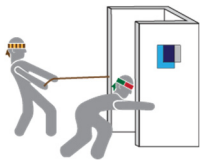


The following rules apply for the UCLouvain 2022 blind prediction competition conducted by the iMMC at UCLouvain in 2022. More information on the tests, as well as full details on the blind prediction competition, can be found at the website of the blind prediction: http://uclouvain.be/blind-prediction.

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 with interest on structural engineering can participate. The personal information (namely contact names, email addresses, affiliation) will not be disclosed, except for the winners with their agreement (see Clause 12).

2. Participants should identify as one of the following three categories in the prediction submission sheet: Practicing Engineer, Researcher, or Student (including doctoral students). If a team includes members from different categories, choose the category that best fits; however, a student team can only include students. These categories will be used for purposes of characterizing the different approaches used, as well as determining the attribution of the monetary rewards, as explained in Clause 11.

3. Two reinforced concrete (RC) U-shaped wall units will be tested: the first specimen, denoted UW1, will be subjected to pure flexure, while the second specimen, denoted UW2, will be subjected to pure torsion. Participants can submit predictions for one unit (either UW1 or UW2) or both.

4. Participants must use the available prediction submission spreadsheet (.xlsx format; please download it from the UCLouvain 2022 blind prediction competition website) to provide the requested information. Participants can submit the compulsory information or the full information (i.e., compulsory + optional) for unit UW1, unit UW2, or both units. In the spreadsheet, the cells coloured in green are compulsory and are used in scoring the prediction. In the Excel spreadsheet, the compulsory information corresponds to rows 3-21 and 32-36 in the sheet named “Input 1”. The cells coloured in beige correspond to the optional data. In the Excel spreadsheet, the optional data corresponds to rows 23-28 and 38-41 in the sheet named “Input 1”. The cells shaded in blue (i.e., in column C) indicates where you need to enter your prediction. If a value is required, the corresponding unit is indicated in column D. The International System of Units (i.e., the metric system) is used for this competition.

5. Participants may submit more than one prediction using alternative prediction methods, 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 create additional sheets, copying for example the sheets “UW1 Optional” or “UW2 Optional”, if their predictions include such optional input parameters. For a participant with multiple predictions, only the first prediction (i.e., “Input 1”, and the corresponding optional data if entered) will be considered for the attribution of the monetary rewards.

6. Participants with some knowledge or familiarity with the test results are excluded from the competition. Those at UCLouvain (i.e., staff and students) whom do not have prior knowledge of the test results can submit predictions but are not eligible for the monetary reward.

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. The latter 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 FAQ section, which will be updated regularly. Applicants are encouraged to view this webpage prior to emailing more questions.
8. The deadline for the prediction entries is Friday August 13, 2022 at 11:59 PM (CEST). The participants should upload their submission spreadsheet file up until this date directly through the website of the UCLouvain 2022 blind prediction competition. On Saturday August 13 at 12:00 AM (CEST) the platform will be automatically closed. The organization encourages the participants to upload their predictions in advance to avoid last-minute difficulties. If needed, the participants can re-upload new versions of their 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 prediction submission sheet (.xlsx format). An automatic notification of confirmation should be received by the participant.

9. The classification of the participants in the blind prediction competition and the attribution of the monetary rewards are determined according to Clauses 10 and 11.

10. This paragraph provides information on the rules for determining the classification of the participants in the blind prediction. This classification will not distinguish between the different participant categories (i.e., practicing engineers, researchers, and students), and it will be established for the following rankings:

    a. Pure flexure, compulsory information. This ranking includes all participants and refers to specimen UW1, subjected to pure flexure. The scoring is attributed according to Table 1, which also indicates the maximum points (MP) for each quantity, up to a total maximum of 100 points.

    b. Pure flexure, full information. This ranking includes all participants submitting the full information (i.e., compulsory + optional) relative to specimen UW1, subjected to pure flexure. The scoring is attributed according to the sum of Table 1 and Table 2, which also indicates the maximum points (MP) for each quantity. 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 two 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.

    c. Pure torsion, compulsory information. This ranking includes all participants and refers to specimen UW2, subjected to pure torsion. The scoring is attributed according to Table 3, which also indicates the maximum points (MP) for each quantity, up to a total maximum of 100 points.

    d. Pure torsion, full information. This ranking includes all participants submitting the full information (i.e., compulsory + optional) relative to specimen UW2, subjected to pure torsion. The scoring is attributed according to the sum of Table 3 and Table 4, which also indicates the maximum points (MP) for each quantity. Regarding the optional information, the participants can submit predictions to all the quantities indicated in Table 4, or to any subset of such

quantities. Only the two 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.

11. This paragraph provides information on the rules for determining the attribution of the monetary rewards. The latter will not be attributed if the predictions of the best-ranked participant, for all the compulsory quantities indicated in each of the Tables 1 and 3, show a relative error larger than the maximum relative error beyond which zero points are attributed. The monetary incentives sum to a total of 1'800 Euro and will be attributed according to the rules below:
    a. Pure flexure, all categories. This reward, totalling 650 Euro, will be attributed to the first-placed participants submitting the full information (i.e., compulsory + optional) relative to specimen UW1, i.e., to the winner defined according to the ranking defined in Clause 10.b. No distinction is made between the different categories (practicing engineers, researchers, or students).
    b. Pure torsion, all categories. This reward, totalling 650 Euro, will be attributed to the first-placed participants submitting the full information (i.e., compulsory + optional) relative to specimen UW2, i.e., to the winner defined according to the ranking defined in Clause 10.d. No distinction is made between the different categories (practicing engineers, researchers, or students).
    c. Pure flexure, student category. This reward, totalling 250 Euro, will be attributed to the first-placed participants in the student category submitting the full information (i.e., compulsory + optional) relative to specimen UW1, i.e., according to the ranking defined in Clause 10.b. This reward is cumulative with the reward in Clause 11.a if the winning team is a student team. A proof of the student status of the team members will be asked by the organization.
    d. Pure torsion, student category. This reward, totalling 250 Euro, will be attributed to the first-placed participants in the student category submitting the full information (i.e., compulsory + optional) relative to specimen UW2, i.e., according to the ranking defined in Clause 10.d. This reward is cumulative with the reward in Clause 11.b if the winning team is a student team. A proof of the student status of the team members will be asked by the organization.
12. The winners of the rankings in Clause 10, and the recipients of the monetary reward in Clause 11, will be asked if they accept their name to be disclosed. Otherwise, only the country of origin of the winning participants will be reported.

13. A summary of the experimental results and of the anonymised predictions, without participant classifications, will be presented at the Third European Conference on Earthquake Engineering and Seismology (3ECEES) in Bucharest during the period from September 4-9, 2022. The organizers will upload the presentation given at the conference to the website of the UCLouvain 2022 blind prediction after the conference.

14. An online live video session towards the end of September / October 2022, open to everyone, will release the main results to the participants and announce the winners for all the rankings defined in Clause 10. This information will also be uploaded to the website of the UCLouvain 2022 blind prediction competition. Some of the winners of each category will be invited to briefly present their method of prediction during the live session.

Pure Flexure Test (Specimen UW1)

Table 1. Scoring Information for the compulsory information

	Maximum Points (MP)	How points are awarded	Maximum relative error below which maximum points are attributed (EMP)	Maximum relative error beyond which zero points are attributed (EZP)
Failure Mode (multiple choice)	10	0, 2, or 10 points[a]	N/A	N/A
Peak lateral strength (F_u) towards pos. D	15	Based on relative error[b]: interpolation between EMP and EZP	5%	25%
Peak lateral strength (F_u) towards pos. C	15	Based on relative error[b]: interpolation between EMP and EZP	5%	25%
Displacement[c] at $0.75F_u$ towards pos. D	15	Based on relative error[b]: interpolation between EMP and EZP	5%	50%
Displacement[c] at $0.75F_u$ towards pos. C	15	Based on relative error[b]: interpolation between EMP and EZP	5%	50%
Displacement capacity (Δ_u)[d]	30	Based on relative error[b]: interpolation between EMP and EZP	5%	50%

[a] 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.

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

[c] This displacement corresponds to the displacement attained during first loading at 0.75 F_u (i.e., the displacement at the envelope curve, and not after cycling).

[d] Zero points will be attributed if the indicated direction for which the displacement capacity is attained is different than the experimentally observed one.

Table 2. Scoring information for the optional information

	Maximum Points (MP)[a]	How points are awarded	Maximum relative error below which maximum points are attributed (EMP)	Maximum relative error beyond which zero points are attributed (EZP)
Maximum tensile strain at δ of 0.5% at Position D[b]	50	Based on relative error[c]: interpolation between EMP and EZP	25%	75%
Plastic Hinge Length (L_p)[d]	50	Based on relative error[c]: interpolation between EMP and EZP	5%	30%
Residual Displacements[e]	50	Based on relative error[c]: interpolation between EMP and EZP	25%	75%
Total Amount of Energy Dissipated	50	Based on relative error[c]: interpolation between EMP and EZP	20%	50%
Force-displacement cyclic response until failure[f]	50	Based on relative error[c]: interpolation between EMP and EZP	10%	50%

[a] A total maximum number of points of 100 can be awarded for the optional information. Participants can submit predictions to all the quantities indicated in this table, or to any subset of such quantities. Only the two quantities 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 largest tensile strain recorded experimentally, using a base length of 200 mm above the interface between the foundation and the wall, will be used to compare with the predictions. The experimentally derived strain value/s will be taking from optical fibre measurements along the outermost 12mm longitudinal rebars in the boundary ends of the West flange and at a translational drift (δ) of 0.5% at Position D (see the "Test_description.pdf" document). An average of the two optical fibres on each of these two south outermost rebars will be performed.

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

[d] The plastic hinge length (L_p) will be experimentally determined from strain and curvature profiles up the wall height using digital image correlation (DIC) data (see "Test_description.pdf" document). Two plastic hinge lengths are required: one for bending with flange ends in tension, and one for when flange ends are in compression. If only one L_p value is provided, it will be used for both wall directions. More information the derivation of L_p can be found in Hoult *et al.* (2018).

[e] See the publication from Hoult & Almeida (2022) for more information on the definition of residual displacements. The required values of the residual displacement predictions correspond to the unloading after attaining the set of drift (or displacement) levels indicated on the prediction submission sheet (see also the "Test_description.pdf" document). The relative error used for the classification will be the average of the relative errors for all the residual displacement predictions.

[f] The required values of force predictions correspond to the set of drift (or displacement) levels indicated on the prediction submission sheet (see also the "Test_description.pdf" document), at first excursion. The relative error used for the classification will be the average of the relative errors for all the force predictions.

Pure Torsion Test (Specimen UW2)

Table 3. Scoring Information for the compulsory information

	Maximum Points (MP)	How points are awarded	Maximum relative error below which maximum points are attributed (EMP)	Maximum relative error beyond which zero points are attributed (EZP)
Failure Mode (multiple choice)	20	0, 5, or 20 points[a]	N/A	N/A
Peak torque (T_u)	30	Based on relative error[b]: interpolation between EMP and EZP	10%	40%
Rotation[c] (θ) at $0.75T_u$	20	Based on relative error[b]: interpolation between EMP and EZP	15%	60%
Rotation capacity (θ_u)	30	Based on relative error[b]: interpolation between EMP and EZP	15%	60%

[a] The correct prediction of failure mode will be awarded 20 points. If the selected failure mode occurred as a secondary failure mode of the test U-shaped wall, the prediction will be awarded 5 points.

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

[c] This rotation corresponds to the rotation attained during first loading at 0.75 T_u (i.e., the rotation at the envelope curve, and not after cycling).

Table 4. Scoring information for the optional information

	Maximum Points (MP)	How points are awarded	Maximum relative error below which maximum points are attributed (EMP)	Maximum relative error beyond which zero points are attributed (EZP)
Maximum tensile strain at θ of 1.0 mrad[a]	50	Based on relative error[b]: interpolation between EMP and EZP	25%	75%
Residual Rotations	50	Based on relative error[b]: interpolation between EMP and EZP	25%	75%
Total Amount of Energy Dissipated	50	Based on relative error[b]: interpolation between EMP and EZP	20%	50%
Envelope of the torque-rotation response until failure[c]	50	Based on relative error[b]: interpolation between EMP and EZP	15%	50%

[a] The largest tensile strain recorded experimentally, using a base length of 200 mm above the interface between the foundation and the wall, will be used to compare with the predictions. The experimentally derived strain value/s will be taking from optical fibre measurements along the outermost 12mm longitudinal rebars in the boundary ends of the West flange and at a rotation (θ) of 1.0 mrad. An average of the two optical fibres on each of these two south outermost rebars will be performed.

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

[c] The values tested will correspond to the torque attained at each of the rotation levels imposed (see also the "Test_description.pdf" document). The average torque attained in the positive and negative directions of the rotating wall will be used to compare with the submitted predictions.

References

Hoult, R. D., Goldsworthy, H. M., & Lumantarna, E. (2018). Plastic hinge length for lightly reinforced C-shaped concrete walls. *Journal of Earthquake Engineering*, *24*(7), 1083-1114.

Hoult, R., & Beyer, K. (2021). RC U-shaped walls subjected to in-plane, diagonal, and torsional loading: New experimental findings. *Engineering Structures*, *233*, 111873.

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.

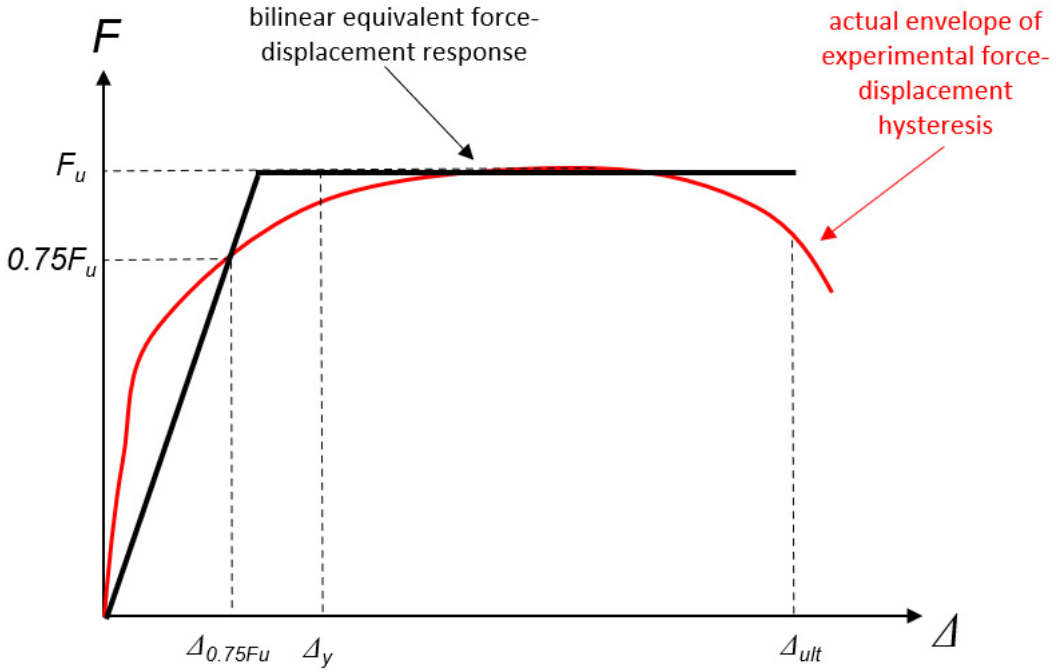
Annex

A1. Failure Modes

Governing failure mode	Description	Category
Flexure with reinforcement tension fracture	Longitudinal reinforcement fractures from flexural-induced tension at large plastic strains	Flexure
Flexure with buckling and fracture of longitudinal reinforcement	Subsequent to yielding in flexural tension and reversal into flexural compression stress, longitudinal reinforcement buckles and eventually fractures in the buckled region in a subsequent excursion into tension	
Flexure with buckling of longitudinal reinforcement followed by concrete failure	Subsequent to yielding in flexural tension and reversal into flexural compression stress, longitudinal reinforcement buckles. Failure is, however, due to concrete crushing.	
Flexure with compression failure of concrete, without buckling of longitudinal reinforcement	Concrete crushes from flexural compression without prior clear buckling of longitudinal reinforcement but after yielding of longitudinal reinforcement	
Flexure with compression failure of concrete, before rebars yield in tension	Concrete crushes from flexural compression before the longitudinal rebars yield in tension	
Flexure-diagonal tension	Diagonal tension shear failure with rupture of horizontal reinforcement, after prior flexural yielding	Flexure-shear
Flexure-diagonal compression	Diagonal compression shear failure with crushing of the compression strut, after prior flexural yielding	
Flexure-sliding shear	Sliding shear or shear-friction failure, after prior flexural yielding	
Pre-emptive diagonal tension	Diagonal tension shear failure with rupture of horizontal reinforcement, without prior flexural yielding	Pre-emptive shear
Pre-emptive diagonal compression	Diagonal compression shear failure with crushing of the compression strut, without prior flexural yielding	
Pre-emptive sliding shear	Sliding shear or shear-friction failure, without prior flexural yielding	
Anchorage failure of longitudinal rebars	Failure occurs due to anchorage-related issues, e.g. rebar slippage or rebar fracture inside the foundation	
Lateral instability	Failure is largely caused or influenced by a global out-of-plane instability mechanism of the wall flanges	

A2. Force-Displacement Definitions

- The ultimate lateral displacement is defined as that corresponding to the displacement at $0.8F_u$, i.e. after 20% strength degradation has occurred from peak force capacity, at the envelope curve. If a non-ductile failure is predicted to occur, the displacement can be taken at the point prior to the abrupt loss of strength.
- Note that, while displacement (Δ) and force (F) are used below to illustrate the response for unit UW1, the counterpart quantities for unit UW2 are rotation (θ) and torque (T).



A3. Energy Dissipation

The cumulative energy dissipation during the test until failure will be calculated as:

$$E_{cum} = \sum_{i=1}^{N} E_i$$

where E_i is the energy dissipation for the cycle *i* as indicated by the hatched area ABCDE in the figure below, and *N* is the number of cycles until failure. Note that, while displacement (*Δ*) and force (*F*) are used below to illustrate the response for unit UW1, the counterpart quantities for unit UW2 are rotation (*θ*) and torque (*T*).