TOWER 333

Final Report

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Executive Summary:

The purpose of this report is to determine through analytical methods the performance of the lateral force resisting system implemented as a part of the AE Senior Thesis for the design of the 260 foot tall office tower, Tower 333 in Bellevue, Washington under seismic and wind loads. Costs and related issues were investigated as a part of the overall study.

Existing Lateral System:

Originally implemented as a dual-resisting lateral system, a combination of special exterior moment frames and a special 24" thick concrete shear wall centralized core was used. The concrete core is 40 feet by 32 feet with 7 foot openings for elevator access in the 32 foot length side. Moment frames consisting of rolled W shapes with columns ranging from W14x730 at the mezzanine level to W14x132 at the penthouse level are used. The moment frame beams range in size from W36x256 at floor 1 to W18x86 at the penthouse level..

Gravity System:

A 2-1/2" concrete slab on a 3" deep metal composite deck with an f'c of 4,000psi and WWF 6x6 W3.5xW3.5 reinforcing is used as the existing floor system. Supporting the slab are W18x40 composite steel beams which span 42' N-S in a typical bay. Beams frame into composite steel girders on the interior which are typically W18x97 spanning E-W.

Conclusion:

In order to determine Tower 333's lateral resisting system response to seismic and wind loads a model of Tower 333's lateral system was created in ETABS. Lateral elements consisting of the core and perimeter moment frames were modeled and connected with a rigid diaphragm on each floor. The model was loaded with seismic and wind forces calculated using spreadsheets in accordance with ASCE-7 '05 and analyzed under the different load combinations required by ASCE-7. Using this ETABS model, in conjunction with hand calculated spot checks I was able to confirm that the assumptions made prior to the design of Tower 333 were appropriate. These assumptions include drift limitations of L/400 for wind and ASCE-7 '05 section 12.8.6 allowable drift for seismic. Based on the relative base shear distributions, it was determined that the moment frames

resist 10% of the lateral load. However, these frames were initially designed for 25% of the seismic force in conjunction with the dual system requirements of ASCE-7 for the Seattle area. An examination of the drift results reveals that the dual system as originally designed is well balanced and subject to only minimal building torsions.

This thesis study included an in depth examination of the lateral system as a core-only design. Eliminating the exterior moment frames from the lateral system saves not only money in the design and fabrication, but also in erection time, which will ultimately decrease the total cost of the building as well as provide an earlier move in date for tenants. An initial lateral analysis using the Equivalent Lateral Force Method, (ELF,) resulted in seismic forces controlling over wind. (For a table of the wind and seismic forces and drifts see Appendix D1.) An initial core size was first determined and from this preliminary design, a set of iterative analyses were conducted in ETABS to develop the most economical and efficient design of the core walls and coupling beams. The main controlling factor in the design of the core was the drift limitations. Once these limitations were under control the rest of the building could be modeled and tested in ETABS to obtain design forces. From these design forces then, a design of the concrete core and coupling beams using a combination of hand calculations following ACI318-05 and computer programs such as PCA Column was determined. Despite an increase in concrete volume of the core, the elimination of the moment frames results in a more economical design and added revenue to the owner due to the early move in date. It is the recommendation of the author of this thesis study that the alternative core-only design of the lateral system is a beneficial design appropriate for implementation.