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Structural
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The Helena
New York City, NY
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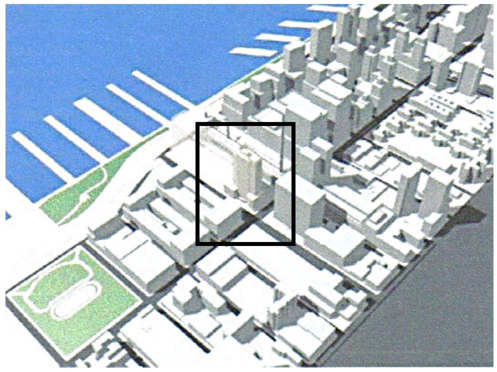


Pictures courtesy of Fox & Fowle Architects

Thesis Proposal

Executive Summary

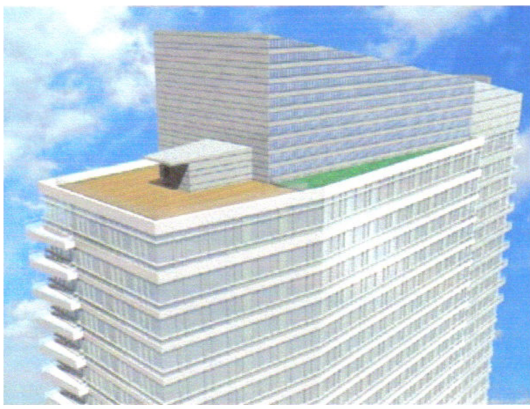
This document serves as a proposal to make a design adjustment to The Helena and subsequently making other analyses based on the major design as well as checking other systems to make sure they are compatible with the major design. The Helena is a 600,000 square foot apartment building in Manhattan, New York. The structural system for the building is designed of reinforced concrete columns which are not spaced to design a typical bay. From a detailed analysis performed throughout the past several months, it is seen that the column layout of this building is a problem which has limited the design of the building's floor system to one best fit choice of a two-way flat plate slab. As part of this proposal, a new column layout will be created to give the floor design more options to a possible alternative floor system as well as the use of a different foundation system. As part of the supplemental design, the foundation will be re-designed using the new locations and loads of the columns as well as being based on the soil competency and bearing capacity. Also, the mechanical ductwork for the building will be analyzed to determine whether the new column locations will interfere with the routing of the ductwork. Depending on the results of this analysis, a schematic would need to be made to layout a new routing plan for the mechanical ductwork.

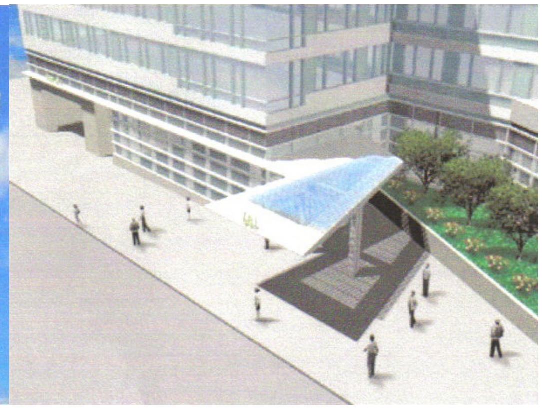
Building Background

The Helena, built in Manhattan, is a 40-story apartment building costing approximately \$160 million. It stands 400 feet above the ground below and has a total area of about 600,000 ft^2. The sub-grade portion of the building is a mixed use area consisting of parking spaces as well as rooms for storage and technical equipment. This section of the building is two stories, the cellar and the sub-cellar. The ground floor's main feature is a retail area off to the right of the main entrance doors. Each of the sub-grade floors and ground floor has an approximate area of 29,400 ft^2. Above grade, the front of the building concaves and the building takes on a more unique shape. Up to the seventh floor, the Southwest corner of the building juts out from the main rectangular shape. These floors have an approximate floor area of 20,000 ft^2. This is also the design of the Southeast corner of the building which maintains this shape up to the tenth floor. The floor layout makes the change from having two jutting sections to only one and thus trimming down the floor area to about 16,000 ft^2. Starting from the eleventh floor to the roof, the building gets back to taking on the shape of a rectangle. The floors in this portion of the building have an approximate floor area of 12,500 ft^2.

The building envelope is different from that of the usual apartment building which uses the 'heavy' appearance of brick and small windows. The Helena is enclosed in floor-to-floor, high performance glass which lets in a large amount of light but helps to dissipate the energy from the heat gain which would normally occur with regular windows. These windows also help to facilitate a better heating and cooling flow for the mechanical systems.

Green design played a major role in the development of the plans for The Helena. To cap off the building, a green roof will be created to help decrease the energy absorbed by the roof as well as catch rain water to use in the building's cooling system. The upper roof area is clad in sleek metal panels which have the capability to collect solar energy and convert it for use in the building's electrical manufacturing plant. The Helena also features a black water treatment facility and integrated recycling shoots on every floor to make the building more environmentally friendly.

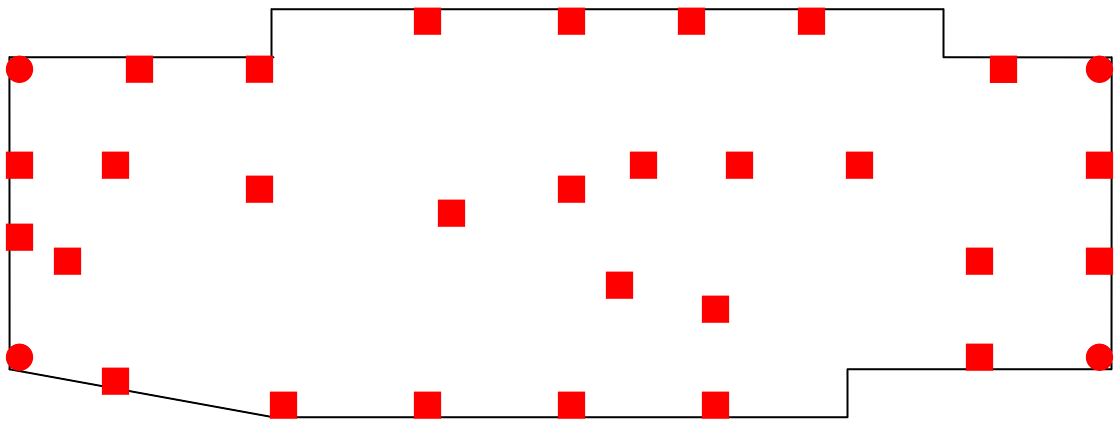




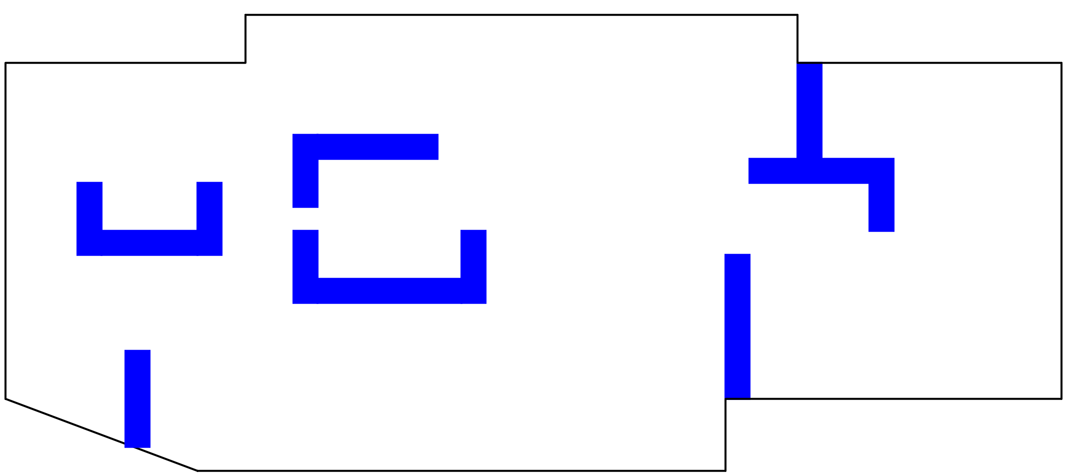
Spread and monolithic footings make up the building's foundation system. The footings are to bear on undisturbed rock with a minimum bearing capacity of 40 tons per square foot. Some of the footings are further secured and tied down by 100-ton rock anchors. Each footing sits on a 2" thick mud slab and is composed of 5960 psi normal weight, reinforced concrete.

The superstructure of The Helena is composed of reinforced concrete which ranges in compressive strength from 5000 psi to 8000 psi. The gravity system for the building is made up of reinforced concrete columns holding up a two-way flat plate slab. The typical floor layout is an 8" slab reinforced with #4 bars at 12" on center each way. The columns vary in size per floor and come in rectangular as well as circular cross-sectional shapes. The circular columns are placed in the retail area where they will be exposed as an intentional architectural feature. Shear walls which run the entire height of the building make up the lateral support system for The Helena. The shear walls will resist the wind and seismic lateral forces on the building. The concrete strength of the shear walls is to be the same as that of the columns
on the same levels, which is noted in the previous section. There are 7 shear walls (A,B,C,D,E,F,G) supporting the lateral load up to the 7th floor and from the 8th floor to the 38th floor, there are 6 shear walls (B,C,D,E,F,G) to take the loads. On the 39th floor, there are 4 shear walls (D,E, part of C, and part of F) which are designed for lateral support. The shear walls are designed to be 16" thick from the sub-cellar the the 24th floor, 14" thick from the 25th floor to the 34th floor, and 12" thick for the remaining floors. All of the shear walls are not typical through

their entire height however. Shear wall G is a non-typical wall because it is shifted 8’-1” to the right and 6’-1.5” down at the 8th floor. Shear wall B is shortened by 6’-0” when the floor plan changes at the 11th floor. For the walls that are rectangular and constant, their design can be treated like large cantilever beams, but the other walls have a more complicated design.



Column layout for typical floor



Shear wall layout for typical floor

Proposed Study

Rather than trying to improve on the design of this building, the goal of this proposal is to determine why this solution was chosen as the best and if there were any other alternatives that were viable.

As can be seen from the figures above, there is not a symmetric layout to the columns or shear walls. The focus of this study will be on determining if a new layout for the columns is practical and if this change will create the chance to further investigate an alternative floor system. In Technical Assignment #2, the existing floor system was found to be the best solution for the building because of the lack of a consistent placement of the columns. This re-design will make for the construction of typical bays throughout the floor layout and will open up more options for alternative floor systems.

A re-design of the column layout will also create the need for a review of the loads which will be placed on the columns at their new locations to determine if re-sizing is necessary. Also an issue with the column placement is the placement of the shear walls. As with the columns, there is not a symmetric layout to the placement of the shear walls. A layout for the columns can also help to create a supportive frame with the shear walls to alleviate some of the lateral load forces placed on the shear walls.

From making an overview of Technical Assignment #2 as well as applying new knowledge and information, the implementation and analysis of a pre-cast concrete plank floor system will be conducted to determine if it would be beneficial to use this system instead of the existing floor system.

Re-location of the columns will translate into the need to re-locate some of the footings for the building's foundation. The movement of the footings may create the chance to use a different and possibly more efficient or economic foundation system. Possible alternatives for this system will be discussed and presented if the alternative is found to be a practical and necessary solution. In addition to re-locating the footings for the foundation, moving the columns will also create the need to check over the mechanical system to determine whether or not it is necessary to re-route the ductwork to make sure it fits into the new schematics of the floor layout. This topic will be considered for part of the breadth work to be done in addition to the main structural analysis.

Proposed Study Method

Along with hand calculations and the use of the CRSI manual, a computer program may be used to design the building elements or used as a check of the elements which were determined from hand calculations. As was used for the analysis of the building in previous assignments, all calculations and building components will be designed using ACI 318-02 and New York City Building Code.

New schematics will be created to be able to compare the new column layout to the architectural layout of the floor for compatibility. Small architectural compensations may need to be made to allow for the fit of some columns into areas that may not have been previously considered as column placement positions.

The same loads will be used as were used in Technical Assignment #1 to calculate the new loads on the columns in their new positions. Column takedown tables will then be created to determine the new loads which will be transferred to the foundation footings. Geotechnical information will need to be obtained to determine if the soil will be competent enough to withstand the new bearing capacity to be placed upon it. RS Means and ICE 2000 will be used as possible ways to find out the cost and schedule information, respectively, for the re-design of the foundation.

Breadth Options

The first breadth option which will be discussed in this report will be a construction management cost/time analysis of the new structural floor system. A breakdown of the cost and time needed to create and install the two systems will be compared to determine if the proposed alternative system would be a viable option for the building's design.

Also in conjunction with the movement of the columns, the positioning of the mechanical ductwork will need to be checked to see if it needs to be re-routed based on the new location of the building columns. The current mechanical locations in the current drawings will be compared to the new schematics for the proposed new locations of the columns to determine if the new column locations will interfere with the paths of the ductwork.

Tasks

Task 1: Create a schematic for the new layout of the columns. Compare the architectural drawings to the structural drawings and create a new column layout based on the possible positions which can be used.

Task 2: Determine the new floor system structure based on the new column locations.

Task 3: Design the sizes for the new columns based on the loads created by the new floor system.

Task 4: Research geotechnical information to determine if the soil will be competent to be able to sustain the new loads which will be placed upon it.

Task 5: Design foundation based on re-location of columns, new column loads and the competency of the soil.

Task 6: Use estimation and scheduling information to create a cost/time analysis for the newly designed floor system.

Task 7: Using the schematic for the new column layout, determine if the layout of the mechanical ductwork will need to be re-routed to compensate for the new column locations.

Task 8: Create written report and presentation material.

Schedule

Week 1 (January 10 - January 14): Task 1
Week 2 (January 17 - January 21): Task 2
Week 3 (January 24 - January 28): Task 2/3
Week 4 (January 31 - February 4): Task 3
Week 5 (February 7 - February 11): Task 4
Week 6 (February 14 - February 18): Task 5
Week 7 (February 21 - February 25): Task 5
Week 8 (February 28 - March 4): Task 6
Week 9 (March 7 - March 11): Task 6
Week 10 (March 14 - March 18): Task 7
Week 11 (March 21 - March 25): Task 8
Week 12 (March 28 - April 1): Task 8
Week 13 (April 4 - April 8): Task 8
Week 14 (April 11 - April 15): Presentations
Week 15 (April 18 - April 22): Wrap-up
Week 16 (April 25 - April 29): Wrap-up

Conclusion

This document is a proposal to layout an analysis of the existing structural, foundation, and mechanical systems of The Helena. The structural alteration to the building is to be the main focus of the design and the foundation and mechanical work will be supplemental as they are reactionary designs to the main structural design. Once the analysis of the different systems is complete, a presentation will be created to convey the findings of this analysis and to determine whether or not the proposed actions would be a viable alternative to the existing system.