Fluctuating band model

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ABSTRACT

The formation and evolution of shear bands in dry granular materials in quasi-static and slow shear will be investigated. Some experiments and discrete element simulations show wide shear zones others display narrow shear bands which may evolve in time. The transient properties of such a system can be very interesting featuring e.g. non-monotonic behaviour [1]. The aim of our contribution will be the presentation of a simple model which can reproduce quantitatively the observed results.

The fluctuating band model belongs to the class of mesoscopic elasto-plastic models, where flowing of a jammed material is described by a self-organized process. The granular material under shear load will fail eventually in a surface which minimizes the dissipation rate. The slip of the material creates local rearrangements and thus if after a small elastic regime the load again creates a new shear band it must be found in the modified material structure. The actual observed flow will be an ensemble average of the above instantaneous shear bands. This self-organized nature of the model can reproduce with great accuracy the non-monotonic transient behaviour of the shear zone width.

It can be further proven that for such a system only the geometry, and the relation between the wall and bulk properties are important. We tested it in an experiment with a modified Couette cell, with bottom split which was made at the outer wall. Complicated flow profiles were observed for different filling heights which was again faithfully recovered using one material parameter: the ratio of the effective friction coefficients of the material at the wall and in the bulk.

Finally the model is tested against other models in a simpler geometry of simple shear where our model is strangely equivalent with the Bak-Sneppen model of evolution [3]. Since this model is very well studied it allows the analytic treatment of the model to some extent and its detailed verification against discrete element simulations including the comparison to other models.

REFERENCES

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