

---

# Hilton Hotel at BWI Airport

Linthicum Heights, MD



## **Thesis Proposal**

Thomas Sabol

Structural  
Advisor: Dr. Ali M. Memari  
The Pennsylvania State University  
December 15, 2006

---

---

## **EXECUTIVE SUMMARY**

### ***Building Description***

Hilton Hotel at BWI Airport is an 11-story, 203,300 s.f hotel located in Linthicum Heights, Md. The primary structural entity is cast-in-place reinforced concrete. Typical floors are 7-1/2" post tensioned flat plate systems, while the lateral system comprises of concrete shear walls.



### ***Proposal***

Since hotels generate revenue based on occupancy, I am proposing an alternate structural system that will allow the hotel to open earlier due to a faster erection time. The alternate floor system will maintain a similar floor thickness, which will not increase the height of the building.

### ***Solution***

I intend to design a *Girder-Slab* system with steel columns for all floors. If this is not feasible for floors ground through 3, a composite beam and slab will be utilized for those floors. A braced frame lateral system will be investigated to maintain the continuity of a steel structure.

### ***Breadth Topics***

With a redesign of the structural system, I plan to investigate the impacts it will have on construction, cost, schedule, and sequencing of erection. The second breadth topic will be an investigation on how consumers feel regarding their stay at a LEED rated hotel compared to a non-LEED rated hotel.

---

**TABLE OF CONTENTS**

Executive Summary .....	i
Introduction.....	1
Background.....	1-4
Foundation .....	1-2
Columns .....	2
Floor System .....	2-3
Lateral System .....	3
Adjacent Structure .....	3-4
Problem Statement .....	4-5
Problem Solution .....	5-6
Solution Method.....	6-7
Breadth Topics .....	7
Task & Tools.....	7-8
Time Tables .....	9

## INTRODUCTION

Hilton Hotel at BWI Airport is an 11-story, 131' tall hotel located in Linthicum Heights, Md. This 203,300 s.f. hotel is owned and managed by the Buccini-Pollin Group, and was designed by the architecture firm of Brennan Beer Gorman Monk. Engineering the structure of the hotel was Holbert Apple Associates, while construction was carried out by HITT Contracting Inc.

This hotel is located 2 miles from the BWI Airport as well as a few minutes from Baltimore's Inner Harbor, making it an ideal stay for business and leisure. An elaborate 8,300 s.f. ballroom with an adjacent assembly/pre-function room may be found on the



first floor. The hotel offers dining with the Acqua restaurant and recreation with a swimming pool and hot tub on the second floor as well as an exercise room nearby. Each guest room is equipped with a 32" flat panel television and views of the Baltimore's Inner harbor and BWI. An 80-car parking level is located underneath the hotel ground floor. An assumed height restriction on the building is imposed due to the close proximity of the BWI Airport.

## BACKGROUND

### *Foundation*

Various types of shallow foundations consisting of reinforced concrete transfer building loads to the earth. Spread footings ranging in size of (3'-0" by 3'-0" by 12") to (10'-0" by 10'-0" by 40") transfer gravity loads from columns to the earth. Strip footings carry load from interior concrete basement walls as well as interior masonry walls. Exterior reinforced concrete basement walls are supported by stepped footings around the perimeter of the sub grade parking garage. Three concrete mat foundations reinforced top and bottom with #8 bars 12" o.c. each way carry load from the three groupings of shear walls. Mat foundations are 36" thick under elevator shear walls, and 32" thick under each group of stairwell shear walls. Concrete for foundations is specified to reach

a 28-day  $f'c = 3000$  psi. The floor system for the Parking Level is a 5" slab-on-grade (SOG) reinforced with 6x6 w2.0 x w2.0 WWF. A concrete strength of  $f'c = 3500$  psi was specified for the SOG.

### ***Columns***

Rectangular reinforced concrete columns carry gravity loads from the floor systems in the building. Columns are typically spaced about 27'-0" o.c. and vary in sizes seen in table below. Compressive strengths specified for columns located on floors 4-11 are 4000 psi, while the remaining lower floors are specified for 5600 psi.

**Table 1: Rectangular column sizes**

14x14	12x12
14x26	18x18
14x76	18x26
16x16	26x14
16x28	

### ***Floor System***

Levels ground through three consist of a two-way mild reinforced concrete slab. Slab thickness is 9" with typical 9'x9'x4" drop panels around the columns. The bottom reinforcement in the concrete slab consists of #5 bars at 12" o.c. each way, while the top of slab reinforcement varies in reinforcing bars.

Floors 4-11 are typical framing plans for the hotel guest room floors. The existing structural floor system is a two-way post-tensioned reinforced concrete flat plate. Thickness of the slab is 7-1/2" while the concrete is specified to reach an  $f'c = 4000$  psi. Reinforcing the bottom of the slab is a mat of #4 bars 30" o.c. in each direction. The top reinforcement has various sizes of bars placed in each direction. Typical forces applied on tendons are 295<sup>K</sup> in the East-West direction while 24<sup>K/ft</sup> in the North-South direction. On the interior of the system, tensioning of tendons was achieved, by two pour strips 4'-0" that were left un-poured so anchors could be set. Strips were then poured at a later time.

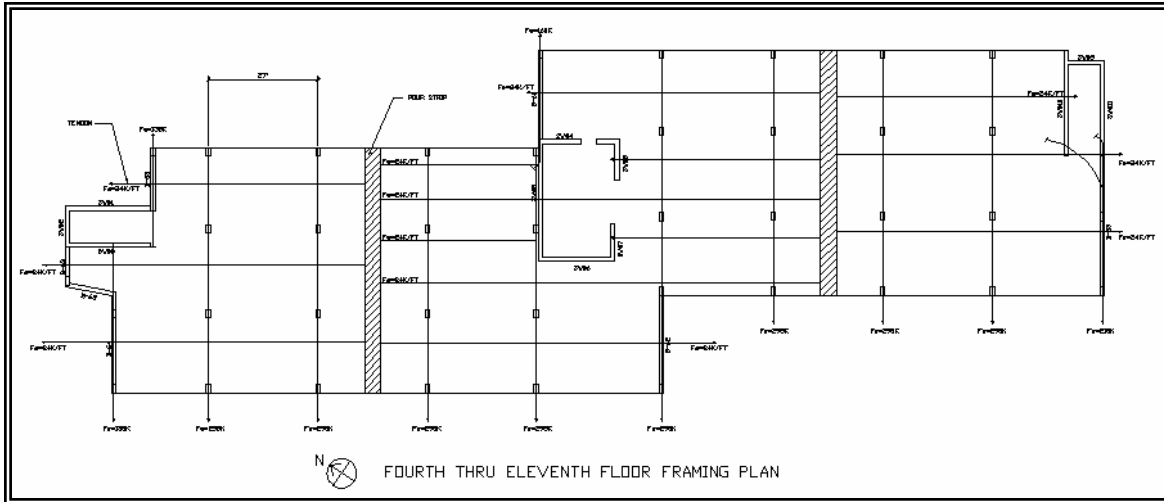


Figure 1: Typical structural floor plan

**Lateral System**

Twelve reinforced concrete shear walls comprise of the lateral load resistance system. Eleven of which span the building height and are located in three locations: 3 walls around two stairwells located near either edge of the north and south sides, and 5 walls are located around an elevator core in the center of the building. The twelfth shear wall is located on the North side of the building and only spans vertically from foundation to the second floor. Shear walls are 1'-0" thick and are specified to reach a 28-day  $f'c = 4000$  psi. Figure 1 shows the 11 shear wall locations on a typical floor plan.

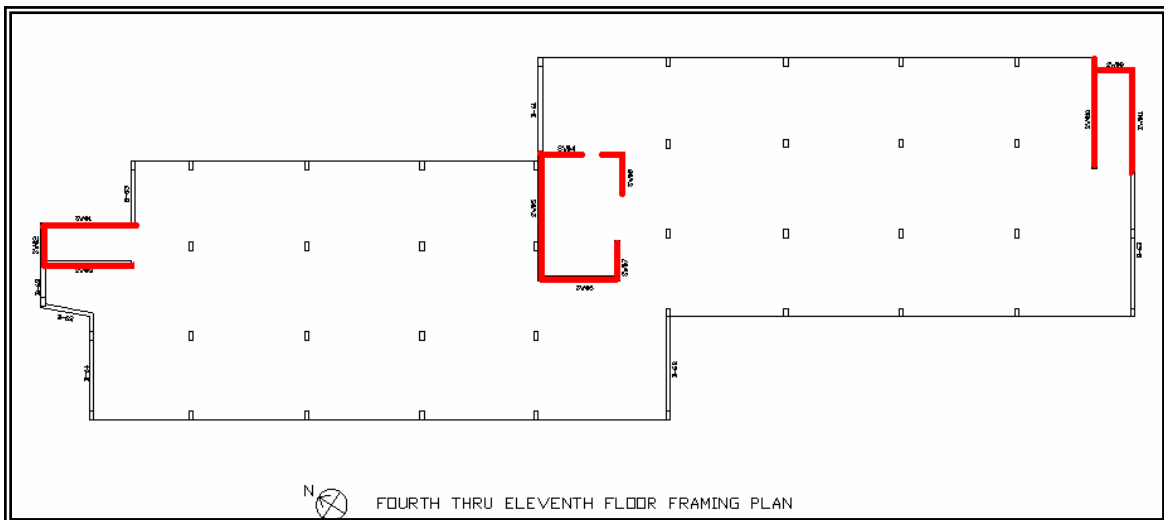
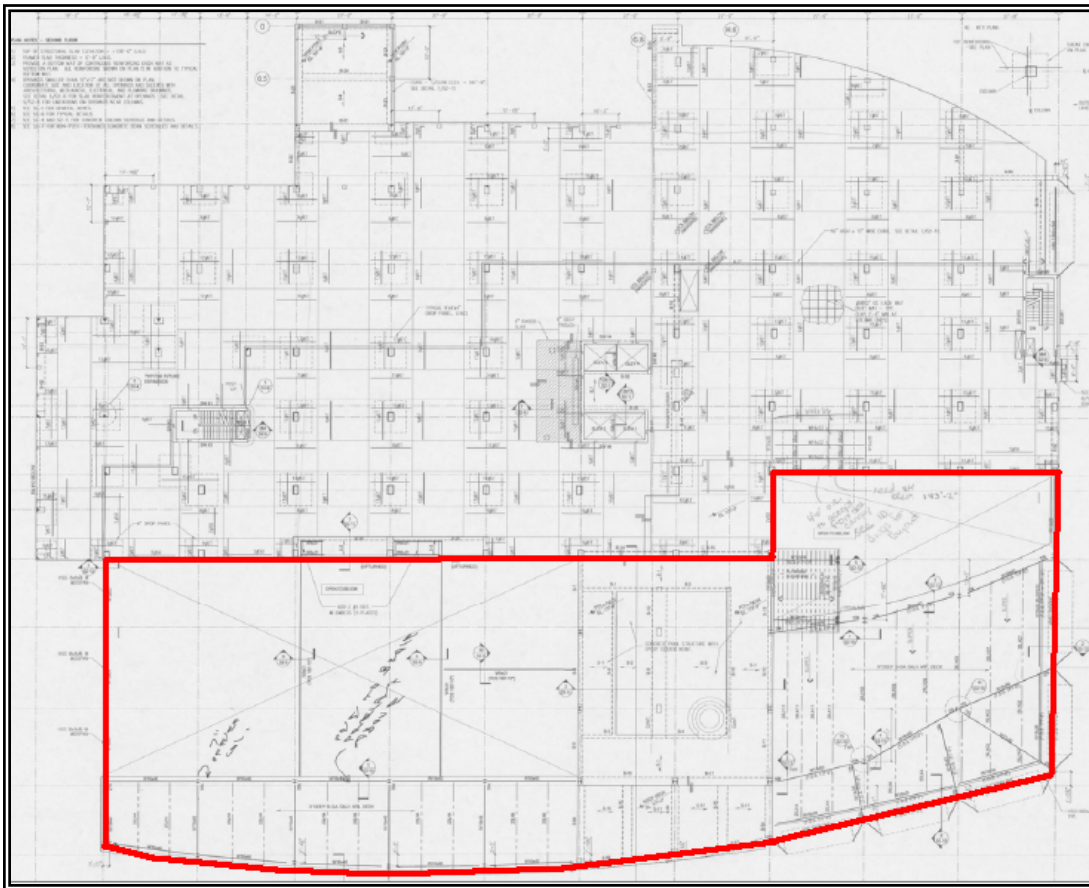


Figure 2: Shear walls on a typical floor plan

### ***Adjacent Structure***

The double-heighten ballroom, adjacent assembly room, pool area, and main entrance spaces are all enclosed by a structural steel system. For recognizable purposes this area of the building is being called the “adjacent structure”, even though the structure is fully integrated into the building with no building expansion joints. Area of the “adjacent structure” is outlined in red in figure 3. This structure will remain the same for my thesis proposal.



**Figure3: 2<sup>nd</sup> Floor plan with highlighted “Adjacent Structure”**

### **PROBLEM STATEMENT**

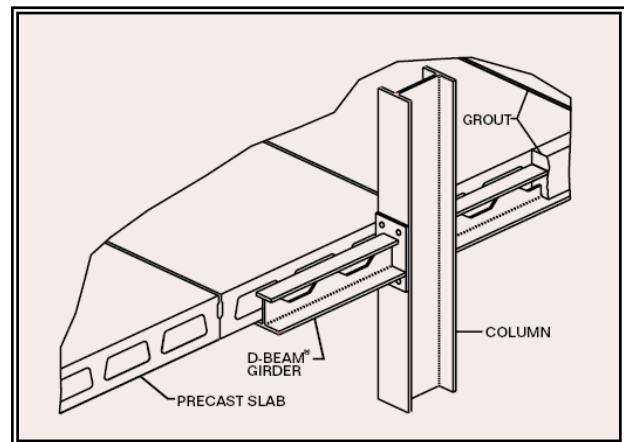
Due to the constraints of the project, the needs of the client, and the involvement of construction professionals, the most efficient structural system was designed. This became a realization while engineering alternate floor systems for Technical Report 2. Because of this the intent of my thesis will be to redesign the structure from cast-in-place concrete to pre-cast deck and steel. This alternative was chosen because of its shallow

floor depth and the speed of its erection. Serviceability of proposed system will be checked against deflection and vibration. To do this I will use loads and code requirements from the IBC, ASCE7, and AISC, as well as any other pertaining to this matter.

## PROBLEM SOLUTION

### *Floor System*

The alternate floor system to be analyzed is a newer system in the industry called *Girder-Slab*. Utilizing a steel shape member and pre-cast hollow core planks, the combination creates a monolithic floor slab assembly. Construction of this system is fairly easy with planks being brought to the site in pieces and placed onto the steel D-shape members. D-beams and planks are grouted upon placing of planks. An 8" thick pre-cast hollow core plank will be used with a DB9x46 beam. The overall floor thickness will be 10".



It should be noted if *Girder-Slab* is not feasible for floors ground through 3, a composite concrete beam and slab will be utilized. This will still allow for a continuity of a steel system. In the floor investigation for Technical Report 2, only typical floors were considered.

An economic analysis of the proposed system compared to the existing will be conducted. Although the girder-slab system may have a higher initial cost compared to the existing, it would increase the speed of erection substantially compared to the schedule of the already built structure. This would result in an earlier opening date for the hotel and in turn would enable the owner to increase their revenue based on an earlier occupancy date.



***Lateral System***

In keeping with the speed of erection of the *Girder-Slab* system, a lateral system composed of steel braced frames will be investigated. Brace frames will have to be able to resist seismic and wind loads prescribed in ASCE7-05, as well as any torsional moments caused by these loads.

**SOLUTION METHOD*****Floor System***

The Girder-Slab system will be designed in accordance with the *Girder-Slab Design Guide*. Design of floor systems will be carried out by hand calculations and Excel spreadsheets. Columns will be designed in accordance with the Steel Construction Manual, 13th Edition, 2005. A Ram Steel model will also be created to assist with the design process. Producing a Ram Steel model of the new structure will allow for comparison of computer generated column sizes to columns sized by hand. Live loads will be determined using ASCE7-05 chapter 2. Load combinations will be determined to consider worse case loading.

A construction schedule will be prepared using Primavera integrated with research conducted on the construction of a *Girder-Slab*/ steel structure. A detailed cost analysis of the system will be performed utilizing R.S. Means and research on the *Girder-Slab* system. If schedule and cost of the existing system cannot be delivered by the contractor, a similar procedure will be done to determine the cost and schedule of the post-tension flat plate system.

A revenue estimate will be determined by estimating the daily room occupancy of the hotel and using the average room price listed on the website. A percentage of income will also be estimated by miscellaneous items, e.g. restaurant, bar, and usage of ballroom/ assembly room. Research will be conducted to estimate daily room occupancy and prices of such items by contacting the hotel. Again this estimate is being conducted to see if the earlier opening date, caused by faster erection of the structure, will offset the initial cost of the proposed system to the existing system.

---

### ***Lateral System***

The lateral system will be designed using wind and seismic loads set forth in ASCE7-05 chapters 6, 11, 12, and 16. Design of braced frames will be in accordance with the AISC seismic design handbook. The Ram Steel model will be utilized in the design of the brace frames also.

### **BREADTH TOPICS**

Engineering an alternate structural floor system from the existing requires changes in construction methods and schedules. A breadth topic that investigates more thoroughly how the erection process of the steel should be coordinated, as well as creating a



sequence of erection. A detailed schedule of the erection as well as placement of cranes will be determined.

The second breadth topic will be an investigation on how consumers feel regarding their stay at a LEED rated hotel compared to a non-LEED rated hotel. A survey questioning consumers' choices and wants regarding their hotel stay while keeping the LEED's emphasis in mind will be conducted. Various people of age, sex, race and social status will be pooled for the survey. Though this survey cannot be generalized to the general public's interest, it will produce an idea of how various people view the idea of a LEED rated hotel. From the results of this survey, it can be determined whether or not a survey that could generalize to the entire public should be conducted. As a student with limited resources, a generalized survey is not feasible, but with the help of a chain of hotels such as Hilton, it can be accomplished.

### **TASKS & TOOLS**

Part I. *Girder-Slab* Alternative Floor System

Task 1. Research in depth *Girder-Slab* system

- a) Conduct interviews with engineers familiar with the system
- b) Write introduction describing how system works

Task 2. Establish trial member sizes

- a) Use superimposed dead loads found in earlier tech reports as well as live loads from ASCE7-05
- b) Establish efficient bay sizes
- c) Use the *Girder-Slab* Design Guide

Task 3. Determine loads to transfer to columns

- a) Find self weight based on member sizes from Task 2
- b) Determine initial columns sizes using hand calculations and RAM

Part II. Main Lateral Force Resisting System

Task 1. Confirm wind and seismic loading

- a) Use ASCE7-05 Chapter 6 Analytic Procedure for wind loads
- b) Use ASCE7-05 Chapter 12 Equivalent Lateral Force Procedure for seismic loads

Task 2. Design lateral load resistance system

- a) Input loads into RAM model
- b) Spot check with hand calculations

Part III. Breadth Topics

Task 1. Produce a construction schedule and cost estimate

- a) Use R.S. Means and contractor information for duration data
- b) Use Primavera to compose a schedule
- c) Use R.S. Means and contractor data to determine cost impacts
- d) Analyze resulting schedule and estimate compared to original

Task 2. Analyze LEED hotel survey results

**TIME TABLE**

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
Task 1: Research of Girder Slab									S
Task 2: Establish trial member sizes									P
Task 3: Build RAM model									R
Task 4: Determine loads on columns									I
Task 5: Confirm wind and seismic loads									N
Task 6: Design lateral load system									G
Task 7: Investigation of cost and construction schedule for redesign									
Task 8: Compile survey results and analyze									B
Task 9: Compile final report									R
Task 10: Create final presentation									E
Task 11: Present to AE faculty									A
Task 12: Breathe Easy									K

	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17
Task 1: Research of Girder Slab	S								F
Task 2: Establish trial member sizes	P								I
Task 3: Build RAM model	R								N
Task 4: Determine loads on columns	I								A
Task 5: Confirm wind and seismic loads	N								L
Task 6: Design lateral load system	G								S
Task 7: Investigation of cost and construction schedule for redesign									
Task 8: Compile survey results and analyze	B								W
Task 9: Compile final report	R								E
Task 10: Create final presentation	E								E
Task 11: Present to AE faculty	A								K
Task 12: Breathe Easy	K								