Section 8.1

Earthwork Presentation/Shop Exercise/Volume Homework Handout

This section will discuss the creation and implementation of a school presentation, shop exercise, and homework handout focused on the Heavy Civil "Earthwork" Industry.

Meet with CTE Educators to discuss the availability of coming into the classroom and presenting a lesson on a practical real-world exercise that pertains to your area of expertise in the construction industry. This could be as simple as a PowerPoint presentation or can become a greater lesson with a shop experience and even leaving the class with a homework handout revolving around a real exercise you would have to perform in your job role.

Determine the time available for classroom visit.

a. PowerPoint Presentation = approximately 45 minutes
b. Shop Exercise = approximately 45 minutes
c. Debrief and Analysis = approximately 30 minutes
d. Q&A = approximately 20 minutes

This exercise took approximately 2 hours 20 minutes but with transition times between the classroom and shop along with a quick bio-break, total time resulted in 2 hours 45 minutes.

Once the presentation material is completed, set up a trial run at the school with the teachers to make sure timing and technical issues are worked out prior to the final run with students. Make sure the facility is setup for easy presentation. Coordinate any supplies necessary to complete the exercise.

Please make sure the presenters and assistants are familiar with the exercise and can answer questions as they arise.

Tip! Candy give aways are always a good thing to have when keeping the attention of students.

The following resources will help to give you a better understanding of the lesson that was presented along with developing a lesson in your field of expertise.

PowerPoint Presentation w/Presenter's notes: PDF Document 8.1a - Earthwork, volume, characteristics of earth, shrink & swell, and employment opportunities.

Volume Activity Packet & Answer Key: PDF Document 8.1b - Instructions and Activity Handout to explain the shop exercise.

Shop Exercise – Supply List w/pictures: PDF Document 8.1c – Pictures and list of supplies needed for exercise.

Volume Computation Math Packet & Answer Key: PDF Document 8.1d – Volume computation problem based on a real scenario for an "Earthwork" gravel excavation.

Kris

- Thank the panel, introduce how I got involved and where I could contribute.
- The committee identified the teachers who were interested in doing an externship and what they were possible looking to learn.
- No exact process.
- I felt like I could help meet the learning objectives that Molly and Jenne from Service High was looking for.
- I put together an agenda and sent to Ruby at the AGC to merry up.
- It was a rush as we were trying to get it done in just a couple of days prior to school starting.
- This externship was a full day job shadowing, beginning the day with a safety briefing with the crew.
- Project office to review the days scope of work. How we use geometry and simple math to help determine the necessary resources needed (crew size, equipment selection, and trucking needs). Example of how we set up Excel Spreadsheets to help us quickly determine the route we need to take for the day based on the resource availability or weather concerns. Also, emphasized on how important quantities are in our industry.
- Also, this allows us to forecast how profitable the day may or not be. Our report card!
- Spent a few hours on the job observing the work and talking with the crew. We discussed the use of GPS and drone technologies.
- Went to lunch and just talked about their program and what they were excited about!
- Visited our gravel pit and discussed how using Drone technology helped us get accurate stockpile qty's but how we used math as a quick double check.
- We then visited a second job site and talked with the grade checker on how he uses math and GPS tech to rebuild ADA Pedestrian Ramps.
- We finished the day back at the job office and discussed some of what we saw that day.
- Aaron was able to take Jason from Bartlett on a more informal ride-along externship. Something that could be done in an afternoon/evening during school. They didn't have a set plan but just allowed the questions to free flow. They visited a job site that had multiple types of work going on from concrete, electrical, earthwork, and mechanical scopes. They were able to talk to a PM from a general contractor and ask additional questions.
- Again, there was no perfect externship process but both allowed for us to gather valuable educator feedback.

Heavy Civil Construction

- "Dirt Work" or "Earthwork"
- We build things
- Small to HUGE equipment
- Heavy Civil Industry
  - Pays very well
  - Benifits

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- Heavy Civil construction will sometimes be referred to as "Dirt Work or Earthwork", and yes we do get to play in the dirt.
- One of the coolest things about construction is that we get to build things. Examples: parking lots, roadways, bridges, foundations for buildings, etc...
- We also get to play with equipment.
- Our industry puts a ton of effort into making sure our workers are well taken care of. Taken care of not just financially but we are looking out for them by offering training, insurance, and retirement.
- View the picture and point out the human standing beside the bucket.

Opportunities

- Project management, HR, IT, accounting, quality control.
- Operators, laborers, truck drivers, foreman, grade checkers, traffic supervisors, and flaggers.

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Engage the students on how this topic can result in employment. Explain all the different paths of employment within the industry.

Dirty Details

- Terms:
  - soil
  - topsoil
  - mud
  - silt
  - clay
  - caliche
  - bed rock
  - peat

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- Discuss the different types of "dirt", let the students come up with what they can.
- All types of dirt have differing properties which is what they are made up of and how much they weigh.
- Think of it like mammals. A human and a whale have some similar traits but we don't look, feel, or weight the same.

Bank -> swell -> Loose

- Dirt in its natural state = "bank"
- When you loosen dirt by disturbance
- Grow in size by about 25%
- This represents it in a "loose" state

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- Explain how dirt just naturally in place is called "bank" yards. Just sitting there with all the natural elements like gravity and rain. Again, we would call this a "Bank Yard".
- When you loosen dirt by disturbance, like digging a hole with a shovel, takes material out of its natural or bank state.
- Have you ever noticed that when you try to put the material you dug out of the hole back in it doesn't exactly fit? You have added air and sometimes reduce moisture content. The pile is just not the same size as the hole without using some sort of force to put it back in.
- Loosening a "Bank Yard" tends to "Swell" about 25%. This mainly is that you are adding air voids to the material.
- This represents dirt being in a "loose" state. We would call this a "Loose Yard".
- Reassure the students that this will all make sense and is important when we do the shop experiment.

Bank -> shrink -> Compacted

- Dirt in its natural state = "bank"
- When you compact dirt
- Shrink in size by about 20%
- This represents it in a "compacted" state

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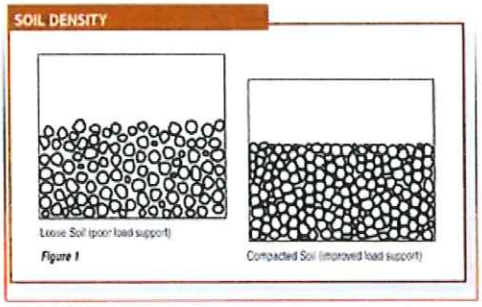
- Refer the students back to a "Bank Yard", material that is in its natural resting state.
- When you compact dirt by adding pressure, like stepping in the sand on a beach, you are taking the material from its natural state "Bank" to a compacted state.
- Compacting natural material from a bank state to a compacted state typically "Shrinks" by about 20%.
- This is what we call taking a "Bank Yard" to a "Compacted Yard".
- Reassure the students that this will all make sense and is important when we do the shop experiment.

Soil (dirt) Density



Why Compact?

There are five reasons to compact soil:

- Increases load-bearing capacity
- Prevents soil settlement and frost damage
- Provides stability
- Reduces water seepage, swelling and contraction
- Reduces settling of soil

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- Typical soil is naturally at a 92% compaction. Target stabilization for stabilized ground to build on is 96% compaction.
- How many people notice how our roads in Alaska will grow and shrink during freeze/thaw conditions. This is the moisture that is in the material freezing and thawing.
- You wouldn't want to build a school or house on ground that has half of it compacted and the other half not compacted. You would get settling and your building would lean and ultimately crack.

Volume

- L x W x H
- 1 in x 1 in x 1 in = 1 cubic in
- 12 in x 12 in x 12 in = 1,728 cubic inches
- 1 ft x 1 ft x 1 ft = 1 cubic ft
- 3 ft x 3 ft x 3 ft = 27 cubic ft
- 1 yd x 1 yd x 1 yd = 1 cy

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- How do you figure volume mathematically: Length x Width x Height
- A cubic inch would be calculated by what formula? Show off the cube and let the students visualize the size.
- How many cubic inches is in a cubic foot? Work the problem and have them come up with the answer of 1,728. Show the students and let them visualize the box that is 1 cubic foot.
- How many feet are in a yard? Work the problem on feet to yards. Show them the cubic yard frame so they can visualize how big this is. In Heavy Civil we quantify volume by cubic yards, usually because inches and feet are too small of a volume.

Volume and Weight

Volume

- 1 cubic foot of dirt in pounds
- 1 cubic yard of dirt in pounds
- 1 cubic yard of dirt in tons

Weight

- Approx. 75 – 110 pounds
- Approx. 2,025 – 2,970 pounds
- Approx. 1.01 – 1.485 tons

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- explain that a cubic foot of dirt equals approx. 75 – 110 pounds
- Have students calculate what a cubic yard would approx. weigh. Approx. 2,000 lbs
- Have students convert the pounds to tons. Tons are a unit of weight that Heavy Civil uses.
- Have a student feel the cubic foot box full of sand to understand the weight.

How much do you bench?

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- Typical wheel loader can hold about 8 cyd bucket. This is approx. 17,600 pounds.
- A Tesla weights about 4,500 pounds. Thus the loader is packing about 4 Tesla's in 1 scoop.
- The largest African Elephant weighs about 12,000 pounds. Thus the loader is packing a full grown African Elephant and 2 ea. 1 year old calves.

Estimating

- Price out "BID" jobs
- Historical data
  - Similar scopes of work
  - Accurate data
  - Analyze

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Give examples of how you would have to price out a job.

1. If you had a summer lawn mowing business and you had to quote a person a price to mow their lawn.

Give examples of how having accurate history data helps you.

1. After you have mowed multiple lawns and tracked the time it took; how could you use that data to help adjust your pricing on future lawns?

Shop Exercise

- Transfer material from a gravel pit to a dump site.
  - Load into trucks.
  - Haul material to job site.
  - Dump truck into job site.
  - Compact material (only 2 teams will be allowed)
- DO NOT SPILL MATERIAL!!
- Document information.

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Show a couple of videos so students can visualize the types of equipment you are talking about to aid in the vision of the simulation.

Give a brief overview of the rules to the simulation to the entire class.

Instructions

Groups 1 & 3

- Assign personnel
  - Project Foreman
  - Excavator operator
  - Truck drivers (1 - 4 ea.)
  - Grade Checker (oversite only)
  - Project Engineer (documentation)

Groups 2 & 4

- Assign personnel
  - Project Foreman
  - Excavator operator
  - Truck drivers (1 - 4 ea.)
  - Compactor operator (compaction efforts)
  - Project Engineer (documentation)

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Give more detailed instructions to the Project Foreman and Project Engineer.

- Divide teams into 4 groups of 5 - 8 = 20 - 32 students
- Explain what is required of each team and the difference between oversite and compaction efforts at the dump site.
- Hand out recording sheet to project engineer and foreman explain what needs to be done.

- Emphasize the importance of communication and documentation.

Share Results

- How many cubic inches was the gravel pit?
- How many total bucket scoops?
- How many total truck loads?
- What was your total time to transfer the material?

GIC: VOLUME ACTIVITY - ANALYSIS

GRAVEL PIT VOLUME	346.5 cubic inches
EXCAVATOR (SCOOP SIZE = 1 TBSP)	0.9153561 cubic inches
TOTAL SCOOPS PER PLAN	379 scoops
TRUCK VOLUME	6.25 cubic inches
TOTAL TRUCK LOADS	55.44 truck loads
TOTAL TIME (assume 3 seconds per scoop)	18.93 minutes

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- Get total time to transfer the material. Document on excel spreadsheet.
- Get total bucket scoops used. Document on excel spreadsheet.
- Get total truck loads used. Document on excel spreadsheet.

Bank -> swell -> Loose "TRUCK"

- Dirt in its natural state = "bank"
- When you loosen dirt by disturbance
- Grow in size by about 25%
- This represents it in a "loose" state or a "Truck" cubic yard

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- Reference how in place ground to put in the back of a truck will swell in size by about 25%
- It should have taken exactly 56 truck loads to transfer the material in the shop exercise based on perfect world geometry.

What did we learn?

- Did you run out of room at your dump site?
- Did you have more room at your dump site?
- Why was there a difference in bucket and load counts?
- Where were the sticky points or areas that were slow?
- What could you have done different to increase production?

CONTRACTOR

TOTAL TIME TO TRANSFER MATERIAL: **18.93** minutes

CREW SIZE	COST
PROJECT ENGINEER	$ 0.68
PROJECT FOREMAN	$ 1.50
EXCAVATOR W/OPERATOR	$ 4.83
GRAVEL TRUCK W/OPERATOR	$ 2.92
GRAVEL TRUCK W/OPERATOR	$ 2.92
GRAVEL TRUCK W/OPERATOR	$ 2.92
GRAVEL TRUCK W/OPERATOR	$ 2.92
GRADE CHECKER	$ 1.33
ROLLER COMPACTOR W/OPERATOR	$ 2.67
TOTAL COST PER MINUTE:	$ 22.68
TOTAL COST:	$ 429.35
TOTAL CUBIC INCHES:	346.5
TOTAL COST PER CUBIC INCH:	$ 1.24

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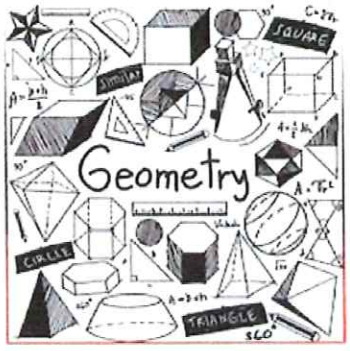
- Discuss with class if they had a shrink or swell.
- Discuss why there might have been a difference in the amount of scoops from team to team. Material, scoop size?
- Discuss areas where a team had difficulties or slow points. Compaction efforts, haul route?
- Discuss what could have made the team more efficient. Bucket size, # of trucks, haul route, compaction efforts?
- Share exact math results and explain why documentation and feedback is important in the real world of contractors. This helps the estimators properly price projects because it is more difficult than it appears.

Geometry Exercise



- Solve for quantity.
  - Overburden volume.
  - Gravel volume.
- Solve for quantity.
  - Overburden to build berm.
  - Remaining overburden.

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- Hand out and explain the geometry exercise.
- Use a real-world project so the students can get a better understanding of the type of work we do.

GIC: Volume Activity Handout **Name**_____ **per**_____

GROUP #: _____

How does math get used in road construction? Consider the roads we all use. What is involved in building a road? A road can't be built on just the "regular" untouched ground for many reasons but primarily because the natural ground is most likely too soft and won't support the traffic over time. Eventually, the road could fail causing a dangerous situation. Thus, contractors will use different types of soils and techniques to condition the soils for optimum performance.

Dilemma: How do you get the ground ready to build on?

This activity will replicate on a small scale what road contractors deal with on a large scale with every project. It is crucial to determine the type of ground you are working with and if the ground can handle the type of traffic required, from small roads in remote areas of Alaska to large airports that must be able to support large jet airplanes.

For this activity there will be 4 groups with specific job functions per person. The goal of this exercise is to excavate (scoop) the material from a gravel pit, load into trucks and transfer the material to the jobsite. At the jobsite you will dump the material. Groups 1 & 3 will not be allowed to compact the material at the jobsite, Groups 2 & 4 will be allowed to compact the material at the job site.

*There are 2 very important rules: Do not spill any material and make sure to document!

Step 1: Assign the following job positions within you team.

1. Project Engineer _____
2. Job Site Foreman _____
3. Excavator Operator (scooper) _____
4. Truck Drivers (1 ea – 4 ea) _____, _____, _____, _____
5. Grade Checker (Groups 1 & 3) or Compactor Operator (Groups 2 & 4) _____

Step 2: Project Engineer and Foreman will get instructions (Project Hand-off Meeting).

Step 3: Project Foreman will debrief team on the scope of work and job assignments for each of their team members.

Step 4: Identify & Calculate

1. What type of material are you working with (circle one)? Flour (overburden) Sugar/M&M's (gravel)
2. Looking from the top down, find the surface area of the earth you need to excavate: Length_____ x Width_____ = _____ (in square inches – to nearest 1/8")
3. Find the volume of the earth you need to excavate: Length_____ x Width_____ x Depth_____ = _____ (in cubic inches)

Step 5: Begin & Document

1. What was the total # of Scoops: _____
2. What was the total # of Truck Loads: _____
3. What was the total amount of time needed: _____

Step 6: Review

1. Did your group have enough room at the jobsite to put all the excavation? _____
    a. If so, calculate the volume of material left at your gravel pit: _____ (in cubic inches)(*use Step 4 to help with this calculation)
2. Did your group have additional room at the jobsite for more material? _____
    a. If so, calculate the volume of room left at your job site: _____ (in cubic inches)(*use Step 4 to help with this calculation)
3. Compute the percentage of "swell or shrink" from Step 4 to Step 6:
    a. Compute: Volume of Step 6 divided by Volume of Step 4 = _____
    b. Multiply you answer by 100 to get % of "swell or shrink" = _____
4. Did you group have a "swell or shrink" of material? _____

Back in classroom to discuss activity outcomes and key points from the exercise to relate to how contractors must use information like this to do estimates, allocate resources and schedule projects. Also, find out what teams performed more efficiently!

Discuss larger Geometry math problem. Handout packet.

GIC: VOLUME ACTIVITY - ANALYSIS

CONTRACTOR	
GRAVEL PIT VOLUME	346.5 cubic inches
EXCAVATOR (SCOOP SIZE = 1 TBSP)	0.9153561 cubic inches
TOTAL SCOOPS PER PLAN	379 scoops
TRUCK VOLUME	6.25 cubic inches
TOTAL TRUCK LOADS	56 truck loads
TOTAL TIME (assume 3 seconds per scoop)	18.93 minutes

GROUP 1	variance	GROUP 2	variance	GROUP 3	variance	GROUP 4	variance
0	-346.5 -100.0%	0	-346.5 -100.0%	0	-346.5 -100.0%	0	-346.5 -100.0%
0	-379 -100.0%	0	-379 -100.0%	0	-379 -100.0%	0	-379 -100.0%
0	-56 -100.0%	0	-56 -100.0%	0	-56 -100.0%	0	-56 -100.0%
0	-18.9 -100.0%	0	-18.9 -100.0%	0	-18.9 -100.0%	0	-18.9 -100.0%

GIC: VOLUME ACTIVITY - COST ANALYSIS

CONTRACTOR			GROUP 1	GROUP 2	GROUP 3	GROUP 4
TOTAL TIME TO TRANSFER MATERIAL		18.93 minutes	0 minutes	0 minutes	0 minutes	0 minutes
CREW SIZE	**COST**					
PROJECT ENGINEER	$	0.68	$ 0.68	$ 0.68	$ 0.68	$ 0.68
PROJECT FOREMAN	$	1.50	$ 1.50	$ 1.50	$ 1.50	$ 1.50
EXCAVATOR W/OPERATOR	$	4.83	$ 4.83	$ 4.83	$ 4.83	$ 4.83
GRAVEL TRUCK W/OPERATOR	$	2.92	$ 2.92	$ 2.92	$ 2.92	$ 2.92
GRAVEL TRUCK W/OPERATOR	$	2.92	$ 2.92	$ 2.92	$ 2.92	$ 2.92
GRAVEL TRUCK W/OPERATOR	$	2.92	$ 2.92	$ 2.92	$ 2.92	$ 2.92
GRAVEL TRUCK W/OPERATOR	$	2.92	$ 2.92	$ 2.92	$ 2.92	$ 2.92
GRADE CHECKER	$	1.33	$ 1.33		$ 1.33	
ROLLER COMPACTOR W/OPERATOR	$	2.67		$ 2.67		$ 2.67
TOTAL COST PER MINUTE:	**$**	**22.68**	**$ 20.01**	**$ 21.35**	**$ 20.01**	**$ 21.35**
TOTAL COST:	**$**	**429.35**	$ -	$ -	$ -	$ -
TOTAL CUBIC INCHES:		346.5	346.5	346.5	346.5	346.5
TOTAL COST PER CUBIC INCH:	**$**	**1.24**	$ -	$ -	$ -	$ -
VARIANCE PER CUBIC INCH:			**$ (1.24)**	**$ (1.24)**	**$ (1.24)**	**$ (1.24)**

GIC: Volume Activity Handout **Name____Answer Key_____ per_____**

How does math get used in road construction? Consider the roads we all use. What is involved in building a road? A road can't be built on just the "regular" untouched ground for many reasons but primarily because the natural ground is most likely too soft and won't support the traffic over time. Eventually, the road could fail causing a dangerous situation. Thus, contractors will use different types of soils and techniques to condition the soils for optimum performance.

Dilemma: How do you get the ground ready to build on?

This activity will replicate on a small scale what road contractors deal with on a large scale with every project. It is crucial to determine the type of ground you are working with and if the ground can handle the type of traffic required, from small roads in remote areas of Alaska to large airports that must be able to support large jet airplanes.

For this activity there will be 4 groups with specific job functions per person. The goal of this exercise is to excavate (scoop) the material from a gravel pit, load into trucks and transfer the material to the jobsite. At the jobsite you will dump the material. Groups 1 & 3 will not be allowed to compact the material at the jobsite, Groups 2 & 4 will be allowed to compact the material at the job site.

*There are 2 very important rules: Do not spill any material and make sure to document!

Step 1: Assign the following job positions within you team.

1. Project Engineer _____
2. Job Site Foreman _____
3. Excavator Operator (scooper) _____
4. Truck Drivers (1 ea – 4 ea) _____ , _____ , _____ , _____
5. Grade Checker (Groups 1 & 3) or Compactor Operator (Groups 2 & 4) _____

Step 2: Project Engineer and Foreman will get instructions (Project Hand-off Meeting).

Step 3: Project Foreman will debrief team on the scope of work and job assignments for each of their team members.

Step 4: Identify & Calculate

1. What type of material are you working with (circle one)? Flour (overburden) Sugar/M&M's (gravel)
2. Looking from the top down, find the surface area of the earth you need to excavate: Length____13____ x Width____9____ = _____117_____ (in square inches – to nearest 1/8")
3. Find the volume of the earth you need to excavate: Length____13____ x Width____9____ x Depth____3____ = ____351____ (in cubic inches)(exact size is 346.5 cubic inches)

Step 5: Begin & Document

1. What was the total # of Scoops: ____379 using 1 Tbsp____
2. What was the total # of Truck Loads: ____56 loads using 6.25 cu in per load____
3. What was the total amount of time needed: ____18.93 minutes (based on 3 sec per scoop)____

Step 6: Review

1. Did your group have enough room at the jobsite to put all the excavation? __Group 1 & 3 yes_____
    a. If so, calculate the volume of material left at your gravel pit: ____varies___ (in cubic inches)(*use Step 4 to help with this calculation)
2. Did your group have additional room at the jobsite for more material? ____Group 2 & 4 yes__
    a. If so, calculate the volume of room left at your job site: _____varies_____ (in cubic inches)(*use Step 4 to help with this calculation)
3. Compute the percentage of "swell or shrink" from Step 4 to Step 6:
    a. Compute: Volume of Step 6 divided by Volume of Step 4 = _____
    b. Multiply you answer by 100 to get % of "swell or shrink" = ___approx. 20 to 30 % targets___
4. Did you group have a "swell or shrink" of material? ___Group 1 & 3 swell, Group 2 & 4 shrink_____

Back in classroom to discuss activity outcomes and key points from the exercise to relate to how contractors must use information like this to do estimates, allocate resources and schedule projects. Also, find out what teams performed more efficiently!

Discuss larger Geometry math problem. Handout packet.

QUALITY ASPHALT PAVING
General Contractors

231 in^3 = 1 gal

Container Size Options: 1.5 gal = 5.6L = 346.5 in^3
3.5 gal = 9.4 L = 577.5 in^3

quick (9 x 13 x 3 = 351 in^3)

Truck Size: 4" x 2.5" x .625" (5/8") = 6.25 in^3

Scoop Size: 1 Tbs = .9153561 in^3
2 Tbs = 1.8307122 in^3

Truck Volume: 1 Tbs = 6.83 scoops
2 Tbs = 3.41 scoops

Scoops = 378.54 @ 3 sec = 1,135.62 / 60 = 18.927 min
630.90 @ 3 sec = 1,892.7 / 60 = 31.545 min

≈ 10 lbs of material
(5 lb of flour ≈ 5.5 x 4 x 8 = 176 in^3)
(x 2 = 352 in^3) NEED 346.5

Section 8.1c

Earthwork Presentation/Shop Exercise/Volume Homework Handout

Shop Exercise – Supply List w/pictures: PDF Document 8.1c – Pictures and list of supplies needed for exercise.

Gravel Pit/Dump Sites: Rubbermaid containers or equivalent (need to be sturdy), all must be the same in size. Make sure to measure the exact volume if the size is not given. For this exercise we used 1.5 gallon containers, purchased from Walmart. **8 ea**

Excavators: Set of measuring spoons, you will use the 1 Tbsp. for the exercise but recommend having a variety to allow students to think about how size would affect the outcomes. Faberware professional set of 7 measuring spoons, purchased from Walmart. **4 ea**

Dump Trucks: Containers that are much smaller than the gravel pits or dump sites. Use Equate soap holder, purchased from Walmart. Make sure that you can measure the exact volume and calculate in the exercise. Example is attached to the instructions. **16 ea**

Compactor: Burger Press, purchased at Walmart. **2 ea**

Material:

Flour – 5 lb bags – 4 ea

Sugar – 4 lb bags – 6 ea

Peanut M&M's – family size – 1 ea

Regular M&M's - family size – 1 ea

Mini M&M's – large size – 1 ea

Candy - large size – for each student 32 ea (optional)

Optional: Larger Container to hold all of supplies. **1 ea**

Directions:

Flour: Pour 2 ea 5 lb bags into one of the 1.5 gal containers. The material will be moderately compacted but should fit. The object is when the students excavate the material, it has the potential to "loosen or swell" and the potential for "compaction".

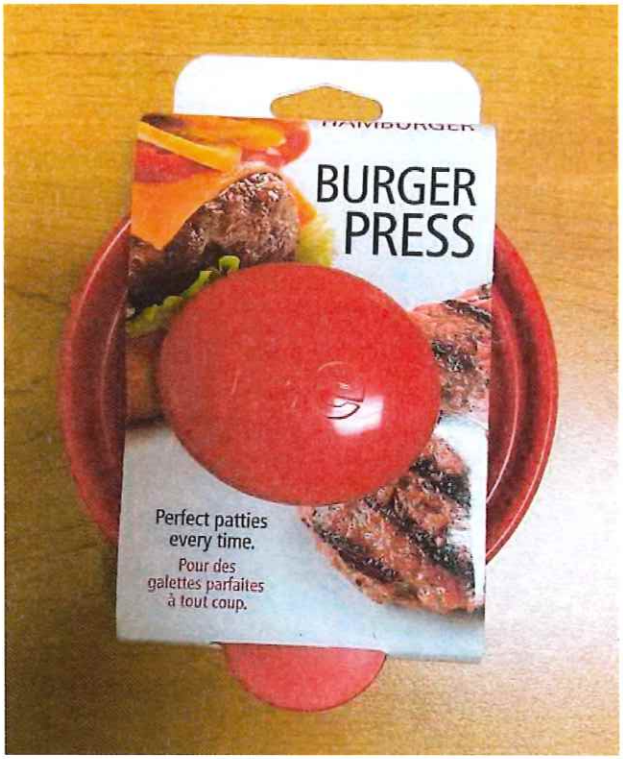
Sugar and M&M's: Pour 3 ea 4 lb bags into one of the 1.5 gal containers, mixing in a generous amount of M&M's to create a finely graded gravel mixture. The material will be moderately compacted but should fit. The object is when the students excavate the material, it has the potential to "loosen or swell" and the potential for "compaction".


Rubbermaid
easy find lids
15.76
20.64


Rubbermaid
easy find Lids
1.5 GALLON | GALONES | 5.6 L
easy find Lids SYSTEM | SISTEMA guarda fácil
LIDS AND BASES SNAP TOGETHER
LES COUVERCLES ET LES BASES S'ENCLENCHENT
TAPAS Y BASES APILABLES QUE ENCAJAN ENTRE SÍ


FARBERWARE
PROFESSIONAL
SET OF 7
MEASURING
SPOONS
INCLUDES:
• ⅛ Tsp. (0.6 mL)
• ¼ Tsp. (1.2 mL)
• ½ Tsp. (2.4 mL)
• 1 Tsp. (4.9 mL)
• ½ Tbsp. (7.3 mL)
• 1 Tbsp. (14.7 mL)
• 2 Tbsp. (29.5 mL)
FARBERWARE
1/8
tsp


equate™
Soap Holder
81131 14564


BURGER
PRESS
Perfect patties
every time.
Pour des
galettes parfaites
à tout coup.


Great Value
Granulated
Sugar
30 Calories
Per Serving
437


GOLD
Medal
ALL PURPOSE
FLOUR
500


PEANUT
m&m
454


FAMILY SIZE
MILK CHOCOLATE
CHOCOLATE CANDIES
m&m's
PEANUT
838


SHARING SIZE
m&m's
478


m&m's
m&m's
m&m's
1988


m&m's
minis
PROT
PI Classic

GIC: Volume Math Packet **Name**_____ **per**_____

How does math get used in road construction? Consider the roads we all use. What is involved in building a road? A road can't be built on just the "regular" untouched ground for many reasons but primarily because the natural ground is most likely too soft and won't support the traffic over time. Eventually, the road could fail causing a dangerous situation. Thus, contractors will use different types of soils and techniques to condition the soils for optimum performance.

This activity will replicate what road contractors deal with on a large scale with every project. It is crucial to determine the type of ground you are working with and if the ground can handle the type of traffic required, from small roads in remote areas of Alaska to large airports that must be able to support large jet airplanes.

Dirt Diggers is a Heavy Civil contractor in the state of Alaska and has an opportunity to build a project in remote Alaska. The job requires the contractor to excavate material from a mine site using the overburden to build a perimeter berm and the gravel to build a road. The mine permit allows the contractor to excavate to a total depth of 70' below the surface. The permit also requires that the remaining overburden be place back in the mine for reclamation and a 50' gap in the perimeter berm for vehicle access in the future. The Soils Engineer determined that the overburden material characteristics would swell at a rate of about 25% and shrink at a rate of about 20%, the gravel material would swell at a rate of about 10% and shrink at a rate of about 5%. Thus, it has been determined that the gravel material is suitable for road construction, but the overburden is not. Dirt Diggers is very excited to take on this project but must determine the volumes of materials to assess whether they have the resources needed to do the work.

*Note: use the information above and the attached "Mine Site Area" and "Figure 2" sheets to find critical dimensions needed to solve the problem.

Dilemma: How much material do I need to build a perimeter berm around the mine site and how much material do I have to build a good road?

Step 1: Solve for the following overburden quantities:

a. Calculate the total surface area of overburden available for excavation: _____ (square feet)
b. Calculate the total volume of overburden available for excavation: _____ (cubic feet)
c. Convert the cubic feet of overburden into cubic yards: _____ (cubic yards)

Step 2: Solve for the following gravel quantities:

a. Calculate the total surface area of gravel (lift 2) available for excavation: _____ (square feet)
b. Calculate the total volume of gravel (lift 2) available for excavation: _____ (cubic feet)
c. Convert the cubic feet of gravel (lift 2) into cubic yards: _____ (cubic yards to the nearest whole number)
d. Calculate the total surface area of gravel (lift 3) available for excavation: _____ (square feet)
e. Calculate the total volume of gravel (lift 3) available for excavation: _____ (cubic feet)
f. Convert the cubic feet of gravel (lift 3) into cubic yards: _____ (cubic yards)
g. Calculate the total amount of gravel available for excavation: _____ (cubic yards)

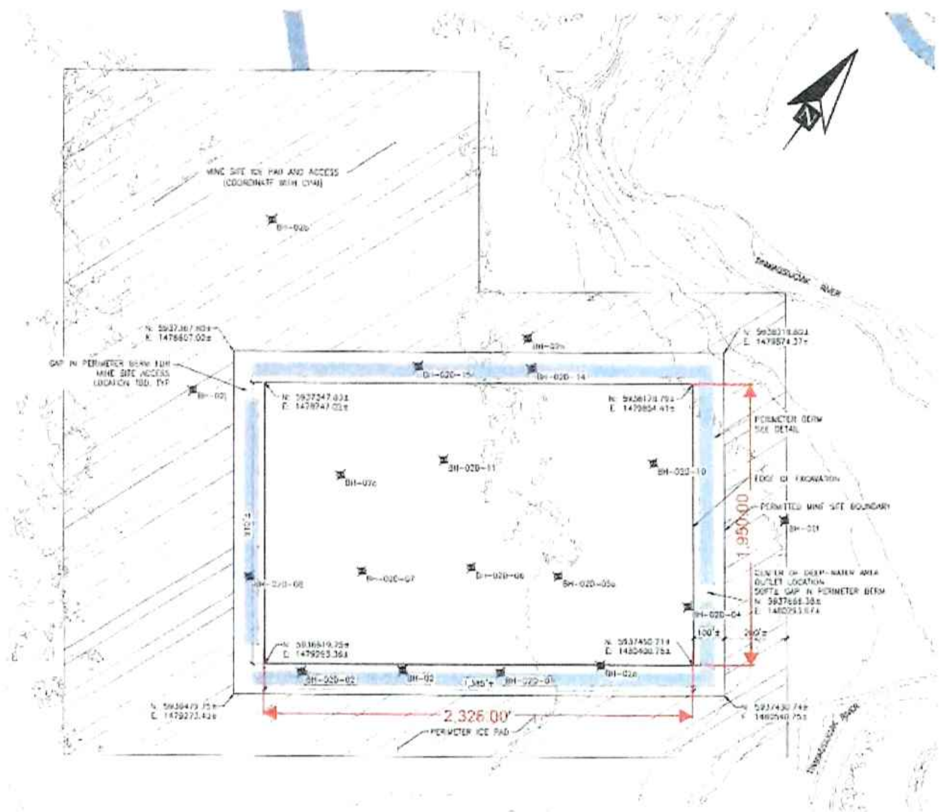
Step 3: Solve for the following quantities of overburden needed to construct a perimeter berm at the mine site and quantity of overburden to be put back in the mine site for reclamation.

a. Calculate the total length of the perimeter berm: _____ (linear feet)

b. Calculate the total amount of overburden needed to construct the berm: _____ (cubic feet)
c. Convert the amount of overburden needed to construct the berm to cubic yards: _____ (cubic yards to the nearest whole number)
d. Calculate the remaining amount of overburden to be placed back in the mine site for reclamation: _____ (cubic yards)

Step 4 "BONUS": Dirt Diggers is trying to calculate how many truck loads would be needed to transport the overburden material to a stockpile area using very large heavy haul trucks. *Think about the shop activity with the flour material*.

a. Calculate how many "loose" cubic yards of overburden are needed to be hauled out of the mine site to a stockpile area: _____ (cubic yards)
b. If a heavy haul truck can hold 36 cubic yards ("loose or truck"), how many truck loads are needed to transport the overburden: _____ (truck loads)
c. Based on this situation, was Dirt Diggers faced with a "shrink" or "swell" factor when excavating the overburden from its natural state (bank cubic yard) to its truck cubic yard: _____

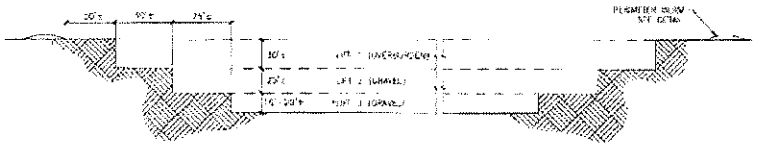


MINE SITE AREA

NOTE:

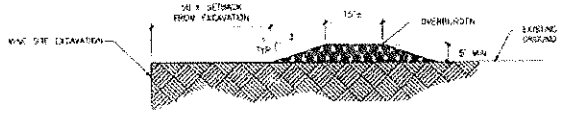
1. CONTRACTOR TO DEVELOP MINE SITE BASED UPON CONTRACTOR DEVELOPED EXECUTION PLAN, AS APPROVED BY OWNER.
2. ALL MINE SITE DEVELOPMENT AND RECLAMATION ACTIVITIES SHALL BE IN ACCORDANCE WITH THE WILLOW MINE SITE MINING AND RECLAMATION PLAN AND ALL OTHER PERMIT REQUIREMENTS. ANY DEVIATIONS FROM THE PLAN SHALL BE APPROVED BY OWNER.
3. COORDINATE WITH OWNER FOR ALL ICE RELATED INFRASTRUCTURE AND SURVEY REQUIREMENTS.
4. DELETERIOUS MATERIALS/REJECT GRAVELS ARE EXPECTED TO BE ENCOUNTERED WITHIN THE GRAVEL PRODUCTION ZONES OF THE WILLOW MINE SITES. DELETERIOUS MATERIALS SHALL BE IDENTIFIED AND REJECTED IN THE MINE SITE, PRIOR TO LOADING/HAULING TO THE PROJECT AND SHALL NOT BE INCORPORATED INTO THE GRAVEL EMBANKMENTS.
5. CONTRACTOR MINE SITE EXECUTION PLAN SHALL ANTICIPATE AND ADDRESS TIMELY IDENTIFICATION AND REMOVAL/DISPOSAL OF INTERBEDDED LAYERS OF DELETERIOUS MATERIAL (SILT/CLAY, etc) WITHIN SAND/GRAVEL LAYERS PRIOR TO HAULING TO THE PROJECT.

03/24/21



TYPICAL MINE SITE SECTION

NOTES:
1. LIFT THICKNESS WILL VARY DEPENDING UPON LOCATION WITHIN MINE SITE.
2. LIFT 3 (GRAVEL) WILL BE EXCAVATED WHERE BORING DATA INDICATES SUITABLE GRAVEL OR MATERIALS. A LAYER OF DELETERIOUS MATERIAL MAY NEED TO BE REMOVED BETWEEN LIFTS 2 AND 3.



TYPICAL PERIMETER BERM

MINE SITE TYPICAL SECTIONS

DESIGNED BY	JWD	DATE	7/27/2021
CHECKED BY	GKT	PROJECT NO	171217

FIGURE 2

GRAVEL PIT - EXCTRACTION

LAYER	LENGTH	WIDTH			EXPLAINATION
OVERBURDEN	2,325.00	1,950.00	4,533,750.00	SQUARE FEET	MULTIPLY THE LENGTH X WIDTH TO FIND SURFACE AREA - LOCATED ON THE "MINE SITE AREA" DETAIL SHEET
			30.00	DEPTH	LOCATED ON "MINE SITE AREA" DETAIL SHEET
			136,012,500.00	CUBIC FEET	TOTAL CUBIC FEET = SURFACE AREA X DEPTH
			27.00	FACTOR	
			5,037,500.00	CUBIC YARDS	TOTAL CUBIC FEET / 27 = CUBIC YARDS
		25%	1.25		
			6,296,875.00	LOOSE CYDS	
		-20%	0.80		
			4,030,000.00	COMPACTED CYDS	
GRAVEL #1	2,145.00	1,770.00	3,796,650.00	SF	AREA IS 90' IN PER SHEET FIGURE 2
			25.00	DEPTH	
			94,916,250.00	CF	
			27.00	FACTOR	
			3,515,416.67	BANK CYDS	
		8%	1.08		
			3,796,650.00	LOOSE CYDS	
		-4%	0.96		
			3,374,800.00	COMPACTED CYDS	
GRAVEL #2	1,995.00	1,620.00	3,231,900.00	SF	AREA IS ADDITIONAL 75' IN FROM + THE 90' AS DETAILED IN SHEET FIGURE 2
			15.00	DEPTH	
			48,478,500.00	CF	
			27.00	FACTOR	
			1,795,500.00	BANK CYDS	
		8%	1.08		
			1,939,140.00	LOOSE CYDS	
		-4%	0.96		
			1,723,680.00	COMPACTED CYDS	

GRAVEL PIT - PERIMETER BERM & RECLAMATION

LAYER	LENGTH	WIDTH			
OVERBURDEN	2,325.00	1,950.00	4,533,750.00	SF	
			30.00	DEPTH	
			136,012,500.00	CF	
			27.00	FACTOR	
			5,037,500.00	BANK CYDS	PAYMENT MEASUREMENT
		25%	1.25		
			6,296,875.00	LOOSE CYDS	HAULED TO STOCKPILE
		-20%	0.80		
			4,030,000.00	COMPACTED CYDS	IF NEEDED TO CALCULATE

BERM			
NORTH	2,470.00	LF	2,325 + 145' (50 setback + 15 slope + 7.5 to center of berm x 2)
SOUTH	2,470.00	LF	2,325 + 145' (50 setback + 15 slope + 7.5 to center of berm x 2)
EAST	2,095.00	LF	1,950 + 145' (50 setback + 15 slope + 7.5 to center of berm x 2)
WEST	2,095.00	LF	1,950 + 145' (50 setback + 15 slope + 7.5 to center of berm x 2)
VEHICLE ACCESS	(50.00)	LF	
	9,080.00	TOTAL LF	
MAIN BERM	681,000.00	CF	
	25,222.22	BANK CYDS	
SLOPES	340,500.00	CF	
	12,611.11	BANK CYDS	
	37,833.33	TOTAL BANK CYDS	

RECLAMATION		
	5,037,500.00	AVAILABLE BANK CYDS
	37,833.33	PLACE IN BERM
	4,999,666.67	TOTAL AVAILABLE TO RECLAIM

TRUCK LOADS	
6,296,875.00	
36	
174,913.19	
174,914	TRUCK LOADS - A PARTIAL TRUCK COUNTS AS A LOAD

GIC: Volume Math Packet **Name_____ANSWER KEY_____ per_____**

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Dilemma: How much material do I need to build a perimeter berm around the mine site and how much material do I have to build a good road?

Step 1: Solve for the following overburden quantities:

a. Calculate the total surface area of overburden available for excavation: __4,533,750_____ (square feet)
b. Calculate the total volume of overburden available for excavation: _136,012,500_____ (cubic feet)
c. Convert the cubic feet of overburden into cubic yards: __5,037,500_____ (cubic yards)

Step 2: Solve for the following gravel quantities:

a. Calculate the total surface area of gravel (lift 2) available for excavation: __3,796,650____ (square feet)
b. Calculate the total volume of gravel (lift 2) available for excavation: ___94,916,250_____ (cubic feet)
c. Convert the cubic feet of gravel (lift 2) into cubic yards: __3,515,417_____ (cubic yards to the nearest whole number)
d. Calculate the total surface area of gravel (lift 3) available for excavation: __3,231,900____ (square feet)
e. Calculate the total volume of gravel (lift 3) available for excavation: ___48,478,500_____ (cubic feet)
f. Convert the cubic feet of gravel (lift 3) into cubic yards: __1,795,500_____ (cubic yards)
g. Calculate the total amount of gravel available for excavation: ____5,310,917_____ (cubic yards)

Step 3: Solve for the following quantities of overburden needed to construct a perimeter berm at the mine site and quantity of overburden to be put back in the mine site for reclamation.

a. Calculate the total length of the perimeter berm: ___9,080_____ (linear feet)

b. Calculate the total amount of overburden needed to construct the berm: ___1,021,500___ (cubic feet)
c. Convert the amount of overburden needed to construct the berm to cubic yards: __37,833_____ (cubic yards to the nearest whole number)
d. Calculate the remaining amount of overburden to be placed back in the mine site for reclamation: ____4,999,667_____ (cubic yards)

Step 4 "BONUS": Dirt Diggers is trying to calculate how many truck loads would be needed to transport the overburden material to a stockpile area using very large heavy haul trucks. *Think about the shop activity with the flour material*.

a. Calculate how many "loose" cubic yards of overburden are needed to be hauled out of the mine site to a stockpile area: ___6,296,875_____ (cubic yards)
b. If a heavy haul truck can hold 36 cubic yards ("loose or truck"), how many truck loads are needed to transport the overburden: _____174,914_____ (truck loads)
c. Based on this situation, was Dirt Diggers faced with a "shrink" or "swell" factor when excavating the overburden from its natural state (bank cubic yard) to its truck cubic yard: ____swell_____