Hiro McNulty – Structural Option
Faculty Advisor – Walt Schneider
Hyatt Regency – Hotel and Conference Center
Pittsburgh International Airport, PA
December 9, 2005
Thesis Proposal

EXECUTIVE SUMMARY

The Hyatt Regency – Hotel and Conference Center at the Pittsburgh International Airport, PA, is a 275,000 square foot multi-use building located directly adjacent to the airport's landside terminal. The building consists of an 11-story tower and 1-story conference center with an additional partial level below grade.

In the original design of the structure, seismic loading was not required to be considered under the building code used, Boca 1996. The original design created a concrete tower, which under current building codes has very large seismic loads based on the building weight. While the current system was determined to be adequate under the calculated seismic loads, by reducing the building weight, it will likely reduce the seismic loading on the building and greatly change the design requirements under current building codes.

Research will be done to re-design the concrete tower to a steel framed system. Both braced and moment frames will be considered with research to determine which would be the most viable solution. Computer modeling will be performed using RAM, which is a commonly used structural engineering software package for structural steel design. Using the software, the building weight can be determined and compared to the calculated weight of the concrete tower. New lateral loading analysis will be performed to determine the decrease in loading due to the decrease in building weight. Analysis will also look at the impact the changes can make on the foundation of the building. With decreased building weight, it is believed that the foundation size can be decreased as well. Once the re-design of the tower is completed, research will be conducted to determine if the tower and conference center should remain independent or if they can be structurally connected without major impact on the buildings.

A cost estimate will be performed to determine the cost impact on the project with the proposed re-design. This investigation will look at the changes in member sizes for steel framing as well as the impact on the foundations. The cost will be compared to the original building cost to determine if the change in the structural systems will be justified. This analysis will be completed after the structural re-design has been completed.

Mechanical concerns will also need to be addressed when changing the structural system. Research will be done to determine if the new system impacts the mechanical systems in the building due to structural changes. In addition, the new system will require additional fire protection, most likely in the form of spray-on fireproofing to the steel members. Changes to mechanical systems as well as necessary changes for fireproofing will be determined and used in the comparison between structural systems.

BUILDING BACKGROUND

The Hyatt Regency – Hotel and Conference Center is a 275,000 square foot complex sitting adjacent to the landside terminal of the Pittsburgh International Airport and is the only hotel located on the airport's property. The complex consists of an 11-story concrete tower and a 1-story steel conference center (each with 1 additional partial level below grade). The building was completed in May 2000.

The building's architecture is designed to compliment that of the terminal buildings. The 11-story tower houses 336 guest rooms, including 11 suites, designed make guests' stay comfortable and convenient. The Hyatt features a coffee bar, health club, indoor pool, sauna, and Mediterranean restaurant among other amenities. The conference center features 20,000 sq. ft. of function and 7,400 sq. ft. of pre-function space and the largest hotel ballroom outside of downtown Pittsburgh. Each portion of the Hyatt are structurally independent, with an expansion joint separating the concrete tower from the steel conference center.

The tower's exterior is a combination of pre-cast concrete panels and a glass and aluminum curtain wall. The conference center is clad with pre-cast concrete, spandrel glass, and metal paneling. At entrance level, around the main lobby, a curved glass curtain wall welcomes guests to the Hyatt. The roofs at both levels are flat, rubberized asphalt membranes.

STRUCTURAL OVERVIEW

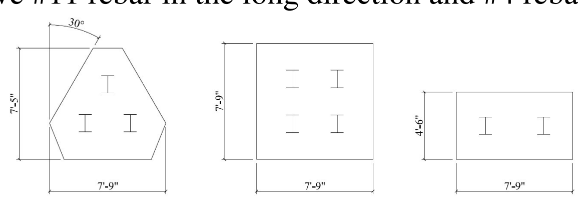
Foundation (Spread Footings, Pile Caps, and Grade Beams)

Spread Footings

- Spread footings are used under the conference center.
- Bottom of footings is located -3'-6" below grade.
- 15 different sizes of spread footings
    - 11 different square footings range from:
      5'-0"x5'-0" to 14'-0"x14'-0"
      Footings are from 12" to 27" deep with rebar sizes from #4 to #8.
    - 4 different rectangular footings ranging from:
      10'-0"x 14'-0" to 12'-0"x 26'-0"
      Footings are from 23" to 28" deep with rebar sized from #7 to #9.

Pile Caps

- Piles and pile caps are used under the main hotel tower.
- 3 sizes of pile caps are used, as follows:
    - Exterior pile caps are roughly triangular, see Pile Cap 1. They are 48" deep and have #11 rebar in 3 directions.
    - Interior pile caps are square, see Pile Cap 2. They are 43" deep and have #8 rebar in both directions.
    - Pile caps at stair wells are rectangular, see Pile Cap 3. They are 40" deep and have #11 rebar in the long direction and #4 rebar in the short.



Grade Beams

- Grade beams are used between spread footings around the exterior of the structure.
- Top of grade beams is at an elevation of -0'-6" which allows the 6" slab-on-grade to extend over the grade beams.
- 10 different sizes of grade beams are used, ranging in size from 18"x36" to 26"x40".
- Grade beams have reinforcement from #6 to #9 rebar with #4 stirrups.

Conference Center

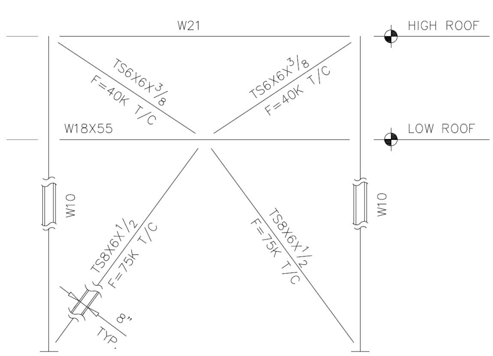
The conference center portion of the building is framed with structural steel; approximately 17,000 square feet on the ground floor (partially below grade) and approximately 50,000 square feet on the first floor.

- Ground Level: The ground level framing supports a composite steel deck and concrete floor slab. A continuous 14" concrete foundation wall contains embedded plates to attach to the steel framing. The steel framing for the first floor is typically W12X19 for 12'-16' spans, W14X22 for 25' spans, and W21X44 for 35' spans. Column sizes range from W10X33 to W10X49.

- First Floor: The first floor is the top level for the conference center. The framing for the roof consists of both W-sections and joists. There is a large size difference in all steel beams, ranging from W12X14 to W21X50 and girders ranging from W24X55 to W27X94. Long-span joists are used over the large span of the main conference center located in the middle of the conference center. 68DLH17(s) frame over the 73' span, with diagonal bracing between joists for stability.

Lateral System

The system has 2 braced frames in each direction to resist lateral loads. The braces used are K-braces, which requires less material than X-braces on each floor. HSS 8X6X½ members brace from the ground level to the low-roof level and HSS 6X6X$^3/_8$ members brace from the low-roof level to the high-roof. The members are designed to take both compressive and tensile loads, so all bracing members participate in resisting lateral forces, regardless of the in-plane direction of the loading.



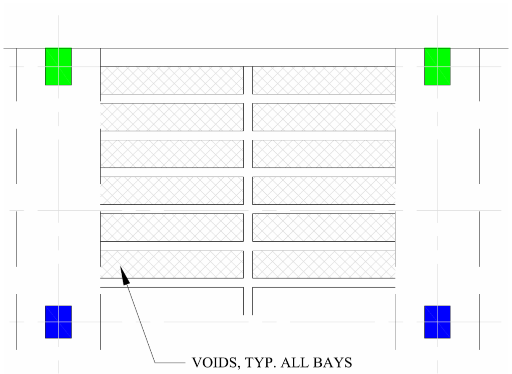
Elevation view of K-braces.

Tower (Guest Rooms)

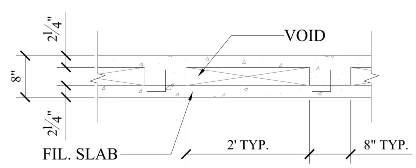
The tower is framed as cast-in place concrete. The concrete moment frames act as a lateral resisting system for the building as well as providing the primary gravity system. Each floor of the tower is approximately 17,000 square feet.

The tower is a system of concrete columns and a one-way slab system. There are 44 columns in the typical tower floor plan, 22"x28" or 22"x32", with 4 smaller columns, 12"x18" or 16"x24" columns around each of the two stair towers. Typical bay sizes are: 27'-0"x18'-0" and 27'-0"x23'-0". *(See plans, next page.)*

6' wide, 8" deep column strips are oriented N-S on the typical tower plans. The floor slab consists of an 8" thick slab with polystyrene voids in a typical layout between column strips (see plan and section views below).

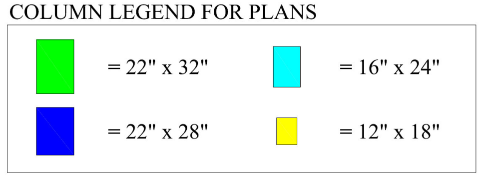


TYPICAL BAY VOID LAYOUT



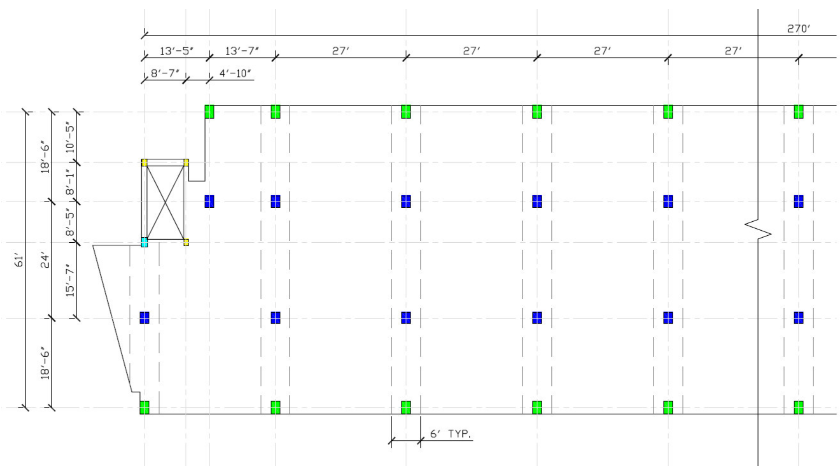
SECTION THROUGH VOIDS

COLUMN LEGEND FOR PLANS

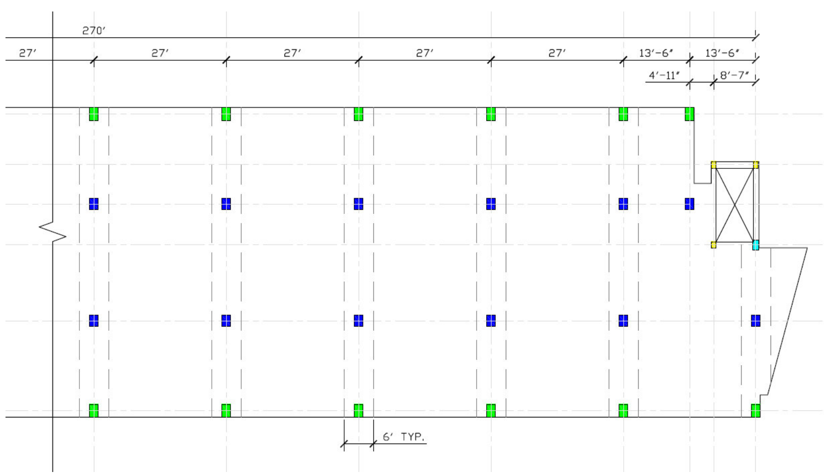


Lateral System

The tower is framed with concrete columns and a filigree slab system. The primary structural columns are 22"x32" for exterior columns and 22"x28" for interior columns. The slab acts as a rigid diaphragm to distribute the lateral loads to the columns, see figures below of tower framing plans for column spacing and orientation. All tower columns use 5000 psi concrete and the floor system is 4500 psi concrete. The columns are oriented with their strong axis in the North-South direction, which will experience the greatest wind forces. The figures below show the column layout on the typical tower floor plan with column size and orientation detailed.



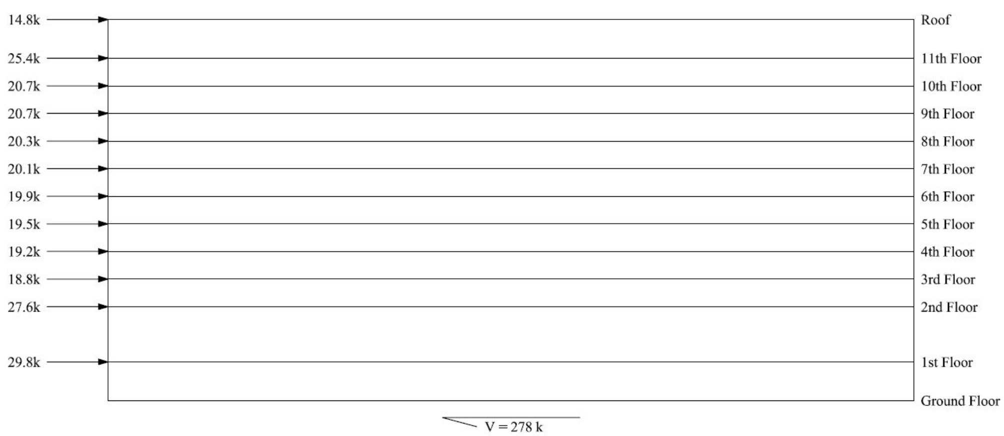
TOWER FRAMING PLAN – WEST END (see column legend for sizes)

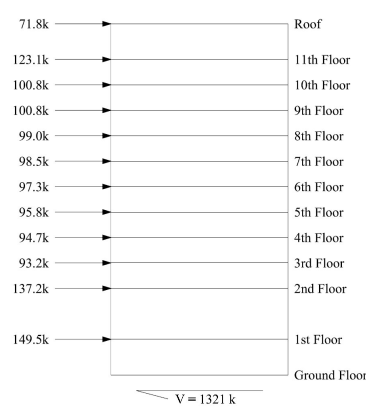


TOWER FRAMING PLAN – EAST END (see column legend for sizes)

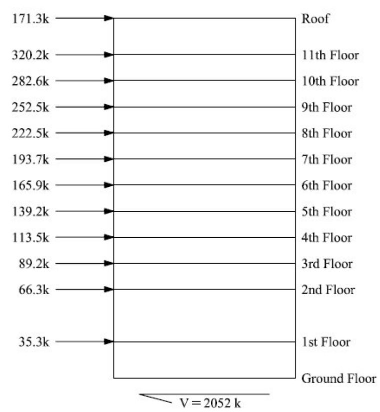
PROBLEM STATEMENT

The actual design for the Hyatt is very suitable for the design conditions given. Analyzing alternative floor systems for the tower revealed that the current design was likely the best solution to the design problem. While the current design may be the best solution to the problem as it was stated there are many other viable solutions to the problem. In the case of the Hyatt, at the time of its design, the codes used did not require seismic loading analysis to be performed. In the lateral analyses in Technical Assignment 3, it was found that the current design's large self-weight greatly increased the seismic loading to the building. While the system was found to be adequate to resist the lateral loadings, there may be alternate designs that can better resist these lateral loads or decrease the building weight to in turn decrease the seismic loading on the building. The main area of concern for these seismic loadings is the concrete tower.





Wind story shears for E-W (above) and N-S (below)



Seismic story shears for E-W (above) and N-S (below)

As seen in the figures, the story shears in the tower from seismic loading are much greater that those from wind loading. In the original design, the seismic loading was not required to be analyzed, so it may not have been considered when selecting the framing system for the tower section of the building.

PROPOSED SOLUTIONS

Structural

Research will be done to re-design the concrete tower to a steel framed system. There are multiple types of steel framing that can be used, so preliminary research will look into the most feasible and best alternative. From Technical Assignment 2, a non-composite steel floor system was analyzed, which warranted further investigation. In addition, composite steel framing will be considered, which will likely be the best alternative due to increased

strength based on composite action. The lateral resisting system will also require a re-design with the change from a concrete frame to a steel frame. Both braced and moment frames will be considered with research to determine which would be the most viable solution.

The main design for the conference center is already a steel framed system with K-braces for the lateral resistance. In the current design, the two facilities are not structurally connected. Once the re-design of the tower is completed, research will be conducted to determine if the two buildings should remain independent or can be structurally connected.

Computer modeling will be performed using RAM, which is a commonly used structural engineering software package for structural steel design. Using the software, once a 3-dimensional model is created for the tower, the building weight can be determined and compared to the calculated weight of the concrete tower. New lateral loading analysis will be performed to determine the decrease in loading due to the decrease in building weight. Analysis will also look at the impact the changes can make on the foundation of the building. With decreased building weight, it is believed that the foundation size can be decreased as well.

Breadth

Construction Management:

With the changes to the structural systems, a cost estimate will be performed to determine the cost impact on the project with the proposed re-design. This investigation will look at the changes in member sizes for steel framing as well as the impact on the foundations. The cost will be compared to the original building cost to determine if the change in the structural systems will be justified. This analysis will be completed after the structural re-design has been completed.

Mechanical:

With the changes to the structural system, some mechanical concerns will also need to be addressed. Research will be done to determine if the new system impacts the mechanical systems in the building due to structural changes. In addition, the new system will require additional fire protection, most likely in the form of spray-on fireproofing to the steel members. Changes to mechanical systems as well as necessary changes for fireproofing will be determined and used in the comparison between structural systems.

PROPOSED TIMETABLE

Week 1 (Jan. 9 – Jan. 15)	Investigate and compare composite and non-composite steel framing for re-design of the tower.
Week 2 (Jan. 16 – Jan. 22)	Begin 3-D computer modeling of tower in RAM structural design software.
Week 3 (Jan. 23 – Jan. 29)	Continue modeling of structure and loadings. Compare braced versus moment frames.
Week 4 (Jan. 30 – Feb. 5)	Perform hand-calculations to verify computer data and compare to results.
Week 5 (Feb. 6 – Feb. 12)	Continue to check computer model and determine new seismic loadings based on new weight.
Week 6 (Feb. 13 – Feb. 19)	Determine effects of re-design on seismic loading. Compare design changes to original design.
Week 7 (Feb. 20 – Feb. 26)	Continue investigation to the impact of structural changes on foundations and loadings.
Week 8 (Feb. 27 – Mar. 5)	Investigate building envelope and changes in mechanical configuration with new design
Week 9 (Mar. 6 – Mar. 12)	Spring Break – work as required. This time will be allotted for necessary schedule changes.
Week 10 (Mar. 13 – Mar. 19)	Determine requirements for achieving fire-rating for the selected framing.
Week 11 (Mar. 20 – Mar. 26)	Begin detailed analysis of cost impact of re-design for structural framing and foundations.
Week 12 (Mar. 27 – Apr. 2)	Finish work on breadth topics and begin finalization of report. Print report when completed.
Week 13 (Apr. 3 – Apr. 9)	Submit report and prepare for presentation.