PCI Precast/Prestressed Concrete Institute

CONTINUING EDUCATION AIA

Terra Cotta-Faced Precast Concrete

PCI designer's notebook

TERRA COTTA-FACED PRECAST CONCRETE

Terra cotta tiles have been used to clad buildings in the United States for several decades, providing a distinctive aesthetic touch. Today, designers are discovering they can embed terra cotta into architectural and structural precast concrete panels as a means to more efficiently use terra cotta on projects. There are also several additional benefits, including aesthetic versatility, accelerated construction, reducing the number of joints and maintenance costs, and high thermal performance.

Many architectural firms have used terra cotta with rainscreens on a number of overseas projects. Hand- setting the material into a traditional rainscreen application in the United States is not as economical as overseas as it leads to higher material and labor costs. A rainscreen design requires stud backing, sheathing, membrane, and aluminum extrusions (a complicated detailing process). Whereas, a terra cotta embedded precast concrete panel can achieve the same look, but provide a more cost-effective solution because of precast concrete's ability to provide multiple functions.

The following discussion on design concepts and details for terra cotta cladding is taken from a presentation by Kristen Vican, RTKL Associates, Inc., Washington, D.C., on the 16-story Hyatt Regency expansion at Tysons Corner, McClean, Va,

Figure 1a Hyatt Regency expansion, Tysons Corner, McClean, Va. All figures and photos: RTKL Associates.

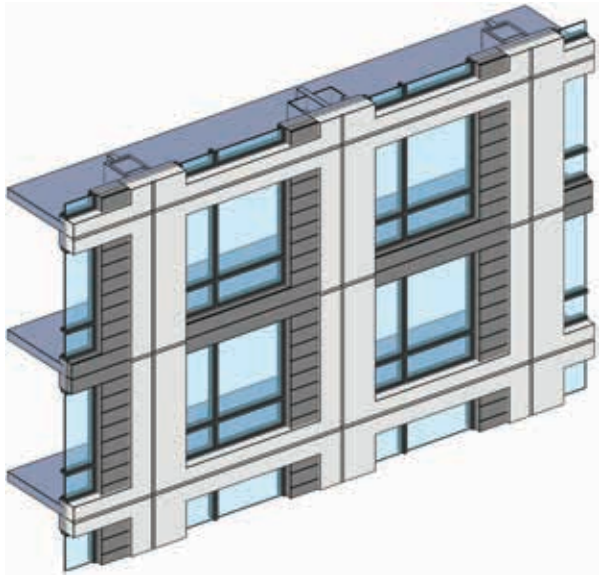

Figure 1b Typical precast panel elevation.

PCI designer'snotebook

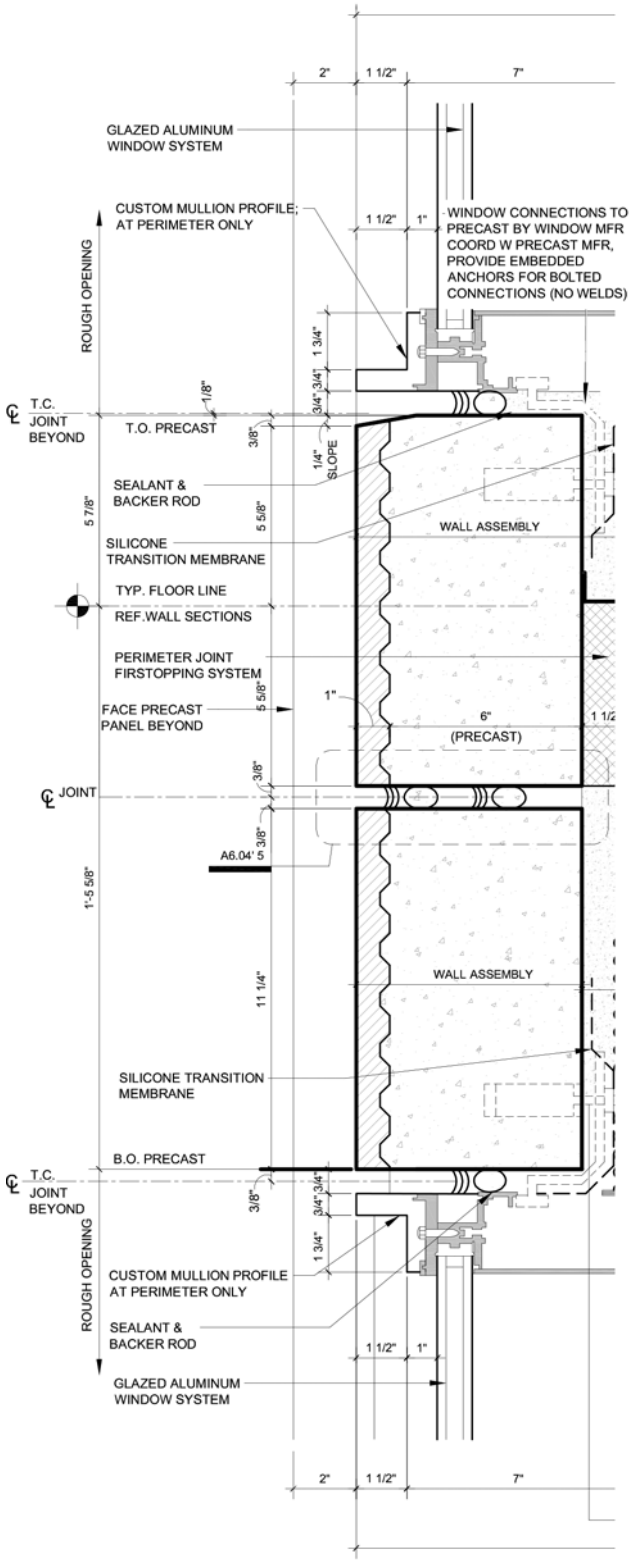

Figure 1c Wall section showing custom mullion to conceal terra cotta edge.

Fig. 1a and 1b.

Early collaboration during schematic design is key. Discussions about design concepts, such as panelization, and detailing concerns need to be addressed with the precaster and terra cotta tile manufacturer, and the plants should be visited to understand the material and fabrication restraints. Specifications should include testing and full-size-visual- mock-up requirements.

Possibly the biggest challenge involves detailing to ensure the floor-to-floor heights work with the tile dimensions to avoid having to cut the tile and leave an exposed edge. Horizontal dimensions are more critical than vertical ones, as these tiles can be more easily modified. Punched windows also must be coordinated to ensure the tile joints align. Punched windows are more challenging to do with terra cotta because of the need to cut the tile. To resolve this, the design team for the Hyatt Regency designed a custom mullion that covers the edges of panels at window openings to avoid needing returns on panels, **Fig. 1c**. It is desirable to consider window placement depth or mullion profiles to conceal edges. The concern with creating metal frames and trim is that the design still needs to allow tolerances for each material, which creates a wider gap. It is preferable to extend the edges of the precast panel past the edges of the terra cotta tiles to cover the ends.

Vertical joints should be kept shallow to minimize water infiltration behind tile

at ship-lap joints. Horizontal joints are less problematic because they typically are ship-lapped, **Fig. 1d**. To ensure continuity of the terra cotta between panels without changing the joint width, joints should be the governing factor and the width at the overlap should accommodate the tile lip.

Custom tiles with finished edges and no ship-lap extension may be required between precast panels and at the top and bottom of rough openings. Angled tiles should be used at sill conditions.

Full-size mock-up panels are essential to ensure all conditions and situations are considered and reviewed prior to the start of precast erection. An aesthetic review should include the location and color of face mixes, selection of reveal depths, and selection of sealant colors. A review of patch and repair procedures also should be undertaken, including the process for replacing a full tile and for repairing minor damage, **Fig. 1e**. Tests performed on the materials, at an independent facility, should include tests for tensile bond strength (pull out tests) and freeze-thaw resistance. See PCI Specification for Embedded Architectural Terra Cotta in Precast Concrete Systems.

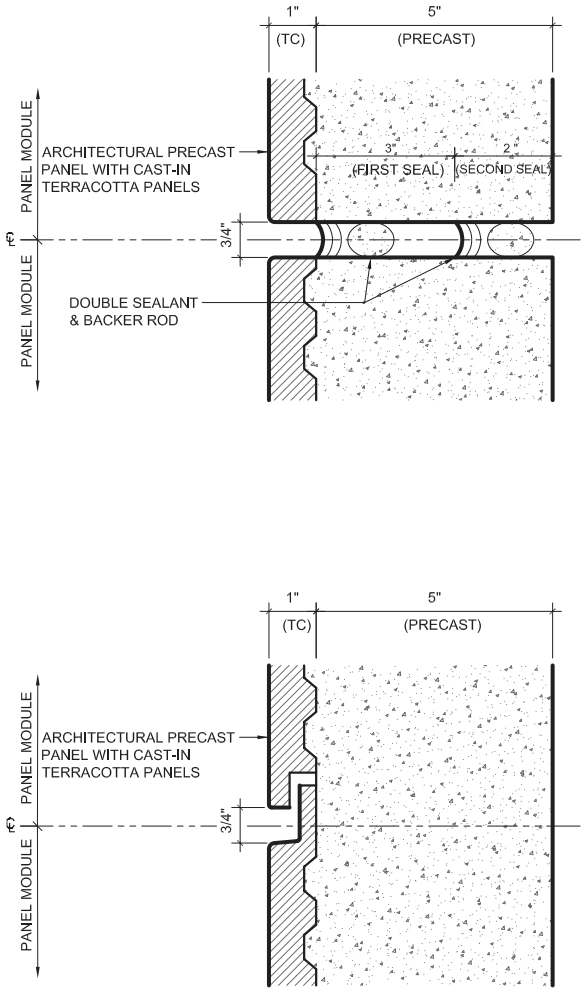

Figure 1d Typical joint and reveal at terra cotta.

The objective of the PCI Specification is to outline material standards and specification criteria for terra cotta manufacturers to meet when supplying materials to precast concrete manufacturers. The intent is to establish acceptable dimensional tolerances and consistent testing standards for terra cotta embedded in precast concrete systems.

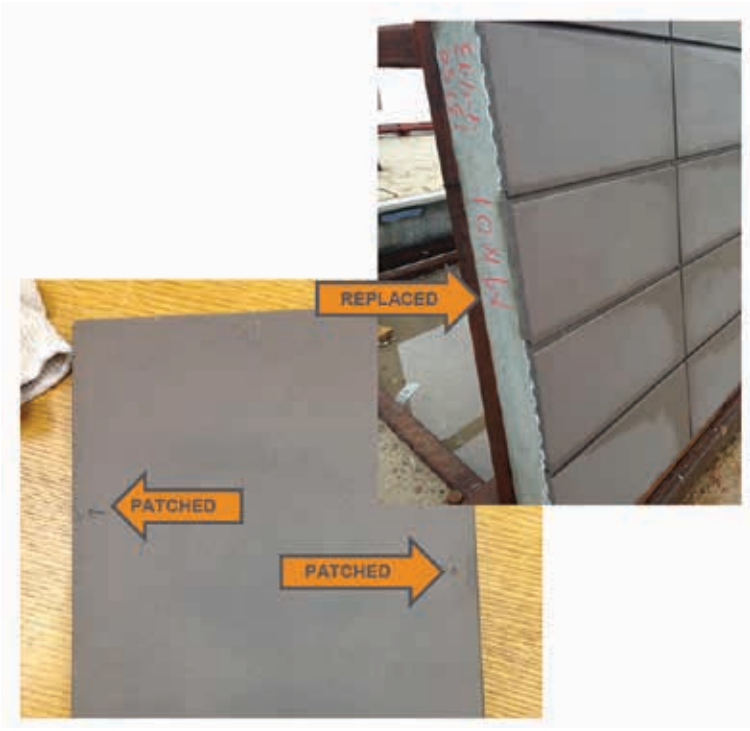

Figure 1e Patch and repair.

The terra cotta manufacturers must confirm through the provision of independent test results that their terra cotta products comply with the PCI Specification. The PCI Specification should appear in all project specifications for terra cotta to be embedded in precast concrete. Terra cotta manufacturers have agreed to promote the compliance of their terra cotta with this specification.

The established parameters are based on the successful use of embedded terra cotta in precast concrete projects. The parameters set forth for use in this specification are attainable terra cotta properties that have been derived with input from terra cotta manufacturers, precasters, engineers, and architects, as well as consideration of existing test results.

Suggested Visual Mock-up Requirements

Erect on site, at location directed by Architect, typical prototype installation of precast concrete and terra cotta-faced precast concrete complete with adjacent building systems interfaces as shown on architect's drawings.

1. Simulate final wall conditions including joint conditions, flashings, sealants including two-stage seal conditions, anchorage, supports and other features used in final Work.
2. Construct mock-ups prior to ordering final materials and after acceptance of samples.
3. Display full, accepted color range and texture. Replace rejected panels until acceptable color range is achieved.
4. Show types of surface defects expected to be encountered, including repair procedures and workmanship. If acceptable repair procedures cannot be achieved on mock-up for specific defects and deficiencies, those defects and deficiencies shall be considered as cause for rejection of panels.
    a. Show patching for minor damage to a tile.
    b. Show replacement technique for one typical full terra cotta tile.
    c. Before commencing mock-up patching, confirm patching procedures with Architect and establish by trial mix formula for patching of finish. Demonstrate patching techniques on mock-up panels prior to actual use on any Project units.
5. Incorporate transitions to related primary materials specified in other sections per the mock-up panels described on Architect's drawings.
6. Maintain approved mock-up until completion of precast Work.

Pre-Production Sample Mock-up: Construct typical precast panels for inspection and approval at precast plant by Architect prior to full production release.

PCI Specification for Embedded Architectural Terra Cotta in Precast Concrete Systems

A. Terra Cotta Units: Thickness, not less than 3/4 in. (19 mm) nor more than 1-1/2 in. (38 mm)

1. Size- Dimensional Tolerances:

   a. Width: Plus or minus 0.039 in. (±1 mm) for any length up to 60 in. (1.5 m).

   b. Height: Plus or minus 0.0625 in. (±1.6 mm) up to 10 in. (250 mm).

      Plus or minus 0.09375 in. (±2.4 mm) up to 15 in. (380 mm).

      Plus or minus 0.125 in. (±3.2 mm) up to 20 in. (500 mm).

      Plus or minus 0.156 in. (±4 mm) up to 24 in. (0.6 m).

   c. Thickness: Plus or minus 0.0625 in. (±1.6 mm).

2. Color and Texture: **[Match Architect's approved samples]**.

   [Match existing adjacent terra cotta]

   a. **<Insert information on existing terra cotta if known>**

3. Special Shapes: Include corners, edge corners, and end edge corners.

4. Cold Water Absorption at 24 hours: Maximum 6.0% when tested in accordance with ASTM C 67.

5. Efflorescence: Rated "not effloresced" when tested in accordance with ASTM C 67.

6. Out of Square: Plus or minus 1/16 in. (±1.6 mm) when measured in accordance with ASTM C 67.

7. Warpage Tolerances:

   a. Straightness (sweep): Plus or minus 0.25% of length

   b. Diagonal Flatness: Plus or minus 0.25% of diagonal

   c. Vertical Flatness: Plus or minus 0.5% of height

8. Variation of Shape from Specified Angle: Plus or minus 1 degree.

9. Tensile Bond Strength: Not less than 150 psi (1 MPa), before and after freeze-

thaw testing, when tested in accordance with modified ASTM E 488. Epoxy steel plate with welded rod on total terra cotta surface for each test.

10. Freeze-Thaw Resistance: No detectable deterioration (spalling, cracking, or chafing) after 300 cycles when tested in accordance with ASTM C 666 Method A or B.
11. Modulus of Rupture: Not less than 2000 psi (13.8 MPa) when tested in accordance with ASTM C 67.
12. Compressive Strength: Not less than 6000 psi (41.4 MPa) when tested in accordance with ASTM C 67.
13. Chemical Resistance: Rated "not affected" when tested in accordance with ASTM C 126.
14. Glaze Resistance to Crazing: Rated "not affected" when tested in accordance with ASTM C 126.
15. Back Surface: Dovetail.

B. Test sample size and configuration shall conform to the following parameters in order to validate compliance by terra cotta manufacturer with PCI Specification for use in embedded terra cotta precast concrete systems:

1. Minimum number of test specimens: Comply with appropriate specifications except for freeze-thaw and tensile bond strength tests on assembled systems.
2. Minimum number of test specimens for freeze-thaw and tensile bond strength test: Ten (10) assembled systems measuring 18 in. x 10 in. (450 mm x 250 mm) long with a 16 in. x 8 in. (400 mm x 200 mm) piece of terra cotta embedded into the concrete substrate (assembled system). Note the piece of terra cotta shall have a dovetail back surface geometry. The 10 assembled systems are divided into five Sample **A** assemblies and five Sample **B** assemblies. The precast concrete substrates shall have a minimum thickness of 2-1/2 in. (63 mm) plus an embedded maximum 1-1/2 -in. (38 mm) -thick piece of terra cotta. The precast concrete shall have a minimum compressive strength of at least 5000 psi (34.5 MPa) and 4% to 6% entrained air. The 16 in. x 8 in. (400 mm x 200 mm) embedded terra cotta piece shall be centered in the 18 in. x 10 in. (450 mm x 250 mm) sample.

About AIA Learning Units

Please visit www.pci.org/elearning to read the complete article, as well as to take the test to qualify for 1.0 HSW Learning Unit.

The Precast/Prestressed Concrete Institute (PCI) is a Registered Provider with both the American Institute of Architects (AIA) and the National Council of Examiners for Engineers and Surveyors (NCEES). Continuing education credit is reported to both agencies.

All certificates of completion, for architects and for engineers, will be available from the Registered Continuing Education Provider (RCEP) web site at www.rcep.net. PCI reports data twice per month so you should see your credits appear (and your certificate will be ready) within 30 days of our receiving your completed quiz.

If you are new to the Registered Continuing Education Provider system, www.rcep.net will email you a welcome email when PCI uploads your data. That email will contain your account password. Your login name at www.rcep.net will be your email address, so you must include it when submitting your completed quiz.

Instructions

Review the learning objectives below.

Read the AIA Learning Units article. Note: The complete article is available at www.pci.org/elearning

Complete the online test. You will need to answer at least 80% of the questions correctly to receive the 1.0 HSW Learning Units associated with this educational program.

Learning Objectives:

After reading this article, readers will be able to:

1. Describe the design considerations for the application of terra cotta on precast concrete.
2. Explain how terra cotta is used in precast concrete.
3. Describe the benefits of using terra cotta-faced precast concrete.
4. Explain the specification and requirements when using terra cotta with precast concrete

Questions: contact Education Dept. - Alex Morales, (312) 786-0300 Email amorales@pci.org