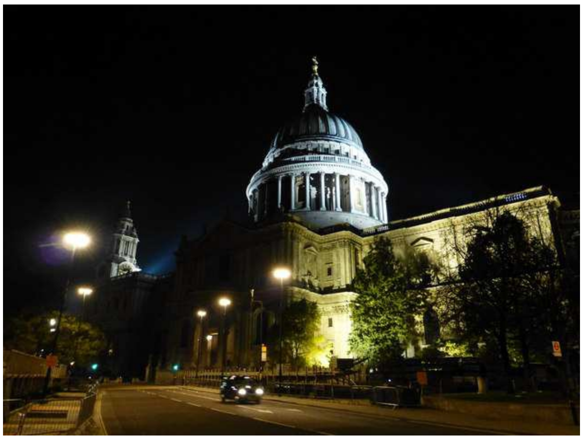
Testing rocks 2 - 'Splat!'
A simple way of testing the plasticity of clay

Engineers often need to build structures such as blocks of offices on clay, rather than on hard rock. The strength of the clay depends on how much it changes when it gets wet, either in the rain or from groundwater. Some clays become very plastic when they get wet and so can deform and flow. They may not then have enough strength to hold up a large building. In this activity we investigate the effect of water on the plasticity of clay.

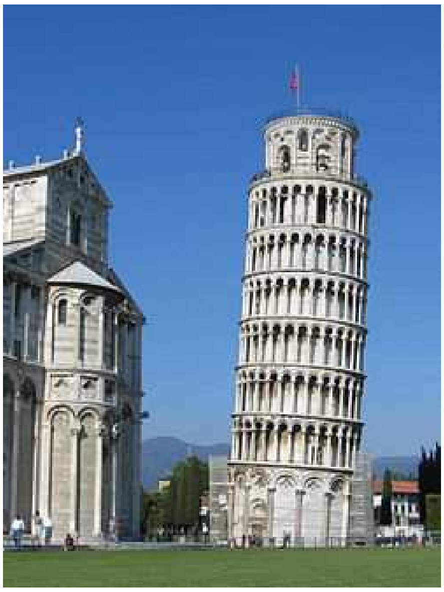
Take a lump of clay and roll it around to make a ball about 50mm in diameter. (If it is too dry, add a little water to soften it). Measure the width (diameter) of the ball with callipers, or by devising your own method. Protect the floor with some old newspaper and then place a sheet of graph paper on it. Use a tape measure to measure a height of 2m from the floor and then drop the clay ball from the 2m mark onto the graph paper. Measure the diameter of the 'splat' of clay, using the squares on the graph paper and write it down. Repeat the activity several times and calculate the average diameter of the 'splat'.
Now add a small measured amount of water from a measuring cylinder and make several more measurements as before. Note down the results and calculate the average diameter.
Repeat this a few times, adding more and more water and testing each time. Plot a graph of the results to answer the question, "How does the water content affect the plasticity of clay?"
Clean up – yourselves and the floor!

Students enjoying making clay balls for 'Splat!'

Measuring the diameter of the clay ball before dropping it, using callipers and a ruler (Photos: *Peter Kennett*)



St Paul's Cathedral, London, by night (built on London Clay) (Photo *© Copyright Paul Farmer and licensed for reuse under Creative Commons Licence)*



The Leaning Tower of *Pisa (User: Marshaü, Creative Commons Attribution-Share Alike 3.0 Unported license)*

The back up

Title: Testing Rocks 2 - 'Splat!'

Subtitle: A simple way of testing the plasticity of clay

Topic: Pupils investigate the relationship between the plasticity of clay and its water content by dropping a clay ball onto the floor and measuring its spread.

Age range of pupils: 14 – 18 years

Time needed to complete activity: 30 minutes

Pupil learning outcomes: Pupils can:
- learn how to carry out a messy activity responsibly;
- make measurements, whilst understanding that they may be approximate;
- construct a graph of water content against the diameter of the clay 'splat'
- discuss how the addition of water affects the properties of a clay;
- suggest other factors which might influence the engineering properties of rocks in practice.

Context: Civil engineers need to measure many different properties of rocks, of which the plasticity of clay is one important factor. We investigate others in other Earthlearningidea activities.
Note that, even though it is still plastic, clay is regarded as a rock by both geologists and geotechnical engineers.

Following up the activity: Pupils could:
- be shown photographs of road cuttings, tunnels or bridge piers and asked to state what other factors may need to be taken into account in planning such structures on clay;
- investigate other engineering properties of rocks, through further Earthlearningidea activities;
- make a field visit to a local engineering project to study how possibly unstable surfaces, particularly of clay, are stabilised;
- invite a local civil engineer or engineering geologist to speak at their school about the importance of understanding the geology before carrying out a new project.

Underlying principles:
- Engineers would use an instrument dropping a heavy brass cone onto a clay sample and the depth of the hole is related to the plasticity of the clay.
- A clay substrate is not necessarily a weakness when planning buildings. Much of London is constructed on a thick clay formation, known as the London Clay and the buildings are stable.
- Clays may be more problematical when they occur on sloping, rather than flat ground, and further engineering measures may be needed to stabilise them.
- The Leaning Tower of Pisa (58m high and 4m out of vertical) is leaning because of the differential compaction of plastic clay beneath. Fortunately, construction was phased over about 200 years and the substrate gradually gained strength as it was compressed, so the tower did not fall down at an early stage. It has now been stabilised at a fixed angle.
- Problems may still occur, in spite of modern techniques, e.g. Houses were built on the Oxford Clay in England during a long dry summer. The ground floors were solid concrete, laid properly in accordance with national specifications and the foundations were taken to the statutory depth to avoid seasonal movement.

  In the subsequent winter, the clay re-hydrated. The foundations did not move, but the floor slab domed upwards. There was a panic on Christmas Eve when the occupant reported a loud bang. A crack in the external wall had shot upwards the full height of the house; narrow at the bottom and some 50mm wide at the top.

  This sort of thing is a problem with modern masonry construction, which is very stiff compared with walls using sand/lime mortar.

Thinking skill development:
Thought processes of 'construction' are involved in collecting data and drawing a graph.
Applying lab work to the real world of engineering involves bridging.

Resource list: per small group of pupils:
- enough soft clay to make a ball of about 50mm diameter: water-based art clay or garden clay
- 2m tape measure
- measuring cylinder with water
- callipers
- graph paper
- floor protection, e.g. newspapers
- cleaning equipment, for pupils and the floor!

Useful links: See the E-library of the National Science Learning Centre for a full version of "Routeway" - http://www.nationalstemcentre.org.uk/elibrary/resource/737/routeway-solving-constructional-problems

Source: Based on an original unit, "Routeway 1 – a testing time for rocks" written for the Earth Science Teachers' Association by Peter Kennett, Julie Warren and Laurie Doyle.
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