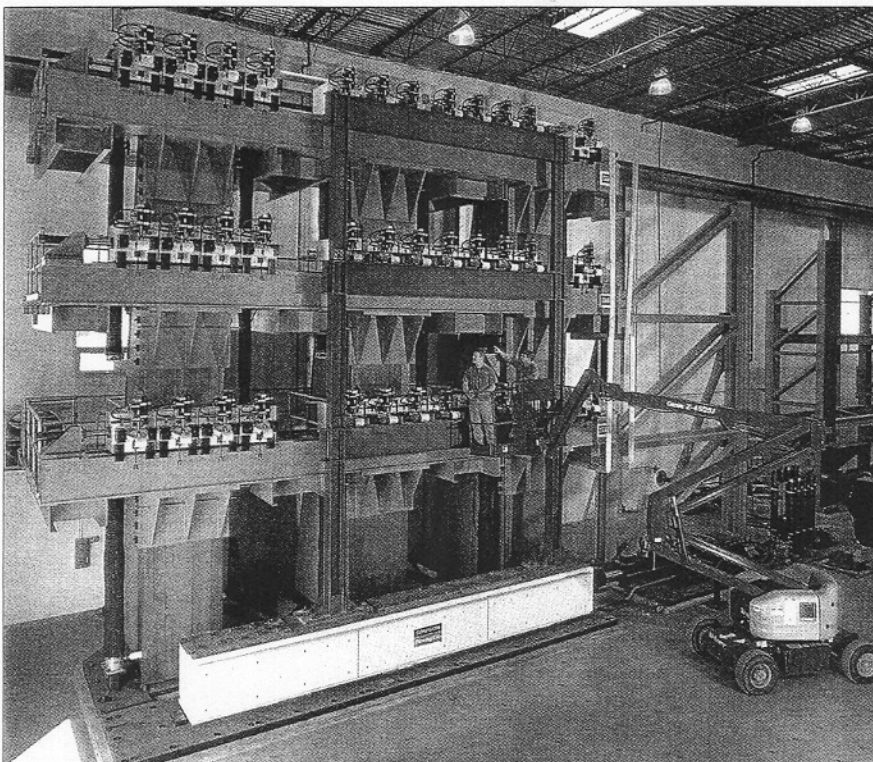




## The Tyrell Gilb Research Laboratory

New structural testing technology could improve building safety

By Steve Pryor, P.E., S.E.

**C**ontinuing advances in structural testing technology will undoubtedly change the way structures are designed and built. Innovations in seismic and high wind testing are yielding the best evidence to date of actual building performance without having to suffer through a real event. A new laboratory in Stockton, Calif., will assist the engineering community with improving building design and safety.

In July, Simpson Strong-Tie Company, Inc., a structural building products manufacturer based in Dublin, Calif., opened the Tyrell Gilb Research Laboratory, a structural testing facility featuring state-of-the-art equipment that is used to test a structure's resistance to

extreme conditions, including high wind and strong earthquake forces. The laboratory's mission is to improve building design and safety by understanding how earthquakes, high winds, and other natural disasters affect building performance.

At the grand opening of the laboratory, a 3-story wall was put to the test using a 4-foot x 25-foot shake table. The wall was designed for a non-near-field ground motion from the 1994 Northridge, Calif., quake and performed well under that loading. However, when subsequently subjected to a large, near-field ground motion recorded during the 1995 quake in Kobe, Japan, the wall was effectively destroyed. The moment magnitudes (MW) of the Northridge and Kobe quakes were 6.7 and 6.9, respectively.

"Simpson's laboratory and testing will help validate years of design methodology, and allow the engineering community to know where we stand with current structural design and safety," said J. Daniel Dolan, Ph.D., P.E., professor of structural engineering for Washington State University. "Simpson will be able to use this technology to design new products that offer a higher level of structural performance."

### Inside the lab

The \$10-million facility houses two main types of test equipment: a one-of-a-kind shake table and two, unique cyclic/static test rigs. Built with more than 500,000 pounds of steel, the specialized equipment can test wall structures up to 5 stories high by simulating vertical and horizontal forces. Together, the two types of testing equipment complement one another by providing a complete picture of a structure's performance capabilities. During the conceptual development phase of the project, Simpson consulted with several prominent members of the academic community in order to ensure that both the shake table and the cyclic/static test rigs would represent state-of-the-art technology for this kind of testing equipment.

**Testing equipment** — Simpson teamed with MTS Systems Corporation, an international mechanical testing and simulation equipment supplier with headquarters in Eden Prairie, Minn., to design and build the shake table. The shake table can test shear wall assemblies up to 25 feet long and 3 stories tall, with an effective specimen weight as heavy as 60,000 pounds. The shake table is moved by a powerful hydraulic actuator, and can be programmed to reproduce specific earthquake ground motions to capture important structural performance effects. The actuator has a static capacity of 150,000 pounds, and the

**Top Left: Simpson's new seismic shake table can accommodate assemblies up to 25 feet long and 3 stories tall.**

32-inch stroke coupled with a high-performance, 800-gallon-per-minute servovalve enables the reproduction of very large magnitude, high-velocity, near-field events.

The vertical and horizontal cyclic test frames, which were designed by an in-house engineering team, apply force laterally to a shear wall to test load paths and capacities. The 2-story cyclic test frame can test walls up to 50 feet long and has a shear capacity of 110,000 pounds, while the 5-story cyclic test frame can test walls up to 16 feet long and has a shear capacity in excess of 110,000 pounds.

The innovative testing equipment solves a major challenge in structural testing — it can accurately measure a structure's earthquake resistance by analyzing a full-scale, standard wall section. While the equipment is some of the largest in the world for testing light-frame wall sections, care was taken in the design to reproduce the as-built boundary conditions as accurately as possible. The lab equipment is designed to simulate full building response without constructing and testing a four-sided structure. This efficiency dramatically reduces both the cost and time associated with testing of this magnitude.

**Solid foundation** — The main test area in the lab consists of a 10,000-square-foot "strong floor" to which the shake table and cyclic/static test frames are connected. This floor, which is 3 feet thick, is constructed with heavily reinforced concrete and covers a full basement of the same area. In addition, it has holes running through it on a 2-foot grid in both directions, so that the machines and experiments can be bolted directly to the floor. The 300,000-pound point load capacity of the floor ensures that it will have adequate strength for nearly any experiment that can be conceptualized. Multiple internal bays in the

basement combine with a 2-foot thick mat foundation to provide the support for the floor.

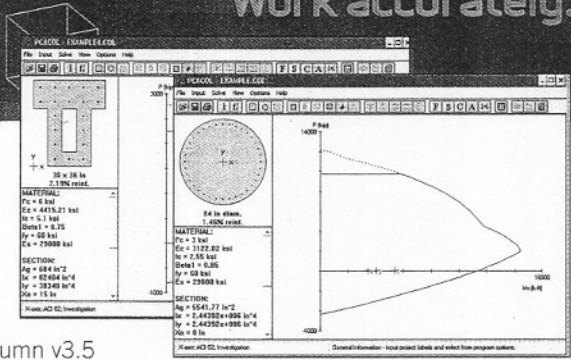
The weight of the floor/basement assembly is 10 million pounds. When used to its full capacity, the combined moving weight of the shake table and test specimen mounted to the strong-floor can be as much as 100,000 pounds. To violently shake the table and specimen requires a massive foundation to withstand the effects of repeated shaking while

also minimizing the transmission of ground vibrations to nearby facilities.

## Conclusion

Research from the Tyrell Gilb Research Laboratory will be used to better understand existing construction techniques as well as to design and test new, innovative structural products, which will lead to improvements in structural design, reliability, and safety. "The seismic testing and research will certainly

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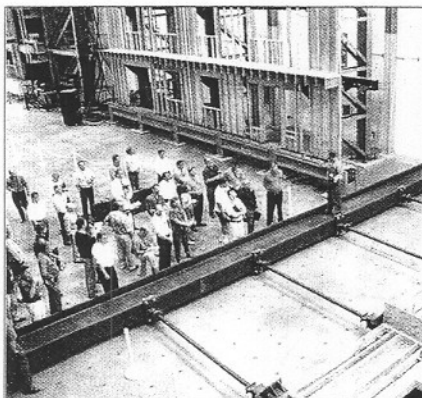
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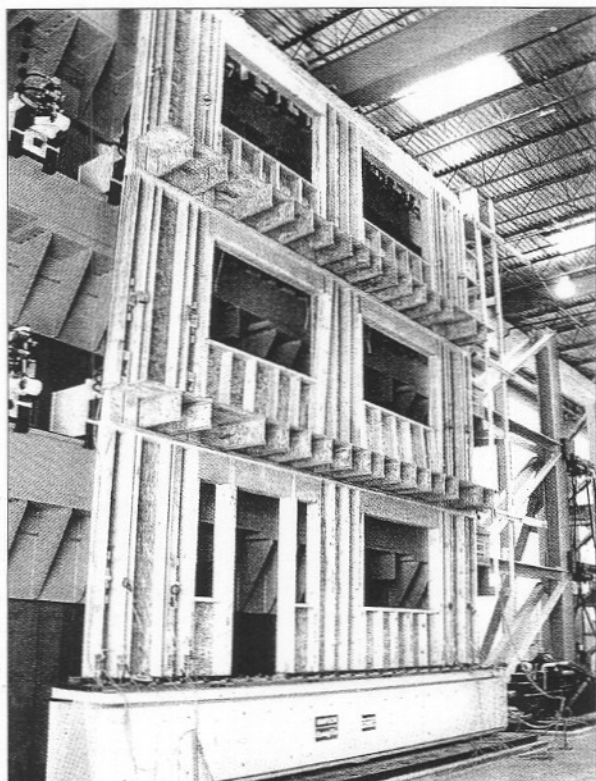
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At the grand opening, more than 70 members of the academic and engineering community witnessed Simpson Strong-Tie's new testing equipment in action.

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A full-scale, 3-story wall was tested at the opening event.

enhance the engineering community's understanding of light frame structures," said Thomas D. Skaggs, Ph.D., P.E., senior engineer for the APA — The Engineered Wood Association. "This real-world testing will allow information to be disseminated quickly between Simpson engineers and the code developers. This should speed the development of practical applications, which can then be used to solve pressing structural issues." Initially, the lab will focus its tests on proprietary and nonproprietary shear wall systems, as well as various types of uplift and overturning restraint systems.

The new lab is named in memory of Tyrell (Tye) Gilb, a Simpson employee who led the company's

research and development efforts for many years. "Tye's legacy of innovative product development will live on through the work done here," said Tom Fitzmyers, CEO of Simpson Strong-Tie. "The new laboratory's testing capabilities will allow us to advance our structural design technology, which will improve building safety and ultimately help save lives. That would have made Tye very proud." ■



**Steve Pryor, P.E., S.E.,** is Simpson Strong-Tie's building systems research and development manager. Pryor is a member of the American Society of Civil Engineers and the

Structural Engineers Association of California. He is an active member of the Building Seismic Safety Council Technical Subcommittee Seven on Wood Construction and the Structural Engineers Association of Northern California Wood Subcommittee. Pryor works at both the corporate office in Dublin, Calif., and the laboratory in Stockton, Calif. He can be reached at [spryor@strongtie.com](mailto:spryor@strongtie.com).

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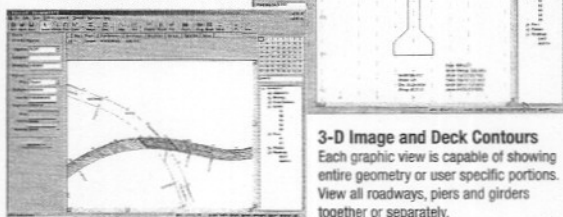
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