



Universidade do Minho



Institute for Sustainability and
Innovation in Structural Engineering



Erasmus Mundus

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GRADUATE SUMMER SCHOOL ON EARTHQUAKE ENGINEERING

**October 1-4, 2012
Guimarães, Portugal**

A four-day summer school on earthquake engineering will be carried out in Guimarães, University of Minho, Portugal, including three different events that can be followed independently or together (for more information and short résumés, see next pages):

- A seminar on “Recent advances and directions in earthquake engineering”, by distinguished international guests;
- A mini-symposium on “Hybrid simulation: Theory and applications” by three experts from University of California, Berkeley, USA;
- A short advanced course on “Probabilistic Performance-based Earthquake Engineering” by Prof. Khalid M. Mosalam, University of California, Berkeley, USA.

A certificate for the participation of each event will be provided by the SAHC Consortium. Participants wishing to receive possible credit recognition of the graduate studies at their home institution will have to carry out a subsequent assignment for marking. In this case, successful attendees will receive a certificate issued by the SAHC Consortium attesting the course and the ECTS credits earned.

Guimarães, Porto

Guimarães, and the neighboring city of Porto, are within the top 10 world destinations for Lonely Planet in 2012. Guimarães also appears in the top destinations from the New York Times and Wallpaper Magazine, being a European Cultural Capital of Europe in 2012. The city is a UNESCO World Heritage city, founded in 1128 and famous for its architectural heritage, food, popular traditions and handcrafts.

Travelling and lodging

The closest airport to the city of Guimarães is the Sá Carneiro Airport in Oporto, served by several low cost and regular airlines. The airport is about 50 km away from both cities. Lodging can be found in hostels (dormitories, single and double rooms) for about 15-25 euro/night. Hotel prices per night start at 35 euro. Information on how to reach Guimarães is available at http://www.uminho.pt/en/home_en/directions.

Fees

The enrolment fees, before September 14, 2012, are:

- Seminar and Mini-Symposium: 40 euro each;
- Short Advanced Course: 75 euro;
- Full Summer School: 100 euro.

After September 14, 2012, prices are increased by 50%. For enrolment and further information please contact Ms. Paula Teixeira: phone (+351 253 510218), fax (+351 253 510217) or email (sec.estruturas@civil.uminho.pt).



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Seminar on recent advances and directions in earthquake engineering

October 1, 2012

Program:

9:00-10:30

Modal Parameter Variation of an Earthquake Damaged Building
Ruben Boroscheck
Division Director of Structures, Construction, and Geotechnics
Civil Engineering Department
University of Chile

10:30-10:45

Coffee Break

10:45-12:15

Earthen Structures in Earthquakes – Laboratory and Field Studies
Marcial Blondet
Engineering Department
Catholic University of Peru

12:15-13:00

Recent Shaking Table Tests in Portugal: Lessons Learned
Paulo B. Lourenço
Institute for Sustainability and Innovation
University of Minho

14:00-15:30

Hybrid Simulations: Theory and Applications in Earthquake Engineering
Khalid Mosalam
Department of Civil and Environmental Engineering
University of California, Berkeley

15:30-15:45

Coffee Break

15:45-17:15

FEM Static and Dynamic Modeling of Roman Vaulted Monumental Buildings
in Opus Caementicium
Renato Perucchio,
University of Rochester, Rochester, New York, USA



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Mini-Symposium on Hybrid Simulation: Theory and Applications

October 2, 2012

Khalid M. Mosalam, Selim Günay and Shakhzod Takhirov
University of California, Berkeley, USA
Guimarães, October 2-3, 2012

Summary

Hybrid simulation is a set of methods for examining the seismic response of structures using a hybrid model comprised of both physical and numerical sub-structures. Because of the unique feature of the method to combine physical testing with numerical simulations, it provides an opportunity to investigate the seismic response of structures in an efficient and economically feasible manner. It is this feature of the method which made it gain widespread use in the recent years. This one-day mini-symposium covers the fundamentals of the method, an introduction to the commonly utilized hybrid simulation tools, namely OpenSees (computational platform) and OpenFresco (interface between computational platform and experimental site) as well as the application of the method in two research projects.

The fundamentals consist of three topics: substructuring, integration methods and simulation errors. These three fundamental topics are also within the main areas of hybrid simulation research conducted up to date. First application of the method is the hybrid simulation of structural insulated panels (SIPs), whereas the second application is real-time hybrid simulation of high voltage electric disconnect switches. Related to the second application, shaking table and static tests and finite element simulations of the disconnect switches are also covered in addition to the structural testing of concrete duct-banks which are used for high voltage distribution lines. Last part of the mini-symposium consists of the use of advanced monitoring and measurement systems such as the use of laser scanning techniques on several laboratory and field applications including applications to historical structures..

Outline:

1. Hybrid simulation fundamentals [3.0 hours]
 - 1.1. Substructuring
 - 1.2. Integration methods
 - 1.3. Simulation errors
2. Hybrid simulation applications [2.5 hours]
 - 2.1. Introduction to OpenSees
 - 2.2. Introduction to OpenFresco
 - 2.3. Application I: Hybrid simulation of structural insulated panels
 - 2.4. Application II: Real-time hybrid simulation of high voltage electric disconnect switches
3. Seismic testing of lifelines related to the electric grid [1.5 hours]
 - 3.1. Shaking table and static tests and finite element simulations of high voltage electric disconnect switches
 - 3.2. Fragility tests of concrete duct-banks for high voltage distribution lines
4. Use of advanced monitoring and measurement systems in structural testing [1.0 hour]



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Short Advanced Course on Probabilistic Performance-based Earthquake Engineering

October 3-4, 2012

Khalid M. Mosalam
University of California, Berkeley, USA
Guimarães, October 2-3, 2012

Summary

Probabilistic performance-based earthquake engineering (PBEE) is gaining significant attention in the recent years and it can be accepted as one of the most powerful and efficient methods of the future of earthquake engineering. This short course covers the various aspects of probabilistic PBEE with an emphasis on the Pacific Earthquake Engineering Research Center (PEER) PBEE methodology, where the method includes most of the elements of probabilistic PBEE alongside its potential to be utilized as a standard design method. First, background is provided about the use of probabilistic PBEE in assessment and design. Subsequently, details of the PEER PBEE methodology are explained and step-by-step applications of the methodology are demonstrated using three examples. Finally, future extension to multiobjective performance-based sustainable design is briefly discussed. This 2-day course is designed after partial consideration of the layout of the fib technical report "Probabilistic Performance-based Seismic Design" prepared by Task Group 7.7.

Outline:

1. PBEE assessment methods [2.0 hours]
 - 1.1. Conditional probability approaches such as PEER and SAC/FEMA formulations
 - 1.2. Unconditional probabilistic approach
2. PBEE design methods [2.0 hours]
 - 2.1. Optimization-based methods
 - 2.2. Non optimization-based methods
3. PEER PBEE formulation [4.0 hours]
 - 3.1. Hazard analysis
 - 3.2. Structural analysis
 - 3.3. Damage analysis
 - 3.4. Loss analysis
 - 3.5. Combination of analyses
4. Application 1: Evaluation of the effect of unreinforced masonry infill walls on reinforced concrete frames with probabilistic PBEE [1.0 hours]
5. Application 2: Evaluation of the seismic response of structural insulated panels with probabilistic PBEE [1.0 hours]
6. Application 3: PEER PBEE assessment of a shearwall building located on the University of California, Berkeley campus [1.0 hours]
7. Future extension to multi-objective performance-based sustainable design [0.5 hour]
8. Recapitulation [0.5 hour]



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Short Résumés

Khalid Mosalam obtained his BS and MS from Cairo University, Egypt, where he also taught for 3 years. In 1996, he earned his PhD from Cornell University in Structural Engineering and subsequently spent one year as a lecturer in the same university. In 1997, he joined the Department of Civil and Environmental Engineering, University of California, Berkeley where he is currently a professor and vice-chair. Mosalam teaches structural engineering, finite element methods, and behavior and design of reinforced and prestressed concrete structures. He conducts research on the performance and health monitoring of structural systems of reinforced concrete, masonry, and wood subjected to extreme loads. He is also active in the areas of assessment and rehabilitation of essential facilities such as bridges and electrical substations. His research approach covers large-scale computations (deterministic and probabilistic) and physical testing including hybrid simulations. Mosalam was a visiting professor at Kyoto University, Japan, and Middle East Technical University, Turkey. He is the recipient of the 2006 ASCE Walter L. Huber Civil Engineering Research Prize with citation: "For advanced computational research integrated with large experiments to solve practical structural engineering problems." Recently, Mosalam became active in the area of building energy efficiency and sustainability.

Marcial Blondet is Professor of Civil Engineering and the director of the doctoral program in Engineering at the Catholic University of Peru (PUCP). He obtained Masters and PhD degrees in Engineering at the University of California, Berkeley. Professor Blondet is a specialist in earthquake engineering and structural dynamics, and has ample experience on the experimental study of the seismic behavior of structures. His main research interests are the development of low-cost solutions to mitigate the seismic risk of informal earthen and masonry dwellings, the conservation of earthen historical monuments in seismic areas, and the use of energy dissipation and base isolation systems for the seismic protection of buildings.

Paulo Lourenço, professor, Department of Civil Engineering, University of Minho, Guimarães, Portugal and Head of the Institute in Sustainability and Innovation in Structural Engineering. He is experienced in the fields of NDT, advanced experimental and numerical techniques, innovative strengthening techniques and earthquake engineering. He is specialist in structural restoration, with consultancy in several World Heritage sites, such as Cathedral of Porto, Monastery of Jeronimos (Lisbon), Castle of Guimaraes or Qutb Minar (New Delhi). He has worked in more than 50 monuments in Portugal, Spain, Italy, Brazil, Cyprus, Iran, India and Morocco. He is Editor of the "International Journal of Architectural Heritage: Conservation, Analysis and Restoration", Editor of the Conference Series "Structural Analysis of Historical Constructions" and Coordinator of the European Erasmus Mundus Master Course on "Structural Analysis of Monuments and Historical Constructions". Supervisor of 25 completed PhD theses and coordinator of several national and international research projects. He is author or co-author of more than 700 technical and scientific publications in the fields of masonry, timber and concrete structures.

Renato Perucchio, Ph.D., Professor of Mechanical Engineering and of Biomedical Engineering, and Director of the Program in Archaeology, Technology, and Historical Structures, joined the University of Rochester faculty in 1984, after receiving a Doctorate in Aeronautical Engineering from the University of Pisa, Italy (1977), and a Ph.D. in Civil Engineering (Structural) from Cornell University (1983). He is the recipient of the 2010 Goergen Award for Excellence in Undergraduate Teaching from The College, UR, 1995 Teacher of the Year Award from the UR School of Engineering and Applied Science, 2007 Richard Skalak ASME Journal of Biomechanical Engineering Best Paper Award, the UR



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Bridging Fellowship (1993), and the UR Wadsworth Sykes Engineering Endowment Award (four times). He is the author or coauthor of over 110 publications, including book chapters, peer-reviewed articles and invited contributions in various areas of computational mechanics. He has directed 15 PhD and 6 MS thesis. His former students are employed in academia, research laboratories, and industry. His research has been supported by over \$7M in collaborative projects. He has direct several undergraduate research projects. His current research and teaching interests are in computational solid and structural mechanics, nonlinear finite element modeling, and in engineering design practices in ancient and pre-industrial societies.

Ruben Boroschek obtained his ME and PhD (1991) from University of California, Berkeley. After his PhD, he spent several non-consecutive years as a postdoc, research assistant and visiting scholar at the same university. In 1992, he joined the Department of Civil Engineering, University of Chile where he is currently associate professor. Boroschek teaches structural dynamics and advanced structural dynamics. Among many other duties, he has been the director of the national network of accelerometers in Costa Rica and Chile, director of the collaborative center for the WHO for disaster mitigation in health facilities, executive secretary and vice-president of the Chilean association of seismology and aseismic engineering, director of the Chilean structural engineering association and director of founding partner of Rubén Boroschek y Asociados Ltda. He conducts research on seismic risk assessment, vulnerability and mitigation of disasters in key facilities (health and industry), earthquake resistant engineering, structural dynamics, seismic isolation and energy dissipation, effect of vibration in humans, modeling of strong motions, and seismic and structural check for complex systems. He published more than 60 papers in earthquake engineering conferences.

Selim Günay obtained his BS, MS and PhD degrees from Middle East Technical University, Turkey. He has been working as a postdoctoral researcher in Civil and Environmental Engineering Department and nees@berkeley laboratory since 2008, where he is responsible for conducting tests of various NEES research projects in the lab. His research topics include hybrid simulation methods, shaking table testing, numerical simulations of different structural systems such as reinforced concrete moment resisting frames with unreinforced masonry infill walls, wood-type structures and ordinary bridge systems. He also conducted research related to performance based earthquake engineering (PBEE), including the Pacific Earthquake Engineering Center PBEE Methodology and development of various approximate methods as an alternative to nonlinear time history simulations.

Shakhzod Takhirov obtained his BS and MS degrees from Tashkent State University, Uzbekistan. In 1989, he earned his PhD from Moscow University, Russia in Mechanical Engineering. Before and after his PhD course at Moscow University he conducted research at Institute of Mechanics and Seismic Stability of Structures (IMSSS), Tashkent, Uzbekistan. His research interests at IMSSS were wave propagation and its diffraction on foundation of a building and subsequent soil-structure interaction. He has a number of publications in wave dynamics: wave diffraction on cracks, in water-saturated soils and anisotropic soils. He has been working at Pacific Engineering Research Center (PEER), UC Berkeley since 1997. His research interests at UC Berkeley are full-scale seismic evaluation of non-structural components and equipment by means of shake table testing. He is also specializing in novel techniques of laboratory and field measurements. At PEER he has been working at various positions with the last one (since 2011) being Site Operations Manager of nees@berkeley.