Faculty Advisor – Professor Kevin Parfitt
Renaissance Schaumburg Hotel and Convention Center
Schaumburg, Illinois

Proposal Report
Due: December 12th, 2005

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Executive Summary

The Renaissance Schaumburg Hotel and Convention Center located in Schaumburg, IL is a 17-story cast-in-place concrete structure which supplies the greater Chicago area with 500 guest suites and many other community services. The structure relies on post-tensioned concrete slabs, 11”-18” shear walls, and 42” circular columns for primary framing support. Although the current design is very efficient in carrying the prescribed loading, there is a chance that the building could increase efficiency in terms of cost and constructability with the implementation of a different structural framing system.

This proposal will focus on a replacement of the current cast-in-place concrete structural system with a composite steel and concrete system. Future analysis of both the current shear wall system and a braced frame lateral system will be used to determine which system will perform with the most efficiency and also compare both methods in terms of cost and construction timeline.

Issues that arise with the other systems throughout the building will also be taken into consideration (including HVAC plenum space). Overall, the continued analysis of The Renaissance Schaumburg Hotel and Convention Center will provide a detailed comparison of the proposed system change with considerations including, but not limited to; design economics, labor/construction costs, material costs, construction schedule impacts, and systems behavior.

This proposal includes simplified sketches for further explanation of system layouts and details. The redesign proposal of The Renaissance Schaumburg Hotel and Convention Center will detail proposed system changes and analysis of redesign impact on the structural system and entire building.

Introduction – Existing Design and Current Building Information

Background Information

The Renaissance Schaumburg Hotel and Convention Center is a 17-story building which provides the community with 500 guest rooms and other social gathering areas that total the building's square footage to just under 466,000 square feet. The building is a cast-in-place concrete structure that implements post-tensioned slab systems throughout most of the stories, rectangular (18"x36" typically) columns, and 11" to 18" shear walls for primary lateral support. Wind forces necessitate the use of the lateral system, and since the RSHCC is located in Schaumburg, IL, just outside of Chicago, it was expected that wind would dictate the lateral system design.

The top 9 stories are highly repetitive and have an average floor-to-floor height of 9'-8", and this provides in a rather efficient building height for 17 stories, topping out the mechanical roof at 185 feet above the ground.

Exterior Photo of Hotel's North Face

Existing Lateral System Information

The Renaissance Schaumburg Hotel and Convention Center's (RSHCC) lateral force resisting system is composed of shear walls (shown in orange below in figure 1).

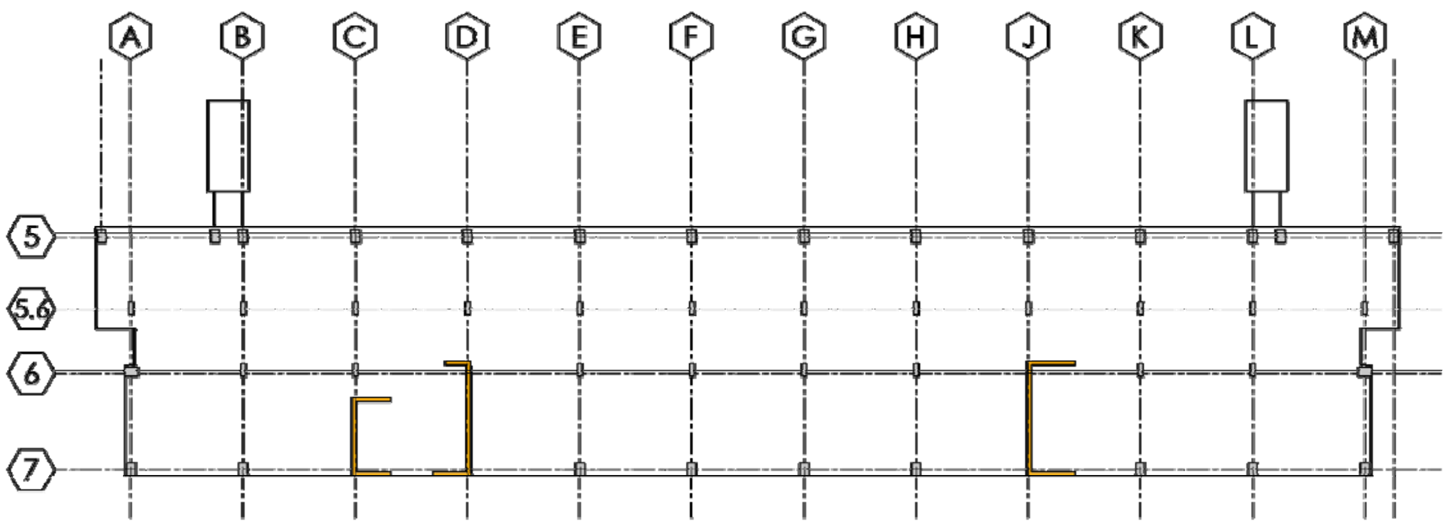

Figure 1 – Current upper level framing plan

These shear walls are to be constructed of 8,000 psi concrete on lower floors (up to floor 6) and 6,000 psi concrete on the upper levels, this is also when they change from a maximum of 18" thick at the bottom, to no less than 11". Reinforcement for the shear walls is typical ASTM A615 Grade 60 steel varying from #4's at 12" as a minimum, to #8's at 8". As one can see from the above figure, there are 9 shear walls that create 3 C-shaped patterns.

Existing Gravity System Information

The most common structural material on this building project is concrete, with minimal amounts of steel reserved for the first 3 floors of the hotel, which are used to transfer gravity loads from the concrete supports above. For the primary support from the foundation to the third through sixth floors, large 42" diameter columns are used, which are then blocked-out to rectangular columns with sizes ranging from 12"x24" to 18"x28" to support the upper levels of the hotel structure (see figure 2 on the right). Shear walls are used in three main locations throughout a typical floor plan and, as a diaphragm element, post-tensioned concrete slabs can be found on almost ever floor of the structure which helps to reduce the amount of concrete typically necessary to carry loads.

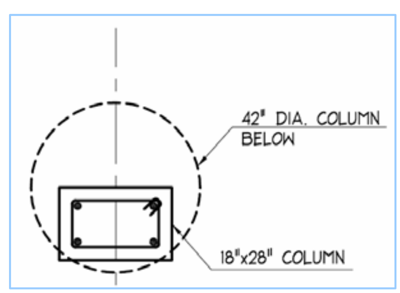

Figure 2- Typical Column Block Out


Atrium Space (Levels 1 through 6)

The RSHCC employs the use of driven steel piles for foundation support, grade beams which vary from 24” to 60” deep are then supported by the piles. All driven steel piles and concrete pile caps must develop a 100 ton capacity with a minimum safety factor of 2. These structural steel piles transfer loads from the foundation into the earth. All perimeter wall and column foundations must all bear a minimum of 3’6” below the finished grade. The grade beams then span over the pile caps and support the slab on grade, which is typically 6” throughout the ground floor plan of the building.

The frame skeleton of the RSHCC is rather unique. The architect called for large atrium spaces and designed the floor systems above the main lobby area to appear as though they almost float. To accomplish this, a typical 42” diameter (4,000psi to 6,000psi) concrete column spans the first 3 to 6 levels of the hotel, which supports the slab. Typical slab thicknesses are 7.5” to 10” and on most floors use post-tension slab system which helps to reduce the amount of concrete needed. Steel is also utilized on lower floors (usually as a gravity load transfer from upper levels of concrete columns) which typical include beam and girder sizes of W16x26 and W24x55 respectively with steel strengths of 50ksi. The column grid for the main hotel structure is laid out in the east-west direction to 27’ on center for 5 spans. However, there is a rather non-regular spacing of north-south column lines which also have 5 spans totaling 117 feet. Each of the two stair cases on the front exterior of the building are constructed out of steel and use moment resisting connections.


“Floating” Slab-to-Column Connection

Slab Systems

Multiple types of concrete slab systems are used in this project including one-way, two-way (with drop-panels), and post-tensioned slabs. Stud-rails are also used near column supports in order to prevent punching failure, eliminate excess drop-panels, and allow for the possibility of smaller column sizes. These stud-rails are typically used on column lines K, L and M, or the south-east side of the building, this is most likely due to the column line’s adjacency to a change in slab elevations[‡].

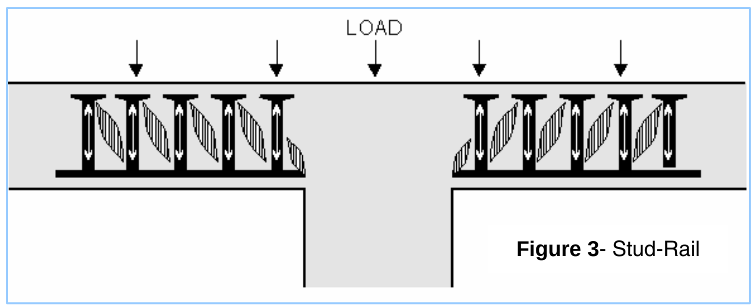

Figure 3- Stud-Rail

The post-tensioned concrete slab is the most prevalent type of floor system used through the 17 stories of the building. Typical effective stresses in the post-tensioned tendons are typically around 20 kips per foot. This type of slab is useful due to its efficient use of concrete. In some systems, it results in a 30% savings of concrete when compared to typically reinforced concrete slabs.

Problem Statement – ***Candidates for further examination***

The design of the RSHCC appears to have been completed with extreme professionalism, and with the highest level efficiency. The systems used in this building include a post-tensioned concrete system and cast in place shear walls and support columns. These systems require a great deal of skill to construct, specifically the erection of the post-tensioned system that requires a significant amount of field testing and has many mandatory construction guidelines/requirements. The floor structure performs the most efficient compared to many of the other systems explored in earlier studies, but at a cost that is considerably higher than concrete slabs formed in steel decking. Overall the current system has been a great example of how to create a building that emphasizes the efficiency of building materials, but it is a strong possibility that the current slab and gravity system may not be the fastest, cheapest, or least difficult system to employ.

Proposed Solutions ***— How the system can be improved***

The current design, although extremely efficient in design and performance, does have room to improve in terms of constructability and building cost. A system that is easier to place, such as steel with composite concrete, will reduce the need for specialized construction of post-tensioned concrete and will have a faster

[‡] Figure 2 – Stud-rail image courtesy www.studrail.com

erection time compared to that of cast-in-place concrete. It is proposed that an analysis in feasibility of a composite steel and concrete system be conducted to compare the advantages and disadvantages of both design systems.

Major redesign considerations include the reduction in number of column lines when converting from concrete to steel support (which typically supports larger spans). A new model of the system will move column line 5.6 (see Figure 1) inline with interior partitions and a specific location will be chosen upon further analysis. This solution will create more open space on each floor of the structure and will allow for fewer connections (resulting in faster construction and more flexibility with floor plans).

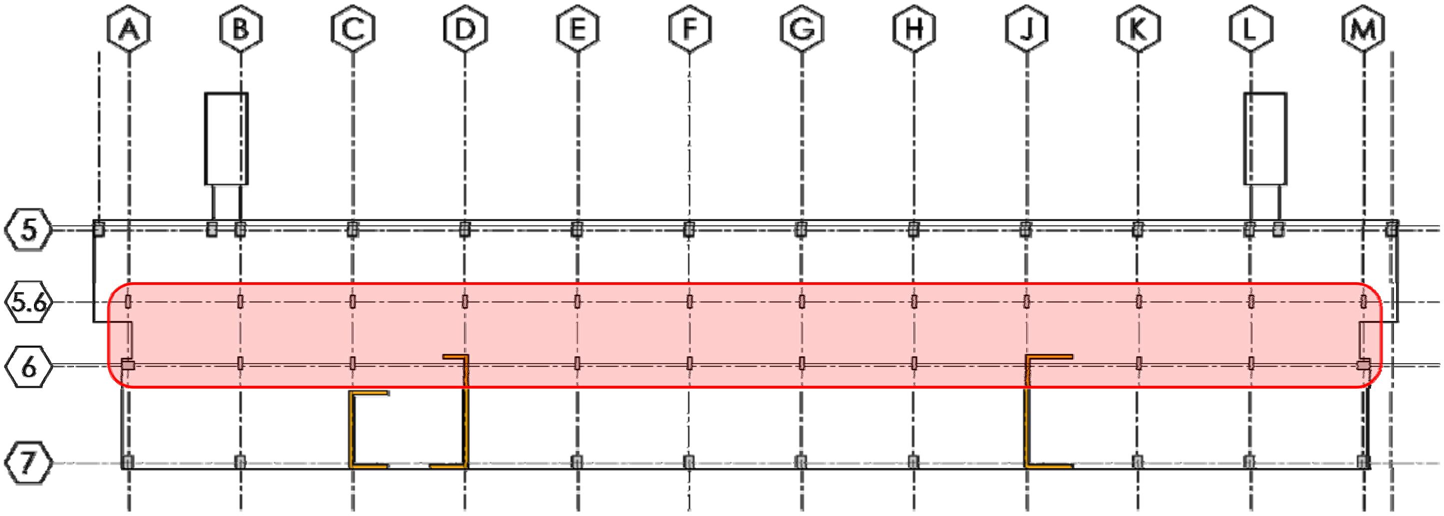

Figure 4 – Area highlighted in red above is area where both column lines 5.6 and 6 will be combined to provide just three spans vertically

Methods of Analysis — Problem solving strategies

The design of the steel system that would be a suitable replacement for the cast-in-place concrete structural system of the RSHCC will follow design procedures developed through the use of the 3rd Edition LRFD Specification from the American Institute of Steel Construction, and with the release of the new 13th Edition Manual of Steel Construction this December, some design procedures will follow the new 2005 Specification. Concrete slab and member analysis will be based on ACI 318-05 as previously discussed.

The load development, as in past reports, will follow from the use of ASCE 7-02. The resultant loading will be applied to both a shear wall system and a braced frame system in order to compare advantages and select an optimal lateral system. Initial framing member sizes will be analyzed using the aide of computer software included RAM Structural System and finalized with the help of ETABS. ETABS will also help to develop forces on lateral elements that will be compared to those resulting from manual calculation using ASCE 7-02.

Tasks and Tools — Development and implementation of design strategies

Shear wall I was checked for reinforcement at the first level of the building and upon completion, the same reinforcement that was called for in the shear wall schedule was also the answer arrived at through hand calculations. A summary of the design can be found below with a detailed processes going through the shear and flexural reinforcement design and double check of possible overturning moment problems in Appendix D.

Discussion

Major tasks for future investigations are outlined below:

- **New Column Grid Layout/Modification**
  - a. Layout a new grid system while attempting to minimize modifications to existing system
  - b. Ensure foundation systems, first floor, and attached structures are properly considered
- **Load Development**
  - a. Re-compute dead load figures
  - b. Determine superimposed dead loads from plans
  - c. Calculate live loads, load cases, and lateral loads based on building codes
- **Preliminary Member sizing**
  - a. Examine suitable steel column and beam sizes for substitution of concrete members
  - b. Develop accurate model based on estimated sizes to be analyzed by computer to determine most efficient design

- o **Floor Framing Design**
  - a. Analyze a suitable replacement system for post-tensioned slab that works with redesign
  - b. Double check gravity member and lateral member design
- o **Bracing/Lateral Systems Design**
  - a. Using ETABS check loads and members for optimal and synchronized design
  - b. Re-design shear wall system or design braced frames to withstand lateral forces
- o **Breadth - Construction Schedule**
  - a. Develop detailed take-offs for steel system
  - b. Create realistic construction schedule and compare to current construction timeline
- o **Breadth - HVAC Systems Impact**
  - a. Investigate plenum space modification due to steel structural system replacement
  - b. Analyze impact/concerns of investigation
- o **Report Finalization**
  - a. Compile final report, finalized CPEP and presentation materials

Schedule of Tasks — A timetable

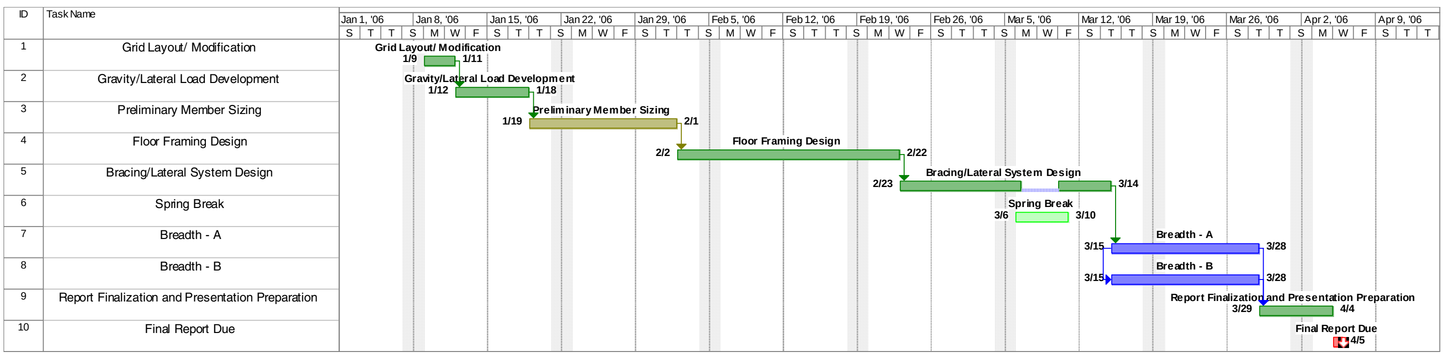

Figure 4 – Schedule timeline for tasks to be completed this spring

Conclusion — Summary of Project Proposal

After exploring some alternate design considerations it is believed that further examination of a couple of key design issues would be a beneficial exercise. This proposal sets out a schedule of analysis to follow and final reports will detail the findings of the redesigns successes and failures. With the solution process detailed above, considerations which included design economics, labor/construction costs, material costs, construction schedule impacts, and systems behavior will be discussed and proper recommendations as to which system performs the best in each category will be announced. Future reports will include the tasks listed above which will result in a redesign of the major gravity load and wind load resisting systems.†

† End of Report