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Discussions

Interactive comment on "The quantitative estimation of the vulnerability of brick and concrete building impacted by debris flow" *by* J. Zhang et al.

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We welcome the insightful feedback from Anonymous Referee #2. He/she makes a meaningful contribution to the improvement of our manuscript. A number of important points are raised, to which we offer the following responses:

1. Most references mentioned in the comments will be inserted in the introduction part while others can be found or loaded due to the database limit.

2. Even if the building still stand of which the load-bearing wall collapsed, human will not be suggested to keeping staying in it since load-bearing wall is very important for

building safe. Therefore, the vulnerability assessment of load-bearing wall of impacted element is rather representative and important for the element.

3. The influence of the transversal wall and the building proof was not taken into consideration and both of them can provide constraint force to the load-bearing wall. Since the displacement and the swing are restrained, the vulnerability assessment of the wall will beyond the actual loss of the wall. Metal frame mounted around the wall can be applied to simulate the constraint force which is hard to determine.

4. Boulder impact with element itself is a probabilistic event let alone the location of the boulder in the contact section between flow and element is unknown. Therefore, slurry modeling is more practicable. In the experiments, the impact point was just the geometrical center of the boards in order to cohere with the center line of the impact force induced by slurry. Since the iron board was rigid, the concentrated load could spread onto the rest of the area of the wall covered by the board due to the displacement of the whole board. Therefore, the experiments can simulate a homogenous impact of debris flow (slurry). Deviation in representing the slurry relates to the material as well as the limited technological level and was analyzed in discussion part.

5. The line of the frame will be in bold to emphasize its location. The support frame mounted on ground is welded with steel. The iron sphere releasing from a certain height will rotate with the center fixed on the beam of the frame.

6. The expression $mv=bhv^2$ is based on the debris flow in unit time. We will add the explanation in the revised version.

7. For example, there is no significant different between the damaged element with maximum crack length 750mm and the element with 751mm. However, the damage assessment of these two elements belongs to different classes according to Table 2. As a result, directly applying this criterion will lead the unreasonable results when the value near the critical number is judged.

8. Physical interpretation of the vulnerability in Equation (7) is added: “V denotes the vulnerability of elements, namely the damage loss percentage of elements.”

9. The length of cracks counts on the dimension of polyline not straight line. Since the cracks develop to the both side edge of the wall, the maximum length should be larger than 3m.

10. Concerning the explanation for the lower value in experiment B, we will delete the second reason as you said it is not unique for B. The third reason is rephrased: “due to the device malfunction, the tractive force between the sphere and the dynamic system did not vanish completely until the sphere departed from the system for a certain distance. This residual tractive force decreased the kinetic energy which the sphere possessed before the impact. ” Therefore, the spheres did not get the expected impact force in the experiments of series B. However, the relevant damage indicators and the vulnerability also were lower than the expected value and cohered with the actual impact force. This deviation will not influence the data analysis if only the measured data is used to establish the vulnerability curve.

11. All the calculation is based on the damage index and their value which is exhibited in Table 4.

12. Directly attack place denotes the wall area covered by board, while the rest area of the wall is indirectly attack place.

13. The function indeed applies only to Fig.7 and 8 not to Fig.6, since no curve fitting is done in Fig.6. The straight line is only the trend line according to the scattered points.

14. The fitting of the curves is based on the least square method. We admit that the determination of the threshold in the equations included subjective judgment due to the limitation of the experiment data.

15. The location of the hard contact has been introduced in section 2.2. The impact point was just the geometrical center of the boards in order to cohere with the center

line of the impact force induced by slurry. For the uniform load, the arm of the force also should be the h/2.

16. As you stated the vertical bending moment will also induce the damage of the element. However, under two assumptions stated in section 2.1 only horizontal bending moment is taken into consideration. Additionally, the width of the contact area between flow and elements is always equal to the width of the walls. The impact conditions are rather complex and diversified therefore the conclusions deduced from the physical models are usually limited to the experimental set up. This paper provides the preliminary research and experimental data about vulnerability of the elements impacted by debris flow, hoping more studies will be conducted to enrich the results of the impact force induced by debris flow.

17. It is hard for the impact force of debris flow exceed the material resistance and breakdown the wall directly. However, with the force arm it is relatively easy for the impact force to damage the element since the anti-shear ability of the brick and concrete is significantly weak. As a result, it is concluded that the bending moment is more representative than the impact force to be the disaster intensity factor.

18. After checking Table 2 and 4, we confirm that the negative sign of the superscript of the unit for the inclination index should be positive sign. We feel sorry for this clerical error.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 5015, 2015.