

SECTION 03200

CONCRETE REINFORCEMENT

03200.01 GENERAL

A. Description

Concrete reinforcement shall include, but not necessarily be limited to, furnishing and placing various types and/or sizes of steel reinforcing for embedment in Portland cement concrete as specified in the Contract Documents.

B. Related Work Included Elsewhere

Not applicable.

C. Quality Assurance

1. Inspection and Testing

The County Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents. When specific tests of materials are called for in the referenced standards and specifications, the County Engineer has the option of requiring that any or all of these tests be performed for materials furnished for a specific project. When testing is required, it will be specified herein or in the "Special Provisions."

2. Tolerances

Reinforcing bars shall be cut and bent within the following tolerances:

- a. Sheared Length: Plus or minus 1 inch for #3 to #11 bars inclusive and 2 inches \pm for #14 and #18 bars.
- b. Depth of Truss Bars: Plus 0, minus ½ inch.
- c. Stirrups, Ties, and Spirals: Plus or minus ½ inch.
- d. All Other Bends: Plus or minus 1 inch.
- e. Tolerances in placement shall conform to Paragraph 7, Section 7 of the Manual of Standard Practice of the Concrete Reinforcing Steel Institute.

D. Submittals

1. Shop Drawings

Shop drawings shall be submitted as specified in the "General Provisions" for all reinforcing bars and shall contain the following data, lists, and information; bar lists, placement plans, and bending diagrams: description, details, dimensions, and locations of each item; details in accordance with requirements of ACI 318.

2. Certificates of Compliance

Certificates of compliance shall be submitted in accordance with the "General Provisions" for all concrete reinforcement stating that the material furnished meets the requirements specified in Section 03200.02.

3. Certified Test Results

- a. Certified test results shall be submitted for all epoxy coatings for deformed steel reinforcing bars showing that they meet the requirements specified in Section 03200.02.
- b. A certified copy of mill tests shall be submitted on each heat of reinforcing steel delivered, showing physical and chemical analysis.

03200.02 MATERIALS**A. Materials Furnished by the County**

The County will not furnish any materials for concrete reinforcement.

B. Contractor's Options

Substitution of smaller size bars will be permitted only upon specific authorization by the County Engineer. Substituted bars shall provide a steel area equal to or larger than that called for by the design provided the spacing is not reduced to a point where the clear distance between the bars is less than one and one-half times the nominal diameter of the bars, nor one and one-half times the maximum size of the course aggregate, nor 1 ½ inches, and further provided that the planned cover is maintained.

C. Detailed Material Requirements

1. General

Reinforcing steel shall conform to the requirements of ACI 318.

2. Bar Reinforcement

Bar reinforcement shall consist of deformed bars conforming to AASHTO A615, Grade 60. Also refer to Section 02651.02.C.11.a.

3. Plain Reinforcement

Tie or dowel bars shall be round steel bars AASHTO A615, Grade 60 or ASTM A 36. Bars shall be epoxy coated. Also refer to Section 02651.02.C.11.b.

Sleeve for dowel bars shall be of sheet metal capable of sliding over $2\pm 1/4$ inch of

the dowel and shall have a closed end with a stop to hold the end of the sleeve at a minimum distance of 1 inch from the end of the dowel bar.

4. Welded Steel Wire Fabric

Welded steel wire fabric shall meet the requirements of AASHTO M 55. Fabric used in pavement construction shall be furnished in flat sheets. When galvanizing is specified, the fabric shall be galvanized after fabrication.

5. Welded Deformed Steel Wire Fabric

Welded deformed steel wire fabric shall meet the requirements of AASHTO M 221.

6. Fabricated Steel Bar Mats

Fabricated steel bar mats shall consist of steel conforming to AASHTO A184.

7. Wire Fabric for Pneumatically Applied Mortar

Wire fabric for pneumatically applied mortar and concrete encasement shall conforming to AASHTO A185. It shall be fabricated from either size W1.5 wire on 3-inch centers in each direction or from W1 wire on 2-inch centers in each direction. It shall have a minimum galvanized coating of 0.8 ounces per square foot when tested as specified in AASHTO A90.

8. Cold Drawn Steel Wire

Cold drawn steel wire for concrete reinforcement shall meet the requirements of AASHTO M 32.

9. Tie Devices

Tie devices for use in securing contiguous traffic lanes of Portland cement concrete pavement or a traffic lane and concrete curb or combination curb and gutter shall be of malleable iron or steel. The tie devices shall meet the dimensions specified and produce a frictional force of at least 160 pounds per foot of spacing when tested in accordance with MSMT 512.

10. Galvanizing

Galvanizing for deformed steel bars shall be in accordance with ASTM A 153.

11. Fusion Bonded Epoxy Powder Coating for Steel

Epoxy coatings for reinforcement steel shall be epoxy powders which are electrostatically spray applied to sandblasted near white steel (fusion bonded epoxy resin). Ties, supports, and inserts used in conjunction with epoxy coated steel reinforcing bars shall be similarly coated.

Fusion bonded epoxy powder coating for steel shall conform to Section 917.02 of the "MSHA Standard Specifications for Construction and Materials, (1993)".

03200.03 EXECUTION**A. Fabrication**

1. General

After bar lists and bending diagrams have been approved, fabricate each unit of reinforcement to the type, shape, size, grade, and dimensions shown on the approved shop drawings.

2. Cutting and Bending

Perform cutting and bending of reinforcing bars before shipment to the site. Bend all bars cold in a manner that will not injure the material and in accordance with the Manual of Standard Practice of the Concrete Reinforcing Steel Institute.

B. Shipping, Handling, and Protection of Material

Reinforcing steel bars shall be shipped in standard bundles and tagged and marked in accordance with the provisions of the Code of Standard Practice of the Concrete Reinforcing Steel Institute. Bundles shall be kept intact and material undamaged and properly identified until ready for use.

Reinforcing steel bars shall be stored on blocking, racks, or platforms so as not to be in contact with the ground.

Bars shall be kept free from dirt, paint, oil, grease, loose or thick rust, detrimental mill scale, or other foreign substances. However, when steel has on its surface detrimental rust, mill scale, dust, or dirt, it shall be cleaned by a method approved by the County Engineer.

C. Placing and Fastening

The placing of bars shall conform to the recommended practices in "Placing Reinforcing Bars" as published by the Concrete Reinforcing Steel Institute.

Reinforcing steel shall be accurately placed in the position shown on the plans and firmly held during the depositing and setting of the concrete. Cover, or the distance between the external face of the bar and the face of the finished concrete, shall be as indicated on the Plans. Reinforcing steel bars embedded in concrete shall not be bent after they are in place. Bars shall be tied at all intersections with 16 ½ gage black annealed wire except that where spacing is less than 1 foot each direction alternate intersections need not be tied. All intersections shall be tied in the top mat of reinforcement placed on the top slabs of box culverts. Abrupt bends shall be avoided except where one steel bar is bent around the other. Stirrups and ties shall always pass around the outside of main bars and be securely attached thereto. All reinforcing steel shall be securely held at the proper distance from the forms by means of plastic coated steel chairs. Blocks for holding reinforcement away from contact with earth shall be precast concrete blocks of approved shape, mix, and dimensions and shall have tie wires embedded in them. Layers of bars shall be separated by approved plastic coated metal chairs or bolsters.

Any broken or damaged concrete spacer blocks shall be removed before concrete is placed. The use of pebbles, pieces of broken stone or brick, metal pipe, or wooden blocks

as spacers will not be permitted.

Reinforcing steel when placed in the work shall be free from flake rust, dirt, and foreign material before any concrete is placed. Any mortar which may be adhering to the reinforcing steel shall be removed. No concrete shall be deposited until the County Engineer has inspected the placing of the reinforcing steel and given permission to place the concrete. The Contractor shall allow the County Engineer 4 hours of normal working time after the reinforcement and forms are in place to conduct the inspection. Any bars of incorrect size, length, or shape shall be removed and replaced with correct bars. Any bars located or spaced incorrectly shall be relocated or spaced correctly before permission is given to place concrete, and such replacements and corrections shall be at the Contractor's expense. All concrete placed in violation of these provisions shall be rejected and removed.

When the ambient air temperature is below 40°F, the temperature of the air in contact with the reinforcement shall be raised to 40°F prior to placing concrete. When the ambient air temperature is above 70°F and the reinforcement is exposed to the direct rays of the sun, the reinforcement shall be cooled by means of a water spray or by shading prior to placing concrete.

D. Splicing

Reinforcement shall be furnished in full lengths as indicated on the Plans. Splicing, except where shown on the Plans, will not be permitted without written approval from the County Engineer; and if additional splices are used, the additional weight occasioned by such splices shall be at the Contractor's expense.

All splices shall conform to Class "C" in ACI 318 or as shown on the Plans. Splices shall be well distributed where conditions permit. Except where otherwise shown on the Plans, lap splices shall be made with the bars placed in contact and wired together.

No welding of reinforcing steel or attachments thereto will be permitted without written authorization by the County Engineer, unless so indicated on the Plans. Welding, if permitted, shall be in accordance with AWS D1.4.

E. Tying New Concrete into Existing Concrete

Refer to Section 416.03.07 of the "MSHA Standard Specifications for Construction and Materials, (1993)".

03200.04 METHOD OF MEASUREMENT

RESERVED FOR FUTURE USE

A. Unit Price

RESERVED FOR FUTURE USE

B. Lump Sum

RESERVED FOR FUTURE USE

CONCRETE REINFORCEMENT

03200-6

03200.05 BASIS OF PAYMENT

A. General

RESERVED FOR FUTURE USE

B. Unit Price

RESERVED FOR FUTURE USE

C. Lump Sum

RESERVED FOR FUTURE USE

SECTION 03300

CAST-IN-PLACE CONCRETE STRUCTURES

03300.01 GENERAL

A. Description

Cast-in-place concrete structures shall include, the construction of Portland cement concrete structures to the lines and dimensions and at the locations shown on the Plans and in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. General excavation; Section 02220.
2. Excavation support; Section 02400.
3. Dewatering; Section 02512.

C. Quality Assurance

1. General
 - a. The County Engineer will inspect all materials before and/or after installation to insure compliance with the Contract Documents. When specific tests of materials are called for in the referenced standards and specifications, the County Engineer has the option of requiring that any or all of these tests be performed for materials furnished for a specific Project. When testing is required, it will be specified herein or in the "Special Provisions."
 - b. The Contractor will conduct normal concrete job control tests, i.e. slump and air content, on the plastic concrete and will prepare test cylinders in accordance with Section 03310.01 unless otherwise specified.
 - c. For the purpose of determining the time when falsework, forms, etc. may be removed, backfill made, and when loads may be applied to structures, an adequate number of test specimens shall be made in addition to the number required to check the quality of the concrete being produced.
2. Inspection

The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the County Engineer's inspection procedures.
3. Tolerances for Formed Surfaces

Formed surfaces shall be true to the lines and dimensions shown on the Contract Documents to the tolerances listed herein:

- a. Variation from plumb:
 - 1) In the lines and surfaces of columns, piers, walls, and in arises:
 - In any 10 foot of length 1/4 inch
 - Maximum for the entire length 1 inch
 - 2) For exposed corner columns, control-joint grooves, and other conspicuous lines:
 - In any 20 foot length 1/4 inch
 - Maximum for the entire length 1/2 inch

- b. Variation from the level or from the grades specified in the Contract Documents:
 - 1) In slab soffits, ceiling, beam soffits, and in arises, measured before removal of supporting shores:
 - In any 10 foot of length 1/4 inch
 - In any bay or in any 20 foot length 3/8 inch
 - Maximum for the entire length 3/4 inch
 - 2) In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
 - In any bay or 20 foot length 1/4 inch
 - Maximum for the entire length 1/2 inch

- c. Variation of the linear structure lines from established position in plan and related position of columns, walls, and partitions:
 - In any bay 1/2 inch
 - In any 20 foot of length 1/2 inch
 - Maximum for the entire length 1 inch

- d. Variation in the sizes and location of sleeves, floor openings, and wall openings: $\pm 1/4$ inch

- e. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls:
 - Minus 1/4 inch
 - Plus 1/2 inch

- f. Footings*
 - 1) Variations in dimensions in plan:

- Minus ½ inch
- Plus 2 inches

- 2) Misplacement or eccentricity:
 - 2% of the footing width in the direction of misplacement but not more than 2 inches

- 3) Thickness:
 - Decrease in specified thickness 5%
 - Increase in specified thickness No limit

- g. Variation in steps:
 - 1) In a flight of stairs:
 - Rise ±1/8 inch
 - Tread ±1/4 inch

 - 2) In consecutive steps:
 - Rise ±1/16 inch
 - Tread ±1/8 inch

*Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items.

4. Defective Work

Porous areas, open or porous construction joints, and honeycombed concrete indicate that all of the requirements for mixing, placing, and handling have not been complied with and shall be considered as sufficient cause for rejection of the members of the structure thus affected. Defective work exposed upon removal of forms shall be entirely removed or repaired within 48 hours after forms have been removed.

No repaired area will be accepted unless:

- 1) the structural requirements have not been impaired by reducing the net section of compression members;
- 2) the bond between the steel and concrete has not been reduced;
- 3) the areas shall be finished so as to blend in every respect with the texture, contour and color of the surrounding concrete.

If the above limitations cannot be satisfied, the members or unit involved shall be removed and satisfactorily replaced entirely at the Contractor's expense.

Defective areas shall be cut out to such depth that all voids, honeycombed, or any other defect are entirely removed. The edges of the material remaining in place

shall be cut perpendicular to the finished surface to the full depth of the material removed but not less than 1 inch.

If the removal of defective concrete affects the structural requirements as above defined, the member likewise shall be removed and replaced.

The area to be repaired and a space at least 6 inches wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. The patch shall be made with mortar; the mix of which shall be predetermined by making trial batches to secure a mix matching the color and texture of surrounding concrete. In order to facilitate color matching, the Contractor shall obtain a quantity of Portland cement from the Contractor's concrete supplier which shall be used to mix the patching mortar. The amount of water used in mixing the mortar shall be as little as is consistent with the requirement of handling and placing. The mortar shall then be put aside for 1 hour during which time it shall be mixed with a trowel to prevent setting. No additional water shall be added to the mix. The mortar shall be thoroughly compacted in place and screeded off so as to leave the patch slightly higher than the surrounding surface. It shall then be left undisturbed for a period of 1 to 2 hours to permit initial shrinkage before being finally finished. The patch shall be finished in such a manner as to match the adjoining surface. On surfaces where unlined forms have been used, the final finish shall be obtained with straightedge spanning the patch and held parallel to the direction of the form marks. After the patches have set sufficiently so that the surface will not be damaged, curing and protection of concrete shall proceed as required for the original concrete section.

D. Submittals**1. Shop Drawings**

Shop drawings shall be submitted as specified in the "General Provisions" for the following materials, and shall include the following information: preformed expansion joint material, joint sealers, curing materials, form release compounds, and waterstops: general product information, chemical composition, and dimensional information where appropriate.

2. Certificate of Compliance

Certificates of compliance shall be submitted in accordance with the "General Provisions" for all waterstop, joint filler, preformed joint fillers, form release compounds, paraffin wax, and Portland cement concrete curing materials stating that the material furnished is in accordance with, and meets the test requirements specified in Section 03300.02.

03300.02 MATERIALS**A. Materials Furnished by the County**

1. The County will not furnish any materials for cast-in-place concrete.
2. The Contractor may purchase water from the County's potable water system in accordance with current County policies and procedures. The Contractor shall

contact the Department of Fiscal Services, Meter Section, for requirements. A backflow prevention device must be placed in accordance with the Standard Details prior to drawing County water.

B. Contractor's Options

The Contractor may furnish higher strength concrete than specified.

C. Detailed Material Requirements

1. Portland Cement Concrete

Portland cement concrete shall be the mix number called for in the Contract Documents and shall be in accordance with the requirements of Section 03310.03.

2. Concrete Reinforcement

Concrete reinforcement shall be the size and type specified and shall be in accordance with the requirements of Section 03200.03.

3. Joint Fillers

The hot applied material shall be in accordance with AASHTO M 173. Manufacturers' recommendations regarding pouring temperature will be used when testing this material. If a range of temperatures is recommended, the mid point will be used as the pour point. The cold applied type shall be in accordance with AASHTO D 1850.

4. Preformed Joint Fillers

Preformed joint fillers shall conform to AASHTO M 153. The bituminous fiber type shall be in accordance with AASHTO M 213 with the bitumen content determined by MSMT 408 or AASHTO T164.

5. Roofing Paper

Roofing paper to be used in expansion joints shall be composed of roofing felt saturated and coated on both sides with an asphaltic material. It shall not weigh less than 39.8 pounds per 100 square feet and shall not crack when bent 90 degrees over a ½ inch radius at room temperature.

6. Waterstops

Waterstops shall be made of rubber or polyvinyl chloride. The rubber type may be natural rubber, suitable synthetic rubber, or a suitable combination of natural and synthetic rubber. The polyvinyl chloride shall contain at least 90% virgin polyvinyl chloride. The remaining 10% may include one or more monomers copolymerized with vinyl chloride or consist of other resins mechanically blended with polyvinyl.

The waterstop shall be of the shape and dimensions shown on the Plans. The cross section shall be uniform along the length and transversely symmetrical so that the thickness at any given distance from either edge of the waterstop shall be

uniform. The waterstop shall be dense, homogeneous, and free from holes and other imperfections.

The waterstop shall meet the following requirements:

Tensile Strength, ASTM D 412, psi min.	2000
Elongation at Break, ASTM D 412, % min.	300
Hardness, Rubber, Type A Durometer, ASTM D 2240	55 ± 5
Hardness, PVC, Type A Durometer, ASTM D 2240	75 ± 5

7. Form Release Compounds

Form release compounds shall effectively prevent the bonding of the concrete to the forms. The form release compounds shall not cause discoloration of the concrete nor adversely affect the quality or rate of hardening at the interface of the forms. The compounds will be tested in accordance with MSMT 503.

The flash point of the material shall not be less than 100°F when tested in accordance with AASHTO T 73.

8. Paraffin Wax

Paraffin wax for use as a bond breaker for concrete shall be water clear. The flash point shall not be less than 380°F when tested in accordance with ASTM D 92.

9. Portland Cement Concrete Curing Materials

Curing materials shall be burlap cloth, sheet materials, or liquid membrane-forming compounds.

a. Burlap

Burlap cloth shall be made from jute or kenaf and shall be in accordance with AASHTO M 182, Class 1, 2, or 3.

b. Burlap Polyethylene Sheeting

Sheet material shall be in accordance with AASHTO M 171 except that tensile strength and elongation requirements are waived. White burlap polyethylene sheeting shall give a finished product weight of not less than 10 ounces per square yard.

c. Liquid Membrane

Liquid membrane-forming compounds shall be in accordance with AASHTO M 148.

Field control testing of the white pigmented curing compounds will be on the basis of weight per gallon. The samples shall not deviate more than plus or minus 0.3 pounds per gallon from the original source sample.

10. Vapor barrier
 - a. Building paper shall be Sisal-Kraft building paper, conforming to requirements of FSS UUB 790A.
 - b. Polyethylene sheeting shall be 0.006 inch thick, conforming to requirements of ASTM D 2103.

03300.03 EXECUTION

A. General

1. Concrete shall be mixed as specified in Section 03310. Concrete shall be delivered to the site in accordance with ASTM C 94.
2. The Contractor will be required to use concrete equipment of sufficient capacity to complete any unit or section of masonry between construction joints, as indicated on Plans, in one continuous operation consistent with placement operations as approved by the County Engineer.
3. Hand mixing may be permitted with written approval of the County Engineer for small volumes of concrete. However, its intended use is for small isolated areas where structural integrity is not critical.
4. Before placing any concrete, the Contractor shall install all sleeves, anchors, frames, fittings, pipes, conduits, or other special devices called for in the Contract Documents. No concrete shall be placed until this work has been approved by the County Engineer. The Contractor shall ascertain that all material to be installed in the concrete by other trades has been placed prior to pouring any concrete. Any concrete poured without prior provisions having been made for inclusion of the indicated inserts and materials will be subject to rejection by the County Engineer and/or correction at the Contractor's expense.

B. Forms

Forms for concrete work shall be mortar tight.

1. Design Criteria

Design of the forms shall be the Contractor's responsibility. Forms shall be designed for strength and deflection to resist all loads and pressure of wet concrete. The design shall provide for rate of pour, effect of vibration, and use of retarders, etc. In addition, horizontal surfaces shall have applied to them a live load of 50 pounds per square foot. This load is to be used in the design of the forms for strength only and is not to be used in computing deflections. However, in the design of forms for horizontal slabs, in no case shall this loading be less than a total of 120 pounds per square foot. (This does not apply to form joists, form wales, etc.) No form member or support thereof shall have a deflection in excess of 1/240 of its span length, and in no case shall said deflection exceed 1/4 inch. An exception is deflection of form surfaces for concrete floor slabs where such concrete is supported by beams, stringers, or girders, which may be 1/180 of the span length but not in excess of 1/2 inch. In steel forms which remain in place, camber shall not be used to compensate

for deflection in excess of the foregoing limits. The design spans of the form sheets shall be the clear span of the form plus 2 inches measured parallel to the form flutes.

2. Concrete and Form Unit Weights

All buckets, buggies, finishing machines, etc. shall be removed from the forms before concrete attains its initial set. The concrete shall be assumed to weight 150 pounds per cubic foot unless lightweight concrete is specified. The lumber in the forms shall be assumed to weigh 60 pounds per cubic foot. When forms are composed of material other than lumber, the unit weight shall be in accordance with the AASHTO specifications.

3. Plywood Forms

The strength of plywood (without backing) shall be calculated on the basis of the grain of the face plies running parallel to its span, and it shall be so installed. When the plywood is against backing, the strength of the plywood will be neglected; and the backing must carry the entire load. In cases where the plywood form panels are to be reused, the actual span length of the plywood shall be 2 inches less than the computed maximum allowable span. The unit stresses to be used shall be as subsequently described.

4. Forms at Construction Joints and Corners

At construction joints in concrete, ties or bolts shall be provided 3 to 6 inches from each side of the joint for tightening the forms against the hardened concrete (first pour) immediately prior to placing fresh concrete. At joints where forms have been removed and reconstructed, the form surface shall extend over the concrete already in place; and the forms shall be drawn tightly against the previously placed concrete immediately prior to placing the fresh concrete. Where forms have been extended, the forms shall be retightened against the concrete already in place immediately before placing fresh concrete.

Forms shall be filleted at all sharp corners, except when otherwise indicated on the Plans and shall be given a bevel or draft in the case of all projections, such as girders, copings, etc., sufficient to insure easy removal.

5. Bracing and Maintenance

Special attention shall be paid to bracing; and where the forms appear to be insufficiently braced or unsatisfactorily built, either before or during the placing of concrete, the County Engineer will order work stopped until the defects have been corrected. All forms shall be so maintained as to eliminate the information of joints due to the shrinkage of lumber. All forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. For narrow walls where access to the bottom of the forms is not readily attainable otherwise, provide temporary openings at the base of column forms, wall forms, and at such other locations as may be necessary to clean out all chips, dirt, sawdust, or other extraneous material immediately prior to placing concrete. Existing forms may be extended after the concrete in said forms have been in place for at least 12 hours, provided such form extension can be done without any damage to the previously

placed concrete.

Unit stresses for forms, form supports, falsework, and bracing shall not exceed the AASHTO Specification except as modified hereafter:

- a. Bending in Timber - Unit stresses stipulated in AASHTO for timber may be increased by 1/3 with a maximum value of 1800 psi.
- b. Horizontal Shear (Timber) - Horizontal shear for beams up to 6 inches in depth shall not exceed 200 psi. Form beams more than 6 inches in depth, the horizontal shear shall not exceed 150 psi. The method for calculating horizontal shear shall be in accordance with AASHTO specifications.
- c. Compression Perpendicular to Grain (Timber) - Unit stresses stipulated in the latest edition of the AASHTO specifications for treated timber may be increased by 25%.
- d. Compression Parallel to Grain (Timber) - Unit stresses stipulated in the latest edition of the AASHTO specifications for treated timber may be increased by 25%.
- e. Timber Columns - Use values from formulas in AASHTO specifications increased by 25% except for long columns when no increase in value will be allowed.
- f. Moduli of Elasticity - Same as stipulated in AASHTO specifications.
- g. Structural Steel Members - The unit stresses developed in structural steel members of formwork or falsework shall not exceed the values stipulated in the AASHTO specifications for the appropriate steel grade, except that the axial allowable tension in the net section may be increased to 24,000 psi maximum, and tension in bolts at root of thread may be increased to 16,000 psi maximum (provided deflections are satisfactory). The 24,000 psi does not apply to the tension flange in beams.
- h. Steel Forms which Remain in Place - The unit working stress in the steel sheet and supporting members shall be not more than 0.725 of the specified minimum yield strength of the material furnished but shall not exceed 36,000 psi. Physical design properties shall be computed in accordance with requirements of the latest published edition of the American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members. The deflection limitations specified in Paragraph of this Article shall also apply to structural steel members.

6. Forms Scaffolds and Platforms

Form scaffolds or working platforms shall be designed and constructed as an integral part of the form supports. Details of these scaffolds or platforms shall be shown on Shop Drawings for forms submitted for review and acceptance. Separate design calculations shall be furnished with the Shop Drawing submission.

Design shall meet the minimum requirements for component parts as determined

under Construction Safety and Health Standards for all projects, except that guardrail height shall be approximately 42 inches high and supports for the scaffolds or working platforms shall be designed to support all dead loads and an applied live load of 75 pounds per square foot of horizontal surface.

7. Form Supports

In addition to all other loads, the design of the form supports, etc., if they are to be used to support the concrete finishing equipment, must also recognize these additional loadings.

8. Forms for Unexposed Surfaces

Forms for unexposed surfaces (such as concrete surfaces in contact with earth) may be composed of sheathing lumber not over 8 inches wide and surfaced four sides to a uniform thickness of at least the minimum dimension approved on the form plans. All sheathing studs and bracing shall be of sound lumber, free from defects and loose knots. Studs and wales shall be straight and true and surfaced on two edges to uniform width. The inside face of the forms shall be of sufficiently smooth construction that the resulting concrete surfaces will be accurately formed and coincident with the required dimensions.

9. Forms for Exposed Surfaces

Forms for surfaces of concrete work exposed to weather or view (such as walls, retaining walls, inside surfaces of culvert barrels, etc.) shall be either lined or unlined forms as described in the following

10. Lined Forms for Exposed Surfaces

The contact surface of lined forms for surfaces exposed to weather or view shall be approved composition board, sanded plywood, or metal, especially manufactured for concrete formwork. All studs shall be surfaced two edges to a uniform width and shall be of a grade of lumber that is solid, straight and free from defects that might impair its strength. The backing for form lining shall be constructed of a good grade of form lumber that is solid, straight, and free from defects that might impair its strength but need not be of quality used for contact forms for unexposed surfaces. All sheathing for form backing shall be surfaced two sides to a uniform thickness of at least the minimum dimension approved on the form plans. Form sheathing shall be built solidly, securely nailed to studs and so spaced as to prevent any bulging of the lining.

All lining shall be used in pieces as wide as is practicable. Where horizontal rustication occurs, horizontal joints in the lining shall be made behind a rustication strip. Otherwise, horizontal joints in the lining shall be placed at the same respective elevations in all portions of the structure. Where vertical rustication occurs, vertical joints in lining shall be made behind a rustication strip. Otherwise, vertical joints must be kept to a minimum and shall be placed to make a uniform pattern. Joints in lining and backing shall not occur at the same place and abutting edges of adjacent sheets shall be nailed to the same board. All joints shall be butted tight together and sealed with an approved crack filler as the lining is nailed in place. The lining shall be nailed to the backing beginning at one end of a sheet

and work uniformly across it to prevent buckling. Three penny blue shingle nails or similar nails with thin, flat heads shall be used to attach the lining material to the backing. The nails shall not be farther apart than 8 inches along the edges, and there shall be at least one nail for each square foot of surface.

11. Unlined Forms for Exposed Surfaces

Unlined forms in contact with surfaces exposed to weather or view shall be constructed of 5-ply, sanded plywood of approved thickness. Plywood shall be made with a waterproof glue and shall be especially manufactured for concrete formwork. All studs and wales shall be surfaced two edges to a uniform width.

Full size sheets of plywood shall be used except where smaller pieces will cover an entire area. All horizontal and vertical joints shall be backed solidly to prevent leakage, and the edges of abutting sheets shall be nailed to the same stud or blocking with sixpenny box nails, not farther apart than 8 inches. Where rustication occurs, horizontal joints in the plywood shall be made behind the rustication strips. Where no rustication strips are used, joints shall be made at the same respective elevations in all portions of the structure. Where vertical rustication occurs, vertical joints in lining shall be made behind a rustication strip. Otherwise, vertical joints must be kept to a minimum and shall be butted tight together and sealed with an approved crack filler as the plywood is nailed in place.

12. Removable Steel Forms

Removable steel forms shall meet all requirements of these Specifications for forms except as otherwise noted herein.

Forms for barrels of reinforced concrete box culverts shall be steel forms or forms having wood or composition wood panel sheathing set in metal frames. The minimum thickness of steel in forms for box culverts shall be 10 gage. Surfaces of box culvert and rigid frame wingwalls and headwalls exposed to view must be wood formed.

13. Release Agents

All forms shall be treated with a form release compound or saturated with water immediately before placing concrete. In case forms have been erected for sometime and have become dry so that joints have opened, then the forms shall be thoroughly soaked until the joints are closed.

14. Form Removal

All forms for concrete work shall be removed and disposed of by the Contractor after formwork requirements have been complied with, except those which are designated to remain in place.

Forms for pipe endwalls may be removed after the concrete has been in place for a period of 24 hours unless it is necessary to protect the concrete against cold weather, in which case the forms shall remain in place for the entire protection period.

Forms for vertical surfaces shall remain in place for a period of 48 hours. If, however, forms are removed before the concrete is 7 days old, the vertical surfaces shall be immediately covered with curing material and the concrete kept wet and so covered until the concrete is 7 days old. Horizontal form, and falsework, carrying loads shall remain in place for a minimum of 7 days and until the concrete has attained a compressive strength of 3000 psi. Internal bulkheads used for forming construction joints, contraction joints, expansion joints, etc. may be removed after the concrete has been in place for 24 hours, if it is necessary to do so for the continuance of the work without interruption.

Method of form removal likely to cause overstressing of the concrete shall not be used. Forms and their support shall not be removed without the approval of the County Engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

15. Reuse of Forms and Falsework Material

Plywood and lining material may be reused provided that the surfaces and edges are in a satisfactory condition and provided that they are cleaned off and sandpapered with the proper grade sandpapers and coated with form release compound.

Forms and falsework material reused shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity, mortar tightness, and smoothness of surface. Any warped or bulged lumber or plywood will be rejected. Unsatisfactory form and falsework materials shall not be used and, if condemned, shall be removed immediately from the work.

16. Form Ties

Only non-removable form ties approved by the County Engineer shall be used. Form ties for water or sewage containing structures shall have a washer attached in the center of the wall to act as a water seal. Ties shall be adjustable in length and of such type as to leave no metal closer than 2 inches from the surface. They shall not be fitted with any lugs, cones, washers, or other device to act as a spreader within the form, or for any other purpose which will leave a hole larger than 7/8 inch in diameter or a depression back of the exposed surface of the concrete.

If approved by the County Engineer, flat ties with 2-inch break back and rubber or plastic elongated cones may be used in removable steel forms for barrels of box culverts. Elongated rubber or plastic cones shall not be used as spreaders within the form.

Tie rod clamps shall remain in place until forms are to be removed as specified elsewhere and until the concrete has hardened sufficiently to permit the tie rods to be removed without damaging the concrete. Care shall be exercised to avoid spalling the concrete on the exposed surface. Cutting ties back from the face of the wall will not be permitted. All voids left in the concrete after the exposed form ties are removed shall be completely filled with non-shrink mortar and the surface finished as specified.

17. Form Support Brackets or Devices

Steel brackets or other devices attached to previously poured concrete for supporting forms may be used provided all parts are satisfactory to the County Engineer for size, strength, and material. No metal of an insert, threader, or anchor, etc. that remains in place in the concrete shall be within 2-1/2 inches of the surface. The concrete supporting the brackets or other devices shall be cured and shall have attained a minimum compressive strength of 3000 psi before the brackets or other devices are attached. All voids left in the concrete after brackets or other devices are removed shall not be greater than 2 inches in diameter and shall be completely filled with non-shrink mortar and the surface finished as specified.

C. Concreting

Before placing concrete, all sawdust, chips, and other construction debris and extraneous matter shall be removed from interior of forms. No struts, stays, and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, will be permitted.

All concrete shall be placed in the dry, unless Plans and/or "Special Provisions" require the placement of tremie concrete.

1. Footings

Spread footing faces shall be placed against plumb, undisturbed material or forms unless shown otherwise on the Plans. If faces of completed and/or proposed excavated footing areas are disturbed during the excavation activities in the area, the footings will be extended to bear on undisturbed faces, at the Contractor's expense.

2. Piles

All material forced upward by the driving of the piling shall be removed prior to placing the concrete. This removal will not be a pay item and shall be done by hand labor unless the pile spacing or use of special equipment will permit this removal without damaging the placed piling. This requirement will be waived in the case of tremie seals if the minimum thickness of footing concrete, pile embedment, and the required sealing capacity of the tremie concrete can be maintained. Any special requirements other than those contained in these Specifications for the tremie type of design will be shown on the Plans.

3. Temperature Controls

Concrete shall not be placed when the air temperature in the shade and away from artificial heat is below 40°F concrete temperatures shall be as specified in section 902 of the "MSHA Standard Specifications for Construction and Materials, (1993)". Concrete below these temperatures shall be heated by one of the following methods:

- a. When the method of heated mixing water is used, the water shall not be above 170°F when introduced into the mix.
- b. When the method of heated aggregates is used, aggregates containing frozen lumps shall be independently heated; and no materials containing

frozen lumps, ice, or snow shall be allowed to enter the mixer. Aggregates may be heated by steam coils or other dry heat but not by discharging live steam or hot water into them. Heating by means of a flame thrower or any direct flame will not be permitted.

When the ambient air temperature is below 40°F, the temperature of the air in contact with the reinforcement shall be raised to 40°F prior to placing concrete. When the ambient air temperature is above 70°F and the reinforcement is exposed to the direct rays of the sun, the reinforcement shall be cooled by means of water spray prior to placing concrete.

When abnormal wind and/or storms are forecast locally by the National Weather Service, concrete shall not be placed during the period covered by the forecast.

4. Foundations

As previously stated, foundations of structures are subject to County Engineer's approval before pouring concrete. The Contractor shall be solely responsible for any reinforcing steel fabricated prior to approval of foundations. If bearing material varies from that assumed in design, footings may be lowered, raised, deepened, subfoundations placed or piles used, or a combination of these methods used to best obtain bearing. If planned footings are changed vertically, reinforcing steel shall be revised as required. Selected backfill will be allowed as subfoundation for box culvert barrels, headwalls, and miscellaneous structures. If Mix No. 1 concrete is used, it need not be vibrated, shall be unreinforced, and the usual curing and cold weather requirements will be reduced to 3 days.

Concrete shall be placed so as to avoid segregation of the material and the displacement of the reinforcement. The use of troughs or chutes, for conveying concrete more than 15 feet from the mixer to the forms will not be permitted. Belt conveyors or concrete pumps shall be used where there is more than 15 feet to point of discharge.

Open troughs and chutes shall be of metal or metal lined. Where steep slopes are required, the chutes shall be equipped with baffles or be in short length that reverse the direction of movement.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure and such that it does not enter an existing water course. Chutes, troughs, pipes, etc. in contact with concrete shall not be aluminum.

Where placing operations would involve dropping the concrete more than 5 feet, the concrete shall be deposited through sheet metal, canvas, or other approved tube. The use of aluminum hoppers or tubes will not be permitted. The lower ends shall be kept as close as possible to the newly placed concrete and not more than 3 feet above it. All tubes, metal, canvas, or other shall have a minimum diameter of 6 inches unless otherwise approved by the County Engineer. An exception to this placing requirement is permitted for the filling with concrete of cast-in-place piles. In this case, tubes or chutes are not required unless specifically called for by the

Contract Documents. The shells or casings shall be filled from a hopper with spout applied directly to the top of the pile shell.

After initial set of the concrete, the forms shall not be jarred; and no strain shall be placed on the ends of the reinforcing bars which project outside the face of concrete.

Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration complying with requirements stated elsewhere in this section.

Concrete shall be placed in horizontal layers not more than 12 inches deep except as hereinafter provided. When less than the complete area of a layer is placed in one operation, vibrated before the preceding layer has taken initial set to prevent injury to the concrete and avoid separation of it shall be terminated in a vertical bulkhead. Each layer shall be placed and joints between the layers.

When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete.

Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcing steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel-bond at and near the surface of the concrete while cleaning the reinforcing steel.

5. Rate of Concreting

Concrete in beams and girders shall be deposited uniformly for the full length of the beam or girder and brought up evenly in horizontal layers. Each of which shall not be over 3 feet high.

Concrete in slab spans shall be placed in one continuous operation and in one layer for each span, unless otherwise provided.

Concrete shall not be mounded on concrete slab forms but in placing shall be distributed over an area to a depth not exceeding the depth of the planned slab thickness plus 6 inches before spreading, compacting, finishing, etc.

Concrete in columns, walls, etc. shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least 12 hours before any concrete is placed above them.

Where walls, piers, columns, struts, posts, etc. allow horizontal construction joints, succeeding lifts shall not be poured until the lower pour has been allowed to set for 12 hours.

6. Pneumatic Placing

Pneumatic placing of concrete will be permitted only if specified in the "Special

Provisions" or if authorized by the County Engineer in writing. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by pneumatic means, the equipment shall be suitable in kind and adequate in capacity for the work. The machine shall be located as close as practicable to the place of deposit. The position of the discharge end of the line shall not be more than 10 feet from the point of deposit. The discharge lines shall be horizontal or inclined upwards from the machine. No parts of the equipment in contact with the concrete mix or the discharge line are to be made of aluminum.

At the conclusion of placement, the entire equipment shall be thoroughly cleaned.

7. Pumping

Placement of concrete by pumping will be permitted only if specified in the "Special Provisions" or if authorized by the County Engineer in writing. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. No parts of pump or the discharge line are to be made of aluminum.

At the conclusion of placement, the entire equipment shall be thoroughly cleaned.

8. Use of Conveyors

Concrete may be moved from the mixer to its final position by use of conveyors. Conveyors shall be in sections, and concrete shall be deposited from one conveyor belt onto the next through a hopper. No individual section of the conveyor train shall rise more than 30 degrees from the horizontal. The belt travel speed shall not exceed 900 feet per minute for concrete slumps not exceeding 2-inches, and this speed shall be decreased for slumps exceeding 2-inches. Polyethylene or some other acceptable cover shall be placed under the conveyor line to contain any spillage from the belts.

9. Cofferdams

Where cofferdams are used, separate forms shall be constructed within the cofferdams except where footing concrete is to be placed against a base of undisturbed material and where the cofferdam is to remain in place and act as the concrete form. The water level in the space between the form and cofferdam shall be kept below the bottom elevation of all fresh concrete for at least 12 hours.

10. Concrete Exposed to Saline Water

In no case shall saline water be allowed to come in direct contact with the concrete until it has been permitted to harden as required by the following table unless directed otherwise in writing by the County Engineer.

Saline Content of Water by Weight in Parts per Thousand	Saline Water Shall not Contact Concrete until the Following Time in Days has Elapsed after Initial Set
0 to 10	0
10 + to 15	7
15 + to 20	14
20 + to 25	21
over 25	30

Unless otherwise noted, such concrete shall be wet cured for at least seven days while being maintained at a temperature of 50°F or above.

11. Construction Joints

Construction joints shall be kept to a minimum and will be permitted only where shown on the Plans, or authorized by the County Engineer in writing.

In order to bond successive courses, suitable keys shall be formed at the top of the lift where construction joints are permitted and at other levels where work is interrupted. These keys shall be as indicated on the Plans. At horizontal construction joints, the pour shall be allowed to set for about 12 hours before placing concrete above same.

After concrete has been placed and before it has hardened, all laitance and foreign material shall be removed from the surface. Before placing fresh concrete adjacent to hardened concrete, the surface of the hardened concrete shall be cleaned thoroughly of any remaining laitance or foreign material, scrubbed with wire brooms and clean water, and thoroughly drenched with water until saturated. It shall be kept saturated until the new concrete is placed.

Unless otherwise specified, the top surface of the concrete shall be leveled whenever a pour of concrete is stopped; and to insure a level, straight joint on exposed face, a strip of sheathing shall be attached to the form at the exposed face where the joint occurs. The concrete shall be carried not more than 1/2 inch above the underside of this strip. About 1 hour after concrete is placed, the strip shall be removed; and any irregularities in the joint line shall be leveled off with a wood float (use steel trowel at exposed face of joint). All laitance shall be removed. To avoid visible joints at chamfers, the top surface of the concrete shall be steel troweled adjacent to the chamfer using the top surface of the chamfer strip as a guide.

Where a feather edge might be produced at a construction joint, as in the sloped top surface of a wingwall, and inset form shall be used to produce a blocked in addition to the proceeding layer which shall produce an edge thickness of concrete of not less than 6 inches in the succeeding layer.

12. Consolidation

All concrete shall be internally vibrated unless herein noted otherwise.

In addition of the internal vibration, certain specified vertical, inclined, or special faces which are exposed to weather or to view shall be externally vibrated when required by the County Engineer.

Vibration shall be in accordance with the following requirements:

- a. All concrete shall be deposited in the forms in its final position and shall be placed in layers of uniform thickness. All concrete shall be consolidated by vibratory methods, except concrete deposited in water or unless otherwise specified.

Vibration shall be internal and applied directly to the concrete, except when the use of other methods is authorized by the County Engineer or provided herein. The County Engineer will be the final judge as to which sections are unsuited for internal vibration.

External vibration applied to the concrete through the forms may be required on certain sections such as those which are very thin, very heavily reinforced, or otherwise crowded with material other than concrete, or where form surfaces are sharply including or battered. External vibration may be used alone or in conjunction with internal vibration when necessary to secure dense surfaces. The County Engineer will determine when and where external vibration must be used.

The Contractor shall provide a sufficient number of vibrators to properly consolidate each batch immediately after it is placed in forms and before the next batch is delivered, without delaying such delivery. The vibration shall be of sufficient intensity and duration to thoroughly consolidate the concrete, but it shall not be continued to such an extent as to cause segregation. Vibration shall not be continued at any one point to the extent that any localized areas of grout are formed.

Vibration shall be applied at points uniformly spaced not further apart than twice the radius over which the vibration is visibly effective.

Vibration shall not be used to transport concrete in the forms or to make it flow in the forms over distances so great as to cause segregation. Vibration shall not be applied directly or through the reinforcement or forms to sections or layer of concrete which have hardened to such a degree that the concrete ceases to be plastic under vibration.

Vibration shall be supplemented by such spading, along form surfaces, in corners, and at locations impossible to reach with the vibrators, as is necessary to insure smooth surfaces and dense concrete.

The provisions of this section shall apply to precast concrete cribbing and other precast members or units, except that if approved by the County Engineer the manufacturer's methods of vibrating may be used.

- b. Internal vibrators shall be of a type and design approved by the County

Engineer. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute. The intensity of application shall be such as to visibly affect a mass of concrete of 1 inch slumps over a radius of at least 18 inches.

Internal vibration shall be applied directly to the concrete at the point of deposit and in the area of freshly deposited concrete. Vibrators shall be inserted in and withdrawn from the concrete slowly. Internal vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms.

- c. When external vibration is required, the vibrators shall be power operated equipment of the size and frequency approved by the County Engineer.

External vibrators shall be clamped to or applied against the forms and operated so as to produce concrete free from honeycomb and having a dense surface free from pockets and entrapped air bubbles. They shall be applied to a level below the top of the concrete being deposited but not so low as to disturb concrete which has partially set. Every precaution shall be taken to avoid damage to or misalignment of the forms.

D. Concrete Surface

- 1. General

Concrete surfaces shall be finished in accordance with one of the following designations. Unless otherwise specified, all concrete work shall have an "Grout Finish" for vertical surfaces and "Thrilled Finish" for horizontal surfaces. Strict compliance with the Specifications and the intent pertaining to finished surfaces will be enforced. Any concrete structure or concrete work which exhibits surfaces with defective finish will not be accepted until finishing has been completed in accordance with the Specifications. All concrete surfaces shall be finished within 24 hours after the forms are removed. If the concrete surfaces are not finished as specified within the time limit mentioned, all other work shall be suspended until the concrete surfaces required to be finished are completed.

APPLICATION

FINISHED DESIGNATION

Structures

For all concrete surfaces not exposed to public view and not to be waterproofed

Rough Form Finish

For all concrete wall surfaces exposed to public view

Grout Finish

Upper horizontal surfaces
Headwalls, wing walls, retaining walls, inlet head pieces

Troweled Finish

Tops of Footings	Float Finish
Horizontal construction joints	Left Rough
<u>Slabs & Miscellaneous Paving</u>	Floated Finish
<u>Incidental Works</u>	
Sidewalks, curb, combination curb and gutter, concrete paving, safety curb, median paving	Broom or Belt Finish
Tops of culvert slabs, culvert invert slabs, concrete ditch paving	Floated Finish
Exterior platforms, steps, landings, and pedestrian ramps	Non slip Finish
Surfaces intended to receive bonded cementitious application	Scratched Finish

2. Rough Form Finish

Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned and, after having been kept saturated with water for a period of not less than 3 hours, shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in proportions used in the grade of the concrete being finished. Any excess mortar at the surface of the concrete due to filling form tie holes shall be struck off flush with a cloth. The mortar patches shall be cured as specified under Curing. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its length with clean and true edges.

The resulting surfaces shall be true and uniform. All surfaces which cannot be repaired to the satisfaction of the County Engineer shall be finished as specified in Paragraph 03300.03 D.3.

3. Grout Finish

All fins, projections, etc. shall be removed. The surface of the concrete shall then be saturated with water and kept wet for at least 2 hours. A grout mix of the same properties as the concrete shall be thoroughly rubbed onto the surface by section using burlap pads or cork floats completely filling all voids, pits, and irregularities. While the grout is still plastic, remove all unnecessary grout by working the surface with a rubber float or burlap. After this grout has dried sufficiently so that it will not smear, the surface shall be wiped off with dry, clean burlap so as to leave a clean

uniform surface. This surface shall then be cured as required, except that only colorless liquid curing compound will be permitted for this method.

4. Scratched Finish

After the concrete has been placed, consolidated, struck off, and leveled, the surface shall be roughened with stiff brushes or rakes before final set.

5. Floated Finish

After the concrete has been placed, consolidated, struck off, and leveled, the concrete shall not be worked further until ready for floating. Floating with a hand float or with a bladed power trowel equipped with float shoes, or with a powered disc float shall begin when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after the first floating, planeness of surface shall be checked with a 10-ft straightedge applied at not less than two different angles. All high spots shall be cut down and all low spots filled during this procedure to produce a smooth surface. The slab shall then be refloated immediately to a uniform sandy texture.

6. Troweled Finish

The surface shall first be float-finished. It shall next be power troweled, and finally hand troweled. The first troweling after power floating shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Additional trowelings shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be essentially free of trowel marks, uniform in texture, and appearance and to a smooth plane.

7. Broom or Belt Finish

Immediately after the concrete has received a float finish, it shall be given a coarse transverse scored texture by drawing a broom or burlap belt across the surface.

8. "Dry shake" Finish

If a "dry shake" application of a selected metallic or mineral aggregate is specified, the aggregate, selected or acceptable to the County Engineer, shall be blended with Portland cement in the proportions recommended by the manufacturer of the aggregate. The surface shall be given a float finish. Approximately two-thirds of the blended material for required coverage shall be applied to the surface by a method that insures even coverage without segregation. Floating shall begin immediately after application of the first "dry shake." After this material has been embedded by floating, the remainder of the blended material shall be applied to the surface at the right angles to the previous application. The second application shall be heavier in any areas not sufficiently covered by the first application. A second floating shall follow immediately. After the selected material has been embedded by the two floatings, the operation shall be completed with a broomed, floated, or troweled finish, as designated in the Contract Documents.

9. Nonslip Finish

Where the Contract Documents require a nonslip finish, the surface shall be given a "dry shake" application, as specified above, of crushed ceramically bonded aluminum oxide or other specified selected abrasive particles. The rate of application of such material shall be not less than 25 pounds per 100 square feet.

10. Exposed Aggregate Finish

Immediately after the surface of the concrete has been leveled, and surface water has disappeared, aggregate of color and size (usually 3/8 to 5/8 inch) selected by the County Engineer shall be spread uniformly over the surface to provide complete coverage to the depth of a single stone.

The spread of selected aggregate shall be embedded into the surface by light tamping and the surface shall be floated until the embedded stone is fully coated with mortar and the surface has been brought to a true plane. Exposure of the aggregate shall start after the matrix has hardened sufficiently to prevent dislodgement of the aggregate. Water, in abundant quantities but without force, shall be allowed to flow over the surface of the concrete while the matrix encasing the selected aggregate is uniformly exposed but not dislodged.

An acceptable chemical retarder sprayed onto the freshly floated surface may be used to extend the working time for exposure of aggregate.

E. Curing

Provisions shall be made for curing all concrete. Curing shall start as soon as concrete has set sufficiently so that curing applications will not damage the surfaces. Curing will also be required while protecting concrete against cold weather.

The following are methods to be used for curing:

1. All units of structures which will be below water in the completed structure, i.e. bottom slabs of culverts, footings, struts, etc., may be gradually flooded after the concrete is 12 hours old provided the water meets all specification requirements for curing water. The temperature of this water must be maintained at a temperature of 35°F or above for the specified curing time.
2. Two layers of burlaps shall be used. Successive strips of each layer shall be overlapped a minimum of 6 inches. The second layer shall be placed not less than 45 degrees to the first layer; or the 6 inches overlap of the second layer may be placed midway (one-half width) of the first layer. The layers of burlap shall be kept thoroughly saturated with curing water for the full time specified for curing.
3. When curing concrete structural slabs, etc., white opaque burlap-polyethylene sheeting or white opaque polyethylene film may be used atop the wet burlap or cotton mats on unobstructed flat and reasonably level surfaces.

The white opaque burlap-polyethylene sheeting or white opaque polyethylene film shall be placed only on unobstructed flat and reasonably level surfaces. They will not be permitted on vertical surfaces, such as walls, columns, abutments, etc.

Adjacent mats or sheets shall be lapped no less than 1 foot. The ends shall be brought down around the sides of the concrete being cured and securely fastened to make an airtight seal.

The White opaque burlap-polyethylene sheeting must be placed on no less than one layer of wet burlap with the burlap side of the sheeting facing down. White opaque polyethylene film, if used, must be placed on no less than two layers of wet burlap.

The white opaque burlap-polyethylene sheeting or white opaque polyethylene film must remain in place for the same length of time as required for burlap or cotton mats. These protective coverings need not be wetted down; however, the covered burlap or cotton mats must be kept wet for the time interval required by the Specifications.

4. The material for liquid membrane-forming compounds shall have a fugitive dye or be white pigmented. The materials shall be thoroughly agitated before and during use and applied by sprayers. Liquid membrane forming compound shall be applied in conformance with the manufactures recommendations.

The cotton mats and burlap must be thoroughly saturated just prior to placement. The requirement for keeping the concrete surfaces saturated at all times during the curing period, regardless of the covering, will be strictly enforced. This saturation of the surfaces must be employed even in areas where there is no ready water supply. The Contractor must furnish, at the Contractor's expense, sufficient water to satisfy this requirement.

5. One layer of cotton mat material shall be used and shall be kept thoroughly saturated with curing water film prior to placement and throughout the time specified for curing. The material shall be kept in tight contact with the concrete.

All vertical surfaces may be cured by leaving forms in place for 7 days. If forms are removed after 48 hours, then the remainder of the 7 days of cure shall be by method 5.

Immediately after the finishing operation for sidewalks and culvert top slabs, the areas of future construction joints shall be covered with two layers of wet burlap which shall extend 6 inches outside the joint area. The finished concrete surface shall then be sprayed with a liquid compound as specified in curing method 4. After 1 day or as soon as the concrete may be walked upon without damage, the concrete shall be cured using method 2, 3, or 5 for the remainder of the 7 day curing period.

All other horizontal surfaces shall be cured using either method 2, 3, or 5 for a period of 7 days.

Cover tops and other horizontal surfaces of endwalls, and headwalls with burlap; and cover vertical surfaces of same after removal of forms with cotton mats and keep concrete, forms, cotton mats, and/or burlap wet for 3 days.

F. Cold Weather Protection

When the air temperature in the shade and away from artificial heat drops to 40°F or lower at the time of placing or at any time within the number of days specified below for

protection, concrete shall be protected and heated after it has been placed. Protection and heating shall be as follows:

1. Ordinary concrete shall be protected and kept continuously at a temperature not less than 50°F for at least 7 days following placement.
2. In no case shall concrete be heated to more than 100°F. At the end of the heating period, the concrete surfaces shall be cooled to the temperature of the outside air by slowly reducing the artificial heat at a uniform rate until the temperature of the outside air is reached within a 24 hours period.

The Contractor shall have available enough tarpaulins, insulating devices, and/or other suitable materials to enclose or protect all portions of the concrete requiring protection. As much as possible of the aforesaid devices and materials shall be installed before placing the concrete, and the remainder shall be installed as rapidly as possible to keep exposure to cold weather to a minimum. Where heating is required, the spaces to be heated shall be completely enclosed and the temperature therein kept at required levels by the use of approved heaters.

All structure concrete requiring cold weather protection and having curing periods less than the cold weather protection period shall be cured for the full cold weather protection period.

The Contractor shall provide a sufficient number of maximum minimum recording thermometers to record the temperatures in each concrete pour undergoing cold weather protection.

The responsibility for defective concrete by reason of heating or lack of heating, or any other hazards incidental to cold weather concreting, shall remain with the Contractor; and such defective concrete shall be replaced by the Contractor at the Contractor's sole expense.

Concrete in place shall be protected to minimize drying and absorption of heat when and as directed by the County Engineer.

G. Underpinning

Where structures are extended, widened, or repaired, it is frequently found that the foundations of the old structure are not in solid or full area bearing on their intended foundations. Frequently, foundations of the extended or new parts are at a lower elevation than the former foundations. These conditions usually led to the necessity of underpinning the old structure, which operation shall consist of the restoring or lowering of the old foundations with concrete masonry. The concrete masonry shall be Mix No. 6. Excavation and the underpinning operations shall be done in part section, so as not to remove more than 10% of the supporting area under the old foundation at one time. The concrete shall be mixed to a stiff consistency (slump not to exceed 1 ½ inch). The underpinning masonry shall usually be applied by hand, well inserted, pushed, rodded, or tapped into position. Where specified, underpinning masonry shall be installed by pneumatic or pumping processes. The usual curing and cold weather requirements will be deleted for underpinning masonry with other provisions for curing and protection improvised on the job as may be directed.

H. Prevention and Removal of Stains on Concrete

The Contractor shall prevent rust of unpainted structural steel, staining by bituminous materials, or any other substance from discoloring any portion of the concrete. The Contractor, therefore, shall devise and use construction procedures or methods that prevent staining of any of the concrete. If, however, any portion of the concrete is stained, the Contractor shall remove such stains and restore the concrete to its original color without damage to the concrete all at the Contractor's expense and as approved by the County Engineer. No chemical solvents will be allowed unless previously approved by the County Engineer.

03300.04 METHOD OF MEASUREMENT

RESERVED FOR FUTURE USE

A. Unit Price

RESERVED FOR FUTURE USE

B. Lump Sum

RESERVED FOR FUTURE USE

03300.05 BASIS OF PAYMENT**A. General**

RESERVED FOR FUTURE USE

B. Unit Price

RESERVED FOR FUTURE USE

C. Lump Sum

RESERVED FOR FUTURE USE

SECTION 03310

PORTLAND CEMENT CONCRETE

03310.01 GENERAL

A. Description

Portland cement concrete shall include, but not necessarily be limited to, furnishing various strengths of Portland cement concrete as specified in the Contract Documents.

B. Related Work Included Elsewhere

Not applicable.

C. Quality Assurance

1. Inspection

The County Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents. When specific materials tests are called for in the referenced standards and specifications, the County Engineer will have the option of requiring that any or all of these tests be performed for materials furnished for a specific Project. When testing is required, it will be specified herein or in the "Special Provisions."

2. Mixes

All mixes furnished shall have been approved by the Maryland State Highway Administration for use on State highway work and produced in plants approved by the State Highway Administration.

3. Control Testing

The Contractor shall furnish the necessary molds meeting the requirements of AASHTO M 205. Sampling shall conform to AASHTO T 141. Control testing shall be in accordance with the following requirements:

<u>Test</u>	<u>Method</u>	<u>Min Test Frequency</u>	<u>Responsibility</u>
Slump	AASHTO T 119	1 per 50 cu. yds. or fraction thereof: min 2 per day	Contractor
Air Content	AASHTO T 152(NOTE 3) or T 196	1 per 50 cu. yds. or fraction thereof: min 2 per day	Contractor
Compression	AASHTO T 23	1 per 50 cu. yds. (or fraction thereof) min 2 test per day	Molding, curing & delivery to an approved laboratory by the Contractor after a 1 to 3 day storage period
Split Tensile Mix No. 7 only	AASHTO T 23	3 per day, 4 specimens per test plus optional early strength tests	Same as for Compression

NOTE 1: A second test will be made if the first slump or air content test fails. The concrete will be accepted or rejected on the basis of second test results.

NOTE 2: Mix No. 7 concrete is required to gain 300 psi strength before opening to traffic.

NOTE 3: Air meter will be calibrated in accordance with MSMT 505.

NOTE 4: Compressive and split tensile strength tests are defined as the average of two companion cylinders.

4. Quality Control During Construction

a. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days for determination of the compressive strength of the concrete.

b. Strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:

1) Average of all sets of three consecutive strength tests equal or exceed the required 28 day compressive strength indicated in

paragraph 03310.03 A.

- 2) No individual strength test (average of two companion cylinders) falls below the required 28 day compressive strength by more than 500 psi.
- c. If either of the above requirements are not met, steps shall be taken to increase the average of subsequent strength test results. If the strength test of laboratory-cured cylinders falls below the specified strength value by more than 500 psi steps shall be taken, if required by the County Engineer, to assure that load-carrying capacity of the structure is not jeopardized. The County Engineer may require cores drilled from the area in question in accordance with ASTM C 42. In such cases, three cores will be taken by the Contractor for each strength tests more than 500 psi below the required 28-day compressive test. Concrete in an area represented by core tests shall be considered structurally adequate if the average of three cores is equal to at least 85% of the required 28-day compressive strength and if no single core test is less than 75% of the required 28-day compressive strength.
- d. If the above criteria are not met, the Contractor shall remove and replace the concrete in question at no additional cost to the County.

D. Submittals

1. Mill Test

The Contractor shall furnish a certified copy of mill tests on each load of cement delivered to the batching plant. The tests shall show the cement's physical and chemical analysis.

2. Control Curves

The Contractor shall furnish manufacturer's curves for all high range water reducer admixture. The curves shall show the fluid ounces of high range water reducer per 100 pounds of cement as related to water reduction and strength gain for 12 hours when used with a cement factor of a minimum of 700 pounds.

3. Mix

The Contractor shall submit to the County Engineer the proportions of materials to be used for each concrete mix. The mixture shall meet the requirements of Section 03310.03 and consist of Portland cement, fine aggregate, coarse aggregate, water, and such admixtures as may be specified.

4. Load Tickets

The producer shall provide and issue, in duplicate, tickets for each load. Each ticket shall show the following:

- a. Contract number;

- b. date;
- c. mix number;
- d. number of cubic yards;
- e. truck number;
- f. time loaded for dry batched material or time water was added for central mixed material;
- g. ounces of air entraining agent and other types of admixtures, if applicable, per cubic yard.
- h. the moisture content of the coarse and fine aggregates in excess of the saturated surface dry condition;
- i. the maximum mixing water that can be added at the job site based on the maximum w/c ratio; (Actual water required for mixing will normally be less than the maximum. In central mix plants, the actual water used shall be shown. Maximum allowed slump shall not be exceeded). Additional mixing of 50% of the total mixing time will be required.

In addition, each load ticket shall contain a certification stating that all materials comply with pertinent specifications and the approved design.

Regardless of the quantities involved, the Contractor will conduct the normal job control tests, i.e. slump and air content on the plastic concrete and making test cylinders unless otherwise specified.

03310.02 MATERIALS**A. Materials Furnished by the County**

- 1. The County will not furnish any materials for Portland cement concrete.
- 2. The Contractor may purchase water from the County's potable water system in accordance with the current County policies and procedures. The Contractor shall contact the County's Department of Fiscal Services, Meter Section, for requirements. A backflow prevention device must be placed in accordance with the Standard Details prior to drawing County water.

B. Contractor's Options

- 1. The Contractor may furnish higher strength concrete than specified.
- 2. Fly ash may be used as a replacement for cement as specified.

C. Detailed Material Requirements

- 1. Portland Cement

Portland cement shall be in accordance with AASHTO M 85 with the fineness determined in accordance with AASHTO T 153 and the time of setting determined in accordance with AASHTO T 131.

2. Fine Aggregate

Fine aggregate shall meet the gradation requirements contained in Table 03310-1 and shall be in accordance with the quality requirements of AASHTO M 6, Class B.

3. Coarse Aggregate

Coarse aggregate shall be in accordance with the Class A quality requirements of AASHTO M 80 using sodium sulfate to determine the soundness. Grading of aggregate shall be in accordance with AASHTO T 27, size numbers 57, 67, or 7, Table 03310-1.

4. Aggregate Gradations

TABLE 03310-1

Mass Percent Passing

<u>Sieves Sizes</u> <u>U.S. Standard</u>	<u>TESTING METHOD 27</u>			<u>AASHTO M 6</u>
	<u>No. 57</u>	<u>No. 67</u>	<u>No. 7</u>	<u>FA, PCC</u>
1 ½ inch	100	-	-	-
1 inch	95-100	100	-	-
¾ inch	-	90-100	100	-
½ inch	25-60	-	90-100	-
⅜ inch	-	20-25	40-70	100
No. 4	0-10	0-10	0-15	95-100
No. 8	0-5	0-5	0-5	-
No. 16	-	-	-	45-80
No. 50	-	-	-	10-30
No. 100	-	-	-	2-10

For aggregate physical property requirements refer to Table 901B of the "MSHA Standard Specifications for Construction and Materials, (1993)".

5. Water from Other Than Potable Sources

Water shall meet the pH requirements of AASHTO T 26, Method B. Water shall not smell or be discolored. Water suspected of questionable quality shall meet limits of the comparison tests with distilled water in accordance with AASHTO T 26. The chloride concentration of water used in mixing and curing of Portland Cement will be determined in accordance with ASTM D 512 and shall not have a chloride concentration exceeding 1000 ppm. The maximum water soluble chloride ion content in the concrete shall not exceed 15% by weight of cement.

6. Chemical Additives for Concrete

Chemical additives for concrete shall not contribute more than 200 ppm of chlorides based on the cement content when tested in accordance with MSMT 610. The relative durability factor of concrete with chemical additives shall be determined in accordance with ASTM C 666, Procedure B.

a. Air Entraining

Air entraining admixtures shall be in accordance with AASHTO M 154.

b. Chemical

Chemical admixtures shall be in accordance with AASHTO M 194, TYPE A or D.

c. High Range Water Reducing Admixtures

When specified, high range water reducing admixtures shall be liquid and meet the requirements of AASHTO M 194, Type F or G. When this material is used in patching, the admixture shall be liquid and meet the requirements of AASHTO M 194, Type F, for air entrained concrete with the following exceptions.

- 1) The water content shall be a maximum of 85% of that of the control.
- 2) The relative durability factor shall be a minimum of 90 when tested in accordance with ASTM C 666, Procedure B.
- 3) The 12 hour compressive strength for Type F admixture shall be 180% of that of control.

Type G shall be used when early strength is not specified.

Additionally, the admixture shall be nonfoaming when tested in accordance with ASTM D 1173. It shall not contribute more than 200 ppm of chlorides based on the cement content when tested in accordance with MSMT 610.

7. Fly Ash

Fly ash shall be in accordance with AASHTO M 295, pozzolan Class C or F, except:

Loss on ignition, for Mix Nos. 3 and 6 % max	3.0
Moisture content, % max	1.0

03310.03 EXECUTION

A. Concrete Mixes

The concrete shall be proportioned by weight. Water and chemical additives may be proportioned by volume or weight. The mix shall be homogeneous, placeable, and uniformly workable.

Coarse aggregate shall be maintained at a uniform moisture content at least equaling its

absorbed moisture. Water, if used for wetting, shall meet the requirements of Section 03310.02.

Portland cement concrete shall meet the following requirements:

Mix No.	28 Day Specified Design Strength (psi)	Compressive	Min Cement Factor pounds per cubic yard	Coarse Aggregate		Max Water/Cement Ratio	Slump Range (Inches)
				AASHTO M 43 Size Number			
1	2500		470	57 or 67	0.55		2-5
2	3000		560	57 or 67	0.50		2-5
3	3500		610	57 or 67	0.50		2-5
4	3500		650	57 or 67	0.55		4-8
5	3500		610	7	0.50		2-5
6	4500		650	57 or 67	0.45		2-5
7	350 Split Tensile		610	57	0.50		1 ½-3 2 ½ max. if slip-formed

NOTE 1: Mix No. 4 shall only be used for placing concrete under water by a tremie method.

NOTE 2: When concrete is exposed to water exceeding 15,000 ppm sodium chloride content or to sewage, Type II cement shall be used. Type I or Type II cement shall be used for all other concrete.

NOTE 3: For total air content, concrete temperature, critical value, standard deviation for portland cement concrete, refer to Table 902A of the "MSHA Standard Specifications for Construction and Materials, (1993)".

NOTE 4: The Contractor may request to substitute a maximum of 15% of the weight of cement with fly ash. When fly ash is used, the minimum cement factor and water cement ratio shall be determined on the basis of combined weight of the cement and fly ash. The maximum percentage of alkali content of cement shall be 1.5%.

B. Mixers and Agitators

1. All mixers shall display a current Maryland State Highway Administration approval stamp. Mixers and agitators and mixing and delivery of ready-mixed concrete shall meet the requirements of AASHTO M 157 with the following exceptions:
 - a. Transit mixed concrete will not be permitted. The following requirements shall apply when additional water is added on the job site:
 - 1) No water shall be added after partial discharge of load.

- 2) A maximum of 3 gallons of water per cubic foot of concrete may be added at the job site provided the maximum specified water-cement ratio shall not be exceeded.
 - 3) The material shall be mixed a minimum of 20 additional revolutions even though the maximum of 100 revolutions may be exceeded.
 - 4) Acceptance will be based upon a retest of the slump and air content.
- b. All concrete shall be discharged within 1 hour after the mixing water is added or 1-1/2 hours after the addition of the cement to the aggregates, whichever is the lesser time.
 - c. No mixer or agitator containing wash water in the drum shall be loaded.
 - d. Should the timing device on a stationary mixer become broken or out of order, the Contractor will be permitted to operate while it is being repaired if the Contractor furnishes an approved time piece with minute and second hand. If the timing device is not placed on good working order within 72 hours, further use of the mixer will not be permitted until satisfactory repairs are made.
 - e. When the concrete is specified or permitted to be made by volumetric batching and continuous mixing, the batching and mixing unit shall meet the applicable requirements of ASTM C 685. Calibration shall conform to MSMT 558.
2. Where no mixer performance tests are made for stationary mixers, the minimum mixing time shall be 75 seconds, unless a greater mixing time is recommended by the mixer manufacturer. The mixing time may be reduced to a point at which satisfactory mixing is accomplished as determined by mixer performance tests in accordance with ASTM C 94, but in no case shall this time be less than 45 seconds. The mixer performance test shall be repeated whenever the concrete indicates that adequate mixing has not been accomplished. Mixing time shall begin when all ingredients are in the mixer drum.

C. CONCRETE MIX APPLICATIONS TABLE

Charles County Concrete Mix Applications Table

Mix No.	28 Day Design Comp. Strength (psi)	Specification Number	Application	Specification Section	Remarks
1	2500	02150.02	Abandonment of Utility Pipelines, manholes, and Other Structures	Removal or Abandonment of Existing Utilities and Underground Structures	or mix no. 3 as specified
		02246.02	Drain Bases	Porous Backfill	
		02520.03	Cast Iron and Reinforced Concrete Pipe Jackets	Pipe, Structural Plate and Pipe Arch, and Box Culverts	STORM DRAINAGE
		02540.02	Pipe Encasement	Storm Drain Rehabilitation	STORM DRAINAGE
		02551.02	Pipe Fitting Buttresses (unreinforced) and Anchorage	Water Mains	WATER & SEWER
		02554.02	Hydrant and Cap Blocking	Fire Hydrants	WATER & SEWER
		02561.02	Pipe Cradle and Encasement	Sanitary Sewers and Sanitary House Connections	WATER & SEWER
		02563.02	Pipe Buttresses and Anchorage	Sanitary Sewer Force Mains	WATER & SEWER
		02564.02	Pipe Encasement	Connections to Existing Sanitary Sewer Facilities	WATER & SEWER
		02566.02	Pipe Anchorages and Buttresses	Low Pressure Systems	WATER & SEWER
2	3000	10529.02	Pipe Slab and Pipe Rail Anchors	Fire Suppression Tanks	
		02292.02	Concrete Ditches	Concrete Ditches	STORM DRAINAGE
		02520.03	Paved Invert of Structural Pipe Plate or Pipe Arch	Pipe, Structural Plate and Pipe Arch, and Box Culverts	STORM DRAINAGE
		02660.01	Sidewalks	Sidewalks	ROADS

Charles County Concrete Mix Applications Table (Continued)

Mix No.	28 Day Design Comp. Strength (psi)	Specification Number	Application	Specification Section	Remarks
2	3000	02670.03	Curb, Combination Curb & Gutter, Aprons for Industrial, Apartment, & Residential Entrances, and Monolithic Medians	Curb, Combination Curb & Gutter, Driveway Aprons and Monolithic Median	ROADS
		02721.01	W-Beam Traffic Barriers	Traffic Barriers	ROADS
		02710.02	Fence Post Encasement	Fences	
		02723.02	Precast Concrete Wheel Stops	Precast Concrete Wheel Stops	
		02733.02	Electrical Pull and Junction Boxes	Electrical Pull and Junction Boxes	
		02744.02	Signal Handboxes	Signal Handboxes	
		02910.02	Inverts and Cradles	Boring and/or Jacking	WATER & SEWER
		02920.02	Invert cradles	Earth Tunneling	
3	3500	02300.02	Concrete Piles	Piling	
		02530.02	Cast-In-Place Structures	Storm Drainage Structures	STORM DRAINAGE
		02551.02	Pipe Fitting Buttresses (reinforced) and Anchorage	Water Mains	WATER & SEWER
		02553.02	Cast-In-Place Meter Vault Lids and Bases	Water Services, Water Meter Settings and Vaults	WATER & SEWER
		02734.02	Concrete Foundations	Concrete Foundations	
		10529.02	Tank Anchorage	Fire Suppression Tanks	

Charles County Concrete Mix Applications Table (Continued)

Mix No.	28 Day Design Comp. Strength (psi)	Specification Number	Application	Specification Section	Remarks
4	3500	03310.03	Placing Concrete under water by tremie	Portland Cement	
5	3500				
6	4500	01421.02	Concrete Barriers	Temporary Precast Concrete Barrier for Maintenance of Traffic	
		03300.03	Underpinning	Cast-In-Place Concrete Structures	
		02721.03	Concrete Barriers	Traffic Barriers	
7	350 split tensile	02680.02	Patching Pavement	Patching Pavement	

03310.04 METHOD OF MEASUREMENT

RESERVED FOR FUTURE USE

03310.05 BASIS OF PAYMENT

RESERVED FOR FUTURE USE

SECTION 03400

PRECAST CONCRETE UTILITY STRUCTURES

03400.01 GENERAL

A. Description

Precast concrete utility structures shall include, but not necessarily be limited to, furnishing and installing precast concrete storm drain structures, manholes, valve and meter vaults, grade rings, and other miscellaneous structures of the configuration and to the extent indicated and in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. Trench excavation, backfill, and compaction; Section 02250.
2. Storm drainage structures; Section 02530.
3. Water valves and appurtenances; Section 02552.
4. Water services, meter settings, and vaults; Section 02553.
5. Sanitary sewer manholes; Section 02562.
6. Dampproofing and membrane waterproofing; Section 07100.
7. Bentonite waterproofing and sealer; Section 07130.

C. Quality Assurance

1. Precast concrete utility structures shall be supplied by a qualified firm with a minimum of 3 years of continuous operations and which has performed at least three representative jobs, 3 years or older, comparable to precast work required for this Contract.
2. The County Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents. Access shall be allowed the County Engineer to the casting plant at any time to inspect the fabrication of units for County projects.
3. Precast units shall be substantially free of fractures and surface roughness. The planes of the ends of sections to be joined shall be perpendicular to their longitudinal axis within 5/8 inch. Precast units shall be subject to rejection on account of failure to conform to any of the Specification requirements. In addition, individual sections may be rejected because of any of the following:

- a. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
 - b. Defects that indicate imperfect proportioning, mixing, and molding.
 - c. Surface defects indicating honeycombing or open texture.
 - d. Damaged or cracked ends, where such damage would prevent making a satisfactory joint.
 - e. Any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more, regardless of position in the section or wall.
 - f. For grade rings, cracks or fractures extending for a length of ½ inch or more regardless of position in the ring. Dimensional tolerances shall be $\pm 1/4$ inch.
4. Precast units shall be set so as to be vertical. The maximum allowable deviation, when measured from the top to the bottom of the completed unit, shall not exceed 1/4 inch.
 5. The manufacturer or supplier shall store completed sections off the ground with ample space between rows and enough clearance above and below to allow full view of walls and joint ends for inspection purposes.
 6. The County Engineer reserves the right to require core samples of finished products.
 7. All precast units shall be marked with the manufacturer's name or trademark, date of manufacture, and the ASTM and/or AASHTO specification under which the unit was manufactured.

D. Submittals**1. Shop Drawings**

Shop drawing shall be submitted as specified in the "General Provisions" for all precast units. The shop drawings shall be fully dimensioned and show reinforcing details, joint details, design loads, pertinent design calculations, and lifting and erection inerts. Shop drawings shall also include the precast unit manufacturer's handling, assembly, and installation directions and recommendations.

2. Certificates of Compliance

Certificates of compliance shall be submitted as specified in the "General Provisions" stating that the precast units furnished, and their components, meet the design, fabrication, and testing requirements specified in Sections 03400.02 and 03400.03.

03400.02 MATERIALS

A. Materials Furnished by the County

The County will not furnish any materials for precast concrete utility structures.

B. Contractor's Options

1. The Contractor may furnish aluminum or plastic-coated steel steps for use in manholes, inlets, and vaults.
2. The Contractor may furnish mechanically wedged-in-place or cast-in-place manhole-to-pipe connectors for sanitary sewer manholes.

C. Detailed Material Requirements

1. Portland Cement Concrete

Portland cement concrete shall meet the requirements specified in Section 03310.02 except as modified herein. Portland cement for units to be used in sanitary sewer systems shall be Type II.

2. Concrete Reinforcement

Concrete reinforcement shall meet the requirements specified in Section 03200.02.

3. Water from Other Than Potable Sources

Water shall meet the pH requirements of AASHTO T 26, Method B. Water shall not smell or be discolored. Water suspected of questionable quality shall meet limits of the comparison tests with distilled water in accordance with AASHTO T 26. The chloride concentration of water used in mixing and curing of Portland cement will be determined in accordance with ASTM D 512 and shall not have a chloride concentration exceeding 1000 ppm.

- 4. Joint Seals Between Sections
 - a. Flexible Joint Sealing Compound

Joint sealing material shall be cold-applied preformed plastic sealing compound meeting the following requirements:

Chemical Composition -	Minimum	Maximum	Test Method
Bitumen (Hydrocarbon Plastic Content) % by weight	50	70	ASTM D4
Inert Mineral Filler % by weight	30	50	AASHTO T111
Volatile Matter % by weight		2.0	ASTM D6
Physical Properties -			
Specific Gravity at 77°F	1.20 to 1.35		ASTM D71
Ductility at 77°F minimum	5.0 cm		ASTM D113
Softening Point at 77°F minimum	320°F		ASTM D36
Flash Point, C.O.C. minimum	600°F		ASTM D92-57
Penetration			
77°F (150 gs.) 5 sec	50	to 120	ASTM D217
or shall be a specially formulated preformed joint sealant in rope like form which swells upon contact with water forming a compression type seal. The specially formulated preformed joint sealant shall meet the following requirements:			
Chemical Composition -			
Butyl Rubber Hydrocarbon % by weight	24.9		ASTM D297
Bentonite % by weight	75.0		SS-S-210-A
Volatile Matter % by weight	below 1.0		ASTM D6
Physical Properties -			
Specific Gravity at 77°F	1.57		
Penetration	58		ASTM D217 150 GTL
	85		ASTM D217 300 GTL
Flash Point	365		ASTM D93-97
Accelerated Aging	Maintain		4 hrs @ 212°F
	99% Solids		
Storage Life	Indefinite		
Application Temperature Range	5° to 125°F		
Service Temperature Range	-40° to 212°F		

- b. Gaskets

Rubber gaskets shall meet the requirements of ASTM C 443.

- 5. Sanitary Sewer Manhole Materials
 - a. Flexible Gaskets Between Manhole and Frame

Flexible plastic gasket between manhole and manhole frame shall be extruded rope Type B, in accordance with AASHTO M 198, butylbased,

3/4-inch diameter minimum.

b. Jointing Mastic

Jointing mastic shall be an elastic, water resistant formulation of plastic bituminous materials and inert fillers so combined when applied to a vertical metal surface and heated to 120°F, the jointing mastic will neither slump nor lose plasticity. When applied directly from the container without further mixing the jointing mastic can be applied in an even, adherent coat within the temperature range of 20° to 100°F.

c. Manhole-to-Pipeline Connectors

Manhole-to-pipeline connectors shall be either mechanically wedge-in-place or cast-in-place as specified in Section 02562.02.

d. Provide thermoplastic cast-in-place inserts with a working tensile load capacity of 1200 pounds for bolting down manhole cover frames where indicated on the Drawings. Inserts shall be ½ inch diameter by 2 3/4 inch minimum length.

6. Dampproofing and Waterproofing

Dampproofing and waterproofing for exterior of precast structures shall be as specified in Section 07100.

7. Steps and Ladders

Steps and ladders shall be as specified in Section 05500.02.

8. Granular Bedding

Granular bedding beneath precast units shall meet the requirements of AASHTO M 43, No. 57, as specified in Section 02621.02.

9. Non-Shrink Mortar

Quick-setting non-shrink cement mortar shall be as specified in Section 03600.02.

03400.03 EXECUTION

A. Design Criteria

1. General

a. Structural design for precast units shall be prepared by a registered Engineer for the precast concrete manufacturer. Units shall be designed for HS 20 load designation or 300 pounds per square foot live load, whichever is most critical for determining the concrete and steel stresses.

b. Where more than one standard is referenced for any given unit, should there be a conflict, the more stringent requirement as determined by the

County Engineer, shall apply.

- c. Unit configuration shall be as shown on the Plans and/or Standard Details.
- d. Distribution of earth loading and live load shall be in accordance with ASTM C 857 or ASTM C 890.
- e. Walls shall be designed using an equivalent fluid pressure of 83 pounds per cubic foot and a 2 foot surcharge. The units shall also be designed to resist all stress encountered during casting, handling, and erection.

2. Manholes

- a. Precast concrete manholes shall meet the requirements of ASTM C 478 except that the minimum compressive strength of the concrete shall be 4000 psi.
- b. Joints shall meet the requirements of ASTM C 443, shall be self-centering, and shall form a uniform water tight joint.

3. Inlets

Precast inlets shall meet the requirements of AASHTO M 199.

4. Grade Rings

Grade rings shall meet the requirements of ASTM C 478 and shall be one-piece, 2 or 3 inches thick, with anchors bolt holes as shown in the Standard Details.

5. Miscellaneous Water and Wastewater Structures

Miscellaneous water and wastewater structures not otherwise covered shall meet the requirements of ASTM C 913.

B. Fabrication

- 1. The precast units shall be factory cast. Job site casting will not be permitted. Concrete in the precast elements shall be continuously placed to prevent formation of seams. The finished units shall be free of voids, cracks, and have beveled corners and edges. All inserts shall be securely attached or embedded in their property location.
- 2. Concrete strength of all precast units at 28 days shall be 4000 psi minimum, unless otherwise specified. It shall be the precast unit manufacturer's responsibility to insure that the specified concrete strength is maintained throughout production of the units. Mix design shall be those previously used by the manufacturer which have proven satisfactory for casting units similar to those specified and producing the required strength. All precast concrete shall be air entrained. Admixtures containing calcium chloride shall not be used.
- 3. Precast concrete units shall be manufactured in accordance with the applicable requirements of ASTM C 858, and as modified herein except that precast concrete

units manufactured by the dry cast (packerhead) process are prohibited.

4. Wall sleeves or gaskets for piping, sumps, steps, access hatches, and other inserts as shown on the Plans and/or Standard Details shall be cast into the structure or inserted at the place of manufacture.

C. Product Handling

1. No precast unit shall be shipped in less than 15 days from date of manufacturer, unless the unit has been tested and is shown to be in full compliance with the Specifications.
2. Precast sections shall be transported and handled with proper equipment to protect the elements from damage. Sections shall be handled by means of lifting inserts embedded in the concrete. Damaged sections that cannot be satisfactorily repaired shall be replaced by new sections at no additional cost to the County.
3. Precast sections shall be stored on wooden blocks to hold them off the ground to prevent dirt and debris from entering the joining surfaces.

D. Installation

1. Excavation, foundation preparation, backfill, and compaction shall be as specified in Section 02250.03.
2. Precast units shall be installed where and as shown on the Plans and Standard Details or as directed by the County Engineer.
3. Pipe connection, penetrations, and other appurtenances shall be installed as specified in the following sections:
 - a. Storm drainage structures; Section 02530.03,
 - b. Water valves and appurtenances; Section 02552.03,
 - c. Water services, meter settings, and vaults; Section 02553.03,
 - d. Sanitary sewer manholes; Section 02562.03.
4. Field modifications of precast units, such as cutting or enlarging holes or slots, will not be permitted without the specific approval of the precast unit's manufacturer and the County Engineer. Permitted modifications shall be made in strict accordance with the manufacturer's directions and recommendations.
5. Mating surfaces shall be cleaned of all foreign materials such as dirt, mud, stones, etc., and where appropriate, joint sealing materials applied prior to assembly of the units.

03400.04 METHOD OF MEASUREMENT

RESERVED FOR FUTURE USE

03400.05 BASIS OF PAYMENT

RESERVED FOR FUTURE USE

SECTION 03600

NON-SHRINK GROUTS AND MORTARS

03600.01 GENERAL

A. Description

Non-shrink grouts and mortars shall include, but not necessarily be limited to, prepackaged, non-shrink, cement-based grouts and mortars requiring only the addition of water. The grouts and mortars shall be specifically formulated for use as a sealant around wall penetrations, for use under machine or column bases, for bolt anchorages, and similar applications where drying shrinkage would be detrimental. Non-shrink grouts and mortars shall be furnished and placed in accordance with the Contract Documents, where indicated on the Plans, or as directed by the County Engineer.

B. Related Work Included Elsewhere

Mortar; Section 04100.

C. Quality Assurance

1. Inspection

The County Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents.

2. Containers

All non-shrink grouts and mortars shall be furnished and stored in the manufacturer's original containers.

D. Submittals

1. Shop Drawings

Shop drawings shall be submitted as specified in the "General Provisions" for all non-shrink grouts and mortars furnished. The shop drawings shall include product description and storage, handling, mixing, and placing instructions or recommendations.

2. Certificates of Compliance

Certificates of compliance shall be submitted in accordance with the "General Provisions" for all non-shrink grouts and mortars stating that the material furnished meets the requirements specified in Section 03600.02.

03600.02 MATERIALS**A. Materials Furnished by the County**

1. The County will not furnish any materials for non-shrink grouts and mortars.
2. The Contractor may obtain potable water from the County's potable water system for mixing with the dry material. The Contractor shall contact the Department of Fiscal Services, Meter Section, for requirements. A backflow prevention device must be placed in accordance with the Standard Details prior to drawing County water.

B. Contractor's Options

Non-shrink grouts and mortars may be either metallic or non-metallic as specified in Article C.

C. Detailed Material Requirements

1. Water from Other Than Potable Sources

Water shall meet the pH requirements of AASHTO T 26, Method B. Water shall not smell or be discolored. Water suspected of questionable quality shall meet limits of the comparison tests with distilled water in accordance with AASHTO T 26. The chloride concentration of water used in mixing and curing of non-shrink grouts and mortars will be determined in accordance with ASTM D 512 and shall not have a chloride concentration exceeding 1000 ppm.

2. Non-Shrink Grouts and Mortars

Non-shrink grouts and mortars shall conform to the requirements of the Corps of Engineers specification CRD-C 588, Type 3.1, b or d. The grout or mortar shall have a minimum compressive strength of 5000 psi in 7 days when tested in accordance with AASHTO T 106 except that the cube molds shall remain intact with the top firmly attached throughout the curing period. The non-shrink grout or mortar shall have a minimum expansion of 0.0% after 7 days when tested in accordance with AASHTO T 160.

03600.03 EXECUTION**A. Preparation**

1. All surfaces to receive non-shrink grout and mortar shall be cleaned of all oil, grease, dirt, and laitance down to sound concrete. Rust shall be removed from the underside of all plates and from all bolts or other embedment items by sanding or power brushing.
2. Where the concrete surface to receive the non-shrink grout or mortar is smooth, the surface shall be roughened with a small chipping hammer and then saturated with water prior to placing the grout or mortar.

B. Forms

When required, forms shall be furnished and placed to confine the non-shrink grout. The forms shall be strong enough to resist buckling and tight enough to prevent leakage.

C. Mixing

1. Mixing water shall be proportioned in accordance with the manufacturer's recommendations for the intended application. Use the stiffest mix possible consistent with placement methods.
2. Mixing shall be accomplished in water-tight containers following the manufacturer's recommendations.

D. Pouring or Pumping Grout

Grout shall be poured or pumped into position in such a manner as to avoid air pockets and to fill the entire void. When necessary, use rods or other tools to compact the grout and remove all voids.

E. Placing Mortar

Carefully place the mortar in such a manner to avoid air pockets and assure that the material is in complete contact with all surfaces. Unless otherwise specified, the finished surface shall be tooled smooth to match the adjacent area.

F. Curing

The non-shrink grout or mortar shall be cured for the time and in the manner recommended by the manufacturer.

03600.04 METHOD OF MEASUREMENT

RESERVED FOR FUTURE USE

03600.05 BASIS OF PAYMENT

RESERVED FOR FUTURE USE