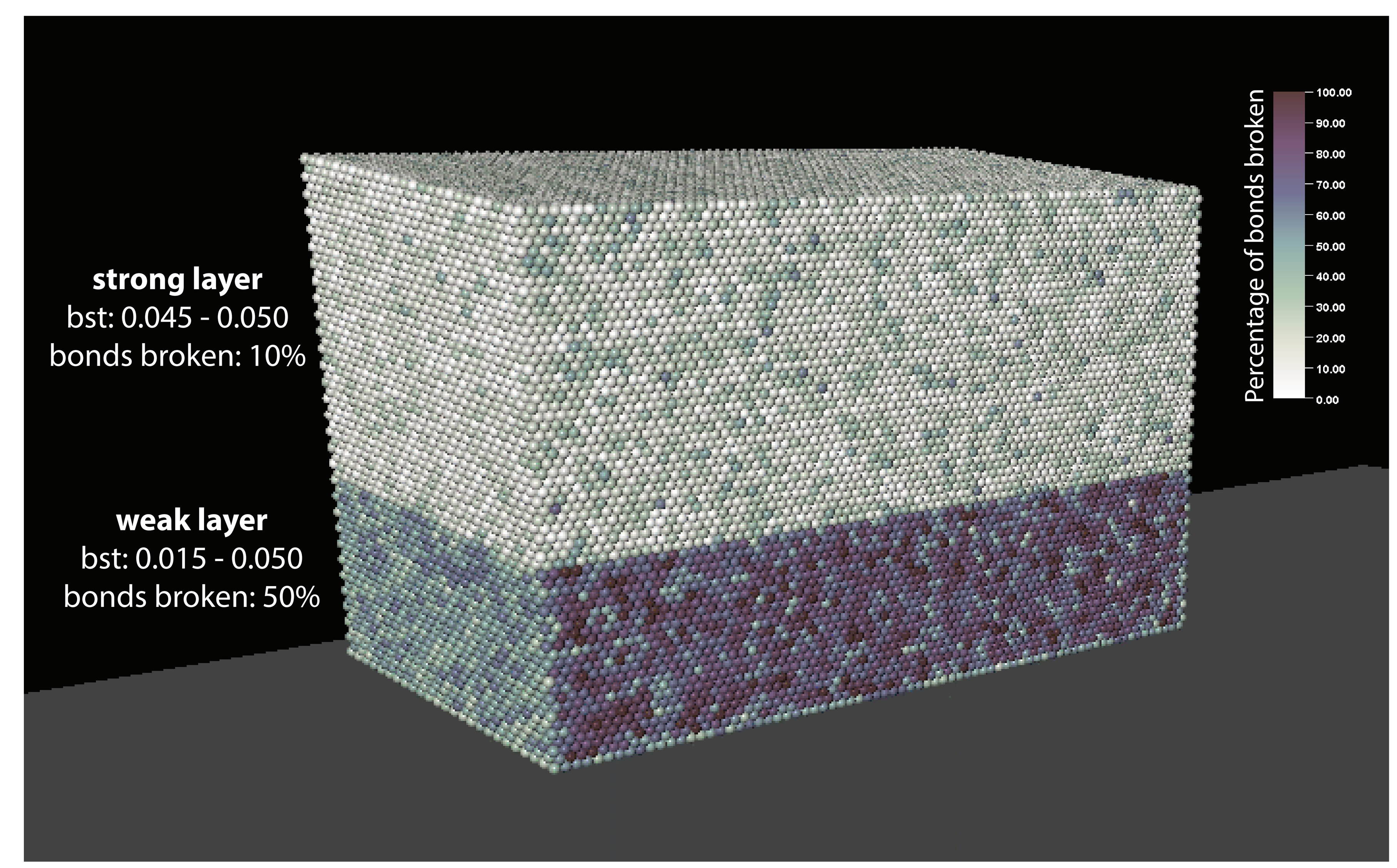
DEM: 3D Block failure 2. Comparing the effect of layer thickness 1

The media consists of 232,500 elements with a radius of 1 unit in a box of dimensions 150 x 70 x 90 units. Elements are distributed in a regular hexagonal configuration where each element has 14 neighbours. Elements interact as though connected by breakable elastic springs, where each link between an element pair can be assigned unique properties to introduce heterogeneity into the system. There are 10 layers representing sediment in the model where the outermost elements are defined to be the box containing the material. These elements do not move and are not connected to the media but have a compressional force to keep the material inside the box. The box is tilted 5° towards the viewer. The front wall in unbounded, so once the experiment begins elements fall under the action of gravity.
If all elements have the same initial bond relationships, the hexagonal configuration will dominate the deformation style and everything will fail simultaneously, or not fail at all because the nature of the lattice means that everything is in an equilibrium state. To prevent this, each element within the material is assigned its own initial breaking strain. This is determined from a percentage (b_range) of the maximum value (e.g. a breaking strain of 0.05 units with a b_range of 50 will assign breaking strains between 0.025 and 0.05 unit to an element). The breaking strain of the link between a pair of bonds is then determined from the average breaking strain of the two elements it connects. The lower the value of b_range, the greater the variation in breaking strains for elements within the material. This creates a randomised value of strengths in the media Once the breaking strains have been calculated for all element pairs, the material is seeded for failure. This is achieved by breaking a percentage of the total intact bonds selected at random. As a consequence an element could have all/none of its bonds broken at the start of an experiment. The random number used to generate these is the same for all experiments, allowing experimental results to be directly compared. The basal surface that the sediment falls on is frictionless, so elements continue to be displaced as the experiments run. For a more detailed explanation of the methodolgy used in these experiments please follow the links on the webpage to publications using this methodology.

In these experiments the effect of the relative strength of two layers and their thickness is investigated where the basal layer is weak material and the upper layer is strong. In the strong layer the b_range is 90 (bst: 0.045-0.050) with 10% of the initial bonds broken and for the weak layer the b_range is 30 (bst: 0.015-0.05) with 50% of the initial bonds broken. The relative thickness of the weak layer increases from 40% (a) to 90% (f) in the experiments.
These figures show the media at the end of the experiment with the boundary walls removed presented as the percentage of broken bonds from the front and in plan view (a)-(f). The name of the corresponding movies are indicated in yellow. The bonds broken in the media are a percentage of the total bonds in a layer so the colouring of broken bonds shows that for some elements almost all bonds are broken in the weak layer at the start of the experiment. The final media coloured as layers in presented in (g)-(l). The weak layer is coloured white-green and the strong layer is represented by brown layers. These have no mechanical variation but help to see the displacement of blocks within the strong layer with time.



Experiments comparing the effect of the seed and b_range are presented in doi:10.48420/19635106 and some investigating the effect of the variable strong and weak layers are available at: doi:10.48420/20209907

Percentage of bonds broken
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
(a) weak layer 40%
MOVIE: WS_4-6
(b) weak layer 50%
MOVIE: WS_5-5
(c) weak layer 60%
MOVIE: WS_6-4
(d) weak layer 70%
MOVIE: WS_7-3
(e) weak layer 80%
MOVIE: WS_8-2
(f) weak layer 90%
MOVIE: WS_9-1


(g) weak layer 40% (white-green)
(h) weak layer 50% (white-green)
(i) weak layer 60% (white-green)
(j) weak layer 70% (white-green)
(k) weak layer 80% (white-green)
(l) weak layer 90% (white-green)