Eucentre TREES Lab:

Laboratory for Training and Research in Earthquake Engineering and Seismology

Facility and Research

Dr. Simone Peloso

PAVIA RISK CENTRE

Foundation Eucentre

EUCENTRE TREES Lab
European Centre for Training and Research in Earthquake Engineering

Eucentre is a non profit Foundation launched by the Dipartimento della Protezione Civile, the Istituto Nazionale di Geofisica e Vulcanologia, the Università degli Studi di Pavia and the Istituto Universitario di Studi Superiori di Pavia, with the aim of promoting, sustaining and overseeing training and research in the field of the reduction of seismic risk, through the following actions:

- Development of applied research in the field of seismic engineering, oriented towards reaching concrete goals of evaluation and reduction of vulnerability and risk;
- Development of activities useful for the definition of specific lines of public action, guidelines and regulator documents;
- Training personnel with strong scientific and professional capabilities in the field of seismic engineering, in particular, in the field of seismology, geology, geotechnics, behaviour of materials and structures, design of new structures, evaluation and retrofit of existing structures, even in emergency situations;
- Carrying out scientific and technical consultancy at a national and international level, in the field of seismic engineering.

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Overview of TREESLab activities

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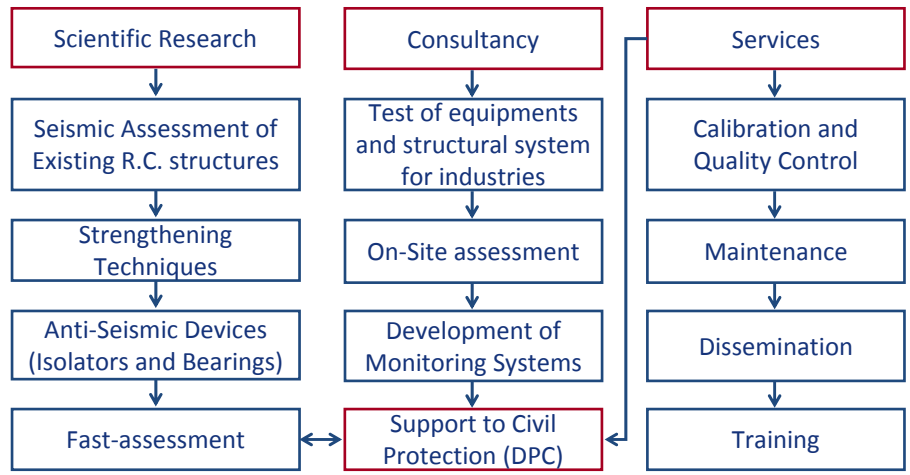

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Global view

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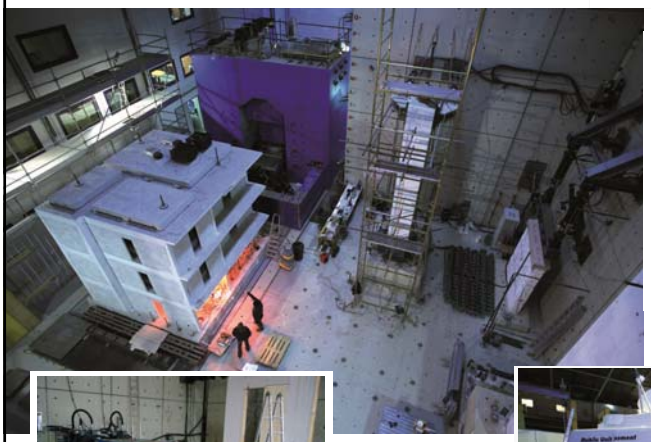
European Centre for Training and Research in Earthquake Engineering



EUCENTRE TREES Lab includes several testing facilities:

- Shaking Table
- Bearing Testing System
- Damper Testing System
- Reaction-walls
- Mobile unit

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Uni-axial High Performance Shaking Table

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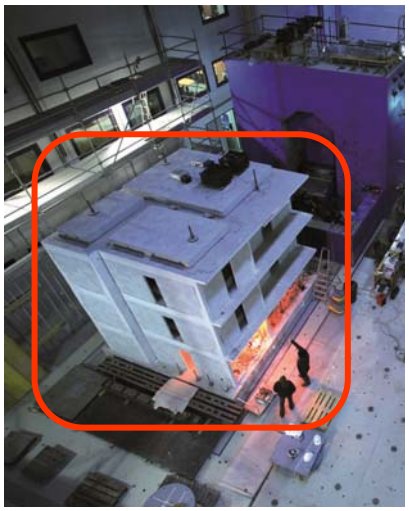

Recent research activities

- Retrofit strategies for stone-temples
- Investigation of the behaviour of mixed RC-URM wall systems
- Seismic performances of RC sandwich panels structures
- Evaluation of the seismic behaviour of stone masonry buildings and retrofit solutions
- Dynamic testing of wooden structures adopting different structural solutions
- Experimental verification of the assessment of existing RC structures and development of FRP based seismic retrofit strategies
- Dynamic testing of 1:4 scaled bridge piers

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Uni-axial High Performance Shaking Table

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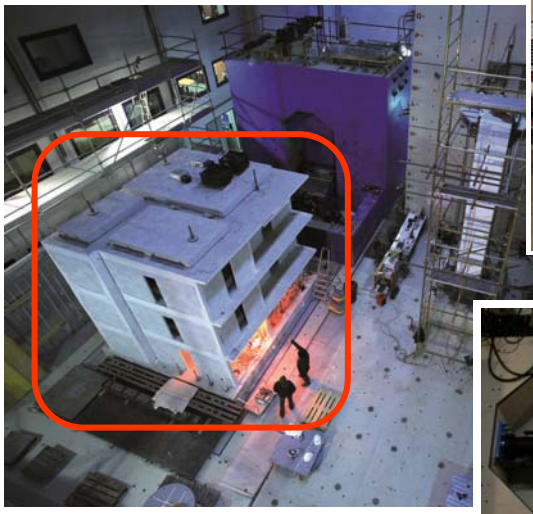

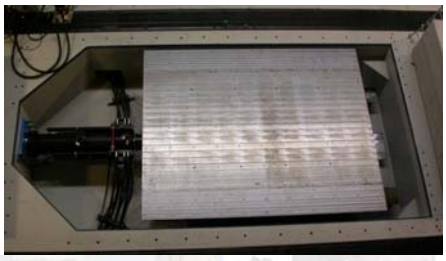

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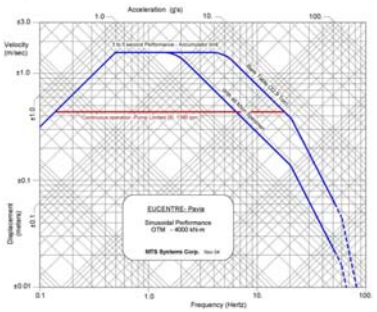
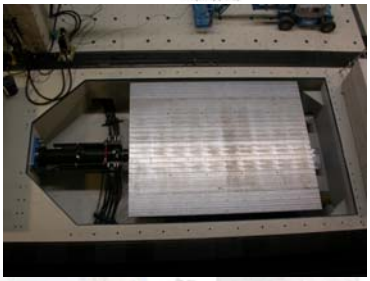
Uni-axial High Performance Shaking Table

Platten dimensions	**5.6m x 7.0m**
Peak Velocity	2.2 m/s
Peak acceleration (bare table)	6.0 g
Peak acceleration with rigid payload (70 ton)	**1.8 g**
Flow rate	11 000 lit/min
Dynamic max force	**1720 kN**
Static max force	2150 kN
Max rigid payload	**140 ton**
Max overturning moment	4000 kNm
First frequency of vibration of the table	84Hz
Dissipation of the system	350 N
Controll software	Customized MTS Adaptive





DPC - Executive Project #2 [2005/09]

During the past years, the collaboration with the Italian Department of Civil Protection included research activities on stone masonry building.

Test of a real scale 2 storeys masonry building before and after retrofit.

The building in the “as built” configuration has been shook at increasing intensity level up to 0.4g

DPC - Executive Project #2 [2005/09]

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Original building: cracks DURING the 0.4g test

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SERIES-POLYMAST Project

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In the framework of the EC-FP7 funded SERIES Project (Seismic Engineering Research Infrastructures or European Synergies), the building was repaired and retrofitted using Textile Reinforced Mortar (TRM) and tested again.

Multiple shaking tests have been performed. The building showed higher capacity than the original structure being able to withstand 0.6g.

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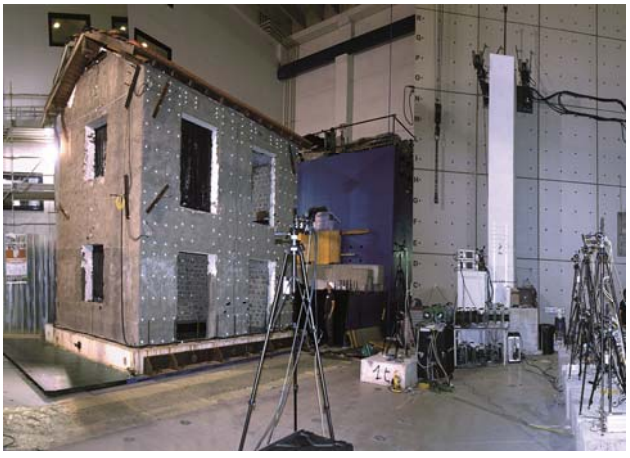
SERIES-CoMaWallS Project

In the framework of the EC-FP7 funded SERIES Project (Seismic Engineering Research Infrastructures or European Synergies), dynamic tests were performed on a 1:2 scaled mixed RC-masonry building.

Multiple shakings were applied to the building up to an acceleration of about 0.8g

Contactless data acquisition with High Definition Digital Cameras



The high definition vision system was introduced in 2008 in addition to traditional experimental equipment.

Cameras acquire the displacement of reflecting markers placed on the specimen.

From the results it is possible to determine the deformation of the system.

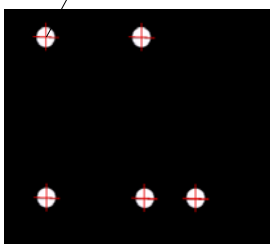
Machine vision system

Measure positions of markers acquiring and analysing a series of digital images

Marker placed on the specimen

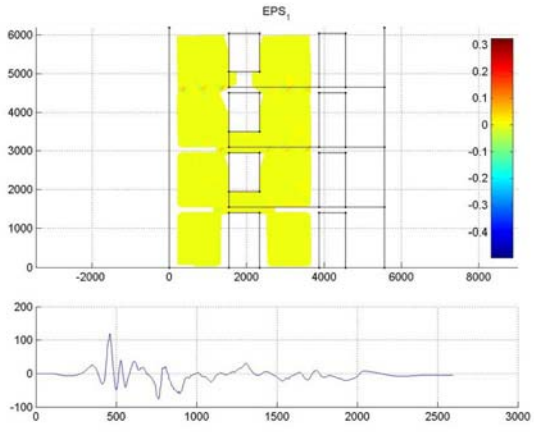
Digital camera

Pixel position → World coordinate (mm): [150;50]px → [240;80] mm



Markers identification performed on acquired images

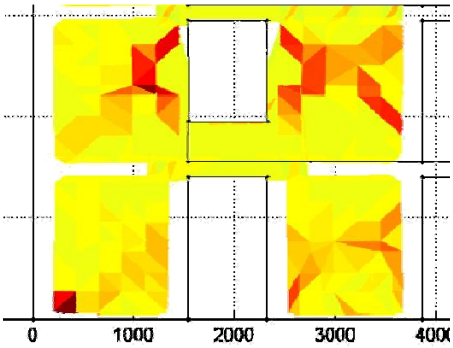
Machine vision system



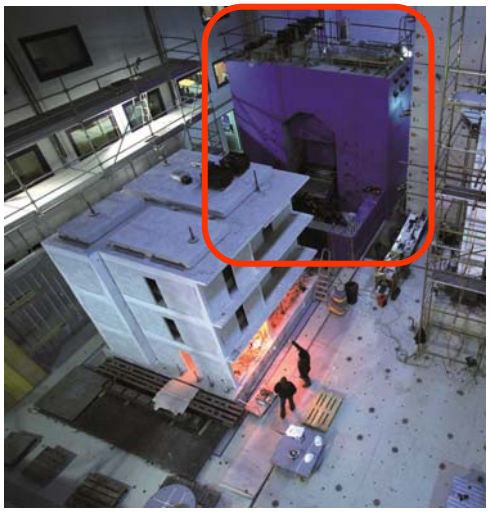
The distribution of deformation across the panels can be evaluated by elaborating the displacements of the markers as recorded by the machine vision system.

Machine vision system

The pictures show the comparison between the building façade at the end of the test and the corresponding maximum strain distribution as computed by the processing of the machine vision system data.



Bearing Testing System (BTS)



The BTS is a high performance facilities for dynamic testing of full scale bearings and isolators.
Its applications includes both research and consultancies activities.
Tests on bearings and isolators are performed on a daily basis supporting the activities of a number of industrial manufactures.

In particular, research activities includes:
- Implementation of numerical models for isolators;
- Development of new materials for anti-seismic devices;
- Hybrid testing strategies.

Bearing Testing System (BTS)

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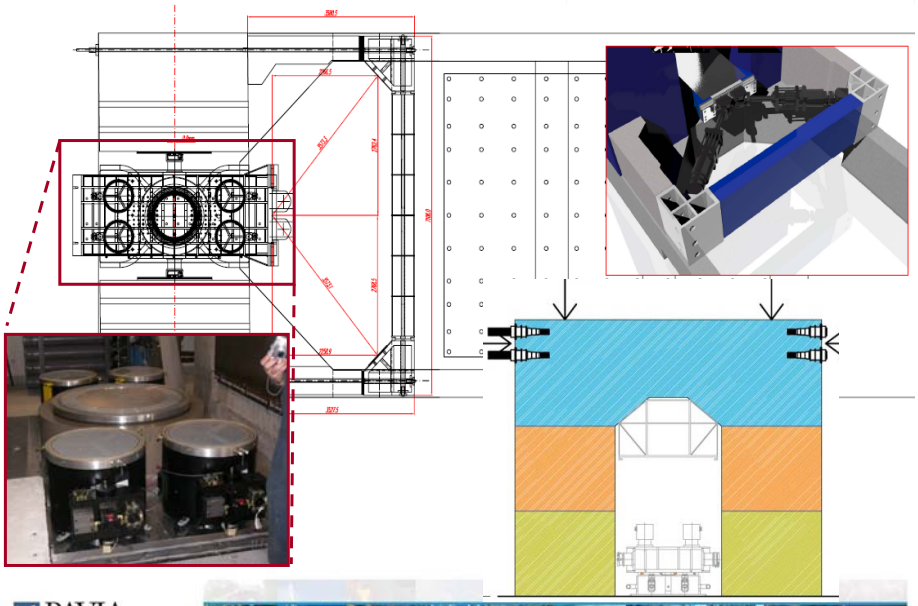

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Bearing Testing System 2D (BTS)

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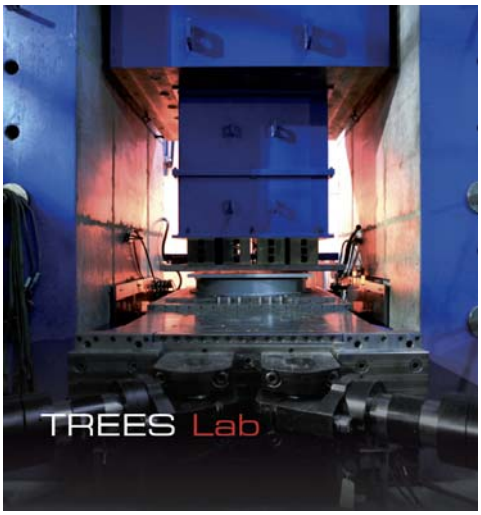
Platen dimension	1.700 m x 1.990 m
Table mass	22.0 ton
5 controlled DoF	**Longitudinal, Vertical, roll, pitch, yaw**
Max displacement	**O: ±495 mm** V: ±75 mm
Peak Velocity	O: ±2.2 m/s, V:±250 mm/sec
Max Force	H: 1 900 kN (4400 kN), **V: 40 000 kN ± 10 000 kN**
Max Overturning Moment	20 000 kNm
Operational Frequency range	0-20 Hz
Flow rate	11 000+16 000 lit/min



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Bearing Testing System (BTS)

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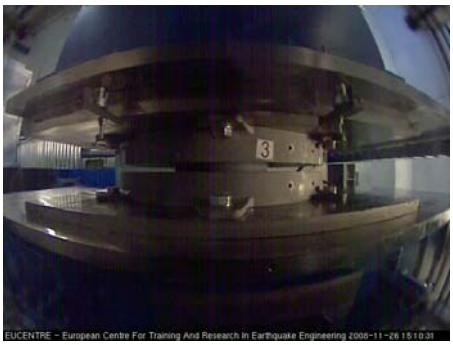
Examples of dynamic testing activities

HIGH DAMPING RUBBER BEARING



CURVED SURFACE SLIDER

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Bearing Testing System (BTS)

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Examples of dynamic testing activities: **FAILURE OF DEVICES**

LAMINATED RUBBER BEARING

CURVED SURFACE SLIDER

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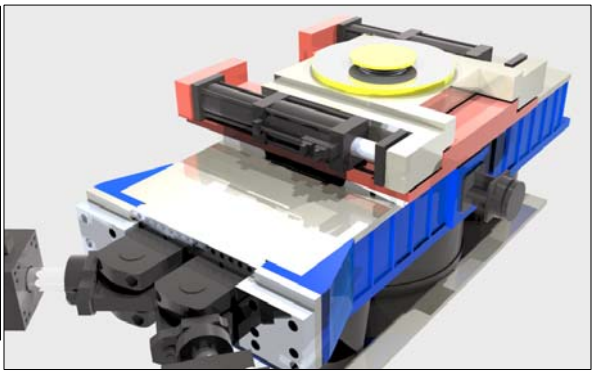
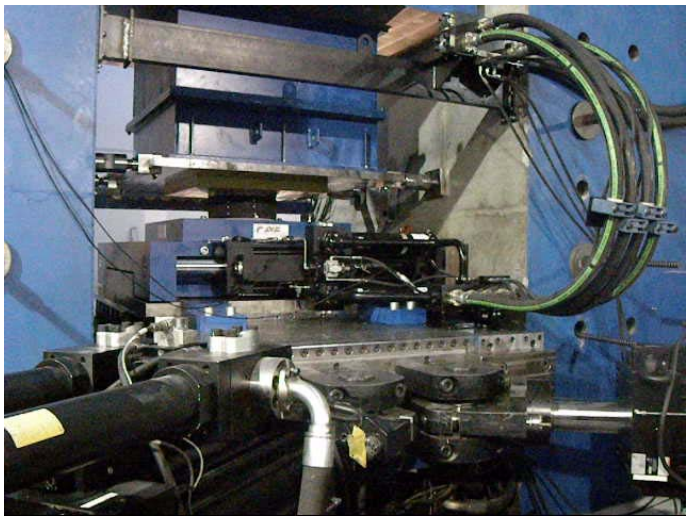
Bearing Testing System 3D (BTS3D)

The BTS has been recently upgraded adding the transversal degree of freedom. This new equipment will allow 3D response investigation exploiting this new possibility of applying transversal movements.

DoF	Longitudinal (existing)	**Transversal (NEW)**
Total stroke (peak to peak)	990 mm	**530 mm**
Peak Force	1900 kN	**1000 kN**
Peak Velocity	2.2 m/s	**0.6 m/s**

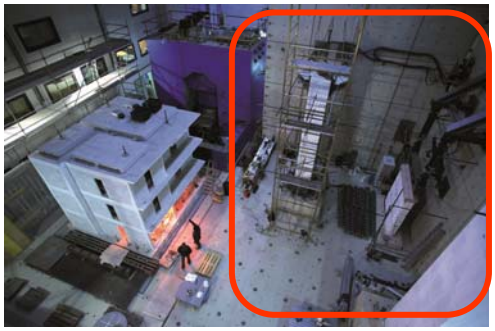


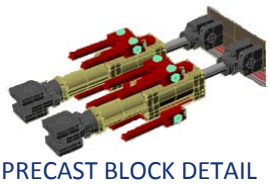
Bearing Testing System 3D (BTS3D)



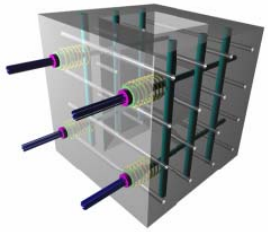
3D Reaction Walls – Strong Floor

The Eucentre TREES Lab Reaction Walls are realized with precast concrete blocks and have been used to test precast connections, frame building, walls, coupling beams of different materials (concrete, steel, wood, masonry, …).





PRECAST BLOCK DETAIL



3D Reaction Walls – Strong Floor

Technical Specifications

- L Shaped wall
- Net area: 140 m^2
- Wall height: 12 m
- 11 hydraulic actuators
- Test: pseudo-static, pseudo-dynamic and hybrid simulations
- Force range: 250-2500 kN
- Stroke Range ±500 mm

Tested elements

- Walls, Columns
- Coupling beams
- Connections
- Frames

Damper Testing System (DTS)

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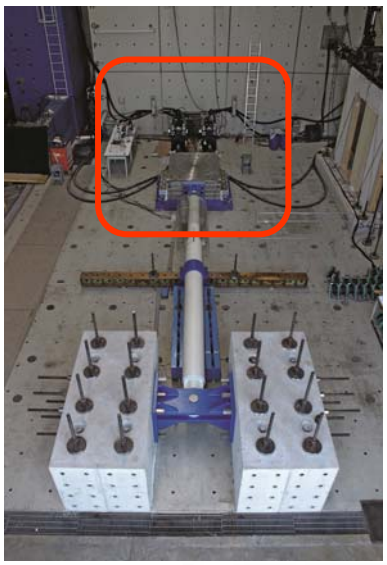
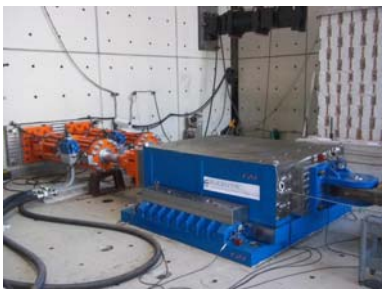


Exploiting the characteristics of the strong floor, this testing equipment is used to evaluate the performances of Damper and Shock Transmission Units.



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Damper Testing System (DTS)

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Examples of dynamic testing activities

Dynamic performance of a Fluid Viscous Damper

Failure of a Fluid Viscous Damper

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Mobile Unit

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The Eucentre TREES Lab Mobile Unit purpose is to transport tools and to be a support for non destructive and semi destructive experimental tests.
The Mobile station is therefore employed for data acquisition on the field and local networking (data sharing, connection to the central unit and to the web).
In the equipped office is also possible to analyze data and structure with finite element modeling.

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Mobile Unit

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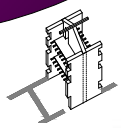
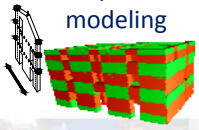
Advanced data management and telepresence

coordination and multi-expertize support centre

Fast/Simplified modeling

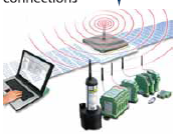




operative unit for advanced structural assessment

Assessor teams

Wireless & wired connections



Transmission system

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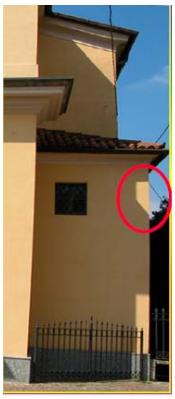
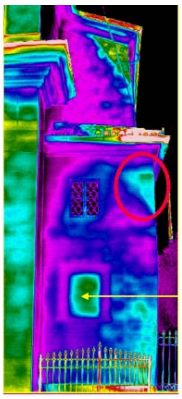
Other Experimental Tests

- SONREB
- GEORADAR
- PACHOMETER
- CORE DRILLING AND CONCRETE COMPRESSION TEST
- TENSILE TEST REINFORCEMENT
- ULTRA-SONIC TEST
- LASER SCANNER
- **THERMOGRAPHIC CAMERA**
- FLAT JACK
- DYNAMIC CHARACTERIZATION
- PULL OUT
- GEOPHONES
- IMPULSE HAMMER/LASER METER

TOOLS: infrared camera, pc
APPLICATIONS: evaluation of wall homogeneity





DR HOUSE

DR HOUSE is a macromodule for post-earthquake building damage and safety assessment. There are three different modules: BSA (Basic Safety Assessment through visual inspection), **ASA (Advanced Safety Assessment through numerical and experimental procedures)** and STC (Short Term Countermeasure).

COORDINATOR: DPC (Italian Department of Civil Protection)

PARTNERS: EUCENTRE, VVF (Italian Department of Firefighters)

AIM: Post-Earthquake advanced structural assessment

Deployment intervention area: 15.000 km from Rome

Rome – Adelaide: 15300 km!

DR HOUSE

After the intervention request from the damaged country, the Eucentre team will be in place in 48 h. Recently the ASA module has been employed during the post-earthquake assessment after the Emilia Earthquakes (May 2012).

Date of the event: May 20, 2012
Arrival of the first team: May 21, 2012
Persons involved: 12 engineer (4 teams) + 2 technicians
Duration of stay: 2 months
Inspected buildings: 531

The Eucentre camp in Cento (FE)

iPad App developed for the visual building assessment

DR HOUSE

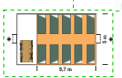
If no accommodation is available, the team will stay in a campsite arranged by the Eucentre TREES Lab.

TREESLab EQUIPMENT

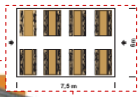
deposit

3 dorms

services (wc – shower)



multi-purpose tent



camp equipment

Compact Seismic Simulator (CSS)

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The CSS is a system by which is possible to simulate seismic event and to observe its effects to structures. The small shaking table is controlled with a remote device (iPad).

Wifi

Compact Seismic Simulator (CSS)

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Table dimensions	1250 x 1250 mm
Maximum stoke	500 mm
Peak velocity (at full load)	0.5 m/s
Peak acceleration (at full load)	1 g
Maximum payload	100 kg
Engine torque	11.5 kNm
Peak dynamic force	1.5 kN
Maximum overturning moment	450 Nm

Wifi

Thanks for your attention

For further information please visit: www.eucentre.it

Be sure to check our latest video on the EUCENTRE YouTube channel