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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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General Comment

The present paper deals with experimental modelling and analysis of debris flow impacts on a brick and concrete wall element, featuring characteristics that are typical for load-bearing walls in China. By substituting the characteristics of a debris flow impact on the wall element with a single impacting iron sphere, a couple of tests at the scale 1:1 are accomplished. Different impact intensities by means of specific weights of the iron sphere, specific heights of fall and specific areas of impact transmission on

the wall (representing different flow depths of the debris flow) are tested. Maximum crack widths in the wall element, maximum crack lengths, the total area of the cracks and the inclination of the wall element are chosen to be indicators within vulnerability analysis by means of Fuzzy mathematics. Thereby, four specific damage levels are quantified. The work presented in the manuscript finally delivers vulnerability curves for the brick and concrete wall element with relation to the maximum impact force or rather the maximum impact bending moment. The latter is thereby evaluated to be best suited as impact process parameter for vulnerability assessment.

Generally, the content of the manuscript is highly interesting and very valuable for vulnerability research. From my point of view, large scale experimental analyses explicitly dealing with the impacts of natural hazards on the elements at risk (buildings) will be more and more intensified in vulnerability research in the near future. The work presented within this paper is a valuable contribution to that.

The content of the manuscript is basically well-arranged, the presented results and findings are clearly pointed out. Except for the below mentioned issues (special comments) and technical corrections I would suggest to better point out and provide already at the beginning of the manuscript (abstract) more basic information in order to improve clarity and comprehensibility while reading: (i) experimental modelling in prototype dimensions (scale 1:1), (ii) impact analyses for a single wall-element, (iii) substitution of debris flow processes with a single iron sphere impacting the considered wall element, etc..

Although the manuscript is entirely understandable, the English phrasing and grammar could and should be slightly improved. It would be worth getting a native English speaking colleague to go through the paper and further improve the language style of the manuscript. English is not my native language. However, a couple of corrections are suggested in the corrections list below. I suggest a minor revision of the manuscript and thereby consideration of the below mentioned issues and corrections:

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Specific Comment

One basic issue of the manuscript is the simulation of a debris flow impact by means of an impact of a single iron sphere. It is also stated that the process behaviour of debris flows is very (too) complex for simulating under laboratory conditions (using a proper similarity law). However, laboratory tests simulating debris flow processes and analysing their impacts on structures have already been accomplished (amongst, a lot of research effort was accomplished at the University of Natural Resources and Life Sciences, Vienna). Concerning the suitability of impacting iron spheres to adequately represent debris flow impact conditions, one sentence and the reference to a prior publication is provided in the manuscript. Within this context I suggest to further extend the introduction part of the manuscript with a short literature review on debris flow experiments (interaction with structures) under laboratory conditions. Further, more information on the suitability of iron-sphere-tests should be provided. Thereby, the aspect of the impact duration should also be covered in more detail: Impacts of debris flows are spatially and temporarily highly variable. The impacts of the iron spheres in the tests represent a single impact of very short duration. It should be verified that these conditions represent torrential hazard impacts properly.

For the experiments a specific wall element made of brick and concrete is analysed by means of nine tests with specific impact conditions each. Assuming that for every experiment, the wall element is reproduced, there is no information provided concerning the material properties and resistance of the wall element at the initial conditions each. There should be more information provided in the manuscript about the procedure of ensuring almost equal initial conditions (characteristics of the wall element), etc.

The experimental set up assumes a wall element that is mounted on the ground by means of a massive foundation. The wall is not fixed vertically at the edges which is, for my understanding, not the typical condition within the static system of a building. Vibrations and deformations of the wall element significantly influence the damage pattern and lastly vulnerability assessment, it is expected that they differ when assuming

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a different bearing condition at the edges of the wall element. In this context I would suggest to provide a comment and more information on the choice of the experimental set up.

With regard to the very elaborate experimental tests, an author's comment, whether the tests can / could also be done by use of a structural numerical model, would be very interesting. Using as well the tests and further numerical model simulations, the results from experimental modelling could thereby be used for numerical model evaluation and a comparatively larger set of tests with specific impact conditions could be managed.

Technical Corrections

p.5015, title: modify to "The quantitative estimation of the vulnerability of a brick and concrete wall impacted by debris flow" p.5016, line2: modify to "...data about the vulnerability of damaged elements due to debris flow events in China." p.5016, line3: to my understanding the term "vulnerability" characterizes an element at risk, but not the hazard process itself; therefore rephrase "...the vulnerability of debris flow..."; in this context I would generally check the manuscript for the correct use of the terms "vulnerability" and "impact" p.5016, line4: change to "...This paper is devoted..." p.5016, line5: use plural for the term "building"; skip the phrase "which widely existed in affected area." p.5016, line6: add the term "physically" before the term "simulated" p.5016, line7: change "...while the iron spheres..." to "... while iron spheres..." p.5016, line10-11: change "The quantitatively estimation of vulnerability of brick and concrete building was finally established..." to "The quantitative estimate of vulnerability of the brick and concrete building was finally..." p.5016, lines13-17: I would skip the last two sentences in the abstract since there is not substantial information covered with it; instead I suggest to provide one more sentence each on the experimental setting and on the results... p.5016, line19: add "on 12 May 2008" after "Wenchuan Earthquake" p.5016, lines22-25: change "Huge volume of the deposit induced by earthquake contribute to new debris flows in more frequency and lager magnitude leading much losses both in life and economic..." to "Huge volumes of sediment deposits and debris sources

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have been induced by earthquakes and contributed to new debris flows in higher frequency magnitude leading much losses both in life and economics. . .” p.5016, lines25-26: “method” for what? “risk estimation” for what? “debris flow work” seems not a proper term; I suggest to rephrase the sentence. . . p.5017, line3: change “. . .debris flow was quite. . .had not be. . .” to “debris flow is quite...had not been. . .” p.5017, line4: change “vulnerability” to “vulnerable” and “attacked” to “potentially affected” p.5017, line6: change “economic” to “economics” p.5017, line7: add “life” after the “. . .human” p.5017, line8: change “statistic method” to “statistical methods”; concerning the phrase “. . .improving the accuracy” it is not clear to which the “accuracy” is related to. . .I suggest to provide more information on that and to provide also literature. . . p.5017, line9: change “. . .are about characteristic of debris flow not element vulnerability. . .” to “. . .are about the characteristics of debris flows but not on the vulnerability of the elements at risk...” p.5017, line10: change “. . .four, the lack of vulnerability results. . .” to “. . .fourth, the lack of data in vulnerability research. . .” p.5017, lines12-13: change “. . .earthquake and cyclone, structural measure is capable to decrease the damage of debris flow. . .” to “. . .earthquakes and cyclones, local structural protection measures are well applicable to decrease the damages caused by debris flows. . .” p.5017, line16 change “region” to “regional” p.5017, lines18-20: meaning and structure of the sentence not clear, I suggest to rephrase p.5017, line20: change “. . .curve was raised. . .” to “. . .curves are applied mainly. . .” p.5017, line21-23: change “were” to “are”; for being clear and more specific I suggest to rephrase this sentence p.5017, line23: change “At beginning, the vulnerability was qualitative. . .” to “Firstly, vulnerability assessment had a purely qualitative character. . .” p.5017, line26: which debris flow event in the Austrian Alps do you mean, any specific? Please provide more information and literature on that. . . skip “Then,” in the next sentence p.5017, line28: change “could also be. . .” to “. . .mean. . .” p.5018, lines1-2: skip “of vulnerability if the numerical simulation of debris flow could be conducted“ p.5018, line4: skip “or investigation” p.5018, line5: change “curve” to “assessment” p.5018,line6-7: which case do you mean? p.5018, lines8-13: this paragraph is very confusing, please rephrase. . . p.5018, line14: use

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plural form for “buildings” p.5018, line15: change “were” to “are” p.5018, lines15-16: change “. . .building is the typical civil architecture in southwestern mountain area of China. Generally, the destruction of load-bearing wall directly lead to the collapse of house.” to “buildings are the typical civil architecture in the southwestern mountain area of China. Generally, the destruction of load-bearing walls directly leads to the collapse of the building.” p.5018, line18: skip ”have” p.5018, line19: change “attacked” to “impacted”; at this point it is not clear what is meant with “substitute of debris flow”; accordingly with the general comment, please provide more basic information at the beginning of the manuscript. . . p.5018, line21: change “Vulnerability curve contains. . .” to “Vulnerability curves contain. . .” p.5018, paragraph 2: this is not clear to me, please rephrase p.5019, lines3-5: change “The experiments here were conducted on the purpose of the vulnerability curve of brick and concrete building which was prototype and had only one story. Since the collapse of building was mainly caused by the destruction of load-bearing wall. . .” to “The experiments were conducted on the purpose of the vulnerability curve of a brick and concrete building with one storey. Since the collapse of building was mainly caused by the destruction of the load-bearing wall. . . p.5019, line6: change “Producing. . .” to “Simulating. . .” p.5019, line8: use plural form for “debris flow impact” p.5019, line9: change “below:” to “further presented.” p.5019, line11: change “vary” to “varies” p.5019, line12: change “site” to “the location” p.5019, line13: skip “could” p.5019, line14: change “Here, only uniform load induced by slurry was considered in this study.” to “In this study, only uniform load induced by slurry was considered.” p.5019, line16: change “attack” to “impact” p.5020, line1: concerning the phrase “. . .the attack time and homogenize the force onto the wall.” – I suppose this was done to best possibly substitute a homogenous impact of debris flow (slurry); this should be stated more clearly and in more details; this holds also for the relation of iron board height and debris flow depth. . . p.5020, line1: change “was” to “is” p.5020, lines3-5: use plural form of the terms “height” (2x), “magnitude” and “sphere” p.5020, line7: add literature of the “Brick and Concrete Structural Design Manual of China” p.5020, lines10-11: rephrase last sentence of this paragraph p.5020, line12, heading: I sug-

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gest to change the heading to “Measurement device” p.5020, lines18-19: change “The maximum dynamic displacement and static displacement were measured by self-made displacement gauge.” to “Maximum dynamic and static displacement were measured with a self-made displacement gauge.” p.5020, line21: change “. . .different width. . .” to “. . .different widths in the load bearing wall. . .” p.5020, lines22-23: change “The camera recorded the experiments process.” to “A camera recorded the experiments.” p.5020,line26 – p.5021, line1: concerning the given parameter ranges provide literature! p.5021, lines1-2: rephrase this sentence. . . p.5012, line3: is the given equation in the text correct? please provide also a description of the parameters in the equation! p.5021, line5: according to the date in Table 1, the weight of the smaller sphere should amount to 49kg p.5021, line8: change “A1, A2, A2,. . .” to “A1, A2, A3,. . .” p.5021, line8: change “The experiments condition are explained in detail. . .” to “Details on the experimental programme are summarized in Table 1.” p.5021, line12: add “a” before “load-bearing” p.5021, line14: change “. . .should be important indicators of the failure criterion of load-bearing wall attacked by debris flow.“ to “. . .are important indicators of the failure of load-bearing walls impacted by debris flow.” p.5021, line16: it is not clear what is meant with “from occupational criterions”, skip “taken into” p.5021, lines17-18: change “. . .wall of brick concrete building attacked by debris flow vertically is. . .” to “. . .wall impacted by debris flow is. . .” p.5021, line19: use plural for “result”, skip “being” p.5023, line8: change “a influence indicator” to “an influence indicator” p.5023, line9: use plural for “indicator” p.5023, line13: use plural for “indicator” p.5023, line19: use plural for “degree” p.5023, line20: use plural for “percentage” p.5024, line11: use plural for “type” p.5024, lines13-15: use plural for “descriptors”, skip “these two” and “can”, change “demonstrate” to “characterizes” p.5024, lines16-19: change “. . .according to momentum theorem mv = Ft, the impact force will increases with the decrease of time when the momentum stays the same.” to “. . .according to the momentum theorem mv = Ft, the impact force will increase with the decrease of impact duration when the momentum stays the same.”; the next sentence is not clear, please rephrase p.5025, line12, heading: I suggest to change the heading to

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"The same height of the iron board" p.5025, line13: change "depth" to "height" p.5025, line15: according to the data in Table 3, the ratio is not correct for the bending moment! p.5025, line20: change "...the cracks is wider spreading in horizontal direction. Part of the wall has dropped..." to "...the cracks are spreading wider in horizontal direction. A part of the wall dropped..." p.5025, line23: rephrase sentence... p.5025, line24: change "...to the edge of wall." to "... to the edge of the wall." p.5025, line25: change "...and more surfer layer has dropped from the..." to "...and the surfer layer dropped significantly from the..." p.5026, line1: change "...1.0 and 2.0 m experiments..." to "...experiments with iron board heights of 1,5 m (B1, B2 and B3) and 2,0 m (C1, C2 and C3)..." p.5026, line1: change "with the" to "in relation to the" p.5026, lines4-5: change "Taking the iron sphere that is 86 kg weight falling from 3m height for example (different height of the board or flow depth),..." to "Taking the iron sphere with a weight of 86 kg and falling from 3m height,..." p.5026, lines8: add "the" before "expected value"; skip "possibly" p.5026, lines12-14: not clear, pleas rephrase and deliver a little more detailed information p.5026, line13: add "the" before "sphere"; change "three" to "third" p.5026, line15: add "the" before "three" p.5026, line20: add "are" before "mainly" p.5026, lines23-24: skip sentence as already mentioned above in the previous section p.5027, line2-4: rephrase sentence p.5027, line6: change "have" to "has" p.5027, line7: change "...momentum (different height of board or flow depth) is..." to "...momentum (different heights of the iron board representing the flow depth each) is..." p.5027, line10: skip "will", change "reduce" to "reduces" p.5027, line11: skip "will", change "absorbe part" to "absorbs a part" p.5027, line12: change "one" to "value" p.5028, line7: change "have" to "has"; change "...is not breakdown by..." to "...does not fail due to..." p.5028, line8: change "will swing" to "swings" p.5028, lines9-10: change "Part of the deformation can recover while others cannot." to "Deformation can be partly recovered." p.5028, line16: add "the" before momentum theorem"; skip "length of the" p.5028, line17: change "decides" to "governs" p.5029, lines3-4: skip "of which the elastic modulus is huge."; concerning the following sentence; comparative values by means of debris flow impacts have to be included in order to prove this state-

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ment; literature should be also provided here; however, if not possible due to a lack of data, the statement should anyhow proved. . . skip also the comma in this sentence p.5029, lines4-6: I suggest to rephrase this sentence p.5029, lines 14-17: I suggest to rephrase this sentence p.5029, line13: skip “is” p.5029, line24: change “. . .concrete and cost much to build the models, the experimental data is limit but precious. . .” to “. . .concrete and the creation of the model is rather costly, the experimental data is limited but precious. . .” p.5029, line26: change “. . .more researches. . .” to “. . .more research. . .” p.5030, lines1-2: change “. . .modification when they are applied on the similar element constructed with brick and concrete.” to “. . .modification when they are applied on brick and concrete wall elements with different construction details.” p.5030, line4: change “. . .carried the experiments out. . .” to “. . .carried out the experiments. . .” p.5030, lines8-9: use capital letters for the research institution; change “. . .also have been. . .” to “. . .has also been. . .”

Table 2, text above: Change “Failure criterion for the load-bearing wall of brick concrete building attacked by debris flow.“ to "Failure criterion for the load-bearing wall impacted by a single iron sphere.“

Figures: I suggest to use the same length dimension in all figures and to be also consistent with it in the text; therefore, check also for the data in the Tables 2 and 4 Figure 1: Since there are no results presented from the tests with the 4m-operation platform, you could skip this in the scheme of the experiment set up; Figure 2: change “look” to “view” concerning the Figures 1 and 2, I suggest to show also the iron board. . . Figure 3: change “attack” to “impacted” Figure 7: The data points C1 and C2 (forces) do not fit with the data provided in Table 2! Figure 8, text below: change “maximum impact moment” to “maximum impact bending moment”

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