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Erie Convention Center and Sheraton Hotel **Erie, Pennsylvania**

Thesis Proposal
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<u>Executive Summary</u>

The Erie Convention Center and Sheraton Hotel, located in Erie, Pennsylvania is an eleven story steel building with a hollow-core precast concrete plank floor system. The hotel and convention center is 132,000 square feet, with 200 guest rooms on the upper nine and a half floors, with all of the amenities of a high class hotel on the bottom one and a half floors.

As with many hotels and convention centers, the bottom floors require large open, column free spaces for the ballroom and conference areas. The steel beam with concrete plank structure was designed in order to accommodate these needs, however there is another option. As the depth work of my thesis, I will investigate the use of a staggered truss system in lieu of steel beams and girders. Because the current structural system is a hybrid system comprised of both steel and precast concrete, coordination between trades during construction is very challenging. In order to address this concern, I will propose an alternative floor system of steel joists and a concrete slab in addition to an analysis of the current precast plank system. The staggered truss system will resist lateral loads in the North/South direction, but additional lateral support will need to be designed for the East/West direction.

In order to take advantage of the location of the site along the Presque Isle Bay, my breadth work will include a study of the savings in equipment and peak energy costs for an open loop heat rejection system. Also, in order to ensure the comfort of the guests, an acoustic analysis between two adjacent guest rooms will be completed to check for acceptable noise levels.

This report includes an in depth description of the current structural system of the Erie Convention Center and Sheraton Hotel and what needs are to be met both structurally and architecturally. A description of the proposed staggered truss system and the alternate floor systems is also included along with the methods that will be used to design this system. A complete list of the design procedures to be used, as well as a weekly schedule concludes this proposal.

Background

The proposed Erie Convention Center and Sheraton Hotel is an eleven story, 132,000 square foot building on the waterfront of the Presque Isle Bay in Erie, Pennsylvania. The center core of the building is a tower housing a conference center as well as 200 guestrooms and all of the amenities that accompany a hotel of this size. Attached to the west side of the center tower is a pedestrian walkway connecting the hotel and convention center to the proposed Bayfront Convention Center. The east side of the tower core is connected to a five story parking garage. Neither the pedestrian walkway, nor the parking garage will be considered in this proposal.

The center tower of the Erie Convention Center and Sheraton Hotel reaches an overall height, including mechanical penthouses and parapets, of 155 feet. The rectangular shape is 175.5 feet by 57 feet and is comprised of 3 bays in the North/South direction, and 7 bays in the East/West direction. Figure 1 shows the basic framing layout of the tower.

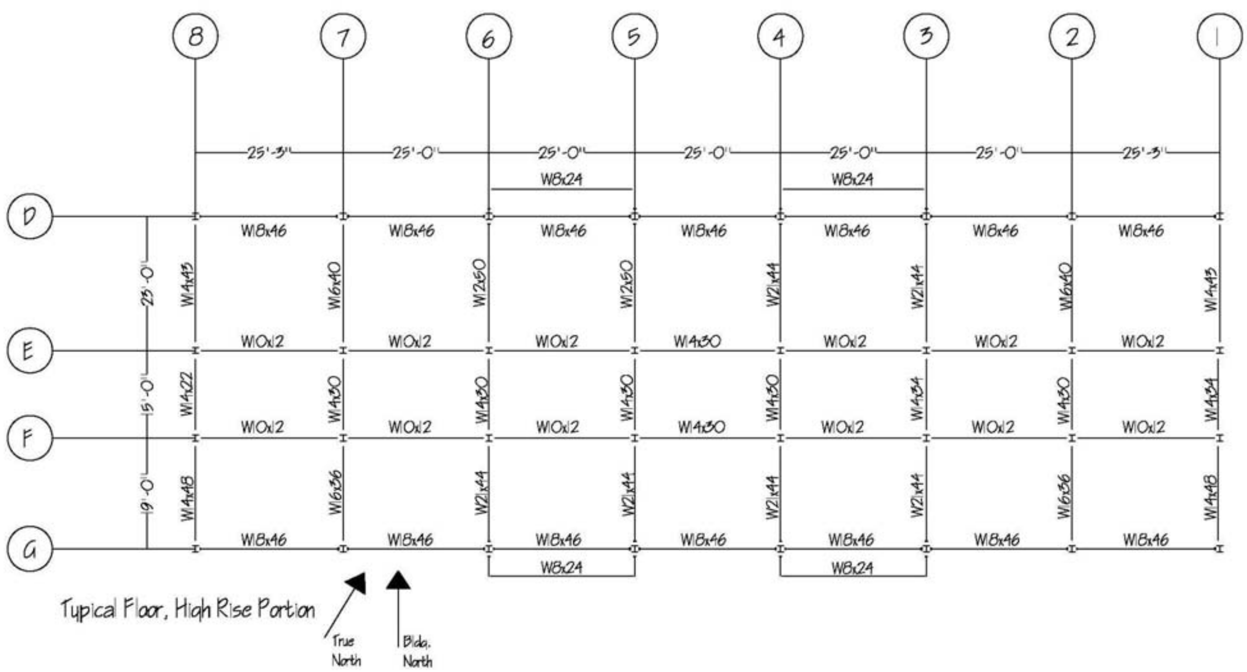

Figure 1: The tower portion of the Erie Convention Center and Sheraton Hotel has a typical framing plan as shown here. The three bays in the North/South direction are sized 19', 15', and 23'. In the East/West direction, the two exterior bays are 25'-3", with five 25' interior bays.

The lateral resisting system of the tower is located on the four perimeter walls. Both diagonal cross-braces and eccentric knee braces are located in the North/South direction, while moment connections resist lateral loads in the East/West direction. The eccentrically braced frames allow for vertical ribbon windows, while providing the structural stability needed to resist the winds coming off of Lake Erie.

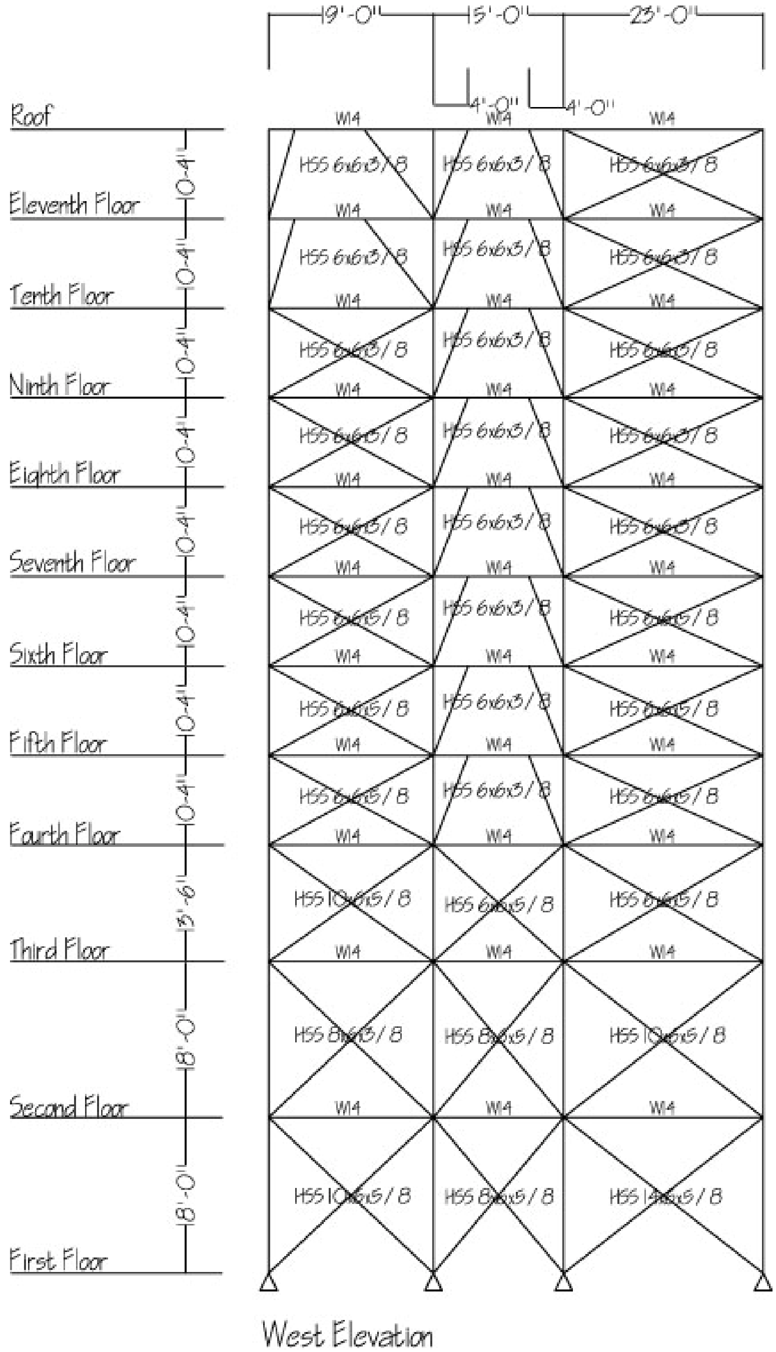

Figure 2: The West Elevation of the lateral bracing is shown here with the combination of diagonal cross braces, as well as eccentric knee braces. The first three floors on the West Elevation have all cross braces because of the attached parking garage. The East Elevation has eccentric knee braces to the ground which allows for the ribbon window to be carried down through the first three floors.

The structural system is comprised of steel framing members that support 8-inch hollow core precast concrete planks that span in the East/West direction for the floor system. The design used for the Erie Convention Center and Sheraton Hotel specifies that no topping is needed except for a ¼" polymer modified cement product for leveling in select places. Grout placed in between the sections of the plank will allow the floor system to act as a diaphragm for the lateral analysis. The building is supported by a foundation system composed of caissons, monolithically cast concrete grade beams and piers, and an 8" structural slab on grade. The caissons have a minimum required diameter of 24", are drilled approximately 20 feet deep, and are made of 3000 psf concrete. By drilling three feet into the bedrock, the net allowable end bearing pressure is 40 ksf. In addition, shaft resistance can be added to the caisson capacity using 3.0 ksf allowable side friction applied to the socket surface area in the bedrock.

Statement of Problem

A structural system must be designed to resist gravity and lateral loads while accommodating the proposed architectural floor plan, which has large open spaces on the bottom floors. The live gravity loads have been found using IBC 2003 for both the private and public spaces of hotels as 40psf and 100psf, respectively. The chosen system is a steel frame with hollow core precast concrete plank floors, however this choice of a hybrid system makes coordinating construction trades difficult.

Proposed Solutions

In order to span the long distances needed, while keeping open spaces, a feasible alternative is a staggered joist system. Staggered joists will span along the regular column lines in the North/South direction, however they alternate bays and floors. A portion of a sample structural elevation can be seen in Figure 3. (Note: This shows the layout of the trusses. The columns are at all floors along the exterior column lines, and fully on the ground floor.)

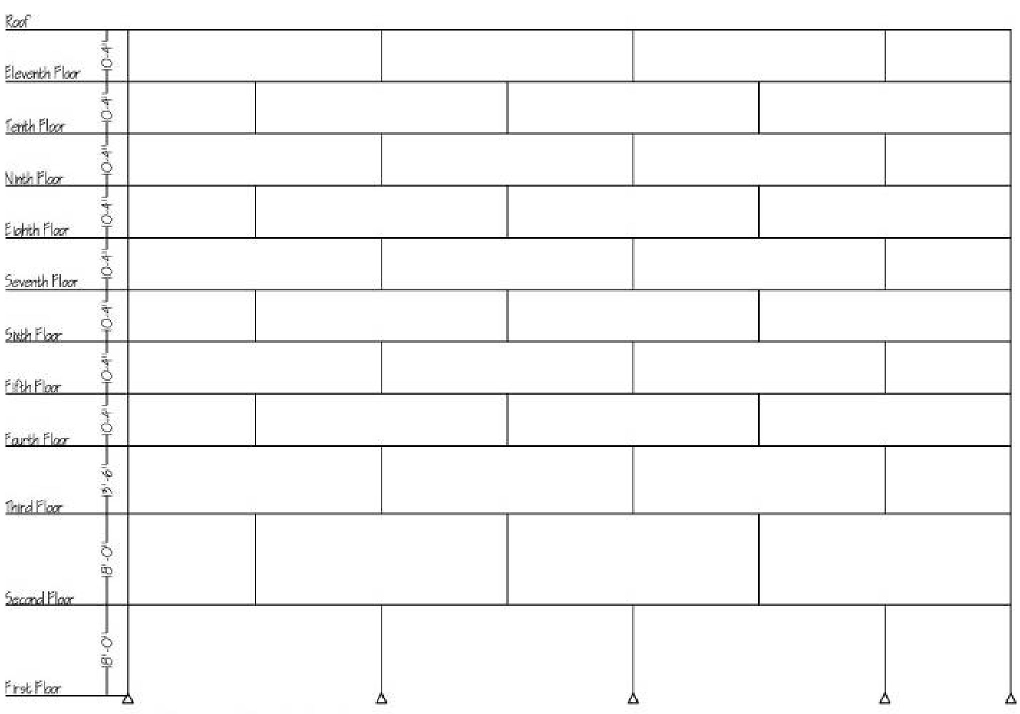

Figure 3

Another positive aspect about a staggered truss system is that at the center, where there needs to be a space allotted for a corridor, there is no shear in the truss. This allows for a space large enough for a corridor to be added, as shown in Figure 4.

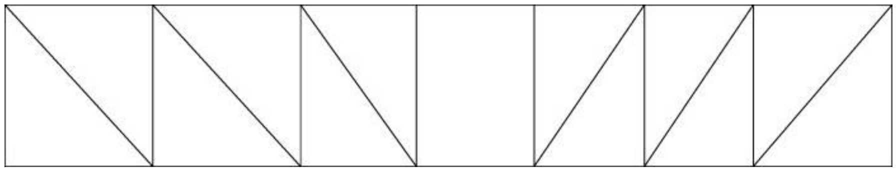

Figure 4

A further analysis of alternate floor systems can be completed in order to change the system from a hybrid structural system to an all steel system. Both a pre-cast plank system will be investigated and designed, as well as a steel joist with slab system. From these two designs, an economic and feasible design can be made.

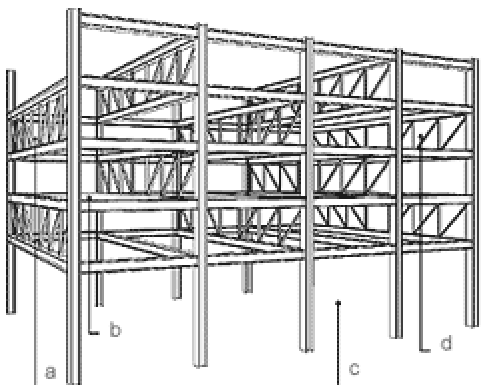

Figure 5: Here is an example rendering of a staggered truss system from a Case Study of Baruch College. This gives a 3-D view of the framing members that will be used.

<u>Solution Method</u>

In order to design the structural system, the member sizes and dead loads of the structure must first be estimated. Using the PCI Handbook, the pre-cast concrete plank can be sized to span the lengths needed under the given loads. The second alternative of a joist floor system must also be designed by using the determined loading and spans, in correlation with a joist manual to pick appropriate sizes to support the given loads. In addition to the ability to resist gravity loads, the shear diaphragm capabilities of strength and stiffness of the floor must also be considered. Once the floor has been sized for gravity loads, the size can further be changed for shear capacity and stiffness.

After the floor systems have been designed, the actual floor-to-floor truss must be initially sized. The basic sizes are found to resist the gravity loads, as well as providing some resistance to lateral loads. Once a general model has been modeled using STAAD, gravity loads can be applied as point loads at panel points on the top and bottom chords. The members of the truss can then be sized and checked by hand. Laterally, the trusses will resist loads acting on a full two bays, due to the staggered system.

Columns can be designed for gravity and lateral loads in the transverse and longitudinal direction. The gravity loads are applied as axial forces because of the truss connection being on the web of the column.

Finally, the lateral system will need to be redesigned to resist wind and seismic loads. The truss system will aid in resisting these loads acting on the longitudinal direction, however, lateral forces acting in the transverse direction will need to be resisted by either a braced frame system, or moment frames. Making any necessary changes to the wind and seismic calculations to solve for story forces, the building can be modeled in a 3-D system to check for sizing.

Tasks and Tools

I. Loads

Task 1: Check live load and dead load assumptions for a staggered truss system with a joist, deck and slab floor, and a hollow core precast plank floor.

a) Estimate a deck size and slab depth for steel joist floor system to find dead loads.
b) Determine dead load for hollow-core precast plank floor with a topping.
c) Estimate initial dead load of staggered truss framing members.

II. Design Floor Systems

Task 1: Alternative 1 (Steel Joist Floor)

a) Using the deck and slab sizes found in the previous section, design the steel joists for the live and dead loading conditions for each span.
b) Check self weight

Task 2: Alternative 2 (Precast Concrete Plank)

a) Using the PCI handbook, design precast concrete plank to span the bays under the live and dead loading conditions found.
b) Check self weight with design loads

III. Design Trusses

Task 1: Estimate trial sizes for design

a) Use the gravity loads found in part (I) to estimate spacing and approximate chord sizes of the trusses.

Task 2: Analyze trial trusses

a) Using STAAD, analyze the trial truss sizes under gravity loads.
b) Adjust member sizes to be larger or smaller based on stresses and interior forces found.

IV. Preliminary Column Design

Task 1: Determine axial loads on columns

a) Find the gravity loads transferred to the columns by the trusses and the columns above.

Task 2: Determine moments on columns

a) Using lateral loads from Tech #3 as values to estimate loads. These will be recalculated at a later point.

V. Design Lateral System

Task 1: Determine Lateral Loads

a) Check wind loads for any changes.

b) Recalculate seismic loads for moment connections and braced frame connections

Task 2: 3-D model

a) Build a 3-D model using a computer program such as ETABS.

b) Place calculated controlling lateral forces on model and analyze.

c) Check drift, stresses, and interior forces of trusses, lateral members, and columns

Task 3: Check members and adjust as necessary

VI. Analyze acoustics

VII. Size equipment and flow rates for an open loop heat rejection to lake water as well as estimate the savings in equipment and peak energy costs for this system.

VIII Prepare final presentation

Time Table

Week #	Section to Complete
1 (Jan. 9)	Trusses (Research)
2 (Jan. 16)	Loads & Design Floor Systems
3 (Jan 23)	Design Trusses
4 (Jan. 30)	Design Columns
5 (Feb. 6)	Design Columns
6 (Feb. 13)	Lateral Loads
7 (Feb. 20)	3-D Model
8 (Feb. 27)	Analysis of Structure/ Make Changes
9 (Mar. 6)	Spring Break
10 (Mar. 13)	Coordination of Trades
11 (Mar. 20)	Heat Rejection
12 (Mar. 27)	Clean up Design/ Begin Final Presentation
13 (Apr. 3-5)	Prepare Final Presentation