Conclusions and Recommendations

CONCLUSIONS AND FINAL RECCOMENDATIONS

The goal of this report was to design and evaluate an alternative superstructure design for Eight Tower Bridge, a high-rise office tower located in Conshohocken, Pennsylvania. The existing composite steel superstructure does adequately resist gravity and lateral loads, but the question still exists: could this building have been designed as a concrete structure?

The long spans that currently exist in Eight Tower Bridge were maintained by designing a one-way, post-tensioned beam and slab floor design. Using post-tensioning allowed for longer concrete spans, which kept the floor plan of the building open and without very many column intrusions. Two post-tension systems were designed. The system employs post-tensioning in the beams that support a 6" reinforced concrete. This system saw a maximum deflection of 0.57" under sustained loading. The second alternative flooring system increased the spacing between beams by adding post-tensioning to the slab. The maximum deflection under sustained loading of this system was found to be 0.55". The original steel system was found to have a deflection of 1.03" after a 1-3/4" camber was subtracted from the total deflection. Both of the concrete systems reduced the overall floor system depth by 3-1/4" and 5-1/4", respectively. However, this reduction in floor system depth did not correlate to a reduction in dead load, as the building's total weight actually increased.

Both concrete systems used the same columns and the same shear wall lateral force resisting system. The shear wall system designed is comprised of 8, 12" shear walls arranged around the building core. The building sees a maximum deflection of 4.66" under seismic loading in the x-direction. Under wind loading, the deflection was found to be 1.76", nearly half the deflection found under the same loading for the steel system.

A construction management study was conducted to see how changing the material of the building would affect the overall cost and construction schedule. The first concrete system resulted in a $14.51/ square foot, while the second system came in at $14.21/square foot. These totals are in 2001 dollars, and include material,

placement, formwork and shoring. The total steel system was totaled $13.94/square foot, but did not include the $500,000 dollars in change orders reported. The construction duration of both concrete systems was found to be comparable, and totaled 28 weeks when concrete was placed using a crane and bucket. If the engineer or concrete contractor could arrange to have the concrete placed by pump (a feat uncommon in high-rise construction, but not out of the question entirely), then the construction duration would only last 23 weeks. This would be a reduction of 5 weeks from the steel construction time of 28 weeks.

An unrelated mechanical systems study was conducted to explore the used of a ground source heat pump for use in heating and cooling of Eight Tower Bridge. The system currently runs a chilled water loop system that uses rooftop mounted cooling towers to chill the liquid in the loop. The ground source pump would use the earth's natural temperature as a reservoir for heat exchange of the liquid in the loop. However, it was found that the initial investment to implement this system heavily outweighed the payback period, which was found to be nearly 19 years for the cooling loop.

Final Recommendation:

Although the alternative concrete design results in an overall thinner floor system, which could allow for reduction in overall building height, saving money on cladding components and MEP costs, it is still suggested that Eight Tower Bridge be constructed out of steel for the following reasons:

1. The cost per square foot of the steel system is lower than the concrete systems ($13.94/sq ft)
2. Interior finishes (i.e. drop ceiling) are more difficult to install in concrete systems, and are the desired finish for most office buildings
3. The Philadelphia region does not have very many experienced post-tensioning contractors, which could potentially cause construction issues
4. The owner, engineer and architect all have experience designing and constructing steel office buildings
5. The rooftop mechanical penthouse is most easily constructed in steel, and is strategically placed on the roof due to flood concerns, eliminating the possibility of placing equipment in the basement

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