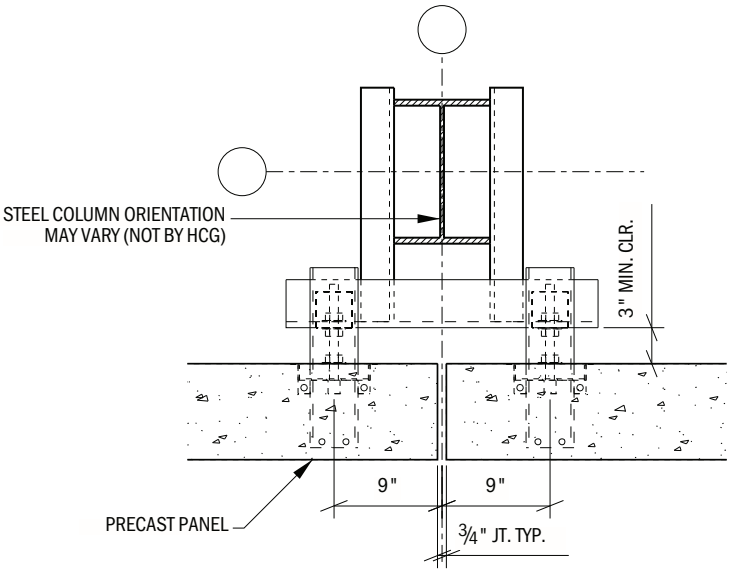
HIGH CONCRETE GROUP LLC

ARCHITECTURAL PRECAST CONCRETE CONNECTIONS GUIDE



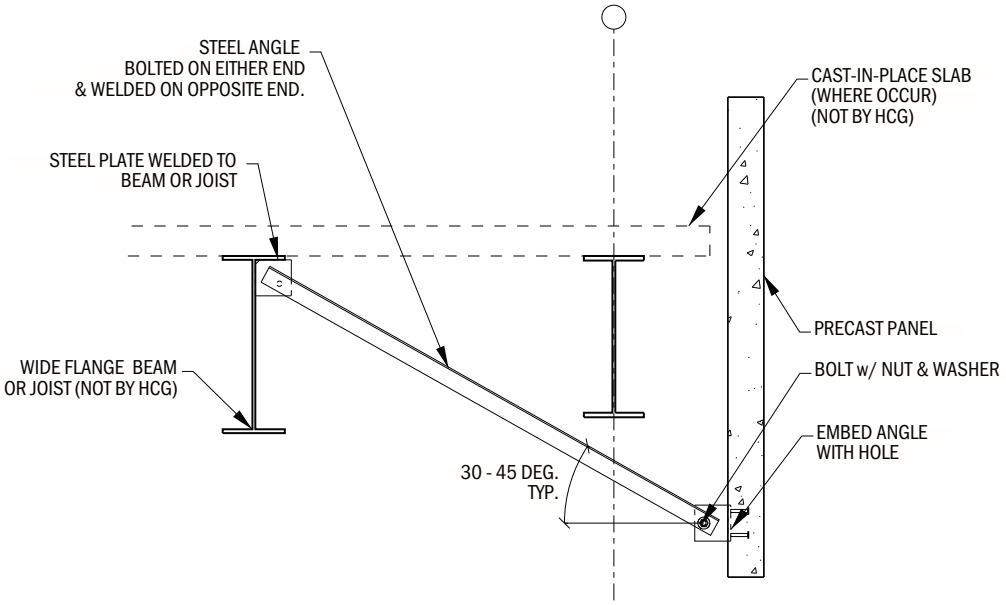


TABLE OF CONTENTS

KEY TERMS

CIP - Cast in Place
CLR - Clearance
DIA - Diameter
HCG - High Concrete Group
JT - Joint
MAX - Maximum
MIN - Minimum
PKT - Pocket
PNL - Panel
PROJ - Projection
STL - Steel
TYP - Typical

CONNECTION GUIDELINES

There are two basic types of connections:

I. LOAD BEARING

Connections that typically resist the panel self-weight and the weight of other construction material attached to the panel.

Design Considerations:

- Only two support points per panel are possible.
- The supports and the loads associated with them usually are directly applied to the CIP foundation, main structural columns, or structural beams. Note: When bearing on beams, the Engineer of Record must review the beams for deflection issues.

2. LATERAL LOAD (TIE BACK)

Connections that typically resist horizonal loads caused by wind, seismic, earth, fluid, and/or temperature.

Generally Classified As:

- End Connections: Connections that resist panel rotation caused by eccentricity of load bearing connections relative to the panel center of gravity in addition to the lateral loads listed above.
- Mid-Span Connections: Connections added based on the length of the panel to resist a portion of the lateral loads listed above.

Design Considerations:

- Minimum of four connections are required.
- Mid-Span connections may be required, depending on panel length.
- End Connections must be “quick release” adjustable connections to allow final panel positioning to occur after the crane is released.
- Mid-span connections typically connect to the top of the slab or other structural member,and must allow for deflection thereof.
- Field adjustment in three directions must be considered. Slotted inserts are typically orientated perpendicular to the span of the framing member, slot in loose hardware is orientated parallel to the span of the framing member.

TYPICAL TOLERANCE TO NON-PRECAST ELEMENTS

In precast construction, tolerances are an important design consideration. Tolerances should be considered in the manufacturing and erection of the precast units, in the construction of supporting and interface materials, and in the differential movement between precast and non-precast elements. To allow for these tolerances, the following minimum clearances need to be provided:

Maintain 1” Clearance For:

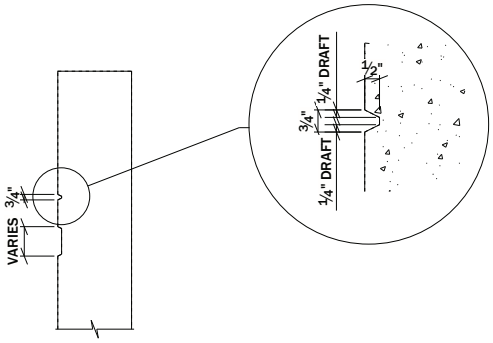
- Horizontal joint between precast and CIP.

Maintain 2” Clearance For:

- Structural steel (beams, columns, and bracing) to precast
  - Special consideration must be reviewed for columns with outward facing splice plates to ensure that plates/bolts are no closer than 2” from precast
- Structural concrete/masonry (beams, columns, walls) to precast
- Elevated slab (including pour stop) to precast
- Column base plates/CIP pedestals that extend above the bottom of precast

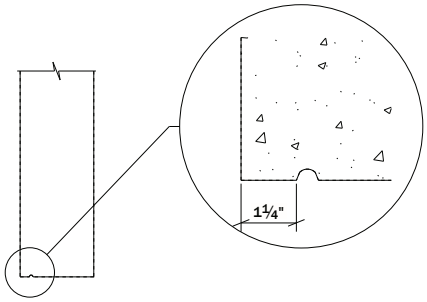
TYPICAL JOINT DETAILS

Preferred vertical and horizontal panel/panel joints should be a standard “butt” joint 3/4” wide (1” also acceptable).



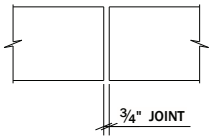
- ¼" DRAFT TYPICAL
- DEPTH INCREASES MAY INCREASE PANEL THICKNESS

REVEAL DETAILS



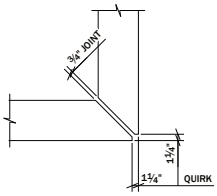
- ½" DIA. HALF-ROUND DRIP TYPICAL

TYPICAL DRIP DETAIL

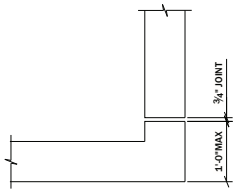


TYPICAL JOINT

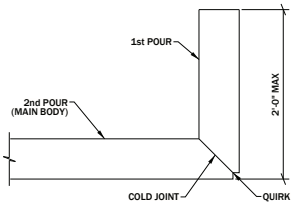
Preferred corner jointing should be a “quirk miter” joint, thus helping to reduce corner chipping spalling



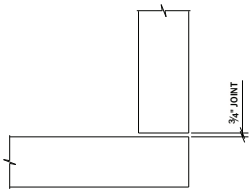
QUIRK MITER



RETURN CORNER

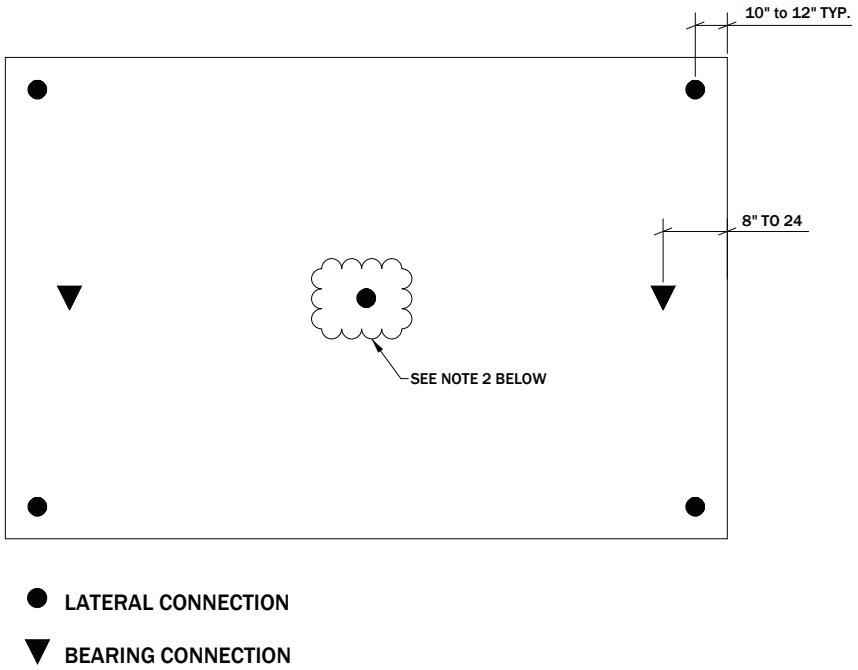


EXTENDED RETURN CORNER



BUTT JOINT

STRUCTURAL CONSIDERATIONS



Panel Thickness	Maximum Panel Length[1]	Maximum Panel Length With No Mid-Span Connections[2]
4”	24’-0”	18’-0”
5”	30’-0”	20’-0”
6”	36’-0”	22’-0”
7”	42’-0”	24’-0”
8”	48’-0”	25’-0”

[1] Maximum panel length is often governed by handling considerations. Panels approaching maximum panel length may require pre- or post-tensioning to prevent cracking of the panel. Panel configuration/geometry may limit panel lengths in these cases or configuration/geometry may need to be altered to accommodate pre- or post-tensioning. Consultation with precast supplier is recommended.

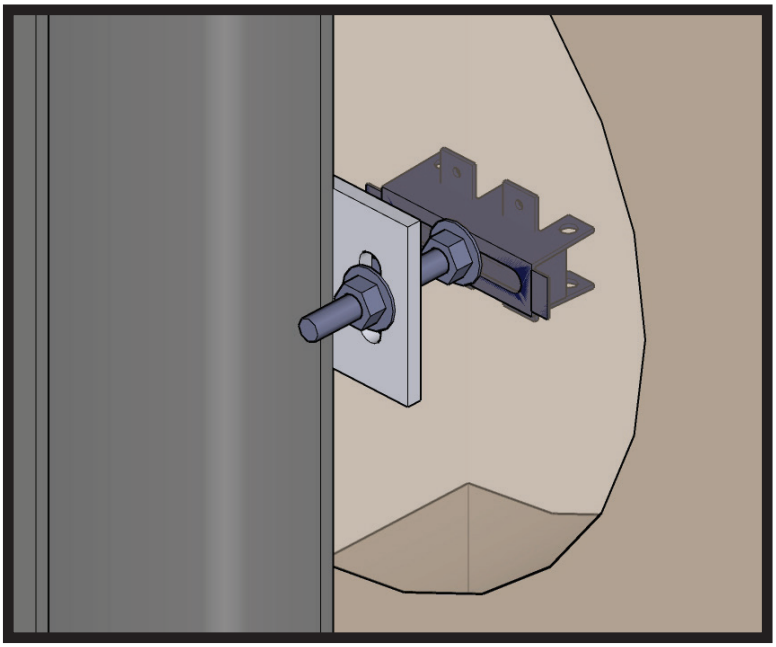
[2] The number of mid span connections required when the panel length exceeds the maximum length allowed without mid span connections is dependent on several variables. Consultation with precast supplier is recommended.

CONNECTIONS TO STEEL COLUMNS

PLATE TIEBACK

APPLICATION:

Out-of-Plane Lateral	✓
In-Plane Lateral	
Bearing	



3D Model

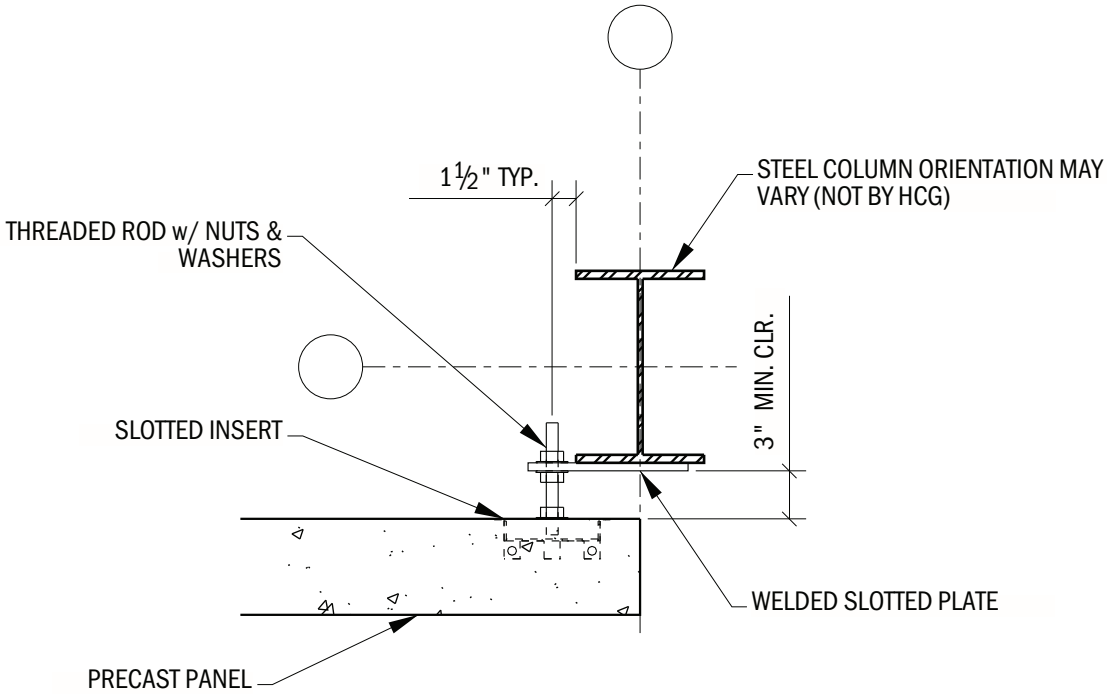
DESIGN CONSIDERATIONS:

- Preferred connection if the interior finish and space between panel and column allow.
- Maintain 3” minimum clearance between the panel and plate to allow room for nuts and washers.

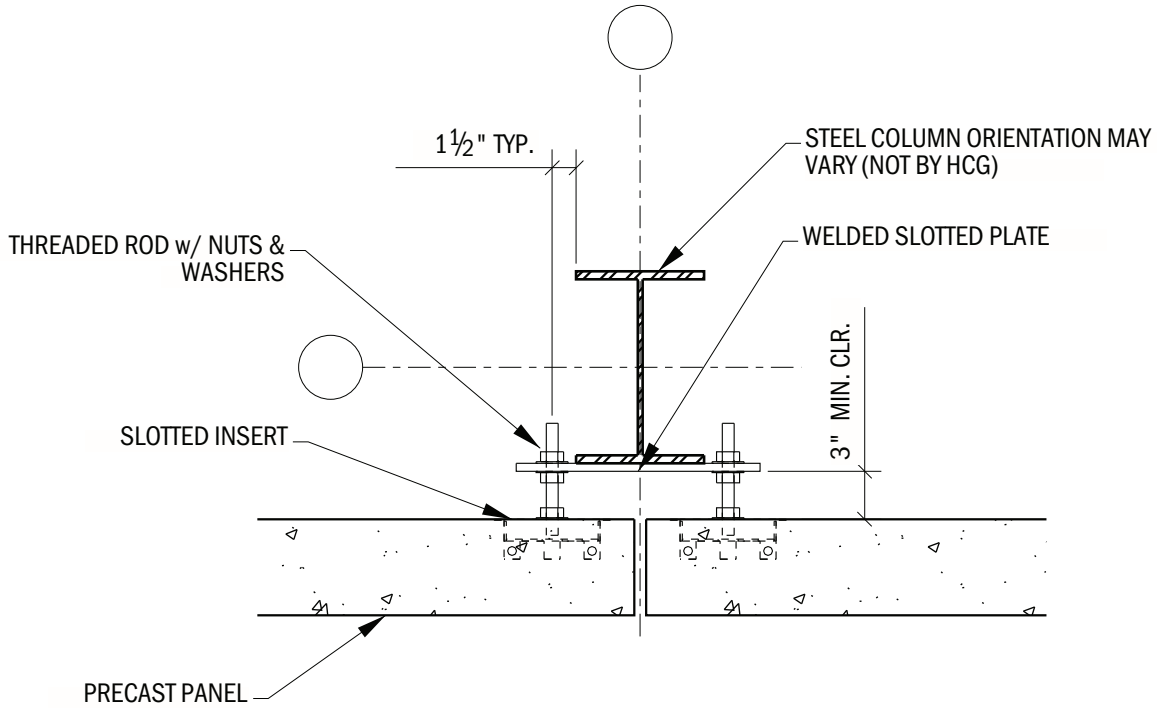
ERECTION CONSIDERATIONS:

- Provides significant adjustment capability.

SINGLE SIDED PLAN

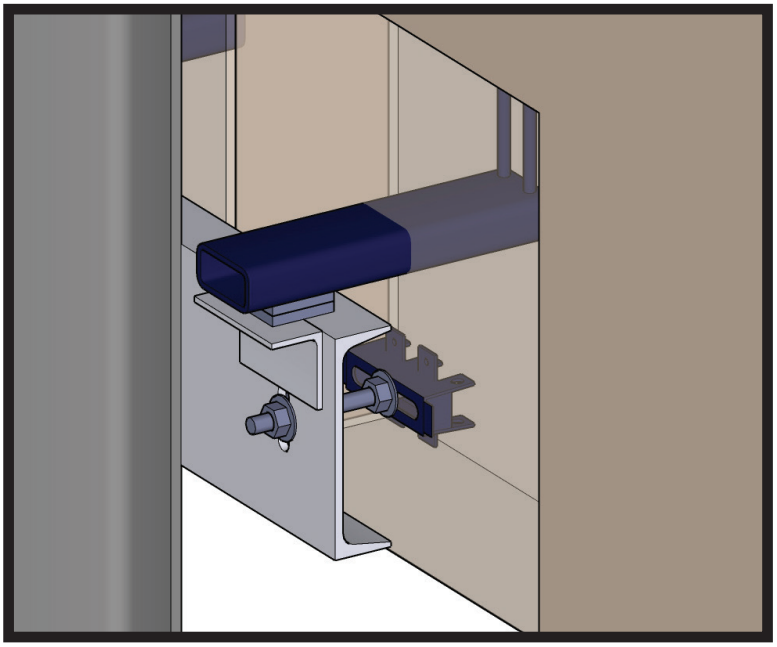


DOUBLE SIDED PLAN



CONNECTIONS TO STEEL COLUMNS

STUB BEAM BEARING WITH BOLTED TIEBACK



3D Model

APPLICATION:

Out-of-Plane Lateral	✓
In-Plane Lateral	
Bearing	✓

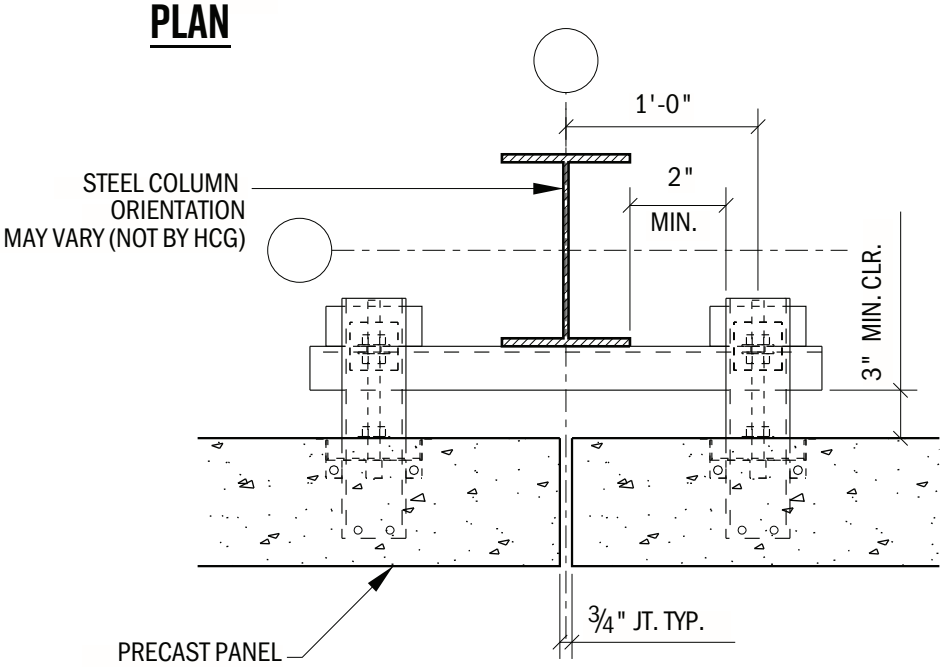
DESIGN CONSIDERATIONS:

- Typically used when the dimension from the back of the panel to the column centerline typically ranges between 10” and 16”.
- The detail is normally located below the finished floor (between the bottom of the steel spandrel beam and suspended ceiling).
- If the detail is located above finished floor, check to be sure the connection is within column closure of finished wall materials.

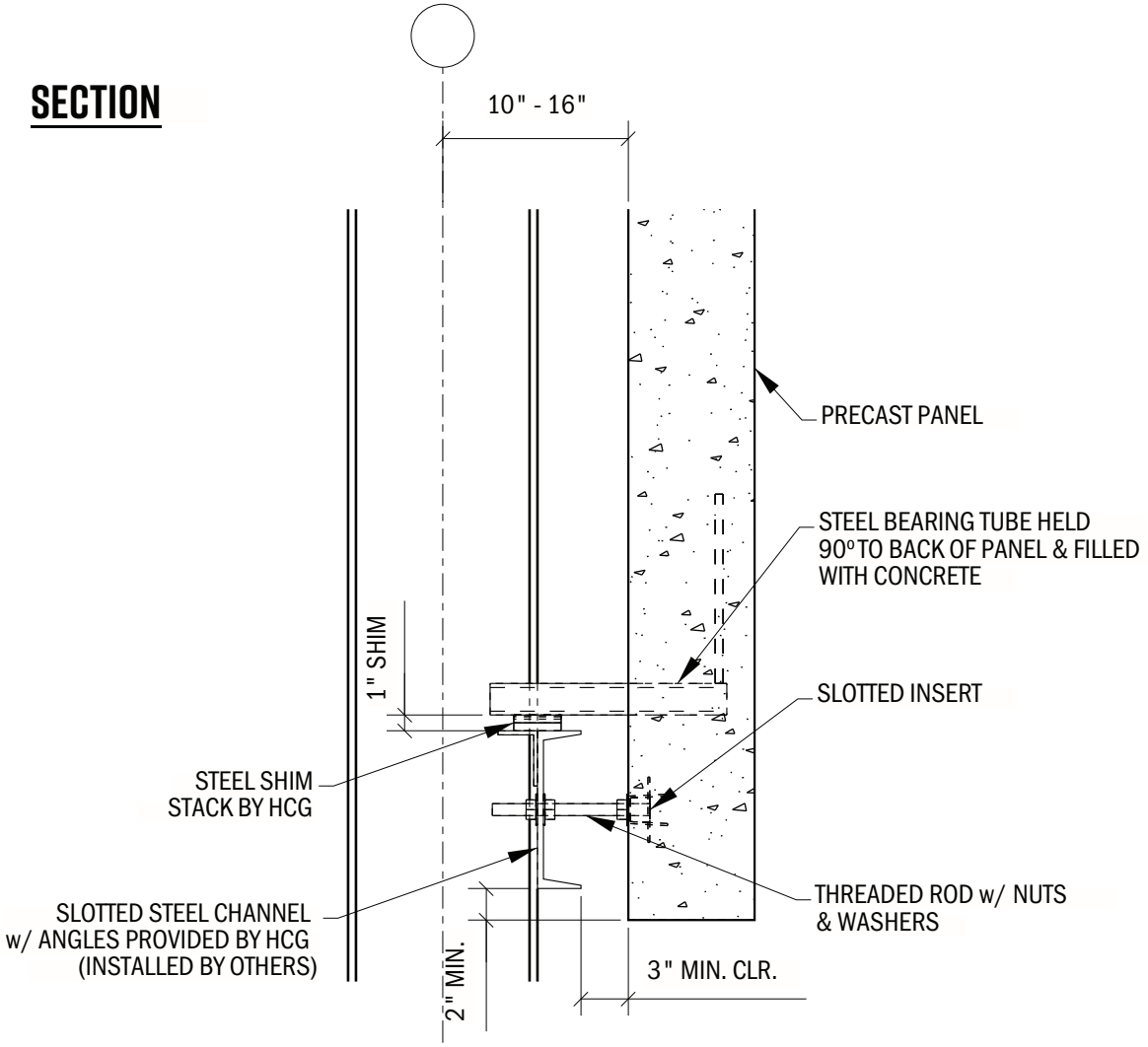
ERECTION CONSIDERATIONS:

- Provides significant out-of-plane adjustment capability.
- Shims must be located as shown to minimize torsion on bearing channel.

PLAN

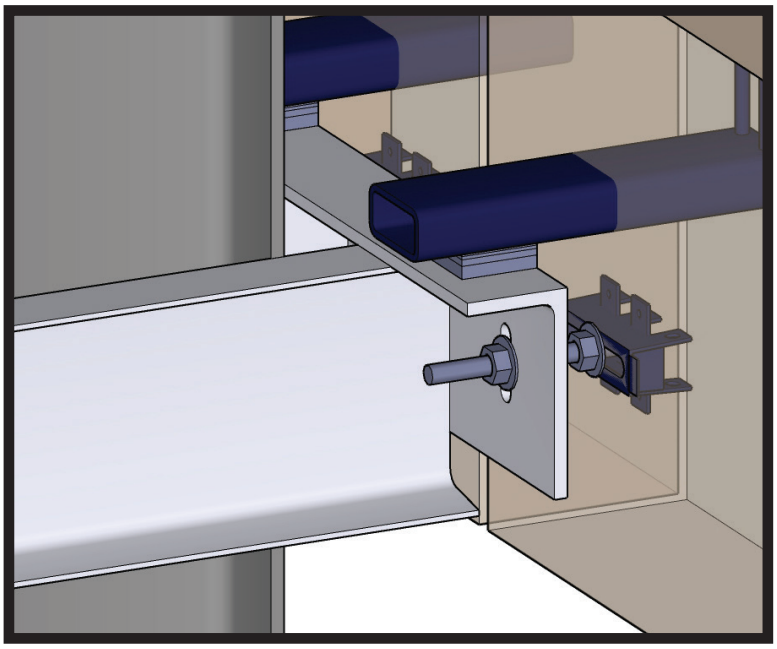


SECTION



CONNECTIONS TO STEEL COLUMNS

STUB BEAM BEARING WITH BOLTED TIEBACK (LARGE ECCENTRICITY)



3D Model

APPLICATION:

Out-of-Plane Lateral	✓
In-Plane Lateral	
Bearing	✓

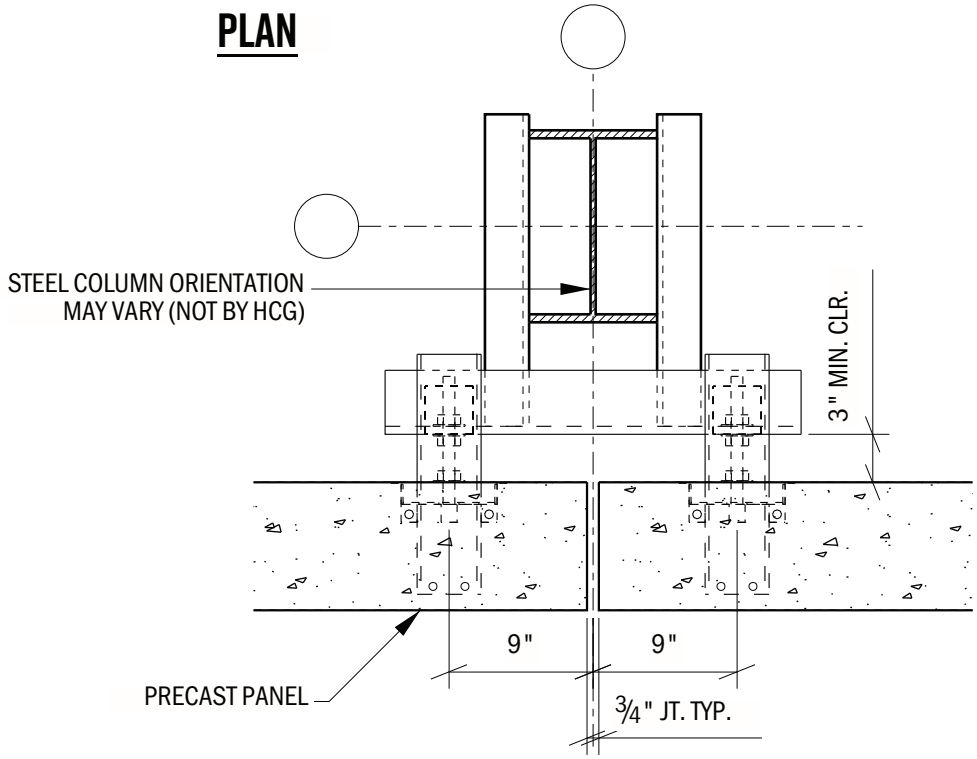
DESIGN CONSIDERATIONS:

- Typically used when the dimension from the back of panel to the column centerline typically ranges between 16”and 24’.
- The Engineer of Record should be informed if this connection is used since it produces a larger moment eccentricity to the column.
- The connection typically located between suspended ceiling and floor above.

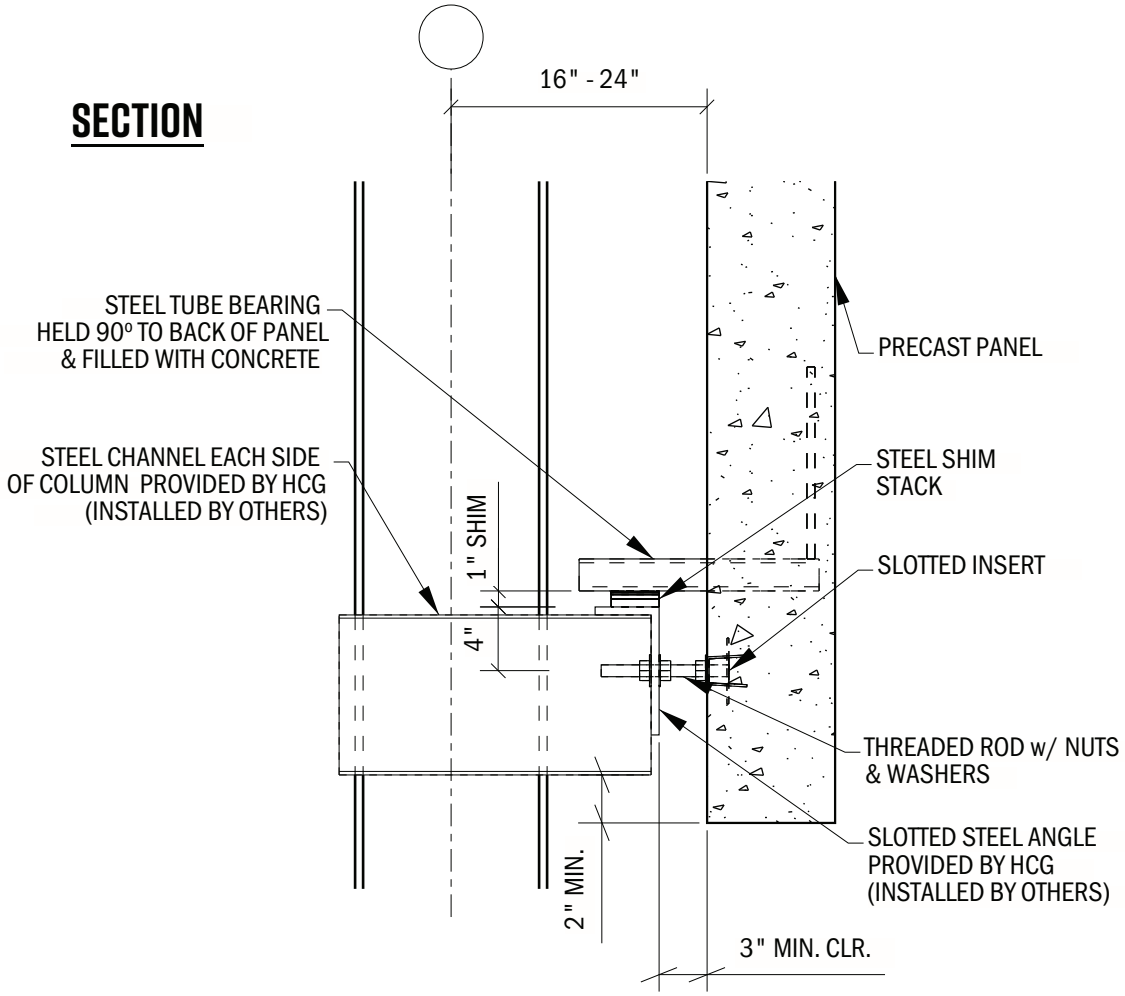
ERECTION CONSIDERATIONS:

- Provides significant out-of-plane adjustment capability.
- Shims must be located as shown to minimize torsion on bearing angle.

PLAN



SECTION

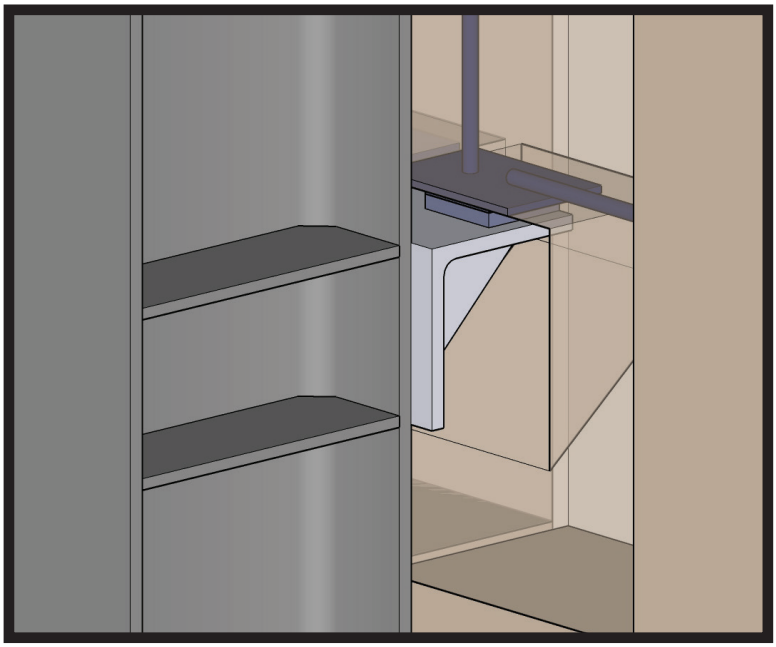


CONNECTIONS TO STEEL COLUMNS

POCKETED BEARING

APPLICATION:

Out-of-Plane Lateral	
In-Plane Lateral	
Bearing	✓

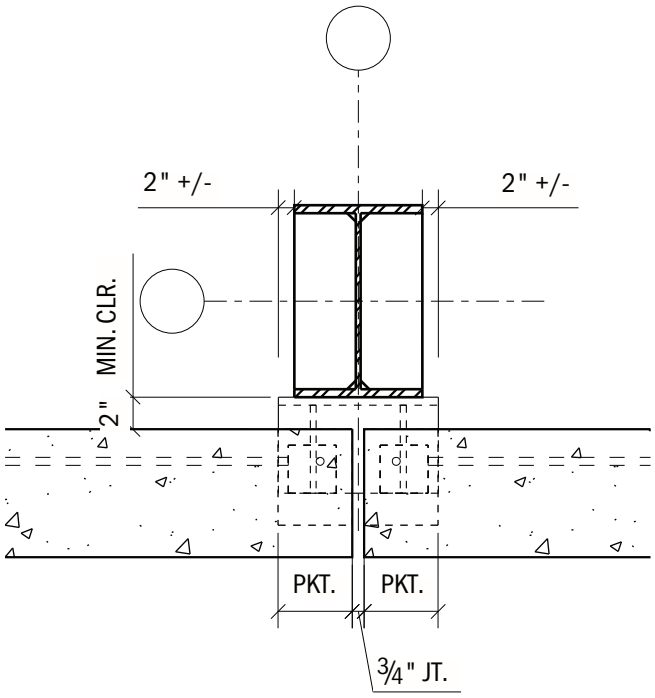


3D Model

DESIGN CONSIDERATIONS:

- Typically used when the panel is close to the structure.
- Maintain a 2” minimum and 5” maximum clearance between the back of the panel and the structure.
- The detail is normally located below the finished floor (between the bottom of the steel spandrel beam and the suspended ceiling). Check access between the bottom of the steel beam and the top of the pocket.
- If the detail is located above finished floor, check to be sure the connection is within the column closure of finished wall materials and adequate shear capacity of the connection above the pocket is available.
- The preferred panel thickness is 8” to maintain 4” minimum pocket overlap to angle. Thinner panels can be utilized but will compromise the clearance between bearing angle and pocket.

PLAN



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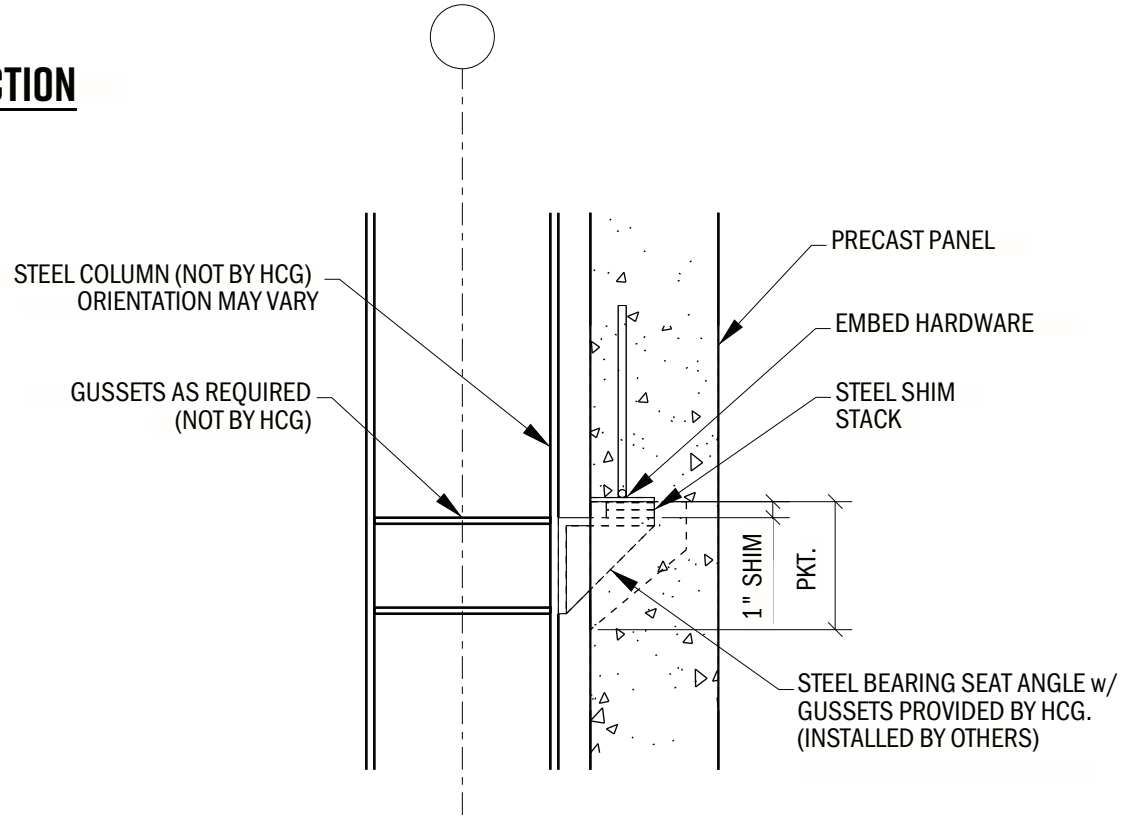
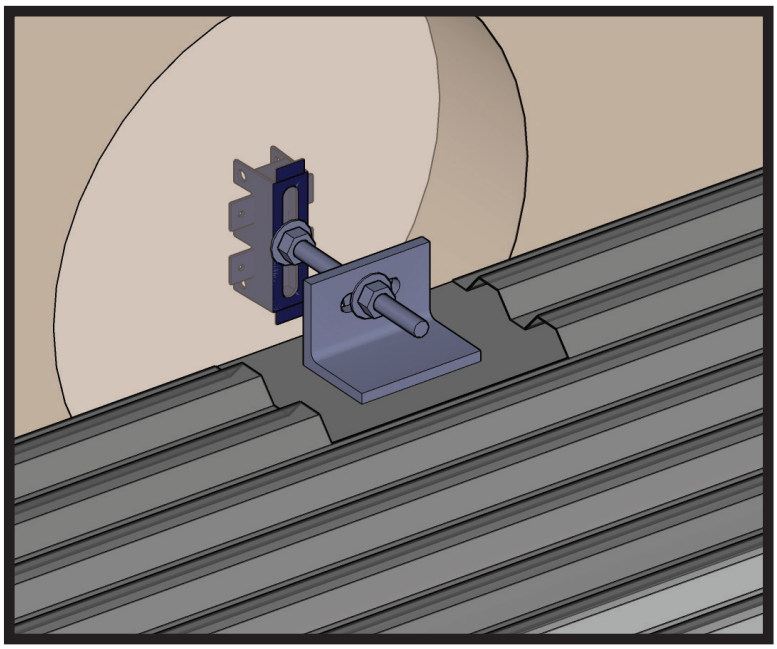


CONNECTIONS TO STEEL BEAMS

CLIP ANGLE TIEBACK

APPLICATION:

Out-of-Plane Lateral	✔
In-Plane Lateral	
Bearing	



3D Model

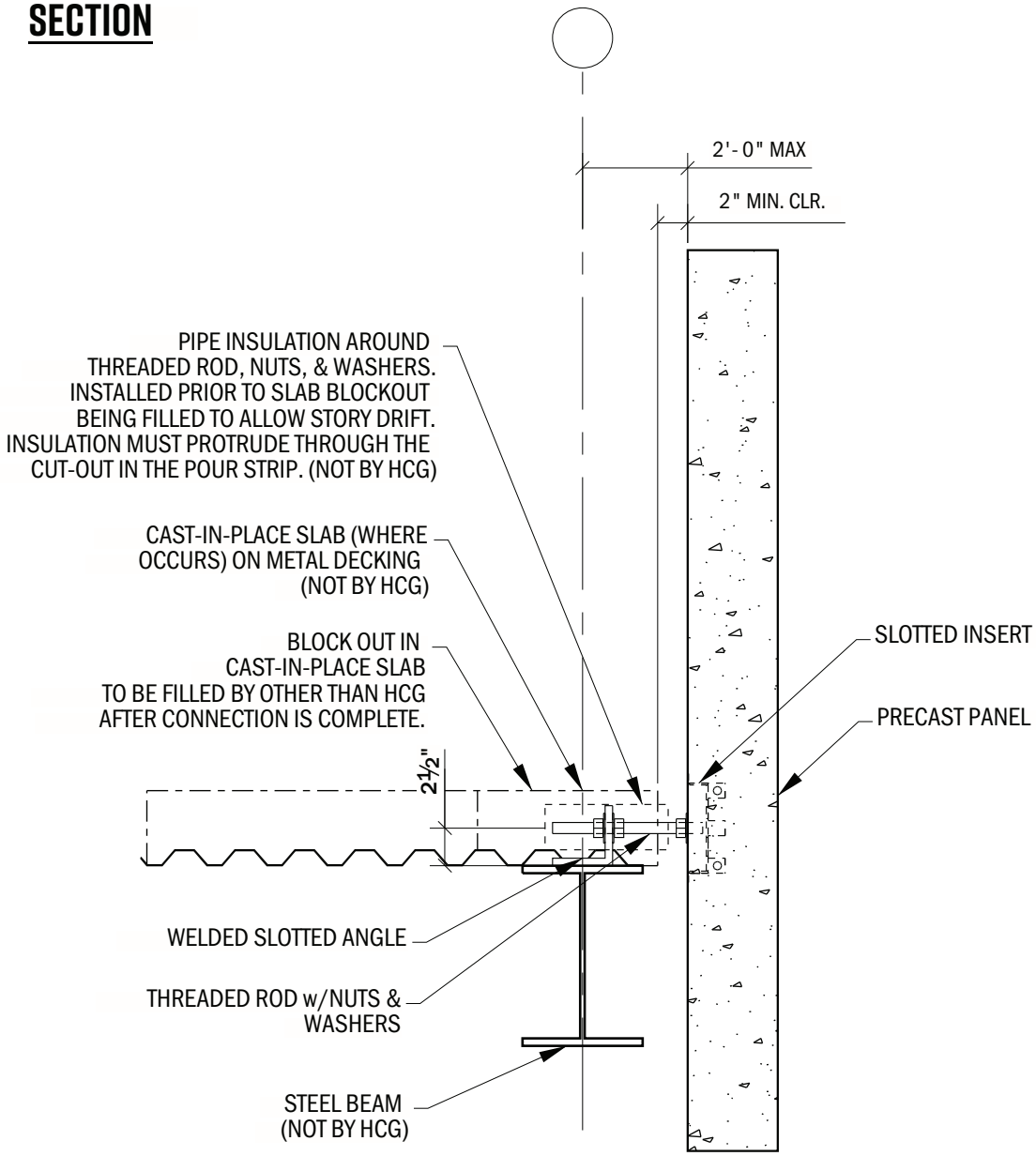
DESIGN CONSIDERATIONS:

- Preferred connection for use at roof level if it can be concealed by deck and insulation.
- Connection can also occur at the bottom of the beam if the beam is laterally braced.
- Connection can be used at floor level by providing a pocket in the slab. The angle must not extend above the slab unless it falls within finished wall.

ERECTION CONSIDERATIONS:

- Provides significant adjustment capability.

SECTION

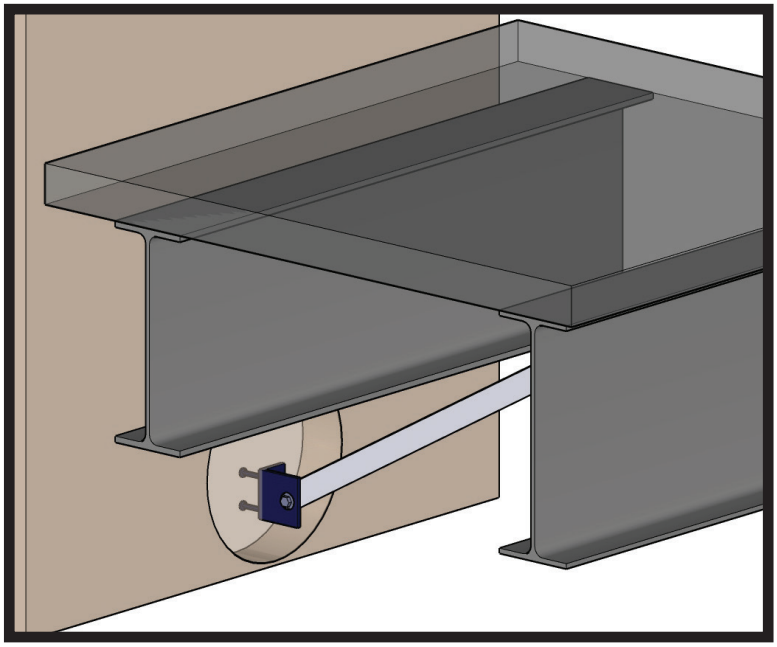

2'- 0" MAX
2" MIN. CLR.
PIPE INSULATION AROUND THREADED ROD, NUTS, & WASHERS. INSTALLED PRIOR TO SLAB BLOCKOUT BEING FILLED TO ALLOW STORY DRIFT. INSULATION MUST PROTRUDE THROUGH THE CUT-OUT IN THE POUR STRIP. (NOT BY HCG)
CAST-IN-PLACE SLAB (WHERE OCCURS) ON METAL DECKING (NOT BY HCG)
BLOCK OUT IN CAST-IN-PLACE SLAB TO BE FILLED BY OTHER THAN HCG AFTER CONNECTION IS COMPLETE.
2½"
SLOTTED INSERT
PRECAST PANEL
WELDED SLOTTED ANGLE
THREADED ROD w/NUTS & WASHERS
STEEL BEAM (NOT BY HCG)

CONNECTIONS TO STEEL BEAMS

KICKER ANGLE TIEBACK

APPLICATION:

Out-of-Plane Lateral	✓
In-Plane Lateral	
Bearing	



3D Model

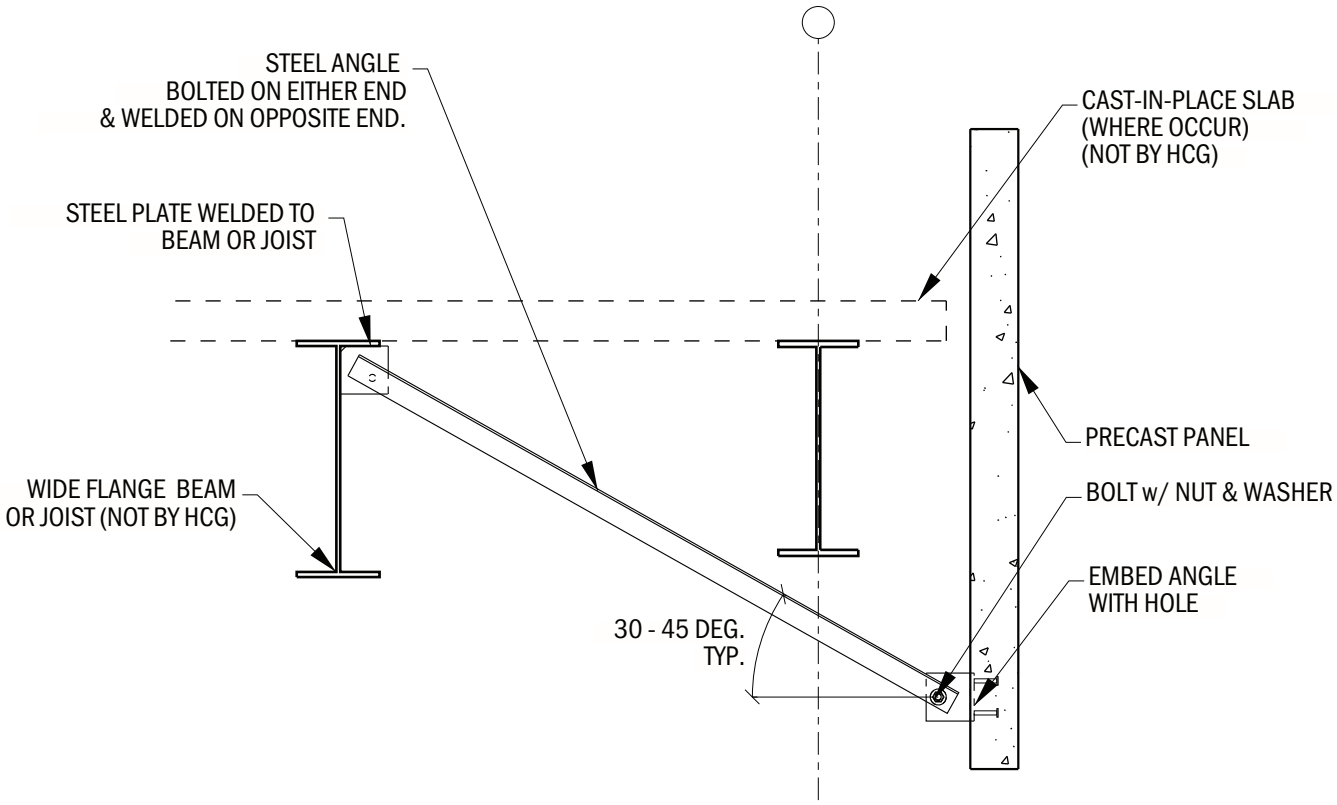
DESIGN CONSIDERATIONS:

- Kickers are generally required when a panel cross section and/or end connections cannot resist the induced torsion caused by the eccentricity of a single mid-span connection. This is often the case at roof conditions where a spandrel panel receives windload from windows below only.
- Gravity connections must resist vertical component of brace load.
- Angle should be approximately 30-degrees but no more than 45-degrees

ERECTION CONSIDERATIONS:

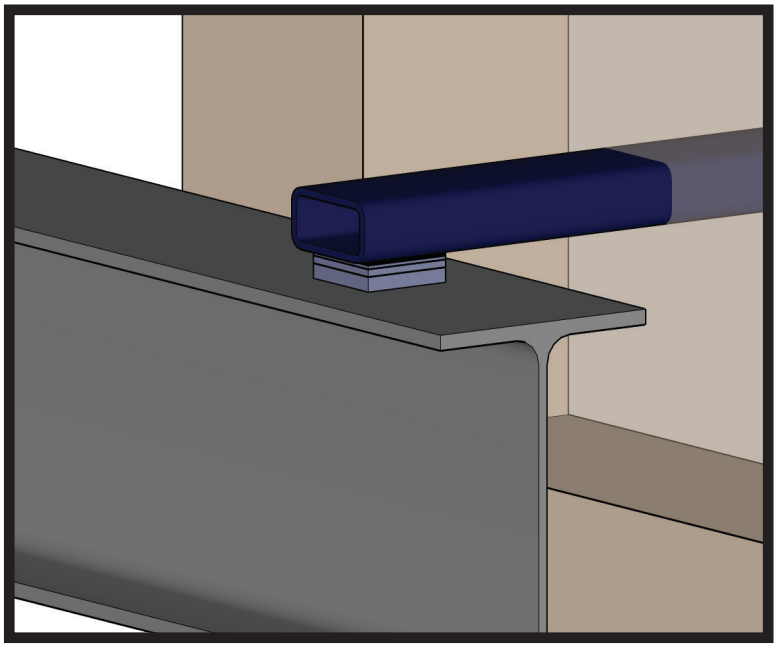
- Angle may be bolted at either end and welded at the opposite end.

SECTION


STEEL ANGLE
BOLTED ON EITHER END
& WELDED ON OPPOSITE END.
STEEL PLATE WELDED TO
BEAM OR JOIST
WIDE FLANGE BEAM
OR JOIST (NOT BY HCG)
30 - 45 DEG.
TYP.
CAST-IN-PLACE SLAB
(WHERE OCCUR)
(NOT BY HCG)
PRECAST PANEL
BOLT w/ NUT & WASHER
EMBED ANGLE
WITH HOLE

CONNECTIONS TO STEEL BEAMS

STUB BEAM BEARING



3D Model

APPLICATION:

Out-of-Plane Lateral	
In-Plane Lateral	
Bearing	✓

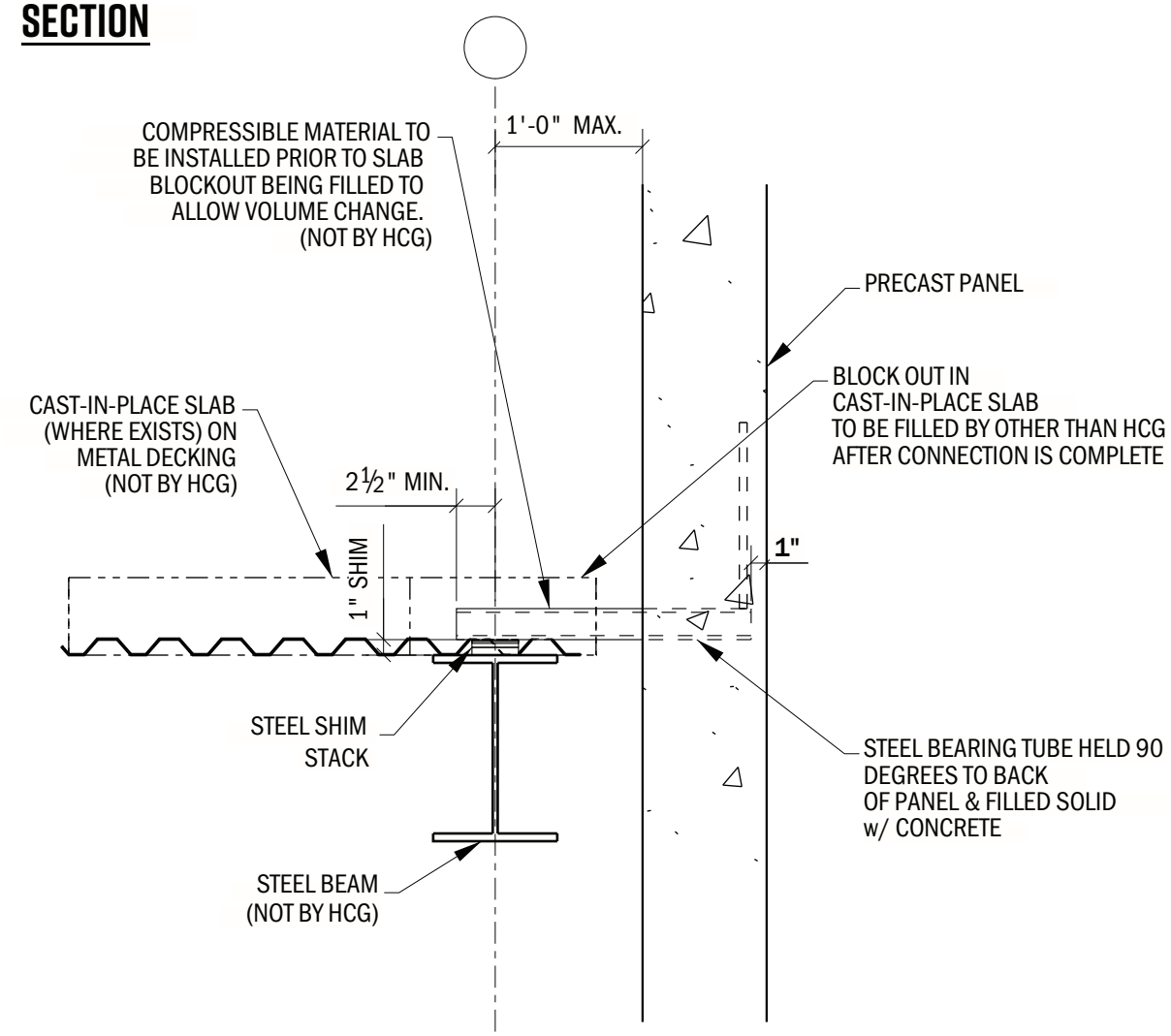
DESIGN CONSIDERATIONS:

- The stub beam moment arm should be limited to 1’- 0”.
- In general, it is better to resist lateral loads (in-plane and/or out-of-plane) by adjacent tieback connections rather than by the stub beam. However, if a connection is required to resist lateral loads, a weld plate can be added to the “tie” stub beam down to the structure. Volume change restraint in plane of panel must then be considered.
- If the connection is used at the roof level, the overall depth of stub beam+shims+tolerance must not exceed deck and insulation thickness.
- The connection can be used at the floor level by adding a pocket in the slab. The overall depth of the stub beam+shims+tollerance must not exceed the slab thickness unless connection falls within the finished wall.

ERECTION CONSIDERATIONS:

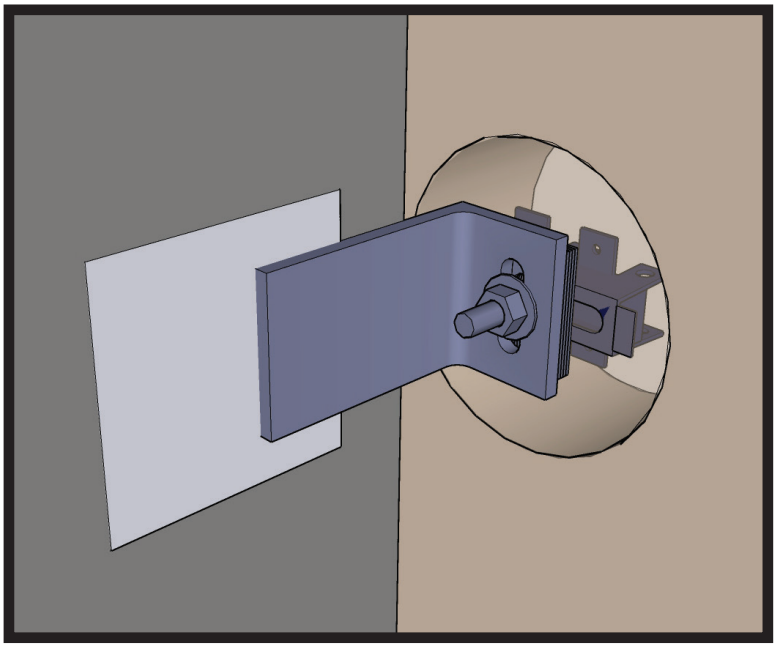
- Shims must be located at the beam centerline to prevent torsion on beam.

SECTION


COMPRESSIBLE MATERIAL TO BE INSTALLED PRIOR TO SLAB BLOCKOUT BEING FILLED TO ALLOW VOLUME CHANGE. (NOT BY HCG)
1'-0" MAX.
PRECAST PANEL
BLOCK OUT IN CAST-IN-PLACE SLAB TO BE FILLED BY OTHER THAN HCG AFTER CONNECTION IS COMPLETE
CAST-IN-PLACE SLAB (WHERE EXISTS) ON METAL DECKING (NOT BY HCG)
2½" MIN.
1" SHIM
1"
STEEL SHIM STACK
STEEL BEARING TUBE HELD 90 DEGREES TO BACK OF PANEL & FILLED SOLID w/ CONCRETE
STEEL BEAM (NOT BY HCG)

CONNECTIONS TO CAST-IN-PLACE COLUMNS

CLIP ANGLE TIEBACK



3D Model

APPLICATION:

Out-of-Plane Lateral	✓
In-Plane Lateral	
Bearing	

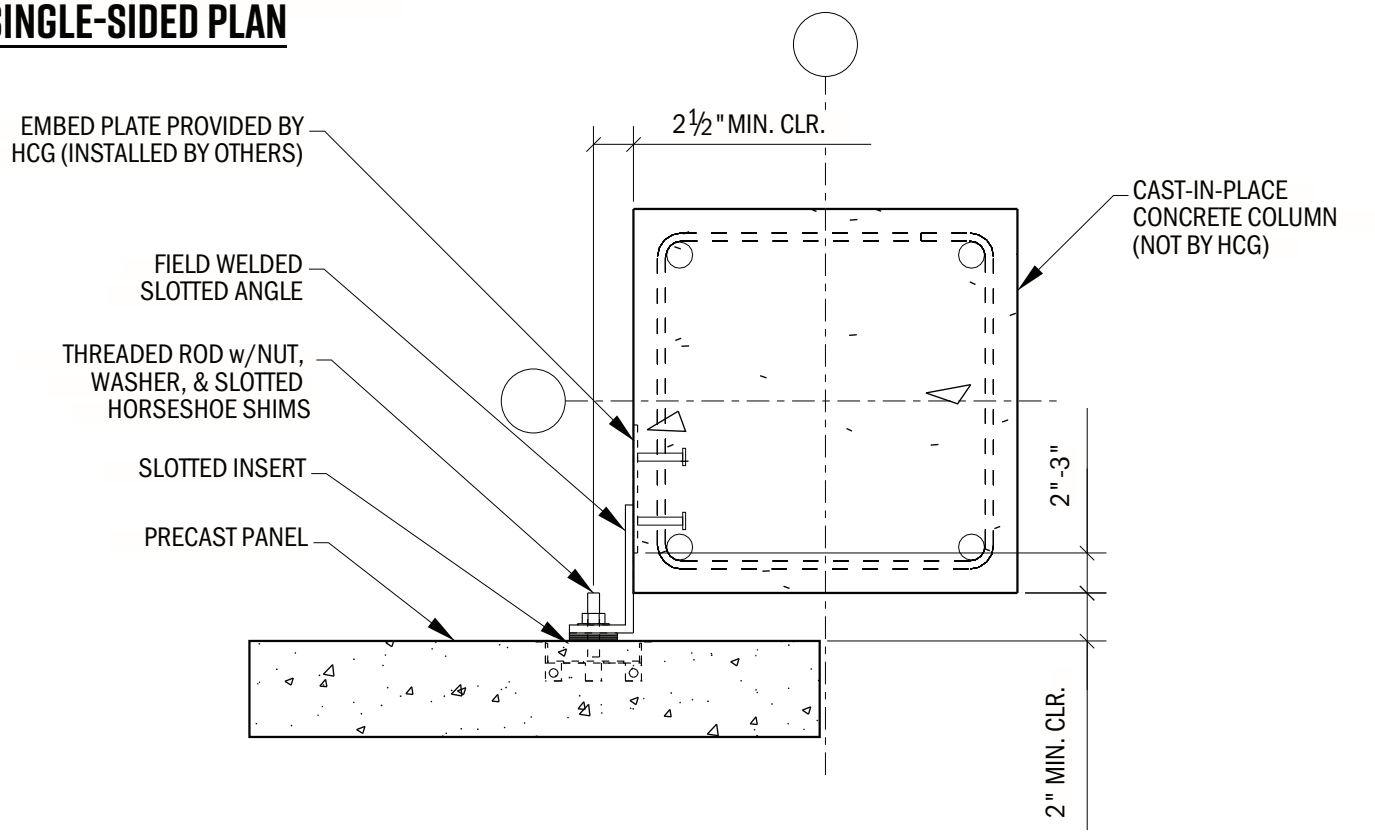
DESIGN CONSIDERATIONS:

- Typically used when the interior finish is close to the column and back of the panel.
- A preferred connection in parking garages where it is exposed to view since it provides a clean look being held close to the panel.
- Maintain 2½" minimum clearance between the panel and the structure.

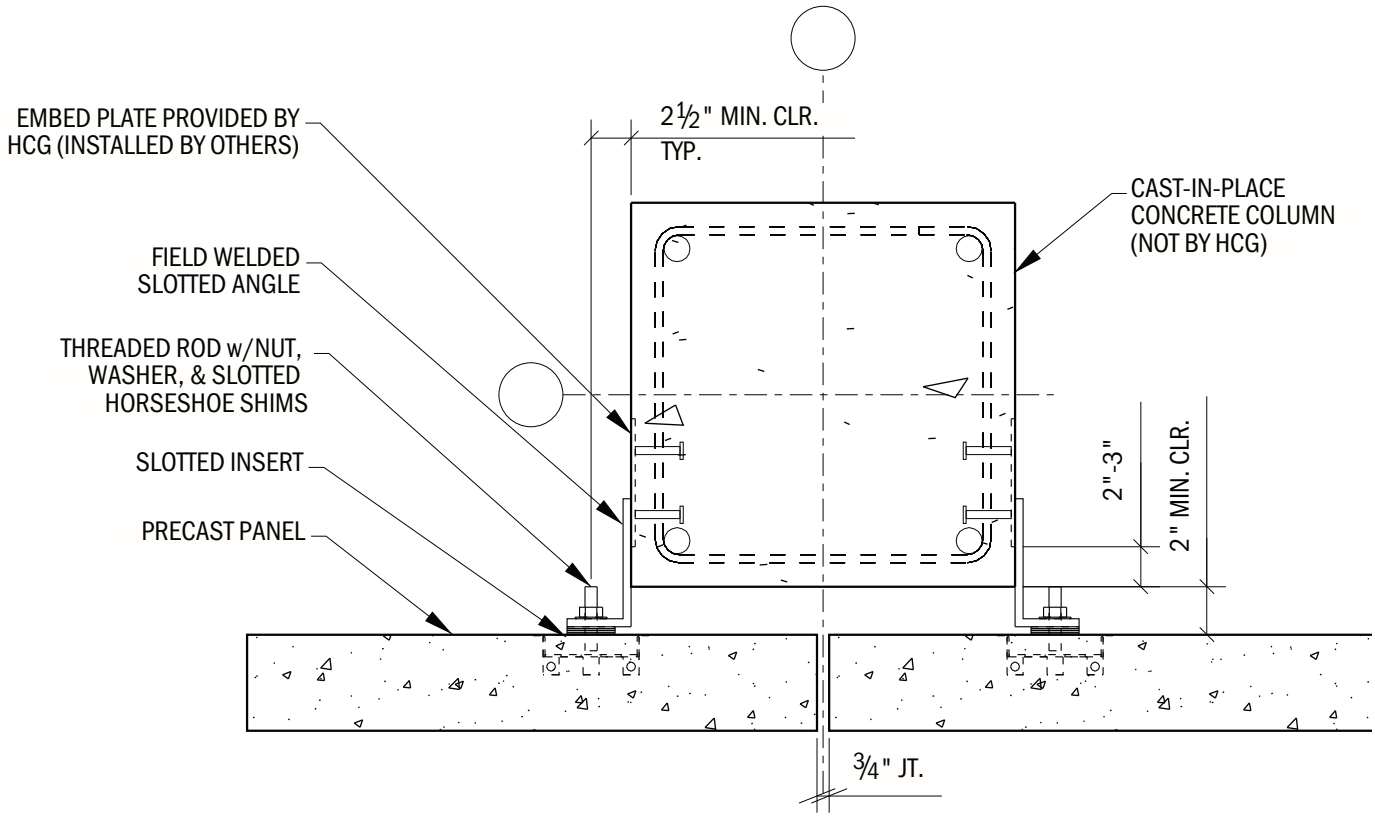
ERECTION CONSIDERATIONS:

- Provides limited adjustment capability.
- Leave gap for horseshoe shims only if panel adjustment is necessary after welding down angle.

SINGLE-SIDED PLAN

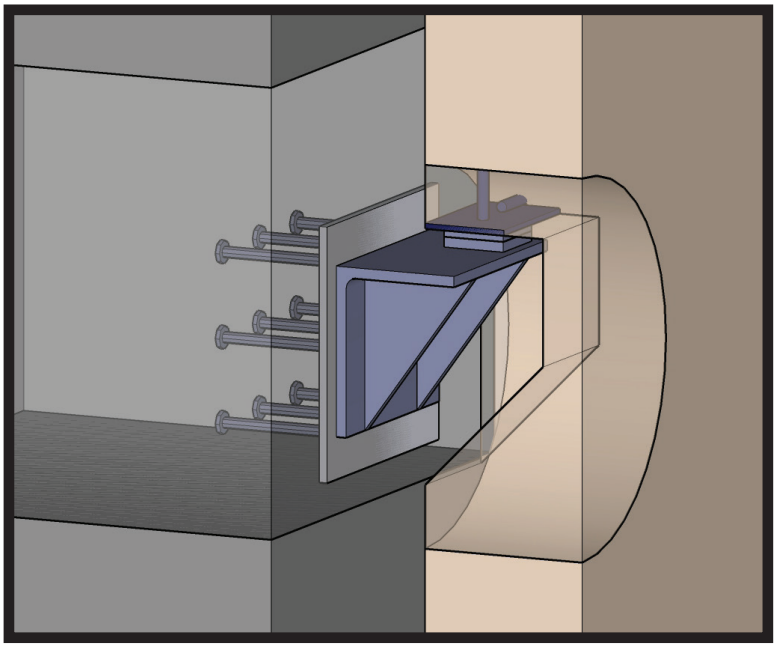


DOUBLE-SIDED PLAN



CONNECTIONS TO CAST-IN-PLACE COLUMNS

POCKETED BEARING



3D Model

APPLICATION:

Out-of-Plane Lateral	
In-Plane Lateral	
Bearing	✔

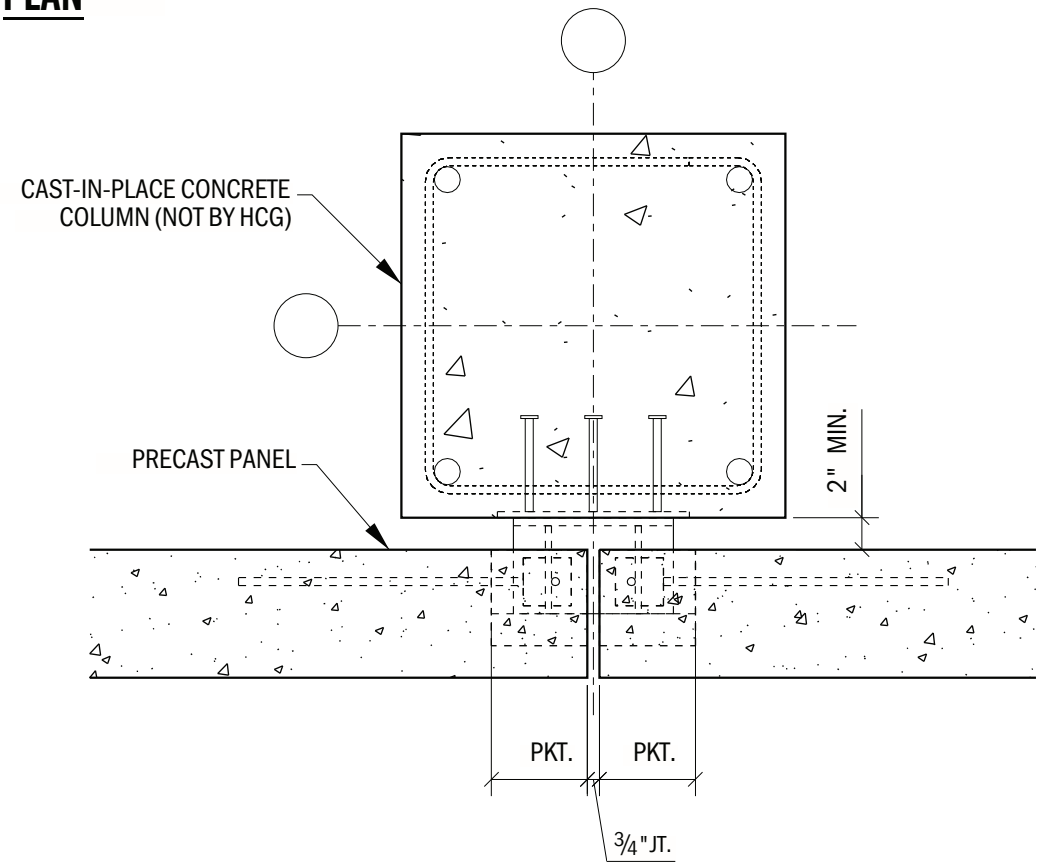
DESIGN CONSIDERATIONS:

- Typically located in the bottom half of the panel to provide adequate shear capacity of concrete above the pocket.
- Maintain 2” minimum clearance between the panel and the structure.
- Preferred panel thickness is 8” to maintain 4” minimum pocket overlap to angle. Thinner panels can be utilized but it will compromise clearance between the bearing angle the and pocket.

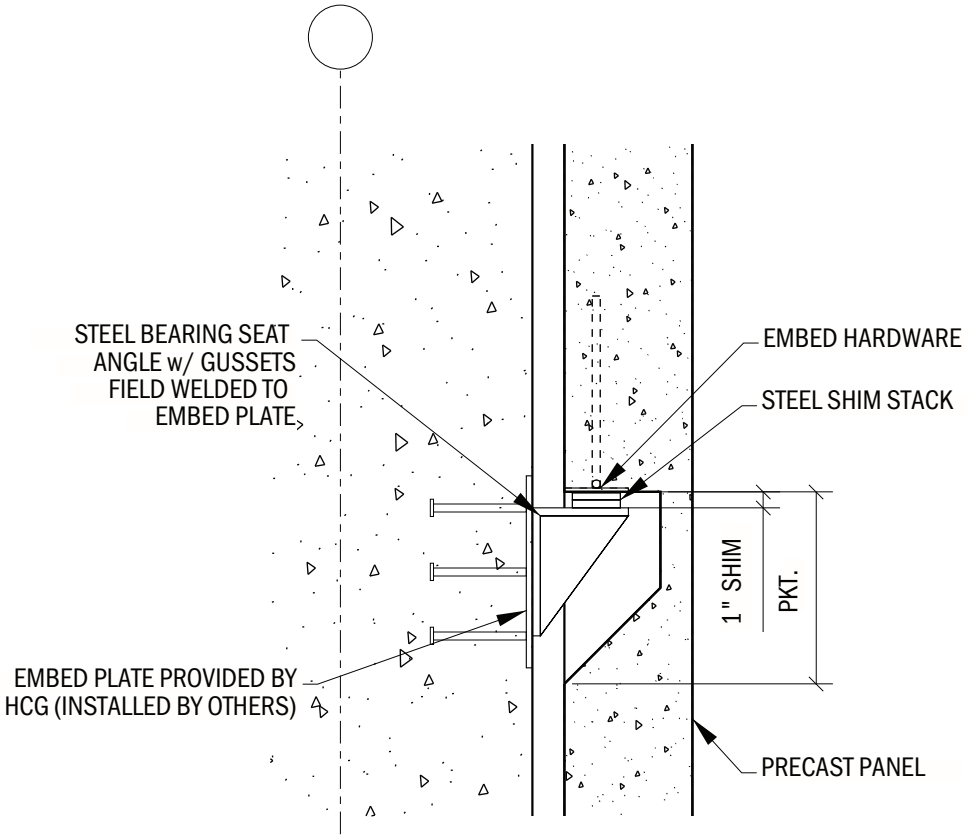
ERECTION CONSIDERATIONS:

- A clean connection hidden from final view; however, it is a blind connection for erector.

PLAN

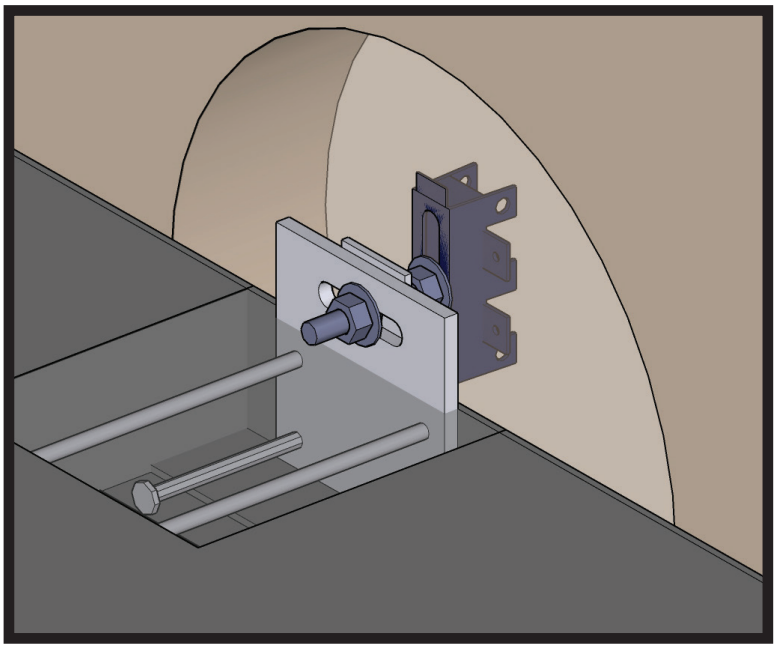


SECTION



CONNECTIONS TO CAST-IN-PLACE SLAB

BOLTED EMBED PLATE TIEBACK



3D Model

APPLICATION:

Out-of-Plane Lateral	✔
In-Plane Lateral	✔
Bearing	

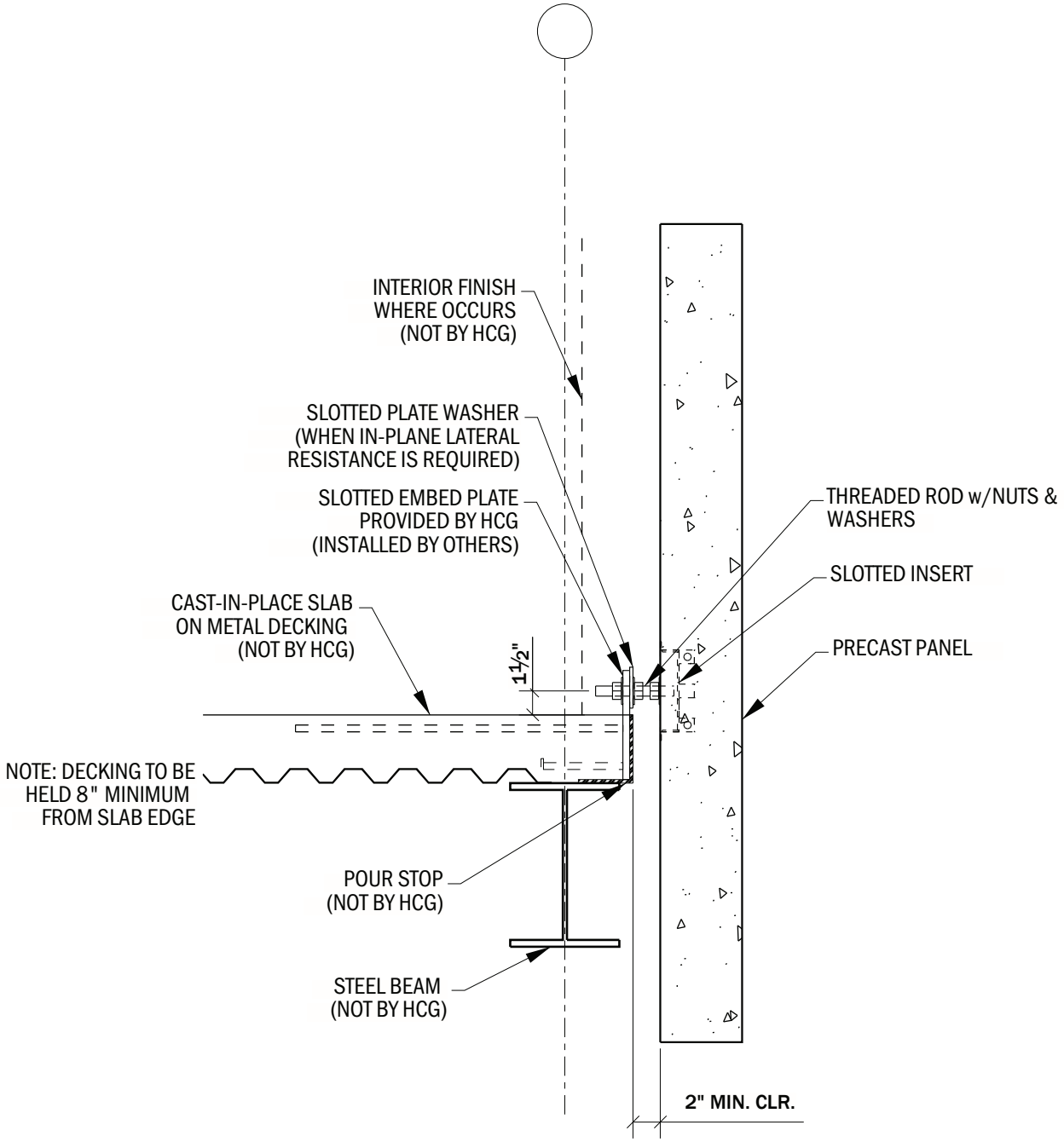
DESIGN CONSIDERATIONS:

- A preferred connection since it does not typically require welding.
- Anchors are carried deep into the slab since slab is thin.
- The interior finish, where it occurs must conceal connection.
- Maintain 2” minimum clearance between the panel and the slab.

ERECTION CONSIDERATIONS:

- Does not typically require welding.
- Provides significant adjustment capability.

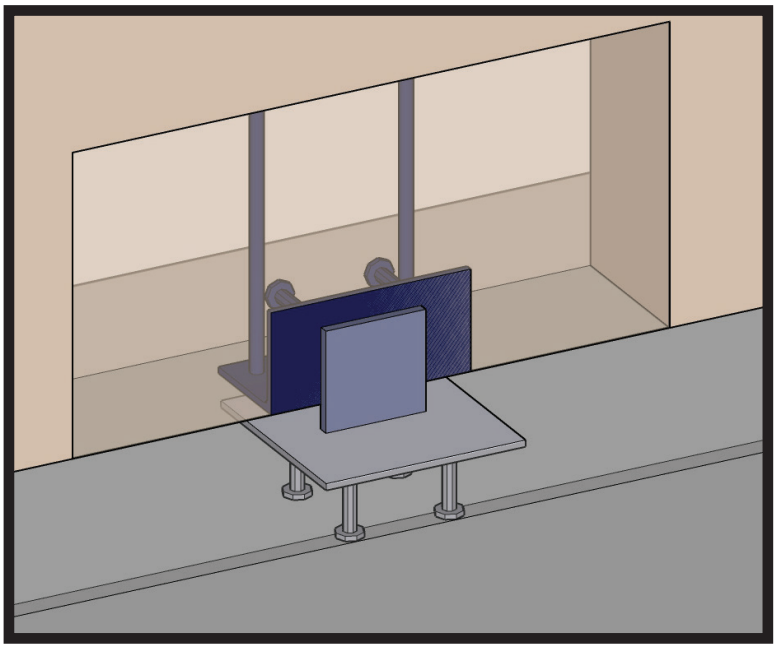
SECTION


INTERIOR FINISH
WHERE OCCURS
(NOT BY HCG)
SLOTTED PLATE WASHER
(WHEN IN-PLANE LATERAL
RESISTANCE IS REQUIRED)
SLOTTED EMBED PLATE
PROVIDED BY HCG
(INSTALLED BY OTHERS)
CAST-IN-PLACE SLAB
ON METAL DECKING
(NOT BY HCG)
NOTE: DECKING TO BE
HELD 8" MINIMUM
FROM SLAB EDGE
POUR STOP
(NOT BY HCG)
STEEL BEAM
(NOT BY HCG)
1½"
THREADED ROD w/NUTS &
WASHERS
SLOTTED INSERT
PRECAST PANEL
2" MIN. CLR.

CONNECTION TO FOUNDATION
WELDED PLATE TIEBACK

APPLICATION:

Out-of-Plane Lateral	✓
In-Plane Lateral	✓
Bearing	



3D Model

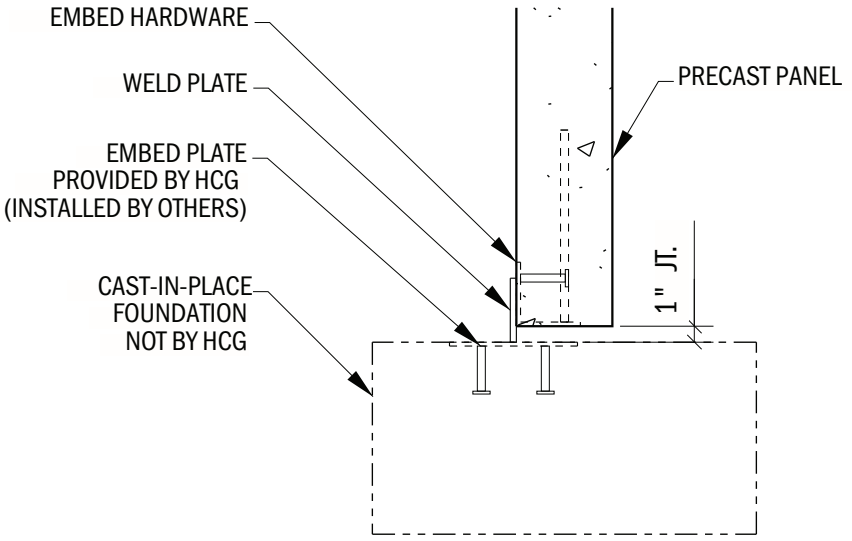
DESIGN CONSIDERATIONS:

- Volume change restraint in plane of panel must be considered.

ERECTION CONSIDERATIONS:

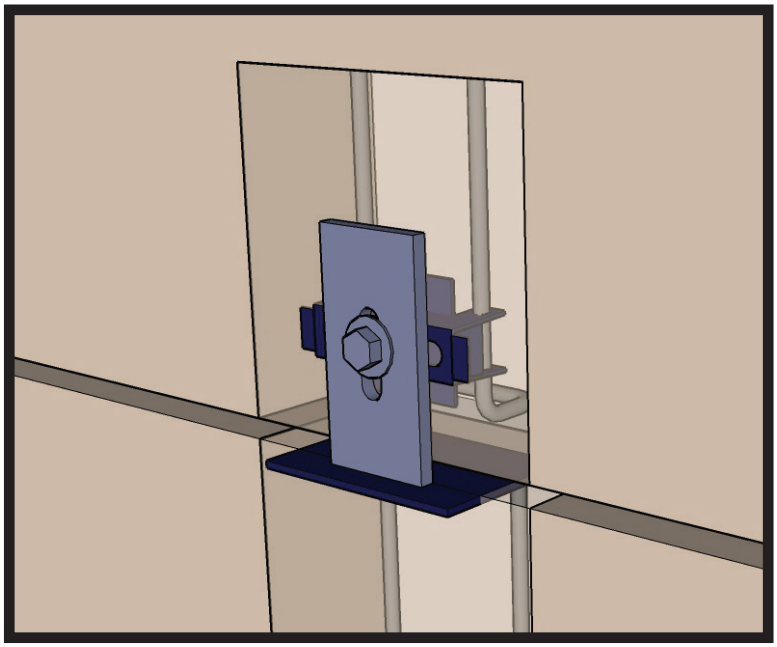
- Provides no adjustment capability.

SECTION


EMBED HARDWARE
WELD PLATE
EMBED PLATE
PROVIDED BY HCG
(INSTALLED BY OTHERS)
CAST-IN-PLACE
FOUNDATION
NOT BY HCG
PRECAST PANEL
1" JT.

PANEL-TO-PANEL CONNECTIONS

BOLTED TIEBACK



3D Model

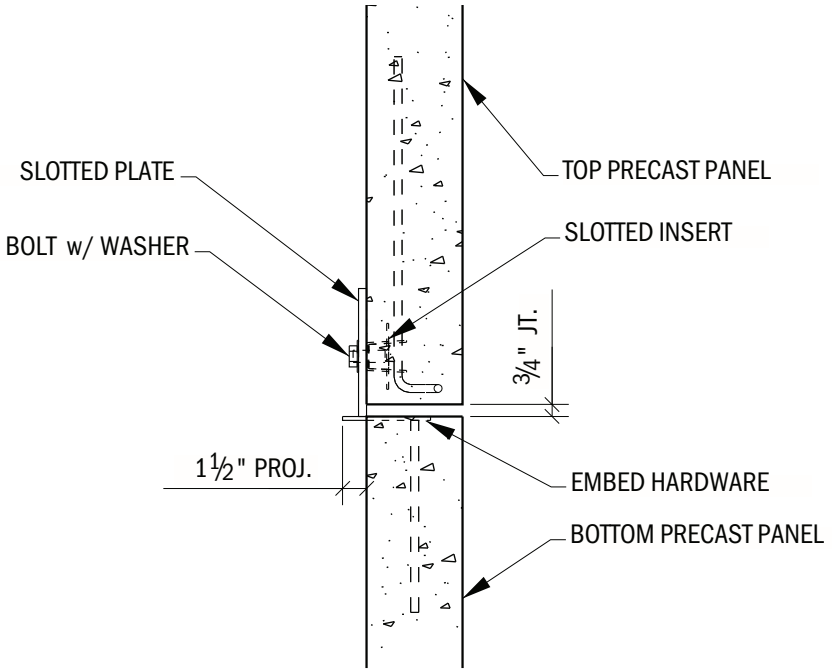
APPLICATION:

Out-of-Plane Lateral	✓
In-Plane Lateral	
Bearing	

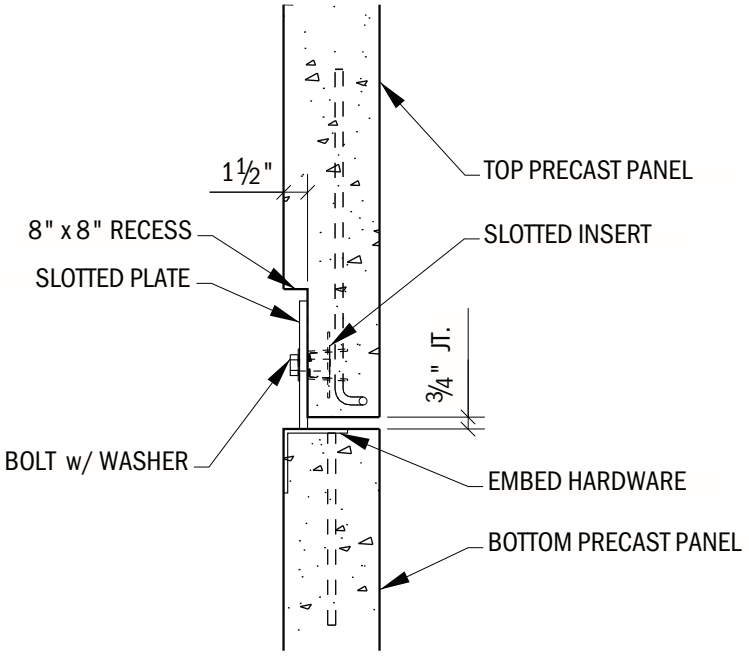
DESIGN CONSIDERATIONS:

- Non-recessed condition is preferred by production in cases where aesthetic considerations are not a concern.
- Use recessed condition only if necessary.
- Horizontal orientation of insert allows in-plane joint movement due to differential floor-to-floor drift and/or volume change in plane of panel.
- Connection can be used at both the horizontal and vertical joints.
- Joint width is typically ¾” with a 1” maximum.

SECTION



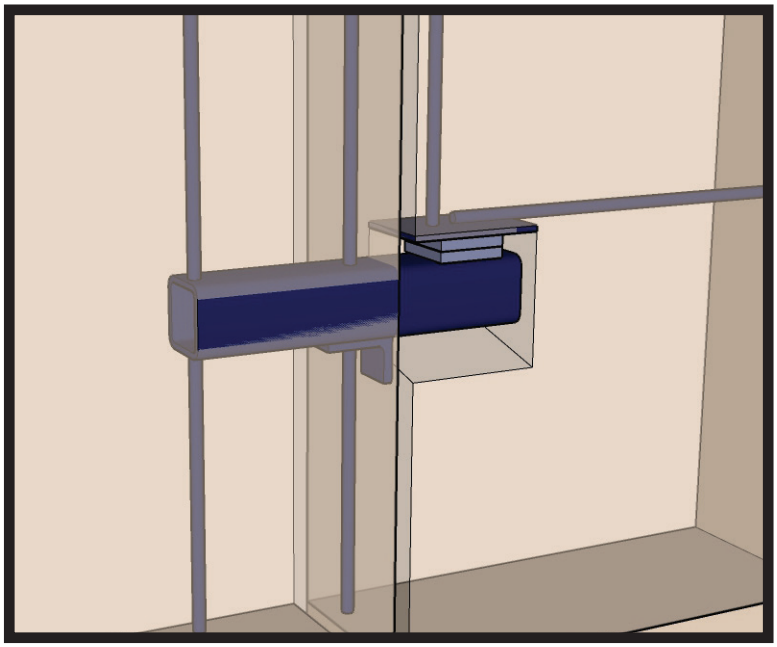
NON-RECESSED OPTION (PREFERRED)



RECESSED OPTION

PANEL-TO-PANEL CONNECTIONS

POCKETED BEARING



3D Model

APPLICATION:

Out-of-Plane Lateral	
In-Plane Lateral	
Bearing	✓

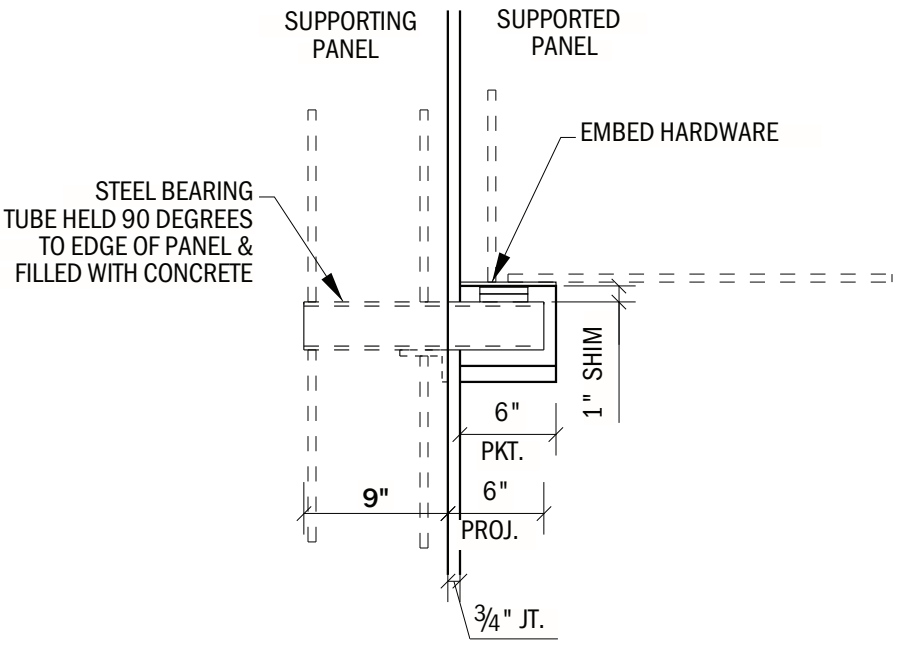
DESIGN CONSIDERATIONS:

- Typically located in the bottom half of the supported panel to provide adequate shear capacity of concrete above the pocket.

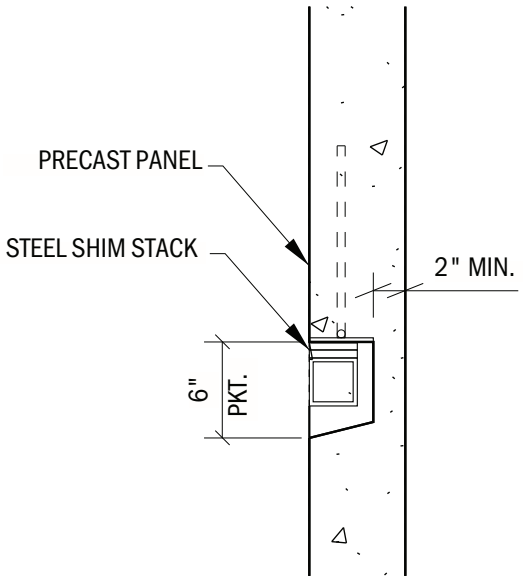
ERECTION CONSIDERATIONS:

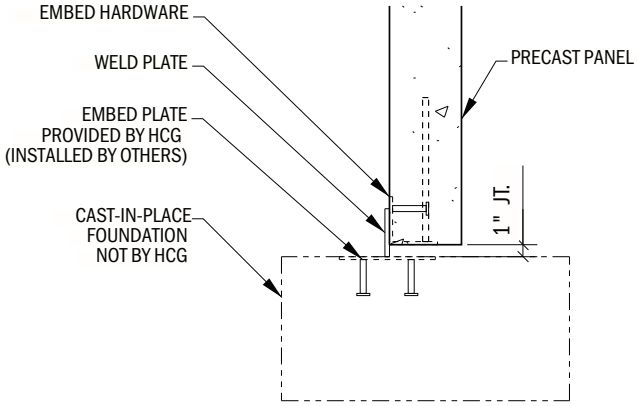
- Requires no pre-welding since the tube protrudes from the edge of panel.

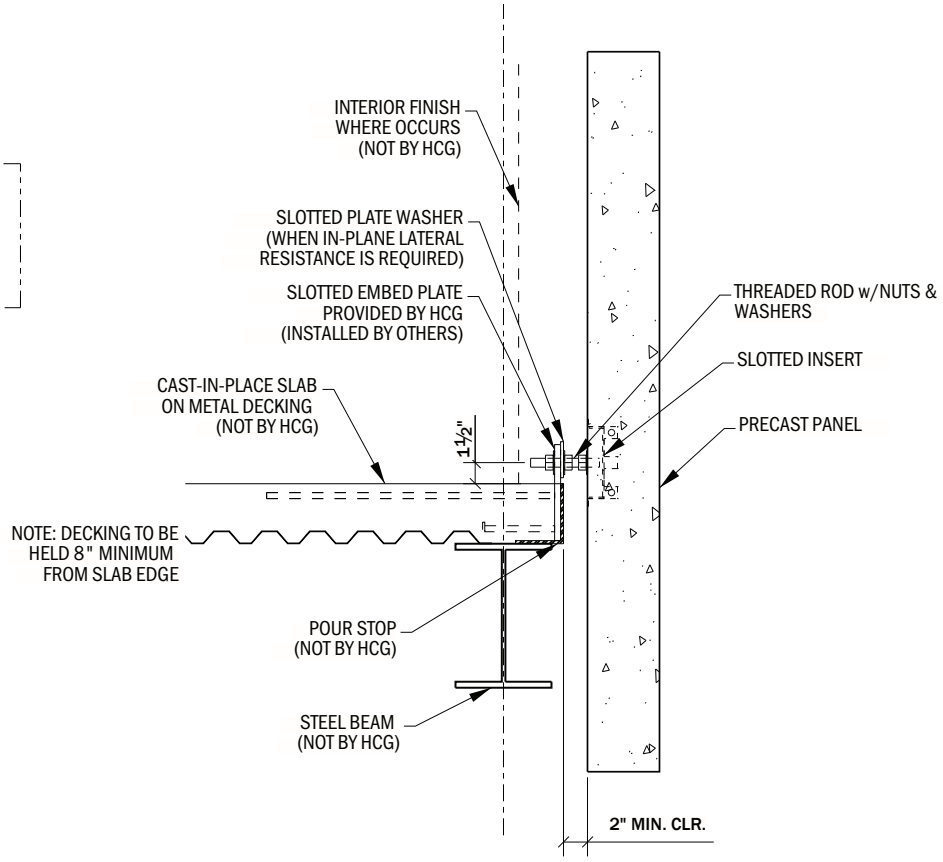
BACK PANEL ELEVATION



SECTION




EMBED HARDWARE
WELD PLATE
EMBED PLATE
PROVIDED BY HCG
(INSTALLED BY OTHERS)
CAST-IN-PLACE
FOUNDATION
NOT BY HCG
PRECAST PANEL
1" JT.


INTERIOR FINISH
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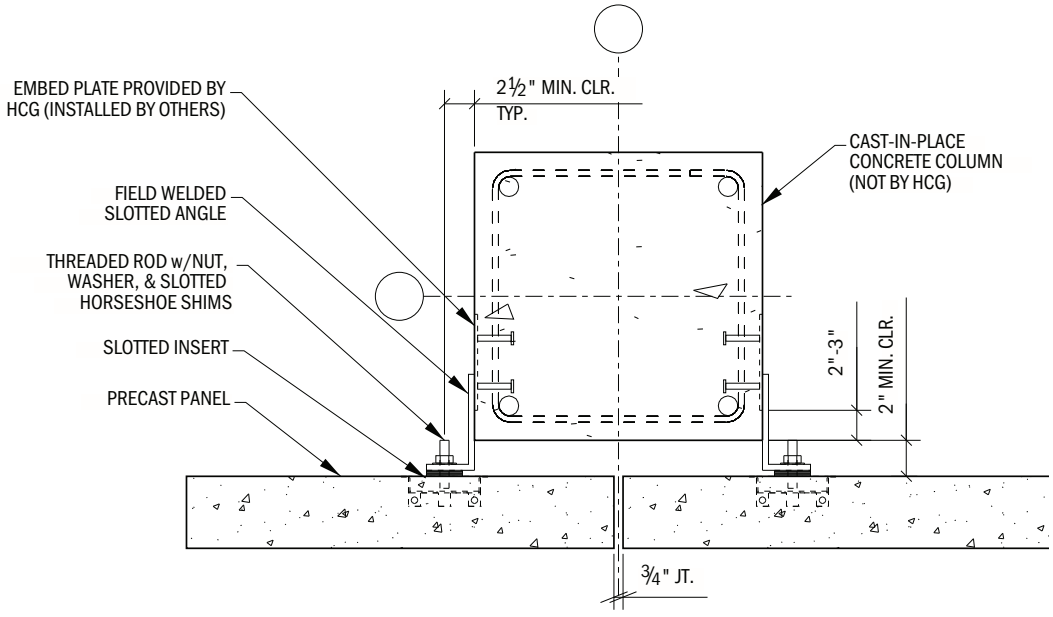
(NOT BY HCG)
STEEL BEAM
(NOT BY HCG)
1½"
THREADED ROD w/NUTS &
WASHERS
SLOTTED INSERT
PRECAST PANEL
2" MIN. CLR.


EMBED PLATE PROVIDED BY
HCG (INSTALLED BY OTHERS)
FIELD WELDED
SLOTTED ANGLE
THREADED ROD w/NUT,
WASHER, & SLOTTED
HORSESHOE SHIMS
SLOTTED INSERT
PRECAST PANEL
2½" MIN. CLR.
TYP.
CAST-IN-PLACE
CONCRETE COLUMN
(NOT BY HCG)
2"-3"
2" MIN. CLR.
¾" JT.