Executive Summary

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The building being analyzed in this report is Eight Tower Bridge, a high rise office tower located in Conshohocken, Pennsylvania. The building is a 16 story steel frame structure with a rooftop mechanical penthouse for HVAC equipment. The total area of the building is approximately 345,000 square feet, with an average of 21,500 square feet of rentable space per floor. Construction of Eight Tower Bridge began on February 12th, 2001 and was completed in April of 2002. The total cost of the building was $43 million, with nearly $4.8 million dollars stemming from the steel superstructure of the building. The steel frame is supported by a combination of pile and mat foundations, and allows for the slab-on-grade on the first floor to be used for vehicle parking. The lateral loads of the building are resisted with a combination of steel braced frames and moment resisting connections.

This report contains a study to see if the superstructure of Eight Tower Bridge could be alternately designed in concrete. Due to the desire to maintain an open floor plan, longer span concrete beams were required, which lent the structure to be post-tensioned. Two alternate post-tensioned floor systems were designed and compared in regards to deflection performance and costs. Both of these systems employed the same cast-in-place concrete column and shear wall designs.

The first flooring system was a one-way beam and slab system incorporating post-tensioning in the beams only. The beam members were sized to a typical 20”x 20”, including the 6” reinforced concrete slab. This system saw a maximum deflection of 0.57” under sustained loading and costs an estimated $14.51/square foot to construct. The second system was also a one-way beam and slab post-tensioned system, although the 6” slab was also post-tensioned. This system allowed for further spacing between beams, but resulted in more post-tensioning. The system saw sustained service load deflections of 0.55” and costs an estimated $14.21 to construct.

Columns were designed for the structure using PCA COL. Columns were first designed for axial loading, and then checked for resistance to lateral loads. Although

not designed as the main lateral force resisting system, these concrete frames will act in concert with the eight, 12" thick shear walls designed to resist lateral loading. These walls were designed using ETABS, and considered under multiple load cases to find a maximum deflection of 4.66", which meets the L/400 limit.

A construction management study was done regarding the cost and building duration for an alternate concrete superstructure. Cost and schedule analysis were done considering both flooring system options, which were found to impact the building cost only, and not the overall construction schedule. The construction duration for both systems was found to be 28 weeks if concrete was placed by crane, and 23 weeks if concrete was pumped into place. These were both comparable to the 28 week construction duration for the original steel building.

A non-structural related mechanical system study was also conducted. This study evaluated the feasibility of replacing the current chilled water loop system that uses rooftop cooling towers to chill or heat water (depending on the season) with a ground source heat pump. A ground source heat pump that uses the earth relatively unvarying temperature as thermal reservoir, was found to reduce to building heating and cooling loads, but resulted in a payback period of over 8 years for the heating cycle and nearly 19 years for the cooling cycle.

This report begins with a building background and existing conditions summary to acquaint the reader with the project. The problem development and proposal of work is then introduced. This is followed by the depth of the report, which includes discussion on problem solutions, post-tensioned concrete and finally, the presentation of the alternate concrete design and how the solution was obtained. Finally, the two shorter breadth studies completed on construction management and the building's mechanical systems are presented, with final conclusions and summaries following.