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The Good and Bad of Precast Podium Construction

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May 10, 2016

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Opportunities Challenges

The ~~Good~~ and ~~Bad~~ of Precast Podium Construction

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Todays Presentation Topics

- History & Definition of Podium Construction
- Gravity Systems
- Lateral Systems
- Special Conditions
- Communication of Project Team
- Question & Answers

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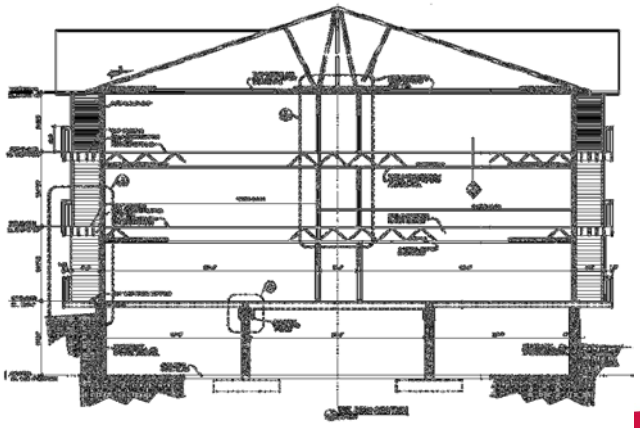

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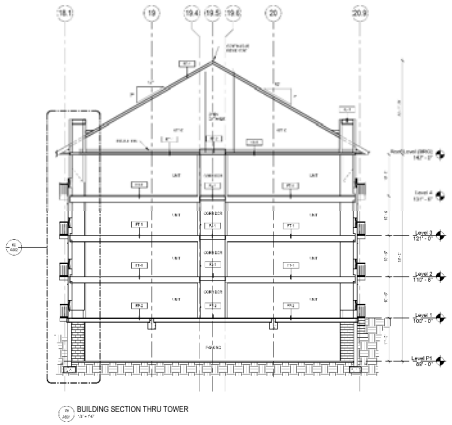

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IBC CODE CHANGES

» Increased area limitations with use of sprinklers

» Allowed 5 levels of wood framing

- Requires exterior bearing walls to be fire resistant
- Framing typically between demising walls rather than exterior to corridor

» Added Horizontal Building Separation Allowance

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2012 IBC

self- or automatic-closing upon detection of smoke in accordance with Section 716.5.9.3. Doors shall not have air transfer openings and shall not be undercut in excess of the clearance permitted in accordance with NFPA 80. Walls surrounding the incidental use shall not have air transfer openings unless provided with smoke dampers in accordance with Section 710.7.

509.4.2.1 Protection limitation. Except as specified in Table 509 for certain incidental uses, where an *automatic sprinkler system* is provided in accordance with Table 509, only the space occupied by the incidental use need be equipped with such a system.

SECTION 510
SPECIAL PROVISIONS

510.1 General. The provisions in Sections 510.2 through 510.9 shall permit the use of special conditions that are exempt from, or modify, the specific requirements of this chapter regarding the allowable *building heights and areas* of buildings based on the occupancy classification and type of construction, provided the special condition complies with the provisions specified in this section for such condition and other applicable requirements of this code. The provisions of Sections 510.2 through 510.8 are to be considered independent and separate from each other.

510.2 Horizontal building separation allowance. A building shall be considered as separate and distinct buildings for the purpose of determining area limitations, continuity of *fire walls*, limitation of number of *stories* and type of construction where all of the following conditions are met:

1. The buildings are separated with a *horizontal assembly* having a *fire-resistance rating* of not less than 3 hours.
2. The building below the *horizontal assembly* is not greater than one *story above grade plane*.
3. The building below the *horizontal assembly* is of Type 1A construction.
4. *Shaft, stairway, ramp* and escalator enclosures through the *horizontal assembly* shall have not less than a 2-hour *fire-resistance rating* with opening protectives in accordance with Section 716.5.

   Exception: Where the enclosure walls below the *horizontal assembly* have not less than a 3-hour *fire-resistance rating* with opening protectives in accordance with Section 716.5, the enclosure walls extending above the *horizontal assembly* shall be permitted to have a 1-hour *fire-resistance rating*, provided:

   1. The building above the *horizontal assembly* is not required to be of Type I construction;
   2. The enclosure connects fewer than four *stories*; and
   3. The enclosure opening protectives above the *horizontal assembly* have a *fire protection rating* of not less than 1 hour.
5. The building or buildings above the *horizontal assembly* shall be permitted to have multiple Group A occu-

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Onyx

Hampton Inn & West 7th Mixed Use

Vintage on Selby

UTEC

GRAVITY SYSTEMS

- Perpendicular Framing
- Parallel Framing
- Live Load Reduction
- Load Distribution
- Prestress Design
- Camber
- Plumbing Holes

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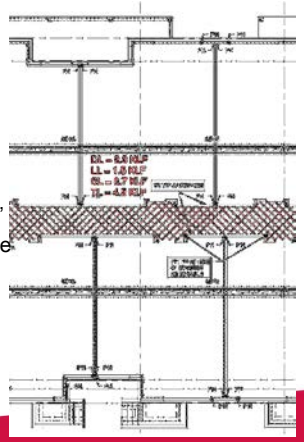
FRAMING LOADS PERPINDICULAR TO HOLLOWCORE

- Framing loads at center bay only
- Exterior bays 8” hollowcore
- Interior bay 12” hollowcore
- Loads are well distributed as each piece receives load
- Typical center bay width of 24’-28’
- Typical beam span 3 parking stalls or 27’
- Limit of hollowcore plank is 5-6 klf service
- 24 IT 28 beams with 3 levels
- 24 IT 32 beams at 4 levels
- Beams designed for torsion
- Distribution width of plank used for LL reduction



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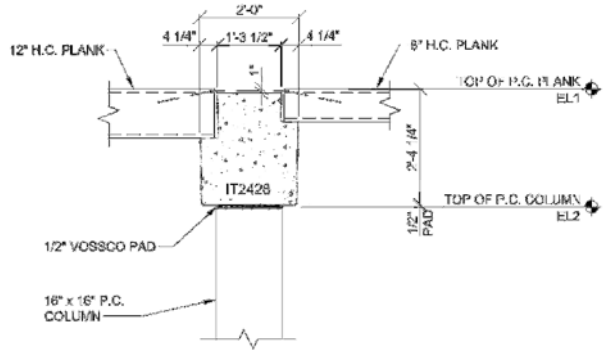

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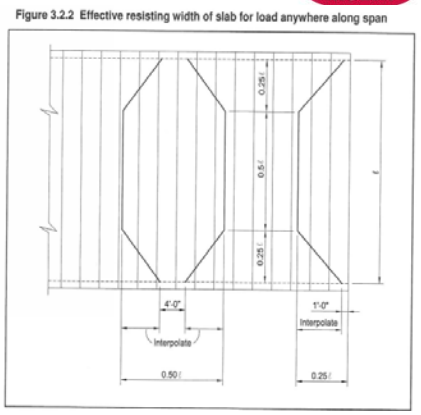
- Slabs grouted together to act monolithically
- Design is for 0.5*span not width of slab
- Area for LL reduction based this distribution width



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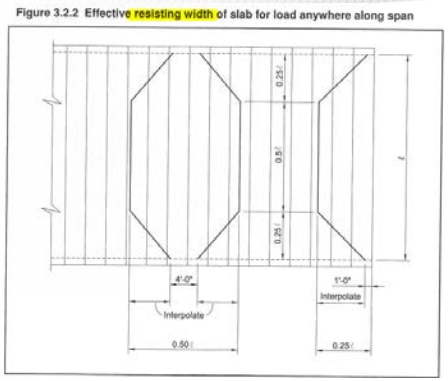
FRAMING LOADS PARALLEL TO HOLLOWCORE

- Single piece of plank receives load and is distributed thru keyways to adjacent plank
- Best to use interior partitions as bearing walls
- Grid spacing similar to perpendicular loading
- 12” hollowcore at all bays
- 24 IT 36 beams with 5 levels of framing
- Limit of hollowcore 5-6 KLF service
- Solid slabs at larger loads

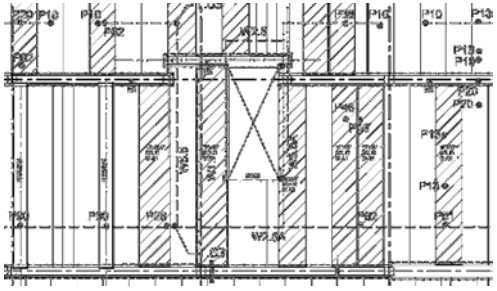


- Resisting width at support is 4'-0"
- Design typically controlled by shear

12" Extra Heavy Plank

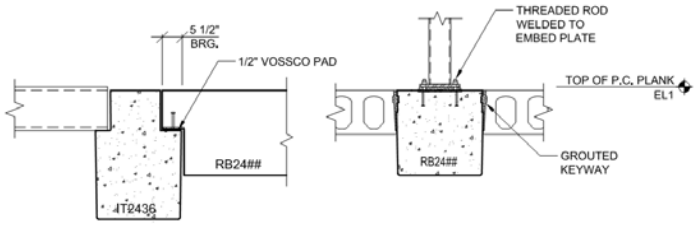
- Wide webs to increase shear capacity
- Voids filled to increase shear capacity
- No steel shear reinforcement
- Lighter section for long spans & light loads

POINT LOADS

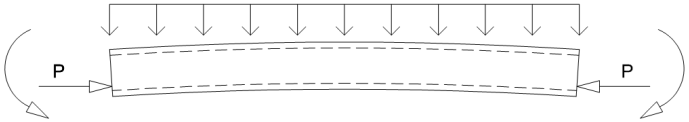


- Hollowcore up to 18K
- Solid Slab up to 40K
- RB limited by side mount connection
- Dependent on span & location

Cross Beam Detail

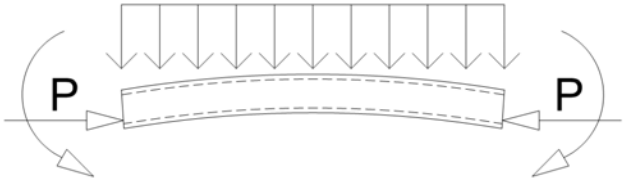


Prestress Design



- *f* = P/A + M/S
- Typically bottom is not cracked at service level loads
- Igross used for deflection calculations
- Results in long spans with shallow depth
- Camber is a result of prestress force
- 270 ksi strand minimizes steel quantity

With 5 levels of wood



- Requires more prestress
- Results in greater camber
- ¾" – 1" Camber in Plank
- ½" – ¾" Camber in Beams
- Center of bay could be 1 ¼" – 1 ¾" above design elevation
- Some dead load will come out with application of DL

Plumbing Holes

- Design includes allowance for plumbing holes
- Typically 1 web with 2 strand in every other hollowcore piece
- Plumber needs to adjust locations to stay within guideline
- Vertical sleeves not allowed in beams
- Horizontal sleeves in beam can be cast in
- Tolerances do not allow pre-planning

Lateral Systems

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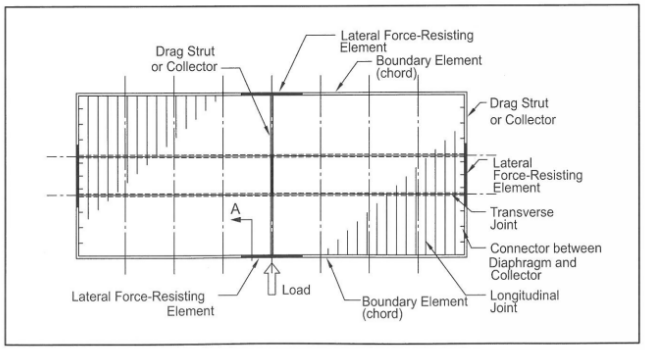
Figure 4.5.1 Diaphragm elements



PCI Manual for the Design of Hollow Core Slabs and Walls

Rigid Diaphragm

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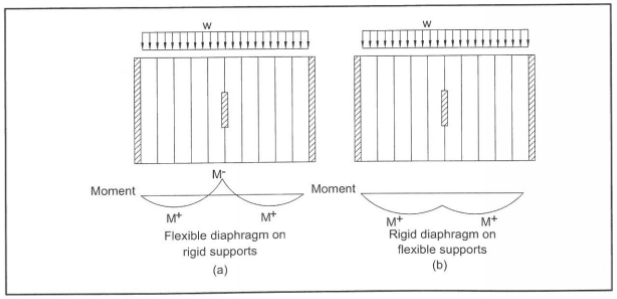
Figure 4.3.1 Diaphragm bending moments



PCI Manual for the Design of Hollow Core Slabs and Walls

- Loads distributed based on stiffness of supports
- 1 Story shear walls will all have similar stiffness
- Loads can be distributed based on polar moment of inertia

Loads Into Diaphragm

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- Framing above distributes lateral load thru out diaphram
- Loading is typically high as the diaphragm is doing to work of multiple floors
- Differential soil loading can add significant lateral forces

Connection to Wood Framing

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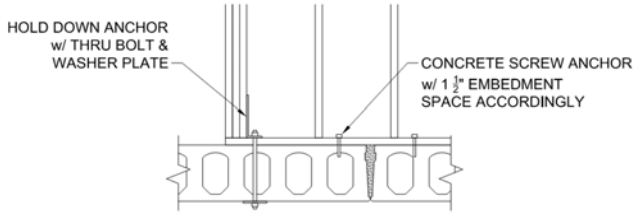

- If hold down lands on beam or wall embed & welded stud can be used
- If uplift is large plank may need to be anchored to wall or beam at supports
- If shear is high core may be filled so that larger embedment may be used at screw anchors

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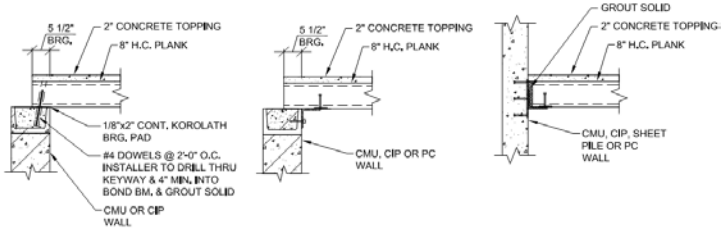
Connection at Exterior Walls



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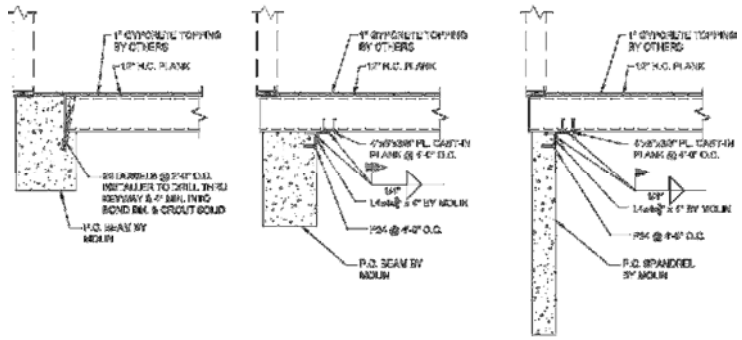

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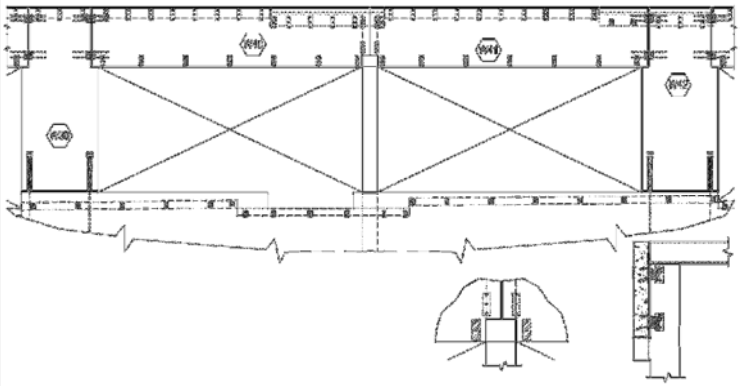

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SPANCRETE MANUFACTURERS ASSOCIATION

DESIGN EXAMPLE

The data listed are minimum test values obtained for shear in the direction noted. Appropriate load factors and strength reduction factors must be applied.

END BEARING DATA

Load Direction	Minimum* V_{test} (KIPS)	Failure Mode
V_1	2.78	Concrete Cone
V_2	3.40	Concrete Cone
V_3	4.50	Rebar Yield

Note: Dowel location in bond beam is critical to maintain capacity.

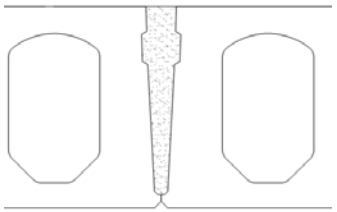
SIDELAP DATA

Load Direction	Minimum* V_{test} (KIPS)	Failure Mode
V_1	1.87	Spalling bond beam face
V_2	2.96	Spalling bond beam face
V_3	2.66	Spalling bond beam face

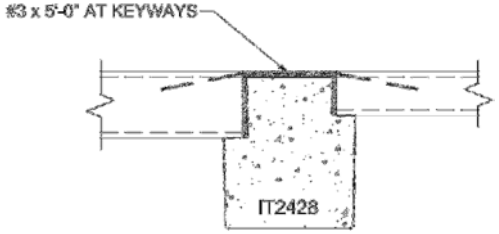
Note: Actual test values must be reduced by appropriate strength reduction factors and safety factors to obtain working load values. The research was done using 48" wide, 8" thick Standard Spancrete® hollowcore. However, this concept applies to all Spancrete cross sections.

Longitudinal Joints

- **ΦVn = Φ (0.08hl)**
- **Vservice**
  - **4.5 KLF 12" Plank**
  - **2.7 KLF 8" Plank**

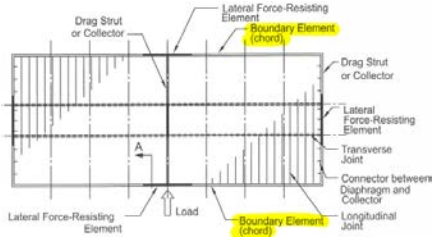


Transverse Joints

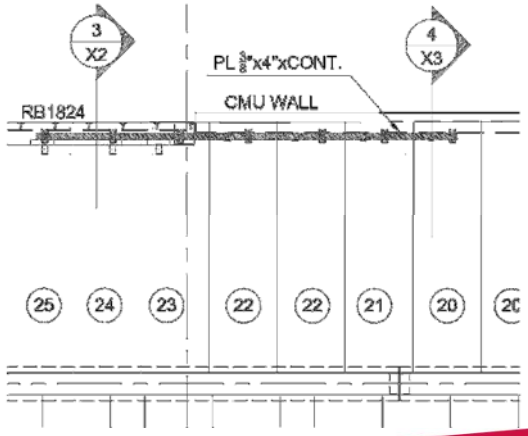


- Reinforcing at joints
  - Shear friction
  - Longitudinal forces
  - Structural integrity

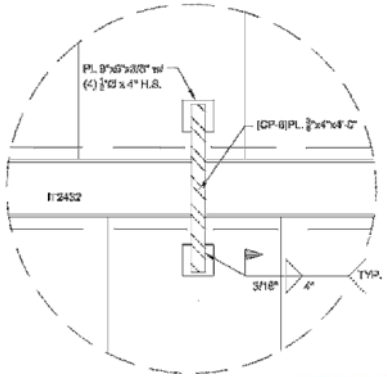
Chord Forces

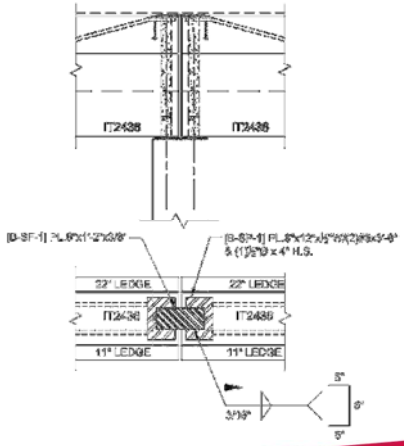


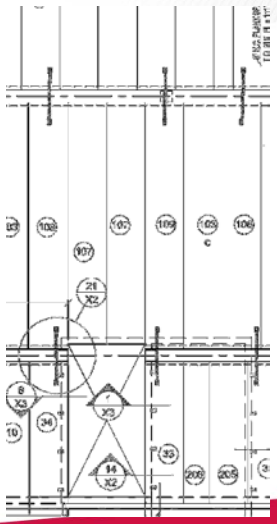
- Dependent on construction type
  - Assumed to be in wall for CMU, CIP or Steel
  - PC beam & column or walls connected together
- Steel strap perpendicular to plank not economical



Chord Parallel to Plank







Drag Strut or Collector

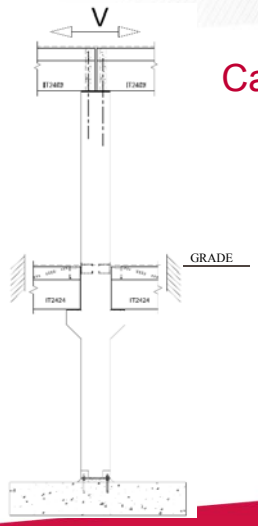
- Plank connected together to collect shear and transfer to shear wall
- Similar details to those previously shown

Loads Out of Diaphragm

- Same connections used for loads into diaphragm
- Dowels may be used for lighter loads
- Wall may be precast, CMU, CIP or braced frame

Topped Diaphragms

- Reinforcement for chords, and drag struts placed in topping
- Typically not used for podium construction
- May be practical in cases of:
  - Irregular geometry
  - Large Span to depth ratios
  - High seismic
- Topping reinforcing designed and detailed by EOR.



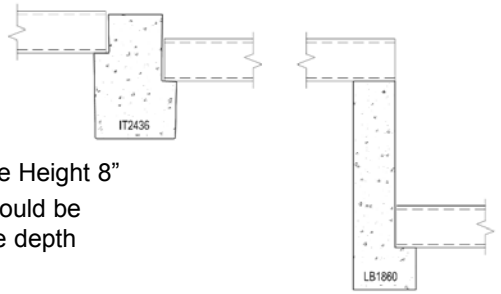
Cantilevered Columns

- Capacity approximately 4-5 kips for 16x16 columns
- 7-8 kips for 20x20 columns
- Consider interaction between cantilevered columns and shear walls

Special Conditions

- Steps in floor elevation
- Sloping floors
- Cantilevers
- Swimming pools
- Construction sequence
- Communication

Elevation Steps



- Minimum ledge Height 8”
- Ledge angle could be used to reduce depth below plank

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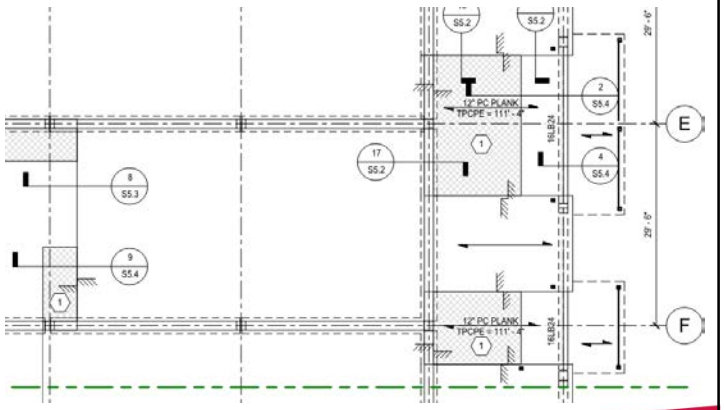

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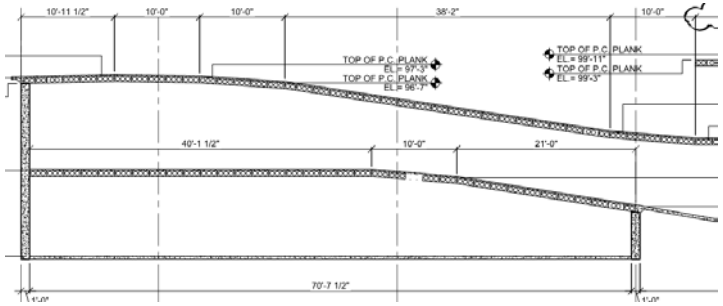
Sloping Floors

Ramps



Cantilevers

Swimming Pools

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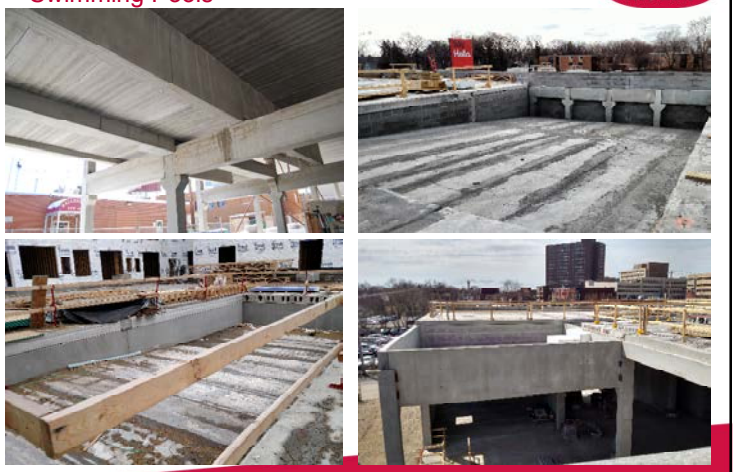

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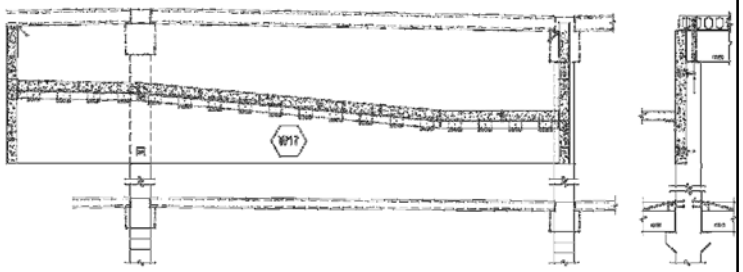

Canopies

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Construction Sequence

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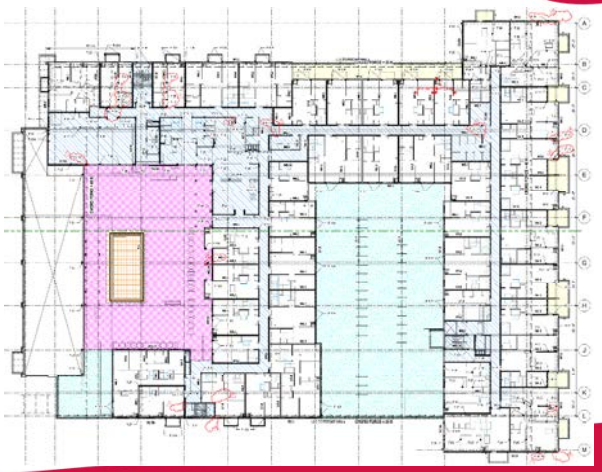
Communication



Loading Plan

- Gravity loads broken into dead, live & snow
- Note if loads are factored or reduced
- Lateral loads for individual shear walls
- Chord forces
- If lateral system is precast give total lateral load
- Soil loads to lateral system
- Soil pressure if precast walls
- Not overly conservative

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Thank You
For Your Attention

Questions?

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