

## PRECAST CONCRETE STAIRS

### Part I- General

#### 1.1 Summary

- A. This section includes the design, fabrication, erection, and complete installation of precast concrete stair platforms.
- B. Related sections include the following:
  - 1. Division 3 section "Cast in Place Concrete."

#### 1.2 Performance Requirements

- A. Structural Performance: Provide precast concrete stairs, stair platforms, and connections designed in accordance with ACI 318 and capable of supporting the full unit dead load plus 100 psf live load. Plank short-term and long-term deflection maximums shall not be greater than Table 9.5(b) of ACI 318.

#### 1.3 Submittals

- A. Production data: For each type of product indicated.
- B. Design mixes: For each concrete mix.
- C. Design calculations: For precast stair units, signed and sealed by the qualified professional structural engineer responsible for its preparation.
- D. Shop drawings: Detail fabrication and installation of precast concrete stair units and platforms. Indicate member locations, plans, elevations, dimensions, shapes, sections, openings, jointing, anchoring, and types of reinforcement, including special reinforcement.
  - 1. Indicate each piece by number on setting drawings and mark units with corresponding non-staining numbers.
  - 2. Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware, inserts, connections, and joints, including accessories.
  - 3. Indicate locations and details of anchorage devices to be embedded in other construction.

4. Comprehensive engineering analysis signed and sealed by the qualified professional structural engineer responsible for its preparation.

- E. Samples: For each type of finish indicated on exposed surfaces of precast Concrete stairs units, in sets of 3, illustration full range of finish, color, and texture variations expected: approximately 12 by 12 by 12 inches.
- F. Welding certificates: copies of certificates for welding procedures and personnel.
- G. Material test reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
  - 1. Concrete Materials.
  - 2. Reinforcement materials.
- H. Qualification data: For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses of architects and owners, and other information specified.

#### 1.4 Quality Assurance

- A. Installer qualifications: An experienced installer who has completed precast concrete work similar in material, design, and extent to that indicated for this project and whose work has resulted in construction with a record of successful in-service performance.
- B. Fabricator qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast concrete units similar to those indicated for this project and with a record of successful in-service performances.
  - 1. Assumes responsibility for engineering precast concrete units to Comply with performance requirements. This responsibility includes preparation of shop drawings and comprehensive engineering analysis by qualified professional engineer.
  - 2. Professional Engineering Qualifications: A professional Structural engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in

providing engineering services of the kind indicated.  
Engineering services are defined as those performed for

Installations of precast concrete that are similar to those indicated for this project in material, design, and extent.

3. Has sufficient production capacity to produce required units without delaying the work.
- C. Testing Agency Qualifications: an independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing in accordance with ACI requirements.
  - D. Design Standards: Comply with ACI 318 and the design recommendations of PCI MNL 120, "PCI Design Handbook – Precast and Prestressed Concrete."
  - E. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and camber and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products."
  - F. Product Options: Drawings indicate size, profiles, and dimensional requirements of precast concrete units and are based on specific types of units indicated. Other fabricators' precast concrete units complying with requirements may be considered.
  - G. Welding: Qualified procedures and personnel according to AWS D1.0, "Structural Welding Code-Steel" and AWS D1.4, "Structural Welding Code-Reinforcing Steel."
  - H. Preinstallation Conference: conduct conference at Project.
- 1.5 Delivery, Storage, and Handling
- A. Deliver precast concrete units to project site in such quantities and at such times to ensure continuity of installation. Store units at project site to prevent cracking, distorting, warping, staining, or other physical damage, and so markings are visible.

B. Lift and support units only at designated lifting and supporting points as shown on Show Drawings.

C. Provide additional reinforcing as required for any stresses in the precast units due to handling, transportation, and erection.

## 1.6 Sequencing

A. Furnish anchorage items to be embedded in other construction without delaying the work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

## Part 2 – Products

### 2.1 Fabricators

A. Basis- of- Design product A: Subject to compliance with requirements, provide products by Bethlehem Precast, Inc.

### 2.2 Mold Materials

A. Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood, or another material that is nonreactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes.

### 2.3 Reinforcing Materials

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

C. Steel Plates, Shapes, Angles, and Bars: ASTM A 36/A 36M.

D. Supports: Manufacture's bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to CRSI's "Manual of Standard Practices," PCI MNL 116, and as follows:

1. For uncoated reinforcement, use all-plastic or CRSI Class 1 plastic-protected bar supports.

## 2.4 Concrete Materials

A. Portland Cement: ASTM C 150, Type III, white, of same type, brand, and source

1. Standard gray Portland cement may be used for nonexposed backup concrete.

B. Normal-Weight aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S.

1. Face-Mix coarse aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining.

- a. Gradation: Uniformly graded.

2. Face-Mix fine aggregates: Selected, natural sand of the same material as coarse aggregates, unless otherwise approved by Architect,

C. Water: Portable, free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

D. Air-entraining Admixtures: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

E. Water-Reducing Admixture: ASTM C 494, Type A.

F Retarding Admixture: ASTM C 494, Type B

G. Water Reducing and retarding admixture: ASTM C 494, Type D

H. High-range, water-reducing admixture: ASTM C 494, Type F

I. High-range, water-reducing and retarding admixture: ASTM C 494, Type G

J. Plasticizing Admixture: ASTM C 1017

K. Fly Ash Admixture: ASTM C 618, Class C or F

L. Silica Fume Admixture: ASTM C 1240

M. Set-accelerating Corrosion-Inhibiting Admixture: commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494, type C.

1. Products

- a. Euclid chemical Company (The); Eucon CIA
- b. Grace Constructing Products, W.R. Grace & Co., DCI
- c. Master Builders, Inc; Rheocrete CNI
- d. Sika corporation; Sika CNL

2.5 Steel Connections Materials

A. Carbon-Steel shaped and plates: ASTM A 36/A 36M

B. Carbon-Steel headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished; AWS D1.1, Type A or B, with shields.

C. Malleable Steel Castings: ASTM A 47

D. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M

E Carbon Steel Bolts and Studs: ASTM A 496

F. High-strength bolts and Nuts: ASTM A 325, type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.

G. Finish: for exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M, after fabrication, and ASTM A 153/A 153M, as applicable.

H. Welding Electrodes: comply with AWS standards.

I. Accessories: Provide clips, hangers, plastic shims, and other accessories required to install precast structural concrete units.

2.6 Grout Materials

A. Sand-cement Grout: Portland cement, ASTM C 150, Type I or Type III, one brand throughout work, and clean, natural sand, ASTM C 144. Mix at ratio of 1

part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

## 2.7 Concrete Mixes

A. Prepare design mixes for each type of concrete required.

1. Limit use of fly ash and silica fume to not exceed, in aggregate, 25 percent of Portland cement by weight

B. Design mixes may be prepared by qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option

C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318.

D. Normal-Weight Concrete: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 days): 5000 psi
2. Maximum Water-Cementitious Materials Ratio: 0.45

E. Water Absorption: 12 to 14 percent by volume, tested according to PCI MNL 117.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content complying with PCI MNL 117.

G. Other admixtures: Use water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures according to manufacturer's written instructions.

H. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

## 2.8 Fabrication

A. Formwork: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for pretensioning and detensioning operations as applicable. Maintain formwork to provide completed precast concrete units of shaped, lines, and dimensions indicated, within fabrication tolerances.

B. Built-in Anchorages: Accurately position built-in anchorage devices and secure to formwork. Locate anchorages where they do not affect position of main reinforcement or concrete placement.

C. Cast-in openings larger than 10 inches in diameter or 10 inches square according to Shop Drawings. Smaller holes may be field cut by trades requiring them, as approved by Architect.

D. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete
2. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete-placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
3. Place reinforcement to obtain at least the minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.



E. Welding shall be continuous with low-hydrogen rods per latest AWS A5.1 or A5.5

F. Mix concrete according to PCI MNL 116 and requirements in this section. After concrete batching, no additional water may be added

G. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 116 for measuring, mixing, transporting, and placing concrete.

H. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 116.

I. Comply with ACI 306.1 procedures for cold-weather concrete placement

J. Comply with ACI 305R recommendations for hot-weather concrete placement

K. Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint casting date on each precast concrete unit on a surface that will not show in finished structure.

L. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat curing using low-pressure live steam or radiant heat and moisture; or in accordance with manufacturer's written instructions.

M. Product Tolerances: fabricate precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product tolerances.

## 2.9 Finishes

A. Finish exposed-face surfaces of precast concrete units to match approved samples and as follows:

1. Smooth Sand-Blast Finish: Provide surfaces free of pockets, sand streaks, and honeycombs, with uniform color. Texture with light sand-blast finish.

B. Finish exposed top and back surfaces of precast concrete units to match face-surface finish

C. Finish unexposed surfaces of precast concrete units by float finish

## 2.10 Source Quality Control

A. Employ an independent testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

B. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 116 requirements

C. Strength of precast concrete units will be considered deficient if units fail to comply with PCI MNL 116 requirements, including the following:

1. Units fail to comply with compressive-strength test requirements
2. Reinforcement of units does not comply with fabrication requirements
3. Concrete curing and protection of units against extremes in temperatures fail to comply with requirements
4. Units are damaged during handling and erecting

D. Testing: If there is evidence that the strength of precast concrete units may be deficient or may not comply with PCI MNL 116 requirements, Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.

1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Architect
2. Cores will be tested in an air-dry condition per ACI 301 if units will be dry under service conditions

3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is equal to at least 85 percent of the 28-day design compressive strength and no single core is less than 75 percent of the 28-day design compressive strength

4. Test results will be made in writing on the same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports will include the following:

- a. Project identification name and number
- b. Date when tests were performed
- c. Name of precast concrete fabricator
- d. Name of concrete testing agency
- e. Identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength at break, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed

E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidify fill with precast concrete mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces

F. Dimensional Tolerances: Units with dimensions smaller or larger than required and not complying with tolerance limits may be subject to additional testing

1. Precast concrete units with dimensions larger than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to comply with construction conditions

G. Defective Work: Precast concrete units that do not comply with requirements, including strength, manufacturing tolerances, and finishes are unacceptable. Replace with precast concrete units that comply with requirements.

## Part 3 Execution

### 3.1 Examination

A. Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected

### 3.2 Installation

A. Install the work of this section in strict accordance with the original design, the approved shop drawings, applicable requirements of authorities having jurisdiction, and the manufacturer's recommended installation procedures as approved by the Architect, anchoring all components firmly into position for long life under hard use

B. Install precast concrete units. Shore and brace precast concrete units to maintain location, stability, and alignment until permanent connections are installed

C. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders

1. Protect precast architectural concrete units and bearing pad from damage by field welding or cutting operations and provide noncombustible shields as required

2. Repair damaged steel surfaces by cleaning and applying a coat of galvanizing repair paint to galvanized surfaces

D. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast concrete units unless approved by architect and specifically accepted by the precast unit manufacturer

E. Erection Tolerances: Install precast concrete units level, plumb, square, and true, without exceeding the recommendation erection tolerances in PCI MNL 127, "Recommended Practice for Erection of Precast Concrete."

F. Grouting Connections and Joints: After precast concrete units have been placed and secured grout open spaces at connections and joints as follows:

1. Provide forms or other approved method to retain grout in place until hard enough to support itself. Pack spaces with stiff grout material,

tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.

2. Mortar shall not be used for grout

### 3.3 Field Quality Control

A. Testing: Engage a qualified independent testing and inspecting agency to perform field tests and inspections

B. Field welds and connections using high-strength bolts will be subject to testing and inspections

C. Testing agency will report test results promptly and in writing to Contractor and Architect

D. Remove and replace work that does not comply with specified requirements

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements

### 3.4 Cleaning

A. clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains

1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations

2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes