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General Report - Session 4

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Commemorate the Legacy of Ralph B. Peck
April 29 - May 4, 2013 CHICAGO
Seventh International Conference on
Case Histories in Geotechnical Engineering
and Symposium in Honor of Clyde Baker

GENERAL REPORT - SESSION 4

4a. Case Histories on Failure and Remediation of Geotechnical Earthquake Engineering, Including Land Slides from Recent Earthquakes

4b. Case Histories on Engineering Vibrations

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INTRODUCTION

This General Report presents a summary of the 22 papers accepted for the Session 4 focused on Case Histories on Failure and Remediation of Geotechnical Earthquake Engineering, including landslides and Lessons from Recent Earthquakes, and Case Histories on Engineering Vibrations, Vibration Control for Underground and Surface Constructions, with Specific Emphasis on the Urban Environment; Predictions, Monitoring and Solutions; Blasting for Tunnels in Soft Ground and Rock, Discontinuous Rocks and their Application to Water Resources Projects, and Remediation.

The papers originate from twelve countries and cover significant topics and projects in the area of geotechnical earthquake engineering, and engineering vibration. These include liquefaction, liquefaction mitigation, lessons from recent earthquakes, landslides, DEM simulation, soil dynamic properties, seismic settlements, seismic hazard and ground motions, seismic waves, site amplification, foundation piles, MSE walls, vibrations and base isolation. Table 1 below presents a list of the accepted papers ordered by topic. The summaries below will provide readers with a general overview of the focus of the papers and is intended to direct the readers to areas of interest. The Session 4 organizers greatly appreciate the efforts of the authors and commend the quality of the accepted papers.

Table 1 – List of papers ordered by topic

Session 4a: Case Histories on Failure and Remediation in Geotechnical Earthquake Engineering, including Landslides, and Lessons from Recent Earthquakes			
Paper No.	**Country**	**Authors**	**Topic**
4.01a	Japan	T. Kokusho	Liquefaction
4.20a	USA	Meneses and Liao	Liquefaction
4.05a	Canada	Mahmood Seid-Karbasi	Liquefaction mitigation
4.14a	USA	Andrews et al.	Liquefaction mitigation
4.03a	Italy	Rainoni et al.	2009 L'Aquila earthquake
4.04a	Indonesia	Bambang Setiawan	2004 Indian Ocean earthquake
4.11a	Turkey	Akin et al.	2011 Van earthquake
4.19a	Chile	C. Ledezma	2010 Maule, Chile earthquake
4.06a	USA	Marino and Osouli	Landslide
4.07a	Australia	Vinod et al.	DEM modeling
4.08a	India	Kirar and Makeshwari	Dynamic Properties
4.17a	USA	Wetenkamp et al.	Seismic settlements
4.23a	USA	Z. Wang	Seismic hazard and ground motions
4.28a	Iran	Mahood and Hamzehloo	Ground motions
4.29a	Iran	M. Mahood	Seismic waves
4.30a	Turkey, USA	Akin et al.	Site amplification
Session 4b: Case Histories on Engineering Vibrations, Vibration Control for Underground and Surface Constructions			
4.01b	India	A. Chattopadhyay and Sahu	Seismic waves
4.03b	Iran, USA	Zand-Parsa and Zand-Parsa	Foundation piles

4.06b	Iran	Panah et al.	MSE wall
4.10b	India	Bandyopadhyay et al.	Base isolation
4.12b	Iran	Ghodrat et al.	Vibrations
4.14b	Tunisia	Ikram and Ridha	Liquefaction

SUMMARY OF PAPERS

Paper 4.01a, LIQUEFACTION POTENTIAL EVALUATION-ENERGY-BASED METHOD COMPARED TO STRESS-BASED METHOD, by T. Kokusho. A series of undrained cyclic triaxial tets with parametrically changing relative density and fines content is reviewed and interpreted within an energy framework approach. One of the findings of the study indicates that a cyclic stress ratio-number of cycles line corresponding to a specific soil strain represents a line of equal dissipated energy. Using the energy-based approach liquefaction potential can be evaluated by comparing the dissipated energy with upward seismic wave energy without considering stress intensity and number of cycles. A comparison between the energy and stress approaches is performed in a hypothetical sand deposit. Similarities and differences are discussed.

Paper 4.03a, THE SEISMIC EVENT AT L'AQUILA ON 6 APRIL 2009: SITE EFFECTS AND CRITICAL POINTS IN MICROZONATION ACTIVITY WITHIN THE ATERNO VALLEY, by Rainoni et al. The paper highlights the influence of site effects on microzonation for Aterno Valley, Italy. First seismicity and geology of the area is discussed followed by effect of lithology on the soil profiles. Local seismic response at 2 locations i.e. Onna and L'Aquila is examined. The paper suggests that the transfer function (ratio of output to input motions) shall be presented with respect to lithological models.

Paper 4.04a, BANDA ACEH-INDONESIA STRONG MOTIONS SIMULATION AND GROUND RESPONSE ANALYSIS DURING THE 2004 INDIAN OCEAN MEGA EARTHQUAKE, by B. Setiawan. et al. The authors investigate the phenomenon of local site effects and soil amplification at Banda-Aceh during the 2004 Sumatra-Andaman mega earthquake. Comparison is made to the soil amplification observed during the 1985 Mexico City earthquake. Discussion of the geology and soil conditions in the region is provided. Site response analysis using the soil profile at one of the softer sites is performed with the computer software NERA. Results of the site response analysis are compared to the observed site effects in Mexico City and the results of earlier studies investigating the site response at Banda-Aceh. In general, aspects of the results were similar to the observed results in Mexico City. However, significant differences were observed when comparing the results to earlier studies of site response at Banda-Aceh.

Paper 4.05a, A 2-DIMENSIONAL APPROACH FOR NUMERICAL MODELING OF SEISMIC GRAVEL DRAINS IN LIQUEFIABLE GROUNDS, by M. Seid-Karbasi. This paper presents the results of a coupled mechanical-hydraulic dynamic analysis performed for a port structure founded on liquefiable soil improved with stone columns. N effective stress approach was used to analyze the excess pore water pressure generation, dissipation and redistribution in the soil layers. Two different analyses are performed and comparison of results is discussed.

Paper 4.06a, BANK INSTABILITY PROBLEMS ASSOCIATED WITH THE RIVERSIDE CONSTRUCTION, by Marino and Osouli. The sliding of a riverbank during construction of a water intake facility in Tennessee was investigated and the failure mechanism was analyzed and presented. The paper summarized the cause of the slides and also the learned lessons.

Paper 4.07a, DEM MODELING OF GRANULAR MATERIALS UNDER CYCLIC LOADING, by Vinod et al. The paper thoroughly reviews the challenges faced in understanding and modeling the cyclic behavior of soil and elaborates in potential of the Discrete Element Method (DEM) to simulate the behavior of granular materials under cyclic loading conditions. Two DEM simulations are presented to illustrate the capabilities of DEM in modeling the cyclic behavior of granular materials such as liquefaction, post liquefaction, and densification. The paper compares the numerical results to the field test data from an instrumented track and concludes the strong capabilities of the DEM technique in modeling the cyclic behavior of granular materials.

Paper 4.08a, EFFECTS OF SILT CONTENT ON DYNAMIC PROPERTIES OF SOLANI SAND, by Kirar and Makeshwari. The shear modulus of the Solani Sand, mixed with varying quantities of silt from the Dhanauri River was measured using a cyclic triaxial system. The addition of differing quantities of silt resulted in increased shear modulus as much as 90 percent for the sample with 10 percent silt. Higher and lower quantities of silt resulted in lower increases in shear modulus. The study also varied relative densities of the sand and sand-silt mixtures, resulting in nearly uniform changes in shear modulus for all samples tested with the highest shear modulus recorded for the sample with 10 percent silt. Additionally, a comparison of damping ratio for the two relative densities tested, also results in a near uniform change with damping ratio lowest for the sample with 10 percent silt.

Paper 4.11a, GROUND DEFORMATION OBSERVED AFTER 23.10.2011 Mw 7.2 VAN EARTHQUAKE, by Akin et al. This paper after providing a brief overview of the Mw7.2 Van earthquake, studies the earthquake-induced ground

deformations related to liquefaction and lateral spread particularly in the Karasu River floodplain. Also the paper describes the soil conditions at liquefied sites.

Paper 4.14a, SOIL LIQUEFACTION SUSCEPTIBILITY MITIGATION AT SMITHLAND HYDROELECTRIC PROJECT, by Andrews et al. This paper describes the ground improvement efforts for the Smithland Hydroelectric Project in Kentucky. Background regarding the project, its location, and site seismicity are given. The presence of potentially liquefiable soils and limestone with karsts resulted in the decision to apply ground improvement to "minimize total and differential settlements, maintain earthquake and post-earthquake stability, reduce earthquake-induced settlement and deformation, and prevent loss of ground into karstic features under static and seismic conditions." A combination of stone columns, compaction grout, and slurry cutoff walls was used to achieve the desired engineering performance of the facility.

Paper 4.17a, ESTIMATING SEISMIC SETTLEMENTS FROM LIQUEFACTION AND CYCLIC SOFTENING AND THEIR IMPACT TO DESIGN OF A SCHOOL BUILDING, by Wetenkamp et al. This paper describes site conditions at a school within the context of foundation performance under seismic loads. Though normally settlement evaluation is focused on liquefaction of sand deposits, this paper focuses on cyclic softening of soft clay layers.

Paper 4.19a, LESSONS FROM THE SEISMIC PERFORMANCE OF PILE-SUPPORTED BRIDGES AFFECTED BY LIQUEFACTION DURING THE M8.8 2010 MAULE CHILE EARTHQUAKE, by C. Ledezma. This paper shows that observed damage and partial collapse of pile-supported bridges during the 2010 M8.8 Maule Chile earthquake are most likely due to the effects of liquefaction-induced lateral and vertical ground displacements that could have led to kinematic loads to pile foundations. Paper presents simplified back-analyses.

Paper 4.20a, PERFORMANCE OF LIGHTWEIGHT STRUCTURES DURING LIQUEFACTION FROM RECENT EARTHQUAKES, by Meneses and Liao. This paper summarizes damage to lightweight structures during recent earthquakes in Peru, Chile, Japan and New Zealand, as well as the 1997 event in Argentina. The paper provides excellent details on damage to structures that can be used by other authors to visit sites and conduct additional testing. The importance of well-documented case histories of damage to structures due to soil property nonlinearity allows for improvement of empirical methods for liquefaction settlement estimation.

Paper 4.23a, SEISMIC HAZARD ASSESSMENT AND DESIGN GROUND MOTIONS: LESSONS LEARNED FROM RECENT EARTHQUAKES, by Z. Wang. This paper presents an argument against the practice of probabilistic seismic hazard analysis (PSHA). Examples from recent earthquakes are used to demonstrate that probabilistic ground motion design maps underpredicted the ground motions that were observed in recent earthquakes such as Tohoku 2011 and Wenchuan 2008. A derivation is performed to demonstrate an inconsistency in units in PSHA. Other factors such as the use of a Poisson probability distribution to describe temporal uncertainty of earthquakes are discussed. An argument is made for the use of deterministic seismic hazard analysis (DSHA) in seismic resistant design.

Paper 4.28a, SPECTRAL ATTENUATION CHARACTERISTICS OF STRONG MOTIONS IN EAST-CENTRAL IRAN USING THEORETICAL DATA, by Mahood and Hamzehlo. Attenuation relation is established for the east-central Iran area using the stochastic finite fault modeling to generate acceleration time histories for the region. The method can be used for regions where the strong ground motions data is insufficient to provide a complete database to develop an empirical attenuation relationship.

Paper 4.29a, VARIATION OF INTRINSIC AND SCATTERING ATTENUATION OF SEISMIC WAVES WITH DEPTH IN THE BAM REGION, EAST-CENTRAL IRAN, by Mahood. The paper establishes the attenuation properties of seismic waves (Q) in the Bam region, East-Central Iran. This research study employs the using the site-specific seismic data collected by a seismograph network for a period shortly after the 2003 destructive Bam earthquake. The attenuation parameters are estimated and their correlation with frequency is established. The results from this study are in good agreement with other studies carried out for similar seismic active regions. According to the results, the paper concludes that the crust in the studied region is highly heterogeneous and tectonically active.

Paper 4.30a, EVALUATION OF SITE AMPLIFICATION OF ERBAA, TOKAT (TURKEY), by Akin et al. Based on the dynamic soil properties, the shear wave velocity profiles were prepared for site response analyses. For dynamic soil properties field tests are conducted and empirical relations are used. The amplification factor (AF) is found for different grids for Erbaa City in Tokat, Turkey. Based on 1-D ground response analyses, AF reported lies in the range of 1.5~2.5 for study area.

Paper 4.01b, PROPAGATION OF SEISMIC WAVES IN AN ANISOTROPIC MEDIA DUE TO A POINT SOURCE, by A. Chattopadhyay and Sahu. The paper formulates the propagation of seismic waves in an anisotropic magnetoelastic structure with a point source. The problem solved in this study consists of a magnetoelastic layer on a heterogeneous medium. The phase velocity of the shear wave is obtained using the Green's function method and it is shown that the dispersion curve is in assertion with the classical Love-type wave equation when the heterogeneity and reinforcement are ignored as well as the magnetic field effect. The paper, furthermore, investigates the effect of above parameters on the wave propagation in the medium.

Paper 4.03b, BRIDGE FOUNDATION PILE DRIVING VIBRATION MONITORING, by Zand-Parsa and Zand-Parsa. The paper described the vibration monitoring process during the pile driven for a bridge foundation. The monitored PPV (peak particle velocitie) was compared with the limit and found there is no damage to structures.

Paper 4.06b, DETERMINATION OF MSE WALL PSEUDO STATIC COEFFICIENT BASED ON SEISMIC PERFORMANCE, by Panah et al. This study employs a numerical approach to evaluate the response of MSE walls to dynamic loading. Based on dynamic finite difference numerical analyses, the authors suggest a pseudo static approach based on the calculated performance (displacements). The effects of several parameters on the dynamic response of the soil-wall system are evaluated such as amplitude and frequency content of the input motion as well as the configuration of the reinforced soil-wall system. The paper concludes that the proposed pseudo static method is less conservative than the available design methods which are mainly based on the limit state equilibrium equations. The coefficients of the proposed pseudo static approach are based on the peak ground acceleration and the seismic performance level.

Paper 4.10b, EXPERIMENTAL INVESTIGATION INTO NATURAL BASE ISOLATION SYSTEM FOR EARTHQUAKE PROTECTION, by Bandyopadhyay et al. This paper describes an experiment used to evaluate the use of shredded tires mixed with sand as means to reduce the ground motions transmitted to a structure during an earthquake (i.e. base isolation). Using a 1mx1m shake table, the response of a scaled footing on sand was compared to the response of the footing on various concentrations of shredded rubber and sand. Results of the experiment suggest that concentrations less than 50% rubber/50% sand showed little improvement in the isolating effect. Concentrations of more than 50% rubber resulted in “wobbling” of the footing during cyclic loading.

Paper 4.12b, AN INVESTIGATION OF THE STACK VIBRATIONS AND GEOTECHNICAL REHABILITATION SOLUTIONS. CASE-STUDY: KHANGIRAN GAS REFINERY, by Ghodrat et al. This paper reviews applied geotechnical solutions such as ground improvement, change of foundation natural frequency and stack mass. Stacks as high as 75m of the sulfur recovery units of the Khangiran Gas Refinery developed significant levels of vibration during winds. Longest vibration duration is 8 hours and maximum tip deflection is 1m.

Paper 4.14b, EVALUATION OF LIQUEFACTION POTENTIAL OF AN EARTH DAM FOUNDATION USING IN SITU TESTS, by Ikram and Ridha. This paper describes the liquefaction evaluation and subsequent ground improvement at the Sidi El Barrak earth dam in northwestern Tunisia. Description of the dam site and its site conditions is provided. Liquefaction susceptibility of the foundation soils is discussed. Extensive liquefaction analysis using simplified methods with both SPT and CPT is performed, and liquefaction is deemed to be a significant hazard. Vibrocompaction is performed beneath the earth dam, and subsequent site investigations and analysis are presented to show that liquefaction hazard has been adequately remediated.

FINAL REMARKS AND TOPICS FOR DISCUSSION

The papers presented in this session cover a wide range of significant topics associated with Geotechnical Earthquake Engineering. Topics include engineering lessons from earthquakes, seismic performance of structures, vibrations, ground failure and effects on structures, and some analytical studies. The papers are a clear indication about the high technical level and expertise of the authors and international geotechnical earthquake engineering community. The purpose of the discussion topics below is to establish a communication venue between the authors and delegates of the conference to foster what we expect to be a lively and fruitful dialogue.

SUGGESTED LIST OF SESSION 4 DISCUSSION TOPICS

1) Damage to bridges induced by ground failure
2) Liquefaction potential evaluation
3) Liquefaction consequences
4) Landslides
5) Amplification of ground motions during earthquakes
6) Base isolation
7) Seismic performance of MSE walls

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