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Senior Thesis, 2006

Erie Convention Center and Sheraton Hotel

Erie, Pennsylvania

The Pennsylvania State University ·Architectural Engineering

Erie Convention Center and Sheraton Hotel

Erie, Pennsylvania

The Project Team:

Owner: Erie Convention Center Authority
Architects: DRS Architects
General Contractor: Barton Malow
MEP Engineers: Karpinski Engineering
Structural Engineers: Atlantic Engineering Services

Building Statistics:

Size: 132,000 sq. ft.
11 Stories
200 Guest rooms
Construction Dates: Spring 2006-2007
Project Delivery Method: Design-Bid-Build
Cost: $62 million
(including Bayfront Convention Center)

Structural:

- Caissons, piers, and grade beam foundation
- Steel structure with 8" pre-cast concrete plank paneled floors
- Cross-braced lateral system

Electrical:

- 277/480 3 phase, 4 wire, utility distribution voltage
- 120/208 3 phase, 4 wire, building distribution voltage
- 500 kW diesel generator for emergency backup

Lighting:

- 8" diameter triple tube compact fluorescent down-lights
- Wall sconces
- Cold cathode recessed horizontal mounted cove fixtures

Mechanical:

- CAV air system
- FCU's for additional loads in multi-use areas
- Radiant floor entry
- Hotel rooms have individual air conditioning units

Architecture:

- Keeps views of Presque Isle Bay
- Based on Sheraton's signature "low-rise Soho" prototype, adapted to a high-rise expression
- Exterior materials: pre-cast concrete base, copper cladding, green tinted glazing, panelized EIFS wall system, and red brick
- Pedestrian bridge connection to Bayfront Convention Center from 5th floor

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Executive Summary

The Erie Convention Center and Sheraton Hotel is an eleven story, 132,000 square foot hotel and convention center, which is part of the Bayfront Convention Center complex, located in Erie, Pennsylvania.

The existing structure, a steel frame with a precast concrete plank floor system, proves to be efficient in its design and constructability; however a staggered truss system provides an alternative to this structural system and was designed and analyzed in depth in this report. A staggered truss system creates open, two bay spaces by eliminating interior columns with the use of floor to floor height trusses on alternating floors. In addition to designing the staggered truss system, the affects that various floor systems can have on the member sizes of the trusses was also investigated. Two floor systems, a hollow core precast plank floor system and a steel joist with deck and concrete slab floor system, were designed. Using these floor systems, two ETABS models were created in order to size the structural members for the staggered truss system based on the differences in the floor systems. Final conclusions were based on cost, schedule, and impacts on architecture.

My breadth topics in this report investigate an alternative to the current heating and cooling system used, as well as a study of the current acoustics and sound level in between two guestrooms.

A lake source open-loop geothermal heat pump was considered in replacement of the conventional air-to-air used. This air-to-water system is much more efficient and will save on electricity needed to heat and cool the building, therefore decreasing the amount of money spent. The money saved per year by using this geothermal heat pump was determined and compared with the first cost to calculate the payback period.

Sound transfer through hotel rooms is a concern, however appropriate noise reduction values were not given. In order to ensure the guests' comfort, I evaluated two typical adjacent guest rooms. The transmission loss through the shared wall as well as the noise reduction was found. Finally, based on the sound pressure of humans talking in one room, the sound pressure in the adjacent room was calculated and compared to ambient sound conditions.

From these studies, I concluded the following:

- The precast plank system is more effective than the steel joist system based on a small floor sandwich, constructability, cost, and affects on the exterior architecture.
- A staggered truss system is cheaper and will have a shorter construction time than the proposed steel frame structure.
- The payback period of approximately three months for the first cost installation of the geothermal heat pumps makes this a much better alternative to the existing heating and cooling system.
- The sound transfer in between two typical adjacent guest rooms is at an acceptable amount.

Background

In April 2002, the largest development project in Erie, Pennsylvania's history was underway with the presentation of a $32-million check to the Erie County Convention Center Authority for the construction of the Bayfront Convention Center and surrounding complex.

This complex includes a supplementary part of the Erie Convention Center, along with a Sheraton Hotel. Additional state funding was granted in August 2004, bringing the total to $44-million, to be added to funds donated by local businesses. The location of the new complex is the revitalized bayfront of Erie along the Preque Isle Bay.

The owner, the Erie County Convention Center Authority, along with the development manager, Acquest Realty Advisors, and the hotel franchisor, Starwood Hotels and Resorts Worldwide, made up the head of the primary project team. The design-bid-build project delivery rewarded the general contractor position to Barton Malow Co. DRS Architects and Atlantic Engineering Services, both located in Pittsburgh, PA were responsible for the architecture and structural engineering, respectively. Karpinski Engineering was the MEP Engineers for the project, while the civil engineering was completed by Urban Engineers of Erie.

The ground breaking in August 2005 began the construction of the complex. Construction is expected to be completed in the summer of 2007.

Site and Architecture

The Port Erie waterfront location of the site for the Erie Convention Center and Sheraton Hotel provides the opportunity for the building to have exquisite views of the Presque Isle Bay, while being within a short walking distance to other bayfront attractions such as the maritime museum, Bicentennial Tower, shopping, marinas, and more. This eleven story hotel and convention center will have 200 guestrooms on the upper nine and a half floors, with the lower one and a half floors for mixed use. Taking advantage of the location along the bay, the ground floor is designed for clear sight lines through the hotel and out into the Presque Isle Bay beyond. A five story parking garage will attach to the east side of the hotel. A pedestrian bridge connecting the hotel and the proposed Bayfront Convention Center on Sassafras Pier will extend west over the West Canal Basin from the fifth floor of the hotel building. A site plan of the complex is shown in Figure1.

Figure 1: The red box highlights the footprint of the Sheraton Hotel. The pedestrian bridge connection to the Bayfront Convention Center, which is located in the bottom of the picture, can be seen. (North faces left)

The architecture is based on Sheraton's signature low-rise 'Soho' prototype adapted to a high-rise expression. The hotel and convention center has a buff-colored precast concrete base, rising to mid-first floor, and is detailed with copper cladding. The tinted green glass windows are accented with silver aluminum mullions and green louvers or metal panels. The exterior wall material is a combination of a panelized EIFS wall system in four different light shades in contrast with red brick, attached to the light gage stud wall structural system. This contrast is seen in the brick "columns" that are offset by the green tinted windows and light cream stucco background. The two story front entrance is approximately 75ft. x 45 ft. and allows for safe drop off and pick up of guests and visitors, protecting them from any harsh weather that may occur.

The site, West Dobbins Landing, was developed gradually by placing timber cribbing and filling with fill materials readily available at the time. The bulkheads on the north, west and south sides were constructed about 15 years ago, and are made of soldier pile walls with concrete wall panels. The site used to house different marinas and boat works. These have been razed; however, some of the foundations may still remain. Because of the historical use as a marine facility, there is also a chance of underground storage tanks on site.

The following two pictures show views of the Bayfront Convention Center. In both pictures, portions of the Sheraton hotel can be seen.

Existing Structural System

The center tower of the Erie Convention Center and Sheraton Hotel reaches an overall height, including mechanical penthouses and parapets, of 155 feet. The footprint 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 2 shows the basic framing layout and member sizes of the tower.

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 3).

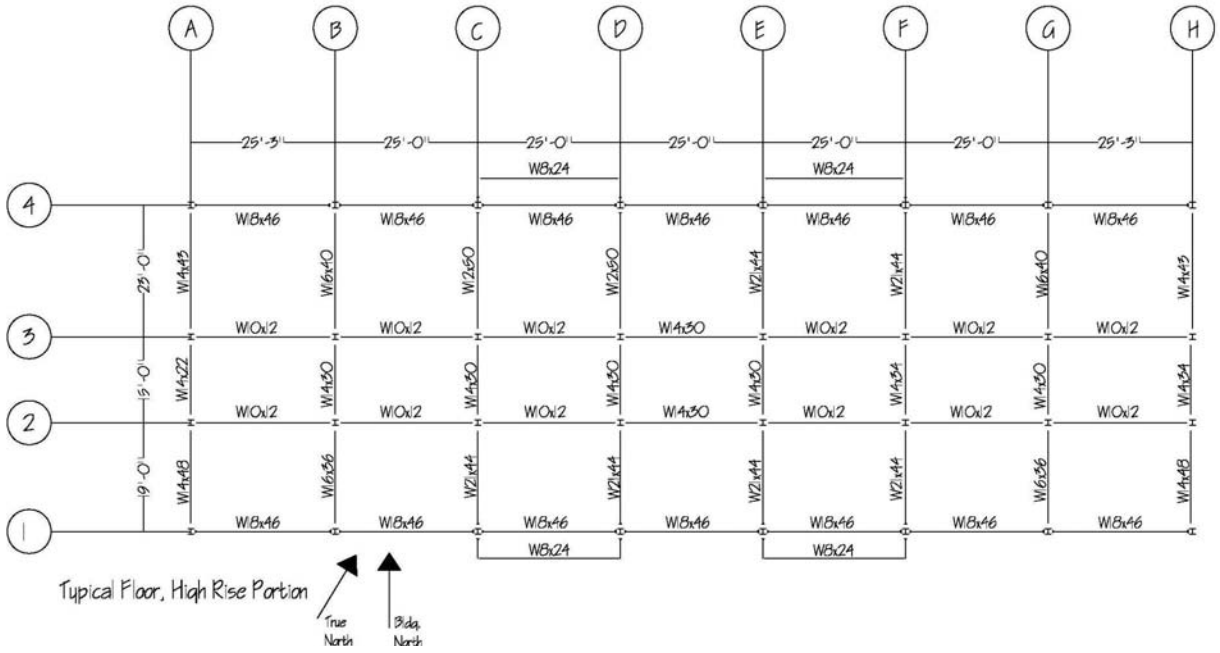
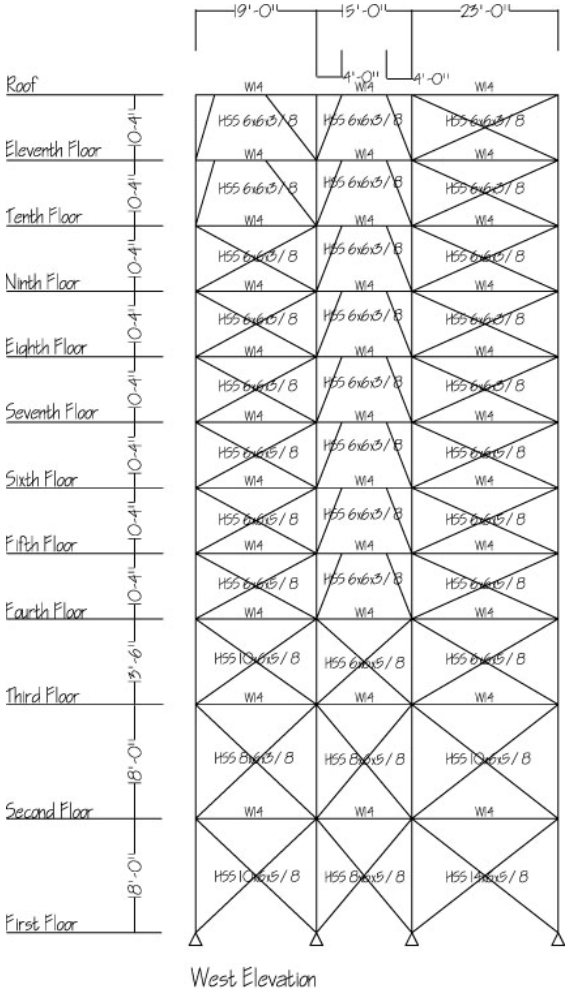


Figure 2: The tower portion of the Erie Convention Center and Sheraton Hotel has a typical framing plan as shown here. The three bays in the North/South direction are sized 19', 15', and 23'. In the East/West direction, the two exterior bays are 25'-3", with five 25' interior bays.



West Elevation

Figure 3: 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 a floor system of 8-inch hollow core precast concrete planks that span in the East/West direction. 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.