the ENGINEER, a high range water reducing admixture (HRWRA), super plasticizer, may be used to increase slump. When a HRWRA is proposed for use on a project. The design mix shall be proportioned to include the HRWRA. The use of a HRWRA in a design mix that was not originally proportioned with a HRWRA is not acceptable under this specification. Higher slump(s) may be used, as directed by the ENGINEER.
6. If portland cement complying with ASTM C150 Type VLA is used, a minimum of 564 lbs/cy may be used.
7. "w : (c+fa)" is defined as *water to cementitious* materials ratio: w-water; (c+fa)-cementitious material as the sum of the portland cement and fly ash. Units are lbs/yd³.
8. Lightweight structural concrete for structures, parking decks, and bridge decks shall be proportioned with a minimum compressive strength of $f'c$ = 4,750 lbs/in² @ 28 days.
9. Minimum requirements for prestressed/post tensioned concrete. Actual criteria may differ as specified in the plans and supplemental technical

specifications.

10. "High Early Release Concrete" may be used where early release of structure to either service or construction loads may be required (≤ 3 days), as authorized by the ENGINEER. "fcr" is the minimum compressive strength for release, as determined by field cured cylinders. Maximum size aggregate shall be 3/4 inch.
11. Designated interior concrete, placed, finished, cured, and maintained by the Contractor in a temperate environment of 40°F or greater, may be constructed with non air entrained concrete complying with all other requirements of this specification for the calendar period after April 30 and before October 1, as authorized by the Engineer. Concrete for wet exposures, showers and wash down areas, vehicle repair and storage floors shall not be included in this variance.

101.8 BATCHING

101.8.1 Portland cement concrete shall be batched in accordance with the requirements of either ASTM C94, or ASTM C685, and the requirements of this Specification, as authorized by the ENGINEER. Batching facilities, mixing, and transporting equipment shall be certified within 12 months prior to batching of a design mix. The plant shall be certified by a NM Registered Professional Engineer, to comply with the requirements of this Specification and Section 13. The certification shall have been completed within 12 months of batching an authorized portland cement concrete design mix. Written certification shall be available for review at the plant by the ENGINEER, and, submitted to the ENGINEER upon request.

101.8.2.1 Ready-mix concrete batch plants shall be certified to comply with the requirements of this Specification. Written certification of compliance shall be available for review at the batch plant by the ENGINEER.

101.8.2.2 Central-Mix Batch Plants shall be certified to comply with this Specification and standards of the National Ready-Mix Concrete Association. The central-mixers rated capacity shall be posted at the batch plant in the operator's area.

101.8.2.3 Portable batch plants shall be certified after erection at a project and prior to batching concrete to be used at the project site. The batch plants rated capacity shall be posted at the batch plant in the operator's area.

101.8.2.4 Ready-mix concrete trucks shall be certified to comply with the requirements of this Specification and the "Standards for Operation of Truck Mixers and Agitators of the National Ready-Mix Concrete Association", and the "Truck Mixer Manufacturer Bureau", latest editions. Written certification of compliance shall be carried in/on the vehicle for verification by the ENGINEER. The manufacturers rated capacity, mixing and agitating speeds shall be posted on the truck mixer. Mixers shall have an operable mixer drum revolution counter and water metering system to measure temper water that may be added to a mixer after batching and prior to discharge of a load.

101.8.2.5 Shrink-mixed concrete batching shall be certified to comply with the requirements of this Specification. Written certification of the program to include a) maximum concrete volume defined for the process/equipment, b) minimum time of mixing in the stationary mixer of materials after the addition of all cementitious material, and, c) minimum supplemental mixing revolutions in the transit mix truck. A copy of the certified procedure shall be available at the batch plant for review by the ENGINEER, and submitted upon request. the

ENGINEER shall be notified by the CONTRACTOR in writing which concrete supplied to a project is produced with this procedure. Shrink mixed batching shall not be used on a project without authorization by the ENGINEER.

101.8.2.6 Volume batching central mix and concrete mobile trucks shall be certified to comply with this Specification. Certification shall include discharge gate settings/material weight batching references for each material carried and a certified water meter and calibration chart to define water settings. Discharge calibration settings shall be established for each production batching rate and authorized design mix batched. The equipment shall be recalibrated if a change in materials or source of materials occurs. Written certification of compliance shall be carried in/on the vehicle for verification by the ENGINEER.

101.8.2.7 On-site batching and mixing equipment for concrete volumes of less than 1 cubic yard shall conform to the requirements of ASTM C192, and shall be approved by the ENGINEER. On-site batched concrete for volumes less than 1 cubic yard shall be either "Redi-2-Mix", "Quikrete", or equal prepackaged concrete mix. The concrete shall be proportioned with water not to exceed a maximum of 1.5 gallons per 60 lbs./bag or equivalent. Concrete batched under this paragraph shall not be used for finished, interior and/or exterior exposed concrete surfaces.

101.9 MIXING

101.9.1 Concrete batched in accordance with ASTM C94, shall be mixed in accordance with the requirements of that Specification and as follows.

101.9.2 Central-Mixed Plants: Concrete mixed in a stationary mixer and transported to the point of delivery shall be mixed from the time all the solid materials are in the drum. The batch shall be so charged with some water in advance of the aggregates and cementitious materials, and all water shall be in the drum by the end of one-fourth the specified mixing time. Mixing time shall be a minimum of 1 minute for the first cubic yard plus 15 seconds for each additional cubic yard, or fraction thereof of additional capacity. Where mixer performance tests have been conducted in accordance with ASTM C94, with the mixer to rated capacity, the mixing time may be reduced to the time at which satisfactory mixing defined by the performance tests shall have been accomplished. When the mixing time is so reduced the maximum mixing time shall not exceed this reduced time by more than 60 seconds for air entrained concrete. Certified concrete uniformity tests shall be conducted in accordance with ASTM C94 and Section 13. If the uniformity requirements are not met, that mixer shall not be used until the condition is corrected.

101.9.3 Shrink-Mixed Concrete:

Concrete mixed in a shrink mix production program shall be mixed in accordance with the certified shrink mix program as defined by the CONTRACTOR. Concrete shall be mixed in a stationary mixer not less than the certified minimum mixing time after all ingredients are batched into the drum, and not less than the minimum mixing revolutions specified for the transit mix truck after the load is transferred into the transit mix truck. Mixing in the transit mix truck shall not exceed the maximum requirements of paragraph 101.9.4. Shrink-mixed concrete procedures shall be certified to provide concrete that complies with the uniformity specifications of ASTM C94 as determined by uniformity tests specified in ASTM C94, for the maximum batch volume of concrete defined by the CONTRACTOR. If uniformity requirements are not met for the combination of stationary plant and transit mixers, the shrink mix program shall not be used. Tempering of shrink mix concrete at the job site shall comply with the requirements of 101.10 and 101.11.

101.9.4 Truck-Mixed Concrete:

Concrete mixed in a truck mixer shall be mixed after all ingredients including water, are in the drum at least 70 revolutions and not more than 100 revolutions at the mixing speed as defined by the Manufacturer. The mixing speed for the mixer shall be identified on the mixer. Certified concrete uniformity tests shall be conducted on transit mixer trucks in accordance with ASTM C94 and Section 13 annually. If the uniformity requirements are not met, that mixer shall not be used until the condition is corrected. Mixing beyond the number of revolutions at mixing speed found to produce the required uniformity of concrete shall be at the agitation speed defined by the mixer manufacturer. The manufacturer's recommended mixing and agitation speeds shall be posted on the truck mixer.

101.9.5 Volume Batched Concrete:

Concrete batched in accordance with ASTM C685, shall be mixed in accordance with the requirements of this Specification and the Manufacturer's recommendations. The continuous mixer shall be an auger type mixer or any other type suitable for mixing concrete to meet the requirements for uniformity specified in ASTM C685,

101.10 TEMPERING BATCHED CONCRETE

101.10.1.1 The slump of a concrete mix sampled at final discharge shall comply with the requirements of TABLE 101.C. Non complying material shall be removed from the structure as directed by the ENGINEER.

101.10.1.2 A load of concrete may only be tempered with water after the mix cycle is complete when, upon arrival at the job site, the slump of the concrete is less than specified, and the time limit and

revolution limit specified in 101.9 are not exceeded.. When additional water is required, the total water in the truck shall not exceed the maximum water to cementitious ratio specified in the authorized design mix when the concrete is discharged. When tempering is required and allowed as defined by the water to cementitious ratio for the design mix, the water shall be injected into the mixer and the drum or blades turned a minimum of 30 revolutions at mixing speed before discharge as long as the revolution limit specified in 101.9 is not exceeded.. Additional water shall not be added to the batch after tempering without authorization by the ENGINEER.

101.10.1.3 When the slump of a sample taken within the time limits specified in 101.9 the specification requirements of TABLE 101.C, the mixer truck may be mixed a minimum of 15 revolutions at mixing speed, as long as the revolution limit specified in 101.9 is not exceeded, sampled and tested. If the slump of the second sample exceeds the maximum specified slump by 0.25 in (6 mm), the load may be rejected as directed by the Engineer.

101.10.2.1 The air content in air entrained concrete, when sampled from the transportation unit at the point of discharge, shall comply with the requirements of this specification. Non complying material shall be removed from the structure as directed by the ENGINEER.

101.10.2.2 When a preliminary sample taken within the time limits specified in 101.9 and prior to discharge for placement shows an air content below the minimum specified level, the CONTRACTOR may add additional air entraining admixture to achieve the specified air content, if the revolutions on the drum counter are less than 300, and the total revolutions, after air entrainment addition will not exceed 300 following mixing a minimum of 30 revolutions at mixing speed after dosage with the admixture. Additional air entraining admixture may not be added to the batch after the initial air entraining admixture tempering. Air entraining admixture shall be batched in accordance with 101.7.2. In addition to sampling and testing for compliance after tempering with the air entraining admixture, a sample shall be taken during discharge from the second half of the load to verify slump and entrained air compliance through the load with the specification.

101.10.2.3 When the entrained air exceeds the specified requirements, the load may be mixed a minimum of 15 revolutions, sampled and tested, if the drum revolutions do not exceed 300, and will not exceed 300 following mixing. If the entrained air exceeds the specification by 0.1 %, the load may be rejected as directed by the ENGINEER.

101.10.3 High range water reducing admixtures,

superplasticizers shall be batched as recommended by the manufacturer.

101.10.4 Aggregates and cementitious material may not be used to temper a batched load of portland cement concrete.

101.10.5 All samples shall be tested for slump, entrained air, and unit weight after tempering..

101.10.6 The field dosage amounts of admixtures and water shall be reported on the truck ticket.

101.10.7 The OWNER shall pay for quality assurance sampling and testing specified 101.15, or as directed by the ENGINEER.

101. 11 DELIVERY & DISCHARGE:

101.11.1 Discharge of the concrete shall be completed within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. These limitations may be waived by the ENGINEER if (1) the concrete is proportioned and certified for use after mixing/agitation time in excess of 1-1/2 hrs, or (2) is of such a slump that it can be placed and finished, without the addition of water to the batch after the time limit noted above is exceeded. In hot weather or under conditions contributing to quick stiffening of the concrete, a time less than 1-1/2 hrs. may be specified by the ENGINEER.

101.11.2 The minimum discharge temperature of concrete in cold weather shall be equal or greater than the temperature specified in Table 101.D.

TABLE 101.D - Cold Weather Construction
Concrete Temperature, min [1]

Ambient Air Temperature	Thin Sections	Heavy Sections & Mass Concrete [2]
30 to 45 °F	60°F	50°F
0 to 30 °F	65°F	55°F
Below 0 °F	70°F	60°F

[1] The maximum concrete discharge temperature of all concrete, except "high early release concrete", produced with heated aggregates, heated water, or both, shall be 70°F. The discharge temperature of "high early release concrete" in cold weather shall be 70 °F - 76 °F.

[2] Sections having dimensions in all directions greater than 2 feet (24 inches)

101.11.3 The discharge temperature of concrete in hot weather should be kept as cool as possible.

Concrete supplied to a project site having a discharge temperature greater than 90 °F may be rejected by the ENGINEER if the concrete cannot be placed and finished after a single tempering with water as authorized under 101.10. Retarding admixtures may be used to control setting in hot weather. The discharge temperature of "high early release concrete" in hot weather shall be specified by the CONTRACTOR.

101.11.4 The CONTRACTOR shall provide to the ENGINEER with each batch of concrete batched and/or delivered to the job site, before unloading at the site, a delivery batch ticket on which the information specified in TABLE 101.E is printed, stamped or written, certifying said concrete. One copy of the ticket shall be available for the ENGINEER and one copy of the ticket shall be available for the quality assurance testing program.

TABLE 101.E
BATCHING TICKET INFORMATION
REQUIREMENTS

- A. Name of Concrete Supplier
- B. Delivery Ticket Number
- C. Date of Delivery
- D. Contractor
- E. Project Name (Optional)
- F. Design Mix Number
- G. Volume of Concrete in Load
- H. Time loaded
- J. Batched Weight (mass) of Cement
- K. Batched Weight (mass) of Fly Ash
- L. Batched Weight (mass) of Fine Aggregate
- M. Batched Weight (mass) of Coarse Aggregate(s)
- N. Batched Weight (mass) or Volume of Each Admixture
- O. Weight or volume of water batched at the plant
- P. Design Mix Target Proportions
- Q. Weight or volume (gal.) of temper water added at the site
- R. Weight or volume of each temper admixture added at the site
- S. Signature and name (printed) of CONTRACTOR'S representative who authorized the tempering, if any, at the site and affiliation to project

101.12 PLACEMENT

101.12.1 Portland cement concrete shall be placed to the lines, sections, grades and elevations, with the procedures specified in the CONTRACT documents. The material shall be consolidated to eliminate all voids, internal rock pockets and defects in the finish

concrete. Casting subgrade and formed surfaces shall be damp, at the placement of the concrete. Removable forms shall be treated with a form release agent prior to placement of the forms for ease of removal of the forms without damage to the supported concrete. Forms shall be sealed to prevent leakage. Form release agents shall not stain the adjacent concrete. Placement and finishing shall be completed prior to the start of the initial set of the concrete.

101.12.2.1 The CONTRACTOR shall submit a concrete pumping plan to the ENGINEER for review and authorization one week prior to the start of a pumped concrete construction program for placements complying with 101.1.1. The submittal should identify the pump manufacturer, size and type, rated capacity(s) for the line diameter(s) to be used and distance(s) to be pumped.

101.12.2.2 Pumping shall conform to the recommendations of the pump manufacturer. The pump manufacturer's operation manual shall be available on the pump equipment, and submitted to the ENGINEER, upon request.

101.12.2.3 Concrete shall be pumped in a uniform continuous flow to point of discharge, with all lines kept full, during the pumping operation. The CONTRACTOR shall provide either a system for controlled discharge of the concrete, or the last 5 feet of the pump line, immediately prior to the line discharge opening, shall have a slope equal or less than 10:1, horizontal to vertical, during the pumping of concrete, as authorized by the ENGINEER. The concrete shall not be dropped a vertical distance greater than four feet at discharge from the pump line without a tremey. Concrete placed by pump shall conform to the requirements of this specification after discharge from the pump line. Pumping of concrete shall not commence without authorization by the ENGINEER.

101.13 FINISHING

The CONTRACTOR shall finish Portland cement concrete as required by the CONTRACT documents, Supplemental Technical Specifications, or as directed by the ENGINEER.

101.14 CURING CONCRETE

The CONTRACTOR shall cure concrete as required by the CONTRACT documents, SECTION 349 of this specification, the Supplemental Technical Specifications, or as directed by the ENGINEER. A concrete structure or element shall not be released to service loads until it has achieved a minimum of 85% of the design strength, f'_c , at the time the structure is placed in service, or the curing program specified in SECTION 349 is completed, or as directed by the ENGINEER. Service loads shall

include construction loads, design loads and environmental exposure.

101.15 QUALITY ASSURANCE SAMPLING AND TESTING

101.15.1.1 Quality assurance sampling and testing shall be performed in accordance with the requirements of this Specification, the Supplemental Technical Specifications, or as required by the ENGINEER. Concrete shall be sampled and tested by a technician/engineer certified as either an ACI certified Concrete Field Testing Technician Grade I, or the equivalent National Institute for Certification of Engineering Technologies Technician, with Specialty Concrete Work Elements Level I 82001, 82002, and Level II 84002, 84003, 84004, 84010.

101.15.1.2 Quality assurance testing and analysis shall be performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, under the direct supervision of a New Mexico Registered Professional Engineer.

101.15.1.3 Testing equipment used in the performance of specified testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certification records shall be maintained at the laboratory for review by the ENGINEER. A copy of the certifications shall be submitted upon request to the ENGINEER. Quality assurance testing shall be directed by the ENGINEER and paid by the OWNER.

101.15.2.1 Samples will be taken in the field by the ENGINEER, in accordance with ASTM C172, at discharge to the structure/application after all tempering at the job site has been completed.

101.15.2.2 A sample shall be taken for each design mix of concrete placed each day, once for each 100 cu yd of concrete, once for each 5000 sq.ft. area of slabs or walls, or fractions thereof, whichever is greater, or as directed by the ENGINEER. Hi-lo thermometers will be provided by the CONTRACTOR to monitor field curing concrete temperatures and companion test specimens while in the field, as directed by the ENGINEER.

101.15.3 Slump tests will be performed on each quality assurance sample in the field in accordance with ASTM C143. Concrete used for slump tests shall not be used in specimens for strength tests. The slump shall not exceed the maximum value defined in TABLE 101.C plus 0.25 in (6 mm). Slumps shall be reported to the nearest 1/4 inch (1 mm).

101.15.4 Entrained air tests will be performed on each quality assurance sample in accordance with the requirements of ASTM C231 for normal weight concrete, and ASTM C173, light weight concrete as specified in TABLE 101.C. Concrete used for entrained air tests shall not be used in specimens for strength tests. The entrained air shall not be less than the minimum nor greater than the maximum entrained air specified plus 0.1 % . Entrained air shall be reported to the nearest one tenth of one percent.

101.15.5.1 The cement content per cubic yard for a load of concrete shall be determined on each quality assurance sample in accordance with ASTM C138. The unit weight shall be reported to the nearest one tenth of a pound per cubic foot (one kilogram per cubic meter). The cement factor shall be reported to the nearest pound per cubic yard (kilogram per cubic meter).

101.15.5.2 The portland cement content per cubic yard for a load of concrete shall be calculated by dividing the batched weight of the portland cement reported on the truck ticket for the load represented by a quality assurance test sample, by the yield, in cubic yards, determined in 101.15.1. The cement content shall be reported to nearest one pound per cubic yard. The portland cement content shall not be less than the minimum cement content for the application specified in TABLE 101.C.

101.15.5.3 The water to cementitious ratio for a load of concrete sampled and tested under this specification shall be calculated by comparing the total water in a load, by weight, the batched water reported on the load's batch ticket plus any water added in the field, to the sum of the portland cement and fly ash reported on the batch ticket. The weight of the water shall be divided by the weight of the cementitious materials and reported to the nearest one hundredth value (xx.xx). The water to cementitious ratio shall be less than or equal to the water to cementitious ratio for the application specified in TABLE 101.C.

101.15.6 A non complying field test, slump test, entrained air test, cement content, shall be verified by sampling and testing a second sample from the same load represented by the non complying sample/tests. If the second sample/tests determine the material is in compliance, the load may be authorized for placement and the all quality assurance tests required shall be performed. If the second test confirms the initial test results, the concrete load may be rejected as directed by the ENGINEER. If the second test confirms the initial sample non complying test, the second sampling and testing shall be paid by the CONTRACTOR, as specified in SECTION 13. The OWNER shall pay for all complying test.

101.15.7.1 Quality assurance compressive strength

concrete specimens/cylinders shall be molded in accordance with ASTM C31. Cylinders shall be sealed metal or plastic molds complying with ASTM C31. The specimens will be submerged in water during the initial field curing at the site when the average ambient temperature is equal or greater than 60 °F, site conditions permitting, as directed by the ENGINEER. If the initial field cure submersion procedure is not used, high-low thermometers shall be used to monitor the initial field cure temperature of the quality assurance specimens, and the recorded temperatures shall be reported in the sampling and testing report. If the curing temperature recorded on the high-low thermometer exceeds 85 °F, concrete compressive test strengths shall be reported as information only, and the lab of record shall revise the initial cure procedure for the assurance specimens to control the curing temperature to less than 85 °F. Cylinders left in the field longer than the maximum specified time shall be so identified and reported "for information only". A sample may be taken to the testing laboratory for testing and casting provided the cylinders can be molded within 15 minutes after sampling.

101.15.7.2 Strength specimens shall be molded and tested in accordance with ASTM C31, C39, C78 & C93, C192, and this specification. The number and type of compressive strength test cylinders shall be a minimum of four (4) 6"dia. x 12"H cylinders for channel concrete, and normal concrete with nominal maximum size aggregate of 1.5 inch to 2.0 inch. The number and type of compressive strength test cylinders shall be a minimum of four (4) 4" dia x 8" cylinders for normal concrete with nominal maximum size aggregate 1 inch and less. The number and type of cylinders shall be a minimum of six (6) 4" dia x 8" cylinders for high early release concrete compressive strength tests. The number and type of Modulus of Rupture flexure test beams shall be a minimum of three (3) 6"x6"x42" beams or equivalent for Modulus of Rupture Tests, as directed by the ENGINEER. Strength specimens shall be cast using concrete from the same load as the concrete field tests. When 4"dia. x 8" cylinders are used, they shall be cast in two equal lifts, each lift rodded twenty five times with a three eights inch (9.5 mm) diameter rod with a three eights inch (9.5 mm) semi spherical tip. The rodding of a lift placed on a lift of concrete shall penetrate into the top of the preceding lift.

101.15.7.3 When strength tests are required for stripping of forms or release of structure, a minimum of 2 test specimens complying with the specimen type specified in 101.15.7.2 for each test shall be molded and cured at the site under the same conditions as the concrete represented by the specimens. The specimens shall be returned to the Lab at the end of the field curing period and tested in accordance with ASTM C39. The test strength shall be the average of the test strengths of the two specimens. The critical concrete compressive

strength (f'_c) shall be a minimum of 85% of the specified design strength.

101.15.7.4 Concrete strength test specimens shall be tested at 7 days and 28 days. One specimen shall be tested at 7 days and 2 specimens shall be tested at 28 days, and reported to The Engineer. The test strength shall be the average of the test strengths of the two specimens tested at either 28 days, or as specified in the Supplemental Specifications, drawings, or by the ENGINEER.

101.15.7.5 High early release concrete strength test specimens shall be tested at 3, 7, and 28 days for concrete. One specimen shall be tested at 3 days and 2 specimens shall be tested at 7 and 28 days, and reported to the ENGINEER. The test strength for high early release concrete shall be the average of the test strengths of two specimens tested at 7 days, or as specified in the Supplemental Specifications, drawings.

101.15.8. Not Used.

101.15.9.1 Evaluation and acceptance of concrete shall meet the criteria established in Chapter 5, Section 5.6, "Evaluation and acceptance of concrete," ACI 318-89. Each strength test result

shall be the average of two cylinders from the same sample tested at 28 days or the specified age. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength tests results equal or exceed the required f'_c and no individual strength test result falls below the required f'_c by more than 500 psi. Quality assurance compressive strength specimens sampled and cast when the average ambient temperature is greater than 60 °F, and cured with an initial field cure procedure other than submersion method specified in

101.15.7.1, shall be evaluated using the highest curing temperature recorded by the high-low thermometer provided for the field cure and Table 101.E. The test compressive strength shall be compared to the estimated strength corresponding to the highest initial cure temperature indicated in Table 101.E. An assurance compressive strength test shall be equal or greater than the compressive strength defined by Table 101.E when the initial field cure temperature is equal or greater than 85 °F and the initial field cure is not the submerged method specified in 101.15.7.1.

TABLE 101.E

MINIMUM COMPRESSIVE STRENGTH, f'_c

$$f'_c \leq P_{TI} \times f'_c / 100, \text{ psi}$$

°F [2]	73	80	85	90	95	100	105	110	115	120
Cure Day(s)	P_{TI} , % of Specified Strength, f'_c [1,3]									
3	100	108	114	120	122	123	125	120	115	110
7	100	101	102	103	100	98	95	91	78	75
28	100	97	95	93	90	88	85	82	78	75

- Notes:
1. Reference ACI 306, 6.6.1
 2. The Non Submerged assurance cylinder cure recorded maximum initial field cure temperature. If a high- low thermometer was not used, the highest ambient temperature recorded for the initial cure period by the national weather service will be used as the initial cure temperature.
 3. f'_c specified compressive strength

101.15.9.2 If individual tests of either laboratory-cured specimens produce strengths more than 500 psi (3.4 MPa) below f'_c , or, if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is adequate. If the presence of low-strength concrete is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled from the area in question

shall be required in accordance with ASTM C42, as directed by the ENGINEER. Three cores shall be taken for each case of an individual cylinder test more than 500 psi (3.4 MPa) below f'_c or where the average of any set of three consecutive strength test results is below f'_c . If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 °f and relative humidity less than 60 percent) for seven days before test and shall be tested dry. If the concrete

in the structure will be more than superficially wet under service conditions, the cores shall be immersed in water for at least 48 hours and tested wet. If coring is required a coring plan will be prepared by the ENGINEER no later than 42 calendar days after the placement date. Coring shall be completed and a report submitted no later than 56 calendar days after placement. Core sampling for non complying tests shall be taken at the direction of the ENGINEER and paid by the OWNER. The CONTRACTOR shall be responsible for material replacement of the same design mix in adjacent concrete at no cost to the OWNER where samples are removed.

101.15.9.3 Concrete in the area represented by core tests shall be considered structurally adequate if the average strength of three (3) cores is equal or greater than 85% of the specified design strength (f'_c), and no single core has a compressive strength less than 75% of the specified design strength. To check testing accuracy, locations represented by erratic core strength may be

retested. If these strength acceptance criteria are not met by the core tests, and if structural adequacy remains in doubt, The OWNER and ENGINEER may order load tests as outlined in Chapter 20, ACI 318 for the questionable portion of the structure. Load tests shall be paid for by the CONTRACTOR.

101.15.9.4 If the structure under consideration does not satisfy the above strength acceptance criteria or the criteria of Section 20.2 or 20.4, ACI 318 The OWNER may order The CONTRACTOR to remove and replace any portion of the structure which is not in compliance with the above. If so ordered, the CONTRACTOR shall perform such work at his own expense. The CONTRACTOR shall patch all core sample holes with the same or similar materials adjacent to the core hole. The patching concrete shall be placed and cured in accordance with the requirements of this specification.

101.15.10 TEST REPORTS

101.15.10.1 Test reports shall include but not limited to the following, as directed by the ENGINEER.

A. Field Data

- 1 Date of Sampling
- 2 Time of Sampling
- 3 City of Albuquerque Project or
- 4 City of Albuquerque project or Permit Number
- 5 Contract Title
- 6 Portland Cement Concrete Supplier
- 7 Delivery Ticket Number
- 8 Design Mix Number
- 9 Sampling location as defined by the Project Plans and Specifications
- 10 Ambient temperature at time of sampling, $^{\circ}\text{F}$
- 11 Material temperature at time of sampling, $^{\circ}\text{F}$
- 12 Mixer drum revolution count at start of discharge of concrete

B. Field Tests Results, with specifications.

	Accuracy	
1 Slump, in (mm)	0.25	1
2 Entrained Air, %	xx.x	
3 Unit Weight, pcf (kg/m^3)	xxx.x	(xxxx)
4 w:(c+fa) ratio	x.xx	x.xx
5 Cement Factor, C.F., lbs/yd^3 (kg/m^3)	xxx	(xxxx)
6 Cement pay factor determined in accordance with 101.16.2		

C. Comments

- 1 Report any addition of water and materials and amounts by either volume or weight, prior to and after sampling.
- 2 Report mixer revolutions count at time of discharge.
- 3 Record number of mixer revolutions after field tempering with water and/or admixtures, and @ what mixer speed, mixing or agitating speed.

D. Laboratory Tests

1	Calendar reference and day count from date of sampling for each strength test sample		
2	fc compressive strength test result reported to psi/ MPa	10	1
3	M.R. Modulus of rupture reported to psi/ MPa	5	0.5

E. Analysis & Certification

The testing laboratory shall provide certification the sampling and testing were performed in compliance with the requirements of the specifications. Certification shall be provided by the New Mexico Registered Professional Engineer in direct responsible charge of the laboratory testing program.

101.15.10.2 Test results shall be reported to the ENGINEER, CONTRACTOR, concrete supplier and OWNER in writing, within 7 working days of completion of the test, as directed by the ENGINEER. Non-complying tests shall be reported within one working day of completion of the test.

101.16 MEASUREMENT AND PAYMENT

101.16.1 Measurement for Portland cement concrete supplied under this specification shall be by LOTS as the area, volumes, and as specified in the contract documents, as directed by the ENGINEER.

101.16.2 Payment for Portland cement concrete supplied under this specification shall be for each LOT, at the contract unit price adjusted in accordance with the

formula below and TABLE 101.F, as directed by the ENGINEER. A LOT shall be defined as either the volume or area of concrete for each design mix placed on a project in a day as defined in the CONTRACT. The adjusted unit price shall be calculated using the formula below and the pay factor, CF_p , defined in TABLE 101.F. The pay factor shall be defined by the number of samples representing a LOT, and, the % variance of the mean/average (M) portland cement content of the LOT from the minimum cement content specified in TABLE 101.C for the application, as determined by field quality assurance sample test results. Acceptance samples for a LOT shall be sampled and tested in accordance with 101.15. All acceptance samples taken in one day for a type of concrete shall represent a LOT of that type of concrete.

$$UP' = PF \times UP$$

UP', Adjusted Contract Unit Price
 PF, Pay Factor, $PF = 0.50 \times (1.00 + CF_p)$
 UP, Contracted Unit Price

TABLE 101.F - CEMENT PAY FACTOR CALCULATION, CF_p

n, number of samples	Deficiency, $D = (C - M)/C$	CF_p
3, OR MORE	$D \leq 0.0$	1.00
	$0.0 < D \leq 1.0$	1.00
	$1.0 < D \leq 2.0$	0.95
	$4.0 < D \leq 6.0$	0.90
	$6.0 < D \leq 8.0$	0.85
	$8.0 < D \leq 10.0$	[1]
	$D > 10.0$	Remove and Replace
D,	Deficient cement content as % of C, minimum	
C,	Minimum cement content specified for the application in TABLE 101.C	
M,	Average or mean (M) cement factor for a LOT. The cement factor shall be calculated as the average of cement factors of all tests taken for a LOT, but not less than three tests, determined in accordance with 101.15.6.	
[1]	If determined by the ENGINEER to be more practical to accept the material, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned pay factor $CF_p = 0.70$.	



APWA (2006) SECTION 101

PORTLAND CEMENT CONCRETE

Revised 09/16/2021

1. In the Subsection 101.15 QUALITY ASSURANCE SAMPLING AND TESTING, paragraph 101.15.2.2, delete the first sentence and replace with the following:

At least one sample from each of the first three concrete loads delivered to the site shall be tested at the point of placement for slump, air content, and unit weight. Example: If a concrete pump is used, the point of placement location would be the end of the pump's outlet hose/nozzle.

One set of compressive strength test cylinders shall be obtained from one of the first three loads, as directed by SCAFCFA. Beginning with the fourth load of concrete delivered to the project, one load from each sub-lot of ten (10) loads will be randomly selected for testing to include slump, air content, unit weight, cement content per cubic yard, and one set of compressive strength test cylinders. Sample requirements are subject to change at the discretion of the Engineer.

END OF SECTION

SECTION 109

RIPRAP STONE

109.1 GENERAL

The riprap stone provided and installed under this specification shall be angular rock, stone or recycled Portland cement concrete complying with the requirements of this specification. The material shall be certified to comply with the specification in accordance with the requirements of Section 13. If a change in material and/or source from that authorized occurs during a project, the CONTRACTOR shall resubmit to include the changed material and/or source for authorization by the ENGINEER. A riprap material shall not be used on a project without written authorization of the ENGINEER.

109.2 REFERENCES

109.2.1 ASTM:

C88
C127

109.2.2 AASHTO:

T103

109.2.3 This Publication

603
610

109.3 MATERIAL

109.3.1 Riprap stone shall be stone, rock or recycled Portland cement concrete complying with this specification. The material shall be free of seams, fractures and coatings and of such characteristics that it will not disintegrate when subject to the action of flowing water.

109.3.2 The minimum specific gravity of the stone shall be 2.65 for sizes and gradation specified in TABLE 209.A, as determined in accordance with ASTM C127, latest edition. If the specific gravity of a stone is less than 2.65, the minimum size of the stone and the depth of the riprap shall be increased in accordance with TABLE 109.8.

109.3.3 The maximum resistance to abrasion shall be fifty (50) percent determined in accordance with the requirements of ASTM C535.

109.3.4 The maximum soundness loss shall be twenty (20) percent determined in accordance with ASTM C88.

109.3.5 The maximum loss to freeze thaw shall be ten (10) percent for 12 cycles determined in accordance with the AASHTO T103, Ledge R, Procedure A.

109.4 SHAPE AND GRADATION

109.4.1 Riprap material shall be rectangular in shape rectangular in shape having maximum to minimum dimension ratio not more than 3:1.

109.4.2 Riprap stone shall comply with the gradation requirements of TABLES 109.A and A 109.B.

109.4.3 Waste Portland cement concrete complying with the requirements of this specification may be used as riprap as specified in the plans and specification, as directed by the ENGINEER.

109.5 PLACEMENT

109.5.1 The placement of riprap stone shall be to the line and grade shown on the plans or as authorized by the ENGINEER. The depth of the riprap shown on the plans shall be adjusted based on Table 109.B for the specific gravity of the material provided. The surface tolerances shall be within the maximum variations shown in Table 109.C.

109.6 MEASUREMENT AND PAYMENT

109.6.1 Riprap shall be measured by the cubic yard (cy) placed to the lines and grades in the plans and specifications complete in place.

109.6.2 Payment for riprap will be made at the contract unit price per cubic yard for the type of riprap required, which payment shall include all material, labor and equipment required in placing riprap stone as specified in Section 603 and/or 610.

TABLE 109.A
CLASSIFICATION GRADATION

DESIGNATION	MAX. DIMENSIONS inches (m)	% SMALLER	Km [1]
A. GABIONS			
TYPE VL	12 (0.30) 9 (0.25) 50-70 6 (0.15) 35-55 3 (0.08) 10	100	6
TYPE L	18 (0.45) 12 (0.30) 6 (0.15) 30-55 3 (0.08) 10	100 50-70	9
B. RIPRAP			
TYPE M	24 (0.60) 18 (0.45) 12 (0.30) 6 (0.15)	100 50-70 30-55 10	12
TYPE H	36 (0.90) 24 (0.60) 12 (0.30)	100 50-70 30-55	18
TYPE VH	48 (1.20) 36 (0.90) 18 (0.45) 9 (0.23)	100 50-70 30-55 10	24

[1] Km = mean particle size

TABLE 109.B
SPECIFIC GRAVITY MULTIPLIER

SPECIFIC GRAVITY	MULTIPLIER
2.65	1.00
2.65	1.05
2.50	1.15
2.40	1.25
2.30	1.35
<2.30	REJECT

TABLE 109.C
CONSTRUCTION TOLERANCES

RIPRAP DESIGNATION	MAXIMUM VARIATION FROM SPECIFIED FINISH GRADE inches (meters)
TYPE VL +/-	3 (0.08)
TYPE L	6 (0.15)
TYPE M	9 (0.25)
TYPE H	12 (0.30)
TYPE VH +/-	12 (0.30)

SECTION 201

CLEARING AND GRUBBING

201.1 GENERAL

This work shall consist of removing natural and man-made objectionable material from the right-of-way, construction areas, road approaches, material and borrow sites, areas through which ditches and channels are to be excavated, and such other areas as may be shown on the plans. Clearing and grubbing shall be performed in advance of grading operations except that in cuts over 3 feet in depth, grubbing may be done simultaneously with excavation, provided stumps, roots, embedded wood, foundations and slabs are removed as specified. Clearing and grubbing shall be in accordance with the requirements herein specified, such as erosion control requirements. Demolition of structures, other than foundations or slabs, shall be as shown on the plans.

201.2 REFERENCES

201.3 PRESERVATION OF PROPERTY

Existing improvements, adjacent property, utility and other facilities, and trees and plants not to be removed shall be protected from injury or damage resulting from the CONTRACTOR's operations. Only trees and plants designated or marked for removal by the ENGINEER shall be removed.

201.4 CONSTRUCTION METHODS

201.4.1 The natural ground surface shall be cleared of vegetable growth, such as trees, tree stumps, logs, roots or downed trees, brush, grass, weeds, and surface boulders, as well as fences, walls, rubbish, foundations and slabs.

201.4.2 Unless otherwise shown on the plans, the entire area of the project within the limit lines specified below shall be cleared and grubbed. No payment will be made to the CONTRACTOR for clearing and grubbing outside these limits, unless such work is authorized by the ENGINEER.

201.5 LIMIT LINES: Except when limit lines for clearing and grubbing are shown on the plans or are staked by the ENGINEER, clearing and grubbing shall extend only within reasonable limits of the work area.

201.6 REMOVAL OF TREES AND TREE BRANCHES

201.6.1 Trees shall be removed in such a manner as not to injure standing trees, plants, and improvements which are to remain. Tree branches extending over a roadway and which clear finish grade by 12 feet or

less shall be cut off close to the boles in a workmanlike manner.

201.6.2 Trees requiring trimming to facilitate normal construction operations shall be trimmed by a tree surgeon.

201.7 REMOVAL AND DISPOSAL OF DEBRIS

Debris to be removed shall be disposed of outside the right-of-way at a location satisfactory to the ENGINEER, except when burning of combustible debris is permitted. The area to be graded and adjacent areas shall be left with a neat and finished appearance. No accumulation of flammable material shall remain on or adjacent to the property line. In case burning precedes construction operations, the piles may be placed in the center of the area; otherwise, the piles shall be placed in the most convenient location at the side of the area and beyond slope lines where they may be burned without damage to surrounding forest cover or adjacent property. Burning shall be done in conformance with local regulations and at such times and in such manner as to prevent the fire from spreading to areas adjoining the construction site. In areas where burning is prohibited by local regulations, all removed material shall be disposed in an approved solid waste disposal site.

201.8 REMOVAL AND DISPOSAL OF SALVAGEABLE ITEMS

Items and materials of salvage value as shown on the plans or as determined by the ENGINEER, unless incorporated in the new work, shall remain the property of the OWNER and shall be delivered to approved storage areas as directed by the ENGINEER. Such items and materials shall be carefully removed and delivered in such a manner as to permit re-use.

201.9 MEASUREMENT AND PAYMENT

201.9.1 CLEARING AND GRUBBING:

201.9.1.1 When the proposal includes an item for clearing and grubbing, the quantity for measurement shall be as indicated in the Bid Proposal.

201.9.1.2 The unit price per acre paid for clearing and grubbing shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in clearing and grubbing as shown on the plans, as provided in these specifications and as directed by

the ENGINEER, including the removal and disposal of resulting material.

201.9.1.3 When the Bid Proposal does not include a pay item for clearing and grubbing as above specified and unless otherwise specified in the Supplementary Specifications, full compensation for any necessary clearing and grubbing required to perform construction operations specified shall be considered as included in the price paid for other items of work and no additional compensation will be allowed therefore.

201.9.2 REMOVAL AND DISPOSAL OF TREES: If the Bid Proposal includes separate estimates of quantities for the removal of trees, the trees shall be classified by size as follows:

201.9.2.1 Trees less than 12 inches in circumference at 3 feet above the original ground surface shall be considered as included in the price for clearing and grubbing or excavation, and no additional compensation will be allowed therefor.

201.9.2.2 Trees between 12 and 30 inches in circumference shall be measured as a unit price for each tree in the item provided in the Bid Proposal for trees of this dimension.

201.9.2.3 Trees more than 30 inches in circumference shall be measured as a unit price for each tree in the item provided in the Bid Proposal for trees of this dimension.



APWA (2006) SECTION 201

CLEARING AND GRUBBING

Revised 07/24/2020

1. In the Subsection 201.1 GENERAL, delete the second sentence and replace with the following:
Clearing and grubbing shall be performed in advance of the grading operations.
2. In the Subsection 201.4.1 CONSTRUCTION METHODS, add the following:

Clearing and grubbing operations shall include stripping of the existing ground surface. Stripping shall be achieved only by cutting, i.e., ground depressions or narrow sections of tributary arroyos should not be inadvertently filled during the foundation preparation. The resulting area shall be cut to provide a uniform, relatively level surface.

3. In Subsection 201.5 LIMIT LINES, add the following:

Unless otherwise approved by the Engineer or otherwise specifically designated on the plans, limits of clearing & grubbing shall not exceed slope limits as shown with finished grade contours on plans.

END OF SECTION



APWA (2006) SECTION 204

FILL CONSTRUCTION

Revised 07/24/2020

1. Delete this section in its entirety and replace with SSCAFCA Technical Specification 1510, EXCAVATION, BORROW AND FILL.

END OF SECTION

SECTION 603

RIPRAP SURFACE TREATMENT

603.1 GENERAL

The construction of riprap surface treatment shall consist of furnishing and placing stone, with or without grout, with or without wire mesh, or sacked concrete riprap. The depth and type of riprap shall be as shown on the construction plans.

603.2 REFERENCES

603.2.1 ASTM

C 143

603.2.2 This publication:

SECTION 101

SECTION 109

603.3 MATERIAL

603.3.1 Riprap stone shall be as specified in Section 109 of these specifications.

603.3.2 Other materials necessary for completion of various types of Riprap Surface Treatments shall be as specified in the following subsections.

603.4 PREPARATION OF GROUND SURFACES

603.4.1 The bed for the riprap shall be shaped and trimmed to provide even surfaces. A footing trench shall be excavated along the toe of the slope as shown on the plans.

603.4.2 Specified filter cloth shall be placed on earth bed prior to placement of stone.

603.4.3 Earth surface shall be shaped and trimmed to conform to the construction plans prior to the placement and compaction of the gravel type of filter material.

603.5 PLACING RIPRAP STONE

603.5.1 When the required riprap is less than 20 inches in depth, stone shall be placed by hand unless otherwise authorized by the ENGINEER. Stone shall be placed to provide a minimum of voids. The larger stone shall be placed in the toe return, foundation course, and on the outer surface of the riprap. Stones shall be placed with their longitudinal axis normal to the face of the embankment and so arranged that each rock above the foundation course has at least a 3 point bearing on the

underlying stones. Bearing on smaller stones used to chink voids will not be acceptable. Interstices between stones shall be chinked with small stones and spalls. The finished surface shall be even and tight and shall not vary from the planned surface by more than 3 inches per foot of depth. When the required riprap is 20 inches or more in depth, the stone may be placed by dumping and spread in layers by bull-dozers or other suitable equipment.

603.5.2 Riprap shall be placed to its full design thickness (depth) in one operation.

603.6 GROUTED RIPRAP

603.6.1 Riprap shall be placed as specified and grouted with Portland cement mortar. The grout shall consist of one part cement and 3 parts by volume of aggregate. The Portland cement shall be Type I or Type II as specified in Section 101 and the aggregate shall be 2 parts sand and 1 part gravel passing a 3/8 inch square mesh screen. The amount of water shall be such as to permit gravity flow into the interstices with limited spading and brooming. The consistency of the grout shall be as approved by the ENGINEER.

603.6.2 Except when hand mixing is permitted by the ENGINEER, grout shall be mixed in an approved machine mixer for not less than 1 1/2 minutes. Should hand mixing be permitted, the cement and aggregate shall be thoroughly mixed in a clean, tight mortar box until the mixture is of uniform color after which clean water shall be added in such quantity as to provide a grout of the specified consistency.

603.7 SACKED CONCRETE RIPRAP

603.7.1 The Portland cement, aggregates, and mixing shall be as specified in Section 101 and as herein specified. The aggregate may be pit-run material, at least 80 percent of which shall pass a 1 1/2 inch square mesh screen. Separating aggregates by primary sizes will not be required. Los Angeles abrasion tests and soundness tests will not be required.

603.7.2 The mixed concrete shall contain 376 pounds (4 sacks) of Portland cement per cubic yard.

603.7.3 The amount of water shall be such as to produce a mixture with a slump of 3 to 5 inches when tested in accordance with ASTM C 143.

603.7.4 Sacks shall be made of at least 10 ounce burlap and shall be approximately 19 1/2 inches by 36 inches measured inside the seams when the sack is laid flat.

603.7.5 Slopes on which the sacked concrete riprap is to be placed shall be finished within 0.2 foot of the designated grades. The first course shall be a double row of stretchers laid in a neatly trimmed trench. The second course shall be a single row of headers. The third and remaining courses shall be stretchers or headers as shown on the plans and shall be placed so that joints between courses are staggered. Dirt and debris shall be removed from the tops of sacks before the next course is laid thereon. Headers shall be placed with the folds upward. Not more than 4 vertical courses shall be placed in any tier until the initial set has taken place in the first course of any such tier.

603.7.6 When, in the opinion of the ENGINEER, there will not be proper bearing or bond due to delays in placing succeeding layers or the hampering of work by storm, mud, or for any cause, a small trench shall be excavated back of the row of sacks already in place and this trench filled with fresh concrete before more sacks are placed. Payment for the concrete in the trenches shall be at the price per cubic yard for sacked concrete riprap. Payment for excavating the trenches shall be considered as included in the payment for the concrete in the trench.

603.7.7 Sacked concrete riprap shall be cured by sprinkling with a fine spray of water every 2 hours during daylight for not less than 3 days.

603.8 WIRE ENCLOSED RIPRAP

603.8.1 Wire enclosed riprap shall consist of a layer of rock of the required thickness enclosed on all sides in wire fabric in conformity with the details shown on the plans. The wire fabric shall be drawn tightly against the rock on all sides and tied with galvanized wire of the required gauge. The ties shall be spaced approximately 2 feet on centers and shall be anchored to the bottom layer of wire fabric, extended through the rock layer, and tied securely to the top layer of wire fabric. When indicated on the plans, wire enclosed riprap shall be anchored to the slopes by steel stakes driven through the riprap into the embankment. Stakes shall be spaced as shown on the plans. Wire fabric used for riprap shall conform to the mesh, gauge, and weight shown on the plans. Tie wire shall be galvanized and of the gauge shown on the plans. Wire fabric shall be furnished in such lengths and widths as to reduce

the number of splices to a minimum.

Deleted: ¶

603.8.2 Steel stakes shall be cut to the required length from steel railroad rails, galvanized steel pipe, or steel angles of the dimension and weight shown on the construction plans.

603.9 FILTER CLOTH

603.9.1 MATERIAL: The filter cloth shall be a non-woven polyester geotextile, such as: Mirafi No. 140N drainage Fabric, Mirafi Inc., Charlotte, North Carolina, or approved equal.

603.9.2 INSTALLATION: The surface to receive the cloth shall be prepared to a relatively smooth condition free of obstructions, depressions, and debris. The cloth shall not be laid in a stretched condition but shall be laid loosely with a long dimension perpendicular to the channel centerline. The cloth shall be placed so the upstream edge overlaps the downstream edge a minimum of 12 inches, with securing pins inserted through both layers at no greater than two-foot intervals. Cloth damaged or displaced before or during installation or placement of the overlaying riprap shall be replaced or repaired to the satisfaction of the ENGINEER at the CONTRACTOR'S expense.

603.10 GRAVEL TYPE OF FILTER MATERIAL

603.10.1 MATERIAL: Filter material shall be comprised of sand, gravel, and cobble in mixes as specified on the plans. Alternate materials such as milled Portland cement concrete, concrete wash, or reclaimed material may be substituted with the ENGINEER'S approval.

603.10.2 INSTALLATION: Filter material shall be used as a subbase for riprap as shown on the plans. The minimum depth of filter material shall be one foot unless the plans provide an alternate detail for filter blanket construction.

603.11 MEASUREMENT AND PAYMENT

603.11.1 Riprap, such as: plain stone, grouted, wire enclosed, or sacked concrete, shall be measured by the cubic yards placed to the lines and grades shown on the construction plans. Payment for riprap will be made at the unit price per cubic yard for the type of riprap as specified in the Bid Proposal and shall include materials, labor, and equipment necessary to complete the work.

603.11.2 Filter cloth shall be measured by the square foot and overlaps shall be measured as a

single layer of cloth. Payment shall be made at the unit price per square foot as per Bid Proposal, and shall include shipping, handling, storage, seams, special fabrication, securing pins, and/or installation.

603.11.3 Gravel type filter material shall be measured by the cubic yard of material in place, in accordance with the construction plans. Payment will be made at the unit price per cubic yard as per Bid Proposal and shall include all materials, labor, and equipment necessary for the installation of the material.

SECTION 1012

NATIVE GRASS SEEDING

1012.1 GENERAL:

Work under this section consists of preparing all area indicated on the plans for native grass seeding, furnishing and installing all seed, fertilizer and soil amendments as specified herein and on the plans, or as authorized by the ENGINEER.

1012.2 REFERENCES:

1012.2.1 This Publication:

Section 1011

1012.3 WORK AREA/TIMING:

1012.3.1 Areas that are disturbed by the CONTRACTOR that are outside the construction limits shown on the plans or authorized by the ENGINEER shall be seeded with native grasses as specified herein at no cost to the OWNER.

1012.3.2 The seeding of disturbed areas shall commence upon completion of the other work in the area.

1012.4 MATERIALS:

1012.4.1 Native Seed: The native seed species and rate of application shall be as shown below and shall be used based on the type of soil or as specified on the plans or in the Supplemental Technical Specification.

1012.4.1.1 Sandy Soils. Seed rate is given in pounds of pure live seed (P.L.S.) per acre.

<u>Variety/ Common Name</u>	<u>Genus/ Species</u>	<u>P.L.S./Acre</u>
"Paloma"Indian Rice grass	Oryzopsis hymenoides	5.0
"Viva" Galleta grass	Hilaria jamesii	1.0
"Niner" Side oats grama	Bouteloua curtipendula	3.0
"Hatchita" Blue grama	Bouteloua gracilis	1.0
Sand dropseed (NM Region)	Sporobolus cryptandrus	1.0
Fourwing saltbush (NM Region)	Atriplex canescens (de-winged)	<u>1.0</u>
Total rate		12.0 lbs/ acre

1012.4.1.2 Clay, Clay Loam, and Sandy gravelly clay loam soils. Seed rate is given in pounds of pure live seed (P.L.S.) per acre.

<u>Common Name</u>	<u>Genus/species</u>	<u>PLS/acre</u>
"Paloma" Indian rice grass	Oryzopsis hymenoides	2.0
"Viva" Galleta grass	Hilaria jamesii	2.0
"Niner" Sideoats grama	Bouteloua curti pendula	2.0
"Hatchita" Blue grama	Bouteloua gracilis	3.0
Sand dropseed (NM Region)	Sporobolus cryptandrus	1.0
Four-wing Saltbush (NM Region)	Atriplex canescens (de-winged)	1.0 1.0
Total rate		11.0 lbs/ac

NOTE: If the area to be seeded is along a recreational trail of any type the seed mixes for either type of soil listed above shall exclude the one (1) pound per acre of Four-wing saltbush. The seeding rate shall be lowered by one (1) pound per acre.

1012.4.1.3 Seeds may be pre-mixed by a seed dealer. Each bag of seed shall be sealed and labeled by the seed dealer in accordance with Federal Seed Laws and New Mexico Department of Agriculture Labeling Laws. This includes: variety, kind of seed, lot number, purity, germination, percent crop, percent inert, percent weed (including noxious weeds), origin, test data and net weight. Federal Seed Laws require that analysis shall be no older than 5 months for seed shipped interstate and no older than 9 months for seed shipped intra-state. The ENGINEER shall receive all labels from all bags of seed used for verification.

1012.4.2 Fertilizer and Soil Amendments: Unless otherwise specified on the plans or in the Supplemental Technical Specification, no fertilizer or other soil amendments are required on areas specified to receive native seeding. If fertilizer and/or other soil amendments are required they shall be in accordance with Section 1011 of these specifications.

1012.4.3 MULCH:

1012.4.3.1 Hay Mulch: Perennial native or introduced grasses of fine-stemmed varieties shall be used unless otherwise specified on the plans. At least 65 percent of the herbage by weight of each bale of hay shall be 10 inches in length or longer. Hay with noxious seed or plants will not be acceptable. Rotted, brittle, or moldy hay will not be acceptable. Marsh grass or prairie hay composed of native grass of species to be seeded will be acceptable. Tall wheat grass, intermediate wheat grass, switch grass, or orchard hay will be acceptable if cut prior to seed formation. Marsh grass hay shall be composed of mid and tall native, usually tough and wiry grass and grass-like plants found in the lowland areas within the Rocky Mountain region. Hay shall be properly cured prior to use. Hay which is brittle, short fibered or improperly cured is not acceptable.

1012.5.2 Straw Mulch: Small grain such as wheat, barley, rye, or oats will not be allowed except by prior approval of the ENGINEER and with the concurrence of the Air Division, Environmental Health Department. Alfalfa or the stalks of corn, maize or sorghum is not acceptable. Material which is brittle, shorter than 10 inches or which breaks or fragments during the crimping operation will not be acceptable.

1012.4.3.3 Gravel Mulch: Gravel mulch shall be crushed or screened gravel 3/4" to 1" maximum size with a minimum of one fractured face unless otherwise specified.

1012.4.3.4 Erosion Control Mats, Fabric or Blankets: The type of erosion control mats, fabric or blankets used shall be as specified or allowed on the plans or in the Supplemental Technical Specifications.

1012.5 SEED BED PREPARATION:

1012.5.1 General:

1012.5.1.1 Prior to the starting of any seed bed preparation the final grades of all earth work shall be inspected and approved by the ENGINEER.

1012.5.1.2 No preparation shall be performed when the surface is wet or muddy or when the soil moisture content is such that the soil is not fully loosened by the discing operation.

1012.5.1.3 The extent of seed bed preparation shall not exceed the area on which seeding, mulching and crimping operations can be completed prior to crusting or wind or water erosion of the prepared surface. If erosion, crusting or re-compaction

occurs, the affected area shall be re-worked beginning with seed bed preparation. Depth of preparation must be approved by the ENGINEER prior to the seeding and mulching operations.

1012.5.2 Mechanical Preparation: The seed bed shall be loosened to a minimum depth of 6" (six inches) by means of disc or harrow. Area of heavy or compacted soil may require additional preparation such as chiseling or ripping if discing alone does not result in preparation to the full minimum depth of 6". The soil shall be worked to a smooth surface free of clods, stones 4" and larger or any other debris or foreign material that could interfere with seeding or crimping equipment operations.

1012.5.3 Hand Preparation: Areas which cannot be prepared with mechanized equipment because of small size irregular shape or slope angle may be prepared to a minimum depth of 2" using hand tools or a rototiller. Any such areas will be specified on the plans.

1012.6 SEEDING:

1012.6.1 General:

1012.6.1.1 Seeding shall not start until the seed bed preparation has been inspected and approved by the ENGINEER.

1012.6.1.2 No more area may be seeded than can be covered with mulch and crimped, or covered with gravel mulch or erosion control mats by the end of the work day. No seeding operations may be conducted when steady wind speed exceeds 10 miles per hour. If winds exceed 10 mph while seeding is underway, seeding operations will be halted and any areas seeded to that point completed.

1012.6.2 Seed Application:

1012.6.2.1 Drill Seeding: Drill seeding is required unless otherwise specified on the plans or in the Supplemental Technical Specifications. Seed shall be applied with a "rangeland" type seed drill equipped with packer wheels. Seed shall be drilled to a maximum depth of 1/2" unless otherwise specified. Direction of seeding shall be across slopes and on the contour whenever possible.

1012.6.2.2 Broadcast Seeding: Seed may be applied using the broadcast method when size, irregular shape or slope angle exceeding 3:1 prevents the use of a seed drill. Seed may be broadcast by hand or by means of a mechanical seeder provided that the seed is evenly distributed over the seeding area. Areas of broadcast seeding

will be hand raked to cover seed. Areas which are broadcast seeded shall be seeded at rate which is double that used for drill seeding.

1012.6.2.3 Seeding With Gravel Mulch: Areas to receive gravel mulch will be seeded at the broadcast seed rate with 1/2 the seed applied prior to application of gravel and 1/2 the seed applied on the surface of the gravel. Water shall be applied in quantity sufficient to wash seed from the surface and into the gravel.

1012.6.2.4 Hydro Seeding: Hydro seeding will not be allowed on areas of non-irrigated native grass seeding unless specified on the plans or in the Supplemental Technical Specifications or authorized by the ENGINEER.

1012.7 MULCHING:

1012.7.1 General:

1012.7.1.1 All seeded areas shall be mulched unless otherwise specified on the plans or in the Supplemental Technical Specifications.

1012.7.1.2 On seeded areas that are level or have slopes 3:1 or less, any of the four (4) types of mulching or erosion control specified herein may be used. On seeded areas that have slopes steeper than 3:1 only gravel mulch or erosion control materials may be used as specified on the plans and in the Supplemental Technical Specifications.

1012.7.2 Hay Mulch: Hay mulch shall be applied at a minimum rate of 1.5 tons per acre of air dry hay.

1012.7.3 Straw Mulch: Straw mulch shall be applied at a minimum rate of 2.5 tons per acre of air dry straw.

1012.7.4 Crimping: Hay and/or Straw mulch shall be crimped into the soil. The mulch shall be spread uniformly over the area either by hand or with a mechanical mulch spreader. When spread by hand, the bales of mulch shall be torn apart and fluffed before spreading. Mulching will not be permitted when wind velocity exceeds 15 miles per hour. The mulch shall be wetted down and allowed to soften for 15 to 20 minutes prior to crimping. A heavy disc such as a mulch-tiller, with flat serrated discs at least 1/4 inch in thickness, having dull edges and the disc spaced 6 inches to 8 inches apart shall be used to crimp (or anchor) the mulch into the soil to a minimum depth of 2 inches or as specified on the plans or the Supplemental Technical Specifications. The discs shall be of sufficient diameter to prevent the frame of the equipment from dragging the mulch.

The crimping operations shall be across the slope where practical but not be parallel to prevailing winds or by tight interlocking "S" curves to avoid straight crimp lines.

If small grain straw mulch is used it shall be crimped in two (2) directions in a cross-hatch pattern.

1012.7.5 Gravel Mulch: Gravel mulch shall be placed by hand or by mechanized equipment that provides full coverage at a uniform thickness of 2 inches in depth.

1012.7.6 Erosion Control Mats, Fabric or Blankets: the type of erosion control mats, fabric or blankets used shall be as specified on the plans or the Supplemental Technical Specifications or as approved by the ENGINEER. The anchoring of the erosion control items shall be as per the manufacturer's recommendations.

1012.8 PROTECTION OF NATIVE GRASS SEEDED AREA:

1012.8.1 GENERAL: The CONTRACTOR shall be responsible for protecting and caring for seeded areas until final acceptance of the work and shall repair at his expense any damage to seeded areas caused by pedestrian or vehicular traffic or vandalism.

1012.9 INSPECTION FOR NATIVE GRASS AREA:

1012.9.1 The following inspection shall be the minimum required inspections to native grass during the course of construction. Additional inspections shall be made at any time at the discretion of the ENGINEER.

1012.9.2 It shall be the responsibility of the CONTRACTOR to notify the ENGINEER, in writing, 48 hours in advance of each required inspection.

1012.9.3 The sequence of required inspections shall not be changed from the sequence listed below. The CONTRACTOR shall not proceed with work of the next sequence without written approval of the work of the previous sequence. Payment will not be approved for items which have not been inspected and approved in writing.

1012.9.3.1 Each phase of soil preparation shall be inspected in process.

1012.9.3.2 Finish grade shall be inspected.

1012.9.3.3 Seed shall be inspected prior to seeding.

1012.9.3.4 Seeded area shall be inspected after completion.

1012.9.3.5 Final inspection of the project and acceptance.

1012.10 MEASUREMENT AND PAYMENT

1012.10.1 MEASUREMENT: The measurement of native grass seeding shall be by the acre.

1012.10.2 Payment: Payment shall be made at the contract unit price per acre of native grass seeding complete in place, which shall include the seed, fertilizer, (if required) area preparation, seeding, soil amendments, (if required) and mulching.



APWA (2006) SECTION 1012 – SUPPLEMENTAL SPEC

NATIVE GRASS SEEDING

Revised 07/24/2020

1. In subsection 1012.4 MATERIALS delete paragraphs 1012.4.1.1 and 1012.4.1.2 in their entirety and replace with the following:

Grass Seed Mix shall include the following species and rates:

Indian Rice Grass	5 lb/ac
Galleta	5 lb/ac
Sideoats Gramma	5 lb/ac
Blue Gramma	5 lb/ac
Sand Dropseed	5 lb/ac

Total Grass Seed Mix application rate = 25.0 lbs / acre

Wildflower Seed Mix shall include the following species and rates:

Globemallow	1 lb/ac
Purple Aster	1 lb/ac
Blue Flax	1 lb/ac
Mexican Hat	1 lb/ac
Blanket Flower	1 lb/ac

Total wildflower seed mix application rate = 5.0 lbs / acre

Seed rate is given in pounds of pure live seed (P.L.S.) per acre.

END OF SECTION

SECTION 1502

SUBMITTALS

1502.1 GENERAL

The requirements of this section of the specifications consist of furnishing all manufacturer's data, shop drawings, samples, certifications, guarantees, reports, operation manuals, maintenance manuals, lubrication charts, spare parts lists, special tools and factory representative required for installation of special items, in strict accordance with the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

1502.2 SUBMITTAL CHECK LIST

The Submittal Check List that will be part of the Supplemental Specifications on each project, lists items which will be required to construct the project for which submittals will be required by the ENGINEER. The list of submittals is for the convenience of the CONTRACTOR and supplier, and should not be considered as the complete and final requirements. Additional submittals and material may be required by the ENGINEER as project progresses.

1502.3 WHAT TO SUBMIT

1502.3.1 The following is an explanation of what to submit if indicated on the check list.

- A. Manufacturer's Data: Any catalog type literature on the item.
- B. Shop Drawings: Detail drawings with all dimensions and locations shown.
- C. Samples: The item that will be supplied.
- D. Certifications: Any certifications required by these specifications or standard specifications and/or requirements for that item, to cover raw materials and testing of the final product.
- E. Guarantees: A copy of the guarantee to be given to the Owner on that item.
- F. Lab Test Reports: Laboratory test reports required to show that the item meets all specified requirements.
- G. Operation Manuals and Maintenance Manuals: The manufacturer's standard Operation and Maintenance Manuals on that item.
- H. Special Tools: A list of special tools required to operate and maintain that item and the number of each tool the manufacturer will supply.

- I. Lubrication Charts and Grease Specs: A list of all lubrication points on that item with frequency and type of lubricant to be used at each point.
- J. Spare Parts List: A list of spare parts that the manufacturer recommends the Owner maintains.
- K. Factor Representative: A factory representative will be required to be present for installation and/or start-up of that item of equipment.
- L. Field Test Reports: The field test reports are reports and/or tests that have been conducted on the item in an existing installation over a period of time.
- M. Pump and Blower Curves: Certified curves based on the test performance of each pump or blower to be installed on this project.
- N. Load Design: Load design calculations shall show the maximum load the item can carry under the support conditions shown on the drawings for both uniform and concentrated loads. These calculations shall be under a New Mexico registered professional engineer's signature.
- O. Additional literature, reports and/or tests may be required by the ENGINEER.

1502.3.2 When pumps of any type are part of the project, in addition to the other information required on pump submittals the CONTRACTOR shall submit the following data for each unit of pumping equipment.

- A. Name of manufacturer
- B. Type of pumps.
- C. Number of stages and speed.
- D. Diameter of impeller.
- E. Type of bearings.
- F. Size of suction and discharge piping and barrel.
- G. Type of thrust bearing.
- H. Shut-off pressure.
- I. Impeller material.
- J. Pump shaft material and diameter.
- K. Capacity and head.
- L. Make and type of motor.
- M. Horsepower of motor with proper NEMA Standard insulation.
- N. Type of motor bearings.
- O. Net weight of complete unit.

- P. Guaranteed KWH required to pump 1,000 gallons against the required head.
- Q. Discharge column:
 - Material
 - Weight per foot
 - Type of Joint
 - Spacing of joints
 - Inside diameter
- R. Line shaft:
 - Material
 - Diameter
 - Length of sections
- S. Line Shaft Bearing:
 - Length
 - Spacing Type
 - Material
- T. Thrust Bearing:
 - Complete computations on thrust conditions.
 - Computed pump thrust at shut-off.
 - Computed pump thrust at operating condition.
 - Rated bearing capacity.
 - Manufacturer.
 - Method of cooling.
 - Weight of bearing.
- U. Combined overall efficiency of pump and motor when operating at rated condition.
- V. Does equipment offered differ from specification requirement?
- W. Do catalogs, descriptive literature, etc., covering all equipment accompany the bid?

SECTION 1502

SUBMITTAL CHECK LIST

[illegible]

SUPPLEMENTAL TECHNICAL SPECIFICATION

SECTION 1501

TEMPORARY PLASTIC BARRIER FENCE

1501.1 DESCRIPTION

This work shall consist of furnishing, installing, and maintaining Temporary Plastic Barrier Fences of the type and at the locations shown in the plans or where directed by the Engineer.

1501.2 MATERIALS

Materials for Temporary Plastic Barrier Fences shall meet the following requirements:

- **Fence:** High-density polyethylene mesh, ultraviolet-stabilized min. 2 years; minimum height 4.0 feet. Color: high-visibility orange or green. When used to protect trees or other vegetation, color shall be high-visibility orange.
- **Posts:** Rigid metal or wood posts, minimum length 6.0 feet.
- **Ties:** Steel wire, #14 gauge or nylon cable ties.
- **Warning signs:** Sheet metal, plastic or other rigid, waterproof material, 1.5 feet by 2.0 feet with 4 inch black letters on a white background. Text shall be: "Protected Site - Keep Out" unless otherwise specified.

1501.3 CONSTRUCTION DETAILS

Fences shall be erected prior to moving construction equipment onto any area designated for protection.

The line of fences as indicated on the plans shall be staked or marked out on the ground by the Contractor and approved by the Engineer before any fence is installed. Where used for protection of individual trees, fence shall be placed at the drip line (extent of canopy). If not possible, placement shall be as close to the drip line as possible and in no case less than 5.0 feet away from the tree trunk.

On approval of the stakeout, posts shall be securely driven on 6.0 foot-maximum centers, normal to the ground, to a depth $\frac{1}{3}$ of the total post length. Plastic barrier fence shall be placed along the side of all posts. Ends of fencing segments shall overlap a distance of at least one half the fence height.

Fencing shall be secured to posts with wire or cable ties at top, middle and bottom of post. Fastener shall be tight enough to prevent the fencing from slipping down. Overlaps shall also be securely fastened.

Barrier fence which is not orange in color shall be flagged at 6.0 foot intervals with red or orange florescent tape. Warning signs shall be mounted on the fence at no more than 100 foot intervals.

Maintenance shall commence immediately after erection of the fence and

continue until one week prior to acceptance of the contract, and shall consist of: replacing damaged post(s) and fencing; re-fastening and tightening fencing; and restoring fence to its intended height.

Fencing used for tree or other vegetation protection shall not be temporarily removed to allow equipment access over a protected area, except as required for items of work specifically shown on the plans and approved by the Engineer in writing.

1501.4 METHOD OF MEASUREMENT

The quantity to be measured for payment will be the number of feet of Temporary Plastic Barrier Fence erected, measured along the top, to the nearest whole foot.

1501.5 BASIS OF PAYMENT

The unit price bid shall include the cost of all labor, materials and equipment necessary to satisfactorily complete the work. Relocation of a fence from one location to another as directed by the Engineer shall be considered as a new location and will be separately paid.

SUPPLEMENTAL TECHNICAL SPECIFICATION

SECTION 1503

MOBILIZATION

1503.1 DESCRIPTION

This work shall consist of preparatory and final work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to and from the project site; for the establishment of all offices, buildings and other facilities necessary for work on the project; and, for all other work and operations which must be performed or costs incurred prior to beginning work on the project.

1503.2 MOBILIZATION ADMINISTRATION REQUIREMENTS

1503.2.1 DEFINITIONS

The following definitions shall apply:

- a) Total original contract amount shall mean the total amount bid as compensation for the contract.
- b) Total original contract amount less mobilization and demobilization shall mean the total amount bid as compensation for the contract less the amounts bid for mobilization.

1503.2.2 GENERAL

It is the intent of this specification to provide for the Contractor to:

- a) Receive 100% of the amount bid for mobilization by the time the Contractor has performed 10% of the total original contract amount bid less the amount bid for mobilization.

1503.2.3 PAYMENT PROCEDURES FOR MOBILIZATION

The following will apply in effecting mobilization payments:

- a) When the Contractor is eligible for payment of less than 5% of the total original contract amount bid less mobilization, the Contractor will be paid 25% of the amount bid for mobilization.
- b) When the Contractor is eligible for payment of from 5% to less than 10% of the total original amount bid less mobilization, the Contractor will be paid 50% of the amount bid for mobilization minus any mobilization amount already paid.
- c) When the Contractor is eligible for payment of 10% or more of the total original contract amount less mobilization, the Contractor will be paid 100% of the amount bid for mobilization minus any mobilization amount already paid.

1503.2.4 PAYMENT CALCULATIONS

P_M	=	Mobilization Payment
M	=	Total amount bid for Mobilization
f_M	=	Mobilization payment percentage factor
	=	0.25, or 0.50, or 1.0, as applicable
P_M	=	$M \times f_M$

EXAMPLE 1 **MOBILIZATION**

Total Original Contract Amount Bid	\$110,000
Amount Bid for Mobilization	\$ 5,000
Total Original Contract Amount Less Mobilization	\$105,000

Percent of Work Completed	f_M		M		P_M
<hr/>					
<5% of \$102,000	0.25	x	5,000	=	\$1,250
>5% to <10% of \$102,000	0.50	x	5,000	=	\$2,500*
≥10% of \$102,000	1.00	x	5,000	=	\$5,000*
*minus previously paid amounts					

1503.3 METHOD OF MEASUREMENT

Mobilization will be measured by lump sum unit.

1503.4 BASIS OF PAYMENT

Mobilization will be paid for at the contract price per Mobilization Bid Item. The amount Bid for Mobilization shall not exceed 5% of the Total Base Bid.

No additional payments will be made for demobilization and remobilization due to shutdowns or suspensions of the work or for other mobilization and demobilization activities required to complete the contract.

SUPPLEMENTAL TECHNICAL SPECIFICATION

SECTION 1507

MATERIALS TESTING AND QUALITY ASSURANCE

1507.1 GENERAL

- A. This Section includes testing and quality control measures required on this project. The Section is additional to requirements specified for testing and quality assurance in the standard specifications and other supplemental specifications.
- B. Materials and equipment are subject to inspection, sampling, and testing before acceptance of the work.

1507.2 RELATED WORK

- A. General and Supplemental General Conditions of the Contract.

1507.3 REFERENCES AND DEFINITIONS

- A. All materials and equipment shall be tested, by the CONTRACTOR, pursuant to their technical specification (unless otherwise specified herein) and the manufacturer's recommendations.
- B. Structure shall include but is not limited to: parking lots, pavement, sidewalk, curb and gutter, foundations, structural concrete, piping, wet-wells, manholes, retaining walls, junction boxes, and buildings.

1507.4 SUBMITTALS

- A. Test Reports from tests performed by independent testing firm: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein and in other supplemental/standard specifications. Independent firm to submit reports to the ENGINEER and CONTRACTOR, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
- B. Test Reports from tests performed by CONTRACTOR: Submit for acceptance, complete test reports from CONTRACTOR certifying that product conforms to performance characteristics and testing requirements specified herein and in other supplemental/standard specifications.

1507.5 QUALITY ASSURANCE

- A. Quality Assurance/Control of Installation – The CONTRACTOR shall:
 - 1. Comply fully with manufacturers' instructions, including each step in sequence.

2. Request clarifications from ENGINEER before proceeding should manufacturers' instructions conflict with Contract Documents.
3. Request clarification from ENGINEER before proceeding should specified reference standards conflict with Contract Documents. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.
4. Comply with specified standards as a minimum quality for the work except when more stringent specified tolerances, codes, or requirements indicate higher standards or more precise workmanship are required.
5. Make sure work is performed by qualified persons.
6. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

B. Testing Laboratory Services

1. Reports will be submitted by the independent firm to the ENGINEER and CONTRACTOR, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

1507.6 TESTING METHODS

Testing methods shall comply with ASTM Standards and as specified in the technical specifications for the project.

1507.7 EXECUTION

A. Testing Laboratory Services

1. The CONTRACTOR will employ and pay for services of an independent testing firm to perform testing.
2. The independent firm will perform tests and other services specified in individual Specification Sections and as required by the OWNER.
3. CONTRACTOR shall:
 - a) Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.
 - b) Notify ENGINEER and independent firm 8 hours prior to expected time for operations requiring services.
 - c) Make arrangements with independent firm and pay for additional samples and tests required for CONTRACTOR'S use.

B. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the ENGINEER. No additional payment will be made for re-testing due to failing tests.

1507.8 TESTING FREQUENCY AND TYPE OF TESTING

Frequency and type of testing shall be per the requirements listed in the specifications for each type of Work. The Engineer may increase and/or add testing for any Work items. The Testing Allowance will be adjusted for increases in testing by Section 1507.9.D.

1507.9 MEASUREMENT AND PAYMENT

Testing shall be paid for as an allowance on a Lump Sum basis. The Contractor may request percent of LS cost payments during construction, however, the Contractor shall provide actual testing lab invoices as back-up for the percent complete that is being requested in a Pay Application.

Testing allowances are provided as part of the project and invoiced for testing will be paid for through this allowance.

Costs included in testing price include:

- A. Cost of engaging an independent testing firm, execution of tests by the testing firm, and reporting results by the testing firm.
- B. Costs of incidental labor and facilities required to assist testing firm.
- C. Costs of testing laboratory services used by CONTRACTOR separate from Contract Document requirements
- D. Costs of re-testing due to failure of previous tests will be included in the cost for testing and no additional payment will be made for this work.

The CONTRACTOR shall submit two copies of the testing firm's invoice to OWNER with Pay Application. Reimbursement to the Contractor will be for actual invoiced costs and no mark-up will be added to this invoice. The Contractor shall receive reimbursement for actual invoice of testing firm upon certification that payment has been made to the testing laboratory. Payment will be made at the next application for payment from OWNER.

END OF SECTION

SUPPLEMENTAL TECHNICAL SPECIFICATION

SECTION 1508

PROJECT RECORD DOCUMENTS

1508.1 GENERAL

This Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.

1508.2 RECORD DRAWINGS

Record Prints: Maintain one set of red-lined prints of the Contract Drawings and Shop Drawings. These prints shall be updated no less frequently than once per week. These prints will be reviewed for verification of updates by the construction observer on a regular basis, depending on the length of the contract. Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with ENGINEER.

- 1508.2.1** Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Mark whichever drawing is most capable of showing field conditions fully. Require individual or entity who obtained record data, whether individual or entity is Installer, SUB-CONTRACTOR, or similar entity, to prepare the marked-up Record Prints.
- a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
- 1508.2.2** Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-references on the Contract Drawings.
- 1508.2.3** Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
- 1508.2.4** Note Construction Change Directive numbers (field orders or Request for Information changes), alternate numbers, Change Order numbers, and similar identification, where applicable.
- 1508.2.5** Verification of current record prints status will be included in the monthly payment approval process that will be noted by the construction's observer's field reports.

1508.3 RECORD SPECIFICATIONS

Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later. Note related Change Orders, field order notes, Request for Information (RFI) notes, Record Product Data, and Record Drawings where applicable.

1508.4 MISCELLANEOUS RECORD SUBMITTALS

Assemble Certifications, Lab Test Reports, and Field Test Reports required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1508.5 SUBMITTALS

See New Mexico Standard Specifications For Public Works Construction Section 1502.

1508.6 RECORDING AND MAINTENANCE

- 1508.6.1** Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur.
- 1508.6.2** Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. It is not advisable to use Project Record Documents for construction purposes. Provide access to Project Record Documents for Engineer's reference on the project site.

1508.7 MEASUREMENT AND PAYMENT

The cost of project record documents shall be incidental to the Work and no separate payment shall be made for this effort. However, the Project Record Documents shall be reviewed per Section 1508.2.5 and they shall be updated prior to pay applications being processed.

END OF SECTION

SUPPLEMENTAL TECHNICAL SPECIFICATION 1516

GALVANIZED GABION MAT

PART 1 GENERAL

1.1. SUMMARY

The work under this specification includes furnishing, assembling, filling and tying double twist woven wire mesh Gabion mats placed on a prepared surface as specified, and in accordance with the lines, grades, and dimensions shown on plans or otherwise established in the field by project engineer.

1.2. UNIT PRICES

1.2.1 Measurement

Gabion mats meeting the requirements of these specifications and acceptably placed within the limits indicated on the drawings or otherwise established in the field, shall be measured for payment by the cubic yard (cubic meter) of stone filled Gabion mats in place.

1.2.2 Payment

Payment shall be made for costs associated with Gabion mat, including the costs of furnishing, assembling, and placing the wire baskets, the stone fill, and all other materials, labor, equipment, tools, supplies, and incidental costs in connection with completing this item of work.

1.3. REFERENCES

ASTM A90/A90M	Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A370	Test Methods and Definitions for Mechanical Testing of Steel Products
A428/A428M	Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles
ASTM A764	Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs
ASTM A641/A641M	Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A902	Terminology Relating to Metallic Coated Steel Products
ASTM A975	Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Poly Vinyl Chloride (PVC) Coating)
ASTM B117	Practice for Operating Salt Spray (Fog) Apparatus
ASTM D412	Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D6711	Standard Practice for Specifying Rock to Fill Gabions, Revet Mattresses, and Gabion mats
AASHTO M288	Standard Specification for Geosynthetic Specification for Highway Applications

1.4. DEFINITIONS

1.4.1 Gabion mat

Gabion mat is a double twisted wire mesh container of variable sizes, uniformly partitioned into internal cells by diaphragms, interconnected with other similar units and filled with stone at the project site to form flexible, permeable, monolithic structures such as channel linings, revetments, scour protections and other erosion control applications.

Definitions of terms specific to this specification and to all materials furnished on the jobsite, except for the rock to fill the baskets and the geotextile, shall refer and be in compliance with ASTM A975.

1.5. FABRICATION

Gabion mats shall be manufactured and shipped with all components mechanically connected at the production facility except the lid which is produced separately from the base. All perimeter edges of the mesh forming the basket and lid shall be selvedged with wire having a larger diameter. The Gabion mat is divided into cells by means of diaphragms. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite.

1.6. SUBMITTALS

Preapproved product under these specifications is galvanized Gabion mat manufactured by Maccaferri Inc. info@us.maccaferri.com; Tel: 301-223-6910.

Submit the following list of items for Engineer's review and approval prior to material supply.

- i. Manufacturer's product technical specifications, and product installation instructions.
- ii. Wire mesh sample with edge and selvedge wires. Minimum sample size shall be 12 in. by 12 in.
- iii. Written manufacturer's certificate of compliance. Manufacturer's Certificate of Compliance shall be signed by person authorized to bind the manufacturer's certifications and must have Manufacturer's name and product manufacturing location.

Equivalent products or any value engineering proposal using alternate product is acceptable provided the following items in addition to above listed are submitted to the Engineer at least 14 days prior to bid.

- i. Test reports from a third-party test laboratory in USA to verify the product compliance with ASTM A975.
- ii. Test reports from a third-party test laboratory in USA to verify the performance and design parameters: admissible velocity and shear stress, Shield's coefficient and Manning's roughness coefficient.
- iii. Mill certifications of the wire used in manufacturing the products.
- iv. Manufacturer's Quality Control Manual.
- v. List of at least ten government projects where the product has been successfully installed.
- vi. Certified document that demonstrates manufacturer has at least 10 years of continuous experience in manufacturing Gabion mats and has manufactured at least 1.0 million cubic yards of Gabion mats.
- vii. Shop drawings and design calculations along with test reports, signed and sealed by the Professional Engineer registered in the state of project location.

1.7. QUALITY ASSURANCE

1.7.1 Wire and Ring Fastener

The owner or owner's representative reserves the right to test additional samples to verify the submitted test records. For equivalent products, furnish minimum three randomly selected field samples of lacing wire and ring fasteners 60 days prior to start of installation. Samples shall be tested to verify following property requirements in accordance with ASTM A975.

- i. Wire thickness
- ii. Tensile strength

- iii. Ring fastener individual pull apart strength

1.7.2 Installation

The General Contractor shall have personals with at least 3 years of experience installing Gabion mats and have installed a minimum of 500 SY of Gabion mats in each of the last three years. In case the General Contractor does not meet the qualifications based on the above requirements, acquire necessary onsite training from manufacturer prior to construction or the services of a qualified gabion /mattress subcontractor must be utilized. A manufacturer's representative shall provide reasonable installation support.

1.8. DELIVERY, STORAGE, AND HANDLING

Gabion mats shall be delivered with all components mechanically connected at the production facility except the lid which is delivered separately from the base. All Gabion mats are supplied in rolls which are banded together at the factory for ease of shipping and handling. Labels in the rolls show the dimensions of the Gabion mats included, the number of pieces and the color code. Lacing wire shall be shipped in coils, and fasteners in boxes.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Gabion mats

Double twisted wire mesh Gabion mats shall be manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Gabion mat sizes, wire diameters, mesh opening sizes, and tolerances shall comply with the requirements of ASTM A975. Gabion mats are classified according to the wire coating, which is applied prior to manufacturing the mesh. Galvanized Gabion mats are manufactured from a heavily zinc coated soft or medium temper steel as per ASTM A975. Wire and wire mesh used for manufacturing Gabion mats shall meet the following requirements:

2.1.1.1 Wire Tensile Strength

The wire used for the manufacturing Gabion mats and lacing wire, shall have a minimum tensile strength of 60,000 psi (415 MPa) to maximum tensile strength of 80,000 psi (550 MPa), in accordance with ASTM A641/A641M.

2.1.1.2 Elongation

The test shall be carried out on a sample at least 12 in. (300 mm) long, and the elongation shall not be less than 12%, in accordance with ASTM A370.

2.1.1.3 Metallic (Zinc) Coating

The minimum quantities of zinc shall be according to the ASTM A641/A641M, Class III soft or medium temper coating.

2.1.1.4 Adherence of Zinc Coating

The adherence of the zinc coating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers, in accordance with A641/A641M.

2.1.1.5 Standard Wire Diameters

All wire diameters shall comply with ASTM A975 as presented in Table 1.

Table 1 Standard Wire Diameters			
	Lacing Wire	Mesh Wire	Selvedge Wire
Wire Diameter Int Ø in (mm)	0.087 (2.20)	0.120 (3.05)	0.153 (3.9)
Wire Tolerance (\pm) Ø in (mm)	0.004 (0.10)	0.004 (0.10)	0.004 (0.10)
Min. Zinc Qty. oz/ft ² (g/m ²)	0.70 (214)	0.85 (259)	0.90 (275)

2.1.1.6 Mesh Characteristics and Strength Requirements

The wire mesh characteristics and minimum strength requirements shall be in accordance with ASTM A975 as presented in Table 2. The tolerances on the wire mesh opening, D (see Fig. 1), shall not exceed $\pm 10\%$.

Table 2 Mesh Characteristics and Minimum Strength	
Mesh Type	8x10/ Galvanized
Mesh Opening, D	3.25 in. (83 mm)
Mesh Tensile Strength	3500 lb/ft (51.1 kN/m)
Punch Test Resistance	6000 lb (26.7 kN)
Connection Strength	1400 lb/ft (20.4 kN/m)

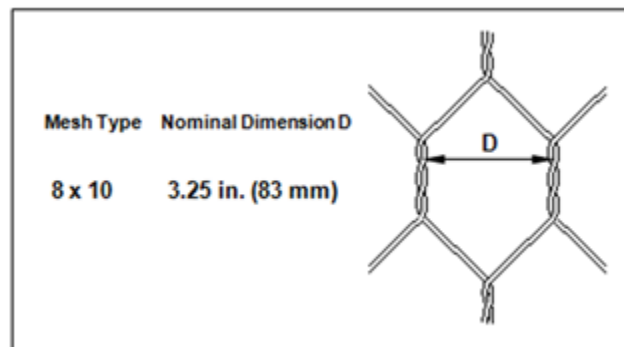


Fig. 1 Mesh type and opening

2.1.1.7 Standard Gabion mat sizes are listed in Table 3. All sizes and dimensions are nominal.

Table 3 Standard Gabion Mat Sizes			
L=Length ft (m)	W=Width ft (m)	H=Height ft (m)	# of cells
60 (19)	6 (1.83)	1 (0.3)	14
60 (19)	9 (2.74)	1 (0.3)	21
60 (19)	6 (1.83)	1.5 (0.45)	14
60 (19)	9 (2.74)	1.5 (0.45)	21
99 (30)	6 (1.83)	1 (0.3)	14
99 (30)	9 (2.74)	1 (0.3)	21
99 (30)	6 (1.83)	1.5 (0.45)	14
99 (30)	9 (2.74)	1.5 (0.45)	21

The tolerances on width, length and height of baskets shall not exceed $\pm 5\%$.

2.1.2 Ring Fasteners

Galvanized steel rings for Galvanized Gabion mats shall be in accordance with ASTM A975 section 6.3. The ring fasteners properties shall be as presented in Table 4.

Table 4 Ring fastener property requirements		
Property	Value	Test Method
Wire diameter	0.120 in. (3.05 mm)	ASTM A764, Type B, Class 3
Wire tensile strength	230,000 to 273,000 psi (1586 to 1882 MPa)	ASTM A764, Table 2

2.1.1 Stone Fill

2.1.1.1 Properties

Rocks shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure.

2.1.1.2 Gradation

The rock used to fill Gabion mats shall be large enough to prevent individual pieces from passing through the mesh openings. Gabion mat rocks shall range between 4 in. and 8 in. (100 mm and 200 mm). The range in sizes shall allow for a variation of 5% oversize and/or 5% undersize rock by weight. In all cases, the sizes of any oversize rock shall allow for the placement of three or more layers of rock within each Gabion mat compartment. In all cases, undersize rock shall be placed within the interior of the Gabion mat compartment and shall not be placed on the exposed surface of the structure.

2.1.1.3 Source

Rock may be naturally available or crushed rock produced by any suitable method and using any device that yields the required size limits. Alternatively, clean crushed concrete can be used to fill the Gabion mats.

2.1.2 Geotextile

Separation geotextile used behind or underneath Gabion mats shall meet AASHTO M288 and/or project specification requirements.

PART 3 EXECUTION

3.1 FOUNDATION PREPARATION

The foundation for Gabion mat wall shall be graded level for a width equal as shown in the project plans. Prior to begin the wall construction, the area under the wall footprint should be prepared and compacted. Any soft or loose material that is encountered should be compacted or removed and replaced. Any debris that will obstruct the proper installation shall also be removed, and the voids carefully backfilled and compacted. If frozen ground conditions are encountered, contact project geotechnical engineer for further recommendations.

3.2 GEOTEXTILE PLACEMENT

Geotextile shall be placed uniformly on the surface as indicated on the drawings or as directed by the project engineer. Place the geotextile in close contact with the soil, eliminating folds or excessive wrinkles both longitudinally and transversely. The geotextile shall be installed with adequate overlap. The minimum overlap distance in the transverse or longitudinal direction is 2.0 ft (0.6 m), except in underwater installations where the minimum overlap is 3.0 ft (1.0 m). It is recommended that traffic not run on exposed geotextile.

3.3 ASSEMBLY

Gabion mats are supplied in rolls. The units shall be opened and unrolled one by one on their proper location. The sides, ends, and diaphragms shall be lifted into a vertical position to form an open box shape. The back and the front panels of the Gabion mat shall be connected to the end panels and center diaphragms using either lacing wire or ring fasteners. The end panels and the diaphragms shall be raised to a vertical position and the selvedge wire shall be wrapped around the edge wire of the top and back panels. Fig. 2 shows assembled double twisted wire mesh Gabion mat.

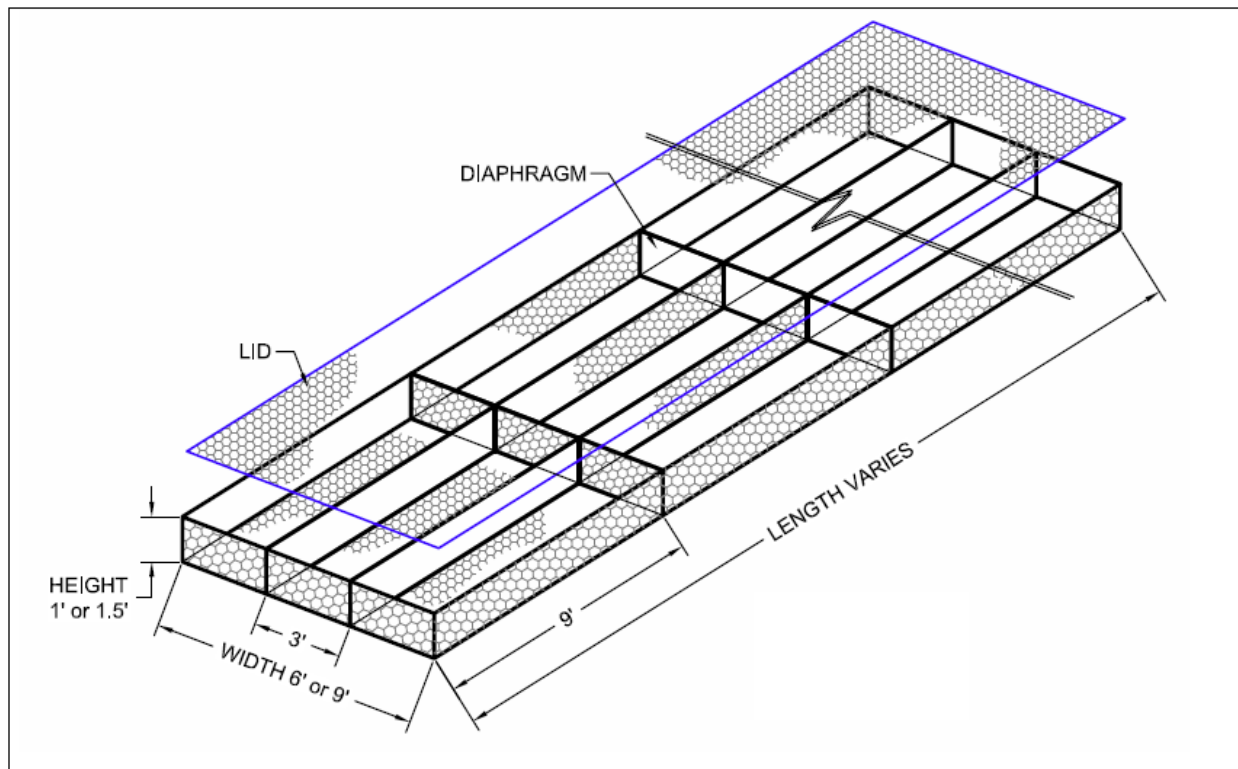


Fig. 2 Assembled double twisted wire mesh Gabion mat

3.4 FASTENING PROCEDURES

3.4.1 Lacing Wire

When using lacing wire, cut a piece of wire approximately 1.5 times the length of the edge to be laced. Longer edges shall be connected by several lengths of lacing wire. The mesh panels shall be pulled tightly together during the tying operation. For vertical joints, starting at the bottom end of the panel, the lacing wire shall be twisted and wrapped two times around the bottom selvedge and then double and single loops shall be alternated through at intervals not exceeding 6 in. (150 mm) as shown in Fig. 3. The operation shall be finished by looping around the top selvedge wire. The use of pliers to assemble the units with lacing wire is recommended to create tighter joints.

3.4.2 Ring Fasteners

When ring fasteners are used to connect Gabion mat panels, spacing of the rings shall be in accordance with ASTM A975, minimum strength requirements of mesh and connections. In any case, the maximum ring spacing along the edges shall not exceed 4 in. (100 mm) as shown in Fig. 3. Ring fasteners shall be installed at the end, diaphragms and along the edges. Each ring fastener shall be closed, and the free ends

of the fastener shall overlap a minimum of 1 in. (25 mm) as shown in Fig 3. The use of either a mechanical or a pneumatic fastening tool is required to install ring fasteners.

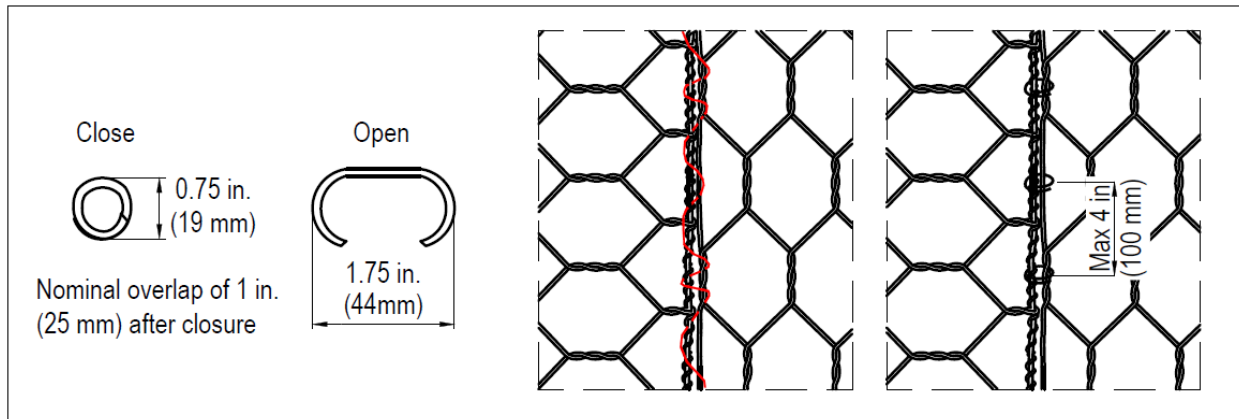


Fig. 3 Fastening procedures

3.5 INSTALLATION AND FILLING

Empty Gabion mat units shall be placed and assembled individually on the approved surface to the lines and grades as shown or as directed by project engineer. Gabion mats shall be connected to each other and aligned before filling the baskets with rock. All connections (panel-to-panel) and basket-to-basket shall be already carried out as described in ASSEMBLY section above. During the filling, some manual stone placement is required to minimize voids. Gabion mats shall be uniformly overfilled by about 1 to 1.5 in. (25 to 40 mm) to compensate for future rock movement.

3.6 CLOSING

After the Gabion mats are filled, lids shall be tightly secured along all edges, ends and diaphragms in the same manner as described for assembling. The panel edges shall be pulled and connected with the lid using the appropriate closing tools such as lid closer, where necessary. Adjacent lids shall be securely attached simultaneously, and all end wires shall then be turned in to avoid protrusions.

3.7 NON-RECTANGULAR SHAPES AND SPECIAL ADAPTATION

Where a complete Gabion mat cannot be installed because of space limitations, the Gabion mat shall be cut, folded or overlapped, and securely connected to suit existing site conditions. All modified Gabion mats shall form a closed cell when completed. Mattresses can be cut to form curves or bevels.

3.8 MAINTENANCE

No routine maintenance is required. Severely damaged Gabion mats shall be completely removed and replaced. If the damage is localized in the fascia, the Gabion mats can be repaired by filling the voids (if any) with rock, and patching it using a new piece of double twisted wire mesh. New piece of wire mesh shall be connected to undamaged mesh with a minimum overlap of 9 to 12 in. (225 to 300 mm) using lacing wire or fasteners.

-- End --