ONLINE POSTGRADUATE COURSE
SEISMIC DESIGN AND RETROFIT OF BUILDINGS AND BRIDGES. (SDR–BB)

2015

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Nowadays, earthquake-resistant design and retrofit of buildings and other constructions is gaining attention worldwide among structural designers and other professionals. Several reasons are behind this tendency:

- Increasing awareness of the enormous damaging potential of earthquakes.
- Highly globalized working environment, where any professional can be involved in design of constructions in seismic prone regions. Noticeably, almost 25% of the world’s population live in seismic areas, many in developing countries; moreover, most of the existing buildings are highly vulnerable to earthquakes. In other words, today’s globalized world requires “earthquake engineers”.
- Newly developed design and analysis tools, such as PBD (Performance-Based Design), Pushover Analysis and IDA (Incremental Dynamic Analysis), among others. These approaches are becoming more complex, hence, the commercial computer codes are equally more complicated.
- Recently-proposed innovative construction and protection technologies, such as Base Isolation, Energy Dissipators, among others.

This teaching activity aims to close this gap by providing the attendants with the practical knowledge to perform any intervention (design, planning, analysis, construction, retrofit, strengthening, repair, modification, promotion, etc.) on buildings and bridges located in moderate, mid and high seismicity areas. To reach this goal, the most advanced formulations included in the regulations are described, and realistic application examples are fully developed using the most spread commercial software codes.

UPC is a highly prestigious teaching and research institution, being currently ranked 36th (QS World University Ranking) in Civil and Structural Engineering.

This activity is a professionally-oriented postgraduate program taught by the UPC School of Professional & Executive Development, the lifelong training at UPC, Universitat Politècnica de Catalunya. This activity is taught online, taking profit of the most advanced capabilities of e-learning; among them, the possibility of tailoring the activity to the individual necessities and the option of adjusting the learning path to the time availability of each attendant. The Program is intended for an international audience; the attendants will be able to interact each other, interchange their professional experiences. The technologies and concepts described in the program are the direct result of the professional, lecturing and research activities of the instructors.

The evaluation will be principally based on a Final Thesis developed by each attendant. The thesis can be presented either online during the last week or face-to-face in Barcelona.
WHO IS IT FOR?

This Program is oriented to professionals involved with buildings and bridges located in seismic prone regions:
- Structural engineers
- Structural consultants and designers
- Construction managers
- Civil engineers
- Building engineers
- Urban planners
- Architects

OBJECTIVES

The main objective of this program is to familiarize the attendants with up-to-date knowledge on seismic design, analysis and retrofit of buildings and bridges. At the end of the Program, the attendants should be able to:

- Carry out any intervention (design, analysis, construction, retrofit, etc.) on buildings and bridges situated in seismic regions.
- Understand and apply correctly current major regulations and guidelines of America, Europe and other regions.
- Use the most common software packages for efficient seismic analysis and design of buildings and bridges.
- Promoting, managing and leading national and international projects dealing with seismic issues.

ADMISSION AND ENROLLMENT

To start the enrolment process for this programme you must complete and send the form that you will find at our website.

Next you will receive a welcome email detailing the three steps necessary to formalize the enrolment procedure:

1. Complete and confirm your personal details.
2. Validate your curriculum vitae and attach any additional required documentation, whenever this is necessary for admission.
3. Pay €110 in concept of the registration fee for the programme. This fee will be discounted from the total enrolment fee and will only be returned when a student isn’t admitted on a programme.

Once the fee has been paid and we have all your documentation, we will assess your candidacy and, if you are admitted on the course, we will send you a letter of acceptance. This document will provide you with all the necessary information to formalize the enrolment process for the programme.

Degree:
Postgraduate diplomas issued by the UPC, Universitat Politècnica de Catalunya.

To obtain this degree it is necessary to have an official or recognized university degree equivalent to a bachelor’s degree or diploma.

Credits:
20 ECTS (160 teaching hours)

Language of instruction:
English

Modality:
Online

Dates:
Start date: April 2015
End date: November 2015

Registration open until the beginning of the course or until end of vacancies.

Registration fee:
3,900 € (EURO)

The enrolment fee can be paid:
- In a single payment to be paid within the deadline specified in the letter of admission to the programme
- In two instalments:
  - 60% of the amount payable, to be paid within the deadline specified in the letter of admission to the programme
  - Remaining 40% to be paid up to 90 days at the latest after the starting date of the programme

More information and virtual interactive chat:
Telephone: (34) 93 112 08 65
www.talent.upc.edu
1. BASIS OF SEISMIC DESIGN

1.1 Dynamics of Structures
- Basic concepts. Displacement, velocity and acceleration. Frequency and period. Excitation (input) and response (output). Mass, damping and stiffness
- Signal analysis. Fourier spectrum

1.2 Earthquake Engineering & Seismology
- Near-source and far-source registers. Impulsivity, directivity and directionality. Influence of the soil type

1.3 Earthquake-Resistant Design
- Effects of seismic inputs on structures. Relative displacement, inter-story drift and absolute acceleration
- Design codes. Eurocode8. American regulations
- Types of building structures: frames, walls, bracings, dual systems. Behavior of building structures under vertical loads and under horizontal forces
- Heuristic seismic design recommendations. Symmetry, uniformity, compactness, lightness, ductility, damping, simplicity, separation. Strong column-weak beam. Short columns
- Types of seismic analyses: static linear, static nonlinear, and dynamic nonlinear
- Multimodal analysis. Number of modes to be considered. Modal combination criteria: SRSS and CQC
- Static nonlinear analysis (push-over). Plastic hinges. Modelling criteria: distributed and concentrated plasticity
- Performance-based design. Performance points (target drifts: IO, LS, CP, DL, SD, NC). American and European (N2) formulations
- Dynamic nonlinear analysis. IDA curves
- Vertical seismic analysis
- Seismic analysis of non-structural components
- Pounding between adjacent buildings. Required gap

2. SEISMIC DESIGN AND RETROFIT OF BUILDINGS

2.1 Seismic Design of Concrete Buildings
- Types of concrete building structures. Frames, structural walls, dual systems. Primary and secondary members. Critical regions. Ductility classes. Response reduction factor
- Local ductility of critical regions
- Precast concrete structures

2.2 Seismic Design of Steel Buildings
- Types of steel and composite building structures. Frames, concentric bracing, eccentric bracing, dual systems
- Critical regions. Ductility classes. Response reduction factor
- Special Truss Moment Frames
- Outrigger walls

2.3 Seismic Design of Timber Buildings
- Timber construction. Heavy timber, platform frame, cross-laminated timber
- Earthquake-resistant qualities of timber buildings. Ductility of the connections. Design criteria
- Example of seismic design of a timber building

2.4 Seismic Design of Masonry Buildings
- Masonry construction. Unreinforced, confined and reinforced masonry
- Earthquake-resistant qualities of masonry buildings. Design criteria
- Example of seismic design of a masonry building

2.5 Seismic Retrofit of Buildings
- Use of the Performance-Based Design
- Knowledge levels. Decisions for structural interventions
- FEMA, ATC and ASCE regulations. Eurocode 8 Part 3

2.6 Seismic Design and Retrofit of Foundations
- Basic concepts of soil response to earthquakes
- Liquefaction. Risk of landslides
- Retaining walls. Mononobe-Okabe formulation
- Shallow and deep foundations. Tie-beams and foundation beams. Raft foundations
- Effect of earthquakes on foundations.
- Applications. Liquefaction potential. Seismic design of foundations. Soil-structure interaction
3. SEISMIC DESIGN AND RETROFIT OF BRIDGES

3.1 Seismic Design and Retrofit of Bridges
• Pedestrian, road and railway bridges
• Types of bridges. Decks. Piles. Abutments. Cable-stayed bridges. Suspended bridges
• Design criteria. AASHTO specifications. Eurocode 8 Part 2
• Long-span bridges: spatial variation of the input ground motion

4. NEW TECHNOLOGIES FOR SEISMIC PROTECTION

4.1 Base Isolation
• Concept of base isolation. Degree of isolation. Limitations. Design criteria. Regulations
• Types of isolators. Rubber bearings. RB, LRB, HDRB. Durability.
• Friction devices; flat and curved surfaces. Other isolators. Supplemental damping
• Applications to buildings and bridges. Other applications. 3D isolation
• Observed seismic performance of isolated constructions
• Applications to seismic retrofit
• Design examples

4.2 Energy Dissipators
• Applications to buildings and bridges. Other applications
• Applications to seismic retrofit
• Design examples

4.3 Mass Dampers
Tuned mass dampers. Design criteria. Efficiency. Regulations. Active and semi-active dampers
Shock absorbers. Tuned liquid dampers. Tuned sloshing dampers and liquid column dampers
Applications to tall buildings, communication towers and steel chimneys. Applications to building slabs and pedestrian and road bridges

5. FINAL THESIS
The topic of the Thesis is proposed by each student and is approved by the director of the Program taking into account the feasibility and the practical interest of the proposal. Eligible themes are seismic designs or retrofits of actual building or bridges, or other relevant theoretical or applied studies. It is strongly recommended that the selected subject is closely related to the professional interests of the attendants.

TEACHING METHODOLOGY

This is an online course, in a full e-learning environment. Online teaching uses the Adobe Connect Technology; this software allows listening, viewing, recording, chatting and interacting with the instructors and the other attendants. Attendants will use the My Tech Space virtual campus, an effective working and communication platform. This campus provides access to the teaching documentation, allows creating virtual personal spaces, includes forum or e-mail communication tools, and facilitates team-working and discussions, among other capabilities. The major e-learning instruments are:

RECORDED LECTURES
Online non-synchronous teaching consist in two types of interactive sessions: theory and computer applications. Since this program is strongly professionally-oriented, theory sessions are mainly based on practical examples. Both types of sessions are divided in twenty-minute intervals. Each interval finishes with the proposal of an exercise, and next interval begins with its solution. This scheme lets attendants assessing continuously their progression. Computer applications sessions are mainly based in the extensive use of the most spread commercial codes, such as SAP, ETABS, SAFE, PLAXIS, ROBOT, SHAKE, RISA, STAAD, among others. In the computer applications sessions, actual examples are worked out from the very beginning to the final design details. These examples are new buildings, retrofitted buildings, high-rise buildings, bridges, base isolation, among others. Attendants are asked to use the same software than the instructor, thus being able to obtain parallel results. Students can ask questions any time, such enquiries will be answered at the earliest availability.

SYNCHRONOUS ONLINE SESSIONS.
A number of synchronous online interactive open sessions will be planned along the duration of the program. Professors will attend the sessions and the students will be able to pose questions and to address their concerns; as well, relevant issues will be discussed. Each synchronous session will last three hours, being scheduled 16:30–18:00 and 18:15–19:45 (Central European Time).

FORUMS
A number of forums will be created to boost the attendants and to allow for open discussions on case studies, and asking questions, among other learning and evaluation activities.

PROVIDED DOCUMENTATION
Wide written and interactive documentation will be delivered to the attendants. This includes teaching notes, scientific and technical papers and reports, books, design codes, worked examples, excel or MatLab files, SAP and ETABS files, and other relevant information.

CONTINUOUS EVALUATION
The progression of the attendants will be monitored by quizzes, multi-answer tests, short exercises, computer applications, and other similar activities proposed by the professors.

FINAL THESIS
Final Thesis is the major output of the program since it allows applying the taught concepts and the described procedures to actual projects. Each attendant will propose a subject of her/his interest; upon acceptance by the academic management, a supervisor (or several) will be assigned. Each student will develop her/his Thesis under tight cooperation with the supervisor. Ordinarily, this process will require extensive use of software codes.

Given the professional orientation of the program, teaching will be mainly based on the major international design codes (FEMA, ACI, AISC, ATC, ASCE, NEHRP, AASHTO, ENs, ISO, Eurocode 8, etc.). Since the national regulations of virtually all the countries are based either on the US codes or in the Eurocodes, the participants will be able to perform any intervention in any seismic country.

Customary language will be English but, eventually, questions can be asked and answered in Spanish, Arabic and French. As well, part of the supplied documentation will be also available in Spanish.
Academic Management

Francesc López Almansa  
BEng. MSc. PE. PhD. Forty years’ experience as advanced structural consultancy and technology transfer in buildings. Full Professor at the Universitat Politècnica de Catalunya. Wide teaching experience in many subjects related to Structural Analysis and Design. Co-Director of the Master Program “Structural Engineering in Architecture” and professor of the Master Programs “Technology in Architecture” and “Soil Engineering and Earthquake Engineering”. Permanently Visiting Professor of the Universities of Girona, Granada and Southern Chile. He has supervised 15 Doctoral Theses, most of them related to earthquake engineering. He is the author of more than 200 research papers published in scientific journals and presented at national and international scientific conferences. He has participated in numerous research projects (national and international) financed by public and private funds, having been a promoter and coordinator of about half of them.

Academic Coordination

Bashar Al Farah  
BEng. MSc. PE. Currently completing, at the Universitat Politècnica de Catalunya, his Doctoral Thesis about advanced numerical simulation of the dynamic structural behavior of buildings that are heavily damaged by earthquakes. Eight years’ experience in analysis, design, construction and supervision of civil engineering structures (high rise buildings, industrial facilities, residential and defense projects, etc.) located in seismic regions, mainly Arab and South American countries. Has a special experience with performing nonlinear seismic analysis for practical and scientific purposes. High expertise in structural analysis software: ABAQUS, ETABS, OpenSees, PLAXIS, PROKON, REVIT, RISA, ROBOT, SeismoSoft, SAFE, SAP, among others. Wide teaching experience in teaching professional courses for civil engineers and architects. Presently working as a structural consultant in Barcelona.

Teaching Staff

Ángel C. Aparicio Bengoechea  
BEng. MSc. PE. PhD. More than forty years’ experience as advanced structural consultancy and technology transfer in bridges, having designed over 400 bridges. Full Professor at the Universitat Politècnica de Catalunya. Wide teaching experience in many subjects linked to Bridges. Visiting Professor of several foreign Universities. Granted with several relevant Medals and Awards for his research achievements. Member of the Editorial Boards of a number of high quality scientific journals. He has supervised over 20 Doctoral Theses, most of them related to bridges. Author of about 200 research papers published in scientific journals and presented at national and international scientific conferences. Participation in numerous research projects (national and international) financed by public and private funds, having been a promoter and coordinator of many of them.

Alfredo Arnedo Pena  

Joan R. Casas Rius  
BEng. MSc. PE. PhD. More than thirty years’ experience as advanced structural consultancy and technology transfer in bridges. Full Professor at the Universitat Politècnica de Catalunya. Wide teaching experience in many subjects linked to Bridges. Visiting Professor of 11 foreign Universities. Granted with several relevant Medals and Awards for his research achievements. Member of the Editorial Boards of a number of high quality scientific journals. Supervised 17 Doctoral Theses, most of them related to bridges. Secretary General of IABMAS (International Association for Bridge Maintenance and Safety), Chairman of Working Commission I on Structural Performance, Safety and Analysis of IABSE, and Member of FIB Working Commission 5. Author of about 200 research papers published in scientific journals and presented at national and international scientific conferences. Participation in numerous research projects (national and international) financed by public and private funds, having been a promoter and coordinator of many of them.

Alferto Ledesma Villalba  
BEng. MSc. PE. PhD. Full Professor of Soil Mechanics and Geotechnical Engineering at the UPC. Thirty years of teaching and research experience on that field, including numerical models in Geomechanics, back-analysis, unsaturated soils, landslides and soil dynamics. Supervisor of 12 Doctoral Theses. Participation and coordination in a number of Research Projects funded by the European Commission. Over 150 publications, most of them papers published in international peer reviewed Journals. Geotechnical advisor of several companies and administrations, mainly in Spain but also in other European and American countries, involving large excavations, urban tunnels and embankment dams. Active member of the International Committee controlling the construction of the high speed train tunnel crossing Barcelona next to World’s Heritage buildings.

Fernando Purroy Narvaiza  
BEng. PE. Professor of the Universitat de les Illes Balears. Co-Director of the Master Program “Structural Engineering in Architecture”, being responsible for the “Strengthening and repair of structures” part. Currently involved in a research project of shape memory materials for strengthening of concrete structures. Structural Consultant since 1992. He has participated and participates in numerous structural rehabilitation projects in historic buildings, sports complexes, hospitals and homes. Pioneering activity in strengthening with FRP (“Fiber Reinforced Plastics”).
The UPC School of Professional & Executive Development offers a wide selection of lifelong training courses with over 200 yearly master’s degrees, postgraduate courses and specialization courses with a professional outreach, adapted to the current economic and social, business and professional needs.

UPC’s lifelong training at a postgraduate level has been designed to broaden the competencies of professionals in the fields of architecture, construction and urbanizations, civil and industrial engineering, business management and administration; sustainability and communication and information technologies.

The courses are top quality, supported by research and knowledge transfer at the UPC and by the collaboration with over 300 companies that participate in the training courses. Since 1994, over 80,000 professionals have found a boost to their careers with these programmes.

The programmes offered make it possible to expand technical learning in each of the technological specialities and make available the necessary tools and knowledge to learn new personal skills in the spheres of project management, administration and leadership. Our goal is to help future managers in the fields of engineering, innovation and technology to learn the ideal knowledge and to develop the necessary skills and capacities to take on responsibility for the new competencies required by the professional market.
INSPIRING INNOVATION.
EMPOWERING TALENT.

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