| CONTENTS

1. SCOPE, TOPICS and OBJECTIVES

The Workshop focus on a broad range of topics related to the Energy-Based Seismic Engineering bringing together experts from several institutions. The Workshop organizers invited papers and presentation proposals relevant to conference themes.

Considering the theme of the Workshop, the presentations are focused on trying to answer to any of the following or related subjects:

- How to develop the seismic hazard and to scale ground motion records in terms of energy?
- Are energy-based IMs able to characterize the damage potential of ground motion?
- Do we need to look for energy-based EDPs?
- How to evaluate accurately the energy dissipation capacity of structural members and systems, especially those with degrading properties?
- How can the damage be estimated in terms of energy?
- How to define local and global collapse in terms of energy?
- What is the influence of structural modeling in energy-based damage assessment of structures?
- How can the energy dissipation demand on structural components be estimated from the total energy input?
- How to elaborate a new framework for seismic design based on the concept of energy?
- How to implement innovative seismic technologies for different types of structural systems in order to dissipate energy and to develop design recommendations for various types of seismic energy dissipation devices?

The Workshop aim to develop a shared comprehensive vision for Energy-Based Seismic Engineering, tackling new challenges for the design and improvement of new and existing structures, together with the application of new smart technologies.

2. COMMITTEES

Honorary Committee

Michael Fardis | U. Patras | Greece
Halûk Sucuoğlu | METU | Turkey

Organizing Committee

Humberto Varum (Chair) | FEUP | Portugal
Amadeo Benavent | UPM | Spain
Fabrizio Mollaioli | U. Rome | Italy
André Furtado | FEUP | Portugal
António Arêde | FEUP | Portugal
David Escolano Margarit | U.P. Madrid | Spain
Giulia Angelucci | U. Rome | Italy
Giuseppe Quaranta | U. Rome | Italy
Hugo Rodrigues | UA | Portugal
Jesús Donaire Avila | U. Jaen | Spain
José Melo | FEUP | Portugal
Leandro Morillas Romero | U. Granada | Spain
Miguel Castro | FEUP | Portugal
Nelson Vila Pouca | FEUP | Portugal
Patrício Rocha | FEUP | Portugal
Vitor Silva | UA | Portugal
Xavier Romão | FEUP | Portugal

Scientific Committee

Ahmet Anil Dindar | Gebze Technical University | Turkey
Amador Teran-Gilmore | U Autonoma Metropolitana | Mexico
Anastasios Sextos | U Bristol | UK
André Furtado | FEUP | Portugal
Bruno Briseghella | U Fuzhou | P.R. China
Carmine Galasso | UCL | UK
Dimitrios Vamvatsikos | U National Technical | Greece
Edén Bojórquez | U Autonoma de Sinaloa | Mexico
Giuseppe Marano | Dept. of Structural, Geotechnical and Building Engineering | Italy
Giuseppe Quaranta | U Rome | Italy
Gustavo Ayala | U Nacional Autonoma de Mexico | Mexico
Halûk Sucuoğlu | Middle East Technical University | Turkey
Humberto Varum | FEUP | Portugal
İhsan E. Bal | U Hanze | The Netherlands
José Jara | UMSNH | Mexico
José Melo | FEUP | Portugal
Juan Andrés Oviedo | Escuela de Ingeniería de Antioquia. Medellín | Colombia
Kenji Fujii | Chiba Institute of Technology | Japan
Luis Guerreiro | U Lisboa | Portugal
Michael Fardis | U Patras | Greece
Michalis Fragiadakis | U Athens | Greece
Michele Barbato | U California | USA
Murat Altug Erberik | Middle East Technical University | Turkey
Nicola Tarque | U Peru | Peru
Pathak Shivang | Thornton Tomasetti | UK
Rita Bento | U Lisboa | Portugal
Roberto Gentile | UCL | UK
Sashi K. Kunnath | U California at Davis | USA
Sutat Leelataviwat | U King Mongkut's | Thailand
Tiziana Rossetto | UCL | UK
Tony T.Y. Yang | U British Columbia | Canada
Vitor Silva | U Aveiro | Portugal
Yin Cheng | U Southwest Jiaotong | P.R. China
Ying Zhou | U Tongji | P.R. China

3. KEYNOTE LECTURES

Haluk Sucuoğlu
Middle East Technical University, Ankara, Turkey

Haluk Sucuoğlu is an Emeritus Professor in the Department of Civil Engineering at the Middle East Technical University, Ankara, Turkey. He is also teaching at the earthquake engineering graduate program of the Pavia University (UME, Rose School) in Italy.

Dr. Sucuoğlu's field of research in earthquake engineering include nonlinear response analysis, energy based procedures, seismic retrofitting, seismic isolation, laboratory testing, earthquake resistant design and blast resistant design. He is a Coordinating Member of the Turkish Seismic Code Committee. Dr. Sucuoğlu has also recently prepared the Seismic Design and Qualification Guidelines for Substations in Turkey. Currently, he is serving as the peer reviewer of several large projects in Turkey including airport terminals, tall buildings and seismic isolation design of hospital complexes and residential buildings. He was the coordinator of the EU FP6 Project No. 17067 "Capacity Building in Earthquake Research for Urban Risk Reduction", 2005-2008.

Dr. Sucuoğlu is an honorary member of the Earthquake Engineering Association of Turkey. He is the editorial board member of Earthquake Spectra, Journal of Earthquake Engineering and Soil Dynamics and Earthquake Engineering Journals. He is the author of a textbook on earthquake engineering for undergraduate students (Basic Earthquake Engineering, Springer, 2014). He is the recipient of Turkish Science and Education Foundation 2012 Science Award.

Energy-Based Earthquake Engineering: Current Challenges and Future Directions

Current status of energy-based assessment and design procedures are evaluated with reference to the force-based and displacement-based procedures. The advantages and shortcomings of energy based approaches are discussed.

Input energy was long recognized as a better demand parameter in expressing the effects of ground motions on structures as compared to accelerations (forces) or displacements (deformations) induced by ground motions. Past research have clearly revealed the weak dependence of spectral input energy on viscous damping ratio and inelastic response, which is a clear advantage for expressing the demand of ground motions from structural systems in performing analysis and design. Moreover, the duration of earthquake excitation, hence the magnitude of causative earthquake is well represented by the input energy spectrum which is a function of initial structural period and ground motion intensity only. The black box in energy based approaches however is both the distribution of input energy in structural systems (analysis), and the energy dissipation capacity of structural components.

Structural design is based on satisfying the fundamental inequality; [Capacity < Demand]. This is an intricate process when demand is dominated by strong earthquake actions, under which inelastic response is inevitable. In force-based design, demand is expressed by the acceleration response spectrum. Analysis is performed by the linear elastic response spectrum procedure, and demands from structural components (capacities) are provided to satisfy the force equilibrium. Both response spectrum analysis and force equilibrium in component design have theoretical basis. However inelastic response is accounted for by reducing the acceleration spectrum with heuristic response reduction factors that has no physical basis. In displacement-based design on the other hand, seismic demand and analysis stages are similar to the force-based design where the demands from structural components are expressed in terms of displacements. Inelastic response is accounted for by employing the equal displacement principle which is also heuristic, but has a stronger basis compared to the response reduction factors. Deformation demands from structural components are satisfied through proper detailing in order to provide the required deformation capacities. Hence, the fundamental inequality is worked in terms of deformations.

Both force and displacement-based procedures do not consider earthquake duration which leads to the degradation of strength and stiffness, both of which are the major causes of damage accumulation under seismic actions. Energy-based design have such an advantage as an alternative, but analysis procedures and energy dissipation capacity of structural components are not yet well defined. The main purpose of this presentation is discussing both issues in a broad perspective, and suggesting practically applicable solutions. Further advantages of energy based approaches associated with the energy dissipating devices and loss estimation under mainshock-aftershock sequences are also assessed.

Amadeo Benavent-Climent
Technical University of Madrid, Madrid, Spain

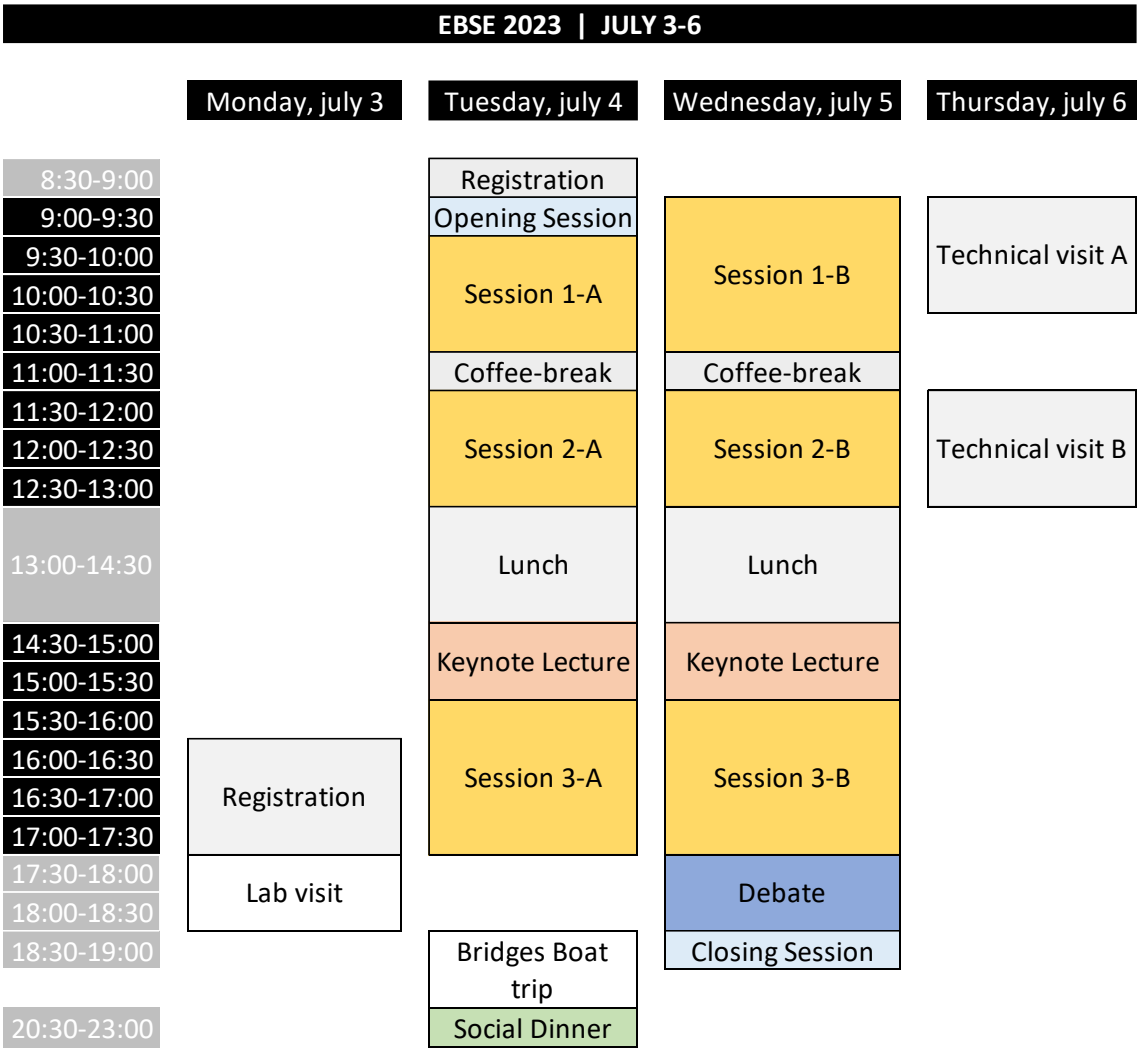
Doctor in Engineering by the University of Tokyo. Currently, Full professor in Earthquake Engineering at the Technical University of Madrid (UPM, Spain) and Deputy Head of the Department of Mechanical Engineering. Coordinator of Master in Earthquake Engineering: Dynamics of Soils and Structures, and Principal Investigator of the Research Group with the same name. Member of the International Advisory Board of several international journals (Bulletin of Earthquake Engineering, Structural Engineering and Mechanics, Earthquakes and Structures). President of Spanish Mirror Subcommittee Eurocodes SC8. Member of Spanish Committee AEN/CTN 140 Eurocodes. Member of European Committee CEN/TC 250/SC 8. Selected by EU as member of Project Team SC8.T1 for next generation Eurocode 8.

Research activity developed in Japan (1992-1998), Technical University of Catalonia (1998-2000), University of Granada (2000-2010) and UPM (2011-2020), in the field of earthquake engineering. Early research in Japan (1992) focused on the seismic behavior of reinforced concrete (RC) beams with web-openings and expanded in 1995 to explore the use of passive control systems in earthquake resistant structures, under the guidance of Professor Akiyama. Central topics in this research involved the design of hysteretic dampers, prediction of ultimate energy dissipation capacity, and developing energy-balance based methods for designing steel and RC structures with passive control devices. His earthquake engineering research has resulted in more than 100 peer-reviewed papers published, most of them in JCR journals, several books and three patents currently licensed, 17 PhD Theses and more than 100 refereed conference papers. Since 2010, he has led 6 research projects funded by the Spanish Government and the Government of Andalucía (1.4 million €), 3 research contracts funded by private companies (0.26 million €) and 2 contracts with public administrations (0.11 million €).

Implementation of the Energy-Balance based approach in the 2nd generation of Eurocode 8 for structures with energy dissipation systems

The second generation of Eurocode 8 implements the energy-balance based analysis for the verification of building structures with displacement-dependent energy dissipation devices. This approach is particularly appropriate for this type of structures since the proper management of the energy input by the ground motion is a key to successful design. In the verification, the designer is concerned not so much with the resistance to lateral forces (force-based approach) or with the lateral displacements (displacement-based approach) but with the product of both, that is, with energy. The structure with energy dissipation systems must be verified for low intensity earthquakes and for severe earthquakes associate with the limit state of significant damage. The method can be also applied for verifying the near-collapse limit state. In call cases, it must be checked that the energy dissipation demand is smaller than the energy dissipation capacity of the structure at each storey. The main formulae used in the analysis is presented, accompanied with some examples of application.

4. GENERAL PROGRAMME



5. DETAILED PROGRAMME

Monday | 3 July	
16:00	Registration
17:30	Structures Laboratory visit

Tuesday | 4 July	
08:30	Registration
09:00	Opening Session Humberto Varum, FEUP, Portugal Amadeo Benavent, UP Madrid, Spain Fabrizio Mollaioli, U. Rome, Italy
	SESSION 1A *(Chairs: Fabio Di Trapani, Kenji Fujii)*
09:30	Proposal of Design Energy Equivalent Velocity Spectrum Using Long-period Ground Motion Records of Magnitude 7 to 7.5 Earthquakes ***Ju-Chan Kim**, Sang-Hoon Oh* Physics-Based Approach to Define Energy-Based Seismic Input: Application to Selected Sites in Central Italy ***Fabio Romanelli**, Franco Vaccari, Cristina Cantagallo, Guido Camata, Giuliano F. Panza* Damage index model for masonry infill walls subjected to out-of-plane loadings ***André Furtado**, Hugo Rodrigues, António Arêde*
11:00	Coffee-Break
	SESSION 2A *(Chairs: Fabrizio Mollaioli, Fabio Romanelli)*
11:30	Reliability-based hysteretic energy spectra using modern intensity measures ***E. Bojórquez**, J. Carvajal, J. Bojórquez, A. Reyes-Salazar* Experimental assessment of the energy that contributes to damage ***David Escolano-Margarit**, Leandro Morillas-Romero, Amadeo Benavent-Climent* Experimental study of RC Frames with window and door openings under cyclic loading *Nisar Ali Khan, Lin Zhou, **Fabio Di Trapani**, Cristoforo Demartino, Giorgio Monti*
13:00	Lunch
14:30	Keynote Lecture 1 *(Chair: Amadeo Benavent)* Energy-based seismic engineering: Current challenges and future initiatives **Halûk Sucuoğlu**, METU, Turkey
	SESSION 3A *(Chairs: Edén Bojórquez, Sutat Leelataviwat)*
15:00	Numerical Evaluation of The Energy Dissipation Capacity of Steel Members Subjected to Biaxial Bending ***E. Cerqueira**, C. Eshaghi, R. Peres, J.M. Castro* Relation Between Input Energy and Equivalent Monotonic Response Curve *C. Leangheng, P. Doung, **S. Leelataviwat*** Engineering demand parameters for cumulative damage estimation in URM and RC buildings ***P. García de Quevedo Iñarritu**, N. Šipčić, P. Bazzurro* Demands and capacities prediction equations of R/C structures based on energy *H. Leyva, **E. Bojórquez**, J. Bojórquez, F. Mollaioli, L. Palemón, M. Barraza* Correlation between seismic energy demand and damage potential under pulse-like ground motions ***G. Angelucci**, G. Quaranta, F. Mollaioli, S. K. Kunnath*
18:00	Bridges boat trip
20:00	Social Dinner

Wednesday | 5 july

	SESSION 1B *(Chairs: Sang-Hoon Oh, Jesús Donaire-Ávila)*
09:00	Constitutive Model Characterization of the RC Columns Using Energy Terms *Bilal Güngör, Serkan Hasanoğlu,* ***Furkan Çalım****, Ziya Muderrisoglu,* ***Ahmet Anıl Dindar****, Ali Bozer, Hasan Özkaynak, Ahmet Güllü* Elastic and Inelastic Input Energy Correlations: Effects of Damping, Pulse Type, and Significant Duration ***Furkan Çalım****, Ahmet Güllü, Ercan Yüksel* Predicting the Distribution of Hysteretic Energy Demand in Frame Members ***Fırat Soner Alıcı****, Haluk Sucuoğlu* New Energy Based Metrics to Evaluate Building Seismic Capacity ***Giulio Augusto Tropea****, Giulia Angelucci, Davide Bernardini, Giuseppe Quaranta, Fabrizio Mollaioli* Cumulative damage of degrading structures due to soft soil seismic sequences ***Jorge Ruiz-García****, José M. Ramos-Cruz*
11:00	Coffee-Break
	SESSION 2B *(Chairs: Gustavo Ayala, Ju-Chan Kim)*
11:30	A displacement-based seismic design procedure with local damage control, dissipated energy and resilience ***J. Abraham Lagunas****, A. Gustavo Ayala, Juan Gutierrez, Cristhian Montiel* Equivalent Number of Cycles Formulation for a Base-Isolated Building ***Kenji Fujii*** Study on spandrel-pier interaction in masonry walls *Kaushal P. Patel,* ***R.N. Dubey***
13:00	Lunch
14:30	Keynote Lecture 2 *(Chair: Fabrizio Mollaioli)* Implementation of the Energy-Balance based approach in the 2nd generation of Eurocode 8 for structures with energy dissipation systems **Amadeo Benavent**, UPM, Spain
	SESSION 3B *(Chairs: F. Soner Alici, J. Abraham Lagunas)*
15:00	Comparison of Energy-Based, Force-Based and Displacement-Based Seismic Design Approaches for RC Frames in the Context of 2G of Eurocode 8 ***Amadeo Benavent Climent****, Jesús Donaire-Ávila, Fabrizio Mollaioli* An energy-based seismic design procedure with damage control for frames with linear and non-linear fluid viscous dampers *Francisco Bañuelos-García,* ***A. Gustavo Ayala****, Marco A. Escamilla* Input-seismic energy by the Fourier amplitude spectrum: reference for evaluation of other methods *Rolando Torres,* ***Gustavo Ayala*** Pore pressure evaluation by seismic loads on the ground using an energy formulation ***Rubén Galindo****, Humberto Varum, Antonio Lara, Hernán Patiño, Daniel Panique*
17:00	Debate and Conclusions *(Chairs: Haluk Sucuoglu, Fabrizio Mollaioli)*
18:00	Closing Session Humberto Varum, Amadeo Benavent, Fabrizio Mollaioli

Thursday | 6 July	
	TECHNICAL VISITS
09:00	Technical Visit A
	FAUP
11:30	Technical Visit B
	Torre/Igreja dos Clérigos + S. Bento
13:00	End

6. ORGANIZATION

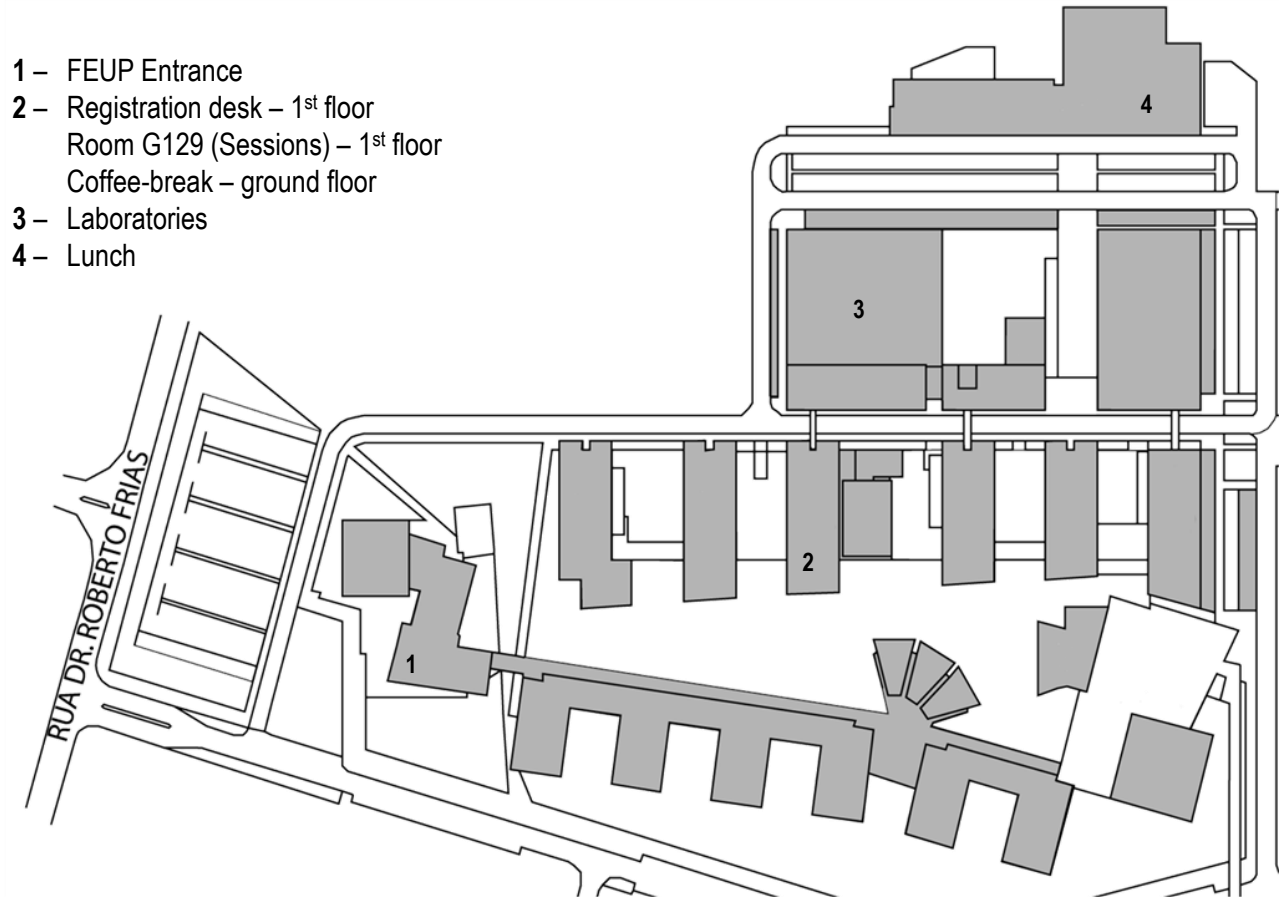
7. INSTITUTIONAL SUPPORT

Universities/Institutes/Laboratories

Media Partners

8. USEFUL INFORMATION

FEUP General Plan



Wifi

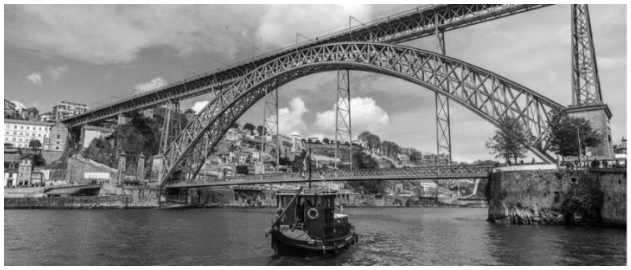
Connect your mobile device to the **UPorto** wifi network. *Open a browser and enter the portal to the following credentials:*

Username: ebse2023

Password: ebse2023@feup

For any issue, contact the secretariat.

9. BRIDGES BOAT TRIP



Douro Azul
Cais da Ribeira (Porto)
https://goo.gl/maps/nGRkbwjfeDYHsVF89

July 4th - 18:30-19:30
Transportation will be provided for participants.

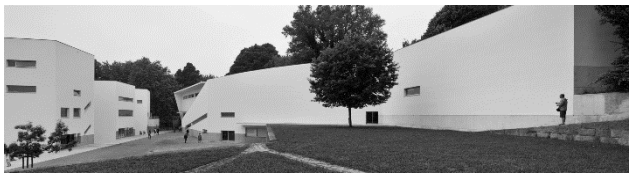
10. SOCIAL DINNER

The Social Dinner will take place on **July 5th** (Wednesday) at **20h30**

Social Dinner
Praia da Luz
R. Cel. Raúl Peres, 4150-155 Porto

11. TECHNICAL VISITS

The Technical Visits will take place on **July 6th** (Thursday)



Technical Visit A (Coordinator: Teresa Ferreira)
Management and Conservation of 20th Century Heritage: Alvaro Siza's World Heritage Nomination

Álvaro Siza's Architecture Works: A contextual approach towards the critical revision of the Modern Movement' are a series of selected properties that illustrate Siza's unique approach to architectural design. The components, located in Portugal, were designed and built over a period of six decades, spanning the second half of the twentieth century. Each has strong individual characteristics, presenting a specific aspect or facet of Siza's architecture, while responding to a set of attributes that express OUV. The nomination process is coordinated by the Faculty of Architecture of the University of Porto, which is one of the buildings selected for the serial nomination.

Technical Visit B (Coordinator: António Arêde)
Porto Downtown Historical Heritage – Structural Monitoring During Underground Excavation Works

The Porto Metro service is presently expanding the existing light rail network. Part of that expansion, namely the new Pink Line, which will connect "Casa da Música" (Music Hall in Boavista zone) to the São Bento train station, is fully made underground and at least half its extension runs underneath important historical heritage-built assets in Porto downtown. Upon request of Porto Metro stakeholder to FEUP, a set of historical masterpieces are being structurally monitored to identify possible issues and effects due to underground excavation works. This includes two iconic Porto buildings, namely the Clérigos Church-Museum-Tower and the São Bento train station, where possible settlements, rotations, vibrations, and crack-openings are being continuously measured by dozens of sensors. The results are online transmitted to FEUP and available through a dedicated digital platform. The technical visit to these two buildings will show the critical zones under observation and the challenges inherent in the installation of monitoring systems in these invaluable cultural heritage icons.

Programme

Participants should individually organize their own transportation to arrive at FAUP by 9 a.m.

09h00 | Technical Visit A (FAUP – Faculdade de Arquitetura da Universidade do Porto)

10h30 | Departure to Porto Downtown Historical Heritage *(transportation provided by the organization)*

11h30 | Technical Visit B (Porto Downtown Historical Heritage – Structural Monitoring During Underground Excavation Works)

13h00 | End of Technical Visits and Goodbye!