Eucentre TREES Lab:

Laboratory for Training and Research in Earthquake Engineering and Seismology

Facility and Research

Ing.Filippo Dacarro

Foundation Eucentre

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

La Fondazione Eucentre, con sede a Pavia, è un ente senza fine di lucro che promuove e sviluppa la ricerca e la formazione nel campo della riduzione del rischio, in particolare sismico. La creazione di Eucentre è avvenuta nel 2003, su iniziativa dei seguenti soci fondatori: Dipartimento della Protezione Civile Nazionale, Università degli Studi di Pavia, Istituto Nazionale di Geofisica e Vulcanologia (INGV), Istituto Universitario di Studi Superiori di Pavia (IUSS).

- Ricerca Applicata nel settore dell'ingegneria sismica, orientata a conseguire concreti obiettivi per la valutazione e riduzione della vulnerabilità e del rischio;
- attività utile alla definizione di specifiche linee di azione pubblica, di atti di indirizzo, di linee guida;
- Training formazione di operatori aventi spiccate capacità scientifiche e professionali;
- Consulenza scientifica e tecnologica a livello nazionale ed internazionale.

INGV

IUSS

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Overview of TREESLab activities

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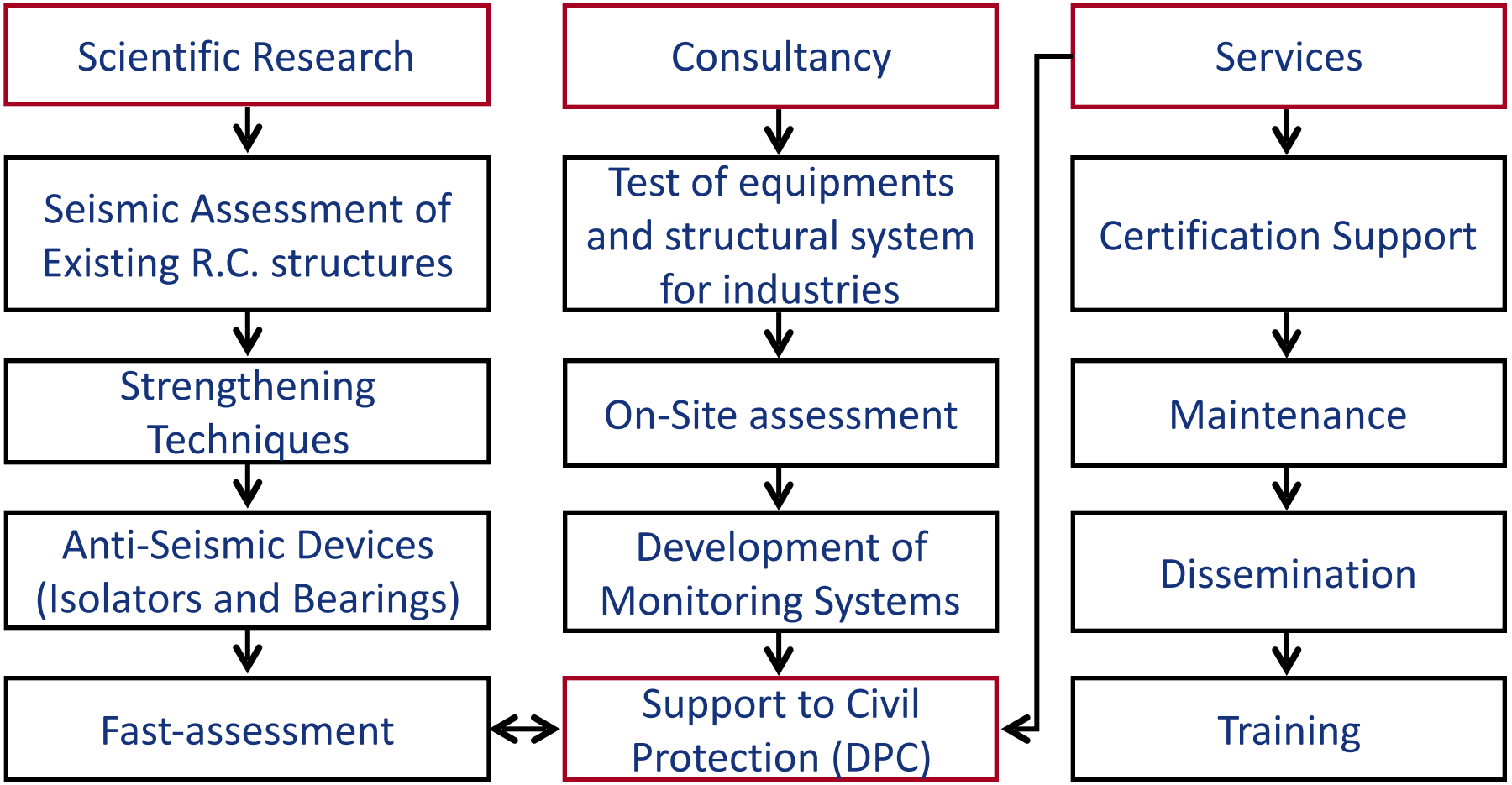

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Global view

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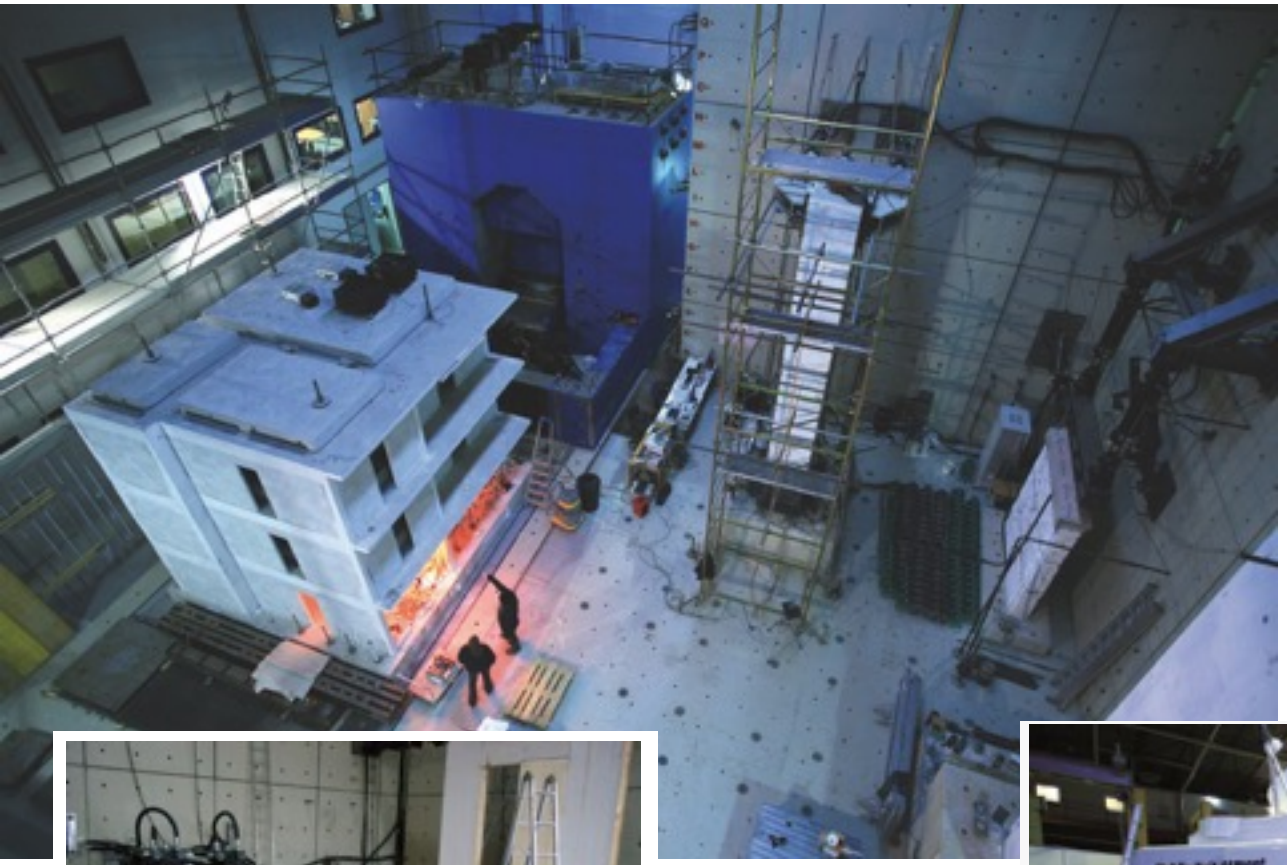

EUCENTRE TREES Lab :

- Tavola Vibrante
- Bearing Testing System
- Damper Testing System
- Reaction-walls
- Mobile unit

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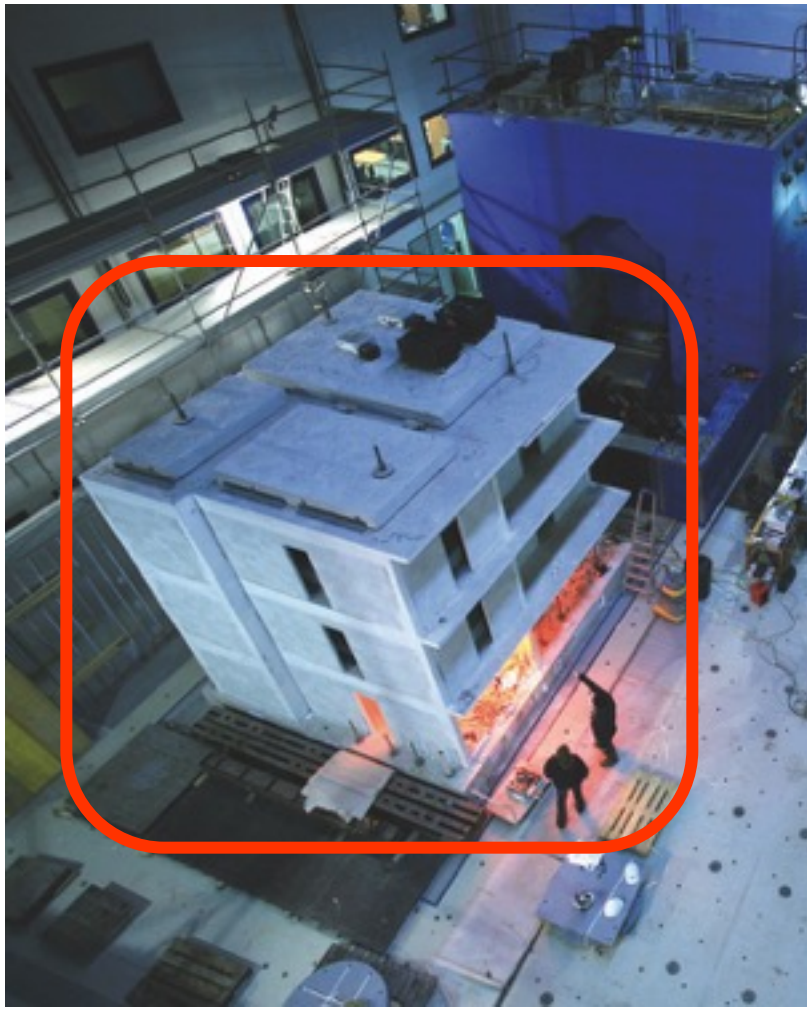

Recent research activities

- Struttue in cemento armato tamponate con muratura;
- Strutture in panneli sandwich di cemento armato;
- Strutture in muratura di pietra con varie tecniche di rinforzo;
- Strutture prefabbricate in legno;
- Strutture in muratura di laterizio (Olanda);
- Sistemi di immagazzinamento con dispositivi di isolamento;
- Sistemi di pareti in muratura con diverse tipologie di laterizio;

Uni-axial High Performance Shaking Table

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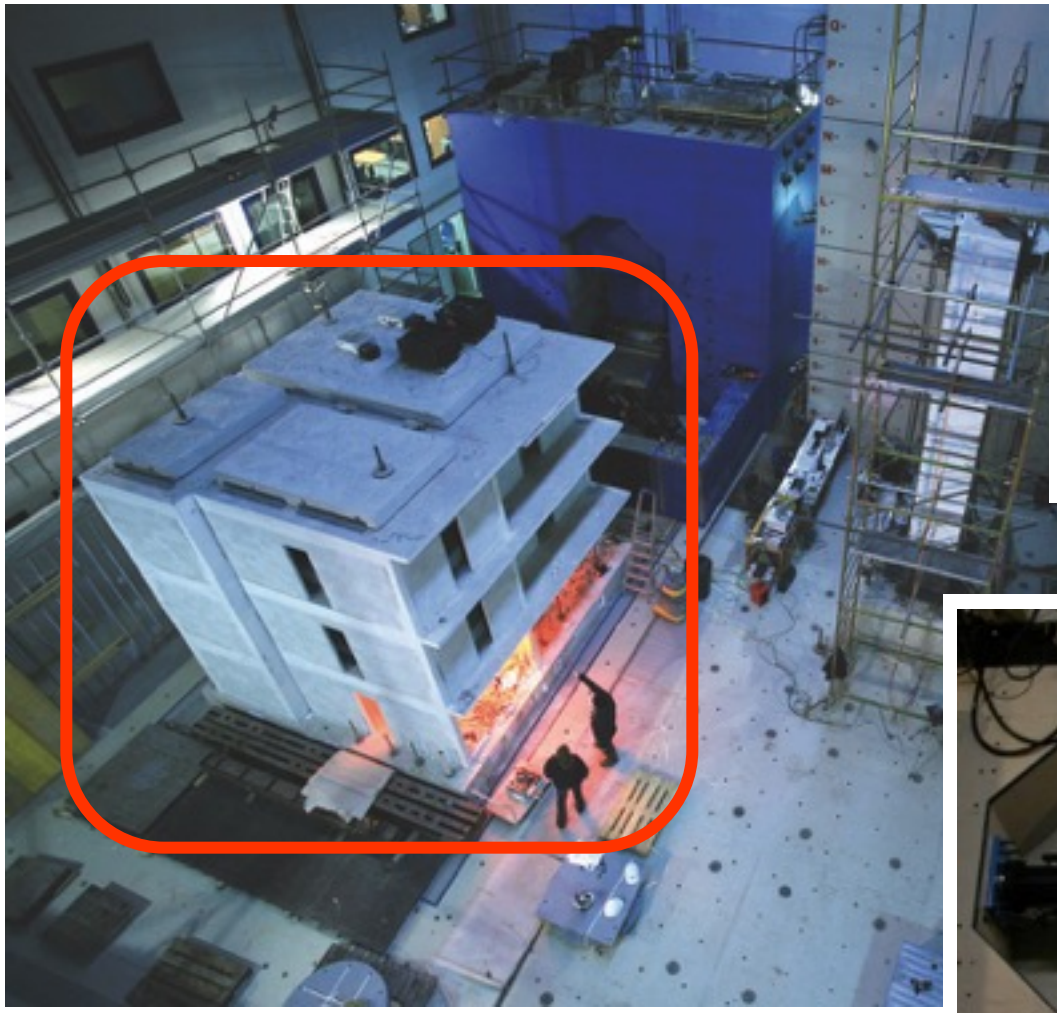

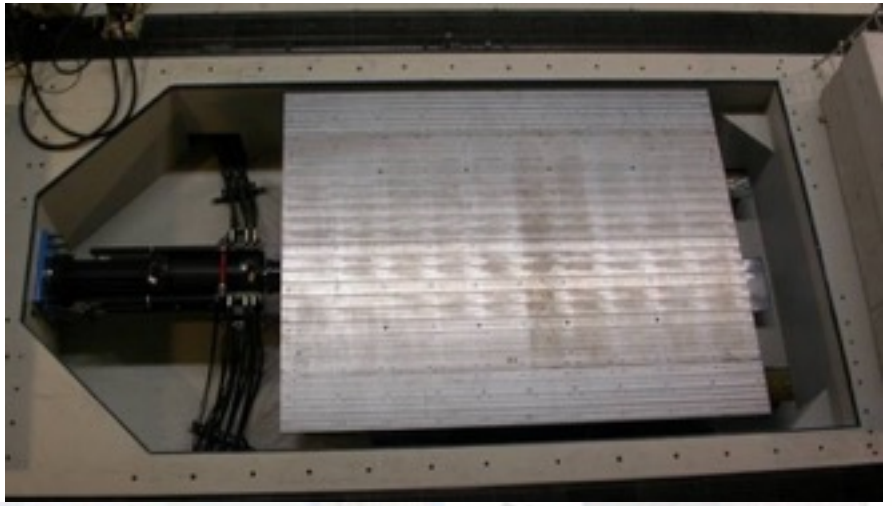

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Uni-axial High Performance Shaking Table

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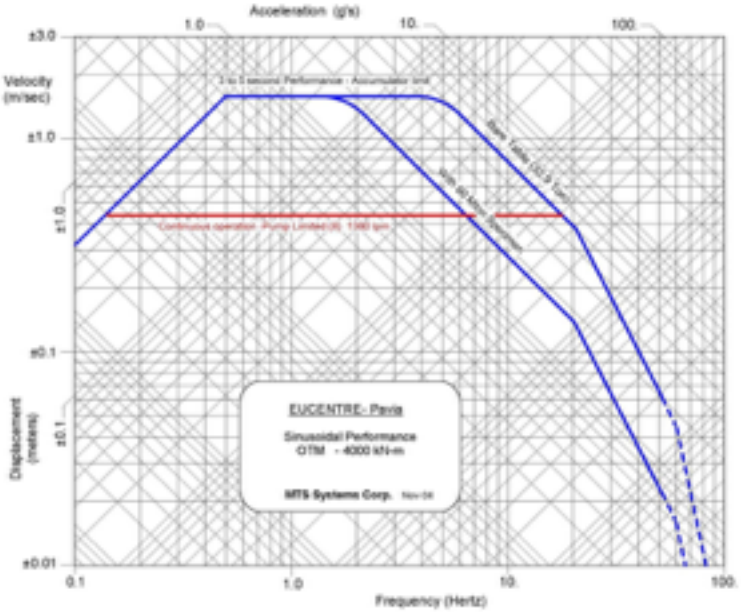
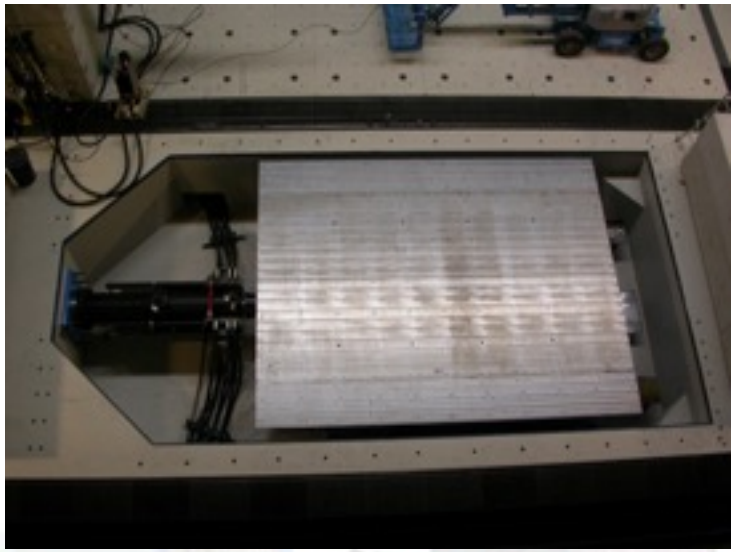
Platten dimensions	**5.6m x 7.0m**
Peak Velocity	2.2 m/s
Peak acceleration (bare table)	6.0 g
Peak acceleration with rigid payload (70 ton)	**1.8 g**
Flow rate	11 000 lit/min
Dynamic max force	**1720 kN**
Static max force	2150 kN
Max rigid payload	**140 ton**
Max overturning moment	4000 kNm
First frequency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





Uni-axial High Performance Shaking Table

Uni-axial High Performance Shaking Table

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DPC - Executive Project #2 [2005/09]

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Progetto Esecutivo in collaborazione con DPC

Campagna di prove sperimentali su un edificio in muratura di pietra in scala reale

Sono stati eseguiti una serie di test di vibrazione ad intensità crescente fino a 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

Il progetto è stato rifinanziato dalla EC nell'ambito del FP7 – FrameWork Series (Seismic Engineering Research Infrastructures or European Synergies), e la struttura danneggiata è stata rinforzata con un intonaco armato.

La struttura è stata quindi sottoposta ad un nuovo ciclo di prove ad intensità crescente fino a 0,6g.

SERIES-CoMaWallS Project

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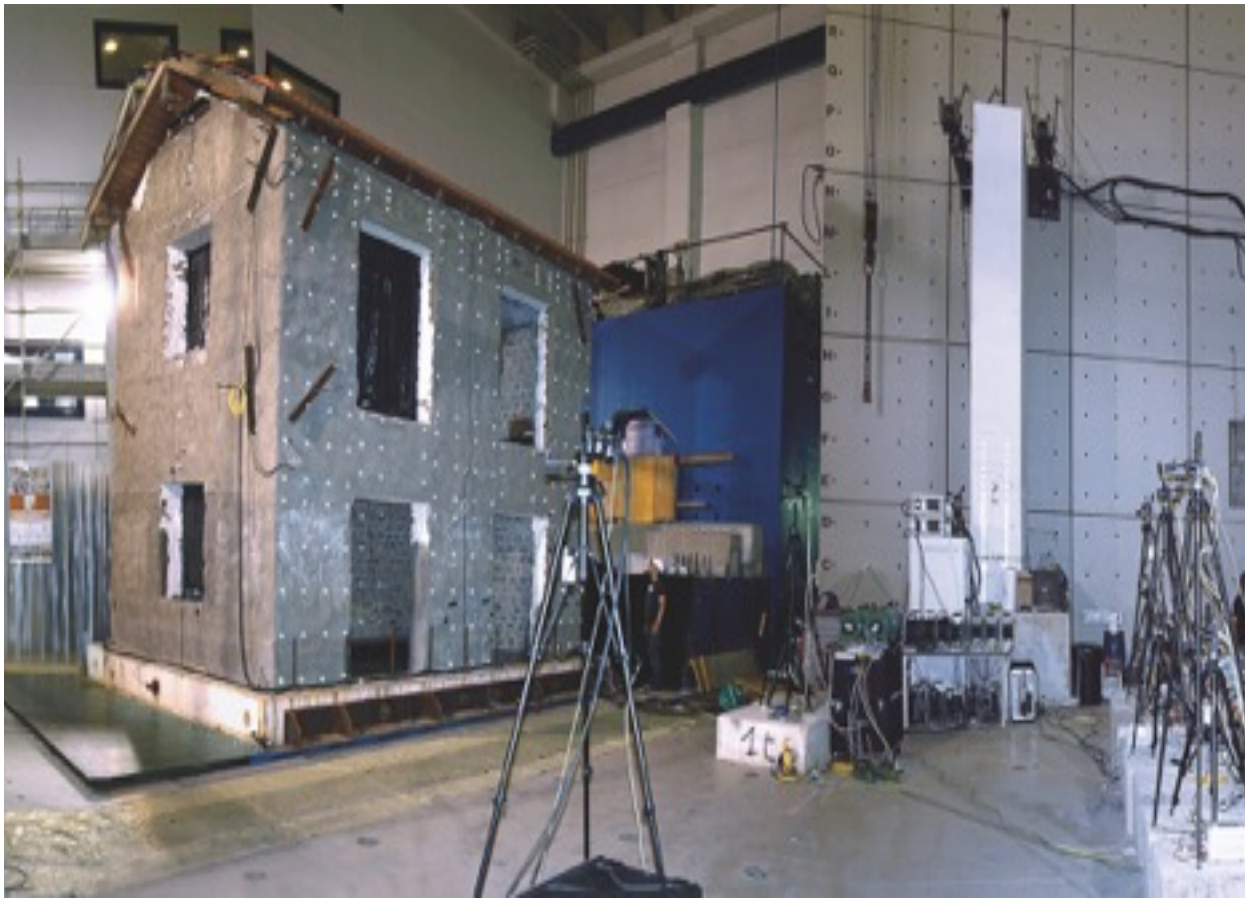
Sempre nell'ambito del FP7 – FrameWork Series (Seismic Engineering Research Infrastructures or European Synergies) è stato finanziato un progetto per prove sperimentali su strutture miste cemento armato/muratura in scala 1:2.

Sono state raggiunte accelerazioni fino 0,8g

Contactless data acquisition with High Definition Digital Cameras



Sempre nell'ambito dei progetti europei è stato realizzato un sistema di acquisizione basato su ottiche ad alta risoluzione ad integrazione dei classici sistemi di acquisizione con trasduttori wired.

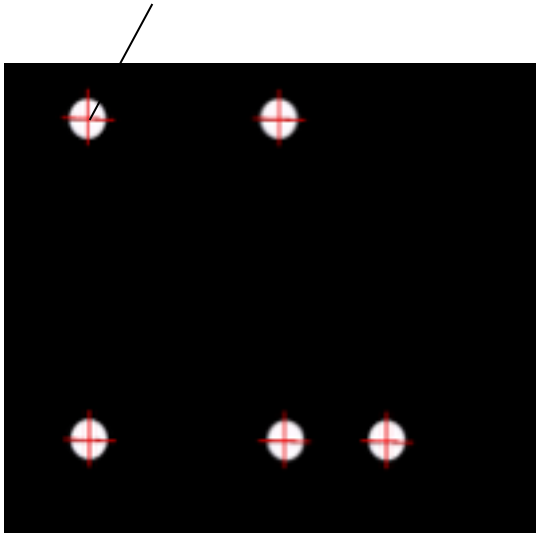
Machine vision system

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

Marker posizionati sulla struttura

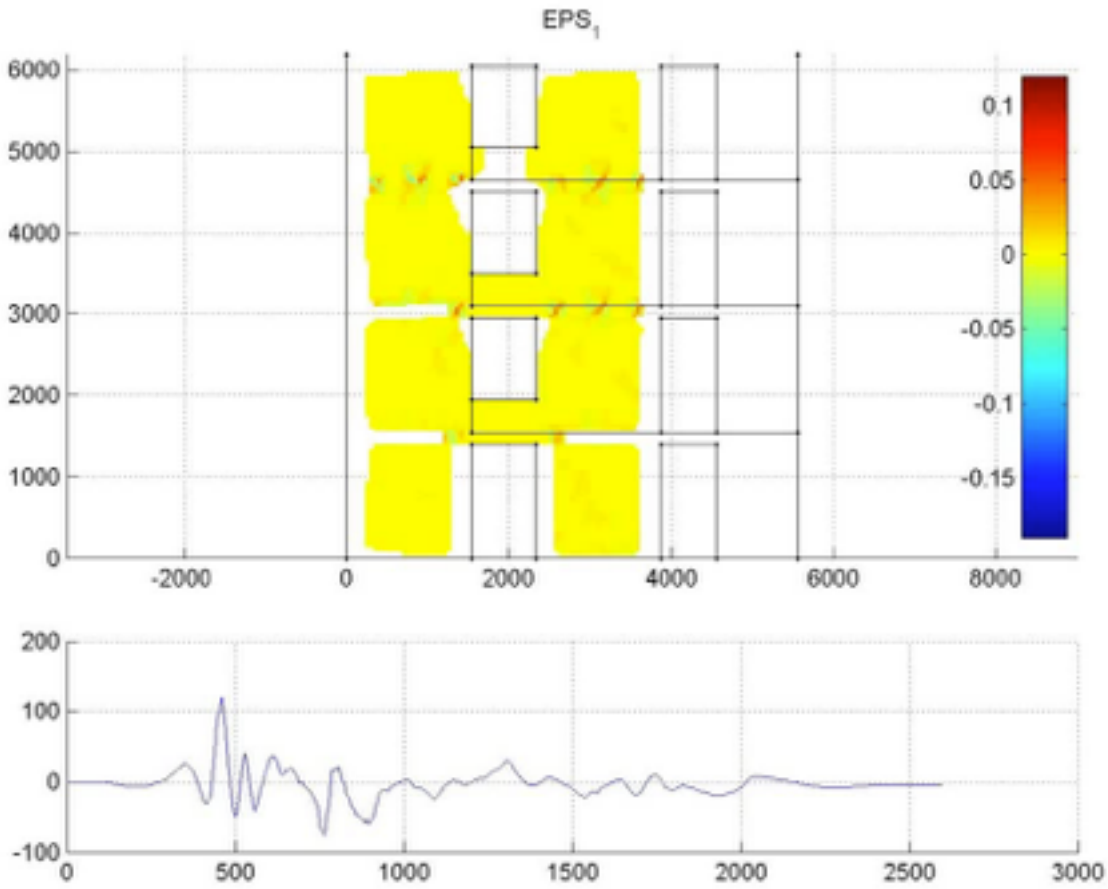
Digital camera

Pixel Position



In fase di calibrazione viene definita la posizione iniziale di ogni marker

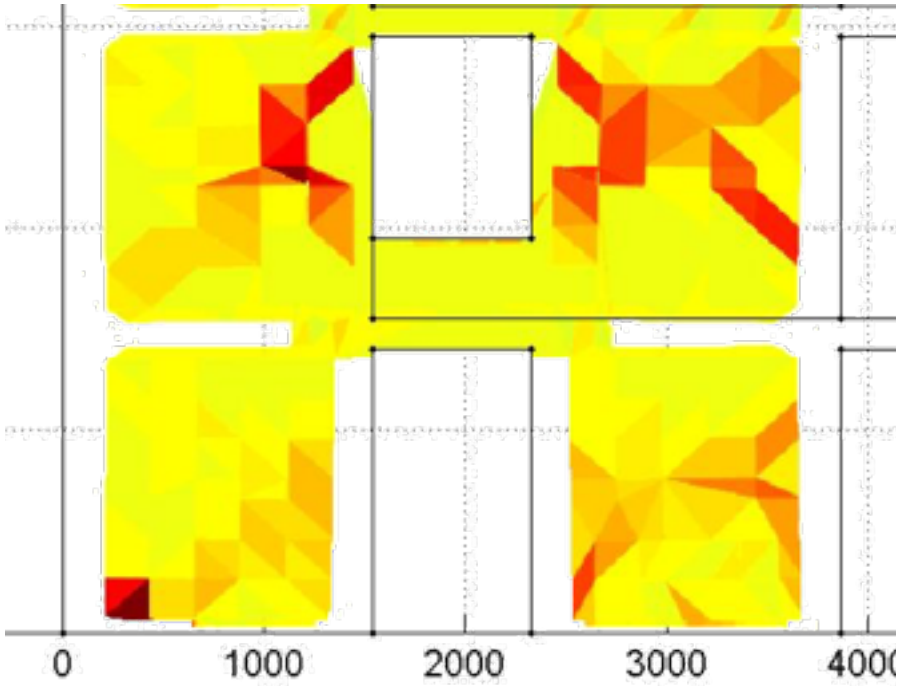
Machine vision system



La distribuzione delle deformazioni nei pannelli di muratura può essere ottenuta dalle elaborazioni automatiche degli spostamenti di ogni singolo marker.

Machine vision system

È possibile verificare il perfetto matching tra l'immagine del danneggiamento della facciata e la proiezione dello stato tensionale ottenuta dall'elaborazione dei dati dell'acquisizione ottica.



3D Reaction Walls – Strong Floor

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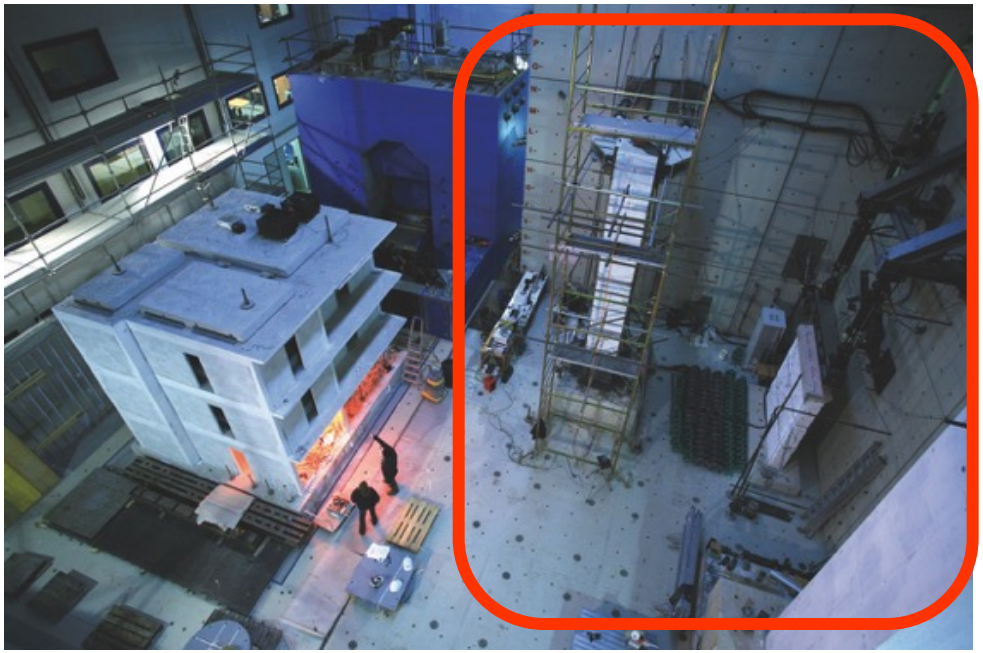
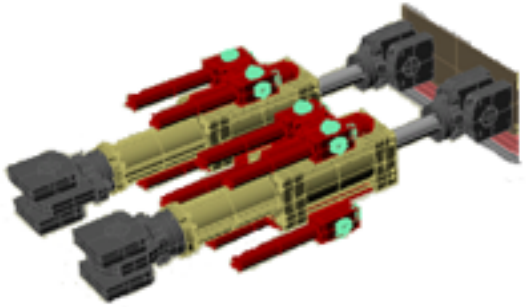
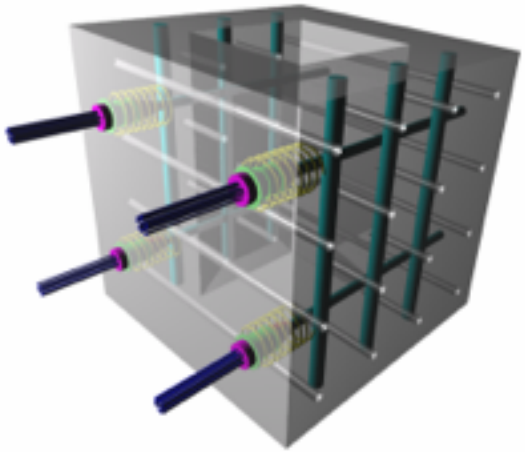
I muri di reazione del laboratorio Eucentre permettono di realizzare test PsS, PsD o Hybrid, su strutture in scala reala o componenti strutturali (pareti, nodi trave-colonna, colonna-fondazione…).





PRECAST BLOCK DETAIL



3D Reaction Walls – Strong Floor

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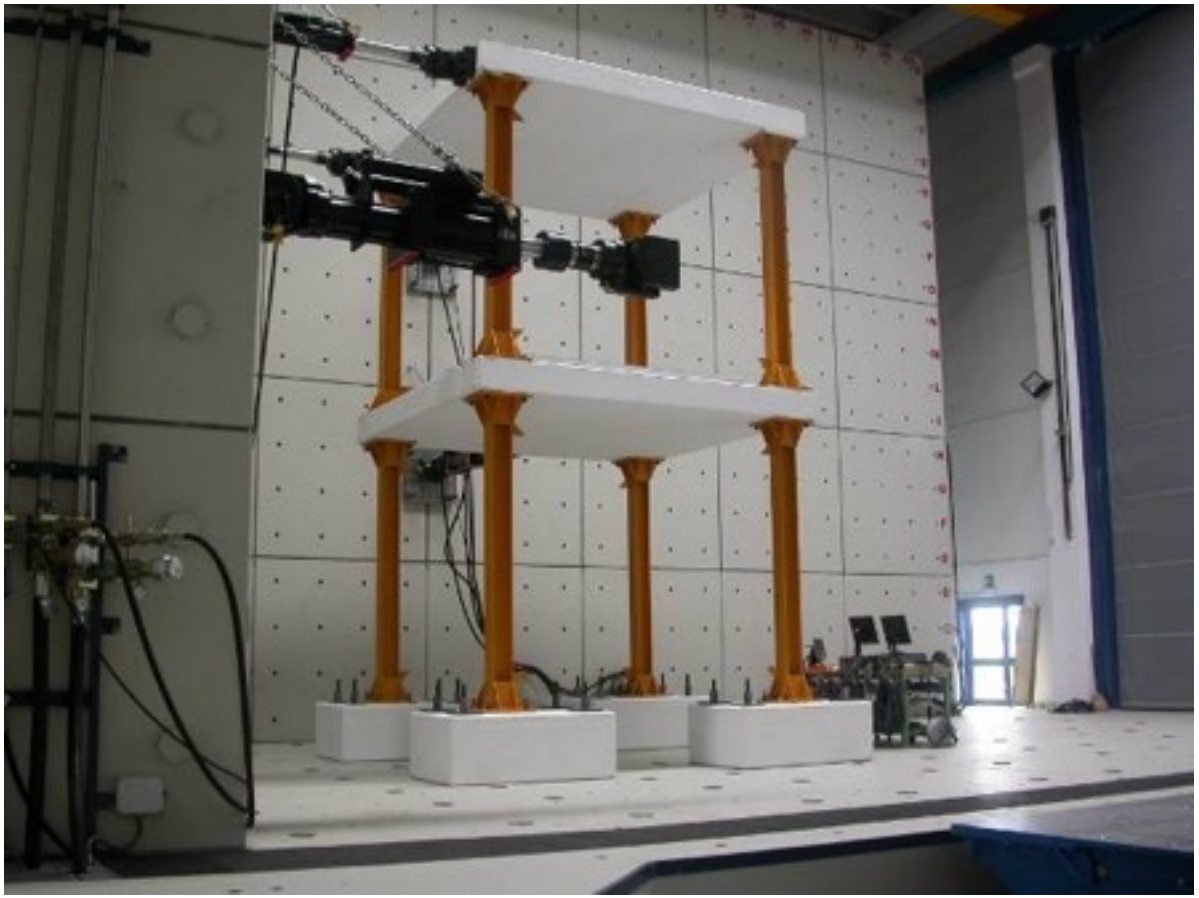
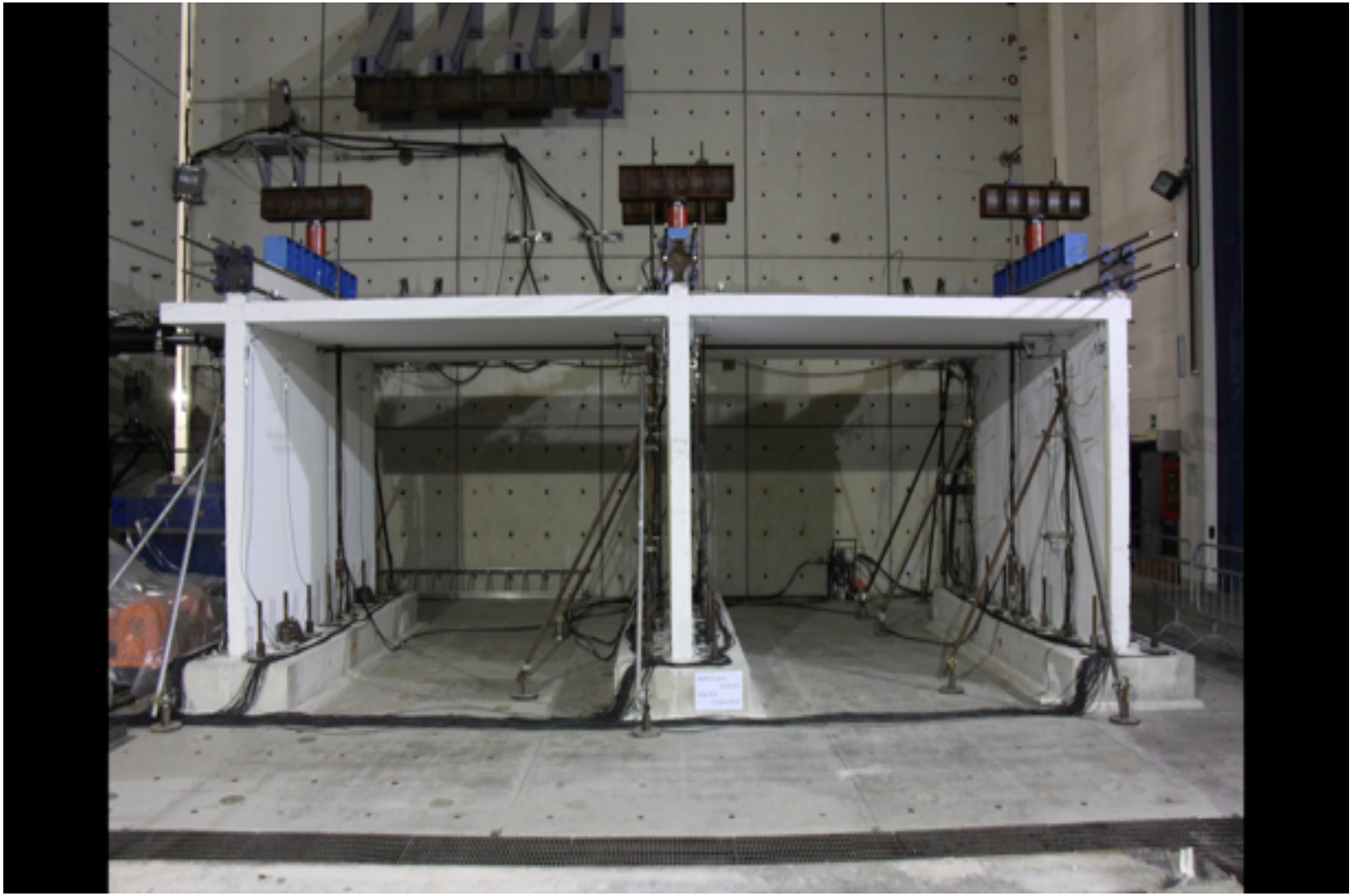
Technical Specifications

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



3D Reaction Walls – Strong Floor



3D Reaction Walls – Strong Floor

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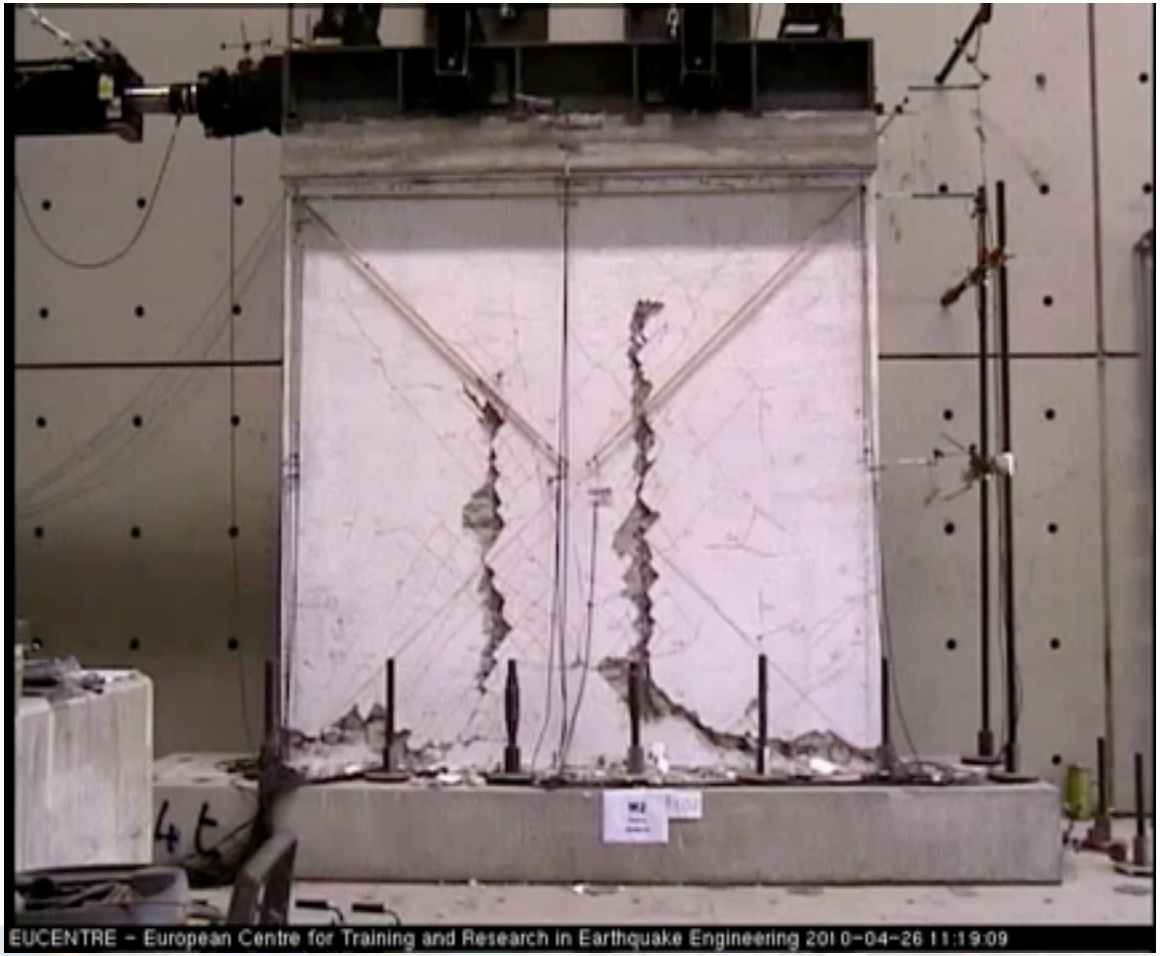

Eucentre Hybrid Testing System (HTS)

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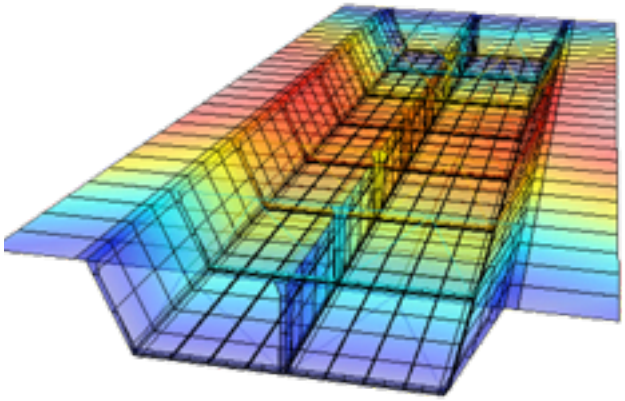

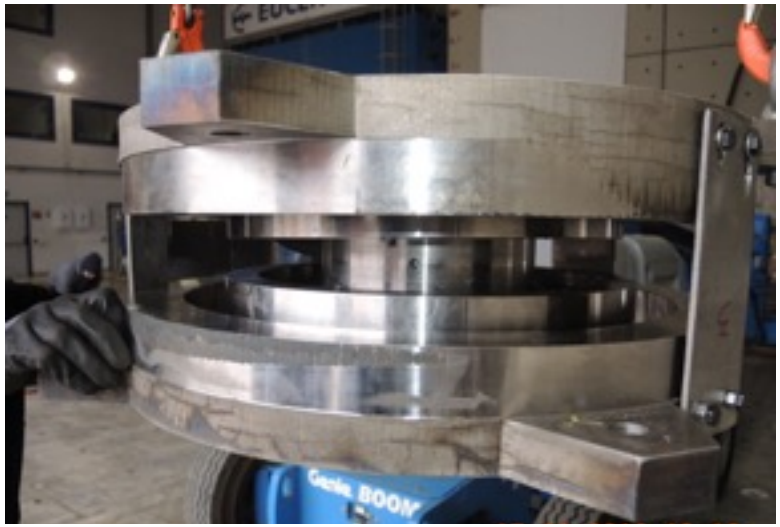

New Lab - Spring 2017

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New Lab - Spring 2017

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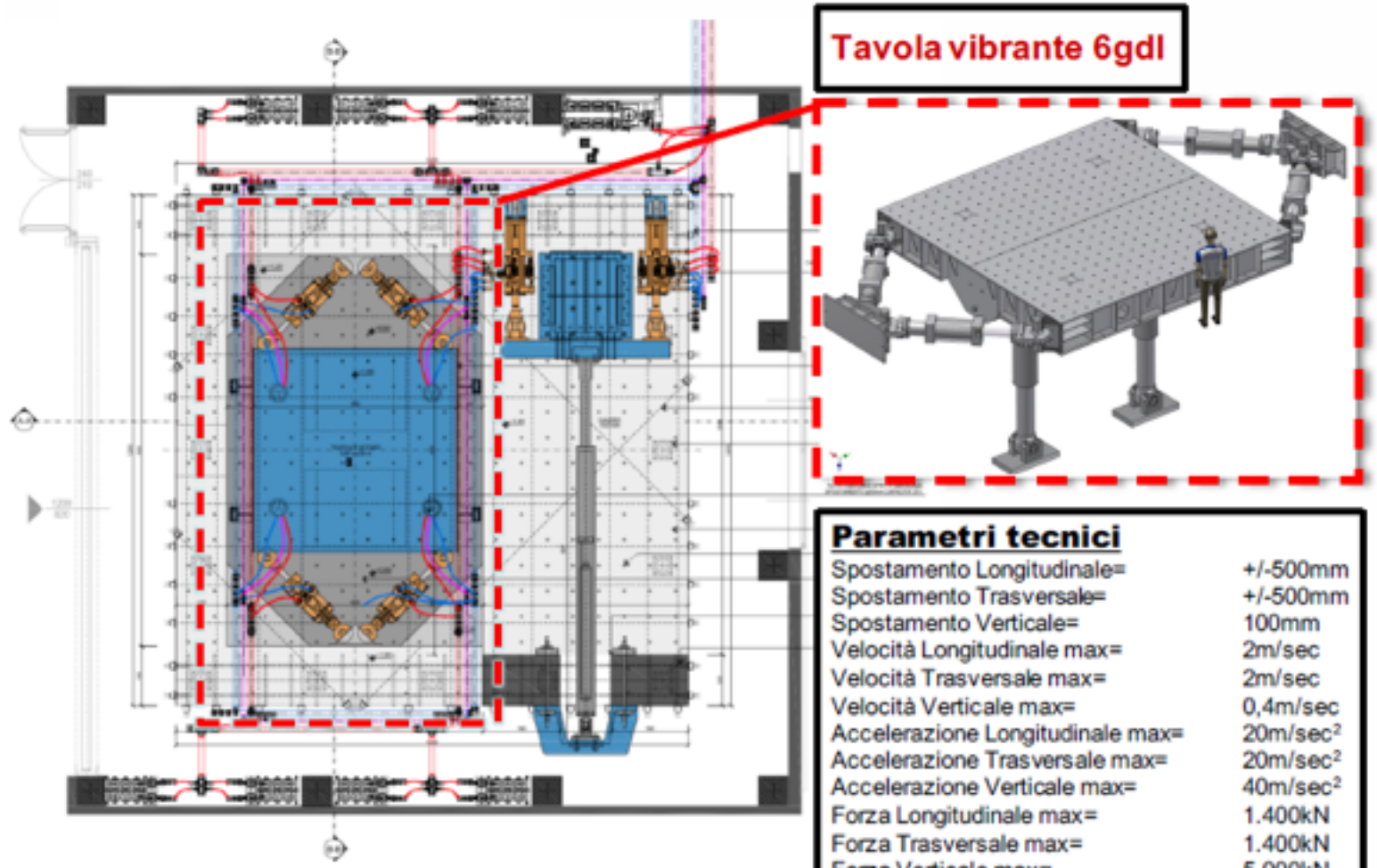
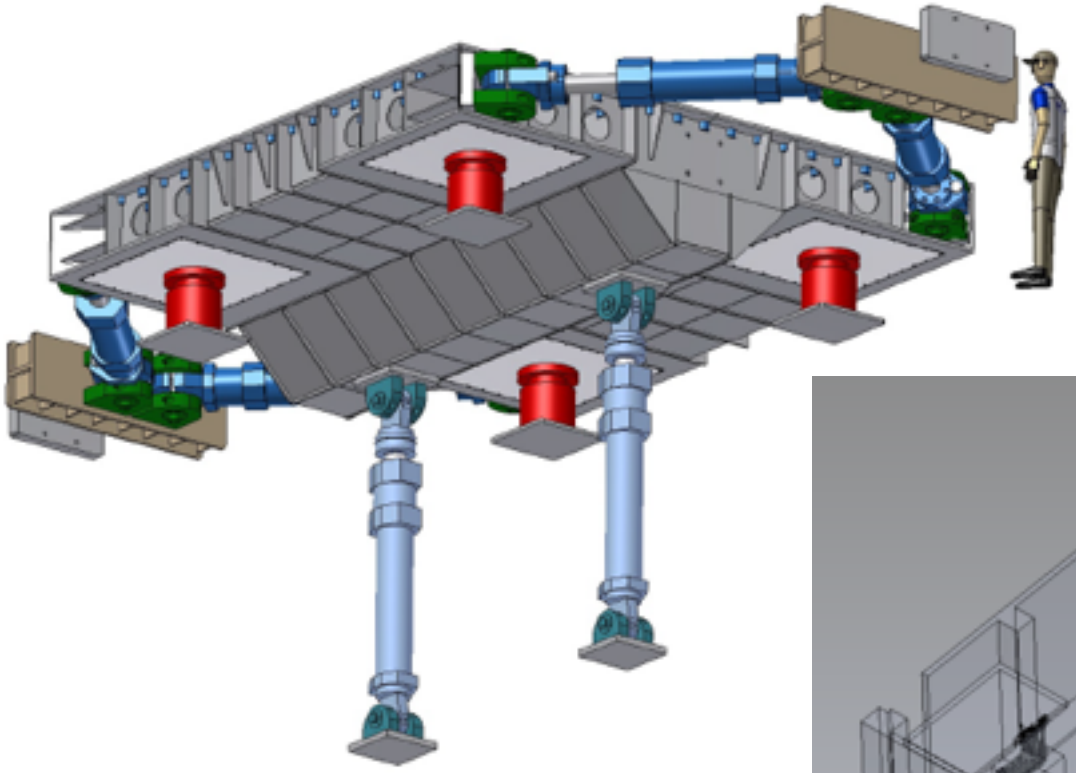
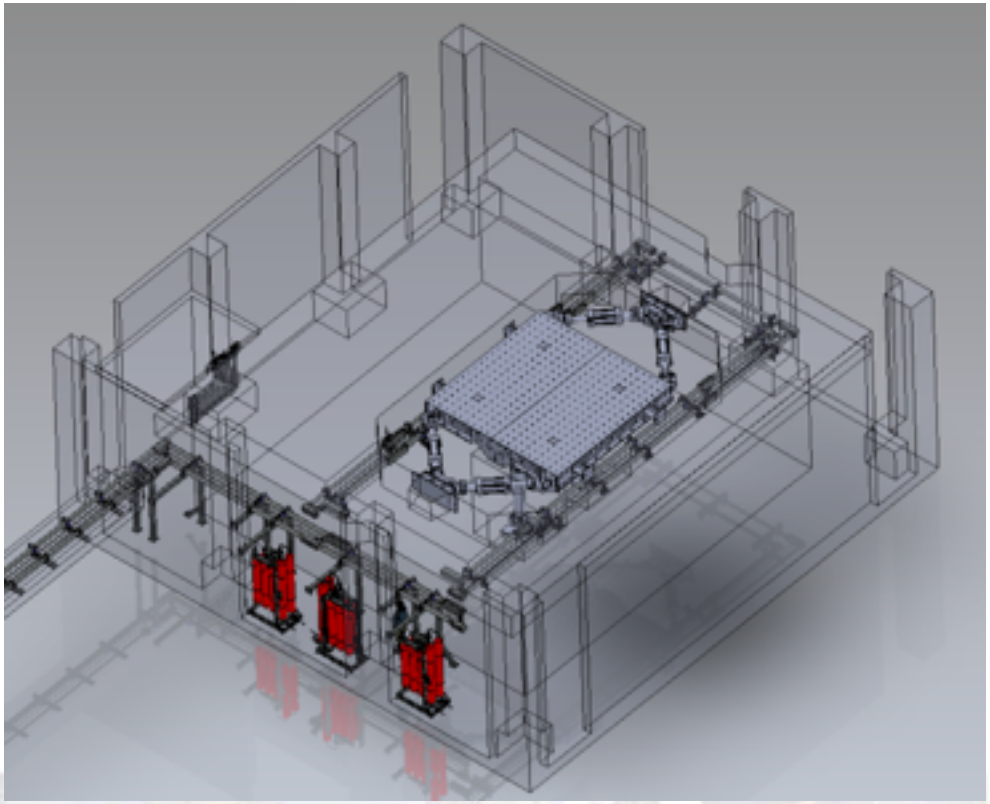


Parametri tecnici

Spostamento Longitudinale=	+/-500mm
Spostamento Trasversale=	+/-500mm
Spostamento Verticale=	100mm
Velocità Longitudinale max=	2m/sec
Velocità Trasversale max=	2m/sec
Velocità Verticale max=	0,4m/sec
Accelerazione Longitudinale max=	20m/sec^2
Accelerazione Trasversale max=	20m/sec^2
Accelerazione Verticale max=	40m/sec^2
Forza Longitudinale max=	1.400kN
Forza Trasversale max=	1.400kN
Forza Verticale max=	5.000kN
Pressione operativa=	280Bar

6-DOF Shake Table





Mobile Unit

Lo scopo della Mobile Unit è quello di rendere possibile l'esecuzione rapida di test di valutazione strutturale in situazione di crisi conseguente ad un evento sismico o genericamente di calamità naturale.

Mobile Unit

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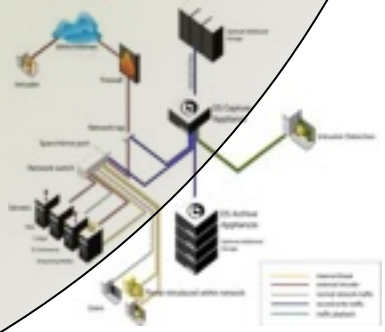
coordination and multi-expertize support centre

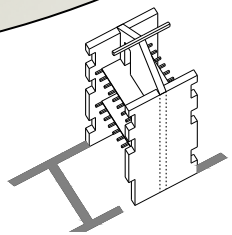
Advanced data management and telepresence



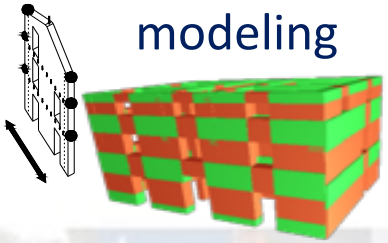
operative unit for advanced structural assessment

Assessor teams

Transmission system



Fast/Simplified modeling



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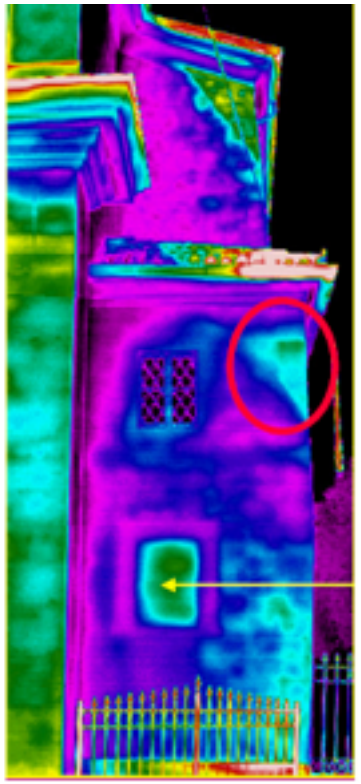
Other Experimental Tests

- SONREB
- 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

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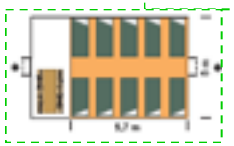
If no accommodation is available, the team will stay in a campsite arranged by the Eucentre TREES Lab.

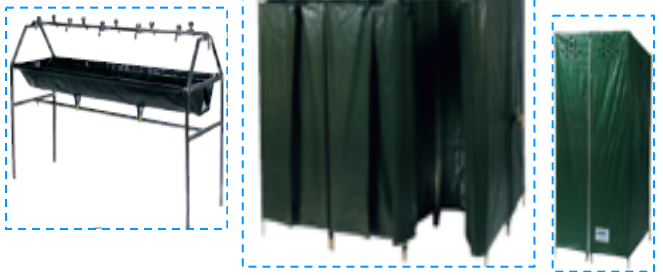
TREESLab EQUIPMENT

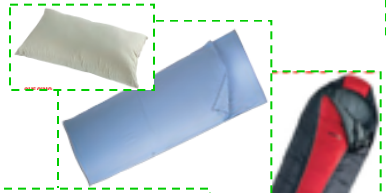
deposit

3 dorms



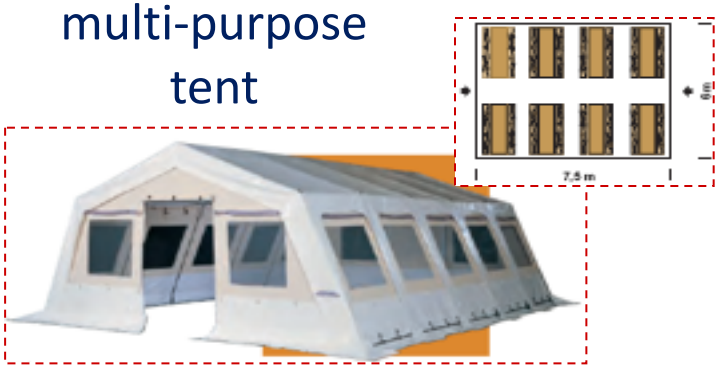
services (wc – shower)





camp equipment

multi-purpose tent



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).

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

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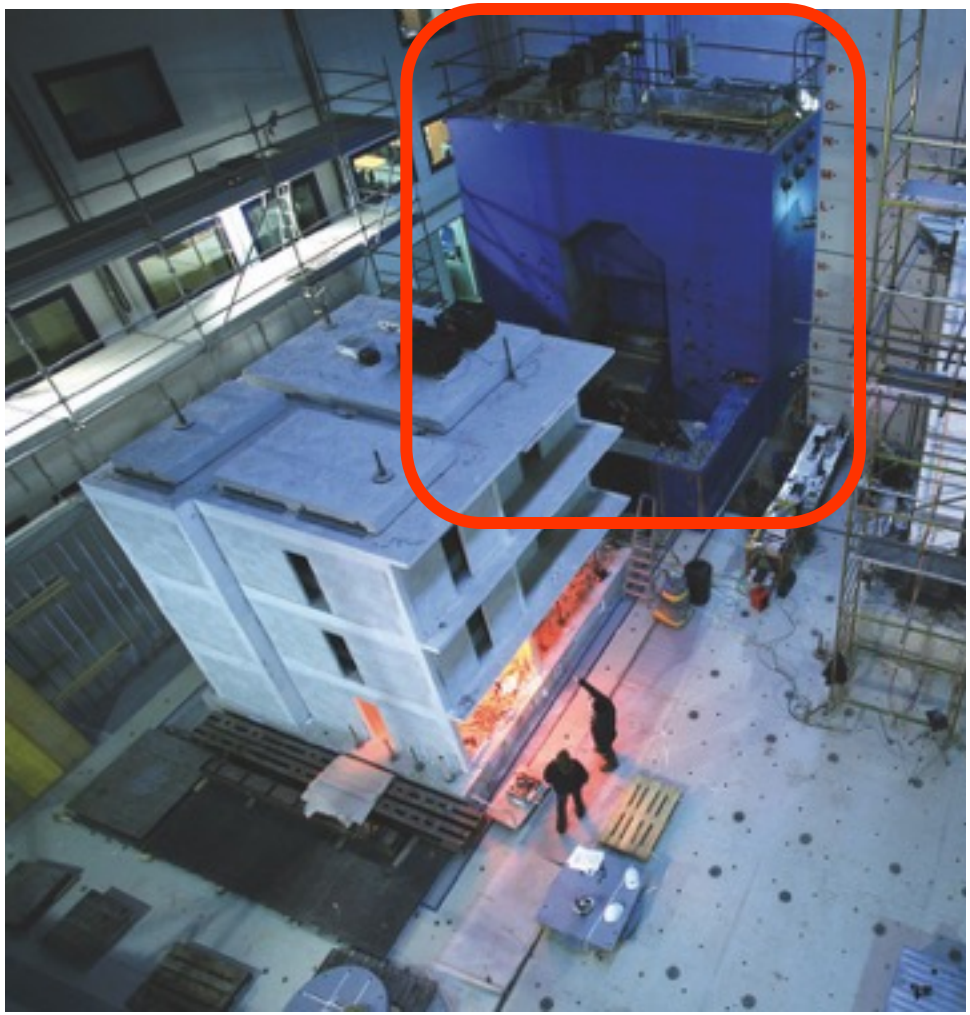
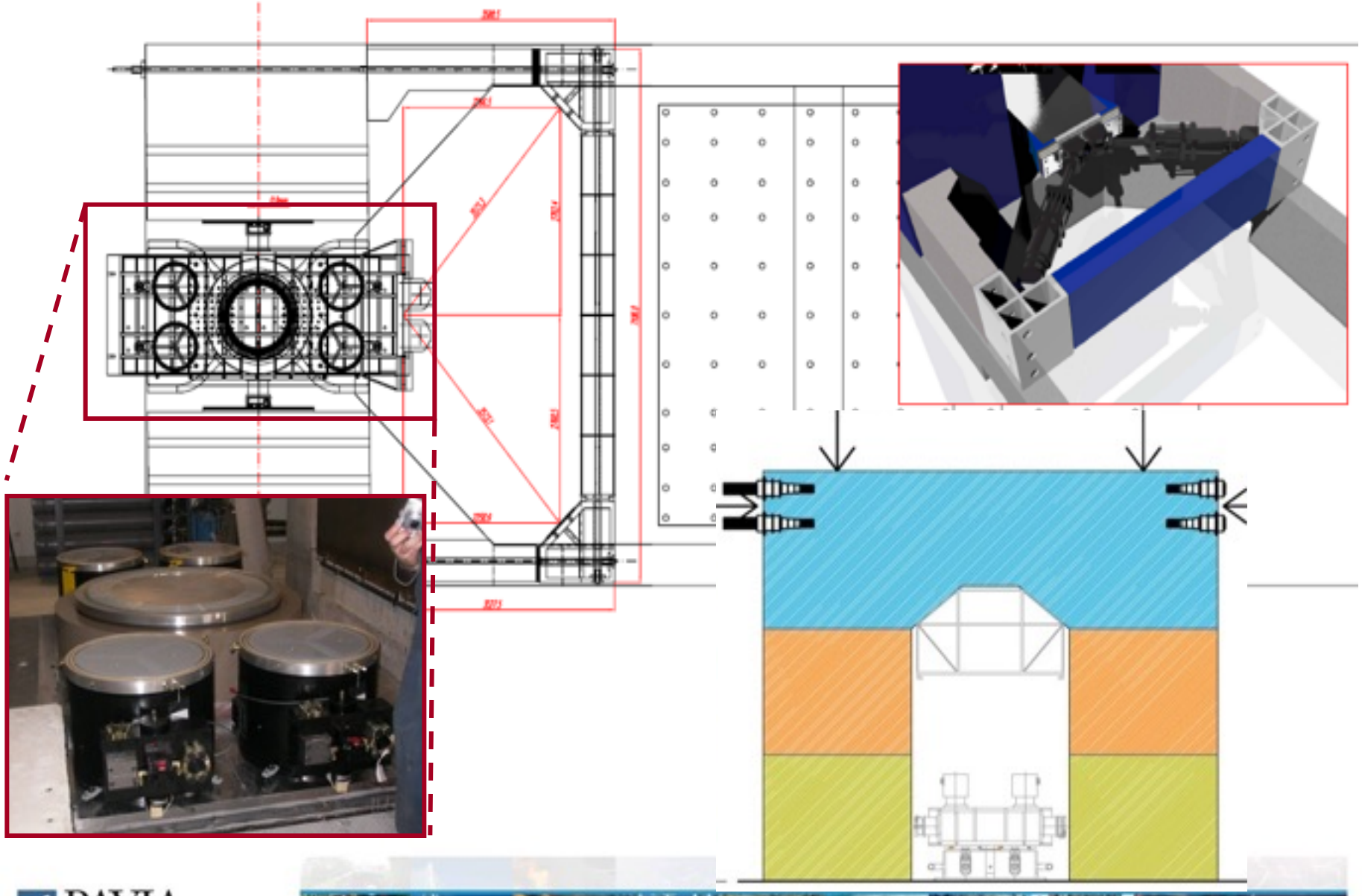
Bearing Testing System (BTS)



Il BTS (Bearing Tester System) è una macchina di prova multi-assiale dedicata a test su dispositivi di appoggio e isolamento sismico di grandi dimensioni.

Supporto alla ricerca e all'industria per quanto riguarda la progettazione e certificazione dei dispositivi

Bearing Testing System (BTS)



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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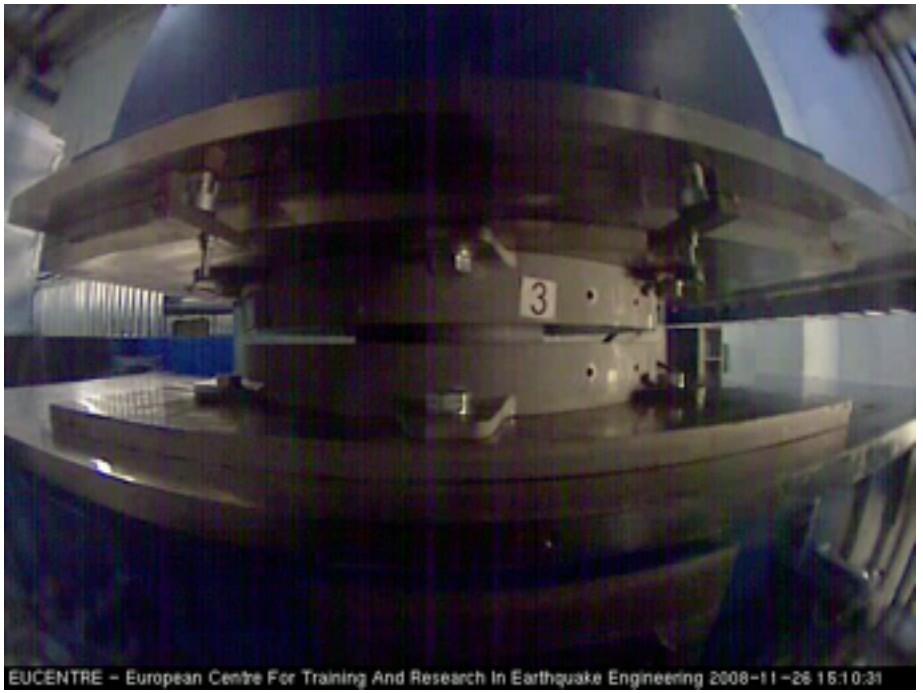
Examples of dynamic testing activities

HIGH DAMPING RUBBER BEARING



CURVED SURFACE SLIDER

Bearing Testing System (BTS)

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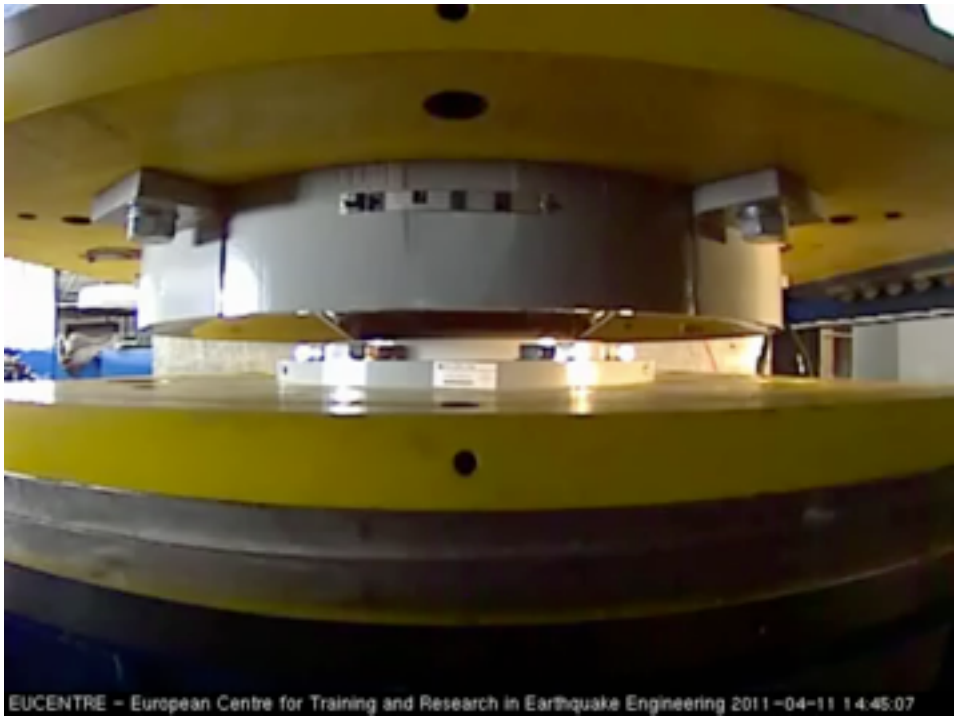
Examples of dynamic testing activities: **FAILURE OF DEVICES**

LAMINATED RUBBER BEARING



CURVED SURFACE SLIDER

Bearing Testing System 3D (BTS3D)

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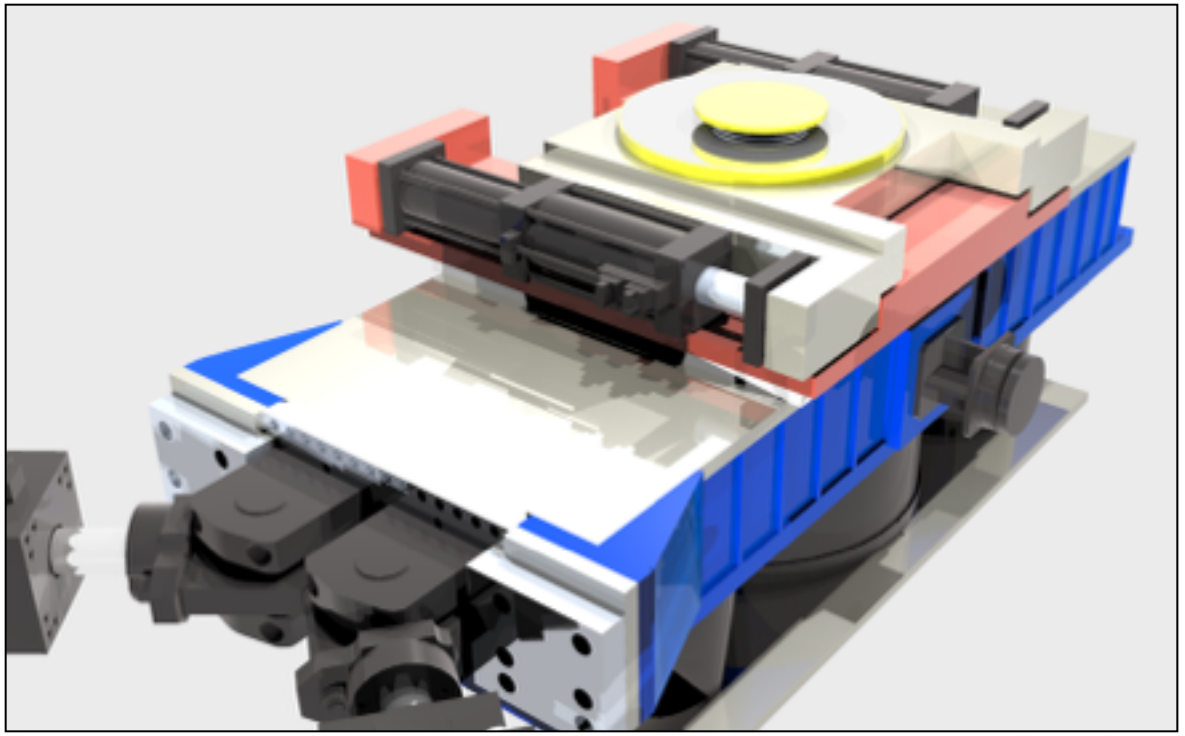
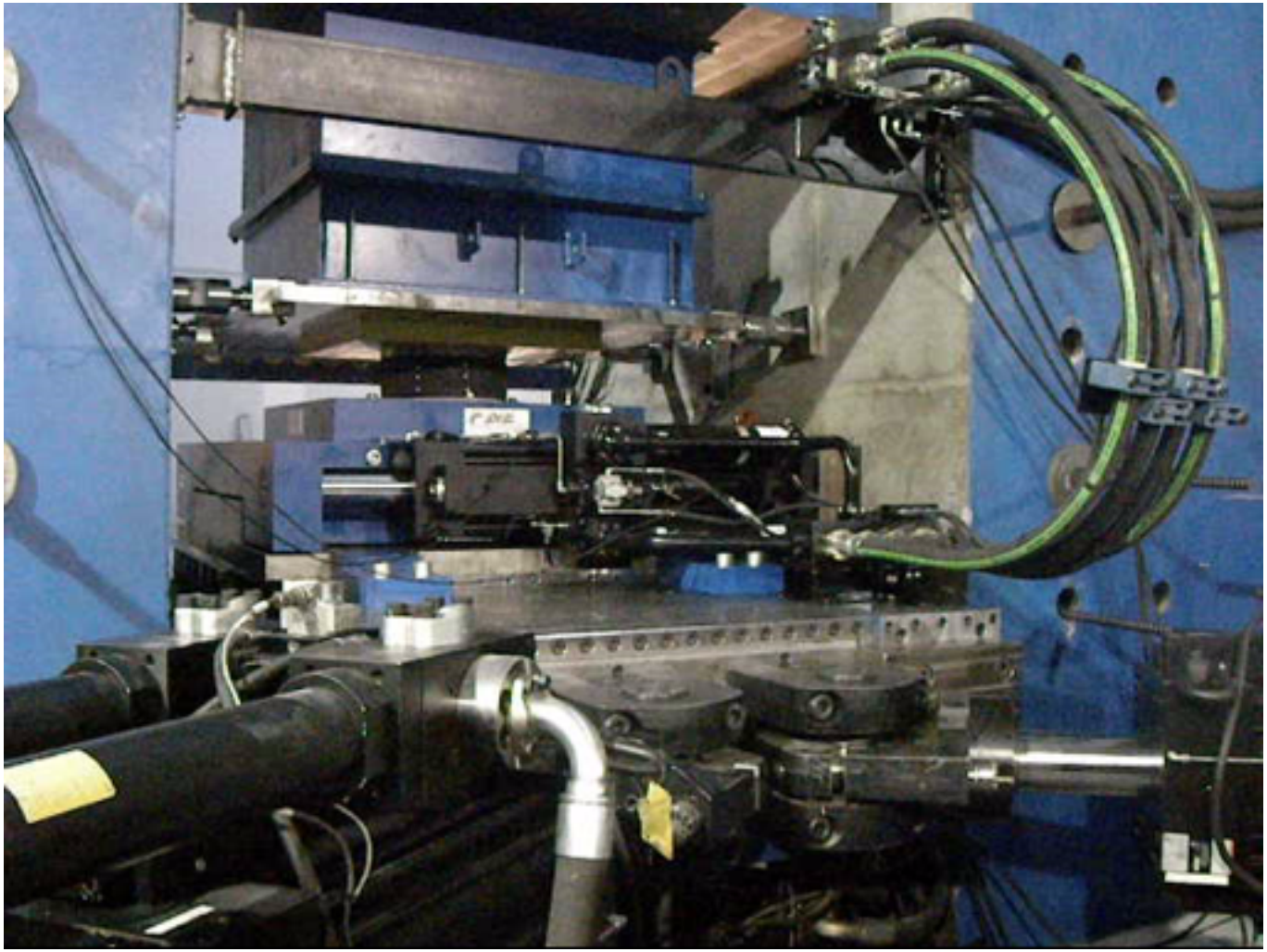
Un finanziamento del DPC ha permesso di aggiungere il gdl mancante al BTS

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)



Damper Testing System (DTS)

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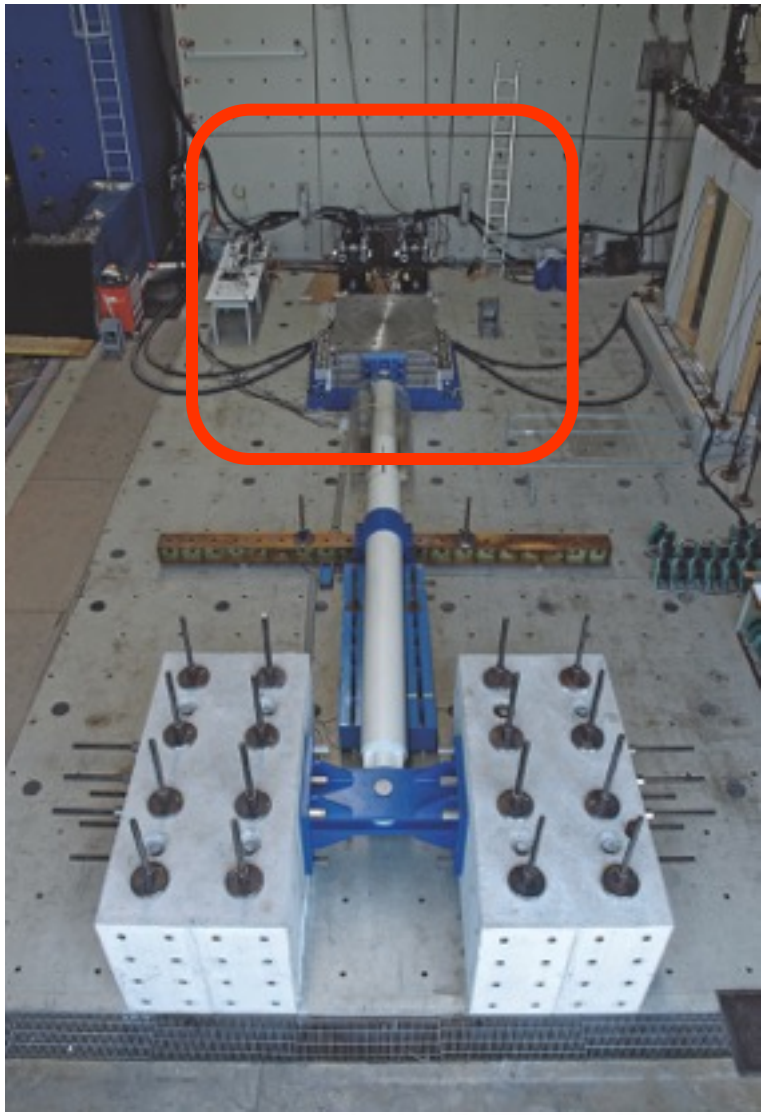
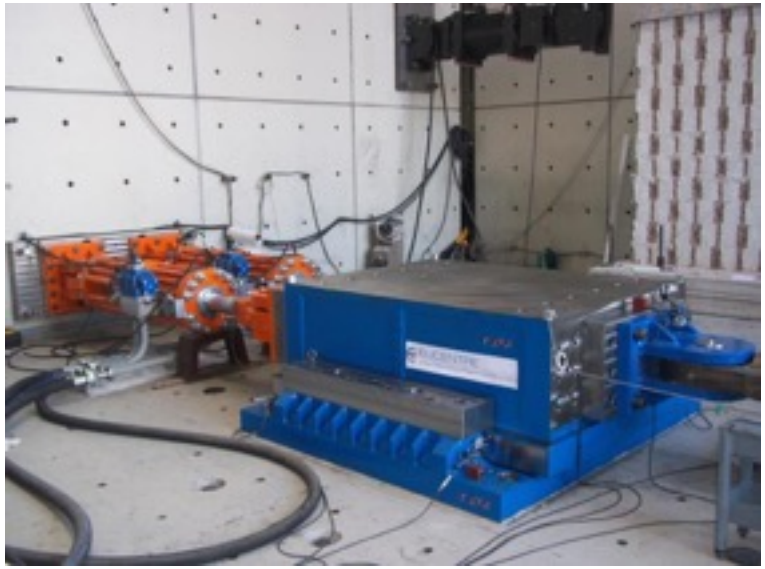


Exploiting the characteristics of the strong floor, this testing equipment is used to evaluate the performances of Damper and Shock Transmission Units.



Damper Testing System (DTS)

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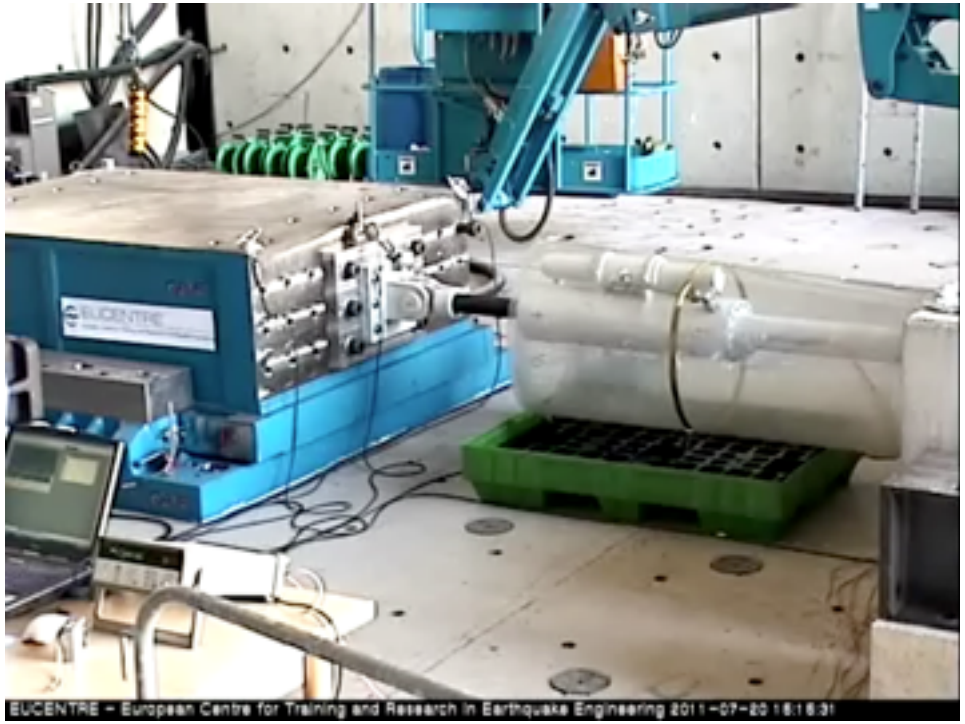
Examples of dynamic testing activities

Dynamic performance of a Fluid Viscous Damper



Failure of a Fluid Viscous Damper

Bearing Testing System 3D (BTS3D)

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PRODOTTI DA COSTRUZIONE

TAB – Technical Assessment Body

CE

NB – Notified Body

Factory Production Control

Initial Type Testing

7aese conference

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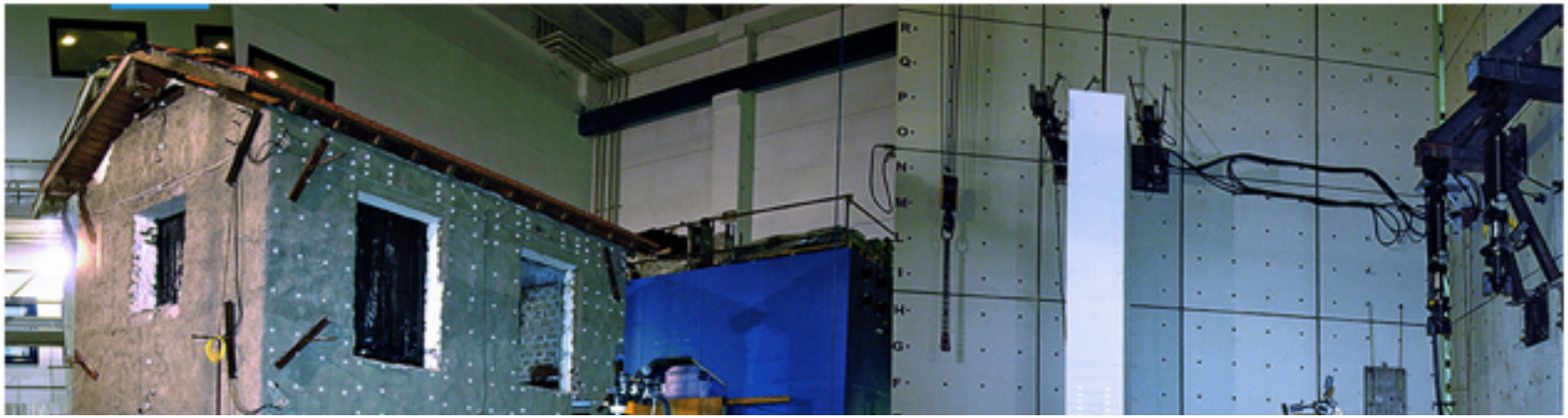

Conference venue: EUCENTRE Foundation, Pavia – Italy • September, 6-8 – 2017

Thanks for your attention

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