Project FROG Leaps Ahead in High-Performance Learning Environments

By Alethea O'Dell

Degenkolb Engineers was an Award Winner in the 2009 NCSEA Annual Excellence in Structural Engineering program (New Buildings under $30M category)

Learning and Technology Center, Sonoma, California.

The days of marginally constructed, unattractive, and uninspiring trailers segregated to the back of schools are fading in favor of dynamic, high-tech, environmentally friendly spaces that respond to schools' and students' needs. The industry leader is Project FROG. FROG has invented a state-of-the-art building kit that provides schools, among many other commercial uses, a brighter, healthier environment which inspires better performance. Frogs are also safe and structurally sound, exceeding seismic codes.

In California alone, there are more than two million students learning in temporary classrooms, and the need for fast, flexible, and reasonably priced facilities is growing – especially in places struck by natural disasters and overwhelmed by population growth.

This pre-engineered approach offers educational institutions a quick-to-deploy, high-performance, reasonably priced middle ground between the traditional design/bid/build construction process and modular trailers. Degenkolb Engineers designed the structural system for this innovative building kit.

Structural Innovation and Complexity

To achieve maximum flexibility in the system, Degenkolb's engineers Ray Pugliesi and Kirk Johnston redefined how a modular system could be constructed. Degenkolb designed the structural system for the FROG kit with light gage and structural steel to improve the lifespan of the structures, comparable to traditional buildings that last 25 to 50 years.

FROG's highly engineered building frames exceed California seismic codes and wind loads over 90 mph. The Division of State Architects (DSA) has awarded FROG several PCs (Pre-Check certifications) for use in California. This over-the-counter permit process allows the units to be installed without a structural plan check every time, which greatly speeds up the process. "Meeting the state's requirements for a pre-approved school building was one of the biggest engineering challenges we faced – and we did it," says Pugliesi.

One of the first modifications to the process was creating a three-dimensional computer model of the design. The model allows the project team to analyze wind, gravity, and seismic loads for various styles of the building and for various environments. One of the challenges was the lack of anchorage of foundations exhibited by modular systems. In order to achieve maximum stability in the structure, Degenkolb's engineers used a standard foundation system with concrete grade beams supporting the gravity and lateral loads. This allowed for simple construction methods and improved performance of the modular system.

Pugliesi and Johnston developed a lateral system of diagonally braced metal deck roof diaphragms and steel braced frames to meet the requirements of a pre-approved product. The roof diaphragm bracing is atypical for a modular system, especially one intended to be one-story. While schools are usually built with solid walls, the steel frame structure of the FROG units allow for all the seismic needs without interrupting the openness and free form of the space.

The structural steel lateral system ensures the safety of occupants in the event of an earthquake, with minimal damage to the structure. Return to operations is expected to occur soon after an earthquake.

All connections are bolted for easy field assembly, with no field welding required. At the roof, double angle steel roof trusses support metal deck and aluminum joists over the central portion of the unit, and light gage built-up headers support the framing at the low roof eaves. The trusses and headers are supported by a combination of light gage and structural steel tube columns. Light gage tube steel joists and steel wide flange beams make up the floor framing system. Around the perimeter are optional cantilevered sunshades that are designed integrally with the aluminum window wall.

Project Team

Structural Engineer: Degenkolb Engineers
Architect: Project FROG
General Contractor: B&H Engineering

Meeting the Green High Performance, Affordable Challenge

Green elements help to create the ultimate learning space with minimal impact on the external environment. The buildings are constructed using highly recycled materials and low/no volatile impact organic compound (VOC) interiors. Additionally, occupancy and daylight sensors reduce the amount of electricity used, while clerestory allow abundant natural daylight. Optional solar panels, living roof, and sunshades offer additional energy and environmental benefits.

Units are easily assembled with a small crew and simple installation equipment, with almost zero site waste. The entire building can be purchased, permitted, delivered, assembled and ready for occupancy in approximately 6 months. FROG buildings are priced below the cost of a similar structure using traditional construction methods.

The smart modular system can be easily configured to create labs, administration spaces, and a variety of other classroom types. Its flexibility is key to owner satisfaction. Project FROG brings the construction industry into the twenty-first century with a new way of building.▪

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