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

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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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• Fast evolution of contemporary masonry architecture (North-Western European area):
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  ▫ Use of unreinforced bearing masonry for mid-rise buildings
  ▫ Requirements for acoustic performances
  ▫ Seismic resistance (low to moderate seismicity)
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  - Requirement for energy performances
  - Use of unreinforced bearing masonry for mid-rise buildings
  - Requirements for acoustic performances
  - Seismic resistance (low to moderate seismicity)
  - Preferential spanning of prefabricated floors
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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- 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
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: \(0.07 \, \text{g} / \, 0.2 \, \text{g}\)

Testing procedure:
- EC8 spectrum-compatible time-history
- Increasing acceleration level (with some levels duplicated)
  - Tests stopped at \(~0.2 \, \text{g} / \, 0.7 \, \text{g}\) (“excessive” displacements)
- Identification stages
MAID - Testing phase 1 - Single walls

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Camera shake-table-yaxis

Start time 2012-04-03T15:59:40.793Z
**MAID** - Testing phase 1 - Single walls

Main experimental results and first numerical/theoretical exploitations:

- Frequency drop

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**Natural frequency of the short walls according to PGA**

- 1\(^{st}\) peak (Without SonicStrip)
- 2\(^{nd}\) peak (Without SonicStrip)
- 1\(^{st}\) peak (With SonicStrip)
- 2\(^{nd}\) peak (With SonicStrip)

**Natural frequency of the long walls according to PGA**

- 1\(^{st}\) peak (Without SonicStrip)
- 2\(^{nd}\) peak (Without SonicStrip)
- 1\(^{st}\) peak (With SonicStrip)
- 2\(^{nd}\) peak (With SonicStrip)
MAID - Testing phase 1 - Single walls

Main experimental results and first numerical/theoretical exploitations:

Seismic behavior

Compression length

Maximum displacement
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
MAID - Testing phase 2 - Sub-structures

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Maid - Testing phase 2 - Sub-structures
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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
  - 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)
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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 ...