



TECHNICAL SPECIFICATIONS

STRUCTURAL

ACA I, ACA II, BOY'S DORMITORY

Project : **CONSULTANCY FOR THE REHABILITATION OF SCHOOL BUILDINGS
(ACA I, ACA II, AND DORMITORY BUILDING I)**

Client : **PHILIPPINE SCIENCE HIGH SCHOOL**

Location : **GOA, CAMARINES SUR**

Prepared By:

Noted By:

Structural Engineer

PRC No. :

PTR No. :

Issued at :

Issued on :

PART 1 - WORKING DRAWINGS

- 1.1** In the interpretation of Structural Plans, indicated dimensions shall govern and distances or sizes shall not be scaled for construction purposes.
- 1.2** In cases of conflict in details or dimensions between the Architectural and Structural plans, verify with the Structural Engineer or his authorized representative for decision.
- 1.3** In case of conflict between the Structural Plans and Structural Specifications, the Plans shall govern.

PART 2 - REINFORCED CONCRETE BEAMS

- 3.1** Unless otherwise noted in the plans or specifications, camber all reinforced Concrete beams at least 10 mm for every 4000 mm of clear span and For cantilever beams shall be 50 mm for every 3000 mm of clear span.
- 3.2** When a beam crosses a girder, rest beam bars on top of the girder bars. At column intersection girder bars shall be on top of beam bars.

PART 3 - REINFORCED CONCRETE SLABS

- 4.1** Unless otherwise noted in plans or specifications, camber all reinforced concrete slabs 8 mm per 3000 mm of shorter span and 14 mm for every 2000 mm of cantilever span.
- 4.2** If bars are reinforced both ways, bar along the shorter span shall be Placed below those along the long span at the center and over the longer span bars near the supports.

PART 4 - STRUCTURAL TOLERANCES

Unless otherwise specified by the Structural Engineer, the following are the acceptable tolerances for cast-in-place concrete construction. All dimensions not within the required tolerances shall be corrected prior to pouring of concrete.

- | | | |
|------------|--|---------------------|
| 4.1 | Cross sectional dimensions and location of reinforcement | |
| | Dimension less than 200 mm | - + 6 mm |
| | 200 mm to 600 mm | - + 9 mm |
| | Over 600 mm | - + 12 mm |
| 4.2 | Deviation from straight line (Sweep and/or plumbness) | -+ 6 mm per 3000 mm |

4.3 Locations of bar cut-off or bonds - + 50 mm

PART 5 CONCRETE PROTECTION FOR BUNDLED REINFORCEMENT

5.1 For bundled bars, the minimum concrete cover shall be equal to the equivalent diameter of the bundled bars, but need not be greater than 50 mm.

PART 6 STANDARD HOOKS

6.1 "Standard hook" for rebar shall mean either of the following:

6.1.1 A semi-circular turn plus an extension of at least 4 bar diameter but not less than 65 mm at free end of bar.

6.1.2 A 90-degree turn plus an extension of at least 12 bar diameter at the free end of bar.

6.2 Minimum diameter of bend measured on the inside of the bar shall be as follows:

10 mm to 25 mm	– 6 bar diameter
28 mm to 32 mm	– 8 bar diameter
No. 11 to No. 18	– 10 bar diameter

PART 7 WELDED SPLICES

7.1 The Contractor shall submit details of all welded splices for approval by the Structural Engineer.

7.2 Only Certified welders shall be allowed to perform welding operations.

7.3 Connection of crossing bars by tack welding is not allowed.

PART 8 CONSTRUCTION JOINT

8.1 Where a joint is to be made, the surface of the concrete shall be thoroughly cleaned and all laitance and standing water removed. Vertical joint also shall be thoroughly wetted and coated with rich cement grout immediately before pour of new concrete.

PART 9 - PIPES EMBEDDED IN CONCRETE

Conduits and pipes, with their fittings, embedded within a concrete column shall

9.1 not displace more than 4 percent of the cross sectional area where strength is calculated or required for fire protection.

- 9.2** Vertical pipes are not allowed to punch through beams or girders.
Aluminum pipes shall not be embedded in
- 9.3** concrete.

PART 1 - GENERAL

1.1 SUMMARY

1. Section includes: Steel reinforcement, including fabrication and installation accessories, for precast shotcrete and cast-in-place concrete, and masonry.

1.2 REFERENCE STANDARDS

1. The publications listed below form a part of this specification to the extent referenced.

The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117 Standard Tolerances for Concrete Construction and Materials

ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures

ACI 318 Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 120 Pipe, Steel, black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses

ASTM A 184 Fabricated Deformed Steel bar Mats for Concrete Reinforcement

ASTM A 185 Welded Steel Wire Fabric for Concrete Reinforcement

ASTM A 497 Welded Deformed Steel Wire Fabric for Concrete Reinforcement

ASTM A 499 Steel Bars and Shapes, Carbon Rolled from "T" Rails

ASTM A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM A 675 Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

ASTM A 706 Low-Alloy Steel Deformed Bars for Concrete Reinforcement

AMERICAN WELDING SOCIETY (AWS)

1.3 SUBMITTALS

1. Shop Drawings
 - a. Detail drawings shall be prepared in accordance with ACI 315. Submittals shall show reinforcing steel schedules, placing plans, sizes, grades, and splicing and bending details. Any embedded plates, bolts, etc., shall also be shown for purposes of checking for potential interference. Drawings shall show support details including types, sizes and spacing. Scaling of drawings will not be permitted to determine required bar lengths.
2. Welding Procedures and Qualifications
 - a. Owner's Representative shall be furnished a list of qualified welders.
3. Certificates of Compliance
 - a. Certified copies of mill reports attesting that the reinforcing steel furnished meets the requirement specified shall be obtained from the supplier prior to the installation of reinforcing steel.

1.4 QUALIFICATIONS

1. Welders shall be qualified in accordance with AWS D1.4. Qualification test shall be performed at the worksite and the Contractor shall notify the Owner's Inspector/Representative 24 hours prior to conducting tests. Welding procedures qualified by others and welders qualified by another employer may be accepted as permitted by AWS D1.4.

1.5 DELIVERY AND STORAGE

1. Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 - PRODUCTS

2.1 MATERIALS

1. **Welded Wire Fabric:** ASTM A 185; wire in accordance with ASTM A 496; mesh and wire sizes as noted on drawings.
2. **Epoxy Grout:** Epoxy grout shall be of type and manufacturers as indicated in drawings.
3. **Reinforcing Steel:** Reinforcing steel shall be deformed bars for 10 mm diameter and above & round bars for 8 mm diameter & below.
4. **Wire Ties:** Wire ties shall be ASTM A 82 16-gauge double annealed wire. Provide corrosion resistant wire for precast concrete.

5. **Supports:** Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI 01 Class A, C or D or precast concrete blocks. Precast concrete blocks shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete blocks shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be

exposed to weather or where surfaces are to be painted, steel supports shall be class C or D. Concrete supports used in concrete exposed to view shall be class C or D.

2.2 FABRICATION

1. **Steel Bar Reinforcement:** Fabricate and detail to shapes and dimensions shown on drawings in accordance with ACI 315.
2. **Bending & Straightening:** In accordance with ACI 318, Chapter 7, unless otherwise noted on drawings; no bending or straightening of reinforcement will be permitted after partial embedment in concrete; heating of reinforcement will be permitted only if entire operation is approved.
3. **Welding:** Welding of reinforcing bars is not permitted unless specifically shown welded on Structural drawings. When welding of reinforcement is indicated and required, provide welds in accordance with AWS D1.4.
4. **Splicing:**
 - a. Reinforcing bars shall be lap spliced for tension unless otherwise noted on the drawings.
 - b. At the Contractor's option, mechanical butt splicing using an exothermic welding process and high-strength sleeves or threaded splicing may be substituted for lap splices with prior approval. Butt welds, thermite welds, and threaded splices shall be capable of developing in tension at least 125% of the specified yield strength (F_y) on the bar.
 - c. Mechanical coupler shall be allowed provided they are capable of developing in tension at least 125% of the specified yield strength (F_y) of the bar. In no case should the result fail in the threaded portion, submit test results and product literature for approval.
 - d. Welding or tack welding of reinforcing bars to other bars or to plates, angles, etc., is prohibited, except where specifically detailed on the approved shop drawings. Where welding is approved, it shall be done by AWS Certified Welders using E9018 or approved electrodes. Welding procedures shall conform to the requirements of AWS D1.4.
5. **Welded Wire Fabric:** In accordance with CRSI, Chapter 2, unless otherwise noted or indicated

PART 3 - EXECUTION

3.1 INSTALLATION

1. **General:** Clean reinforcing steel free from loose rust, mud, oil, and other foreign matter-affecting bond. Install supports in accordance with CRSI, Chapter 3 unless otherwise indicated.
2. **Placement Of Bars:** In accordance with ACI 318 and approved placement drawings. If bars are displaced, or if necessary to shift bars to avoid interference with other reinforcing or

embedded items, and if bars are moved to locations exceeding allowable tolerances, obtain approval of the resulting arrangement prior to placing concrete.

3. **Allowable Tolerances:** In accordance with the requirements of ACI 117, paragraph 6.1
4. **Cover:** Allowable cover for reinforcement is indicated or noted on drawings; where no cover is indicated or noted, allow minimum of 3 inches of cover.
5. **Tie Wires:** After cutting tie wires, turn to the inside of section and bend so that concrete placement will not force ends to exposed concrete surfaces.
6. **Welded Wire Fabric:** Place welded wire fabric reinforcing in accordance with requirements of ACI 315, unless otherwise noted or indicated. Place continuous between control and expansion joints; stop at expansion joints and cut $\frac{1}{2}$ through at control joints unless noted otherwise. Extend fabric across beams and walls. Lap fabric at a minimum of 1 $\frac{1}{2}$ mesh minimum.

3.2 DEFECTIVE WORK

1. **General:** The following reinforcing steel work will be considered defective and shall be removed and replaced by the Contractor:
 - a. Bars with kinks or bends not shown on drawings.
 - b. Bars injured due to bending or straightening.
 - c. Bars heated for bending.
 - d. Reinforcement not placed in accordance with the drawings and/or specifications.

PART 4 - SAMPLING AND TESTING

4.1 General: All steel bars must be positively identified as to heat number and mill analysis.

1. All steel bars that cannot be identified by heat number and mill analysis shall have one tensile and one bend test made for each 2 $\frac{1}{2}$ tons or fraction thereof, of each size and kind of reinforcing steel.
2. Testing procedure shall conform to ASTM A 615.

PART 1 - GENERAL

- 1.1 **APPLICABLE PUBLICATIONS:** The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition shall be applicable.

1.1.1 U.S. Army Corps of Engineers (COE) Waterways Experiment Station Publications:

CRD-C-572 Specifications for Polyvinylchloride Waterstop

CRD-C-621 Handbook for Concrete and Cement, Specification for Nonshrink Grout, Volume II

PS 1	Construction and Industrial Plywood
1.1.2	American Association of State Highway and Transportation Officials (AASHTO)
	Publication:
M 182	Burlap Cloth Made From Jute or Kenaf
1.1.3	American Concrete Institute (ACI) Publications:
117	Standard Tolerances Of Construction for Concrete Construction and Materials.
211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
211.2	Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
301	Specifications for Structural Concrete for Buildings
302	Guide for Concrete Floor and Slab Construction
304	Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
305	Hot Weather Concreting
315	Details and Detailing of Concrete Reinforcement
347	Recommended Practice for Concrete Formwork
1.1.4	American Society for Testing and Materials (ASTM) Publications:
A 82	Cold-Drawn Steel Wire for Concrete Reinforcement
A 185	Welded Steel Wire Fabric for Concrete Reinforcement
A 615	Deformed & Plain Billet-Steel Bars for Concrete Reinforcement
C 31	Making and Curing Concrete Test Specimens in the Field
C 33	Concrete Aggregates
C 39	Compressive Strength of Cylindrical Concrete Specimens
C 42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 94	Ready-Mixed Concrete
C 143	Slump of Portland Cement Concrete
C 150	Portland Cement
C 171	Sheet Materials for Curing Concrete
C 172	Sampling Freshly Mixed Concrete

C 173	Air Content of Freshly Mixed Concrete by the Volumetric Method
C 309	Liquid Membrane-Forming Compounds for Curing Concrete
C 330	Lightweight Aggregates for Structural Concrete
C 494	Chemical Admixtures for Concrete
C 567	Unit weight of Structural Lightweight Concrete
C 881	Epoxy-Resin-Base bonding Systems for Concrete
C 920	Elastomeric Joint Sealants
D 1190	Concrete Joint Sealer, Hot-Poured Elastic Type
D 1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous types)
D 1752	Preformed Sponge Rubber and Cork Expansion Joint Filler for Concrete Paving and Structural Construction
D 1850	Concrete Joint Sealer, Cold Application Type

1.1.5 American Welding Society (AWS) Publication:

D1.4 Structural Welding Code-Reinforcing Steel

1.2 DESCRIPTION OF WORK: The work includes the provision of cast-in place concrete. In the ACI publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the word “shall” has been substituted for “should” wherever it appears.

1.3 SUBMITTALS:

1.3.1 **Shop Drawings:** Reproductions of contract drawings are unacceptable.

1.3.1.1 Shop Drawings for Reinforcing Steel: ACI 315. The Contractor shall submit three (3) sets of shop drawings for review and approval by the Engineer prior to any steel reinforcing bar fabrication and installations. Shop drawings shall be submitted at least seven (7) calendar days prior to any installations of reinforcing bars, depending on the number of drawings submitted, and shall be drawn on either 20” x 30” or 30” x 40” sheets. Indicated bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

1.3.2 **Contractor Mix Design:** Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Furnish a complete list of materials including type, brand, source and amount of cement, and admixtures; applicable reference specifications; and copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Provide fly ash

and pozzolan test results performed within 6 months of submittal date. Obtain approval before concrete placement. Submit additional data regarding concrete aggregates if the source of aggregate changes.

1.3.3 Certificates of Compliance:

- a. Aggregates
- b. Admixtures
- c. Reinforcement
- d. Cement
- e. Fly ash
- f. Pozzolan
- g. Silica fume
- h. Lightweight aggregate

1.3.4 Catalog Data:

- a. Waterstops
- b. Materials for Curing Concrete
- c. Joint Sealant
- d. Joint Filler
- e. Vapor Barrier
- f. Epoxy Bonding Agents

1.4 DELIVERY: Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement.

1.5 STORAGE: ACI 301 for jobsite storage of concrete aggregates. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Provide for accurate identification after bundles are broken and tags removed.

PART 2 - PRODUCTS

2.1 CONCRETE

2.1.1 Contractor-Furnished Mix Design : ACI 211.1 and ACI 301. Concrete shall as specified or indicated on the drawings. no. 57 and 67. The maximum chloride content shall not exceed one percent.

2.1.1.1 Slump
Requirements:

The allowable slump shall be as follows:

ELEMENT	SLUMP (mm)	
	MINIMUM	MAXIMUM
Walls, columns, and grade beams	50	130

- 2.1.2 **Lightweight Concrete Proportion:** ACI 211.2. Provide ASTM C330 aggregates for concrete; concrete strength and unit weight (dry) as indicated on the drawings.

2.2 MATERIALS

- 2.2.1 **Cement:** ASTM C 150, Type I for general use in construction; Type II where concrete is exposed to moderate sulfate action or where moderate heat of hydration is required.

- 2.2.2 **Water:** Water shall be fresh, clean and potable.

- 2.2.3 **Aggregates:** ASTM C 33, Class 1N or 2N, except as modified herein. Obtain aggregates for exposed concrete surfaces from one source. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalis in the cement. Aggregates shall consist of gravel, crushed gravel, or crushed stone conforming to the requirements of ASTM C 33. Submit test results as required in ASTM C 33.

2.2.3.1 Aggregates for Lightweight Concrete: ASTM C330.1

- 2.2.4 **Non-shrink Grout:** COE CRD-C-621.

- 2.2.5 **Admixtures:** Water-reducing retarders shall be used in proportions recommended by the manufacturer. Trial mixes shall be made with the admixture and job materials at temperatures and humidities anticipated on the project. Sampling and testing shall be performed at no cost to the Owner, and with the supervision of the Project Inspector.

2.2.5.1 Retarding: ASTM C 494, Type B, D or G.

2.2.5.2 Water Reducing: ASTM C 494, Type A or F.

2.2.5.3 Fly Ash and Pozzolan: ASTM C618, Type N, F, or C except that the maximum allowable loss on ignition shall be 6 percent for Type N and 2.5 percent for Types F and C and a maximum of 24 plus or minus 2 percent may be retained on a No.325 sieve. Add with cement.

- 2.2.6 **Reinforcement:**

2.2.6.1 Reinforcing Bars: ACI 301 unless otherwise specified. ASTM A 706, Grade 60 (see notes on drawings.) ASTM 615, Grade 40 and 60 may be used provided it meets the requirements of NSCP with regards to their strengths.

2.2.6.2 Mechanical Reinforcing Bar Connectors: ACI 301. Provide 125 percent minimum yield strength of the reinforcement bar.

2.2.6.3 Welded Wire Fabric: ASTM A 185 or ASTM A 497.

2.2.6.4 Wire: ASTM A 82 or ASTM A 496.

- 2.2.7 **Vapor Barrier:** ASTM C 171 polyethylene sheeting, minimum 6 mil thickness.

2.2.8 Polyvinylchloride Water stops: COE CRD-C-572.

2.2.9 Materials for Curing Concrete:

2.2.9.1 Impervious Sheeting: ASTM C 171; waterproof paper, clear or white polyethylene sheeting, or polyethylene - coated burlap.

2.2.9.2 Pervious Sheeting: AASHTO M 182.

2.2.9.3 Liquid Membrane-Forming Compound: ASTM C 309, white-pigmented, Type 2 Class B, free of paraffin or petroleum.

2.2.9.4 Liquid Chemical Sealer-Hardener Compound: Compound shall not contain petroleum resins or waxes. Compound shall not reduce the adhesion of resilient flooring, tile, paint, roofing waterproofing, or other material applied to concrete.

2.2.10 Expansion/Contraction Joint Filler: ASTM D 1751 or ASTM D 1752, 1/2-inch thick, unless otherwise indicated.

2.2.11 Joint Sealants

2.2.11.1 Horizontal Surfaces (3 percent slope, maximum):

- a. Outside Buildings: ASTM D 1190.
- b. Inside Buildings: ASTM D 1190 or ASTM D 1850.

2.2.11.2 Vertical Surfaces (greater than 3 percent slope): ASTM C 920, Type M, Grade NS, Class 25, Use T.

2.2.12 Epoxy Bonding Compound: ASTM C 881, Type I, for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete.

2.2.13 Lightweight Concrete:

2.2.13.1 Structural Lightweight Concrete: ACI 211. Lightweight aggregates shall be expanded clay or other types conforming to ASTM C330. Materials of structural lightweight concrete shall be proportioned to obtain the densities and respective 28-day compressive strengths indicated on the drawings.

2.2.13.2 Non-Structural Lightweight Concrete: Lightweight concrete shall consist of foam concrete or a mixture with the use of perlite aggregates. Foaming agent shall not contain any aluminum. Materials for lightweight concrete shall be proportioned to obtain a maximum density of 70 pounds per cubic foot for roof and 90 pounds per cubic foot for floors with 28-day compressive strength of 500 psi and 900 psi, respectively, unless otherwise indicated on the drawings.

2.2.14 Integral Waterproofing: 3CC System as manufactured by CEMENTAID or approved equal.

- a. **Splices:** ACI 315. See notes on drawings. Unless

indicated otherwise, splices for large diameter bars (28 mm or larger) shall be made only with the use of threaded tension dowel couplers duly approved by the Structural Engineer. (See notes of Mechanical Couplers)

PART 3 - EXECUTION

3.1 FORMS: ACI 301. Provide forms, shoring, and scaffolding for concrete placement unless indicated or specified otherwise. Concrete for footings may be placed in excavations without forms upon inspection and approval by the Engineer. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners or concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water shall be watertight.

3.1.1 Coating: Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms of surfaces to which adhesive, paint, or other finish material is to be applied.

3.1.2 Removal of Forms: Prevent concrete damage during form removal. After placing concrete, forms shall remain in place for the following minimum time period, not necessarily consecutive, where minimum temperatures specified in paragraph entitled "Curing Period and Minimum Temperatures" are maintained adjacent to the concrete and formwork. The minimum time period for removal of forms shall govern where it exceeds the minimum specified curing period.

Where the formwork for one element supports the formwork for another element, the greater time period shall apply to both elements.

ELEMENT	TIME PERIOD (Days Minimum)
Walls, columns, sides of beams girders and slabs on grade	1
Pan joist forms (sides only):	
30 inches wide or less	3
Over 30 inches wide	4
Joist, beam, or girder soffits:	
Clear span between structural supports	
Under 10 feet	7
10 to 20 feet	14
Over 20 feet	21
One-way floor slabs : Clear span between structural supports	
Under 10 feet	4

3.1.2.1 **Special Requirements for Reduced Time Period Prior to Form Removal:** Forms may be removed earlier than specified if ASTM C 39 test results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a certain design strength capable of supporting the induced construction loads. Earliest will be after 4 days where concrete is expected to reach 60% of the design strength and there exist adequate permanent undisturbed shorings. Re-shoring has to be done after removal of forms.

3.1.3 **Reshoring:** Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Where columns, walls, or other load-bearing concrete members are placed in advance of other framing and forms are needed for future use, forms may be stripped after 2 days if loads are not applied to load-bearing members, and if members are cured as specified in paragraph entitled "Curing and Protection". After forms are removed, slabs and beams over 10 feet in span and cantilevers over 4 feet shall be reshored for the remainder of the specified time period in paragraph entitled "Removal of Forms". Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Reshoring elements shall have the same load-carrying capabilities as original shoring and shall be spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.2 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI 301. Provide bars, wire, fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement shall not contain rust, scale, oil, grease, clay, and foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross sectional area or the nominal weight per foot of the reinforcement has been reduced to less than specified in paragraph entitled "Reinforcing Bars". Remove loose rust prior to placing steel. Tack welding is prohibited.

3.2.1 **Tolerances:** Place reinforcement and secure with galvanized or non-corrosive chairs, spacers, or metal hangers. Use concrete or other non-corrosive material for supporting reinforcement on the ground.

3.2.2 **Splicing:** Splices shall be approved prior to use. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 2 inches.

3.2.3 **Future Bonding:** Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Bolt threads shall match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.2.4 **Cover:** ACI 301 for minimum coverage, unless otherwise indicated.

3.2.5 **Setting Miscellaneous Material:** Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.2.6 **Construction Joints:** Locate joints to least impair strength and as approved by

the Structural Engineer. Continue reinforcement across joints unless otherwise indicated.

3.2.7 Expansion Joints and Contraction Joints: For slabs on grade, provide at edges of interior floor slabs, adjacent to walls, and as indicated. Make expansion joints 0.5-inch wide except as indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Sawed joints shall be completed within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.2.8 Water stop Splices: Fusion weld in the field.

3.2.9 Form Ties and Accessories: The use of wire alone is prohibited. Form ties and accessories shall not reduce the effective cover of the reinforcement.

3.2.10 Waterproofing: All concrete for basement walls, water reservoirs and superseded slabs and roof decks that will be exposed to standing water shall be waterproofed by approved product and methodology. Check with the Architect or Structural Engineer for specific type of waterproofing.

3.3 MEASURING, MIXING, TRANSPORTING, AND PLACING CONCRETE

ASTM C 94, ACI 301, ACI 302.1R, and ACI 304, except as modified herein. ASTM C 94 Provide mandatory batch ticket information for each load of ready mix concrete.

3.3.1 Measuring: Make moisture, weight, and air determination of intervals as specified in paragraph entitled "Sampling and Testing." Allowable tolerances for measuring cement and water shall be 1 percent; for aggregates, 2 percent; and for admixtures, 3 percent.

3.3.2 Mixing: ASTM C 94. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 85 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 85 degrees F unless it can be proven by test results that the time can be increased with the addition of admixtures. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.3.3 Transporting: Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.3.4 Placing: Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris and water from within the forms. Deposit concrete

as close as practicable to the final position in the forms. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10-foot centers maximum in each direction when pouring interior slabs and on 20-foot centers maximum for exterior slabs.

3.3.4.1 **Vibration:** ACI 301. Furnish a spare vibrator at the jobsite whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency internal, mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straight edge. Operate vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 18 inches apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 18-inch maximum vertical lifts. . External vibrators shall be used on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of concrete.

3.3.4.2 **Application of Epoxy Bonding Compound:** Apply a thin coat of compound to dry, clean surfaces where indicated. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is stringy. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy-resins.

3.3.5 **Hot Weather:** ACI 305R. Provide and maintain required concrete temperature using Figure 2.1.5 in ACI 305 R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where worksite is remote to water source to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect form from direct sunlight and add water to top of structure once concrete is set.

3.4 SURFACE FINISHES (EXCEPT FLOOR, SLAB AND PAVEMENT FINISHES)

3.4.1 **Defects:** Repair formed surfaces by removing minor honeycombs, pits greater than one square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with non-shrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb (including exposed steel reinforcement, cold joints, entrapped debris, and separated aggregate or other defects) which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete shall not vary more than the allowable tolerances of ACI 347. Exposed surfaces shall be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.4.2 **Not Against Forms (Top of Walls):** Surfaces not otherwise specified shall be finished with wood floats to even surfaces. Finish shall match adjacent finishes.

3.4.3 **Formed Surfaces:**

3.4.3.1 As-Cast Rough Form (For Surfaces Not Exposed to Public View): Remove fins and other projections exceeding 0.25 inch in height; level abrupt irregularities.

3.4.3.2 As-Cast Smooth Form (For Surfaces Exposed to Public View): Form facing material shall produce a smooth, hard, uniform texture on the concrete. Remove fins and other projections.

3.4.4 **Rubbed Finish:** Provide concrete with a smooth form finish. Finish as follows:

- a. Smooth Rubbed: Provide a newly hardened concrete within 24 hours following form removal. Wet surfaces and rub with an abrasive tool to produce uniform color and texture. Use only the cement paste drawn from the concrete rubbing process.

Grout Cleaned: Finishing operations shall not begin until adjacent surfaces to be cleaned are completed and accessible. Cleaning as the work progresses shall not be permitted. Mix one part cement and 1.5 parts fine sand with sufficient water to produce a grout with the consistency of thick paint. Substitute white cement for a part of the gray cement in order to produce a color matching the color of the surrounding concrete, determined by a trial patch. Wet the surface of the concrete sufficiently to prevent absorption of water from the grout. Apply the grout uniformly with brushes or spray gun. Immediately after applying the grout, scrub the surface vigorously with cork float or stone to coat the surface and fill air bubbles and holes. Remove excess grout while still plastic by working the surface with a rubber float, sack, or other approved method. When dry, rub the surface vigorously with clean burlap. Keep damp for 36 hours minimum after final rubbing.

3.4.5 **Surface Finish Samples:** Provide a minimum of three sample concrete panels for each finish for each mix design, 3 feet by 3 feet, 3 inches thick. Use the approved concrete mix design (s). Provide sample panel on-site at locations directed. Once approved, each set of panels shall be representative of each of the finishes specified and shall be representative of the workmanship and finish/es required. Do not remove or destroy samples until directed by the Architect.

3.5 **FLOOR, SLAB AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION.** ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Depress the concrete base slab where quarry tile, ceramic tile, or marble tile are indicated. Provide interior floor slabs with a steel troweled finish or power float finish, as required. After troweling is completed, apply a liquid chemical sealer-hardener compound on interior floor slabs that do not receive floor covering.

3.5.1 **Finish:** Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleed water appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleed water is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to

absorb bleed water.

3.5.1.1 **Floated:** Provide for machinery pads and other exterior slabs where not otherwise specified. Float the surface by hand with a wood or magnesium float, or use a power-driven float. Floating or any one area shall be the minimum necessary to produce an even finish, level within 1/4 inch in 10 feet for exterior work and level within 1/8 inch in 10 feet for interior work where floor drains are not provided.

3.5.1.2 **Steel Troweled:** First, provide a floated finish. When slab attains a proper set, trowel to a smooth, hard, dense finish. Finished surfaces shall be free of troweled marks, uniform in texture, and a true plane, flat within 0.01 foot (Approximately 1/8 inch) in 10 feet. Hand finish portions of the slab not accessible to power-finishing equipment (e.g., edges, corners) to match the remainder of the slab. Power trowel once and finally hand trowel where a finished floor covering (e.g., tile, carpet) is specified. Power trowel twice and finally hand trowel for exposed concrete floors.

3.5.1.3 **Broomed:** Provide for exterior walks, platforms, patios, and ramps, unless otherwise indicated. Provide a floated finish, then finish with a flexible bristle broom. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.5.1.4 **Pavement:** Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straight edge to check slope and flatness; correct and refloat as necessary. Obtain final finish by belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty non-slip surface is obtained. Round edges and joints with an edger having a radius of 1/8 inch.

3.5.2 **Concrete Walks:** Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum apart. Provide walks with a broomed finish. Provide a transverse slope of 1/4 inch per foot. Limit variation in cross section to 1/4 inch in 5 feet.

3.5.3 **Pits and Trenches:** Place bottoms and walls monolithically or provide water stops and keys.

3.5.4 **Curbs and Gutters:** Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Provide a pavement finish.

3.6 CURING AND PROTECTION: ACI 301 unless otherwise specified. Begin curing immediately following form removal. Protect concrete from injurious action by sun, rain, flowing water, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on

concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period.

3.6.1 Moist Curing: Provide for the removal of water without erosion or damage to the structure.

3.6.1.1 Ponding or Immersion: Continually immerse the concrete throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.

3.6.1.2 Fog Spraying or Sprinkling: Provide uniform and continuous application of water throughout the curing period.

3.6.1.3 Pervious Sheeting: Completely cover surface and edges of the concrete with two thickness of wet sheeting. Overlap sheeting 6 inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.6.1.4 Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured.

Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting, overlap and continuously tape sheeting, overlap and continuously tape sheeting joints, and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.6.2 Liquid Membrane-Forming Compound Curing: Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2.1.5 in ACI 305R indicates that hot weather conditions will cause an evaporation rate exceeding 0.2 pounds of water per square foot per hour.

3.6.2.1 Application: Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats shall be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces to rainfall within 3 hours after the curing compound application.

3.6.2.2 Protection of Treated Surfaces and Completed Work: Prohibit foot and vehicular traffic and other sources of abrasion for not less than 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage. Completed works such as stairs, floor slab, and other concrete surfaces which are likely to be damaged by construction loads and traffic shall be protected at all times. Any damage to these surfaces shall be repaired immediately to the satisfaction of the Engineer.

3.6.3 **Liquid Chemical Sealer-Hardener Curing:** Provide for interior floors that do not receive a floor covering, or in lieu of liquid membrane-forming compound curing for other surfaces. Apply sealer-hardener in accordance with the manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer.

3.6.4 **Curing Period:**

TIME PERIOD
(Days Minimum)

CONCRETE STRUCTURE
OR CEMENT TYPE

7

ASTM C 150, Type I or II, either with or without fly ash, pozzolan or ground slag; and ASTM C 595 cement for concrete not specified otherwise.

10

Retaining walls that will be subjected to deteriorating conditions; pavement not under a roof, chimneys.

14

Water tanks for potable and non-potable water; structures that will be in contact with water; decks and similar parts of water front structures over seawater that will not ordinarily be wetted by sea-water.

3.6.4.1 Additional Curing: Double the required curing period if either one or the average of both 7-day test cylinders indicate less than 90 percent of the strength specified (f'c).

3.7 **SAMPLING AND TESTING:**

3.7.1 **Sampling:** ASTM C 172. Collect samples of fresh concrete to perform tests specified. ASTM C 31 for making test specimens. Samples shall be collected at final discharge point.

3.7.2 **Testing:**

3.7.2.1 Slump Tests: ASTM C 143. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 10 cubic yards (maximum) of concrete.

3.7.2.2 Temperature Tests: Test the concrete delivered and the concrete in the forms. Perform tests for each batch (minimum) or every 10 cubic yards

(maximum) of concrete, until the specified temperatures obtained, and whenever test cylinders and slump tests are made.

3.7.2.3 Compressive Strength Tests: ASTM C39. Sampling shall be in accordance with ASTM C 31. Obtain cylinder samples for compressive strength tests at the rate of three (3) sets of five (5) samples per set for each day's pour or for every 150 cubic meters of concrete poured or for every 500 square meters of area for slabs or walls, whichever is greater. Test two (2) cylinders at 7 days, one (1) cylinder at 14 days and one (1) cylinder at 28 days, and hold one (1) cylinder in reserve. If the average strength of the 28-day test cylinders is less than the specified f'_c and a maximum of one single cylinder is less than f'_c minus 500 psi, obtain core samples for compressive strength tests in accordance with ASTM C 42 at the rate recommended in ACI 318. Concrete represented by core tests shall be considered structurally adequate if the average of three cores is equal to at least 85 percent of f'_c and if no single core is less than 75 percent of f'_c . Locations represented by erratic core strengths shall be re-tested. Remove concrete not meeting strength criteria and provide new, acceptable concrete. Repair core holes with non-shrink grout. Match color and finish of adjacent concrete.

3.7.2.4 Air Content: ASTM C 173 or ASTM C 231. Test air-entrained concrete for air content at the same frequency as specified for slump tests.

3.7.2.5 Cost of Tests: All costs of initial tests for compressive strength of concrete and test for reinforcing bars shall be at the Contractor's expense. Cost of re-tests, core tests, load tests and other tests performed as a result of initial test failing to meet all specified requirements shall likewise be at the Contractor's expense.

3.8 SAMPLING AND TESTING OF STEEL REINFORCEMENT

3.8.1 The Contractor shall satisfy the Engineer that steel reinforcement delivered to the site has had sufficient routine inspection and testing carried out by the manufacturer. In addition the following routine testing shall be carried out on steel reinforcement delivered to the site.

3.8.2 Hot –Rolled Steel Reinforcing Bars

- a. Every batch of steel bars delivered to the site shall be tested to verify the mass and tensile properties for every shipment of 5,000 kg or fraction thereof.
- b. The test shall consist of 10 specimens. Abbreviated testing may be considered on a particular batch at the discretion of the Engineer. If the bar pattern of the specific diameter is acceptable for abbreviated testing the test shall consist of 3 specimens.
- c. The specimens should be selected from different bars in the batch. A batch is defined as any quantity of bars of one size and grade, manufactured by the same mill, covered by the same mill certificate, and delivered to the site at any one time. Steel bars in more than one delivery to the site within a short period may be considered as part of the same batch provided that the deliveries belong to one single consignment from the manufacturer and are covered by the same mill certificate.

d. If one of more valid test results is less than 93% of the specified characteristics strength, the batch shall be deemed not complying with the characteristic strength requirements.

e. If one of more valid test results fail to meet the mass, tensile strength, elongation or bend test requirements, two additional specimens for each failure shall be taken from different bars for the same batch and subjected to the test, or tests in which the original specimen failed. If any of the additional specimens fail, the batch shall be deemed not complying.

f. The test report should contain the following information:

1. Full description of test specimens including names of steel manufacturer, country of origin, grade and size as stated by the person submitting them for testing;
2. Sketch of pattern deformation or mill marks;
3. Mill Certificate;
4. Identification of the batch and date of delivery to the site to which the test specimens relate;
5. Measured mass and calculated effective cross-sectional area of test specimens;
6. Results of yield stress tensile strength, elongation and bond tests if required.

3.8.3 Mechanical Splicing

- a. Splice sample should be taken at a rate of 1 sample for every 250 splices or 6 samples for every floor, whichever is greater.
- b. The only acceptable form of full strength butt joint for a bar in tension comprises a mechanical coupler satisfying the following criteria:
 1. When a test is made of representative gauge length assembly comprising reinforcement of the size, grade and profile to be used and a coupler of the precise type to be used, the permanent elongation after loading to $0.60 F_y$ should not exceed 0.10 mm.
 2. A full mechanical connection shall develop in tension as required at least 125% of the specifying strength (F_y) of the steel bar.

3.9 COST OF TESTS

3.10.1 All costs of initial tests for compressive strength of concrete and test for reinforcing bars shall be at the Contractor's expense, including costs of retests, core tests, load tests and other tests performed as a result of initial tests failing to meet all specified requirements.

3.10 TOLERANCES

3.11.1 Tolerances of formwork, reinforcements, finished concrete work shall be in accordance with ACI Standard 117.

PART 1- GENERAL

1.1 APPLICABLE PUBLICATIONS: The latest edition of the publications listed below form a part of this specification to the extent referenced.

1.1.1 American Society for Testing and Materials (ASTM) Publications:

A 82	Cold-Drawn Steel Wire for Concrete Reinforcement
A 90 Articles	Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel
A 153	Zinc Coating (Hot-Dip on Iron and Steel Hardware)
A 615 Reinforcement	Deformed and Plain Billet-Steel Bars for Concrete
C 90	Hollow Load-Bearing Concrete Masonry Units
C 91	Masonry Cement
C 144	Aggregate for Masonry Mortar
C 150	Portland Cement
C 270	Mortar for Unit Masonry
C 476	Grout for Reinforced and Non-Reinforced Masonry

1.2 SUBMITTALS:

1.2.1 **Samples:** Submit for approval samples of each type of wall reinforcements and wall ties and design mix for grout.

1.2.2 **Certificates of Conformance:** Submit certificates attesting that masonry cement, masonry units, aggregates and accessories meet the requirements specified herein.

1.3 DELIVERY AND STORAGE: Deliver cement and other cementitious materials to the site in unbroken bags, barrels, or other approved containers, plainly marked and labeled with manufacturer's names and brands. Store cementitious materials in dry, weather tight sheds or enclosures and handle so as to prevent entry of foreign materials and damaged by water or dampness. Handle masonry units with care to avoid chipping and breakage. Protect masonry material from damage, and except for sand, keep dry until used.

PART 2- PRODUCTS

2.1 MASONRY UNITS

2.1.1 **Concrete Masonry Units:** Units of modular dimensions and air, water, or steam cured. Store Type II units at the site before use a minimum of 28 days for air-cured units, 10 days for atmospheric steam or water-cured units, and 3 days for units cured with steam at a pressure of 120 to 150 psi and at a temperature of 350 to 365 degrees F for at least 5 hours. Surfaces of units which are to be plastered or stuccoed shall be sufficiently rough to provide a suitable bond; elsewhere, exposed surfaces of units shall be comparatively smooth and/or uniform in texture.

- a. **Hollow Load-Bearing Units:** ASTM C 90, Grade N-1 or N-II, made with normal weight aggregates with ultimate compressive strength of at least 1,200 psi at 28 days.
- b. **Hollow Non-Load Bearing Units:** ASTM C-129 made with normal weight aggregates, and with ultimate compressive strength of at least 650 psi at 28 days.
- c. **Special Shapes:** Provide special shapes such as closures, header units, and jamb units as necessary to complete the work. Special shapes shall conform to the requirements for the units with which they are used.

2.1.2 **Precast Concrete Lintels:** Same materials and surface texture as adjacent masonry units, with a 28-day compressive strength of not less than 2,000 psi. Provide reinforcing as indicated. Provide lintels of sizes indicated, straight and true, with at least 8 inches of bearing at each end.

2.2 MORTAR

2.2.1 **Portland Cement:** ASTM C 150, Type I.

2.2.2 **Masonry Cement:** ASTM C 91, except that the air content of the mortar specimen shall be not more than 16 percent by volume in lieu of 22 percent. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar.

2.2.3 **Sand:** ASTM C 144.

2.2.4 **Water:** Clean, potable, and free from substances which could adversely affect the mortar.

2.2.5 **Mortar Types:** ASTM C 270, Type M for foundation walls, Type N or S for non-load bearing, non-shear wall interior concrete masonry and Type S for all other masonry work. If masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates

and on mixing to obtain the type of mortar required.

2.3 ACCESSORIES

- 2.3.1 **Horizontal Joint Reinforcement:** Horizontal joint reinforcements shall be reinforcing bars, as indicated, conforming to ASTM A615, or fabricated from cold drawn steel wire, conforming to ASTM A82. The wire shall be zinc-coated after fabrication by the hot-dip process in accordance with ASTM A 153 either bright steel, copper-clad steel, or zinc coated after fabrication. Reinforcement shall consist of two or more parallel longitudinal wires, not less than 0.1620 inch (8-gage) in diameter, weld connected with cross wires, not less than 0.1350-inch (9-gage) in diameter. Cross wires shall be crimped to provide an effective moisture drip in wall cavity. The out-to-out spacing of the longitudinal wires shall be 1-¹/₂ to 1-³/₄ inches less than the actual width of the masonry. The distance between welded contacts of cross wires with each longitudinal wire shall not exceed 16 inches. Joint reinforcement shall be provided in flat sections, not less than 10 feet in length, except that corner reinforcement and other special shapes may be less in length.
- 2.3.2 **Ties:** Provide approved design of copper-clad steel, zinc coated steel, or non-corrosive metal having the equivalent total strength of steel types. Zinc-coat items by the hot-dip process after fabrication to a minimum of 1.25 ounces of zinc per square foot of surface when tested in accordance with ASTM A 90.
- a. Wire Mesh Ties: Wire not lighter than 20-gage, galvanized, ½ inch mesh with width of one inch less than thickness of masonry.
 - b. Corrugated Metal Ties: Not less than 7/8 inch wide by approximately 6 inches long and not lighter than 22-gage.
- 2.3.3 **Fastenings:** Provide suitable and approved bolts, metal wall plugs, or other approved metal fastenings for securing furring to masonry and elsewhere as necessary. Bolts or other fastenings longer than 1-½ inches (40 mm) shall be attached to masonry units only where there are grouted cells.

PART 3 - EXECUTION

- 3.1 **INSTALLATION:** Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Do not change source of supply materials after the work has started if the appearance of the finished work would be affected.

3.1.1 Protection

- a. Stains: Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.
- b. Loads: Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed.

- 3.1.2 **Workmanship:** Masonry wall shall be carried up level and plumb all around.

One section of the walls shall not be carried up in advance of the others, unless specifically approved by the Engineer. Unfinished work shall be stepped back for joining with new work; toothing will not be permitted, except where specified.

Heights of masonry shall be checked with an instrument at each floor, and at sills and heads of openings, to maintain the level of the walls. Door and window frames, louvered openings, anchors, pipes, ducts, conduits shall be built in carefully and neatly as the masonry work progresses. Spaces around metal doorframes shall be filled solidly with mortar. Masonry units shall be handled with care to avoid chipping, cracking, and spalling of faces and edges. Drilling, cutting, fitting, and patching, to accommodate the work of other, shall be performed by masonry mechanics. Masonry shall be cut with masonry saws in exposed work, where indicated by the Engineer. Structural steelworks, bolts, anchors, inserts, plugs, ties, lintels, and miscellaneous metalwork specified elsewhere shall be placed in position as the work progresses. Chases of approved dimensions for pipes and other purposes shall be provided where indicated or necessary. Tops of exposed walls and partitions, not being worked on, shall be covered with a waterproof membrane, well secured in place. Unless indicated otherwise, partitions shall extend from floor to the bottom of the floor or roof construction above. Walls and partitions shall be structurally bonded or anchored to each other and to beams and columns. Non-load bearing partitions and interior walls shall be securely anchored to the construction above, in a manner that provides lateral stability while permitting unrestricted deflection of construction above. Scaffolding shall be inspected regularly, and shall be amply strong, well braced, and securely tied in position. Overloading of scaffolding will not be permitted.

3.1.3 **Mortar Mixing:** Measure mortar materials in proper containers to maintain control and accuracy of proportions. Do not measure materials with shovels. Unless specified otherwise, mix mortar in proportions by volume. Introduce and mix aggregate in such a manner that the materials will be distributed uniformly throughout the mass. Add water gradually and mix not less than 3 minutes, until proper plasticity is obtained. Machine mix mortar, is mixers of the type in which the quantity of water can be controlled accurately and uniformly. Hand mixing may be used only when specifically approved. Keep mortar boxes, pans, and mixer drums clean and free of debris or dried mortar. Do not use re-temper ed mortar which has not been placed in its final position within 1-1/2 hours after the initial mixing.

- d. **Mortar:** Mix mortar at the site using materials conforming to ASTM C 270 to obtain type of mortar required. Measurement and mixing shall conform to ASTM C 270. When masonry cement is used, conform to printed mixing instructions of the masonry cement manufacturer.
- e. **Grout:** ASTM C 476. Provide fine grout in grout spaces less than 2 inches in any horizontal dimensions or in which clearance between reinforcing and masonry is less than $\frac{3}{4}$ inch. Provide coarse grout in grout spaces 2 inches or greater in all horizontal dimensions, provided the clearance between reinforcing and masonry is not less than $\frac{3}{4}$ inch.

3.1.4 **Mortar Joints:** Uniform thickness of $\frac{3}{8}$ inch (10 mm), unless otherwise indicated. Tool exposed joints slightly concave with a round or other suitable jointer slightly larger than the width of the joint so that complete contact is made along the edges of the units, compressing and sealing the surface of the joint. Strike flush joints that will not be exposed. Tool horizontal joints first. Brush joints to remove all loose and excess mortar. All horizontal joints shall be level; vertical joints shall

be plumb and in alignment from top to bottom of wall within a tolerance of not more than $\frac{1}{2}$ inch in 40 feet. Provide concrete curb or pedestal at the bottom with the necessary height to obtain a clear height of the masonry wall in modules of masonry unit height plus mortar of $\frac{3}{8}$ inch (10 mm) to avoid cutting of masonry units. Insertion of broken masonry units at the top of wall below a beam or slab will not be permitted.

3.1.5 Concrete Masonry Unit Work: Lay the first course in a full bed of mortar for the full width of the unit. Lay succeeding courses in running bond unless otherwise indicated. Form bed-joints by applying the mortar to the entire top surfaces of the inner and outer face shells. Form head joints by applying the mortar for a width of about 1 inch to the end of the adjoining units laid previously. The mortar shall be smooth, not furrowed, and shall be of such thickness that it will be forced out of the joints as the units are being placed in position. Where anchors, bolts, and ties occur within the cells of the units, place metal lath in the joint at the bottom of such cells and fill the cells with mortar or grout as the work progresses. Use concrete brick for bonding walls, working out the coursing, topping out walls under sloping slabs, distributing concentrated loads, backing brick headers, and elsewhere, as required. Do not dampen concrete masonry units before or during laying.

a. **Special Concrete Masonry Unit Work:** Where exposed concrete masonry unit walls and partitions are indicated, provide special concrete masonry unit work. Select units for uniformity of size, texture, true plane, and undamaged edges and ends of the exposed surfaces. Place units plumb, parallel, and with properly tooled joints of maximum $\frac{3}{8}$ inch (10 mm) thickness. Keep exposed surfaces clean and free from blemishes or defects. Lay units in the bond pattern indicated.

b. **Reinforced Concrete Masonry Unit Walls:** Where vertical reinforcement occurs, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before grout is placed. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Position reinforcing accurately as indicated. As masonry work progresses, secure vertical reinforcing in place at vertical intervals not to exceed 160 bar diameters. Embed horizontal reinforcing in grout as grouting proceeds. Minimum clear distance between masonry and vertical reinforcement shall not be less than $\frac{1}{2}$ inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tying them together.

3.1.6 Bonding and Anchoring: Unless indicated otherwise, extend partitions from the floor to the bottom of the floor or roof construction above. Structurally bond or anchor walls and partitions to each other and to concrete walls, beams, and columns. Securely anchor non-load bearing partitions and interior walls to the construction above as indicated. Completely embed anchors in mortar joints.

a. **Corners of Load-Bearing Walls:** Provide a true masonry bond in each course, except where indicated or specified otherwise.

- b. Intersections of Load-Bearing Walls: Provide a true masonry bond in each course or anchor with rigid steel anchors not more than 2 feet apart vertically, unless otherwise indicated.
 - c. Intersections of Non-Load-Bearing Partitions with Other Walls or Partitions: Tie with wire mesh at vertical intervals of not more than 2 feet or with masonry bonding in alternate courses.
 - d. Masonry Walls Facing or Abutting Concrete Members: Anchor masonry to the concrete with dovetail or wire-type anchors inserted in slots or inserts built into the concrete. Locate anchors not more than 18 inches on centers vertically and not more than 24 inches on centers horizontally.
- 3.1.7 **Horizontal Joint Reinforcement:** Provide reinforcement in every other course and in the first two courses above and below openings in walls and partitions of concrete masonry units. Reinforcement shall be continuous except at control joints and expansion joints. Reinforcement above and below openings shall extend not less than 24 inches beyond each side of openings. Provide reinforcement in the longest available lengths, utilizing the minimum number of splices. Overlap ends not less than 12 inches. Provide welded L-shaped assemblies not less than 32 by 32 inches, both of the same size members and the same construction as the straight reinforcement, at corners and intersections of walls and partitions. Place the reinforcement and apply mortar so as to provide mortar cover for the wire of at least $\frac{5}{8}$ inch for exterior wall face and $\frac{1}{2}$ inch for interior wall face.
- 3.1.8 **Concrete Masonry Unit Lintels and Bond Beams:** Provide special units, fill cells solidly with grout of concrete, with a strength same as masonry or higher and provide not less than two $\phi 16$ reinforcing bars, unless indicated otherwise. Reinforcing shall overlap a minimum of 40 bar diameters at splices. Terminate bond beams and reinforcing on each side of expansion joints (and control joints). Concrete masonry units shall be thoroughly wet prior to pouring concrete grout. Concrete masonry units used for lintels and bond beams shall have exposed surfaces of the same material and texture as the adjoining masonry units. Allow lintels to set at least 6 days before shoring is removed. Lintels shall be straight and true and shall have at least 8 inches of bearing at each end.
- 3.1.9 **Control Joints:** Provide where indicated in concrete masonry unit walls. Provide control joints of the sawed type or the built-in type, as the case requires. Joints shall occur directly opposite each other on both faces of the wall and shall be filled with an approved non-staining elastic calking compound or sealant.
- 3.1.10 **Grout Placement:** Place grout from the interior side of walls, except as approved otherwise. Protect sills, ledges, offsets, and other surfaces and remove any excess grout immediately. Grout shall be well mixed to prevent segregation and shall be sufficiently fluid to flow into joints and around reinforcing without leaving voids. Place grout by pumping or pouring from buckets equipped with spouts in lifts not exceeding 4 feet. Keep pours at 1- $\frac{1}{2}$ inches below the top of masonry units in top course, except at the finish course. Puddle or agitate grout thoroughly to eliminate voids. Do not displace masonry from its original position. Remove masonry displaced by grouting operation and relay in alignment with fresh mortar.

3.1.11 **Forms and Shoring:** Construct to the shape, lines and dimensions of members indicated and make sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry. Forms shall remain on girders and beams not less than 10 days after completion of the members. Not less than 16 hours shall elapse before uniformly distributed construction loads are applied to completed masonry members. Not less than 64 hours shall elapse before concentrated loads are applied.

3.2 CLEANING

- 3.2.1 **Protection:** Protect work which may be damaged, stained or discolored during cleaning operations.
- 3.2.2 **Pointing:** Upon completion of masonry work, cut out defective mortar joints and tuck joints and all holes solidly with mortar.
- 3.2.3 **Cleaning:** Clean exposed masonry surface with clear water and stiff fiber brushes and rinse with clear water. Where stains, mortar, or other soil remain, continue cleaning as follows: Clean masonry surfaces by scrubbing with warm water and soap and rinsing thoroughly with clean water. Restore damaged, stained, and discolored work to its original conditions or replace with new work.

PART 1 - GENERAL

1.1 SUMMARY

1.1.1 Structural steel framing and shoring system, complete with base plates, bracing, anchorage including the following:

- a. Erection and connecting structural steel frame and temporary structural steel framework.
- b. Baseplate grouting.

1.2 APPLICABLE PUBLICATIONS: The publications listed below form part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition shall be applicable.

1.2.1 American Institute of Steel Construction (AISC):

1. "Code of Standard Practice for Steel Buildings and Bridges," except Paragraph 4.2.1 is modified by deletion of the following sentence: This approval constitutes the owner's acceptance of all the responsibility for the design adequacy of any connections designed by the fabricator as a part of his preparation of these shop drawings."
2. Manual of Steel Construction, Allowable Stress Design, 9th Edition, 1989.
3. "Specifications of the Design, Fabrication and Erection of Structural Steel for Buildings."

4. Specification for Structural Joints Using ASTM A325 or A490 Bolts.

1.2.2 American Society of Testing and Materials (ASTM):

A6 General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.

A36 Structural Steel.

A53 Pipe.

A123 Zinc (Hot-Dip Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip.

A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A307 Carbon Steel Externally and Internally Threaded Standard Fasteners.

A325 High Strength Bolts for Structural Steel Joints.

A441 High Strength, low Alloy Structural Manganese Vanadium Steel.

A490 Quenched and Tempered Alloy Steel Bolts for Structural Steel Joint.

A500 Grade B Cold-Formed Welded and Seamless Carbon Steel Structuring Tubing.

A501 Hot-Formed Welded and Seamless Carbon Steel Structural Pipe.

A572 High Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality.

A588 High Strength Low-Alloy Structural Steel with 50,000 PSI Minimum Yield Point to 4-inch Thickness.

1.2.3 American Welding Society (AWS):

A2.4 Welding Symbols

A3-0 Terms and Definitions

A5.1 Specifications for Mild Steel Electrodes for Flux Cored Arc Welding.

A5.20 Specification for Low-Alloy Steel Covered Arc-Welding Electrodes.

A5-5 Specification for Low-Alloy Steel Covered Arc-Welding Electrodes.

A5.17 Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.

A5-23 Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.

D1.1 Structural Welding Code-Steel.

D1-4 Reinforcing Steel Welding Code, including Metal Inserts and Connections in Reinforced Concrete.

F959 Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.

1.2.4 Federal Specifications (Fed. Spec.):

TT-C-490 Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings

TT-P-645 Primer Paint, Zinc Chromate, Alkyd Type

1.2.5 **Steel Structures Painting Council (SSPC) Publications:**

SP3 Power tool Cleaning

SP6 Commercial Blast Cleaning

1.3 **QUALITY ASSURANCE**

1.3.1 **Fabricator/Erector:** Must have plant, facilities and personnel qualified and sufficient to fabricate and/or erect structural metal framing as indicated on drawings. Must have minimum of 5 years' experience and to be able, upon request, to show framing of size, materials and scope similar to work of this contract.

1.3.2 **Material:** Provide only structural steel certificate as conforming to specified requirements and fabricate especially to the requirements of this contract. Material which, does not conform to the requirements of this contract, may be rejected at any time prior to final acceptance.

1.3.3 **Allowable Tolerances:** Unless otherwise specified or noted on drawing, provide structural steel work in accordance with the following minimum tolerances:

a. Fabrication Tolerances: In accordance with requirements of AISC specification unless noted otherwise and as required to maintain the erection tolerances specified herein.

b. Erection Tolerances: In accordance with requirements of AISC. The contractor alone shall be responsible for the correct fitting of all structural members including the elevations and alignments. Refer to the drawings for additional requirements.

1.3.4 **Connection Identification:** Each person installing connections shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified so that the Owners Testing Lab can refer to the person making the connection.

1.3.5 **Test and Inspection:** Work is subject to special testing and inspection. The fabricator/erector shall provide the Owners Testing Lab and Architect/Engineer access to places where material is being fabricated/erected. Notice shall be given for joints requiring inspection for proper end preparation, root opening, etc., and prior to welding.

1.3.6 **Connections Designed on the Structural Drawings:**

a. Contractor shall not deviate from these designs unless approved by the Architect/Engineer.

b. Connections shown on the drawings may eliminate certain methods of erection.

- c. If contractor elects a method of erection that required a change of some of the connections, it must be approved by Architect/Engineer.

1.3.7 Engineering by Contractor: Design and calculations shall be prepared by a Contractor's Structural Engineer, for the support of hoisting equipment, welding machines and other superimposed loads, for the stacking of materials such as metal decking, etc., and where required for temporary bracing, shoring and other safety related construction procedures.

- a. It is Contractor's responsibility to obtain and pay for such engineering services.

1.3.8 Welder Qualifications:

Each welder performing work on this project shall be qualified

- a. in accordance with the American Welding Society. AWS D1.1.
He shall have been qualified a minimum of six (6) months
- b. before commencement of welding on this project.
Copies of each welder's qualification records shall be made
- c. available to
the Engineer for inspection.

1.3.9 Inspections: Shop welding is to be done in ICBO approved licensed shops. Field welds shall be continuously inspected by a qualified inspector per UBC Section 306.

1.3.10 Vendor Quality Assurance: The fastener supplier shall visit the project site during the bolting start-up to demonstrate proper installation procedures and verify inspection procedure with the Owners Testing Lab. The fastener supplier must provide documentation of quality assurance including mill reports and description of bolt origin. Submit performance records from two prior projects of similar size. Records should include percentage of bolt failure during erection and rate of replacement required during inspection. Supplier quality assurance program shall also be outlined. Program must include assurance that bolts from only one heat will be included in a keg.

1.3.11 Shop Testing by Contractor: The Contractor shall perform ultrasonic testing and visual inspection of all plate material and rolled sections greater than 1-½ inches in thickness and located at welded connections for discontinuities prior to fabrication. The test area is defined as a cone up to 6 inches away from the weld in the connection. These tests shall be in addition to the ultrasonic testing of all full-penetration welds which will be performed by the Owners Testing Lab. The contractor's testing shall be approved by the Architect/Engineer and Owners Testing Lab. All costs associated with this testing shall be borne by the Contractor.

- a. Ultrasonic Testing: Conduct in accordance with ASTM A435 with the following modifications and supplementary requirements:
 - i. Supplementary Requirement S1, requiring 100 percent scanning of the test area to be included.
 - ii. Section 5.2, Acceptance Standards, is supplemented with the following provision: "The fabricator, insofar as practical, may reposition a rejected plate so that rejected defects are not

located in a test area.”

- 1.3.12 Use adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

1.4 SUBMITTALS

- 1.4.1 Shop Drawings: Submit shop drawings for review prior to commencing any fabrication of structural steel.

- a. Before shop drawings are submitted, fabricator shall back check drawings to discover obvious drafting and detailing errors. Show framing layout, dimensions, connections with adjoining materials
- b. and construction, finishes, welds, bolts and fasteners, anchoring and all fabrication or erection accessories required.
- c. Show field welds, cuts, holes and fasteners. Verify all dimensions and correlate with adjoining construction
- d. and materials.
- e. Indicate size, type and grade of all members.
- f. Include with each detail shown on the top shop drawings a reference to the Architect's and Engineer's drawings and details, where applicable.

- 1.4.2 Submit fabricator's quality assurance procedures to the architect, engineer, owner and Owners Testing Lab.

- 1.4.3 Indicate welded connections on shop drawings using standard AWS welding symbols. Show all welded connections with details showing size, length, location and type of welds.

- 1.4.4 Mill Reports: Submit certified copies of mill reports indicating heat and melt numbers of steel.

- a. If test reports are not submitted or test reports cannot be identified with material proposed for use in the work, then secure and perform structural test on 5 percent of all such identified steel.
- b. Contractor shall furnish all such material for testing and pay for all such tests.
- c. Furnish Owner, Architect and Structural Engineer certified copies of all test reports.

- 1.4.5 Inspection Test Reports: Upon request, submit to Engineer copies of ultrasonic testing reports.
- 1.4.6 Placement Plans: Submit placement plans and details as required for the satisfactory placing, connection and anchorage of all structural members.
- 1.4.7 Survey Reports: Upon request, promptly submit an accurate survey of actual elevations and location of base plates and anchor bolts and alignments as well as elevations of all steel as noted on the drawings.
- 1.4.8 Certification: Submit manufacturer's certified test reports on load indicator washers and/or tension control bolts on at least three samples from each heat supplied to conform to tolerance range.
- 1.4.9 Welding Procedures: For welded joints pre-qualified and non-pre-qualified by AWS D1.1, submit detailed description of welding procedures proposed for use on structural metals. Obtain approval prior to any welding operation. Furnish joint welding procedure qualification tests as required by AWS D1.1 for non-pre-qualified welded joints.
- 1.4.10 Manufacturer's Certification: Required as follows:
 - a. Bolts, Nuts and Washers: Furnish complete manufacturer's mill test reports conforming to ASTM A325, Type 1, or ASTM A490. Markings and chemistry must also comply to specification. Certification numbers must appear on product containers and correspond to certification numbers on mill test report to be accepted. Mill test report must be supplied to both purchaser and Owners Testing Lab.
 - b. Filler material welding.

1.5 DELIVERY, STORAGE, HANDLING

- 1.5.1 Comply with the requirements of the general conditions and of ASTM A6, including the following.
- 1.5.2 Store materials to permit easy access for inspection and identification.
 - a. Keep steel members off the ground, using pallets, platforms or other supports.
 - b. Protect steel members and packaged materials from erosion and deterioration.
- 1.5.3 Do not store materials on the structure in a manner that might cause distortion or damage to the members of the supporting structures. Repair or replace damaged materials or structures at no additional expense to owner.
- 1.5.4 Columns, beams, girders and other members, which are to receive sprayed-on fireproofing, shall be free of loose rust, heavy mill scale, oil, dirt or other foreign substances prior to application of fireproofing materials.
- 1.5.5 All fasteners shall be stored and protected in accordance with the current requirements of the "Specification for Structural Joints using ASTM A325 or A490 Bolts."

1.6 JOB CONDITIONS

Coordination: Coordinate exact locations of beam penetrations with mechanical and/or electrical contractor. Exact locations of all penetrations must be submitted to the Engineer for review.

Temporary Bracing: Temporary bracing and guylines shall be provided to adequately protect all persons and property and to ensure proper alignment.

Temporary Floors: All temporary flooring, planking and scaffolding necessary in connection with the erection of the structural steel or support of erection machinery shall be provided. The temporary floors or use of steel decking shall be as required by law and governing safety regulations. The reduced load capacity of members and assembly, especially the floor and roof beams and girders, due to their untraced connection prior to welding of metal deck and completion of concrete slabs is hereby noted.

Holding and Protection: In assembling and during welding, the component parts shall be held with sufficient clamps or other adequate means to keep parts straight and in close contact. In welding, precautions shall be taken to minimize "lock-up" stress and distortion due to heat. During high winds, welding shall be done only after adequate wind protection is furnished and set up.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

- 2.1.1 **Carbon Steel and High Strength Low-Alloy Steel:** Provide steel shapes, plates and bars of structural quality, sizes and types noted on drawings for use in welded and bolted construction. Steel manufactured by the acid Bessemer process shall not be used for structural purposes. Steel, which in the opinion of the inspector is badly corroded or physically damaged, shall not be incorporated in the work.
- 2.1.2 **Coating:** Provide steel unprimed where steel is to be fireproofed. Metal Shop Finish for required primer and painting of non-proofed steel.
- 2.1.3 **Standard Fasteners:** Low-carbon steel externally and internally threaded fasteners conforming to requirements of ASTM A307, Grade A. Provide hexagonal heads and nuts for all connections. Include lock washers under nuts or self-locking nuts.
- 2.1.4 **High-Strength Fasteners:** Quenched and tempered steel bolts and nuts conforming to requirements of ASTM A325 or ASTM A490.
 - a. Provide heavy hexagonal head bolts and nuts, and hardened steel washers.
 - b. Load indicator washers conforming to ASTM F959 or tension control bolts shall be used.
 - c. Any proposed substitutions must have documentation submitted for review and approval of the structural engineer prior to construction.
 - d. Acceptable tension control bolt suppliers shall be Lejuene Bolt Company/Lakeview, Minn. And Bristol Industries/Brea, Calif.
- 2.1.5 **Welded Electrodes:**

a. For base metal conforming with ASTM A36, A53 and A500, shielded metal arc, flux-cored arc and submerged arc welding use E70XX, E7XT-X and F7X-EXXX electrodes in accordance with AWS A5.1, AWS a5.20, AWS A5.20 or AWS 23.

2.1.6 **Steel Stud Anchors:** All steel stud anchors welded to steel beams or plates for concrete anchorage shall be "tru-weld studs," Division of Tru-Fit Screw Products Corporation, Cleveland, Ohio, "Nelson Stud," Division of Gregory Industries, Inc., Lorain, Ohio or approved equal. All stud anchors shall be automatically end-welded in shop or field with equipment recommended by manufacturer of studs.

2.1.7 **Drilled-in-Concrete Anchors:** Refer to structural drawings.

2.1.8 **Shop Painting:**

a. Pre-Treatment: Mil. Specs DOD-P-15328 or Fed. Specs. TT-C-490, Type I, II or IV.

b. Primer: Fed. Specs TT-P-645

2.1.9 **Galvanizing:** ASTM A123 or A153, as applicable, unless specified otherwise.

a. Galvanizing Repair Paint: Mil. Specs. DOD-P-21035

2.1.10 **Other Materials:** Provide all incidental and accessory materials, tools, methods and equipment required for fabrication and erection of structural steel framing as indicated on drawings.

2.1.11 **General:** Miscellaneous materials or accessories not listed above shall be provided as specified hereinafter under the various items of work and as indicated on the drawings or required for good construction practice.

2.1.12 Provide additional structural steel support framing for metal deck where normal deck bearing is precluded by column flange plates or other framing members.

2.1.13 Provide other materials, not specifically described but required for a complete and proper installation, as selected by the contractor subject to the approval of the Engineer.

2.2 FABRICATION

2.2.1 Fabricate all steel in accordance with requirements of AISC specifications and in accordance with details indicated on the drawings or as approved on shop drawings.

a. Identify all steel at mill showing grade and yield points.

b. Identify each piece with an erection mark corresponding to identifications noted on erection drawings.

2.2.2 **Cutting:** All holes and openings must be approved by the owner's Structural Engineer.

- a. No flame cutting by hand for openings greater than one half the depth of the member shall be allowed, unless approved by engineer.
 - b. All flame-cut holes shall be smoothed by chipping, planning or grinding members to required AISC tolerances.
 - c. Sharp bends or kinks will not be allowed.
 - d. Flame cutting by hand will not be allowed for holes at connections.
- 2.2.3 Materials shall be properly marked and matched-marked where field assembly requires. The sequence of shipments shall be such as to expedite erection and minimize the field handling of material.
- 2.2.4 Milled surfaces shall be completely assembled or welded before milling. Milled surfaces to provide full bearing over the cross section.
- 2.2.5 Beams and girders shall be upward cambered where indicated on the drawings. For beams and girders without specified cambers, fabricate members so that after erection, any minor camber due to rolling or fabrication is upward.
- 2.2.6 Beam connections shall be as shown or noted on the drawings.
 - a. Unless noted otherwise, standard connections shall be used in accordance with AISC standards.
 - b. Steel requiring adjustment shall be provided with slotted holes, as indicated on the drawings.
- 2.2.7 Combination of bolts and welds techniques and procedures shall conform to the requirements of UBC – Standard No. 27-6.
 - a. Welding, AISC specification for the “Design, Fabrication and Erection of Structural Steel for Buildings,” and AWS “Structural Welding Code,” and “Filler Metal Specifications.”
- 2.2.8 For stud anchor and deformed bar anchor welding, the area where the anchor is to be attached shall be made free of all foreign material such as rust, oil, grease, paint, etc.
- 2.2.9 Welding processes other than shielded metal arc, flux core arc, and submerged arc may be used provided procedure qualification tests in accordance with the American Welding Society are made for the intended application of all such processes.
- 2.2.10 Built-up sections assembled by welding shall be free of warpage and all faces shall be true alignment.
- 2.2.11 Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS.
- 2.2.12 Welding sequences, preheat methods, and detailing of joints shall be such as to reduce the residual stresses to a minimum.
 - a. Structural Engineer may authorize suitable testing to determine magnitude of residual stresses due to welding on several initial fabricated production units. Such testing will be performed in a timely manner coordinated with the

fabricator's production schedule.

- b. **Types of Welds:** Required weld types are indicated by symbols on drawings; characteristics of welds in accordance with standard specifications or codes as applicable; each welder shall mark his identification symbol on his work.
- c. **Welding:** Shape edges to be joined as indicated on drawings; prepare and clean edges of all oil, grease, scale and rust in accordance with AWS D1.1.
- b. **Reinforcing Steel:** Welding or tack welding or reinforcing bars to other bars or plates, angles and similar shapes is prohibited, except where specifically shown on plans or approved by structural engineer, where required, use electrodes in accordance with requirements of AWS D1.4/12.1, and the structural general notes.

2.2.13 The toughness and notch sensitivity of the steel shall be considered in the formation of all welding procedures to prevent brittle and premature fracture during fabrication and erection.

2.2.14 Detailing of connections, welding sequences and preheat methods shall be such as to minimize the accumulation and concentration of through thickness strains due to weld shrinkage.

2.2.15 **Cleaning:** Clean all surfaces of oil, grease, loose rust, loose mill scale and other foreign matter present in sufficient quantities to impair bond of spray fireproofing.

- a. Remove all slag or flux remaining on any bead before proceeding; remove any cracks or blow holes that appear on any bead by chipping, grinding or gas gouging before proceeding.

2.2.16 **Fabrication Tolerances:** In accordance with AISC specifications, except as required to maintain the erection tolerances specified herein. Maximum tolerances for camber of steel beams/girders shall be plus or minus ¼ inch.

2.2.17 **Steel Stud and Deformed Bar Anchors:**

- a. All anchors shall be automatically end-welded in the shop or field with equipment recommended by the manufacturer of the studs and by qualified welders. Steel stud material, welding and inspection shall be in accordance with AWS D1.1. End-weld in such a manner as to provide complete fusion between the end of the stud and the plate. There shall be no porosity or evidence of lack of fusion between the welded end of the stud and the plate.
- b. **Tests and Inspections:** At the beginning of each day's work, a minimum of two test stud welds shall be made, with the equipment to be used, to metal which is the same as the actual work pieces. The test studs shall be subjected to a 90-degree bend test by striking them with a heavy hammer. After the above test, the weld section shall not exhibit any tearing out or cracking.

PART 3 – EXECUTION

3.1 ERECTION

3.1.1 **General:** Erect structural steel framing in accordance with governing codes and specifications. Conform to configurations and connections as approved on shop and erection drawings.

3.1.2 **Bracing:** Provide temporary shoring and bracing members as necessary.

3.1.3 **Column Base and Bearing Plates:** Align attached column bases and

bearing plates for beams and similar structural members. Set loose column bases and bearing plates. Grout solid with non-shrink grout as specified.

3.1.4 **Field Assembly:** Accurately assemble structural framing to lines and elevations indicated within specified or noted tolerances.

- a. Align and adjust various members of framing system prior to fastening.
- b. Prior to assembly, clean bearing surfaces and surfaces, which will be in permanent contact.
- c. Splice structural members only where indicated or where approved.
- d. Cut holes by drilling only.
- e. Fasten splices of compression members after bringing abutting surfaces completely into contact.
- f. Make all field connections by high strength bolting or welding, unless otherwise noted.
- g. Tighten and leave erection bolts in place after welding. Where high strength bolts is required, provide identified and marked bolts; install using procedure as hereinafter specified; mark tightened bolts.

3.1.5 Do not use gas cutting torches in the field, unless approved by Architect/Engineer for correcting fabrication errors in the structural framing.

3.1.6 Furnish shim plates or develop fills where required to obtain proper fit and alignment.

3.1.7 **Composite Construction:** This building utilizes composite (concrete and structural steel) construction for various beams, careful sequencing of steel erection and concrete placement is recommended.

3.1.8 **Connections:** No welding or bolting shall be done until as much of the structure as will be stiffened by the welding or bolting has been properly aligned.

3.1.9 **Drift pins** shall not be used to enlarge unfair holes in main material. Holes that must be enlarged shall be reamed up to a maximum of $\frac{1}{16}$ th of an inch larger to admit bolts. Burning, drifting and reaming may be used to align unfair holes, in members only after approval by the Owner's Structural Engineer.

3.1.10 When high-strength friction or high-strength bearing bolts are used, the installation shall be by use of direct tension indicator washers or tension control bolts as specified.

- a. All bolts shall have threads extended not less than $\frac{1}{4}$ inch beyond nuts. Provide a minimum of one washer per bolt.

3.1.11 Mutilate threads or use lock nuts for unfinished bolts to prevent nuts from backing off. Draw unfinished bolt heads and nuts tight against the work.

3.1.12 Establish required leveling and plumbing measurements on the mean operating temperature of the structure.

- a. Make allowances for differences between temperature at time of erection and mean temperature at which the structure will be maintained when completed and in service.

3.1.13 The steel erector shall leave the steel clean of oil or other contaminants as outlined under Part 2 of this specification.

3.2 HIGH STRENGTH BOLT INSTALLATION AND INSPECTION

3.2.1 **General:** All high-strength bolts, nuts and washers, as well as their installation and inspection, shall conform to requirements of current edition of "Specification for Structural Joint using ASTM A325 or A490 Bolts," except that the installation of "turn-of-nut tightening" will not be accepted.

- a. All high-strength bolts, both friction and bearing type, shall be installed in accordance with Paragraph 5D, "tightening by use of direct tension indicator," unless, noted otherwise on the drawings.

- b. Load-indicator washers (LIW) or tension bolts (TCB) shall be used as the authorized direct tension indicator.

3.2.2 Load Indicator Washers (LIW): LIW shall be supplied, providing tensions at gaps specified no less than the minimum and no more than 20 percent above the minimum bolt tensions per Table 3, "Structural Joints Using ASTM A325 or A490 Bolts," (-0, +20%)

- a. The manufacturer shall provide certified test reports of at least three load indicators from each heat supplied to confirm the tolerance range (-0, +20%.)

- b. Hardened washers shall be used under elements turned on all high – strength bolts to reduce galling of components

- c. Prior to the final tightening of all high-strength bolts in multi-bolt connections, draw together all the piles of steel by partially compressing LIX protrusions during "snug tight" operation. This will show that each bolt has been partially tensioned, allowing for plat compression so that there will be no subsequent loosening of the bolts when they are finally tightened. The tensioning shall progress systematically from the most rigid part of the joint to its free edges until the protrusions of all LIW's are closed to the required gap.

- a. The Inspection Testing Laboratory (ITL) need not be present during the entire installation and tightening operation, provided that it has done the following:

- i. Inspected the surfaces and bolt type for conformance to plans and specifications as proof to start bolting.

- ii. Will, upon completion of all bolting, verify the minimum specified bolt tensions visually and by using the feeler gauge as "no go" inspection on a few bolts in each connection (10 percent or two bolts, whichever is greater.)

- b. All LIW's shall be of the same surface condition, either "weathered" or "bright."

3.2.3 **Tension Control Bolts (TCB):** TCB shall be supplied providing shearing of

the bolt tip at no less than the minimum and no more than 20 percent above the minimum bolt tension per Table 3, "Structural Joints Using ASTM A325 or A490 Bolts," (-0 , + 20%.) To ensure quality control, test a minimum of three bolts for each grade, diameter and type for each heat, tests shall be performed at weekly intervals on three bolts for each grade, diameter and type taken from the supply of bolts on the floor actually being installed at the time. Tighten each bolt in the SWBTC until the torque-off spline has sheared, and observe the tensions values obtained. The values obtained on the SWBTC shall be no less than the minimum and no more than 20 percent above the minimum bolt tension per Table 3 (-0, +20%).

- a. Prior to the final tightening of all high-strength bolts in a multi-bolt joint, draw together all the plies of steel to a "snug-tight" condition by partially tightening the bolts without shearing the torque-off spline. After a "snug-tight" condition has been accomplished, tension the bolts until the torque-off spline shears, progressing systematically from the most rigid part of the joint to its free edge.
- b. The ITL need not be present during the entire installation and tightening operation, provided the ITL has:
 - i. Prior to the start of bolting, inspected all surfaces and bolt types for conformance with plans and specifications.
 - ii. Performed the quality control bolt tests specified above.
 - iii. Visually inspected 100 percent of the high-strength bolts for proper installed tension. Except as noted below, it will be assumed that properly installed bolt tensions have been achieved if the spline has twisted off.

3.2.4 **Other Inspections:** In both LIW and TCB installation, the ITL shall further examine large, multibolt, multirow connections for possible loss of bolt tensions due to fit-up problems.

- a. In the case of a dispute regarding final installed bolt tensions in a specific joint, a calibrated torque wrench shall be used to verify the installation as outlined in Section 6 (D) 4 of "Structural Joints Using ASTM A325 or A490 Bolts."

3.3 CUTTING

3.4.1 Do not field cut or alter structural member without the written approval of the Structural Engineer.

3.4.2 Do not use gas cutting torches for correcting fabrication errors in structural framing.

3.4.3 Finish Gas-cut sections equal to a sheared performance.

3.4 ERECTION TOLERANCES AND SURVEY

3.5.1 Plumb, level and align individual pieces in accordance with the requirements of the "AISC Code of Standard Practice for Steel Buildings and Bridges."

3.5.2 Field Survey: Make an accurate survey of alignments and elevations of all

steel members as noted on the drawings.

- a. Should locations vary beyond the allowable tolerances, notify Architect/Engineer and take necessary corrective measures and modify details and/or procedures as required and approved.
- b. Permanent benchmarks shall be established by a registered Professional Engineer employed by Contractor in accordance with the requirements of contract documents.

End of Specification

Structural Engineer

PRC No. :

PTR No. :

Issued at ;

Issued on :