ARCHITECTURAL PRECAST CONCRETE WALL PANELS

CONNECTION GUIDE
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INTRODUCTION

Architectural precast concrete has been used since the early 20th century, coming into wide use in the 1960s. The versatility of precast concrete makes it ideal for architectural applications. The exterior surface of a precast concrete piece can vary from a form face finish similar to cast-in-place to an exposed aggregate finish that is highly ornamental. Some precast panels act as column covers while others extend over several floors in height and incorporate window openings.

In most cases, the architect selects the cladding material for appearance, provides details for weatherproofing and specifies performance criteria. The structural engineer designs the structure to hold the cladding, designates connection points and evaluates the effects of structural movement on the cladding. The precast concrete manufacturer designs the cladding for the specified loads, erection loads and connection details, and provides for the weatherproofing, performance and durability of the cladding itself.

Typically, each precast panel is independently supported to the building structure using an assemblage of metal components and anchors. Joints around each of the precast panels are usually filled with sealant.

The purpose of this manual is to present panelized options and connection details that are commonly used with architectural precast concrete.

Precast Panel Types for Building Envelopes

There are generally three types of precast panels used as part of building envelopes: cladding or curtain walls; load-bearing wall units; and shear walls.

Precast cladding or curtain walls are the most commonly used precast concrete components for building envelopes. This type of precast concrete panel does not transfer vertical loads but simply encloses the space. Cladding components are designed to resist wind, seismic forces generated by their own weight and forces required to transfer the weight of the panel to the support. Common cladding units include wall panels, window wall units, spandrels, mullions and column covers. These units can usually be removed individually if necessary.

Load-bearing wall units resist and transfer loads from other elements and cannot be removed without affecting the strength or stability of the building. Typical load-bearing wall units include solid wall panels and window wall and spandrel panels.

Precast concrete shear wall panels provide a lateral load-resisting system when combined with the diaphragm action of the floor construction. The effectiveness of precast concrete shear walls is largely dependent on the panel-to-panel connections.

In some cases, precast panels are used as formwork for cast-in-place concrete. The precast panels act as a form, providing the visible aesthetics of the system, while the cast-in-place portion provides the structural component of the system.

Support and Anchorage Systems

Precast concrete panel connections are an important component of the envelope system. Precast manufacturers use numerous different types of anchors, which are often characterized as gravity and lateral connections.

The primary purpose of the connection is to transfer load to the supporting structure and to provide stability. The criteria used to design precast connections includes but is not limited to:

- Strength
- Ductility
- Volume change accommodations
- Durability
- Fire resistance
- Constructability

Types of Connections

Hardware design for connections should take into account the tolerances for both the precast concrete components and the structure. These considerations may require clip angles and plates with slots or oversize holes to compensate for dimensional variations, field welding or sufficient shim spaces to allow for variations in elevation. Sufficient minimum clearance between precast units and structure should be provided to allow for product, interface and erection tolerances. Hardware should be designed to compensate for additional stress at maximum anticipated clearance.
**Bolted Connections**

Bolted connections simplify and speed-up the erection operation, because the connection is positive immediately. Final alignment and adjustment can be made later without tying up crane time. Bolting should be in accordance with the erection drawings, using material specified by the designer.

**Welded Connections**

Welded connections are the most common and typical connection used in the erection of precast concrete. These connections are structurally efficient and adjust easily to varying field conditions.

The connections are usually made by placing a loose plate between two structural steel plates that are embedded both in the cast-in-place or the precast concrete panel and welded together. Some connections are designed to bend and yield in one direction while remaining rigid in all other directions. Welded connections should be installed exactly as shown on the erection drawings and details.

**Dowel/Anchor Bolt Connections**

In a dowel connection, the strength of dowels in tension or shear depends on dowel diameter, embedded length and the bond developed. Good practice is to provide sufficient embedment to develop the full dowel strength.

Threaded anchor bolts and rebar anchor dowels that protrude from the foundation are the critical first connection to precast members. Usually, this work is performed by a subcontractor not responsible to the erector. It is important that these items be placed accurately in both plan and vertical alignment.

**Notes**

The connections described in this guide are generic connections. Please contact the NPCA technical staff or your local NPCA architectural precast concrete producer to discuss the connections for your specific project.

This manual does not claim or imply that it addresses all safety-related issues, if any, associated with its use.

The manufacture of concrete products may involve the use of hazardous materials, operations and equipment. It is the user’s responsibility to determine appropriate safety, health and environmental practices and applicable regulatory requirements associated with the use of this manual and the manufacture of concrete products.

Use of this manual does not guarantee the proper function or performance of any product manufactured in accordance with the requirements contained in the manual. Routine conformance to the requirements of this manual should result in products of an acceptable quality according to current industry standards.

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THE FOLLOWING SYMBOLS ARE UTILIZED THROUGHOUT THESE DETAILS. REFER TO CONNECTION DETAILS ON THE SHEET SERIES FOR VARIOUS CONNECTION TYPES:

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CONNECTIONS LEGEND

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P-O

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PANELIZATION OPTION 1 – SPANDRELS AND COLUMN COVERS

NOTES:
1. SEE P-0 FOR LEGEND.
2. SEE CONNECTION DETAILS FOR MORE INFORMATION.
3. CONNECTION QUANTITIES AND SPACING AS DETERMINED BY DESIGN.
4. MAXIMUM PANEL HEIGHT XX'-X''.
5. MAXIMUM PANEL LENGTH XX'-X''.

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PANELIZATION OPTION 1 – BUILDING SECTION

STEEL FRAME

CONCRETE FRAME

CEILING

GLAZING

PRECAST SPANDREL
NOTES:
1. SEE P-0 FOR LEGEND.
2. SEE CONNECTION DETAILS FOR MORE INFORMATION.
3. CONNECTION QUANTITIES AND SPACING AS DETERMINED BY DESIGN.
4. MAXIMUM PANEL HEIGHT XX'-X''.
5. MAXIMUM PANEL LENGTH XX'-X''.

PANELIZATION OPTION 2 – HORIZONTAL WINDOW UNITS
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

PANELIZATION OPTION 2 – BUILDING SECTION

STEEL FRAME

CONCRETE FRAME

WINDOW UNIT SECTION MAX. HEIGHT = 12'-0"

+12" FROM TOP OF SLAB TO TOP OF PANEL

CEILING

GLAZING

PRECAST WINDOW UNIT

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PANELIZATION OPTION 3 – VERTICAL WINDOW UNITS

NOTES:
1. SEE P-0 FOR LEGEND.
2. SEE CONNECTION DETAILS FOR MORE INFORMATION.
3. CONNECTION QUANTITIES AND SPACING AS DETERMINED BY DESIGN.
4. MAXIMUM PANEL HEIGHT XX'-XX".
5. MAXIMUM PANEL LENGTH XX'-XX".

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PANELIZATION OPTION 3 – BUILDING SECTION

STEEL FRAME

CONCRETE FRAME

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NOTES:
1. SEE P-0 FOR LEGEND.
2. SEE CONNECTION DETAILS FOR MORE INFORMATION.
3. CONNECTION QUANTITIES AND SPACING AS DETERMINED BY DESIGN.
4. MAXIMUM PANEL WIDTH XX’-X”.
5. MAXIMUM PANEL HEIGHT XX’-X”.

PANELIZATION OPTION 4 – LOW RISE STRUCTURE

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LATERAL BRACING DESIGNED BY E.O.R., SUPPLIED BY STEEL MANUFACTURER

MAXIMUM UNBRACED PANEL HGT. = ±XX" - X"

PANELIZATION OPTION 4 – BUILDING SECTION

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CONNECTION DETAIL – SHIM BEARING

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CONNECTION DETAIL – SHIM BEARING

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CONNECTION DETAIL – DOWEL PIN

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CONNECTION DETAIL – DOWEL PIN

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CONNECTION DETAIL – DOWEL PIN

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CONNECTION DETAIL – ADJUSTABLE TIE BACK

S-3.1

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CONNECTION DETAIL – ADJUSTABLE TIE BACK

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CONNECTION DETAIL – ADJUSTABLE TIE BACK

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CONNECTION DETAIL – ADJUSTABLE TIE BACK

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CONNECTION DETAIL – ADJUSTABLE TIE BACK

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CONNECTION DETAIL – ADJUSTABLE TIE BACK

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CONNECTION DETAIL – ADJUSTABLE TIE BACK

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PLAN VIEW

CONNECTION DETAIL – ADJUSTABLE TIE BACK

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CONNECTION DETAIL – ADJUSTABLE TIE BACK

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CONNECTION DETAIL – FIXED TIE BACK

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CONNECTION DETAIL – FIXED TIE BACK

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CONNECTION DETAIL – FIXED TIE BACK

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CONNECTION DETAIL – FIXED TIE BACK

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CONNECTION DETAIL – FIXED TIE BACK

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PLAN VIEW

PRECAST UNIT

STEEL PLATE

LINE OF INTERIOR FINISH

STEEL COLUMN

GRID
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – FIXED TIE BACK

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CONNECTION DETAIL – FIXED TIE BACK

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CONNECTION DETAIL – PANEL TO PANEL

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PLAN VIEW

CONNECTION DETAIL – PANEL TO PANEL

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CONNECTION DETAIL – GRAVITY

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CONNECTION DETAIL – GRAVITY

STEEL ANGLE

LINE OF INTERIOR FINISH

STEEL PLATE

GRID

GQ TO FILL RECESS POCKET WITH GROUT AFTER ERECTION

CIP BEAM OR SLAB

PRECAST UNIT

1/2"
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTING DETAIL – GRAVITY

STEEL ANGLE

LINE OF INTERIOR FINISH

PLASTIC SHIMS

GC TO FILL RECESS POCKET WITH GROUT AFTER ERECTION

OP BEAM OR SLAB

J RECESS

PRECAST UNIT

BAR SLUG

STEEL PLATE

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CONNECTION DETAIL – GRAVITY + TIE BACK

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CONNECTION DETAIL – BEARING CONNECTION

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CONNECTION DETAIL – GRAVITY

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CONNECTION DETAIL – GRAVITY

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NPCA ARCHITECTURAL PRECAST CONNECTION GUIDE

S-6.7
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

SECTION A-A

ELEVATION

STEEL PLATE

RECESS

STEEL PLATE

STEEL SHIMS

STEEL ANGLE

PRECAST UNIT

ELEVATION

STEEL PLATE

RECESS

STEEL SHIMS

SECTION A-A

http://precast.org

NPCA ARCHITECTURAL PRECAST CONNECTION GUIDE

SCALE DN.BY DATE

NTS WCR 06/29/11

CONNECTION DETAIL – PANEL-TO-PANEL + GRAVITY

S-6.8
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – GRAVITY PLUS ADJ. TIE BACK

http://precast.org

SCALE    DN.BY    DATE
NTS       WCR      06/29/11

NPCA ARCHITECTURAL PRECAST CONNECTION GUIDE
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – GRAVITY

http://precast.org

NPCA ARChitectural PRECAST CONNECTION GUIDE

SCALE | DN.BY | DATE
NTS | WCR | 06/29/11
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – GRAVITY PLUS FIXED TIE BACK

S-6.11

http://precast.org

SCALE DN.BY DATE
NTS WCR 06/29/11
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – GRAVITY PLUS FIXED TIE BACK

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NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – GRAVITY

S-6.13

http://precast.org

SCALE | DN.BY | DATE
NTS   | WCR  | 06/29/11

NPCA ARCHITECTURAL PRECAST CONNECTION GUIDE
CONNECTION DETAIL – BEARING PLUS ADJ. TIE BACK

NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – BEARING PLUS ADJ. TIE BACK

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SCALE | DN.BY | DATE
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NTS | WCR | 06/29/11

NPCA ARCHITECTURAL PRECAST CONNECTION GUIDE
NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – BEARING PLUS ADJ. TIE BACK

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SCALE   DN.BY   DATE
NTS   WCR   06/29/11

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NOTE: PRECAST REINFORCING NOT SHOWN FOR CLARITY

CONNECTION DETAIL – BEARING PLUS ADJ. TIE BACK

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SCALE DN.BY DATE
NTS WCR 06/29/11

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