Executive Summary

Res Tower II is a 26 story, 296 foot tall, dormitory located in Boston, Massachusetts. There are three levels of public space with 23 levels of private study and living spaces. A steel framing system supports the lightweight concrete composite floor system and lateral loads are resisted by moment connected steel braced frames pinned to a mat foundation.

The goal of this thesis was to design a staggered truss system for Res Tower II and investigate the most efficient use of the trusses. Investigations were made into using the staggered truss system to resist 100% of both gravity and lateral loads or using it to support the gravity loads only and designing a new appropriate lateral system. AISC Design Guide 14: *Staggered Truss Framing Systems* was followed closely in the design of truss members and connections.

An acceptable shear wall design was completed but the wall thickness was larger than desired. For this reason, a moment frame was implemented into the structure and wall thicknesses decreased. To design the most efficient structural system, an investigation was completed to find an appropriate height to stop the moment frames and allow the shear walls to continue for the remainder of the building height.

Recognizing that changing the structure of the building will impact all parts of its design, studies were completed for the architectural and construction impacts a staggered truss system would have on Res Tower II.

There were three main areas of concern for the architectural study. In each of these spaces, a rendering was done to analyze how an exposed truss would affect the interior architectural dynamic. In some cases, the truss had to be removed to avoid negatively affecting the architecture but in one case, it was decided to keep the truss in the system and keep it exposed because it added excitement to a mundane space.

A new site logistics plan and construction schedule were created to adjust for the new structural system. This involved studying the surrounding buildings, deciding on a proper site layout and determining construction durations for five main steps of the construction process.

Two highly repetitive truss connections were designed to meet the MAE requirements for this thesis. To allow for construction ease and by following typical practice, connections were designed using bolts and welds depending on the type of connection.

Conclusion

A staggered truss system was successfully designed and efficiently implemented into Res Tower II. As a result of investigating the best use of a staggered truss system to resist gravity and lateral loads, it was determined that for Res Tower II, it is not practical to design the truss system to resist lateral loads. The staggered truss system efficiently supports the gravity loads but to resist lateral loads, member sizes would need to be unreasonably large.

To allow the trusses to only support gravity loads, a lateral system was designed using concrete shear walls and steel moment frames. To increase the moment of inertia and stiffness of the central core shear walls, coupling beams were added to connect the two C shaped walls surrounding the elevators. The steel moment frames were stopped at the 19th floor to increase the efficiency of the system. Max deflections of 5.79 inches at the 19th floor and 8.74 inches at the 26th floor are both within code limitations. This is an efficient design and the designer feels confident that this system could be used in the construction of a Boston high rise.

A goal for this design was to avoid negatively affecting the interior appearance of Res Tower II. The trusses are only exposed in a study lounge on the second floor. Exposing the structure in this area positively changes the space by adding a landmark feature to an ordinary space.

A logical site logistics plan was created that provides a delivery route and site layout that avoids blocking any traffic and does not influence the infrastructure of the surrounding buildings. The construction schedule provides a rational process that allows for an uncongested site and efficient construction duration.