

Can We Make Sand Strong?: Mechanically Stabilized Earth

Grades 6-8

Employs Engineering Design ETS1.A, ETS1.B, and ETS1.C: Defining and Delimiting an Engineering Problem, Developing Possible Solutions, and Optimizing the Design Solution, respectively.

Summary: Students will use different materials to increase and test the friction strength of sand grains, a common geotechnical engineering problem.

Background:

Engineers are often tasked with building quickly, safely, and in space-limited areas, especially when considering how to build ramps, high roads, and strong foundations. Soil and sand are cheap materials, but on their own, are very weak; the strength they have comes from friction between each grain. By increasing the confining pressure on a soil or sand mass, the friction strength between each grain increases, which increases the overall strength of the mass. One way to accomplish this is to pile soil out horizontally, but this takes up an incredible amount of space. Another way is to reinforce the soil by placing materials in between layers of soil, which increases the confining pressure. This method is commonly used in our towns and cities, and is called Mechanically Stabilized Earth (MSE). This video from Practical Engineering provides additional helpful background behind the engineering of MSE and lab the students will do:

https://www.youtube.com/watch?v=0olpSN6_TCc

Activity Details:

Students qualitatively test different materials that increase the confining pressure of wet sand. They begin by testing the strength of packed wet sand, and then perform separate tests for each of the given materials. They layer in packed sand, then a piece of the material they are testing, then more sand and another piece of material, and continue until they have 3-4 layers of sand and the reinforcing material (see diagram below). They record their qualitative observations and then rank the materials in order of strength. After all the groups complete their rankings, decide as a class which material to put to the ultimate test. Layer packed sand and the material in a box outside or on a tarp and remove the walls from the box. Students can take turns standing on the reinforced sand to see how strong it is.

Materials (per group):

Container – quart yogurt cups or prepared food containers from grocery stores work well
Sand – enough to fill the container, mixed with water so that it is damp so it sticks together but is not watery
Tray
Spoon
Rock or weight
Reinforcing materials: paper, fabric, wire mesh/window screen, plastic sheet, paper towel
Scissors

Materials (per class):

Cardboard box – about 1'-2' x 1'-2', with sides easily removable
Sand – enough to fill the box, mixed with water so that it is damp but not watery
Material – whichever the class decides to test together, and enough to make 4-6 layers
Tarp

Diagram

