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Data Article

Dataset from shake-table testing of four full-scale URM walls in a two-way bending configuration subjected to combined out-of-plane horizontal and vertical excitation

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A B S T R A C T

This data article provides experimental data obtained from the incremental dynamic shake-table testing of four single leaf unreinforced masonry (URM) walls constructed in Calcium Silicate (CS) bricks reported in “Two-way bending experimental response of URM walls subjected to combined horizontal and vertical seismic excitation” [1]. These walls were tested in the second phase of a larger experimental campaign addressing the out-of-plane (OOP) response of full-scale URM panels in two-way bending configurations at EUCENTRE, Pavia, Italy. Data corresponding to the first phase of testing for four single leaf and one cavity wall has already been made available through Tomassetti *et al.* [2] and the information necessary to interpret these results can be found in Graziotti *et al.* [3]. The walls of the tests reported in this data article were constructed in an intentionally weakened mortar but using the same Calcium Silicate (CS) bricks as Graziotti *et al.* [3]. The walls were also tested in boundary conditions that were not addressed in [3] and a specimen was also subjected to simultaneous horizontal OOP and verti-

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cal seismic excitation in one of the tests. Videos documenting the failure of specimens tested in both phases of the experimental campaign can be viewed online on YouTube [4].

Specifications Table

Subject area	*Engineering*
More specific subject area	*Structural dynamics, Earthquake engineering*
Type of data	*Experimentally recorded raw data that was subsequently filtered and processed, tables and figures explaining the organisation of the data.*
How data were acquired	*All full-scale walls were equipped with wire potentiometers, linear potentiometers, accelerometers and a 3-D optical motion-capture system*
Data format	*Experimentally recorded raw data which was subsequently filtered and processed is provided in .txt files*
Parameters for data collection	*The tested specimens were unreinforced masonry walls in geometries and support conditions that can be commonly found in practice.*
Description of data collection	*Incremental unidirectional and bi-directional dynamic shake-table tests were performed up to collapse conditions of the specimens, using input motions compatible with the induced-seismicity scenario for the Groningen region of the Netherlands*
Data source location	*The reported experiments were performed on the multiaxial shake table of the 6Dlab of EUCENTRE in Pavia, Italy*
Data accessibility	*Experimentally recorded data is included with this article as supplementary material. The same can also be downloaded from the EUCENTRE repository at the URL* www.eucentre.it/nam-project/?lang=en
Related research article	*S. Sharma, U. Tomassetti, L. Grottoli, F. Graziotti, Two-way bending experimental response of URM walls subjected to combined horizontal and vertical seismic excitation, Eng. Struct. 2020; doi.org/10.1016/j.engstruct.2020.110537* [1]

Value of the Data

- The data provided with this article corresponds to one of the first experimental campaigns in literature addressing the dynamic out-of-plane two-way bending response of full-scale unreinforced masonry walls.
- The data elaborated from laboratory tests in this article can be used as a benchmark for numerical models in literature (e.g. [5–12]) for their calibration and development in simulating the out-of-plane two-way bending response of URM walls.
- Analytical methods and design rules (e.g. [13,14]) to assess the out-of-plane two-way bending response of URM walls can be validated and developed using this data.

1. Data Description

Experimentally recorded data during the shake table testing of four single leaf full-scale unreinforced masonry walls (Fig. 1) is provided with this article. Sensors were used to measure accelerations and displacements of these walls in every test of the testing sequence (Table 3 of reference article [1]). Frequencies higher than 50 Hz were filtered from the experimentally recorded raw data. Displacement recordings are provided in units of mm while accelerations and forces are given in units of g and kN, respectively.

The position of the sensors on the specimens along with their operational status in the dynamic tests is provided in Tables 1–3 and Figs. 2–4. If a particular instrument was not recording in certain tests of the testing sequence, these test numbers are indicated in the column “Offline”

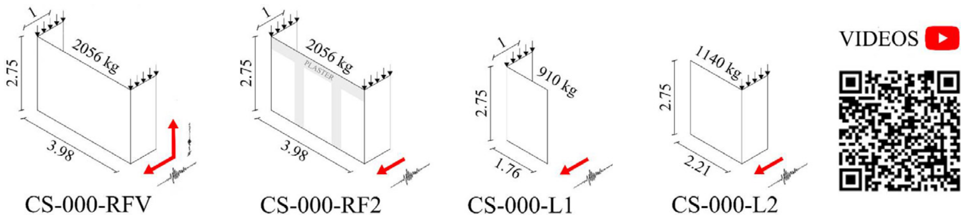

Fig. 1. Geometry, mass and direction of applied excitation for the specimens (all dimensions in m) [1] and QR code to access YouTube playlist [4] documenting the failure of specimens.

of Tables 1–3. In the same column, "-" indicates that the instrument was recording in every run of the entire testing sequence. The mass distribution adopted to calculate the inertial force of the OOP panel (which is also provided in the data) has been provided in Figs. 2–4. It is to be noted that this distribution was changed through the incremental dynamic testing sequence to take into account the progression of cracks and damage. The lumped masses that were associated with each accelerometer as a result of these mass distributions have been indicated in Tables 1–3. For more details on how the inertial force associated with each specimen was calculated, the reader is directed to the reference article [1].

The data corresponding to all the tests of the testing sequence (Table 3 of the reference article [1]) of a specimen is provided in a folder named as the specimen itself i.e. all data corresponding to the specimen CS-000-RFV [1] is grouped in a folder named as "CS-000-RFV". Multiple .txt files can be found inside each folder. Each .txt file corresponds to a single test of the testing sequence and is also named accordingly i.e. as "TestT#" with "T#" referring to the test number from Table 3 of the reference article [1]. The first column of every .txt file corresponds to a time vector while all other columns to instrument recordings as per the number indicated under "Col." in Tables 1–3. It is to be noted that, for specimens CS-000-L1 and CS-000-L2, which were tested simultaneously on the shake table, the results for both specimens are provided in a single .txt file contained in a folder named "CS-000-L1&L2". Figs. 2–4 provides a visual representation of the instrumentation adopted for each specimen. The exact coordinates of the location of each instrument is provided in Tables 1–3.

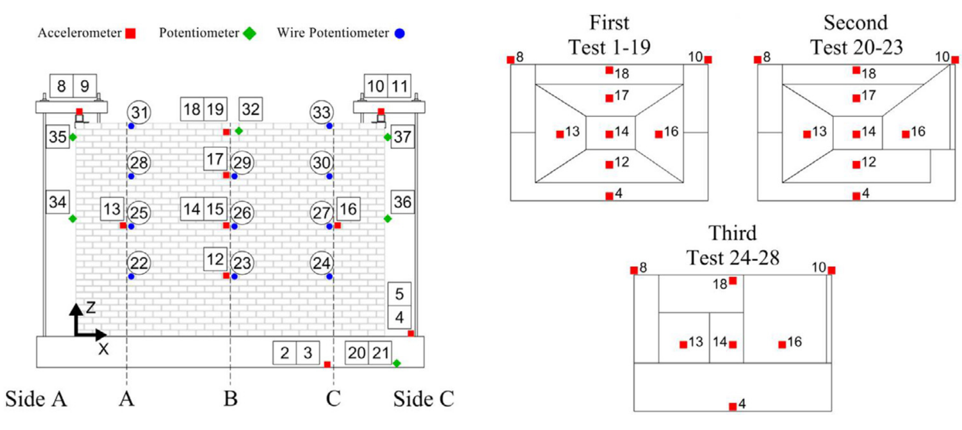

Fig. 2. Instrumentation, mass distribution evolution and associated Test# for specimen CS-000-RFV.

Table 1
CS-000-RFV data organisation.

Col.	Instr.	Description	Offline	Location		Associated Mass		
				X [mm]	Z [mm]	1st [kg]	2nd [kg]	3rd [kg]
1	–	’Time [s]’	–	–	–	–	–	–
2	Accelerometer	’Shake Table X Acceleration [g]’	–	–	–	–	–	–
3	Accelerometer	’Shake Table Z Acceleration [g]’	–	–	–	–	–	–
4	Accelerometer	’Foundation X Acceleration [g]’	–	–	–	460	428	725
5	Accelerometer	’Foundation Z Acceleration [g]’	–	–	–	–	–	–
6	Accelerometer	’Frame X Acceleration [g]’	–	–	–	–	–	–
7	Accelerometer	’Frame Z Acceleration [g]’	–	–	–	–	–	–
8	Accelerometer	’Side A Ret. Wall X Acceleration [g]’	–	–	–	128	128	166
9	Accelerometer	’Side A Ret. Wall Z Acceleration [g]’	–	–	–	–	–	–
10	Accelerometer	’Side C Ret. Wall X Acceleration [g]’	–	–	–	128	33	34
11	Accelerometer	’Side C Ret. Wall Z Acceleration [g]’	–	–	–	–	–	–
12	Accelerometer	’1/4 B Wall X Acceleration [g]’	28	1995	775	251	312	–
13	Accelerometer	’1/2 A Wall X Acceleration [g]’	–	885	1425	255	255	195
14	Accelerometer	’1/2 B Wall X Acceleration [g]’	–	1995	1505	126	126	131
15	Accelerometer	’1/2 B Wall Z Acceleration [g]’	–	1995	1505	–	–	–
16	Accelerometer	’1/2 C Wall X Acceleration [g]’	–	3105	1425	242	306	558
17	Accelerometer	’3/4 B Wall X Acceleration [g]’	28	1995	2070	242	234	–
18	Accelerometer	’4/4 B Wall X Acceleration [g]’	–	1995	2640	223	233	245
19	Accelerometer	’4/4 B Wall Z Acceleration [g]’	1–16	1995	2640	–	–	–
20	Potentiometer	’Shake Table X Displacement [mm]’	–	–	–	–	–	–
21	Potentiometer	’Shake Table Z Displacement [mm]’	–	–	–	–	–	–
22	Wire Potentiometer/Optical	’1/4 A Wall Displacement [mm]’	21–28	885	775	–	–	–
23	Wire Potentiometer/Optical	’1/4 B Wall Displacement [mm]’	21–28	1995	775	–	–	–
24	Wire Potentiometer/Optical	’1/4 C Wall Displacement [mm]’	21–28	3105	775	–	–	–
25	Wire Potentiometer/Optical	’1/2 A Wall Displacement [mm]’	21–28	885	1425	–	–	–
26	Wire Potentiometer/Optical	’1/2 B Wall Displacement [mm]’	21–28	1995	1505	–	–	–
27	Wire Potentiometer/Optical	’1/2 C Wall Displacement [mm]’	21–28	3105	1425	–	–	–
28	Wire Potentiometer/Optical	’3/4 A Wall Displacement [mm]’	21–28	885	2070	–	–	–
29	Wire Potentiometer/Optical	’3/4 B Wall Displacement [mm]’	21–28	1995	2070	–	–	–
30	Wire Potentiometer/Optical	’3/4 C Wall Displacement [mm]’	21–28	3105	2070	–	–	–
31	Wire Potentiometer/Optical	’4/4 A Wall Displacement [mm]’	–	885	2720	–	–	–
32	Potentiometer/ Optical	’4/4 B Wall Displacement [mm]’	–	1995	2720	–	–	–
33	Optical	’4/4 C Wall Displacement [mm]’	–	3105	2720	–	–	–
34	Potentiometer/ Optical	’1/2 Side A OOP Detachment [mm]’	–	220	1425	–	–	–
35	Potentiometer/ Optical	’4/4 Side A OOP Detachment [mm]’	–	220	2640	–	–	–
36	Potentiometer/ Optical	’1/2 Side C OOP Detachment [mm]’	–	3770	1425	–	–	–
37	Potentiometer/ Optical	’4/4 Side C OOP Detachment [mm]’	–	3770	2640	–	–	–
38	–	’Inertial Force [kN]’	–	–	–	–	–	–

Table 2
CS-000-RF2 data organisation.

Col.	Instr.	Description	Offline	Location		Associated Mass
				X[mm]	Z[mm]	1st[kg]
1	–	'Time [s]'	–	–	–	–
2	Accelerometer	'Shake Table Acceleration [g]'	–	–	–	–
3	Accelerometer	'Foundation Acceleration [g]'	–	–	–	473
4	Accelerometer	'Frame Acceleration [g]'	–	–	–	–
5	Accelerometer	'Side A Ret. Wall Acceleration [g]'	–	–	–	108
6	Accelerometer	'Side C Ret. Wall Acceleration [g]'	–	–	–	108
7	Accelerometer	'1/4 B Wall Acceleration [g]'	–	1995	695	260
8	Accelerometer	'1/2 A Wall Acceleration [g]'	–	885	1340	199
9	Accelerometer	'1/2 B Wall Acceleration [g]'	–	1995	1340	126
10	Accelerometer	'1/2 C Wall Acceleration [g]'	–	3105	1340	188
11	Accelerometer	'3/4 A Wall Acceleration [g]'	–	885	2070	165
12	Accelerometer	'3/4 B Wall Acceleration [g]'	–	1995	2070	121
13	Accelerometer	'3/4 C Wall Acceleration [g]'	–	3105	2070	157
14	Accelerometer	'4/4 C Wall Acceleration [g]'	–	1995	2640	150
15	Potentiometer	'Shake Table Displacement [mm]'	–	–	–	–
16	Potentiometer	'1/4 A Wall Displacement [mm]'	–	885	855	–
17	Potentiometer	'1/4 B Wall Displacement [mm]'	–	1995	855	–
18	Potentiometer	'1/4 C Wall Displacement [mm]'	–	3105	855	–
19	Potentiometer	'1/2 A Wall Displacement [mm]'	–	885	1425	–
20	Potentiometer	'1/2 B Wall Displacement [mm]'	–	1995	1425	–
21	Potentiometer	'1/2 C Wall Displacement [mm]'	–	3105	1425	–
22	Potentiometer	'3/4 A Wall Displacement [mm]'	–	885	2070	–
23	Potentiometer	'3/4 B Wall Displacement [mm]'	–	1995	2070	–
24	Potentiometer	'3/4 C Wall Displacement [mm]'	–	3105	2070	–
25	Potentiometer	'4/4 B Wall Displacement [mm]'	–	1995	2720	–
26	Potentiometer	'1/2 Side A OOP Detachment [mm]'	–	220	1425	–
27	Potentiometer	'4/4 Side A OOP Detachment [mm]'	–	220	2640	–
28	Potentiometer	'1/2 Side C OOP Detachment [mm]'	–	3770	1425	–
29	Potentiometer	'4/4 Side C OOP Detachment [mm]'	–	3770	2640	–
30	–	'Inertial Force [kN]'	–	–	–	–
31	Optical	'4/4 A Wall Displacement [mm]'	–	885	2720	–
32	Optical	'4/4 C Wall Displacement [mm]'	–	3105	2720	–

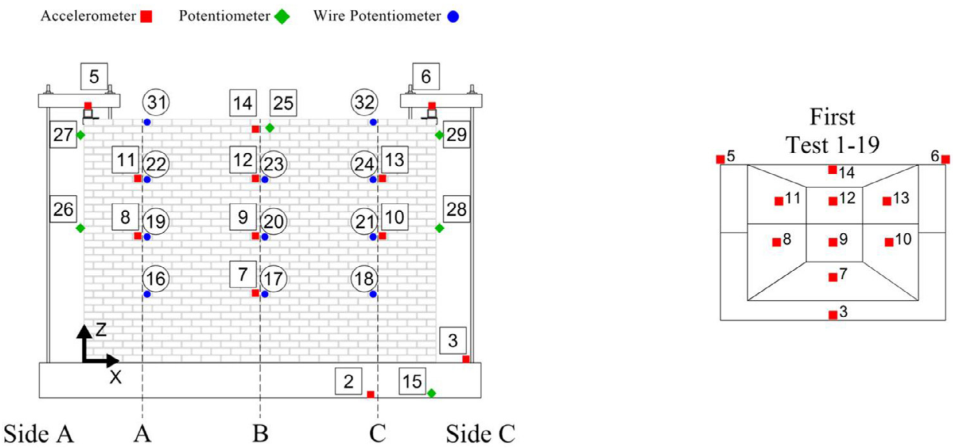

Fig. 3. Instrumentation, mass distribution evolution and associated Test# for specimen CS-000-RF2.

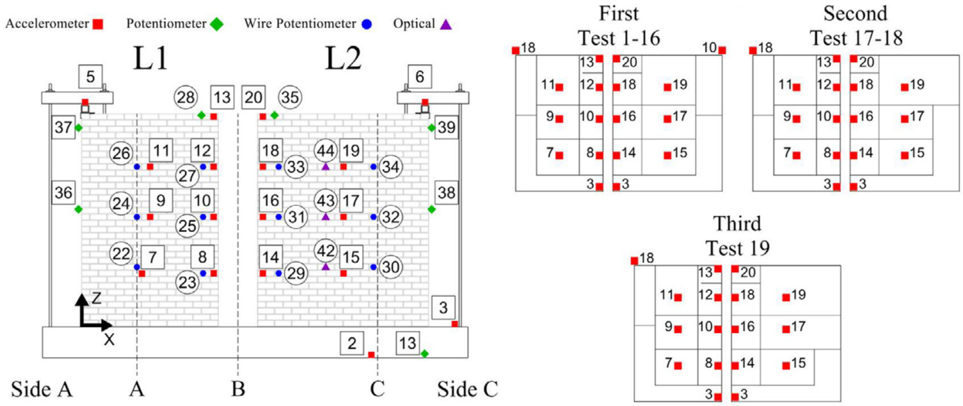

Fig. 4. Instrumentation, mass distribution evolution and associated Test# for specimen CS-000-L1&L2.

2. Experimental Design, Materials, and Methods

All the full-scale specimens were tested on the multiaxial shake table of the new 6DLab of EUCENTRE, Pavia, Italy. The horizontal (OOP) input motions used corresponded to accelerograms recorded at the first floor level of a full-scale building prototype experimentally tested by Graziotti *et al.* [8]. The characteristics of these input motions can be found in Table 2 of the reference article [1]. Additionally, a specimen (CS-000-RFV) was subjected to simultaneous vertical and horizontal seismic input. The applied vertical excitations were recorded at the ground level of the same building prototype [8]. Low amplitude motions having a broad frequency bandwidth were also used in between test runs to document any change in the frequency associated with the first natural mode of vibration of the specimens.

The instrumentation adopted for each specimen consisted of accelerometers, potentiometers, wire potentiometers as well as a 3D optical acquisition system. Expected deformed shapes were used as the basis of choosing the location of the sensors on the wall specimens. In particular: accelerometers were installed to record acceleration-time histories, potentiometers were used to measure relative displacements and wire potentiometers to record displacements relative to different parts of the adopted setup or the shake table. The 3D optical acquisition system was also used to measure displacements at both locations equipped and not equipped with traditional instrumentation i.e. potentiometers and wire potentiometers. This system was especially useful in continuing to have sufficient locations at which displacement was measured in dynamic tests performed at high intensities when traditional instruments had to be removed for the sake of preserving them from damage during collapse.

3. Illustrative Examples

- Referring to Table 1, column 5 of “Test6.txt” in the folder “CS-000-RFV” corresponds to recordings of the ’Foundation Z Acceleration [g]’ i.e. vertical acceleration of the foundation when specimen CS-000-RFV was subjected to FEQ1-DS0 scaled at 110% in both the horizontal (OOP) and vertical directions i.e. T#6 in Table 3 of the reference article [1].
- Referring to Table 3, columns 28 and 35 of the file “Test14.txt” in the folder “CS-000-L1&L2” corresponds to recordings of the ’4/4 B L1 Displacement [mm]’ and ’4/4 B L2 Displacement [mm]’ respectively i.e. OOP displacements at the location of the intersection of the free edges of specimens CS-000-L1 and CS-000-L2 (see Fig. 4). This data was recorded when both specimens were subjected to FEQ1-DS4 in the horizontal (OOP) direction scaled at 150% and 120%

Table 3
CS-000-L1&L2 data organisation.

	Instr.	Description	Offline	Location		Associated Mass		
				X [mm]	Z [mm]	1st [kg]	2nd [kg]	3rd [kg]
1	–	'Time [s]'	–	–	–	–	–	–
2	Accelerometer	'Shake Table Acceleration [g]'	–	–	–	–	–	–
3	Accelerometer	'Foundation Acceleration [g]'	–	–	–	460	481	412
4	Accelerometer	'Frame Acceleration [g]'	–	–	–	–	–	
5	Accelerometer	'Side A Ret. Wall Acceleration [g]'	–	–	–	95	95	95
6	Accelerometer	'Side C Ret. Wall Acceleration [g]'	–	–	–	122	–	–
7	Accelerometer	'1/4 A L1 Acceleration [g]'	–	775	695	127	127	127
8	Accelerometer	'1/4 B L1 Acceleration [g]'	–	1660	695	56	56	56
9	Accelerometer	'1/2 A L1 Acceleration [g]'	–	775	1425	120	120	120
10	Accelerometer	'1/2 B L1 Acceleration. [g]'	–	1660	1425	52	52	52
11	Accelerometer	'3/4 A L1 Acceleration [g]'	–	775	2070	176	176	176
12	Accelerometer	'3/4 B L1 Acceleration [g]'	–	1660	2070	51	51	51
13	Accelerometer	'4/4 B L1 Acceleration [g]'	–	1660	2640	28	28	28
14	Accelerometer	'1/4 B L2 Acceleration [g]'	–	1885	695	80	80	80
15	Accelerometer	'1/4 C L2 Acceleration [g]'	–	2880	695	150	150	150
16	Accelerometer	'1/2 B L2 Acceleration [g]'	–	1885	1425	75	75	75
17	Accelerometer	'1/2 C L2 Acceleration [g]'	–	2880	1425	140	140	210
18	Accelerometer	'3/4 B L2 Acceleration [g]'	–	1885	2070	71	71	71
19	Accelerometer	'3/4 C L2 Acceleration [g]'	–	2880	2070	206	307	307
20	Accelerometer	'4/4 B L2 Acceleration [g]'	–	1885	2640	39	39	39
21	Potentiometer	'Shake Table Displacement [mm]'	–	–	–	–	–	–
22	Wire Potentiometer	'1/4 A L1 Displacement [mm]'	–	775	695	–	–	–
23	Wire Potentiometer	'1/4 B L1 Displacement [mm]'	–	1660	695	–	–	–
24	Wire Potentiometer	'1/2 A L1 Displacement [mm]'	–	775	1425	–	–	–
25	Wire Potentiometer	'1/2 B L1 Displacement [mm]'	–	1660	1425	–	–	–
26	Wire Potentiometer	'3/4 A L1 Displacement [mm]'	–	775	2070	–	–	–
27	Wire Potentiometer	'3/4 B L1 Displacement [mm]'	–	1660	2070	–	–	–
28	Potentiometer	'4/4 B L1 Displacement [mm]'	–	1660	2640	–	–	–
29	Wire Potentiometer	'1/4 B L2 Displacement [mm]'	–	1885	695	–	–	–
30	Optical	'1/4 C L2 Displacement [mm]'	–	2880	695	–	–	–
31	Wire Potentiometer	'1/2 B L2 Displacement [mm]'	–	1885	1425	–	–	–
32	Optical	'1/2 C L2 Displacement [mm]'	–	2880	1425	–	–	–
33	Wire Potentiometer	'3/4 B L2 Displacement [mm]'	–	1885	2070	–	–	–
34	Optical	'3/4 C L2 Displacement [mm]'	–	2880	2070	–	–	–
35	Potentiometer	'4/4 B L2 Displacement [mm]'	–	1885	2640	–	–	–
36	Potentiometer	'1/2 Side A L1 OOP Detachment [mm]'	–	220	1425	–	–	–
37	Potentiometer	'4/4 Side A L1 OOP Detachment [mm]'	–	220	2640	–	–	–
38	Potentiometer	'1/2 Side C L2 OOP Detachment [mm]'	–	3770	1425	–	–	–
39	Potentiometer	'4/4 Side C L2 OOP Detachment [mm]'	–	3770	2640	–	–	–
40	–	'Inertial Force L1 [kN]'	–	–	–	–	–	–
41	–	'Inertial Force L2 [kN]'	–	–	–	–	–	–
42	Wire Potentiometer	'1/4 L2 Displacement [mm]'	–	3325	695	–	–	–
43	Wire Potentiometer	'1/2 L2 Displacement [mm]'	–	3325	1425	–	–	–
44	Wire Potentiometer	'3/4 L2 Displacement [mm]'	–	3325	2070	–	–	–

to the spectral acceleration at the fundamental period of CS-000-L1 and CS-000-L2 respectively i.e. T#14 in Table 3 of the reference article [1].

Declaration of Competing Interest

This paper describes an activity that is part of the "Study of the vulnerability of masonry buildings in Groningen" project at the EUCENTRE within the framework of the research program on hazard and risk of induced seismicity in Groningen sponsored by the Nederlandse Aardolie Maatschappij BV. The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

CRediT authorship contribution statement

S. Sharma: Investigation, Formal analysis, Writing - original draft. **L. Grottoli:** Data curation, Software, Visualization. **U. Tomassetti:** Conceptualization, Investigation, Visualization. **F. Graziotti:** Conceptualization, Supervision, Writing - review & editing.

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Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2020.105851.

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