

Executive Summary

This is a new, 138,000 square foot laboratory and classroom building located on an urban university campus in the Northeast USA. It has a construction cost of approximately \$50 million, and has several unique architectural features, such as a biowall and a 5-story atrium through the core of the building. The main gravity system consists of voided filigree slabs and beams resting on cast-in-place columns, but the mechanical penthouse is constructed of steel. The lateral system consists of 15 shear walls scattered throughout the building, augmented above the concrete-steel transition by five braced frames.

The bulk of this report is comprised of several redesigns of the original structure. Because the existing structure was extremely efficient, the choice was made to attempt to design a viable alternative in steel, with moment frames as the lateral system. This was first done at the present site in the Northeast USA. It was found that the resulting design weighed approximately 11,800 k (about half the weight of the original structure), and was controlled by wind forces and the associated industry-standard drift limitations.

A scenario was then created in which the California State University, Northridge (CSUN) had commissioned the design of the building instead of the original owner. A geotechnical report was located for a site on CSUN's campus which was similar to the original site. The steel structure was redesigned for code minimum requirements to resist the controlling seismic forces at this new site and maintain the code-allowed drift. The resulting structure weighs approximately 12,300 k.

Finally, high-performance design was investigated by producing two designs for Immediate Occupancy criteria, as defined in ASCE's "Seismic Rehabilitation of Existing Buildings" (ASCE 41-05). The first design achieved this higher performance rating through the use of larger, stiffer steel moment frames. This structure weighed approximately 13,500 k. Then, the code-minimum frame was augmented with viscous fluid dampers on concentric steel braces in order to achieve the higher performance requirement. This design was verified with nonlinear analysis in SAP 2000. The resulting structure weighed approximately 12,500 k. Master's level coursework was integrated throughout the report in the computer modeling of the structures (AE 597A) as well as earthquake design (AE 538). However, the most direct application of mater's-level coursework can be found in the hand design of a variety of connections for the 3 structures in California (AE 534). The hand calculations for these designs can be found in Appendices E and F.

To fully compare the structures, a construction management breadth was undertaken. This used quantities from the take-offs of both structural components and some additional architectural features which were considered to determine durations for activities. Then, the existing schedule was modified to remove the existing superstructure, and the new durations for the superstructure (as well as additional architectural items) were added. These durations were used to calculate general conditions cost of the projects. The costs of the original structure and the four redesigned structures were calculated using a mix of square foot estimating, detailed estimating, and original cost data provided by Turner Construction. This analysis found that the steel structures were almost uniformly less expensive than the original structure, but they also had durations 2-3 months (10-15%) longer than the original schedule.

Finally, since the building was relocated to California, a sustainability breadth was undertaken to determine if a photovoltaic system or a green roof (neither of which were included on the original building) would be viable at the new location. Each system was designed and then evaluated with a life-cycle assessment, a payback period, a carbon footprint, and the number of additional LEED points they would earn. Each system could earn the building one additional LEED point, but the other analyses clearly indicate that the green roof is the more viable system.