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The John A. Blume Earthquake Engineering Center

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Editor's Note: Many of you are not aware that in addition to the several students, researchers, faculty members, and staff who make the Blume Center their home, the Center also houses two organizations, GeoHazards International and The National Performance of Dams Program. We take this opportunity to introduce these two organizations.

GEOHAZARDS INTERNATIONAL

GeoHazards International, a nonprofit corporation, was created in 1993 with the goal of reducing the human and economic consequences of earthquakes in the world's most vulnerable communities. Their approach is to help improve urban earthquake risk management through collaboration. GeoHazards International now maintains an office in the Blume Center and the staff includes Civil Engineering/Geophysics Consulting Professor Brian Tucker, Civil Engineering/Geophysics Visiting Scholar Carlos Villacis, and former Stanford Structural Engineering Student Laura Dwelley [B.S and M.S., 1996]. For more information, see the GeoHazards International WWW Page at: http://pangea.stanford.edu/~tucker/geohaz.html.

NATIONAL PERFORMANCE OF DAMS PROGRAM (NPDP)

The National Performance of Dams Program (NPDP) is a cooperative effort of dam engineers and safety professionals in the United States and Canada to create an information resource in the performance of dams. The objectives of the NPDP are to retrieve, archive, and disseminate information on the performance of dams. The NPDP grew out of a Stanford project on dam safety that was funded by FEMA in 1984. The NPDP was officially organized in 1994 and has been located in the Blume Center since that time. Civil Engineering Consulting Professor Martin McCann [PhD, 1984] directs the NPDP and is assisted by Scott Nelson. For more information, see the NPDP WWW Page at http://blume.stanford.edu/~npdp/npdp.html.

CENTER NEWS

Professor Anne Kiremidjian and **Dr. Stephanie King** participated in the ASCE Natural Disaster Reduction Conference held in Washington DC on December 3-5, 1996.

Professor Anne Kiremidjian participated in the 1996 US-Japan Workshop on Seismic Retrofitting and Protective Systems for Bridges held on December 9-11, 1996 in Osaka, Japan

Professor Allison Smith and Ph.D. candidate **Erik Straser** participated in the Second International Workshop on Structural Control "Next Generation of Intelligent Structures" held in Hong Kong on December 18-21, 1996.

Professor Haresh Shah participated in the 11th Seminar on Seismology and Earthquake Engineering in Tsukuba, Japan on October 14 - November 5, 1996 and the International Conference on Urban Engineering in Asian Cities in the 21st Century in Bangkok, Thailand on November 20-23, 1996.

FINAL PLANS FOR SHAH SYMPOSIUM APRIL 25-26, 1997

Planning for the Shah Symposium has been underway for several months, and we now have a full program of distinguished speakers. Included among the speakers are Wilfred Iwan, Howard Kunreuther, Edward Jobe, Tsuneo Katayama, Yuxian Hu, Anand Arya, Luis Esteva, Giuseppe Grandori, Allin Cornell, Roger Borcherdt, and George Mader. In addition, William Holmes plus students and faculty from the Blume Center will be speaking about the reconstruction of the Blume Center and the current research activities. The Symposium is titled *Risk Management and Mitigation for Natural Hazards.*

A welcoming reception for all attendees will be held on Thursday, April 24 at 7:00 pm at Hyatt Rickeys in Palo Alto. The main program begins Friday morning (April 25) in Fairchild Auditorium on Stanford campus and continues through Saturday. The Saturday afternoon program includes the rededication of the “new” Blume Center, which has been completely reconstructed. The photo on the left shows Professor Haresh Shah with Dr. John Blume at the original dedication of the Blume Center in 1974.

If you wish to register for the Symposium or the Banquet (see page 4), please use the registration form that you (should have) received in the mail, or contact us by phone at 415-723-4150, by fax at 415-725-9755, or by e-mail at ShahSymp@ce.Stanford.edu.

RESEARCH SPOTLIGHT

Seismic Demands For Steel Moment Resisting Frame Structures

by Akshay Gupta, Ph.D. Candidate
Research Assistants: Alex Hernandez, Chris Warner, and Mike Tsai
Research Advisor: Professor Helmut Krawinkler

Part of SAC Program to Reduce the Earthquake Hazards of Steel Frame Structures
Project Sponsor: Federal Emergency Management Agency (FEMA)

Introduction:
A great majority of modern mid- and high rise buildings, especially on the West Coast, have steel moment resisting frames (MRF) as the primary lateral load resisting system. Much confidence has been placed into this type of construction, which was considered the safest one for earthquake resistance, as steel elements are expected to deform but not break in severe earthquakes. This confidence was greatly shaken when during the July 1994 Northridge earthquake many steel MRF structures suffered damage in the form of fractures of welded connections.

Scope of current research:
This research focuses on a comprehensive evaluation of the seismic demands for steel MRF structures in three different seismic regions (Los Angeles, Seattle, and Boston). For this purpose the behavior of three model buildings (a 3 story, a 9 story, and a 20 story), each designed for each of the three regions is being studied by subjecting them to ensembles of earthquake ground motions. Non-linear dynamic analysis is being carried out to study the seismic performance of these structures, which will then be used to develop general guidelines for design, performance prediction and safety evaluation of steel MRF structures.

The above description falls into what is termed as the design (or performance) evaluation phase (Fig. 1). Much research has and is being carried out on the conceptual design phase as well. The current research will also attempt to tie in the two phases by providing a comprehensive comparison of results between the two phases, thereby allowing the estimation of local demands in real structures, given only the structure strength and spectral information.

Modeling of the Structure:
The easiest, and the most commonly used, representation of a structure is as a 2D centerline model. The 2D assumption is acceptable especially if the structure is symmetric. The use of centerline dimensions, however, can

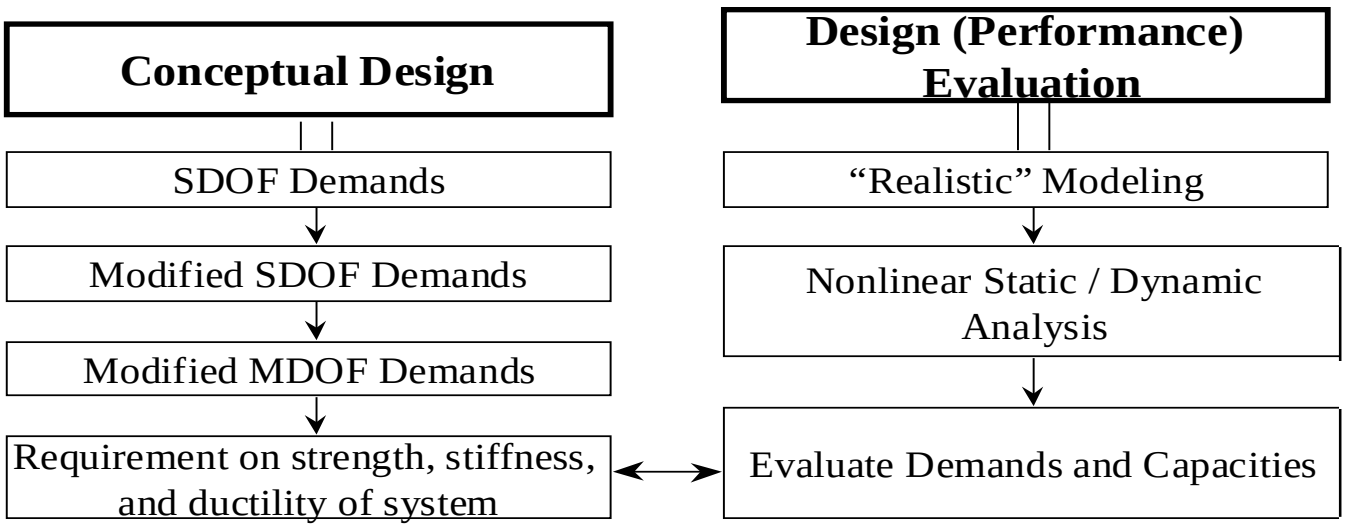

Figure 1. Basic Design Philosophy

lead to severe errors in estimating a structure's performance. In this research "realistic" models of structures are being used. This includes taking into account the effects of the slab (beam-slab interaction), non-structural elements, resistance provided by the shear connections and accurate representation of the joint panel zone. The joint panel zone is modeled as shown in Fig. 2, with a trilinear joint shear-distortion relationship. This is particularly important as the joint panel zone may be the weak element and as a result most of the deformation demand may be in the joint panel zone as against in the beam.

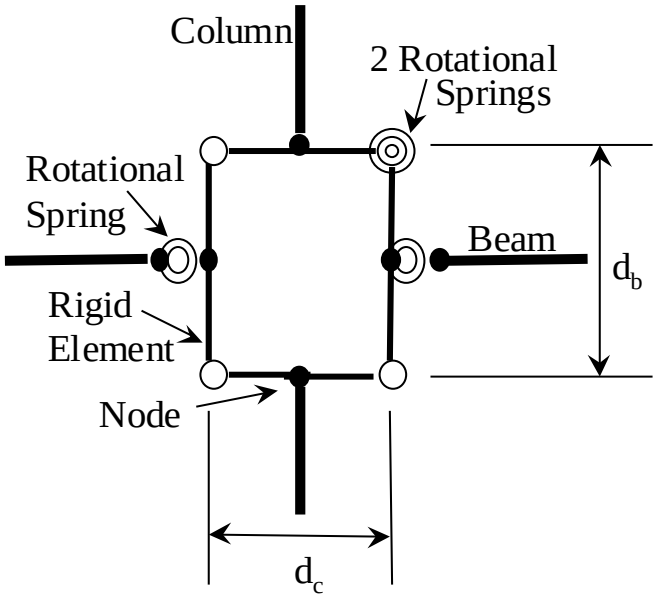

Figure 2. Analytical Model of Joint Panel Zone

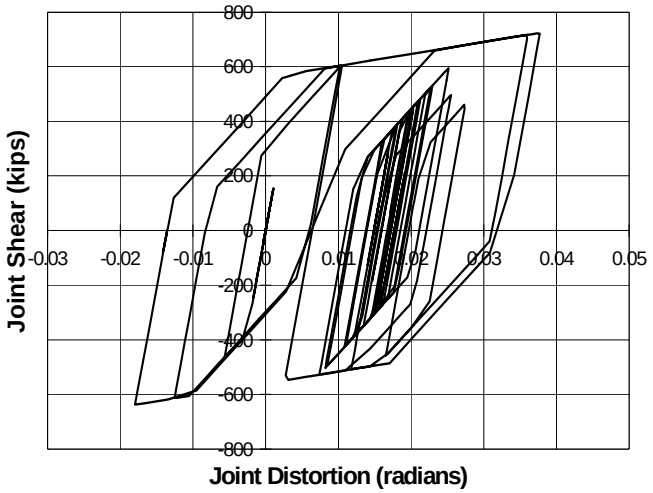

Figure 3. Joint Shear-Distortion Response

For instance, in an analysis of the 3 story structure in Los Angeles, a particular beam had a plastic hinge rotation demand of 0.03 radians with centerline model analysis as compared to a demand of 0.009 radians with accurate joint panel zone modeling. The joint shear-distortion response, for a particular joint, is as shown in Fig. 3

Other Areas under Study:

Some of the other issues that are being investigated, as part of this FEMA sponsored program, include the following:

- developing a loading protocol (loading history) for experimental studies
- evaluating the performance of the structures for a wide range of demands that may be imposed by the earthquake ground motions (different regions, different return periods)
- assessing demands at column splices
- relating the results of inelastic static analysis (push over analysis) and inelastic dynamic analysis
- investigating the structure P-delta effects
- evaluating the effects of redundancy and geometry of a structure in terms of bay width, number of frames and bays
- relating the results from the design evaluation phase to the results from the conceptual design phase
- clearly distinguishing between demands on beam (connection) rotation and joint distortion
- relating energy demands to force and deformation demands

Conclusion:

There is inherent uncertainty in the occurrence and intensity of earthquakes. The socio-economic impact of any such event is enormous, not only because of the potential for reduced seismic safety but also because of the great cost of mitigating measures. This makes it imperative to have a better and clearer understanding of the behavior of structures. The need exists for clear design guidelines and procedures which will provide a means for the performance and safety evaluation of existing and new structures.

The research described above looks at both the individual parts of the problem, such as relative importance of joint distortion vs. beam rotation, and the bigger picture which deals with the overall performance of the structure. It will integrate local and global behavior and tie the behavior to a conceptual design philosophy. This will provide a holistic view of the problem and also suggest the methods and procedures required for predicting seismic performance and performing safety evaluations for steel structures. It will also provide information for the development of design guidelines for different performance levels.

NEWLY PUBLISHED TECHNICAL REPORTS

NO. 117 - *Effects of Architectural Walls on Building Response to Ambient and Seismic Excitations* by Vicki L. Vance and H. Allison Smith, June, 1996.

No. 118 - *Risk Assessment for Highway Transportation Sytems* by Nesrin Basoz and Anne S. Kiremidjian, November, 1996.

No. 119 - *A Method for Earthquake Motion-Damage Relationships with Application to Reinforced Concrete Frames* by Ajay Singhal and Anne S. Kiremidjian, October, 1996.

NEWLY SPONSORED RESEARCH PROJECTS

Professor Allin Cornell received a SAC Phase II project to study the safety and reliability of steel moment resisting systems, including the effects on the system seismic safety when a certain fraction of the joints (randomly located in the structure) are expected to be of the only partially ductile type. He is working in conjunction with Professor Helmut Krawinkler.

SHAH RETIREMENT BANQUET - YOU ARE INVITED

The Retirement Banquet for Professor Haresh Shah will be held on Friday evening, April 25, 1997 in the Camino Ballroom at Hyatt Rickeys in Palo Alto, California (4219 El Camino Real, about two miles south of the Stanford campus). The Social Hour begins at 6:00 pm with dinner at 7:00 pm. The cost is $50 per person.

If you would like to attend, please send your reservation to:

Carol Strovers, Banquet Coordinator
Dept. of Civil Engineering, Stanford University
Stanford, California 94305-4020
Phone: (415) 725-9072; Fax: (415) 725-9755; E-mail: ShahSymp@ce.Stanford.edu

The deadline for reservations is April 4, 1997. Please make out your check to “Shah Symposium/Stanford University.” Also, please tell us your choice of menu (fish, meat, or vegetarian).

A Symposium on *Risk Management and Mitigation for Natural Hazards* is being held on April 25 and 26, in conjunction with Professor Shah's retirement (see story on Page 1).

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(mailing label)