Franklin & Marshall College Row

Lancaster, PA

Outline of Presentation Topics

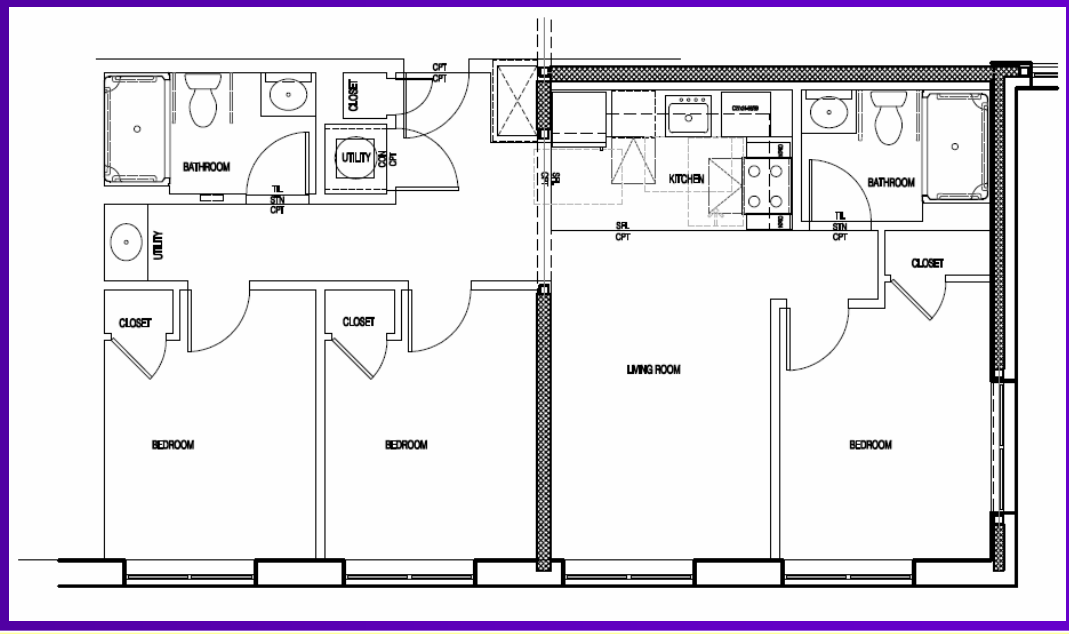
1. Project Overview
2. Analysis 1 – Building Information Modeling (BIM) Utilization
3. Analysis 2 – Composite Metal Deck v. Precast Concrete Plank Flooring
4. Analysis 3 – Cold Weather Construction
5. Conclusion

Project Overview

- Project Cost
  - $15,250,000
- Project Size
  - 111,641 SF
  - 6 stories
- Project Duration
  - 15 months
  - 5/8/06 to 7/31/07
- Project Delivery Method
  - CM at Risk with a GMP

Building Features

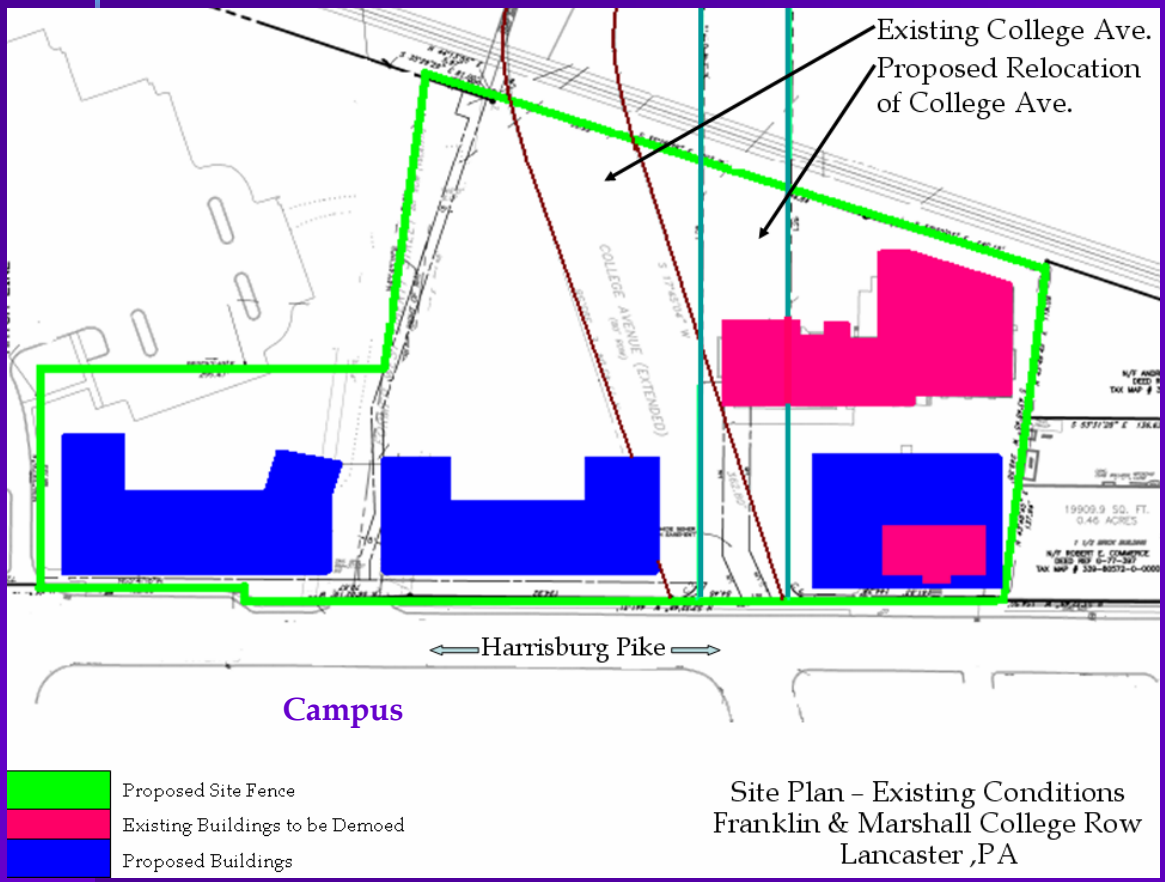
- 81% Residential
  - Top 5 floors containing 65 units - 1, 3 and 4 bedrooms
  - Handicap-accessible unit, common lounge, and laundry facilities on each floor
- 15% Retail
- 4% Offices



Building Design

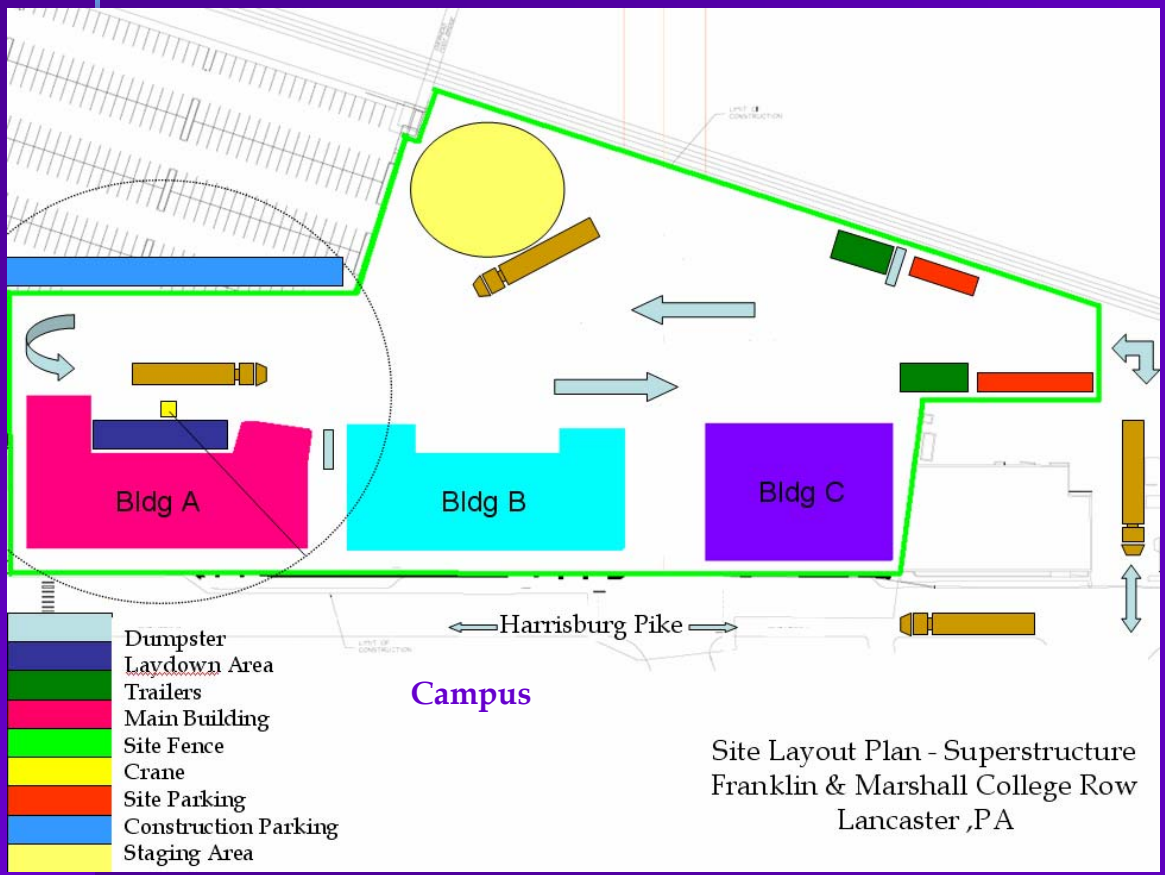
- Spread footings with selective compaction grouting
- Strip footings for masonry foundation walls
- Structural steel
- Slab on grade
- Composite slab on deck
- Load-bearing block and precast hollow core concrete plank
- Façade is brick veneer, metal sheeting, and calcium silicate masonry units

Site Plan – Existing Conditions



- Features
  - Demolition of historical buildings
  - Limited pedestrian traffic
  - Keep footbridge accessible
  - Reroute gas and electric lines

Site Layout Plan – Superstructure



- Features
  - One main gate for deliveries
  - Centrally located crane and laydown area
  - Open site

Analysis 1 – Building Information Modeling

- Digital representation of the building process to facilitate exchange and interoperability of information in digital format
- BIM covers geometry, spatial relationships, geographic information, quantities, and properties of building components
- Application possibilities of BIM include coordination of trades, activity sequencing, and scope of work details

BIM Goals and Outcomes

- Goals
  - Address benefits of BIM, focusing on owners
  - Look at the integration of BIM with operations and maintenance procedures
  - Review software applications

- Outcomes
  - BIM provides owner with visualization of building
  - Ease of coordination during construction
  - Organization of maintenance operations
  - Benefits for future renovations

Questionnaire Results

- Benefits
  - Coordination of trades
  - More detail, more accurate estimates
  - Reduced paper usage
- Drawbacks
  - Integration of new technology
    - Cost, Training, Capability
  - Industry's willingness to change
- BIM after project completion
  - Turnover as-built model, only good if accurate
  - Ease of future renovation
    - Design and updates
  - Reduce storage space
  - Helpful for operations and maintenance

BIM Case Study – Dickinson School of Law Building

- Penn State
  - University Park
- Project Cost
  - $60,000,000
- Building Size
  - 113,000 SF
- Design Phase
  - October 2005 to April 2007
- Construction Phase
  - January 2007 to January 2009
- Building Features
  - library, mock courtroom, classrooms, offices, cafeteria, and parking

BIM Case Study – Dickinson School of Law Building

- Decision to use BIM late in 2006
- Hope that additional costs will be outweighed by any “savings" from use of BIM
  - Easier coordination
  - Less conflicts
  - Less time lost in field
- High quality as-builts
- Ease of maintenance operations

BIM from an Owner Perspective

- Owner benefits before, during, and after construction
- Owner characteristics
  - Understand time = money
  - Enforce training for using the technology
  - Set standards among design, construction, and conclusion of project
- Facility Management
  - Knowledgeable employees
  - Update technology

BIM Software Review – Autodesk FMDesktop

- Tool to maintain as-built model
- Facility manager functions
  - Space and asset management
  - Project management
  - Emergency management
  - Maintenance management
- Facility manager features
  - Tabular or graphical output
  - view, query, pan, zoom, print, and share facility drawings
  - Planning, tracking, and managing

BIM Conclusions – Relating BIM to Franklin & Marshall

1. Decision to invest the money into the technology
2. Ability to hire knowledgeable designers and contractors
3. Eliminates room for drawing storage
4. Simplifies maintenance operations
5. Eases future renovations

Analysis 2 – Composite Metal Deck v. Precast Plank

- Problem
  - Current system is a combination of composite metal deck and precast hollow core concrete plank
- Goal
  - Compare two systems based on methods, schedule, and cost
- Outcomes
  - Precast concrete plank has higher cost
  - Composite metal deck has longer schedule
  - Precast concrete plank better suited to repetition and residential construction

Floor System Comparison

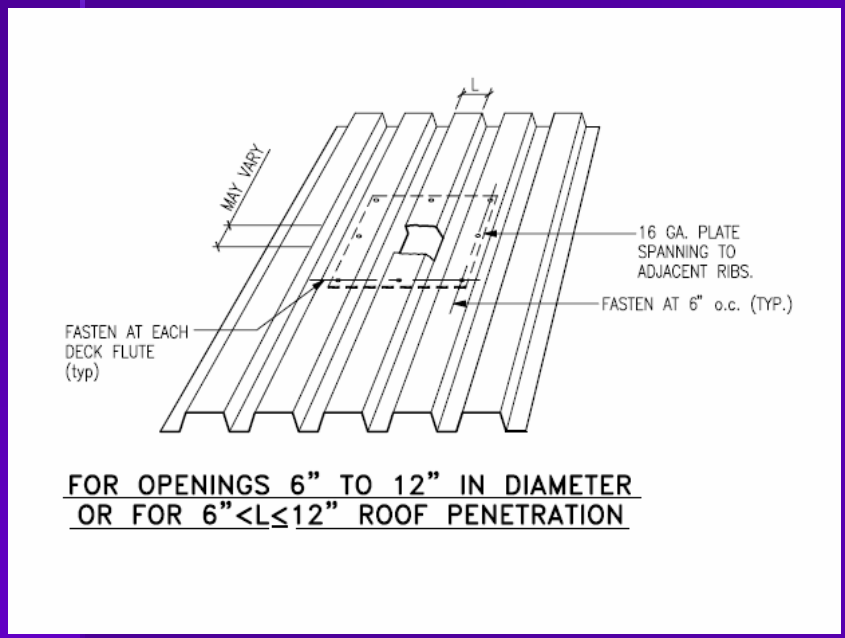
Composite Metal Deck

- More on-site labor
- Formwork
- Reinforcement
- More bearing walls needed for support
- More affordable equipment
- Horizontal load resistance

Precast Concrete Plank

- Eliminates on-site prep work
- High strength – less support needed
- Substantial crane needed
- Delivery expenses
- Less sound transmission
- Longer fire safety rating

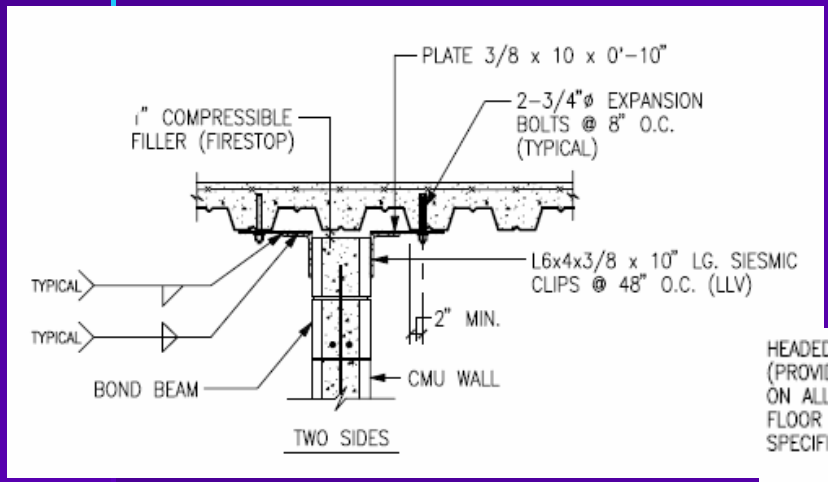
Flooring Design – Composite Metal Deck



Main Functions:

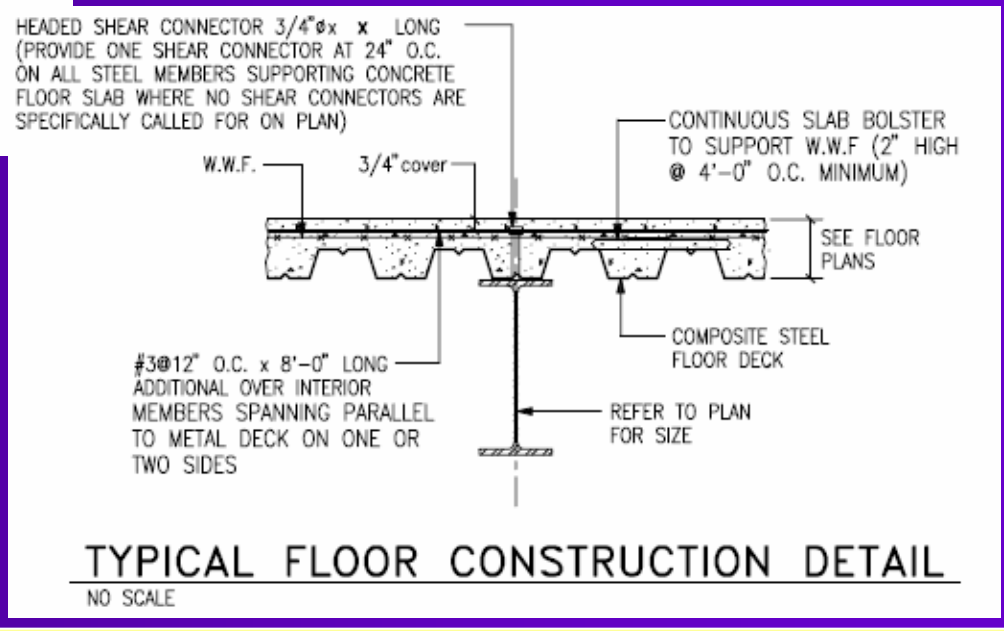
1. Platform during construction
2. Act as a form
3. Provide positive bending reinforcement for a concrete slab
4. Provide resistance to horizontal wind or earthquake loads

Flooring Design – Composite Metal Deck

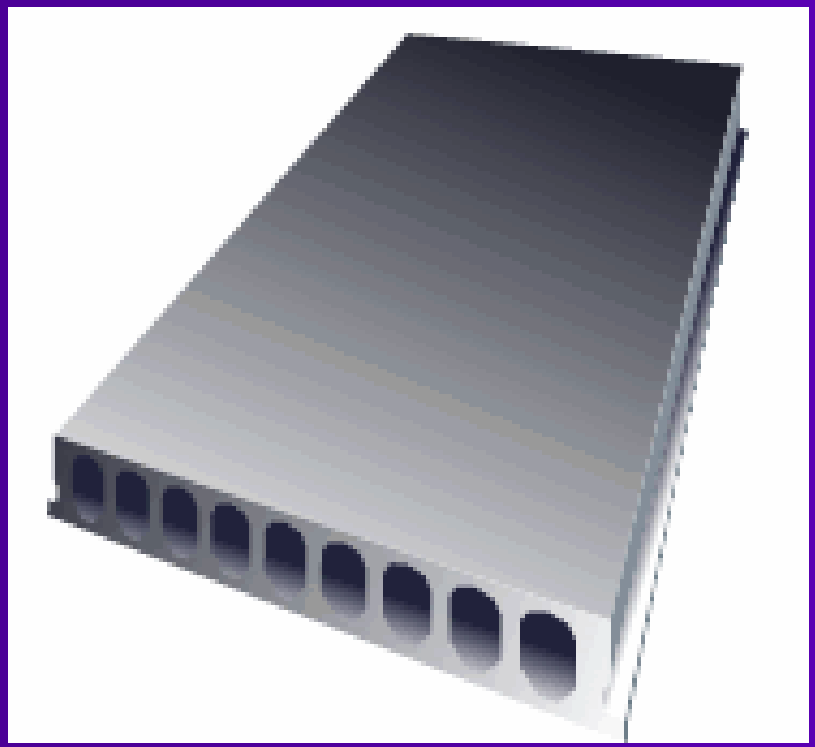


Deck and Bearing Wall

Deck and Steel Beam



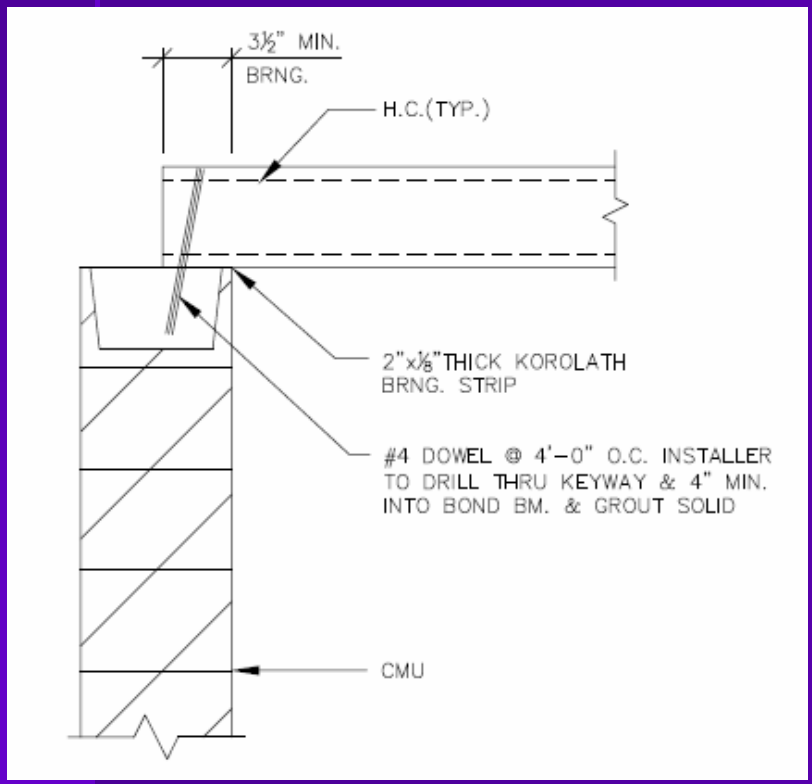
Flooring Design – Precast Hollow Core Concrete Plank



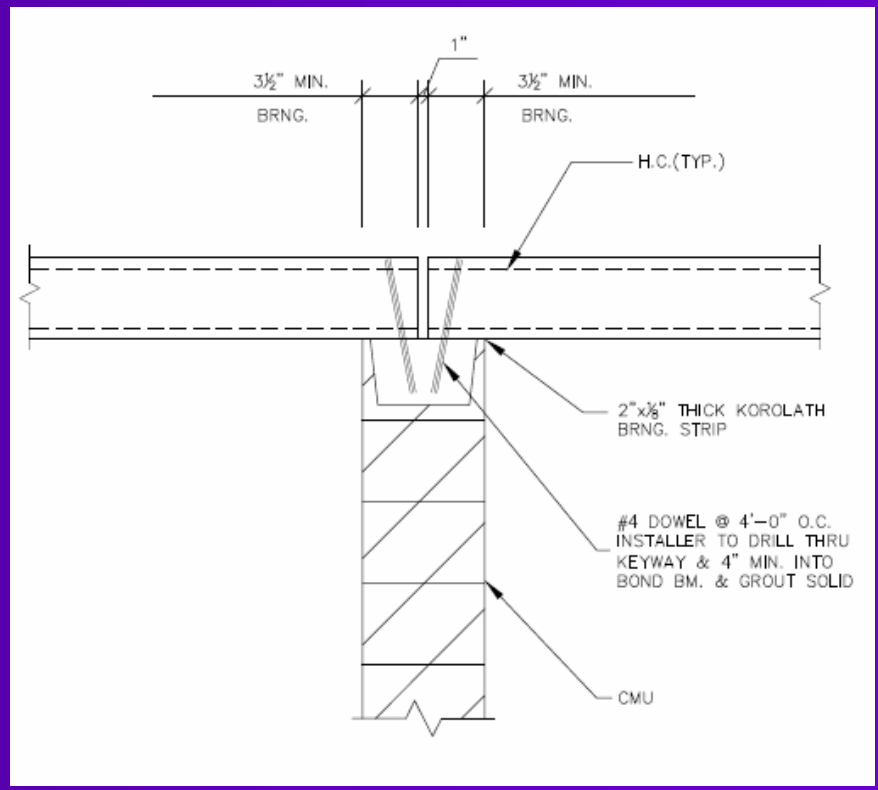
- Speedy production and erection
- Fire protection rating up to 4 hrs
- Noise control
- Unique designs, colors, and textures

Flooring Design – Precast Hollow Core Concrete Plank

Exterior Wall Connection



Interior Wall Connection



Cost and Schedule Comparisons

Composite Metal Deck

- Cost: $1,288,000
- Schedule: 45 days

Precast Concrete Plank

- Cost: $1,583,500
- Schedule: 30 days

Comparison parameters

- 5 upper floors of building
- Total of 93,034 square feet
- Same crew size for each system

Flooring Analysis Conclusions

1. Precast plank approximately $300,000 more than composite metal deck
   - 10% of structural cost
   - 2% entire budget cost
2. Composite metal deck 15 days longer than precast plank
3. Varying floor layouts and uses
   - 1st floor tenant space
   - 2nd - Roof are repeated pattern and residential space

Analysis 3 – Cold Weather Construction

- Problem
  - Concrete activities scheduled during winter months, effect on those activities
  - Schedule and cost impacts
- Goals
  - Analyze requirements for cold weather concrete work
  - Analyze effects on schedule and budget
- Outcomes
  - Concrete activities on critical path, difficult to change
  - Expedite work to avoid working in extreme conditions

Cold Weather and Concrete

- Cold weather construction at 40°F
- Average temperatures for Lancaster, PA
  - December 40°F/24°F
  - January 35°F/19°F
  - February 39°F/21°F
  - March 49°F/29°F
- Air-entraining agents
- Increase set time
- Reduced strength gain rates

Schedule Analysis

- Concrete activities on critical path
- Steel delayed, delaying concrete work
- Bulk of concrete work in December, January, February, and March
- Expedite work
  - Increase crew size
  - Extend working hours
  - Weekend work

Cost and Material Analysis

- Temporary Heat
  - Cost of natural gas
  - Heater rentals

- Temporary Protection
  - Labor (overtime)
    - Extended hours
    - Weekend work
  - Material
    - Hoses
    - Blankets
    - Plastic window covers

- Additional cost approximately $145,000

Cold Weather Conclusions

- Expedited work
  - Longer working hours
  - Weekend work
- Concrete protection
  - Temporary heaters
  - Steam hoses
  - Insulating blankets
  - Plastic window/opening covers
- Admixtures
- Need to have a good temporary protection plan

Summary and Conclusions

- Analysis 1 – Building Information Modeling
  - Design phase: aid in visualization, reduce rework
  - Construction phase: ease coordination, reduce change orders
  - Lifecycle: ease maintenance operations and future renovations
- Analysis 2 – Composite Metal Deck v. Precast Plank
  - Precast plank suited for residential and repetition projects
  - Precast plank would increase cost by 2%and decrease schedule by 3 weeks
- Analysis 3 – Cold Weather Construction
  - Need a good temporary protection plan
  - Schedule can be reduced by expediting work

Questions?

- Acknowledgments
  - Penn State AE Faculty
  - Penn State OPP Personnel
  - Alexander Building Construction, LLC
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  - Elkus | Manfredi Architects
  - Franklin & Marshall College
  - BIM Questionnaire Participants
  - My Friends and Family