

Pearl Condominiums Philadelphia, PA



Picture Courtesy of Blackney Hayes

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Structural Option
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Penn State University



Presentation Outline

- Building Introduction
- Existing Structural System
- Goals of Redesign
- Structural Depth
- Breadth Studies
- Conclusions and Recommendations
- Acknowledgements



Building Introduction

- *Location and Site:* 9th and Arch Street
Philadelphia, PA
- *Size:* 111,570 S.F.
- *Number of stories:* 6
- *Completed:* October 2007
- *Building Use:* Mixed Use Development Housing
Including Retail on the Ground Floor and Apartments
on the Upper Floors.
- *Total Cost:* \$22,646,674
- Design-Bid-Build



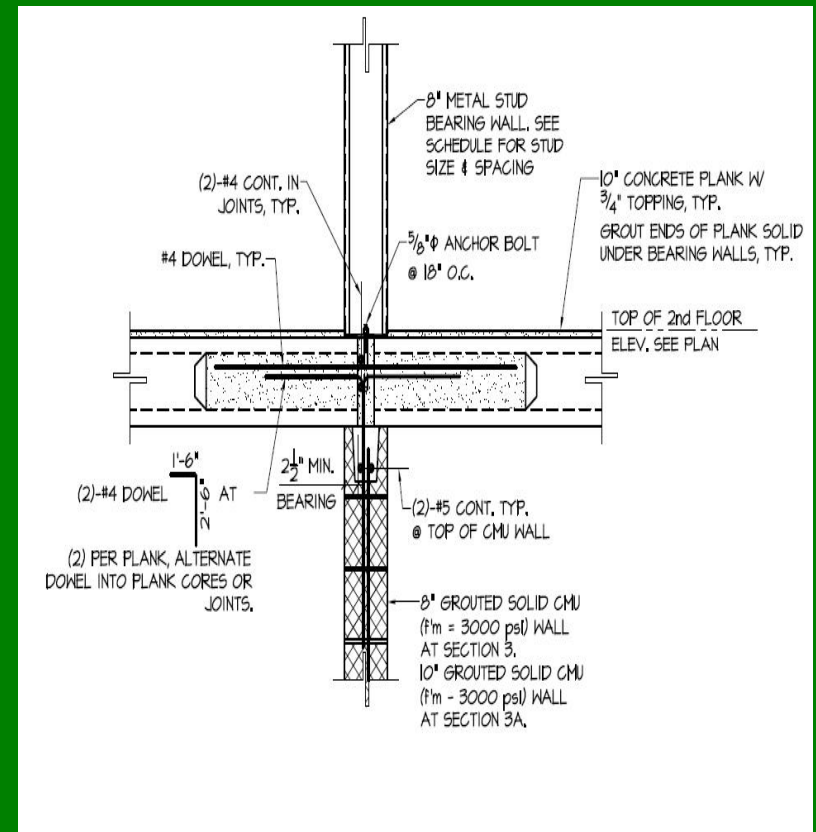
Building Introduction

- *Project Team:*
 - Owner - Parkway Corporation
 - Architect – Blackney Hayes Architects
 - Construction Manager – JJ Deluca Company Inc.
 - Structural Engineer – Pennoni Associates Inc.



Existing Structural System

- *Current Structural System*
 - Superstructure: Load Bearing Walls Composed of Metal Studs and Concrete Masonry Units
 - Roof System: Steel Joists and Metal Deck
 - Floor System: 10" Precast Concrete Plank with a 3/4" Concrete Thick Topping
 - Foundation System: Grade Beams Bearing on Drilled Piers

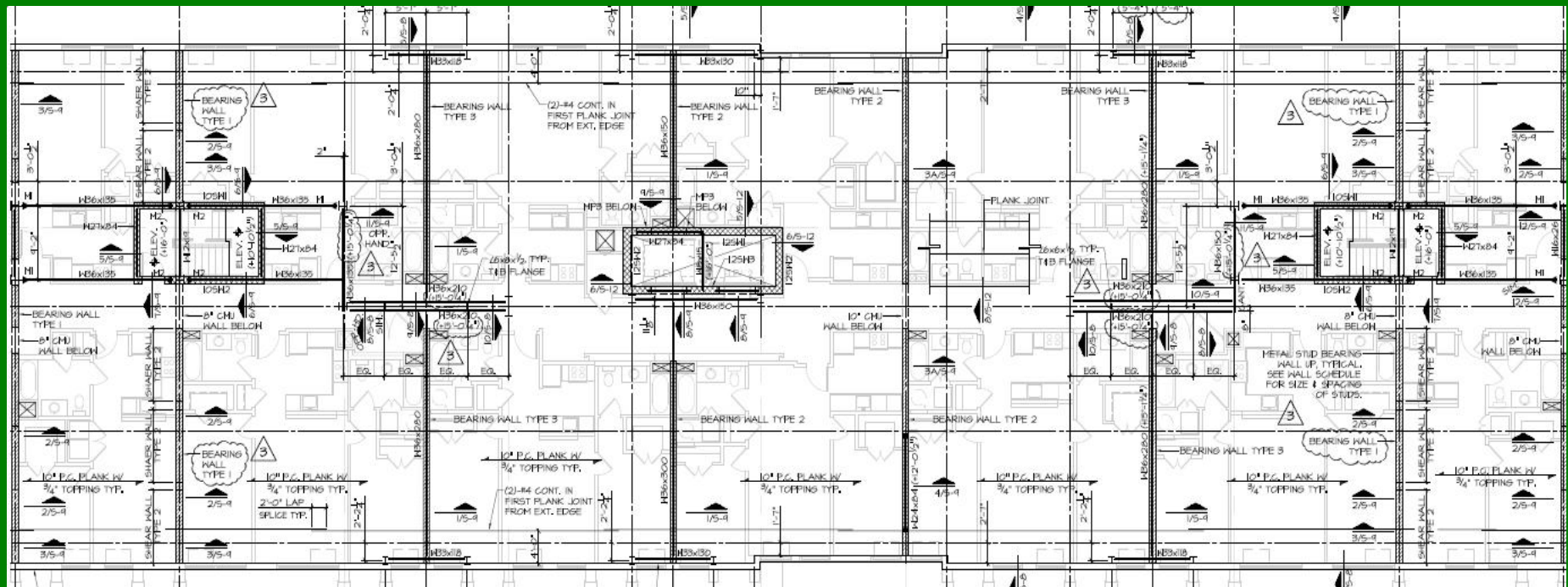


Picture Courtesy of Pennoni Associates



Existing Structural System

- *Current Structural System*
 - Second Floor acts as a Transfer Floor
 - Also Present are Large Steel Moment Frames



Picture Courtesy of Pennoni Associates



Existing Structural System

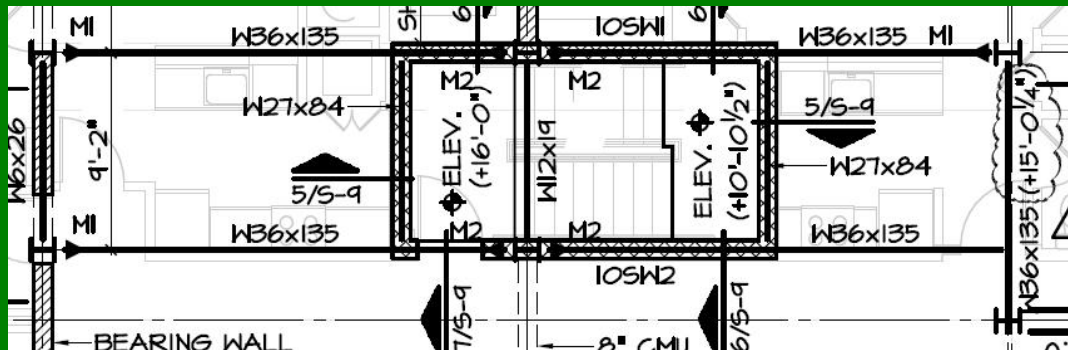
- Lateral System
 - Concrete Masonry Shear Walls
 - Metal Stud Shear Walls
 - Large Steel Moment Frames

CMU SHEAR WALL SCHEDULE					
10SW1 - 10' WALL THICKNESS			STAIR (E-W)		
LEVEL	VERTICAL CHORD REINFORCING (BOTH ENDS OF WALL)	INTERMEDIATE VERTICAL REINFORCING (CENTERED IN CELL)	Fm (PSI)	CONCRESS HORIZONTAL REINFORCING IN BOND BEAM	REMARKS
7th - ROOF	2 - #6	#5 @ 48" O.C.	1500	#4 @ 48" O.C.	-
6th - 7th	2 - #6	#5 @ 32" O.C.	1500	#4 @ 48" O.C.	-
5th - 6th	2 - #7	#5 @ 24" O.C.	1500	#4 @ 32" O.C.	-
3rd - 5th	4 - #7	#5 @ 16" O.C.	1800	#5 @ 32" O.C.	-
2nd - 3rd	4 - #8	#5 @ 8" O.C.	2000	#5 @ 32" O.C.	-
-	-	-	-	-	-

* VERTICAL CHORD REINFORCING IS DETAILED AS TOTAL NUMBER OF REINFORCING BARS AT EACH END. FOR EXAMPLE 10-#8 BARS IS EQUIVALENT TO (2)-#8 IN FIRST 5 CELLS OF WALL AT EACH END.

10SW2 - 10' WALL THICKNESS					
STAIR TOWER					
LEVEL	VERTICAL CHORD REINFORCING (BOTH ENDS OF WALL)	INTERMEDIATE VERTICAL REINFORCING (CENTERED IN CELL)	Fm (PSI)	CONCRESS HORIZONTAL REINFORCING IN BOND BEAM	REMARKS
7th - ROOF	2 - #5	#5 @ 48" O.C.	1500	#4 @ 48" O.C.	-
6th - 7th	2 - #5	#5 @ 32" O.C.	1500	#4 @ 48" O.C.	-
5th - 6th	2 - #6	#5 @ 24" O.C.	1500	#4 @ 32" O.C.	-
3rd - 5th	2 - #7	#5 @ 16" O.C.	1800	#5 @ 32" O.C.	-
2nd - 3rd	4 - #8	#5 @ 8" O.C.	2000	#5 @ 32" O.C.	-
-	-	-	-	-	-

* VERTICAL CHORD REINFORCING IS DETAILED AS TOTAL NUMBER OF REINFORCING BARS AT EACH END. FOR EXAMPLE 10-#8 BARS IS EQUIVALENT TO (2)-#8 IN FIRST 5 CELLS OF WALL AT EACH END.



METAL STUD SHEAR WALL SCHEDULE						
WALL TYPE 1 8" METAL STUD WALL (8'-8" LENGTH)						
LEVEL	COLUMN SECTION	BOOT TYPE	STRAP SIZE (EA. FACE)	STRAP CONNECTION AT EA. END	T ₁ (KIPS)	ANCHOR BOLT
7th - ROOF	800C250-39	A	4" - 54 mils	4 - #12	2.8 ^K	(2)-1/6"Ø
6th - 7th	800C250-54	B	4" - 54 mils	Ø - #12	Ø.2 ^K	(2)-1/6"Ø
5th - 6th	(2) - 800C250-54	B	Ø" - 54 mils	12 - #12	19.0 ^K	(2)-1/6"Ø
3rd - 5th	(2) - 800C250-68	C	Ø" - 54 mils	16 - #12	16.7 ^K	(2)-1/6"Ø
2nd - 3rd	(2) - 800C250-71	D	Ø" - 54 mils	18 - #12	19.9 ^K	(2)-1/6"Ø
-	-	-	-	-	-	-

WALL TYPE 2 8" METAL STUD WALL (9'-0" LENGTH)						
LEVEL	COLUMN SECTION	BOOT TYPE	STRAP SIZE (EA. FACE)	STRAP CONNECTION AT EA. END	T ₁ (KIPS)	ANCHOR BOLT
7th - ROOF	800C250-39	B	4" - 54 mils	4 - #12	3.2 ^K	(2)-1/6"Ø
6th - 7th	800C250-54	B	4" - 54 mils	Ø - #12	Ø.6 ^K	(2)-1/6"Ø
5th - 6th	(2) - 800C250-54	D	Ø" - 54 mils	12 - #12	15.6 ^K	(2)-1/6"Ø
3rd - 5th	(2) - 800C250-68	D	Ø" - 54 mils	16 - #12	17.5 ^K	(2)-1/6"Ø
2nd - 3rd	(2) - 800C250-71	D	Ø" - 54 mils	18 - #12	20.4 ^K	(2)-1/6"Ø
-	-	-	-	-	-	-

Pictures Courtesy of Pennoni Associates



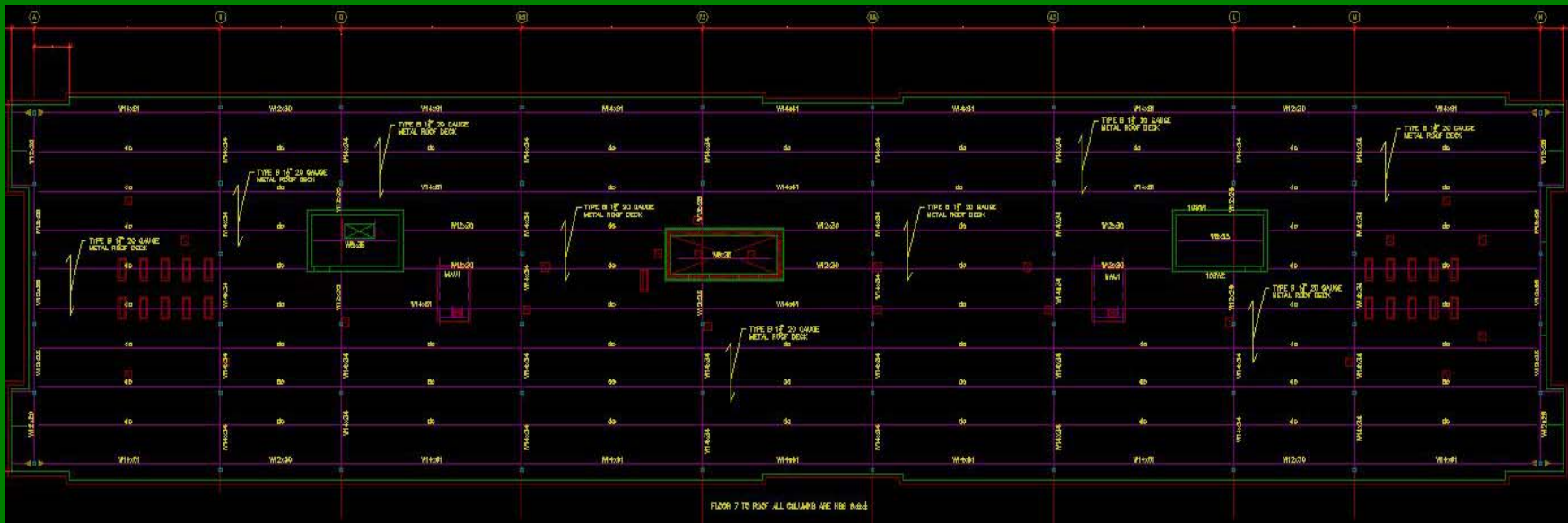
Goals Of Redesign

- Primary Goal
 - Eliminate the Dependency on Load Bearing Walls While Creating Minimal Change to Architectural Floor Plans
- Secondary Goal
 - Compare Cost and Schedule of New System to Existing Structure



Structural Depth

- Redesign of Roof System
 - Added green roof (25 psf)
 - Longest Beam Span: 34'-9" (W14x61)
 - Longest Girder: 12'-1" (W14x34)
 - Columns: HSS 6x6x1/4





Structural Depth

- Redesign of Floor System
 - Flex Frame
 - Combination of Precast Concrete Planks and Open-Web Dissymmetric Beams
 - Two Types of Dissymmetric Beams
 - » DB-8 and DB-9



Pictures Courtesy of Girder-Slab

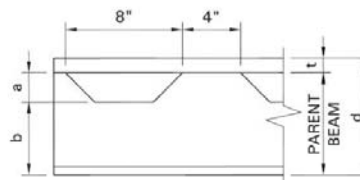


Structural Depth

- Redesign of Floor System
 - Floor System
 - 8" Precast Concrete Planks with 2" Concrete Topping
 - Camber 1" for Span of 34'-9"
 - DB 9x46
 - Maximum Span: 13'
 - Tributary Width: 34'

D-Beam® Dimensions Table

Designation	Web Included		Depth d	Web Thickness t _w	Parent Beam			Top Bar w x t
	Weight lb/ft	Avg. Area in ²			Size	a	b	
DB 8 x 35	34.7	10.2	8	.340	W10 x 49	4	3	3 x 1
DB 8 x 37	36.7	10.8	8	.345	W12 x 53	2	5	3 x 1
DB 8 x 40	39.8	11.7	8	.340	W10 x 49	3	3.5	3 x 1.5
DB 8 x 42	41.8	12.3	8	.345	W12 x 53	1	5.5	3 x 1.5
DB 9 x 41	40.7	11.9	9.645	.375	W14 x 61	3.375	5.25	3 x 1
DB 9 x 46	45.8	13.4	9.645	.375	W14 x 61	2.375	5.75	3 x 1.5

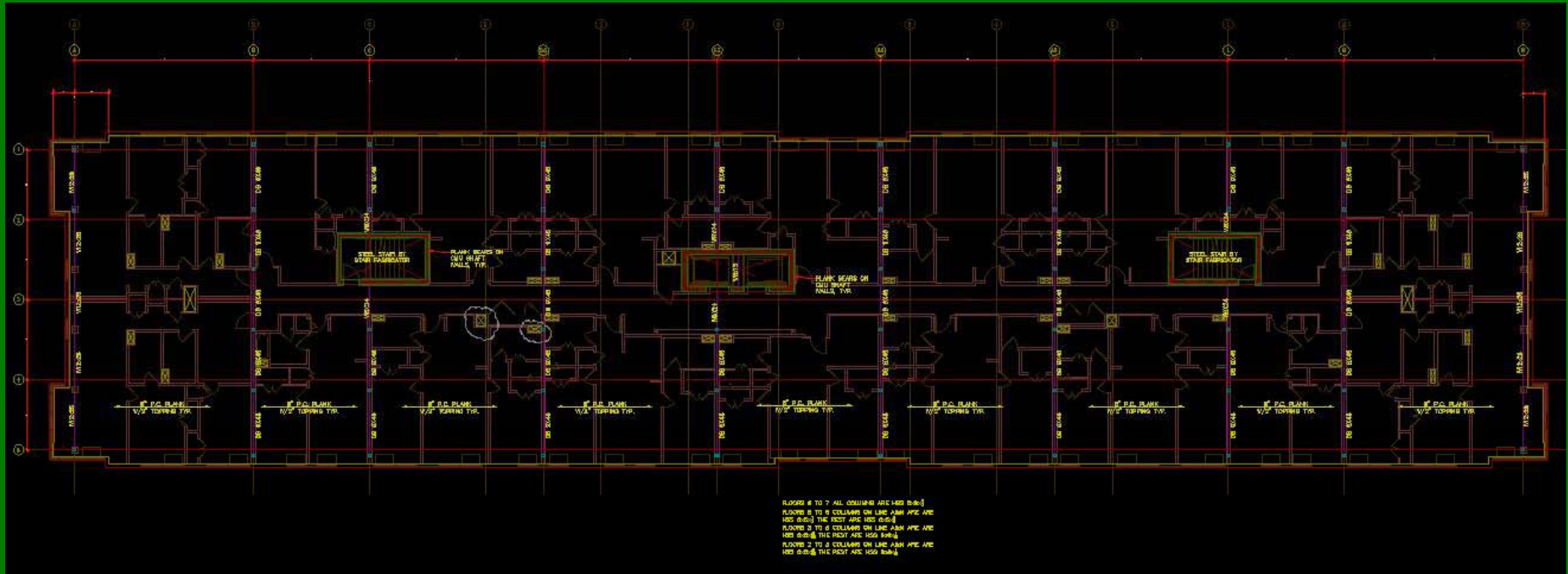


Pictures Courtesy of Girder-Slab



Structural Depth

- Typical Floor Layout (Floor 3,5,6,7)





Structural Depth

- Redesign of Lateral System
 - Change of CMU Shear Walls to Cast in Place Concrete Shear Walls
 - Result: 8" Concrete Walls with #5 @ 14" for Vertical and Horizontal Reinforcement
- Comparison of Foundation System
 - Drilled Piers: Cost - \$18 Per Foot for 10" Diameter
 - Pile: Cost - \$28 Per Foot for HP 10x42



Structural Depth

- Conclusion
 - The Roof System
 - Beam and Girder System Decreases Overall Depth of System
 - Floor System
 - Flex Frame System Eliminates Reliance on Load Bearing Walls
 - Lateral System
 - Cast in Place Shear Walls Reduce the Overall Thickness of the Walls



Breadth Studies

- Construction Management
 - Goals of Breadth
 - Compare Cost Analysis For Existing and Redesigned Structures
 - Schedule Analysis of Redesign Structure vs. Existing Structure



Breadth Studies

- Cost Analysis
 - Comparison Considered the Second Floor Framing and Above
 - First Floor and Foundation Would be Similar for Both System
 - Existing Structure Cost: \$1,754,524
 - Proposed System Cost: \$1,760,136
- Schedule Comparison
 - Existing Structure Time: 3 months
 - Proposed System Time: 2 months 12 days



Breadth Studies

- LEED Certification
 - Goals
 - To Gain a minimum of a LEED Certification (26-32 points)
 - Sustainable Sites: Could Achieve as High as 9 out of 14 Possible Points
 - Material & Resources: Could Achieve as High as 10 out of 13 Possible Points



Conclusion

- Flex Frame System
 - Viable Alternative
 - Small Impact on Architectural Floor Plan
 - Proposed System Does Not Create a Substantial Change in Cost and Schedule
 - Cons
 - Limited By Possible Precast Concrete Planks (Only 8")
 - Would Redesign Second Floor Framing to Reduce Members Sizes



Acknowledgements

- **Parkway Corporation**
 - Mr. Bob Hicks
- **Blackney Hayes Architects**
 - Mr. Michael Resnic
- **Pennoni Associate Inc.**
 - Mr. Keith Weitknecht
 - Mr. Mike Padula
- **The Pennsylvania State University**
 - Dr. Linda Hanagan
 - The entire AE faculty and staff



Questions ?

