
USACE / NAVFAC / AFCEA UFGS-03415A (September 2001)

Preparing Activity: USACE (CW) Superseding
UFGS-03415A (January 1996)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UML dated 22 December 2004

Latest change indicated by CHG tags

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SECTION 03415A

PRECAST-PRESTRESSED CONCRETE

09/01

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SECTION 03415A

PRECAST-PRESTRESSED CONCRETE 09/01

NOTE: This guide specification covers the requirements for furnishing all plant, labor, material, and equipment and performing all operations required for furnishing, hauling, and placing the precast-prestressed concrete, complete, as specified herein and shown on the contract drawings.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214R	(2002) Evaluation of Strength Test Results of Concrete
ACI 318/318R	(2002) Building Code Requirements for Structural Concrete and Commentary

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(2002ae1) Portland Cement
ASTM C 33	(2003) Concrete Aggregates

ASTM INTERNATIONAL (ASTM)

ASTM C 1069	(1986; R 1997e1) Specific Surface Area of Alumina or Quartz by Nitrogen Adsorption
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 231	(2003) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2001) Air-Entraining Admixtures for Concrete
ASTM C 31/C 31M	(2003a) Making and Curing Concrete Test Specimens in the Field
ASTM C 311	(2002) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C 39/C 39M	(2003) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 430	(1996; R 2003) Fineness of Hydraulic Cement by the 45-Micrometer (No. 325) Sieve
ASTM C 494/C 494M	(1999ae1) Chemical Admixtures for Concrete
ASTM C 595	(2003) Blended Hydraulic Cements
ASTM C 595M	(1997) Blended Hydraulic Cements (Metric)
ASTM C 618	(2003) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1999) Quality Control for Plants and Production of Structural Precast Concrete Products
PCI MNL-120	(1999) Design Handbook - Precast and Prestressed Concrete

1.2 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Erection[; G][; G, [____]]

The Contractor shall prepare and submit for approval complete shop drawings that show the precast unit manufacturer's

recommended details and materials for the work required by paragraphs DELIVERY, STORAGE, AND HANDLING and ERECTION. The shop drawings shall include: design computations; marking of the units for the placing drawings; anchorages for work of other trades; anchorages to support construction; size and location of steel tendons; methods of stressing; location and sizes of all openings 300 mm 12 in. wide or larger to be cast into members; formwork; joints between units and other construction; reinforcing steel details; method of curing; and, pickup points and lifting devices.

SD-03 Product Data

NOTE: Delete this submittal if an Erection Plan is not required.

[Erection Plan[; G][; G, [____]]

The Contractor shall prepare a detailed erection plan which shall be submitted at least 15 days prior to the date that erection of members is to begin.]

Design Calculations

Design calculations shall be submitted prior to the initiation of manufacture of members to be used under this contract.

Concrete Mixture Proportions[; G][; G, [____]]

Concrete mixture proportions shall be submitted for approval.

Construction Records

Construction records of the manufacturing, handling, and erection of the precast prestressed concrete members shall be submitted.

SD-04 Samples

Precast Panel

One sample panel for each concrete finish specified shall be submitted for approval.

SD-06 Test Reports

Materials

Certified test reports of required material tests shall be submitted prior to the use of the materials in the work. Reports shall be furnished for each shipment and shall be identified with specific lots.

Concrete

The results of concrete strength testing by the contractor shall be submitted not more than 5 days after the tests are completed.

[SD-07 Certificates

NOTE: Delete the portions of SD-07 that will not
require certificates under this specification.
Certificates for Cement and Pozzolan are excluded
from this deletion.

Cement
Pozzolan
[Air-Entraining Admixture]
[Water-Reducing Admixture]
[Accelerating Admixture]
[Aggregates]

Cement[,][and] Pozzolan, [Air-Entraining Admixture,]
[Water-Reducing Admixture,] [Accelerating Admixture,][and
Aggregates] shall be certified for compliance with all
specifications requirements.

Air Content

Each precast member delivered to the jobsite shall be
accompanied by a certificate certifying that the air content in
the concrete in that member is in compliance with the
specifications. The certification must be based on an air content
test conducted in conformance with ASTM C 231 on at least one of
the batches of concrete from which the member was cast.]

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements

1.3.1.1 Precast-Prestressed Members and Connections

Design of members and connections shall be in accordance with ACI 318/318R
and PCI MNL-120.

1.3.1.2 Loads

Loadings for members and connections shall include all dead load, live
load, applicable lateral loads such as wind and earthquake, applicable
construction loads such as handling, erection loads, and other applicable
loads.

1.3.1.3 Design Calculations

Design calculations for members and connections not shown in the contract
drawings shall be made by a registered professional engineer experienced in
the design of precast-prestressed concrete.

1.3.2 Performance Requirements

Perform the following testing to ensure the materials and method used meet
the requirements of these specifications and will produce precast-
prestressed concrete members which are suitable for their intended use.

1.3.2.1 High-Strength Steel Tendons

Testing shall be as specified in Section 03230 STEEL STRESSING TENDONS AND ACCESSORIES FOR PRESTRESSED CONCRETE.

1.3.2.2 Concrete

Concrete shall be sampled and cylinders made in accordance with ASTM C 172 and ASTM C 31/C 31M.

a. Concrete Test Cylinders. A minimum of two concrete test cylinders per bed shall be made to verify the strength of concrete at the time of stress transfer and a minimum of two test cylinders per day or 38 cubic meters 50 cubic yards of concrete or fraction thereof, whichever results in the most cylinders, shall be made for each mix design to verify the attainment of the specified strength.

b. Cylinder Making. Cylinders shall be made as near as possible to the location where they will be cured and shall not be disturbed in any way from 1/2 hour after casting until they are either 24 hours old or ready to be tested. Concrete in cylinders may be consolidated by rodding or by vibration as specified in ASTM C 31/C 31M.

c. Cylinder Curing

(1) Test cylinders shall be cured with similar methods as the members they represent. In lieu of actual curing with the members, cylinders may be cured in curing chambers correlated in temperature and humidity with the beds. In such a case, the correlation shall be constantly verified by use of recording thermometers in the curing chambers and comparison with the temperature records of beds and by use of the same methods of moisture retention for curing chambers and casting beds.

(2) For beds cured by steam or radiant heat, cylinders shall be placed at random points along the bed. If there is any indication of variable heat, cylinders shall be placed in the coolest area.

(3) Test cylinders to indicate compliance with specified 28-day or earlier strength shall remain in the bed with the member until the member is removed. At that time, the cylinders shall be removed from their molds and placed in storage in a moist condition at 23 degrees plus or minus 1.5 degrees C 73.4 degrees plus or minus 3 degrees F.

d. Testing of Cylinders

(1) Testing of cylinders to determine compressive strength shall be performed in accordance with ASTM C 39/C 39M. The strength of concrete at any given age shall be determined as the average of two cylinders, except a single cylinder test can be used to determine stress transfer strength or predictive strengths at less than 28 days.

(2) Testing machines shall be calibrated in accordance with ASTM C 39/C 39M.

1.3.2.3 Air Content

The air content tests shall be conducted in accordance with ASTM C 231. At least one air content test shall be conducted on the concrete from which each member is cast.

1.4 PRECAST PANEL

Before casting precast members, one sample precast concrete panel not less than 600 by 600 by 125 mm 24 by 24 by 5 inches deep shall be submitted with proposed surface texture, including surface sealer. After approval, the sample panels shall be retained at the job site to serve as the standard of quality for texture, surface finish, and concrete color.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Transportation

1.5.1.1 Transporting Members

In transporting members by truck, railroad car, or barge, provision shall be made for supporting the members as described above, except battens can be continuous over more than one stack of units, with adequate bracing to ensure their maintaining the vertical position and damping of dangerous vibrations. Trucks with double bolsters are satisfactory provided the members are fully seated on the outer bolsters at not more than 1 m 3 feet or the depth of the member from the end and the inner bolster is not more than 2.3 m 8 feet from the end of the member or the designated pickup point. Adequate padding material shall be provided between tie chains or cables to preclude chipping of concrete.

1.5.1.2 Lateral Deflection or Vibration

Any noticeable indication of lateral deflection or vibration during transportation shall be corrected by rigid bracing between members or by means of lateral trussing.

1.5.2 Storage

1.5.2.1 Storage Areas

Storage areas for prestressed members shall be stabilized, and suitable foundations shall be provided, so differential settlement or twisting of members will not occur.

1.5.2.2 Stacked members

Stacked members shall be separated and supported by battens placed across the full width of each bearing point. Battens shall be arranged in vertical planes at a distance not greater than the depth of the member from designated pickup points. Battens shall not be continuous over more than one stack of precast units. Stacking of members shall be such that lifting devices will be accessible and undamaged. The upper members of a stacked tier shall not be used as storage areas for shorter members or equipment.

1.5.3 Handling of Members

The location of pickup points for handling of the members and details of the pickup devices shall be shown in shop drawings. Members shall be

handled only by means of approved devices at designated locations. Members shall be maintained in an upright position at all times and picked up and supported as shown in approved shop drawings.

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall comply with the following:

2.1.1 Cement

Cement shall comply with the following:

2.1.1.1 Portland Cement

NOTE: The tricalcium aluminate (Ca_3A) content of the Type III cement should be kept below 8 percent if it is anticipated that the concrete will be exposed to an environment with moderate concentrations of sulfate such as in seawater or exposure to concentrations of 150 parts per million water-soluble sulfate in soil. If it is anticipated that the concrete will be exposed to an environment with severe concentrations of sulfate, the Ca_3A content of Type III cement should be limited to 5 percent.

Portland cement shall conform to ASTM C 150, Type I, II or III. [The tricalcium aluminate content of the Type III cement shall be limited to 5 or 8 percent.]

2.1.1.2 Blended Hydraulic Cement

NOTE: The suffix (MS) should be added to the descriptor of the blended hydraulic cement when moderate sulfate resistance is desired.

Blended hydraulic cement shall conform to ASTM C 595M ASTM C 595 Type IS [(MS)], Type IP [(MS)], Type I(SM) [(MS)].

2.1.1.3 [Silica Fume

Silica fume may be furnished as a dry, densified material or as a slurry. Silica fume, unprocessed, or before processing into a slurry or a densified material, shall conform to the following requirements:

- a. Silicon dioxide content: 85-percent minimum, test method ASTM C 311.
- b. Loss on ignition: 6.0-percent maximum, test method ASTM C 311.
- c. Surface area, nitrogen adsorption, 15,000 m_2/kg minimum, test method ASTM C 1069.
- d. Oversize, percent retained on 45-micrometer sieve: 5-percent

maximum, test method ASTM C 430.

The Contractor shall provide at his expense the services of a manufacturer's technical representative, experienced in mixture proportioning, placement procedures, and curing of concrete containing silica fume. The manufacturer's representative shall be available for consultation by both the Contractor and the Government during mixture proportioning, planning, and production of silica-fume concrete and shall be on site immediately prior to and during at least the first placement of concrete containing silica fume and at other times, if directed.]

2.1.2 Pozzolan

Pozzolan shall conform to ASTM C 618 Class F or C.

2.1.3 Other Materials

NOTE: Fill in the appropriate state department of transportation if this portion of the specification is used. Otherwise it should be removed.

2.1.3.1 Aggregates

Aggregates shall meet the requirements of ASTM C 33 [or the requirements of the State of [_____] Department of Transportation].

2.1.3.2 Admixtures

In no event shall admixtures containing chlorides or nitrates be used in the concrete.

[a. Air-entraining admixture shall be certified to comply with ASTM C 260.]

[b. Water-reducing admixture shall be certified to comply with ASTM C 494/C 494M Type A.]

[c. Accelerating admixture shall be certified to comply with ASTM C 494/C 494M Type C.]

2.1.4 Steel Reinforcement

Steel reinforcement shall be in accordance with Section 03201 STEEL BARS AND WELDED WIRE FABRIC FOR CONCRETE REINFORCEMENT.

2.1.5 Steel Tendons

Steel tendons shall be in accordance with Section 03230 STEEL STRESSING TENDONS AND ACCESSORIES FOR PRESTRESSED CONCRETE.

2.2 CONCRETE MIXTURE PROPORTIONS

2.2.1 Concrete

Concrete shall be composed of cementitious material, water, fine and coarse aggregate, and admixtures. The cementitious material shall be portland or blended hydraulic cement and pozzolan where appropriate. [The admixtures

shall be an air-entraining agent] [and may include a water-reducing admixture when its formulation and use are approved].

2.2.2 Proportions

NOTE: Delete the references to maximum water-cement ratio (w/c) if specification is based solely on a specified strength.

The concrete mixture proportions shall meet the following requirements:

[Maximum Water-cement ratio (w/c) = [____].]
Specified Strength = [____] MPa [____] psi at [____] days.

[Air Content = 5 to 7 percent as determined in accordance with ASTM C 231.]
Proportions shall be selected so [that the maximum permitted w/c ratio is not exceeded and so] as to produce an average strength exceeding the design strength f'_c by the amount indicated below. Where the production facility has a standard deviation record determined in accordance with ACI 214R, based on 30 consecutive strength tests of similar mixture proportions to that proposed, obtained within 1 year of the time when concrete placing is expected, it shall be used in selecting average strength. The average strength used as the basis for selecting proportions shall exceed the specified strength f'_c by at least.

2.8 MPa if standard deviation is less than 2.1 MPa
3.8 MPa if standard deviation is 2.1 to 2.8 MPa
4.8 MPa if standard deviation is 2.8 to 3.4 MPa
6.2 MPa if standard deviation is 3.4 to 4.1 MPa

400 psi if standard deviation is less than 300 psi
550 psi if standard deviation is 300 to 400 psi
700 psi if standard deviation is 400 to 500 psi
900 psi if standard deviation is 500 to 600 psi

If the standard deviation exceeds 4.1 MPa 600 psi or if a standard deviation record is not available, proportions shall be selected to produce an average strength at least 8.3 MPa 1,200 psi greater than the specified strength.

Mixtures shall be proportioned in accordance with ACI 211.1. The trial mixtures shall be formulated using the same materials as those to be used in the units supplied under this specification, and the selected proportions shall be submitted for approval with the results of cylinder strengths at [28 days] [____] days.

2.3 EVALUATION AND ACCEPTANCE

2.3.1 Concrete

A test result shall be the average of the strengths of the two test cylinders made in accordance with paragraph SYSTEM DESCRIPTION, subparagraph PERFORMANCE REQUIREMENTS, subparagraph CONCRETE, subparagraph "a", CONCRETE TEST CYLINDERS. The strength level of the concrete will be

considered satisfactory if the average of all sets of three consecutive strength tests equal or exceed the specified strength $f'(c)$ and no individual test falls below the specified value by more than 3.4 MPa 500 psi. Members manufactured with concrete that does not meet the strength requirements shall be rejected.

2.3.1.1 Air Content

All members cast with concrete having a measured air content less than 5 percent shall be rejected. Members cast with concrete having an air content up to 9 percent may be incorporated into the work if the strength requirements are met.

2.3.2 Tolerances

The precast-prestressed members shall be manufactured within the following tolerances. Members failing to meet the dimensional tolerances shall be rejected.

2.3.2.1 Length of Member

The length of the member shall not deviate from the length shown in the contract drawings by more than plus or minus 19 mm 3/4 inch or plus or minus 1 mm per m 1/8 inch per 10 feet of length, whichever is greater.

2.3.2.2 Cross-sectional Dimensions

The cross-sectional dimensions of a member, if less than 900 mm 36 inches, shall not vary by more than plus or minus 6 mm 1/4 inch and, if over 900 mm 36 inches, they shall not vary by more than plus or minus 9 mm 3/8 inch.

2.3.2.3 [Horizontal Alignment (Sweep)]

The horizontal alignment of the members shall not deviate from a straight line parallel to the theoretical centerline by more than 13 mm or 1 mm per m 1/2 inch or 1/8 inch per 10 feet of length, whichever is greater. The maximum gap between two adjacent members due to sweep shall not exceed 25 mm 1 inch.]

2.3.2.4 [Camber]

The actual camber of beams shall not deviate from the computed camber by more than plus or minus 1 mm per m 1/8 inch per 10 feet but not more than plus or minus 1/2 inch maximum total deviation.]

2.3.2.5 [Camber Differential]

The differential in camber at midspan between adjacent members shall not exceed 2 mm per m 1/4 inch per 10 feet of length or 3/4-inch maximum.]
[The differential in camber at midspan between adjacent members shall not exceed 1 mm per m 1/8 inch per 10 feet of length or 19 mm 3/4 inch maximum.]

2.3.2.6 Position of Tendons

The position of the tendons shall not deviate from the design position by more than plus or minus 6 mm 1/4 inch.

2.3.2.7 Handling Devices

The actual position of handling devices shall not deviate from the designed

position by more than plus or minus 150 mm 6 inches.

2.3.2.8 [Anchors and Inserts]

The actual position of anchors and inserts shall not vary by more than plus or minus 25 mm 1 inch from positions shown in the contract drawings.]

2.3.2.9 Flange Thickness

The thickness of a flange or slab shall not vary from the dimensions in the drawings by more than plus 6 mm 1/4 inch or minus 3 mm 1/8 inch.

2.3.2.10 Depth of Member at Support

At the supports, the depth of a member shall not deviate from the dimensions shown in the contract drawings by more than plus or minus 6 mm 1/4 inch.

2.3.2.11 [Distance Between Stems]

The actual distance between stems shall not deviate from the dimension shown in the contract drawing by more than plus or minus 3 mm 1/8 inch.]

2.3.2.12 Squareness of Ends

The ends of members shall not deviate from being square by more than plus or minus 6 mm 1/4 inch. Squareness shall be checked in both the vertical and horizontal planes.

2.3.3 Defects

2.3.3.1 Minor Defects

Minor defects are those which involve less than 900 mm^2 36 square inches of concrete and do not expose stressing tendons or reinforcing steel. These defects will be repaired as specified hereinafter. Cracks which are visible but are $250 \text{ }\mu\text{m}$ 0.01 inch wide or less will be accepted.

2.3.3.2 Major Defects

Major defects are those which involve more than 900 mm^2 36 square inches of concrete or expose stressing tendons or reinforcing steel. If one or more major defects appear in a member, it shall be rejected. Cracks of a width of more than $250 \text{ }\mu\text{m}$ 0.01 inch shall be cause for rejection of the member.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication of precast-prestressed members shall follow the applicable provisions of the PCI MNL-116, except as specified herein.

3.2 BEDS AND FORMS

3.2.1 Casting Beds

All casting beds shall have concrete support on unyielding foundations.

3.2.2 Forms

Forms, both fixed and movable, shall be of steel. All forms and beds shall be thoroughly cleaned after each use.

3.2.3 Bulkheads

Bulkheads, spacers, templates, and similar equipment having influence on the accuracy of dimensions and alignment shall be regularly inspected and maintained after each casting.

3.2.4 Alignment

Accurate alignment of forms shall be maintained during the casting operation to assure compliances with tolerances specified in paragraph EVALUATION AND ACCEPTANCE. Leakage of the paste in form joints is not acceptable, and measures shall be taken to prevent such leakage. Measures shall also be taken to provide corner chamfers.

3.2.5 Form Ties

For exposed members, form ties, if used, shall be of the threaded or snap-off type so no parts will be left at the surface of the finished concrete.

3.3 TENDONS

The tendons shall be placed, stressed, and destressed in accordance with Section 03230 STEEL STRESSING TENDONS AND ACCESSORIES FOR PRESTRESSED CONCRETE.

3.4 ANCHORAGES FOR POSTTENSIONING

Anchorage for posttensioning tendons will not interfere with the placement of the member such that adequate compaction of the concrete in the anchorage zone is impeded.

3.5 STEEL REINFORCEMENT

Steel bars and welded wire fabric shall be placed in accordance with Section 03201 STEEL BARS AND WELDED WIRE FABRIC FOR CONCRETE REINFORCEMENT.

3.6 CONCRETE PLACEMENT

Concrete placement shall be in accordance with Section 03301A CAST-IN-PLACE STRUCTURAL CONCRETE, except that once placement is started in a member it shall be carried on in a continuous operation until the member is completed. Members shall be cast in a horizontal position and casting in tiers will not be permitted. Adequate vibration shall be provided with internal and form vibrators so the cast members shall be free of rock pockets or surface blemishes resulting from inadequate vibration. Cold joints shall not be permitted in prestressed concrete members. If delays occur that result in hardening of the concrete so it will not receive a vibrator and again become plastic, the concrete shall be removed and the forms shall be washed out and refilled, otherwise partially cast members will be rejected.

3.7 CURING AND PROTECTION

Concrete for the manufacturing of the precast-prestressed concrete members shall be cured and protected in accordance with Section 03301A CAST-IN-PLACE STRUCTURAL CONCRETE or by other methods further specified here.

3.7.1 Curing with Steam at Atmospheric Pressure

Steam curing shall be under a suitable enclosure to retain the live steam to minimize moisture and heat losses. The enclosure shall allow free circulation of the steam around the sides and top of the beams. Steam jets shall be so positioned so they do not discharge directly on the concrete, forms, or test cylinders. The cycle of steam application shall conform to the following:

3.7.1.1 Curing After Placing and Vibrating

After placing and vibrating, the concrete shall be allowed to attain its initial set before the steam is applied. During the period between placement of the concrete and application of steam, provisions shall be made to prevent surface drying by means of a coating of membrane curing compound, moist covers, or equally effective methods. Application of the steam shall be delayed not less than 2 hours and not more than 10 hours after the time of concrete placement. If the ambient temperature is below [_____] degrees C 50 degrees F, enough heat shall be applied to maintain the concrete at its placing temperature.

3.7.1.2 Temperature Increase

The ambient temperature within the casting enclosure shall be increased at a rate not to exceed 22 degrees C 40 degrees F per hour. Temperature increase shall be as uniform as possible.

3.7.1.3 Temperature Range

The temperature shall be increased until the ambient temperature in the casting enclosure is between 60 and 71 degrees C 140 and 160 degrees F. Once this temperature range is reached, it shall be maintained until the concrete has reached the compressive strength necessary for stressing or destressing the tendons.

3.7.1.4 Temperature Decrease

In discontinuing the steam curing, the ambient air temperature shall decrease at a rate not to exceed 22 degrees C 40 degrees F per hour. Temperature decrease shall be as uniform as possible.

3.7.1.5 Recording Thermometers

Recording thermometers showing the time-temperature relationship through the curing period from placing concrete to transfer of prestress shall be provided. At least one recording thermometer per casting enclosure shall be used. The desired curing time-temperature relationship shall be placed on the recording chart of the recording thermometer to aid the personnel controlling the temperature during curing. Recording charts shall be made available upon request and shall be clearly visible during the curing process.

3.7.2 Curing with Radiant Heat and Moisture

3.7.2.1 Radiant Heat

Radiant heat may be applied to beds by means of pipe circulating steam, hot oil, or hot water or by electric blankets or heating elements on forms. Pipes, blankets, or elements shall not be in contact with concrete, form surface, or test cylinders.

3.7.2.2 Moisture Loss

During the cycle of radiant heat curing, effective means shall be provided to prevent rapid loss of moisture in any part of the member. Moisture may be applied by a covering of moist burlap or cotton matting. Moisture may be retained by covering the member with a plastic sheet in combination with an insulating cover or by applying a liquid seal coat or membrane curing compound.

3.7.2.3 Temperature Limits

Temperature limits and use of recording thermometer shall be as specified for curing with steam at atmospheric pressure.

3.7.2.4 Termination of Curing

Termination of curing shall be as specified in Section 03301A CAST-IN-PLACE STRUCTURAL CONCRETE unless the concrete has been cured by one of the two methods stated above. Termination of curing for concrete cured by either the steam at atmospheric pressure method or the radiant heat with moisture shall be determined based on the compressive strength of the concrete necessary for stressing or destressing the tendons.

3.8 REPAIRS

All honeycombed areas, chipped corners, air pockets over 6 mm 1/4 inch in diameter, and other minor defects shall be repaired. Form offsets of fins over 3 mm 1/8 inch shall be ground smooth. All unsound concrete shall be removed from defective areas prior to repairing. All surfaces permanently exposed to view shall be repaired by a blend of portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete.

3.9 FINISHING

3.9.1 Unformed surfaces

Unformed surfaces shall receive a [wood float] [magnesium float] [steel trowel] [_____] finish.

3.9.2 [Formed Surfaces]

Formed surfaces shall match the texture and color of the sample panels, paragraph PRECAST PANEL.]

3.10 ERECTION

Erection shall comply with the following.

3.10.1 Storage Provisions

All provisions for storage and handling given in paragraph DELIVERY, STORAGE, AND HANDLING shall be observed at the erection site.

3.10.2 Seating of Precast Prestressed Concrete Members

The precast prestressed concrete members shall be set into place in a manner which assures full bearing. If the bearing called for in the contract drawing is not obtained, then the members shall be removed and the situation corrected.

3.10.3 Roof and Floor

Roof and floor single or double T-beams shall be erected in an increasing or decreasing magnitude of camber to minimize differential between beams. The contractor shall measure T-beam camber and number the beams prior to erection.

3.10.4 Welding

Welding during erection shall be done in accordance with Section 05055A METALWORK FABRICATION, MACHINE WORK AND MISCELLANEOUS PROVISIONS. When welding or burning with a welding electrode, the ground shall be attached directly to the base metal. Under no circumstances shall the member be used as a conductor for the ground.

3.10.5 [Erection Plan

The erection plan shall be in sufficient detail so that adequacy of equipment, techniques, and accessories can be determined and comments offered. Acceptance of the Contractor's erection plan shall not relieve the Contractor of his responsibility for erecting precast prestressed members into position as required by the plans and specifications.]

3.11 CONSTRUCTION RECORDS

Complete construction records shall be kept of the manufacturing, handling, and erection of the precast-prestressed concrete members. Records shall be kept for, but not limited to, the following items:

- a. Specifications of material used in the manufacture of the members.
- b. Time-temperature history of the concrete members from casting to the transfer of the prestress force.
- c. Records of the tendon stressing operation including initial prestress force, measured elongation, how it was measured, and how the tendons were stressed and destressed.
- d. Records of inspection of the members before and after the prestress force is transferred to the members.
- e. Records of the inspection of the members each time they are moved.
- f. Records of any defects in the member and any corrective measures taken.

-- End of Section --

