CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

FOREIGN TRIP REPORT

SUBJECT: First European Conference on Earthquake Engineering and Seismology (a joint event of the 13th European Conference on Earthquake Engineering and the 30th General Assembly of the European Seismological Commission)
Project No. 20.06002.01.332
AI No. 20.06002.01.332.638

DATE/PLACE: September 3–8, 2006
Geneva, Switzerland

AUTHOR: Luis Ibarra

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BACKGROUND AND PURPOSE OF TRIP:

The European Conference on Earthquake Engineering is an international conference that takes place every four years and addresses a broad spectrum of topics pertaining to seismic and structural engineering. In 2006, the European Association of Earthquake Engineering and the European Seismological Commission combined the 13th European Conference on Earthquake Engineering and the 30th European Seismological Commission General Assembly to form the first European Conference on Earthquake Engineering and Seismology. The technical program consisted of six common keynote and five engineering keynote presentations. The parallel oral sessions were divided into eight common sessions, nine engineering sessions, 13 special theme sessions (engineering), and 25 sessions organized by the European Seismological Commission. Also, two poster presentations were included in the program.

The Center for Nuclear Waste Regulatory Analyses (CNWRA) staff attended this conference to present the paper "Inelastic Absorption Energy Factors for Short Period Deteriorating SDOF Systems," which is authored by Luis Ibarra and Asadul Chowdhury. This paper was reviewed and accepted by U.S. Nuclear Regulatory Commission (NRC) and presents the results of a parametric study that evaluates the inelastic absorption energy capacity factors of short period deteriorating single-degree-of-freedom systems with low ductile nonlinear characteristics. Systems with these dynamic characteristics are usually encountered in nuclear facilities, where thick reinforced concrete shear walls with low aspect ratios are commonly used to withstand lateral loads. In addition, staff attended several sessions where seismic topics related to the prelicensing activities performed at CNWRA were discussed.

SUMMARY OF ACTIVITIES AND PERTINENT POINTS:

The conference included several parallel sessions and poster presentations addressing a broad range of earthquake engineering topics, such as structural engineering, design criteria and codes, site response and site effects, seismic hazard, geotechnical engineering, etc. Thus, the staff could attend only a selected number of oral sessions. This report focuses on the response of structural systems to seismic excitations, advances in seismic provisions, assessment of uncertainty in seismic engineering, and analytical and experimental evaluation of reinforced concrete structures. These topics are directly related to staff-developed activities that support NRC prelicensing activities for the potential geologic repository at Yucca Mountain, Nevada.

Several structural performance presentations were made in the engineering sessions. J. Restrepo (engineering keynote presentation K6) discussed the development of new reinforced concrete structural systems that are designed for specific performance objectives and intended to minimize seismically induced structural damage. K. Kanemoto, H. Sakata, and A. Wada (paper 344) evaluated the cracks that occur in reinforced concrete columns after an earthquake. They estimated crack widths during cyclic loading and residual crack widths under various parameters. P. Bisch, D. Chauvel, and J.P. Touret (paper 1,472) estimated the crack openings of reinforced concrete walls subjected to seismic events. A review of previous experimental data was performed, and it was shown that limited reliable data for an accurate evaluation of cracks in shear walls are available. E. Coelho, M. Fischinger, A. Campos Costa, M.J. Falcao, and P. Kante (paper 642) discussed an experimental program on a five-story structural wall tested in a three-dimensional shaking table. The results indicated that although considerable structural overstrength was observed in the wall, the deformation capacity was less than 1 percent of the height.

A. Kappos, I. Moschonas, T. Paraskeva, and A. Sextos (paper 275) presented a methodology for deriving seismic fragility curves for bridges using advanced analysis tools. The fragility curves are drawn assuming a lognormal distribution, and bridge damage states are generated using either pushover analysis or dynamic time history analysis. K. Mackie and B. Stojadinovic (paper 1,219) developed fragilities for two typical single column-per-bent, post-tensioned box girder reinforced concrete bridges. Seismic demand models were developed using nonlinear time history analysis, and damage in the columns was determined from a database of experimental tests. R. Vacareanu, B. Chesca, and P. Olteanu (paper 1,000) developed seismic fragilities of high-rise reinforced concrete resistant frames based on maximum peak interstory drift ratio.

Several studies addressed the modification of dynamic response due to soil effects. L. Lehmann and R. Borsutzky (paper 933) assessed the influence of the soil on seismic analysis of structures. They proposed a new numerical methodology for analyzing wave propagation in an infinite domain using a three-dimensional soil-structure interaction model. Z. Lubkowski, N. Peiris, M. Willford, and X. Duan (paper 1,165) presented a paper describing performance-based analysis techniques used on different projects to assess the seismic performance of structures and foundations at relatively soft sites. The soils at such sites are often strained to their strength limit during strong earthquakes. Also, P. Rousillon and C. Boutin (paper 931) presented a parametric analysis of soil–structure interaction. The study highlights the parameters that govern the main mechanism of the phenomenon: geometrical effect and rigidity contrast and their influence on the complex modal features of the system. G. Gazetas (engineering keynote presentation K7) discussed the methods and analysis of shallow, embedded, and deep foundations subjected to strong seismic shaking. The role of foundation uplifting and soil plastification was also illustrated through case histories. Along the same lines, M. Preisig, G. Jie, and B. Jeremic (paper 1,598) presented an analysis of beneficial and detrimental effects of soil–foundation–structure interaction on seismic response.

The soil effects on nuclear facilities were evaluated in several studies. O. Gurbuz and D. Watkins (paper 1,230) presented a two-step method of seismic analysis that has been used in many major facilities to perform three-dimensional finite element soil–structure interaction analyses. The analysis method provides a convenient way to combine member stresses due to seismic load with other types of loadings, such as dead and live load and static soil pressure. The two-step seismic analysis method is presented along with sample results from two recent nuclear safety-related buildings. Also, C-H. Hyun, J-M. Kim, W-H. Kim, Y-S. Chung, and M-S. Kim (paper 1,356) evaluated a simplified criterion for determining whether or not soil–structure interaction analysis is required for seismic response analysis of nuclear power plant structures. ASCE 4-98 prescribes that a fixed-base support may be assumed in modeling structures for seismic response analysis when the frequency obtained assuming a rigid structure supported on soil springs (i.e., the interaction frequency) is more than twice the dominant frequency of a fixed-base flexible structure (i.e., the fixed-base frequency). This relationship was evaluated through hand calculations and numerical analysis using the computer program SASSI. V. Guyonvarh and G. Devesa (paper 210) also evaluated the use of coupled and regulatory methods in seismic soil–structure interaction for nuclear power plants and dams. The study considers a soil–structure interaction numerical method based on substructuration and frequency resolution, which couples a finite element method software and a boundary element method. This method is compared to a simplified design method, usually applied in regulatory studies of nuclear power plants, that consists of soil springs located below the foundation. In addition, B. Daniel (paper 1,247) presented experimental and theoretical results of soil–structure interaction effects on nuclear facilities. Because reactor buildings of nuclear power plants are generally constructed close to other buildings, the study evaluates the soil–structure interaction effects between adjacent buildings.

O. Citak, H. Kawase, M. Fushimi, and S. Ikutama (paper 718) evaluated the seismic response of large-scale rigid structures, such as a nuclear power plants, as a function of seismic parameters of strong motions such as peak ground acceleration and peak ground velocity. The objective of the study was to investigate the relationship of seismic responses of rigid structures and strength indexes of ground motions parameters and to identify basic shear indexes that can indicate or predict damage levels without complex calculations. M. Kostov Marin, D. Stefanov, and N. Koleva (paper 817) presented recent developments in analytical methodologies for predicting earthquake response behavior of nuclear structures. Finally, J. Kralic (paper 925) compared probabilistic and deterministic assessments to evaluate seismic safety of nuclear power plants. Seismic probabilistic risk assessment and seismic margin assessment methodologies are used in this comparison.

Regarding system identification studies, G.M. Calvi, R. Pinho, and H. Crowley (paper 1,535) assessed the elongation of the period of vibration of reinforced concrete buildings during strong ground shaking. Analytical models replicating the results of experimental tests are introduced and additional studies on the elongation of the vibration period during seismic action are presented. F. Dunand, P. Gueguen, P.Y. Bard, and M. Celebi (paper 1,021) compared the dynamic parameters extracted from weak, moderate, and strong building motion. The study includes buildings where several earthquake records are available, allowing the dependence of dynamic characteristics with shaking intensity to be investigated.

Simplified methodologies to assess the nonlinear response of structural systems, such as the pushover analysis method, were the topic of several studies. B. Ferracuti, M. Savoia, R. Pinho, and R. Francia (paper 863) proposed an adaptive pushover procedure, in which the shape of the load distribution is updated step by step. The adaptive procedure accounts for progressive structural stiffness degradation and the modification of the vibrational period. A. Chopra (paper 1,327) presented the evaluation of the modal pushover analysis procedure for asymmetric-plan buildings. The paper evaluates the accuracy of the modal pushover procedure against the "exact" nonlinear response history analysis. F. Forootan and A.S. Moghadam (paper 447) presented a study in which the drift response of multistory asymmetric buildings are compared using pushover analyses and nonlinear time history analyses. In addition, S. Akkar, A. Metin, and A. Yakut (paper 628) presented the improved nonlinear procedures for estimating maximum deformation demands on structural systems proposed in the ATC-55 project. The studied procedures are based on initial versions of ATC-40 and FEMA-356 recommendations.

Several papers were related to the probabilistic seismic hazard analysis methodology.

N. Abrahmson (common keynote presentation K2) addressed issues with current practices in seismic hazard analysis and provided some recommendations for improvements. The presentation focused on the shortcomings of current probabilistic seismic hazard analysis methodology, such as the selection of the bin size for the deaggregation, the use of uniform hazard spectra, estimation of scenario spectra, estimation of epistemic uncertainty, and the use of a strict lower bound magnitude. F. Scherbaum, J. Bommer, F. Cotton, and H. Bungum (paper 1,312) presented the current state of ground-motion prediction methodology in the probabilistic seismic hazard analysis methodology for regions in low seismicity. The information presented was generated in the PEGASOS project in Switzerland. The key issues in the context of ground-motion prediction for probabilistic seismic hazard analysis methodology for the near future are to better understand the aleatory variability of ground motion and to develop suites of ground-motion prediction equations that employ the same parameter definitions. Also, K. Coppersmith and R. Youngs (paper 1,270) provided some of the lessons learned using formal expert elicitation in probabilistic seismic hazard analysis, which require the quantification of the uncertainties in important inputs to the analysis.

CONCLUSION:

The participation in this conference was a highly beneficial way to interact with researchers in the earthquake engineering community. The presentations on academic, industrial, and government agency projects provided an excellent overview of leading edge research and potential areas of further development. An electronic copy of the proceedings is available in the CNWRA library.

PROBLEMS ENCOUNTERED:

None

PENDING ACTIONS:

None

RECOMMENDATIONS:

None.

POINTS FOR COMMISSION CONSIDERATION/ITEMS OF INTEREST:

None.

ATTACHMENTS:

None.

"ON THE MARGINS:"

None.

SIGNATURE:

10/05/06

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