

## ***Interactive comment on “A multi-hazard risk prioritization framework for cultural heritage assets” by Giacomo Sevieri et al.***

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**The manuscript presents a very interesting multi-level procedure to prioritise disaster risk reduction measures for cultural heritage assets, considering multiple hazards. The manuscript is well organised and written, allowing a good understanding of the proposed framework. Just some typos can be detected in some instances, which can be easily removed. The methodology presented in this paper has different potentialities; for instance, the quantitative consideration of possible construction deficiencies at multiple scales is strongly appreciated because it may have a significant impact on relative risk estimates used in the prioritization scheme. Therefore, this reviewer recommends a minor revision of the manuscript according to the comments provided below.**

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We sincerely thank Dr Parisi for the positive overall assessment of our contribution and for the insightful comments on our manuscript. Based on these comments, various revisions have been made to further improve the quality of the paper.

**1) Just some typos can be detected in some instances, which can be easily removed.**

We thank Dr Parisi for this observation. An additional proofreading of the manuscript has been performed to fix any typos and further improve the readability of the manuscript.

**2) The CHeRiSH RVS form illustrated in Fig. 2 includes the possible description of the “Opening Layout” (“Building Information” module), which may play a key role in the inplane response of load-bearing URM walls to horizontal seismic actions. It seems that horizontal misalignment of openings at given storeys is not taken into account. Please comment on this and eventually include this feature in the form.**

The in-plane behaviour of URM buildings is affected by the horizontal/vertical misalignment of openings as well as their layout (i.e., position on the façade, this is one of the factors determining the dimension of piers). The misalignment is considered through the entry “façade regularity” whose three options (i.e., 1. Regular, 2. Medium, 3. Irregular) express vertical/horizontal alignment of openings (Table 3). This way to parametrize the problem derives from D’Ayala and Speranza (2002)<sup>1</sup>, which developed the FaMIVE (Failure Mechanism Identification and Vulnerability Evaluation) approach. We thank Dr Parisi for this comment as we understand this aspect was particularly

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clear in the original manuscript/form. We have now changed the entry name “façade regularity” to “opening alignment” both in the RVS form (Fig.2) and in Table 3. We have also modified/added the following sentences to the revised version of the manuscript:

Line 392, page 15:

*“...Indeed, it is well known that the activation of out-of-plane local mechanisms is strictly linked to the geometry of the piers (i.e., Opening Layout), which is also determined by the position of the openings (i.e., Opening Alignment), and the connection with orthogonal walls, diaphragms and roof (D’Ayala, 2005)...”*

Line 397, page 15

*“...The dimension of the piers, which is linked to the Opening Layout and the Opening Alignment, affect both the out-of-plane and the in-plane behaviours (e.g., Parisi and Augenti, 2013) of the URM building resisting members. However, in the proposed approach, these secondary parameters are considered only in the Local Behaviour component to avoid counting their effect twice...”*

<sup>1</sup> D’Ayala, D. and Speranza, E. (2002) An integrated procedure for the assessment of seismic vulnerability of historic buildings. In:12th European Conference on Earthquake Engineering, paper no. 561.

**3) What is the meaning of “Frame masonry” and “Reinforced” in the section “Type of Lateral Load Resisting System” of the “Structural Information” module? Please make a double check of the taxonomy reported therein; it seems that the “Moment Resisting Frame System” type is not mentioned.**

We thank Dr Parisi for this observation. There were various inconsistencies in the

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form that have now been corrected, resulting in various changes in the taxonomy of the sections: "Material of Lateral Load Resisting System" and "Type of Lateral-load Resisting System". The changes are reported below:

- "Material of Lateral Load Resisting System": the options "reinforced masonry" and "confined masonry" have been added.
- "Type of Lateral-load Resisting System": the options "frame masonry", "confined masonry", "reinforced" and "dual system" have been removed. Whereas the entries: "Moment Resisting Frame System", "Load Bearing Walls" and "Combined" have been added.

**4) Did the authors evaluate the possibility of including adobe masonry in the section "Masonry Type" of the "Masonry" module? Regardless of the actual use of adobe masonry in the Philippines, the RVS form could include it to allow the implementation of CHeRiSH procedure in other countries.**

The option "Adobe bricks" has now been added in the section "Masonry type" of the proposed RVS form. However, specific criteria for the formulation of baseline scores and performance modifiers should be further investigated, in future studies, to adapt the proposed approach to the specific case of adobe masonry.

**5) Line 384: I suggest replacing "Wall-to-Diaphragm connection" by "Floor-to-Wall connection" because existing floors, particularly in old masonry buildings, do not necessarily develop a diaphragmatic action in the global seismic response. This also applies, for instance, in Fig. 4.**

We agree with the reviewer, the term floor-to-wall connection better expresses the idea of the constraining effect of the floor to the piers. The term *Wall-to-Diaphragm*

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*connection* has been now changed to *Floor-to-Wall connection* in the revised version of the manuscript/form.

**6) Table 3: It appears that the façade regularity depends on the opening layout, but they are separately scored. Is there any overlapping between scores? Please comment in the text.**

The answer to this comment is strictly related to the answer to the first comment above, and we thank again Dr Parisi for highlighting that this aspect was not very clear in the original manuscript. The criterion Façade regularity (which in the revised version of the manuscript is called Opening alignment) refers to the alignment of the openings, while the criterion Opening layout refers to the position of the opening on the façade. This latter is key to determine the pier geometry. We believe that the sentences added with reference to the first comment above also address the issue raised here, clarifying this aspect of the proposed approach.

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