

**CITY OF ELKO
DIVISION 3 – CONCRETE**

CATTLE DRIVE ACCESS ROAD and WATERLINE PROJECT

SECTION 03200

REINFORCING

PART 1 GENERAL

1.01 DESCRIPTION.

- A. Provide reinforcing work, complete as indicated, specified and required.
- B. Work Included in This Section. Principal items are:
 - 1. Furnishing and placing bar and mesh reinforcing for cast-in-place concrete including dowels for masonry work.
 - 2. Furnishing reinforcing steel bars for masonry, including delivery to the site.
- C. Related Work Not Included in This Section.
 - 1. Installation of reinforcing in masonry (Section 04220).
 - 2. Formwork (Section 03150).
 - 3. Cast-in-Place Concrete (Section 03300).

1.02 QUALITY ASSURANCE.

- A. Code Requirements. Unless otherwise specified, all work specified herein and as shown on the drawings shall conform to the applicable requirements of Chapter 26 of the Uniform Building Code, latest edition.
- B. Testing. Materials shall be tested as hereinafter specified and unless specified otherwise, all sampling and testing shall be performed by an Owner approved Testing Laboratory with cost borne by the Contractor.
 - 1. Test Samples. Bars, ties, and stirrups shall be selected by Testing Laboratory representative from material at the site or from place of distribution. Selection shall include at least two (2) pieces, each 18" long, of each sampling.
 - 2. Required Tests.
 - a. Identified Bars. Testing will not be required if reinforcement is taken from bundles as delivered from the mill, identified as to heat number and accompanied by certified mill analyses and certified mill test reports, and is properly tagged with Identification Certificate so as to be readily identified, unless otherwise directed by the Engineer.
 - b. Unidentified Bars. When positive identification cannot be made or when random samples are taken, tests shall be made from each five (5) tons or fraction thereof for each size. One tensile and one bend test shall be made from specimens of each size of

reinforcement. Contractor shall bear costs and delays caused by testing unidentified bars.

- C. Standard. Reinforcing steel installations shall conform to the specification requirements of the Concrete Reinforcing Steel Institute "Manual of Standard Practice" (herein referred to as the CRSI Manual) except as otherwise indicated or specified.
- D. Field Quality Control. Continuous inspections, where required by the Special Conditions, shall be performed by the "Special Inspector" qualified and approved by Governing Building Code Authority or Inspector as otherwise qualified and approved by the Owner.
 - 1. Inspection of Reinforcing. Provide twenty-four (24) hour advance notice to permit inspection of in-place reinforcement prior to closing forms, and refer to applicable requirements of Section 03300, "Cast-In-Place Concrete".
 - 2. Concreting Operations. During concrete placing, assign construction personnel to inspect reinforcement and maintain bars in correct positions at each pour location.
 - 3. Welding Inspection. Where allowed, perform shop and field welding of reinforcing steel under continuous inspection of the Owner's Inspector or an Inspector representative of the Testing Laboratory approved by the Owner. Notify Owner at least twenty-four (24) hours in advance of any procedure involving the welding of reinforcement.

1.03 SUBMITTALS.

- A. Submit the following in advance of fabrication in conformance with applicable requirements of General Conditions.
- B. Shop Drawings. Submit six (6) sets of shop drawings for reinforcing steel prepared in accordance with ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures". Show layouts, bending diagrams, assembly diagrams, dimensioned types and locations of all bar laps and splices, and shapes, dimensions, and details of bar reinforcing and accessories. Include layout plans for bar supports and chairs, with typical details. Owner's review shall be general, and acceptance will not relieve Contractor of responsibility for accuracy.
- C. Samples. Submit two (2) 12" long samples of each bar support and two (2) samples of each individual type chair, with catalog data.

PART 2 PRODUCTS

2.01 REINFORCING.

- A. Use deformed bars conforming to ASTM A615, Grade 60 Type "S". Where welding of reinforcing is required, use deformed bars conforming to ASTM A706 unless otherwise specifically designated on Drawings.

2.02 WELDED WIRE MESH.

- A. Conform to ASTM A185.

2.03 TIE WIRE.

- A. Annealed steel, 16 gage minimum.

2.04 COUPLER SPLICE DEVICES.

- A. Reinforcing bar coupler/splice devices which bear current I.C.B.O. Research Recommendation Approval, and which develop at least 125 percent of bar yield strength in tension may be used in lieu of lapped bar type splices. Submit for Owner's approval in each instance.

2.05 SUPPORTS AND ACCESSORIES.

- A. Use no aluminum, galvanized steel, plastic or stainless steel supports or accessories. Supports shall conform to CRSI Manual of Standard Practice, Chapter 3, for Types SB, BB, BC, JC, HC, CHC, and others of standard types as required, or precast concrete block supports (DOBIES) with embedded wire ties or dowels. Metal chairs shall be Class "1" plastic coated chairs and spacers.

2.06 DOWELS.

- A. Where and as designated on Structural Drawings, provide reinforcing bar dowels in new work and for anchorage to existing concrete.

2.07 FABRICATION AND DELIVERY.

- A. Conform to CRSI Manual Chapters 6 and 7 except as otherwise indicated or specified. Bundle reinforcement and tag with suitable identification to facilitate sorting and placing, and transport and store at site so as not to damage material. Keep a sufficient supply of tested, approved, and proper reinforcement at site to avoid delays.
- B. Bending and Forming. Fabricate bars of indicated size and accurately form to shapes and lengths indicated and required by methods not injurious to materials. Do not heat reinforcement for bending. Bars with kinks or bends not scheduled will be rejected. Field bend NO bars that are partially embedded in concrete, except as shown on the plans or specifically approved by the Engineer.
- C. Reinforcing Bars for Masonry. Bars shall be detailed and fabricated at the shop, ready for installation by masons.

PART 3 EXECUTION

3.01 PLACING.

- A. Unless otherwise indicated or specified, conform to CRSI Manual Chapter 8 including placement tolerances, except no reduction of concrete cover is allowable for bars at concrete surfaces exposed in liquid or water-containing structures.

- B. Cleaning. Before placing reinforcing, and again before concrete is placed, clean reinforcement of loose mill scale, oil, or other coating that might destroy or reduce bond. Do not allow form coatings, release agents, bond breaker, or curing compound to contact reinforcement.
- C. Concrete Coverage. Concrete coverage over reinforcing bars shall be as indicated on the Drawings. The coverage shall be to the outer edge of ties, stirrups, bar spacers, hangers, and like items, and the reinforcing shall be detailed and fabricated accordingly. Refer to Structural General Note requirements of the Drawings.
- D. Securing in Place. Accurately place reinforcement and securely wire tie in precise position at all points where bars cross. Tie stirrups to bars at both top and bottom. Bend ends of binding wires inward allowing no encroachment on the concrete cover; exercise special care at surfaces to remain exposed and unpainted. Support bars in accordance with CRSI Manual Chapter 3, Specifications for Placing Bar Supports, using approved chairs and supports. Ties or supports for reinforcing bars and mesh properly placed and tied into position are not to be removed or dislodged for the convenience of other crafts or for the purpose of crawl holes.
- E. Splices. Splices shall be wired contact lap splices unless otherwise indicated or approved. Splices shall conform to ACI 318, (Class A) (Class C) top bars and Typical Structural Details, except where lap length is indicated on the Drawings.
 - 1. Vertical Bars. Splicing of vertical bars in concrete is not permitted except at the indicated or approved horizontal construction joints or as otherwise specifically detailed.
 - 2. Horizontal Bars. Unless otherwise shown, make lap splices with at least one continuous bar between adjacent splices. Splices in any one run of bar shall be spaced at least twenty (20) feet apart with splices in adjacent bars offset at least ten (10) feet. Where double mats of bars occur in walls, lap splices in opposite mats shall be offset at least five (5) feet.
- F. Welding. Welding of reinforcing bars is not permitted unless indicated or approved in each case, with continuous inspection as hereinbefore required. Welds for securing crossing bars are not allowed. Perform welding in shop or field by direct electric arc process, with thoroughly trained and experienced certified operators qualified in accordance with AWS Code. Conform all welding to AWS "Structural Welding Code - Reinforcing Steel". Use low-hydrogen electrodes. Welds shall develop at least 125 percent of the yield strength of the connected bars.
 - 1. Preparation. Clean surfaces to be welded of loose scale and all foreign material. Clean welds each time electrode is changed. Chip burned edges clean before welds are deposited.
 - 2. Characteristics of Welds. When brushed with wire brushes, completed welds shall exhibit uniform section, smoothness of welded metal, feather edges without undercuts or overlays, freedom from porosity and clinkers, and good fusion with penetration into base metal. Cut out welds or parts of welds found defective with chisel and replace with proper workmanship; cutting torch for removing defective welding is not acceptable.
- G. Additional Reinforcing. Provide additional reinforcing bars at sleeves and openings as indicated or required. Where additional bars are not shown for such locations, obtain Engineer's instructions and provide additional bars as directed, at no extra cost to the Owner.

- H. Welded Wire Mesh. Install necessary supports and chairs to hold in place during concrete pours. Straighten mesh to lay in flat plane and bend mesh as shown or required to fit work. Laps shall be no less than one complete mesh unless otherwise detailed. Tie every other wire at laps.
- I. Dowels. For anchorage where shown or required to existing construction, use non-shrink epoxy type grout or deferred bolting devices as approved in each instance and conforming to "Product" Article requirements of Section 03300, "Cast-In-Place Concrete".
- J. Holes for epoxying dowels in place in existing concrete shall provide 2" minimum clearance on all sides of dowel bar.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION.

- A. Provide cast-in-place concrete work, complete as indicated, specified and required, including all appurtenant work as indicated.
- B. Work Included in This Section. Principal items are:
 - 1. All cast-in-place concrete including bases for mechanical and electrical equipment.
 - 2. Concrete standards, materials, mixes and tests, placement, finishing, patching, grouting, and crack repair.
 - 3. Embedded waterstops for cast-in-place concrete.
 - 4. Concrete curing.
 - 5. Sealing of joints in liquid-containing structures and elsewhere shown.
 - 6. Treatment of concrete surfaces.
- C. Related Work Not Included in This Section.
 - 1. Formwork (Section 03150).
 - 2. Reinforcing work (Section 03200).
 - 3. Concrete Unit Masonry (Section 04220).
 - 4. Architectural finishing
 - 5. Sealers, coatings, and waterproofing for treating concrete surfaces.
 - 6. Pre-stressed concrete.
- D. Definitions.
 - 1. Water-Bearing Structure shall be construed to mean any structure any part of which contains water or process liquids, or which protects spaces from groundwater.
 - 2. Definitions of surface treatments of concrete structures.
- E. Waterproofing. The Division 7 material to be applied, or the application of Division 7 material, to either earth-supporting below-grade surfaces or water-bearing surfaces of either

existing or new walls common to occupied areas (i.e. galleries, pump rooms, etc.), for the purpose of making such walls impervious to water or sewage.

- F. Damp-proofing. The Division 7 material to be applied, or the application of Division 7 material to either earth-supporting below-grade surfaces or water-bearing surfaces of either existing or new walls common to occupied areas (i.e. galleries, pump rooms, etc.), for the purpose of retarding the passage or absorption of water or water vapor. An alternate specified method of damp-proofing might be the addition of a suitable admixture or treated cement to the concrete.
- G. Coating. The Division 9 material or system, or application of Division 9 material or system, to protect or paint concrete surfaces.
- H. Sealer. A coating applied to seal the pores in an uncoated surface.
- I. The sealer for surfaces to be painted is the prime or first coat of a Division 9 painting system.
- J. The sealer for surfaces to be left unpainted is a clear transparent waterproof coating.
- K. Seal Coat. A layer of Division 2 bituminous material applied to seal the concrete surface.
- L. Sealant or Sealing Compound. A Division 7 impervious material for the purpose of excluding water by sealing or caulking joints in water-bearing surfaces or traffic surfaces, for the purpose of excluding moisture or sound by sealing or caulking joints in surfaces or partitions, or for the purpose of providing a bond breaker.

1.02 REFERENCE STANDARDS.

- A. Except herein modified, concrete work shall conform to the latest requirements/edition of ACI 301, Specifications for Structural Concrete for Buildings, and to requirements of ACI Standards and ACI Recommended Practices as contained therein.

1.03 SOURCE QUALITY CONTROL.

- A. Code Requirements. Unless more stringent requirements are specified herein and/or shown on the Drawings, all work shall conform to the applicable requirements of the Uniform Building Code, latest edition.
- B. Testing. Materials shall be tested as hereinafter specified and unless specified otherwise all sampling and testing shall be performed by Owner approved Testing Laboratory with cost borne by the Contractor.
 - 1. Portland Cement. Submit notarized Mill Certificates, provided by the cement manufacturer, including full compliance with requirements specified. In the absence of certificates, Testing Laboratory shall perform tests for each 250 barrels of cement at Contractor's expense, tests made in accordance with ASTM C150 with tensile strength test made at 7 days. Cement shall be tagged for identification at location of sampling.
 - 2. Stone Aggregate for Concrete. Test aggregate before and after concrete mix is established and whenever character or source of material is changed. Include a sieve analysis to determine conformity with limits of gradation. In accordance with ASTM C75, take

samples of aggregates at source of supply or at the ready-mix concrete plant. Submit certified test results.

- a. Sieve Analysis. ASTM C136.
 - b. Organic Impurities. ASTM C40. Fine aggregate shall develop a color not darker than reference standard color.
 - c. Soundness. ASTM C88. Loss resulting therefrom, after 5 cycles, shall not exceed 8% of coarse aggregate, 10% for fine aggregate.
 - d. Abrasion of Concrete Aggregate. ASTM C131; loss shall not exceed 10½% after 100 revolutions, 42% after 500 revolutions.
 - e. Deleterious Materials. ASTM C33.
 - f. Materials Finer Than 200 Sieve. ASTM C117; not to exceed 1% for gravel, 1.5% for crushed aggregate per ASTM C33.
 - g. Reactivity Potential. ASTM C289. Ratio of silica released to reduction in alkalinity shall not exceed 1.0.
- C. Applicator. The applicator of waterproofing, damp-proofing, coatings, sealers, seal coats, or sealants shall be approved by the manufacturer of the material.

1.04 CONCRETE MIX DESIGNS AND PRELIMINARY TESTS.

- A. At Contractor's expense, Testing Laboratory shall prepare mix designs for all cast-in-place concrete to have the required 28-day compressive strengths, and shall perform preliminary testing in accordance with the following requirements. Test results shall be submitted to the Owner. **Contractor may furnish mixes as specified in Part 2.02 in lieu of trial batches where appropriate.**
- B. Mix Designs.
1. Strength Requirements. Design concrete mixes for use in various locations, for minimum 28-day compressive strengths and maximum aggregate sizes required by Structural Drawings and these Specifications, as follows, except as otherwise specified in the Special Conditions:
 - a. 4,000 psi Concrete. 4000 psi concrete shall be provided throughout except as specified hereinafter, or in the Special Conditions.
 - b. 3,000 psi Concrete. 3,000 psi concrete shall be provided for concrete used in:
 1. all reinforced concrete, interior and exterior, not otherwise specified;
 2. anchors and anchor walls;
 3. pipe cradles, encasements, and beam supports;
 4. reinforced valve supports;
 5. concrete for grout topping (with reduced-sized aggregate as directed);

6. paving;
 7. sewer manhole bases and collars;
 8. sewer tree lateral clean-out supports;
 9. sewer chimney lateral supports.
 10. Non-machine laid curbs and gutters
 12. Spandrels
 13. Driveways and approaches
 14. Sidewalks
 15. Exterior slabs
 16. Stairs on grade
- c. 2,500 psi Concrete. 2,500 psi concrete shall be provided for non-reinforced concrete used in:
1. sewer overflow encasements;
 2. sewer lateral joint encasements;
 3. pipe joint mortar;
 4. fence post footings;
 5. non-reinforced cut-off walls;
- d. 2,000 psi Concrete. 2,000 psi concrete shall be provided for concrete used in:
1. non-reinforced thrust blocks and pipe pads;
 2. valve supports;
 3. sewer clean-out supports not otherwise specified.
2. Basis for Mix Designs. Design concrete mixes for workability of mix and durability of concrete. Concrete mixes shall be rigidly controlled in accordance with laboratory trial batch method or combinations of materials previously evaluated as required by Sections 5.3, respectively, Standard Building Code Requirements for Reinforced Concrete (ACI 318, latest edition), of the American Concrete Institute and to satisfy herein specified concrete strength requirements. When, in the opinion of the Engineer, it becomes necessary to increase the cement content to gain the required strength, such adjustment shall be made at the Contractor's expense.
3. Water/Cement Ratios. Mixes for normal weight aggregate concrete shall be designed within the following maximum water/cement ratios when concrete is to be used in the various locations:
- a. For 4,000 psi water-bearing structural concrete limit water/cement ratios by weight as follows:
 1. Freshwater-bearing structures 0.48 maximum
 2. Sewage-bearing structures 0.45 maximum
 - b. For all other concrete, water/cement ratios shall be no greater than 0.53.
- C. Preliminary Strength Tests. In laboratory, prepare nine (9) compression test cylinders for each concrete mix design (unless more tests are required for an earlier age). Fabricate and cure cylinders in accordance with ASTM C31. Use concrete, aggregates and admixtures proposed for the concrete work. In accordance with ASTM C39, test three sets of two cylinders at 28-day age. For each mix, no individual strength test result shall fall below the required f'_c .

- D. **Drying Shrinkage Tests.** For each mix design used for preliminary strength tests, using same concrete materials including admixtures, prepare three (3) test specimens for drying shrinkage testing. Specimens shall be 4 inch by 4 inch by 11 inch prisms fabricated, cured, and tested in accordance with ASTM C157, using 10 inch effective gauge length. Measurements shall be taken at one (1) day, seven (7) days, fourteen (14) days and twenty-one (21) days of curing. Zero measurement shall be the one day reading when determining shrinkage. The measurements after 7, 14, and 21 days of drying shall be taken and reported separately. The average drying shrinkage of each set of test specimens after two (2) days of drying shall not exceed 0.036% for concrete in all portions of water-bearing structures and not exceed 0.05% for all other structural concrete, except concrete for footings, piles and pile caps will not require drying shrinkage tests. Single specimens shall be within a tolerance of 25% of said maximum percentage.
- E. **Reports.** File three (3) copies of each mix design, preliminary strength test report, and drying shrinkage test report with Owner for review and approval. Contractor shall submit a letter of certification by an approved testing laboratory that the concrete materials, mixes, properties, and work conform to the requirements indicated and specified.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING.

- A. Deliver materials in a timely manner to insure uninterrupted progress of work. Store materials in a manner that will preclude damage and permit ready access for inspection and identification.
- B. Materials for treatment of concrete surfaces. The contractor shall deliver sealers, coatings, waterproofing, or other surface treatment materials to the site in their original, unopened containers with the manufacturer's labels intact, describing contents and manufacturer.
- C. Stored materials shall be kept covered and precautions shall be taken for the prevention of fire. Empty containers and soiled or oily rags shall be removed from the site at the end of each day's work.

1.06 PAYMENT.

- A. Payment for cast-in-place concrete shall be based upon concrete poured and found acceptable upon the removal of forms and performance of required finishing. Under no conditions will more than 90% payment be made for concrete formed and poured until required finishing is completed.
- B. On large structures requiring construction over multiple payment periods, consideration may be given by the Engineer for payment as follows:
- C. Forms and rebar in place and accepted for concrete pour - 50% maximum of concrete price per cubic yard.
- D. Concrete poured and forms stripped, and found acceptable to the stage of construction - 35% maximum of concrete price per cubic yard.
- E. Concrete finished and found acceptable - 15% of concrete price per cubic yard.

**PRODUCT
MATERIALS.**

A. Portland Cement. Standard brand of domestic Portland cement, ASTM C150, Type II, low alkali. Do not change brand of cement during progress of work without written approval of Engineer. For concrete exposed to sulfate-containing soils, solutions or other chemically aggressive solutions, use Type V Portland cement as specified.

B. Normal Weight (Stone) Aggregates. Furnish natural aggregates from approved pits, free from opaline, chert, feldspar, mica (fools gold), siliceous magnesium limestone or other deleterious or reactive substances. Conform to ASTM C33 except as modified herein. Fine aggregates shall pass a #4 sieve. Do not use pozzolan or other additives to compensate for aggregate alkali reactivity.

1. Coarse Aggregates. Clean, hard, fine-grained sound crushed rock or washed gravel which does not contain in excess of 5% in weight of flat, chip-like, thin, elongated, friable or laminated pieces, or more than 2% by weight of total amount of cherty material and soft particles, or more than 1% of chert as soft material as defined on Table 3 of ASTM C33. Consider any piece having a major dimension in excess of 5 times its average dimension to be flat or elongated.
2. Maximum Sizes. As indicated on Drawings, except for concrete in water-bearing structures where coarse aggregate sizes per Table 2 of ASTM C33 shall be No. 467 (12 inches), No. 57 (1 inch), or No. 67 (3/4 inch) as otherwise required by design, specifications and ASTM C33, and except that coarse aggregate nominal maximum size shall not exceed one-fifth the narrowest dimension between sides of form, one-third the depth of slabs, or three-fourths of minimum clear spacing between reinforcing bars.
3. Quality. All aggregates shall meet the test requirements of Article "Source Quality Control" hereinbefore.
4. Abrasive Aggregate. "Alundum" by Norton Company, "Carborundum" by Union Carbide, or equal aluminum oxide, uniformly graded between No. 12 and No. 30 sieves, applied uniformly at minimum rate of 1/4 lb. per sq. ft. and locked into cement matrix with the final troweling.

C. Admixtures. **Use one manufacturer's products throughout.** Upon Engineer's approval of use and of a particular brand or type, assure that use is reflected in mix designs. Approved manufactures are W.R. Grace and Master Builder Products.

1. General. Use no admixture containing chlorides or triethanolamine. Admixtures used in combination shall be physically and chemically compatible and shall be so certified by each admix manufacturer and by Testing Laboratory that prepared respective mix designs.
2. Retarding-Densifier Admixture. In all concrete use a hydroxylated carboxylic acid type admixture in the amounts recommended by the manufacturer. The admixture shall provide the following, and Contractor shall provide proof thereof at time of request for approval:
 - a. Decrease drying shrinkage.
 - b. Increase compressive strength at all ages up to and including five (5) years.

- c. Increase flexural strength, modulus of elasticity, and abrasive resistance.
 - d. The water/cement ratio and required strengths shall be maintained as scheduled (cement factor for a cubic yard of concrete, reduced proportionately).
 - e. There shall be no loss of workability resulting from reduction in slump. If the admixture is of liquid type, it must be considered in proportioning water.
3. Air Entrainment. Use air entrainment additive conforming to ASTM C260 as approved by the Owner.
- a. For normal weight aggregate concrete subject, after curing, to freezing temperature while wet shall contain air entrainment within limits of Table 4.2.1 of ACI 318, latest edition and Table 4.2.2.4 of ACI 301, latest edition.
 - b. Air Entrainment in Water-bearing Concrete Structures, as determined in accordance with ASTM C231 or C173, shall provide air contents as follows for mixes with the following coarse aggregate sizes:
 - 5% ± 1% for Size 467 (12 inch nominal size)
 - 6% ± 1% for Sizes 57 or 67 (1 inch or 3/4 inch nominal sizes)

D. Water. From a domestic potable source.

E. Expansion Joint Material. Type I, preformed sponge neoprene expansion joint filler conforming to AASHTO Designation M-153.

F. Bituminous Mastic. For fills at specific designated locations (such as fills at precast panel lift-eyes and dowel hole fills in precast concrete panels) use either Hot-Applied Type Joint Sealer, ASTM D1190 or Cold-Applied Type Joint Sealant, ASTM D1850. Material shall bond to concrete, prevent moisture infiltration and, when set, shall be non-tracking at summer temperatures.

G. Waterstops. Waterstops shall be produced by an extrusion process in such a manner that any cross section shall be dense, homogeneous and free from porosity and other imperfections. They shall be symmetrical in cross-sectional shape and uniform along their length.

The manufacturer must certify in writing that all waterstops are extruded from elastomeric polyvinyl chloride compound and that this compound shall be virgin PVC compound and not contain any scrap or reprocessed materials whatsoever.

The manufacturer must also certify in writing that all waterstops meet or exceed the physical properties requirements set forth in the U.S. Corps of Engineers' CRD-C572-74 specification and furnish a copy of certified independent laboratory test data showing compliance.

All waterstop intersections (ells, tees, crosses, etc.) shall be fabricated by the manufacturer and these shall have 2 ft. long legs to facilitate field butt splicing. Where field dimensions are encountered which will not accommodate the specified waterstop, waterstop of reduced dimension may be approved by the Engineer for a specific application.

H. Concrete Joint Sealants. For sealing joints in nonwater-bearing concrete surfaces, use materials conforming with requirements specified in Section 07920, "Sealants and Caulking". For sealing concrete joints which will be immersed or intermittently immersed in water or sewage-bearing surfaces, use: Karlee Company's "Lastex M" 100 percent solids polyurethane sealant; Mameco

International's Vulkem 227, Vulkem 45, or Vulkem 245 contingent upon need for self-leveling, non-sag and atmospheric humidity at time of usage; Hunt's Seal Flex 227-U Special Reservoir Grade polyurethane sealant; or equal.

1. Primer. Use primer produced and/or recommended by sealant manufacturer.
2. Back-up Preformed Joint Filler. Use closed-cell polyethylene foam or equal impervious, compatible, compressible foam material recommended for retaining sealant depth in expansion joints while curing. Use no bitumen or oil saturated material.
3. Bond Breakers. Bond breakers, where required, shall be polyethylene tape or equal as recommended by sealant manufacturer to prevent adherence of sealant to back-up material.

I. Dry Pack Mortar. Dry pack mortar shall consist of by volume one part special cement, three parts sand and water. The special cement and sand shall be combined in the proper proportions and then thoroughly mixed with the required amount of water. The dry pack mortar shall contain only enough water to permit placing and packing and shall be mixed for the time limit as indicated by the manufacturer in advance of use. The dry pack mortar shall be placed against thoroughly wet concrete and shall be cured by water, fog spray, spray-on membranes, sisal kraft paper, or other curing method acceptable to the Owner.

J. Grout. Grout to be applied to the concrete surface shall consist of one part Portland Cement to three parts dry, washed sand to sufficient water to allow placement, screening, and finishing.

K. Rich Grout. Rich grout shall consist of by volume one part Portland Cement, two parts sand and water. The rich grout shall be mixed and cured in the same manner as required for dry pack mortar.

L. Neat Grout. Neat grout shall consist of Portland Cement, flyash, water and optional admixtures. Neat grout is intended to be injected under low pressure to backfill the annular space between steel casing pipes and carrier pipes.

M. Nonshrink Grout. Nonshrink grout shall be made with the following proportions:

- One part Type II Portland Cement (one sack);
- One part Nonshrink Aggregate (100 lbs.);
- One part clean, well graded concrete sand (100 lbs.);
- Approximately 5.5 gallons of water per sack of cement

1. In all locations where the surface of the grout will be exposed to view, the nonshrink grout shall be recessed approximately one-half inch back of the exposed surface and the recessed area filled with cement mortar grout.

N. Nonshrink Concrete. All nonshrink concrete shall contain one pound of nonshrink aggregate per pound of water that is in excess of two gallons per sack of cement. Recess surface exposed to field as specified for nonshrink grout above.

O. Nonshrink Aggregate. Nonshrink aggregate shall be non-metallic as produced by Master Builders, an equivalent product of Sonneborn, or a product by any other manufacturer that will meet the same ASTM requirements and equal performance.

P. Epoxy. Epoxies for grouting, crack repair, patching, bonding or other uses shall be as follows as manufactured by Adhesive Engineering Company, Sika Chemical Company, or equal by other manufacturer. Throughout, use products of single manufacturer.

1. All epoxy mixing, surface preparation and application shall be made in conformance with manufacturer's printed specifications, as approved by the Engineer.
2. For bonding new concrete to old concrete and for grouting metal anchors, use Sika's "Sikadur Hi-Mod", Adhesive Engineering Company's Concsive 1001-LPL, except Concsive 1170 or 1422 shall be used as recommended by manufacturer to satisfy entailed project temperature and surface moisture variations at time of application; or equal.
3. For patching concrete surfaces, making high strength epoxy concrete or grout, and grouting metal anchors, use Sika's "Sikadur Hi-Mod LV"; Adhesive Engineering Company's "Concsive 1180"; or equal.
4. For pressure injection or gravity-feed grouting, use Sika's "Hi-Mod LV"; Adhesive Engineering Company's "Concsive Structural Concrete Bonding Process System" as recommended by manufacturer and approved by Engineer; or equal.

Q. Floor Hardener. Use hardened, non-metallic aggregate dust-on type floor hardener consisting of a single manufacturer's system equal to L. M. Scofield Company's natural gray "Lithochrome Hardener" applied uniformly at rate of 100 lbs. per 100 sq. ft. of floor space, or Master Builders' natural gray "Premixed Mastercron" applied at rate of one pound per sq. ft. of floor space. For use with air-entrained concrete, use Burke Company Non-metallic Floor Hardener Group Order #326 applied at a rate of 75 lbs. per 100 square feet. Burke Sparten Cote Cure-Seal-Hardener shall be used with Burke Non-Metallic Floor Hardener #326.

R. Liquid Curing Compound. Use "TLF" or "Clear 225 TU" by Hunt Process Company, Burke "Rez-X", or equal conforming to ASTM C309 and providing no detrimental affects with deferred finishes. On surfaces within reservoirs or other concrete structures containing potable water, use nontoxic materials which are free of odor and taste. Provide supporting technical data. Floor hardener treated floors shall use materials only as recommended in writing by hardener manufacturer.

S. Sheet Curing Materials. ASTM C171, waterproof paper, polyethylene film or white burlap-polyethylene sheet, non-staining.

T. Vapor Barrier Membrane. Under interior on-grade slabs of occupied areas provide lapped and sealed vapor barrier membrane using Fortiber "Moistop", "Damproof XX" by Nicolet of California, Incorporated, or equal with manufacturer's recommended polyethylene pressure sensitive tape sealant used continuously at lapped joints, penetrations and at perimeter walls or footing surfaces. Throughout, use products and system of single manufacturer.

U. Gasket Seal for Manhole and Wet Well Precast Concrete Members. Provide gasket seals at mating joint of precast concrete sections. Size gaskets to suit joint dimensions, surface conditions and to assure watertight completed installation. Seal shall consist of either compressible closed-cell neoprene rods with compatible bonding agent recommended by material manufacturer; of No. 95 extruded butyl rod and No. 2 Primer each produced by General Sealants, Incorporated, City of Industry, California; or equal non-bituminous joint sealing compressible gaskets.

V. Synthetic Sponge Rubber Filler. Synthetic rubber filler shall be an expanded closed-cell sponge rubber, manufactured from a synthetic polymer neoprene base. The material shall be No. 750.3 Ropax Road Stock as manufactured by the Presstite Division of Interchemical Corporation;

Bondtex as manufactured by Rubatex Corporation; or approved equal. The size of the material shall be 25% greater in diameter than the nominal joint width. The manufacturer's instructions for surface preparation and application shall be used as a guide for installation, except that the material shall not be installed by stretching beyond its normal length.

W. Expansion Joint Filler. Bituminous fiber expansion joint filler shall be in accordance with ASTM D1751. Bituminous expansion joint material shall not be used in joints to be sealed with synthetic rubber sealing compound.

X. Concrete Expansion Bolts/Deferred Bolting Device (D.B.D.). Except as otherwise specified, where expansion bolts are called for on the Drawings, Parabolt Concrete Anchors as manufactured by the Molly Company, Kwik-Bolts as manufactured by McCulloch Industries, Incorporated, or a concrete anchor by any other manufacturer that shall meet the same Federal Specification requirements and shall equal the performance, shall be used. All bolts thus furnished and used on this project shall be manufactured of stainless steel.

CONCRETE MIXES.

A. 28-Day Compressive Strength. It shall be the sole responsibility of the Contractor to mix, place, and cure concrete which shall be of 150 lb./cu. ft. nominal density and which shall attain the compressive strengths at 28 days as designated on Structural Drawings or in these specifications for use in various locations.

B. Maximum Aggregate Size. Conform to Article 2.01 B.2. For 4,000 psi concrete use 1½ inch maximum size aggregate unless otherwise designated; for 3,000 psi concrete use 1 inch maximum size aggregate; for 2,500 and 2,000 psi concrete use ¾ inch maximum size aggregate. In no case shall the size of the coarse aggregate exceed 75% of the horizontal space between reinforcing bars or between reinforcing bars and forms.

C. Mix Designs. Conform with requirements of Article 1.04 "Concrete Mix Designs and Preliminary Tests". At least 60 days before any Class concrete is to be placed, the Contractor shall submit for approval for each proposed mix a mix design made by a Civil Engineer registered in Nevada or a Testing Laboratory approved by the Owner.

CONCRETE MIXING.

Concrete shall be ready-mixed, supplied from an off-site commercial ready-mix plant approved by Owner, each load accompanied by a bonded weigh-master's certificate listing the quantity of each concrete ingredient, admixture quantity, water content and slump, and time of loading and departure from ready-mix plant. Also include notations to indicate equipment was checked and found to be free of contaminants prior to batching.

A. Ready-Mixed Concrete. Unless approved otherwise in advance of batching, all concrete of a single design mix for any one day's pour shall be from a single batch plant of a single supplier. Conform to ASTM C94, except materials, testing and mix design shall be as specified herein. Use transit mixers equipped with automatic devices for recording number of revolutions of drum.

All applicable mixing requirements specified herein for concrete mixed at the site shall govern transit-mixed concrete and the Owner shall have free access to the batching plant at all times. For concrete mixed in top-loading truck mixers, each batch shall be turned not less than 40 and not more than 300 revolutions of the mixer drum at mixing speed when the fine and coarse aggregate are charged into the mixer simultaneously (cement and water may be charged separately). When the fine and coarse aggregate are charged into the mixer separately, each batch shall be turned not less than 60 and not more than 300 revolutions of the drum at mixing speeds.

For concrete mixed in end-loading truck mixers, each batch shall be turned not less than 60 and not more than 300 revolutions of the mixer drum at mixing speed when the mixer is loaded in excess of 50 percent of the gross drum volume as provided hereinafter. When the mixer is loaded (not to exceed 50 percent of the gross drum volume) the provisions specified for top-loading truck mixers will apply.

Truck mixers shall be loaded in accordance with manufacturer's capacity ratings, but in no case shall the volume of mixed concrete exceed 50 percent of the gross volume of the drum for top-loading mixers and 58 percent of the gross volume of the drum for end-loading truck mixers.

Mixing speed shall be in accordance with manufacturer's recommendations, but in no case shall the speed be less than 4 revolutions per minute or greater than a speed resulting in a peripheral velocity of the drum of 225 feet per minute. The power unit shall be equipped with a governor to insure constant speed. Each truck mixer shall be equipped with a device for counting the number of revolutions of the drum, which device shall be interlocked so as to prevent the discharge of concrete from the drum before the required number of turns. After the drum is once started, it shall be revolved continuously until it has completely discharged its batch. Water shall not be admitted to the mix until the drum has started revolving. The right is reserved to increase the required minimum number of revolutions or to decrease the designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing, and the Contractor will not be entitled to additional compensation because of such increase or decrease.

B. Mixing Water Limitations. If water is added at the batching plant, ready-mixed concrete shall not be held in the mixer for more than one and one-half hours from the time the water is added. When temperature of concrete is 85°F or above, reduce holding time to 45 minutes. Do not deliver ready-mixed concrete to job with total specified amount of water incorporated therein. Withhold 2½ gallons of water per cubic yard, then incorporate in mix before concrete is discharged from mixer truck. If no water is added at the batching plant, measured quantities of water shall be added at the site and a minimum of fifteen minutes mixing given, or mixing to overcome segregation. Adding of water shall be under observation of Inspector. Each mixer truck shall arrive at the job site with its water container full. In event container is not full or concrete tests to a greater slump than specified, the load is subject to rejection.

C. Job Mixed Concrete. Contractor shall obtain the approval of the Owner for equipment and procedures proposed for job mixed concrete.

D. Consistency and Slump. Adjust quantity of water so concrete does not exceed maximum slumps specified when placed or specified water/cement ratio; use minimum necessary for workability required by the part of the structure being cast. Measure consistency of concrete in accordance with ASTM C143. Concrete exceeding maximum slump will be rejected.

Part of Structure	Maximum Slump
Footings and mass concrete not reinforced	3 inches
Slabs, and floors and reinforced footings	2 to 3 inches
Columns, walls over 8 inches thick	3 to 4 inches
Walls up to 8 inches thick	3½ to 4 inches
Equipment bases	3 to 5 inches

EXECUTION

PREPARATION BEFORE PLACING.

Remove excess water from forms before concrete is deposited. Divert any flow of water without washing over freshly deposited concrete. Remove hardened concrete, debris, and foreign materials from interior of forms and from inner surfaces of mixing and conveying equipment.

A. Forms. Prior to placing concrete, forms shall meet the requirements of Section 03150, as approved by the Engineer. Concrete to be poured on earthwork such as slabs or stairs on grade shall meet the same requirements for approval prior to pouring as above specified for the approval of forms.

B. Reinforcement. Reinforcement shall have been secured under work of Sections 03150 and 03200, and inspected and approved. Embedded metal shall be free of old mortar, oils, mill scale, and other encrustations or coatings that might reduce bond. Wheeled concrete-handling equipment shall not be wheeled over reinforcing nor shall runways be supported on reinforcing.

"Break-out" bars or dowels bent for forming, for subsequent straightening prior to adjacent pour, will be allowed with bars of #5 maximum size, only where specifically called out on the Drawings, and only where kinks or breaks are not likely as a result of straightening. This does not imply approval of cold joints where none designed, or any deviation from construction joint requirements elsewhere in these specifications.

C. Wetting. Wet wood forms sufficiently to tighten up cracks. Wet other materials sufficiently to reduce suction and maintain concrete workability.

D. Earth Subgrade. Lightly dampened 24 hours in advance of concrete placing, but not muddied. Re-roll as necessary for smoothness, and remove all loose materials.

E. Aggregate Fill Base. Prepare same as earth subgrade. Center 30-mil plastic sheeting or roofing cap sheet on base course under indicated waterstop joints to retain mix fines within mix and prevent their percolation into base course.

WATERSTOPS.

Heat fuse joints and connections in strict compliance with manufacturer's instructions including heating tools and devices. Waterstops shall be continuous in joints, following offsets and angles in joints until spliced to waterstops at intersecting joints, completely sealing the structure. Waterstops shall be aligned and centered in joints. Secure flanges of waterstops to reinforcing bars with 18 gage wire ties spaced maximum 18 inch center. All waterstops, splices, joints, intersections, and welds shall be tested with an approved holiday spark tester before concrete is placed. Locate waterstops where shown on drawings and in all water-bearing walls and slabs where common to: earth-bearing or earth-support; occupied areas; or above-grade exposed surfaces.

Waterstop shall be positioned correctly during installation and all splices in length or at intersections shall be performed by heat sealing and in accordance with manufacturer's recommendations.

Waterstop joints shall conform to Drawing requirements, if requirements are shown on the Drawings, and, whether or not requirements are shown on the Drawings, shall be properly heat-spliced at ends and crosses to preserve continuity. All splicing shall be done using mitered joints. Forms for construction joints shall be constructed in such manner as to prevent injury to waterstops. Waterstops shall be securely held in position in the construction joints by wire ties.

In narrow walls requiring both rebar and waterstop, the rebar shall be offset to one side and the keyway and/or waterstop shall be offset to the opposite side sufficiently to allow placement of both

rebar and waterstop without contact. In order to accommodate such an offset, double curtain steel may be replaced by one properly designed larger bar upon approval by the Engineer.

All in-place waterstop installations including locations and joints shall be approved by Owner prior to placement of concrete.

JOINTS IN CONCRETE.

Locate joints in concrete where indicated unless otherwise approved. Obtain approval of points of stoppage of any pour, prior to scheduling of pour.

A. Construction Joints. Unless otherwise shown, all construction joints shall be provided with suitable keyways of other keying methods. Clean and roughen contact surfaces of construction joints by removing entire surface and exposing clean aggregate solidly embedded in mortar matrix. Use mechanical chipping, sandblasting, or application of surface mortar retarder followed by washing and scrubbing with stiff broom. Cover and protect waterstops and other inserts from damage. The hardened concrete shall be watered and kept wet for at least 24 hours before placing new concrete. At construction joints not containing waterstops, the coarseness amplitude of the prepared surface shall be 1/4 inch minimum in accordance with the latest edition of ACI 318, Section 11.7.9. Provide sealant for construction joints where shown on the shop drawings and/or which will be immersed or intermittently immersed in water or sewage. Sealant shall be per Section 03300, Part 2, 2.01, H. Where construction joints are not indicated on the Drawings, provide slabs and walls with construction joints at intervals not greater than 30 feet.

Starter walls shall be used unless detailed otherwise. Where utilized, starter walls shall extend a minimum of 3 1/2 inches.

Where "break-out" bars are required by the contract drawings for future structure extensions, except where other methods are specifically set forth on the contract drawings a required mortar-tight enclosure of the reinforcing dowels shall be provided by installing the break-out bars in capped PVC pipe embedded 1 inch minimum into the structural concrete.

B. Expansion Joints. Provide where indicated, 1/2 inch width unless otherwise detailed. Except where synthetic rubber (sealant) sealed joints are shown or specified, provide expansion joint filler and joint sealer, filler head down 1/2 inch to 3/4 inch and sealer finished flush with surface. At synthetic rubber sealed joints, hold filler down 1/2 inch unless otherwise shown, ready to receive sealant.

1. Location of joints in interior slabs on grade shall be as detailed on the Drawings. Sawed control joints shall be as approved by the Engineer.
2. Control joints in exterior slabs shall be located as indicated on the Drawings, or as follows if not noted:
 - a. Provide bond breaker with 1/2 inch expansion joint material at junction of walls, bases, columns, etc.
 - b. Provide 1/2 inch expansion joints at changes in direction of slabs, or abrupt changes in width and not greater than twenty (20) feet apart on slabs without control joints.
 - c. Control joints in exterior slabs shall be sealed with the specified sealer.

C. Roof and Floor Slabs. Pour slabs in alternating checkerboard fashion between indicated construction joints, as approved. Slabs in place shall be cured as required elsewhere in these specifications a minimum of seven (7) days before adjoining slabs are cast.

D. Intermediate Screed Strips. Intermediate screed strips shall be required for all slab pours unless otherwise approved. Such approval for the omission of intermediate screeds shall be for each individual pour and no blanket approval shall be given.

E. Gasket Seals. At joints between precast concrete manhole and/or wet well units, clean mating surfaces of both members. Then within groove, place and lay continuous rod of specified compressible gasket to provide watertight installation after placement of matching tongued concrete member and compression of the gasket.

F. Joining Existing Structures. Where a construction joint to an existing structure requires a waterstop and none is found in the existing structure, Contractor shall join the old structure by chamfering the new concrete at the joint and filling the chamfer with specified epoxy sealant.

Where required reinforcing is not found protruding from the existing structure, required reinforcing shall be placed by drilling and placing dowels of the proper size and spacing.

Where required waterstop and reinforcing is found in the existing structure, joints shall be treated as other construction joints under Articles 3.01 and 3.02.

G. Concrete for Buried Electrical. Buried electrical conduits shall be encased in concrete. Immediately after pouring concrete, red mineral oxide shall be evenly sprinkled on top of concrete to a minimum of 3/8" thick and then lightly raked into top of wet concrete encasement. Red coloring shall be pure mineral oxide, limeproof and nonfading. Amount and type of coloring agent used shall not reduce the quality of concrete below that specified.

CONVEYING AND PLACING CONCRETE.

A. Do not pour concrete until reinforcing steel and forms have been inspected and approved. Notify Owner not less than one full working day in advance of readiness for inspection of forms and reinforcing. Specific approval of individual forms by the Engineer shall be obtained before ordering of concrete. The Contractor shall give the Engineer a minimum of 24 hours notice of a scheduled concrete pour following the completion of forming. Upon inspection of the forms, reinforcing, waterstop placement, etc., the Engineer will immediately issue a written approval to pour concrete showing approval of the scheduled pour or disapproval. In the event of disapproval, the Engineer will show the Contractor the specific deficiencies, for correction within the 24 hour period prior to the scheduled pour. Upon notification by the Contractor of correction of deficiencies and reinspection and approval by the Engineer, the pour may proceed as scheduled. In the event required corrections are not made, or are not approved, the disapproval of the pour shall stand and the pour shall not proceed as scheduled, but shall be rescheduled.

Any concrete not in accordance with these specifications, out of line, level, or plumb; or showing cracks, rock pockets, voids, stalls, honeycombing, exposure of reinforcing, or any other damage which will be detrimental to the work will be considered defective and must be corrected and replaced as directed by the Engineer at no additional cost to the Owner. Any concrete work that is not formed as indicated; is not true within 1/250th of the span; is not true to intended alignment; is not plumb or level where so intended; is not true to intended grades and levels; has voids or honeycombs that have been cut, resurfaced or filled, unless under the direction of the Engineer; has any sawdust, shavings, wood or embedded debris; or does not fully conform to the contract provisions, shall be deemed to be defective and shall be removed from the site.

1. Handle or pump no concrete utilizing aluminum equipment.
2. Delivery tickets shall show the following:

- a. Batch number.
- b. Mix by compressive strength with maximum aggregate size.
- c. Types and amount of admixtures included.
- d. Air content.
- e. Slump.
- f. Time of loading and discharge.
- g. Amount of water put in at batch plant.
- h. Location in the work.
- i. Specification class of concrete.
- j. Date of delivery.

3. If any water is added at the job site, it shall be approved by the Engineer and the delivery ticket noted as to the amount of water added. One copy of each delivery ticket shall be submitted daily to the Engineer.

B. Weather. Do not place concrete during rain or freezing weather unless approved measures are taken to prevent damage to concrete. Concrete placed during periods of dry winds, low humidity, high temperatures, and other conditions causing rapid drying shall be initially cured with a fine fog spray of water applied immediately after finishing and maintained until final curing operations are started. Also under hot weather conditions, steps shall be taken to reduce concrete temperatures and water evaporation by proper attention to ingredients, production methods, handling, placing, protection, and curing.

1. Preventative measures taken for concrete placement during hot or cold weather shall be approved by the Engineer. There shall be no placing of concrete when ambient temperatures are below 35°F or above 100°F, or when such will be the case within 24 hours of the pour. Any concrete previously placed shall be protected from freezing.

C. Conveying. Do not drop concrete from its point of release at mixer, hopper, tremies, or conveyances more than 6 feet, nor through reinforcing bars in a manner that causes segregation. Provide form windows, tremies, elephant trunks, and equivalent devices as required. The use of chutes for conveying or depositing concrete is not allowed except for small isolated portions of the work and only with prior approval. Deposit concrete directly into conveyances and from conveyances to final points of repose. Deposit concrete so that the surface is kept level throughout, a minimum being permitted to flow from one portion to another.

D. Placing Concrete. Concrete shall be placed and compacted within 90 minutes after water is first added to the mix, and no concrete shall be placed after there is evidence of initial set. This placing time shall be reduced to 45 minutes when the temperature of the concrete is 85°F or above. Retempering of concrete is not allowed.

1. Horizontal Construction Joints. Horizontal surfaces of previously placed and hardened concrete shall be wet and covered with a 6 inch thick layer of concrete of the design mix with 50% of coarse aggregate omitted just before balance of concrete is placed.
2. Lifts. Pour concrete into forms immediately after mixing in a manner that will prevent separation of ingredients. Except as interrupted by joints, all formed concrete shall be placed in continuous, approximately horizontal layers, the depths of which generally shall not exceed 18 inches.
 - a. Walls. Pour walls of water-containing structures, including tank exterior walls, as one continuous operation from footing to top of wall between indicated construction joints at the specified pour rate.

Each section of wall shall be in place at least seven (7) days before the adjoining wall section is cast. Shear walls and columns within tanks and other walls may have horizontal construction joints at approved locations.

- b. Slabs. Pour slabs as one continuous operation between indicated or approved construction joints. Cure in-place slabs not less than seven (7) days prior to pouring alternate slabs. Then continue to cure until required curing time is attained.
 - c. Beams and Slabs. Pouring of all beams and slabs must be continuous and monolithic with the floor system where so shown on the Drawings. At least two (2) hours must elapse after depositing concrete in walls or columns before pouring beams, etc. supported thereon.
3. Pumping Concrete. No increase in the specified slumps will be allowed and required water/cement ratios shall be maintained for concrete pumping. Aluminum tubes are not acceptable for conveying concrete. Equipment shall be capable of maintaining the specified pour rates. Conform with requirements of ACI 304.2R-96, except as more stringent requirements are specified herein. Minimum conduit (tube) diameter shall be 4 inches.
4. Pour Rates.
- a. Vertical Elements. Place concrete in lifts as specified at a rate that does not overstress forms nor allows the top of a lift to begin to harden before the next lift is placed. Cold joints are not acceptable.
 - b. Slabs. Place concrete at a rate that ensures all deposits are joined to concrete that is still plastic and within 10 minutes of the previous pour. Concrete adjoining alternate slabs shall not be placed until the adjoining concrete has cured as required elsewhere in this specification for at least seven days unless otherwise approved by the Engineer.
5. Field Tests. During the progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with the standards of quality specified herein. These tests will be made in accordance with ASTM C31 and ASTM C39.

Each test will consist of a minimum of four cylinders, and the Owner, at his discretion, may take such tests as frequently as necessary to prove the quality of the concrete. In no case shall less than one test be made of each day's pour or of each 50 yards of concrete. The Contractor shall furnish the concrete for such tests but the remaining testing expense will be borne by the Owner. Specimens will be cured under job conditions.

For all concrete, the standard age of test will be 28 days, but the 7-day test may be used provided that the relation between the 7 and 28 strengths of the concrete is established by tests for the materials and proportions used.

Slump tests will be in accordance with ASTM C143.

Enforcement of Strength Requirement. Concrete is expected to reach a higher compressive strength than that indicated as minimum compressive strength. At least the specified minimum cement shall be used, and more cement shall be used, if necessary,

to meet all minimum and maximum requirements shown in the table. Failure to meet these conditions shall be considered failure of the concrete.

One test shall consist of the results of testing three (3) standard specimens in accordance with ASTM C31 and C39, except that if one specimen in a test shows manifest evidence of improper sampling, molding, or testing, it shall be discarded and the remaining two strengths averaged. Should more than one specimen presenting a given test show defects due to improper sampling, molding, or testing, the entire test shall be discarded.

If the concrete fails to meet the specifications in the preceding paragraph, the Owner shall have the right to ask for additional curing of the affected portion followed by cores taken in accordance with ASTM C42 all at the Contractor's expense. If the additional curing does not bring the average of three cores taken in the affected area to at least the strength specified, the Owner may require strengthening of the affected portions of the structures by means of additional concrete or steel, or he may require replacement of these affected portions, all at the Contractor's expense. Core tests for below-strength concrete shall be paid for by the Contractor even though such core tests indicate the concrete has obtained the required minimum compressive strength.

E. **Compaction.** Effective compaction shall be obtained by vibration, agitation, spading, and rodding until the concrete is free from voids, air bubbles, or rock pockets. Vibrators shall not be used to transport concrete within the forms. No less than one spare vibrator for each two vibrators in use on a pour, each in good working condition shall be kept on the job during pours. One experienced workman shall be assigned to the operation of each vibrator as his only duty. Operations not deemed to be satisfactory by the Owner shall be immediately corrected.

1. **Vibration.** All concrete, with the exception of concrete slabs 4 inches or less in depth, shall be compacted with high frequency, internal mechanical vibrating equipment supplemented by hand spading and tamping. Concrete slabs 4 inches or less in depth shall be consolidated by wood or metal grid tampers, spading and settling with a heavy leveling straight edge. Carefully vibrate concrete around waterstops and ensure the waterstops are not bent or damaged.
 - a. **Vibrators.** Vibrators shall be designed to operate with vibratory element submerged in the concrete, and shall have a frequency of not less than 7,000 impulses per minute when submerged. The vibrating equipment shall be adequate at all times in number of units and power of each unit to consolidate the concrete to the maximum practicable density so that it is free from air pockets, honeycomb, entrapped air and so it closes snugly against all surfaces of forms and embedded items.
 - b. **Operation of Vibrators.** Do not allow vibrators to contact forms or reinforcing. In vibrating a freshly placed layer of concrete, the vibrator shall be inserted vertically through the preceding layers that are still completely plastic and slowly withdrawn, producing the maximum obtainable density in the concrete without creating voids. Under no circumstances shall the vibrator enter or disturb concrete that has stiffened or partially set. The interval of vibrator placing shall not exceed two-thirds the effective visible vibration diameter of the submerged vibrator. Avoid excessive vibration that causes concrete segregation or causes an inordinate amount of entrained air to move to the face of the forms, which shall be causes for rejection of the concrete pour.
 - c. **Re-Vibration of Retarded Concrete.** Concrete containing retarding admixture for structural walls and columns shall be placed by a schedule that allows each layer

of concrete to be in place and compacted for at least 30 minutes before the next layer of concrete is placed. Bleed water on the surface of the concrete shall be removed before additional concrete is placed and the concrete in place re-vibrated before the next lift is placed. At tops of walls and columns concrete containing excess water or fine aggregate caused by vibration shall be removed while plastic, and the space filled with compacted concrete of the correct proportions, vibrated in place.

F. Slabs. Set screeds at maximum 8 foot centers, as approved, and verify correct elevations with instrument level, and consideration for any camber in the form. Compact and tamp concrete to bring 3/8 inch mortar to surface, and wood float to straightedges and screeds. Make finished surfaces level or sloped as detailed, with maximum deviation of 1/4 inch from 10 feet straightedge for exposed finishes, and there shall be no low spots to impound water. Do not use steel or plastic floats of any kind of initial floating operations. Unless otherwise specified, do not apply hereinafter specified finishes until surface water disappears and surface is sufficiently hardened. Remove all bleed water and laitance as it appears.

G. Tolerances.

1. Forms, sleeves, and inserts shall be set, and concrete shall be cast, to the lines and grades indicated on the plans and as detailed in these specifications. The maximum deviation from true line and grade shall not exceed the tolerances listed in the following table.

Item	_____	Maximum Tolerance
Sleeves and inserts		+1/8 inch -1/8 inch
Projected ends of anchor bolts		+1/4 inch -0.0 inch
Anchor bolt setting		+1/16 inch -1/16 inch

2. Formed surface tolerances for concrete shall meet requirements for ACI surface classes as follows, unless otherwise specified herein or in the Special Provisions.

Class "A".	Exposed interior and exterior concrete to be coated or painted. Abrupt irregularities must meet a modified requirement of 1/16 inch maximum.*
Class "B".	Coarse textured concrete intended to receive plaster, stucco or wainscoting.
Class "C".	Exposed interior and exterior concrete not requiring coating or painting.
Class "D".	Permanently concealed surfaces below permanent ground level or operating water surface.

Permitted Irregularities in Formed Surfaces

Checked with a 5-foot Template.

Type of Irregularity	ACI Surface Tolerance Class of Surface			
	A	B	C	D
Gradual	1/8 inch	1/4 inch	2 inch	1 inch
Abrupt	*1/16 inch	1/4 inch	1/4 inch	1 inch

3. Deviation in alignment of slabs or walls shall not exceed a rate of 1/8 inch in 10 feet within the tolerances specified.
4. Slabs shall be uniformly sloped to drain.
5. Regardless of the tolerances listed herein, it shall be the responsibility of the Contractor to limit deviations in line and grade to tolerances which will permit proper installation and operation of mechanical equipment and piping.

3.05 CURING FORMED CONCRETE. Maintain forms containing concrete in a thoroughly wet condition until forms are removed. Maintain all concrete in a continuously moist condition for not less than 7 consecutive days after pouring (14 days on projects subject to Federal Wage Determination). Keep concrete moist with fine fog spray until protected by curing materials. Use water curing method, specified liquid membrane-forming compound, or concrete curing paper or mats, all subject to approval for each specific use. Vertical surfaces shall not be cured by sprinkling method unless specifically approved by the Engineer.

3.06 PLACING GROUT.

- A. Grout all steel bearing plates, columns, and other structural parts set to hardened concrete using nonshrink grout. Use an approved premixed grout, adding only water in the amount recommended by the manufacturer.
- B. Generally, use driest practicable mix and pack into place so no voids remain between steel and the supporting concrete.
- C. When necessary, use sufficient water to produce a flowable mixture, and pour, first forming sand dams to retain the grout until partially set. When sufficient set is attained, remove dams and pack grout to refusal on all four sides, to eliminate voids; fill any resulting edge voids with drier mix.
- D. In all locations where the surface of the grout will be exposed to view or in an area of high humidity, nonshrink grout shall be recessed to approximately one-half inch back of the exposed surface and the recessed area filled with cement mortar grout.

3.07 ANCHORS, SLEEVES, STAIR NOSINGS, ETC.

- A. Install in forms, in accordance with layout information provided by their suppliers, all necessary anchors, anchorage inserts, sleeves, slots, etc., required for fastening or passing the work of other Sections; also all such surface items as edge angles, manhole frames and other castings, trench cover frames or gratings, access panels, expansion joint covers, stair nosings, etc., having anchorage features requiring that they be installed before concrete is placed.

B. All such items shall be accurately located, carefully plumbed and leveled, securely fastened in place so that alignment and level will not be disturbed during concreting, and protected from damage until concreting is completed.

C. Provide all openings and chases in concrete, shown on the Drawings or as otherwise required.

3.08 EQUIPMENT BASES. Provide all concrete bases or foundations shown for equipment or fixtures included in other Sections of the work unless the Drawings or Specifications indicate that bases are to be furnished as part of the equipment.

A. Material. In general, use 3,000 psi concrete as required by Article 1.04, unless otherwise specified on the Drawing.

B. Installation of Nuts and Bolts. Work from approved setting Drawings. Use steel or plywood templates and apply nuts above and below, to hold bolts in vertical position. During the course of the placement of any concrete, the Contractor shall have sufficient personnel, of whatever skill or trade required, available to check the location of all embedded anchor bolts, edge angles for grating, or any other item which may be deemed appropriate by the Engineer. This check shall be made immediately after the work has progressed to a point such that the item shall not be subject to disturbance and prior to the concrete having obtained sufficient set such that adjustment of the items, if necessary, cannot be made with unacceptable damage to the concrete. If the operation is such that repeated checks are required, they shall be made.

C. Size. Generally, the size indications and dimensions of bases shown on Drawings are approximate. The actual size, in all cases, shall be determined from the equipment furnished. Work from approved equipment supplier's drawings.

3.09 FINISHING FORMED CONCRETE.

A. Within 5 days following the removal of forms, the following finishing operations shall be performed. No other finishing operations are required for permanently concealed concrete (i.e., concrete below permanent ground surface or operating water level). When specifically approved by the Engineer, finishing of concrete may be performed by units, (i.e. a complete wall, a complete structure, etc.), in which case 10% minimum concrete payment shall be retained for the finishing operation.

Finishing operations to be performed:

1. Remove projections and offsets.
2. Saturate form tie holes with water and fill voids with mortar of same mix as concrete (less coarse aggregate), cure and dry; white bonding glue manufactured for this purpose may be added to the mix in accordance with the manufacturer's instructions.
3. Patch all damaged areas due to spalling, voids, rock pockets and bleeding of cement (generally caused by form leaks) with mortar over a concrete adhesive bonding agent manufactured for this purpose and applied in accordance with the manufacturer's instructions. Cut out all rock pockets to sound concrete, edges square to the surface and back beveled, and patch with tempered mortar applied over an approved epoxy concrete adhesive. Large areas (as determined by the Engineer), and all other damaged areas over 1/2 inch in depth shall be repaired similarly. Other damaged areas less than 1/2 inch in depth shall be similarly repaired, but an approved white concrete bonding agent may be used in place of epoxy concrete adhesive.

4. Finish patches flush with adjoining surfaces and cure the same as the original concrete.

Attention is directed to the need for properly curing the repair patches, and for utilizing the proper bonding agent for a given situation (i.e., below operating water level). Information regarding the manufacturer's recommended use shall be furnished to the Engineer for his evaluation.

Pursuant to the specifications, all concrete must be cured for seven (7) days after pouring or patching, including sacked concrete, except concrete sacked after 7 days following pouring or patching needs no further curing.

5. Small air holes may be considered those which would be covered over by sacking, and need not be repaired on external walls being waterproofed or other areas not required to be sacked under the specifications. Air holes larger than this shall be considered voids.

Minor cement paste leaks are those not exposing aggregate and which can be covered over by sacking, and should be treated similarly to small air holes. Anything larger shall be considered a rock pocket or a bleed hole, depending upon the condition. Some small bleed holes may, at the discretion of the Engineer, not need to be chipped out, but may be merely sandblasted to sound concrete prior to patching.

B. All exposed interior and exterior formed concrete (i.e., concrete not permanently concealed from direct visible exposure under facility operating conditions, including gallery and equipment room walls and ceilings), and all concrete to be coated in the finished structure shall, in addition to the foregoing, be Brush-Off Blast Cleaned (SSPC-SP7-63) to open all paste and air holes and to remove curing compound and dust. It shall then be rubbed with cement of consistent color and burlap and/or with brick and water to eliminate pockets and produce reasonable smooth surfaces suitable for painting. A reasonable smooth surface shall be defined as a surface with no projections or form marks greater than 1/16 of an inch and no indentations after finishing. Chamfers and fillets shall be made straight and true, and uniform.

Concrete to be temporarily concealed until facility is expanded shall be considered exposed concrete.

- 3.10 FINISHING SLABS AND FLATWORK. As specified above, initially compact, bring 3/8 inch mortar to surface and float surfaces. Finished surfaces shall be "puddle-free" and level or sloped as indicated to above specified maximum deviation limits. Surfaces which are not within these limits shall be removed and replaced at no additional cost to Owner; patching is not acceptable. Keep surface moist with fine fog spray of water to prevent drying during finishing operations and until curing media is applied. Dusting with cement or sand during finishing operations is not permitted.

A. Precautions. Slabs have not been designed for heavy construction loads. Contractor shall repair or replace damaged slabs resulting from his use of heavy equipment or loadings as directed by the Engineer.

B. Rough Slabs. Broom surfaces of slab after initial set of concrete leaving coarse aggregate slightly exposed. Apply on following areas and surfaces:

1. Concrete to receive deferred concrete, grout or mortar.
2. Tops of footings for masonry.

C. Monolithic Trowel Finish. For all floor, slab, and flatwork surfaces not otherwise indicated or specified. After surface water disappears and floated surface is sufficiently hardened, steel trowel and re-trowel to smooth surface. After concrete has set enough to ring trowel, re-trowel to a smooth uniform finish free of trowel marks or other blemishes. Avoid excessive troweling that produces burnished areas.

D. Steel Float Finish. Same as monolithic trowel finish, except omit second re-troweling. Apply on following area and surfaces:

1. Apply on floor slab surfaces in water-bearing structures.
2. Areas scheduled to receive resilient floor coverings.

E. Swirl Non-Slip Finish. Prepare same as steel float finish, then perform final troweling with circular motion and slightly lift trowel to produce uniform swirl (sweat trowel) non-slip finishes matching sample selected by Owner from Contractor-prepared 2-foot square sample panels. Unless otherwise specified, provide uniform coarse texture on exterior walking surfaces.

F. Wood Float Finish. Float to screeds. When ready, finish with wood floats to a uniformly textured surface. Apply on following areas and surfaces:

1. Exterior walking surfaces exceeding 1:10 slope.

G. Floor Hardener Application.

1. Floor hardener shall be applied by dust-on method to all interior exposed concrete floors, and to other specifically designated floors using specified materials and rates of coverage.
2. Prior to application, the Contractor shall consult with the manufacturer's field representative in regard to application of floor hardener under prevailing job conditions.
3. Float and trowel floor hardener into the surface of freshly floated concrete floors shall be in strict accordance with the manufacturer's printed instructions.
4. Cure as work progresses using method conforming to hardener manufacturer's printed directions.

3.11 CURING SLABS AND FLATWORK. Apply curing media as soon as feasible after finishing operations without marring surfaces, and in any case on same day. Keep surfaces moist until curing is applied. Upon approval of liquid compounds, apply in strict accordance with material manufacturer's published application rates; apply two (2) spray coats, second coat sprayed at right angle direction from first coat. Carefully mask and protect adjoining surfaces where compound is used.

A. Curing Period and Protection. Maintain curing materials in proper sealed condition for minimum of 7 days (14 days on projects subject to Federal Wage Determination) after application. Keep traffic on curing surfaces to the minimum possible, and completely off liquid compound cured surfaces. Immediately restore any damaged or defective curing media.

B. Restriction. Do not use liquid membrane-forming curing compound within water-bearing structures, or on surfaces to receive deferred concrete or masonry, or on surfaces to receive fluid-applied protective coatings or waterproofing.

C. Liquid Membrane-Forming Curing Compound. Upon approval, and except as restricted above, use liquid curing compound for all slabs, floors, and flatwork. On slabs having floor hardener treatment, cure such slabs in strict conformance with printed recommendations of floor hardener manufacturer. Other special precautions may be required if concrete is exposed to freezing or otherwise adverse weather conditions during the curing period.

D. Sheet Curing. Use concrete curing sheet material on surfaces where liquid curing is not permitted, and on all joints sealed with pressure sensitive tape; immediately repair any tears during curing period. Verify that surfaces remain damp for full curing period; if necessary or directed, lift sheeting and wet surfaces with clean water, and replace sheeting.

E. Water Curing. Alternate to either liquid curing compound or sheet curing method where approved. Keep concrete continuously wet by ponding, sprinklers, or equivalent for entire curing period.

3.12 FORMED STAIRS AND TREADS. Stair nosings are required on all stairs. Accurately place cast abrasive nosings and screed tread surface flush and level. Cut riser back as indicated. At exterior and wet interior locations, apply coarse textured swirl non-slip abrasive finish on surface of treads and landings. Strip protective tape from the nosings on completion of cement finishing operations.

3.13 CHAMFERS AND FILLETS. Unless otherwise shown on the drawings or directed by the Engineer, exposed edges of formed concrete structure shall be provided with a 45°, 3/4 inch x 3/4 inch chamfer. Where fillets are shown on the drawings, they shall be formed with a 45°, 3/4 inch x 3/4 inch form chamfer, formed with a 3/8 inch radius form, or tooled with a 3/4 inch radius rounding tool. Where project is an expansion of an existing facility, chamfer selected shall be compatible with chamfer of existing facility.

3.14 JOINTS WITH SEALANT. Sandblast joints to clean sound concrete, using oil-free air to provide surfaces free of oil, foreign materials, and moisture. Mix and place primer, and sealant in accordance with manufacturer's printed instructions. Install foam backing in joints so sealant depth is between one-half and two-thirds of joint width. Isolate backing from sealant using a bond breaker such as polyethylene tape, aluminum foil, or wax paper.

A. Manufacturer's Supervision. A technical representative of the sealant manufacturer shall be present at the time sealant operations are started to supervise and approve preparation, sealant mixing, and sealant applications procedures and applicators. The representative shall make frequent visits to the site to ensure that sealant installations conform to the manufacturer's instructions, and shall issue a written report to Owner covering each visit.

B. Crack Sealing. Before and after backfilling of the tanks, all cracks over 0.01 inch wide in concrete surfaces of tanks and other water-containing structures shall be cutout as detailed and the groove filled with backing, primer, and sealant.

C. Joint Sealer. Unless specified otherwise, IGAS type joint sealer shall be used where joint depth is equal to or greater than twice the joint width. Colma type joint sealer shall be used where the depth to width ratio is less than 2:1.

D. Sealant. All sealant shall be placed in strict accordance with the manufacturer's printed specifications by a firm specializing in this type of work for not less than five (5) years, or by the Contractor under direct supervision of the manufacturer's representative.

E. Sealant Locations. All locations where sealant is placed must be cleaned by sandblasting and be free from oil, foreign materials, and moisture. Lower surfaces of joints shall be isolated with a bond breaker such as polyethylene, wax paper, aluminum foil or polyethylene tape.

3.15 INSTALLATION OF PIPELINES THROUGH CONCRETE STRUCTURES.

A. Whenever a pipeline or any material terminates or extends at or through a structural wall or sump, the Contractor shall install in advance of pouring the concrete the fitting or special casting required for the particular installation. Otherwise, prepare and submit shop/erection drawings of other installation methods and obtain approvals in advance of commencement of work.

B. Whenever any run of pipe is installed per approved shop/erection drawings subsequent to placing of concrete, the Contractor shall accurately position the opening in the concrete for such pipelines. Unless otherwise required, all pipes penetrating fluid containing or earth-supporting portions of the structure shall be ring flanged.

1. Opening shall be of sufficient size to permit a perfect final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through wall to insure watertightness around openings so formed.
2. The boxes or cores shall be provided with continuous keyways to hold the filling material in place and to insure a watertight joint.
3. Boxes or cores shall be filled with nonshrink grout or nonshrink concrete.

3.16 FIELD QUALITY CONTROL.

A. Concrete Tests. At Owner's expense, Owner's selected Testing Laboratory shall perform the concrete tests:

1. Compression Tests. Make one set of at least four standard test cylinders from each day's placing and each 150 cubic yards, or fraction thereof, each class of concrete. Date cylinder, number and tab, indicating location in structure from which sample was taken. Indicate slump test result of sample. Do not make more than one set of test cylinders from any one location or batch of concrete.
2. Test Cylinders. Provide for testing by Owner or Testing Laboratory to take test cylinders at the job in accordance with ASTM C31. Test specimens in accordance with ASTM C39 at the age of 7 and 28 days. Contractor shall furnish labor and assistance for casting test cylinders, and shall furnish moist curing cabinets, as required, conforming to ASTM C31 at the site.
3. Core Tests. Should strength of concrete, as indicated by tests, fall below required minimum, then additional tests of concrete which the unsatisfactory samples represent may be required by Owner. Testing Laboratory will make such test in accordance with ASTM C42. Contractor shall fill the holes made by cutting cores with dry pack concrete. Tests for below-strength concrete shall be paid for by the Contractor even though such tests indicate the concrete has obtained the required minimum compressive strength.
4. Air Content. At time that compression test cylinders are cast, test a sample of the same concrete for air content in accordance with ASTM C231.

3.17 WATERTIGHTNESS OF CONCRETE STRUCTURES.

A. All concrete structures designed to contain or convey fluid shall be tested for watertightness by the Contractor by filling with water to levels approximating what will be attained during operation and measuring the drop in level due to leakage, if any. These tests shall be made under the direction of the Owner, and if necessary, the tests shall be repeated until watertightness is insured.

B. Rate of filling shall be limited to minimize shock-effect to new concrete construction. Water shall be held under each condition long enough to satisfy the Owner that the structures are watertight. Structures shall be free of internal or external water leakage.

C. The total loss of water-level in any basin or flume shall not exceed 1/2 inch depth in 24 hours. Leakage shall be located and stopped and the structure again tested until this requirement is met. If the structure does not meet the test, the Contractor shall repair or replace at his own expense, such part of the work as may be necessary to secure the desired results, as approved by the Owner.

D. Regardless of the rate of leakage, there shall be no visible leakage from any concrete structure.

3.18 ALTERATIONS AND REWORK. Existing concrete surfaces to receive new concrete shall be heavily sandblasted to expose coarse aggregate and produce clean coarse textured surface. Such prepared surfaces shall be coated with epoxy bonding compound immediately prior to placing concrete. The compound shall be an approved equivalent to Sika Chemical Company's "Sikastix Adhesive", Hunt Process Company's "HB Series Epoxy Mortar", or equal of type, mix and application in strict accordance with manufacturer's printed recommendations and directions for various conditions.

3.19 QUALITY OF WORK. Concrete work which is found to be in any way defective or out of tolerance may be ordered by the Owner to be removed and replaced. Should this occur, all costs shall be paid by the Contractor.

END OF SECTION

SECTION 03400
PRECAST CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Precast prestressed structural concrete units.
- B. Architectural precast concrete units.

1.2 RELATED SECTIONS

- A. Work Excluded: Cutting of openings in structural concrete units that are less than 12 inches (305 mm) in diameter or rectangular with no dimension greater than 10 inches (254 mm).

1.3 REFERENCES

- A. ACI 301- Specifications for Structural Concrete for Buildings; 1996.
- B. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 1989 (Reapproved 1997).
- C. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary; 1999.
- D. ACI 347R - Guide to Formwork for Concrete; 1994.
- E. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 1997a.
- F. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 1998.
- G. ASTM A 185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement; 1997.
- H. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 1998.
- I. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength; 1997.
- J. ASTM A 416/A 416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete; 1998.
- K. ASTM A 497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement; 1997.

- L. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 1996a.
- M. ASTM A 706/A 706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement; 1998.
- N. ASTM A 767/A 767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement; 1997.
- O. ASTM A 775/A 775M - Standard Specification for Epoxy-Coated Reinforcing Steel Bars; 1997.
- P. ASTM C 33 - Standard Specification for Concrete Aggregates; 1999a.
- Q. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2000.
- R. ASTM C 150 - Standard Specification for Portland Cement; 1999a.
- S. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete; 1998.
- T. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete; 1999a.
- U. AWS D1.1 - Structural Welding Code - Steel; 2000.
- V. AWS D1.4 - Structural Welding Code - Reinforcing Steel; 1998.
- W. CE CRD-C 621 - Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Nonshrink); 1993.
- X. CRSI (DA4) - Manual of Standard Practice; 1997, 26th Edition.
- Y. PCI MNL-116S - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products; 1985, Third Edition.
- Z. PCI MNL-120 - PCI Design Handbook - Precast and Prestressed Concrete; 1999.
- AA. PCI MNL-127 - Recommended Practice for Erection of Precast Concrete; 1985.
- BB. PCI JR-307 - PCI Committee Report - Tolerances for Precast and Prestressed Concrete; PCI Journal, VI. 30, #1, January –February, 1985, and 1993 supplement.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Manufacturer and Installer Qualifications.
- C. Concrete Mix Design: Prior to production of units, submit concrete mix designs to Structural Engineer of Record for review and approval.

- D. Samples: Two samples, 12 inches (305 mm) square, showing actual architectural color and texture, using approved mix design.
- E. Design Calculations: Provide complete calculations demonstrating design of units and connections, prepared under direct supervision of and sealed by Design Engineer, for review and approval of Structural Engineer of Record.
- F. Product Data: Catalog and design data on all inserts, bearing plates, anchors and materials required to manufacture, transport, or erect units.
- G. Shop Drawings: Submit complete plans and details for manufacturing and erecting units, prepared under direct supervision of and sealed by Design Engineer, for review and approval of Structural Engineer of Record.
- H. Erection Plan: Prior to installation, submit for review and approval of Structural Engineer of Record an erection plan, including calculations and details for guying, staying and shoring units for structural stability during construction stage before all permanent structural connections are completed. Show how guying, bracing and shoring would be removed, replaced, and relocated before all permanent structural connections are completed. If during construction, modifications to erection procedures are necessary, revise and resubmit erection plan. Installer remains responsible for all means and methods of erection.
- I. Source Quality Control Test Reports.

1.5 QUALITY ASSURANCE

- A. Structural Engineer of Record: Responsible for overall structural design of structure; no production shall proceed without his approval of unit design calculations, shop drawings, and erection plan.
- B. Design Engineer: Responsible for design of units and their connections; an engineer registered in State of Nevada who has at least five years experience in precast/prestressed concrete design.
- C. Manufacturer Qualifications: Firm certified by Prestressed Concrete Institute Plant Certification Program for five years prior to start of production for full level structural work (C-4), and:
 - 1. Certified for architectural precast concrete (A-1).
 - 2. Able to show evidence of an in-house engineering department managed by a registered professional engineer.
 - 3. Capable of producing such quantities as to assure continuity of delivery and erection.
 - 4. Having available storage space for all units not yet installed (no on-site storage is available).
- D. Installer Qualifications: Manufacturer, or other firm acceptable to manufacturer who has been regularly engaged for at least 5 years in erection of precast units similar to those required for this project.
- E. Welder Qualifications: Certified in accordance with AWS D1.1 or D1.4 as applicable.

- F. Mock-Up: Build 48 by 48 inch (1220 by 1220 mm) mock-up at production facility, using color and texture from approved small size sample, for review and approval by Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Lift and support units during manufacturing, yard handling, and installation only at lifting or supporting points or both, as shown on shop drawings, and using appropriate lifting devices.
- B. Store units in a manner to prevent cracking, distortion, warping, staining, or other physical damage.
- C. Deliver units to project site in such quantities and at such times to assure continuous operations.
- D. Transport units with proper equipment and methods and with qualified personnel.
- E. Use all means necessary to protect materials before, during and after installation and also protect work of others.

1.7 PROJECT CONDITIONS

- A. After installation, do not allow temporary storage of materials on precast units to exceed total design load of that unit or of that portion of unit loaded by stored materials.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. All precast concrete shall be supplied by a single manufacturer.
- B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 SCOPE

- A. Precast Concrete: Provide all units shown in Contract Documents and as needed for a complete and proper installation.
 - 1. Provide units of dimensions indicated to fit cast-in-place supports, straight and without warp, bow, or camber unless so specified.
 - 2. Include cutting or casting of openings indicated in Contract Documents that are 12 inches (305 mm) or more in diameter and rectangular openings 10 inches (254 mm) or more in any dimension.
 - 3. Include openings in Tee stems and beam webs for electrical conduits, as shown in Contract Documents.
 - 4. Other openings will be located and drilled or cut by installer requiring them after precast erection, after approval by precast manufacturer.
- B. Structural Concrete Columns, Walls, Stairs, and Spandrel Beams:

1. Strength of Concrete: 5000 psi (34.5 MPa).
 2. Water-Cement Ratio: 0.45 plus 0.00 or minus 0.05.
 3. Air Content: 5 percent plus/minus 1-1/2 percent.
- C. Structural Concrete Double Tees and Beams:
1. Strength of Concrete: 6000 psi (41.4 MPa).
 2. Water-Cement Ratio: 0.4 plus 0.00 or minus 0.05.
 3. Air Content: 5 percent plus/minus 1-1/2 percent.
- D. Architectural Concrete Wall Panels, Column Covers, Copings, Sills, and Sunscreen Fins:
1. Strength of Concrete: 5000 psi (34.5 MPa).
 2. Air Content: 4 to 6 percent.
- E. Finishes:
1. Formed Non-Architectural Surfaces: Smooth form finish free from honeycomb. Fill all air pockets and holes over 1/4 inch (6 mm) in diameter with approved sand-cement paste. Grind smooth all fins and all form offsets over 1/8 inch (3 mm).
 2. Formed Architectural Surfaces: To match Architect's sample, available for viewing at Architect's office.
 3. Unformed Faces of Columns: Hard steel trowel finish.
 4. Top Surface of Double Tees: Broom finish parallel with length of tee.

2.3 DESIGN CRITERIA

- A. Design units in accordance with:
1. _____ building code.
 2. ACI 301, 304, 318, and 347.
 3. CRSI Manual of Standard Practice.
 4. PCI MNL-116.
- B. Design shown in Contract Documents, including any calculations furnished for information by Structural Engineer of Record, and system analysis results, specified forces, component dimensions and connection configurations, is considered satisfactory for development of final unit designs.
1. Consideration has been made for customary stresses incurred in factory precasting, transporting and erecting, however, since plant and erection practices vary, manufacturer is responsible for ensuring that final unit design, manufacturing, transportation and erection process is compatible with Contract Documents requirements or for providing alternate designs that meet these requirements, subject to review and approval of Structural Engineer of Record.
 2. Provide all design required for conditions not shown in Contract Documents and submit calculations for those designs as specified in SUBMITTALS.
- C. Design ledges, haunches, bearing areas, and connections as recommended in PCI MNL-120 "PCI Design Handbook", Part 6, with additional load factor of 1.3 applied to structurally critical connections, which include but are not limited to haunches, dapped end bearings and connections without redundant means of load transfer.
- D. Provide at least minimum reinforcing specified in ACI 318. Include in analysis of prestressed components a check of shear reinforcing requirements at 0.1L, 0.2L, 0.25L and 0.3L, where L is component length.

- E. Submit all proposed modifications to Contract Documents to Structural Engineer of Record. Provide complete design calculations and drawings, prepared and signed by Design Engineer. No alternate design not so specifically submitted for approval will be considered approved even if it is included on shop drawings that are approved.

2.4 CONCRETE MATERIALS

- A. Concrete: Establish concrete mix design by methods specified in ACI 318, Chapter 5, using standard deviation calculation in accordance with section 5.3.1.1 or 5.3.1.2.
 - 1. Comply with criteria specified under APPLICATIONS.
 - 2. Batching Concrete: Provide concrete batching plant complying with ASTM C 94/C 94M and certified by National Ready Mixed Concrete Association. Volumetric batching of concrete is prohibited.
 - 3. Make all measurements by weight, accurate within most recent tolerance limits of ASTM C 94/C 94M.
 - 4. Provide concrete having temperature at time of placement not more than 85 degrees F (29 degrees C); protect from temperature variations after placement in forms.
 - 5. Use of calcium chloride or admixtures containing chloride ions or other salts is prohibited, except in architectural concrete where maximum of 0.1 percent is allowed.
- B. Cement: ASTM C 150 Portland cement.
 - 1. For Exposed Architectural Concrete Facing Mix: Type I or III, white cement.
- C. Aggregates: ASTM C 33.
- D. Admixtures:
 - 1. Air-Entraining: ASTM C 260.
 - 2. Water-Reducing, Retarding, Accelerating: ASTM C 494/C 494M, type as required.
 - 3. Pigments: Nonfading lime resistant.

2.5 REINFORCEMENT AND CONNECTION MATERIALS

- A. General: Provide all reinforcement, accessory and connection materials required.
 - 1. Provide all bearing pads, base plates, inserts, clamps, nuts, bolts, storage, protection and other necessary appurtenances and connections required.
 - 2. Provide anchor bolts, plates, sleeves and other hardware items for connections between cast-in-place concrete and precast units.
 - 3. Allow adequate tolerances for placement of connection items.
 - 4. Furnish items that must be installed by others to site in time for timely installation.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; except:
 - 1. Reinforcing Used to Fabricate Embedded Parts or Connections by Welding: ASTM A 706/A 706M.
 - 2. Epoxy Coated Bars: ASTM A 775/A 775M; where indicated.
 - 3. Galvanized Bars: ASTM A 767/A 767; where indicated.
- C. Welded Anchor Studs: AWS D1.1.
- D. Prestressing Strand (Tendons): ASTM A 416/A 416M.

1. Load-Bearing Units: Grade 270, 270,000 psi (1860 MPa) minimum ultimate strength, 7 wire, low relaxation; to protect against corrosion, coat exposed ends of strands in prestressed members with leak proof liquid roof coating.
 2. Architectural Units: Grade 250, 7 wire, stress relieved.
- E. Welded Wire Fabric: ASTM A 185 or ASTM A 497.
- F. Reinforcing Wire: ASTM A 82.
- G. Supports for Reinforcement at Surfaces Exposed to View: CRSI Class 1, plastic protected legs.
- H. Supports for Reinforcement at Surfaces Exposed to View: CRSI Class 2, stainless steel protected legs.
- I. Connection Materials:
1. Anchor Bolts: ASTM A 307, minimum.
 2. Plates: ASTM A 283/A 283M, Grade C.
 3. Shapes: ASTM A 36/A 36M.
 4. Stainless Steel: AISI Type 304; no finish required; provide where indicated.
 5. Provide galvanized components where exposed, to ASTM A 153/A 153M.
 6. Prime paint other components.
- J. Bearing Pads: One of following:
1. MASTICORD as manufactured by JVI Inc., or FIBERLAST as manufactured by Voss Engineering, Inc. unless otherwise noted.
 2. Laminated Fabric-Rubber Pads: Preformed, unused synthetic fibers and new unvulcanized rubber; surface hardness of 80 Shore A durometer plus/minus 10 percent; Sorbtex, Fabreka, or approved equal.
 3. Expansion Bearing Pads: Assemblies consisting of lower and upper components.
 - a. Upper Component: Stainless steel support plate and sheet of stainless, 14 gage minimum, with minimum 2B mill finish; larger than lower component by at least 1/2 inch (12 mm) in each direction.
 - b. Lower Component: MASTICORD or FIBERLAST bearing pad, a stainless steel support plate and a bonded contact layer of PTFE (Teflon).
- K. Mechanical Splices for Future Expansion Column and Wall Reinforcing Anchorage: NMB Splice Sleeve.
- L. Double Tee Flange-to-Flange Shear Connectors: Dayton/Superior P-11 or approved equal.
- M. Rod Anchor Bars: Dayton/Superior High Strength Coil Rod, or approved equal.
- N. Grout: Non-metallic shrinkage resistant grout, CE CRD-C 621.
- O. Grout: Metallic shrinkage resistant grout.
- P. Grout: Portland cement sand grout; ASTM C 150 Type I cement and ASTM C 404 sand.

2.6 FABRICATION

- A. Cast units in metal or other approved surfaces that achieve specified finishes, straight and without warp, in true alignment, watertight and of such rigidity as to guarantee sectional dimensions as specified in PCI MNL-116.
 - 1. Manufacturing Tolerances: In accordance with PCI MNL-116, except for double tee lengths: plus 1/4 inch (6 mm) and minus 3/4 inch (19 mm).
 - 2. Clean forms between each casting.
 - 3. Use non-oil-based parting compound to ensure no discoloration and keep surface imperfections to minimum.
- B. Furnish and cast in all inserts shown in Contract Documents and as required.
 - 1. Provide all lift loops and erection inserts with 1-1/2 inches (38 mm) minimum concrete or grout cover.
 - 2. Locate lift loops and erection inserts so they are not objectionable in completed structure. Recess inserts that must be located in areas that will be exposed to view in completed construction and patch with minimum of 1-1/2 inches (38 mm) of non-shrink, non-staining grout to match surrounding concrete, or cover and protect them in an approved manner.
- C. Welding: Weld reinforcing steel in accordance with AWS D1.4.
 - 1. Use proper pre-heat for welding high strength steels, as specified by AWS procedures for ambient temperature.
 - 2. Welding processes shall not reduce cross-sectional area of concrete reinforcement.
- D. After stripping, keep surfaces of units damp and at minimum temperature of 50 degrees F (10 degrees C) and protect units from exposure to weather until strength of structural concrete has reached at least 3500 psi (24 MPa).
 - 1. Do not ship units to site until strength of concrete has reached 85 percent of specified compressive strength or until unit can safely support superimposed dead load of other precast units, whichever is greater.
- E. Finish formed and unformed surfaces of units as specified under APPLICATIONS.
 - 1. Make finishes in accordance with PCI MNL-116.
 - 2. Accomplish patching, where required, in such a manner that structural integrity is restored and appearance and durability are not impaired, using skilled mechanics.
- F. Mark each piece with identifying designation and date of casting; place marks so they are not objectionable in completed work.

2.7 SOURCE QUALITY CONTROL

- A. Fabricate units in accordance with ACI 318 and PCI MNL-116; perform casting in a covered production facility.
- B. Permit access of Owner, Structural Engineer of Record, and Owner's representatives to all part of manufacturing facility.
- C. Keep plant quality control records and inspection procedures for this project available for independent review, verification and in-plant inspection by an independent testing agent, and Structural Engineer of Record.

- D. Owner will arrange and pay for production testing by independent testing agency; manufacturer shall arrange and pay for testing necessary to qualify design mixes in accordance with:
 - 1. PCI MNL-116, Manual For Quality Control For Plants and Production of Precast Prestressed Concrete Products.
 - 2. PCI MNL-120, PCI Design Handbook.
 - 3. ACI 318, Building Code Requirements for Reinforced Concrete.

- E. Perform and pay for testing complying with PCI Plant Certification requirements, by an independent testing agency; use certified test equipment, and unless otherwise specified, comply with:
 - 1. PCI MNL-116, Manual For Quality Control For Plants and Production of Precast Prestressed Concrete Products.
 - 2. PCI MNL-120, PCI Design Handbook.
 - 3. ACI 318, Building Code Requirements for Reinforced Concrete.

- F. Design Mix Testing: Test to show compliance with specifications.
 - 1. Analysis and testing of all aggregates to be used.
 - 2. Test concrete mix designs to show ability to produce specified strength using aggregates as delivered.
 - 3. No concrete shall be placed until materials and concrete mixtures are shown to comply with specifications, including 28 day compressive strengths.

- G. Production Testing: Keep daily reports on file and available for inspection; submit copies at end of each 28 day concrete cycle.
 - 1. Continuous daily supervision of mixing, placing, air content control and slump testing of all concrete.
 - 2. Daily inspection and checking of operations at concrete batching plant.
 - 3. Daily inspection of fabrication, transportation, storage and compression testing of test cylinders taken from concrete actually placed in work.
 - 4. Daily inspection of form work and placement of reinforcing.

- H. Do not change source or supply of aggregate or cement during course of project without prior notice to Structural Engineer of Record; provide new design mix tests using material from new source at manufacturer's expense.

- I. Make at least six cylinders per casting bed for each casting. Make and test two cylinders for judging stress transfer strength from concrete placed during later half of each bed casting. Test two more cylinders to show 28 day strength, or strength at an earlier age if specified, and hold two in reserve.

- J. Tag or stamp each piece with Quality Control Certificate attesting that unit complies with specifications, tolerances, and finishes.

PART 3 EXECUTION

3.1 INSPECTION

- A. Inspect substrates to receive precast concrete work.

1. Verify that bearing surfaces on field placed bearing walls and footings are true and level and within plus/minus 1/2 inch (12 mm) of design elevation unless otherwise indicated in Contract Documents.
 2. Verify accurate placement and alignment of anchor bolts, plates, or dowels in column footings, beams, wall footings and other field placed supporting elements.
- B. Report deficiencies which make substrates unsuitable to receive units to Architect.
- C. Verify availability of access to site and firm level surfaces for hauling and erection equipment to operate under their own power on stabilized grade.

3.2 PREPARATION

- A. Install temporary shoring and bracing complying with manufacturer's erection plan.

3.3 INSTALLATION

- A. Erect in accordance with Precast/Prestressed Concrete Institute Field Certification Program.
- B. Install units using suitable lifting devices at points provided by manufacturer.
- C. Install and secure in position as indicated in Contract Documents, shop drawings, and erection plan.
 1. Align and level units as shown on shop drawings; minimize variations between adjacent units by jacking, loading or any other feasible method as recommended by manufacturer and acceptable to Structural Engineer of Record.
 2. Erection Tolerances: Comply with PCI MNL-127.
- D. Perform field welding by certified welders using equipment and materials compatible with base metal.
- E. Submit project record documents prior to Substantial Completion, showing all revisions and modifications made during fabrication and erection.

3.4 CLEANING AND PROTECTION

- A. At completion of work, and at such other times as directed by Architect, remove of surplus materials, rubbish and apparatus from project site.
- B. Protect installed products until completion of project.
- C. Touch-up, repair or replace damaged products and finishes before Substantial Completion.

END OF SECTION

SECTION 03470

PRECAST CONCRETE VAULTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies the concrete work and appurtenances required for precast concrete vaults. Vaults shall be constructed of reinforced concrete sections and shall conform to the minimum dimensions shown on the Plans. Cast-in-place vaults will be considered acceptable only after approval is granted by the ENGINEER.

1.02 SUBMITTALS

- A. The CONTRACTOR shall submit to ENGINEER 4 sets of shop drawings showing size and placement of reinforcing steel, wall opening locations, etc., and structural calculations for the vault design sealed by a licensed Civil Engineer.
- B. The CONTRACTOR shall submit shop drawings of the proposed structure for review prior to construction. Drawings must provide information for complete review including dimensions, reinforcement design calculations and layout, etc.

PART 2 PRODUCTS

2.01 MATERIALS

A. Precast Concrete Sections

1. Precast sections shall be cast in a yard specializing in precast concrete materials.
2. All vaults shall be inspected during casting by an independent, certified testing laboratory, approved by the ENGINEER, to establish the strength of the concrete and the adequacy of curing, to certify the date the vaults were cast, and to confirm that the steel has been properly placed. This testing shall be performed by the laboratory at the CONTRACTOR's manufacturing plant, prior to shipment.
3. At least three cylinders shall be taken each day that vaults are cast, with batch samples to be designated by the laboratory representative. At least one set of cylinders shall be taken for each nine cubic yards of concrete used in the construction of the precast vaults. These samples shall be tested for strength. If the samples fail to meet minimum concrete strength requirements set forth in the Specifications, all vault sections manufactured from the concrete from which the cylinders were made will be considered rejected.
4. In addition, the OWNER reserves the right to core vaults either at the site or point of delivery to validate strength of concrete and placement of steel. If cores fail to demonstrate the required strength or indicate incorrect placement of reinforcing steel, all sections not previously tested will be considered rejected until sufficient additional cores

are tested, at the CONTRACTOR's expense, to substantiate conformance to these requirements.

B. Concrete

1. All concrete used in the construction of vaults shall be capable of obtaining a 28-day compressive strength of 4,000 psi.

C. Curing

1. All concrete shall be cured in accordance with any one of the methods specified in ASTM 478. The facilities for curing shall, however, be subject to the review and prior approval of the ENGINEER. No precast concrete shall be delivered to the job site until the specified minimum compressive strength of 4,000 psi, as determined by crushing tests on cured concrete cylinders, has been obtained.

D. Access Opening

1. The access opening shall be equipped with double leaf adjustable torsion spring assisted door as shown on the Plans.

E. Access Doors

1. Access door and frame shall be 1/4-inch steel diamond pattern. Door shall be equipped with heavy forged brass hinges, stainless steel pins, spring operators for easy operation and an automatic hold open arm with release handle. A snap lock with removable handle shall be provided. Cast in portion of frame shall be coated with bituminous paint prior to casting into concrete. Where double leaf doors are required, a safety chain shall be installed on the doors.

F. Joint Sealing Compound

1. Precast sections shall be jointed with a preformed joint sealing compound, "Ram-Nek", manufactured by K. T. Snyder Company, Inc., Houston, Texas, "Quikset" manufactured by Quikset Utility Vaults, Santa Ana, California, or equal, applied in accordance with the manufacturer's instructions.

PART 3 EXECUTION

3.01 INSTALLATION

A. Transportation and Delivery

1. Every precaution shall be taken to prevent injury to the precast sections during the transportation and unloading of the sections. The precast sections shall be unloaded using skids, pipe hooks, rope slings, or suitable power equipment, if necessary and the sections shall be under perfect control at all times. Under no conditions shall the precast sections be dropped, dumped or dragged.

2. If any precast section is damaged in the process of transportation, or handling, such section shall be rejected and immediately removed from the site and replaced at the CONTRACTOR's expense.

B. Excavation and Backfill

1. Excavation and backfill shall be done in accordance with the provisions of Section 02200 of these specifications and the Plans.

C. Joint Sealing Compound

1. The sealing compound shall be applied as follows:
2. The joint shall be cleaned with a brush.
3. The Silicon treated protective paper shall be removed from one side of the preformed rope and preformed rope shall be laid paper side up on the cleaned joint surface. The surface shall be pressed firmly end-to-end around the entire joint making 1-inch laps where necessary.
4. The protective paper shall be removed from the preformed rope and the next section shall be lowered into place.
5. Sufficient preformed joint sealing compound shall be installed so as to completely fill the joint and show a "squeeze-out" on the inside and outside of the joint.

D. Pipe and Fittings

1. All pipe and fittings, including installation shall conform to the provisions of the specifications of the designated pipe and fittings.

E. Pipe Penetrations

1. The pipe penetrations shall incorporate Link Seal assemblies, Model C LS 575 with WS-18-375 Steel Sleeve as per the Plans.

F. Elevation and Installation

1. Each section shall be set perfectly plumb. Riser sections of various heights shall be used in order to bring the top of the vault access opening to the required elevation.
2. The elevations at which access openings are to be set shall conform to the requirements set forth on the Plans, but in all cases shall be governed by the ENGINEER in the field. Where the access opening is within the roadway or shoulder, it is to be placed flush with the existing surface. Where the structure is outside the limits of the traveled shoulder, but not in roadside ditch, it should be placed 1/10 foot or more above the existing ground surface. Where the access opening falls within the existing roadside ditch or right of way, it is to be placed approximately 1-1/2 feet above the existing ground surface or as directed by the ENGINEER.

G. Concrete Finish

- a. Concrete walls, roof and floor shall have surface defects repaired and have a minimum rough form finish as specified in the ACI (American Concrete Institute) Manual of Concrete Practice Section 301, Chapters 9 and 10.

H. Cleaning

1. Vaults walls, floor and ceiling shall be cleaned of any foreign debris, including forms, tape, form oil, etc., prior to final acceptance. All vaults shall be thoroughly cleaned of any accumulation of silt, debris, or foreign matter of any kind.
2. Access openings shall be cleaned of foreign matter to insure a satisfactory fit and appearance prior to final acceptance.

I. Testing

1. It is the intent of the Plans and Specifications that vaults be as watertight and free from infiltration as possible. Any evidence of leakage throughout the warranty period shall be repaired to the satisfaction of the OWNER at the sole expense of the CONTRACTOR.

END OF SECTION