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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Assessment of rockfall hazard on the steep-high slopes: Ermenek (Karaman, Turkey)" *by* Hidayet Taga and Kıvanç Zorlu

Anonymous Referee #2

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The paper presents a geotechnical investigation of a rockfall endangered area. While illustrating the hazard problem of the study case its content cannot be considered research. Albeit that the paper highlights an important hazard case that is worth investigating for the purposes of hazard risk reduction. The paper does not contain any new or novel methods to the scientific field of rockfall. The content is on the whole well presented with a structured report. However there are a number of questionable results presented in the rockfall analysis and the methodology and justifications for various assumptions therein are poorly discussed. Given these main points I do not recommend this manuscript for publication.

Specific comments: 1) The subject matter of rockfall hazards falls within the scope of

NHESS. However, the methodologies applied all be they current engineering practice, they do not represent the state of the art in rockfall science, and do not reveal anything new.

2) The methods applied are of standard geotechnical engineering practice and do not present any advances in technology, analysis techniques or methodology.

3) The authors provide a brief overview of rockfall models available to practicing geotechnical engineers. The review of rockfall models is by no means exhaustive and many of the current state of the art methods are missing from this review (e.g. Leine et al., 2013; Andrew et al., 2012; Basson, 2012). The model selected is a "rebound model" and assumes a spherical body for the rock applying restitution coefficients and friction to simulate ground contact. This method is full of uncertainty, in particular where factors such as rock shape and terrain roughness are forced into the contact parameters represented as restitution values (Lines 211 – 213). It is known that coefficients of restitution in rockfall modelling show a high degree of scatter and values above unity (see Buzzi et al., 2012 and Bourrier et al., 2012). Although there has been some attempt to provide a calibration of the coefficients of restitution applied in this work; the justification based on the field tests to determine the coefficients of restitution is vague and there is no discussion as to the selected range of restitution values that are applied randomly during the simulations. How are the contact parameters applied stochastically in the rockfall model? How does that selection of a spherical model affect the results? Would the large blocks in the images in figure 9 even become mobile unless they were spherical as is modelled?

4) The selection of block sizes is justified as they fall within the minimum and maximum measured values of detachable blocks. But how is this representative of the entire hazard case, what is the distribution of block sizes for the area? The applied methods to investigate the rock slope are extensive, including a discontinuity and thin section analysis. Indeed these are interesting; however it is not clear how these investigations relate to the main analyses performed in this paper. To a large extent these analyses

seem unnecessary. What is the significance of the joint spacing analysis, how are the joints controlling the block size? Are the blocks that are defined by jointing representative of the blocks that are impacting the buildings at the base of the slope? With the maximum energies given in table 4 it is likely that the rocks will fragment on impact with the slope. Can the given energies realistically be expected to impact the settlements at the base of slope? The application of the rockfall model requires that a 2-D profile is drawn over the terrain. What is the justification for the selected profiles? How does this deal with the likely lateral dispersion of rockfalls?

5) The results present the hazard case for the settlement below the slope, and are used to argue for the proposed mitigation solutions of evacuating the area. This may be justified, but it is difficult to reliably discern this from these analyses. The kinetic energies in table 4 are given in kJ, however the values given for maximum and minimum kinetic energy are far and beyond what is plausible for a rock in free fall from the given slope heights (see attached file). Can it be that the authors have given values in Joules as opposed to Kilo Joules as is stated in the header of the table? Based on this assumption and converting the given values to kilo Joules there are still discrepancies with the results. If the simulation results are compared to the maximum potential energy for the slope there are instances where the simulated kinetic energy exceeds the potential energy for the slope (Profile 6). Moreover, if the translational kinetic energy is computed from the given velocities they do not match the values given for maximum kinetic energy. This suggests that a component of rotational kinetic energy is contained in the maximum kinetic energy values quoted. The rotational aspect of rockfall is not discussed. How is the rotational component of rockfall computed in the model?

6) How is the conclusion that common rockfall mitigation methods are not suitable for this particular site justified? This is not clear in the text. Is the statement in line 269 -270 based on the output of the rockfall model or observations of rockfall?

7) The authors present in figure 13 an image of the back analysis applied to ascertain the coefficients of normal and tangential restitution; details of this methodology are

lacking. Commonly restitution coefficients are derived from the ratio of the rebound to the incident velocity of a given impact. It appears that video analysis has been applied to attain the velocities. However, firstly this is not clear nor are any details given as to how the images have been scaled to extract the velocity. What was the frame rate of the videos used in these measurements, what was the depth of field of the passing block? Such factors have a strong bearing on the velocity that is extracted, respectively the resultant restitution coefficients. How many experiments were performed to attain the distributions of the restitution coefficients given? Restitution coefficients measured by velocity assuming a point mass are renowned for large scatter, which is an effect of the rock's shape.

11) On the whole the symbols and abbreviations are correct. Table 4 contains kinetic energy values labelled as kJ that far exceeds that which is likely for the described rockfall case. It is assumed that the authors are quoting their results in Joules as opposed to kilo Joules.

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Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2015-337/nhess-2015-337-RC2-supplement.pdf

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