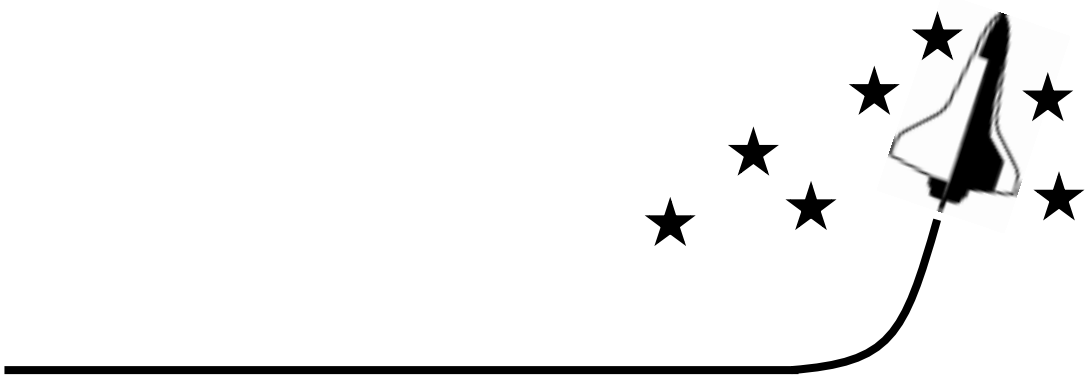
FACULTY NOTES

The LTAs and Spinoffs are designed so that each professor can implement them in a way that is consistent with his/her teaching style and course objectives. This may range from using the materials as out-of-class projects with minimal in-class guidance to doing most of the work in class. The LTAs and Spinoffs are amenable to small group cooperative work and typically benefit from the use of some learning technology. Since the objective of the LTAs and Spinoffs is to support the specific academic goals you have set for your students, the Faculty Notes are not intended to be prescriptive. The purpose of the Faculty Notes is to provide information that assists you to take full advantage of the LTAs and Spinoffs. This includes suggestions for instruction as well as answers for the exercises.



FACULTY NOTES

LTA 13

It Ain't Heavy, It's My Crawler

Background Information

Math Subject Area: Volume, Unit Conversion

Math Prerequisites: Basic understanding of volume, manipulation of formulae, and unit conversion.

ATE-Supported Engineering Technology Field(s): Civil Engineering.

Learning Technology Suggested: Scientific Calculator

Approximate Class Time required for LTA: One class period plus homework

How Much Do We Need?

1) Describe the steps you will follow to calculate the amount of Flowable Fill needed to fill in the empty space in the tunnel.

   The students should realize that they need to convert all units to a common unit, perhaps feet, so they can calculate volumes. They will need to find the volume of the rectangular prism tunnels and then subtract the volume of the cylindrical pipes. For example:

   We will need to calculate the volume of the two tunnels and then subtract the volume of the pipes. The tunnels are "boxes" with volume = length*width*height. The pipes are "cylinders" with volume $\pi r^2 h$.

   The length of the tunnels is 379.5 ft. The width is 4.5 ft for the left tunnel and 4 ft for the right tunnel. The height of both tunnels is 6.5 ft.

   The "height" of the pipes is 379.5 ft.

   The 14 small pipes have radius (1/6) ft.

   One big pipe has radius (3/4) ft.

   The biggest pipe has radius 1 ft.

2) Carry out the steps you outlined in Exercise 1 to determine the volume of Flowable Fill needed to fill in the empty space in the tunnel.

Volume of tunnels

Left side: (4.5 ft)(6.5 ft)(379.5 ft) = 11,100.375 ft^3

Right side: (4 ft)(6.5 ft)(379.5 ft) = 9,867.000 ft^3

20,967.375 ft^3

Volume of pipes

24 inch pipe: $\pi(1ft)^2(379.5ft)$ = 1,192.234 ft^3

18 inch pipe: $\pi(0.75ft)^2(379.5ft)$ = 670.632 ft^3

4 inch pipes: $14\pi\left(\frac{\frac{1}{6}}{2}ft\right)^2(379.5ft)$ = 463.647 ft^3

2,326.513 ft^3

Volume of Flowable Fill needed

20,967.375 ft^3 - 2,326.513 ft^3 = 18,640.862 ft^3 or 32,211,409.54 in^3 or 690.402 yd^3

How much will it cost?

The current price for Flowable Fill is \$41/yd^3.

3) Describe the steps that you will follow to calculate the cost of filling the tunnel. (Hint: Be careful with your units!)

(If the student has not already converted to cubic yards it will need to be done now since the cost was given per cubic yard.) We will take the number of cubic yards of Flowable Fill needed and multiply by \$41/yd^3.

4) Carry out the steps you outlined in Exercise 3 to determine how much it will cost to fill the tunnel. (Note: The cost of the Flowable Fill is just a small part of the total \$700,000 cost of the project.)

Cost to fill tunnel = 690.402 yd^3 * \$41/yd^3 = \$28,306.48

Did the contractor do the job correctly?

5) Determine whether or not the contractor has filled the tunnel. Be sure to show work to clearly explain your answer. If a discrepancy exists, give a real-life example of something that would have approximately the same amount of volume as the discrepancy to illustrate its size (a shoebox, a house…).

   If we take the number of truckloads of Fill and multiply by the number of cubic yards per truckload, we will get the total cubic yards used by the contractor.

   71 truckloads * 9 yd^3 /truckload = 639 yd^3 of Flowable Fill.

   We needed 690.402 yd^3 to fill the empty space in the tunnel.

   The contractor is approximately 51 yd^3 short of the required amount.

   One real-life example: The amount of Flowable Fill that the contractor was short would fill a small bedroom from floor to ceiling.

6) Assume that all of the Flowable Fill from the 71 truckloads settles to the bottom so that there is an air pocket at the top. Also assume that the fill is divided between the two sides of the tunnel in such a way that the height of fill in each tunnel is the same. Approximate the amount of space left empty at the top of the tunnel. Would there be enough space for a rat to run through, a person to crawl through, …?

   51 yd^3 = 51 * 27 = 1377 ft^3
   379.5 ft * 8.5 ft * height of space = 1377 ft^3
   So, height = 1377 ft^3 / (379.5 ft * 8.5 ft) = 0.427 ft or approximately 5 inches, and a rat would fit through this space comfortably.

   Note: If the space for the top four pipes is taken into account, this would add on only a little over a half inch to the depth of the air space.