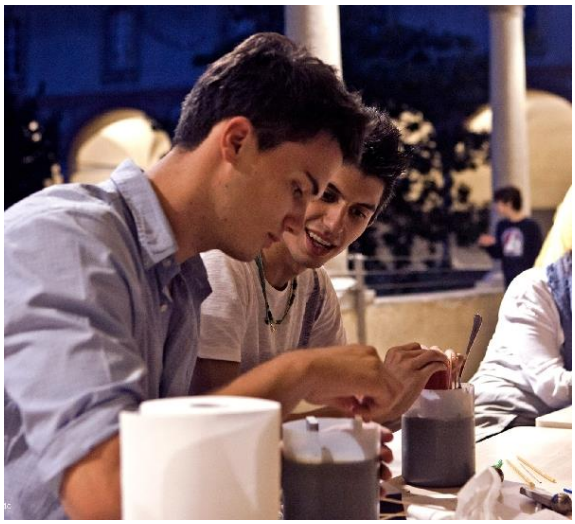
ENGINEERing challenge workshop for science museums in the field of geotechnical



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ENGINEERing challenge workshop in the field of geotechnical

Workshop ID card

Name of the workshop: The strength of the soil

The Challenge: To avoid that a building built on a granular soil tilts when the soil is wet and shaken

The Engineering field: Geotechnical engineering

The science field: Geology

Target audience: Families with children from the age of 7, classrooms with pupils from the age of 9

Type of activity: workshop

Duration of activity: 45-50 minutes

Specific notes: it is better (also if not essential) to work in a space with running water

Context

The participants meet the phenomenon of soil liquefaction and they investigate how to avoid that causes damage to buildings.

Maximum number of participants: about 25
Number of facilitators (intern): 1
Location: it is not required a particular location, we need a room with tables and, if possible, running water
Set up time needed: 1 h before the start of the whole activities, 5 minutes between one group and the next, asking the participants to help the explainer

General objectives

The Engineer Museum Activities:

- ✓ Offer the participants to find and experiment different solutions to solve a "real" engineer problem
- ✓ Give a new perspective on Engineering as a field, a process, a way of thinking and working
- ✓ Introduce and exemplify the EDP (Engineer Design Process: Ask, Imagine, Plan, Create, Improve), or part of it
- ✓ Give the participants the possibility to reflect on what they have done and how the Engineers work.
- ✓ Are based on IBSE - Inquiry Based Science Education and are not gender oriented.

Specific unit objectives

- ✓ understand the stability of a soil granular and saturated with water
- ✓ investigate how to oppose to the effects of the phenomenon

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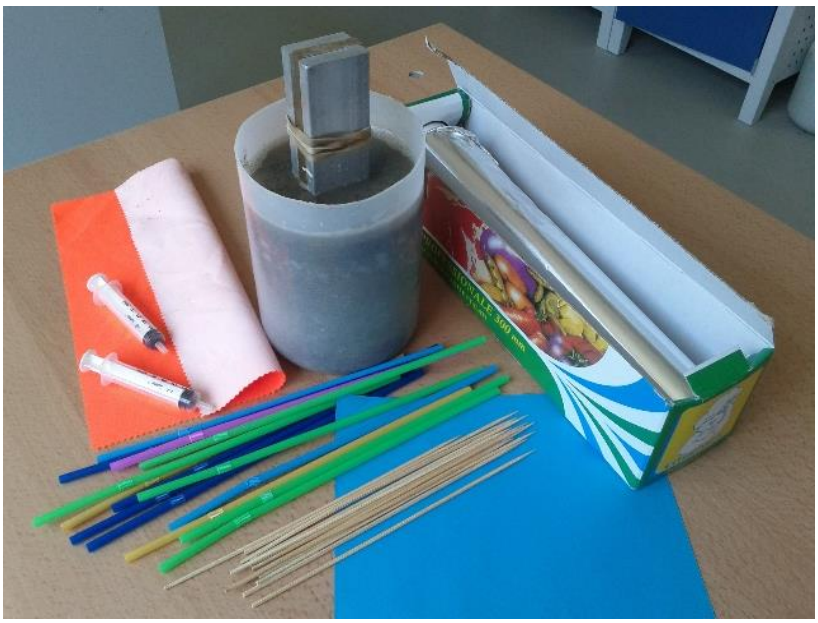
Resources



material	Total amount	Expendable	Non- expendable
little container	10	✓	✓

fine sand	It depends from the volume of the container	✓	✓
water	It depends from the volume of the container	✓	
Steel ball (optional)	10		✓
tablespoons	10		✓
weights (we use little metal tiles, held together by rubber band)	10		
straws	100	✓	
syringes (without needle)	10		✓
skewers	50	✓	
plastic sheets	20	✓	
rubber bands	50		✓
aluminum foil	1 roll	✓	
pieces of rubber, like inner tubes for bicycles	10	✓	
scissors	10		✓
trays	10 for the participants + 2 for dirty materials on the table of explainer		✓

little plastic bottles, for example those for water, 33 cl	10		✓
rice	enough to fill completely the bottles + 1 kg		✓
Containers for rice, like tupperware	10		✓
pencil	10		✓
tables	5 for the participants + 1 for the materials		✓
stools	20		✓

The workshop

Before the activities the facilitator has to prepare the wet sand in the containers:

_pour the water in the container till ¼ of its height
_pour slowly the sand in the water to fill almost all the container: the quantity of water and sand is ok when water forms a thin film on the surface of the sand - if the sand is too dry pour a bit of water, if there is too much water pour it outside.

For the activity with the rice the facilitator prepares a little bottle for the demonstration:

_fill with rice the bottle to the brim, then pat the bottom of the bottle on the table: the level of rice lowers
_ add rice and pat again, until the level of rice does not lower more.

Introduction

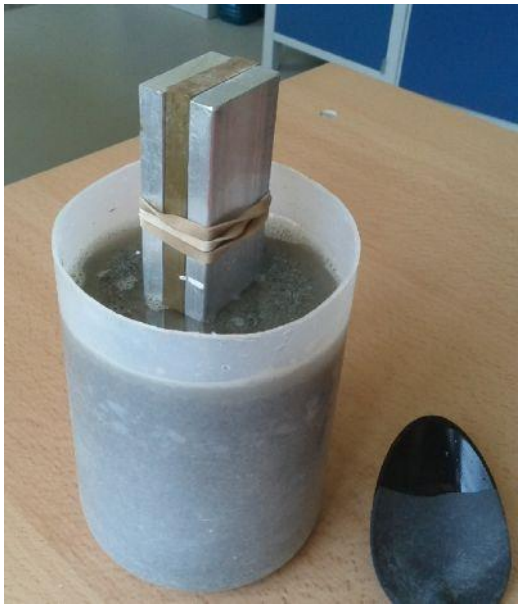
Welcome the participants and tell who you are.

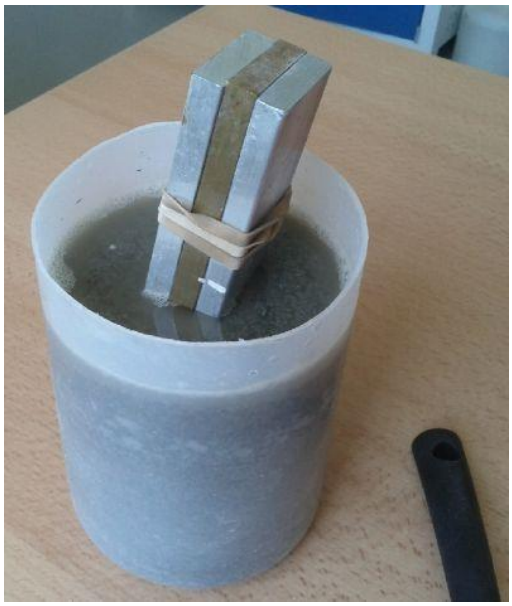
Facilitator says: "In many plains the soil is very grainy and the aquifer is at shallow depth. These soils are useful for farming and often these regions are populated, with villages and towns. It may happen that an intense earthquake activates in those soils an unexpected behavior. Let's see what it is, magnifying the situation: we use sand saturated with water. What you will experience is not still very far from what happens in reality."

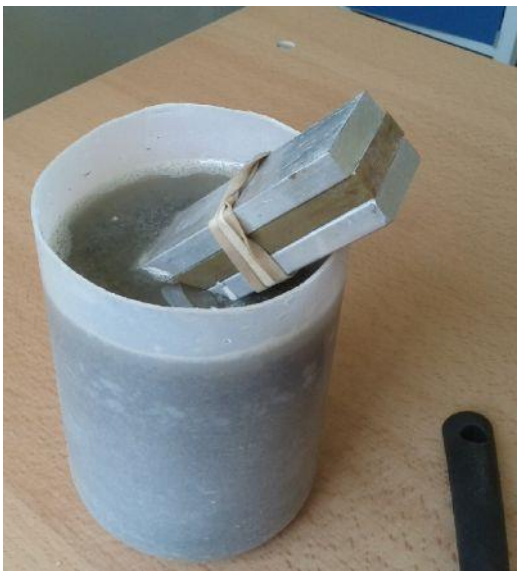
The main activity

1. bring the participants so that everyone can see what he does
2. take a container of saturated sand and with the tablespoon dig a little 'of sand, placing it abreast of the hole
3. tap the side of the container with a spoon or the fingers: the bottom of the hole fills with water and the pile of sand "melts" and drips in the hole
4. take a steel ball and drop it from about 30 cm on the sand: the ball sinks into the sand very little - the sand saturated with water seems rather solid
5. tap the side of the container with a spoon or the fingers: the steel ball sinks rapidly

6. pull out the ball and lay a weight on the sand: "this is a building, let's see what happens"
7. press down the building but this does not sink, then tap lightly the container: the building tilts, until falling



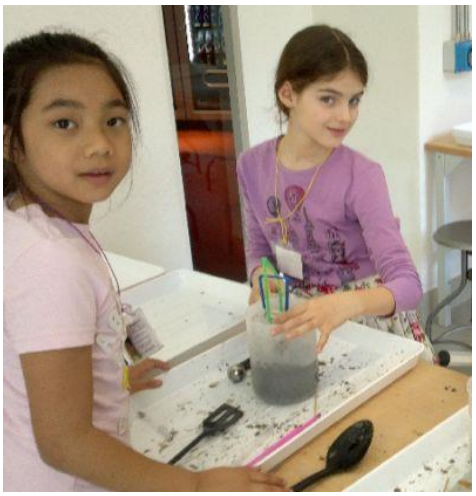
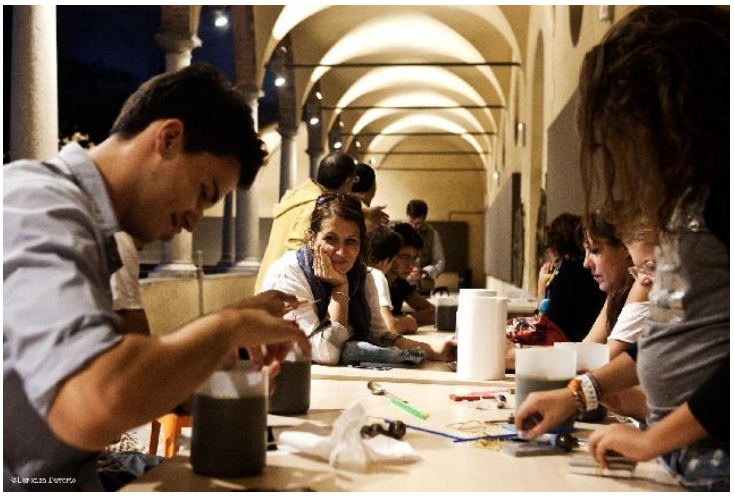




8. the facilitator says to the participants "An earthquake can cause the liquefaction of soil, and buildings can be seriously damaged. The engineering challenge is: how to avoid that a building tilts?"

9. show the materials: "You can use these materials to solve the problem."

10. when participants have experienced a solution, or multiple solutions, the facilitator asks them to retrieve the materials they used and bring them back on the table of materials

If there is time (about 10 minutes) the facilitator proposes another activity: "Sand and soil are granular materials. So, is it dangerous to build on a granular material? Not always, it depends of geological conditions. We can test the strength of a dry granular material: rice!"

1. take a container with rice and a little bottle: "Here's what to do."
2. start filling the bottle with the rice, then stop and say "To do before I have already filled one" - take the bottle you have already prepared
3. insert a pencil in the rice and show that he is straight: "Beh, a pole in the rice should be quite stable"
4. take the pencil and lift it, lifting also the bottle: "What happens? Try it yourself"
5. distribute bottles, containers with rice and pencils
6. at the end, ask the participants to retrieve the materials they used and bring them back on the table of materials

Conclusion

With students there is a discussion about what they noticed and the solutions they found. If there is time, the facilitator writes the observations on a flipchart: at the end, she/he gives the board to the students.

There isn't a conclusion with the general public.

Information for the facilitator

Background information

Dilatency and Liquefaction of a fine sand, http://vimeo.com/22705742

Extreme Soil Liquefaction, http://youtu.be/Rd6W2aP2dkA

Japan 2011, http://youtu.be/FH84wrnvHpw

The Quick Clay Landslide at Rissa – 1978, http://youtu.be/3q-qfNlEP4A

Soil Liquefaction web site , http://www.ce.washington.edu/~liquefaction/html/main.html

About Liquefaction: Giving Ground - http://geology.about.com/od/liquefaction/a/liquefaction.htm

Soil liquefaction, from wikipedia - http://en.wikipedia.org/wiki/Soil_liquefaction

Problems you can encounter

The facilitator must clean trays and tables before the next group begin the activity: press the visitors to remove from the sand all the object they put in and to bring them back on the table of materials. Inevitably a bit 'of sand and rice fall to the ground.

Tips & tricks regarding the materials

As a container for the sand we used a plastic bottle (soft enough) and we cut the neck. It works well. We tried a container like tupperware but it doesn't work well: perhaps the edge is too rigid. But in these two exhibits http://www.exploratorium.edu/faultline/activezone/liquefaction.html and http://youtu.be/Xow8X-bVDqM they used a rigid container. We will try with a little aquarium, or a flowerpot.

When preparing the container of sand saturated with water first pour the water and then the sand. If you pour the sand first and then the water you need to mix a long time with a spoon to penetrate the water everywhere, and then you have to rest the container for at least a day and check the mix.