This manuscript explores the possibility of using numerical modelling to hint the morphology of fractures by comparing them with results from laboratory experiments. The modeling is accomplished using DEM methods able to recreate a reliable shape of fracture surfaces, then compared to natural fracture surface from lab experiments. The Authors claim to have explored this comparison in the various stress conditions, yet due to the small size of the generated natural fractures, this comparison is restricted to the two experiments developed in tri-axial conditions. This significantly reduces the impact of the manuscript, that may correctly focus on the used comparisons and requires a more focused title and abstract.

Even in the only two compared experiments there are substantial differences in the roughness results between numerical and experimental results. This mostly derives from the confusion between extensional fractures and faults (i.e. shear fractures). The experimental fractures show a clear shear-related formation (their reported angle to the stress conditions is exactly what expected for faulting). And this might well be the main factor that produces the found roughness differences! The slip along the surface, even if very limited, is responsible for a smoothing process (that, in the case of large faults would derive in to the well-known “fault mirrors”, characterized by the almost absence of roughness along the slip direction). This smoothing is proportional to the slip amount, yet could be easily replicated in the numerical modelling (that are intentionally by the author halted at the rupture point, even if the slip starts immediately DURING the enucleation of the shear-fracture surface). This additional behavior can be accomplished by adding the proper directional smoothing kernel on the re-oriented rupture plane (on the “height” component?). My suspect is that the proper application of this filter would significantly reduce the difference in the roughness between numerical modelling and experimental results.

On the other hand, more information are required on the grain-size of the DEM modelling. We know that the efficiency of a stress to break grains is inversely proportional to the grain dimension. That is, the grain-size distribution used in the DEM may affect the roughness of the results. My suggestion to the authors is to include this factor in the modelling and to explore its role on the roughness in the numerical experiments.

On last point is about the discarded fractures related to their small dimensions… I did not fully understand it. Was it a problem of resolution in the scanning with respect to the particle dimensions of the DEM (i.e. to have comparable number of points)? What about improving the scanning resolution or enlarging the samples in the experiments? It would be of great interest to fully explore the generation of real, small extensional fractures.

In conclusion, the manuscript in its present form is not suitable for publication, despite the interesting, and surely inspiring, subject the Authors propose. In this way, I strongly recommend to improve it and resubmit, hoping that my suggestions will be useful.

Here is a list of observations on the text:

Line 6 and forward- why using the term self-affine with respect to self-similar (e.g. Turcotte, 1992, a reference that is strangely missing)

Line 30 it is better to use resolution rather than “scale”

Line 53 Please indicate explicitly the dimensions of the model (3D re-projected on a 2D+height dimension?)

Line 68 cylindrical since is a symmetrical 2D model? This is not clear

Line 87 why 30 degrees? Is it related to the frictional angle, as suggested in: (e.g.) A Nur, H Ron, O Scotti, 1986?

Line 90 more info on this “final step” will ease the understanding of the numerical process

Line 106, 126 and in the manuscript: there is some confusion among the terms “height”, “y’”, and “z’”. It seems they might indicate the same coordinate axis. Please explicit or indicate the differences

Line 153 please add indications on how the random selection is accomplished

Line 157: it would be useful if you indicate here the relation between the Hurst exponent and the fractal dimension D

Line 163. Here is where a full description of the particle size distribution in the numerical experiment should be added

Line 163 : “a large number”

Line 165 : s1 > s2 > s3 >0

Line 179: please indicate which is the “chosen speed” and why it was chosen since this will affect the rupture roughness

Line 186: please quantitatively specify “rest” and indicate how it has been chosen

Line 195-198 the quantitative comparison between experiments at different speed would prove this sentence

Line 202 among

Line 218-221 Please rephrase Abstract and Introduction accordingly!

Line 226: Apologize for my ignorance: what is mio unit?

Line 224-227 To complete the indications, the distance between lens and object must be specify, since this influence the resolution

Line 240 were calculated, were

Line 264-267 as discussed earlier, the found angle is obvious: faulting (shear plane)

Fig.9 indicate the unit of the x-axis “Distance” scale and its relation to particle size

Line 281-287 as discussed earlier, this is something that has to be fully discussed earlier for its general meaning

Line 304-307 a figure is require to prove it

Line 315-317 is this statistically meaningful?

Line 318-322 Does this mean that their distribution is not self-similar (“self-affine”)? A comment will help

Line 339-344 refer to what presented earlier

Line 347-356 According to this sentence, the manuscript should be reshaped to avoid creating disconfirmed expectations by the readers

Line 357-360 the use of two different measure (% and ration) might be confusing for the readers

Line 364-380 refer to what discussed earlier

Line 367-369 add a comment on grinding and smoothing produced by sliding

Line 403 apologize again for my ignorance: what is “Brasilian test”? Maybe some description of it for “the rest of us” will improve the reader comprehension

Line 409-411 I strongly doubt this, according to the relation with the role played by grain-size distribution (see earlier). Is this (forced) sentence necessary? Or better justify it!

Line 415-416 at least the values of the results must be mentioned. As it is written, it seems a subjective elimination of undesired data…

Line 422-435 again the problematics connected to grain-size distribution. My suggestion is to discuss this earlier in the text (in the introduction?)

Line 429 The experiment velocity (i.e. velocity of propagation of fracture surfaces) will influence the re-organization of stress and the influence of local secondary stress components, and therefore the resulting roughness. This has to be taken into account when presenting results. Perhaps a series of experiments at different velocity will highlight this very interesting point.

Line 443 please specify that they result from tri-axial conditions! (and therefore the development of faults - shear surfaces)

Line 451 better “result” rather than “phenomenon” ?

Francesco Salvini