The Harry and Jeanette Weinberg Center

Mercy Hospital Medical Office Building
Baltimore, MD

Thesis Proposal

(Revised and Resubmitted)

Kevin Clouser
Structural Option

January 29, 2007
Faculty Consultant: Dr. Boothby

Executive Summary

Building at-a-glance

The Harry and Jeanette Weinberg Center is a medical office building located in Baltimore, Maryland. Rising 6 stories above St. James Place, The Weinberg Center has 127,000 square feet of office space. Steel framing combined with a composite action slab on metal deck comprises the gravity system for The Weinberg Center while chevron shaped braced frames resist any lateral loads.

Proposal

Suppose that local zoning codes limit the overall height of The Weinberg Center. If this were the case, would a steel structure still be the most economical choice for the design of The Weinberg Center. The proposed thesis will investigate whether a building height limit would have made a concrete structure a better choice than a steel one. The building height will be limited by changing the floor-to-floor heights of stories 2 through the roof to 12'-0". Existing elevations of floors 1 and 2 will remain since they match existing elevations that must be kept to properly connect the parking garage and the elevated walkway to The Weinberg Center.

Solution Methods to Complete Proposal

The solution to the proposed thesis will include investigations into the design of an economically competitive concrete system under the building height restrictions. This redesign will allow for the open floor plan and window filled facade that is present on the existing structure. I will compare such things as project cost (material and labor), constructability and project timetable changes. The new system will be compared to the existing steel framing structure.

Breadth Investigations

Access to Mechanical, Electrical, Lighting, and Plumbing documents for The Weinberg Center can not be obtained breadth topics will focus on the design of a 20 person conference room. Areas to be investigated and designed include lighting for the conference room in conjunction with acoustical performance. The conference room will be designed with a ceiling height to match that of the existing structure and the new, redesigned structure. Comparisons will then be drawn between the two designs.

Introduction

The Harry and Jeanette Weinberg Center is a 6 story medical office building located in downtown Baltimore, MD. The Weinberg Center is Mercy Medical Center's signature building. It houses many of Mercy's Centers of Excellence in its 127,000 square feet. Such centers include The Weinberg Center for Women's Health & Medicine at Mercy and The Institute for Cancer Care at Mercy. The building features many state-of-the-art facilities and some of the nation's top physicians.

Mercy enlisted the services of RTKL as the design architects and structural engineers for The Weinberg Center. RMF Engineering was contracted out as the MEP designers. Harkins Builders was hired as the general contractor to build the Weinberg Center. The building was opened in mid 2003 and is located across the street from Mercy's main medical center.

Background

Foundation

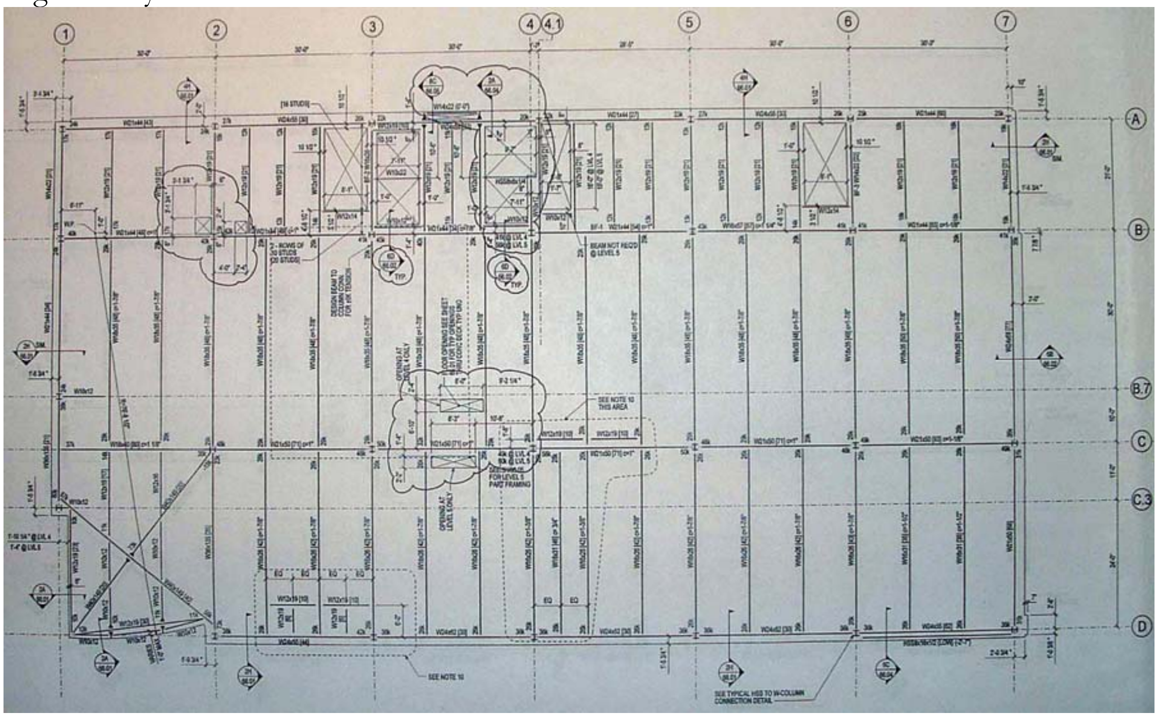
The foundation is composed of straight shaft drilled caissons, spread footing, slab-on-grade and a concrete retaining wall along the west elevation. Caissons bear on rock at depths exceeding 36'-0" in order to reach bearing capacities of 90ksf. Spread footings are all 12" thick. Assumed bearing pressures for spread footings and slab-on-grade is 2.0ksf. The Slab-on-grade is divided into quadrants between column areas and is typically 6" thick with a maximum thickness of 10" in the North-West corner. A concrete Retaining wall is located below the St. Pauls Place entrance and is 15" thick, 22'-0" high and carries minimal loads from the floor above.

Columns

The columns of The Weinberg Center are all W14 shapes. They range in size from a W14x24 at the penthouse level down to a W14x283 in the basement. Columns are typically spliced at the floor 1, floor 3 and floor 5. The longest columns are 29'-1" tall and are located on the top floors. All columns are ASTM A572 GR50.

Floor System

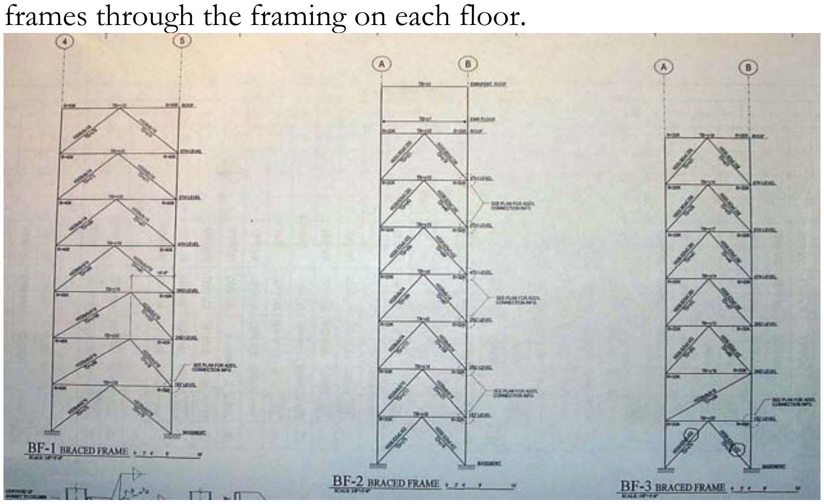
The floor system is a made up of simply supported girders (typical sizes are W21x50 or W21x44) that span 30'-0" column to column in the N-S direction and simply supported infill beams (typical sizes are W16x26 and W18x35) span 40'-0" at 10'-0" on center in the E-W direction. Infill beams that span more that 30'-0" are cambered upward in the middle by 1-7/8". Girders that span 30'-0" are cambered up in the middle by 1" to 1-1/8". A 1-way slab-on-deck utilizing composite action is used to carry floor loads to the beams. The slab is 3.25" lightweight concrete (strength f'c=3000 psi on a 2"-20 gage deck with 6x6-W1.4xW1.4 welded wire fabric. The maximum span for the slab on deck is 10'-0", the typical beam spacing. The main lobby on floor 1 is 2 stories high so floor 2 only runs around the North, West and South walls. The glass/aluminum corner is framed out by running a diagonal beam to truncate the corner, and then cantilevering beams off the diagonal to the façade. The cantilevered beams are supported with moment connections into the diagonal girder; opposite the cantilevered beams is another moment connected beam tying back into the structural system to balance any torsion effects (See appendix for typical bay and glass/aluminum façade corner framing). All structural steel is fy=50ksi while all plates and angles are fy=36ksi steel.



The roof is framed out in the same way the floors are except that none of the roof shapes are cambered. The roof girders range from a W21x44 to a W24x62 while the beams range from W16X26 to W18x40. The high roof framing for the glass/aluminum corner is more simplified than the floor framing and composes of W14 and smaller shapes.

Lateral Force Resisting System

The lateral force resisting system composes of 3 braced frames that run the entire height of the building around the building core. Four smaller braced frames are located at the top of the glass/aluminum corner, and a few moment frames are located at the penthouse level. The 3 main frames are chevron braced with the exception of 1 diagonal brace. Two of the braced frames carry lateral load in the E-W direction while the remaining braced frame carries the load in the N-S direction. The load is distributed to the braced frames through the framing on each floor.



Proposal

Problem

Suppose that local building codes place an overall building height on The Weinberg Center. This limit would have forced floors 2 through 6 to have floor to floor heights of 12'-0". Would a steel building structure have been the most economical choice for The Weinberg Center, or would a concrete structure be a better choice under these circumstances. I propose to redesign The Weinberg Center as a post-tensioned structural system. The large and varying spans across the buildings width would work well as a post-tensioned concrete design. In the end I want to find out if a concrete structure would have been a better choice with a limited building height.

Solution to Problem

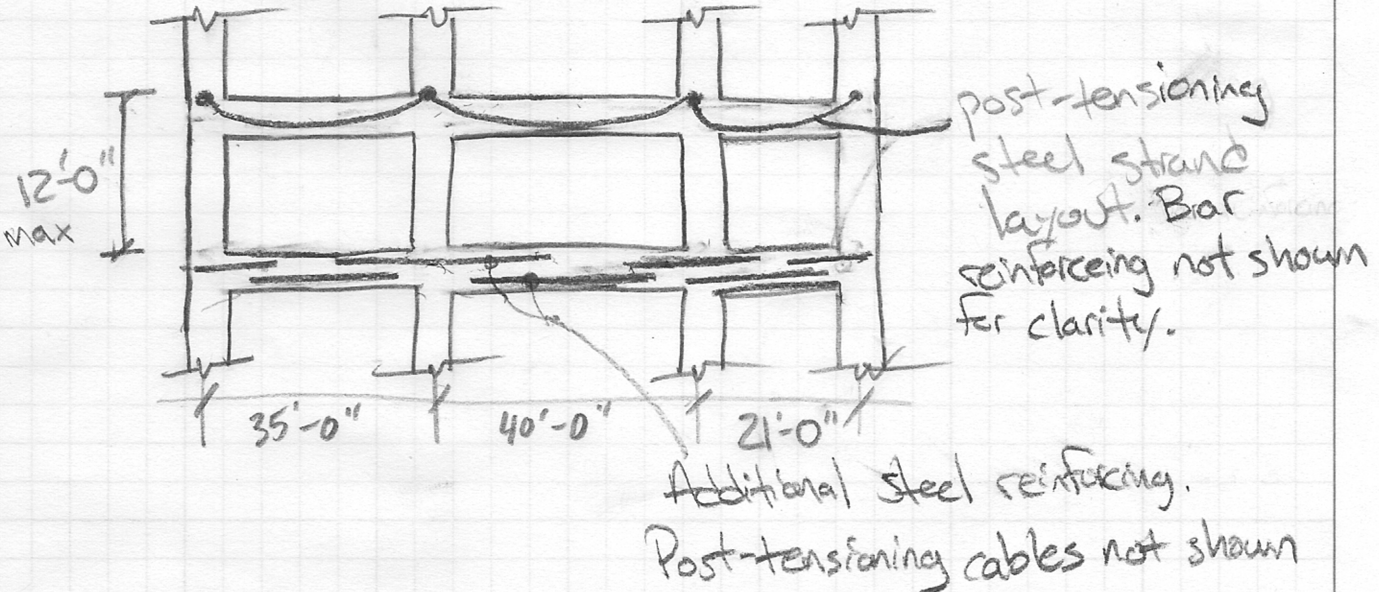
The proposed thesis will investigate whether a concrete structure would have been better for The Weinberg Center project with limitations placed on the overall building height. I will then redesign The Weinberg Center with a height limitation set to 12'-0" floor to floor height. This height limitation would only go into effect after floor 2 since existing elevations must be maintained on floors 1 and 2. The reason that these elevations must be kept is to allow the continued access to the street, parking garage and the elevated walkway that make The Weinberg Center unique and functional.

I will design a post-tensioned concrete slab and beam system. Beams will have a depth of approximately 24". Post-tensioning will be added to the slab and beams in order to minimize thicknesses and allow the installation of Mechanical, Electrical and Plumbing (MEP) equipment in the cavity above the suspended ceiling. This system will allow roughly 2'-0"+/- for MEP equipment. The intent of this system is to see if it is economically competitive with the existing structure.

The proposed alternate System will have a height restriction of 12'-0" floor-to-floor for floors 2 through 6. The intent of this design is two-fold. First it is intended to allow an investigation of how height restrictions impact the design of a concrete building. Second, it is of interest to determine if a concrete system would have been an economically competitive system given local zoning regulations had limited the height of The Weinberg Center concrete system would have been better than steel.

Building Section showing Post-tensioning layout & Steel bar reinforcing.

Alternate System #2



Solution Methods

In order to design these systems I will use several engineering tools available to me. All live loads will be in compliance with ASCE 7-05. The design of my building will follow ACI 318-05 code requirements. I will create a frame model of my building Risa3D. I will then apply gravity, wind, and seismic loads to my building frames obtain worst case. Using the loadings combinations found in ASCE 7-05 Chapter 2 I will obtain worst case member forces that will be used to the post-tensioned concrete system. Serviceability requirements will be satisfied using industry standards of L/360 for gravity deflections, H/400 for building drift in wind and seismic drift limits found in ASCE 7-05 Chapter 12. After I have obtained the design for my buildings I will compare the redesigned building to that of the existing structure. Things I will compare will include differences in cost of materials and labor, constructability of each system, and rough project timetable changes. To complete these tasks I will use RS Means to develop cost differences and changes in the amount of work that will need to be completed to complete each project.

Breadth Requirements

Breadth work that will be investigated will focus around changes in the design of a typical conference room given that the floor-to-ceiling height will be reduced from the existing heights. I will design the lighting and the acoustical systems for this conference room. For the current system a floor-to-ceiling height of 9'-8" is typical and will be used for the design. The redesigned structure will limit the floor-to-ceiling heights to 8'-0" and I will redesign the two systems with this change in mind. I will then discuss what differences would be expected in a redesign of this conference room for my redesigned structural system. The redesigned building has a shallower floor-to-ceiling height and as such will impact the design of the lighting and acoustics of the conference room.

Tasks and Tools

Task 1 – Determining Gravity Loads on Building

- Determine loads on structure from Architecture and Structural Drawings
- Determine Live Loads on Structure from ASCE 7 load tables

Task 3 – Design Post-Tensioned Floor Systems

- Establish a minimum slab thickness from ACI 318
- Use the CRSI design handbook to get trail member sizes
- Use note from Dr. Boothby and Concrete Design Class to design post-tensioned beams and, possibly, slab

Task 3 – Calculate Wind and Seismic Loads

- Use ASCE 7 Section 6 Method 2 – Analytical Procedure to determine Wind Loads
- Use ASCE 7 Section 8 to determine Seismic Loads on Structure

Task 4 & 5 – Build Risa Models and Calculate Member Forces

- Using Risa I will construct preliminary models in order to determine critical load cases and member forces for final design of the structure

Task 6 – Investigation of Concrete Sway Frames

- Using member forces from Risa output and Notes obtained from Dr. Boothby I will design/check a concrete sway frame system for The Weinberg Center

Task 7 – Compare Existing system to Alternate Systems

- Perform cost comparison between existing and alternate systems using RS Means
- Determine rough construction project changes using Labor Hours obtained form RS Means

Task 8 – Breadth Research

- Use notes from Dr. Ling as well as the book "Architectural Acoustics" by M. David Egan for the acoustical design of the conference room
- Use notes from Professor Mistrick and the book Electrical Systems in Buildings by S. David Hughes to design the lighting system for the conference room
- Discuss any differences the design of the conference room would have if the floor-to-ceiling height was restricted to 8'-0"

Kevin Clouser
Senior Thesis Schedule

The Harry and Jeanette Weinberg Center - Mercy Medical Office Building
AE 482 - Senior Thesis

Faculty Advisor: Dr. Boothby
Spring 2007

	January		February					
Activity	**21~27**	**28~31**	**1~3**	**4~10**	**11~17**	**18~24**	**25~28**	**1~3**
Revise and Resubmit Proposal								
Determine Gravity Loads for Floor System, check Lateral Loads								
Design Post Tensioned Floor Systems								
Calculate Wind and Seismic Loads								
Analyze Building using Equivalent Frame Method								
Redesign concrete members if necessary, design foundations								
Investigate & Design Concrete Sway Frames,								
Investigate System Costs and Rough Construction Time Tables								
Breadth 1: Design of the Conference Room for Lighting								
Breadth 2: Design of the Conference Room for Acoustics								
Compile Information and Submitt Report								
Develop Powerpoint Prestentation, Revise Report								
Present My Thesis to Faculty Jury								
Reflect on Thesis and make any suggested changes								

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Spring 2007

	March				April			
Activity	**4~9**	**10~18**	**19~24**	**25~31**	**1~7**	**8~14**	**15~21**	**22~28**
Revise and Resubmit Proposal								
Determine Gravity Loads for Floor System, check Lateral Loads	S							
Design Post Tensioned Floor Systems	P							
Calculate Wind and Seismic Loads	R							
Analyze Building using Equivalent Frame Method	I							
Redesign concrete members if necessary, design foundations	N							
Investigate & Design Concrete Sway Frames,	G							
Investigate System Costs and Rough Construction Time Tables								
Breadth 1: Design of the Conference Room for Lighting								
Breadth 2: Design of the Conference Room for Acoustics	B							
Compile Information and Submitt Report	R							
Develop Powerpoint Prestentation, Revise Report	E							
Present My Thesis to Faculty Jury	A							
Reflect on Thesis and make any suggested changes	K							