T.C. WILLIAMS HIGH SCHOOL

ALEXANDRIA, VA

CHRISTOPHER B. DEKER

STRUCTURAL OPTION

EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

T.C. Williams is a 3 Story 461,000 SF high school in Alexandria, VA, designed to accommodate 2,500 students. This report deals with the two classroom wings, and attempts to create a more economical design.

Due to poor soil conditions, a Geopier 'Rammed Aggregate Pier' Soil Reinforcement system was installed to create a soil bearing capacity of 6,000 PSF. The total bid price for this system was $780,000. It was decided to reduce the size of the school's footprint, while adding two additional stories. The existing square footage of each classroom wing will not change from the original 108,000 SF. Along with decreasing the cost of the existing structure, changing the shape of the wings will add other benefits as well. It was calculated with the new layout of the classroom wings, that 91% of the rooms in these buildings will receive natural lighting, an approximate increase of 24%. The existing building as a whole took pride in the fact 70% of rooms in the entire building had an outside view, and this new layout greatly increases this number to around 82%. Additionally, with the new layout of the classroom wings, less corridor area is needed for the same results. An expected savings of approximately 5,000 additional square feet of floor area will be added to classrooms in each wing.

After some inspection, it was noticed that decreasing the building footprint would actually increase the cost of the structure, due to the cost of the floor system being even larger than that of the foundations. To justify the advantages of the new layout, further cost cutting systems needed to be set in place. Most noticeably the floor system and lateral resisting systems were changed for more economical solutions.

The new floor system was designed using composite steel joists from Vulcraft. In order to decrease the number of joists, and thus save on the expensive costs of fireproofing, the joists were designed to be spaced a maximum of 8 feet on center. In order to still meet the vibration criteria of 0.5%g, only a quarter inch of concrete was able to be saved. If vibration wasn't a critical criterion a much more efficient floor system could have been used. However, it was decided that in a school setting, vibration issues would be critical to ensure the comfort of all students. After pricing the new floor system a total savings of $4.65 per square foot was saved on the floor system.

A new lateral system was also designed, and takes advantage of the masonry partitions already in place. The existing steel concentrically braced moment frames were replaced by fully

grouted 8 inch masonry shear walls. The shear walls span 34 feet in length and are required to be fully reinforced at 8 inches on center. This is mostly due to the cause of high torsional forces created from the layout of the shear walls. This was due to the required stacking of the shear walls on the new architectural floor plan, and the layout of these walls cannot change without an additional time consuming redesign of the architectural floor plans. Additionally the story drift of these walls was calculated to be 0.55 inches, well below the maximum 2.25 inches (L / 400) allowed by code. A total savings of $1.19 per square foot of building floor area, or $128,000, was saved from the use of masonry shear walls over braced frames. Even though a savings was created from the use of these shear walls, a major downfall is the increase in construction time, which greatly affected the schedule of the redesign. An estimated 58 days of construction time is added to the project, which eliminates the original time savings from the reduction of excavation and Geopier reinforcing.

Some unforeseen difficulties were also realized during the redesign faze. The increase in height ended up adding much more square footage of wall surface area to the project, than was saved from the reduction in linear feet of the wall. Also additional reinforcement and grout was needed to stabilize the wall at its additional heights. The new exterior façade was priced $497,100 higher than the existing.

An additional unforeseen cost increase of the roof system was realized when problems arose with the mechanical roof systems. With the new building layout, the mechanical systems which once were hidden from site may now be seen from the surrounding residential areas. This created the need for a redesign of the roof system, which was able to fix this problem while adding $1.25 per square foot to the cost of the roof.

With all factors considered the total savings was found to be just $10,000 per classroom wing, which is a very negligible savings of a structural system originally costing 4.6 million per wing, and a total project cost of $87 million for the entire school. 17 Days were also added to the completion date, 11 which are work days, 6 of which are weekends. However, through further inspection this issue may also be negligible as the school was completed 2 months before the start of August classes in 2007.

With the future construction of a similar building, the owner would have many options. If the owner feels that the extra 5,000 SF per wing or 10,000 SF for the entire school, and a 24% increase of extra rooms with an outside view beneficial, then he may be willing to accept the slight increase in construction time, while also benefiting from a measly $10,000 in savings. If he still would feel this new design would be beneficial, but an increase in construction time

would be damaging, then he could opt to replace the masonry shear walls with the concentrically steel braced frames, adding an estimated $100,000 to the total cost. This option would also add the decrease of 50 days of construction time, decreasing the total construction time by over a month. Furthermore a simple change in floor systems from composite steel beams to composite steel joists would save $162,750 without having any negative effect on the original design.