Hampton Inn & Suites – National Harbor, MD

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Thesis Proposal
12/13/06

Executive Summary

Structural System

The Hampton Inn & Suites in National Harbor, MD, is an eleven story hotel complex which reaches 130 feet in height. Each floor is constituted by a 10-1/2" concrete flat plate and 2-1/2" drop panels at column locations. All concrete is normal weight and ordinarily reinforced with 60ksi rebar. Lateral loads are absorbed and transferred to the foundation by twelve concrete shear walls. All shear walls are one foot thick, but have varying lengths. Foundations consist of spread or strip footings, or a combination of the two. Columns are all 12"x24" and each floor covers approximately 10,000 square feet.

Proposal

After analyzing the structure through the first three technical reports, it became clear that concrete was the correct material choice. Its span to depth ratio sets it apart from other materials, which allows more plenum space throughout the building. However, the thickness of the slab led to considerable seismic base shear. Instead of a normally reinforced 10-1/2" concrete flat plate, I propose to investigate an alternative solution of a thinner post-tensioned slab, and a possible redesign of the building's lateral elements.

Breadth Studies

An obvious breadth study relates directly to the proposed change of flooring systems, and that is a study of constructability. Material costs as well as scheduling issues must be addressed as the construction method is reanalyzed. A comparative cost analysis between the existing conditions and the proposed solution will be conducted, as well as an in depth scheduling investigation.

The second breadth topic that will be explored is the curtain wall system on the façade of the building. A general building envelope study will determine the effectiveness of the current system. An alternative system will be compared to the existing envelope, and cost and schedule factors will also be evaluated.

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Overview

The Hampton Inn & Suites in National Harbor, Maryland, is an eleven story hotel structure that lies in one of America's premiere development sites. A mixed use community, National Harbor boasts a 7,300,000 square foot master plan in George's County, Maryland. With over 2,500 residential units, 4,000 hotel rooms, one million square feet of retail, dining, and entertainment, and 500,000 square feet of class "A" office space, it is easy to see why National Harbor is one of America's premiere up and coming attractions. The owner, OTO Development, chose STV, Inc. for the building's architectural design. The hotel includes amenities such as an indoor pool, internet lounge and an eleventh floor lounge and balcony.

Existing Conditions

Foundations

Foundations consist of spread or strip footings, or a combination of the two, based on the recommendations of the geotechnical report prepared by ECS Mid-Atlantic, LLC, dated December 15, 2005. Soil bearing capacity is calculated at 4500 psf. Tops of footings are assumed to be 14'-2" below finished grade, unless noted otherwise. Typical spread footings are centered below columns and range between 7' square to 15' square. These footings are up to 4' thick under shear walls, while the strip footings are typically 24" deep and 6'-6" wide, and span between the spread footings. Sixteen number 5 reinforcing bars are used longitudinally in the strip footings with eight on top and eight on the bottom. Number 4 bars spaced at 12" on center are used transversely for the top and bottom.

Concrete strengths vary according to placement. Footings and walls receive 4000 psi concrete, while slab on grade uses 3500, both normal weight. Shear walls are to match strengths called out on the column schedule. The slab on grade is reinforced with 6x6-W2.9xW2.9 WWF.

Columns

All columns are 12"x24" with chamfered edges, where exposed. There are 32 columns which span from the foundation to the roof, over 115 feet, with number 4 ties spaced at 12 inches all the way up. Vertical reinforcing ranges from ten number 11 bars to six number 8 bars. In all cases, the vertical reinforcing is distributed along the 24" face of the column in two sheets, one on each side. In all cases, class B lap splices are required for vertical splicing. Concrete strength is normal weight 6000 psi from the foundation to the third floor, where it drops to 5000 psi until it reaches the roof. Typical floor to floor heights are close to 10'.

There is a double-height pool structure on the first floor that rests on grade. Because it intersects with two column lines, the two columns start at the second floor and proceed to the roof. They cannot continue down to the foundation, so their weight is picked up by a transfer beam that is 36" deep, 44" wide, and heavily reinforced with six number 8 bars on top, ten number 11 bars on the bottom with an additional row of six number 9 bars also on the bottom. The reinforcing is tied together with number 5 closed stirrups spaced at ten inches on center. This transfer beam also frames into to two similar girders, tied into columns, at either end.

The last two columns start at the roof and help hold up a mechanical screen wall. The roof of the screen wall consists of W14x22 curved steel members with 1-1/2" galvanized metal roof deck resting on top.

<u>Floor Slabs</u>

The floor slabs are usually 10-1/2" thick when not near columns. At each column there is a 2-1/2" drop panel to combine for a 13" slab thickness. A typical drop panel size is 5'-6"x6'-9" and accounts for 38 square feet. Steel reinforcing is laid out longitudinally and transversely on both the bottom and top. The slab reinforcing ranges from number 4 bars to number 6 bars spaced approximately 12 inches apart. Where not specified, number 5 bars spaced at 6" is the minimum required.

For slabs on level 3 and below, concrete strength is normal weight 6000 psi. Slabs resting on the fourth floor and up have a strength of 5000 psi. Minimum reinforcing protection for floor slabs is 3/4".

The slabs on this project are considered to act as two way slabs, meaning that they carry load in both lateral directions. The three largest bays have dimensions of 29'x26'-10". There are no beams spanning between columns in this case. In the largest bay, the drop panels cover roughly 6 feet of the span, or 20.7%.

<u>Lateral System</u>

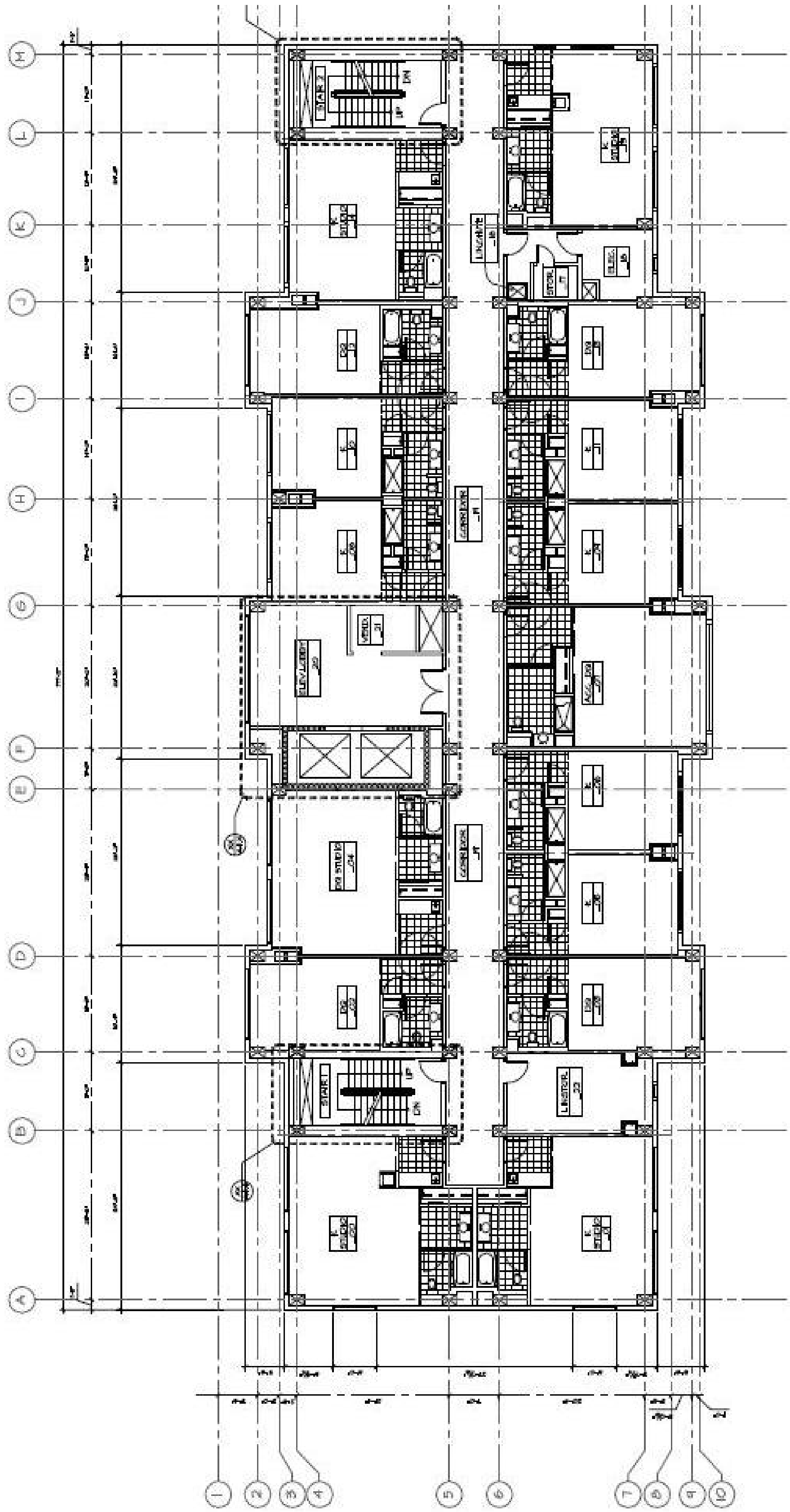
The lateral components of this building are comprised of twelve shear walls of varying length. Five of the twelve are aligned with Plan North, while the other seven are aligned plan East-West. Each shear wall is one foot thick and is vertically reinforced with number 5 bars at 18" on center. They are each tied into the foundation by rebar that matches vertical reinforcing called out in the plans. All rebar is to have class B splices and extend one foot into the foundation with

90^{o} hooks. In most cases, two columns act as bookends for each shear wall. In these cases, the shear wall reinforcement of number 5 bars spaced at 18 inches is continued into the columns and hooked 90^{o}.

The longest shear walls are 23' along grid lines B and C running North to South. In the East-West direction, the longest shear wall is located along grid line 6, and is 19'-6" long. Nine of the twelve shear walls wrap around the two stair cases and lone elevator shaft that are spaced evenly throughout the building's long dimension.

Loading Schedule

	Corridor	Storage	Guest	Roof	Canopy
Slab	148	148	148	148	--
M/E/C/L	8	8	8	8	8
Roof	--	--	--	2	2
Insulation	--	--	--	8	8
Total Dead	156	156	156	166	16
Live	100	125	40	30	30
Partition	--	--	20	--	--
Total	256	281	216	196	48



3RD THROUGH
7TH FLOOR PLAN

Problem Statement

Concrete is the general material of choice for most hotel designers. It offers many unique advantages to other systems: it has a slim profile between floors, it is cost efficient, and it is easily cast on the job site. The problem with normally reinforced concrete flat plates is that, due to its dead weight, it makes the structure weigh more than a more 'athletic' system would. At 10-1/2" thick, the flat plate weighs in at 131 pounds per square foot. This considerable dead weight dictates that the seismic base shear, according to ASCE 7-05, will be significantly greater than a lighter structure.

Proposed Solution

To combat the high seismic base shear discovered in technical report three, a lighter alternative to normal weight concrete flat plate will be investigated. While researching flooring systems for technical report two, it was conservatively determined that an 8" post tensioned slab would be adequate for the applied loads. This decrease in slab profile results in an approximate savings of 25% from the original weight of the slab. Additionally, because the slab will be lighter, the drop panels located at each column will be redesigned where necessary, or completely eliminated if deemed acceptable. Smaller column sections may be possible due to the decrease in punching shear experienced by the concrete slab. Overall, the switch to a post tensioned flooring system will reduce the weight of the building considerably. A possibility also arises that the number of shear walls could be decreased proportionally to the reduction of seismic base shear. This gives the project team even more flexibility in the design of the structure.

All structural calculations will be carried out according to current building codes, such as ASCE 7-05, IBC 2003, ACI, and all other codes that apply. A RAM model of the building was created for technical assignment three, and this model can be adapted to model a lighter concrete floor section. This will indicate if the lateral system can be modified due to a less significant seismic base shear. Slab design will be in accordance to ACI provisions for post tensioned floor applications.

Breadth Studies

An obvious breadth study relates directly to the proposed change of flooring systems, and that is a study of constructability. Material costs as well as scheduling issues must be addressed as the construction method is reanalyzed. A comparative cost analysis between the existing conditions and the proposed solution will be conducted, as well as an in depth scheduling investigation.

The second breadth topic that will be explored is the curtain wall system on the façade of the building. A general building envelope study will determine the effectiveness of the current system. An alternative system will be compared to the existing envelope, and cost and schedule factors will also be evaluated.

Analysis Breakdown

Floor System

1. -Analyze superimposed dead loads per construction documents
   -Through ASCE 7-05, determine proper live loads

2. -Estimate slab thickness and post tension tendon profile
   -Refine calculations of slab thickness and tendon profile

3. -Determine reinforcement according to ACI

Lateral System

1. -Verify wind and seismic loadings through ASCE 7-05

2. -Distribute lateral loads to shear walls

3. -Design lateral resisting elements

Breadth Studies

1. -Analyze construction issues such as cost and schedule

2. -Thermal examination of curtain wall system and building envelope
   -Cost analysis of proposed system

Schedule

Task Week -->	15-Jan	22-Jan	29-Jan	5-Feb	12-Feb	19-Feb	26-Feb
~~Determine Gravity Loads, Live Loads~~	Done						
~~Estimate Slab Thickness~~	Done						
Preliminary Tendon Profile		In Progress					
Refine Slab Calculations			In Progress				
Determine Reinforcement through ACI							
Verify Lateral Loadings							
Distribute Lateral Loads							
Design Lateral System							
Construction and Schedule Investigation							
Curtain Wall System Analysis							
Final CPEP Updates and Maintenance							
Final Review of Report, Printing, Binding							
Present to Faculty							

Task Week -->	5-Mar	12-Mar	19-Mar	26-Mar	2-Apr	9-Apr	16-Apr
Determine Gravity Loads, Live Loads							
Estimate Slab Thickness							
Preliminary Tendon Profile							
Refine Slab Calculations							
Determine Reinforcement through ACI							
Verify Lateral Loadings							
Distribute Lateral Loads							
Design Lateral System							
Construction and Schedule Investigation							
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Final CPEP Updates and Maintenance							
Final Review of Report, Printing, Binding							
Present to Faculty							

Legend: ~~Strikethrough~~ = Completed
Italics = In Progress