COMMISSION OF THE EUROPEAN COMMUNITIES
FP7- INFRASTRUCTURES-2008-1
SP4-Capacities

SERIES

SEISMIC ENGINEERING RESEARCH INFRASTRUCTURES FOR EUROPEAN SYNERGIES

General Committee Final workshop

Ispra (IT), May 30 th, 2013

Université de Liège

ArGEnCo

MAID project :

Seismic behavior of L- and T-shaped unreinforced Masonry shear walls including Acoustic Isolation Devices

H. Degée & C. Mordant, ULg (BE), M. Dietz, Bristol (UK), L. Vasseur, WB
With the contribution of: ULg (ARGENCO), EQUALS, Wienerberger, CDM, RWTH

MAID – Context and objectives of the Project

- Fast evolution of contemporary masonry architecture (North-Western European area):

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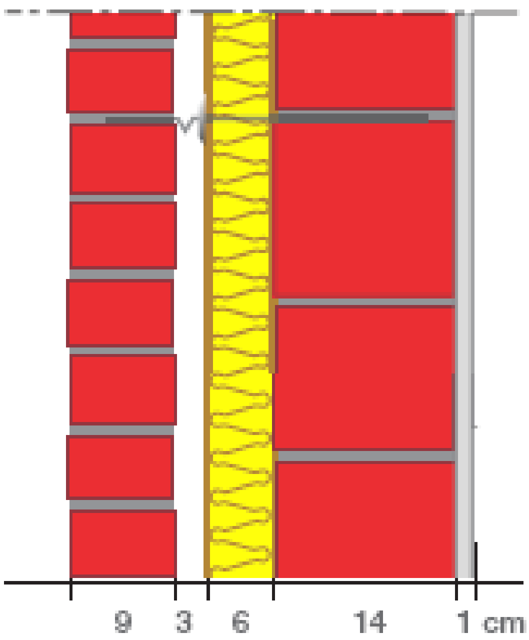
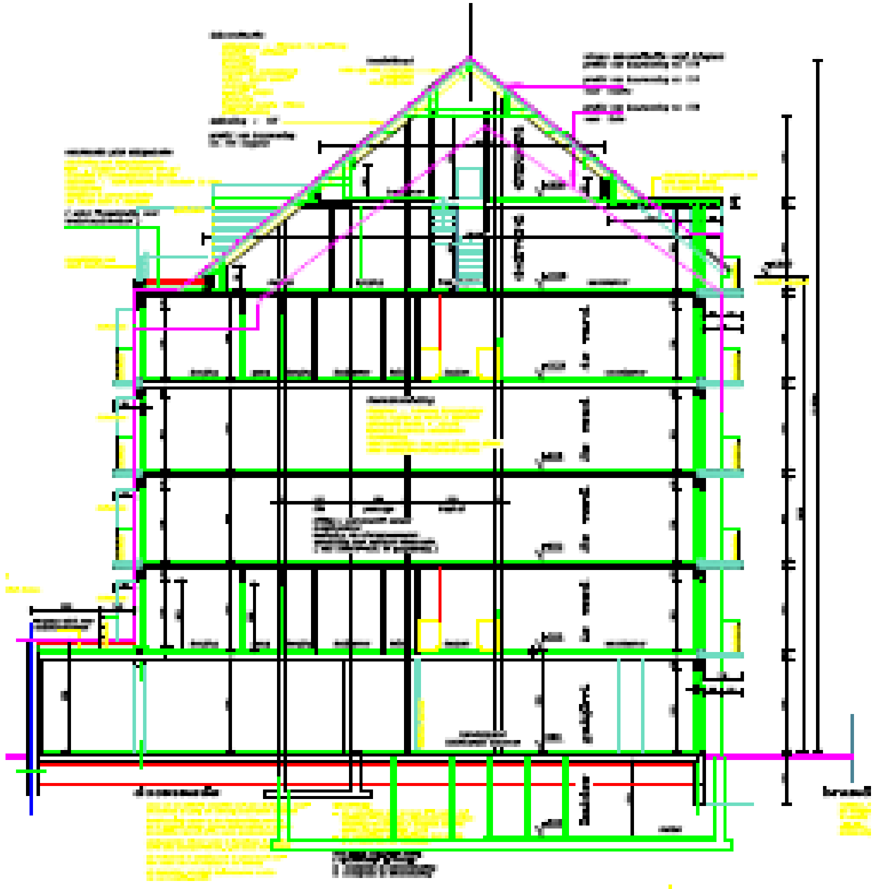
MAID – Context and objectives of the Project

- Fast evolution of contemporary masonry architecture (North-Western European area):
  - Requirement for energy performances



MAID – Context and objectives of the Project

- Fast evolution of contemporary masonry architecture (North-Western European area):
  - Requirement for energy performances
  - Use of unreinforced bearing masonry for mid-rise buildings



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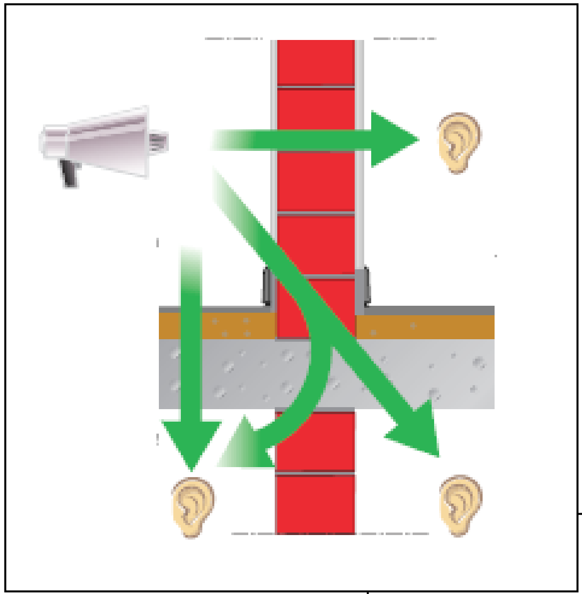

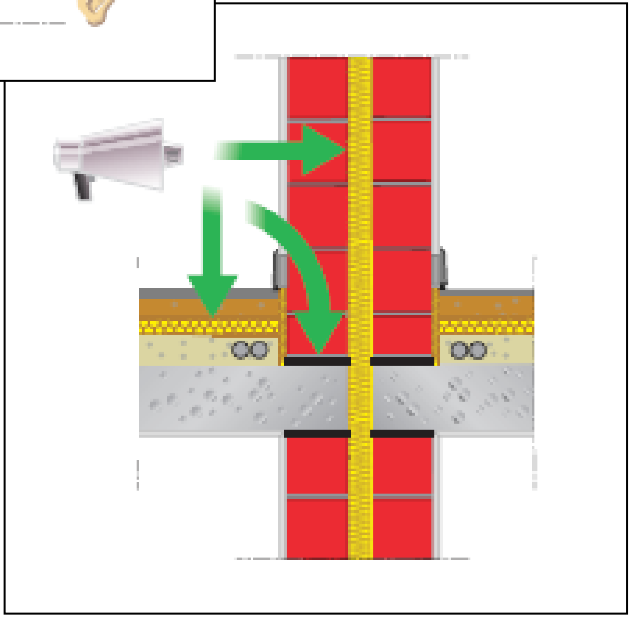

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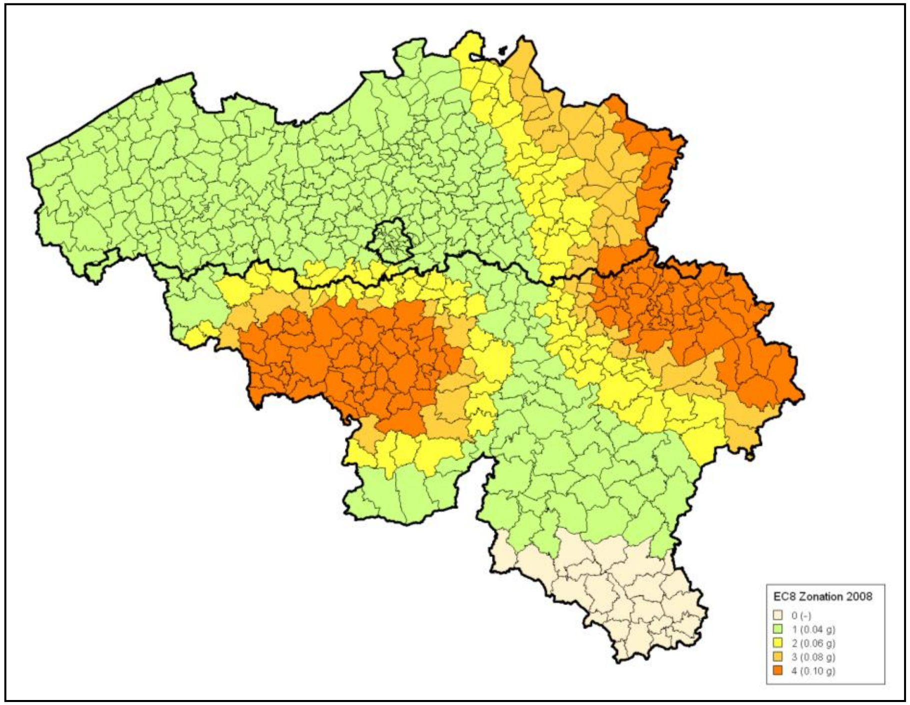
  - Requirements for acoustic performances
  - Seismic resistance (low to moderate seismicity)



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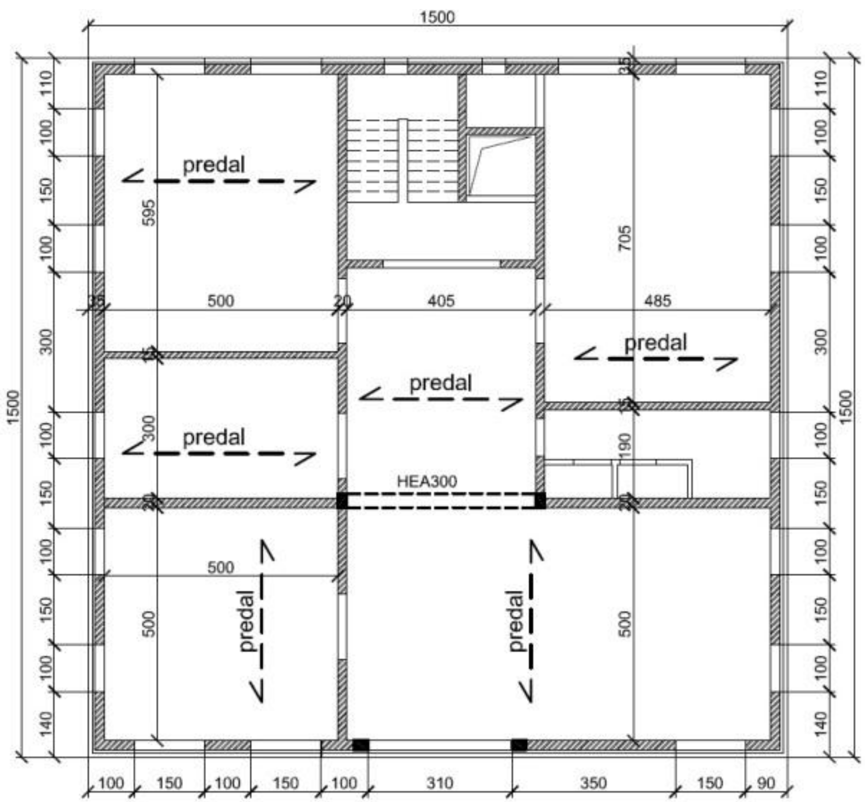
  - Use of unreinforced bearing masonry for mid-rise buildings
  - Requirements for acoustic performances
  - Seismic resistance (low to moderate seismicity)
  - Preferential spanning of prefabricated floors



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MAID – Context and objectives of the Project

- Objectives of the experimental work within SERIES:
  1. Characterization of the dynamic behavior of walls with acoustic rubber devices (comparative study)

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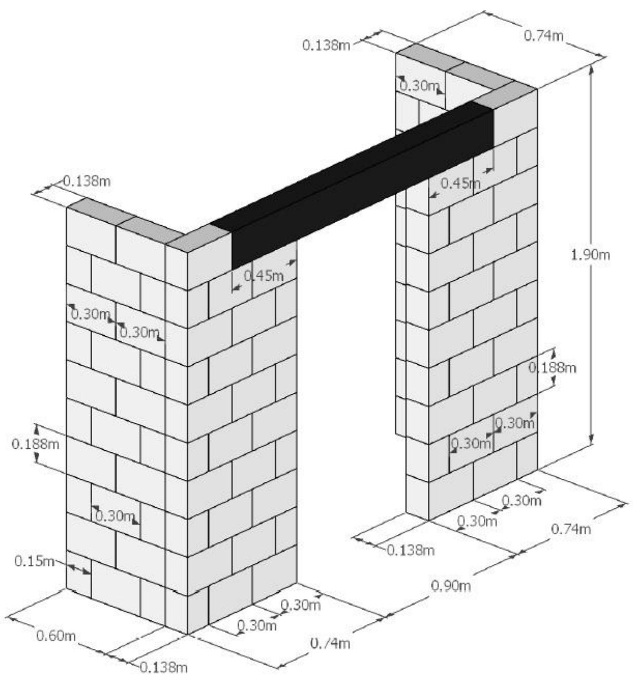
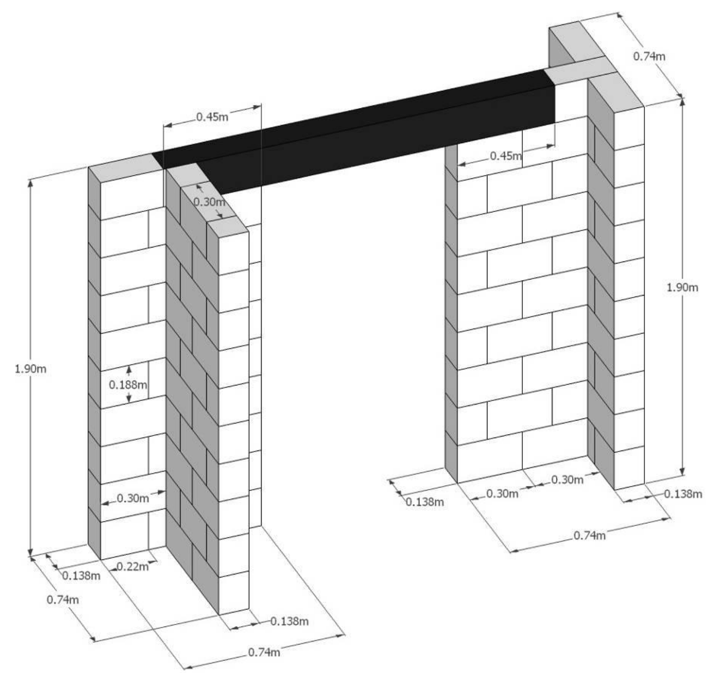
MAID – Context and objectives of the Project

- Objectives of the experimental work within SERIES:
  1. Characterization of the dynamic behavior of walls with acoustic rubber devices (comparative study)
  2. Characterization of the dynamic behavior of flanged walls with differential loading





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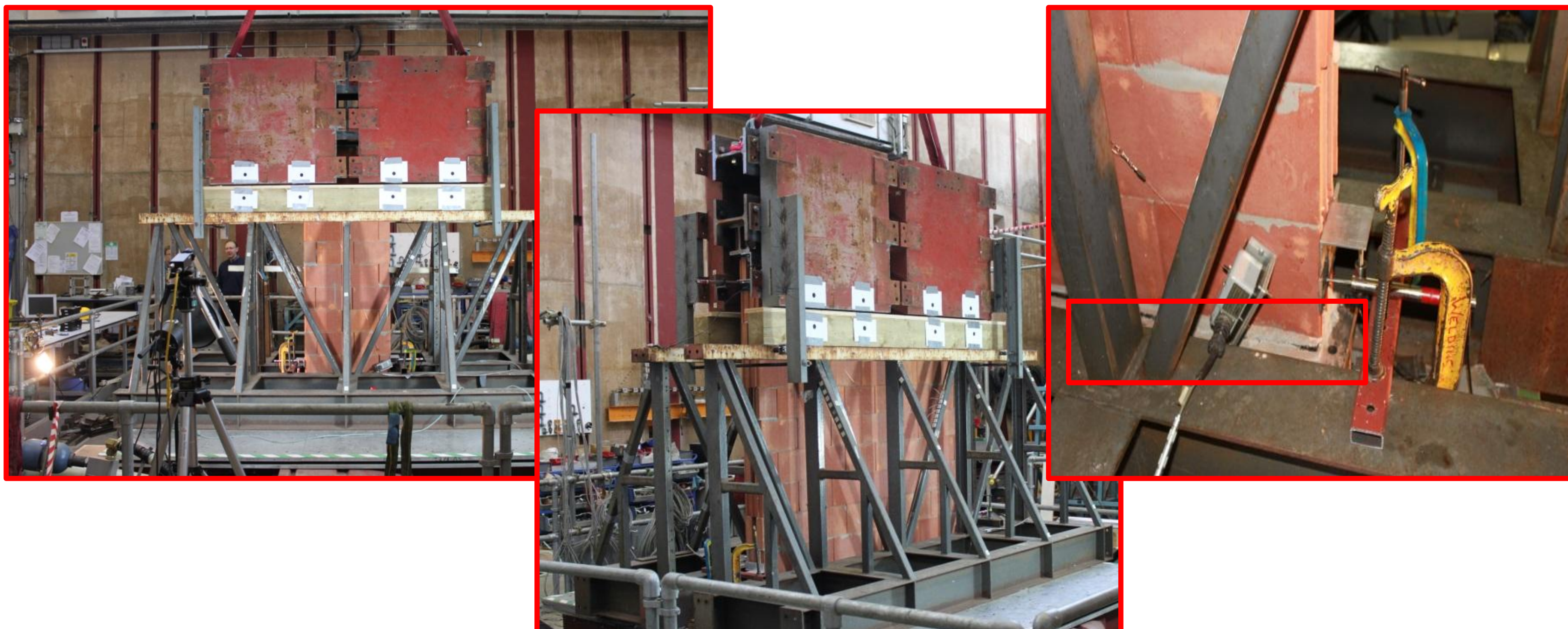
MAID – Testing phase 1 – Single walls

Mock ups:

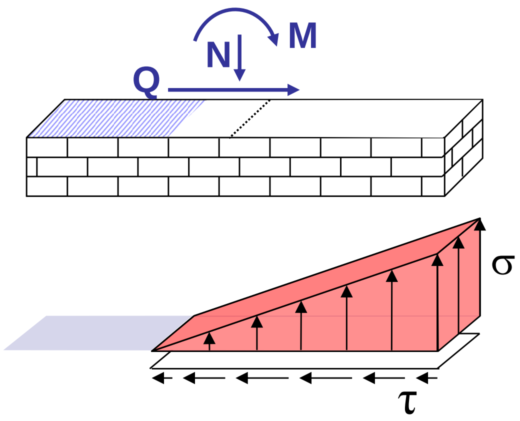
- Four single walls
- **With** and **without** rubber soundproofing devices
- Two different aspect ratios (0.4 and 1.0: bending ←→ shear behavior)



MAID - Testing phase 1 - Single walls

Preliminary design:

- Based on the classical EC6 model with nominal material properties (static equivalent seismic forces)



Maximum acceleration for 5 tons: **0.07 g / 0.2 g**

Testing procedure:

- EC8 spectrum-compatible time-history
- Increasing acceleration level (with some levels duplicated)
  - Tests stopped at ~ **0.2 g / 0.7 g** ("excessive" displacements)

\+ Identification stages

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MAID – Testing phase 1 – Single walls

TA5_120403_S7

Camera shake-table-yaxis

Start time 2012-04-03T15:59:40.793Z

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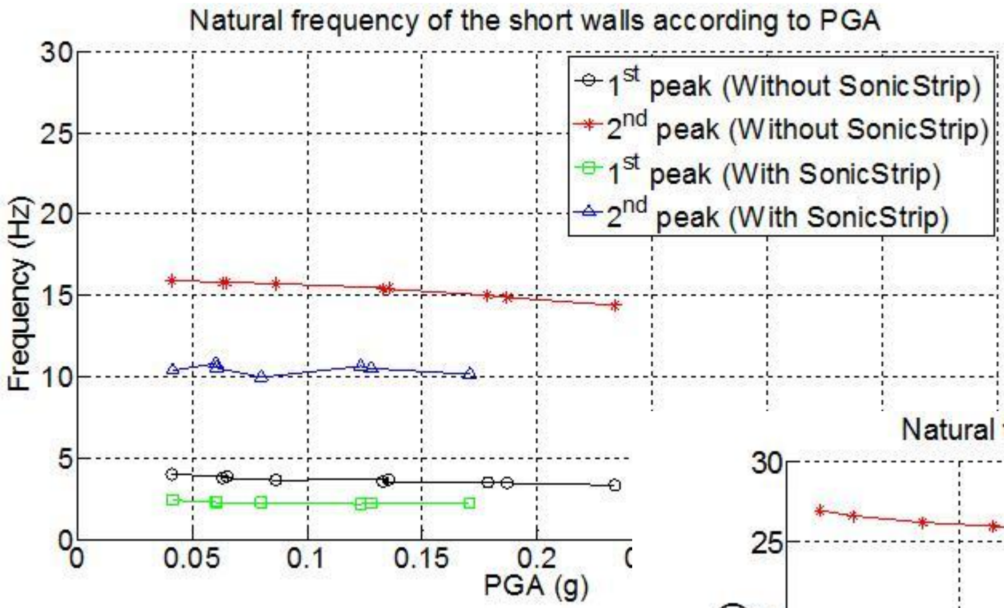
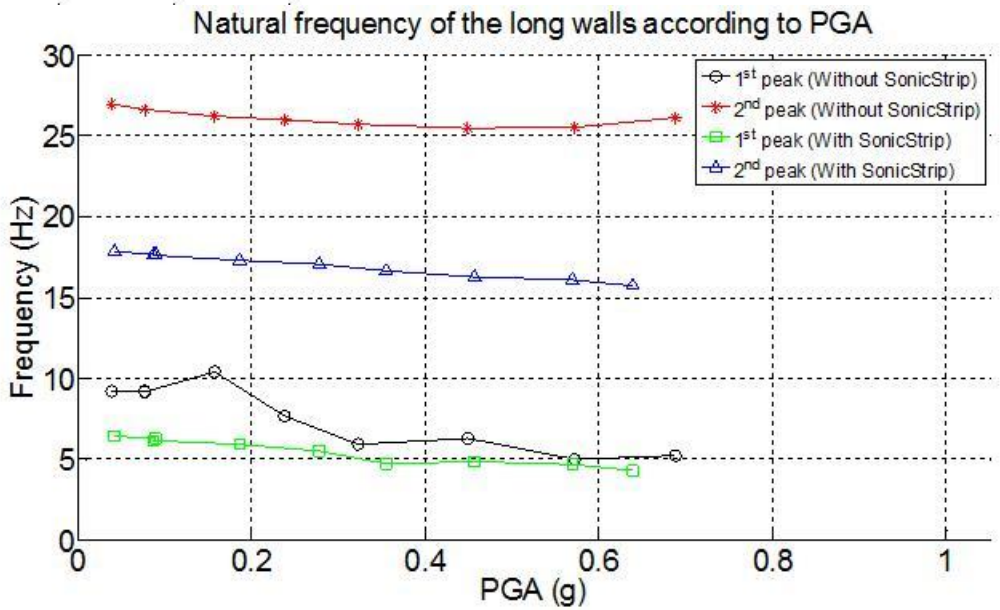
MAID – Testing phase 1 – Single walls

Main experimental results and first numerical/theoretical exploitations:



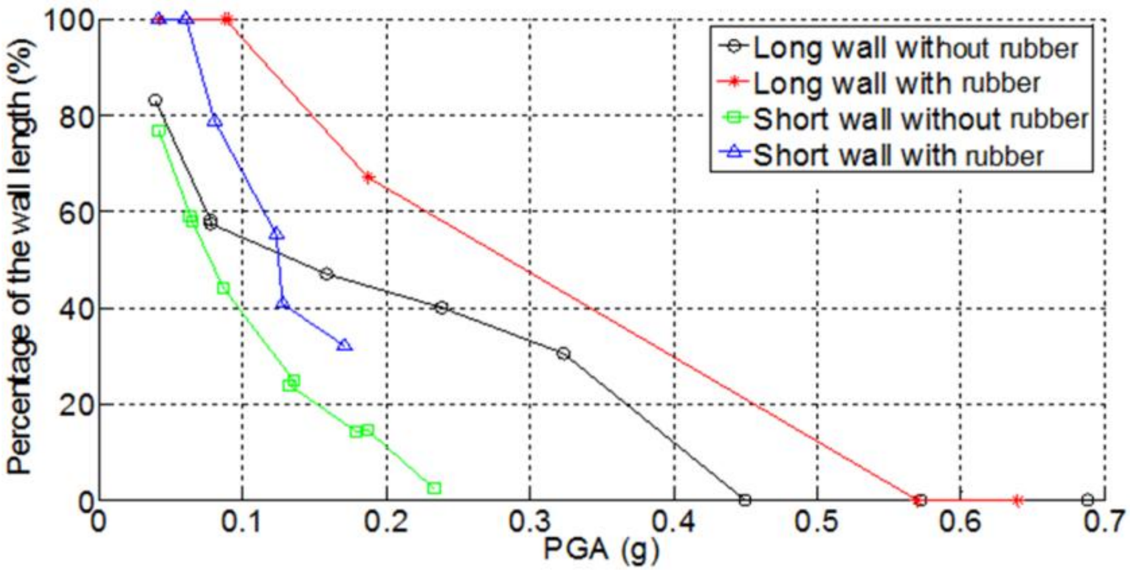
Frequency drop



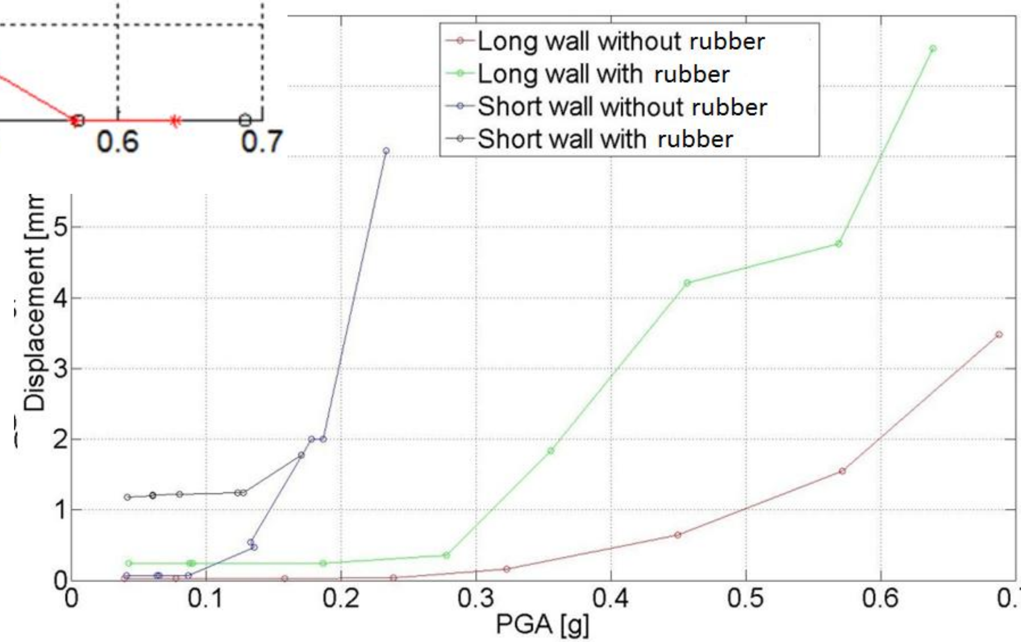
MAID – Testing phase 1 – Single walls

Main experimental results and first numerical/theoretical exploitations:

Seismic behavior



Compression length



Maximum displacement

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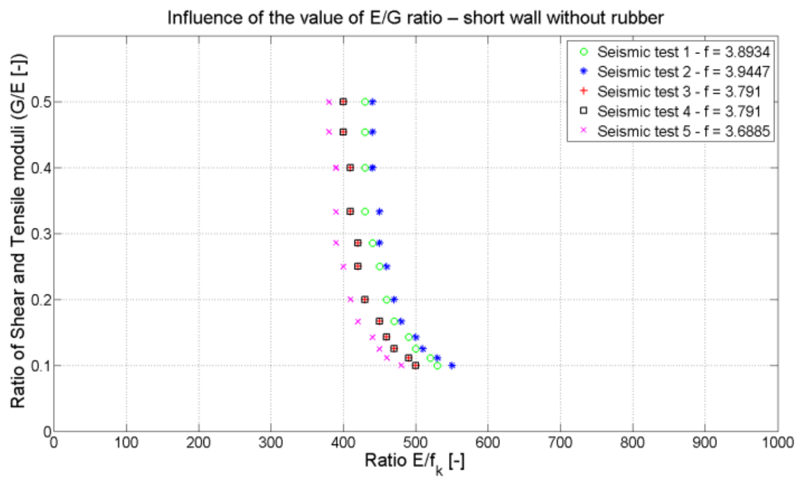
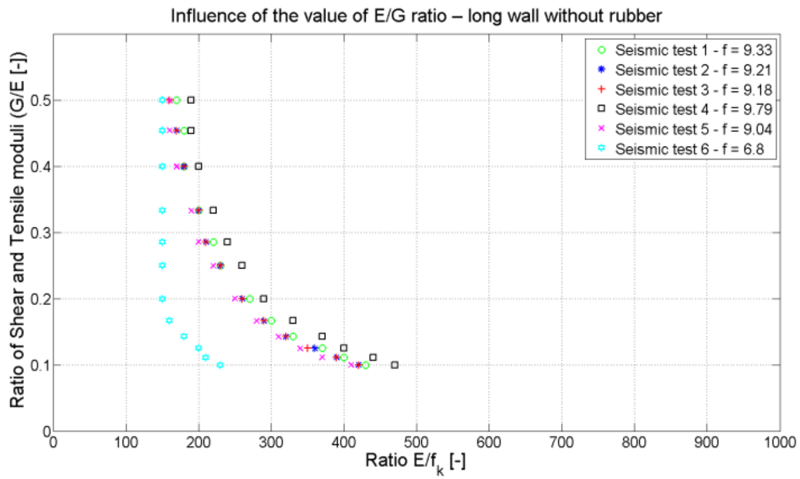
MAID – Testing phase 1 – Single walls

Main experimental results and first numerical/theoretical exploitations:

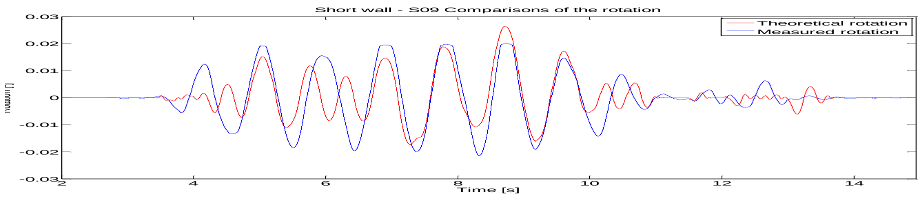
Calibration of numerical models

- Cantilever model (relevant for identification tests or limited accelerations): calibration of E and G modulus (see paper VEESD)





- Rigid body rocking model (suitable for large acceleration) – see paper COMPDYN



MAID – Testing phase 2 – Sub-structures

Mock ups:

- Two masonry portal frames coupled by a lintel and loaded by a concrete slab (+ additional masses)
- Case 1: piers with T cross section / Case 2: piers with L cross section
  - Case 1: Uniform gravity loading (significant overall and local **torsion effects**)
  - Case 2: Uniform gravity loading + Gravity only on flange walls

MAID - Testing phase 2 - Sub-structures

Preliminary design:

- Based on a conventional EC6/EC8 model with nominal material properties for characterizing each pier + pushover/N2 method to evaluate the redistribution capacity

→ Maximum acceleration (longitudinal earthquake):

- **Case 1 (T)**
  - **Uniform loading: 0.76 g**
  - **Loads on shear wall: 0.78 g (shear wall alone: 0.71 g)**
  - **Loads on flanges: 0.64 g**
- **Case 2 (L)**
  - **Uniform loading: 0.83 g**
  - **Loads in shear wall: 0.85 g (shear wall alone: 0.71 g)**
  - **Loads on flanges: 0.65 g (shear wall alone: 0.22 g)**

MAID - Testing phase 2 - Sub-structures

Testing procedure:

- EC8 spectrum-compatible time-history
- Increasing acceleration level - Tests stopped at
  - Case 1 (T): **0.45 g** – Important rocking effect + damaging of piers due to local torsion effects

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MAID – Testing phase 2 – Sub-structures

University of BRISTOL

BLADE

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Camera demountable-two

Start time 2012-05-24T15:26:58.668Z

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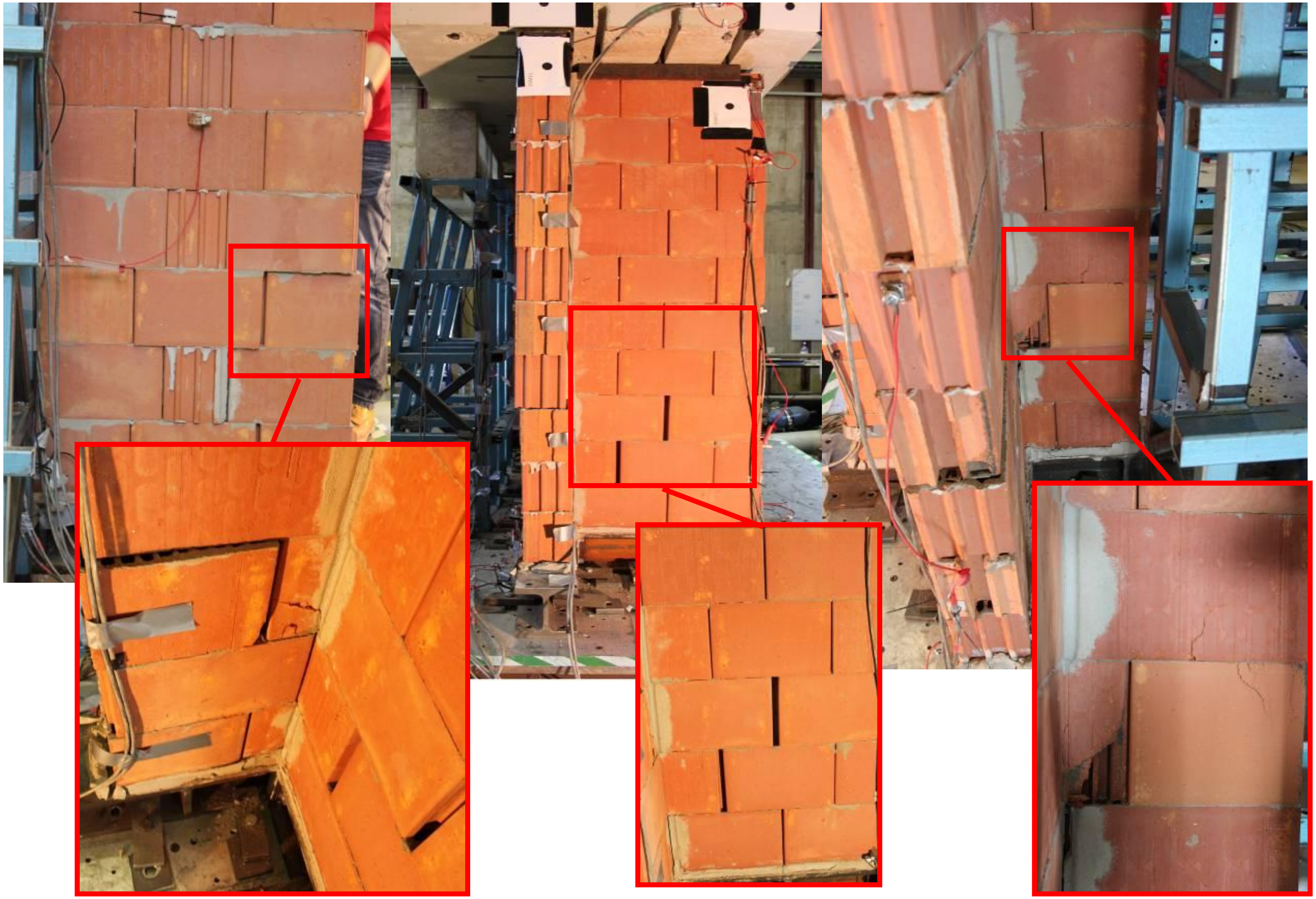
MAID – Testing phase 2 – Sub-structures



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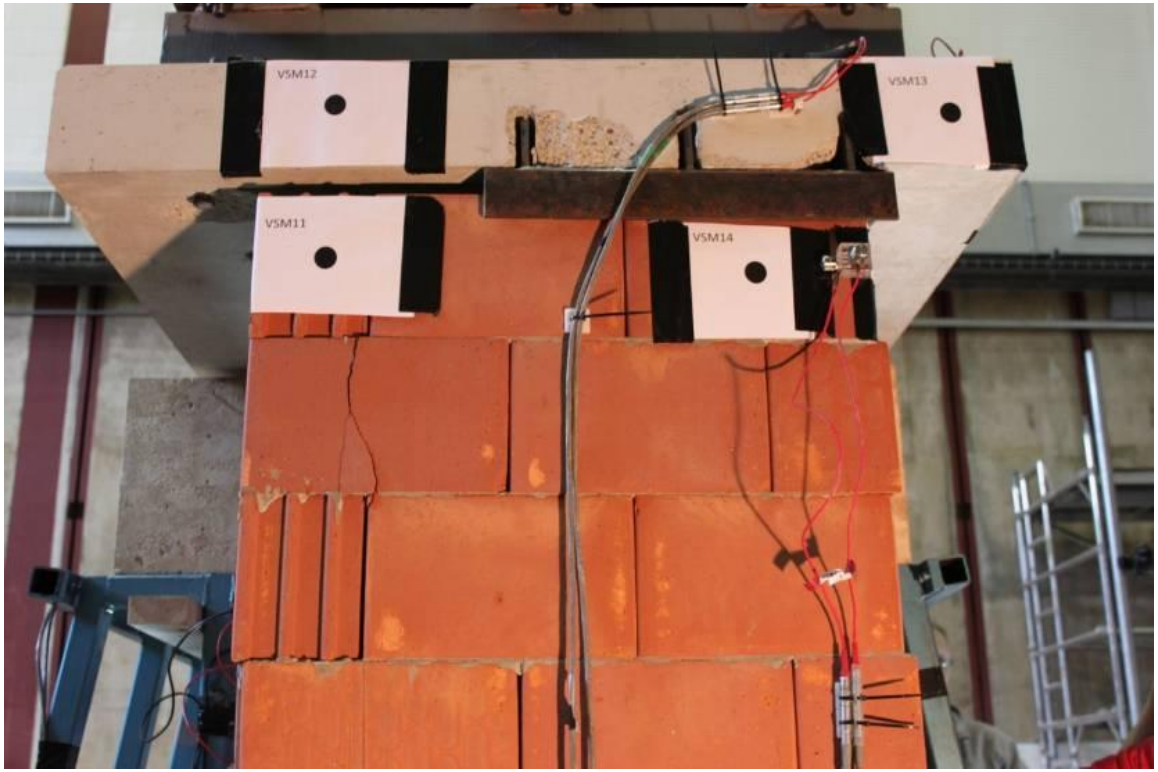
  - Case 2.a (L – uniform): **0.32 g** – Stopped before damaging to allow testing case 2.b in good conditions (slight rocking however observed)
  - Case 2.b (L – load on flanges): **0.25 g !!** – Failure of the connection of the shear wall with the flange (not considered in the preliminary design)

MAID – Testing phase 2 – Sub-structures



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- Quantitative post-processing of the results and model calibration still in progress…

MAID – Conclusions

- Effect of the soundproofing rubber elements:
  - Increase the deformability of the system (longer period)
  - Limits the damage associated with rocking motion
  - Simple predictive models of the compression length are reliable
  - Cantilever and rocking models accurate in their range of applicability
- Frame behavior of flanged shear walls:
  - Basic models strongly overestimate the seismic capacity
  - Flanges trigger less usual effects
  - Importance of further investigating local effects of torsion and force transfer mechanisms at the interface flange/shear wall
- Further analyses still to come …