

THE DUNCAN CENTER

DOVER, DELAWARE



RACHEL GINGERICH, STRUCTURAL OPTION

SENIOR THESIS PRESENTATION

APRIL 15, 2008



PRESENTATION OUTLINE



- A. Building Introduction**
- B. Existing Steel Structural System**
- C. Proposal Introduction**
- D. Depth/Proposed Concrete Structural System**
- E. Construction Management Breadth**
- F. Acoustics Breadth**
- G. Proposal Recommendation**

BUILDING STATISTICS

Location: Dover, Delaware

Area: 76, 557 SF

Height: 93'-0"

Stories: 6 total

~Floor to floor height of 14'-0"

~5 floors and a penthouse
on the top floor

~ Balconies on 4th and 5th floors



Personal Photo: Taken August 16, 2007

BUILDING STATISTICS

Floor Occupancies

~1st-4th Floor:

Open Flex Office Spaces

~5th Floor:

“The Outlook Center” Ballroom

~6th Floor:

Management Offices

Mechanical Rooms

~Basement:

Mechanical Room

Electrical Room



Personal Photo: Taken August 16, 2007

BUILDING CONSTRUCTION

Overall Project Cost:

\$10.7 million

Additional Tenant Fit-Out Cost:

\$46,000

Construction Start Date:

June 2003

Construction End Date:

June 2004

Project Delivery Method:

Design-Build

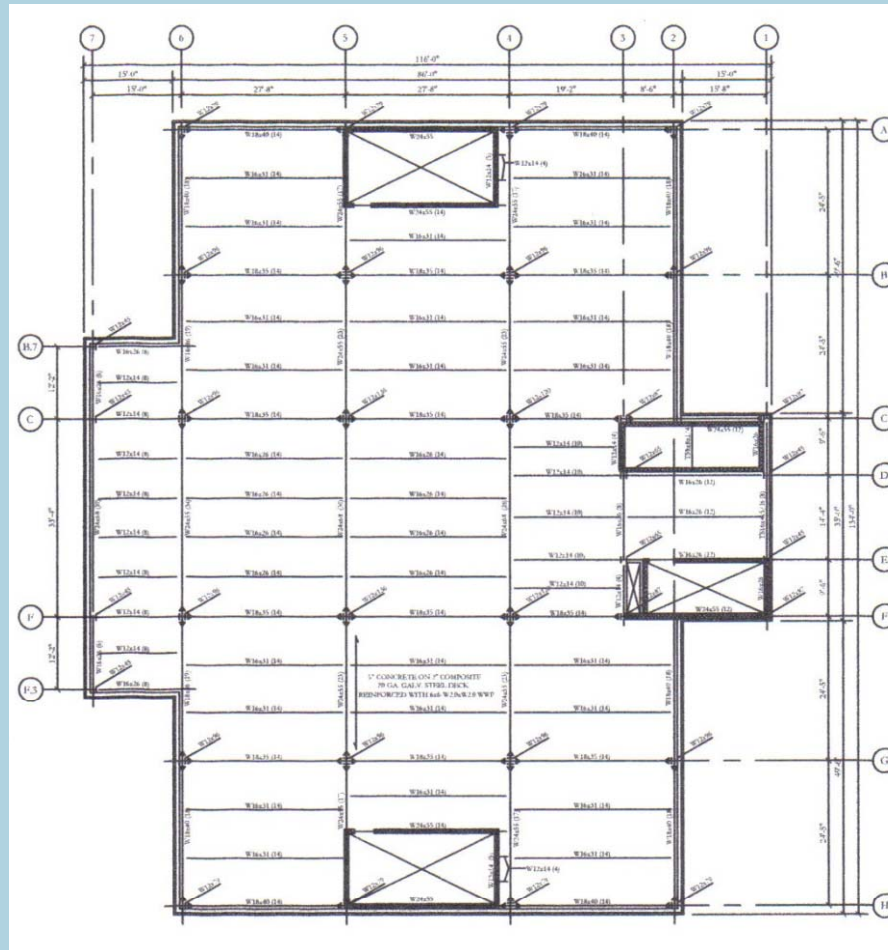


Photo by Jackson Architects: Taken July 23, 2003

EXISTING FRAMING SYSTEM

~5" concrete on 2" composite metal deck

~24'x27' typical bays of composite beams and girders



EXISTING LATERAL SYSTEM

- ~Steel Moment Frames
- ~Flange welded/web bolted connections

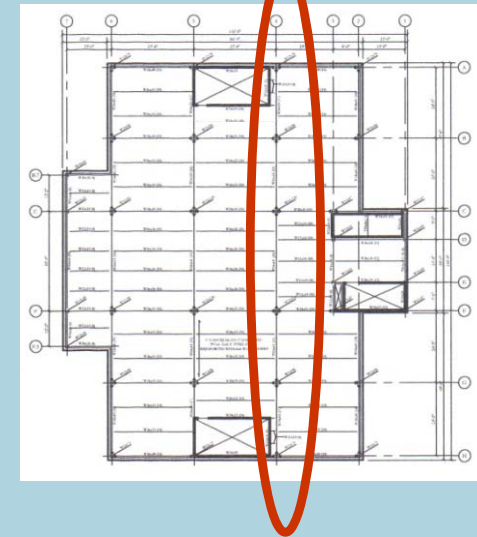
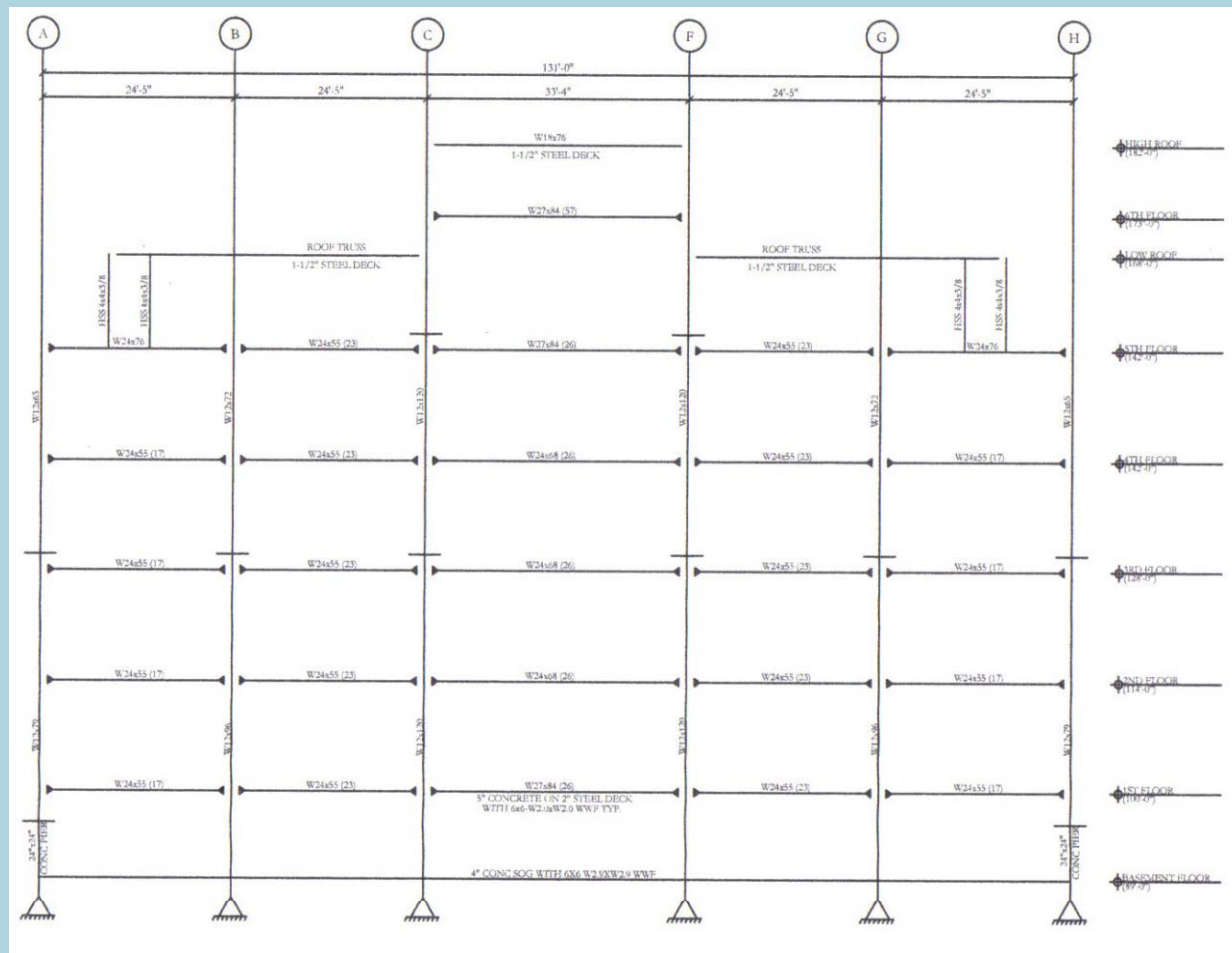


Personal Photo: Taken August 16, 2007

EXISTING LATERAL SYSTEM

North-South Direction

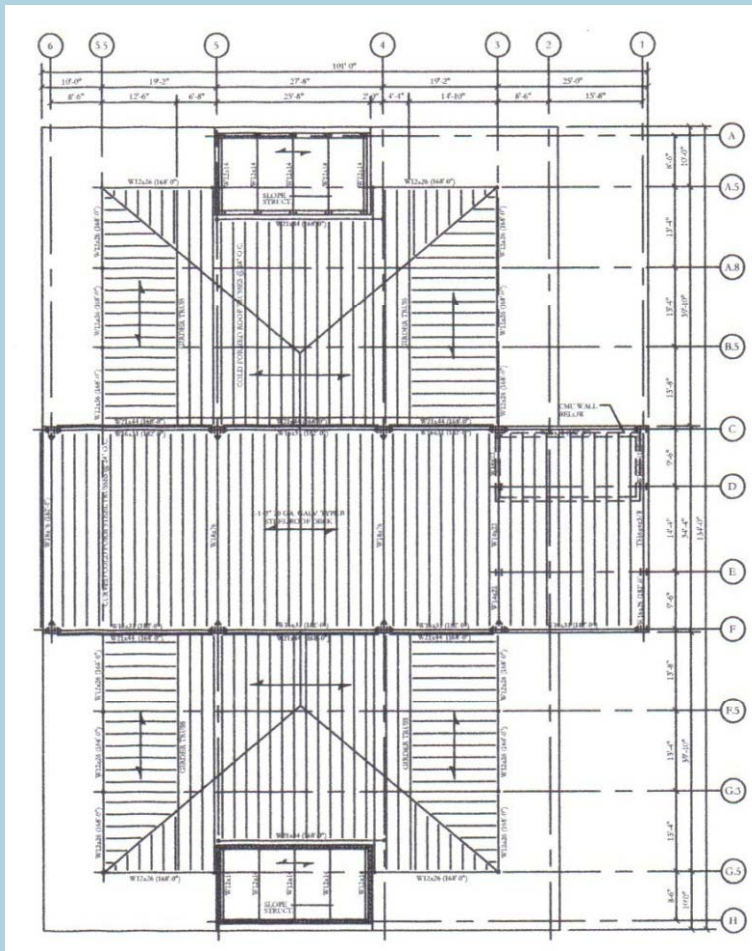
Line 4



EXISTING ROOF FRAMING PLAN

~Cold formed roof trusses spaced @ 24" o.c.

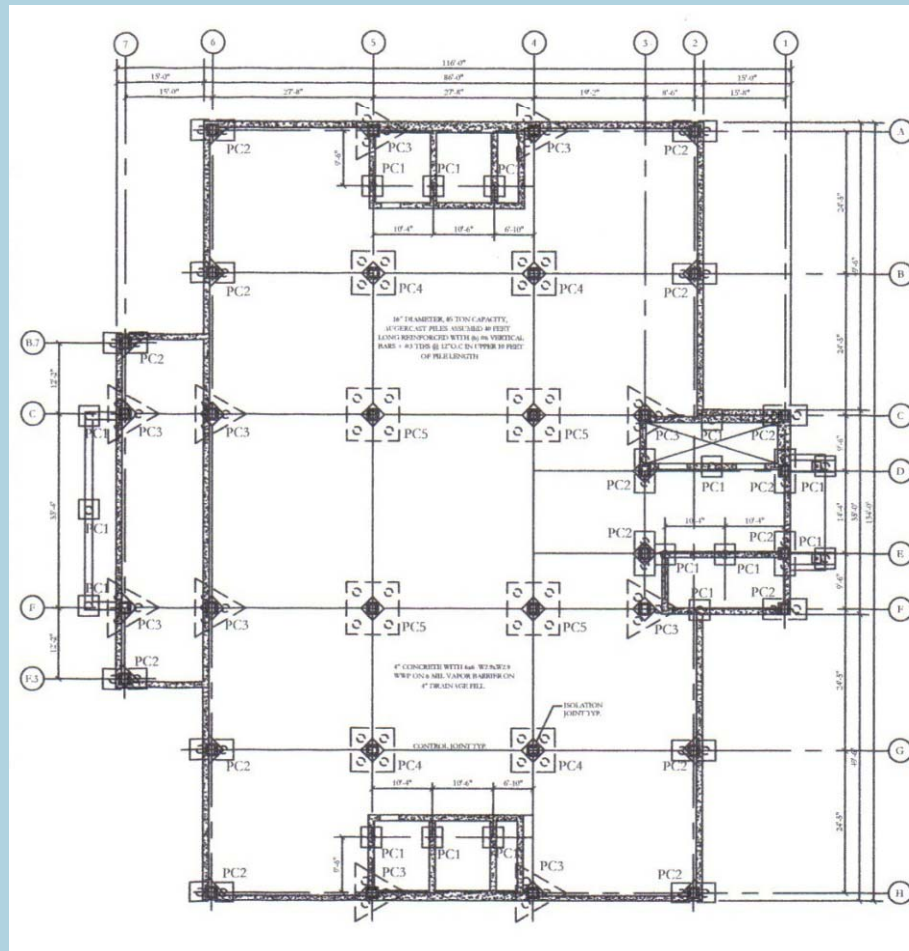
~1-1/2" metal roof deck



EXISTING FOUNDATION PLAN

~16" dia. augercast piles with pile caps; 85 ton compressive capacity

~24"x24" concrete piers





REASONS FOR PROPOSAL



- ~Two-way flat plate slab found to be comparative to existing in Technical Assignment #2
- ~Eliminate moment connections
- ~Eliminate fireproofing
- ~Increase mechanical cavity space
- ~Reduce cost
- ~Reduce Schedule
- ~Improve acoustics for ballroom
- ~Improve acoustics for floors adjacent to the ballroom

REASONS FOR PROPOSAL

~Two-way flat plate slab found to be comparative to existing in Technical Assignment #2

Change Structural System to Concrete

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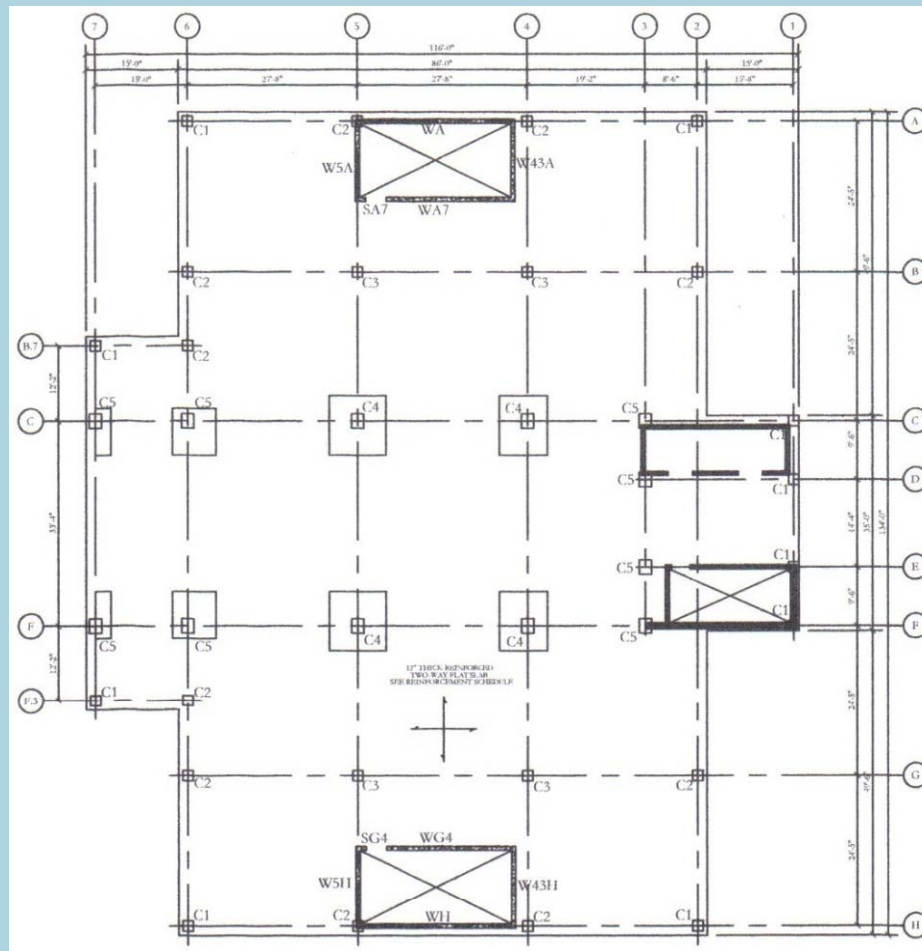
Compare Acoustic Performance of Existing vs. Proposed

- ~Improve acoustics for ballroom
- ~Improve acoustics for floors adjacent to the ballroom

PROPOSED FRAMING SYSTEM

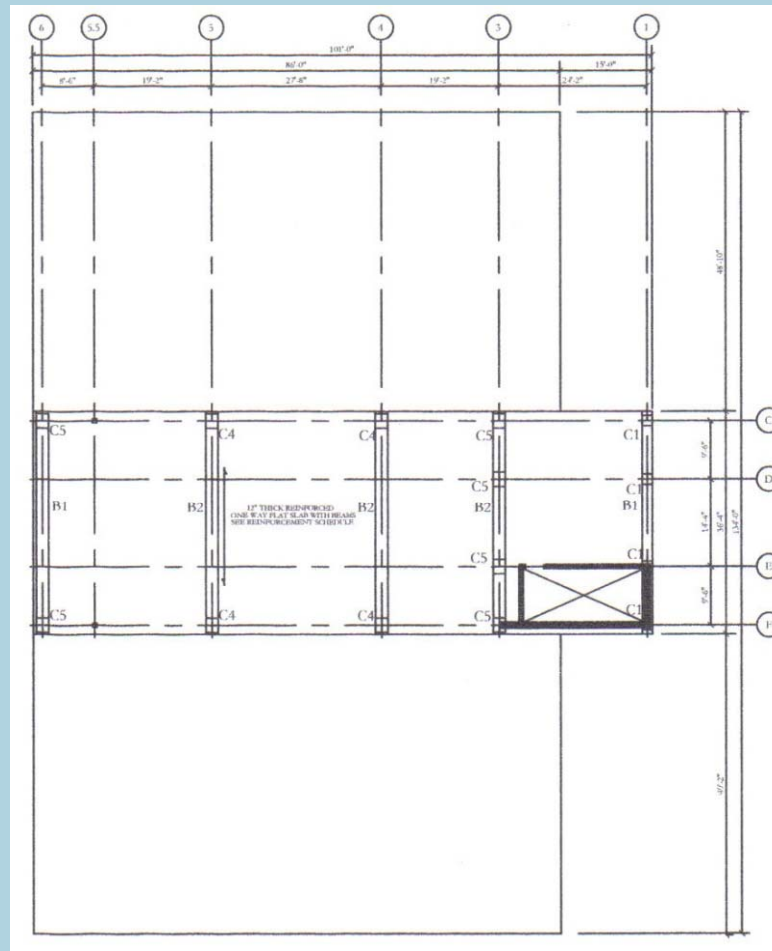
~1st-4th Floors: 12" two-way flat slab; #5 spaced @ 12" o.c. each way

~5th Floor: 14" two-way flat slab, #5 spaced @ 10" o.c. each way



PROPOSED FRAMING SYSTEM

~6th Floor: 12" one-way slab with beams, #5 spaced @ 9" o.c. each way



PROPOSED LATERAL SYSTEM

- ~Shear walls replace existing North and South masonry stair towers
- ~8" thick shear walls with #4 spaced @ 12" o.c. vertical & #4 spaced @ 10" o.c. horizontal

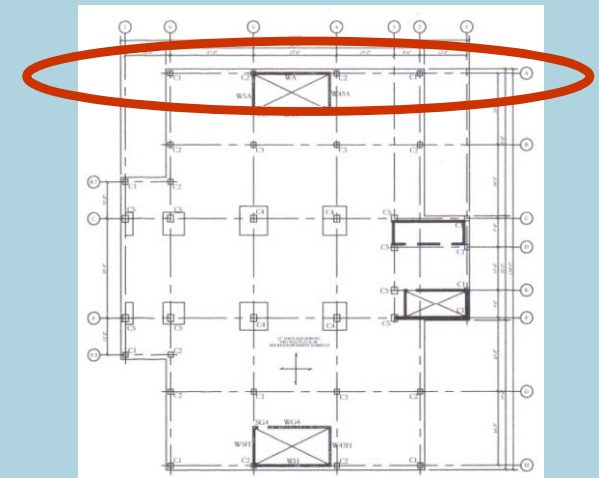
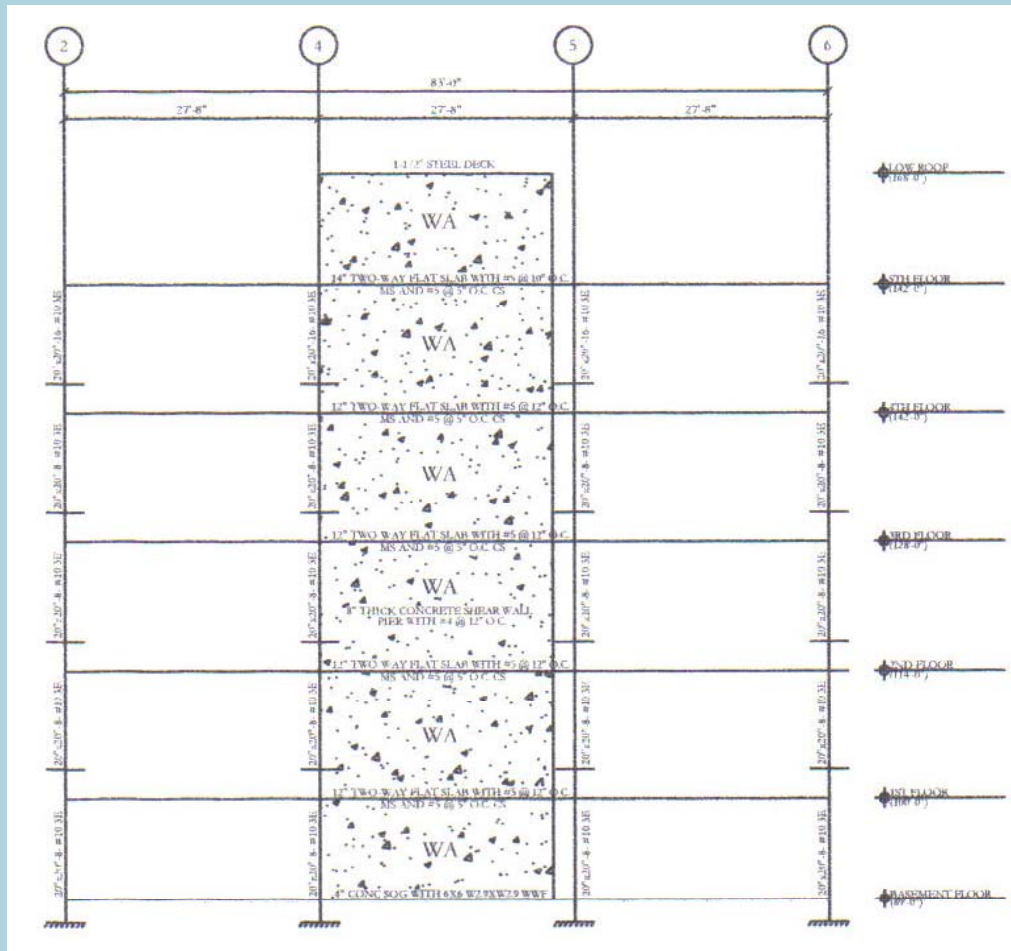


Personal Photo: Taken August 16, 2007

PROPOSED LATERAL SYSTEM

East-West Direction

Line A

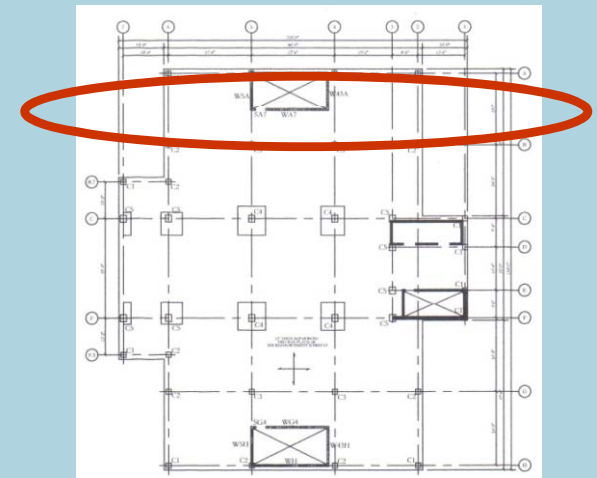
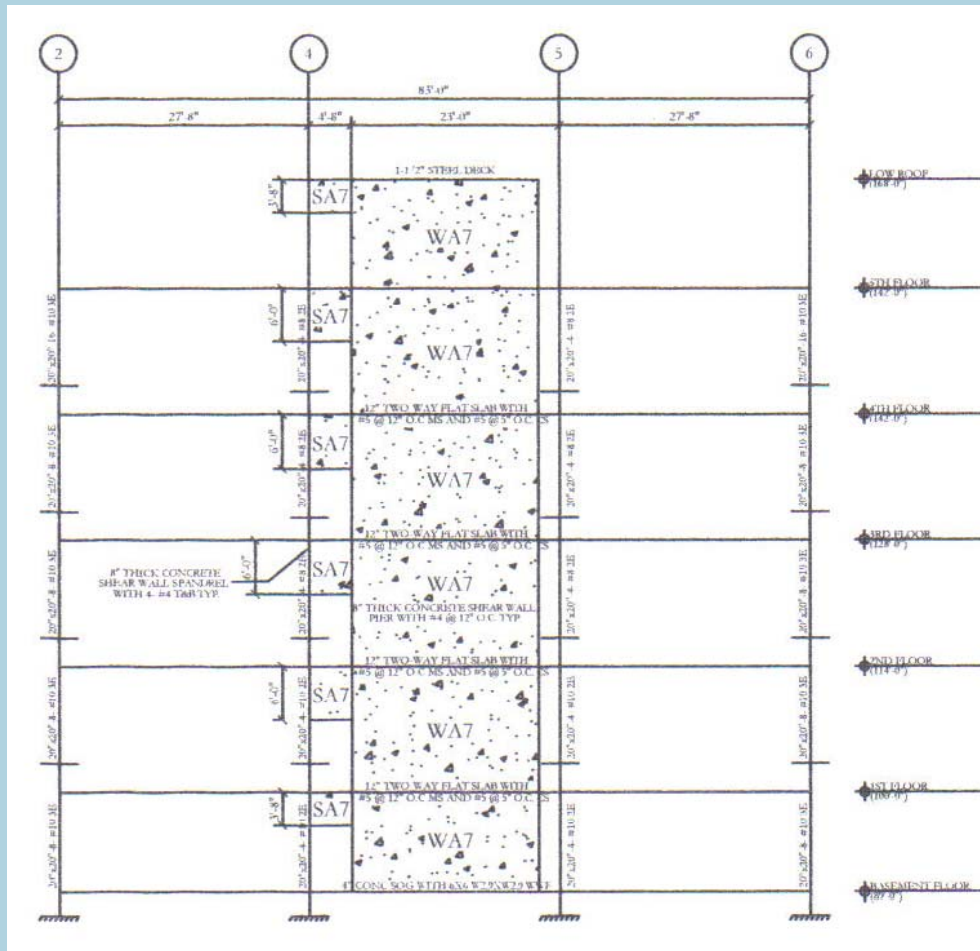


PROPOSED LATERAL SYSTEM



East-West Direction

Line A7

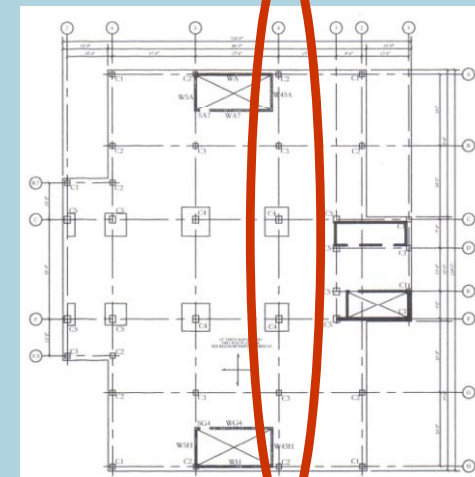


PROPOSED LATERAL SYSTEM



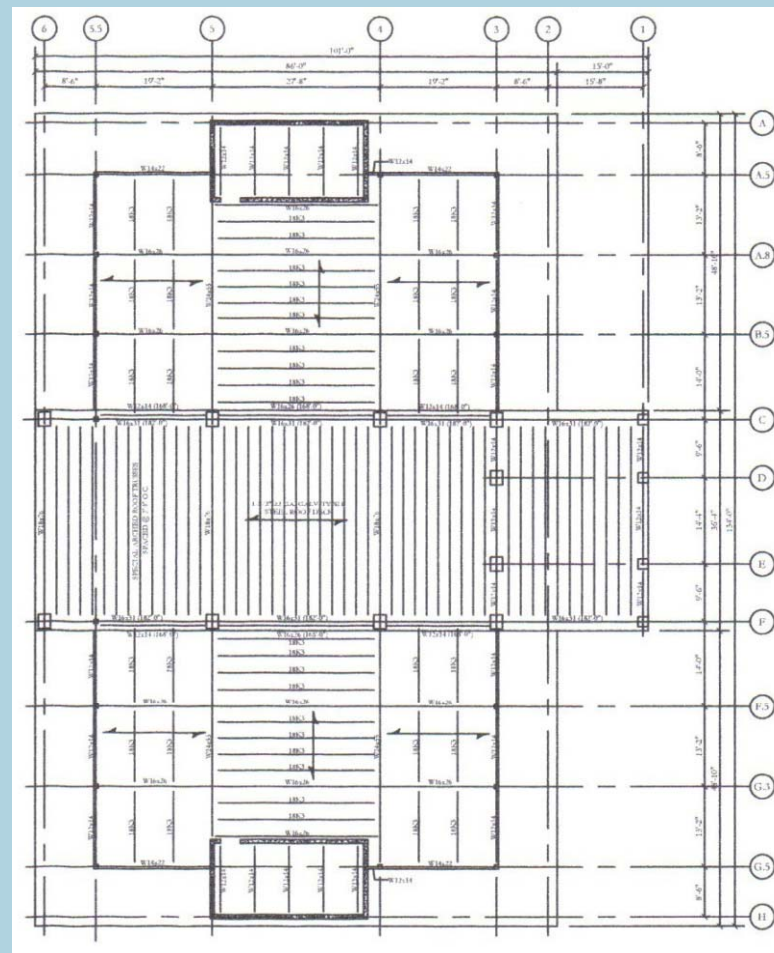
North-South Direction

Line 4



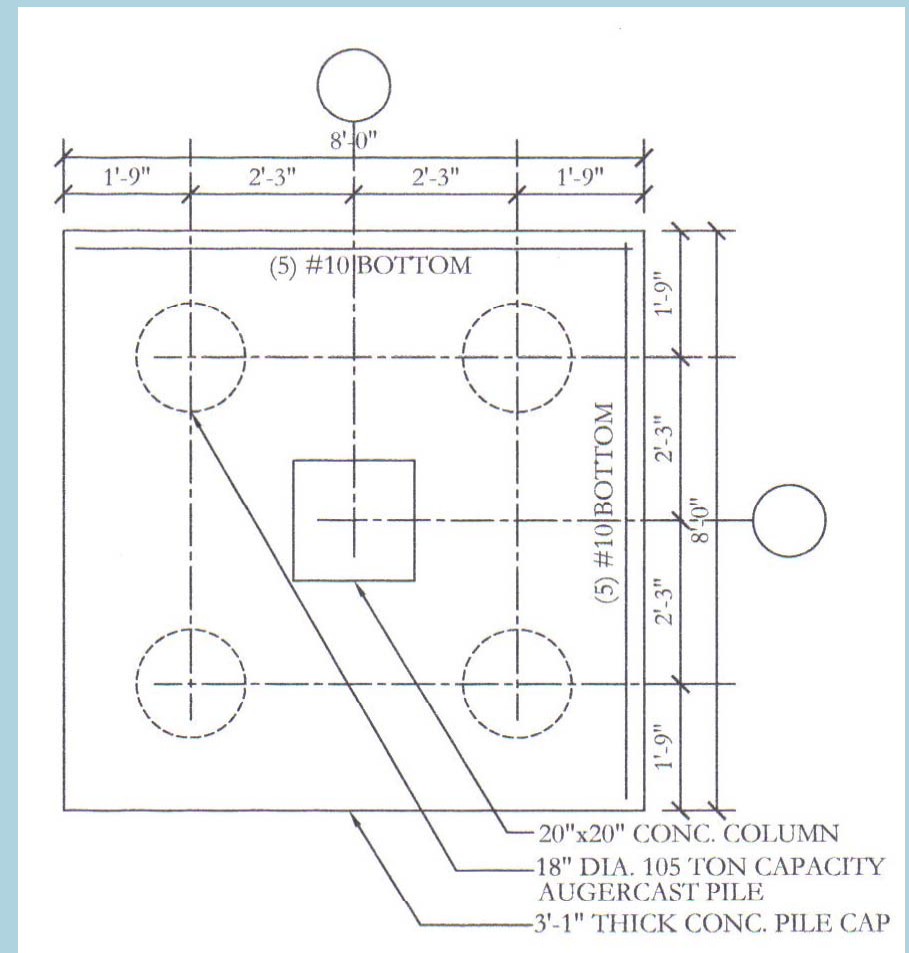
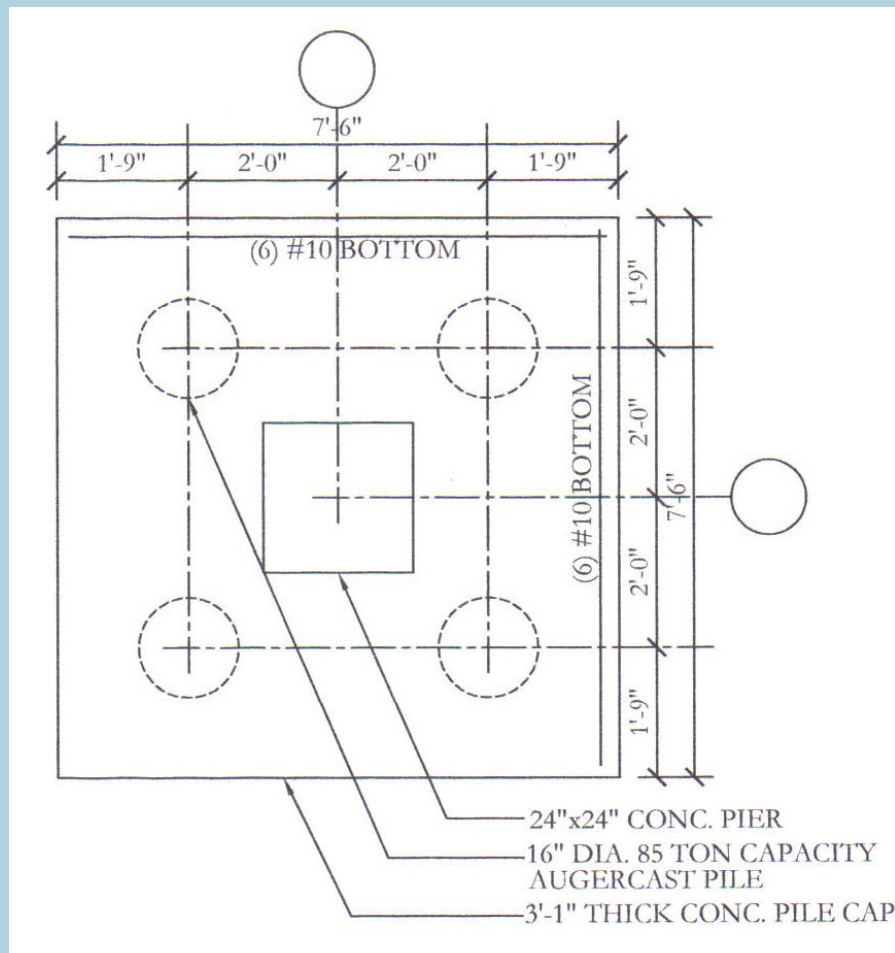
PROPOSED ROOF FRAMING SYSTEM

- ~Light steel framing with open web steel joists
- ~1-1/2" metal roof deck



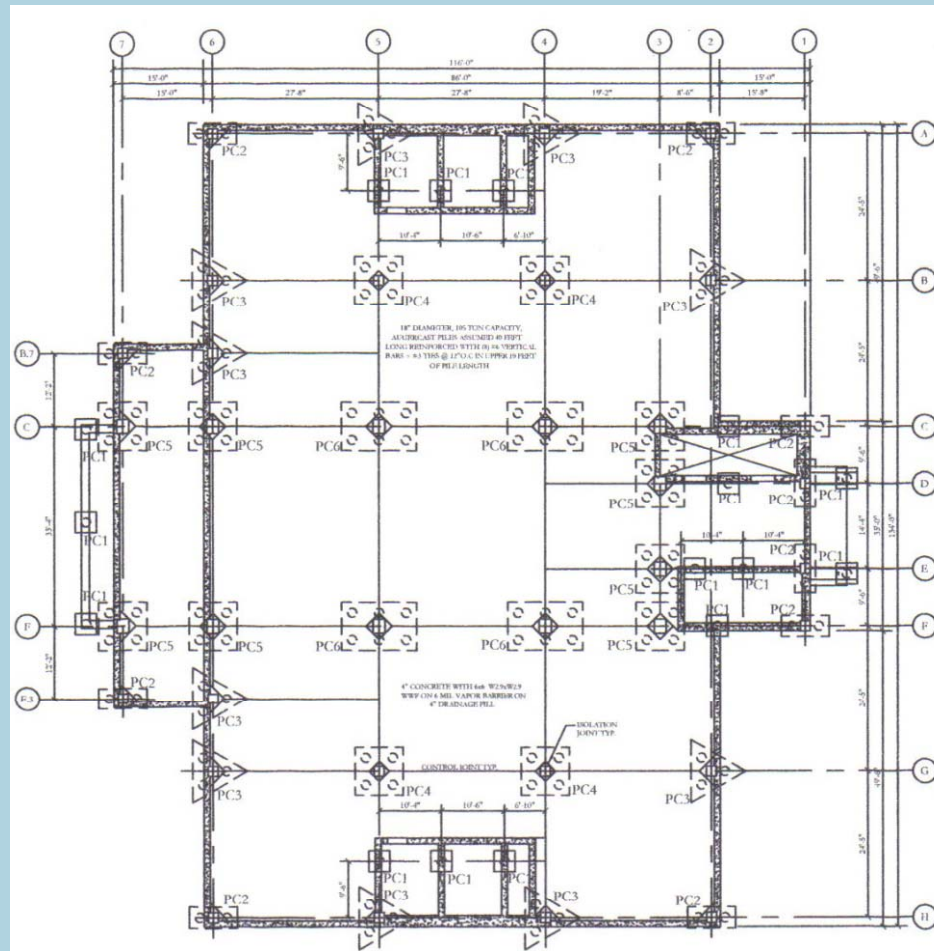
PROPOSED FOUNDATION SYSTEM

~Pile cap configurations controlled by geometry



PROPOSED FOUNDATION SYSTEM

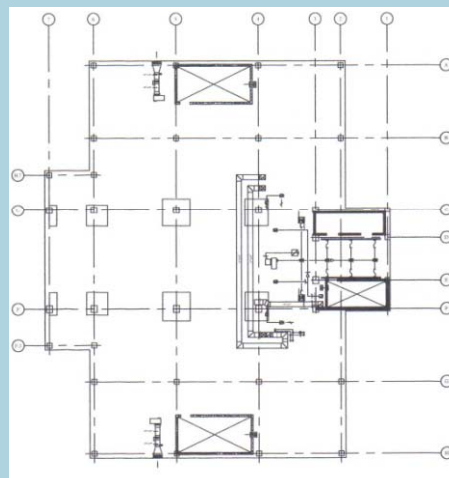
- ~18" dia. augercast piles with pile caps; 105 ton compressive capacity
- ~Columns connect directly to pile caps



DEPTH CONCLUSIONS

Mechanical Cavity Space Comparison

Floor	Existing Steel Structural System	Proposed Concrete Structural System	Increase
1st Floor	2'-3"	3'-0"	9"
2nd Floor	2'-3"	3'-0"	9"
3rd Floor	2'-3"	3'-0"	9"
4th Floor	2'-3"	3'-0"	9"
5th Floor	2'-3"	2'-10"	7"
6th Floor	2'-3"	2'-6"	3"



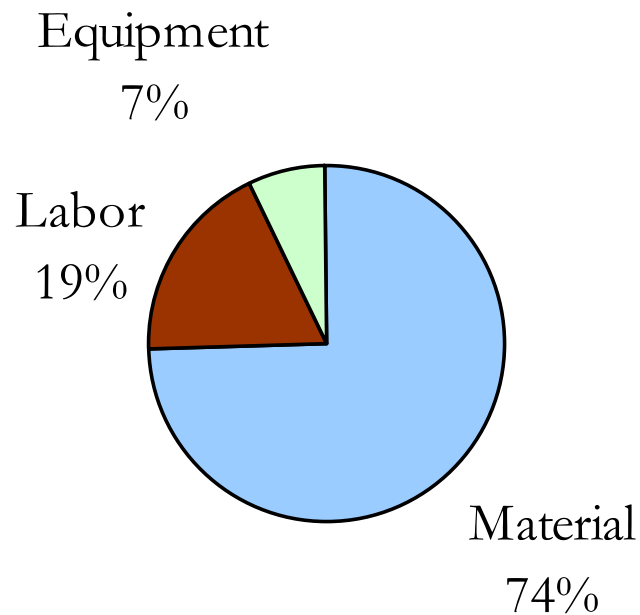
DEPTH CONCLUSIONS

- ~Foundations not as dramatically affected as expected
- ~Moment connections eliminated
- ~Reduced fireproofing, but did not eliminate
- ~Increased mechanical cavity space

COST COMPARISON

Existing System Cost

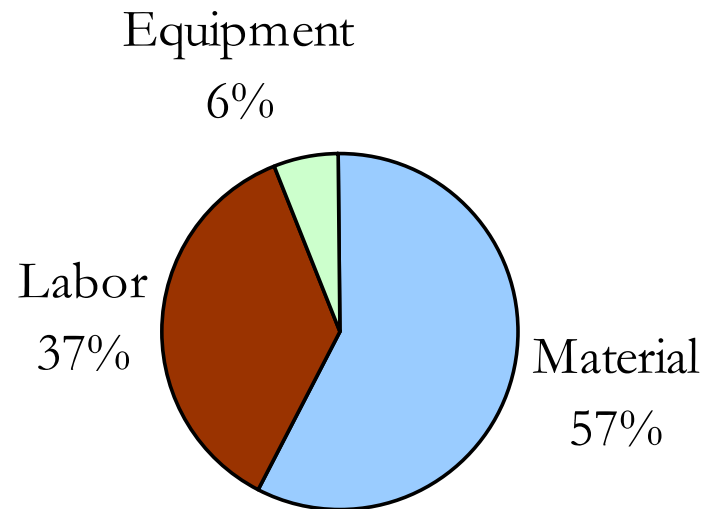
Material	Labor	Equipment	Total
\$1,530,000	\$384,000	\$140,000	\$2,059,000



COST COMPARISON

Proposed System Cost

Material	Labor	Equipment	Total
\$952,000	\$611,000	\$96,000	\$1,664,000





COST COMPARISON



Existing vs. Proposed Cost Comparison

System	Total
Existing	\$2,059,000
Proposed	\$1,664,000
Difference	-\$395,000

Reduction of Cost by 20%

SCHEDULE COMPARISON

Existing System Schedule

Start Date	Finish Date	Duration (months)
Monday, June 2, 2003	Friday, December 24, 2004	18



Personal Photo: Taken August 16, 2007

SCHEDULE COMPARISON

Proposed System Schedule

Start Date	Finish Date	Duration (months)
Monday, June 2, 2003	Wednesday, June 22, 2005	24



Personal Photo: Taken August 16, 2007



SCHEDULE COMPARISON



Existing vs. Proposed Schedule Comparison

System	Duration (months)
Existing	18
Proposed	24
Difference	+6

Increase of Schedule by 6 months



REVERBERATION TIME COMPARISON



Existing System Half Occupancy Reverberation Time

Frequency	Desired Reverberation Time (s)	Actual Reverberation Time (s)
125 Hz	1.43	0.55
500 Hz	1.10	0.58
4000 Hz	0.85	0.36

Existing System Full Occupancy Reverberation Time

Frequency	Desired Reverberation Time (s)	Actual Reverberation Time (s)
125 Hz	1.43	0.54
500 Hz	1.10	0.55
4000 Hz	0.85	0.35



REVERBERATION TIME COMPARISON



Proposed System Half Occupancy Reverberation Time

Frequency	Desired Reverberation Time (s)	Actual Reverberation Time (s)
125 Hz	1.43	1.55
500 Hz	1.10	2.11
4000 Hz	0.85	0.73

Proposed System Full Occupancy Reverberation Time

Frequency	Desired Reverberation Time (s)	Actual Reverberation Time (s)
125 Hz	1.43	1.46
500 Hz	1.10	1.77
4000 Hz	0.85	0.68



REVERBERATION TIME COMPARISON



Existing vs. Proposed System Reverberation Time Comparison
(based upon full occupancy)

Frequency	Desired Reverberation Time (s)	Existing Reverberation Time (s)	Proposed Reverberation Time (s)
125 Hz	1.43	0.54	1.46
500 Hz	1.10	0.55	1.77
4000 Hz	0.85	0.35	0.68

Increased Reverberation Time

SOUND TRANSMISSION COMPARISON

Existing System Sound Transmission Class

Floor System	Floors	STC Rating
5" Concrete on 2" Composite Steel Deck	All	
3" Reinforced Concrete Slab	All	39



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SOUND TRANSMISSION COMPARISON

Proposed System Sound Transmission Class

Floor System	Floors	STC Rating
12" Reinforced Concrete Slab	1st-4th, 6th	88
14" Reinforced Concrete Slab	5th	99



Personal Photo: Taken August 16, 2007



SOUND TRANSMISSION COMPARISON



Existing vs. Proposed System Sound Transmission Class

(based upon 5th floor)

System	STC Rating
Existing	39
Proposed	99
Difference	+60

Increase of Sound Transmission Class by 60

SUCCESS OF PROPOSAL

~Eliminate moment connections



SUCCESS OF PROPOSAL

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- ~Reduce cost

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- ~Reduce cost
- ~Reduce Schedule

SUCCESS OF PROPOSAL

- ~Eliminate moment connections ✓
- ~Eliminate fireproofing ✗
- ~Increase mechanical cavity space ✓
- ~Reduce cost ✓
- ~Reduce Schedule ✗
- ~Improve acoustics for ballroom ✓

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Proposed system not recommended due to increase in schedule.

THANK YOU & CREDITS

Owner & General Contractor:

Bob Duncan &

all The Duncan Center team

Structural Engineer:

Baker, Ingram & Associates

Architect:

Jackson Architects

Penn State Architectural Engineering Faculty

The Duncan Center

500 W. Loockerman St.
Dover, Delaware 19904

(302) 674-0400


BAKER, INGRAM & ASSOCIATES
STRUCTURAL ENGINEERS



PENNSYLVANIA STATE UNIVERSITY
DEPARTMENT OF
ARCHITECTURAL ENGINEERING



QUESTIONS?

