UCSD To Construct World's First Bomb Blast Simulator

Technical Support Working Group (TSWG) contract to result in design manual for technologies to harden buildings against terrorist bomb attacks

December 16, 2003

Denine Hagen

Structural engineers at the University of California, San Diego (UCSD) Jacobs School of Engineering will test the effects of bomb blasts in a new blast simulator laboratory under construction at UCSD. It will be the world's first facility designed to study structural damage caused by bomb blasts without creating actual explosions. The researchers will also test new technologies to harden buildings against bomb blasts, including a UCSD composite overlay technique (originally designed to protect structures from earthquakes) which has proven effective in full-scale explosive blast tests and has been deployed abroad in several U.S. buildings.

The Explosive Loading Laboratory Testing Program is supported through a $4.2 million contract from the Technical Support Working Group (TSWG), the federal interagency organization for combating terrorism. TSWG has named UCSD as one of its primary contractors in the focus area of blast mitigation, and a key deliverable in the program will be a design manual describing proven methods for hardening high-risk buildings against terrorist bomb blasts.

"Today, designing buildings that are blast resistant is more of an art than a science," said Frieder Seible, Dean of the Jacobs School and principal investigator on the project. "The controlled and repeatable tests we will do with the blast simulator will allow us to create and validate computer tools that can then be used to tailor the design and assessment of important facilities."

Bomb blasts damage buildings by creating shock waves - moving air with such force and velocity that the pulses literally push and pull structural walls and columns. When key load bearing components begin to fail, it can lead to the progressive collapse of the entire building. The UCSD blast simulator will recreate the speed and force of explosive shock waves through servo-controlled hydraulic actuators. Researchers will perform blast simulations on critical load-bearing elements (e.g., columns, beams and girders, walls, and floors), and on non-structural elements such as curtain walls and windows. The machine is being designed by Jacobs School structural engineers and MTS Systems Corporation, a company that has created other velocity-generating test laboratories for automotive crash tests and military weapons tests.

The blast simulator is an extension of the UCSD Powell Structural Research Laboratories, and is located at a new Field Station eight miles east of the UCSD campus at Camp Elliott. [The blast simulator is adjacent to the world's first *outdoor* shake table, currently under construction.] It is expected that the blast simulator will be up and running by early 2005.

The new TSWG contract builds on UCSD research that has been ongoing since 1998 to apply earthquake retrofit techniques to harden buildings against bomb blasts. A series of full-scale explosive tests have yielded dramatic results, showing that load-bearing columns wrapped with UCSD carbon composite overlays can withstand the impact of bomb blasts with little structural damage. Since the testing began, several embassies and military installations have been retrofitted with UCSD's overlay technology. Another UCSD seismic retrofit

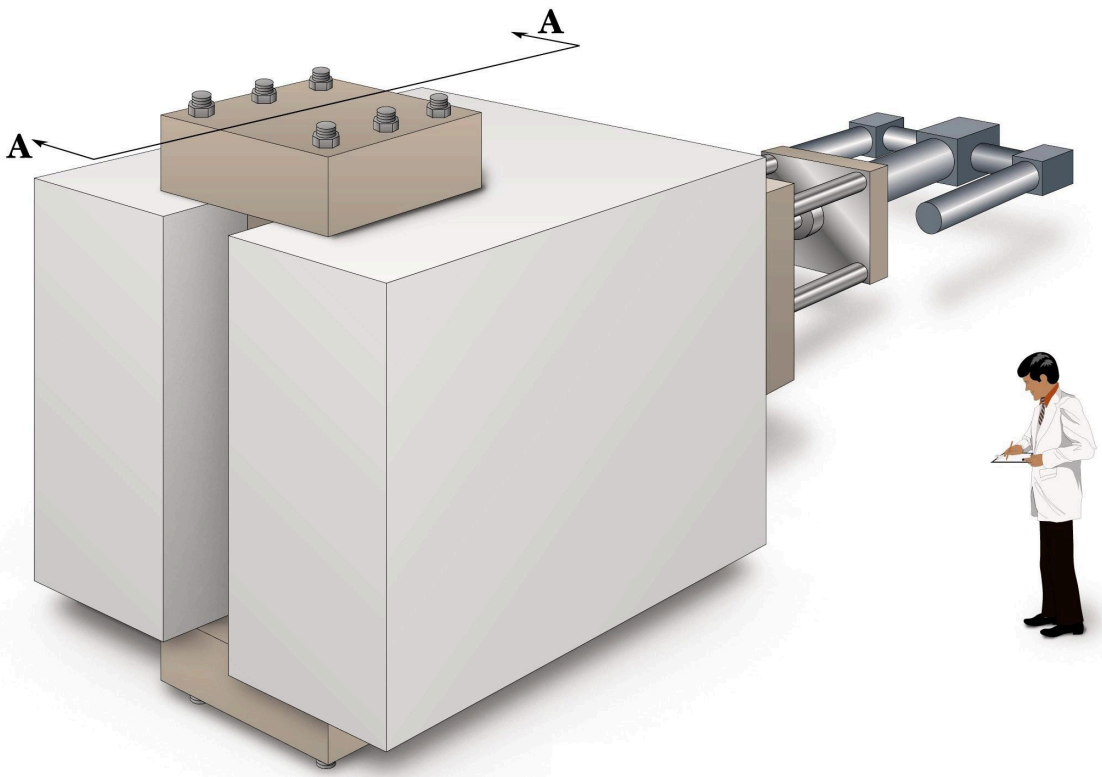
technique - placing steel jackets around concrete columns - has also proven successful in hardening buildings against bomb blasts in the test series.

"These technologies mitigate damage to buildings by confining and containing concrete in load-bearing columns. We're actually strengthening columns so that they can take large structural deformations such as bending or swaying without collapsing," says Seible. "Also, concrete is brittle and can break apart in an explosion, but when we wrap it with these materials we can contain the concrete for the short duration of the shock wave."

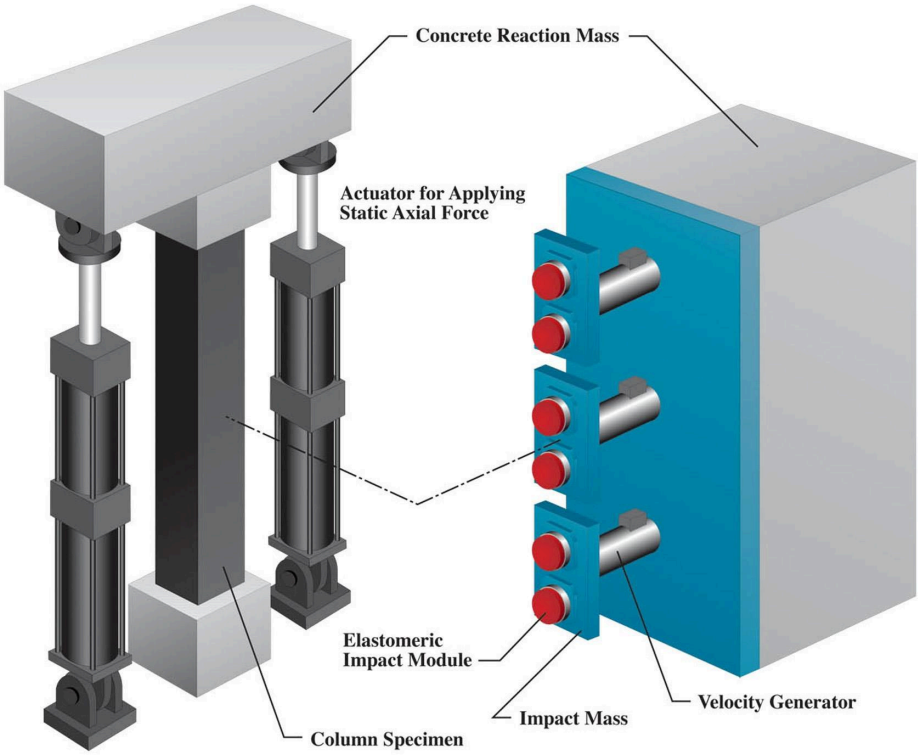
Seible says the team will continue to refine the steel jacket and carbon overlay techniques for blast mitigation through experiments in the new simulator, and will also address another challenge: how to strengthen walls and floors, as well as non-structural elements such as curtain walls and infill walls, so that they can move during a blast without causing buildings to collapse.

The Charles Lee Powell Structural Research Laboratories are operated by the UCSD Jacobs School's Department of Structural Engineering. The Powell Labs are world-renowned for testing large-scale structural systems. Existing facilities include the Seismic Response Modification Device Testing Facility with a 16 ft. by 12 ft., six-degree-of-freedom shake table designed to test new technologies to retrofit the state's longest span bridges; the Structural Systems Laboratory for testing of buildings up to five stories tall and bridges up to 120 ft. long; and the Structural Components Laboratory which includes a 65 ft. long reaction wall for side-by-side testing of full- or large-scale components and a 16 ft. by 10 ft. uni-axial shake table.

Media Contacts: Doug Ramsey, (858) 822-5825 Denine Hagen, (858) 534-2920, cell-(858) 245-8506



UCSD Blast Simulator



Blast Simulation Column Test