

# Award Winners

Oklahoma Hall was presented an Outstanding Project Award (New Buildings \$10 to \$30 Million) in the NCSEA 2004 Excellence in Structural Engineering Awards program.

## Oklahoma Hall: Bachelor Enlisted Quarters P-593

### A New Era in Hawaii Military Housing

By Francis K. Humay, Ph.D., S.E.

In light of current world events, progressive collapse is a topic that has recently received considerable attention in the U.S. Incorporation of progressive collapse mitigation into the structural design process, unlike seismic design, is not enforceable by any national building code in the U.S. One agency that does require the consideration of progressive collapse is the Department of Defense (DoD). The DoD has mandated that the risk for progressive collapse be reduced for all inhabited buildings of three stories or more.

Oklahoma Hall at Pearl Harbor is the first residential building designed and constructed in Hawaii that meets the DoD's progressive collapse standards. For this five-story dormitory, the Navy desired an enhanced level of protection. The structure is designed to withstand the removal of load-bearing elements within a prescribed distance from the exterior face of the building. The additional progressive collapse requirements for Oklahoma Hall were not accompanied by a substantial increase in project funding. Selection of an economical structural system was vital to ensuring a successful project.

There are various approaches to providing resistance to progressive collapse, some more efficient than others. The design-build team of Baldrige and Associates Structural Engineering (BASE), Dick Pacific Construction, and RIM Architects evaluated several different structural systems.

BASE worked closely with the design-build team and the owner to develop a structural scheme that not only met, but exceeded the progressive collapse criteria without impacting the architectural and functional requirements of the project.

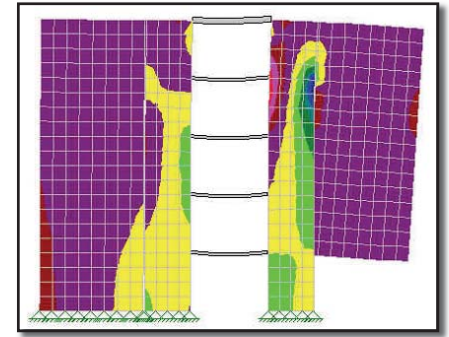
Progressive collapse is resisted by the BASE Hanger System (BHS). The BHS is a multi-hazard solution, providing not only progressive collapse mitigation, but also resistance to other hazards such as earthquakes and hurricanes. On first

inspection, the structural framing for Oklahoma Hall appears no different than many other dormitory-type buildings. By design, however, the BHS is unobtrusively integrated into the functional layout of the building.

In the scenario that a section of load-bearing wall is removed from the building, alternate load paths can develop due to the special detailing of the concrete walls between units. Each wall is divided into two distinct vertical elements, an exterior and an interior. The separation between the two elements consists of a weakened (or fuse) section, a backup wall and a physical gap. At the top floor, however, the interior and exterior portions of the wall are continuous. If the support at any level is lost due to an extraordinary event, the continuous portion of wall is designed to perform as a hanger or deep cantilever beam, carrying the weight of the unsupported walls below. The BHS' behavior can be likened, albeit a grim analogy, to a hangman's noose. Additional continuous vertical reinforcement with mechanical splices at each level was added to resist the tensile forces in the wall.

Although not explicitly required by the DoD standards, the BHS remains within the elastic range of behavior. A maximum calculated vertical deflection of only about 16 mm (5/8-inch) is predicted using cracked section properties of the concrete. In addition, the inherent redundancy in the BHS actually allows more than one wall to be removed without progressive collapse.

Incorporation of the BASE Hanger System was achieved with a mere premium of roughly 3% of the overall cost of the structure. Much of the extra cost is attributable to additional reinforcing steel, and labor involved with the system's unique detailing. Moreover, the progressive collapse elements did not



alter the Contractor's schedule or preclude them from using the same wall forming system used on similar projects without the progressive collapse requirements. The Architect was also pleased by not being constrained with any additional structural framing.

As a result, the design of Oklahoma Hall promotes a sense of community as opposed to a barracks (or bunker) type atmosphere. Falling within the historic boundaries of Pearl Harbor, Oklahoma Hall's architectural façade was designed to be compatible with the historic details, shapes and building components prevalent on base. This new bachelor enlisted quarters symbolizes the optimal synergy between quality of life, historic Hawaiian architecture and force protection. ■

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### Project Credits:

#### Structural Engineer of Record:

Baldrige & Associates Structural  
Engineering, Inc., Honolulu, HI

#### Owner:

Pacific Division NAVFACENGCOM  
(ACQ0242), A-E MILCON  
(Contracts Branch)

#### Architect:

RIM Architects, Honolulu, HI

#### Contractor:

Dick Pacific Construction Co., Ltd,  
Honolulu, HI

