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Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe
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TRANSNATIONAL ACCESS TO EUROPEAN HIGH-CLASS LABORATORIES

Within the EU funded Horizon 2020 Research and Innovation programme under grant agreement No.730900 - SERA, Transnational Access (TA) to the largest collection of high-class experimental facilities for earthquake engineering in Europe – and worldwide – is offered to selected talented research groups (**https://sera-ta.eucentre.it/**)
Users are integrated in the scheduling of the infrastructure during the execution programme of each project, from the design and construction of the specimen, to instrumentation, experimental testing and interpretation of the experimental results, receiving from the staff of the infrastructure all the support needed to carry out their project. A support team is allocated to each user on a daily basis, to develop and execute the test programme, including appropriate technicians for test model fabrication, instrumentation, etc. The infrastructure facilities are well prepared for hosting external researchers who, during their stay, are integrated with the permanent staff, from whom they receive technical and scientific assistance. After receiving the necessary training, users are able to fully participate in the test preparation, execution, data acquisition and interpretation.

Services that are provided to the users include among others:
- first-class technical and scientific support and collaboration from the staff of the infrastructure;
- support for analytical and numerical modeling;
- technical assistance in the definition and design of the test model and of the experimental setup, to adapt the testing program to the characteristics of the infrastructure;
- support for the fabrication of the test specimen(s), either in reduced or full scale;
- support in the definition of the instrumentation layout focused on the key objectives of the research;
- assistance in the choice of the input signals;
- support to data-processing, analysis and results interpretation;
- support to logistic, user hosting and meeting organization;
- travel accommodation subsistence.

A user team is eligible for TA support under the grant when the User Group Leader and most users work in EU member countries or EU associated countries, different from where the selected installation is located. Access for user groups with most users not working in a EU or associated country is limited to 20% of the available TA resources.

HIGHLIGHTS

- The 10 most advanced European research infrastructures for earthquake engineering, integrated studies on geotechnical site effects, engineering seismology and array seismology are open to talented research groups.

- Free-of-charge Transnational Access (TA) and support is provided to European researchers to carry out experimental research at the EU's five largest shaking tables, the EU's two largest reaction walls and pseudodynamic (PsD) testing facilities, one centrifuge test facility, one bearing tester facility, two facilities for integrated studies on geotechnical site effects and engineering seismology, and a unique infrastructure in Europe for array seismology.

- 17 TA projects have been selected for funding within the 1st SERA TA call.

- The 2nd call for proposals will be open from January 5th 2018 till March 4th 2018.

Project detail:
Start date: 01/05/2017
End date: 30/04/2020
Duration: 36 months
Reference: 730900 - SERA
Call: H2020-INFRAIA-2016-1

European Commission

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SERA TA FACILITIES

SERA TA FACILITIES

- ELSA Reaction Wall, JRC, Ispra (IT)
- Shake Lab Bearing Tester and Shake Table, EUCENTRE, Pavia (IT)
- AZALEE Shake Table TAMARIS/CEA, Paris (FR)
- LNEC-3D Shake Table LNEC, Lisbon (PT)
- STRULAB Reaction Wall, University of Patras, Patras (GR)
- EQUALS Shake Table, University of Bristol, Bristol (UK)
- DYNLAB Shake Table IZIIS, Skopje (MK)
- Centrifuge University of Cambridge, Cambridge (UK)
- EUROSEISTEST and EUROPROTEAS, Aristotle University, Thessaloniki (GR)
- Array Seismology NORSAR, Kjeller (NO)

- Distribution of projects per TA facility:

Research Infrastructure	Facility	Total TA Projects (estimated)	Projects Assigned in the 1st call	New Projects Availability
JRC	ELSA	2	2	0
EUCENTRE	SHAKE-LAB	3	1	2
CEA	AZALEE	2	2	0
LNEC	LNEC-3D	3	2	1
University of Patras	STRULAB	3	2	1
University of Bristol	EQUALS	7	3	4
IZIIS	DYNLAB	3	1	2
University of Cambridge	Centrifuge	5	2	3
Aristotle University of Thessaloniki	Euroseistest & Europroteas	10	1	9
NORSAR	Array seismology	8	1	7
Research Infrastructure		**47**	**17**	**30**

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European Commission

ELSA Reaction Wall at JRC

The European Laboratory for Structural Assessment (ELSA) was opened in 1992. It operates a reaction wall facility of unique dimensions and testing capabilities in Europe and worldwide. The ELSA team comprises 35 scientific and technical staff. It has developed and implemented the pseudo- dynamic (PsD) testing method and performed numerous large-scale reference tests. ELSA has become a world renowned reference for experimental research, fostering collaboration across EU laboratories, research centres and industry. ELSA operates a 16 m-tall, 21 m-long reaction wall, with two reaction platforms of total surface 760 m2 that allow testing real-scale specimens on both sides of the wall. The laboratory is equipped with 28 actuators with capacities between 0.2 and 3 MN and strokes between ±0.125 and 1.0 m. The actuators control system is designed in-house to perform tests with the continuous PsD method with substructuring, that permits testing elements of large structures, bidirectional testing of multi-storey buildings, and testing of strain-rate dependent devices.

ELSA has been supporting research related to the structural/seismic safety of structures, including: reference tests on reinforced concrete (RC) buildings with and without infill wall panels; reference and pioneering tests on fullscale bridges, including irregular configurations, isolation and asynchronous input motion using the PsD method with non-linear substructuring; tests on models of parts of monuments for the development of assessment methods and protection techniques; reference tests on concrete-steel composite structures; experimental tests on fibre-reinforced concrete composite structures; reference tests on models representative of existing vulnerable structures for the development of conventional or novel techniques and the calibration of European codes for assessment, strengthening and repair; development of the continuous PsD method, allowing more efficient seismic testing of large-scale specimens; development of base isolation and energy dissipation systems; experiments on active and semi-active control of windor traffic-induced vibrations. Further to the current areas of research, new ones that will be opened to users comprise: performance of elements of buildings using glass as structural material, performance of structures against multiple natural and man-made hazards, multi-functional materials/elements for energy-efficient new and existing (nearly zeroenergy) buildings, pre-normative research in support of the next generation of the Eurocodes, applications of automated construction, innovative sensors for smart infrastructures and cities.

Services currently offered by the infrastructure: The services offered by ELSA are of vital importance for European research in structural and earthquake engineering, enabling scientists to carry out high-quality research through: experimental facilities that are unique in Europe for testing full-scale large structures under seismic or other loads; the competence in computational mechanics to support the design, simulation and interpretation of experiments; the critical mass of its research team, that allows the set-up of co-ordinated research projects; the established collaboration with the main research institutions outside Europe (China, Japan, Korea, Taiwan, USA, etc.) in earthquake engineering; a database containing the experimental data generated by the infrastructure and already used for calibration/adoption of European standards and mitigation of seismic risk for existing ordinary and heritage structures. Users will benefit from the knowledge generated by ELSA, as represented by the most relevant scientific achievements comprising large-scale seismic tests on bridges with asynchronous input motion, buildings under bidirectional seismic action, base-isolated structures, buildings with passive protection devices and components of the ITER Joint Undertaking infrastructure.

The experimental tests that are conducted at ELSA are of such scale and complexity, that no other infrastructure in Europe can match. The uniqueness of the services that ELSA offers makes it a first candidate for European users to apply for access. Since its opening, ELSA developed a tradition of collaboration with research and industrial partners from all over Europe. Users from new Member States have had increased access to ELSA during FP7. Around 100 international users benefit every year from the ELSA infrastructure. This proposal is expected to increase the number of users from other countries. This conclusion is drawn from the experience from the last FP project that offered transnational access to seismic testing facilities, namely the FP7 SERIES project, where ELSA provided a total of 36 access days to 30 users from 16 institutions of 9 European countries.

> Website
https://ec.europa.eu/jrc/en/research-facility/elsa

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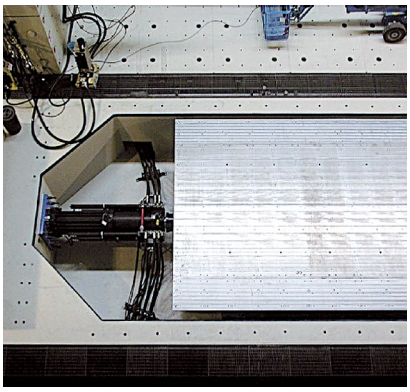
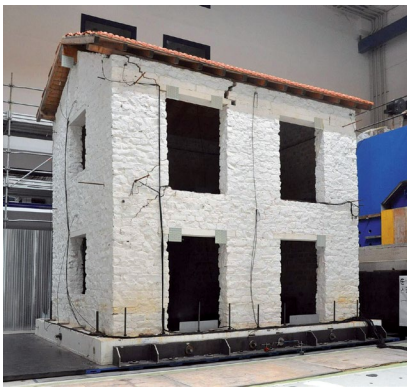
Shaking Table at EUCENTRE





The EUCENTRE Foundation, European Centre for Training and Research in Earthquake Engineering, based in Pavia (Italy), is a non-profit organisation that promotes, supports and sustains training and research in the field of seismic risk mitigation.
Part of EUCENTRE is its experimental laboratory TREES Lab. This experimental facility has been specifically designed according to the most innovative technologies and thanks to its high performance equipment allows conducting both dynamic and static experimental research on full-scale prototypes.
TREES Lab features four main experimental facilities, two of which are open for SERA Transnational Access: the high performance uniaxial Shaking Table and the bi-axial Bearing Tester System, designed for testing of full-scale bearings and isolation devices.
The Shake Table allows the experimental simulation of any real event that has been measured to date with a considerable payload, in order to test large dimension prototypes in realistic conditions (with a payload of 100 tons, accelerations beyond 1.0 g can be still achieved). The structure of the table is a honeycomb like steel network to ensure high stiffness and a reduced mass, compatible with the forces developed during the structural tests. Six guides, supported with hydrostatic bearings, ensure minimum friction. A MTS closed-loop control system based on acceleration, velocity and displacement drives the shake table movement. The table is 5.6 m x 7.0 m, can displace 1.0m with peak velocity 2.2m/s and peak acceleration 6.0 g. The dynamic peak force 1720 kN allows accelerating payloads of 60 tons to 1.8 g. The maximum payload is 140 tons, allowing for the hosting of large-scale specimens.
Any of the testing installation can be integrated with a multi-purpose acquisition system to record experimental data (250-channel system, 18 bit A/D converter). Additionally, a contactless system for displacement monitoring is available for shake table testing. A new machine vision system recently replaced the one in developed in 2008, allowing for 3D monitoring of displacements.
Services currently offered by the infrastructure: The core activities of EUCENTRE are: applied research in the field of earthquake engineering, with a view to improve existing practice in assessment and reduction of seismic vulnerability and risk; support work towards the development of guidance documents for both practitioners and governing bodies; scientific and technological consultancy, at both national and international levels; training for practitioners and technicians.

> Website
http://www.eucentre.it/trees-lab-experimental-methods/?lang=en

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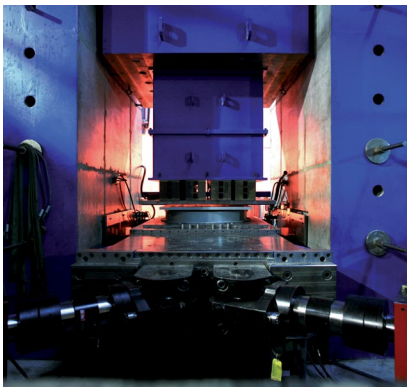
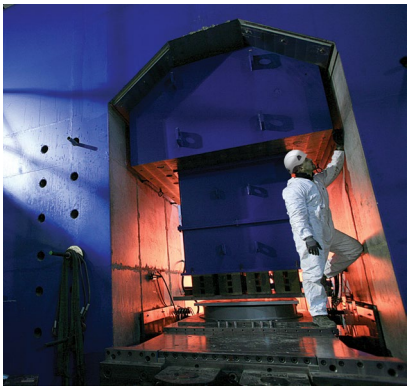
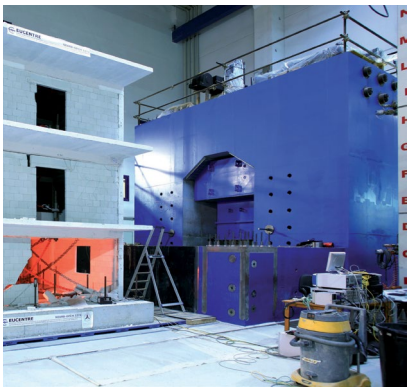
Bearing Tester System at EUCENTRE







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TREES Lab features four main experimental facilities, two of which are open for SERA Transnational Access: the high performance uniaxial Shaking Table and the bi-axial Bearing Tester System, designed for testing of full-scale bearings and isolation devices.
The Bearing Tester Machine is used to carry out static and dynamic experimental tests on isolation and dissipation devices. The base table (1.7 m x 4.3 m) allows vertical, longitudinal, roll, pitch and yaw degrees of freedom, under a static vertical load up to 40000 kN and an additional dynamic vertical load up to 10000 kN. The BTS Controller is a real-time digital controller that provides PID closed-loop control with a delta-P feedback signal. An additional component of the BTS, installed for particular tests, allows increasing the controlled degrees of freedom to 6 and performing tests with 3D movements.
Any of the testing installation can be integrated with a multi-purpose acquisition system to record experimental data (250-channel system, 18 bit A/D converter). Additionally, a contactless system for displacement monitoring is available for shake table testing. A new machine vision system recently replaced the one in developed in 2008, allowing for 3D monitoring of displacements.
Services currently offered by the infrastructure: The core activities of EUCENTRE are: applied research in the field of earthquake engineering, with a view to improve existing practice in assessment and reduction of seismic vulnerability and risk; support work towards the development of guidance documents for both practitioners and governing bodies; scientific and technological consultancy, at both national and international levels; training for practitioners and technicians.

> Website
http://www.eucentre.it/trees-lab-experimental-methods/bi-axial-bearing-tester-system/?lang=en

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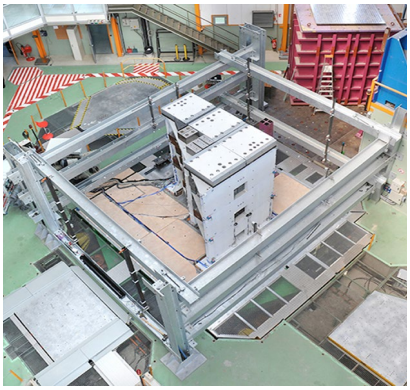
AZALEE Shaking Table at TAMARIS/CEA



The TAMARIS infrastructure and its main shaking table AZALEE, to which access is offered, belong to CEA's Seismic Mechanics Study Laboratory (EMSI), who is leading the French SEISM Institute, is part of the Paris Saclay University regrouping about 19 academic partners and research institutes, and has international RTD collaborations with other facilities (EU, Japan, China, USA). The AZALEE shaking table, with 100t allowable model mass, is one of the largest shaking tables in Europe. To date, tests with masses up to 92t have been successfully performed. The shaking table is 6mx6m and 6 Degrees-of-Freedom (DoF), allowing testing specimens under independent excitations of various types: sinusoidal, random, shock and time-history with 0 to 100 Hz frequency ranges. Maximum accelerations of 1g and 2g in the horizontal and vertical directions, respectively, can be applied to specimens with the maximum payload of the table. The peak velocity of the shaking table is 1m/s, peak displacements are 0.125 m and 0.1 m in the horizontal and vertical directions, respectively.

Services currently offered by the infrastructure: The services offered to users that make the infrastructure unique include a team of about 20 expert scientists and technicians working in earthquake engineering RTD projects, a high quality control and acquisition system allowing recording 256 channels, and a scientific computing and processing system (CAST3M) for the definition and execution of tests and subsequent interpretation of results.

The areas of research supported by the infrastructure cover a variety of experimental and analytical RTD national and international projects, both in the nuclear and non-nuclear fields, for equipment, buildings and soil-structure interaction; both new and existing structures are addressed. Assessment and retrofitting of existing buildings and equipment are of special interest for the laboratory.

In the framework of the recent FP7 SERIES project, TAMARIS hosted 3 TA Projects with more than 30 users in total: ENISTAT (Experimental and numerical investigation of torsionally irregular RC shear wall buildings with thermal breakers), BANDIT (Seismic strengthening of deficient RC buildings using ductile post-tensioned metal strips (PTMS)), and BRACED (Assessment of the seismic response of concentrically-braced steel frames). From 2008 to 2014, the TAMARIS infrastructure has also hosted a series of shaking table campaigns and two international numerical benchmarks, on a 3-story ¼-scale RC model representative of a nuclear building and characterized by strong asymmetry.

This was part of the research program SMART ("Seismic design and best- estimate Methods Assessment for Reinforced concrete buildings subjected to Torsion and nonlinear effect") launched by CEA, EDF and the International Atomic Energy Agency (IAEA). Finally, the TAMARIS facility is involved in the European INDUSE2-SAFETY project launched in 2014, aiming at evaluating component fragility and assessing seismic safety of "special risk" petrochemical plants under design basis and beyond design basis accidents".

> Website
http://www-tamaris.cea.fr/

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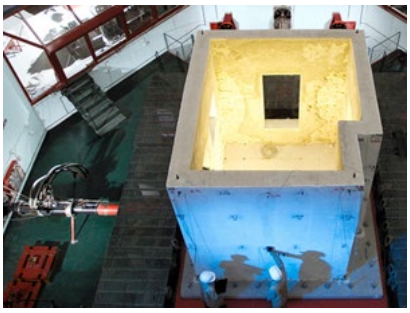
LNEC
LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

LNEC-3D Shaking Table



The infrastructure has a 5.6mx4.6m 3D shaking table (LNEC-3D), to which access is offered, located in a large testing hall with 10m height and an overhead crane with 400kN capacity, resulting in a versatile test facility that can be used for a variety of earthquake and dynamic load tests.
The LNEC-3D shaking table (ST) has three independent translational degrees of freedom, with the rotational ones being passively restrained via a stiff torque tube system. The actuators allow for dynamic forces of 1000kN in the vertical and 700kN in the horizontal directions to be applied to the system, with peak velocities up to 0.7m/s and peak displacements of 0.2m in all directions.
The control of the ST is fully digital, allowing input displacements of any form in a frequency range of 0-40Hz.
The digital control hardware and software was upgraded in 2011 into a more advanced and open platform, whereby the introduction of new control strategies or the implementation of new test strategies (e.g., hybrid simulations) is facilitated. The acquisition system allows a large number of physical variables (such as pressures, forces, accelerations, displacements, strains, etc.) to be monitored, using the extensive instrumentation available or specially developed instrumentation. The possibility of performing digital image processing for motion tracking using a set of synchronized fast megapixel cameras is under development.
The LNEC-3D ST was designed specifically for testing structures and components up to collapse or near-collapse conditions. It has a large capacity in terms of payload (max. weight of 40 tonnes), allowing tests on medium-sized structures or larger structures at reduced scale. A special feature of this installation is that the ST is surrounded by three stiff reaction walls, which can be used for different test setups. As an example, substructuring tests may be performed by introducing additional actuators between the reaction walls and the model on the ST, in order to simulate the dynamic reaction of a numerical substructure on the physical model.
Services currently offered by the infrastructure: This facility has participated in a large number of European and National R&D&I projects, namely offering transnational access since EU R&D&I FP2. Tests performed therein include: development and qualification of construction systems in reinforced concrete, steel, masonry or wood; seismic response control systems; geotechnical tests using a laminar box; retrofitting schemes; sustainable construction materials.
Experimental tests are often complemented with the development and calibration of numerical models and with the experimental assessment of the structural vulnerability. There is also a long tradition of developing experimental methods and instrumentation devices, used for structural health monitoring or for substructuring tests. As a measure of the widespread interest in using this facility, there will be five international users performing ST tests at the facility in 2016.
The services provided to users of the infrastructure are: a) Assistance in the definition and design of the test model and experimental setup; b) Fabrication of test models, including automatic controlled sand pouring for geotechnical models; c) Preliminary destructive or non-destructive tests for identification of material properties; d) Assistance in the design, calibration and implementation of instrumentation, providing state-of the-art sensors, materials and components and the necessary workmanship; e) Data acquisition systems; f) Assistance in the definition of input signals; g) Use of analytical tools to support the design of the specimen and the test campaign; h) Photographic and video records of the test campaign; i) Data processing, analysis and interpretation of test results, namely using techniques for modal assessment and system identification; j) A computer network with access to advanced computer codes for static and dynamic analysis of structures; k) A data repository web portal, where all test results will be made available to the general public; and l) Training in topics specific to users' interest and to the project to which experimental access is offered.

> Website
http://www.lnec.pt/estruturas/en/core/earthquake-engineering-and-structural-dynamics-unit/presentation-1/

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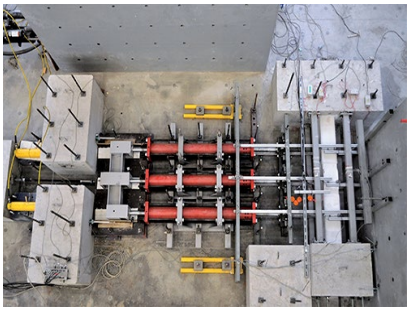
STRULAB
structures laboratory
Civil Engineering dept University of Patras



STRULAB Reaction Wall at University of Patras

The Structures Laboratory (STRULAB, 1991) is a facility of Civil Engineering Dept. of University of Patras. The Department academic personnel have an intense RTD activity in earthquake engineering since the 1980s. With the Univ. of Pavia, Grenoble and METU the Division awards MSc in Earthquake Engineering and Engineering Seismology to international and EU students through Erasmus Mundus MEEES project (www.meees.org). The Department is highly reputable in the area of Structures & Earthquake Engineering and is included in the top 150 departments worldwide (2014 QS World University Ranking list STRULAB research activity includes over 40 EC (e.g. as partner PREC8, ICONS, SAFERR, CASCADE, NODISASTR, LESSLOSS, SYNERG, EXCHANGE-SSI and coordinating institute SPEAR, ACES, SERIES) or national RTD projects in the last 35 years. Its research outcome has been widely recognized (e.g. the current method adopted in EC 8, Part 1-3 for the assessment and rehabilitation of existing structures has been developed at STRULAB by Prof. Fardis). Research activity at STRULAB covers the seismic response of reinforced concrete structures, the design of new and the assessment of existing RC structures, the effectiveness of traditional/innovative systems for repair/retrofitting of substandard buildings and the behavior of bridges. New experimental techniques have been employed and further developed – it is one of the few facilities having performed distributed (intercontinental) hybrid simulation tests. Its research thrust had direct contribution to the prenormative research for European norms (Eurocode 8) through the lab Director, Prof. M. Fardis (ex-chairman of CEN/TC250/SC8 and currently vice-chairman of CEN/TC250).

STRULAB has an 18mx16m strong floor and two, 5.5m-tall strong walls (6m, 4m) in orthogonal configuration for biaxial testing. Its main equipment comprises 8 actuators (capacities 360kN to 1MN and strokes ±0.25m to 1.0m) and 9 pistons (300–1000kN capacities). Three of the actuators may be used for dynamic testing of components, with one of them (1500lpm servovalve) being employed for testing isolation devices. Continuous flow of 490 lt/min of oil is supplied by pumps, complemented by several standalone accumulators of different capacities. Two, 4-channel controller banks with networking capabilities are used for test execution, operated in tandem or independently. Its 128-ch data acquisition system is linked to a web database for on-line observation or off-line test rehearsal. The lab has implemented and operates for the last 5 years the central portal (www.dap.series.upatras.gr) of a distributed database (developed in SERIES project, www.series.upatras.gr) providing access and sharing of data available at the databases of participating labs.

Services currently offered by the infrastructure: STRULAB is among the few European laboratories employing the pseudodynamic testing method with sub- structuring (hybrid simulation) and between even fewer ones having performed a geographically distributed hybrid simulation comprising international participation. Advanced numerical simulation tools and models for the nonlinear response of structures under seismic excitation developed at STRULAB (www.ansruop.net) are also available. STRULAB operates a distributed database (SERIES project), allowing free query/access of data residing in local repositories of many European laboratories. The Data Access Portal (www.dap.series.upatras.gr) provides wide visibility to experimental data made available by several laboratories. The telepresence capabilities at STRULAB facilitate virtual presence of users during testing.

STRULAB infrastructure is particularly suited to seismic testing of small to medium–sized structures. Users will be supported by a primary group of two senior academics specializing in analytical/experimental research in earthquake engineering, and of two, highly experienced, postdoctoral researchers.

> Website
http://www.strulab.civil.upatras.gr/

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University of BRISTOL

EQUALS Shaking Table at University of Bristol

The Earthquake and Large Structures Laboratory (EQUALS) is part of the £20m Bristol Laboratories for Advanced Dynamics Engineering (BLADE) in the Faculty of Engineering at the University of Bristol, UK. It houses a 15t capacity, 6 degree of freedom earthquake shaking table surrounded by a strong floor and adjacent strong walls up to 15m high (Figure 1). The shaking table is accompanied by a set of 40 servohydraulic actuators that can be configured to operate in conjunction with the shaking table, strong floor and reaction walls, providing a highly adaptable dynamic test facility that can be used for a variety of earthquake and dynamic load tests. A special feature of EQUALS is the digital control system. This has world leading features, including a 'hybrid test' capability in which part of the structural system of interest can be emulated by a numerical model embedded in the digital control system while only a sub-component need be tested physically. The EQUALS shaking table is one of the few earthquake shaking tables in the world with this capability. The associated control software was developed in-house.

The EQUALS laboratory is a node of the UK Network for Earthquake Engineering Simulation (UK-NEES), which forms part of the worldwide NEES. NEES enables participation of remote users in experiments via high performance video conferencing and, where appropriate, direct interactivity and control of test and data acquisition equipment, enabling senior researchers to interact remotely with their junior staff at the lab. Data and video can also be streamed in real-time to remote users for use in off-line analyses. EQUALS is also newly connected to Bristol Is Open (BIO), the University's new living laboratory research infrastructure comprising a dedicated high performance programmable fibre optic and wireless network around the city centre, overlain by an innovative City Operating System (CityOS). BIO enables the shaking table to be coupled to full scale experiments that are embedded in the city.

The shaking table consists of a stiff 3 m x 3 m cast aluminium platform weighing 3.8 tonnes and is capable of carrying a specimen payload of 15t. The platform can accelerate horizontally up to 3.7g with no payload and 1.6g with a 10t payload. Corresponding vertical accelerations are 5.6g and 1.2g respectively. Peak velocities are 1.0 m/s in all translational axes, with peak-to-peak displacements of 300 mm. A large database of recorded earthquake records can be applied, or synthetic motions can be readily created. Extensive instrumentation is available, including up to 256 data acquisition channels.

Services currently offered by the infrastructure: The EQUALS facility is supported by a primary group of ten senior academics, led by Prof Colin Taylor, with very broad experience across earthquake engineering and civil engineering dynamics. They form part of a larger, multi-disciplinary group of academics specialising in advanced dynamics and materials from across the Civil, Aerospace, Mechanical Engineering, and Non-linear Dynamics fields. EQUALS users of can draw on the support of a wider academic group. The primary academic group has supported around 150 external users over the past 15 years through TNA programmes.

EQUALS is also supported by five, highly experienced, postdoctoral research assistants, who will provide day- to-day support for the users, including design of the experimental programmes. Four experienced technicians provide specimen fabrication and manufacturing as well as shaking table operation support. The Faculty has an extensive manufacturing workshop equipped with numerically controlled machines etc.

Over the past 20 years, the EQUALS shaking table based research has included the response of cable stayed bridges, soil-structure interaction, the use of discrete damping elements in building structures, base isolation systems, torsional response of buildings, masonry structures, steel and concrete buildings, multiple support excitation, travelling earthquake wave effects, non-linear self-aligning structures, dams, reservoir intake towers, retaining walls, and advanced composite strengthening systems. The facility is equipped with two lamellar, flexible, shear boxes for geomechanics testing. One of these is 6 m long, 1.5 m deep and 1 m wide; the other is 1.5 m long, 1.0 m deep and 1 m wide. EQUALS is particularly suited to testing of small to medium sized specimens in order to investigate fundamental dynamic and seismic phenomenon. EQUALS has particular expertise in seismic testing of geotechnical problems.

> Website
http://www.bristol.ac.uk/engineering/research/earthquakegeo/

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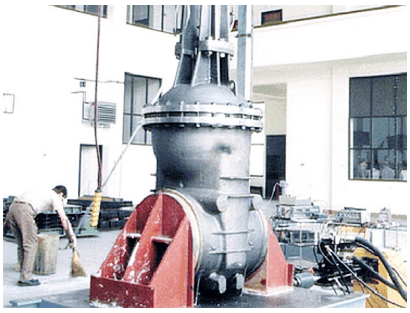
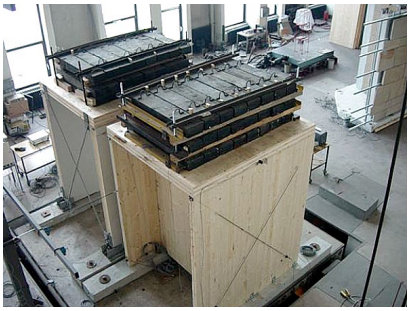
DYNLAB Shaking Table at IZIIS





The IZIIS' Dynamic Testing Laboratory (DYNLAB) is part of the Institute of Earthquake Engineering and Engineering Seismology (IZIIS). IZIIS is one of the oldest institutes in the world of this type since it was established in 1965. In addition to the master studies, Ph.D. studies have also been carried out at the Institute. The Institute has a long tradition in organizing short- and long-term courses. Through the long-term courses, the Institute has trained over 520 candidates from 74 countries worldwide in the field of earthquake engineering and seismology.

Considering basic research, the Institute took part in many national, bilateral, European projects (FP Framework Programme) as well as projects financed by NATO through the SfP Programme. The Institute has a long tradition in experimental in situ forced and ambient vibration testing and experimental laboratory quasi-static and shaking table testing. The first shaking table tests were carried out at IZIIS in the seventies of the last century. The shaking table that is offered to the users in this project represents a five–degrees-of-freedom MTS shaking table. It is presently one of the most advanced shaking tables since it possesses a new state-of-the-art digital control system produced by MTS as the most renowned producer of these simulators. The main characteristics of this sophisticated shaking table are: Size of table: 5.0 x 5.0 m; Weight of table: 30 t; payload: 40 t;5 DOF, two lateral and four vertical actuators; Type of excitation: random, harmonic or computer generated; Frequency range: 0.1-80Hz; Maximum stroke: horizontal ±125 mm and vertical ±50 mm; Maximum acceleration (bare table) horizontal 3.0 g and vertical 1.5g Maximum velocity, horizontal 1.0 m/s, vertical 0.5 m/s.

For the purpose of exact definition of behaviour of specimens, new equipment for data acquisition and measuring as well as sensors are available at DYNLAB. The institute possesses a large number of professional (ARTEMIS, etc.) and tailor made software (using LAB VIEW and MATLAB tools) for data acquisition, signal pre- and post- processing.

Services currently offered by the infrastructure: IZIIS, led by its Director – Prof. Dr. Mihail Garevski, has experienced academic teams that work in different departments and are specialized in buildings, engineering structures, geotechnical and seismological investigations. These teams have directly or indirectly participated in testing of segments and models of buildings, bridges, dams and alike as well as prototypes of industrial equipment on the seismic shaking table.

A great number of unique tests have been carried out on the seismic shaking table in cooperation with other institutions and companies from different parts of the world.

Noteworthy is the contribution of IZIIS and participants from other countries to the reduction of the seismic vulnerability of cultural historic monuments. The project involving testing of a Byzantine church on the shaking table (realized jointly with the Paul Getty Institute from LA) as well as the testing of a cathedral model (FP6 project) and a mosque model (FP6 project) have contributed to the improvement of the strengthening techniques for cultural historic monuments.

The German company GERB has been testing its innovations for reduction of vibrations of structures on the IZIIS' seismic shaking table for 25 years. The Austrian producer of bricks Wienerberger has also been testing the behavior of models constructed of their bricks under the effect of earthquakes. Also, the seismic shaking table has been used for analysis of timber structures (projects carried out for Austrian and Slovenian producers of timber structures) under the effect of earthquakes. A scaled segment of the Beauharnois power house of HydroQuebec has been tested on the shaking simulator, as well. Siemens and other producers of electrical equipment have performed seismic qualification tests on their products on the IZIIS' seismic shaking table.

> Website
http://www.iziis.edu.mk/

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https://sera-ta.eucentre.it/

Centrifuge at University of Cambridge

The Schofield Centre is part of the Department of Engineering at University of Cambridge. It is housed at a separate site in the western part of Cambridge about 3 miles from the main department and is part of the Centre for Construction Process modelling. The Schofield Centre is a world-leading research centre for centrifuge modelling with 4 academics, 5 dedicated technical staff and offers training to about 30 PhD students and international visitors on various projects at any given time.

The Schofield centre houses the 10 m diameter Turner beam centrifuge. This machine is 150 g-ton machine and can carry payloads of up to 1 tonne. It is routinely used to test soil-structure systems like buildings with pile foundations, retaining walls etc. at the correct prototype stresses and strains. To model earthquake loading specialist actuators are mounted on the centrifuge swings that deliver strong earthquake input motions to the model soil-structure systems.

At present there are two earthquake actuators, one a purely mechanical earthquake actuator called the Stored Angular Momentum (SAM) actuator and a second, more recently added Servo-Hydraulic earthquake actuator. SAM actuator can apply powerful, sinusoidal shaking motions at g levels of up to 100g. The peak dynamic force that this actuator can produce is about 100 kN. Servo-hydraulic earthquake actuator can apply realistic earthquake motions like Kobe motion or Northridge motion to the models being tested and can operate at g levels of up to 80g. This actuator can also create a dynamic force of 100 kN and can operate in the frequency range of 10~200 Hz (noting frequency scales with the g level at which the model is being tested).

The data acquisition is carried out using on-board computers that were developed to function in the high gravity environment. It is possible to log up to 60 channels of data in any given test at a sample frequency of 10 kHz. Miniature instrumentation is used in each test such as MEMS accelerometers, miniature PPT's to measure pore pressure and LVDT's/Laser non-contact displacement measurement devices. Further, high speed cameras with 2 MPixel resolution and a frame rate of 1000 frames per second are also available to obtain high resolution images to carry out Particle Image Velocimetry.

Access will also be given to the model preparation of the soil samples using the computer controlled automatic sand pouring system and the CAM-SAT system that will allow soil samples to be saturated with high viscosity pore fluids under computer controlled mass flux.

Services currently offered by the infrastructure: The core activities of the Schofield Centre are: fundamental and applied research into geotechnical engineering problems including those in the field of geotechnical earthquake engineering, with a view to develop a deep understanding of the seismic behaviour of soil-structure systems, to improve existing practices in design as well as in risk estimation, evaluation of risk mitigation methods; scientific and technological consultancy, at both national and international levels; training for academicians, practitioners and technicians.

> Website
http://www.eng.cam.ac.uk/research/academic-divisions/civil-engineering/research-groups/geotechnical-and-environmental-group

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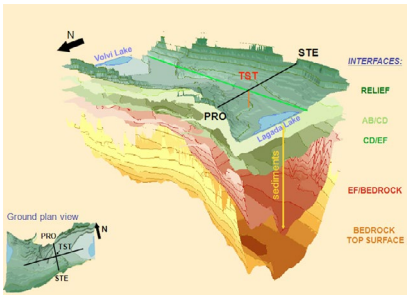
EUROSEISTEST DATABASE

EUROSEISTEST and EUROPROTEAS



EUROSEISTEST combined with the EUROPROTEAS and its data providing web portal (http://euroseisdb.civil.auth.gr) is among the most powerful and advanced large-scale infrastructures in Europe and worldwide, supporting advanced research in earthquake engineering, geotechnical earthquake engineering, soil dynamics and seismology. It consists of a 3D array of 21 accelerographs and a large-scale model structure (EUROPROTEAS) dedicated to study soil-structure interaction and wave propagation for free and forced oscillation.

EUROSEISTEST is the longest running (since 1993) test site of its kind at global scale and operates in the best known valley in the world, both from geometrical and geological-geotechnical point of view. It is an excellent site for testing and validating numerical models and to generate new knowledge in ground motion and wave propagation; it has already generated more than 85 scientific publications in peer review journals and conferences.

Services currently offered by the infrastructure: Data and metadata properly archived are being disseminated to the scientific community through a web portal. Researchers of AUTH provide technical and scientific support to the existing data and/or the design and implementation of new experiments. They also help international researchers in the analysis and interpretation of the data gathered by the use of the infrastructure, whenever requested. Above all, AUTH researchers work constantly on the abrupt operation of the infrastructure and the improvement of the quality of its data.

Several hundreds of down-hole and cross-hole investigations, passive array microtremor measurements and more than 20km of P- and S-wave refraction and surface-wave inversion surveys have been conducted in EUROSEISTEST combined with an extensive laboratory program to estimate the dynamic soil properties of all soil categories and to develop a detailed and highly accurate 3D geophysical / geotechnical / geodynamic model of the whole valley.

EUROSEISTEST comprises an ideal site to perform interdisciplinary research for site characterization in complex geological and geotechnical environment, to apply new monitoring techniques, to use and check new techniques and tools for 3D site and geodynamic imaging and to perform advanced studies in soil dynamics, site characterization and engineering seismology.

The rich record of previous and on-going research projects the 60 subscribers of the EUROSEISTEST mailing list and the analytics of the traffic in EUROSEISTEST's web portal demonstrate the widespread interest from worldwide users.

During the last three-month period, there have been 1398 sessions in the web portal by 719 users, 7.15% coming from Greece, 80.4% from other countries and 12.45% of unidentified origin.

> Website
http://euroseisdb.civil.auth.gr/

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Array Seismology at NORSAR

NORSAR is the premier operator of seismological arrays in Europe and a worldleader in array seismology. The infrastructure at NORSAR consists primarily of a data centre and field installations on Norwegian territory and the European Arctic, comprising four different seismic arrays (with apertures ranging from 1 to 60 km equipped with 1C or 3C short-period or broadband sensors) and three single 3C broadband stations. NORSAR is an active partner in the Norwegian National Seismic Network, operates a other international institutions operating seismic arrays and stations in Northern Europe and the European Arctic. NORSAR provides access to its unique digital database of seismic recordings from all its installations reaching back to April 1971. NORSAR has a group of scientists and engineers, which captures 40 years of experience and produces world renowned research in array seismology and automatic analysis of seismic data streams. By offering access to its infrastructure, NORSAR will contribute its knowledge on 1) array seismology, 2) automatic on-line data processing, 3) near real-time seismic monitoring in various scales from regional seismicity, aftershock sequences and mining-induced seismicity to microearthquakes associated with ground instabilities or hydrothermal activities, and 4) seismic hazard and risk assessment as well as earthquake engineering. Thereby, NORSAR will disseminate further developments in these research topics and promote their application in Europe and the rest of the world.

Services currently offered by the infrastructure: The infrastructure's offer implies a full integration in the scientific environment, which consists of three departments: a department on 'Seismology and Test Ban Monitoring' including the National Data Centre (NDC), with responsibility for the operation of the stations, quality control, as well as realtime and offline data analysis, a department on 'Microseismic Monitoring' and a department on 'Earthquake Hazard and Risk'. A visitor under the TA program may be involved with one or more of these groups. During recent years, NORSAR had between 10 and 20 research visitors per year with visit durations between couples of days up to about one month. Longer work stays, in particular, were often the nucleus for joint publications in peer-reviewed journals, the base for PhD or Master theses or visitors used the knowledge achieved to build, plan or refurbish their own seismic arrays.

> Website
https://www.norsar.no/

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SERA is the "Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe", responding to the priorities identified in the call INFRAIA-01-2016 - 2017 Research Infrastructure for Earthquake Hazard.

Project detail
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Duration: 36 months
Reference: 730900 - SERA
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