The Harry and Jeanette Weinberg Center

Mercy Hospital Medical Office Building
Baltimore, MD

Thesis Proposal

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Structural Option

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Executive Summary

Building at-a-glance

The Harry and Jeanette Weinberg Center is a medical office building located in Baltimore, Maryland. 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

Since the existing steel framing with braced frames is a very good structural system for this type and occupancy of building my proposal centers around redesigning the structural system in concrete. The proposed thesis with include designing a concrete flat slab with post-tensioned beams as supports. The building height will then 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 elevations of existing that connect to The Weinberg Center at these heights. These designs will also allow for the open floor plan and window filled façade that is present on the existing structure.

Solution

The solution to the proposed thesis will include such investigations as desiging an economically competitive concrete system with equivalent height to the existing structure. An investigation will also be conducted to find out if limiting the floor-to-floor heights can still yield a competitive system. Each system will be compared to the existing steel framing structure

Breadth Investigations

Since access to Mechanical, Electrical, Lighting, and Plumbing documents for The Weinberg Center can not be obtained breadth topics will focus around 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 Alternate System #1 at 9'-6". An investigation will then be conducted to see what in this design would change to accomidate a smaller ceiling height of 8'-0" to 8'-6".

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 that houses many of Mercy's Centers of Excellence including 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

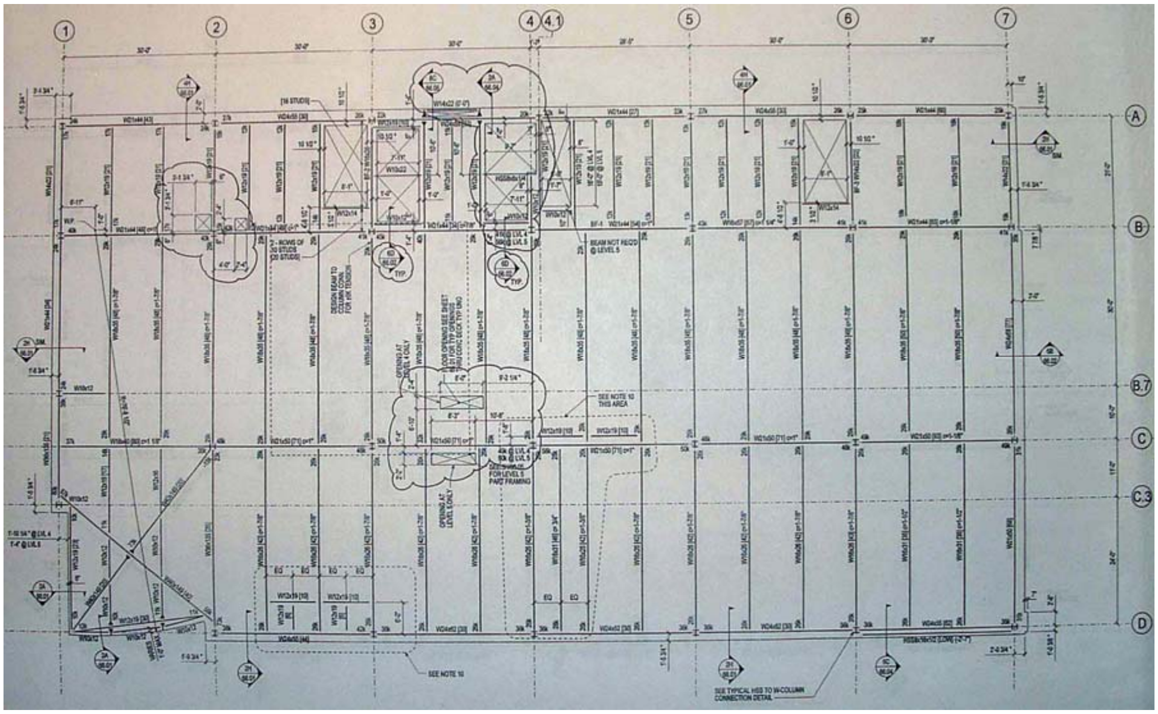
The foundation is composed of straight shaft drilled caissons, spread footing, slab-on-grade and a concrete retaining wall along the west elevation. Caissons bear on rock at depths exceeding 36'-0" in order to reach bearing capacities of 90ksf. Spread footings are all 12" thick. Assumed bearing pressures for spread footings and slab-on-grade is 2.0ksf. 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. The concrete retaining wall 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

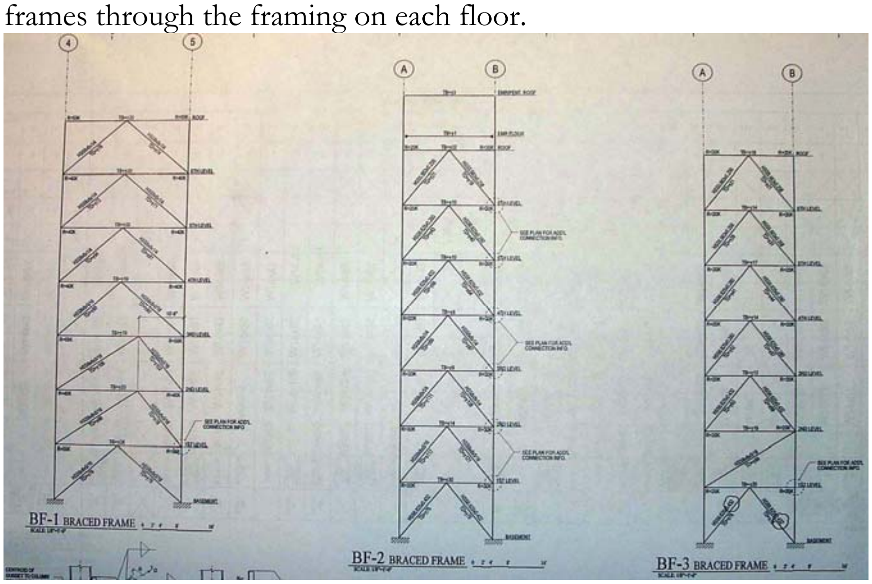
The floor system is a made up of simply supported girders (typical sizes are W21x50 or W21x44) that span 30'-0" column to column in the N-S direction and simply supported infill beams (typical sizes are W16x26 and W18x35) span 40'-0" at 10'-0" on center in the E-W direction. Infill beams that span more 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 moment connected 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

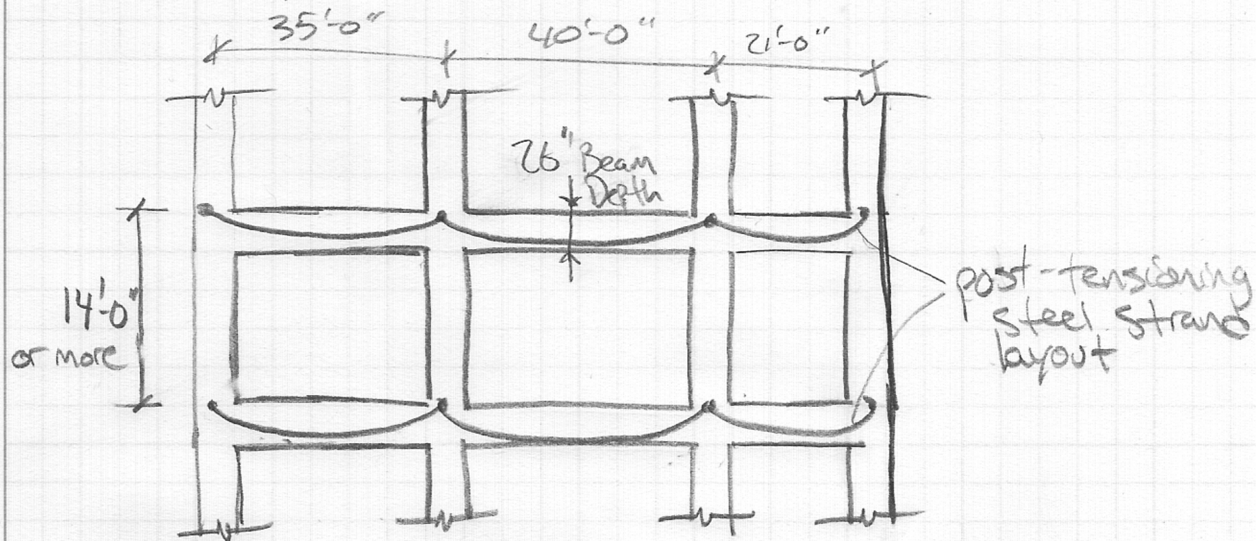
The Harry and Jeanette Weinberg Center is a very typical office building. The construction type has a proven track record of being both economic and durable under its designed use. The investigation of Technical Assignments 2 and 3 only reinforced these facts and no significant issues with either the floor or lateral systems were found. It is this lack of problems that leads me to want to investigate a concrete design for this building. Because of the large and varying spans across the buildings width this type of building would lead itself very well to a post tensioned concrete beam system. This proposed thesis will do an investigation into the economic impact that changing The Weinberg Center's structural system to post tensioned concrete would have had on the project. As part of this investigation I will redesign the building as having no height limitation. I will then look at redesigning 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 for access to the street, parking garage, and the elevated walkway must be kept.

Solution

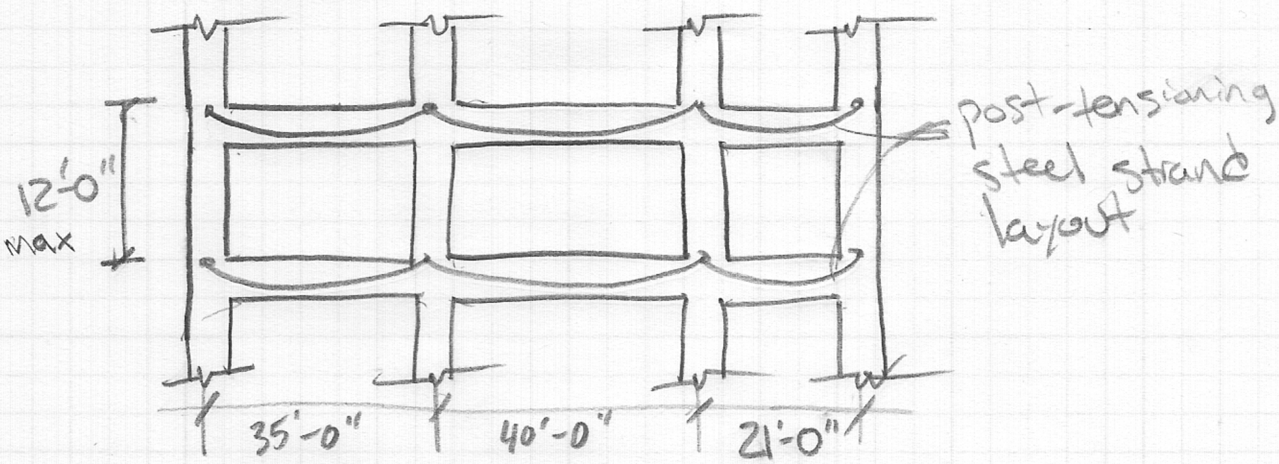
Alternate System #1 will not alter the current height of The Weinberg Center. It will be comprised of a flat slab system with post-tensioned continuous beams. Beams will have a depth of 26" and a width not to exceed that of the columns at 26" square. Post-tensioning will be added to the slab in order to keep the slab thickness down if it is determined that it is needed. This system will allow roughly 2'-4" for MEP equipment. The intent of this system is to see if it is economically competitive in terms of overall cost and constructability of the concrete building compared to that of the existing steel framing.

Alternate System #2 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 will be to see how a height restriction will impact the design of beams and slab. Second it will be to see if by imposing a height restriction if it is still economically competitive with the concrete and steel system by comparing overall cost and constructability.

Alternate System #1



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 model of my redesigned building in ETabs in order to obtain member forces and moments. I will then design the post-tensioning system based on these design forces and a serviceability requirement of L/360 for gravity deflections and H/400 for building drift. After I have obtained a design of my building I will compare my design to that of the existing steel system.

Breadth Requirements

Breadth work that will be investigated will focus around the design of a typical conference room designed for alternate system #1. I will design the lighting and the acoustical systems for this conference room. For alternate system #1 a floor to ceiling height of 9'-6" is typical and will be used for the design of this room. I will then discuss what differences would be expected in a redesign of this conference room for my alternate system #2. This 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 ETabs Models and Calculate Member Forces

- Using ETabs 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 ETabs 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 MC^2
- Determine rough construction time tables for each system using Primivera Project Planner (P3)

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
- Describe any differences the design of the conference room would have if the floor-to-floor height was restricted to 8'-6" or less

	Week 1	Week 3	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
Task 1 - Determine Gravity Loads for Floor System									S
Task 2 - Design Post Tensioned Floor Systems									P
Task 3 - Calculate Wind and Seismic Loads									R
Task 4 - Build Model of each building in ETabs									I
Task 5 - Calculate Member Loads Based on Worst Case									N
Task 6 - Investigate & Design Concrete Sway Frames									G
Task 7 - Investigate Costs and Rough Construction Timelines									
Task 8 - Design of the Conference Room									B
Task 9 - Compile Information and Write Final Report									R
Task 10 - Develop Powerpoint Prestentation to Faculty									E
Task 11 - Present My Thesis to Faculty Jury									A
Task 12 - Reflect on Thesis and make suggested changes									K

	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17
Task 1 - Determine Gravity Loads for Floor System								F
Task 2 - Design Post Tensioned Floor Systems								I
Task 3 - Calculate Wind and Seismic Loads								N
Task 4 - Build Model of each building in ETabs								A
Task 5 - Calculate Member Loads Based on Worst Case								L
Task 6 - Investigate & Design Concrete Sway Frames								
Task 7 - Investigate Costs and Rough Construction Timelines								E
Task 8 - Design of the Conference Room								X
Task 9 - Compile Information and Write Final Report								A
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