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PREVIOUS VERSIONS: (-)

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The following rules apply for the ERIES - ALL4wALL 2023 blind prediction competition conducted by the iMMC at UCLouvain in 2023. More information on the tests, as well as full details on the blind prediction competition, can be found at the website of the blind prediction: https://uclouvain.be/blindprediction.

General Rules

1. Participants may consist of individual or teams, where no distinction is made between the results from an individual or a team. If an individual is part of a team, the individual cannot participate in the competition separately as an individual. Anyone in the civil and structural engineering fields can participate.

2. Participants should identify as one of the following three categories in the submittal spreadsheet: Practicing Engineer, Researcher, or Student (including doctoral students). If a team submits a prediction with a mix of categories, choose the category that best fits. A student team can only include students. These categories will be used for purposes of characterizing the different approaches used. A technical session in the WCEE2024 (which takes place in Milano from June 30 to July 5) – currently with 62 submitted abstracts, "CMS-1: RC structural walls: advances and future challenges for design, modelling, testing, and construction", will present the results of this competition, and the winners of each category will have the opportunity to participate and present their modelling technique (in person if they are attending the conference, online if they are not). The organisers reserve the right to not invite the winners of each category if the predictions are very far off the experimental results.

3. Two RC U-shaped wall units will be tested; the first unit, UWS1, will be detailed completely with reinforced steel; the second unit, UWS2, will be detailed with reinforced steel and supplemented with NiTi shape memory alloy rebars in the extreme boundary regions of the wall and at the base; however, this competition is only focused on the response of the first test unit: UWS1.

4. Participants must use the available submittal Microsoft Excel spreadsheet to provide the requested information. Participants can submit the compulsory information or the full information (i.e., compulsory + optional) for unit UWS1, as further explained in the subsequent clauses below. In the spreadsheet, the cells coloured in green describe the fields that need to be compulsorily addressed and are used in scoring the prediction. In the Excel spreadsheet, the compulsory information corresponds to rows 1-17 of the first spreadsheet, "Input 1". The cells coloured in orange correspond to the optional data, which can also be used in scoring the prediction. In the Excel spreadsheet, the optional data corresponds to rows 20-25. The cells shaded in yellow (i.e., columns C-K) correspond to those where the participants should include their predictions. If a numerical value is required, the corresponding units are also indicated. The International System of Units (i.e., the metric system) are used for this competition.

5. Participants may submit more than one prediction if using a different approach, but are limited to a maximum of three. To do this, the participant should create a copy of the original Excel sheet named "Input 1" and rename it for each additional prediction (i.e., "Input 2"). The participants may also need to copy additional sheets, such as the "Force-Displacement" tab, for example, if their predictions include such parameters.

6. Persons with inside knowledge or familiarity with the test results are not allowed to participate in the competition.

7. Questions about the blind prediction competition, or for further details on the experimental test setup, can be submitted to the organisers via the email blind-prediction@uclouvain.be. This will be available until the deadline of submissions, see clause 8. The salient or common questions, with the corresponding answers given by the organization, will be posted on the competition webpage under the Frequently Asked Questions (FAQ) section, which will be updated regularly. Applicants are encouraged to view this webpage prior to emailing any questions.

8. The deadline for the prediction entries is January 31, 2024. The participants should upload their spreadsheet file up until this date directly through the website of the ERIES – ALL4wALL 2023 blind prediction competition, after which the platform will be automatically closed. The organization encourages the participants to upload their predictions in advance to avoid last-minute blockages. If needed, the participants can re-upload readjusted predictions, which will override previously submitted ones. The online submission requires a single name (i.e., your name, or a group/team name), one email address, institution or affiliation (optional), and the submittal document (.xlsx format).

9. This paragraph provides information on the rules determining the classification of the participants in the blind prediction. Although the overall classification will not distinguish between the different participant categories (i.e., practicing engineers, researchers, and students), sub-classifications will be established for each category and the winners will be invited to participate in the technical session CMS-1 in the WCEE2024, as discussed in clause 2. The classification will be established for the following rankings:

    a. Compulsory information. This ranking includes all participants submitting the compulsory information relative to the dynamic response of specimen UWS1. The scoring is attributed according to Table 1 (i.e., maximum of 100 points), which also indicates the maximum points (MP) for each evaluation criterion, the maximum relative error for which the full points will be attributed, and the minimum error for which no points will be attributed.

    b. Full information. This ranking includes all participants submitting the full information (i.e., compulsory + optional) relative to the dynamic response of specimen UWS1. The scoring is attributed according to the sum of Table 1 and Table 2 (i.e., maximum of 200 points), which also indicates the maximum points (MP) for each evaluation criterion, the maximum relative error for which the full points will be attributed, and the minimum error for which no points will be attributed. Regarding the optional information, the participants can submit predictions to all the quantities indicated in Table 2, or to any subset of such quantities. Only the three optional quantities in which the participants will obtain the higher number of points will be considered for the ranking (i.e. for a total maximum of 100 points for the optional information). In other words, the total maximum number of points for the full information score is 200.

10. The winners of the rankings in clause 9 will be asked if they accept their name to be disclosed. Otherwise, only the country of origin of the winning participants will be reported. Again, the winners will also be invited to participate in the technical session CMS-1 in the WCEE2024 (clause 2).

11. An open online live video session towards the end of April 2024 will release the main results to the participants and announce the winners for all the rankings defined in clause 9. This information will also be posted online to the website of the ERIES – ALL4wALL 2023 blind prediction competition. Some of the winners of each category will be invited to briefly present their method of prediction during the live session, and later in the technical session CMS-1 in the WCEE2024 (clause 2).

12. A summary of the experimental results and of the anonymised predictions, without participant classifications, will be presented at the World Conference on Earthquake Engineering 2024 (WCEE2024) in Milan, Italy during the period from June 30 – July 5, 2024. The organizers will upload the paper and presentation given at the conference on the website of the ERIES – ALL4waLL 2023 blind prediction after the conference.

Table 1. Scoring Information for the compulsory information

Criterion	Maximum Points (MP)	How points are awarded	Relative Error for Maximum Points (EMP)	Relative Error for Zero Points (EZP)
Failure Mode (multiple choice)	20	0, 2, or 10 points$^{\alpha}$	N/A	N/A
Maximum relative horizontal displacement (EW-direction)$^{\beta}$ at *h* = 4290 mm	40	Based on relative error$^{\gamma}$ from correct answer	10%	50%
Maximum lateral EW inertial force$^{\delta}$ at *h* = 4290 mm	40	Based on relative error$^{\gamma}$ from correct answer	10%	50%

$^{\alpha}$The correct prediction of failure mode will be awarded 10 points. If the selected failure mode occurred as a secondary failure mode, the prediction will be awarded 2 points.

$^{\beta}$The EW-direction corresponds to the east-west direction of the shake table, which is in the direction parallel to the flanges of the U-shaped wall cross-section. Importantly, the relative horizontal displacement will be calculated as the average of the two potentiometers (aka string pots) due to the possibility of torsional rotations (subtracted of the shake table displacement). See Figure 1b and Figure 3 of the Test Description document for additional information.

$^{\gamma}$The relative error is determined as $\left|\frac{experimental - predicted}{experimental}\right|$

$^{\delta}$The east-west inertial force is to be calculated based on the measured east-west acceleration, from an accelerometer installed on the collar at 4290 mm from the foundation (i.e., at mid-thickness of the collar), multiplied by the imposed mass on wall unit (of 28.23 tonnes). Note that this value for the mass includes an approximation for the mass of the collar of the wall. (See figures in the Test Description for additional information.)

Table 2. Scoring information for the optional information

Criterion	Maximum Points (MP)[a]	How points are awarded	Relative Error for Maximum Points (EMP)	Relative Error for Zero Points (EZP)
Maximum tensile strain experienced by the rebar in the flange end[b]	33⅓	Based on relative error[c] from correct answer	10%	40%
Maximum Residual Displacement[d]	33⅓	Based on relative error[c] from correct answer	20%	50%
Energy Dissipated[e]	33⅓	Based on relative error[c] from correct answer	20%	50%
Maximum yielding height experienced by the rebar in the flange end[f]	33⅓	Based on relative error[c] from correct answer	10%	40%
Relative displacement-time history at *h* = 4290 mm (in the EW-direction)[g]	33⅓	Based on cumulative error[h]	5%	60%
Relative torsional rotation[i] time history at *h* = 4290 mm	33⅓	Based on cumulative error[f] from correct answer	10%	50%

[a]A maximum number of points of 100 can be awarded for the optional information. Participants can submit predictions to all the criteria indicated in this table, or to any subset of such criteria. Only the three criteria for which the participants will have higher number of points will be considered for the ranking. Together with the compulsory information, this means that the total maximum number of points for the full information is 200.

[b]The maximum tensile strain of the instrumented rebar in the boundary end of flange two (towards the north-east of the cross-section) will be experimentally determined for each ground motion (GM) from strain profile data using distributed optical fibre optic sensors (DFOS, see Figure 1b in the "Test_description.pdf" document). It is noted that maximum tensile strains of roughly 0.01 (i.e., 1%) can be achieved from the DFOS prior to information loss. Because of this limitation, the ground motion runs where the maximum strain cannot be clearly identified will not be considered.

[c] The relative error is determined as $\left|\frac{experimental-predicted}{experimental}\right|$

[d]See the publication from Hoult & Almeida (2022) for more on the definition of residual displacements used here. Residual displacement will be measured from the absolute East-West displacement measurements from the potentiometers at a height of 4290 mm from the foundation, subtracted of the residual shake table displacement (if any). Residual displacement will be that measured at the end of the ground motion, during rest.

[e]The total energy dissipated is computed as the area enclosed in the curve defined by the east-west inertial force and the east-west relative displacement. Please refer to the footnote on Table 1 regarding the calculations of inertial force and EW-displacement required for these energy dissipation calculations.

[f]The yielding length (L_y) of the rebar in the flange boundary end will be experimentally determined from strain profile data using distributed optical fibre optic sensors (DFOS, see Figure 1b of the "Test_description.pdf" document). The instrumented rebar in the boundary end of flange two (towards the north-east of the cross-section) will be used to determine the maximum yielding length during the time history. It is noted that maximum tensile strains of 0.01 (i.e., 1%) can be achieved from the DFOS prior to information loss. More information the derivation of L_p can be found in Hoult *et al*. (2023a).

[g]The EW-direction corresponds to the east-west direction of the shake table, which is in the direction parallel to the flanges of the U-shaped wall cross-section. See figures in the Test Description document for additional information. Importantly, the relative displacement time-history will be calculated as the average of the two potentiometers (aka string pots) due to the possibility of torsional rotations.

[h]The cumulative error calculations corresponds to that proposed by Sousa *et al*. (2020), with more information provided in Appendix A2.

[i]The torsional rotation of the wall unit will be calculated from the relative EW horizontal relative displacement measurements from the potentiometers attached to the flange ends of the collar at a height of 4290 mm from the foundation. (See Figure 3 of the Test Description for additional information.)

References

Eom, T. S., & Park, H. G. (2010). Evaluation of energy dissipation of slender reinforced concrete members and its applications. Engineering Structures, 32(9), 2884-2893.

Hoult, R. D., & Almeida, J. P. (2022). Residual displacements of reinforced concrete walls detailed with conventional steel and shape memory alloy rebars. *Engineering Structures*, *256*, 114002.

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

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Sousa, R., Almeida, J. P., Correia, A. A., & Pinho, R. (2020). Shake table blind prediction tests: Contributions for improved fiber-based frame modelling. Journal of Earthquake Engineering, 24(9), 1435-1476.

Appendices

A1. Failure Modes

Governing mode	Description	Category
Flexure with reinforcement tension fracture	Longitudinal reinforcement fractures from flexural tension	Flexure
Flexure with buckling of longitudinal reinforcement	Subsequent to yielding in flexural tension and reversal into flexural compression stress, longitudinal reinforcement buckles	Flexure
Flexure with compression failure of concrete	Concrete crushes from flexural compression	Flexure
Flexure-diagonal tension	Diagonal tension shear failure in region that had yielded in flexure	Flexure-shear
Flexure-diagonal compression	Diagonal compression shear failure in region that had yielded in flexure	Flexure-shear
Flexure-sliding shear	Sliding shear or shear-friction failure in region that had yielded in flexure	Flexure-shear
Pre-emptive diagonal tension	Shear failure in diagonal tension, without prior flexural yielding	Pre-emptive shear
Pre-emptive diagonal compression	Shear failure in diagonal compression, without prior flexural yielding	Pre-emptive shear
Pre-emptive sliding shear	Sliding shear or shear-friction failure, without prior flexural yielding	Pre-emptive shear

A2. Cumulative Error

As proposed by Sousa *et al*. (2020), the cumulative error can be computed in the time (t) or frequency (f) domains as follows:

$$Cumulative\ Error = \frac{RMSE}{RMS_M} = \frac{\sqrt{\frac{1}{n}\sum_n \left(x_{M,i}(t) - x_{C,i}(t)\right)^2}}{\sqrt{\frac{1}{n}\sum_n \left(x_{M,i}(t)\right)^2}} = \frac{\sqrt{\frac{1}{n^2}\sum_n \left|X_{M,i}(f) - X_{C,i}(f)\right|^2}}{\sqrt{\frac{1}{n^2}\sum_n \left|X_{M,i}(f)\right|^2}} \quad \text{A2.1}$$

where $x_{M,i}(t)$ and $x_{C,i}(t)$ are the measured (subscript index M) and calculated (subscript index C) displacement times series (at the collar, see Figure 3 of the Test Description document) with n discrete time (t) samples, and $X_{M,i}(f)$ and $X_{C,i}(f)$ are the Fourier transforms of the corresponding time series, as a function of the frequency (f). Furthermore, *RMSE* is the Root Mean Square Error, RMS_M is the Root Mean Square of the magnitudes of the measured signal, which in our case is displacement in the Y-direction (i.e., East-West of the shake table). More information on the cumulative error computations can be found in Sousa *et al*. (2020)