Thesis Proposal

Roosevelt Island Southtown Building No. 5, NY, NY

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Structural Option

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EXECUTIVE SUMMARY

Building Description

Southtown Building No. 5 is a luxury apartment building located in the center of Roosevelt Island in Manhattan's East River. It houses 123 apartments in 16 floors with an underground cellar which houses storage units as well as mechanical and electrical space. The primary structural system consists of reinforced concrete two-way flat plate floor slabs with concrete shear walls. The typical floor thicknesses are 8" thick, while the lateral system is mainly 12" thick from the cellar to the main roof.

Proposal

Most of New York City's buildings, especially apartment buildings, are constructed based on occupancy. The following proposal consists of an alternate structural system that will open the building earlier by shortening the erection time of the structure. This alternate system will not increase the overall height of the building. Since height is critical in this case, the floor system will maintain a similar floor thickness.

Solution

A girder-slab floor system with steel columns will act as the primary gravity system. A braced frame core will provide continuity as the lateral system. This system will not only allow for a comparable floor thickness, but it will also allow for a faster erection time.

Breadth Topics

The impact of the proposed floor system will create many new changes in the construction of the building. As an additional consideration, the construction, cost, schedule, and sequencing of erection will be investigated for the new framing system. Additionally, LEED rated buildings will be researched to conclude if the impact on the environmental will have an advantage over the added costs. If deemed as an advantage, LEED rated points and techniques will be chosen to help this building achieve a gold LEED rating.

Introduction

Roosevelt Island Southtown Building No. 5 is the fifth building out of nine in a large scale new development located in the center of Roosevelt Island, an island located off of Manhattan's east coast in the East River. The building will have a 123 luxury apartments consisting of 1, 2 and 3 bedrooms. This 187 feet tall apartment building houses over 130,000 square feet in 16 stories. The building is jointly owned by the Related Companies and the Hudson Companies. It was designed by Costas Kondylis and Partners with the structural engineering being performed by DeSimone Consulting Engineers. Monadnock Construction was the general contractor of this project.

On the first floor, the building has a full service lobby with concierge service and mail room, a health club, multi-purpose room, children's play area, building storage, and three 2-bedroom apartments. The building has 120 additional luxury apartments in the 15 floors above on all 4 sides of the building to maximize the views and sights of Manhattan's skyline.

On the main roof, the building offers an enclosed Party room to host gatherings and social events. Additionally, private terraces surround the exterior of the main roof. Above the main roof is the bulkhead mechanical room followed by the elevator machine room to top off the building. As with most buildings in New York City, a strict height constraint is in place with this building.

Background

Foundations

Three types of foundation systems are used for Southtown Building No. 5. Individual footings are used for interior columns of the building. These footings range from 3'-0" x 3'-0" to 4'-6" x 4'-6". A mat footing is used at the base of the later force resisting shear walls. The mat is typically 42" thick with some step downs required for the elevator, boiler, and sump pits. Finally, a 12" thick foundation wall is used around the perimeter of the cellar. This system incorporates exterior concrete piers into the wall with footings at the base.

Floor System

The floor system of the apartment building is typically an 8" two-way normal weight concrete flat plate with varying size bays. At the cellar floor, a 6" concrete slab is used with W2.0 x W2.0 welded wire fabric. At the first floor, a 9" concrete slab is used to accommodate for higher occupancy loads. Concrete strength is typically 5000 psi with typical reinforcement for the floor system is #4 @ 14” bottom steel and #4 @ 14” top steel. Middle strip reinforcement is used in the floor slab in some areas of higher stress. Due to the party room and lounge area on the main roof, a 10” concrete floor slab with #5 @ 12” top and bottom steel is used.

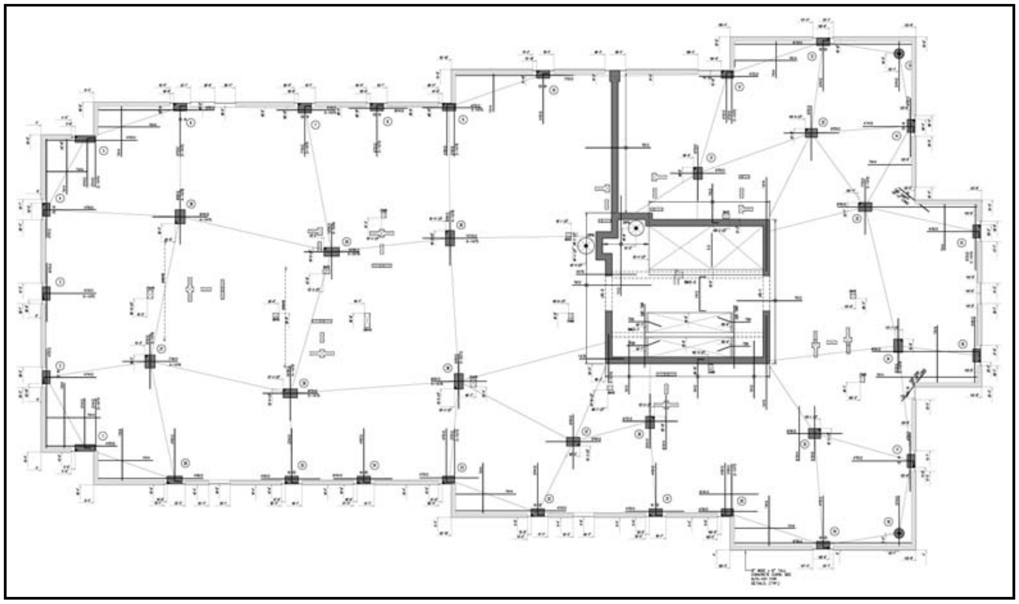

Figure 1. Typical floor plan for Roosevelt Island Southtown Building No. 5

Columns

The columns in this New York building are typically rectangular reinforced concrete with varying sizes and reinforcement. The most common column size is 14” x 24” with 8 #6 bars as structural reinforcement. Bay sizes range in size with no geometrical grid system. The largest bay is approximately 24’ x 26’. Column loads vary greatly within the building, especially as the elevation rises. The largest loads at the foundation level is 1056 kips of dead load and 139 kips of live load.

Lateral System

Reinforced concrete shear walls make up the lateral force resisting system of the building. The elevator and stairwell core in the center of the building have been assigned as the location of these shear walls. The shear walls rise from the cellar level of the building all the way to the elevator mechanical room. A 12” typical shear wall section consists of #4 @ 12” horizontal reinforcement and #5 @ 12" vertical reinforcement. Openings in the shear walls require link beams in order to transfer high shear forces from one side of the opening to the other. The concrete used in the shear walls vary with the height of the building from 7ksi in the cellar to 5ksi at the roof.

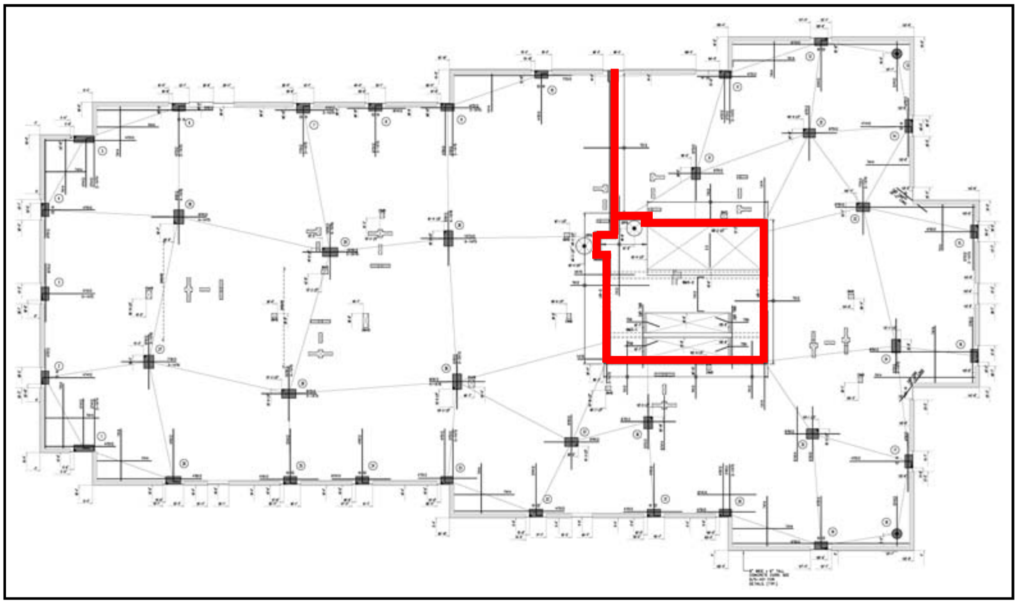

Figure 2. Typical floor plan for Roosevelt Island Southtown Building No. 5 with the shear wall lateral system highlighted in red

Problem Statement

Due to the location of the project and the needs of the client, the most efficient structural system was originally designed. This became apparent in the previous Technical Assignment #2 where the existing floor system was compared to four other proposed systems. The intention of this proposal will be to redesign and reevaluate the current cast-in-place reinforced concrete system to a Girder-Slab system using asymmetrical steel beams and precast concrete planks. The serviceability and strength of the new system will be checked using codes and loads from the following but not limited codes: IBC, ASCE7-05, and AISC

Problem Solution

Floor System

The proposed floor structure to be analyzed and implemented is the Girder-Slab system. It is a new and innovative way to build that combines the benefits of steel and concrete into one monolithic floor system. The system is comprised of an interior girder known as an open-web dissymmetric beam, known as a D-Beam, which supports precast, prestressed hollow-core slabs on its bottom flange. The D-Beams also have openings in some of the web to allow for grouting of the hollow core planks. Upon grouting, the system develops composite action and is able to resist lateral movement between the planks and beams.

After the initial calculations performed in Technical Assignment #2, DB9x41 beams were chosen with an 8” x 4’-0” hollow core plank with a 2” topping. An overall depth of approximately 10” can be achieved with this system.

The construction and economic costs associated with this system will be analyzed and reviewed. The Girder-Slab may prove to have a shorter erection time but a longer lead time that cast-in-place concrete. The erection time will allow for a quicker construction time but may be outweighed by the initial costs of the system. These topics as well as other will be reviewed and compared in upcoming reports.

Lateral System

In order to allow for the fastest erection time, a lateral resisting system consisting of diagonal braced frames will be investigated. Braced frames will be located around the elevator core and central stairwell. The braced frames will have to be able to resist the seismic and wind loads set by previous Technical Assignments. This lateral system must be able to resist any torsion effects created by these loads.

Solution Method

Floor System

The Girder-Slab floor system will be designed in accordance with the *Girder-Slab Design Guide*. This system will be analyzed by the use of hand calculation and excel spreadsheets. The steel column sizes, spacing, and connection will be designed using the 13th Edition American Institute of Steel Construction Manual, 2005. A RAM steel model will be created to assist with the design process. The sizes and orientation of steel columns will be compared with the sizes retrieved by hand calculations. Live loads will be determined using chapter 2 of ASCE7-05. These loads will be implemented into the computer generated model using the proper load combinations.

After a more thorough investigation into the Girder-Slab system, a construction schedule will be prepared using Primavera. Furthermore, a detailed cost analysis will be performed integrating my research and the conclusions of the industry standard R.S. Means catalog. From this analysis, a complete comparison will be performed with the existing system.

In order to see if the shorter erection time offsets the initial material costs, a revenue estimate of the apartment building will be performed. The average apartment cost per month will be considered for this analysis and compared to the amount of time that is cut from the construction schedule to see if the proposed system poses as an advantage.

Lateral System

The lateral system will be designed using wind and seismic loads determined by ASCE7-05, chapters 6, 11, 12, and 16. The braced frame design will be designed using the AISC seismic design handbook. The RAM steel model will be used to assist in the design of the braced frame system.

Breadth Topics

Construction Management Breadth Study

In order to analyze the impact of the alternate floor system, a thorough investigation will be conducted into the changing construction methods and schedules. The erection process will be analyzed in order to create the most efficient coordination process for the proposed framing system. With the purpose of minimizing erection time and making the construction process as efficient as possible, it will be determined when the necessary material will be ordered to offset the induced lead time. A construction schedule will be created as well as a cost analysis to provide a more in-depth look into the effects on the construction management of a building with a different framing system.

LEED Rated Breadth Study

The second breadth topic will be an investigation into creating a LEED rated apartment building. With the building being set on a historic island off the coast of Manhattan, the environmental effects of the building become a significant factor. If the building was LEED rated, it would help reduce the carbon emissions of the building and create a more environmentally friendly area. On a larger scale, if the rest of the nine apartment buildings in the complex were also built with LEED rated materials and building techniques, the island would promote a much healthier lifestyle. These LEED rated topics will be carefully researched and implemented into the construction of the building. After review of the LEED points scale, a number of factors will be chosen in order to achieve a LEED rated building.

Tasks & Tools

Part I. Girder-Slab Floor System

Task 1. Conduct thorough research of Girder-Slab system

a) Conduct phone call interviews with engineers whom are familiar with the system
b) Create a introduction describing the new-found research and come to some conclusions on the system.

Task 2. Find initial member sizes

a) Use the Girder-Slab Design Guide to find most efficient design with the implementation of Dead and Live loads established in earlier Technical Assignments
b) Re-align grid of building to establish new bay sizes and spacing without altering the original architectural layout

Task 3. Determine all gravity loads for column transfer

a) Determine self-weight of Girder-Slab system based on member sizes
b) Find initial column sizes using RAM Steel model and referencing with hand calculations

Part II. Braced Frame Lateral Resisting System

Task 1. Establish wind and seismic loading

a) Using previous Technical Assignments, determine wind and seismic loading
b) Reference ASCE7-05, chapter 6 for wind loads
c) Reference ASCE7-05, chapter 12 for seismic loads

Task 2. Design braced frame lateral load resisting system

a) Create RAM Steel model with all load
b) Spot check braced frame with hand calculations

Part III. Breadth Topics

Task 1. Construction Management Breadth Topic

a) Using R.S. Means catalog, create a construction cost estimate and cost impacts of new framing system
b) Input construction data based on personal interviews and research into Primavera to generate a schedule
c) Compare resulting schedule and estimate with original

Task 2. LEED Breadth Topic

a) Conduct thorough research of LEED certified buildings, especially apartment buildings
b) Investigate ways to achieve LEED rating
c) Implement research into building and examine results

Timetable

	Jan. 14-20	Jan. 21-27	Jan 28 - Feb 3	Feb. 4 -10	Feb. 11-17	Feb. 18-24	Feb. 25-Mar. 2	Mar. 3-9	Mar. 10-16
Task 1: Research of Girder-Slab system	■	■							S
Task 2: Establish initial steel member sizes		■	■						P
Task 3: Create RAM Steel Model		■	■	■	■	■			R
Task 4: Determine all imposed loads on columns			■	■					I
Task 5: Check new loads on existing foundations			■						N
Task 6: Verify all wind and seismic loads				■					G
Task 7: Design lateral load system				■	■	■			
Task 8: Update CPEP website			■		■		■		■
Task 9: Breadth investigation into cost and construction schedule for				■			■	■	
Task 10: Breadth investigation into LEED					■				B
Task 11: Working draft report									R
Task 12: Edit and correct report									E
Task 13: Create final report									A
Task 14: Create final presentation									K
Task 15: Review presentation and practice									
Task 16: Present to AE faculty and jury									
Task 17: ABET evaluation, Finish Website									
Task 18: R & R									

	Mar. 17-23	Mar. 24-30	Mar. 31-Apr. 6	Apr. 7-13	Apr. 14-20	Apr. 21-27	pr. 28- May	May 5-9
Task 1: Research of Girder-Slab system					F			F
Task 2: Establish initial steel member sizes					A			I
Task 3: Create RAM Steel Model					C			N
Task 4: Determine all imposed loads on columns					U			A
Task 5: Check new loads on existing foundations					L			L
Task 6: Verify all wind and seismic loads					T			S
Task 7: Design lateral load system					Y			
Task 8: Update CPEP website								
Task 9: Breadth investigation into cost and construction schedule for new system								
Task 10: Breadth investigation into LEED					J			W
Task 11: Working draft report					U			E
Task 12: Edit and correct report					R			E
Task 13: Create final report					Y			K
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