

## ***Interactive comment on “The effects of cushion’s particle size and thickness on coefficient of restitution under the rockfall impacts” by Chun Zhu et al.***

**Chun Zhu et al.**

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The paper has been significantly improved considering the suggestions from the reviewer and the questions have been properly answered. Therefore, it is suggested to accept the paper for publication falls the following minor points are corrected (minor revision): (1) There are still many typo errors which might due to that the authors directly copied the improved manuscript form Word to LaTeX. Most of the time the neighboring words are connected together, or a blank space between words is missing, or the font size is not right. The authors should check very carefully the following (but may not limited to) lines and make corrections: 38-41, 56-60, 68-72, 75, 81, 85-89, 95, 107, 120,

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123, 138-141, 158-159, 168-173, 179, 197, 222, 226-232, 238, 252, 276-281, 290, 300-301, 309, 321-322, 334, 342-344, 351, 359, 362, 366-376, 390, 396, 402-405.

AC: Thanks for the reviewer’s suggestion. I have readjusted the manuscript form carefully. I am so sorry about this mistake due to the version difference.

(2) In line 158, it should be ‘spherical blocks with diameters of 4 cm, 6 cm, . . .’.

AC: Thanks for the reviewer’s suggestion. I have revised the sentence.

The spherical blocks with radii of 2 cm, 3 cm, 4 cm and 5 cm (Figure 2) are made to simulate rockfall.

(3) In Tables 1-3, the units for the parameters should not be italic or bold.

AC: Thanks for the reviewer’s suggestion. I have revised the units for parameters in Tables 1-3.

(4) It is suggested the authors to check the Eqn. (6) and the related text contents whether the parameters and subscripts are correctly written.

AC: Thanks for the reviewer’s suggestion. I have revised the Eqn. (6) and the related text contents. The location of  $R_y$  is at Figure 11, I have moved the representation to the proper position. I have replaced the ‘4’ with ‘Number of levels’ to facilitate the readers’ understanding.

(In the manuscript) The analysis method used to optimize the calculation results and the optimization process is shown in Figure 11, and  $R_y$  is the range of factory.

Fig.11 Flow chart for the optimization analysis of the test (See attachment)

The four parameters, rockfall block radius,  $r$ , movement height,  $H$ , cushion thickness,  $h$ , and particle size,  $d$ , belong to the factor set  $x \in \{A, B, C, D\}$ , and the number of levels for all factors is four. The statistical test parameter under level  $y$  of factor set  $x$  can be calculated by determining  $K_{xy}$  ( $x=A, B, C, D$ ;  $y=1, 2, 3, 4$ ), i.e., the sum of all the test

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result indices  $P_{xy}$  containing level  $y$  of factor  $x$ , and dividing it by the total number of levels to obtain the average value  $k_{xy}$  in which  $P_{xy}$  is the random variable of the normal distribution:

Formula (6) (See attachment)

where  $K_{xy}$  is the statistical parameter of factor  $x$  at level  $y$ ,  $k_{xy}$  is the average value of  $K_{xy}$ , and  $N_y$  is the number of levels.

(5) At proper places one can shortly address why the authors use spherical instead of non-spherical blocks for tests. A short comment extracted from the text already given by the authors in the answer to reviewer would be good.

AC: Thanks for the reviewer's suggestion. I have supplemented the reason why the authors use spherical instead of non-spherical blocks for tests in second paragraph of 'Experimental Studies' section.

Compared with the non-spherical blocks, spherical blocks with same quality are relatively difficult to be resisted by the same control methods through a large number of tests, spherical blocks presented higher and more consistent COR values compared to cubical blocks. (Asteriou et al, 2016). A phenomenon was also reported that tabular shaped rocks gradually become rounded and wheel-like due to sharp corners breaking off during the descent (Leine et al., 2014). If the designed cushion can resist the spherical rocks, and it also can effectively resist the non-spherical rocks. When designing the protective cushion, the serious conditions of spherical rocks should be considered to ensure fully the safety of worker.

(6) The style of the references is not kept the same. Please very carefully check the references one by one. Attention the typos which are similar to the comment (1).

AC: Thanks for the reviewer's suggestion. I have revised fully the style of the references according to the requirements of Journal.

(7) It is suggested to provide the three tables ('The experimental parameters of the

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first group of tests', 'The experimental parameters of the second group of tests', and 'Orthogonal test results with the uncertainties') as supplemental material for the paper. Both the average value and the standard deviation should be given in these tables, if it is not ideal to plot the uncertainties in the Figures 8-10.

AC: Thanks for the reviewer's suggestion. I have calculated the standard deviation of test data in the Figures 8-10 and Table 2, please check the attachment, I have redrawn the Figure 8 with the error bar (Mean  $\pm$  SD) as an example (See attachment). However, the Figure 9 and Figure 10 include too many curves, if I redraw each curves with the error bar, the Figure 9 and Figure 10 will be confusing and Intricate, thus I will added the standard deviation for three test results of the same experiment as the supplemental material for the paper.

(8) Please check the style of the variable names used in the whole text, including figures and tables. Sometimes they are italic, sometimes not. It is better to keep the style consistent.

AC: Thanks for the reviewer's suggestion. I have revised the style of the variable names to keep the consistency.

Please also note the supplement to this comment:

<https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2018-16/nhess-2018-16-AC3-supplement.pdf>

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2018-16>, 2018.