

Executive Summary

The following Senior Thesis Final Report is the result of multiple technical analysis developed from the knowledge acquired in the Architectural Engineering curriculum as well as through experienced industry members. This final report focuses on the construction and renovation of the Intramural Building at the Pennsylvania State University, located in University Park, PA. Four analysis were performed in an effort to accelerate the project's schedule, lower costs, and improve the delivery of the project through the use of prefabrication, shared risks, collaboration and planning standards of construction.

Analysis 1: Prefabrication of Building Enclosure

The first analysis focused on implementing prefabricated brick panels to replace the existing brick veneer façade, as well as a unitized curtain wall system replacing the current stick-built glazing. With the opportunity of manufacturing and assembling panels faster offsite and reducing unnecessary labor costs onsite, the use of prefabricated panels and unitized curtain wall system provide both cost savings and schedule acceleration. Through these methods, the exterior enclosure schedule would be accelerated by 12 days and provide cost savings of \$75,613 from the prefabricated panels only. On the other hand, the exterior schedule would be accelerated by 29 days and add \$114,973 to project costs if implemented with the unitized curtain wall system.

The prefabricated brick panels were analyzed through thermal and moisture performance calculations, identifying that they would perform as well as the current system.

Analysis 2: Prefabrication Structural Effects

The second analysis focused on how the implementation of the prefabricated brick panels would affect the building's structural system. Since the panels act as a curtain wall system and do not bear any loading but the panel itself, calculations had to be performed to analyze if the structural system would be altered. Because the panels weigh less than the existing exterior system, the structural frame wouldn't need to be changed, but with hopes of reducing production costs this analysis was performed. The exterior beams supporting panel loads could be reduced from a W18x35 to a W16x36, which would increase the costs of the structural frame by \$780.90 plus additional uncontrolled costs. Due to the cost increase and the possible effects of having a smaller beam size to the structural connections between beams and columns, this proposed change would not be implemented.

Composite Beam and column redesign calculations were perform to analyze the feasibility of the new exterior façade loading.

Analysis 3: Integrated Project Delivery Implementation

The third analysis addressed the feasibility of utilizing a different delivery method than the traditional system utilized by the owner. The University is a fan of delivering projects as the traditional design-bi-build, or as in the case of this project CM at Risk. Delivering the Intramural Building with an Integrated Project Delivery Method would bring great results to the owner such as potential reduced construction costs, project duration, and increased project quality. Although this delivery method requires high owner involvement throughout the project, the costs of associated risks, liabilities and lack of owner experience would lead to not recommend this proposal. Taking an IPD approach on the other hand, would still benefit the project from collaborative efforts and early project team involvement.

Analysis 4: Phased vs. Empty Renovation, Standards and Noise Effects

The fourth analysis addressed the different considerations an owner needs to evaluate when planning a project which includes a renovation and new construction. A mock scenario was generated to identify if the decision of keeping the Intramural Building occupied during the renovation was the right one. In addition, construction standards were produced for renovation projects to be implemented within the University's program. With these, a study on construction noise was performed, identifying the different effects on building occupants and how these could be prevented. The proposed construction standards, which focus on the safety and health of building occupants primarily are greatly recommended for the owner to improve the quality of projects.