S4H newsletter October 2021-September 2022

New Members in the S4H Team

1. Dr. Marco Funari joined the group as a postdoctoral researcher in September 2021. Dr. Funari is mainly responsible for developing an integrated analytical approach for the out-of-plane seismic assessment and subsequent intervention design of heritage masonry buildings within the WP3 and WP4 of S4H. In June 2022, Dr. Funari was appointed as Lecturer at the University of Surrey, UK.

2. Mr. Simon Szabó joined the S4H team as a Ph.D. candidate in October 2021. Mr. Szabó graduated from the Budapest University of Technology and Economics, Hungary. His skills encompass both architectural and structural engineering. Currently, his research focuses on modelling historical constructions, aiming to study the global structural behaviour within the framework of WP3 and WP4. The final aim would be the formulation of practical engineering tools for the seismic assessment of masonry buildings.

3. Ms. Federica Vadalà joined the S4H team as a Ph.D. student in October 2021. Ms. Vadalà graduated from the University of Catania, Italy. Her skills involve both structural and geotechnical engineering. In the S4H project, Ms. Vadalà is mainly be responsible for the WP4, which provides a set of new standards combined with an integrated analytical approach for the out-of-plane seismic assessment and subsequent intervention design of heritage masonry buildings.

New Experimental Setup at UMinho: Settlement Table

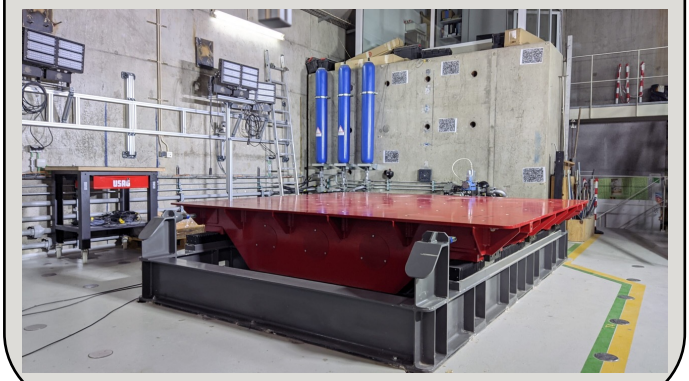
The S4H team recently installed a large settlement table for experimental testing. The table is 1 m x 1.5 m, and it is connected to three linear guides to ensure vertical translation (1D movement). An actuator is connected to the table that controls and measures its vertical movement, while the linear guides prevent any bending moment. The whole setup is connected to a stiff steel base fixed to the floor. Finally, the settlement table is placed next to a fixed platform of 1.5 m^2. Tested specimens are placed on both tables with the soil settlement provided by the vertical movement of the settlement table. The examined tests include dry-joint masonry structures, yet they can be extended to any other structures benefitting from the large size of the setup.

Setup of the Shaking Table

The S4H team is currently conducting tests on the brand new (1D-movement) shaking table which has been recently installed at UMinho.

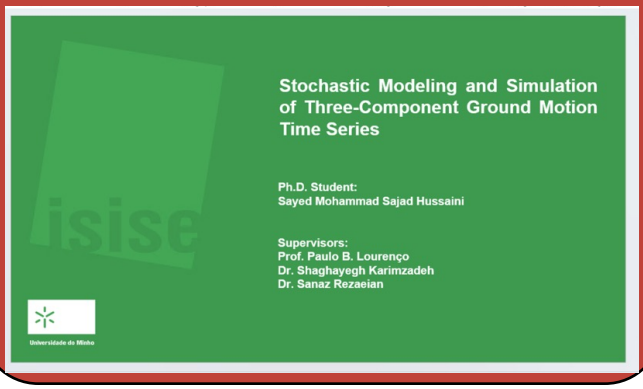
Its overall specifications are: an effective squared area of 2.90 m x 2.90 m, with a payload capacity of 30 kN and a displacement range of +/- 125mm. The table has an internal grid of threaded holes which allows testing all kinds of configurations with different boundary conditions.

The testing area is monitored by a novel 6-camera digital image correlation system (DIC), which permits capturing the dynamic behaviour of any model placed on the shaking table. The output includes a high-precision displacement contour over time and a 3D-digital model that indicates the local deformation of the specimen.



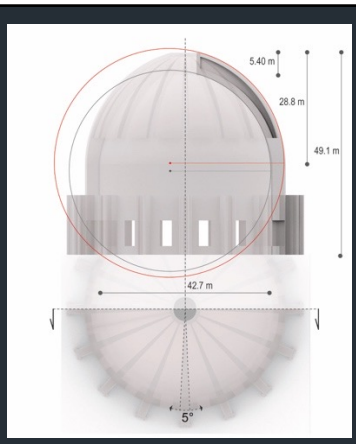
Successful Thesis Project Defence for the S4H PhD Student

Mr. Sajad Hossaini, a PhD candidate of the S4H team, deserves congratulations for completing the first year of his program by successfully defending his thesis project. In line with the WP1 of S4H, Mr. Hossaini's thesis plan, titled "Stochastic Modelling and Simulation of Three-Component Ground Motion Time Series," focuses on modelling the stochastic behaviour of earthquake ground motion records.



New Journal Publication of the S4H Team (24 Oct 2021)

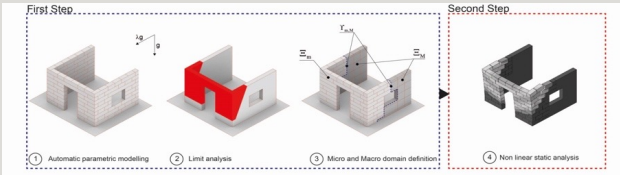
The S4H team, in collaboration with Asst. Prof. Luis C. Silva and Dr. Elham Mousavian, has published an article in the International Journal of Architectural Heritage (Taylor & Francis) titled "Real-Time Structural Stability of Domes Through Limit Analysis: Application to St. Peter's Dome".



The paper develops a digital tool to perform a rapid seismic assessment of masonry arches and domes. Unlike time-consuming and advanced methods of analysis, the present procedure allows the users to perform a structural assessment of a historic masonry dome in a few seconds and offers the possibility of including the dome's drum and rings as a strengthening measure, whose number, position, and material are user-defined. The goal is to make the tool easily and freely available at the disposal of students, researchers, and structural engineers.

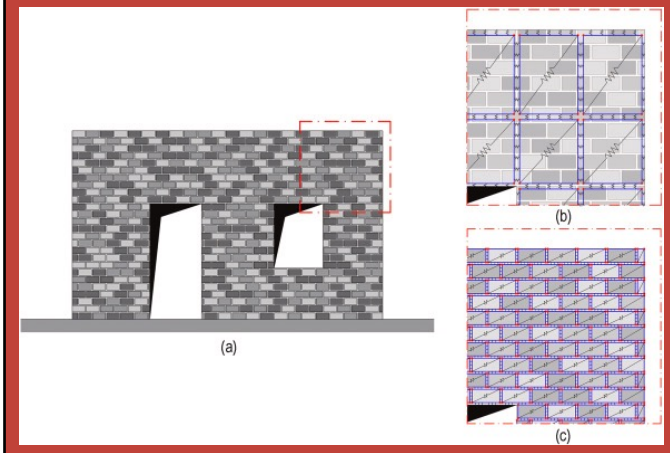
New Journal Publication of the S4H Team (19 November 2021)

The S4H team, in collaboration with Asst. Prof. Luis C. Silva, has published an article in the International Journal for Multiscale Computational Engineering (Begell) titled "A Concurrent Micro/Macro FE-Model Optimized with a Limit Analysis Tool for the Assessment of Dry-Joint Masonry Structures". The paper proposes a two-step strategy for the mechanical analysis of unreinforced masonry (URM) structures, subjected to either in- or out-of-plane loading. The application of the framework is based on nonlinear static (pushover) analysis and conducted on three benchmarks: (i) an in-plane loaded URM shear wall; (ii) a U-shaped URM structure; and (iii) a URM church. Results are given in terms of load capacity curves, total displacement fields, and computational running time; and are also compared against those found with an FE microscopic model and with a limit analysis tool.



New Journal Publication of the S4H Team (8 February 2022)

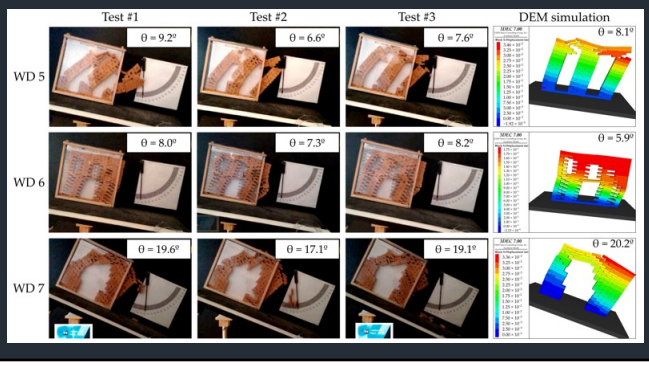
The S4H team, in collaboration with Ms. Valeria Cusmano and Prof. Ivo Caliò, has published an article in the Journal of Building Engineering (Elsevier) titled "On the Use of a Mesoscale Masonry Pattern Representation in Discrete Macro-Element Approach".



This paper presents numerical investigations using the mesoscale approach coupled with the discrete macro-element approach for masonry structures, i.e. each macro-element represents a single unit stone. At first, parametric analyses are performed on a U-shape masonry prototype made of stone. Nonlinear static analyses are performed to investigate parameters that affect the results. The outcomes focus on the influence of masonry patterns and demonstrate how the irregularity of units can affect the structural response.

New Journal Publication of the S4H Team (17 February 2022)

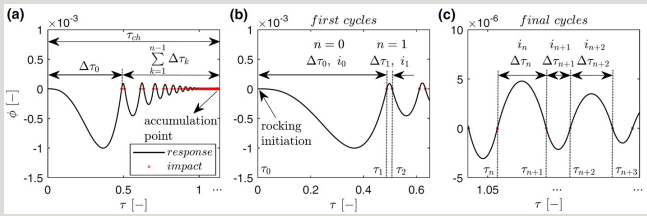
The S4H team, in collaboration with Prof. Gabriele Milani, has published an article in the journal of Applied Sciences (MDPI) titled "Joint Stiffness Influence on the First-Order Seismic Capacity of Dry-Joint Masonry Structures: Numerical DEM Investigations".



The paper numerically investigates the effect of joint stiffness on the collapse of scaled-down tilting tests conducted on perforated dry-joint masonry shear walls. The outcomes reveal that the geometrical imperfections of bricks and the absence of vertical precompression load can lead to very low equivalent dry-joint stiffness, which strongly affects the results, both in terms of collapse and damage limit state.

New Journal Publication of the S4H Team (13 June 2022)

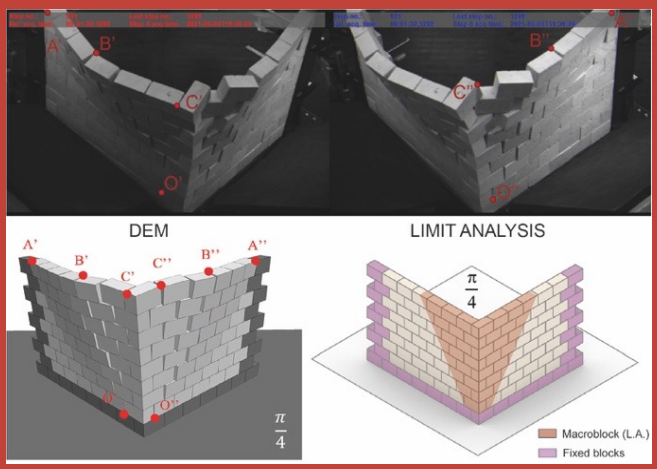
The S4H team, in collaboration with Assoc. Prof. Elias G. Dimitrakopoulos, has published an article in the journal of Nonlinear Dynamics (Springer) titled "Chattering: An Overlooked Peculiarity of Rocking Motion".



The paper focuses on the chattering behaviour of a freestanding rocking block when subjected to low amplitude ground excitations. Chattering is a highly nonlinear phenomenon that can have a substantial influence on the dynamic response. Specifically, complete chattering refers to the phenomenon during which the block undergoes a theoretically infinite sequence of decaying impacts, in finite time, which eventually bring the block to rest even under a nonzero ground excitation. This study investigates the conditions under which complete chattering occurs and the corresponding (chattering) time needed for this to happen. In this context, the study adopts perturbation theory and conducts asymptotic analysis to treat the chattering phenomenon for rocking structures.

New Journal Publication of the S4H Team (1 July 2022):

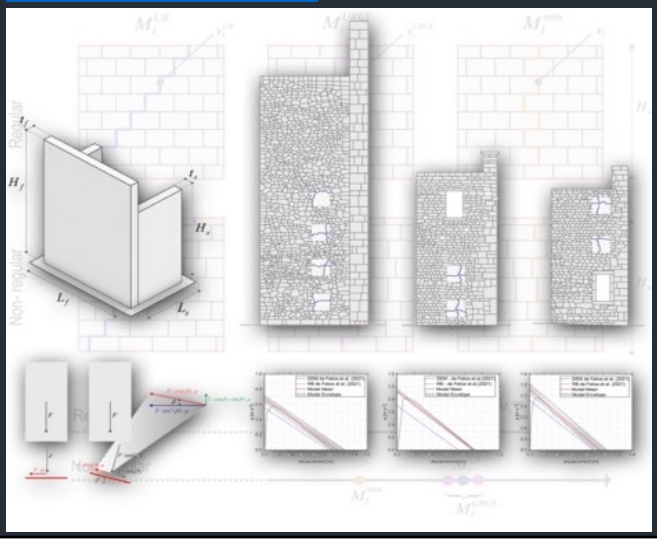
The S4H team has published an article in the journal of Construction and Building Materials (Elsevier) titled "Experimental, Numerical and Analytical Investigations of Masonry Corners: Influence of the Horizontal Pseudo-Static Load Orientation".



This paper expands the knowledge of the behaviour of masonry corners. In particular, the influence of the seismic load orientation is investigated experimentally, numerically, and analytically. Both units and interfaces have been subjected to a material characterisation process, following which pseudo-static 1:4 scaled experiments on a tilting table have been conducted on a symmetric dry-joint masonry corner. The experimental results have also been simulated using a discrete element model. The paper also develops a new analytical limit analysis model, which considers both experimental and numerical observations and accounts for rocking-sliding and flexural mechanisms. In general, a good agreement is found between the three approaches, both in terms of collapse mechanism and load multiplier.

New Journal Publication of the S4H Team (13 July 2022)

The S4H team, in collaboration with Asst. Prof. Bora Pulatsu, has published an article in the journal of Structures (Elsevier) titled "A Solution for the Frictional Resistance in Macro-Block Limit Analysis of Non-Periodic Masonry".



The paper proposes a general equation to assess the crack inclination upper threshold when non-periodic textures characterise masonry walls. The proposed formulation introduces the computation of the frictional resistance at the macro-block interface by evaluating two masonry quality indexes, i.e. vertical, and horizontal lines of trace. The proposed equation is adopted in conjunction with a macro-block limit analysis formulation in which the failure mechanism is parametrised and formulated according to the upper bound limit analysis theorem, coupled with a heuristic solver that can minimise the load multiplier and identify the geometry of the associated macro-block. The proposed analytical model is verified in a number of case studies by comparing advanced DEM simulations and numerical results arising from the literature.

Publications in International Conferences

AGU Fall Meeting (13-17 December 2021)

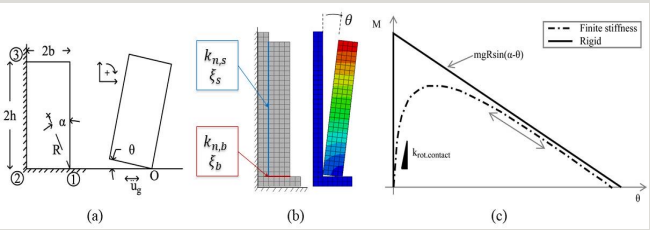
The S4H Team has recently presented two conference papers at the AGU Fall Meeting, 2021 (New Orleans, LA).

AGU FALL MEETING
New Orleans, LA & Online Everywhere
13–17 December 2021

The first paper titled "Stochastic Ground Motion Simulation of the 9th of July 1998 Faial Earthquake (Azores, North Atlantic)" simulates the 9th of July 1998 Faial earthquake (Azores, North Atlantic) based on the stochastic finite-fault ground motion simulation approach, while the second titled "On the Effect of Different Code-Based Ground Motion Selection Approaches for the Estimation of the Seismic Demand of Masonry Structures by Using Real Ground Motion Data Set" investigates the effects of alternative code-compatible ground motion record sets in seismic demand estimation of masonry structures.

CMN Conference (12-14 September 2022)

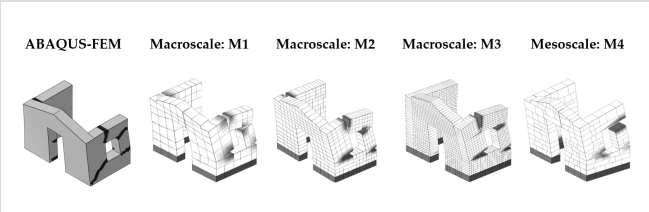
The S4H team participated in the CMN2022 Congress on Numerical Methods in Engineering, which was held in Gran Canaria, Spain.



The S4H group presented the paper titled "Dynamic Simulation of One-Sided Rocking Masonry Facades using an Energy-Consistent Viscous Damping Model". This work attempts to bridge the gap between the well-established energy loss of the classical rocking theory and the treatment of damping of block-based computational models for the one-sided rocking motion.

3ECEES Conference (4-9 September 2022)

The S4H team participated in the 3rd European Conference on Earthquake Engineering & Seismology (3ECEES), which was held in Bucharest, Romania.



The S4H group presented the paper titled "Seismic Assessment of Unreinforced Masonry Structures: A Coupled Mesoscale-DMEM Approach". This work mainly aims to: i) apply the DMEM approach by adopting a mesh representation consistent with real masonry patterns and ii) evaluate what phenomenon affects the structural response.

Participation in Getty Peer-Review Meeting (4-8 April 2022)

S4H team members recently presented their research work in the peer-review meeting of the Repair and Retrofitting component of the Bagan Conservation Project of the Getty Institute. The multi-year project aims to develop a sustainable and holistic approach to the conservation and management of the site of Bagan.

During this meeting, Mr. Vlachakis and Dr. Funari presented their work on rocking dynamics and limit analysis, respectively, while Dr. Karimzadeh described her work on probabilistic seismic hazard analysis. The participants of the meeting had also the opportunity to visit the experimental facilities of the University of Minho (shaking-table, tilting table, settlement table).

Invited Speakers at Scientific Workshops

Safeway Final Workshop (February 2-3, 2022)

The SAFEWAY project funded by the EU organised a workshop on solutions for the long-term resilience of infrastructure assets with numerous interesting presentations and discussions. Among them, Prof. Paulo B. Lourenço, coordinator of the S4H project, was invited as a keynote speaker together with Prof. Jose M. Adam (Universitat Politècnica de València) and Prof. Eleni Chatzi (ETH Zürich) in a special session on "Excellence science contributing to more resilient critical assets".

Cosmos Workshop (7–8 June 2022)

The S4H team recently presented the ongoing study on the WP1 of S4H in the "Consortium of Organizations for Strong Motion Observation Systems (COSMOS)" workshop. The COSMOS workshop focused on developing international guidelines and standards for archiving, disseminating, and validating simulated ground motion data. Researchers from different institutions gathered to summarise examples of simulated ground motion datasets and discuss the metadata needed to describe the simulated data for users.

As an invited speaker in the workshop, Dr. Shaghayegh Karimzadeh presented ground motion simulation efforts in Portugal.