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Natural Hazards and Earth System Sciences
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 have learned much from the comments of B. Gems, which are fair, encouraging and constructive. Great thanks are given for the language advices which is very careful and valuable. Concerning the comments we offer the following responses:

1. Several references about debris flow impact both in real-scale and small-scale are added into the introduction part. The corresponding literature review is also added. 2. According to the experiments of Zhang (2005), the wall impacted by an iron sphere was loaded a delta impulse which was similar to the impact loading in the field observation

of the real-scale debris flow in Jiangjia Ravine in China on August 25, 2004 (Hu et al., 2011): the impact load increased to the peak rapidly then decayed gradually in relatively long time with fluctuation. However, the loading process in the debris flow event continues more than 10 seconds since the flow impacted the obstacle constantly and the peak load fluctuated in approximate 5 seconds. The loading process with an iron sphere was short and had a single peak value. However, the impact process in field was composed of multiple impact loads of debris flow in unit time. This explained the multiple peak values during the impact of the debris flow in Jiangjia Ravine. Similarly, a delta shape signal also observed in the impact force sample caused by small-scale debris flow in other researches (Scheidl et al. 2012; Bugnion et al. 2012). If a debris flow in unit time was viewed as a whole, an iron sphere impact under laboratory conditions can simulate this field process. Therefore an iron sphere can be applied as a substitute of debris flow properly. 3. Besides the initial content about the wall element in the text, more information is provided: The material of the walls was stated as follows: the brick was 240 mm $\times$115 mm$\times$53 mm and was bought from factory. The compressive strength of the brick was 10MPa. The mortar made of water, cement and sand was in standard curing for 28 days (temperature =(20$\pm$2)âĎČ, relative humidity $\geq$90%). The test cubes in the same curing condition for 29 days had the average compressive strength 8.2 MPa. 4. In the southwestern of China, the civil architecture mostly adopted the brick and concrete which is cheap and easy to obtain. Therefore, the wall element in the experiments is constructed according to the procedure of the house building. Of course, distinction exists among the houses so that we also refer to Brick and Concrete Structural Design Specification of China and adopt the mostly used material and structure. 5. Physical model is effective way to obtain the data when the object is too complex to have a series of formula to describe it. However, the experiments cost much and is time consuming. Numerical simulation would be more convenient but needs equations and more data to calibration. Though the experimental set up is simple we provide the vulnerability curve for a single wall. We hope more data will emerge and the researches of the elements vulnerability caused by debris flows

can go further. Therefore, we can use numerical model to evaluate more elements both in quantity and type.

We thank B. Gems for his interest, patience and encouraging feedback. References cited in this reply: [1] Bugnion, L., McArdell, B., Bartelt, P., Wendeler, C.: Measurements of hillslope debris flow impact pressure on obstacles, Landslides 9, 179–187, doi:10.1007/s10346-011-0294-4, 2012. [2] Construction Industry of China: Specification of the design of masonry structures, Beijing, 2011. (in Chinese) [3] Hu, K.,Wei, F., Li, Y.: Real-time measurement and preliminary analysis of debris flow impact force at Jiangjia Ravine, China. Earth Surf. Process. Landforms 36, 1268-1278, doi:10.1002/esp.2155, 2011. [4] Scheidl, C., Chiari M., Kaitna R., Müllegger M., Krawtschuk A., Zimmermann T. and Proske D.: Analysing Debris-Flow Impact Models, Based on a Small Scale Modelling Approach, Surveys in Geophysics, 34(1), 121-140, doi:10.1007/s10712-012-9199-6, 2012. [5] Zhang, Y.: Dynamic response of mountainous civil architecture in east China impacted by debris flows, Ph.D. thesis, Institute of Mountain Hazards and Environment, CAS, Chengdu, 2005. (in Chinese)

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