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Natural Hazards and Earth System Sciences
Discussions

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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RC: Although the effort of attaining the comprising set of 628 tests is valued, the specified test procedure and its error handling is not evaluated profoundly enough to strengthen the authors claims. The authors themselves state that "if an obviously outlying result was obtained, the test was repeated to reduce the error." In experimental series, a unified test procedure yields the given results and subsequent data analysis then shows the range of extremal values. The judgment of an "obviously outlying result" does not correspond to a scientifically detached experimental setup and mind setting. Outliers – or at least unexpected measurement results - might hint to unexpected ef-

fects and processes, to experimental limitations, to faulty experimental procedures, etc. and are not to be discarded a priori. The authors are urged to rethink their approach to experimental findings and focus on a nonbiased data collection.

The full table of measurement results presented in the appendix do not show the uncertainties, but has to be evaluated by the reader itself. The requirement on a scientifically valuable publication and its figures is to concisely transport the gathered knowledge to the readership. It should serve to showcase the received results together with their experimental limitations – in case they are of significant size. A summary of barely treated raw results is favorable with respect to the data origin point of view, but does not serve the purpose of transporting knowledge to the reader. As an example for a minimal data treatment, a revised version of Figure 8 is attached with the uncertainties drawn from the presented measurement data. If taken the standard deviation from the attached measurements in Table 1 of the Appendix, then the graph looks the following. It is clear to the reader that the change in COR from 4 cm to 5 cm block size is not apparent within the error bars. Only after such considerations, any conclusion on data quality and/or experimental sufficiency in terms of number of drops per series are possible. As example for a thorough and concise presentation of similar results, consult for example the article "Geotechnical and kinematic parameters affecting the coefficients of restitution for rock fall analysis" P.Asteriou et. al. (https://doi.org/10.1016/j.ijrmms.2012.05.029). Such data presentation is expected and needed for the COR data to merit possible publication.

AC: Thanks for the reviewer's instructive suggestion. I had stated that "if an obviously outlying result was obtained, the test was repeated to reduce the error." The obviously outlying results were the two rare conditions that VCOR=0 or VCOR > 1. When the blocks of a small radius collided with the cushion of large particle size, such as blocks of 2 cm radius collided with the cushion of 24 mm particle size, blocks can be stuck in the seam between the particles due to the occasionality. When the blocks with relative high kinetic energy collided with the cushion of large particle size, many particles had collided out from the platform, which may be captured by the cameras, posing some error, and these conditions are rare. Therefore if an obviously outlying result (a clear error) was obtained, the test was repeated to reduce the error. I am sorry to make you misunderstand due to my expression problem.

I have calculated the standard deviation of test data in the Tables according to the reference you recommended “Geotechnical and kinematic parameters affecting the coefficients of restitution for rock fall analysis”, and 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 curve with the error bar, the Figure 9 and Figure 10 will be confusing and Intricate, thus I have added the standard deviation for three test results of the same experiment as the supplemental material for the paper (See attachment). Thank you for your understanding and suggestion.

RC: Optimization analysis and discussion of test result: Due to the lack of data quality verification in the first step, the optimization analysis is based on bad ground. However, if amendments are done and the presented search for the leading parameter for COR and damage depth should remain unchanged, the following improvements need to be done: The presented formula (6) lacks Ry, so the derivation of Ry is not clear. Additionally, it is suggested that instead of 4 it is suggested to state “Number of levels” such that a reader who jumps to the equations is not baffled by this specific number. As the formula is not complete and in Table 3 levels are labelled k1 to k4 but in the upper discussion it is only a kxy, it is not clear how to obtain the factors presented in Table 3 for the individual levels. A clarification in notation and procedure is needed.

AC: Thanks for the reviewer’s suggestion. I have revised the Eqn. (6) and the related text contents. The location of Ry is at Figure 11, so the representation of Ry was moved to the proper position. I have replaced the ‘4’ with ‘Number of levels’, and revised the Table 3, adopting the expression of ‘kx1 to kx4’ to substitute for ‘k1 to k4 to facilitate the readers’ understanding (See attachment).

(In the manuscript) The analysis method used to optimize the calculation results and the optimization process is shown in Figure 11, and Ry 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 xâĹĹ(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 Kxy (x=A, B, C, D; y=1, 2, 3, 4), i.e., the sum of all the test result indices Pxy containing level y of factor x, and dividing it by the total number of levels to obtain the average value kxy in which Pxy is the random variable of the normal distribution:

Formula (6) (See attachment)

where Kxy is the statistical parameter of factor x at level y, kxy is the average value of Kxy, and Ny is the number of levels.

RC: Furthermore, Figures 12 and 13 show many trend lines. Again, no uncertainties are given with respect to the trend lines. This is mandatory for the reader to judge the significance of the trend. An uncertainty boundary for the trend lines, estimating the error propagation from experiment to statistical evaluation should be included.

AC: Thanks for the reviewer’s suggestion. According to the method of Influencing factor range analysis of all evaluation indices, the trend lines in Figures 12 is the line for average value of the COR statistical value of factor x at level y (y=1, 2, 3. 4). Due to the definition of error bar, it is meaningful to obtain the error bar of the test data if all the tests are conducted with the same conditions, and the range analysis method don’t require all the conditions are same, it just needs to calculate the average value of the COR statistical value of a factor xA (either of the four factors) at level y (y=1, 2, 3. 4) in all the orthogonal test results, no matter what other factors xB, xC, xD (the other three of the four factors) are different, so it is inappropriate to calculated the error bar of every data in the Table 3, because every data are calculated based on different test parameters, thus I think the Figures 12 and 13 with no uncertainties is reasonable. However, I fully agree with the review's point that it should give uncertainties for readers, so I supplemented the standard deviation of COR and damage depth L for three tests results in same test as the supplemental material (See attachment). According to the tables of standard deviation of COR and damage depth L, it can be seen the standard deviation are relative small, and the average vale of three test results of each test can be used for the subsequent range analysis.

RC: A few comments to further authors responses: Orthogonal test theory: The procedure is introduced, but merely as a disclaimer. Orthogonality is a basic concept in Linear Algebra. The labelling, though, has been misused in software testing and in test procedures as describe in this work, where it only should label the treated input factors as "independent". Although an "orthogonal test design" sounds elaborate, it is not to be advertised as "uniformly dispersed, neat and comparable, making it highly representative". A deletion of this text section is requested. Only data quality can judge whether a test procedure lives up to those high expectations. It is strongly suggested not to oversell used techniques.

Although a deletion of "orthogonal" is favored, a clear statement of "orthogonal test design meaning changing four input parameters independently" or similar is favored. Although some improvements in language and readability have been carried out, the text still is full of typos, especially tangled words are ubiquitous. A more careful proof reading of any final submission is mandatory. Special attention should be given to consistent variable labelling, figure layouts, figure captions, page breaks, typos. Overall the presented work still needs major refurbishments in order to be eligible for publication.

AC: Thanks for the reviewer's suggestion. I agree with your point, and I have revised the introduction of orthogonal test theory to avoid overselling used techniques, the style of the variable names are revised to keep the consistency, the typos in my manuscript are rectified carefully to facilitate readers to understand, and the style of the references

are also revised fully according to the requirements of Journal. I am really sorry about this mistake due to the version difference. Thank you sincerely for your careful and patient revision.

(In the manuscript) To explore the degree of influence of cushion particle size and thickness on COR when a rockfall moves through the cushion, orthogonal test theory was adopted to design a test program (Tao et al., 2017). Orthogonal testing is a design method that allows testing of multiple factors and multiple levels. It is based on orthogonality and selects representative points from a comprehensive experiment for testing, so that fewer trials can fully reflect the impact of the variation of each factor on the index. When these factors cannot be considered in full, the leading factor is considered to achieve the expected effects to a great extent. Four independent parameters, the rockfall block radius, r, movement height, H, cushion thickness, h, and particle size, d, were selected as the basic factors of orthogonal design to test. The purpose of doing an orthogonal test is to explore the degree of influence of the four different factors on the COR and damage depth, L, and find the best combination to reach the optimal protective effect when a rockfall collides with a cushion. The damage depth (L) is the depth to which the cushion is influenced after a rockfall has collided with it and can be used to represent the degree of damage to the cushion.

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2018-16/nhess-2018-16-AC4-supplement.pdf

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