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Construction Management

Frederick Memorial Hospital
Project 2000 Phase IV
Additions & Renovations
Frederick, Maryland

2006 Architectural Engineering Senior Thesis, Dr. David Riley Advisor

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Introduction

- Project Information & Background
- Courtyard Infill Structure Design
- Precast Panelized Masonry System
- Infection Control Risk Assessment
- Research: Getting to Know the Owner

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Project Information & Background

Client & Project Information

- Frederick Memorial Hospital
  - Private not for profit opened in 1902
  - Currently a 298 bed facility
  - Phase 4 is the last phase in a 6 year construction initiative (Project 2000)
- Project 2000 Phase IV Additions & Renovations:
  - Complete Renovation of the G wing
  - The interior courtyard of the G wing, previously a garden, to be infilled to create more usable square footage for each floor in the wing
  - New red brick envelope to match existing facility
  - $10.2 Million cost
  - 11 month schedule, July 2005 through May 2006
  - Hospital remains in operation throughout construction

FREDERICK MEMORIAL HEALTHCARE SYSTEM

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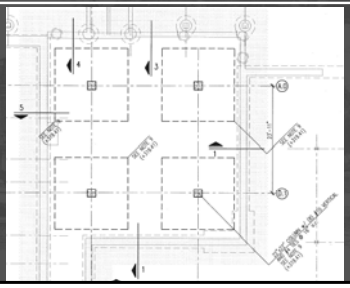
Courtyard Infill Structure Design

Existing Design | *Proposed Design* | *Design Using RAM* | *Impact of Design* | *Cost Implications* | *Schedule Implications* | *Conclusion*

- 42' (east-west) x 40' (north-south) cast-in-place concrete
- Four 22" x 22" columns each with (10) #8's vertically and a 10' x 10' 3 ½"-thick drop panel at each floor level
- 9" thick concrete reinforced with #5's at 9" o.c. in the top of the slab and #4's at 8" o.c. in the bottom of the slab
- Slabs cantilever out from columns



Courtyard Infill Structure Design

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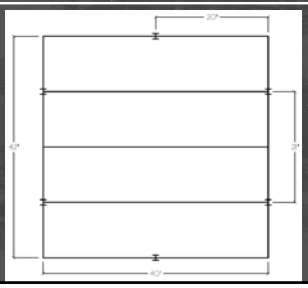
- Structural steel system with concrete slabs on metal deck
- Design intent is to eliminate the need for columns in the middle of the infill without altering the floor plan too much
- The new design places the columns at the exterior of the floor area minimizing the need for cantilevers
- Constraining the design is the fact that the floor area is surrounded by corridors, making it impossible to simply place columns at the four corners of area.
- The design consists of 2 columns spaced 21' apart along the north and south side of the area, and 1 column in the middle of the 40' span in each the east and west sides
- Three main girders span the 40' in the north-south direction.



Courtyard Infill Structure Design

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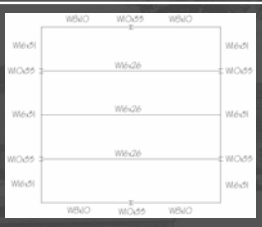
- Slab designed as a 5" concrete slab on USD 2" Lok-floor with 6x6 W1.4/W1.4 Mesh
- Beam and column sizes, the number of shear studs, as well as the footer sizes were calculated in RAM Structural System
- The structure consists of the W10x33 columns with the following girder and beam sizes: W8x10, W16x26, and W16x31
- Each column on the north and south side has a 3' x 3' x 1'6" thick footer that is reinforced on the bottom with 10 #4 bars each way
- The columns on the east and west side have 3' x 3' x 1'6" thick footers that are reinforced on the bottom with 6 #4 bars each way.



Courtyard Infill Structure Design

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- New Design has an impact architecturally
  - No longer any columns in the interior of the floor plan allowing for greater flexibility
  - Columns now fall in corridors at certain areas, and in kitchenette on 2nd floor
  - Corridors still meet IBC Section 1016.2 minimum width of 72" for healthcare facility
- Steel structure results in a floor cross section of 8" thicker than with a concrete structure
  - Height of the duct in the area is 10", and the largest pipes are 1-1/2"


1st Floor


2nd Floor

Courtyard Infill Structure Design

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- The proposed structural steel design is roughly half as much as the existing cast-in-place concrete design.
- Reasons for difference in cost:
  - Concrete is a very labor intensive form of construction, requiring a lot of man hours
  - Steel does not require as many workers so there is less labor cost
  - A steel structure can be erected faster, resulting in savings from less crane time, as well as savings from less general conditions time.

Phase	CSI	Description	Quantity	Unit Price	Cost
Foundation	3110	Formwork for Spread Footings	625 SF	7.15 /SF	$4,454
	3210	Rebar for Spread Footings	2 Tons	1800 /Tons	$3,600
	3310	Concrete for Spread Footings, 5000 PSI	87 CY	123.5 /CY	$10,743
Superstructure	3110	Plywood Forming System for Columns	1330 SF	7.7 /SF	$10,241
	3110	Plywood Forming System for 2-Way Flat Plate with Drops	8712 SF	10.45 /SF	$91,040
	3150	Shoring System for 2-Way Flat Plate with Drops	7480 SF	1.02 /SF	$7,630
	3210	Reinforcing Steel for 2-Way Flat Plate with Drops	25 Tons	1625 /Tons	$40,625
	3210	Reinforcing Steel for Columns	4 Tons	2200 /Tons	$8,800
	3310	5000 PSI Placed with Crane, for Flat Plates and Columns	252 CY	137.5 /CY	$34,650
	3350	Machine Trowel Finish 2-Way Flat Plates	7480 SF	0.7 /SF	$5,236
Location Modifier - Hagerstown				0.89	-$23,872
Estimate Total					**$198,149**

Existing Cast-in-Place Cost

Barton Malow

Courtyard Infill Structure Design

Frederick Memorial Healthcare System

Existing Design *Proposed Design* *Design Using RAM* *Impact of Design* ***Cost Implications*** *Schedule Implications* *Conclusion*

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Phase	CSI	Description	Quantity	Unit Price	Cost
Foundation	3210	Rebar for Column Footings	4.14 CWT	38.5 /CWT	$242
	3310	Concrete for Column Footings, 3000 PSI	8.33 CY	68.1 /CY	$568
Superstructure	3320	6x6 W1.4/W1.4 Mesh in SOD	73.92 SQS	27.1 /SQS	$2,001
	3311	Concrete for SOD	82.96 CY	72.9 /CY	$6,046
	3330	Machine Trowel Finish	6720 SF	0.33 /SF	$2,220
	5129	3/4" Shear Studs	522 EA	1.56 /EA	$814
	5129	Steel I Beams	140 CWT	68.73 /CWT	$9,622
	5129	Steel I Girders	94.1 CWT	68.73 /CWT	$6,466
	5129	Steel I Columns	87.1 CWT	68.73 /CWT	$5,988
	5310	2" USD Lok Floor Deck	6720 SF	1.3 /SF	$8,836
	7810	Cementitious Fireproofing	2606 BDFT	45 /BDFT	$118,143
		Decrease in Crane Time (15 days per schedule)	15 DAY	1513 /DAY	-$22,695
		Less General Conditions	2 WK	12837 /WK	-$25,674
Location Modifier - Hagerstown				0.89	-$15,208
Estimate Total					**$97,369**

Proposed Structural Steel Cost

Barton Malow

Courtyard Infill Structure Design

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- The courtyard infill structure takes 3 weeks (15 days) less to construct as structural steel with slab on metal deck rather than cast-in-place concrete
- The main reason for this difference in construction times is because of the discrepancy in production rates between cast-in-place and structural steel

Courtyard Infill Structure Design

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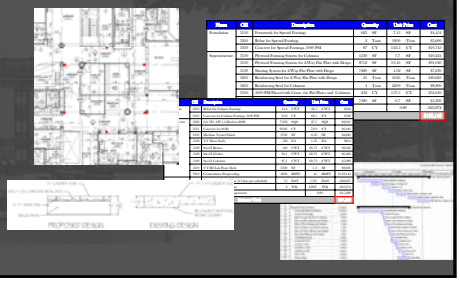
- In terms of cost and schedule the structural steel is cheaper and faster than cast-in-place concrete
- The structural steel requires fireproofing whereas the concrete does not
- The structural steel floor cross-section is 8" thicker than the existing floor design
- The structural steel design eliminates the need for columns in the interior of the courtyard infill, although some of the corridors are narrowed at spots



Precast Panelized Masonry System

Façade Design *Heat & Moisture Analysis* *U Value Analysis* *Structural Implications* *Cost Implications* *Schedule Implications* *Conclusion*

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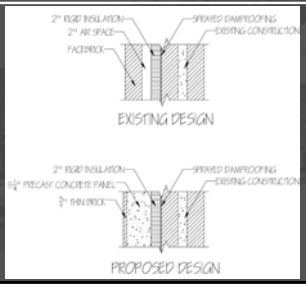
- The existing walls built over 50 years ago are just 2 layers of brick separated by a layer of grout
- The existing façade design entails constructing a brick veneer wall in front of the old façade
  - The designed façade consists of standard 3-5/8" brick, a 2" airspace, 2" of rigid insulation, and damproofing sprayed on the exterior of the old façade
- The proposed design for the façade consists of manufactured precast masonry panels instead of hand laid brick veneer
  - The panels Scott System Inc. Brick Snap© panels, 5 ¼" thick concrete with ¾" thick thin bricks cast on the concrete
  - Each panel 20' long by 11' tall; 4 panels span from foundation to roof



Precast Panelized Masonry System

Façade Design | ***Heat & Moisture Analysis*** | *U Value Analysis* | *Structural Implications* | *Cost Implications* | *Schedule Implications* | *Conclusion*

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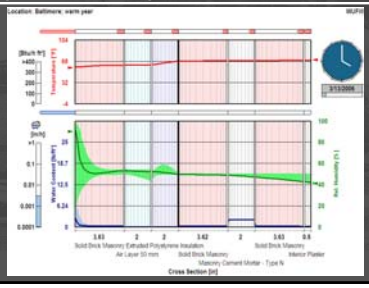
- The old façade, and the existing and proposed designs were analyzed the German program Wärme-und Feuchtetransport Instationär (WUFI)
- The program calculates simultaneous heat and moisture transport through building envelopes taking the following into account for the calculations:
  - thermal conduction, enthalpy flows through moisture movement with phase change, short-wave solar radiation, nighttime long-wave radiation cooling, vapor diffusion, solution diffusion, capillary conduction, surface diffusion, etc.
- Design intent is to see if the precast panel performs adequately when compared to the brick veneer



Precast Panelized Masonry System

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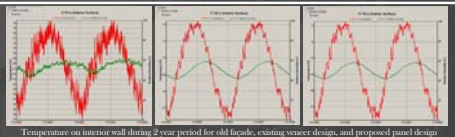
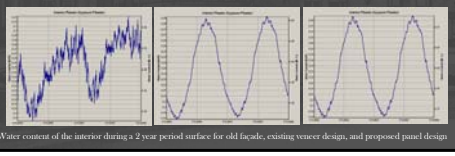
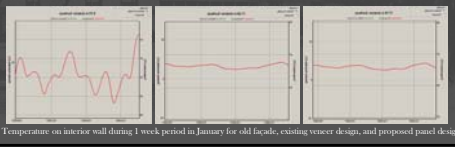
- Proposed precast panels perform the same as a brick veneer
- Both the panels and the veneer are more stable in terms of heat and moisture transfer than the existing construction, and a marked improvement



Temperature on interior wall during 2 year period for old façade, existing veneer design, and proposed panel design



Water content of the interior during a 2 year period surface for old façade, existing veneer design, and proposed panel design



Temperature on interior wall during 1 week period in January for old façade, existing veneer design, and proposed panel design

Precast Panelized Masonry System

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- For Frederick Maryland, with 5000 heating degree days, ASHRAE standards dictate that a non-residential facility should have a maximum 0.3 U value for the exterior walls
- The existing construction of the walls is definitely inadequate, but the brick veneer and the precast panel with insulation both meet the standards and are more than adequate

Old Façade	
U Value	0.4673
U incl. windows	0.4755

Brick Veneer	
U Value	0.0745
U incl. windows	0.1809

Precast Panels	
U Value	0.07619
U incl. windows	0.182143

Precast Panelized Masonry System

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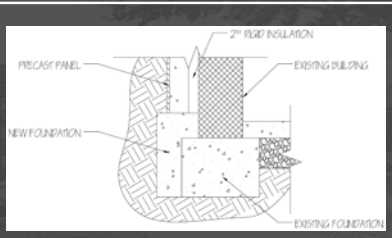
- Existing design calls for brick veneer to bear on existing foundation
- The extra weight of the panels compared to the brick veneer requires the existing foundation to be retrofitted to accommodate the extra stress

Equivalent 20' wide by 11' high area	
Brick Veneer	Precast Panel
7975 lbs	16088 lbs



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- Precast panels are $100,000 more expensive than brick veneer
- Cost for the manufacture and deliver precast panels activity quoted from Mark Taylor of Nitterhouse Concrete Products Inc.
- Reasons for difference in cost:
  - Although precast erection is less labor intensive than brick veneer construction, labor hours for manufacture greatly increase the cost
  - A crane is required for precast erection, increasing the cost
  - A somewhat equalizing factor is that precast can be erected quickly, saving general conditions time

Description	Quantity	Unit Price	Cost
Manufacture and Deliver Precast Panels	15772 SF	35 /SF	$552,020
Crane for Panel Erection	20 DAY	1,513 /DAY	$30,260
Less General Conditions	4 WK	12837 /WK	-$51,348
Location Modifier - Hagerstown		0.89	-$64,051
Estimate Total			**$466,881**

Proposed Precast Panel Cost

Description	Quantity	Unit Price	Cost
Brick Veneer, 4" standard brick with polystyrene cavity insulation	15,772 SF	26.8 /SF	$422,690
Location Modifier - Hagerstown		0.89	-$38,304
Estimate Total			**$384,386**

Existing Brick Veneer Cost

Precast Panelized Masonry System

Façade Design *Heat & Moisture Analysis* *U Value Analysis* *Structural Implications* *Cost Implications* *Schedule Implications* *Conclusion*

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- The brick veneer will take 54 work days, whereas the precast panels will take 30 work days
- The main reason for this difference in schedule length is because of the discrepancy in production rates between precast panel erection on brick veneer construction
- Other factor to consider:
  - The design must be 100% complete before panels are manufactured
  - The schedule savings allow for the hospital to be dried in faster

Precast Panelized Masonry System

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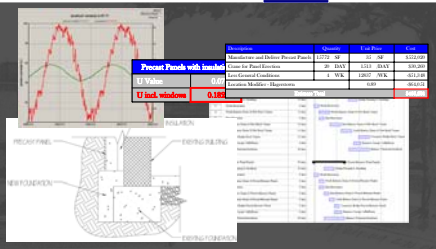
- In terms of heat and moisture transport a system of precast panels with rigid insulation performs just as well as a brick veneer façade
- The panels need the rigid insulation in order to meet ASHRAE standards
- The panels require a new foundation to be constructed to support the extra weight that the panels have versus the brick veneer
- A crane is introduced to the site plan, but there is not longer the need for scaffolding
- The precast panels are more expensive than the brick veneer
- One month is saved on the schedule, and the building is dried in faster



Infection Control Risk Assessment

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- CDC estimates healthcare associated infections account for an estimated 2 million infections, 90,000 deaths, and $4.5 billion in excess health care costs annually
- CDC, AIA, and APIC all strongly support the implementation of an infection control risk assessment on a construction project
  - "a multidisciplinary, organizational, documented process that focuses on reduction of risk from infection; acts through phases of facility planning, design, construction, renovation, facility maintenance, and coordinates and weighs knowledge about infection, infectious agents, and care environment, permitting the organization to anticipate potential impact."

AIA

APIC

CDC Department of Health and Human Services
Centers for Disease Control and Prevention

Infection Control Risk Assessment

Background Information | ***ICRA Analysis*** | *Suggested Infection Control Actions* | *Implications of ICRA* | *Comparison to FMH Methods* | *Conclusion*

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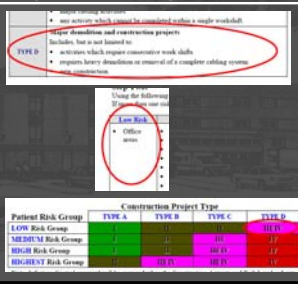
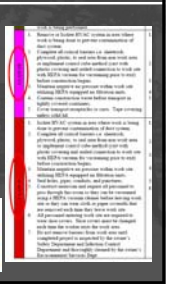
- An ICRA was performed to determine if the proper precautions were being taken at FMH
- For this analysis the "Infection Control Risk Assessment Matrix of Precautions for Construction & Renovation" distributed by APIC was used
- Series of questions identifying aspects of the project that will dictate the risk of infection on the project



Patient Risk Group	TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk Group	I	II	II	III IV
MEDIUM Risk Group	I	II	III	III IV
HIGH Risk Group	I	II	III IV	III IV
HIGHEST Risk Group	II	III IV	III IV	IV



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- All HVAC returns in the construction spaces should be completely sealed off with plastic
- Temporary wall partitions that are completely sealed around the edges should be constructed separating the construction area from the hospital
- Negative pressure utilizing HEPA filtration should be maintained in the zones adjacent to the hospital
- Testing should be performed daily to ensure that the area around the temporary barriers is indeed in negative pressure when compared to the hospital on the other side of the barrier.
- All above ceiling penetrations from the construction area into the hospital should be completely sealed
- Place sticky mats at all construction entrances into the building. This will prevent excess dust and dirt from being tracked inside.
- Construction debris should be wrapped in plastic, sealed, and HEPA-filter vacuumed before removal from the construction area.
- Debris and construction tools should be cleaned daily to prevent build up of dust and microorganisms

Infection Control Risk Assessment

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- Construction manager must take the lead and stress the importance of infection control to the subcontractors
- Subcontractors on this job are not specific hospital contractors
- Infection control can be expensive

Infection Control Risk Assessment

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- Additional precautions being taken above suggestions from ICRA:
  - Interim barriers installed before temporary barriers constructed
  - Preventative measures during site construction

Infection Control Risk Assessment

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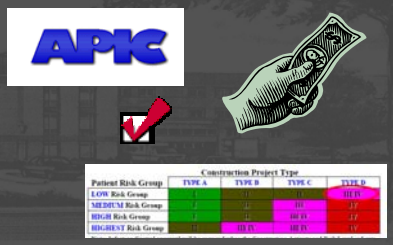
- Infection control is very important on hospital construction projects
- After performing ICRA several specific methods for minimizing infection risk were identified
- Some implications were the need for getting contractors to understand the importance of minimizing infection risks, and the need for maintaining the infection control budget if money starts to becomes tight
- When comparing the results of the assessment to what is actually being done at FMH it is apparent that all necessary precautions are being made



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Research: Getting to Know the Owner

Research Background | *Summary of Results* | *Recommendations* | *Conclusion*

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- At the 2005 PACE Roundtable industry members lamented the fact that "owner" rarely consists of one person.
- The end result of this research will be a description of the different entities in an owner, describing what characterizes them and what is important to them, and recommendations on how to get to know the owner.

PACE The Partnership for Achieving Construction Excellence

- Survey sent out to various contractors containing questions pertaining to getting to know and communicating with the owner:
  - How do you get to know and communicate with the president? The CFO? The operator? The end user?
  - What do they like? Or dislike?
  - What complexities does multiple "owners" cause?
  - Who is the hardest to get on your side? The easiest?

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Research: Getting to Know the Owner

Research Background | ***Summary of Results*** | *Recommendations* | *Conclusion*

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- President:
  - Big picture issues, budget and schedule
  - Face to face, verbal interaction
- CFO:
  - Cash flow, more specifics than president
  - Verbal communication, monthly reports as well
- End user:
  - concerned about quality and design
  - Involved on project level
- Operator:
  - Performance of building
  - Involved on project level

- Other complexities:
  - Too many opinions
  - Too much communication
  - Hard to figure out who is in charge in different situations
  - CM occasionally has to play peacekeeper between owners
  - Hard to gain trust of those with little construction experience

Research: Getting to Know the Owner

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- Trust must start at the top
- Face to face meeting between president and project executive
- Meetings should be held when project is not running as smoothly
- Try to involve the groups as early as possible
- Foster an environment of honesty and trust

Research: Getting to Know the Owner

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- Ultimately, the onus falls on the contractor
- Managing the owners is almost as important as managing the subcontractors
- At the very beginning of the project, before construction has even started, the contractor should assess the situation
- In the end it will come down to time and money

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Conclusion

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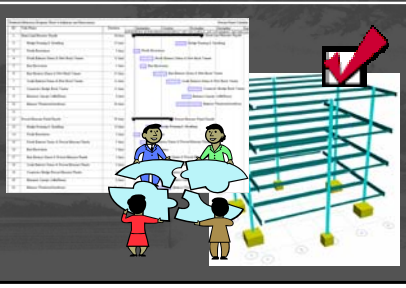
- The structural steel system was superior in terms of cost and schedule when compared to the existing cast-in-place
- The precast masonry panels provided adequate thermal and moisture resistance when compared to the existing brick veneer, but was more expensive
- The infection control risk assessment provided precautions that should be taken, and FMH has followed those precautions
- Industry research showed that having many owners adds complexity to the project, but with proper action this can be alleviated



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Conclusion

Conclusions | ***Acknowledgements*** | *Questions*

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- Dr. David Riley, Associate Professor – Construction, Pennsylvania State University
- Dr. John Messner, Assistant Professor – Construction, Pennsylvania State University
- Dr. Moses Ling, Associate Professor – Mechanical, Pennsylvania State University
- Dr. Louis Geschwindner, Professor Emeritus – Structural, Pennsylvania State University
- Dr. Linda Hanagan, Associate Professor – Structural, Pennsylvania State University
- Ralph Colarusso, Project Executive, Barton Malow Company
- Leaha Martyniuska, Project Engineer, Barton Malow Company
- Mark Taylor, Vice President – Chief Operating Officer, Nitterhouse Concrete Products Inc.
- Chad Westall, Technician, Scott System Inc.

THANK YOU!!!

Conclusion

Conclusions | *Acknowledgements* | ***Questions***

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QUESTIONS????

COMMENTS????