BUCKLING RESTRAINED BRACED FRAMES

In modern seismic design practice lateral design forces are obtained by reducing the forces from the elastic level by a factor of up to 8, giving design forces in the order of 0.1g - 0.2g. Therefore, structures so designed are expected to sustain large inelastic cyclic deformations during strong earthquakes, thereby dissipating large portion of the seismic input energy in order for them to survive without collapse and loss of life. This philosophy is dictated by considerations of economy and low probability of design level earthquakes (return periods of 500-2500 years) during the lifetime of a structure.

Steel braced frames are very efficient for resisting lateral forces due to wind or earthquakes. However, in the event of design level earthquake shaking conventional braces undergo large reversed axial deformations in tension yielding and post-buckling range resulting in severe degradation of strength and energy dissipation capacity. This shortcoming led to development of an innovative concept of Buckling Restrained Brace which consists of a steel core confined by and unbonded to steel-only or steel-and-concrete outer “shell” to prevent buckling of the core. The steel core, which carries the axial force, therefore, yields freely in cyclic tension and compression without buckling, resulting in excellent energy dissipation capacity, and seismic behavior of the structures.

Development of Buckling Restrained Brace (also referred to as “Core Loaded Sleeved Column” or “Unbonded Brace”) has a rather long history, which spans over 30 years and includes the work of numerous investigators in many countries, including India, Japan, Taiwan, Canada, and U.S. Practical code design provisions and procedures have been quite well established now and hundreds of major buildings have been built using this innovative framing system. Credit is due to the following key individuals who have been responsible for carrying out analytical and testing work, as well as introducing the system in building codes and design-construction practice:

Kalyanaraman, V., (Indian Institute of Technology, Madras, India), Sridhara, B.N., Consulting Engineer, Bangalore, India), et al., “Analytical Study of ‘Sleeved Column’ Buckling Restrained Braced System”, Proceedings, Structural Engineers Association of California (SEAOC), Squaw Creek, CA, September 2003.

The following papers are from a Special Theme Session on “Buckling Restrained Braces for Rational Seismic Design” (MTC 12), Proceedings of 13th World Conference on Earthquake Engineering, Vancouver, Canada, August 2004:

Wada, A. (Tokyo Institute of Technology), and Nakashima, M. (Kyoto University), “From Infancy to Maturity of Buckling Restrained Braces Research”.

Tsai, K-C. (NCREE, Taiwan), et al., “Research and Application of Double-Core Buckling Restrained Braces in Taiwan”.

Sabelli, R. (DASSE Design, Inc. San Francisco), et al., “U. S. Building Code Provisions for Buckling Restrained Braced Frames: Basis and Development”.

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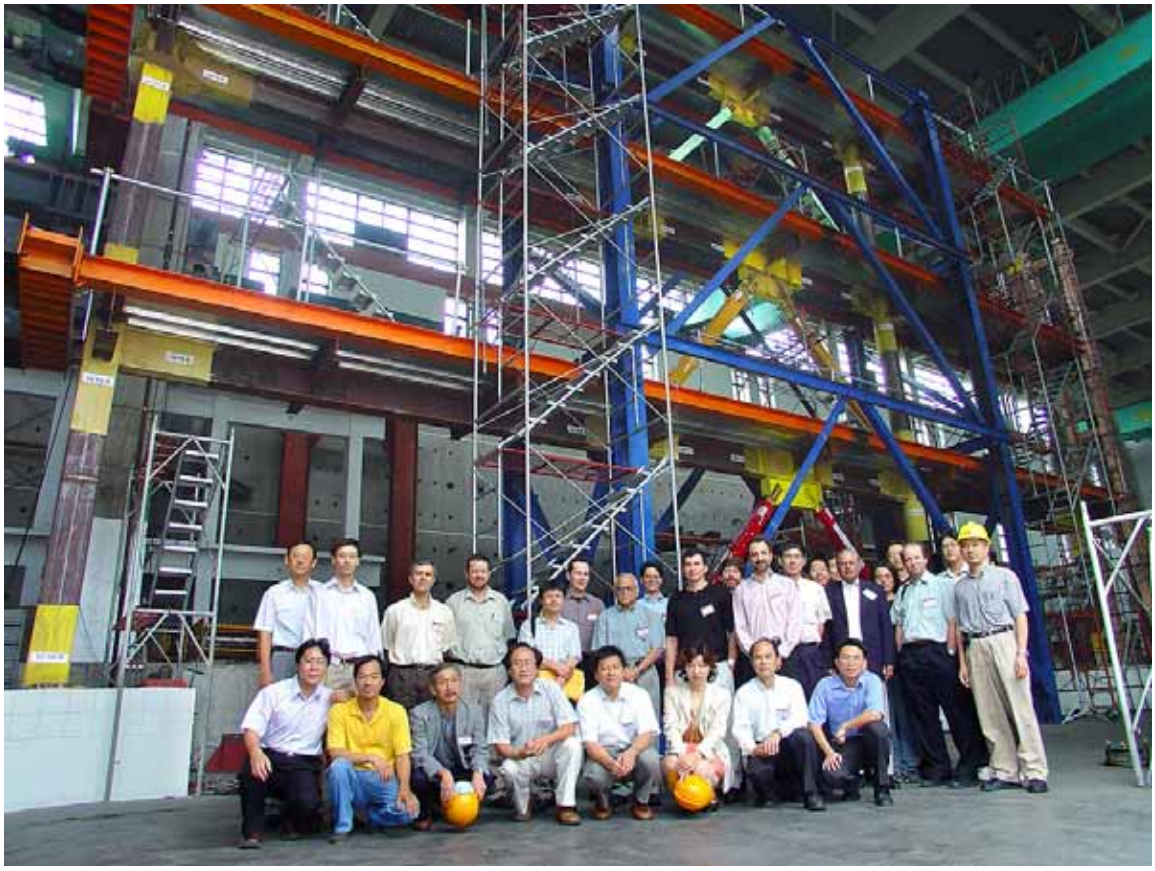

A 3-Story, 3-Bay Full Scale BRBF Tested at NCREE, Taiwan, October 2003; The Frame Jointly Designed by Researchers at NCREE and at the University of Michigan.