FRIEDMAN FAMILY VISITING PROFESIONALS PROGRAM

Visit to University of Texas at Austin: April 27, 2016

This report summarizes the visit of **Ivan G. Wong** from Lettis Consultants International that took place at the University of Texas at Austin on April 27, 2016

ITINERARY OR AGENDA

Provide the itinerary of the visit. For example:

TIME:	ACTIVITY:
11:45 AM – 12:00 PM	Student Chapter President meets & welcomes Visiting Professional to campus
12:00 PM – 1:00 PM	Lunch with student chapter
1:00 PM – 2:00 PM	Meeting with Prof. Patricia Clayton
2:00 PM – 3:00 PM	Guest lecture by Prof. Visiting Professional
3:00 PM – 4:00 PM	Meeting with CISR/TexNet (Prof. Ellen Rathje, Dr. Peter Hennings, and Dr. Alexandros Savvaidis)
4:00 PM – 4:30 PM	Meeting with Prof. Kenneth Stokoe
4:30 PM – 5:30 PM	Meeting with Prof. Brady Cox

STUDENT CHAPTER VISIT PLANNING COMMITTEE

LEAD ORGANIZER(S): Stalin Armijos, Vice President, starmijos@utexas.edu

- Anne Hulsey, President, annehulsey@utexas.edu
- Andrew Stolte, Executive Board Member, a.c.stolte@utexas.edu

Prof. Patricia Clayton and Prof. Ellen Rathje assisted in planning

VISITING PROFESSIONAL LECTURE OVERVIEW

Ivan Wong's presentation was entitled "Induced Seismicity and the Oil and Gas Industry – The Science, Risk, and Politics". A brief introduction to the topic of induced seismicity was introduced and emphasis was placed on earthquakes induced by the injection of waste water produced during the extraction of oil and gas. A few case histories were presented and comparisons were made between induced and natural earthquake events.

The presentation was attended by students and faculty in Geotechnical, Structural, and Petroleum Engineering programs at the University of Texas at Austin (UT), many of whom are members of the EERI student chapter. The audience response was generally positive. The topic is a growing research area UT and not well understood or covered in coursework.

Lecture Abstract

Recent earthquakes associated with oil and gas activities in the central and eastern U.S. (Oklahoma, Colorado, Texas, Ohio, and Arkansas) have drawn the attention of the media, the general public, public officials and of course, the oil and gas industry. Across this region, the seismicity rate has doubled over

the past 11 years (Ellsworth, 2013). According to the U.S. Geological Survey, this rate change can largely be attributed to earthquakes induced by fluid injection associated with oil and gas production, particularly the disposal of wastewater from hydraulic fracturing operations. Although the largest induced earthquakes have been associated with wastewater disposal (moment magnitude [M] > 4.5), confusion in the public and the media over the distinction between the process of hydraulic fracturing and the disposal of its wastewater has led to intense scrutiny of hydraulic fracturing, particularly from regulatory agencies.

Albeit rare, given the few cases where fluid injection-induced earthquakes have been felt or sometimes damaging, it is critically important that induced seismicity be better understood so that any potential hazards can be mitigated. Specific issues that need to be addressed include: (1) the site-specific factors which can lead to induced seismicity, e.g., why some wells trigger earthquakes and the vast majority do not; (2) how to predict the maximum magnitudes and rates of potential induced seismicity; (3) how can fluid injection-induced earthquakes be controlled; and (4) how to estimate the hazards posed by induced earthquakes.

To address issue (4) and assess the potential effects on population and infrastructure from injection-induced seismicity, the need to be able to predict the resulting ground shaking is critical. Although injection-induced earthquakes seldom exceed M 5 in size, their shallow nature could lead to large amplitudes particularly at high frequencies in the near-field, e.g., peak ground acceleration. Alternatively the ground motions from induced earthquakes could be lower than natural tectonic earthquakes because they occur in a weak shallow crust resulting in low stress drops. Minor nonstructural damage has been reported for the 2013 M 4.8 Timpson, Texas, earthquake. Only minor non-structural damage is expected from earthquakes smaller than M 5.0 because of their short durations of only a few seconds. For events larger than M 5, some structural damage to unreinforced masonry and adobe structures has been reported for both the 2011 M 5.3 Trinidad, Colorado, and 2011 M 5.6 Prague, Oklahoma events.

The chief obstacle to being able to predict the ground motions from injection-induced earthquakes is the sparse strong motion database at short distances from which to develop empirically-based ground motion prediction models. There are four major issues that need to be addressed in developing a ground motion model for injection-induced earthquakes: (1) Are ground motions from injection-induced earthquakes statistically different from ground motions from natural earthquakes?; (2) How do injection-induced earthquake ground motions scale with magnitude and distance?; (3) Is this scaling a function of tectonic regime like natural earthquakes which are partitioned between tectonically active regions like western North America or stable continental regions like central and eastern North America?; and (4) are any of the current ground motion models for natural earthquakes appropriate for injection -induced seismicity or do new models have to be developed?

Professional Bio

Principal Seismologist with Lettis Consultants International in Walnut Creek, California. Ivan has more than 40 years of experience in the fields of engineering seismology and seismic geology. A major focus in his career has been earthquake hazard reduction and awareness and public outreach. At URS, Ivan has directed the seismic hazard evaluations of more than 500 critical and important facilities worldwide, mostly for the Federal government. He has managed some of the largest seismic hazard evaluations performed in the U.S. including the Yucca Mountain Project. For FEMA, Ivan has been involved in the education and implementation of the seismic risk assessment software HAZUS in several areas in the U.S. He has been the recipient of numerous NEHRP external research grants from the USGS that have supported the development of urban probabilistic and scenario hazard maps and other earthquake hazard-related studies.Ivan is a past member of the EERI Board of Directors, past President of the EERI Northern California Chapter, past member of the Editorial Board

for EERI's Earthquake Spectra, and currently serves as an Associate Editor for the Bulletin of the Seismological Society of America. He is a member of numerous scientific and engineering committees, panels, and working groups including Chair of the Working Group on Utah Earthquake Probabilities and a member of the CISN Advisory Panel, ANSS National Steering Committee, and the American Nuclear Society Working Groups on Probabilistic Seismic Hazard Analysis and Surface Fault Rupture and Deformation. Ivan has also been particularly active in serving the U.S. Geological Survey on several review and advisory panels including the review panel for the 1996 national hazard maps. Ivan has authored or coauthored more than 300 professional publications.

SUPPLEMENTAL ACTIVITES

Lunch with student chapter

Ivan Wong and students from our student chapter had lunch together at a local restaurant. Conversation topics included Ivan Wong career experiences as a professional engineering seismologist, the research topics of the graduate students, induced seismicity in Texas and the recent earthquakes in Ecuador and Japan.

Meetings with faculty at the University of Texas

Ivan Wong met with the members of the faculty at UT with research topics in Earthquake Engineering.

RESULTS, FEEDBACK AND LESSONS LEARNED

Having Ivan Wong as a visiting professional has provided the UT community with clear ideas about induced earthquakes and their potential consequences in infrastructure and local economy. The lecture was clear enough that students with different backgrounds were able to process all the information provided. This type of approach is suggested for future visiting professionals due to the diversity of backgrounds of people listening the lecture. For future visiting professional, we would like to listen about:

- Performance based design in structural engineering practice
- Topics about current practice in geotechnical engineering
- Case studies were cutting-edge technology has been applied in earthquake engineering

ACKNOWLEDGEMENTS

The University of Texas at Austin EERI Student Chapter gratefully acknowledges the support of the Friedman Family for sponsoring the travel of Ivan Wong through their Friedman Family Visiting Professional Program endowment.
Additionally, The University of Texas at Austin EERI Student Chapter gratefully thanks the help and support of Prof. Ellen Rathje and Prof. Patricia Clayton.

LIST OF ATTACHMENTS

Included at the end of this report are various attachments to supplement the information included above. A list of the attachments is included below:

- Flyer posted to promote the lecture.

Earthquake Engineering Research Institute

UT-Austin Student Chapter

and

EERI's Friedman Family Visiting Professionals Program

present

Induced Seismicity and the Oil and Gas Industry: The Science, Risks, and Politics

by

Ivan G. Wong

Principal Seismologist, Lettis Consultants International

Wednesday, April 27, 2016
2 p.m. – 3 p.m.
ECJ 6.406

THE UNIVERSITY OF TEXAS AT AUSTIN STUDENT CHAPTER

Any Questions? Please contact: Anne Hulsey (annehulsey@utexas.edu)

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