Activity 3.4.7 Cut and Fill (Optional)

Introduction

Construction of a structure or pavement requires preparation of the site. Foundations, abutments, or roadbeds require the removal of the top layer of soil that contains organic matter. Once that layer is removed, it might be necessary to dig deeper or add soil material to level a surface or create a slope for drainage. Soil is expensive to move, so planning is necessary to reduce the construction cost. Soil is also expensive to purchase; therefore, existing topsoil is set aside for future use in the final stages of grading and landscaping. Desirable non-organic soil can be used to fill in low spots.

The plot is studied, and the site plan is adjusted many times to balance the amount of soil to be removed with the amount needed to fill in low spots on the site. In addition, plans must be made to achieve desired slopes and positive drainage across the site. This process of subtracting and adding soil is called cut and fill.

There are times when the soil that is removed or “cut” can be reused for fill. Other times, because of drainage, load bearing, or organic characteristics, the soil is not suitable and must be disposed of, which adds to the cost of the project. Knowledge of the soil type is important in making decisions. We will investigate soil characteristics in Unit 4. Once final grades are established, the site grading plan is created.

Cut and fill can be planned and simulated with computer software which breaks the surface down into triangular shapes. This provides a more accurate method of calculation. Engineers working with modern software can query the software to find the total volume of cut and fill and make cost projections. In this activity you will explore the concepts behind cut and fill by examining a simple excavation.

Equipment

- Topographic map Hillside Cut and Fill
- Engineer’s scale
- Colored pencils
- Calculator
- Sample of a cut and fill plan

Procedure

1. Obtain and study the Hillside topographical map.
2. Place the foundation for a 100 ft by 60 ft building with the long edge exposed for best solar gain. The elevation of the bottom of the foundation should be 16 feet.
3. Assume that all material removed can be used again.
4. Select a location for the foundation and sketch a plan view of the foundation on the topographic map.
5. Draw a profile cut line (vertically on the page) through the center of the foundation – this line indicates the location of the profile view.
6. Project the elevation at each contour line to the graph area on the left of the page. Indicate each elevation with a point.
7. Connect the points with a dashed line. This is the profile of the existing grade.
8. Sketch the foundation on the profile view as a 6 in. thick slab.
9. Sketch a new solid line that will represent the finish grade. Be sure that the slope of the finish grade does not exceed the angle of repose.
10. Use a colored pencil to identify the material that will need to be cut. Use a second color to indicate fill material. Note that when cuts are made, the slope of the soil cannot exceed the angle of repose; however, for simplicity, we will assume that a vertical cut can be made (perhaps using sheet piling).
11. Using the same colors, shade the areas on the topographic map that require cut or fill.
12. Draw a grid over the foundation area using squares 10 feet on each side (100 sq. ft).
13. For each square in the cut area, multiply the 100 square feet of the grid square by the depth of material that must be subtracted for that square. Keep a running total of all of the material that must be removed.
14. For each square in the fill area, multiply the 100 square feet by the depth of material that must be added to that square. Keep a running total of all of the material that must be added.

Cut and Fill Table

REGION	GRADE ELEV.	FINISHED ELEV	CUT(-) OR FILL(+) DEPTH	REGION AREA	CUT(-) VOLUME	FILL (+) VOLUME
A 1						
A 2						
A 3						
				TOTALS		

Conclusion

1. Would the location of your foundation change the amount of material that must be moved?

2. How would your foundation location change if the material we removed could not be reused?

3. If it costs \$20/yd^3 to purchase additional fill material and \$5/yd^3 to dispose of extra cut material, what is the cost to obtain or dispose of the soil necessary for this foundation construction? Note that you will need to convert the cut/fill volume from cubic feet to cubic yards.