Executive Summary

The New Hospital of the University Medical Center at Princeton is a six-story facility which rises 106'-0" above grade and is the centerpiece of an entire medical complex currently under construction in Plainsboro, NJ. The current structural system of the hospital is steel framing with a composite beam floor diaphragm. Lateral forces are resisted by eighteen braced frames spread throughout the building and two long moment frames on both the north and south exterior faces. Spread footings are located underneath each steel column to carry the loads to the ground.

Due to strong lateral loads on the structure, the base of each braced frame experiences a net tensile force depending upon the direction of the loading. In order to resist this upward pull on the foundation, tension only mini-piles are anchored into the bedrock below and then attached to the spread footings underneath each braced frame.

The proposed thesis includes a redesign of the structural system using concrete rather than steel framing. The overall goal is to increase the weight of the building enough so that the downward compressive force at the footing is greater than the upward tension force, thereby eliminating the need for mini-piles underneath the footings. A second goal is to improve vibration performance of the original composite beam floor system by redesigning it as a two-way flat slab. The structure will be modeled and redesigned in RAM Structural System. Hand calculations will be performed to check these designs.

By changing the structural material to concrete, the lateral force resisting system of the building will be redesigned with concrete shear walls in both the N-S and E-W directions. Since the self-weight of the building is increased, the spread footings will need to be upsized in order to properly handle the increased compressive forces. An effort will be made to maintain the original layout in order to reduce the architectural impact of the redesign.

A concrete redesign will also present new issues that must be addressed. One of these issues is the increase in seismic forces due to a heavier structure. Seismic forces will be recalculated based upon the Equivalent Lateral Force Procedure set forth in ASCE7-05 and compared with the wind forces to determine the controlling load combination on the redesigned structure. Floor vibrations due to walking and mechanical equipment must fall within guidelines for a hospital set forth in AISC Design Guide 11.

A scheduling and cost analysis will be performed to evaluate the advantages and disadvantages of the redesign. Finally, an architectural study of the south façade will be performed to determine the impact of replacing exposed circular HSS columns with circular concrete columns along the south façade of the hospital.