

GUIDE SPECIFICATION FOR ARCHITECTURAL PRECAST CONCRETE (PCI MNL 117)

This Guide Specification is intended to be used as a foundation for the development of an office master specification or in the preparation of specifications for a particular project. In each case, this Guide Specification must be modified to fit the conditions of use. Individual attention should be given to the deletion of inapplicable provisions and all essential items related to a particular project should be included. Also, fitting requirements should be added where blank spaces have been provided. The Guide Specifications are on the left. Notes to Specifiers are on the right.

Guideline Specifications

1. General

1.01 Description

A. Work included:

1. The specifications establish general criteria for materials, production, erection and evaluation of precast concrete as required for subsequent related sections of these specifications. The work to be performed shall include all labor, material, equipment, related services, and supervision required for the manufacture and erection of the structural precast concrete units shown on the contract drawings and schedules.

B. Related work specified elsewhere:

1. Concrete reinforcement: Section _____.
2. Cast-in-place reinforcement: Section _____.
3. Precast, prestressed concrete: Section _____.
4. Structural steel framing: Section _____.
5. Water repellent coatings: Section _____.
6. Insulation: Section _____.
7. Flashing and sheet metal: Section _____.
8. Sealants and caulking: Section _____.
9. Painting: Section _____.
10. Glass and Glazing: Section _____.
11. Glazing Accessories: Section _____.

Notes to Specifiers

1.01.A Local standard practice may indicate that responsibility for erection may not be included.

1.01.B.1 Architectural precast concrete reinforcing steel requirements are different from cast-in-place reinforcement and should be specified in this section.

1.01.B.2 For placement of anchorage devices in cast-in-place concrete for precast concrete panels.

1.01.B.3 For precast floor and roof slabs, beams, columns and other structural elements. Some items, such as prestressed wall panels on industrial buildings, could be included in either specification, depending on the desired finish and tolerance expectation.

1.01.B.4 For steel supporting structure, attachment of anchorage devices on steel for precast concrete panels, and sometimes loose anchors/connectors.

1.01.B.5 For exposed face of panels. Delete when specified in this section.

1.01.B.6 For insulation that is job-applied to precast concrete panels. Insulation cast in precast concrete panels during manufacture should be specified in this section.

1.01.B.7 For counter flashing inserts and receivers, unless included in this section.

1.01.B.8 For panel joint caulking and sealing.

1.01.B.9 For field touch-up painting. Delete when specified in this section.

1.01.B.10 For glazing of precast concrete panels in plant. Delete when specified in this section.

1.01.B.11 For reglets used with structural glazing gaskets. Delete when specified in this section.

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- C. Work installed but furnished by others:
1. Counter flashing receivers or reglets: Section _____.
 2. Inserts or attachments for: _____ Section _____.

D. Testing agency provided by owner or special inspection.

1.02 Quality Assurance

A. Manufacturer qualifications:

The precast concrete manufacturing plant shall be certified by the PCI (Precast/Prestressed Concrete Institute) plant certification program, the NPCA (National Precast Concrete Association) plant certification program, or other qualified third party certification prior to start of fabrication of this project. Precast concrete manufacturer must have produced product similar to what is being specified for a minimum of five years. Manufacturer shall be certified at the time of bidding. Certification shall be in the appropriate product groups and categories.

****OR****

Acceptable manufacturers:

1. Fabcon Precast
2. _____

B. Erector qualifications:

Regularly engaged for at least five years in erection of architectural precast concrete units similar to those required on this project.

C. Welder qualifications:

In accordance with AWS D1.1

D. Testing:

In general compliance with testing provisions in MNL-117. Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.

- PCI MNL-117, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products, and
- "Fabcon Design Guidelines for Precast Concrete Wall Panels", current version.

E. Testing agency:

1. Not less than three years experience in performing concrete tests of type specified in this section.
2. Capable of performing testing in accordance with ASTM E 329.
3. Inspected by Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology.

F. Requirements of regulatory agencies:

Manufacture and installation of structural precast concrete to meet requirements of _____.

*ASTM Specifications—as referred to in Part 2, Products.

*AWS D1.1—Structural Welding Code—Steel

*ACI 318—Building Code Requirements for Reinforced Concrete

1.01.C Delete when furnished by precast concrete manufacturer. Add additional items as may be required for the particular project.

1.01.C.2 May include inserts/attachments for window or door frames, window washing equipment, etc.

1.01.D Delete when testing agency is provided by precast concrete manufacturer or general contractor. Coordinate with appropriate section of Division 1, General Conditions.

1.02.A It is recommended that the architect approve individual precast concrete manufacturers who meet the Quality Assurance Specification at least ten days prior to the bid date, or identify approved manufacturers in the specification.

1.02.C Certified within the past year. Delete when welding is not required.

1.02.E Delete when provided by owner.

1.02.E1 Usually 2 to 5 years.

1.02.F Local building code or other governing code relating to precast concrete. For projects in Canada, standards from the Canadian Standards Association should be listed in addition to or in place of the U.S. standards.

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Notes to Specifiers

- G. Allowable tolerances:
1. Manufacture and install wall panels so that each panel after erection complies with the dimensional tolerances listed in MNL 117 depending on product type expected.
- H. Job Mockup:
1. After standard samples are accepted for color and texture, submit full-scale unit meeting design requirements as required.
 2. Mockup to be standard quality for architectural precast concrete work.
 3. Incorporate mockup into work in a location reviewed by architect/engineer after keeping mockup in plant _____ for checking purpose.
- I. Source quality control:
1. Quality control and inspection procedures to comply with applicable sections of MNL-117.
 2. Water absorption test on unit shall be conducted in accordance with MNL-117.
- 1.03 Submittals**
- A. Samples:
1. Submit samples representative of finished exposed face showing typical range of color and texture prior to commencement of production.
 2. Sample size: Approximately 12 in. x 12 in. and of appropriate thickness, representative of the proposed finished product.
- B. Shop Drawings:
1. Erection drawings:
 - A. Member piece marks and completely dimensioned size and shape each member.
 - B. Plans and/or elevations locating and defining all products furnished by manufacturer.
 - C. Sections and details showing connections, cast-in items and their relation to the structure.

- 1.02.G Dimensional tolerances apply to both manufacturing and after manufacturing. The tolerances listed in PCI MNL-117 is also listed in Chapter 8 of the PCI Handbook. Most manufacturers can meet closer tolerances, if required, but closer tolerances normally increase costs. The normal tolerances of the support system should also be recognized.
- 1.02.H.1 Under MNL-117 full-scale samples or inspection of the first production unit may be requested, especially when a new design concept or new manufacturing process or other unusual circumstance indicates that proper evaluation cannot otherwise be made. It is difficult to assess appearance from small samples. Mockups are rarely requested for MNL-117 architectural prestressed concrete.
- 1.02.H.2 Use to determine range of acceptability with respect to color and texture variations, surface defects and overall appearance. Mockup should also serve as testing areas for remedial work. It should also be stated in the contract documents who the accepting authority will be.
- 1.02.H.3 Delete when mockup is not to be included in work. State how long unit should be kept. Mockup is normally incorporated in the building, at least for production units.
- 1.03.A Number of samples and submittal procedures should be specified in Division 1. All approved samples should be initialed by the architect. pre-bid samples should be submitted a minimum of 10 days prior to bid date.
- 1.03.A.1 If the back face of a precast concrete unit is to be exposed, samples of the workmanship, color, and texture of the backing should be shown as well as the facing.
- 1.03.B State the number of copies required for approval. Current practice usually calls for three prints of shop drawings to be submitted for approval. Submittal with architect/engineer to conform with allotted shop drawing approval time shown on the precast concrete supplier's order acknowledgment. When erection drawings contain all information sufficient for design approval, production drawings, except for shape drawings, need not be submitted for approval, except in special cases. However, record copies are frequently requested Guidelines requested. for the preparation of drawings are given in the PCI Drafting Handbook—Precast and Prestressed Concrete, MNL-120, current edition.

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- D. Relationship to adjacent material.
- E. Joints and openings between members.
- F. Description of all loose, cast-in and field hardware.
- G. Location, dimensional tolerances, and details of anchorage devices that are embedded in or attached to structure or other construction.
- H. Erection sequences, when required to satisfy stability, and handling requirements.
- I. Reaction or loads to be identified in details as required.

2. Production drawings:

- A. Member shapes (elevations and sections) and dimensions.
- B. Sections and details to indicate quantities and position of reinforcing steel, anchors, inserts, etc.
- C. Handling devices.
- D. Finishes.
- E. Joint and connection details.
- F. Methods for storage and transportation.

C. Design calculations:

Submit, on request, structural design calculations performed by an engineer, registered in the state where the project is located, experienced in the design of structural precast concrete.

D. Design modifications:

1. Submit design modifications necessary to meet performance requirements and field coordination.
2. Variations in details or materials shall not adversely affect the appearance, durability or strength of units.
3. Maintain general design concept without altering size of members, profiles and alignment.

E. Test reports:

Submit, on request, reports on materials, compressive strength tests on concrete and other tests on units.

1.04 Product delivery, storage and handling

A. Delivery and handling:

1. Deliver all architectural precast concrete units to project site in such quantities and at such times to ensure continuity of erection.
2. Handle and transport units in a position consistent with their shape and design in order to avoid stresses which would cause cracking or damage.
3. Lift or support units only at the points shown on the shop drawings.
4. Support units during shipment w/shimming/dunnage material.
5. Do not place units directly on ground.

1.03.B.1.D Details, dimensional tolerances and related information of other trades affecting precast concrete work should be furnished to precast concrete manufacturer.

1.03.B.1.G Drawings normally prepared by precast concrete manufacturer and provided to general contractor for work by other trades.

1.03.B.1.H If the sequence of erection is critical to the structural stability of the structure, or for access to connections at certain locations, it should be noted on the contract plans and specified.

1.03.D. 1-3 Modification should be agreed upon by all parties. Some modifications may be necessary because of limitations from manufacturing or structural complications.

1.03.E The number and/or frequency of each type of test should be clearly stated in the specifications by listing the required testing or by reference to applicable standards, such as PCI MNL-117. Schedule of required tests, number of copies of test reports, and how distributed are included in Testing Laboratory Services, Section _____.

1.04.A Erector should coordinate arrival of precast concrete units and provide for possible storage and for erection in a safe manner within the agreed schedule and with due consideration for other trades. Handling procedures, including type and location of fastenings, should normally be left to the precaster. Erector can be manufacturer also.

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- B. Reinforcing steel:
1. Materials:
 - A. Bars:
 1. Deformed billet steel: ASTM A615
 - B. Welded wire reinforcement:
 1. Welded plain steel: ASTM A185
 - C. Fabricated steel bar or rod mats: ASTM A184
 - D. Prestressing strand: ASTM A416, grade 250K or 270K
- C. Cast-in anchors:
1. Materials:
 - A. Structural steel: ASTM A36 minimum
 - B. Stainless steel: ASTM A 666, type 304, grade _____.
 - C. Carbon steel plate: ASTM A 283, grade _____.
 - D. Bolts: ASTM A 307 , A 325 or A490.
 - E. Welded headed studs: ASTM A 108.
 - F. Deformed bar anchors: ASTM A 496 or A 706.
 2. Finish:
 - A. Shop primer: FS TT-P-86, oil base paint, type I, or SSPC-Paint 14, or manufacturer's standard.
 - B. Hot-dipped galvanized: ASTM A 123, electroplated or metallized.
 - C. Cadmium coating: ASTM B 766.
 - D. Zinc rich coating: DOD-P-21035, self curing, one component, sacrificial.
- D. Sandwich panel insulation: Expanded Polystyrene R (min)
- =4.17/in @ 40°
- =3.85/in @ 75°
- E. Grout:
1. Cement grout: Portland cement, sand, and water sufficient for placement and hydration.
 2. Non-shrink grout: Premixed, packaged ferrous or non-ferrous aggregate shrink-resistant grout.
 3. Epoxy-resin grout: Two-component mineral-filled epoxy-resin: ASTM C 881 or FS MMM-A-001993.

- 2.01.B.1 Grades of reinforcing steel are determined by the structural design of the precast concrete units. Panels are normally designed as crack-free sections or with controlled cracking, thus the benefit of higher grade steel is not utilized.
- 2.01.B.1.A.1 State uncoated, galvanized or epoxy coated. Use galvanizing or epoxy coating only where corrosive environment severe exposure conditions justify extra cost. Availability of galvanized or epoxy coated bars should be verified.
- 2.01.C.1.A For carbon steel connection assemblies.
- 2.01.C.1.B Stainless steel anchors for use only when resistance to staining merits extra cost. (A),(B).
- 2.01.C.2.A For exposed carbon steel anchors.
- 2.01.C.2.B For exposed carbon steel anchors where corrosive environments justifies the additional cost. Field welding should generally not be permitted on galvanized elements, unless the galvanizing is removed.
- 2.01.C.2.D For galvanized repair use high zinc-dust content paint with dry film containing not less than 94% zinc dust by weight and complying with DOP-P-21035A or SSPC paint 20.
- 2.01.D Specify type of insulation such as foamed plastic (polystyrene and polyisocyanurate), or lightweight mineral aggregate concretes. Thickness of sandwich panel insulation may be governed by wall U-value requirements.
- 2.01.E Indicate required strengths on contract drawings.
- 2.01.E.2 Grout permanently exposed to view should be non-oxidizing (non-ferrous).

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- F. Bearing Pads/Shims:
1. Random oriented fiber reinforced: Shall support a compressive stress of 3000 psi with no cracking, splitting or delaminating in the internal portions of the pad.

2. Plastic: Multimonomer plastic strips shall be non-leaching and support construction loads with no visible overall expansion.

2.02 Concrete Mixes

A. Concrete Properties

1. Water-cementitious materials ratio: Maximum 40 lbs. of water to 100 lbs. of cementitious materials.
2. Air entrainment: Amount produced by adding dosage of air entraining agent that will provide 3% to 19% of entrained air in standard 1:4 sand mortar as tested according to ASTM C 185; entrained air % is 8% to 11%.
3. Coloring agent: Color and types of aggregates, and tints, are subject to availability. Variation in color and texture of natural materials is inherent in the final product. Maximum concentration of tint not greater than 3%. Contact Fabcon sales representative for availability of color of aggregates and tints.
4. 28-day compressive strength: Minimum of 7000 psi when tested by 6 x 12 or 4 x 8 in. cylinders; or minimum 6250 psi when tested on 4 in. cubes.
5. Release strength of 3500 psi.

B. Face mix:

1. Minimum thickness of face mix after consolidation shall be at least 1 in.
2. Water-cementitious materials and cementitious materials-aggregate ratios of face and backup mixes shall be similar.

- C. Design mixes to achieve required strengths shall be prepared by independent testing facility or qualified personnel at precast concrete manufacturer's plant.

2.01.G.1 Standard guide specifications are not available for random oriented, fiber reinforced pads. Proof testing of a sample from each group of 200pads is suggested. Normal service load stresses are 1500 psi, so the 3000 psi test load provides a factor of 2 over service stress. The shape factor for the test specimens should not be less than 2. If adequate test data are provided by the pad supplier, further proof testing may not be required.

2.01.G.2 Compression stress in use is not normally over a few hundred psi and proof testing is not considered necessary. No standard guide specifications are available.

2.02.A The backup concrete and the surface finish concrete can be of one mix design, depending upon resultant finish, or the surface finish (face mix) concrete can be separate from the backup concrete. Clearly indicate specific requirements for each face of the product or allow manufacturer's option.

2.02.A.1 Keep to a minimum consistent with strength and durability requirements and placement needs. Are determined by manufacturer.

2.02.A.2 Gradation characteristics of most facing mix concrete will not allow use of a given percentage of air. PCI recommends a range of air entraining be stated in preference to specified percentage.

2.02.A.3 Amount used should not have any detrimental effects on concrete qualities. Delete if coloring agent is not required.

2.02.A.4 Vary strength to match requirements. Strength requirements for facing mixes and backup mixes may differ. Also the strength at time of removal from the molds should be stated if critical to the engineering design of the units. The strength level of the concrete should be considered satisfactory if the average of each set of any three consecutive cylinder strength tests equals or exceeds the specified strength and no individual test falls below the specified value by more than 500 psi.

2.02.B Delete if separate face mix is not used.

2.02.B.1 Minimum thickness should be sufficient to prevent bleeding through of the backup mix and should be at least equal to specified minimum cover of reinforcement.

2.02.B.2 Similar behavior with respect to shrinkage is necessary in order to avoid undue bowing and warping.

2.02.C Proportion mixes by either laboratory trial batch or field experience methods using materials to be employed on the project for each type of concrete required. Tests will be necessary on all mixes including face, backup, and standard, which may be used in production of units. Water content should remain as constant as possible during manufacture.

Guideline Specifications

Notes to Specifiers

2.03 Fabrication

A. Manufacturing procedures shall be in general compliance with PCI MNL-117.

B. Finishes:

1. Exposed face to match approved sample or mockup panel.

****OR****

2. Smooth finish:

A. As cast using flat, smooth, molds or liners.

****OR****

3. Smooth finish:

A. As cast using fluted, sculptured, board finish or textured form liners.

****OR****

4. Textured finish:

A. Achieve finish on face surface of precast concrete units by form liners applied to inside of forms.

****OR****

5. Exposed aggregate finish:

A. Apply even coat of retardant to face of mold.

B. Remove units from molds after concrete hardens.

C. Expose coarse aggregate by washing and/or brushing or lightly sandblasting away surface mortar.

D. Expose aggregate to produce a uniform exposure.

****OR****

6. Exposed aggregate finish:

A. Pressure spray with acid and hot water solution.

****OR****

B. Treat surface of unit with brushes which have been immersed in acid solution.

C. Protect hardware, connections and insulation from acid attack.

D. Expose aggregate to produce a _____ exposure.

****OR****

7. Exposed aggregate finish:

A. Use power or hand tools to remove mortar and fracture aggregates at the surface of units (bush hammer).

****OR****

8. Sandblasted finish:

A. Sandblast away cementitious materials and matrix to produce a _____ exposure.

****OR****

2.03.A PCI MNL-117 for structural shall comply with 'Grade B', Appendix C.

2.03.B Finishing techniques used in individual plants may vary considerably from one part of the continent to another, and between individual plants. Many plants have developed specific techniques supported by skilled operators or special facilities.

2.03.B.1 Preferable to match sample rather than specify method of exposure.

2.03.B.2 Difficult to obtain uniform finish.

2.03.B.4 Many standard shapes of form liners or screeds are readily available.

2.03.B.5.D Matrix can be removed to a maximum depth of one-third the average diameter of coarse aggregate but not more than one-half the diameter of the smallest sized coarse aggregate.

2.03.B.6.D (light) (medium) (deep)

2.03.B.7.A Use with softer aggregates such as dolomite and marble.

2.03.B.8.A (light) (medium) (deep). Exposure of aggregate by sandblasting can vary. Remove matrix to a maximum depth of one-third the average diameter of coarse aggregate but not more than one-half the diameter of the smallest sized coarse aggregate. Depth of sandblasting should be adjusted to suit the aggregate hardness and size.

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9. Veneer faced finish:
- A. Cast concrete over tile, brick, terra cotta or natural stone placed in the bottom of the mold.

10. _____ back surfaces of precast concrete units after striking surfaces flush to form finish lines.

C. Cover:

1. Provide at least E/F in. cover for reinforcing steel.

2. Do not use metal chairs, with or without coating, in the finished face.

3. Provide embedded anchors, inserts, plates, angles and other cast-in items with sufficient anchorage and embedment for design requirements.

D. Molds:

1. Use molds to maintain units within specified tolerances conforming to the shape, lines and dimensions shown on the approval shop drawings.

2. Construct molds to withstand vibration method selected.

E. Concreting:

1. Convey concrete from the mixer to place of final deposit by methods which will prevent separation, segregation or loss of material.

2. Consolidate all concrete in the mold by high frequency vibration, either internal or external or a combination of both, to eliminate unintentional cold joints, honeycomb and to minimize entrapped air on vertical surfaces.

F. Curing:

1. Precast concrete units shall be cured until the compressive strength is high enough to ensure that stripping does not have an effect on the performance or appearance of the final product.

G. Panel Identification:

1. Mark each precast panel to correspond to identification mark on shop drawings for panel location.

2. Mark each precast panel with date cast.

2.04 Concrete Testing

- A. Make one compression test at 28 days for each day's production of each type of concrete.

2.03.B.9.A Provide a complete bond breaker between the natural stone face material and the concrete. Ceramic tile, brick and terra cotta are bonded to the concrete.

2.03.B.10 (float finish), (steel trowel), (broom). Use for exposed back surfaces of units.

2.03.C.1 Increase cover requirements when units are exposed to corrosive environment or severe exposure conditions. For exposed aggregate surfaces, the E/F in. cover should be from bottom of aggregate reveal to surface of steel.

2.03.C.2 If possible, reinforcing steel cages should be supported from the back of the panel, because spacers of any kind are likely to mar the finished surface of the panel. For smooth cast facing, stainless steel chairs may be permitted. The wires should be soft stainless steel and clippings should be completely removed from the mold.

2.03.D.2 Molds for structural precast concrete should be built to provide proper appearance, dimensional control and tightness. They should be sufficiently rigid to withstand pressures developed by plastic concrete, as well as the forces caused by consolidation. The molds are the property of the precast concrete manufacturer.

2.03.E.2 The prime objective is to consolidate the concrete thoroughly, producing a dense, uniform product with fine surfaces, free of imperfections. Bonding between backup and face mix should be ensured if backup concrete is cast before the face mix has attained its initial set.

2.03.F A wide variation exists in acceptable curing methods, ranging from no curing in some warm humid areas, to carefully controlled moisture-pressure-temperature curing. Consult with local panel manufacturers to avoid unrealistic curing requirements.

2.03.F.1 Stripping strength, which could be as low as 2000 psi, should be set by the plant based on the characteristics of the product and plant facilities. It is the responsibility of the precaster to verify and document the fact that final design strength has been reached.

2.04.A This test should be only a part of an in-plant quality control program.

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B. Specimens:

1. Provide two test specimens for each compression test.
2. Obtain concrete for specimens from actual production batch.
3. 6 in. x 12 in. or 4 in. x 8 in. concrete test cylinder, ASTM C 31.
****OR****
4. _____ sized concrete cube, _____.
5. Cure specimens using the same methods used for the precast concrete units until the units are stripped, then moist cure specimens until tested.

C. Keep quality control records available for the architect upon request for two years after final acceptance.

3. EXECUTION

3.01 Inspection

A. Before erecting architectural precast concrete, the general contractor shall verify that structure and anchorage inserts required to support panels are within tolerances.

3.02 Erection

- A. Clear, well-drained unloading areas and road access around and in the structure (where appropriate) shall be provided and maintained by the general contractor to a degree that the hauling and erection equipment for the precast concrete products are able to operate under their own power.
- B. General contractor shall erect adequate barricades, warning lights or signs to safeguard traffic in the immediate area of hoisting and handling operations.
- C. Set precast unit level, plumb, square and true within the allowable tolerances. General contractor shall be responsible for providing lines, center and grades in sufficient detail to allow installation. General contractor shall verify that bearing surfaces comply with specifications and, if not in compliance, shall make necessary corrections prior to start of erection.
- D. Provide temporary supports and bracing as required to maintain position, stability and alignment as units are being permanently connected.
- E. Tolerances for location of precast units shall be in accordance with Chapter 8 of this handbook.
- F. Set non-load bearing units dry without mortar, attaining specific joint dimension with steel or plastic spacing shims.
- G. Fasten precast units in place by bolting or welding, or both, completing dry packed joints, grouting sleeves and pockets, and/or placing cast-in-place concrete joints as indicated on approved erection drawings.
- H. Temporary lifting and handling devices cast into the precast concrete units shall be completely removed or, if protectively treated, left in place unless they interfere with the work of any other trade.

2.04.B.3 Specify size. Cube specimens are usually 4 in. units, but 2 in. or 6 in. units are sometimes required. Larger specimens give more accurate test results than smaller ones. Source: (molded individually), (sawed from slab).

2.04.C These records should include mix designs, test reports, inspection reports, member identification numbers along with date cast, shipping records and erection reports.

3.02.A General contractor should coordinate delivery and erection of precast concrete products with other jobsite operations.

3.02.C Controlled reference lines should be used because the characteristics of precast concrete make a surface elevation difficult to define. Where thickness is not of exact concern, lines used in erection should be controlled from exposed exterior precast concrete surfaces.

3.02.F Shims should be near the back of the unit to prevent their causing a spall on face of unit when shim is loaded. The selection of the width and depth of field-molded sealants, for the computed movement in a joint, should be based on the maximum allowable strain in the sealant.

3.02.G The erector should protect units from damage caused by field welding or cutting operations and provide non-combustible shields as necessary during these operations. Structural welds should be made in accordance with the erection drawings which should clearly specify type, extent, sequence and location of welds. Adjustments or changes in connections, which could involve additional stresses in the products or connections, should not be permitted without approval by the architect/engineer. Precast concrete units should be erected in the sequence indicated on the approved erection drawings.

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3.03 Repair

- A. Repair exposed exterior surface to match color and texture of surrounding concrete and to minimize shrinkage.

- B. Adhere large patch to hardened concrete with bonding agent.

3.04 Cleaning

- A. After installation and joint treatment, if necessary, manufacturer shall clean soiled precast concrete surfaces with detergent and water, using fiber brush and sponge, and rinse thoroughly with clean water in accordance with precast concrete manufacturer's recommendation.
- B. Use acid solution only to clean particularly stubborn stains after more conservative methods have been tried unsuccessfully.
- C. Use extreme care to prevent damage of precast concrete surfaces and to adjacent materials.
- D. Rinse thoroughly with clean water immediately after using cleaner.

3.05 Protection

- A. All work and materials of other trades shall be adequately protected by the erector at all times.
- B. A fire extinguisher, of an approved type and in operating condition, shall be located within reach of all burning and welding operations at all times.
- C. The erector shall be responsible for any chipping, spalling, cracking or other damage to the units after delivery to the jobsite unless damage is caused in site storage by others. After installation is completed, any further damage shall be the responsibility of the general contractor

3.03.A Repair is normally accomplished prior to final cleaning and caulking. It is recommended that the precaster execute all repairs or approve the methods proposed for such repairs by other qualified personnel. The precaster should be compensated for repairs of any damage for which he is not responsible. Repairs should be acceptable providing the structural adequacy of the product and the appearance are not impaired. All repairs and remedial work should be documented and kept in job record files.

3.03.B Bonding agent should not be used with small patches because of the greater likelihood of discoloring the patch.

3.05.C After erection of any portion of precast concrete work to proper alignment and appearance, the general contractor should make provisions to protect all precast concrete from damage and staining.