Dataset: Shake-table Tests on Two 40-ton Reinforced Concrete U-shaped Walls with Uniaxial and Bidirectional-Torsional Response

Ryan Hoult[*],[a)] M.EERI António A. Correia,[b)] Alex Bertholet,[a)] Paulo Candeias,[b)] Gwendal Cumunel,[c)] Catherine Doneux,[a)] Denis Garnier, [c)] Yunhyeok Han,[d)] Tatjana Isakovic,[e)] Antonio Janevski,[e)] Stefania Lo Feudo,[d)] Andrea Orgnoni,[f)] Basile Payen,[a)] Dan Palermo,[g)] Rui Pinho,[h)] M.EERI Filipe Ribeiro,[b)] João Pacheco de Almeida[a)]

Reinforced concrete (RC) structures, widely used in mid- to high-rise construction, face significant challenges related to sustainability, durability, and seismic resilience. Despite extensive experimental research on RC walls, studies specifically focusing on their torsional response remain limited. To address these gaps, the ERIES-ALL4wALL project investigates the torsional and bidirectional flexural behavior of RC U-shaped walls, a key structural feature in contemporary and future high-rise buildings. This paper presents experimental findings from shake-table tests on two slender U-shaped walls, evaluating their nonlinear flexural and torsional performance under realistic seismic ground motions. Advanced instrumentation techniques—such as camera-based vibration measurements—are introduced to capture detailed performance data. The accompanying open-access data is then outlined, enabling further research and development of models to improve the resilience and sustainability of RC core walls in urban environments.

ORGANIZATION OF TEST DATA

All test data for UWS1 and UWS2 are publicly available for download from *Dataverse* at https://doi.org/10.14428/DVN/MSDSWS. The data folder structure is summarized in Figure 1 and can also be viewed directly on *Dataverse* by selecting the "Tree" view. The dataset is organized by specimen, with dedicated folders for each test unit, labeled "UWS(i)".

Before proceeding, it is important to note that Dataverse automatically converts certain file types, such as Microsoft Excel (.xlsx) and comma-separated values (.csv) files, into tabular data (.tab) format for online

[*]Corresponding author, ryan.hoult@newcastle.edu.au, Laboratoire Essais mécaniques, Bâtiment VINCI, Place du Levant 1, 1348 Louvain-la-Neuve, Belgium.
a) Institute of Mechanics, Materials and Civil Engineering, UCLouvain, Louvain-la-Neuve, Belgium
b) National Laboratory for Civil Engineering (LNEC), Lisbon, Portugal
c) Navier, ENPC, Institut Polytechnique de Paris, Univ Gustave Eiffel, CNRS, Marne-la-Vallée, France
d) QUARTZ Laboratory, Vibrations, Acoustics, Mechanical Structures and Shapes, ISAE-Supméca, Saint-Ouen-sur-Seine, France
e) Faculty of Civil and Geodetic Engineering, University of Ljubljana, Ljubljana, Slovenia
f) University School for Advanced Studies IUSS Pavia, Pavia, Italy
g) Dept. of Civil Engineering, York University, Toronto, ON, Canada
h) Department of Civil Engineering and Architecture, University of Pavia, Pavia, Italy

viewing. However, users have the option to download the original uploaded files in their native formats, as described below.

UWS(i) FOLDERS

The data is organized by wall unit. Figure 1 illustrates the folder and file structure for a generic specimen, UWS(i) ("i" stands for 1 or 2), representing the standardized layout. However, minor variations exist between the two wall units due to differences in instrumentation and test setup. Each wall unit dataset contains two main folders:

1. "UWS(i)_General". This folder contains the following files:
   - "UWS(i)_Lab_Book.xlsx": a copy of the laboratory notebook, which records all of the observations made during the experimental tests, is provided in the form of a Microsoft Excel spreadsheet.
   - "UWS(i)_Specimen_Description.pdf": a report summarizing the test specimen and test setup.
   - "UWS(i)_Plans.pdf": the wall construction drawings, with detailed representation of the reinforcement layout.
   - "UWS(i)_Test_Report.pdf": a test report summarizing the observed behavior and overall test results.

   There are also additional sub-folders:

   (i). "Material_Tests": this sub-folder contains the results of the material tests that were performed on the concrete (i.e., compression tests on regular 150 mm × 300 mm cylinders).

   (ii). "Photos": this sub-folder contains the collected photos before and during the test, taken at subsequent load stages, and separated by the photo of the "GM" (i.e., Ground Motion) number sign attached to the wall units.

2. "Processed_Data". In general, this folder contains different processed data files in Binary MATLAB (.mat) (Mathworks, 2020), Comma Separated Values (.csv), and Microsoft Excel (.xlsx) formats. The following files can be found in this sub-folder:
   - "UW(i)_Processed_Data.pdf": a document that provides more detailed information on the processed instrumentation files. This important document summarizes all the data acquisition files and how they can be read.

   Sub-folders at this sub-level contain different processed data:

   (i). "Conventional": this sub-folder contains the processed dataset from the conventional instrumentation (e.g., potentiometers, LVDTs, accelerometers, etc). This data is stored in a Microsoft Excel file, "UWS(i)_DATA.xlsx". The Microsoft Excel file contains nine tabs,

corresponding to each ground (input) motion intensity (i.e., GM0 through to GM8). Furthermore, each column of data corresponds to an instrument that can be visualized in the "Instrumentation_Setup.pdf" file, also stored in this sub-folder. For more information on how to use this data, please see the "UW(i)_Processed_Data.pdf" document.

(ii). "DFOS" (only applicable to unit UWS1): this sub-folder contains the processed and indexed strain measurements captured by the DFOS system; these files are only provided in Binary MATLAB (.mat) file type. Two files are included in this sub-folder:

- "UW(i)_OpFib_Parameters.mat" contains instrument information about the distributed fiber optic sensors (e.g., frequency, location of gages, recording time, etc).
- "UW(i)_OpFib_Strain.mat" contains the strain measurements (in units of microstrain = $\times 10^{-6}$ mm/mm) recorded during testing.

(iii). "OptiTrack": this sub-folder contains data from the motion capture OptiTrack instrumentation. This data is separated into files corresponding to each ground motion (GM) and is provided in Comma Separated Value (.csv) files. Each column of the .csv files contain information on the x-, y-, and z- coordinates of the different markers. More information on how this file can be interpreted can be found in the "UW(i)_Processed_Data.pdf" document.

(iv). "Virtual_Targets": this sub-folder contains the data corresponding to the optical measurements extracted from the circular and cross virtual targets painted on the surface of the walls. Similar to the OptiTrack data, Comma Separated Value (.csv) files are provided for each ground motion intensity, and each column of data contain information on the x-, y-, and z- coordinates of the virtual targets. More information on how this file can be interpreted can be found in the "UW(i)_Processed_Data.pdf" document.

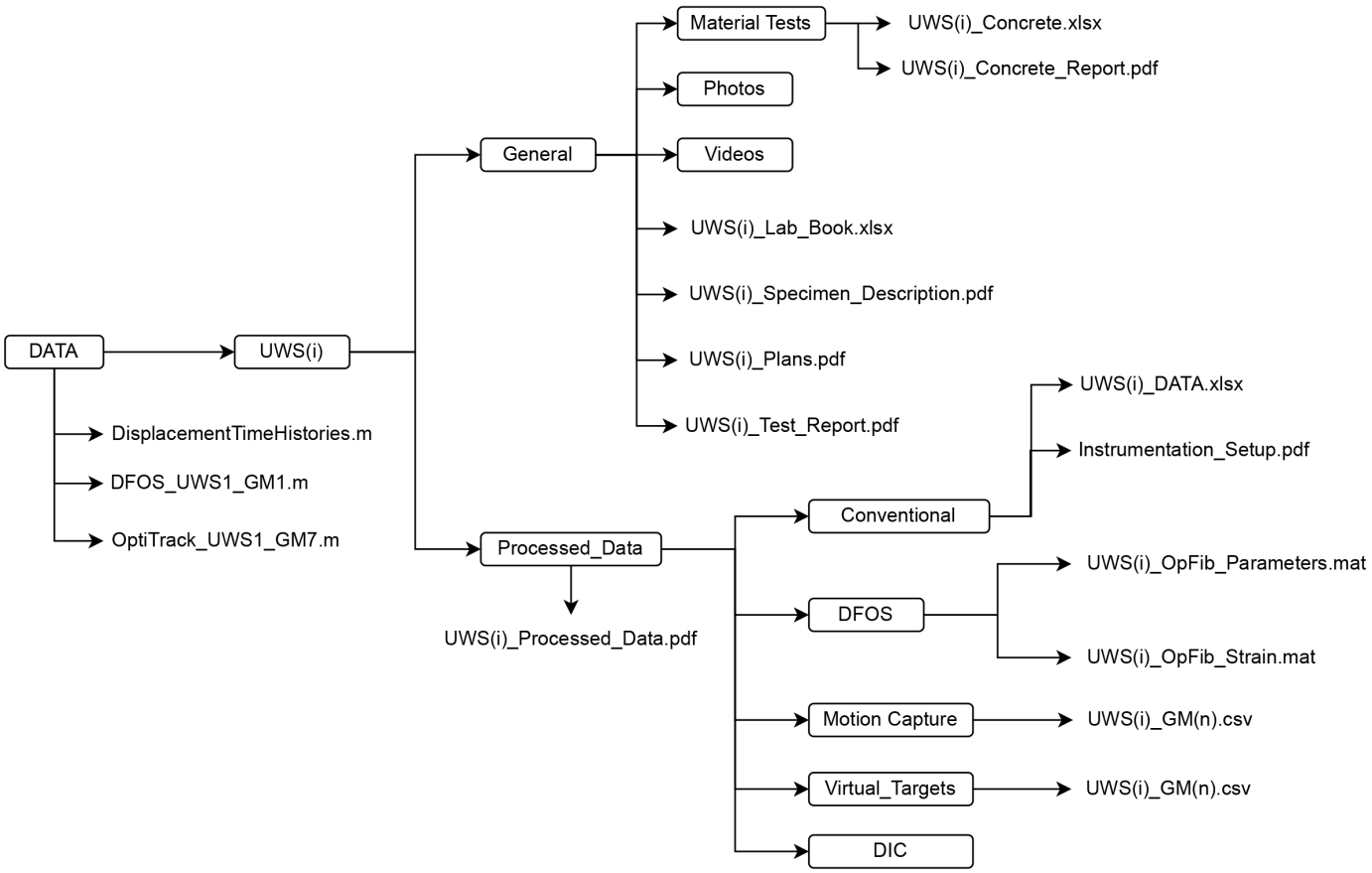

Figure 1 Flowchart of test data organization. The *i* and *n* parameters correspond to the wall unit number (1 or 2) and the ground motion number (0–8), respectively.

POSTPROCESSED DATA AND EXAMPLE PLOTS

This section includes some examples of plots and figures that can be produced by using the provided experimental data. All plots have been created using the post-processed data. MATLAB files (".m") have been provided on the online repository that can replicate the plots and figures in this section (see Figure 1, under "DATA").

EXAMPLE PLOTS OF GLOBAL BEHAVIOUR

Figure 2 presents the displacement time-histories for both test units, UWS1 and UWS2, under each ground motion (GM). Displacements from GM0 are not reported here.

For unidirectional input motions in the west-east direction (GM1, GM3, GM5, and GM7), the corresponding west-east displacement ("WE Disp.") of both test units is nearly identical, despite differences in reinforcement type and content (i.e., steel vs. FeSMA). However, under bidirectional input motions (GM2, GM4, GM6, and

GM8), a noticeable difference emerges in the north-south displacement ("NS Disp.") between the two test units.

For instance, under GM8, UWS1 exhibits a displacement of -19.9 mm (i.e., toward the north), whereas UWS2 records -24.1 mm. This distinction is significant because UWS2 also experienced greater crushing at the north flange boundary end. It is likely that the increased displacement demand in the northward direction, coupled with displacements to the east and a rise in torsional rotation, contributed to the extent of crushing in UWS2 compared to UWS1.

These figures can be reproduced using the "DisplacementTimeHistories.m" MATLAB script, located in the primary DATA folder (see Figure 1). The data files used to generate these plots can be found in DATA / UWS(i) / Processed_Data / Conventional / DATA.xlsx.

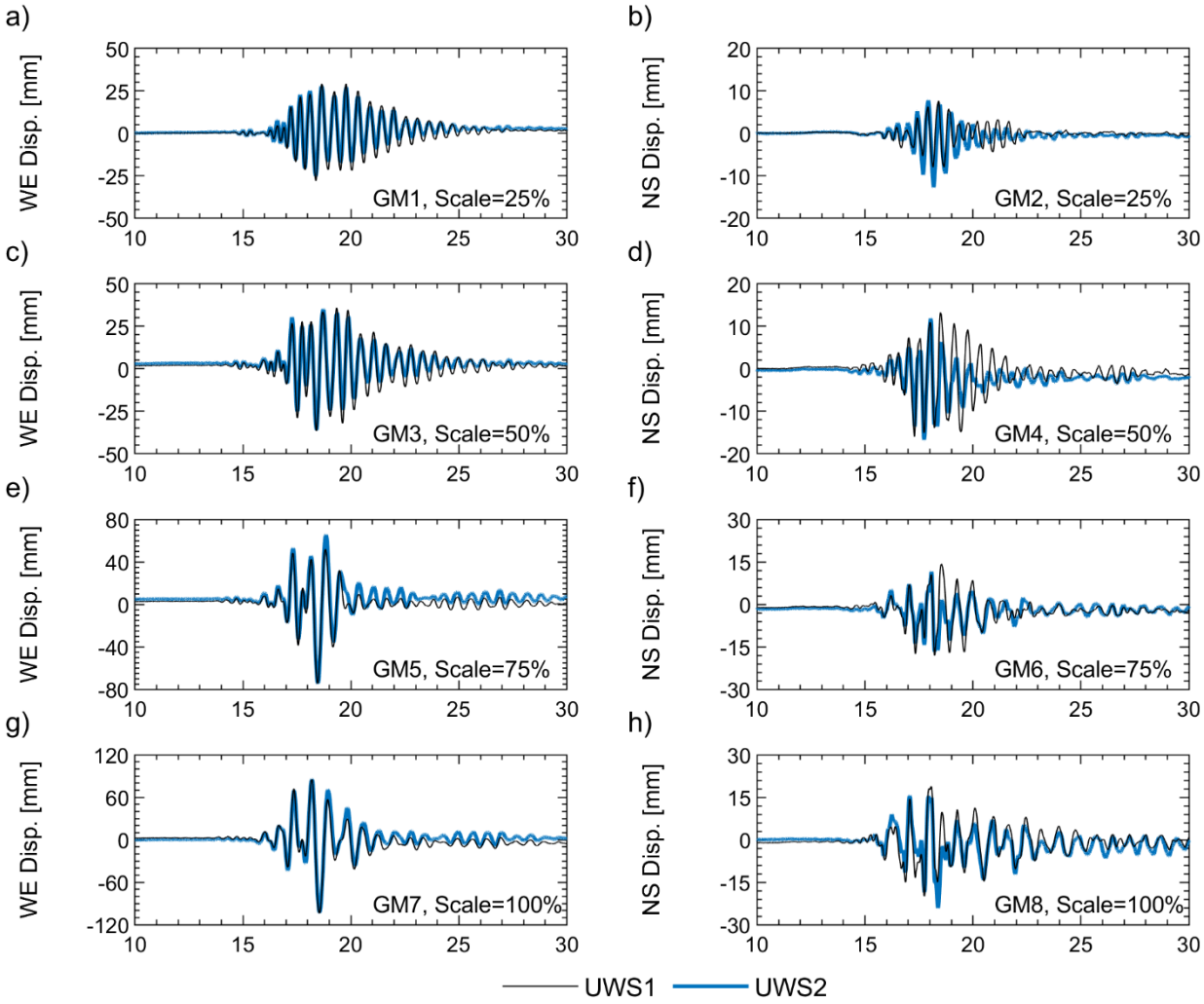

Figure 2 Displacement time-histories for units UWS1 and UWS2. "WE Disp." and "NS Disp." is short for west-east and north-south displacement, respectively.

EXAMPLE PLOTS OF LOCAL BEHAVIOUR

The distributed fiber-optic sensors (DFOS) were used to measure longitudinal rebar strains. Figure 3a presents the longitudinal strain profiles of the instrumented rebar in the north flange boundary end of UWS1 during GM1. The strain profiles are shown for two key instances: (1) when the wall experiences its largest displacement towards the east, resulting in compression, and (2) when the wall experiences its largest displacement towards the west, resulting in tension.

The results in Figure 3a confirm that, under these input motions, the wall remains in a cracked-elastic state. The largest tensile strains at the base of the north flange boundary end reach approximately 1.4 mm/m (0.14%), which is about half the strain required for steel yielding. Notably, a small increase in compressive strains is observed at approximately 1.5 m above the foundation, aligning with the height of the first-story intermediate slab. This may result from increased axial force in the boundary element due to the flexural response and the coupling effect of the intermediate slab (Janevski & Isaković, 2025).

In contrast, Figure 3b presents the longitudinal strain profiles from the OptiTrack data corresponding to the maximum wall displacement towards the east and west under GM7. The tracking markers for OptiTrack were attached to the outer surface of the north flange, approximately 75 mm from the boundary end edge, with a vertical spacing of ~150 mm, though minor height variations existed because of the intermediate slabs. These results indicate an inelastic response, as expected. The tensile strain profiles align well with observed crack patterns on the south flange (Figure 3a). A key limitation of using “spot sensors” (Hoult *et al.*, 2023), such as the OptiTrack passive markers used in this study, is their inability to directly measure strain penetration into the foundation—unlike the DFOS in Figure 3a.

These figures can be reproduced using the "DFOS_UWS1_GM1.m" and “OptiTrack_UWS1_GM7.m” MATLAB scripts, located in the primary DATA folder (see Figure 1). Regarding the latter file, two MATLAB functions are also needed to run the script, “OptiTrack_reader.m” and “importOptiTrackCSVfile.m”. The data files used to generate these plots can be found in the DATA / UWS(i) / Processed_Data / DFOS and OptiTrack subfolders.

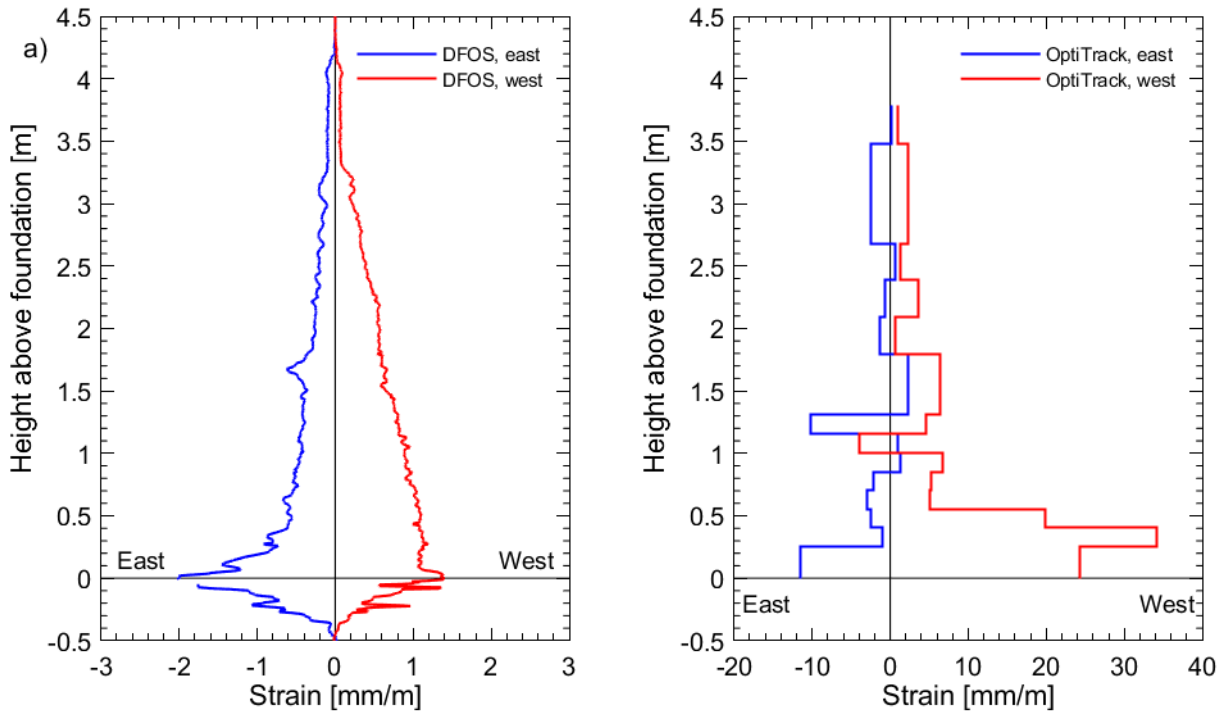

Figure 3 Longitudinal (Vertical) strain profiles for UWS1 measured from (a) DFOS of steel bar in north flange boundary end during GM1 (b) OptiTrack during GM7 corresponding to the largest west-east displacement.

REFERENCES

Hoult, R., Bertholet, A., & Almeida, J. P. d. (2023). Core versus Surface Sensors for Reinforced Concrete Structures: A Comparison of Fiber-Optic Strain Sensing to Conventional Instrumentation. *Sensors, 23*(3), 1745. doi: https://doi.org/10.3390/s23031745

Janevski, A., & Isaković, T. (2025). Seismic response of RC walls coupled by slabs without coupling beams. *Engineering Structures, 329*. doi: https://doi.org/10.1016/j.engstruct.2025.119861