Activity 41: Slope Stability

Maine Geological Survey

Objectives:

Students will apply the concept of slope to observe and measure the stability angle of fine gravel, sand, and topsoil. Selected follow-up activities will allow them to test the validity of their measurements in the first part of this exercise.

Time:

This activity is designed to last one 45 minute period, with students working in groups of three

Background:

In examining erosion and runoff problems, two factors normally taken into account are the type of soil and the slope stability. In this exercise students will measure slope stability using three different substrate materials. Under natural conditions, all materials will tend to slump until they reach a specific angle, often called the angle of repose, at which the slope stabilizes. Movement of the materials composing the slope ceases. Many factors affect this angle and may be examined in the follow-up activities. As you ride along roads in your area where new construction has taken place, look for evidence of slope instability, such as earthflows, and the practices used to help eliminate this problem. See diagram of typical failed slope (Figure 1).

Materials:

All students will need pens and notebooks. Each student team will need:

- Sheets of newspaper
- A protractor
- A stiff cardboard box approximately 14x20x3 inches in size and open on one end
- 400 ml of fine gravel, sand (beach sand works well), and topsoil or loam

Procedure:

Before starting, have students place newspaper on their desks or lab tables. Place the section of cardboard box on the table with the one open end near the center of the newspaper. Deposit all 400 ml of one of the samples in the center of the cardboard box and spread it out into a flat .5 inch layer.

At this point one of the students holds the protractor vertically with the origin at the end of the cardboard on the newspaper (see student sheet). One of the other students will be an observer/recorder and the third student will be the tilter. The tilter slowly lifts the end of the cardboard continuously. The observer will note when the first particles begin to slide off and will record the angle. Students should switch assignments and repeat steps 1 - 8 for three trials. Repeat steps 1 - 9 for the other three samples. See student data tables.

Gravel should slump at the lowest angle, sand next, and topsoil last if all materials have relatively the same moisture content.

Follow-Up:

The angle at which the sample slides down the face may be used as an index of slope stability. The angle at which particles begin to slide indicates the approaching loss of slope stability, and the final slide indicates total loss of stability. Exceeding these angles, even in nature, will normally result in the same collapse of the slope unless other factors are at work in the environment.

Indicate what effect wet samples would have on the outcome of the experiment.

Have students discuss and describe the impact of any variables, such as moisture content, which may alter the outcome of the experiment.

What would be the results of testing mixed samples? This can be quickly and easily tested using the same procedure.

Have students check with a construction company to find out if the instability angles would have any effect on construction standards and practices.

Predict the effect of ground cover on stability and describe what actions a person might use to prevent problems in their own local environment.

References:

Activity developed by James H. Barden, in conjunction with the 1991 CREST intern program.

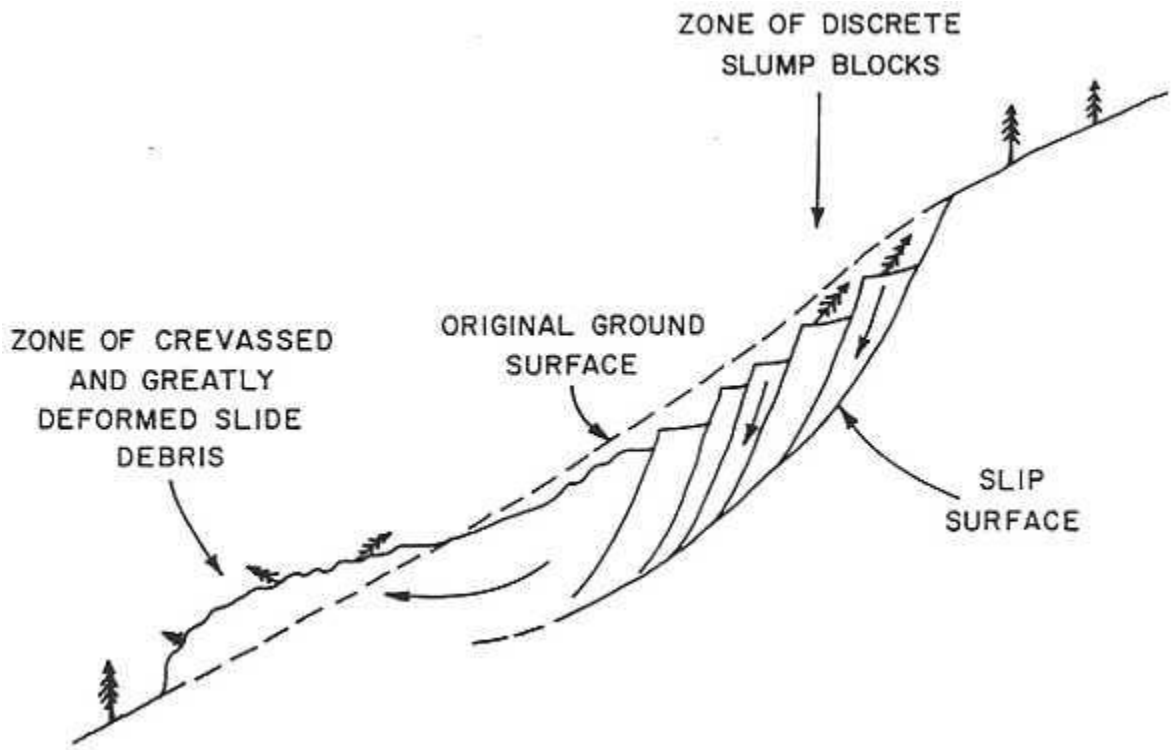

Figure 1. Cross section of a slump (from *W. B. Thompson, 1979, Surficial Geology Handbook for Coastal Maine: Maine Geological Survey, following p. 36*).

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Student Sheet

Purpose:

To apply the concept of slope and slope stability to different types of soil and ground material.

Materials:

Each group of three should have the following - some sheets of newspaper, a protractor, a piece of stiff cardboard box, open on one end, that measures 14x20x3 inches, 400 ml each of fine gravel, sand, and topsoil. Each student will need their pens and notebooks.

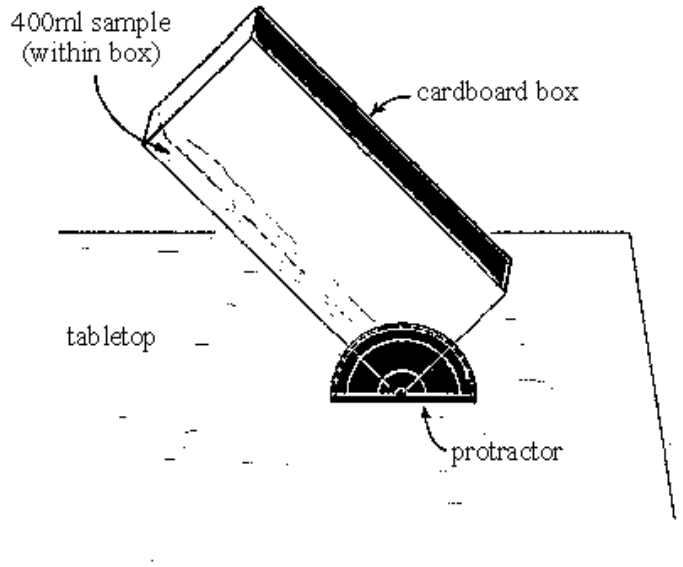

Figure 2. Experimental set-up. Note the position of the protractor.

Procedure:

1. Cover your desk or work area with newspaper. This will make cleaning up after each trial a lot easier.
2. Place a 14x20x3 inch piece of cardboard box so that the open end is more or less in the center of the newspaper.
3. Carefully deposit one of the 400 ml samples in the center of the cardboard, and flatten the pile into a flat layer about .5 inches thick.
4. Assign one member of your group to be the observer/recorder, another member to be the holder of the protractor, and the third member to be the tilter of the cardboard.
5. Have the holder of the protractor hold the protractor vertically with the origin (zero point) at the end of the cardboard sheet on the newspaper (Figure 2).
6. Have the tilter SLOWLY lift the end of the cardboard in a smooth but continuous motion.
7. The observer will note when particles first begin to slide off the pile and will observe and record this angle.
8. The lifter will continue lifting until all the remaining particles slide off in a mass. The recorder will observe and record this second angle.
9. Switch assignments, clean off the newspaper and repeat steps 2 -8 for two more trials with the same material.
10. Repeat steps 1 - 9 with the other two samples. Remember to keep your workspace clean throughout the experiment.

Observer	Angle of First Fall	Angle of Total Fall
Gravel		
1:		
2:		
3:		
Average		
Sand		
1:		
2:		
3:		
Average		
Topsoil		
1:		
2:		
3:		
Average		

Questions:

1. Describe and discuss any variables which have affected the outcome of this experiment.

2. What do you think would happen if the experiment were tried with damp or wet materials? Predict the results. Your instructor may allow you to test your hypotheses.

3. What would be the result of performing this experiment with a surface that was coarser or smoother? Predict the results and explain the reasoning behind your predictions.