Hilton Baltimore Convention Center Hotel

Western Podium

Baltimore, MD

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Structural Option

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Thesis Proposal

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EXECUTIVE SUMMARY

The HBBCH is a convention center as well as a hotel in downtown Baltimore. It consists of two towers of hotel rooms as well as a large podium that includes a pool/fitness area, grand ballroom, and parking garage.

The existing structural systems consist of normal weight two-way flat plate concrete slab with drop panels on six floors, a foundation system that consists of caissons and spread footings, and a lateral system that consists of rigid moment frames that are inherent in monolithic concrete-framed construction as well as shear walls placed around the elevator shafts and stairwells.

Although the structural systems are designed to be as efficient as possible different systems were looked at in three technical reports, and it was found that the only gravity system that could perform as well as the current is a post-tensioning slab system. This will hopefully allow for larger floor-to-floor heights, lower building weight, and larger spans between columns. Also the steel framing system underneath the pool/fitness area could be changed from steel braced frames to steel staggered trusses, which will allow for larger spans, and hopefully a decrease in overall building weight. Due to the chance of a significant change in building weight there will be an impact on the foundation system as well.

Of course when modifying the structural system of a building, the construction process and costs will be affected directly. In order to fully understand the impact of the modifications of the structural systems the schedule and construction costs of the building will be taken into account.

Finally in order to demonstrate the improved environment for the tenants of the hotel and groups that use the ballroom from the redesigned structural systems, sound and vibration control studies will be conducted. In regards to the sound study various wall/partition, and floor assemblies will be analyzed and assigned STC and NR ratings. With the aid of extensive research, a report will be made to show how the existing two-way flat plate floor system and the proposed post-tensioning slab system compare in sound transmission and vibration control.

INTRODUCTION

The Hilton Baltimore Convention Center Hotel (HBCCH) is located right in downtown Baltimore next to the Baltimore Orioles stadium Camden Yards, and located blocks away from Inner Harbor. HBCCH is broken up into two podiums, East and West. The eastern podium is a 4-story building that houses a junior ballroom, meeting rooms and a multipurpose restaurant. The western podium is a 21-story building that houses the main hotel lobby, parking garage, grand ballroom with corresponding kitchen, meeting rooms, pool/health club, and 757 hotel rooms. The grand ballroom has moveable partitions located in the ceiling that allow multiple events to take place there. The western podium offers over 900,000 SF of hotel space. The structure of the western podium consists of concrete beams, columns and shear walls to resist lateral loading. The green roof above the grand ballroom is supported by special joists and while the pool above the grand ballroom is supported by steel beams.

Fig. 1 - Photo of Grand Ballroom. (Note Partition tracks in ceiling)

FOUNDATION SYSTEMS

The foundation of the western podium consists of caissons and spread footings. The spread footings will bear on firm natural soils and have a minimum bearing capacity of 4ksf. The drilled caissons will have straight shafts to bear on gneiss rock and have a minimum safe bearing capacity of 100ksf. The depths of the bottoms of the caissons vary from 14 feet all the way up to 32 feet below level B2's floor slab. The compressive strength of the drilled caissons and spread footings are 3500 psi, while the caisson caps that the columns bear on have a compressive strength of 4000 psi. A typical caisson section is shown in figure 2.

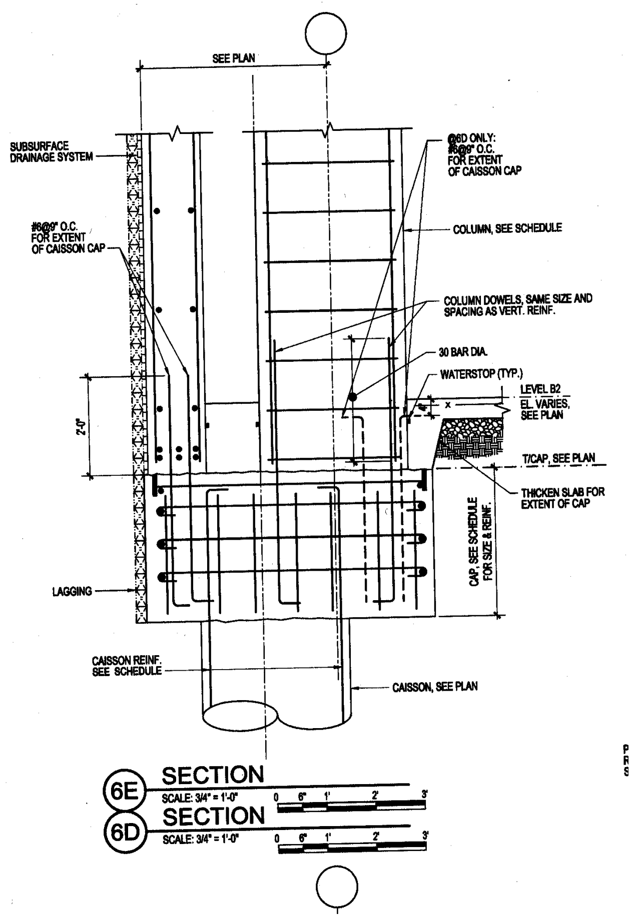


Fig. 2

FLOOR SYSTEM

The floor system consists of two-way slabs whose thicknesses range from 8" thick on the floors with hotel rooms to 11" in the underground parking garage. The slabs shall are reinforced with 6x6-W1.4xW1.4 WWF, except for the slab-on-grade which is reinforced with 6x6-W2.1xW2.1 WWF as seen in figure. 3. Drop panels are located on the B1, 1st, Mezzanine level, 2nd, 3rd, and 15th floors. The drop panels vary from 5" up to 11" in thickness. Typical spans for floors consisting of hotel rooms are 26'-10". The column system layout is a very uniform layout consisting of typical exterior bays of 26'-10" x 18'-8" and interior bays of 26'-10" x 19'-7". All columns consist of either a gravity resisting member or a combination of lateral and gravity resisting members. Column sizes vary from 12" x 18" columns to 44" x 30" Columns. Sloped columns can be found on the second and third floors of the western podium. This is to allow maximum open area for the ballroom as well as to allow for the typical grid for the hotel rooms in the two towers. A typical sloping column is shown in figure 2 as well as a typical concrete column post on beam detail is shown in figure 2.

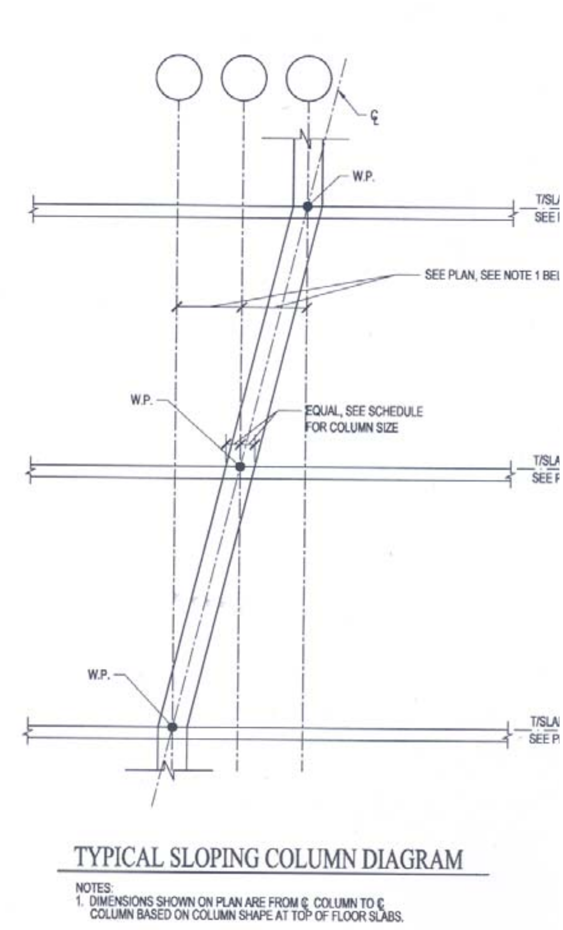


Figure 3

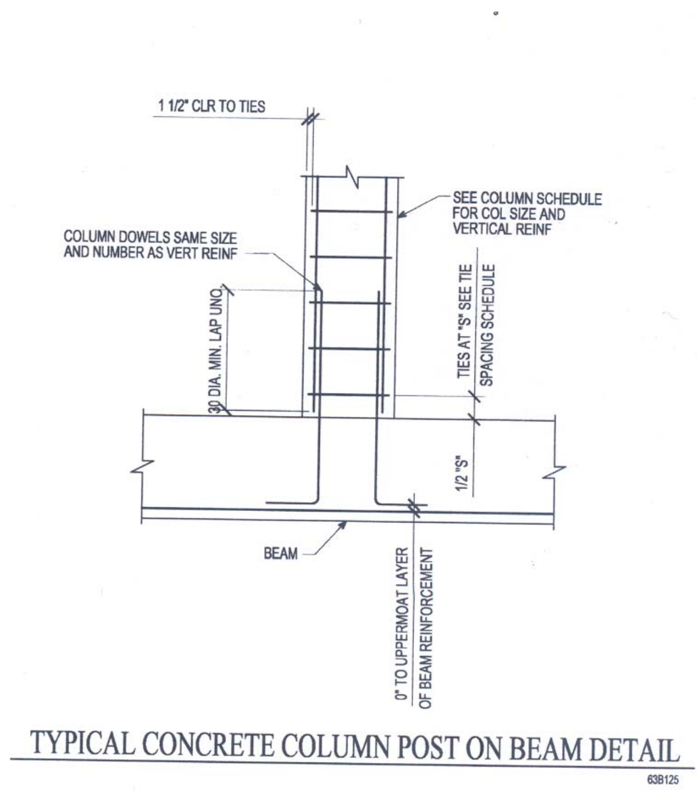


Figure 4

LATERAL SYSTEM

The lateral resisting system for wind and seismic loads consist of rigid moment frames that are inherent in monolithic concrete-framed construction. A shear wall system is used as well for resisting wind and seismic loads. Shear walls are located around the elevator shafts and stairwells. The shear walls thickness ranges from 12" up to 18". A shear wall plan for the elevator is shown in figure 5. A model of the lateral system is shown in figure 6.

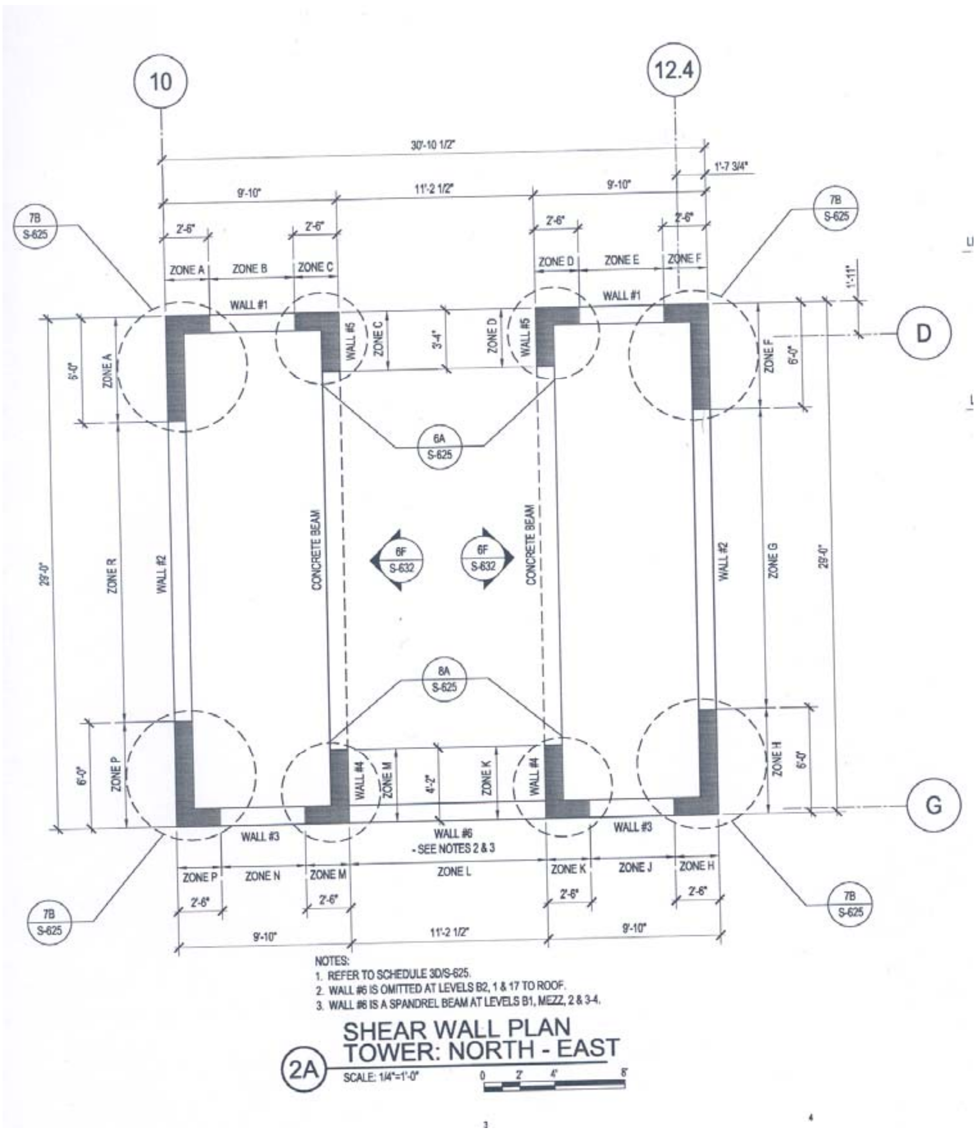


Figure 5

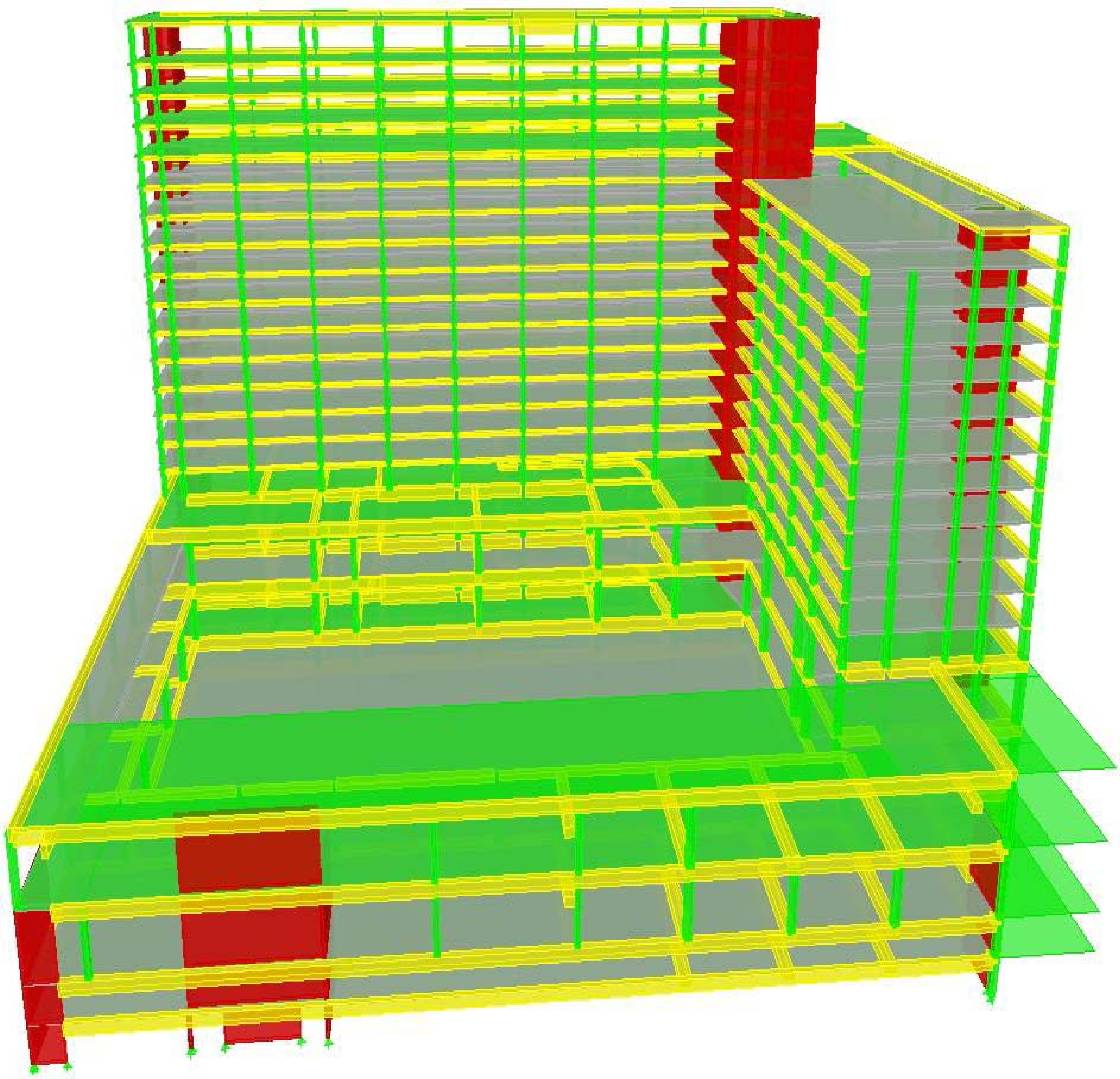
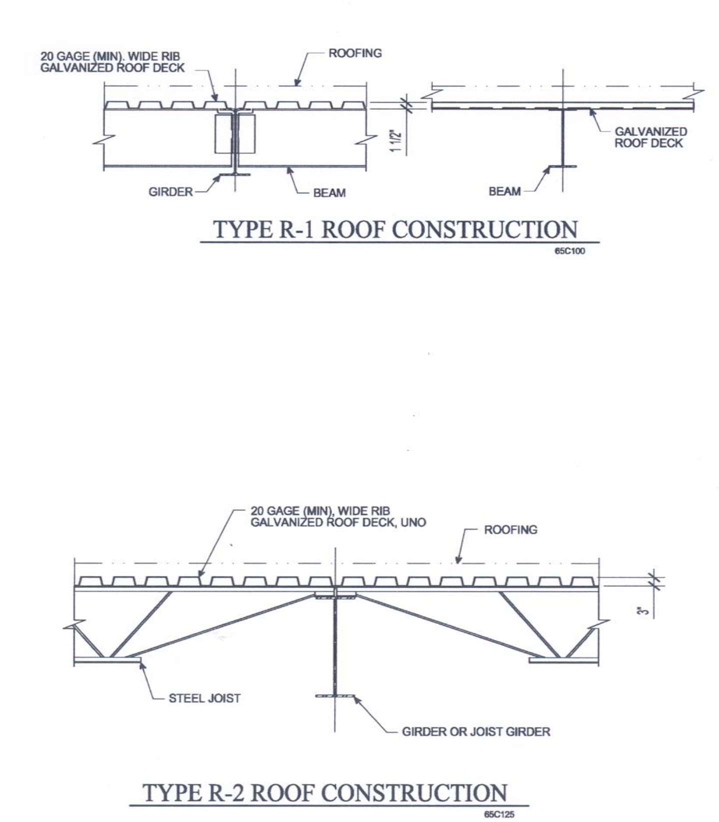


Figure 6

ROOF SYSTEM

As shown in Fig. 3, the roof system either type R-1 or R-2 roof construction. Type R-2 roof construction is used for the green roof above the grand ballroom and exercise room while type R-1 roof construction is used for the roofs located on the 15th and 21st floors. Fig. 4 shows the transition from the green roof assembly to the corresponding roof construction assembly.



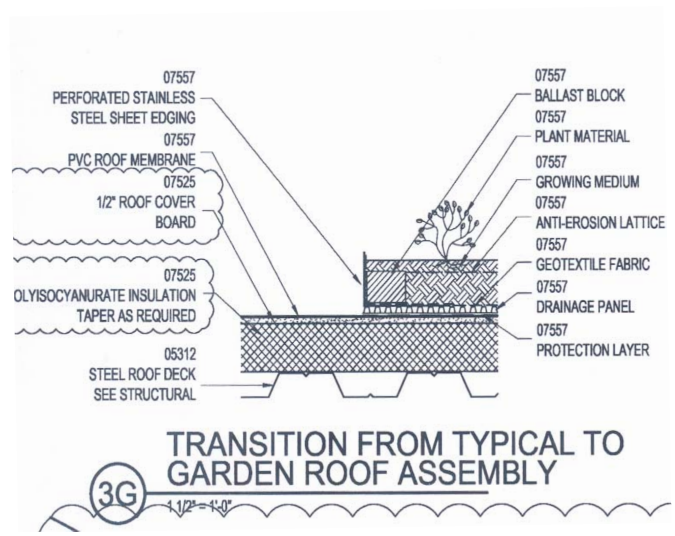


Figure 8 - Green Roof Transition

Figure 7 - Roof Construction Details

PROBLEM STATEMENT

Project Goal: To redesign the gravity system throughout the building as well as redesign steel frame system underneath buildings pool.

The Baltimore Hiltons current gravity system design is a two-way flat plate slab with drop panels on six floors. This gravity system was found to be the most efficient system available. During Technical Report II, A Structural Study of Alternative Floor Systems, it was found to be the most effective out of the four systems analyzed. However a fifth system, post-tensioned concrete slab, was mentioned but not analyzed. A post-tensioned floor system would hopefully allow a larger floor-to-ceiling height as well as longer spans, faster construction and reduced weight compared to two-way flat plate slabs. The framing system underneath the pool and fitness room consist of steel beams and joists. Around and underneath the pool there are two levels of steel beams. One level is around the pool while there is another level of steel beams that run directly beneath the pool. A different system that could be instead of the beams is staggered trusses. Staggered Trusses would allow for a larger span between members as well as a reduced weight compared to just using steel beams.

PROBLEM SOLUTION

As stated above a proposed solution for the gravity system would be to redesign all the floor slabs using post-tensioning design. It was noted in Technical Report II that this could be a more efficient system than two-way flat plate slabs but it was never analyzed. Using post-tensioned slabs would allow for smaller slab thickness, which in turn create larger floor-to-ceiling heights and decrease the weight of the building.

The proposed solution for the steel framing system under the pool and the fitness room as stated above would be to use staggered trusses. This would allow for larger spans between members and hopefully decrease the weight of the building causing.

Both solutions decrease the building weight which in turn will have an impact on the existing foundation system of caissons and spread footings at certain spots.

BREADTH TOPICS

In addition to the structural proposal, two non-structural aspects of the Baltimore Hilton Convention Center will also be investigated. With the redesign of the gravity system and steel framing system significant changes pertaining to construction management and architecture are to be expected.

Breadth 1: Construction Management Study
In order to properly evaluate how a post-tensioning slab system will affect the project, a cost and schedule analysis will be taken into consideration. By changing the current two-way flat plate system to a post-tensioning system, the construction process and materials will be different. Prior to the beginning of this investigation, research and an interview with the project manager will be conducted to acquire any pertinent information regarding the overall construction process. With the aid of Microsoft Project and Navis Works, a schedule will be created to determine how constructability and overall project costs are affected.

Breadth 2: Acoustical and Vibration Control Study

A major concern with having a pool and fitness room directly above the grand ballroom is the sound transmission from all the activity in the pool and fitness room down into the grand ballroom. As well as the sound transmission between the grand ballroom when it is divided up into multiple rooms to accommodate multiple events. Also a vibration control study will be done for the hotel towers. Various floor and wall assemblies will be compared to determine the best option for sound control and vibration control. Also the post-tensioning slab system will be compared to the current two-way flat plate system to demonstrate how the redesign improves sound and vibration control. STC ratings, which represent an approximated performance of a material in reducing the transmission of speech, will be determined for the various wall and floor assemblies including the two different floor systems. Also NR values will be considered to compare how well various floor and wall assemblies can isolate the hotel rooms (receiving room) from an adjacent room or hallway (source).

TASKS AND TOOLS

Primary Study – Structural

1.) Design Post-tensioning slab system
    a. Create 3D ETABS model
    b. Hand calculations according to ACI 318-08
        i. Determine Slab thickness
        ii. Tendon Layout
        iii. Moment Capacity
2.) Design Concrete Columns
    a. Maintain a similar column layout to the current layout as much as possible
    b. Determine Loads from new floor system (based on Task 1)
    c. Hand calculations – ACI 318-08
    d. Design columns using PCA column
3.) Design Staggered Trusses
    a. Research Staggered Trusses
    b. Determine loads on system
    c. Size member of trusses
4.) Evaluate and Redesign (if necessary) Foundation System

Breadth

Construction

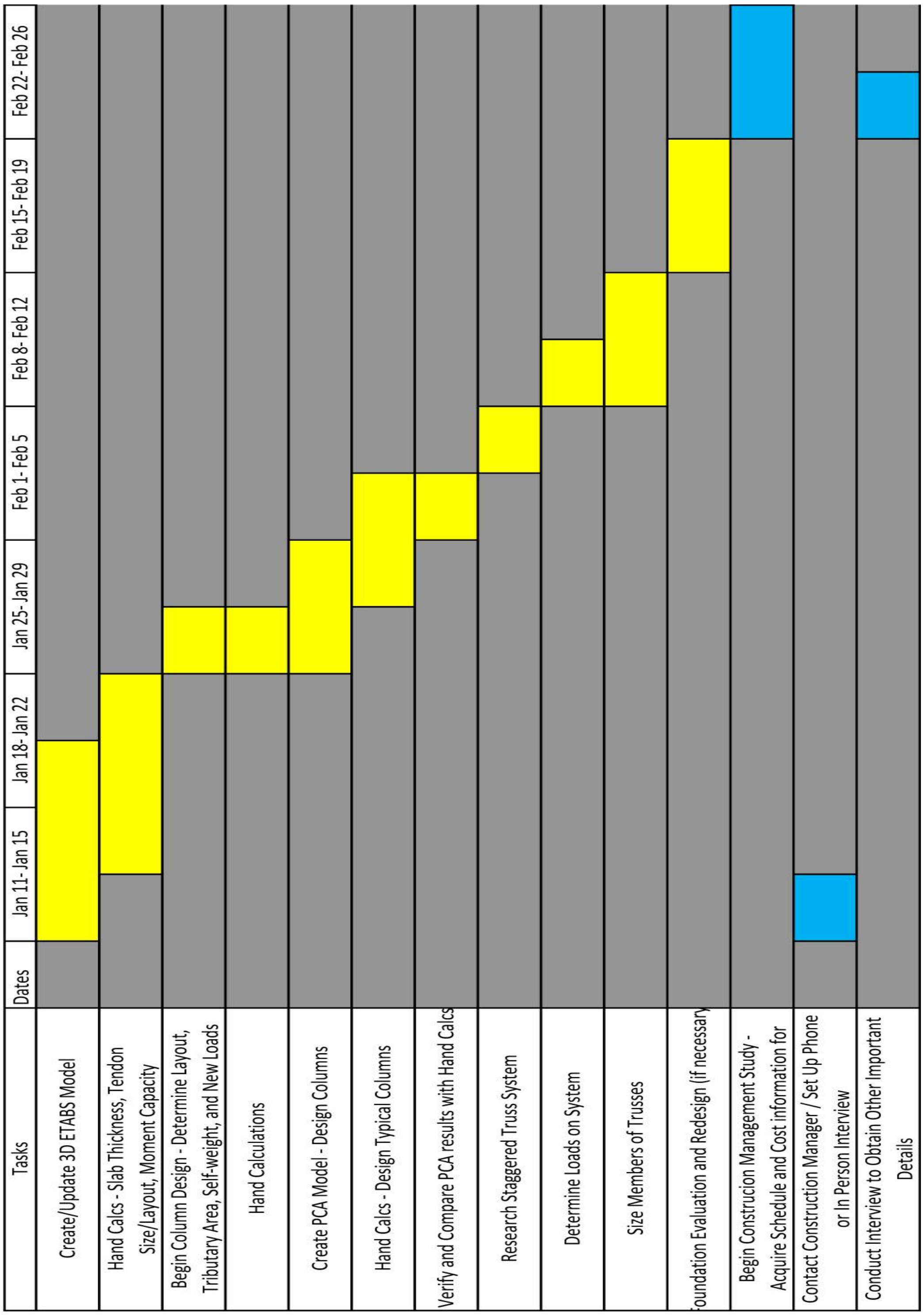
1) Acquire schedule, cost and other construction related information for existing building.
  a) Interview (by phone or in person) project manager
  b) Research and gather related information
2) Create schedule for proposed building
  a) Research
  b) Microsoft Project – create schedule
3) Research Labor Unions (specifically in Baltimore)
4) Compare existing building to proposed design
  a) Cost (material/labor)
  b) Schedule and time constraints
  c) Constructability
  d) Material and laborer availability

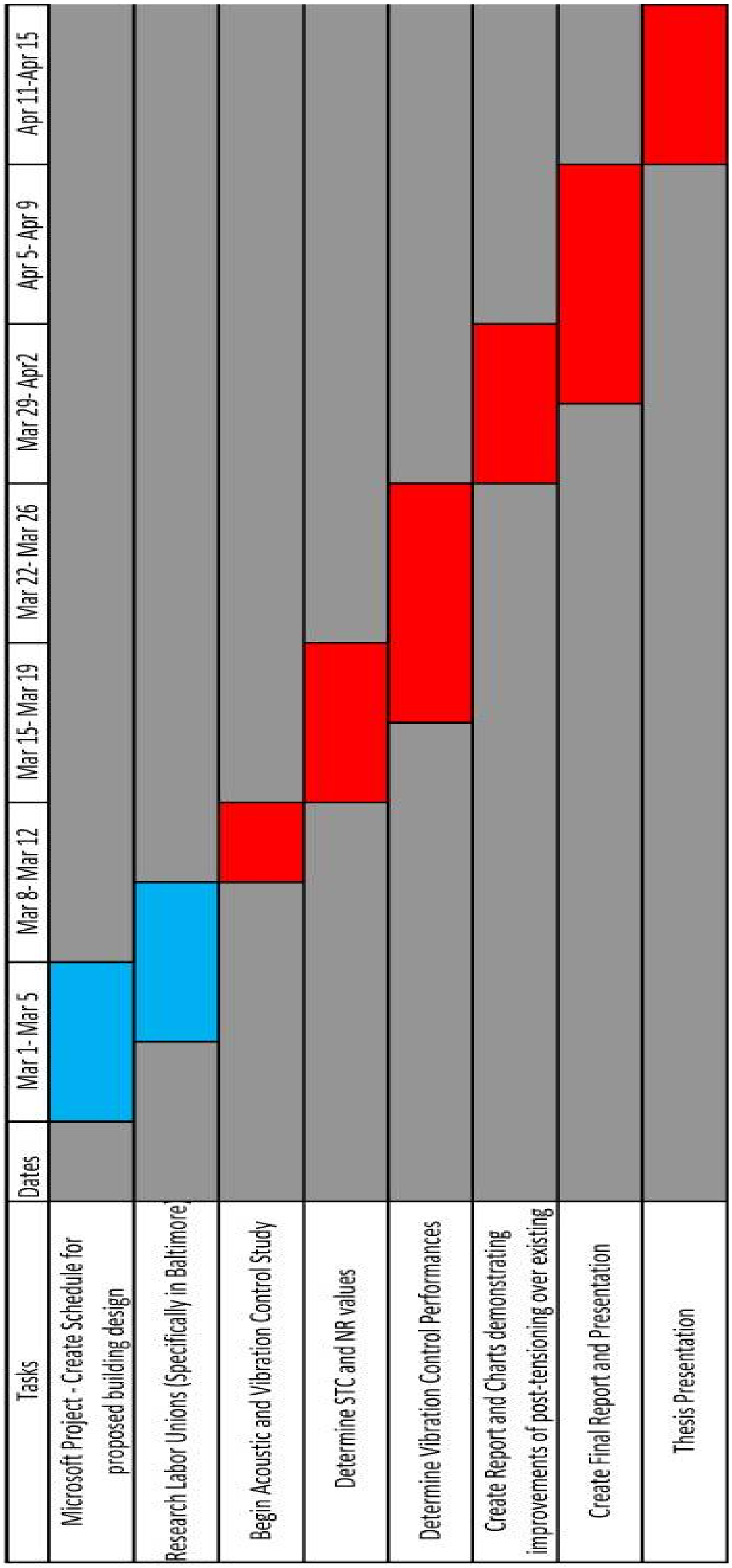
Acoustic and Vibration control Study

1) Research the acoustic control performance of the existing floor system and proposed system
2) Determine STC and NR ratings for each system
3) Sound control comparison study
4) Repeat process for various wall and partition assemblies
5) Research vibration control performance of existing and proposed floor systems
6) Vibration control comparison study

7) Gather data and make report explaining both the magnitude and significant acoustical and vibratory improvements or hindrances of system changes.

Schedule


Tasks
Dates
Jan 11- Jan 15
Jan 18- Jan 22
Jan 25- Jan 29
Feb 1- Feb 5
Feb 8- Feb 12
Feb 15- Feb 19
Feb 22- Feb 26
Create/Update 3D ETABS Model
Hand Calcs - Slab Thickness, Tendon Size/Layout, Moment Capacity
Begin Column Design - Determine Layout, Tributary Area, Self-weight, and New Loads
Hand Calculations
Create PCA Model - Design Columns
Hand Calcs - Design Typical Columns
Verify and Compare PCA results with Hand Calcs
Research Staggered Truss System
Determine Loads on System
Size Members of Trusses
oundation Evaluation and Redesign (if necessary
Begin Construcion Management Study - Acquire Schedule and Cost information for
Contact Construction Manager / Set Up Phone or In Person Interview
Conduct Interview to Obtain Other Important Details


Tasks
Dates
Mar 1- Mar 5
Mar 8- Mar 12
Mar 15- Mar 19
Mar 22- Mar 26
Mar 29- Apr2
Apr 5- Apr 9
Apr 11-Apr 15
Microsoft Project - Create Schedule for proposed building design
Research Labor Unions (Specifically in Baltimore)
Begin Acoustic and Vibration Control Study
Determine STC and NR values
Determine Vibration Control Performances
Create Report and Charts demonstrating improvements of post-tensioning over existing
Create Final Report and Presentation
Thesis Presentation

Conclusion

The HBCCH, located right in downtown Baltimore next to the Baltimore Orioles stadium Camden Yards, and blocks from Inner Harbor, is an impressive 20 story building that features two hotel towers, 15-stories and 10-stories tall, a grand ballroom, pool/fitness area, two story parking garage and a green roof all in the western podium. The current gravity system consists of two-way flat plate slabs with drop panels on the B1, 1st, Mezzanine, 2nd, 3rd, and 15th floors. In order to improve the environment around the tenants of the hotel the structural system will be redesigned to a post-tensioning slab. This will be expected to have a thinner slab thickness, allow larger spans between columns, and decrease in weight of building. The structural system underneath the pool/fitness area is also going to be looked at to be improved by using staggered trusses instead of steel beams. Staggered trusses will allow for larger spans and hopefully a lower building weight.

As a consequence of the building weight changing from the redesign of the gravity system and steel framing system the foundation system might have to be redesigned according to how the building weight changes.

Additional areas of focus will include a cost and schedule analysis as well as an acoustic and vibration control analysis of the ballroom and pool areas.