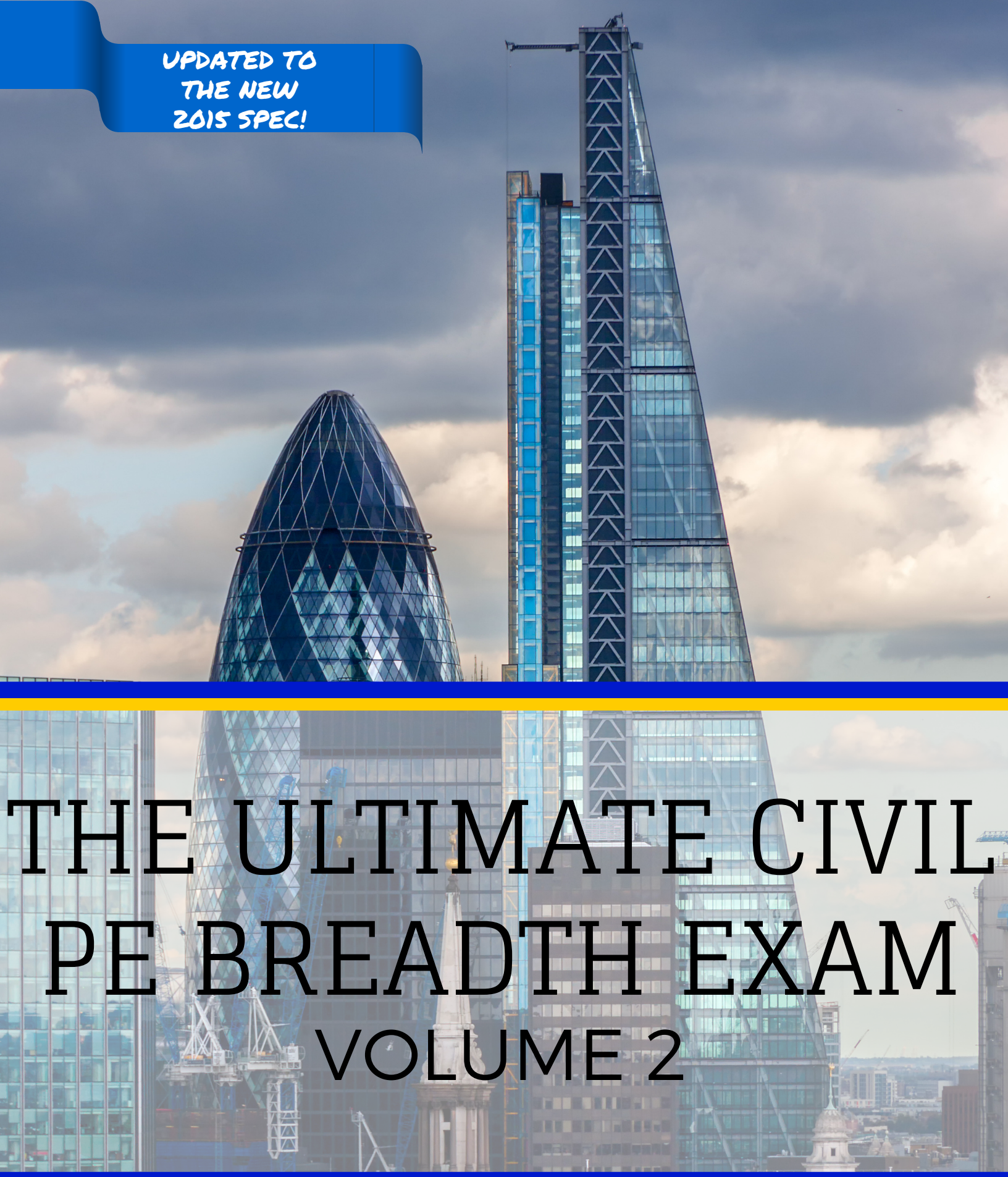

UPDATED TO THE NEW 2015 SPEC!

THE ULTIMATE CIVIL PE BREADTH EXAM

VOLUME 2

CIVIL ENGINEERING ACADEMY

WELCOME…AGAIN!

Welcome to The Ultimate Civil PE Breadth Practice Exam Volume 2! Thank you so much for purchasing this eBook!

If you have already purchased The Ultimate Civil PE Breadth Practice Exam Volume 1 then you are familiar with the look and feel of the exam. This is 40 more problem solving questions from each of the 5 categories that you will be tested on. This has been updated to meet the new test specifications as of April 2015. This test has fewer theory questions and is slightly more difficult than volume 1 (hopefully that doesn't scare you!). This is to help you gain more practice, experience, and ultimately more confidence in passing.

Again, this test is not endorsed by the NCEES organization. These are problems that my team and I have written to help you succeed in passing the PE exam. I would encourage you to take this timed to see how long it takes you. Afterwards, you can take note of the areas that you might need to work on. I have spent some time getting all the information here for you so that it is easy to use. Each problem is labeled and sub-labeled so you know what problem and area you are dealing with.

As always, I value your feedback and any constructive criticism you might have on this exam, the site, or the videos I make to help you on your journey to pass the PE.

I know that with a lot of practice you will become much more proficient in working problems and doing them with not much assistance. Keep at it and you will be prepared to pass the PE.

I don’t need to tell you about the benefits of obtaining your PE license because I’m sure you already know them. You must get it to have a great career in civil engineering (and a lot of other fields!).

As always, I wish you the best of luck!

Sincerely,

Isaac Oakeson, P.E.

(You’re going to have that by your name too!)

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Legal Mumbo Jumbo

Civil Engineering Academy's

The Ultimate Civil PE Breadth Exam Volume 2

Isaac Oakeson, P.E.

Rights and Liability Stuff:

If you find errors in this book (I am human of course), or just want to comment on things, then please let me know! I can be reached through the website at www.civilengineeringacademy.com or by email at isaac@civilengineeringacademy.com.

(START TEST)

1. Suppose that 2000 ft^3 of concrete is required to pour 40% of the slabs of the third floor of the Black Crown Hotel. To construct a 3500 psi concrete, the batching plant produced a 1:2:4 by volume mixture. Compute the bulk volume of the cement required (yd^3).

a) 10.6
b) 74.1
c) 29.6
d) 37.0

PROBLEM 1 SOLUTION:

PROJECT PLANNING

QUANTITY TAKE OFF METHODS

Use the proportions to compute the bulk volume. The ratios are given in this sequence cement:fine aggregate:coarse aggregate. Write the ratios down and multiply by the volume required to see what you need of each type.

Material	**Solution**	**Bulk Volume**
Gravel (coarse agg.)	2000(4/7)	1142.9 ft^3
Sand (fine agg.)	2000(2/7)	571.4 ft^3
Cement	2000(1/7)	**285.7 ft^3**

The cement required is 285.7 ft^3 or **10.6 yd^3 (Answer A)**

2. Specifications on a job required a fill using borrow soil to be compacted at 95% of its standard proctor maximum dry density. Tests indicate that this maximum is 124 pcf with 12% moisture content. The borrow material has a void ratio of 0.6 and a solid specific gravidity of 2.65. Compute the minimum volume (ft^3) of borrow soil required per 1 ft^3 of fill.

a) 2.25
b) 1.00
c) 3.05
d) 1.14

PROBLEM 2 SOLUTION:

PROJECT PLANNING

QUANTITY TAKE-OFF

First, for the borrow soil, solve for the dry unit weight of the soil:

$\gamma_{dry} = G_s\gamma_w/(1+e)$

$\gamma_{dry} = (2.65)(62.4)/(1+0.6)$

$\gamma_{dry} = 103.35$ pcf

Then solve for the compacted soil at 95% compaction:

$\gamma_{dry} = 0.95(124)$

$\gamma_{dry} = 117.8$ pcf

The weight of the compacted soil = the weight of soil needed as borrow:

$117.8(1) = 103.35\ (V_{borrow})$

V_{borrow} = **1.14 ft³ (Answer D)**

3. The following table tabulates the activities for a new project's network diagram. Based on the data provided what is the duration of the project (weeks)?

a) 14
b) 20
c) 10
d) 12

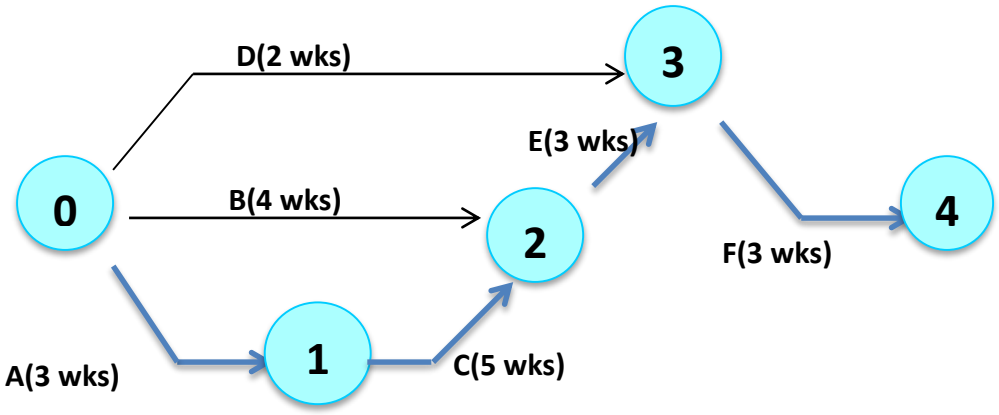
Path	Duration (weeks)
0-1 (A)	3
0-2 (B)	4
0-3 (D)	2
1-2 (C)	5
2-3 (E)	3
3-4 (F)	3

PROBLEM 3 SOLUTION:

PROJECT PLANNING

ACTIVITY IDENTIFICATION AND SEQUENCING

Path	Duration (weeks)
0-1 (A)	3
0-2 (B)	4
0-3 (D)	2
1-2 (C)	5
2-3 (E)	3
3-4 (F)	3



First, draw the paths given and then find the critical path (longest duration, blue arrows).

Path DF= 2+3 = 5 weeks

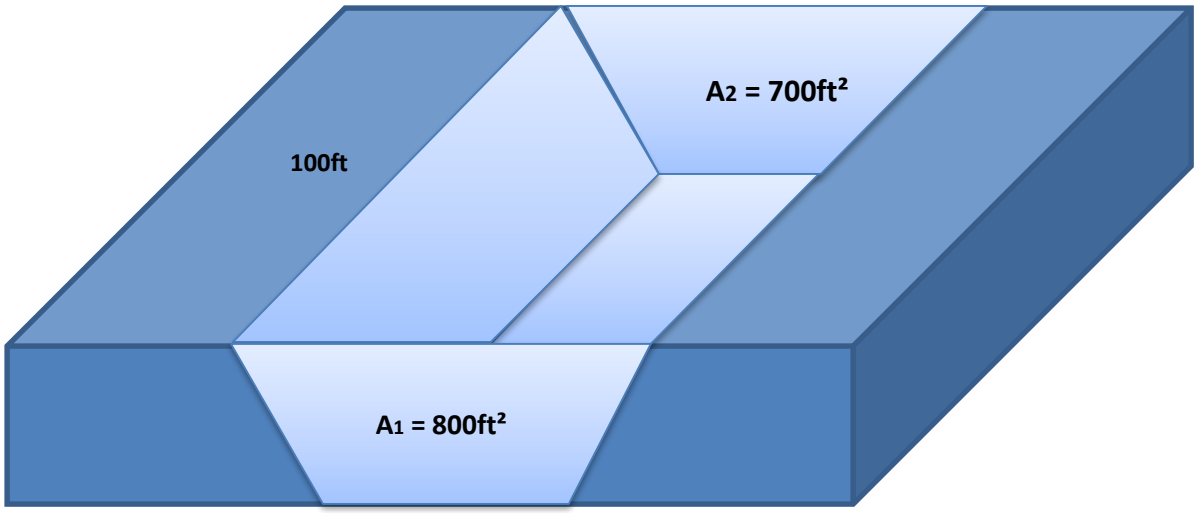
Path ACED = 3+5+3+3 = **14 Weeks (Answer A)**

Path BEF = 4+3+3 = 10 weeks

In order to finish a project we should complete all activities from the starting node to the finishing node (0 to 4). But all activities should be done to complete a project. Example: In order for node 2 to be completed, activities at path AC should be accomplished since it has the longest duration of activity inside node 2.

4. A road is to be constructed and the cut is shown. Determine the cost of the excavation process if it is worth $2.5/ft³. Use the end area method.

a) 187,500
b) 185,800
c) 178,500
d) 185,700



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PROBLEM 4 SOLUTION:

PROJECT PLANNING

COST ESTIMATING

First, compute the volume of soil excavated (cut) using the end area method:

Volume= (A1+A2)L/2

Volume= (800+700)(100)/2

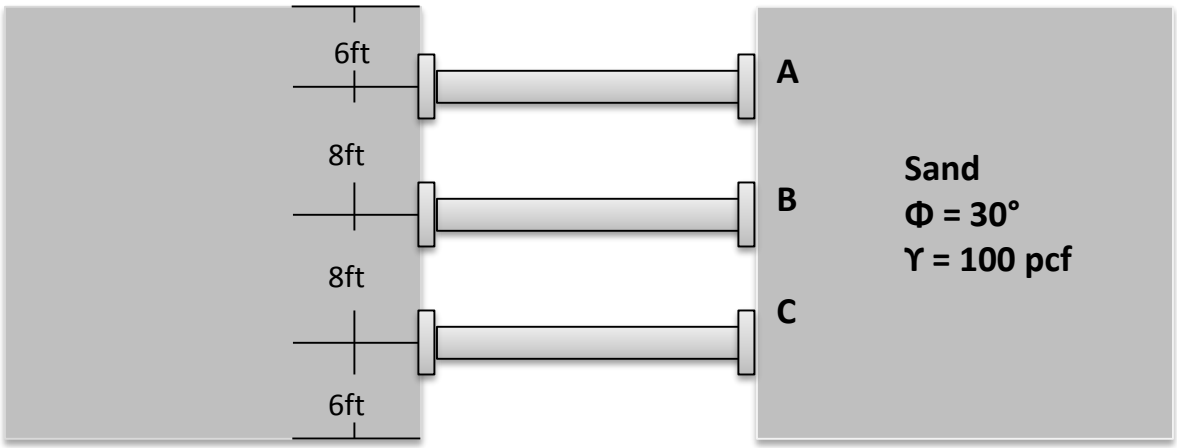
Volume=75000 ft^3

Now solve for the cost of the excavation:

Cost=75000(2.5)=**$187,500 (Answer A)**

5. A 28 ft deep braced cut in a sandy soil is shown. The struts are placed 5 ft center to center. Compute the reaction (lbs) at strut C using Peck's empirical pressure diagram.

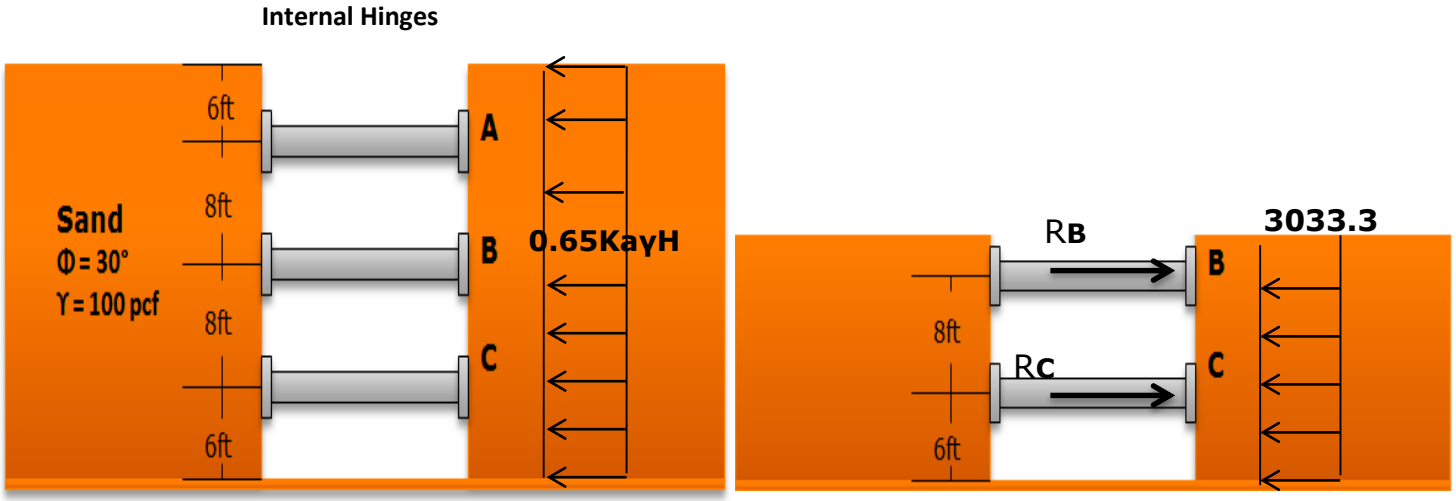
a) 37160
b) 38990
c) 35660
d) 31590



PROBLEM 5 SOLUTION:

MEANS AND METHODS

TEMPORARY STRUCTURES



First, solve for the active earth pressure coefficient:

K_A = 1 – sin 30 / 1 + sin 30
= **1/3**

Find the maximum lateral pressure for braced cuts in sand (Peck's):

P_A = 0.65KaγH
= 0.65(1/3)(100)(28)(**5**)
= **3033.3 lbs/ft**

Then isolate BC to solve for the reaction at point C:

↻ **$\Sigma M_B = 0$:**

0 = - 3033.3 (14)(7) + R_C (8)

R_C = 37160 lbs (Answer A)

6. A contractor is going to be setting up rigging using a sling basket with a 60° angle to lift a 2,000 lb anchor bolt cage. What is the minimum rating of the sling to lift the load (lb)?

a) 1155
b) 2310
c) 2000
d) 2210

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PROBLEM 6 SOLUTION:

MEANS AND METHODS

CONSTRUCTION LOADS

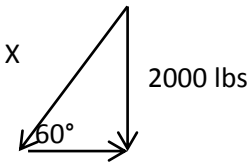
This problem can be resolved into a simple statics problem. The confusion might come in what to actually list as the rating for the sling.

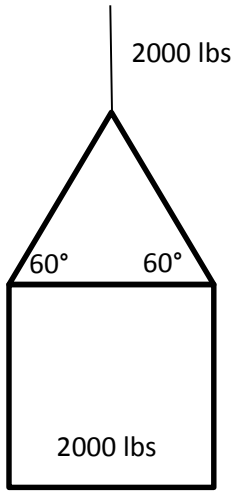
Draw a force triangle and solve for X:

Tan60°=1000/X

X=1154.7 lbs per leg

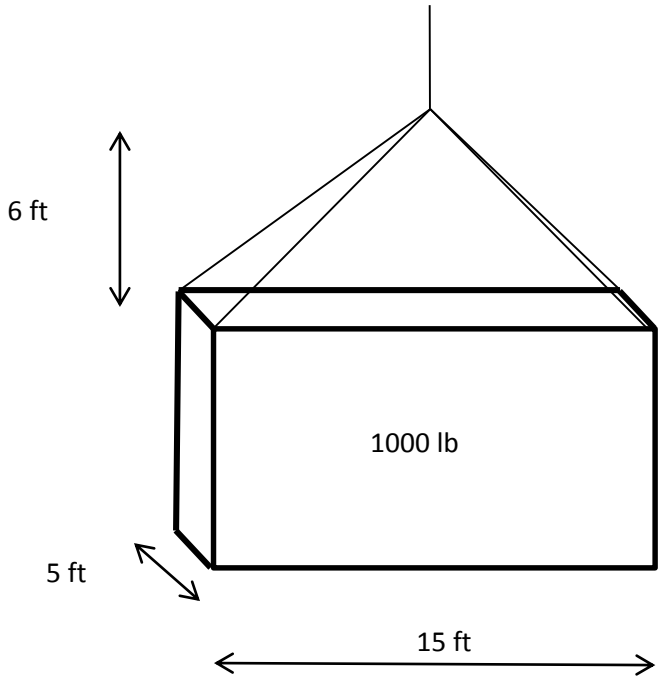
1154.7 x 2 = **2309 lb rating for the sling. (Answer B)**





7. A crane is caring a crate weighing 1000 pounds. It is held by four cables attached to the corners. The attachment point is located directly above the center of the load. What, most nearly, is the tension in each cable (lb)?

a) 250
b) 300
c) 340
d) 410



PROBLEM 7 SOLUTION:

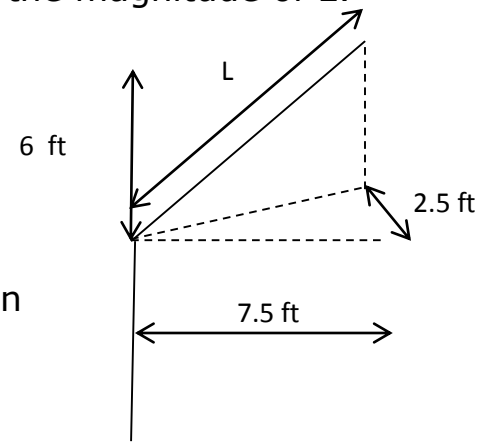
MEANS AND METHODS

CONSTRUCTION LOADS

Because the problem is 3 dimensional we are dealing with a X, Y, and Z coordinate. In order to get the length of each cable we must do the following:

Remember that the pickup point is half of 15 ft and that the pickup point is half of 5 ft in width too. Solve for the magnitude of L:

$L=\sqrt{7.5^2+2.5^2+6^2}$ = 9.92 ft



Next you need to solve for the vertical component in each cable. It can be written as the following:

$F_y=F(6/9.92)=0.605F$

Next take the sum of forces in the y direction and solve for the force in the cable:

4Fy-1000=0

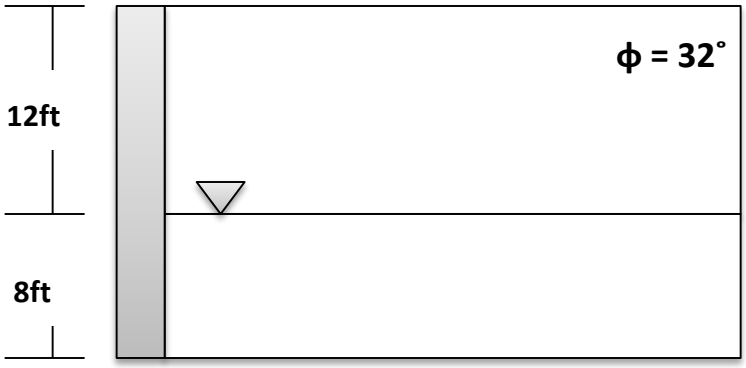
4(0.605F)=1000

F=**413.2 lbs (Answer D)**

You can see that each cable sees a much larger load that you would think based on the angle you are pulling up at.

8. A vertical retaining wall has a height of 20 ft that supports a horizontal backfill. Its dry unit weight is 100 lb/ft³ and a saturated unit weight of 140 lb/ft³. Ground water was found at 8 ft below the ground surface. Compute the total Rankine active force per unit length of wall (lb/ft).

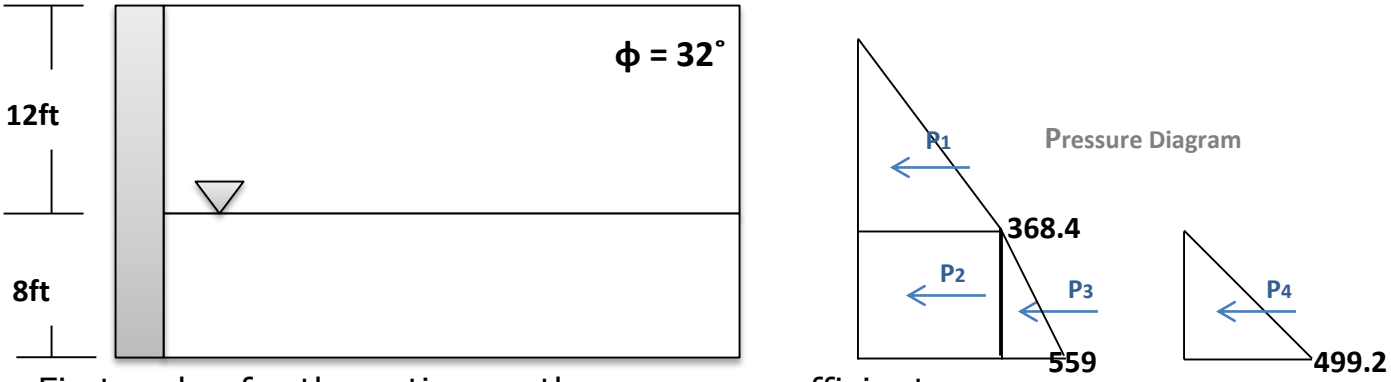
a) 9005
b) 8544
c) 7920
d) 6785



PROBLEM 8 SOLUTION:

SOIL MECHANICS

LATERAL EARTH PRESSURE



First, solve for the active earth pressure coefficient:

K**a = (**1 – sin 32) /(1 + sin 32)
K**a = 0.307**

Then draw the pressure diagram using the given unit weight and pressure coefficient:

1st soil layer = 12(100)(0.307) = **368.4 psf**
2nd soil layer = 8(140-62.4)(0.307) = **190.6 psf**
Pore water pressure = 8(62.4)(1) = **499.2 psf**

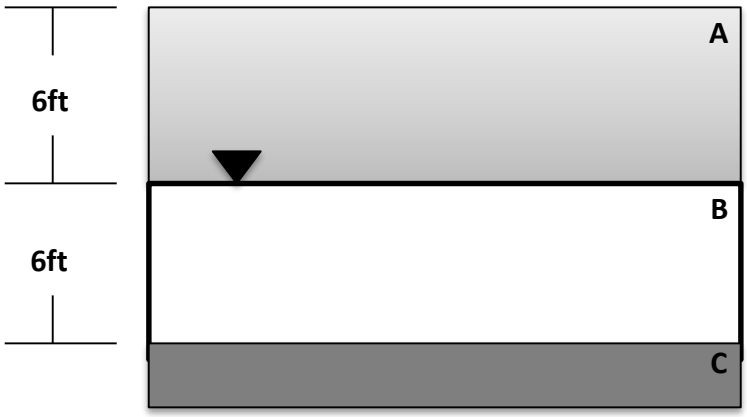
Then solve for the forces by parts from the diagram and add for the total force:

Note: P1, P2, and P3 are all from the effective pressure of the soil, while P4 is from pore water pressure.

P_1 = 368.4(12) / 2 = **2210.4 lbs**
P_2 = 368.4(8) = **2947.2 lbs**
P_3 = (559-368.4)(8) / 2 = **762.4 lbs**
P_4 = 500(8) / 2 = **2000 lbs**
$P_T = P_1 + P_2 + P_3 + P_4$ = 2210.4 + 2947.2 + 762.4 + 2000 =
7920 lbs per ft (Answer C)

9. From the soil layer shown, determine the closest effective stress at point C (lb/ft²). Layer A is dry, layer B and C are saturated.

a) 1087
b) 1095
c) 1054
d) 1025



Soil Properties
Gs = 2.70
e = 0.61

PROBLEM 9 SOLUTION:

SOIL MECHANICS

EFFECTIVE AND TOTAL STRESS

First, solve for the dry unit weight and saturated unit weight of the soil:

$\gamma_{dry} = G_s\gamma_w/(1+e) = 2.7(62.4) / 1 + 0.61 =$ **104.65 pcf**

$\gamma_{sat} = (G_s+e)\gamma_w/(1+e) = (2.7 + 0.61)(62.4) / 1 + 0.61 =$ **128.3 pcf**

Then solve for the effective stress at point C:

σ` = 104.65 (6) + (128.3 – 62.4)(6) = **1023.3 psf (Answer D)**

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10. A normally consolidated clay layer is 15 ft (one way drainage). From the application of a given pressure, the total anticipated primary consolidation settlement will be 3 inches. Given that the coefficient of consolidation is 0.00323×10^{-3} ft²/s, how many days will it take for 50% settlement to occur if the time factor from a table is 0.197?

a) 159
b) 124
c) 170
d) 205

11. Settling on a structure has three distinct periods. Which of the following statements is *not* true about settling?

a) Elastic settling occurs *immediately* after a structure is constructed.
b) Secondary consolidation occurs in clay soil and happens at a much slower rate *after* primary consolidation has finished.
c) Primary consolidation occurs gradually in clay because water is being extruded from the voids.
d) An influence chart can be used to determine the primary consolidation rate.

PROBLEM 10 SOLUTION:

SOIL MECHANICS

SOIL CONSOLIDATION

Solve for the time to consolidate:

$$t = \frac{T v H^2}{Cv}$$

$t=(0.197)(15)^2/(0.00323x10^{-3})$

t=13722910 sec

Convert to days:

t=159 days (Answer A)

PROBLEM 11 SOLUTION:

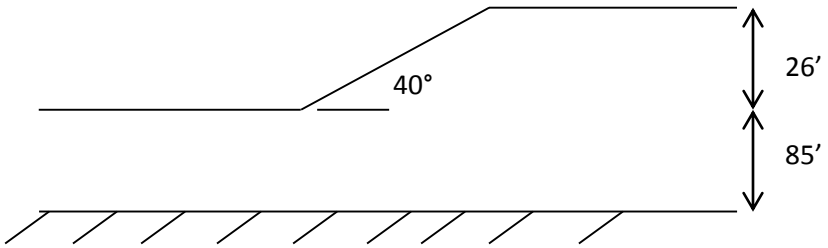
SOIL MECHANICS

FOUNDATION SETTLEMENT

All of the answers to this are true about settlement except d. The influence chart (Newmark) is used to find the vertical pressure underneath a foundation. It is not used to determine the primary consolidation rate. See Settling in the CERM. **(Answer D)**

12. What is the factor of safety for the following slope stability analysis? The clay soil has the following properties: γ= 120 pcf, c=600 psf.

a) 1.2
b) 1.8
c) 2.0
d) 2.5

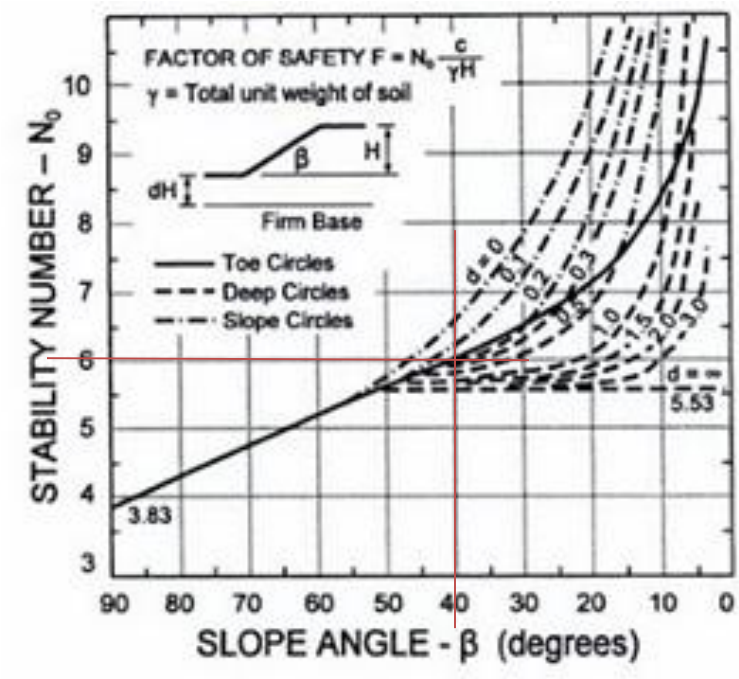


PROBLEM 12 SOLUTION:

SOIL MECHANICS

SLOPE STABILITY

To solve this use the Taylor slope stability chart (CERM Fig. 40.6)



Soil Mechanics, NAVFAC Design Manual DM-7.1

To find d you solve d=H/D = 26 ft/85 ft = 0.3 and the slope was given as 40°. See where these two intersect to find the slope stability number N_o. Say N_o = 6.

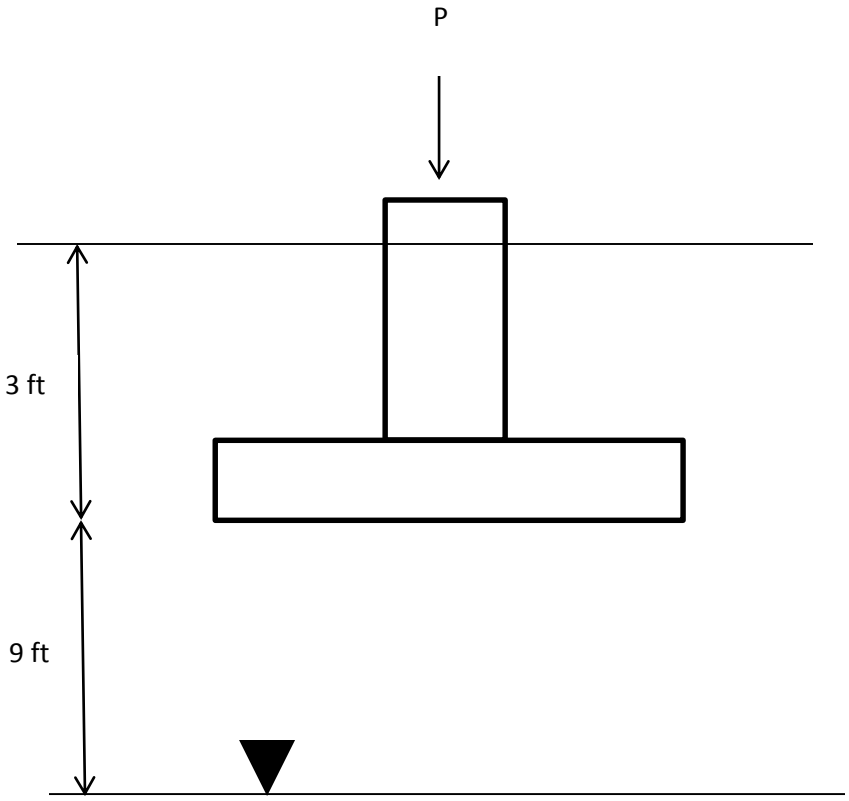
Solve for the safety factor:

$F = N_o c/(\gamma H) = (6*600)/(120*26) =$ **1.15 (Answer A)**

This is an unacceptable safety factor. You want between 1.3-1.5.

13. A 5 foot square footing is embedded 3 ft into sand. The sand has a density of 120 pcf and bearing capacity factors of N_c=51, N_q=38, N_γ=44. Determine the maximum allowable column load P (lb) to maintain a factor of safety of 3. Ignore shape factors.

a) 8800
b) 8900
c) 11500
d) 13500



PROBLEM 13 SOLUTION:

SOIL MECHANICS

BEARING CAPACITY

Solve for the ultimate bearing capacity of the soil:

$\mathbf{Q_{ult} = cN_c + \gamma DN_q + 0.5\gamma BN_\gamma}$

C=0 for sands

D=depth into sand layer

B=width of footing

Groundwater is neglected because it is greater than $D_{footing}$+B

Q_{ult} = 0 + 120(3)(38)+0.5(120)(5)(44)

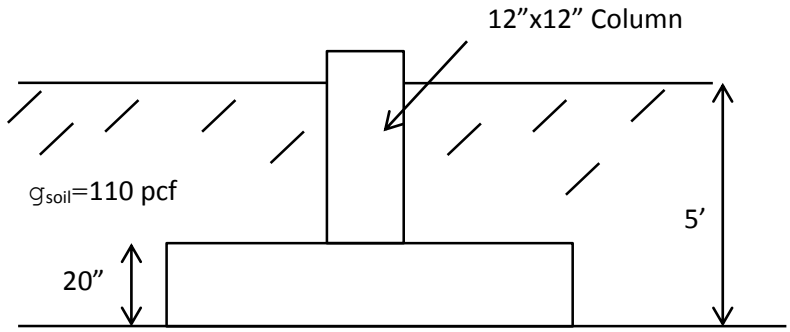
Q_{ult} = 26880 psf

Solve for allowable load given the safety factor of 3:

$Q_{allow}=\frac{Qult}{FS} = \frac{26880}{3}$ = **8960 (Answer B)**

14. A square footing with a depth of 20 inches carries a dead load of 100 kips and a live load of 80 kips. From the figure shown, determine the approximate dimension of the footing given the allowable soil bearing capacity of 4000 psf. Use a concrete unit weight of 150 pcf.

a) 8 ft x 8 ft
b) 7 ft x 7 ft
c) 7.5 ft x 7.5 ft
d) 8.5 ft x 8.5 ft



PROBLEM 14 SOLUTION:

STRUCTURAL MECHANICS

FOOTINGS

Solve for the Total Unfactored Load:

100+80=180 kips

Effective stress, σ' = 4000-110(5-20/12)-150(20/12)

σ'= 3383.3 psf

Effective stress, σ' = Unfactored load/ area of footing

3383.3=180 kips(1000 lb/kip)/Area of footing

Area of footing = 53.2 ft^2

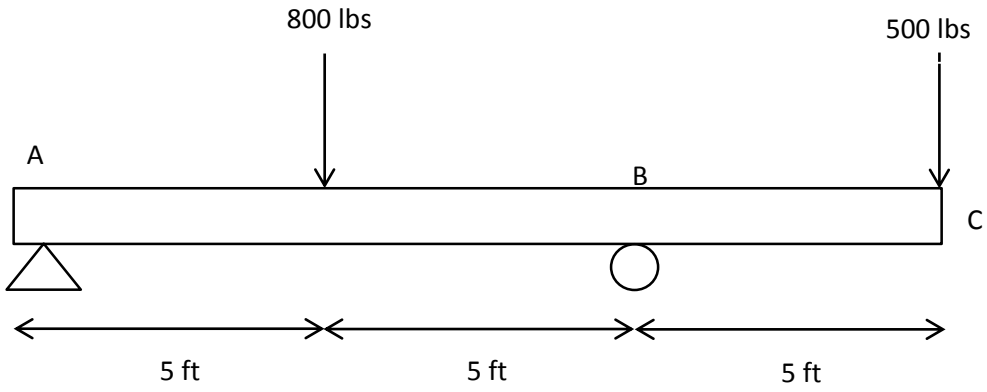
Dimension=√(53.2) = 7.29, therefore go with 7.5 ft.

Dimensions = 7.5 ft x 7.5 ft (Answer C)

Note: since it is specified as a square footing, the length and the width should be equal.

15. In the figure shown, the beam is simply supported at point A and 5 ft from point C. Determine the maximum positive moment (lb-ft).

a) 550
b) 650
c) 750
d) 1500



PROBLEM 15 SOLUTION:

STRUCTURAL MECHANICS

BEAMS

First, use the equilibrium equations to solve for the reactions:

$$\sum M_A = 0$$

$0=800(5)-R_B(10)+500(15)$

R_B=1150 lbs

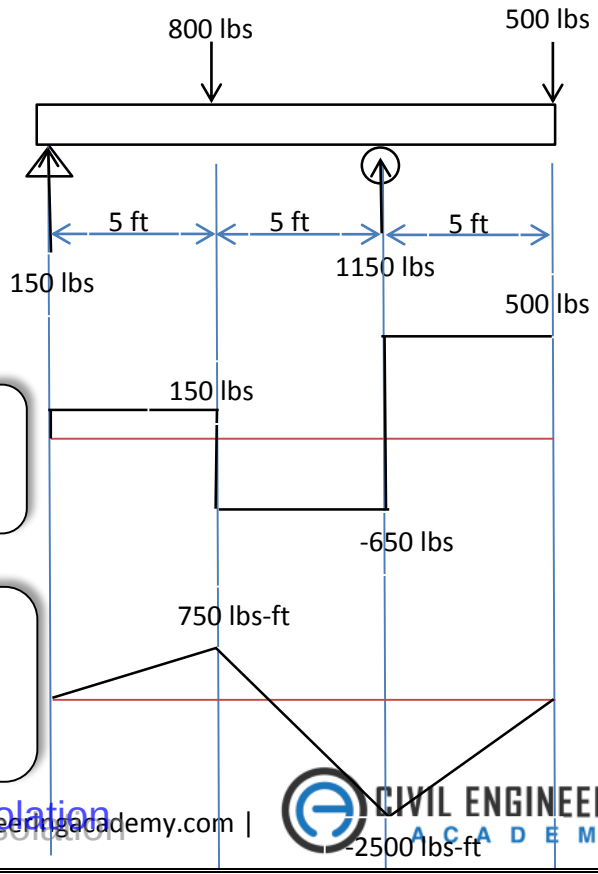
$$\sum F_y = 0$$

$0=R_A-1300+1150$

R_A=150 lbs

Draw the shear and moment diagrams; the max positive moment is **750 (Answer C):**

Note: To determine the maximum positive moment, draw the shear force diagram and the moment diagram.



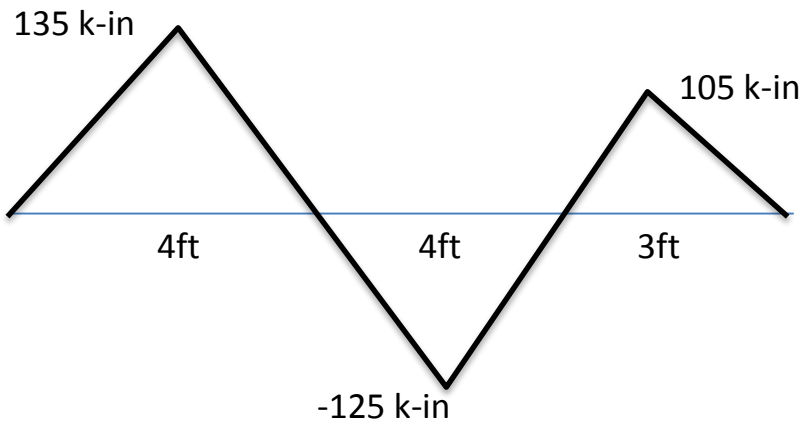
Shear Diagram: Moving along the beam you start at +150 until you hit 800 lbs, -650 is next (150-800=-650) followed by a positive 500 lbs (-650+1150=500).

Moment Diagram: Because the moment is the integral of the shear, every time the shear crosses 0 you should have a max or a min point. To find the max and min's find the area under the shear curve: 150 lb*5 ft=750, and linear because shear slope is 0, then 650 lb*5 ft=3250, so take 750-3250=-2500 and then up to 0.

16. After analyzing a beam, its moment diagram is shown below. Given the diagram, determine the maximum positive bending stress (ksi). The section modulus of the beam, S=8.14 in³.

a) 16.58
b) 15.36
c) 12.89
d) 29.84

Moment diagram



PROBLEM 16 SOLUTION:

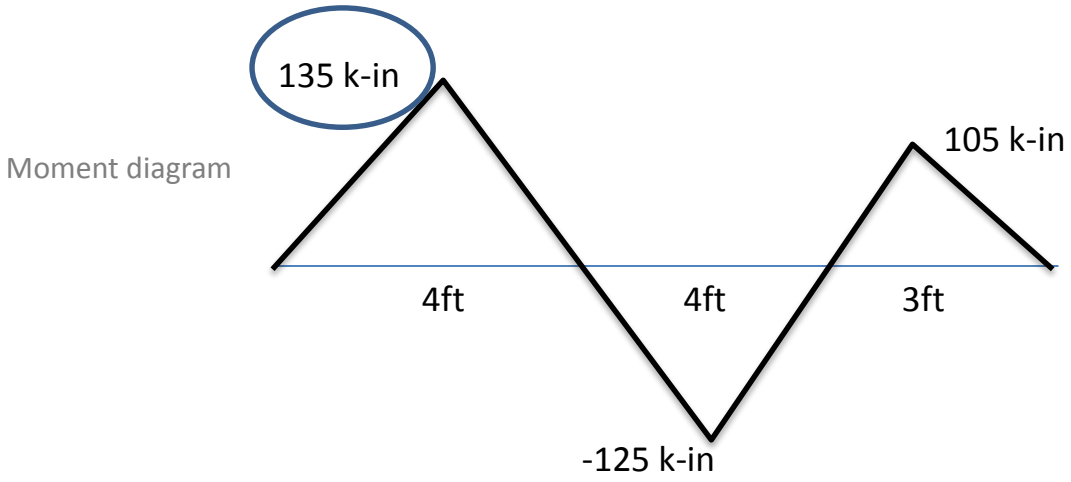
STRUCTURAL MECHANICS

BENDING

The maximum positive bending moment is 135 k-in. The maximum negative bending moment is -125 k-in. Therefore, use the larger of the two, 135 k-in.

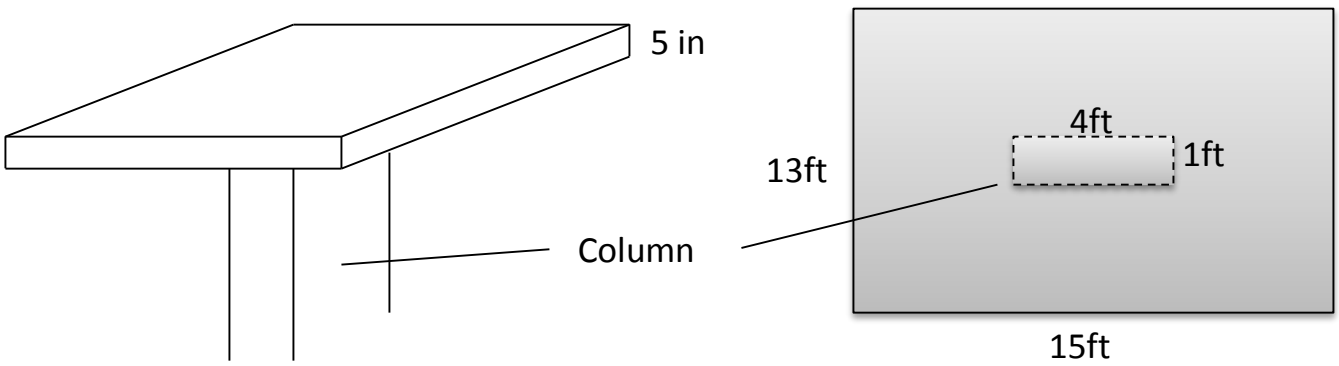
Solve for the bending stress:

f_B = M c / I or M / S
f_B = M / S = 135 / 8.14
f_B = **16.58 ksi (Answer A)**



17. A column carries a concrete flat plate with a 5 inch thickness. The slab carries a dead load of 80 psf. Determine the compressive stress of the column (psi). Use a concrete unite weight of 150 pcf (tributary area 13 ft x 15 ft).

a) 21.16
b) 48.24
c) 35.21
d) 27.40



PROBLEM 17 SOLUTION:

STRUCTURAL MECHANICS

COLUMNS

First, convert all pressure loads to concentrated loads:

Dead load = 80(13)(15) = 15600.0 lbs

Slab weight = 150(13)(15)(5/12) = 12187.5 lbs

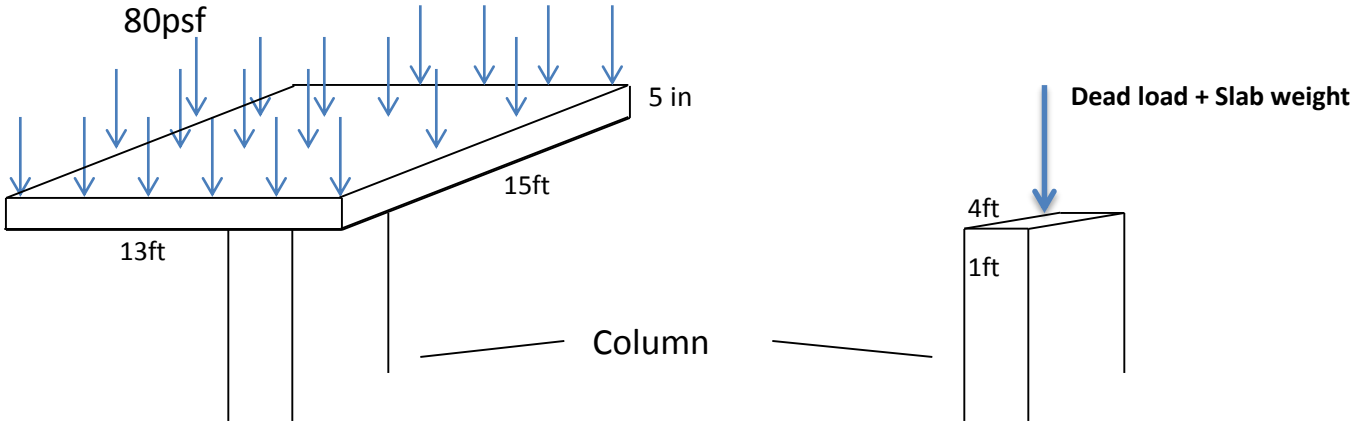
27787.5 lbs

Then use the formula for compressive stress.

f_A = P / A

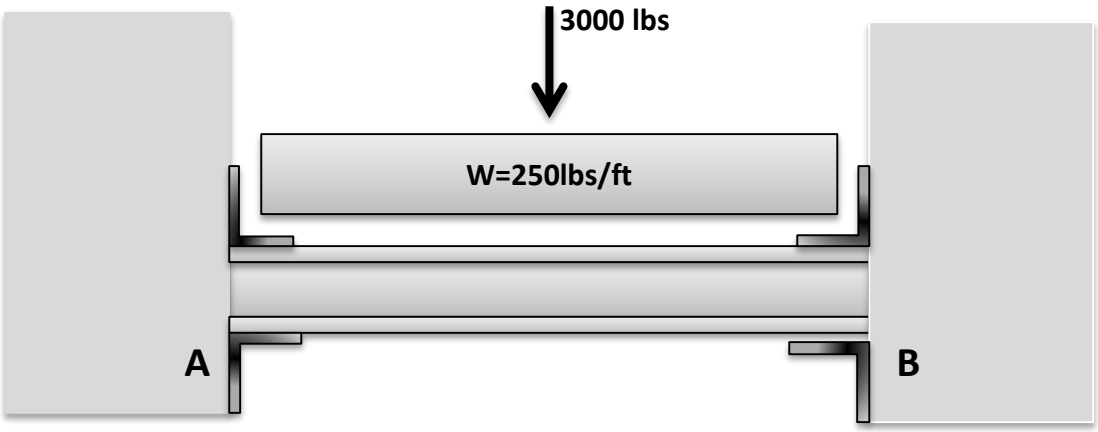
f_A = 27787.5 / (4 x 1)

f_A = 6946.9 psf = **48.24 psi (Answer B)**



18. A 20 ft beam, loaded as shown, is fixed at both ends. Given the properties of the beam, determine the deflection at the midpoint (in).

a) 0.87
b) 1.5
c) 1.3
d) 0.12



Beam Properties
E = 29000 ksi
I = 118 in^4

PROBLEM 18 SOLUTION:

STRUCTURAL MECHANICS

DEFLECTION

First, solve for the deflection of the concentrated load and uniform load.

δP = PL³/192EI

= (3000/1000)(20/12)³ /
192 (29000)(118)

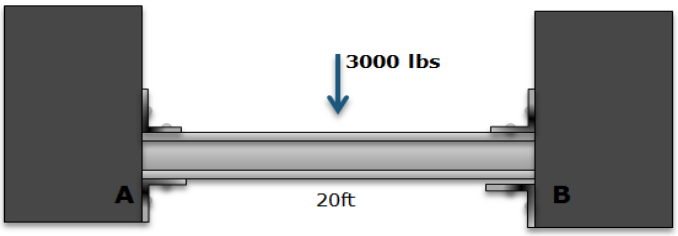
= **0.063 in**

δw = wL⁴ / 384EI
= (250/1000*12)(20/12)⁴ /
384 (29000)(118)
= **0.053 in**

Then use superposition to solve for the total deformation.

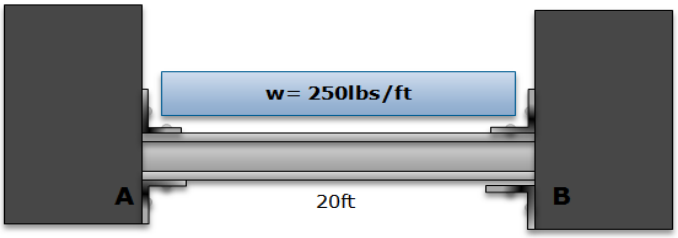
δP + δw = δTOTAL
0.063 + 0.053 = **0.12 in (Answer D)**

$\delta_P = PL^3 / 192EI$



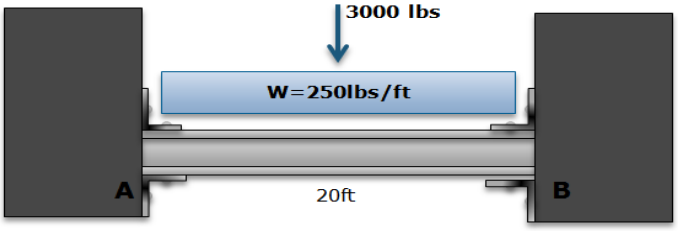
+

$\delta_w = wL^4 / 384EI$

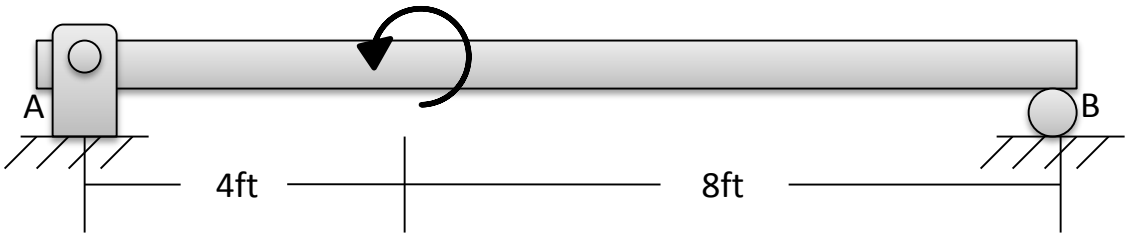


=

$\delta_P + \delta_w = \delta_{TOTAL}$

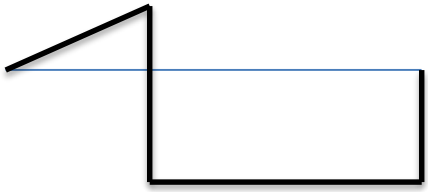


19. Determine the moment diagram of the loaded beam given.

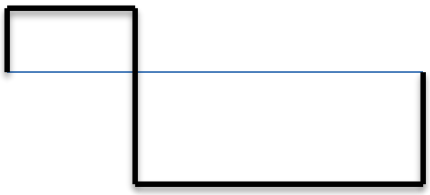


a)

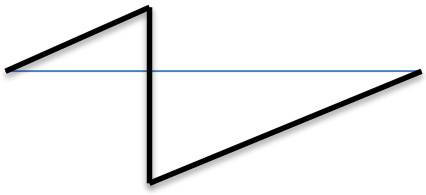
b)



c)



d)



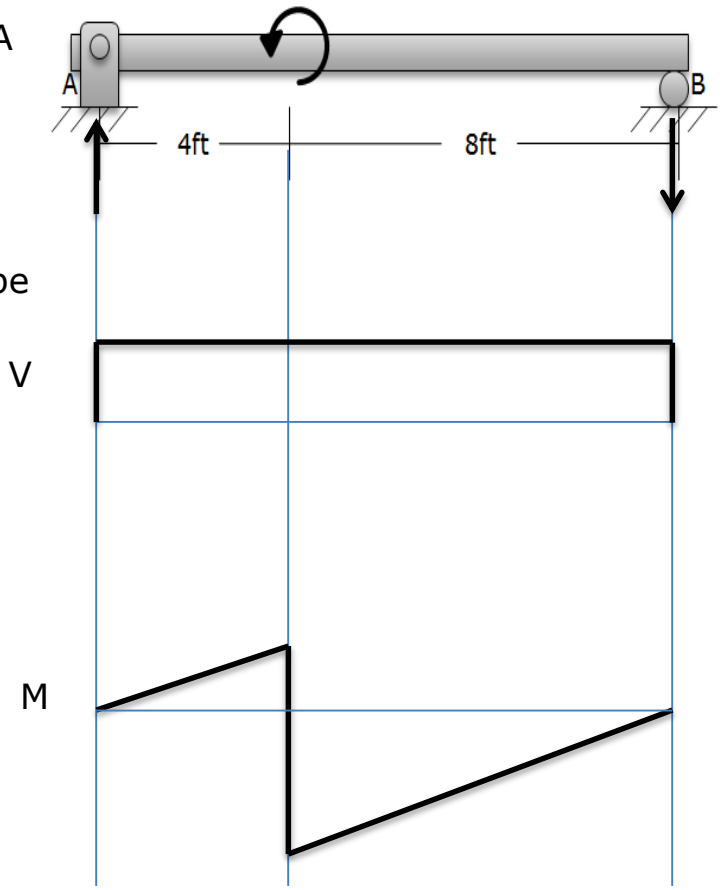
PROBLEM 19 SOLUTION:

STRUCTURAL MECHANICS

BENDING MOMENT DIAGRAM

The reactions from the supports at A and B should create a resisting moment in order to maintain the equilibrium. Since the given load is counterclockwise, the resisting moment from the reactions should be clockwise.

From the information given, we can now draw the shear and moment diagram without any given values.

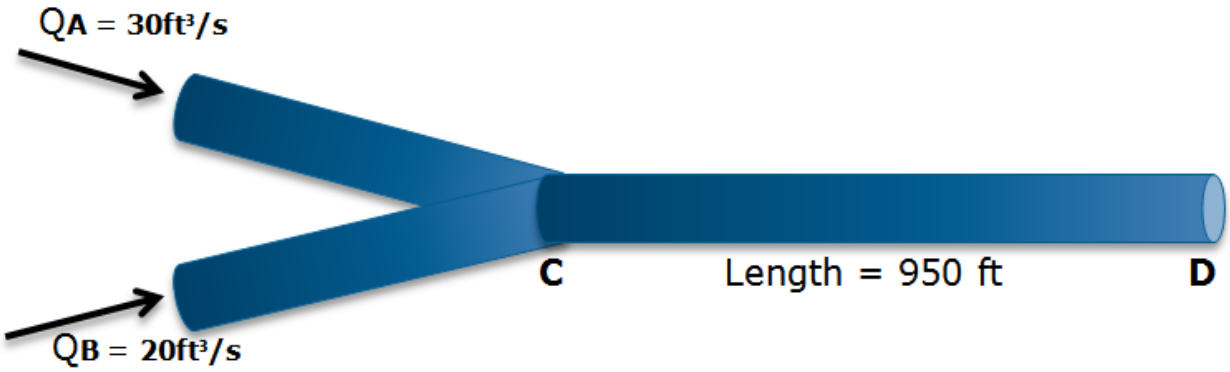


The reaction at A starts the shear up and then carries on until the reaction at B. Because the shear has a zero slope the moment is linear until you hit the internal moment at 4 ft. This drops the moment to some value and then it increases linearly until you hit zero because the shear still has a zero slope. Remember that the shear is the derivative of the moment.

ANSWER D

20. In the figure shown below, design the diameter (inches) of pipe CD given a headloss of 14.5 ft using Manning's Equation (n=0.013).

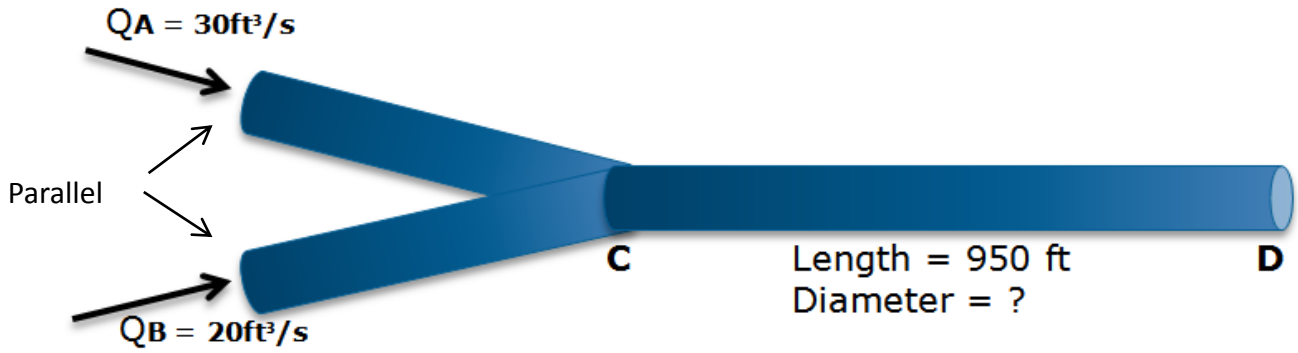
a) 20
b) 45
c) 30
d) 60



PROBLEM 20 SOLUTION:

HYDRAULICS AND HYDROLOGY

PRESSURE CONDUIT



First, solve for the flow rate along the pipe:

$Q_A + Q_B = Q_{CD}$
$30 + 20 = 50\ ft^3/s$

Note: When pipes are parallel, flow rates should be added.

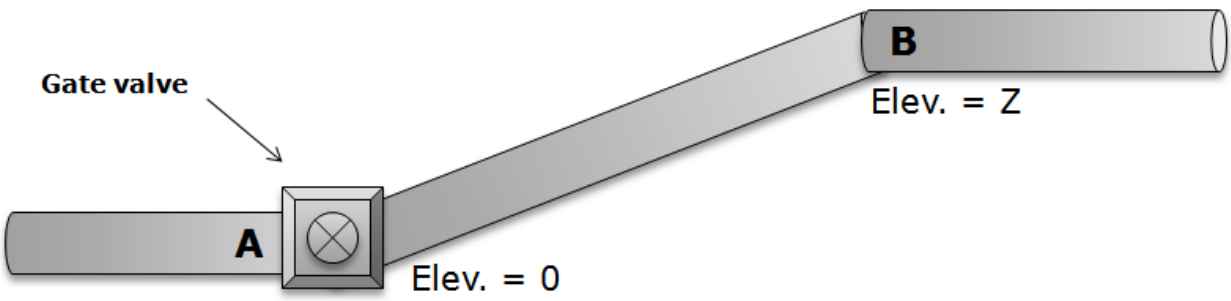
Then solve for diameter of pipe using the head loss (use Manning's equation):

$h_f = 4.65\ n^2\ L\ Q^2 / D^{16/3}$
$14.5 = 4.65\ (0.013)^2\ (950)\ (50)^2 / (D)^{16/3}$

D = 2.49ft x 12 in/ft = 29.84 in = **30 inches (Answer C)**

21. Water flows from point B to A. In the system shown, the pressure from A to B is 1200 psf when the gate valve is closed, and when the valve is opened, it measured 1000 psf. Determine the headloss from point B to A.

a) 19.2
b) 35.2
c) 20.2
d) 10.2



PROBLEM 21 SOLUTION:

HYDRAULICS AND HYDROLOGY

PRESSURE CONDUIT

Solve using Bernoulli's equation:

$(P_1 / \gamma + V_1^2 / 2g + z_1 - HL = P_2 / \gamma + V_2^2 / 2g + z_2)$

Solve for elevation Z at point B. Solve by using the Bernoulli equation given when the gate valve was closed. Notice that velocity head is cancelled out on both sides when it is closed because the flow is not moving. There is also no head loss so we don't need to account for that. You are left with the following:

$P_B / \gamma = P_A / \gamma - z$
$1200 / 62.5 = z$
Z = 19.2 ft

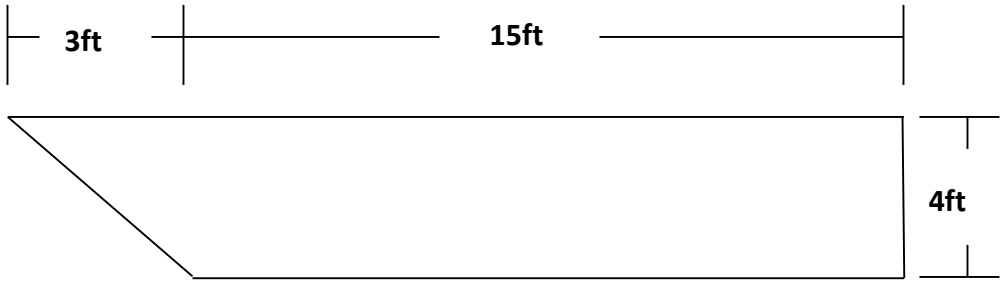
Now solve for head loss. Use the Bernoulli equation given when the gate valve is now open. Now that we have the elevation at B it should be easy:

P_B / γ - **HL** $= P_A / \gamma - z$
$1000 / 62.5 - HL = -19.2$

HL = 35.2 ft (Answer B)

22. Determine the hydraulic radius (ft) from the channel section shown.

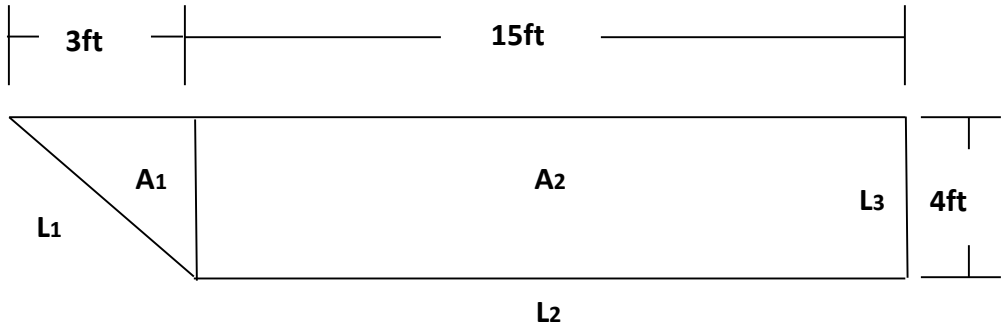
a) 2.87
b) 3.00
c) 2.50
d) 2.75



PROBLEM 22 SOLUTION:

HYDRAULICS AND HYDROLOGY

OPEN CHANNEL FLOW



First, solve for the area and the wetted perimeter of the channel:

Area = $A_1 + A_2$
Area = 3(4) / 2 + 15 (4)
Area = 66 ft²

Wetted Perimeter:

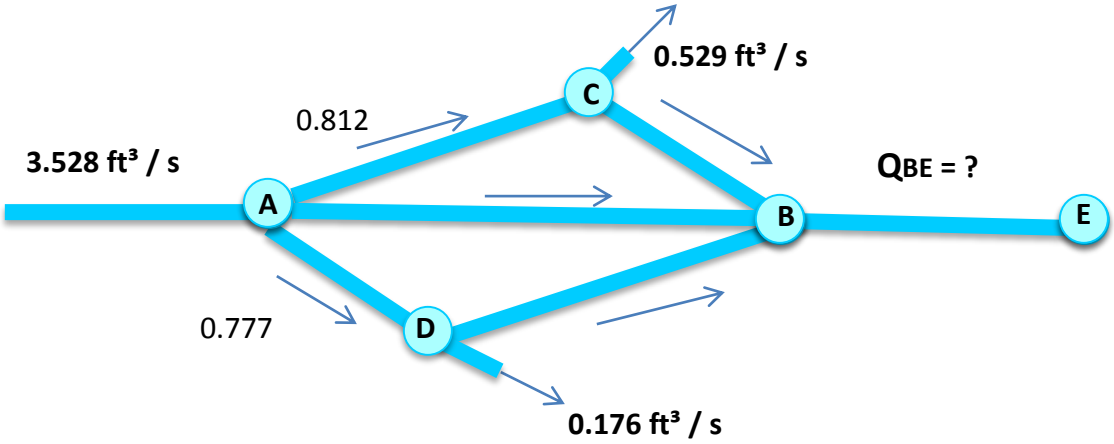
$P = L_1 + L_2 + L_3$
P = 5 + 15 + 4 = 24 ft

Then solve for the Hydraulic Radius:

R = A / P = 66/24 = **2.75 ft (Answer D)**

23. Given the pipe network with flow rates shown, determine the flow rate at pipe BE.

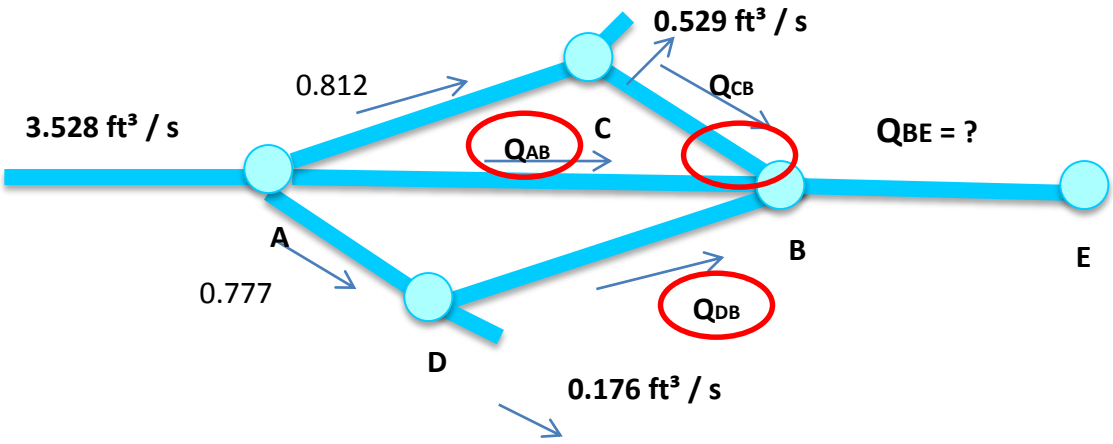
a) 2.771
b) 2.935
c) 2.824
d) 2.698



PROBLEM 23 SOLUTION:

HYDRAULICS AND HYDROLOGY

PRESSURE CONDUIT



First, solve for the flow rates depending on the given discharges in each pipe before it:

$Q_{AB} = Q_A - Q_{AC} - Q_{AD} = 3.528 - 0.812 - 0.777$
$Q_{AB} =$ **1.939 ft³/s**

$Q_{CB} = Q_{AC} - Q_C = 0.812 - 0.529 =$ **0.283 ft³/s**

$Q_{DB} = Q_{AD} - Q_D = 0.777 - 0.176 =$ **0.601 ft³/s**

Then solve for Q_{BE} by adding all flow rates towards point B:

$Q_{BE} = Q_{CB} + Q_{AB} + Q_{DB}$
$Q_{BE} = 0.283 + 1.939 + 0.601$ **= 2.824 ft³/s (Answer C)**

24. An oil $\rho = 1.7$ slugs/ ft^3 flows through a cast iron pipe at a velocity of 3 ft/s. The pipe is 150 ft long and has a diameter of 6 inches. Given an absolute viscosity $\mu = 0.0017$ lbs - s / ft^2. Determine the head loss (ft) due to the friction factor. Use Reynold's number.

a) 1.897
b) 1.542
c) 1.675
d) 1.786

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PROBLEM 24 SOLUTION:

HYDRAULICS AND HYDROLOGY

PRESSURE CONDUIT

First, solve for the Reynolds number and check to see if the flow is laminar or turbulent:

$N_R = \rho DV / \mu$
$N_R = (1.7)(6/12)(3) / (0.0017)$
$N_R = 1500$
1500 < 2000, Therefore the flow is laminar

Note: Nr>2000 = Laminar Flow

Nr<2000 = Turbulent Flow

Then solve for the friction factor.

$f = 64 / N_R$
$f = 64 / 1500$
f = 0.0426

Note: The formula used if the flow is laminar, f=64/Nr

Lastly, solve for the head loss using the Darcy Weisbach formula:

$HL = fLV^2 / 2gD$
$HL = (0.0426)(150)(3)^2 / 2(32.2)(6/12)$
HL = 1.786 ft

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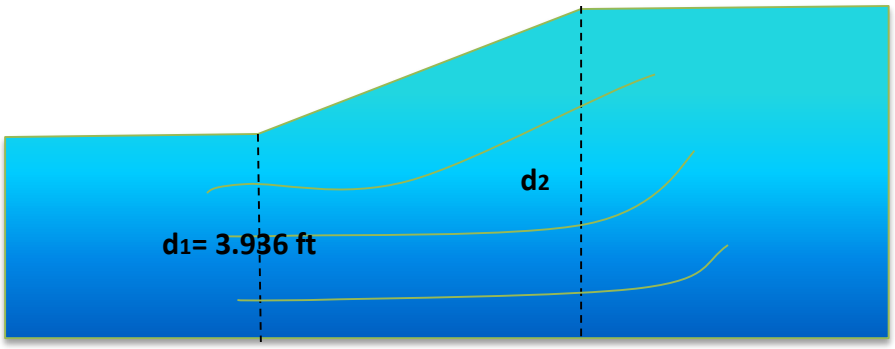
25. In a non-uniform flow, water has a discharge of 705 ft^3/s through a rectangular channel measuring 13 ft wide. The water runs from a steep slope to a mid-slope creating a hydraulic jump. The upstream depth of flow is 3.94 ft. Determine the downstream depth of flow (ft).

a) 4.98
b) 5.23
c) 4.81
d) 5.12



PROBLEM 25 SOLUTION:

HYDRAULICS AND HYDROLOGY

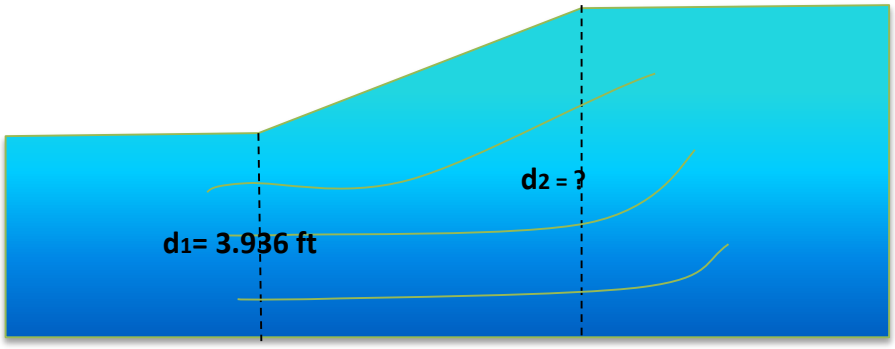
OPEN CHANNEL FLOW

First, solve for the flow rate per foot of the jump:

$q = Q/b = 705/13$
$q = 54.321\ ft^3\ /s\ /ft$

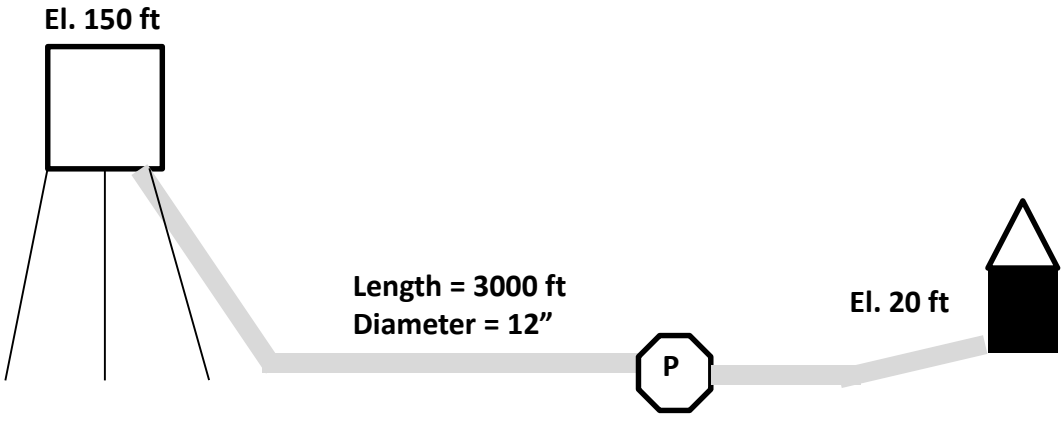
Then solve for the downstream depth of flow:

$q^2 / g = d_1 d_2 (d_1 + d_2) / 2$
$(54.231)^2 / 32.2 = (3.94)(d_2)\ (3.936 + d_2)$
d_2 = 5.12 ft (Answer D)



26. A simplified water supply system is shown in the figure. The pressure supplied to the townhomes is 10,000 psf and the discharge of the system is 4 ft^3/s. Determine the head that the pump will need for the given situation (ft). Use f=0.012. The water tower is open to the atmosphere.

a) 40
b) 45
c) 50
d) 55



PROBLEM 26 SOLUTION:

HYDRAULICS AND HYDROLOGY

CONTINUITY EQUATION

First, solve for the velocity and head loss of the system using the given.

$V = Q / A = 4 / (\frac{\pi}{4}(1)^2) = 5.09$ ft/s

$HL = fLV^2 / 2gD$
$HL = (0.012)(3000)(5.09)^2 / 2(32.2)(12/12) = 14.48$ ft

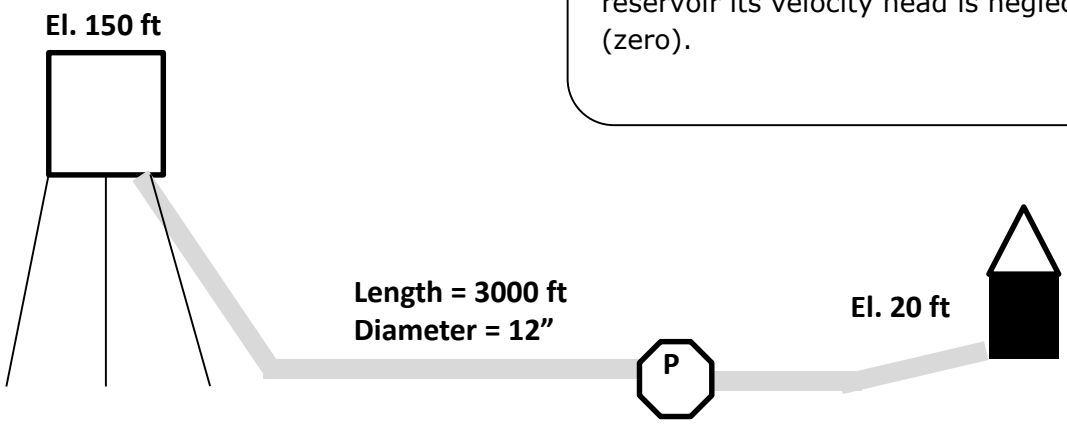
Then use Bernoulli's theorem from the Elev. 150 ft to Elev. 20 ft point:

~~P_1 / γ~~ + ~~$V_1^2 / 2g$~~ + $z_1 - HL + HP = P_2 / \gamma + V_2^2 / 2g + z_2$

$z_1 - HL + HP = (P_2 / \gamma) + (V_2^2 / 2g) + z_2$
$150 - 14.48 + HP = 10000/62.4 + ((5.09)^2 / 2(32.2)) + 20$

HP = 45.1 ft (Answer B)

Note: Since the tank is open to the atmosphere, initial pressure head is zero and because of the large area of the reservoir its velocity head is neglected (zero).



27. A back tangent of a simple curve intersects the forward tangent at station 67+62 which is 345 ft from the PC. Compute the external distance (ft) of the curve when the radius of the curve is 300 ft.

a) 146
b) 187
c) 157
d) 45

PROBLEM 27 SOLUTION:

GEOMETRICS

BASIC CIRCULAR CURVE ELEMENTS

First, solve for the angle of the simple curve:

$T=R\tan\frac{I}{2}$

$345=300\tan(I/2)$

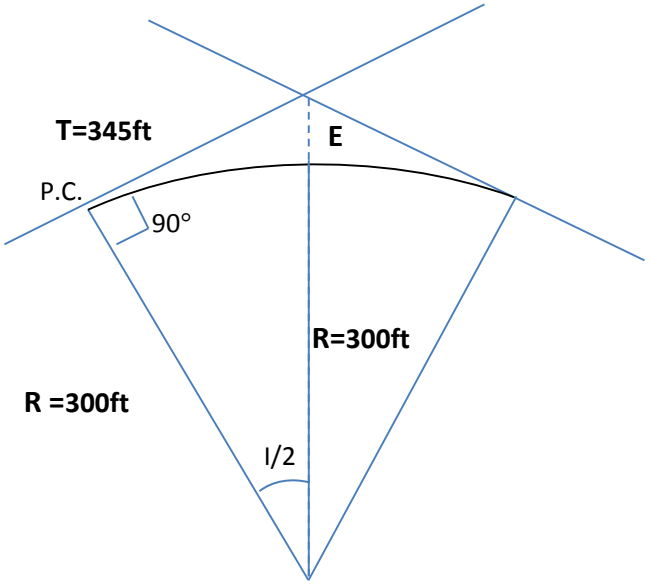
$I=98°$

Then, solve for the external distance, E:

$\cos\frac{I}{2}=\frac{R}{R+E}$

$\cos(98/2)=300/(300+E)$

E=**157.28ft (Answer C)**



28. A train passing point A at a speed of 65 fps accelerates at 2.46 fps² for one minute along a straight path, and then decelerates at 3.3 fps². How far from point A will it be 2 minutes after passing point A (ft)?

a) 15144
b) 13879
c) 13855
d) 13760

PROBLEM 28 SOLUTION:

GEOMETRICS

TRAFFIC VOLUME

First, instead of constructing a v-t graph and s-t graph, you can employ this approach (see graph). $V_o t$ is zero if the vehicle starts from rest. In this problem V_o=65 fps.

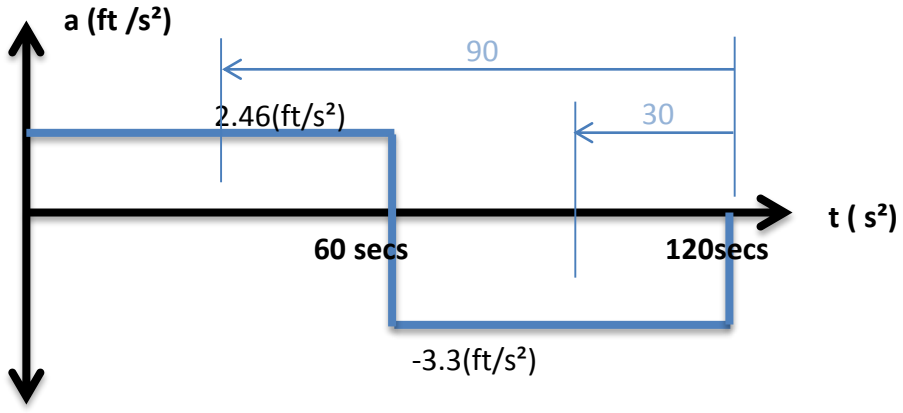
D=area under the a-t graph

D=$V_o t$+Q (Q= area x distance from the a-t graph)

D=65(120)+2.46(60)(90)-(3.3)(60)(30)

D=**15144 ft (Answer A)**

Acceleration – Time graph
(a-t graph)



29. A vertical parabolic curve has a back tangent of -5% and a forward tangent of 3%. If the stationing of PC is at 80+50, locate the stationing of the lowest point of the curve. The length of the curve is 820 ft.

a) 86+62
b) 81+62
c) 85+62
d) 88+62

PROBLEM 29 SOLUTION:

TRANSPORTATION

HORIZONTAL CURVE

First, solve for the location of the lowest point in the curve:

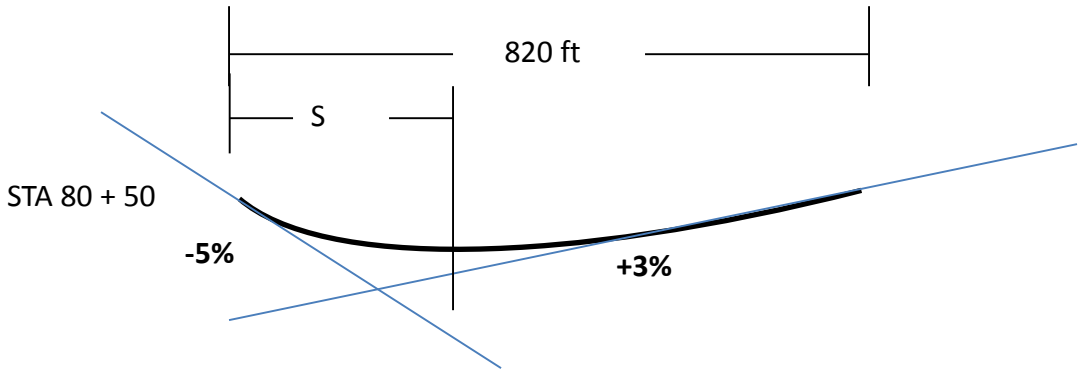
$x=\frac{g1}{g1-g2}(L)$

x=(0.05)(820)/(0.05+0.03)

x=512.5 ft

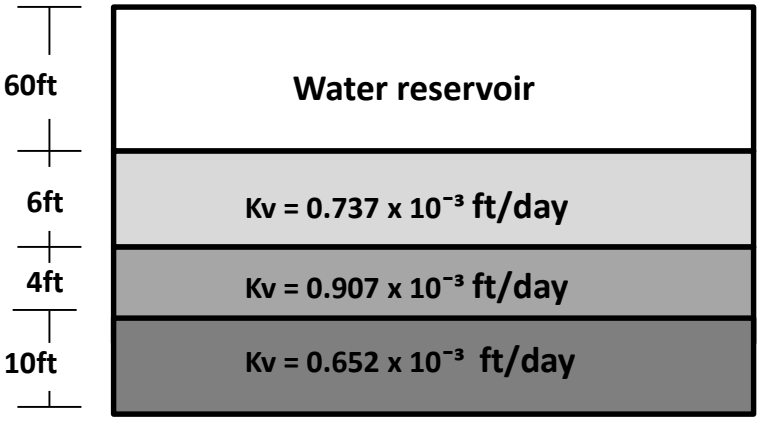
Solve for the station of the lowest point:

Sta 80+50 + 512.5 or 8050+512.5=**8562.5 (85+62.5 Answer C)**



30. A reservoir is underlain by layers of stratified soil as depicted in the figure. Compute the average coefficient of permeability in ft/day.

a) 0.981×10^{-3}
b) 0.717×10^{-3}
c) 0.399×10^{-3}
d) 0.565×10^{-3}



PROBLEM 30 SOLUTION:

MATERIALS

SOIL PROPERTIES

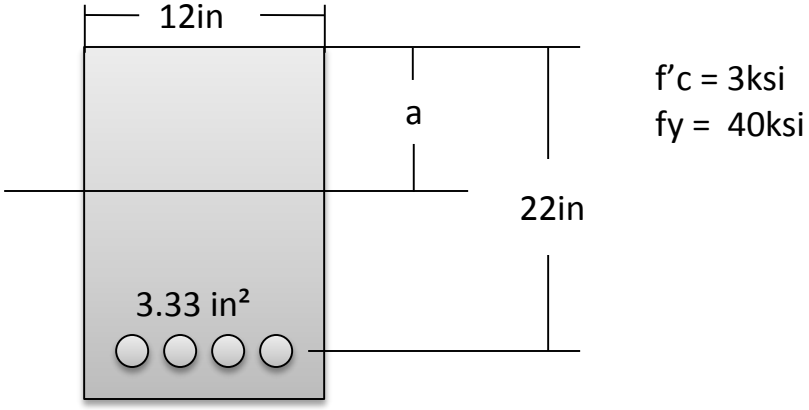
Solve for the average permeability of the soil:

$$\text{Keq}=\frac{H}{\frac{h1}{k1}}+\frac{H}{\frac{h2}{k2}}+\frac{H}{\frac{h3}{k3}}=\frac{20}{\left(\frac{6}{0.000737}\right)}+\frac{20}{\left(\frac{4}{0.000907}\right)}+\frac{20}{\left(\frac{10}{0.000652}\right)}$$

$=\mathbf{0.717x10^{-3}\ ft/day\ (Answer\ B)}$

31. Given a concrete beam that has a dimension of 12”x25” (3” covering) and a tension steel area of 3.33 in². Determine the depth of the equivalent stress block (in inches). Assume that the steel yields.

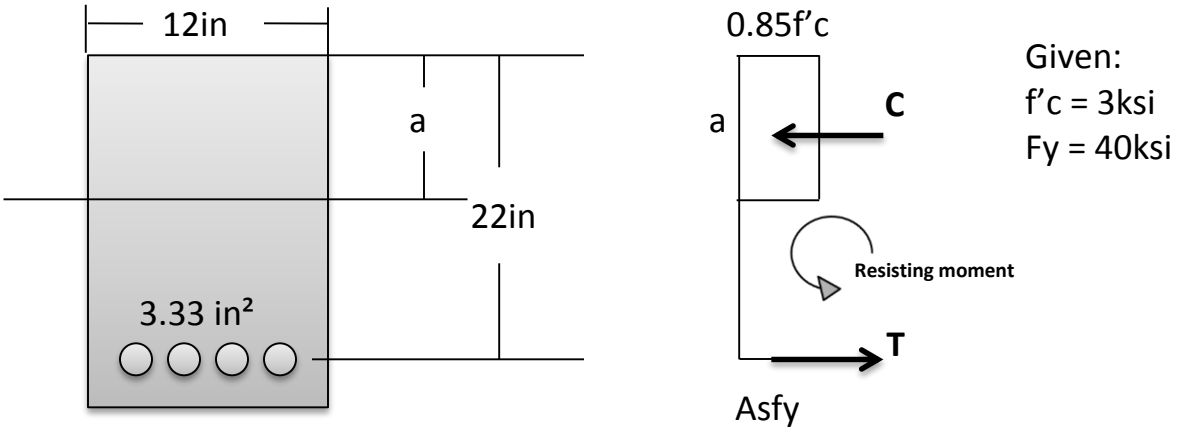
a) 4.35
b) 6.73
c) 5.41
d) 11.0



PROBLEM 31 SOLUTION:

MATERIALS

CONCRETE



In concrete, the resisting force from the steel and effective concrete block should be in equilibrium. Therefore, C=T.

C=T (C=internal force from the effective compression block of concrete, T= internal force from the tension of the steel rebar)

$0.85f'c(a)(b) = Asfy$

$0.85(3)(a)(12) = (3.33)(40)$

a = **4.35 in (Answer A)**

32. The angle of friction of a cohesive soil which was tested using a tri-axial shear test is equal to 29°. Failure occurred when the shear stress reached 45 psi and the normal stress reached 65 psi. Determine the cohesion of soil (psi).

a) 10
b) 16
c) 9
d) 20

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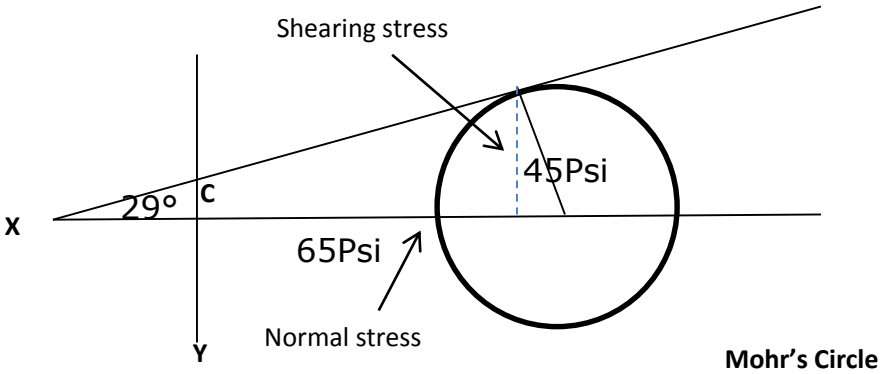
PROBLEM 32 SOLUTION:

MATERIALS

MATERIAL TEST METHODS



First, draw the Mohr's circle of the problem then solve for x:

tanΦ = Shearing stress / Normal stress + **x**
tan29° = 45 / (65 + x)
x = 16.18 psi

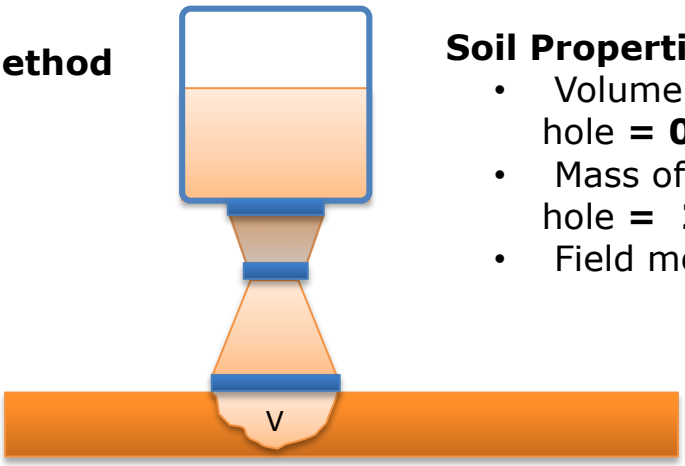
Then solve for the cohesion:

tanΦ = c / x
tan29° = c / 16.18
c = 8.97 psi (Answer C)

33. The laboratory compaction test of a certain type of soil gives a maximum dry density of 120 pcf with an optimum moisture content of 14%. The Sand Cone Method was used to determine the field unit weight and the results are shown below. Determine the relative compaction.

a) 90.2
b) 92.5
c) 94.6
d) 95.4

Sand Cone Method



Soil Properties

- Volume of soil excavated from the hole **= 0.017 ft³**
- Mass of moist soil removed from the hole **= 2.2lbs**
- Field moisture content **= 13%**

PROBLEM 33 SOLUTION:

MATERIALS

COMPACTION

First, we solve for the field dry unit weight:

$\gamma_{moist} = W / V$

$\gamma_{moist} = 2.2 / 0.017 = 129.14$ pcf

$\gamma_{dry} = \gamma_{moist} / 1 + w$

$\gamma_{dry} = 129.14 / 1 + 0.13$

$\gamma_{dry} =$ **114.52 pcf**

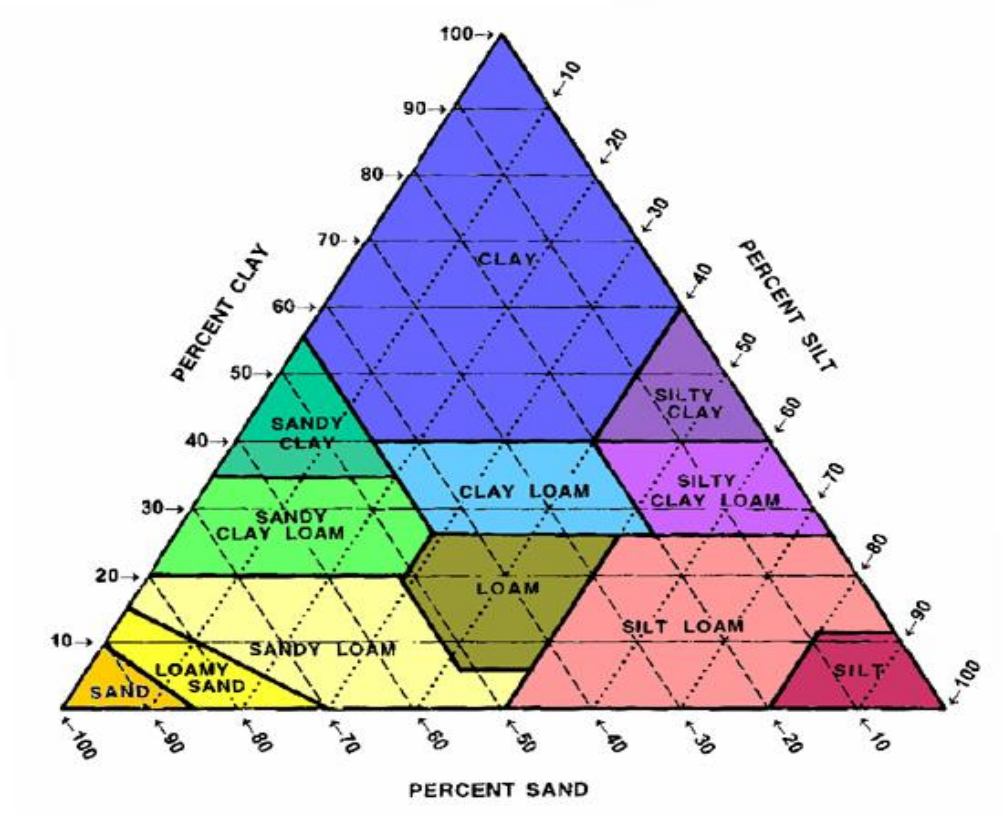
Then we solve for the relative compaction:

$R_c = \gamma_d / \gamma_{dmax}$

$R_c = 114.52 / 120 = 0.9543 =$ **95.43% (Answer B)**

34. A given soil has the following particle size distribution: 8% sand, 20% gravel, 48% silt, and 24% clay. Classify the type of soil using the USDA method below.

a) Silt Loam
b) Loamy Sand
c) Sandy Clay Loam
d) Silty Clay Loam



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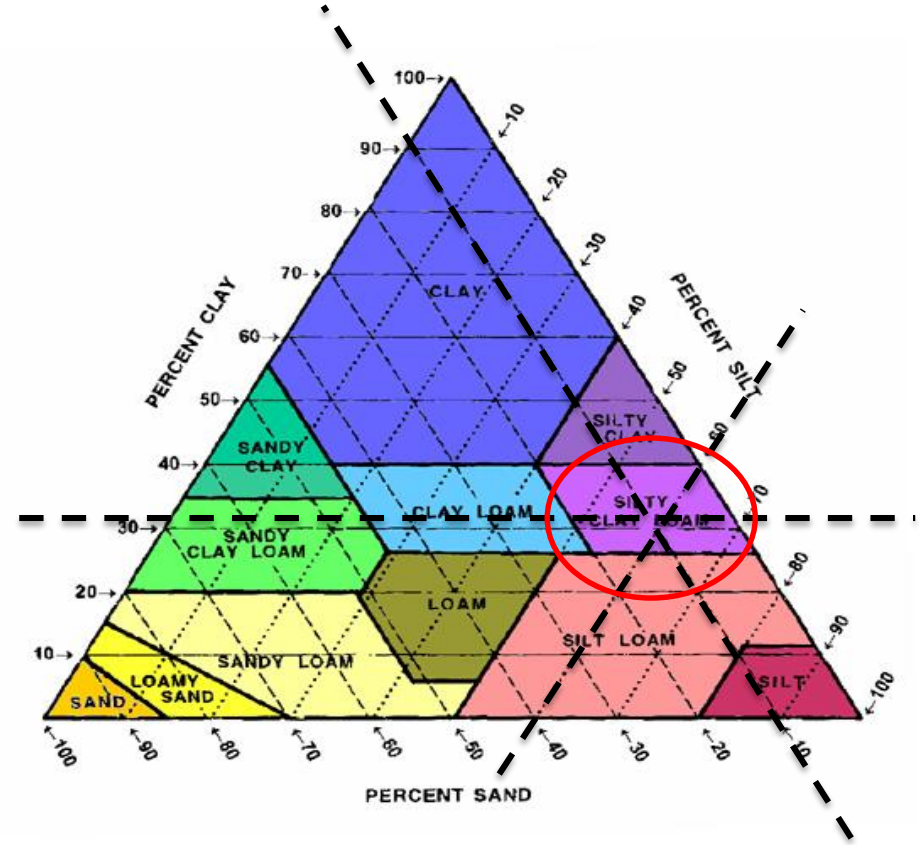
PROBLEM 34 SOLUTION:

MATERIALS

SOIL CLASSIFICATION



In classifying the soil using USDA, we need to exclude the percentage of gravel.

New sand percentage: 8%/(100%-20%)=10%

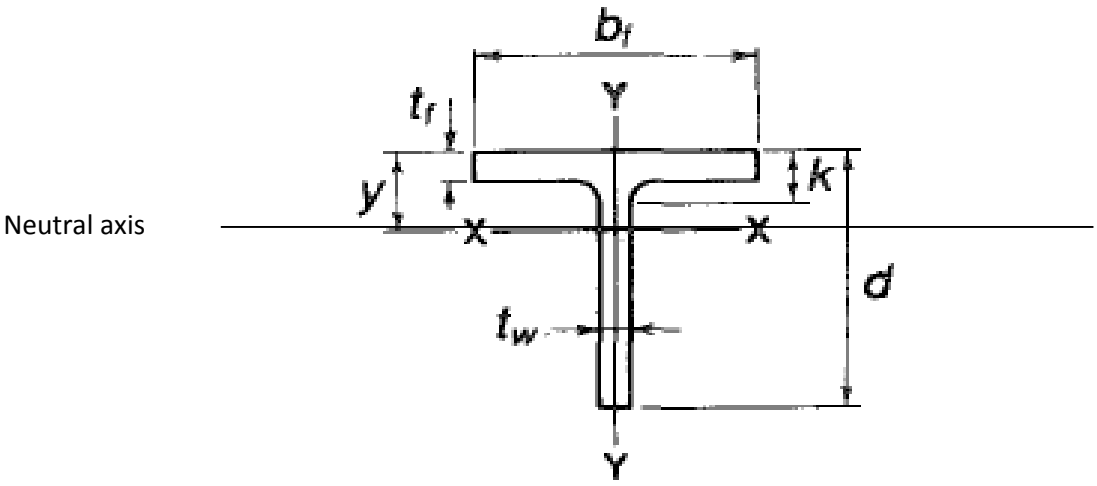
New silt percentage: 48%/(100%-20%)=60%

New clay percentage: 24%/(100%-20%)=30%

Then draw the lines along the USDA chart. The soil falls in the **SITLY CLAY LOAM** area. **(Answer D)**

35. Given the location of the neutral axis of the structural steel tee section shown, determine the maximum bending stress (ksi) if the moment is 150 k-ft.

a) 11
b) 40
c) 26
d) 51

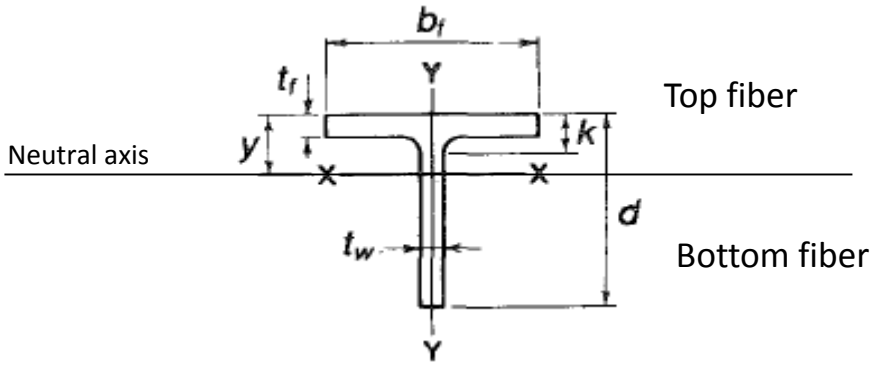


WT 13.5 x 108.5 properties:
d = 14.215 in
y = 3.11 in
Ix = 502 in^4

PROBLEM 35 SOLUTION:

MATERIALS

STRUCTURAL STEEL



WT 13.5 x 108.5 properties:
d = 14.215 in
y = 3.11 in
Ix = 502 in^4

Solve using the bending stress formula:

$f_B = Mc / I$

Top fiber:

$f_B = M(y) / I = (150)(12)(3.11) / 502 = 11.15$ ksi

Bottom fiber:

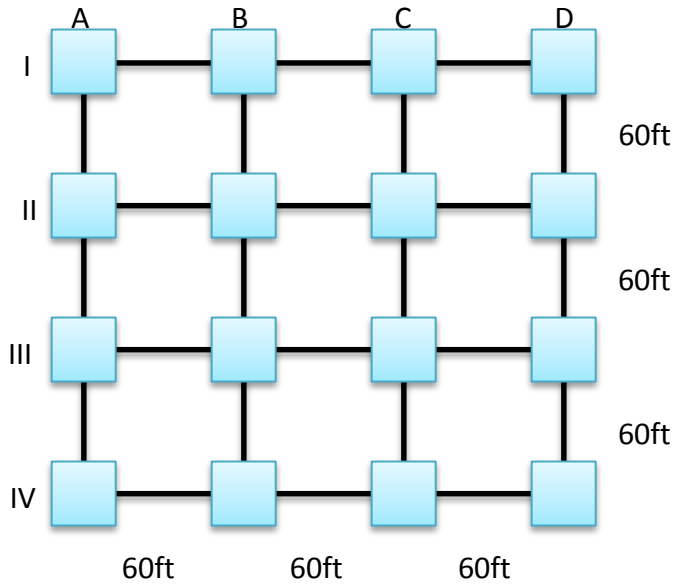
$f_B = M(d - y) / I = (150)(12)(14.215 - 3.11) / 502 =$ **39.82 ksi**
(Answer B)

Since the bottom fiber has the larger value it is the maximum bending stress.

36. A square lot is divided into 60 ft squares and the corners are numbered I-IV vertically and A-D horizontally. The heights removed after excavation are tabulated below for a borrow pit. Compute the volume of earthwork excavated (ft^3).

a) 395,460
b) 459,360
c) 435,960
d) 345,690

AI = 20.3	BI = 19.0	CI = 20.5	DI = 15.1
AII = 18.4	BII = 14.1	CII = 17.1	DII = 12.5
AIII = 12.5	BIII = 8.4	CIII = 14.1	DIII = 8.8
AIV = 6.9	BIV = 6.23	CIV = 12.8	DIV = 5.9



PROBLEM 36 SOLUTION:

SITE DEVELOPMENT

EXCAVATION

Use the formula for excavations:

$$V=\frac{A}{4}(\sum h_1 + 2\sum h_2 + 3\sum h_3 + 4\sum h_4)$$

Σh_1 = 20.3 + 15.1 + 6.9 + 5.9

= **48.2ft**

Σh_2 = 18.4 + 12.5 + 19.0 + 20.5 +

12.5 + 8.8 + 6.2 + 12.8

= **110.7ft**

Σh_3 = **0 ft**

Σh_4 = 14.1 + 17.1 + 8.4 + 14.1

= **53.7ft**

Solve for the volume:

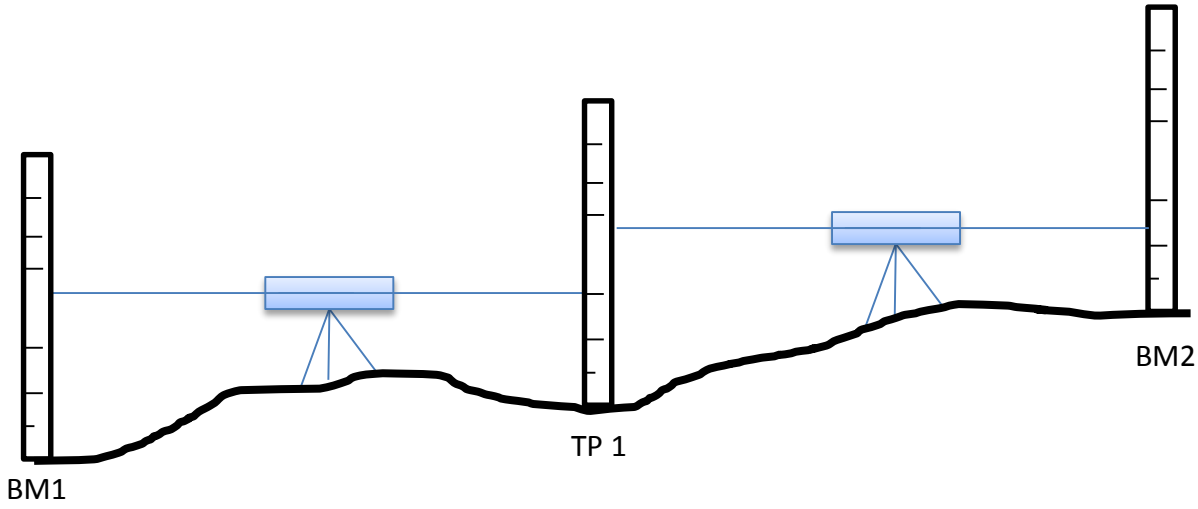
V = (60)(60)/4

[48.2+2(110.7)+3(0)+4(53.7)]

V = 435,960 ft³ (Answer C)

37. A surveyor measures the elevation on a construction site. Based on the data below, find the difference in elevation between BM1 and BM2 (ft).

a) 4.23
b) 6.30
c) 10.63
d) 4.10



Station	BS	FS	Elev
BM1	8.56		540.51
TP1	9.45	4.23	
BM2		3.15	?

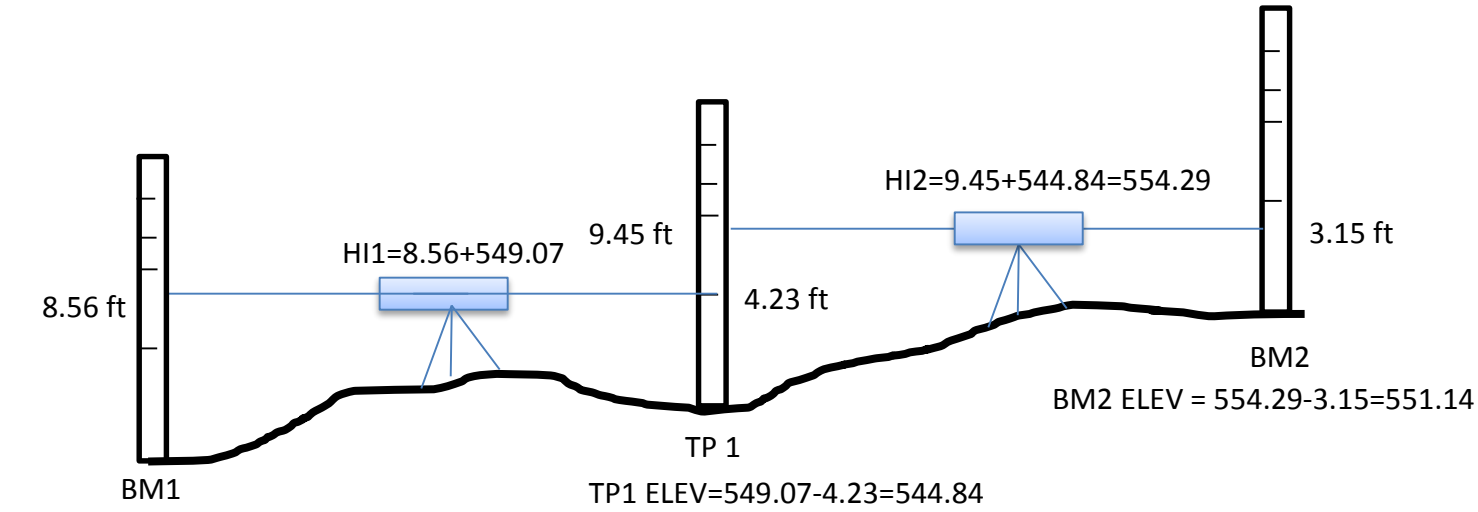
PROBLEM 37 SOLUTION:

SITE DEVELOPMENT

CONSTRUCTION SITE LAYOUT

First, plug all the data given into the appropriate field. You can do this using the figure or by making a table. I've solved this using the figure:

Station	BS	FS	Elev
BM1	8.56		540.51
TP1	9.45	4.23	
BM2		3.15	?



After figuring out the elevations at each location, take the elevation at BM2 and subtract it from BM1's elevation to find the difference:

551.14-540.51 = **10.63 ft (Answer C)**

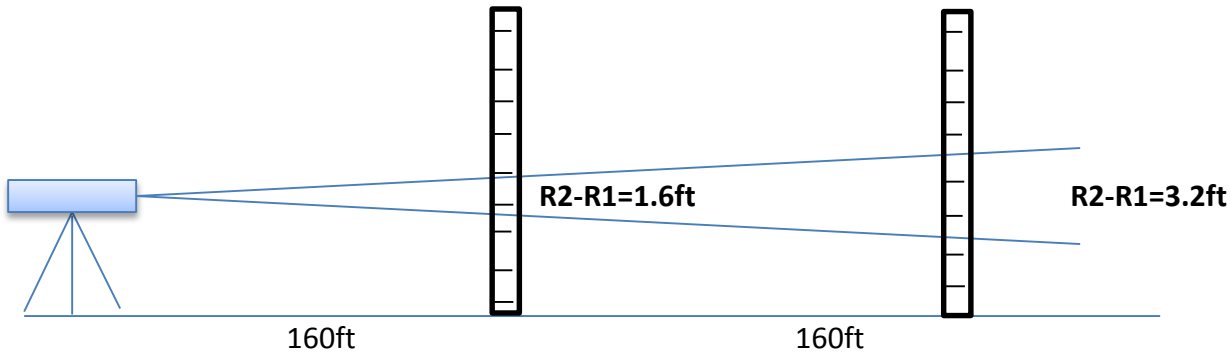
38. Two levelling rods placed at a distance of 160 ft and 320 ft from the instrument gives an intercept of 1.6 ft and 3.2 ft respectively. Determine the stadia interval factor, K.

a) 150
b) 120
c) 100
d) 160

PROBLEM 38 SOLUTION:

SITE DEVELOPMENT

CONSTRUCTION SITE CONTROL



Use the equation for stadia reading to find the interval factor, K:

$x = K\triangle R + c$
$160 = K(1.6) + c$
$320 = K(3.2) + c$

X=distance from telescope
K=interval factor
R=reading on rod (between top and bottom reading)
C=instrument factor

Substitute the first equation into the second and solve for K:

K = **100 (Answer C)**

39. Hearing safety is of high importance on a construction site. According to OSHA, what is the maximum "all-day" 8 hour noise level limit (dBA)?

a) 90
b) 92
c) 100
d) 115

40. A surveyor is setting up new control points for a building layout. The tangents have a bearing of N40°E and S65°E respectively. Determine the angle of intersection.

a) 105°
b) 115°
c) 65°
d) 75°

PROBLEM 39 SOLUTION:

SITE DEVELOPMENT

SAFETY

Typical permissible noise exposure levels range, but according to OSHA, sec 1910.95, for 8 hours it is 90 dBA. Chapter 82 of the CERM covers some construction and jobsite safety issues with OSHA standards included. **(Answer A)**

PROBLEM 40 SOLUTION:

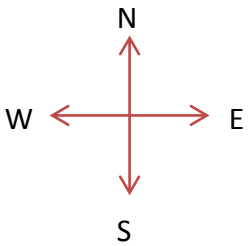
SITE DEVELOPMENT

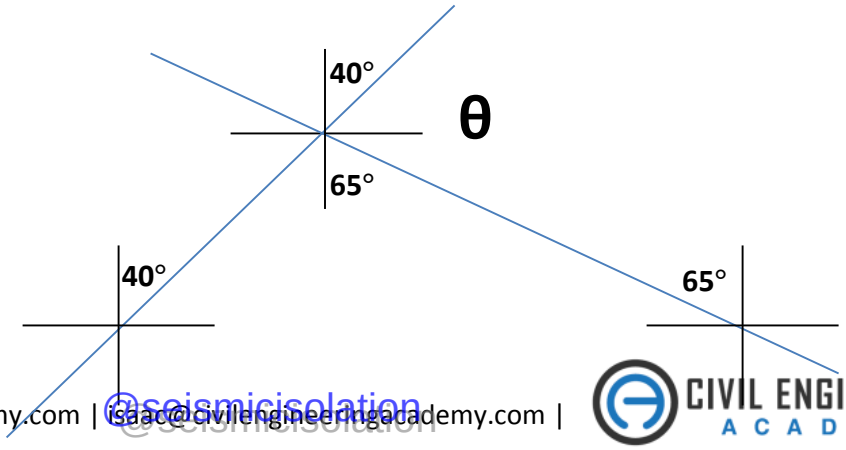
CONSTRUCTION SITE LAYOUT AND CONTROL

From the figure below, the angle of intersection is:

$\theta = 180° - 40° - 65°$

$\theta = 75°$ **(Answer D)**





(END)

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