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On the influence of Particle Shape in fault gouge simulations using the Discrete Element Method

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Over time, rough fault systems develop a boundary layer of fragmented rock as tectonic plates grind past each other. Understanding the frictional characteristics of this gouge zone is of importance in the prediction of the earthquake potential of faults. Frictional response can be affected by a number of factors including particle size distribution and whether or not strain localization occurs. A popular numerical method used to understand the evolution of gouge material is the Discrete Element Method (Abe and Mair, 2005). The DEM solves the equations of motion for each individual grain within the system over a series of finite time intervals. A large component of doing this involves the detection of particles that are likely to be in contact with each other. Spherical particle shapes are often used to simplify this process, however they have a tendency to roll rather than slide which reduces the overall bulk frictional response of the gouge material. Two options exist for the incorporation of shape into these models. The first requires complication of the contact detection scheme by allowing particles to be polyhedral in shape. The second is to cluster particles together into a basic shape which is an approximation of the intended shape.

The purpose of this study is to show the impact of different cluster shapes on the bulk frictional response of the media. A number of cluster types were selected involving different bonded configurations of the particles (peanut shaped, tetrahedral, cubic etc.) and the resulting bulk frictional response measured using a shear cell apparatus. Results show that the complexity in the shape of the cluster does not play such a significant role in the behaviour of bulk assemblages. The most important factor is that the particle is not spherical and is able to interlock with its neighbours in some fashion. This leads to the conclusion that simpler shapes with fewer particles may be used as an analogue for more complex shapes in many cases. The reduced computational burden in using simpler shapes will permit more in depth studies of the frictional properties of fault gouge zones over longer time periods.