HIGH RISE CONDO
SOHO, NEW YORK, NY

Proposal

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Structural Option
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EXECUTIVE SUMMARY

The Soho high rise condominium project consists of 13 above grade stories and two below grade stories. The building encompasses roughly 175,000 SF stretching from 28 feet below grade to 175 feet above grade. The first floor houses highly marketable retail spaces while the remaining 12 stories are condominium units. A sub-cellar level is set aside for resident parking and the cellar level contains a pool lounge, exercise facility, resident storage spaces and mechanical rooms. There are also roof terraces and Jacuzzi pools located at the 6th Floor step back.

In Technical Report 2 it was found that the slab depth was controlled primarily by the double cantilevers located at the corner sections of the building. A possible reduction in floor slab thickness of up to 1 ½" could be achieved by adding edge beams to the flat plate at these key locations. In addition a light weight concrete solution will be investigated for the flat plate to decrease the weight of the structure and therefore the column and foundation sizes. The lateral system will also be evaluated and redesigned to accommodate these changes in the flat plate. The proposed design changes will be carried out using design reference and computer modeling as well as faculty consultation throughout the semester. This in depth study will provide a better understanding of engineering economics as it applies to high rise construction.

The structural redesign of the Soho high rise will be further evaluated through breadth studies in non-structural design areas. First, a study of the building envelope will be undertaken, evaluating the effectiveness of the current systems ability to isolate the interior and exterior environments. This will then be compared to a possible alternative system and its abilities, cost and impact on construction schedule. Secondly, I plan to explore the criteria that would certify this building as a LEED design. This will include a discussion on cost, material and building system selection.

INTRODUCTION

The Soho high rise condominium project consists of 13 above grade stories and two below grade stories. The building encompasses roughly 175,000 SF stretching from 28 feet below grade to 175 feet above grade. The first floor houses highly marketable retail spaces while the remaining 12 stories are condominium units. A sub-cellar level is set aside for resident parking and the cellar level contains a pool lounge, exercise facility, resident storage spaces and mechanical rooms. There are also roof terraces and Jacuzzi pools located at the 6th Floor step back. Column layout and typical bays vary in size to accommodate the variations in apartment layout and architectural floor plan. The flat plate slab construction is ideal for residential construction in Manhattan, due to limited building heights imposed by the city of New York. The overall floor depth of the system is small limiting overall floor to floor height, thereby increasing the number of floors and maximizing rentable floor space. The flat plate allows easy coordination with other trades due to the flat profile of the underside of the slab.

The floor system of the Soho high rise is typically a 10-1/2" two-way normal weight concrete flat plate with bays range in size from 13 feet by 21 feet to 25 feet by 25 feet. Typical reinforcement is #4 @12" bottom steel and #5 @ 16" top steel. Additional reinforcement is required at most of the columns because of the inadequacy of the uniform steel to resist the increased moment. In a number of cases as many as 10 additional # 7 bars are required. The columns in the Soho high rise are primarily standard reinforced concrete with varying sizes, shape and reinforcement depending on their location in the building. The most typical sizes are 20x14 and 12x19, both with 6 #9 bars as reinforcement. The foundation system for the high rise is a 4' thick concrete mat.

Concrete shear walls make up the buildings lateral load resisting system. The two elevator cores have been used as the main components of these elements and are connected up to the seventh floor where they become independent sections. Mechanical and architectural penetrations have been allowed in several areas, but require specially detailed link beams to transfer the shear forces. Typical shear wall reinforcement is two layers of #4 @ 12" o.c. each way, but increases in some areas to accommodate for axial load and increased shear forces that must be resisted. All shear walls are cast in place with a 28 day compressive strength of 5000 psi. Typical shear wall thickness is 12", although there are some 8" thick wall sections.

PROBLEM STATEMENT

Due to the needs of the client, engineers, contractors, and building schedule, the system provided was the most efficient system for the specific project at the time of construction. Had these constraints not existed more solutions may have been explored by the design engineer. I intend to propose a value engineered solution that will decrease construction cost, project duration and material usage. To do this I will use load and code requirements from IBC, ASCE 7, and ACI.

PROBLEM SOLUTION

In Technical Report 2 it was found that the slab depth was controlled primarily by the double cantilevers located at the corner sections of the building. A possible reduction in floor slab thickness of up to 1 ½" could be achieved by adding edge beams to the flat plate at these key locations. In addition a light weight concrete solution will be investigated for the flat plate to decrease the weight of the structure and therefore the column and foundation sizes. The lateral system will also be evaluated and redesigned to accommodate these changes in the flat plate. The proposed design changes will be carried out using design reference and computer modeling as well as faculty consultation throughout the semester.

SOLUTION METHOD

The floor system will be designed in accordance with ACI-318-05, referencing all applicable sections. Design will be carried out using the Direct Design Method. Hand calculations will be used to check an PCA-SLAB gravity model. All dead and live loads will be those used in previous technical reports as have been interpreted from ASCE 7-05. The floor system will be designed not only for strength requirements, but also for serviceability requirements such as deflection limits set by ACI. The lateral system will be evaluated for both wind and seismic forces in accordance with the methods set forth in ASCE 7-05 and redesigned to meet the new prescribed lateral forces. Hand calculations will be used to back up an integrated ETABS model and a design for the worst load case will be evaluated.

A comparative cost analysis between the existing and alternate system will be evaluated using RS means, cost works and industry contacts. A brief discussion on schedule impact will also be included using information obtained from industry representatives.

BREADTH OPTIONS

The structural redesign of the Soho high rise will be further evaluated through breadth studies in non-structural design areas. First, a study of the building envelope will be undertaken, evaluating the effectiveness of the current systems ability to isolate the interior and exterior environments. This will then be compared to a possible alternative system and its abilities, cost and impact on construction schedule.

The Second breadth option will explore LEED certification of the Soho high rise. This will include a discussion on cost, material and building system selection. A number of the 69 total LEED criterion will be investigated and their viability as options will be evaluated. This study will look at which requirements are already met as well as which options will be the most cost effective to implement.

TASKS & TOOLS

Phase I: Two-way Floor System Analysis

- Task 1: Determine Superimposed Loads
  - a. Determine Superimposed Dead Loads from Arch and MEP plans
  - b. Determine Live Loads from ASCE 7-05
- Task 2: Establish trial Sizes
  - a. Determine minimum slab thickness from Gilbert Method and Park and Gamble Method and compare to ACI-318
- Task 3: Refine floor system
  - a. Use Direct Design Method to Establish Reinforcing requirements
  - b. Input preliminary sizes into PCA-SLAB and evaluate system for gravity loads

Phase II: Lateral System Analysis

- Task 1: Determine Wind and Seismic Loads
  - a. Determine Wind loads using section 6 of ASCE 7-05
  - b. Determine Seismic loads using Equivalent lateral force procedure from ASCE 7-05 and implement dynamic analysis (response spectrum)
- Task 2: Distribute loads to structural components
  - a. Input loads into ETABS model
  - b. Determine loads from each loading scheme and find controlling combination
- Task 3: Design Lateral System Components
  - a. Determine required concrete sections and reinforcement
  - b. Layout rebar

Phase III: Breadth Studies

- Task 1: Building Envelope Analysis
  - a. Thermal and moisture analysis of curtain wall systems
  - b. Cost comparison of curtain wall systems
- Task 2: LEED Design
  - a. Determine LEED criteria to investigate
  - b. Determine cost implications

SCHEDULE

	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14
Task 1: Determine Gravity Loads	■													
Task 2: Design RC Flat Plate system		■	■											
Task 3: Determine wind and seismic loads				■										
Task 4: Build ETABS 3-D Model					■	■								
Task 5: Determine Load Distribution of Lateral Forces							■							
Task 6: Design Shear Walls							■	■	SPRING BREAK					
Task 7: Investigate Cost and Schedule Implications								■						
Task 8: Investigate cost and thermal performance of curtain wall systems										■	■			
Task 9: Investigate LEED design certification											■			
Task 10: Compile final report												■		
Task 11: Create final presentation													■	
Task 12: Present to faculty														■