

Franklin Square Hospital Patient Tower



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B.A.E. / M.A.E.

Outline of Presentation

Background

Introduction

Criteria/Goals

Steel Design

Vibration Study

Connection Design

Design Summary

Architectural Study

Cost/Schedule

Conclusion

❖ **Background of Building**

❖ **Introduction to Thesis**

➤ **Criteria/Goals**

❖ **New Design**

➤ **Vibration Study**

➤ **Connection Details (M.A.E.)**

➤ **Design Summary**

❖ **Architectural Breadth**

❖ **Cost /Schedule Breadth**

❖ **Conclusions**

Location

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Baltimore, MD



Building Statistics

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- ❖ 356,000 Square Feet
- ❖ 7 Stories
- ❖ Construction November 2007- June 2010
- ❖ Cost-\$119 Million

Functions

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Emergency Department



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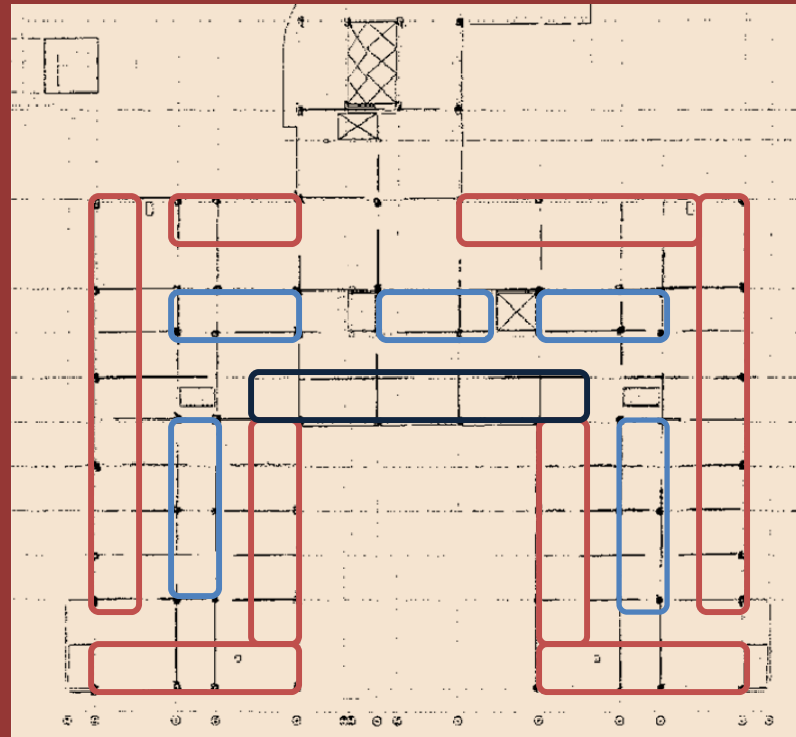
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Reinforced Concrete
Offices



Existing Conditions

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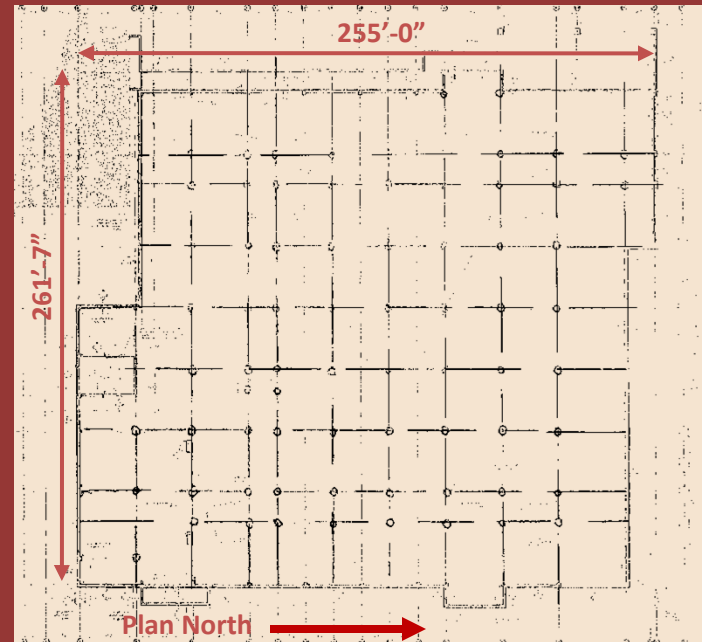
Architectural Study

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Foundation System

- ❖ **Drilled piers/caissons**
- ❖ **4' diameter**
- ❖ **-2'-0" - 42'-0" (3,000psi)**
- ❖ **Grade beams: (24"x24")**
- ❖ **5" SOG (3,000 psi)**
- ❖ **Existing retaining wall plan North**
- ❖ **12" foundation wall around perimeter**



Existing Conditions

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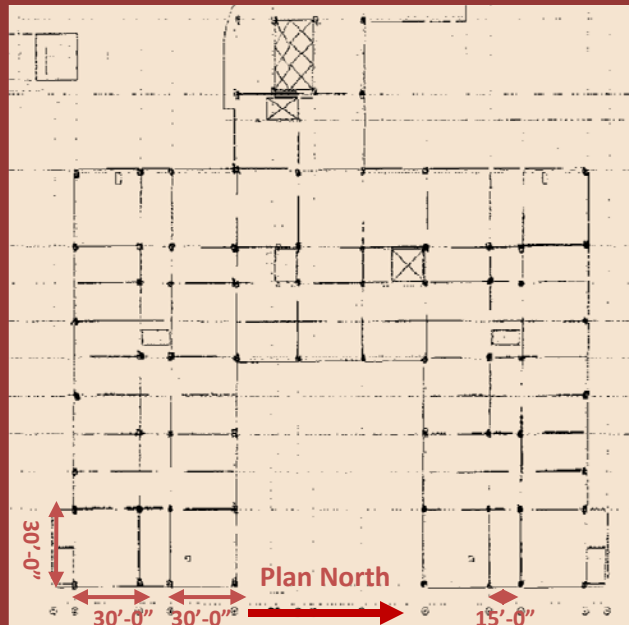
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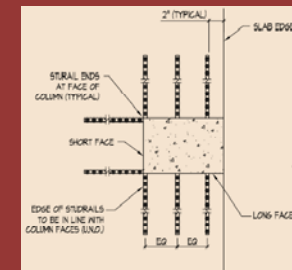
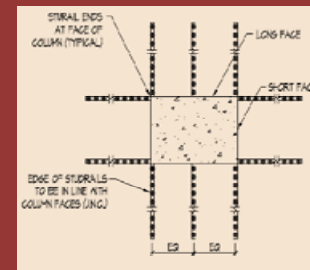
Cost/Schedule

Conclusion

Floor System



- ❖ Two-way flat plate slab
- ❖ 5,000 psi
- ❖ Typical bay 30' x 30'
- ❖ 30' x 15' bays around egress
- ❖ Perimeter beams (5,000 psi)
- ❖ Typical 21" x 21" columns
- ❖ 7,000 psi (ground-third)
- ❖ 5,000 psi (fourth-penthouse)
- ❖ Stud rails



Existing Conditions

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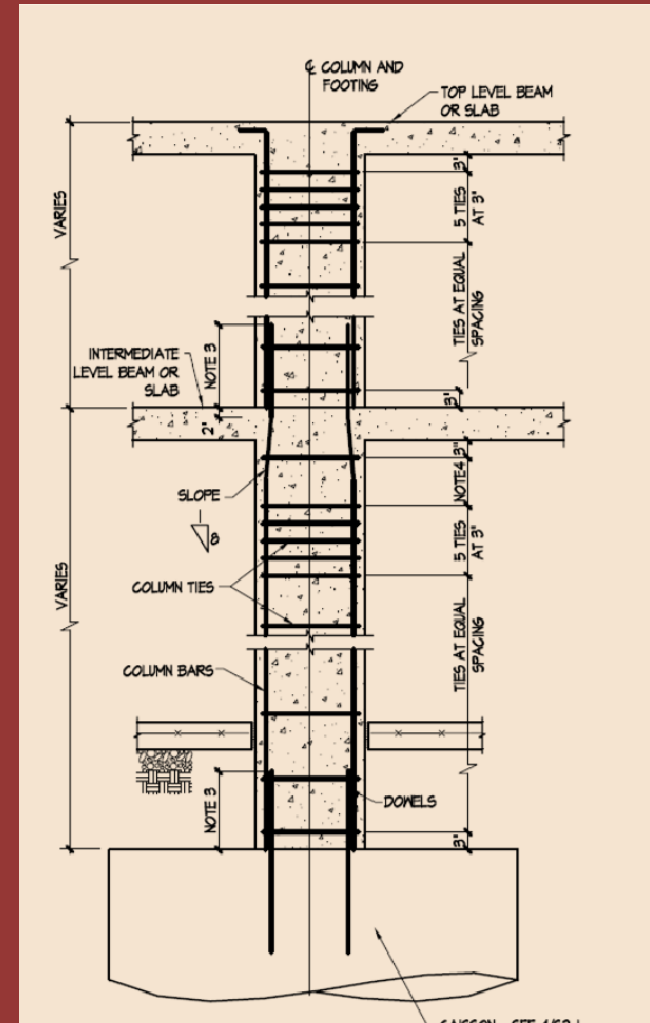
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Lateral System

❖ Concrete moment frames



1 COLUMN BAR BENDING DETAIL NTS

Existing Conditions

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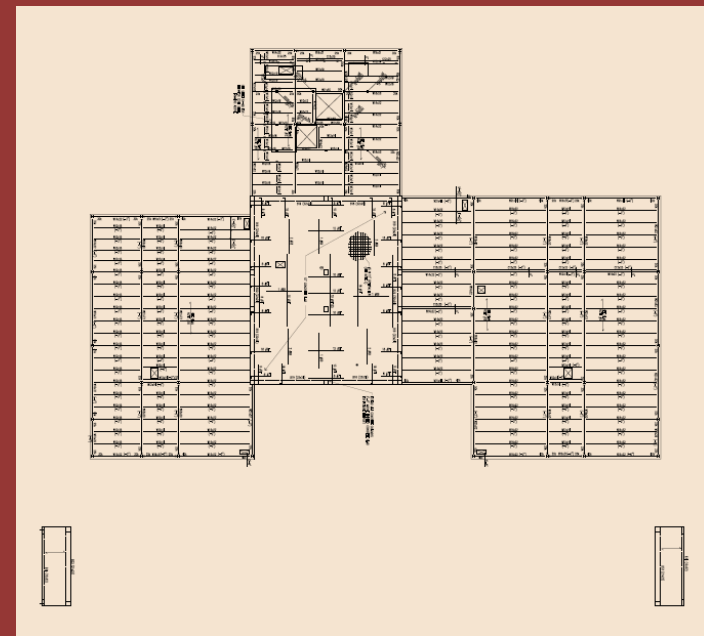
Architectural Study

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Roof System

- ❖ **W12 and W14 beams spanning 15'-0", 20'-0" and 30'-0"**
- ❖ **Beams spaced at 5'-0"**
- ❖ **W16, W18, and W21 girders spanning 30'**
- ❖ **Roof Deck 1.5" deep, wide rib, 20 gage galvanized metal deck**



Reasons for Redesign

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Multiple Steel to Concrete Connections



Reasons for Redesign

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Lateral Loads Including Reducing Weight

Wind Chapter 6 ASCE 7-05

Direction	N-S	E-W
V (kips) =	339	418
1.6 *V (kips) =	542	669

Seismic Chapters 11 and 12 ASCE 7-05

Total Weight of Building (kips) =	46,529
V (kips) =	865

Reasons for Redesign

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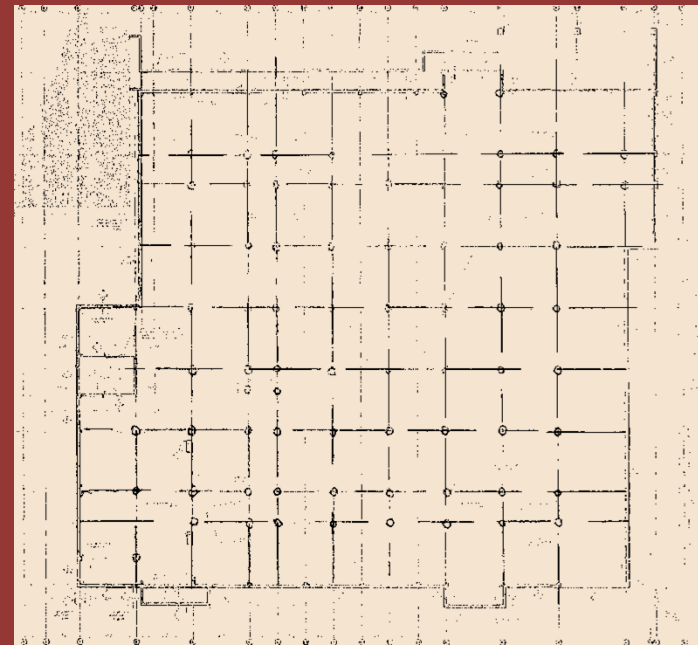
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Foundation System

- ❖ 123 Caissons
- ❖ 123 Tons of Steel
- ❖ 2,404 CY of Concrete



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- ❖ Reduce the seismic loads so the difference between seismic and wind loads aren't so large

- ❖ Decrease impact on foundation

- ❖ Provide an efficient system to resist loading utilizing typical member sizes

- ❖ Eliminates concrete to steel connections in existing design

- ❖ Preserve the flexibility in floor plan according to the architect's requests

- ❖ Façade compliments existing building

- ❖ Maintain or reduce costs of structural system

- ❖ Maintain or reduce time in structural schedule

Seismic Design Research

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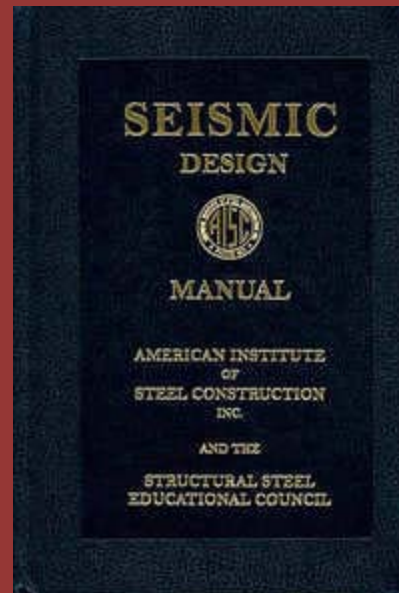
Design Summary

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- ❖ Can use R value up to 8
- ❖ The higher the R value the more detailed
- ❖ Design Philosophy:
Concentrate damage at points that will not affect gravity load carrying capacity
- ❖ Members and connections to remain elastic



Moment Frame Orientation

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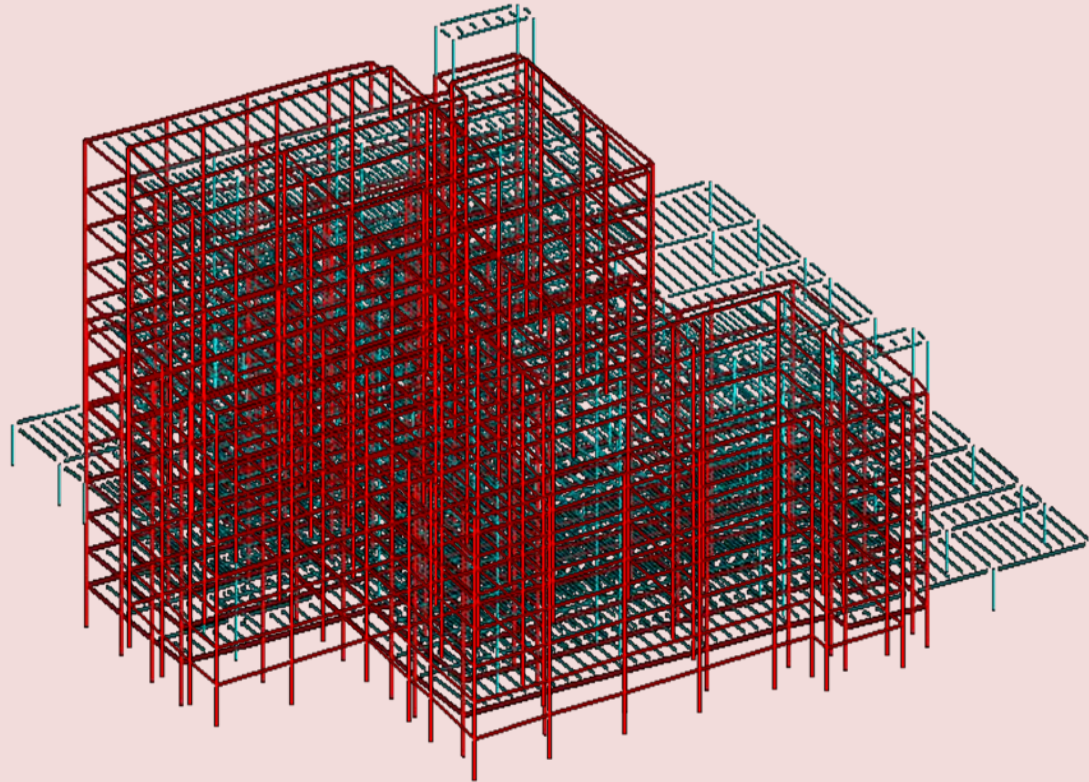
Connection Design

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RAM Assumptions

- Columns are pinned at foundation
- Gravity members are simply supported
- Lateral members are fixed-fixed
- Connection to existing building not included

Moment Frame Orientation

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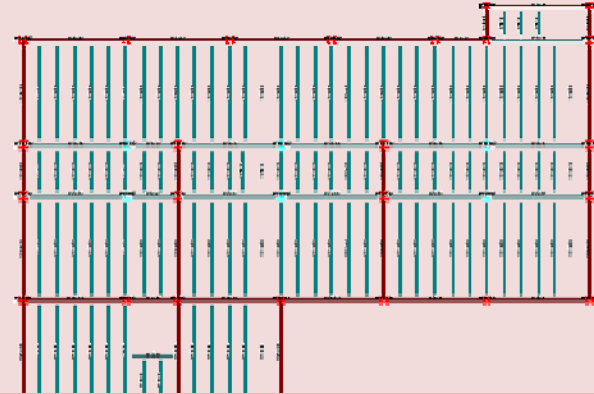
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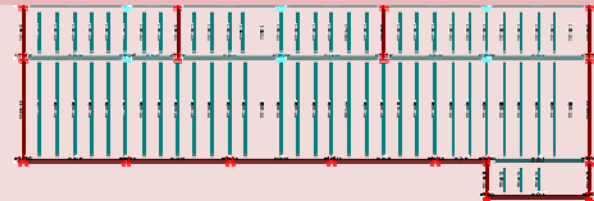
Conclusion

Red – Lateral

Blue – Gravity



Eliminated Steel to Concrete Connections!



Vibration Study

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ICU – Second Floor

AISC Design Guide 11
Chapter 4 Design for Walking Excitation

W14x22 ($a/g = 0.85$) to

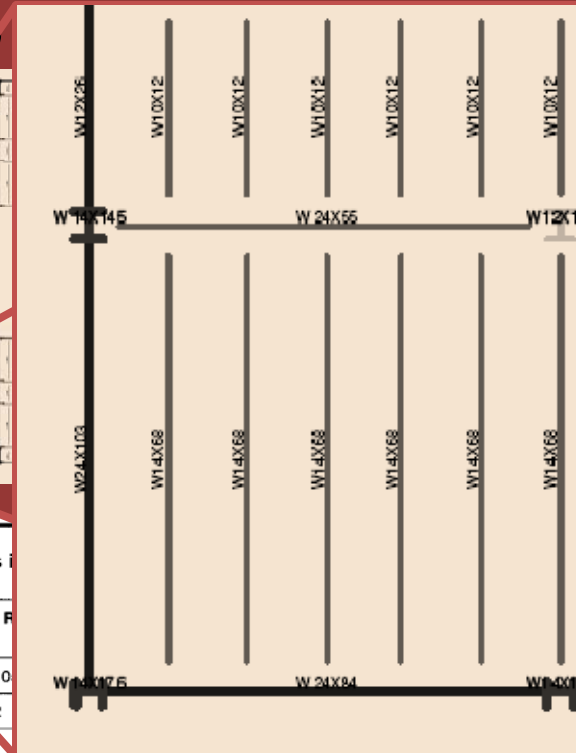
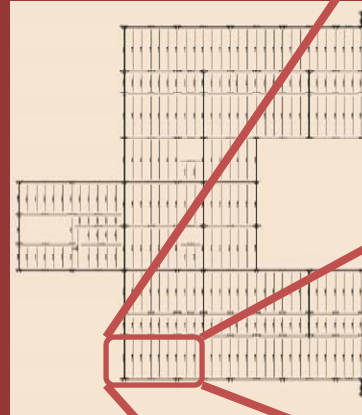


Table 4.1
Recommended Values of Parameters in
Equation (4.1) and a_o/g Limits

	Constant Force P_o	Damping Ratio β	
Offices, Residences, Churches	0.29 kN (65 lb)	0.02–0.03	
Shopping Malls	0.29 kN (65 lb)	0.02	
Footbridges—Indoor	0.41 kN (92 lb)	0.01	
Footbridges—Outdoor	0.41 kN (92 lb)	0.01	5.0%

* 0.02 for floors with few non-structural components (ceilings, ducts, partitions, etc.) as can occur in open work areas and churches,
0.03 for floors with non-structural components and furnishings, but with only small demountable partitions, typical of many modular office areas,
0.05 for full height partitions between floors.

Vibration Study

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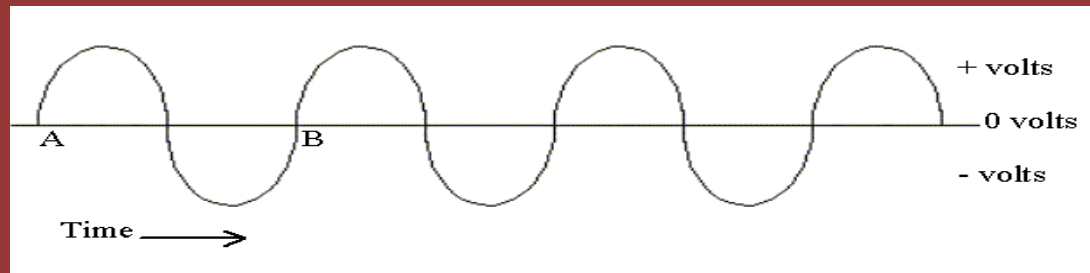
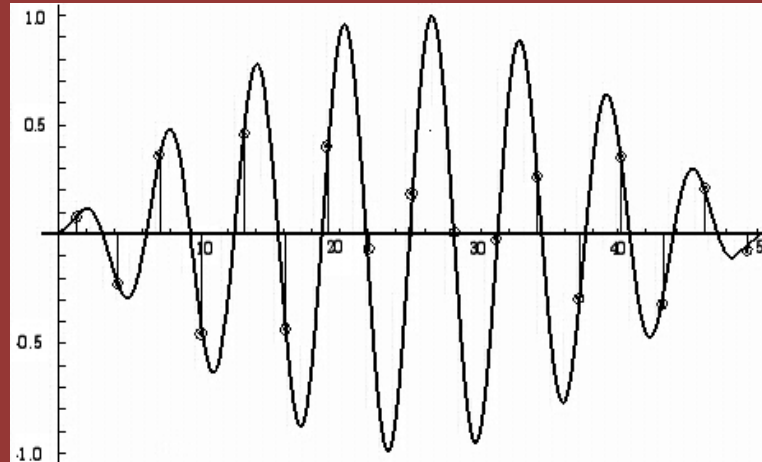
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Chapter 6 Design for Sensitive Equipment



$$F_n = 4.46 \text{ Hz}$$

Vibration Study

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Chapter 6 Design for Sensitive Equipment

Table 6.1
Vibration Criteria for Sensitive Equipment

Facility Equipment or Use	Vibrational Velocity*	
	(μ in./sec)	(μ m/sec)
Computer systems; Operating Rooms**; Surgery; Bench microscopes at up to 100x magnification;	8,000	200

	$\omega = 2 \cdot \pi \cdot fn$	$\omega = (ap/g) \cdot 386.4 / (2 \cdot \pi \cdot fn)$
fast	132305	37063
moderate	29107	8154
slow	7938	2224

Connection Design (M.A.E)

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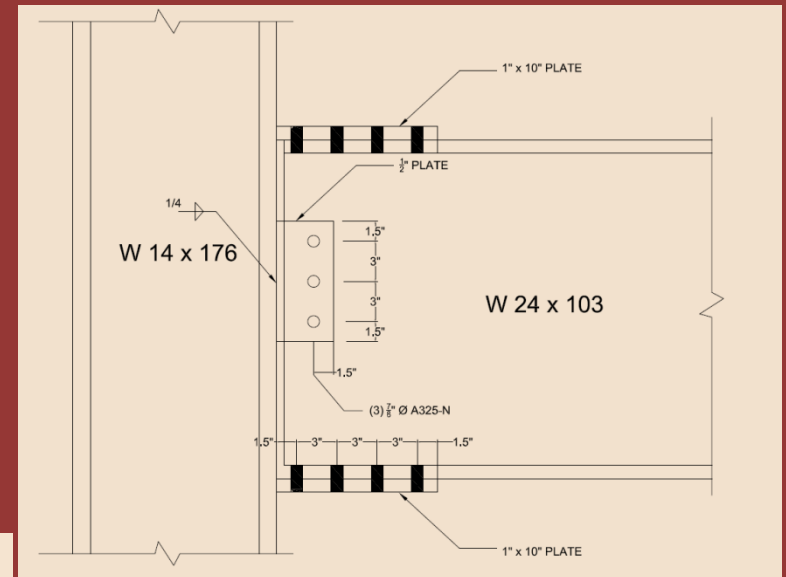
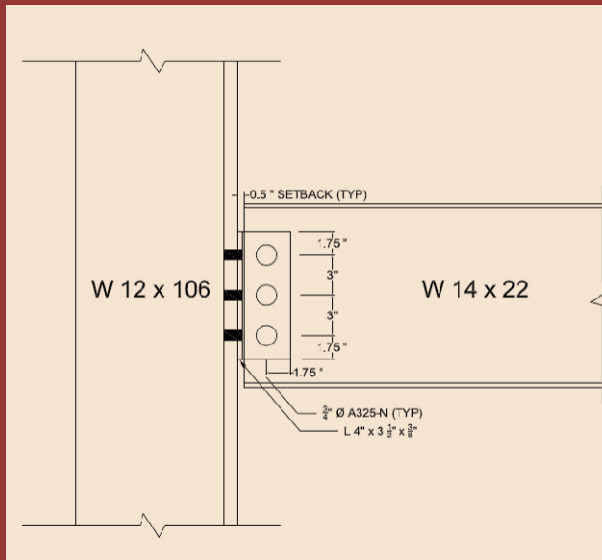
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Typical Moment Connection



Shear Girder/Column Flange Connection

Connection Design (M.A.E)

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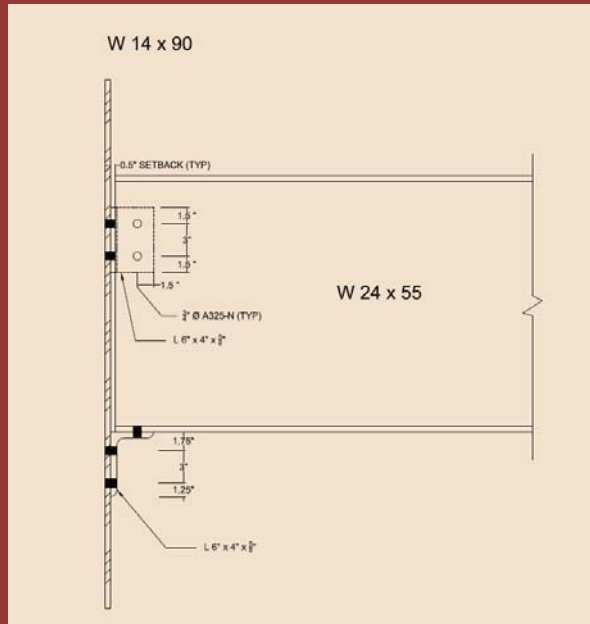
Connection Design

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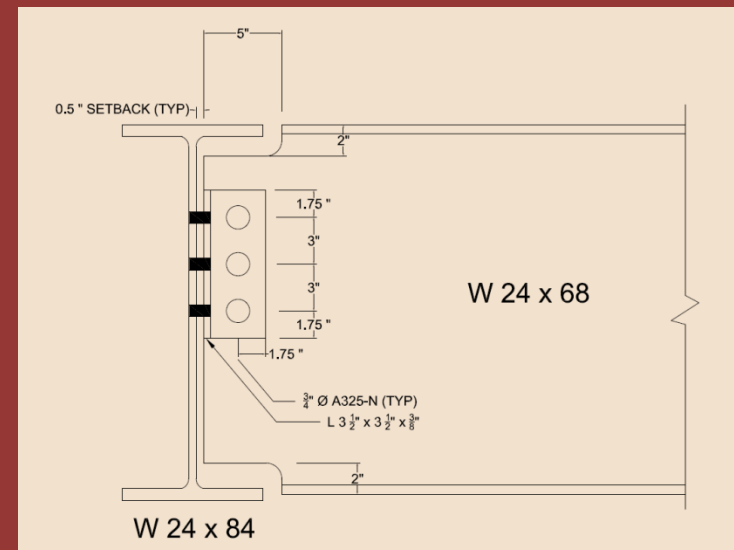
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Shear Girder/Column Web Connection

Shear Beam/Girder Connection



Lateral Loads

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Wind

Direction	N-S	E-W
V (kips)	391	481
1.6*V (kips)	626	770

Reduced Seismic Loads!

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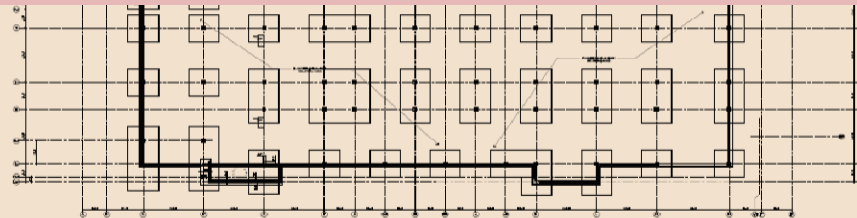
❖ Typical 15'x15'x36" Spread Footings

❖ (30) #6 Each Way

❖ Base Plates 20.5" x 14.5"



Reduced Impact on Foundations!



Architectural Study

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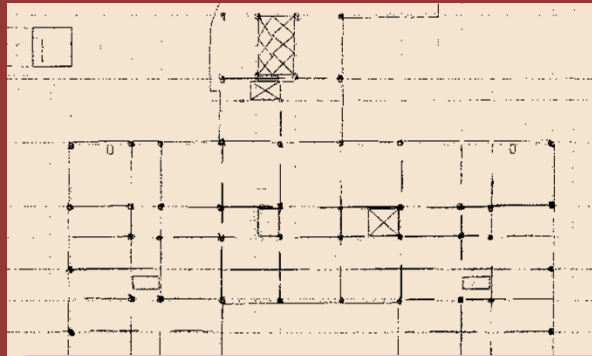
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Floor Plan



Preserved Flexibility in Floor Plan!

Façade Study

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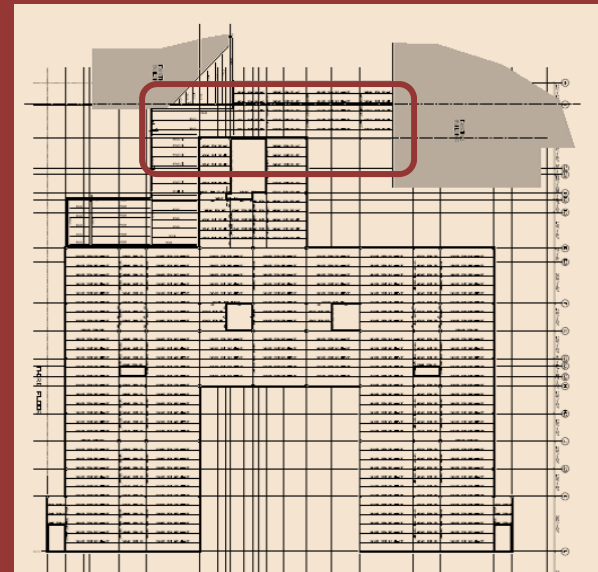
Connection Design

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Façade Study

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Façade Still Compliments Existing Building!



Cost Analysis

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Concrete

Beams	\$658,417
Column	\$7
Slabs	\$6

Steel

Beams	\$3,724,769
	\$1,282,158
	\$95,200

Increase in Cost : (

Concrete

Steel

Concrete
\$11.95/sq foot

Steel
\$19.93/sq foot

Schedule Analysis

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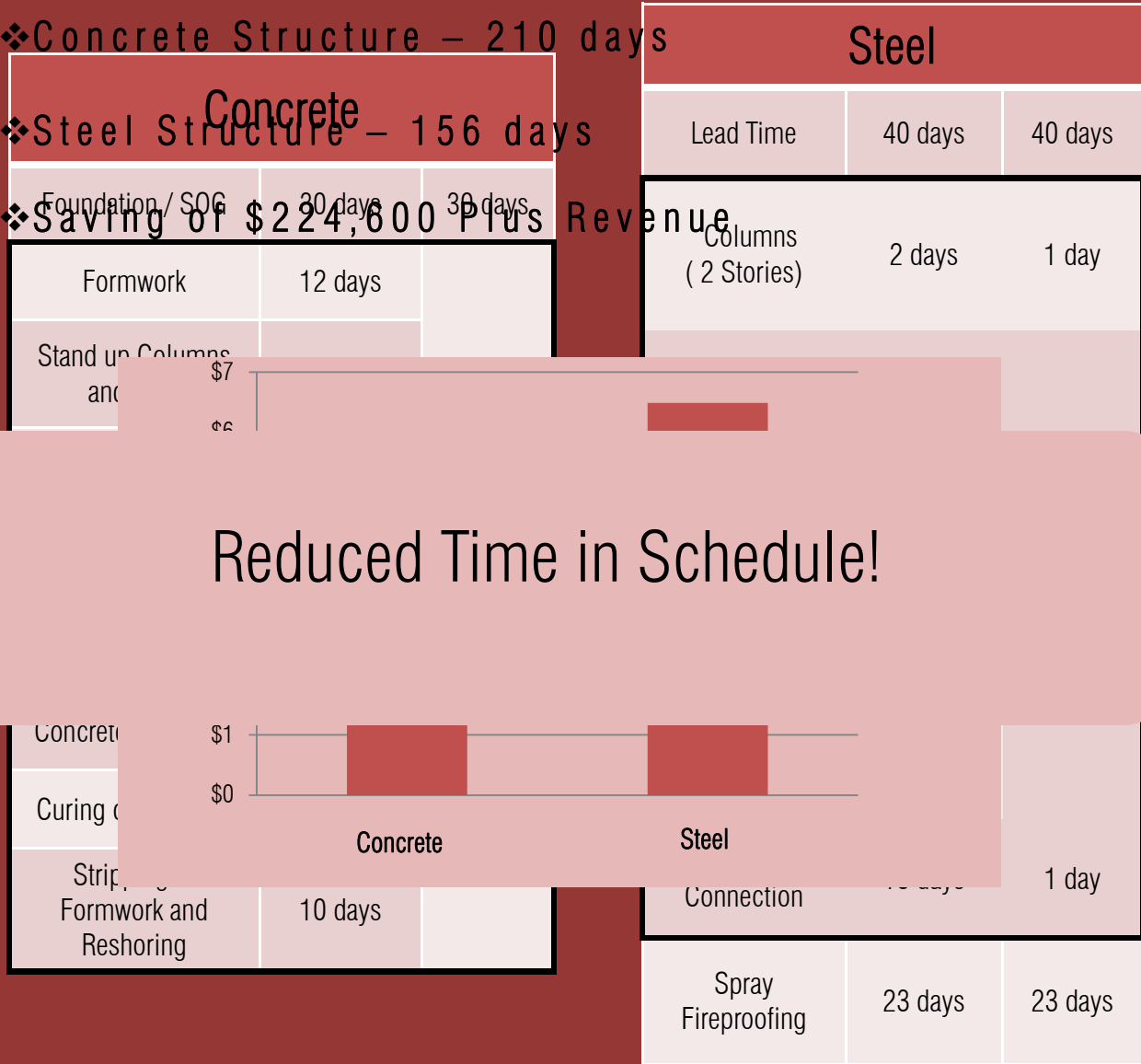
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❖ Concrete Structure – 210 days

❖ Steel Structure – 156 days

❖ Saving of \$224,600 Plus Revenue



Criteria/Goals

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Conclusion

- ✓ Reduce the seismic loads so the difference between seismic and wind loads aren't so large
- ✓ Decrease impact on foundation resulting in eliminated the current caisson system
- ✓ Provide an efficient system to resist loading utilizing typical member

Steel is Viable Option!

- ✓ Eliminates complicated concrete to steel connections in existing design
- ? Maintain or reduce costs of structural system
- ✓ Maintain or reduce time in structural schedule

Acknowledgements

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Franklin Square Hospital Patient Tower

Questions and Comments

