SECTION 3B

PRECAST CONCRETE PANELS

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.

1.1 Federal Specification (Fed. Spec.):

SS-W-110C	Water-Repellent, Colorless, Silicone Resin Base

1.2 American Concrete Institute (ACI) Standards:

211.1-81	Selecting Proportions for Normal, Heavy-Weight, and Mass Concrete
214-77	Evaluation of Strength Test Results of Concrete
318-77	Building Code Requirements for Reinforced Concrete
347-78	Recommended Practice for Concrete Formwork
512.1R-64	Suggested Design of Joints and Connections In Precast Structural Concrete
533.3R-70	Fabrication, Handling and Erection of Precast Concrete Wall Panels

American Institute of Steel Construction (AISC) Publication:

Code of Standard Practice for Steel Buildings and Bridges (1976)

American Society of Civil Engineers (ASCE) Publication:

Connections for Precast Members Can Be Trouble Free (by Paul Gordon, Pages 62-64, Civil Engineering, Volume 36, No. 7, July 1966)

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

A 36-81a	Structural Steel
A 123-78	Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
A 185-79	Welded Steel Wire Fabric for Concrete Reinforcement
A 307-82a	Carbon Steel Externally Threaded Standard Fasteners

A 325-82	High-Strength Bolts for Structural Steel Joints
A 615-82	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C 33-82	Concrete Aggregates
C 143-78	Slump of Portland Cement Concrete
C 150-82	Portland Cement
C 173-78	Air Content of Freshly Mixed Concrete by the Volumetric Method
C 260-77	Air-Entraining Admixtures for Concrete
C 330-80	Lightweight Aggregates for Structural Concrete
C 494-80	Chemical Admixtures for Concrete

1.6 American Welding Society (AWS) Publications:

D1.1-82	Structural Welding Code - Steel
D1.4-79	Structural Welding Code - Reinforcing Steel

1.7 Portland Cement Association (PCA) Bulletin:

D-117	Connections in Precast Concrete Structures, Effects of Restrained Creep and Shrinkage (April 1967)

2. QUALITY ASSURANCE: Precast concrete panels shall be the product of an experienced company with capacity and facilities to manufacture materials of the quality an finish specified and of the quantity indicated without delay to progress to work. Precast concrete manufacturer shall have been regularly engaged in the design and fabrication of precast concrete for a minimum of 3 years. The manufacturer shall have an established Quality Assurance Program in effective operation at the plant.

3. SUBMITTALS: Contractor shall submit the following materials for information, except as specifically indicated below, and in accordance with the SPECIAL PROVISIONS.

3.1 Shop Drawings and Placing Drawings: Drawings shall show the manufacturer's recommended details and material for the work required by paragraph ERECTION and the following:

a. Marking of the units for the placing drawings.

b. Anchorage for work of other trades.

c. Anchorage to supporting construction.

d. Location and sizes of all openings 12 inches wide or larger to be cast into the members.

e. Formwork.

f. Joints between units and between units and other construction.

g. Reinforcing steel details.

h. Method of curing.

i. Pickup points and lifting devices.

3.2 Materials: Two pound samples each of cement, fine aggregate and coarse aggregate and one sample of each type of handling insert and reglet proposed to be furnished shall be submitted.

3.3 Sample Precast Panel: Before casting precast panel units, one sample precast panel not less than 24 inch by 24 inch by 5 inch deep showing surface finish, including surface sealer, shall be fabricated and submitted for information in accordance with the SPECIAL PROVISIONS. Production of units shall not proceed until finishes of the sample have been approved. The sample precast panel shall be retained at jobsite to serve as the standard of quality for texture, surface finish, and concrete color.

3.4 Production Precast Unit: Prior to the manufacturing of precast units, one full size precast unit shall be fabricated and submitted for information in accordance with the SPECIAL PROVISIONS. Production of units shall not proceed until the full size unit has been approved. The unit may be used on the building with the approval of the Contracting Officer.

3.5 Contractor-Furnished Mix Design: Concrete mix design shall be submitted to the Contracting Officer for approval.

3.6 Test Reports: Certified test reports showing the results of manufacturer's mill or plant tests performed by an independent testing laboratory shall be submitted for approval in advance of any precasting operations. The laboratory shall be certified by the National Bureau of Standards Cement and Concrete Reference Laboratory. Test reports shall show that the materials comply with the applicable specifications and shall include but not be limited to the following items:

a. Reinforcing steels.

b. Cement.

c. Admixtures.

d. Curing materials.

Reports shall be furnished for each shipment and shall be identified by specific lots.

3.7 Design Calculations: Design calculations by precast concrete manufacturer shall be submitted for approval. All equations used or

assumptions made shall be referenced to appropriate source of information by page and paragraph number. Calculations shall include but shall not necessarily be limited to the following:

a. Stresses in members due to bending, shear, compression and torsion caused by vertical and lateral loads, and handling, where critical.

b. Deflection.

c. Ultimate capacity of the members.

d. Stresses in members due to shrinkage, creep, and thermal expansion.

e. Stresses at notches, openings, or recesses where these are deemed significant. Where these are not deemed significant, so state in design calculations.

4. DELIVERY AND STORAGE: Members shall be protected from chipping, warping, staining of exposed surfaces and similar damage during handling and delivery, and shall be stored off the ground and properly supported until placed. Members shall be accessible for inspection and identification.

5. DESIGN:

5.1 General: Precast concrete manufacturer shall verify that members and their connections will withstand erection and transportation loads.

5.2 Bearing and Connection Design: The Contractor may propose alternate connections functionally equal to those shown, subject to the approval of the Contracting Officer and as shown in PCA D-117, ACI 512.1R and ASCE article entitled, Connections for Precast Members Can Be Trouble Free".

6. GENERAL: The work shall be in accordance with the referenced publications, all portions of which are mandatory unless otherwise specified. Where conflicts between referenced publications exist, ACI 318 shall govern.

6.1 Contractor-Furnished Mix Design: A concrete mix design shall be prepared in accordance with ACI 318. Concrete may be proportioned from additional data derived from ACI 211.1 and 214 for an assumed coefficient of variation of 15 percent and a probability of one test in ten falling below the specified strength, provided that the mix designs reflect actual concrete plant standard deviations and the resulting production concrete conforms to the specified requirements. The mix-design shall be based on current materials previously evaluated by the concrete manufacturer whose established methods of statistical quality controls are in conformance with ACI 318. In the absence of such data, the Contractor shall sample and test the aggregates for the design of concrete. Concrete shall be 5000 psi compressive strength at 28 days with graded aggregates to 3/4 inch maximum. Air-entrained concrete may be approved, provided the air-entraining agent is added to the mixer to produce 4 to 6 percent of air by volume. Slump shall not exceed 3 inches.

6.2 Miscellaneous Connections: Anchors, bolts, steel welding inserts, and connection plates, indicated or necessary in connection with the

fabrication and erection of precast concrete members shall be provided. Connections shall be positioned and shall be held in position rigidly to prevent displacement while concrete is being placed. On-site and off-site welding shall be in accordance with AWS D1.1 and D1.4, as applicable.

7. MATERIALS:

7.1 Portland Cement: Portland cement shall conform to ASTM C 150, Type I or Type III. All cement used shall be obtained from a single mill.

7.2 Aggregates: ASTM C 33, concrete aggregate for sandblasted finish panels. Fine aggregate shall be graded No. 4 to 0 and coarse aggregate shall be graded 3/4 inch to No. 4. Lightweight concrete aggregate ASTM C 330, graded as for concrete aggregate specified for finish panels may be used at the Contractor's option.

7.3 Water: Water for mixing and curing, including free moisture and water in the aggregates, shall be clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, silt, organic matter and other deleterious substances. Turbidity of the water shall not exceed 2000 ppm.

7.4 Admixtures: Admixtures including air-entraining, if used, shall have prior approval of the Contracting Officer and shall be from one source. Admixtures shall be added at the mixer and shall be approved agents conforming to ASTM C 260 or ASTM C 494. Admixture shall be certified by the manufacturer to be free of chlorides. Calcium chloride shall not be used.

7.5 Bolts and Nuts: ASTM A 325 and A 307.

7.6 Miscellaneous Steel: Miscellaneous steel items to be cast into the members shall conform to ASTM A 36 and shall be galvanized in accordance with ASTM A 123.

7.7 Continuous threaded, rods, strut inserts, and loop inserts shall be as indicated and shall meet or exceed the requirements specified hereinafter. Items may be of any style that satisfies the load requirements and is properly embedded in the concrete.

Item	Size (Inches)	Minimum Ultimate Capacity In Tension (Pounds)
Continuous Threaded Rod	1/2	9,000
	3/4	18,000
Strut Insert	1/2	9,000
Loop Insert	1/2	9,000
	3/4	9,400

Reglets: Spring lock type not less than 20-gage galvanized steel.

7.9 Reinforcing Bars: ASTM A 615, Grade 60 steel in precast panels.

7.10 Welded Wire Fabric: ASTM A 185 galvanized.

7.11 Joint Filler: Closed cell neoprene by an approved manufacturer.

7.12 Surface Sealer: Fed. Spec. SS-W-110, clear silicone base water repellant. Sealer shall not stain, soil, darken or discolor concrete finish.

7.13 Interlocking conduit shall be semirigid galvanized deformed tubing of minimum 26-gage steel with a minimum inside diameter of 3 inches, as indicated.

7.15 Sleeve anchors for panels shall be a minimum of 20-gage stainless steel. The size of each anchor shall be as shown. Sleeve anchors, including additional reinforcement, shall be provided in strict accordance with the manufacturer's recommendations.

7.17 Shims: Plastic bearing shims shall be "Korolath" by Koro Corporation, Hudson, Massachusetts; plastic buttons by Hohmann and Barnard, Inc.; plastic shims by Preco, Plainview, New York; or approved equal.

8. FABRICATION:

8.1 Forms: Forms shall be well braced and stiffened against deformation, shall be accurately constructed, shall be watertight, and for precasting operations shall be supported on unyielding casting beds. The forms shall be such as to produce a smooth, dense surface. Exposed edges shall be chamfered as indicated. Form ties shall be either the threaded or snap-off type so that no form wires or metal pieces will be left at the surface of the finished concrete.

8.2 Tolerances of Individual Elements: Precast elements shall be true to size and dimensions with inserts and anchoring devices located accurately. Height and width shall be within plus 1/8 inch or minus 1/4 inch and thickness shall be within plus 1/4 inch of indicated dimensions. Bow or warp shall not exceed 1/360.

8.3 Placing of Reinforcement:

8.3.1 Reinforcing Bars and Wire Fabric: Reinforcement shall be fabricated as required and placed in position in the forms within the specified tolerances. Reinforcement shall be adequately secured so as to remain in the proper position during placement of the concrete.

8.3.2 Splicing of Reinforcement: Splicing of reinforcement shall be in accordance with the applicable requirements of ACI 318. Wire fabric and bars shall be held in proper position until the welding is completed.

8.4 Placing of Concrete: Concrete shall not be deposited in the forms until the reinforcement, anchorages, and forms have been inspected and approved. Conveying of the concrete to the casting site shall be as rapid as practicable. The method of conveying the concrete shall not require a higher slump than that required for placing. Depositing a large quantity at any point and running it or working it along the forms shall not be

permitted. Special care shall be taken to fill all parts of the forms, to work the coarse aggregate back from the face, and to force the concrete under and around the reinforcement without displacing them.

8.5 Vibrating: Concrete shall be consolidated in the form by approved high frequency vibration. This vibration may be either internal, external, or a combination of both. Where external vibration is used, forms shall be of a design adequate to withstand such external vibrating without distortion of failure.

8.6 Curing: Prior to the start of casting operations, the method of curing proposed and the details of curing operations shall be submitted to the Contracting Officer for approval. The casting bed for concrete members cured by steam shall be enclosed completely with a suitable enclosure to minimize moisturized head losses. Curing by any of the following methods shall be maintained until adequate strength is reached for handling without damage to the members.

8.6.1 Steam or Hot Water Curing: Concrete shall be cured by steam or hot water at maximum temperature of 165 degrees F. After placement of the concrete, members shall be held for a minimum precuring, presteaming period of 3 hours.

8.6.2 Continuous Water Curing: The surface of the concrete shall be kept moist until the compressive strength reaches the adequate strength required for handling without damage to the members.

8.7 Cracks: Precast concrete containing cracks which are visible but not measurable by ordinary means may be accepted. Cracks of width measurable by ordinary means, 0.01-inch wide and over, will be cause for rejection.

8.8 Formed Surfaces: Honeycombs, chipped corners, and other voids shall be patched as directed. Air pockets and holes over 14 inch in diameter shall be filled with a sand-cement paste. Form offsets or fins over 1/8 inch shall be ground smooth.

8.9 Finishes and Finishing:

8.9.1 Production panels shall match final approved sample. The units shall have a light sandblasted finish on all exterior surfaces.

8.9.2 Prior to curing, wood float or magnesium float exposed surfaces to a smooth, even, impervious finish, free from trowel marks.

8.9.3 After curing and removal of forms, remove fins and loose material and repair small defective areas as specified in paragraph REPAIRS to the satisfaction of the Contracting Officer. Large defective areas will be grounds for rejection of precast units.

8.9.4 Unformed Surfaces: Unformed surfaces shall receive a wood float or magnesium float finish.

9. ERECTION:

9.1 General: Prior to delivery, the method proposed for the lifting, transporting, and placing of the members shall be approved. Precast members shall not be shipped from the plant site or erected until test cylinders show that the concrete has attained the required strength. Members shall be erected in accordance with ACI 533.3R, except as modified by the placing drawings. Members shall be adequately braced until all permanent connections are made. Welding shall conform to AWS D1.1. The Contractor shall compensate for deviations in steel or concrete work which are within tolerances permitted by AISC Code of Standard Practice for Steel Building and Bridges and ACI 347.

9.2 Openings: Openings not indicated on the shop drawing shall be job cut. Holes less than 12 inches in diameter through members shall be made by drilling with a diamond tipped core drill in the field.

9.3 Inserts: Field placed inserts, such as hand-drilled or power-drilled inserts may be placed in members, provided the installation of these inserts does not interfere with reinforcing steel.

9.4 Calking: Joints shall be calked with sealant shown in accordance with SECTION: CALKING AND SEALANTS.

10. ERECTION TOLERANCES: Erected wall panels shall not exceed the following tolerances:

a. Variation from plumb in plane of wall, top, and bottom connection points - plus or minus 1/4 inch.

b. Misalinement in the flat surface of two adjacent panels - 1/4 inch.

c. Minimum width of joint between adjacent panels - 3/8 inch.

d. Maximum width of joint between adjacent panels - 3/4 inch.

e. Variation from level or from grades indicated:

In 10 feet - 1/4 inch.

In any bay or 25 feet maximum - 3/8 inch.

In 40 feet or more - 3/4 inch.

11. SAMPLING AND TESTING:

11.1 General: Samples and tests required below, and all other tests shall be made at the Contractor's expense. The tests shall be performed by an independent testing laboratory. Certified copies of test reports shall include all test data and results.

11.2 Concrete Testing: During the progress of the work, plastic concrete, as delivered to the casting site, shall be sampled and tested for slump, air content, and compressive strength in accordance with ACI 318,

Part 2, Chapter 3, and Part 3, Chapter 4. No fewer than 6 cylinders shall be made during each concreting cycle. Not more than one test in ten shall fall below the specified strength.

11.3 Slump Tests: Slump tests shall be in accordance with ASTM C 143.

11.4 Tests for Air Content: If air-entraining agents are used, tests shall be made at the same time that specimens for compression tests are made. The air content of the concrete shall be determined by direct measurement, using the volume method in accordance with ASTM C 173.

11.5 Test Results: If the measured slump or air content falls outside the limits specified, a check test shall be made. In the event of a second failure, the load of concrete represented will be rejected.

11.6 Failure to Meet Strength Requirements: If the compressive strength tests fail to meet the above requirements, the Contracting Officer may require load tests be made in accordance with ACI 318. Units failing to meet the requirements of the load tests shall not be used.

12. REPAIRS:

12.1 Units that have minor damage to which acceptable repairs can be made shall be patched as directed. Before starting repair work, approval from the Contracting Officer shall be obtained for each unit in question. The same type of materials as in base unit shall be used in repair work. Patches shall be thoroughly bonded to the unit and shall match adjacent work in color and texture.

12.2 Erecting inserts, anchors or reinforcement supports shall not show on exterior face of precast units.

13. CLEANING: After installation, exterior surfaces of precast units shall be washed with soap and clean water as recommended by the manufacturer, and shall be thoroughly rinsed with clean water. Soap not harmful to surface finish and which does not leave a film on the surface of precast units shall be used.

14. SEALING: After exterior surfaces have been cleaned, two coats of surface sealer conforming to Fed. Spec. SS-W-110 shall be applied. Surfaces shall be thoroughly dry when sealer is applied. Sealer shall be applied by spray in accordance with manufacturer's instructions.

15. ACCEPTANCE OF WORK: Units that are cracked or show other evidence of failure, or panels that do not match approved sampled, or that are damaged too extensively to be repaired, or have patches which do not reasonably match adjacent surfaces, will be rejected and shall be removed from site. New acceptable units shall be furnished and installed at no additional cost to the Government.