

Earthquake prediction - when will the earthquake strike?

Modelling the build-up of stress and sudden release in the Earth that creates earthquakes

Ask pupils why they think many people can be killed when an earthquake strikes. (*Answers will include falling masonry and glass, collapsing highways, landslides, associated fires etc, but should also include the difficulty of knowing exactly when and where an earthquake will strike. If we could predict when earthquakes would strike, people could be told to move out until the danger was over*).

Most earthquakes are caused by sudden movement along natural fractures in the rocks, called faults.

Explain that we are going to model how forces acting in the Earth can build up stresses, which are suddenly released when rocks fail (fracture). Set up three or four house bricks, or similar heavy objects as in the photograph. Attach a length of elastic rope, or a coiled spring to the middle brick with string or wire. Pull steadily on the elastic or spring until the top bricks suddenly slide over the lower ones. This represents the point at which rocks below ground fracture and move, resulting in an earthquake on the surface above them. (It will probably be necessary to hold down the front brick on the table to prevent it from sliding). Repeat the activity several times, trying to increase the tension on the spring at the same rate as before. Each time, ask the pupils to observe how long it takes before the movement occurs and by how much the bricks move. (*The results are seldom consistent, demonstrating that there is considerable variation in the timing and amount of movement along real fault planes in the Earth – viz. great unpredictability*).

The activity may be extended by varying the friction between the bricks. This may be done by

adding more bricks, sprinkling sand between the layers of bricks, or even trying to lubricate the surface between them.

(Warn pupils to beware bricks falling off the bench).

A shallow dish of water placed near the bricks may show a shimmer of ripples over the surface when the bricks move. This is analogous to the damaging surface waves created when an earthquake strikes.



The brick 'earthquake' in action – a) using another pupil to restrain the front brick from moving



The brick 'earthquake' in action – b) Using a Newton meter to quantify the forces involved. The front brick is stopped from sliding by a board, held to the bench by a clamp. (Photos: P. Kennett)

The back up

Title: Earthquake prediction - when will the earthquake strike?

Subtitle: Modelling the build-up of stress and sudden release in the Earth that creates earthquakes

Topic: Use a pile of house bricks to demonstrate the build up of stress before 'brittle failure' takes place. Repeat the demonstration to show the variability in both the timing of the event and the stress required to produce failure.

Age range of pupils: 10-18 years

Time needed to complete activity: 10 mins

Pupil learning outcomes: Pupils can:

- measure a displacement between the bricks on the table;
- measure a time interval between the initial application of a force and the movement of the bricks;
- describe how a steady build-up of stress can lead to sudden movement of heavy objects;
- explain why the timing and scale of an earthquake is difficult to predict.

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- explain that shock waves are caused by the sudden movement of the bricks, similar to those produced in the Earth when rock masses fracture.

Context: The activity could form part of a lesson on earthquakes and their effects, leading to an understanding of the difficulties faced by civil authorities in clearing an earthquake-prone district in time to prevent casualties. It is also a useful application of the theory of forces.

Following up the activity: If a Newton meter or a spring balance is available, the force required to overcome friction and cause the bricks to move may be measured (if pupils are quick to spot it!). Carry out a websearch for real data on earthquakes. Discuss other means of earthquake prediction, both high technology (strain gauges etc.) and 'traditional', e.g. observations of animal behaviour.

Underlying principles:

- Most earthquakes are caused by the build-up of stresses in the Earth being suddenly released as rocks fail.
- Earthquakes may also be caused by the gradual rise of magma towards the surface, by explosive volcanic activity, or by nuclear explosions.
- Major earthquakes are mostly limited to the margins of the Earth's tectonic plates, a) where large slabs of the Earth's outer layers are being dragged down into the mantle below, e.g. below the Andes: b) where plates are sliding past each other, e.g. along the San Andreas Fault zone in California or the Anatolian Fault zone in Turkey.
- Earthquakes also frequently occur below the constructive plate margins beneath the oceanic ridges, but these are usually less

severe and are distant from centres of population.

Thinking skill development:

- A pattern is established that a steadily increasing stress leads to sudden failure.
- The variation in the force required to produce such failure making it difficult or impossible to predict provides cognitive conflict.
- Applying the model to real earthquake situations is a bridging skill.

Resource list:

- at least 4 house bricks, or similar uniform heavy objects
- a coiled spring, elastic rope or length of strong domestic elastic
- string
- ruler
- optional: Newton meter; sand; water;.

Useful links: Try the Earthlearningidea activities 'When will it blow – predicting eruptions', published September 2007; 'The Himalayas in 30 seconds! – making a miniature fold mountain range in an empty box', published 28th January 2008; 'Earthquake through the window – what would you see, what would you feel?', published 31st March 2008.

See also:

<http://www.earthquakeprediction.gr/>
http://news.nationalgeographic.com/news/2004/07/0720_040720_earthquake.html

Source: This activity was originally adapted by Peter Kennett of the Earthlearningidea team from a more elaborate version shown on TV by the Open University in the 1970s!

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