PE Civil Practice Exam

AM

Four new Practice Exams + Solutions

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Four Practice Exams for PE Civil

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First Edition

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Preface

Beginning January 2015, the National Council of Examiners for Engineering and Surveying (NCEES) changed the Civil Engineering Specification for Civil PE exam. Now Civil PE are offered in the following Disciplines;

Transportation
Construction
Structure
Geotechnical Engineering
Water Resource and Environmental

Each discipline is divided to two areas of breadth and Depth.
The breadth part is common for all disciplines and includes the following specifications.

a) Project Planning
b) Means and Methods
c) Soil Mechanics
d) Structural Mechanics
e) Hydraulics and Hydrology
f) Geometrics
g) Materials
h) Site Development

In this book we have presented four Style PE Civil Practice exam to prepare you for the breadth part of exam. Problems in each specification have been separated. This way you may concentrate on your area of strength if you want to.

I hope you find this book helpful for passing the PE Civil exam.

Shawn (Shahriar) Jahanian, Ph.D, PE
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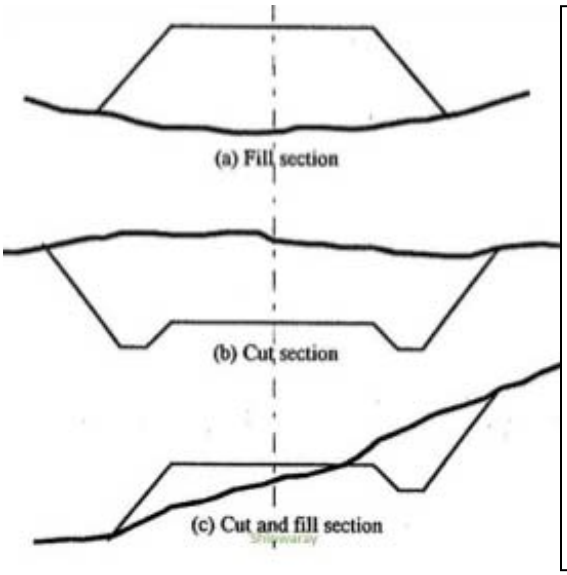
First PE Style Exam (AM) Questions

1) Find the remaining amount of soil after excavation and embankment in cubic yard considering swell coefficient as 0.26 and shrinkage coefficient as 0.1.



STA 12+10

Fill = 50 cf, C=0 cf

STA 12+40

Fill= 0, C= 60 cf

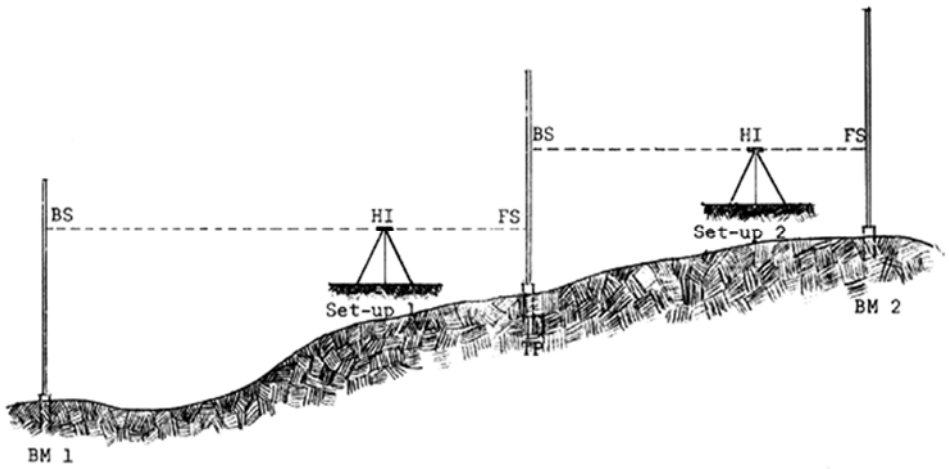
STA 12+70

Fill = 35 cf, C=20 cf

A) 32 B) 47 C) 78 D) 62

2) Find the elevation of BM2 if the following readings are given if the elevation of BM1 is 01+30:

Station	BS	FS
BM1	3.3	
TP	2.4	1.5
BM2		1.2



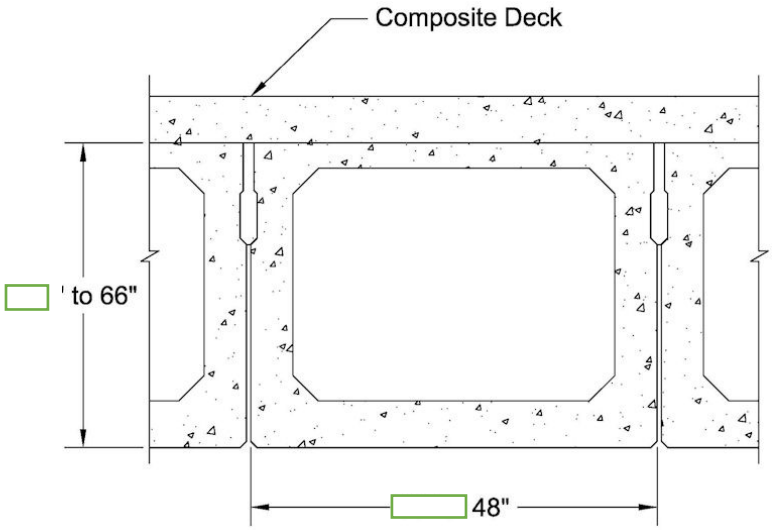
A) 1+30

B) 1+31.2

C) 1+33

D) 1+31.8

3) For the pre-cast concrete bridge box girder which one is the most likely closer to the required volume of concrete for one box? Thickness is 8” for two sides and bottom chord and 4” for the top chord. Each corner has 3 by 3 inches hunches. Length of bridge is given equal to 200’



A) 1500 cf

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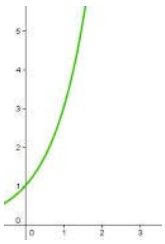
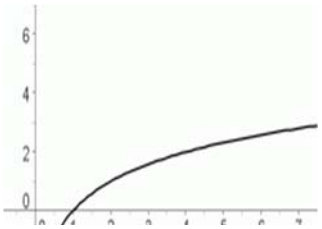
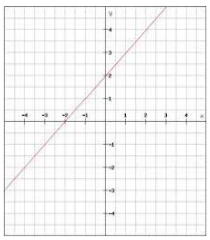
C) 1825 cf

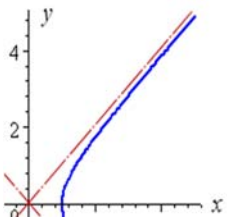
D) 1250 cf

4) Which one of these 4 cost functions shows more increasing in rate of expenses over the time? (Horizontal axis shows time and vertical axis shows costs.)

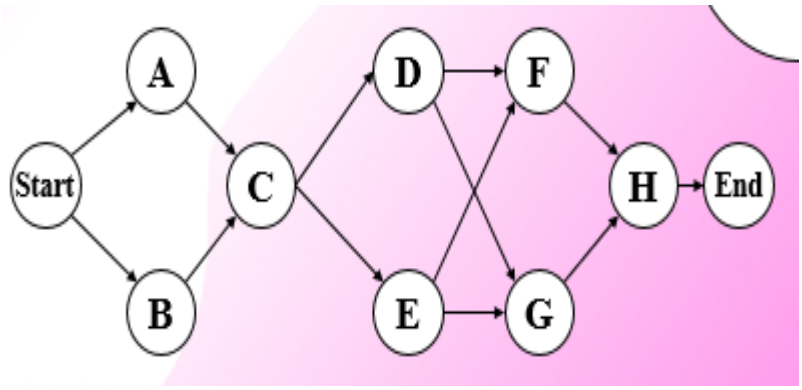
A) 

B) 

C) 

D) 

5) For the following paths find the critical path using the CPM?



Activity	Time
A.	4 weeks
B.	16 weeks
C.	8 weeks
D.	24 weeks
E.	28 weeks
F.	4 weeks
G.	8 weeks
H.	4 weeks

A) 44 B) 48

C) 60 D) 64

6) A dump-hauler has a purchase price of $109,000. Freight for delivery is $5000. Tires are an additional 25,000 with the estimated life time of 4500 hours. The hauler expected to operate 1500 hours annually and for 11 years. Maintenance fees for the hauler is estimated at $18000. What is the before-tax estimated hourly cost of operation excluding operator labor cost?

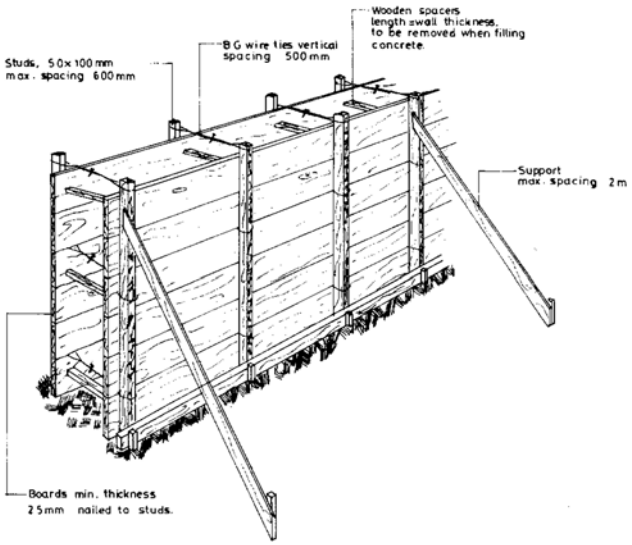
A) 35 B) 41

C) 23 D) 15

7) How many 4 by 8 in samples required for a 7000 sf shear wall with 180 cy^3 of concrete?

A) 2 specimens
B) 3 specimens
C) 4 specimens
D) 5 specimens

8) For the wall form work, if the height of wall is equal to 10 ft. and the distance between inclined supports is 3 ft. find the force in the support assuming the 45 degree angle for it.



A) 7500 lb.

B) 10607 lb.

C) 1500 lb.

D) 150 lb.

9) If the maximum moisture content is given equal to 17% and specific gravity of soil is given equal to 2.67 find the dry density according to the modified proctor test procedure.

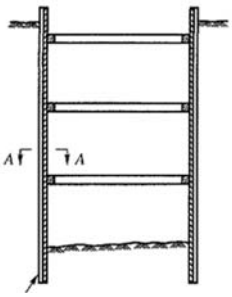
A) 125 pcf

B) 95 pcf

C) 115 pcf

D) 150 pcf

10) In the temporary structure in the referred picture if the soil is un-drained stiff clay which one is correct?



A) Soil pressure has a uniform distribution.
B) Soil pressure has a trapezoidal form
C) Soil pressure is triangular and the maximum pressure is at bas
D) Soil pressure is triangular and the maximum pressure is at top.

11) Which one of the following compactors shall be used for the compaction just behind the retaining wall?

A) A) sheepsfoot compactor
B) Smooth drum
B) C) Small plate compactor
D) pneumatic

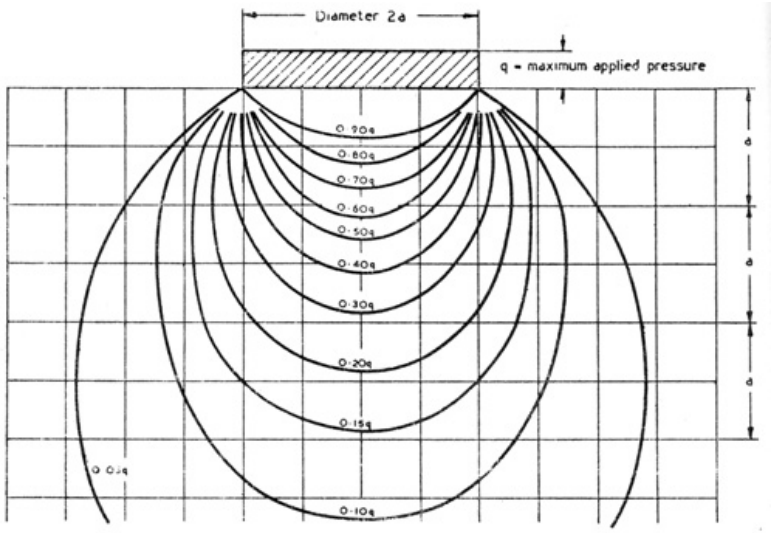
12) A fine grained soil has a Liquid Limit (LL) of 70% and a Plasticity limit (PL) of 30%. The soil can be classified as:

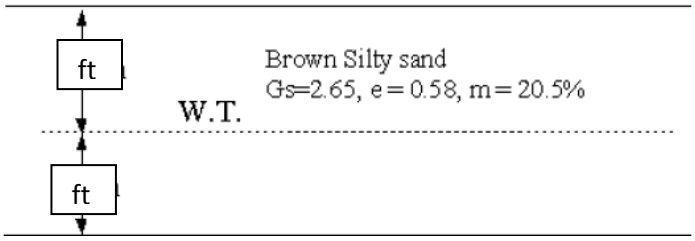
A) CL
B) CI
C) CH
D) MI

13) For a fully braced retaining wall in the basement of a 10 stories building, which formula will give the pressure at the bottom of the wall. (Height of wall is equal to 10 ft.)

A) P= Soil density * 10 * Ka (active soil pressure)
B) P= Soil density * 10 * K0 (at rest soil pressure)
C) P= Soil density * 10 * Kp (passive soil pressure)
D) P= Soil density * 10 * Ka (active soil pressure) * 10/2

14) The ground water level is at 9ft. below ground. What is the total stress at 15 ft. below ground? Consider a footing on top layer with the width of 10 ft. which makes a pressure of 150 psf. Use both figures to find the pressure.





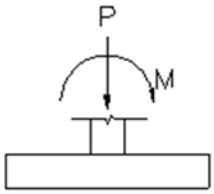
A) 2200 psf
B) 1778 psf
C) 1200 psf
D) 1860 psf

15) A soil sample has 30% passing the No. 4 sieve and 10% passing the No. 200 sieve. The coefficient of uniformity is greater than 4. Classify the soil according to the Unified Soil Classification System.

A) SP-SM
B) SW-SM
C) SP
D) GW

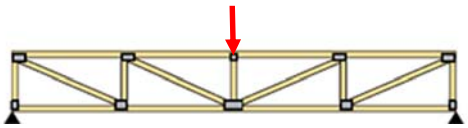
16) For the shown footing, find the maximum compressive stress. (P= 1000 lb. M= 500 lb-ft. B=D=width of footing = 9 ft.)

A) 20.3 psf
B) 8.2 psf
C) 16.5 psf
D) 12.3 psf

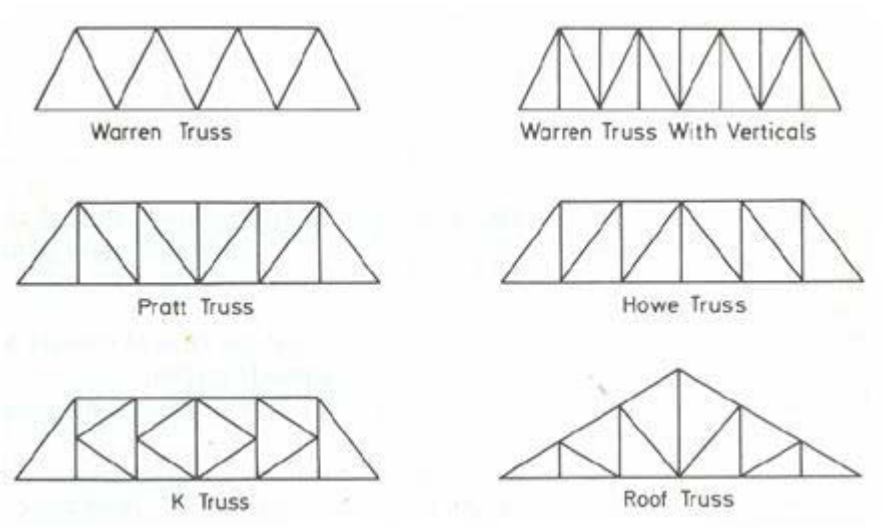


17) Referring to the figure, find the maximum tension force at the bottom chord if the force is equal to 1000 lb. the length of span is 20 ft.(4@5'), and height of the truss is given equal to 5 ft.

A) 1200 N
B) 1000 N
C) 5000 N
D) 2000 N

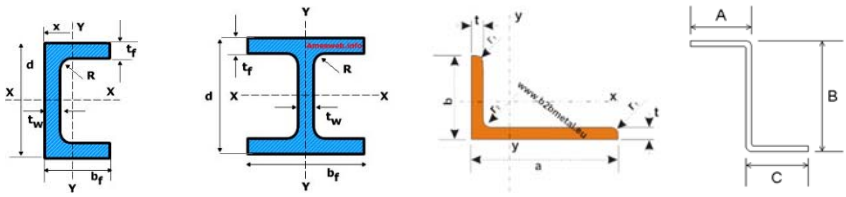


18) Which model has just compressive force in the diagonal members?



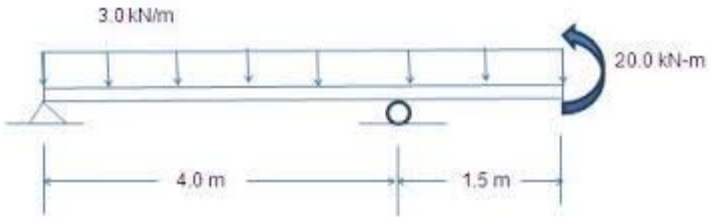
A) Warren and roof trusses
B) Howe truss
C) K and Warren trusses
D) Pratt truss

19) If a design engineer wants to use one of the following sections as a simple beam on the sloped roof, which section(s) may give a better results?



A) I section
B) Z and angle sections
C) I and channel sections
D) Channel, Z, and Angle sections

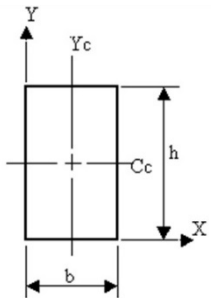
20) For the beam in the referred picture find the maximum bending moment at the mid-span.



A) 6 KN-m
B) 16.6 KN-m
C) 14.3 KN-m
D) 8.3 KN-m

21) What is the ratio between plastic section modulus and elastic section modulus and (shape factor) for the rectangular section as follows:

A) 1.5
B) 1.33
C) 2
D) 1.7



22) A contractor need to make a concrete with target strength of 4 KSI and 0.5KSI as standard deviation. What should be the average of compressive strength tests for the concrete mix design?

A) 4.7 KSI
B) 3.3 KSI
C) 4.1 KSI
D) 4.0 KSI

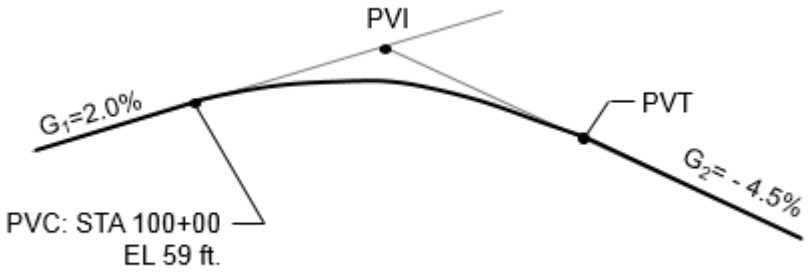
23) Concrete curing shall be maintained above 50 ^{o}F and in a moist condition for at least:

A) 3 days after placement.
B) 10 days after placement.
C) 15 days after placement.
D) 7 days after placement.

24) Find the maximum bending moment on a beam with the length of 20 ft. for the two 2000 lb. moving load (crane wheels) with the distance of 4 ft.

A) 20000 lb-ft
B) 16000 lb-ft
C) 19200 lb-ft
D) 18000 lb-ft

25) If the PVC station of 100+00 at 59 ft. elevation is connected to the PVT station at 104+00 referring to the following figure, find the station of the crest.

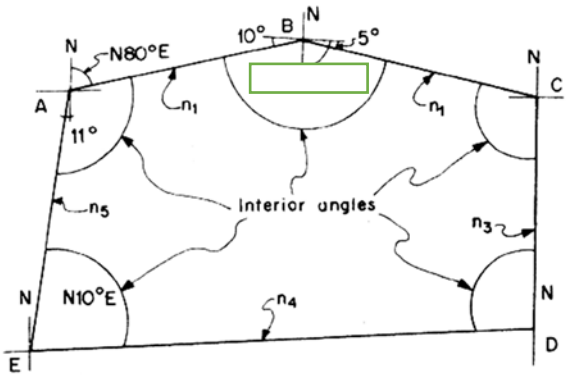


A) 101+23 ft.
B) 102+00 ft.
C) 101+50 ft
D) 101+15 ft.

26) A car is traveling at 50 mph in a county at night on a steep wet road with 6% uphill slope. Find the stopping sight distance.

A) 300 ft.
B) 389 ft.
C) 112 ft.
D) 241 ft.

27) In a close traverse, what is the bearing of NC?



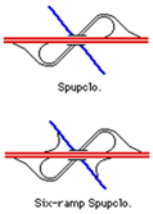
A) S5E
B) N85W
C) S85E
D) N5W

28) A horizontal curve is designed with a 1500 ft. radius. The tangent length is 400 ft. and the PT station is 20+00. Find the length of the curve?

A) 382 ft.
B) 540 ft.
C) 420 ft.
D) 781 ft.

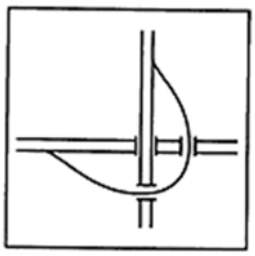
29) In the following intersections layouts, which one is strongly recommended in the both urban and the rural areas for the local road or street.

A



B

C



D

30) A district road with a bituminous pavement (friction coefficient=0.16) has a horizontal curve of 700 ft. If the design speed is given equal to 45 mph find the super-elevation.

A) 3%
B) 5%
C) 7%
D) 9%

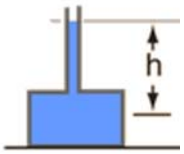
31) Degree of curve is

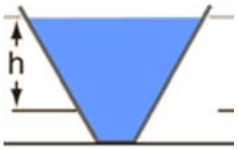
A) Equal to the interior angle.
B) Bearing of the curve.
C) Defined in degree.
D) Proportion to the reciprocal of the radius.

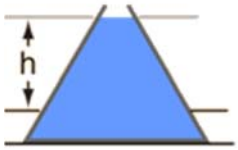
32) Spiral (transition) curves

A) are never used.
B) have a particular radius.
C) are used to produce a transition between two tangents.
D) are used to produce a gradual transition from tangents to circular curve.

33) Which one has more pressure at the depth of h?

A) 

B) 

C) 

D) They have equal pressure

34) A 3h storm over a 150 km^2 area produces a total runoff volume of $7*10^6$ m^3 With a peak discharge of 360 m^3/Sec. What is the total excess precipitation?

A) 1.4 cm
B) 2.6 cm
C) 3.6 cm
D) 4.6 cm

35) A 3h storm over a 150 km^2 area produces a total runoff volume of 7*106 m^3 with a peak discharge of 360 m3/Sec. find the unit hydrograph discharge?

A) 78 $m^{3/}$s.cm
B) 120 $m^{3/}$s.cm
C) 210 $m^{3/}$s.cm.
D) 260 $m^{3/}$s.cm

36) What is the flow rate for a street V channel finished (clean) concrete channel with a width of 1', channel slope of 0.5%, with a "normal" water depth of 0.5'?

A) 0.55 cfs
B) 1.20 cfs
C) 0.25 cfs
D) 2.41 cfs

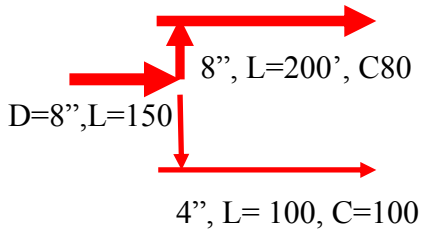
37) Rainfall intensity is

A) The amount of precipitation per second.
B) The runoff after a rainfall.
C) The amount of precipitation per hour.
D) The design storm.

38) What is the definition According to the US environment protection (EPA) which area needs permit for the land disturbing and it will called as "disturb"?

A) 10 or more acres
B) 100 or more acres
C) 1 or more acres
D) 1000 or more acres

39) 8 MGD (million gallon per day) of water flows into the new schedule-40 steel pipe network as shows below. Find the rate of flow in the upper branch.



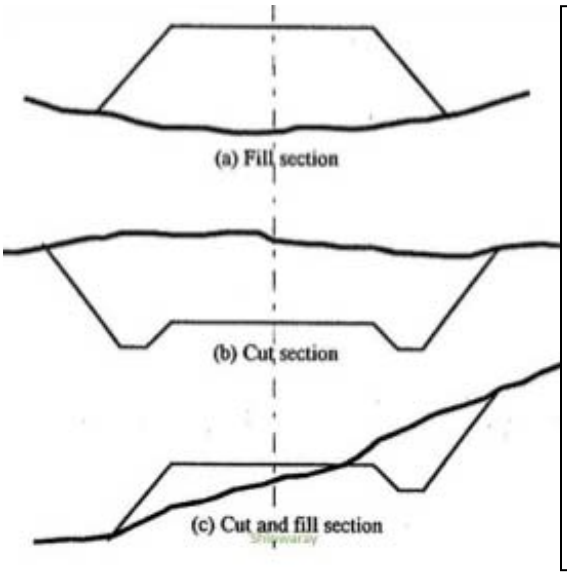
A) 1.1 MGD
B) 6.2 MGD
C) 5.0 MGD
D) 1.95 MGD

40) In a drainage project for an underground subway station if the required amount of well drawdown is 3 ft. in the 50 ft. depth of the aquifer. The hydraulic conductivity is given equal to 120 gal/(day-ft^2), well radius is equal to 0.3 ft. and the water table recover at radius of 1000 ft. find the required pumping flow rate ?

A) 13524 gal/day
B) 71020 gal/day
C) 18520 gal/day
D) 5624 gal/day

Solutions
First Style exam

1) Find the remaining amount of soil after excavation and embankment in cubic yard considering swell coefficient as 0.26 and shrinkage coefficient as 0.1.



STA 12+10

Fill = 50 cf, C=0 cf

STA 12+40

Fill= 0, C= 60 cf

STA 12+70

Fill = 35 cf, C=20 cf

A) 32 B) 47 C) 78 D) 62

The Answers is A

This method is used widely and most of the estimators use this method where length is much greater than width.

Earthworks Formulas

$$Average\ End\ Formula\ V = \frac{L(A_1+A_2)}{2}$$

L=Distance between A_1 *and* A_2

Also, 1 mile = 5280 ft. = 1760yards and 1 yard = 3 ft.

Each station introduce with the distance from the origin in feet, so STA 12+10 means: 1210 ft. Then distance between 2 stations in this problem is given equal to 30 ft. using the average area method:

Vcut(a-b)= (0+60)/2 * 30 = 30*30 = 900 cf

Vfill(a-b)= (50+0)/2*30 = 25*30= 750 cf

Vcut(b-c)= (20+60)/2 * 30 = 40*30 = 1200 cf

Vfill(b-c)= (0+35)/2*30 = 17.5*30= 525 cf

Total volume of excavation = 900+1200 = 2100 cf = 77.8 cy

Total volume of embankment = 750+525= 1275 cf = 47.2 cy = CCY (Compacted material)

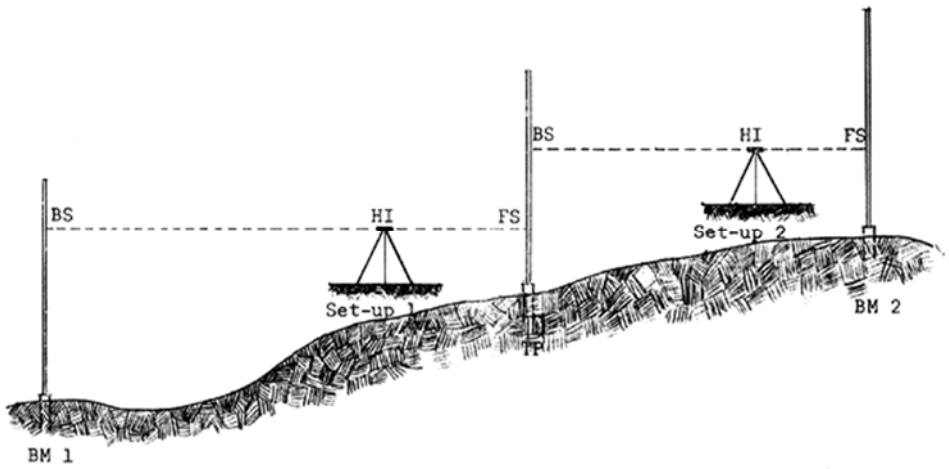
BCY= CCY /(1-Shrikage) = 47.2/(1-0.1) = 52.4 cy This is the required amount of soil at bank after excavation.

The remaining volume between required BCY and excavation is the amount of soil that will not be used = 77.8 -52.4 = 25.4 cy

The remaining volume of excavated soil after swelling (LCY) that should be hauled out of the site = excavation at bank * (1+swell) = 25.4*(1+0.26) = 32 cy

2) Find the elevation of BM2 if the following readings are given if the elevation of BM1 is 01+30:

Station	BS	FS
BM1	3.3	
TP	2.4	1.5
BM2		1.2



A) 1+30 B) 1+31.2

C) 1+33 D) 1+31.8

The Answers is B

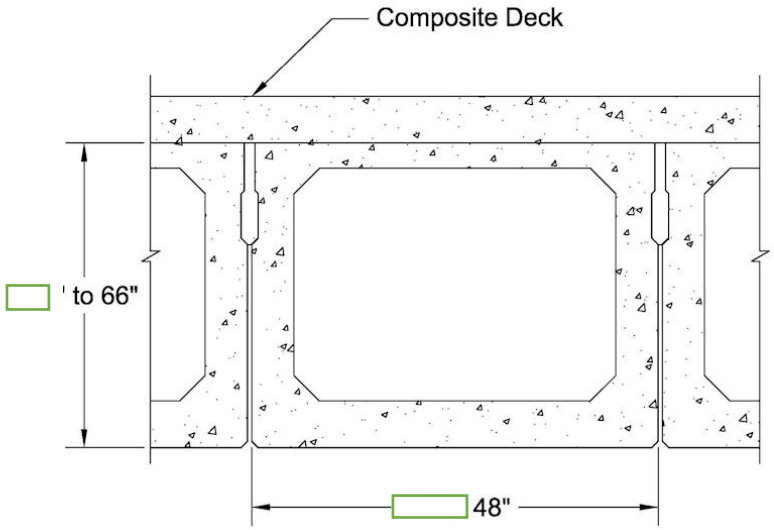
The height between two points are given equal to: Back sight (BS) - Foresight (FS) = height, positive answer means FS is higher than the BS.

BM1 to TP = BS-FS= 3.3-1.5= +1.8

TP to BM2 = BS-FS= 2.4-1.2= +1.2

Elevation at BM2 = Elevation at BM1 + height = 130 + 1.8 + 1.2 = 133=1+33

3) For the pre-cast concrete bridge box girder which one is the most likely closer to the required volume of concrete for one box? Thickness is 8" for two sides and bottom chord and 4" for the top chord. Each corner has 3 by 3 inches hunches. Length of bridge is given equal to 200'



A) 1500 cf

B) 1000 cf

C) 1825 cf

D) 1250 cf

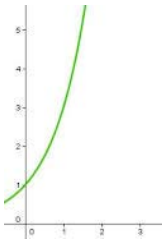
The Answers is C

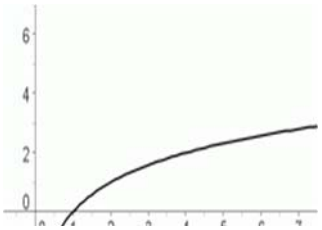
To find the answer the section can be divided in the certain geometric shapes. Then the area of each section can be found. Volume is equal to the area multiplied by the length of girder. All dimensions in inches have been converted to ft by dividing by 12.

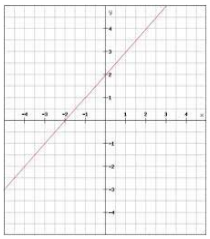
A= ((36*4+(66-4-8) *8*2+(36*8)+4*(3*3)/2))/(12*12) = 9.125 sf (area of section)

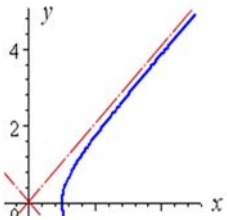
Volume = 9.125*200= 1825 cf

4) Which one of these 4 cost functions shows more increasing in rate of expenses over the time? (Horizontal axis shows time and vertical axis shows costs.)

A) 

B) 

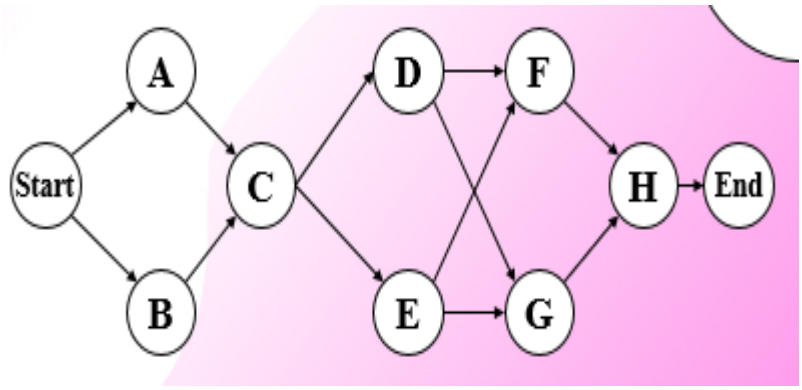
C) 

D) 

The Answers is A

The question shows different cost functions. The choice B shows the decreasing in rate over the time (Log function), choices C shows the constant expenses over the time. Choice A, is an exponential function and shows for rate of change over the time than D.

5) For the following paths find the critical path using the CPM?



Activity	Time
I.	4 weeks
J.	16 weeks
K.	8 weeks
L.	24 weeks
M.	28 weeks
N.	4 weeks
O.	8 weeks
P.	4 weeks

A) 44 B) 48

C) 60 D) 64

The Answers is D

The critical path is the path with the longest time.

Paths' Lengths
ACDFH = 44
ACDGH = 48
ACEFH = 48
ACEGH = 52
BCDFH = 56
BCDGH = 60
BCEFH = 60
BCEGH = 64

6) A dump-hauler has a purchase price of $109,000. Freight for delivery is $5000. Tires are an additional 25,000 with the estimated life time of 4500 hours. The hauler expected to operate 1500 hours annually and for 11 years. Maintenance fees for the hauler is estimated at $18000. What is the before-tax estimated hourly cost of operation excluding operator labor cost?

A) 35 B) 41

C) 23 D) 15

The Answers is C

The best way to estimate the hourly cost is to find all expenditures and cost for a year, then the hourly cost can be estimated prorate:

The total hauler cost = 109000+5000= $114,000

The hauler price per year: 114,000+/12= $ 9500 per year

Tires will work 4500 hr and every year 1500 years of operation is expected so:
4500/1500=3 years is the life time for the tires

Therefore, tire costs for a year is become: 21000/3 = $7000

Total annual expenditures = $9500+$7,000+$18000 = $34,500

Hourly rate = 34500/1500 hr/year = 23

7) How many 4 by 8 in samples required for a 7000 sf shear wall with 180 cy^3 of concrete?

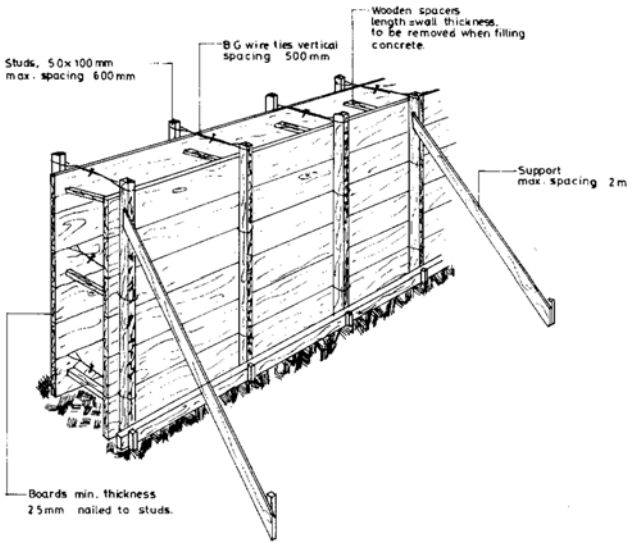
A) 2 specimens
B) 3 specimens
C) 4 specimens
D) 5 specimens

The Answers is B

P70-71, ACI 318-08, 5.6.2.1 and 5.6.2.4.

Based on the code instructions, 3 specimens are required for the 4 by 8 in cylinder samples and for each 150 cy^3 or 5000 sf needs one sample. So for 180cy^3 2 samples are required and for the 7000 sf also 2 samples are required. So, with this size of samples 3 samples are required.

8) For the wall form work, if the height of wall is equal to 10 ft. and the distance between inclined supports is 3 ft. find the force in the support assuming the 45 degree angle for it.



A) 7500 lb.

B) 10607 lb.

C) 1500 lb.

D) 150 lb.

The Answers is B

P18, ASCE 37-02, 4.7.1.

Concrete density = 150 lb/cf (ASCE 7-10, Chapter 3, 3.1 and C3, table C3-1 & C3-2.)

$$C_C = w \times h$$

Cc= 150*10 = 1500 psf/ft., is the lateral pressure at the base of the wall.

The pressure is distributed in the triangular form so the problem is like a beam with triangular load.

We need to find the reaction of this beam then we can find the force in the lateral support.

So we can find RA as:

RA

(1500 * 10/2)*1/3*3 = 7500 lb.

To find the force in the soldier

α=45 degree

F= RA/ Cos 45 = 7500/ Cos 45= 10606.6 lb.

9) If the maximum moisture content is given equal to 17% and specific gravity of soil is given equal to 2.67 find the dry density according to the modified proctor test procedure.

A) 125 pcf

B) 95 pcf

C) 115 pcf

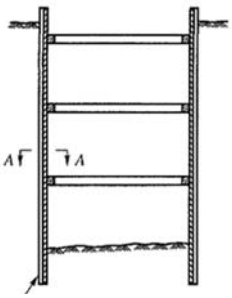
D) 150 pcf

The Answers is C

According to the modified proctor test procedure, the dry density is equal to:

$$\rho = \frac{\rho_w}{w + \frac{1}{SG}} = \frac{62.4}{0.17 + 1/2.67} = 114.59\ lb/ft^3$$

10) In the temporary structure in the referred picture if the soil is un-drained stiff clay which one is correct?



A) Soil pressure has a uniform distribution.
B) Soil pressure has a trapezoidal form
C) Soil pressure is triangular and the maximum pressure is at bas
D) Soil pressure is triangular and the maximum pressure is at top.

The Answers is B

This is the definition for the temporary structures. In the clay soil the pressure has trapezoid form and in sand it is uniform. In none of the conditions it has triangular form.

11) Which one of the following compactors shall be used for the compaction just behind the retaining wall?

C) A) sheepsfoot compactor B) Smooth drum
D) C) Small plate compactor D) pneumatic

The Answers is C

As general rule, heavy compactor equipment cannot be driven within 3 feet (0.3 m) of the back of the wall and based on definitions in this zone (settlement zone) only the small plate compactor shall be used.

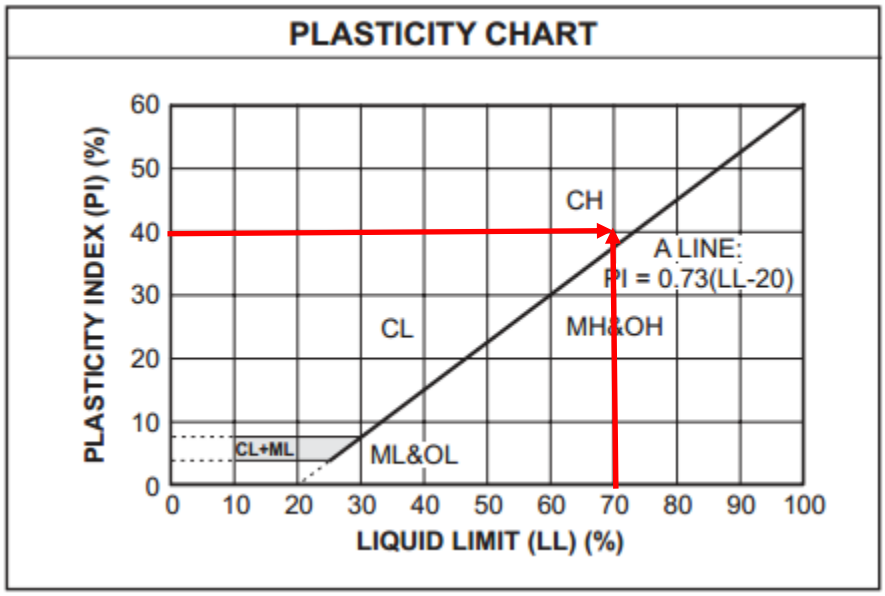
12) A fine grained soil has a Liquid Limit (LL) of 70% and a Plasticity limit (PL) of 30%. The soil can be classified as:

A) CL
B) CI
C) CH
D) MI

The Answers is C

For the fine grained soil according to the unified chart easily the soil classification can be defined as follows:

PI= LL-PL So, PI = 70-30 = 40%



So the soil is classified as CH.

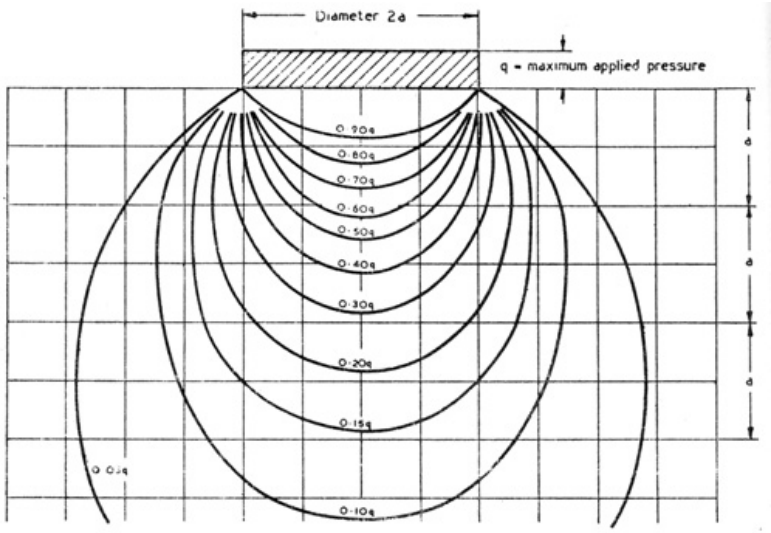
13) For a fully braced retaining wall in the basement of a 10 stories building, which formula will give the pressure at the bottom of the wall. (Height of wall is equal to 10 ft.)

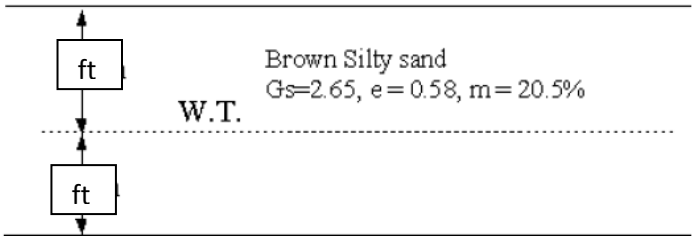
A) P= Soil density * 10 * Ka (active soil pressure)
B) P= Soil density * 10 * K0 (at rest soil pressure)
C) P= Soil density * 10 * Kp (passive soil pressure)
D) P= Soil density * 10 * Ka (active soil pressure) * 10/2

The Answers is B

Rankine and Coulomb theories assume that wall moves slightly and then active and passive pressure will start acting on the wall. If the wall is fully braced or considered as at rest, then K0 or at rest soil pressure coefficient shall be considered. Since in all basements, walls are designed as perimeter walls and braced with floors, and other walls, K0 shall be considered for them.

14) The ground water level is at 9ft. below ground. What is the total stress at 15 ft. below ground? Consider a footing on top layer with the width of 10 ft. which makes a pressure of 150 psf. Use both figures to find the pressure.





A) 2200 psf
B) 1778 psf
C) 1200 psf
D) 1860 psf

The Answers is B

To solve the problem, the amount of density for each layer shall be estimated.

For the first layer (Brown Silty Sand):

$$\rho_{dry} = Gs.\rho_w \frac{1}{(1+e)} = 2.65 * 62.4 \frac{1}{1+0.58} = 104.65\ lb/cf$$

$$\rho_{wet} = \rho_{dry}(1+m) = 104.65 * (1+0.205) = 125.32\ lb/cf$$

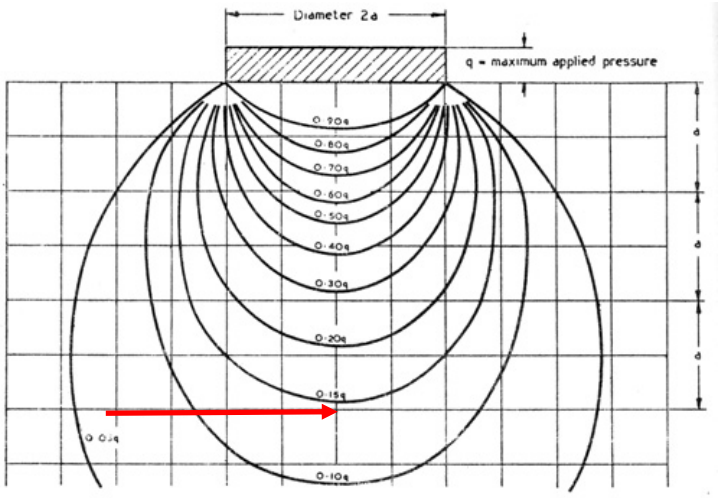
Total stresses are equal to:

$\sigma_{(0-9)} = \gamma h = 125.32 * 9 = 1127.88\, psf$

$\sigma_{(9-15)} = \gamma h = 104.65 * 6 = 627.9\, psf$

Foundation stress is estimated from the figure as:

Depth = 15' width of footing is = 10ft. so stress shall be found in 3d and it is equal to = 0.15 q = 0.15*150 = 22.5 psf



So the total stress = 22.5+1127.88+627.9= 1778.28

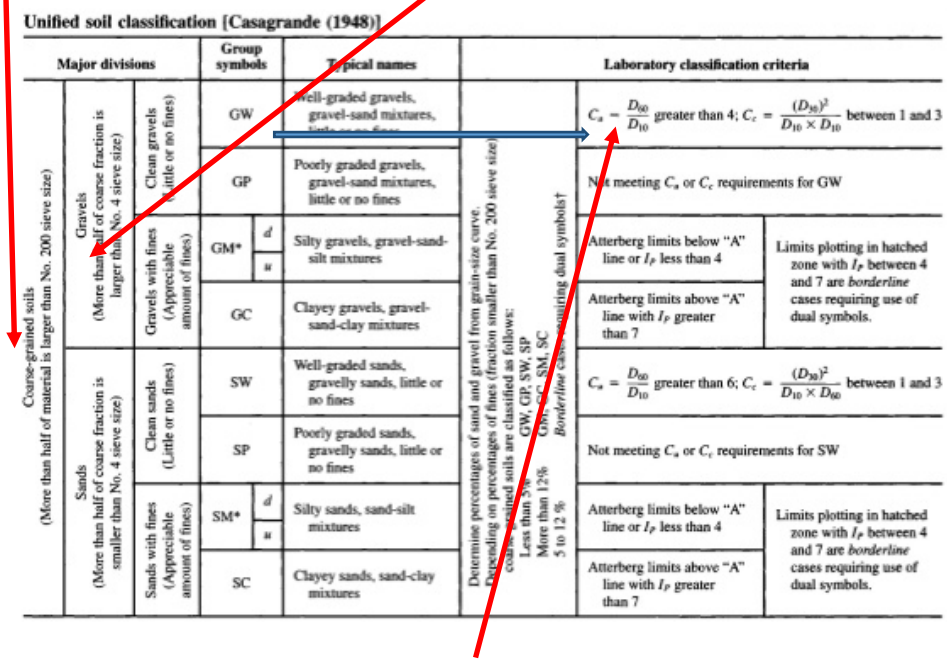
15) A soil sample has 30% passing the No. 4 sieve and 10% passing the No. 200 sieve. The coefficient of uniformity is greater than 4. Classify the soil according to the Unified Soil Classification System.

A) SP-SM
B) SW-SM
C) SP
D) GW

The Answers is D

According to the Unified Soil classification table the soil can be classified as GW. See the below table.

10% passing Sieve #200 30% passing through #4 means less than 50% on #4



Unified soil classification [Casagrande (1948)]

Major divisions			Group symbols	Typical names	Laboratory classification criteria	
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{10}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting C_u or C_c requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM* d / u	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or I_P less than 4	Limits plotting in hatched zone with I_P between 4 and 7 are *borderline* cases requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line with I_P greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting C_u or C_c requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM* d / u	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or I_P less than 4	Limits plotting in hatched zone with I_P between 4 and 7 are *borderline* cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with I_P greater than 7	

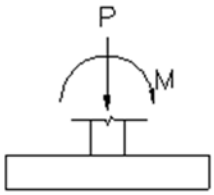
Determine percentages of sand and gravel from grain-size curve. Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP; More than 12% GM, GC, SM, SC; 5 to 12% *Borderline* cases requiring dual symbols†

Uniformity is> 4

10% passing means more than 50% larger than #200 sieve and 30% passing from #4 means less than half is smaller than #4 so the soil can be (GW, GP, GM, or GC). The uniformity bigger than 4 shows the soil is classified as GW.

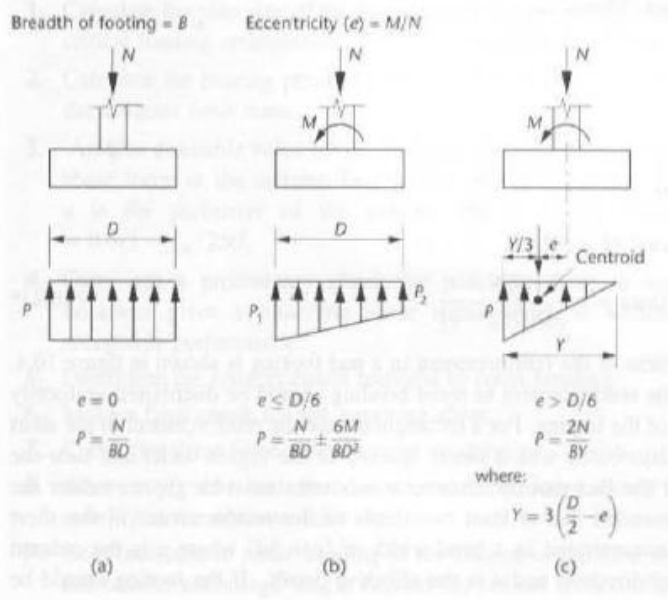
16) For the shown footing, find the maximum compressive stress. (P= 1000 lb. M= 500 lb-ft. B=D=width of footing = 9 ft.)

A) 20.3 psf
B) 8.2 psf
C) 16.5 psf
D) 12.3 psf



The Answers is C

To find the stresses under the foundation three different conditions might be happened which are shown in the below picture.



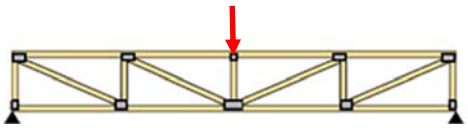
So, the eccentricity is equal to:

e= M/P = 500/1000 = 0.5 < D/6 = 9/6= 1.5

So, the method in "b" shall be used because the footing has not tension.

Max. Stress = P/(B*L) * (1+ 6e/L) = 1000/(9*9) * (1+6*0.5/9) = 16.46 psf

17) Referring to the figure, find the maximum tension force at the bottom chord if the force is equal to 1000 lb. the length of span is 20 ft.(4@5'), and height of the truss is given equal to 5 ft.



A) 1200 N
B) 1000 N
C) 5000 N
D) 2000 N

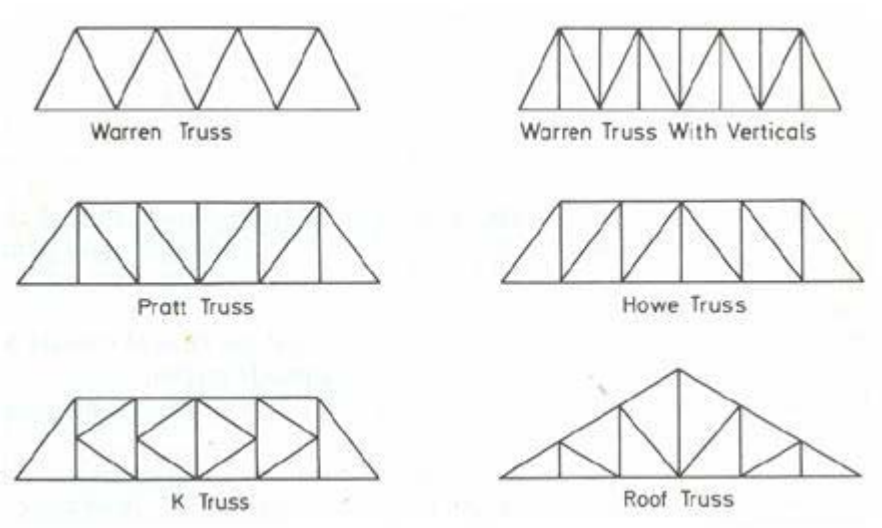
The Answers is B

To find the force in the bottom chord easily find the bending moment at mid-span. M/height of truss will give the forces in top and bottom chord. So:

M= PL/4 = 1000*20/4 = 5000 lb.

F= M/d = 5000/5 = 1000 lb.

18) Which model has just compressive force in the diagonal members?

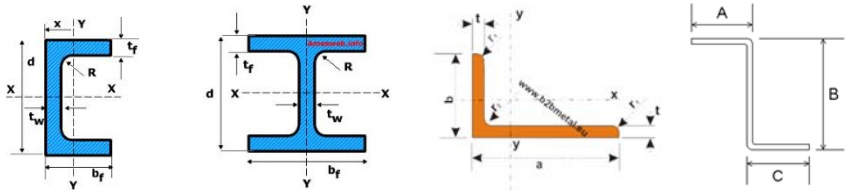


A) Warren and roof trusses
B) Howe truss
C) K and Warren trusses
D) Pratt truss

The Answers is B

Pratt truss has all tension members while Howe has all compression members. All other types have a mix of compression and tension diagonals. Since the question asked for just compression the answer is Howe truss.

19) If a design engineer wants to use one of the following sections as a simple beam on the sloped roof, which section(s) may give a better results?

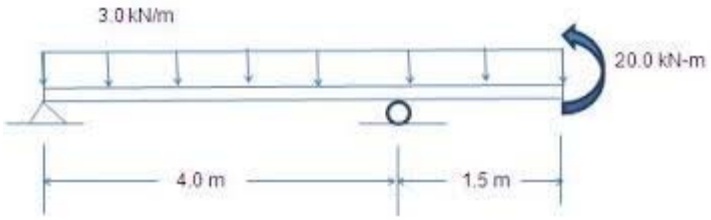


A) I section
B) Z and angle sections
C) I and channel sections
D) Channel, Z, and Angle sections

The Answers is D

Angles and Z sections have 2 principle axis other than the X and Y axis, because are asymmetric sections. So, if they use on top of the sloped roof the actual load will work on their real axis and consequently it creates the minimum bending moments. With a proper selection of roof angle and principle axis angles the biaxial bending moment on sloped roof will be converted to the uniaxial bending moment. Channel has a center of rotation which will help to decrease the effect of horizontal vector on the sloped roofs. So. All three sections are suitable for the sloped roofs. I sections are the most deficient sections on the sloped roofs, because always they face the biaxial bending moment and consequently the designed sections have more weight that the Z, angle, or channels.

20) For the beam in the referred picture find the maximum bending moment at the mid-span.



A) 6 KN-m
B) 16.6 KN-m
C) 14.3 KN-m
D) 8.3 KN-m

The Answers is C

Using the super position law, the mid span bending moment is the sum of the bending moment from the simple span beam and the cantilever over hang.

So :

Simple span beam (mid span) = wl^2/8 = 3*4^2/8 = 6 KN-m

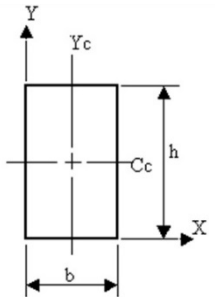
Overhang creates negative bending moment and the concentrated moment is positive so:

The negative bending moment at support = M-wL^2/2 = 20- 3*1.5^2/2 = +16.625

At the mid span half of this bending moment will be added to the mid span bending moment (simple beam effect) so, the total moment = 16.625/2 + 6 = 14.3 KN-m

21) What is the ratio between plastic section modulus and elastic section modulus and (shape factor) for the rectangular section as follows:

A) 1.5
B) 1.33
C) 2
D) 1.7



The Answers is A

Elastic section modulus = $I/C = (bh^3/12)/(h/2) = bh^2/6$

Plastic section modulus = $\Sigma Ay = b*(h/2) * (h/4) * 2 = bh^2/4$

Shape factor = $(bh^2/4) / (bh^2/6) = 3/2 = 1.5$

22) A contractor need to make a concrete with target strength of 4 KSI and 0.5KSI as standard deviation. What should be the average of compressive strength tests for the concrete mix design?

A) 4.7 KSI
B) 3.3 KSI
C) 4.1 KSI
D) 4.0 KSI

The Answers is A

P67, ACI 318-08, 5.3.2.1

The required compressive strength for the f'c<5 KSI is given by the following formula:

$$f'_{cr} = f'_c + 1.34S_s$$

S_s = to the standard deviation of the samples and 1.34 according to the normal distribution function represents the 90% success in the samples and 10% failure.

So:

$$f'_{cr} = 4.0 + 1.34 * 0.5 = 4.67 \text{ KSI}$$

23) Concrete curing shall be maintained above 50 °F and in a moist condition for at least:

A) 3 days after placement.
B) 10 days after placement.
C) 15 days after placement.
D) 7 days after placement.

The Answers is D

P77, ACI 318-08, 5.11.

This is the definition of code.

Concrete curing shall be maintained above 50 °F and in a moist condition for at least 7 days after placement.

24) Find the maximum bending moment on a beam with the length of 20 ft. for the two 2000 lb. moving load (crane wheels) with the distance of 4 ft.

A) 20000 lb-ft
B) 16000 lb-ft
C) 19200 lb-ft
D) 18000 lb-ft

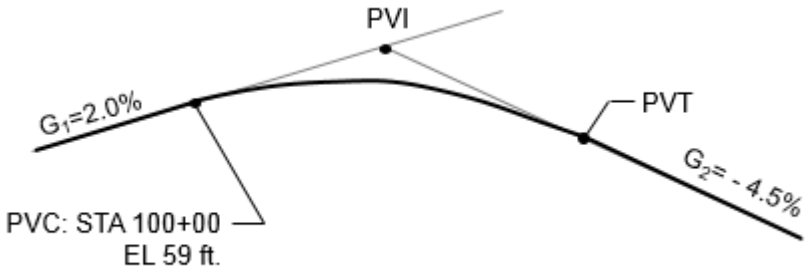
The Answers is D

The maximum bending moment for the moving load does not occur in the mid span. The maximum bending moment for the 2 equal moving load is equal to:

$$M = \frac{PL}{2}(1 - \frac{a}{2L})$$

Where "a" is the distance between loads, L is the length of span, and P is the moving load. So, M= 2000*20/2*(1-4/(2*20)) = 18000 lb-ft

25) If the PVC station of 100+00 at 59 ft. elevation is connected to the PVT station at 104+00 referring to the following figure, find the station of the crest.



A) 101+23 ft.
B) 102+00 ft.
C) 101+50 ft
D) 101+15 ft.

The Answers is A

P3-149, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.4.6.

400 ft. vertical curve, therefore:

- PVI is at STA 100+00 and PVT is at STA 102+00

Elevation of the PVI is 59' + 0.02(200) = 63 ft.

Elevation of the PVT is 63' – 0.045(200) = 54 ft.

High point elevation requires figuring out the equation for a vertical curve

- At x = 0, y = c => c=59 ft.
- At x = 0, dY/dx = b = G_1 = +2.0%
- a = (G_2 – G_1)/2L = (-4.5 – 2)/(2(4)) = - 0.8125
- $y = -0.8125x^2 + 2x + 59$
- High point is where dy/dx = 0
- dy/dx = -1.625x + 2 = 0
- x = 1.23 stations = 01+23

Station of the crest = (1+23)+100+00=101+23

26) A car is traveling at 50 mph in a county at night on a steep wet road with 6% uphill slope. Find the stopping sight distance.

A) 300 ft.
B) 389 ft.
C) 112 ft.
D) 241 ft.

The Answers is B

P3-2, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.2.2.

According to the AASHTO 2004 code, the stopping sight distance for horizontal curves is equal to:

$$S = 1.47.(2.5).V + \frac{V^2}{30(0.347 + G)}$$

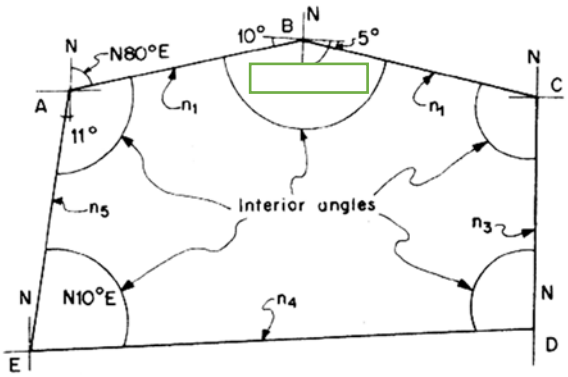
G is the slope of the road, for the uphill road = +0.06 (it will be negative for the downhill)

Friction coefficient = f = 0.1

V= 50 mph

S= 1.47 . 2.5 . 50 + 50^2/(30*(0.347+0.06) = 388.5 ft.

27) In a close traverse, what is the bearing of NC?



A) S5E
B) N85W
C) S85E
D) N5W

The Answers is C

A bearing of a line is the direction of the line with respect to any given meridian and is described by 90^0 quadrant in which the line falls and by the acute angle between the line and the meridian within the quadrant.

Since line BC lies in the second quadrant and so the angle should be measured between line and S, So the angle is: 90-5 = 85^o and the direction is S and E, So, S85E is the answer.

28) A horizontal curve is designed with a 1500 ft. radius. The tangent length is 400 ft. and the PT station is 20+00. Find the length of the curve?

A) 382 ft.
B) 540 ft.
C) 420 ft.
D) 781 ft.

The Answers is D

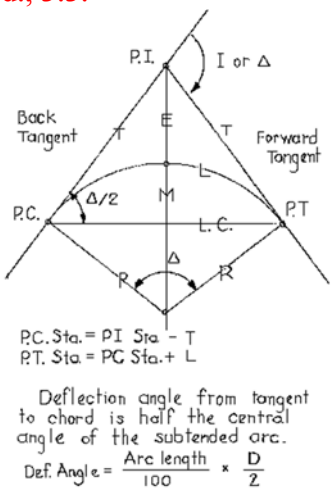
P3-18, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.3.

Since we know R and T we can use T = R.tan(delta/2) to get delta

400=1500 tan(delta/2) then delta = 29.86 degrees

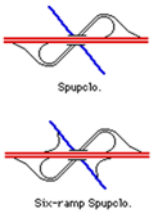
D = 5729.6/R. Therefore D = 3.82

L = 100(delta)/D = 100(29.86)/3.82 = 781 ft.



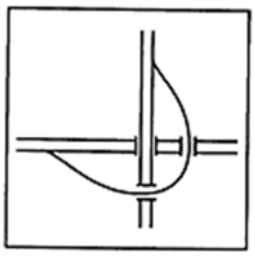
29) In the following intersections layouts, which one is strongly recommended in the both urban and the rural areas for the local road or street.

A



B

C



D

The Answers is C

P10-1, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 10.2.

According to the AASHTO definitions, the full and half cloverleaf intersections and trumpet are recommended for the rural highways (A, B, and D) and not recommended for the local roads. The diamond (C) is recommended for the urban and rural local roads.

30) A district road with a bituminous pavement (friction coefficient=0.16) has a horizontal curve of 700 ft. If the design speed is given equal to 45 mph find the super-elevation.

A) 3%
B) 5%
C) 7%
D) 9%

The Answers is A

P3-43, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.3.5.

For 70 mph, f = 0.16

$R_v = V^2/15(f+e)$ or $e + f = V^2/15\ R$, then: e (super elevation) = 45^2/(15*700)-0.16 = 0.03

31) Degree of curve is

A) Equal to the interior angle.
B) Bearing of the curve.
C) Defined in degree.
D) Proportion to the reciprocal of the radius.

The Answers is D

P3-18, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed.
This is the definition in AASHTO code.

32) Spiral (transition) curves

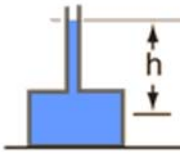
A) are never used.
B) have a particular radius.
C) are used to produce a transition between two tangents.
D) are used to produce a gradual transition from tangents to circular curve.

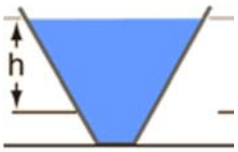
The Answers is D

P3-59, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.3.8.

This is the definition for the spiral curve.

33) Which one has more pressure at the depth of h?

A) 

B) 

C) 

D) They have equal pressure

The Answers is D

According to the fluid mechanic principles, the pressure is not related to the shape, so at the depth of "h" the amount of pressure is the same for all shapes.

34) A 3h storm over a 150 km^2 area produces a total runoff volume of $7*10^6$ m^3 With a peak discharge of 360 m^3/Sec. What is the total excess precipitation?

A) 1.4 cm
B) 2.6 cm
C) 3.6 cm
D) 4.6 cm

The Answers is D

According to the unit hydrograph definition:

V=total volume of runoff = Ad(area of the drainage watershed) * Pave(average precipitation)

Pave= V/Ad = $7*10^6/ (150)*10^6$ = 0.046 m = 4.6 cm

.

35) A 3h storm over a 150 km^2 area produces a total runoff volume of 7*106 m^3 with a peak discharge of 360 m3/Sec. find the unit hydrograph discharge?

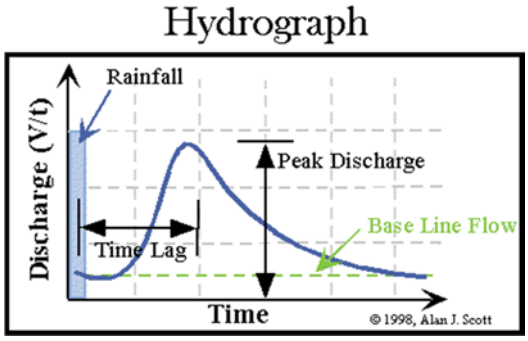
A) 78 $m^{3/}$s.cm
B) 120 $m^{3/}$s.cm
C) 210 $m^{3/}$s.cm.
D) 260 $m^{3/}$s.cm

The Answers is A

According to the unit hydrograph definition:

V=total volume of runoff = Ad(area of the drainage watershed) * Pave(average precipitation)

Pave= V/Ad = $7*10^6/ (150)*10^6$ = 0.046 m = 4.6 cm



$Q_{p,unit}$ = Peak discharge/P_{ave} = 360/4.6 = 78.2

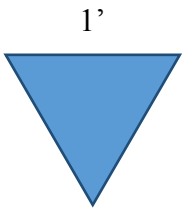
36) What is the flow rate for a street V channel finished (clean) concrete channel with a width of 1', channel slope of 0.5%, with a "normal" water depth of 0.5'?

A) 0.55 cfs
B) 1.20 cfs
C) 0.25 cfs
D) 2.41 cfs

The Answers is A

$$V = \frac{1.49}{n} R_h^{2/3} S^{1/2}$$

n is 0.015,
hydraulic radius= (d Cos α)/2



α = Arch tan (0.5/0.5) =45°
So, HR = 0.5* (cos 45) / 2 = 0.176
d=0.5'
S is 0.005 ft/ft, so
V = 2.2 ft/sec
Q = V*A= 2.2 ft/sec*(0.5*0.5)/2*2 sq.ft. = 0.55 cfs

37) Rainfall intensity is

A) The amount of precipitation per second.
B) The runoff after a rainfall.
C) The amount of precipitation per hour.
D) The design storm.

The Answers is C

This is the definition.

38) What is the definition According to the US environment protection (EPA) which area needs permit for the land disturbing and it will called as “disturb”?

A)10 or more acres

B) 1 or more acres

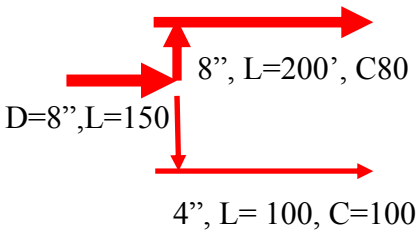
C) 100 or more acres

D) 1000 or more acres

The Answers is B

US environment protection (EPA) effective March 10, 2003 any activity in the area of 1 or more acres needs NPDES (National Pollutant Discharge Elimination System) permit.

39) 8 MGD (million gallon per day) of water flows into the new schedule-40 steel pipe network as shows below. Find the rate of flow in the upper branch.



A) 1.1 MGD
B) 6.2 MGD
C) 5.0 MGD
D) 1.95 MGD

The Answers is B

Parallel pipes have three principles that govern the distribution of flow between the two branches. 1- head loss are the same for each branch 2- head loss at each junction is the same as each branches, 3- the total flow rate is the sum of the flow rates in the two branches. According to the 3rd principle, $V_t = V_a + V_b$

So:

Diameter = 8" flow area = 50.24 in^2

Diameter = 4" flow area = 12.56 in^2

Using the Hazen-Williams expression for the velocity of flow in the pipe:

$V= (0.55CD^{0.63}hf^{0.54})/L^{0.54}$

$V1= 0.55 * 80 * (8/12)^{0.63} * hf^{0.54} / 200^{0.54} = 1.95\ hf^{0.54}$

The same for lower branch:

$V2=2.28\ hf^{0.54}$

. hf1=hf2

V1*A1/V2*A2 = (1.95 * 50.24) / (2.28*12.56) = 3.42, V2=0.29 V1

Vt =V1+V2 = V1.A1+0.29 V1.A2 = 1.29 V1.A1=1.29 Q1, then Q1= 5MGD/1.29 = 6.2MGD

40) In a drainage project for an underground subway station if the required amount of well drawdown is 3 ft. in the 50 ft. depth of the aquifer. The hydraulic conductivity is given equal to 120 gal/(day-ft^2), well radius is equal to 0.3 ft. and the water table recover at radius of 1000 ft. find the required pumping flow rate ?

A) 13524 gal/day
B) 71020 gal/day
C) 18520 gal/day
D) 5624 gal/day

The Answers is A

$$Q = \frac{\pi K(y_1^2 - y_2^2)}{Ln(\frac{r1}{r2})}$$

Where, K= hydraulic conductivity = 120 gal/ (day-ft2)

For the maximum drawdown of well we need to check it at the well center, so:

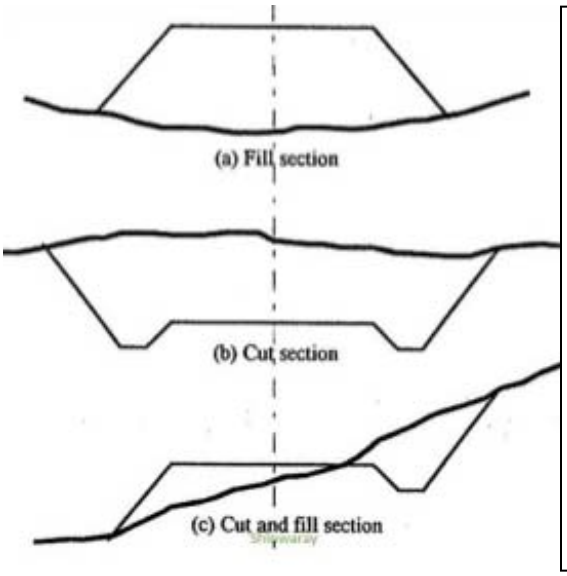
y1= 5 ft. and, y2=50-3 = 47 ft.

Since we want to find the Q at the center of well we do not need the information about the radius of well and radial distance and r1=r2

$$Q = \frac{\pi 120(50^2 - 47^2)}{Ln(\frac{1000}{0.3})} = 13524.17\ gal/day$$

Second PE Style Exam (AM) Questions

1) Find the net excavation in cubic yard.



STA 12+10

Fill = 50 cf, C=0 cf

STA 12+40

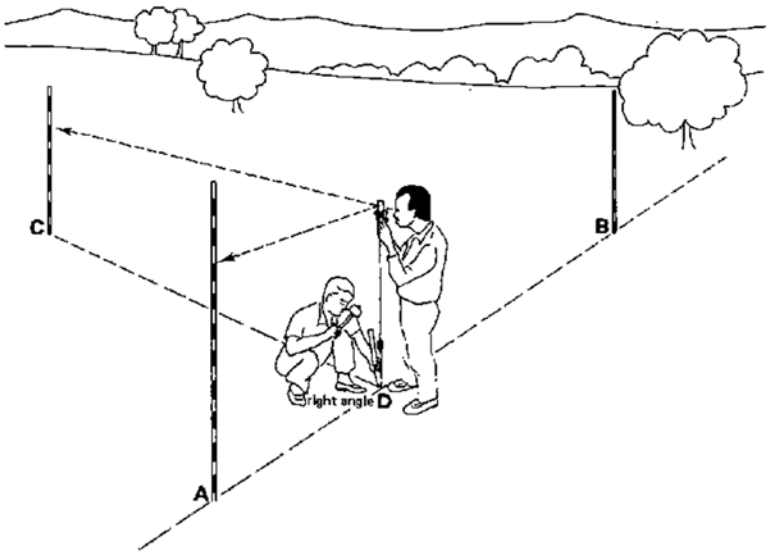
Fill= 0, C= 60 cf

STA 12+70

Fill = 35 cf, C=20 cf

A) 31 B) 10 C) 20 D) 50

2) The elevation of station C is given equal to 01+20. If the back sight on A is 3.5 ft. and the foresight for C in 5.1, another foresight reading on B shows 2.2 ft. Find the elevation of the point B.



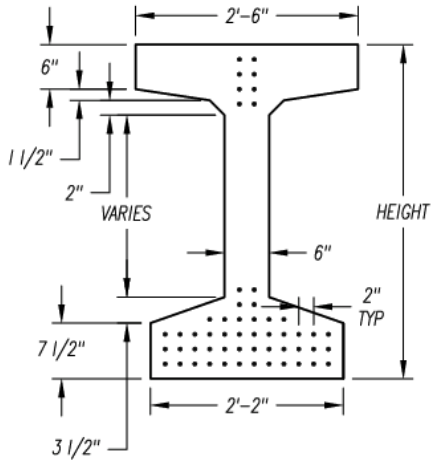
A) 1+20.5

B) 1+22.9

C) 1+17.1

D) 1+18

3) For the pre-stressed concrete bridge girder which one is the most likely closer to the required volume of concrete for this girder if the length of girder is given equal to 30 ft. Height = 3 ft.



A) 3.95 cf

B) 152.3 cf

C) 118.8 cf

D) 145.8 cf

4) A precast concrete wall with the thickness of 8", height of 8' and width of 6'. A hauler truck should carry these precast walls. The capacity of the hauler is 20 US tons. How many pieces of wall can be transported by the hauler?

A) 10 B) 8

C) 12 D) 3

5) A project is described by the following precedence table. The project manager wants to decrease the normal project time by 4 days. Most nearly, how much will it cost to reduce the project completion time by three days?

Activity	Predecessors	Normal time (days)	Crash time	Normal cost daily	Crash cost daily
A	-	8	6	50	100
B	A	2	1	80	140
C	A	6	4	80	100
D	B	2	1	100	150
E	C	6	3	90	200
F	E	3	1	80	160
G	D,F	4	2	120	300

A) $200 B) $120

C) $180 D) $140

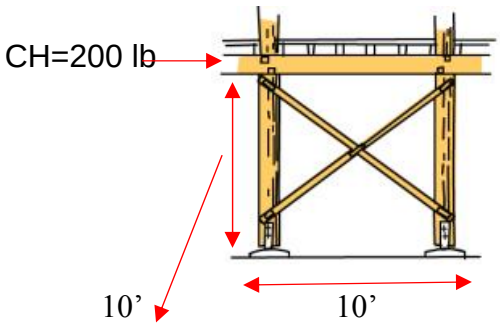
6) The amount of sales for contract has given equal to $1,000,000 including $100,000 for tax and $70,000 for the insurance. At the end of the project contractor has owned $50,000 of equipment and tools (assets) in addition $400000 assets that he does. Contractor paid $650,000 for the man power, equipment, and materials for this project. Find the gross profit, operation profit, net profit, and return on assets.

Choice	Gross profit	Operational profit	Net profit	Return on assert
A	18%	40%	83%	35%
B	35%	83%	18%	40%
C	40%	18%	35%	83%
D	83%	35%	40%	18%

7) The test strength of the 4 by 8 in. cylinder sample is taken as the average of the strength of

A) 2 specimens
B) 3 specimens
C) 4 specimens
D) 5 specimens

8) For the scaffolding as shown in the picture estimate the axial force in the bracings.



A) 200 lb.

B) 141lb

C) 100 lb.

D) 282 lb.

9) In a proctor test the maximum dry density is given equal to 125 lb/cf with 20% of water content. If the sample dry density of the road pavement equal to 123, what is the amount of the relative compaction?

A) 90%

B) 95%

C) 98%

D) 100%

10) The water content of soil is defined as the ratio of

A) Volume of water to volume of voids in soil
B) Volume of water to volume of given soil
C) Weight of water to weight of air in voids
D) Weight of water to weight of solids of given mass of soil.

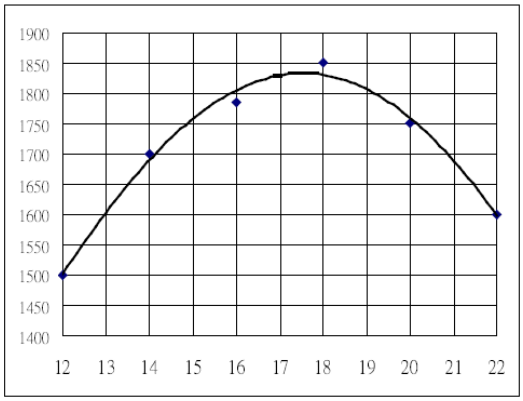
11) Design of a footing on the loose sand requires which one of the following activities:

A) It is not possible
B) Loose sand should always be compacted prior to put footing on it.
C) No need for compaction because we design the footing based on the soil strength.
D) Compaction is required if the modified proctor test is less than 50% for the natural ground.

12) A fine grained soil has a Liquid Limit (LL) of 40% and a plasticity Index of 30%. The soil can be classified as:

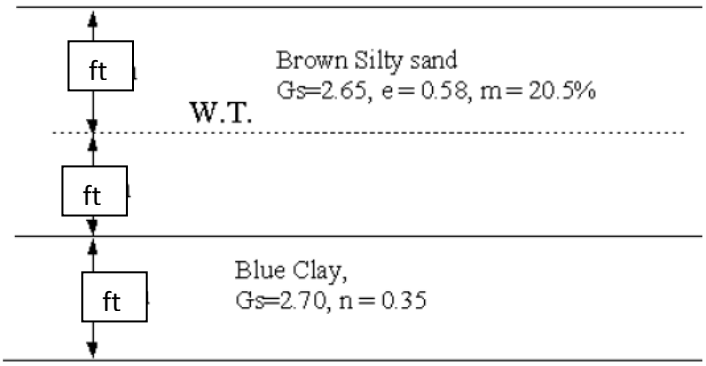
A) CL
B) CI
C) CH
D) MI

13) The diagram below shows the results of a standard compaction test. The Optimum Moisture Content (O.M.C.) of the soil is



A) 12%
B) 17.5%
C) 18%
D) 22%

14) The ground water level is at 9ft. below ground. What is the total stress at the bottom of the blue clay (i.e. at 23ft. below ground)?



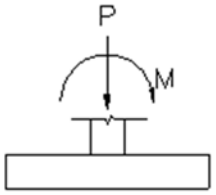
A) 2200 psf
B) 1759 psf
C) 1200 psf
D) 1860 psf

15) A soil sample has 70% passing the No. 4 sieve and 10% passing the No. 200 sieve. The coefficient of uniformity is 4 and the fines are non-plastic. Classify the soil according to the Unified Soil Classification System.

A) SP-SM
B) SW-SM
C) SP
D) GW-GM

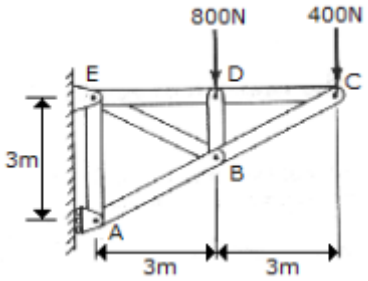
16) For the shown footing, find the maximum compressive stress. (P= 1000 lb. M= 3000 lb-ft. B=D=width of footing = 9 ft.)

A) 60 psf
B) 30 psf
C) 49 psf
D) 12 psf



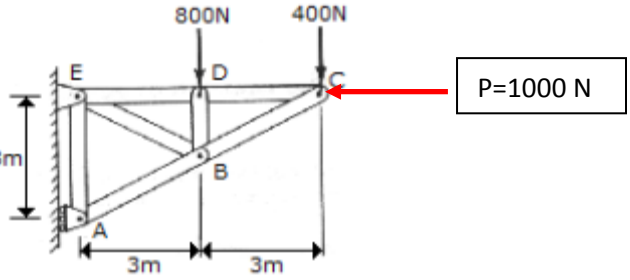
17) Referring to the figure, find the force in the member DB.

A) 1200 N
B) 800 N
C) 400 N
D) 600 N

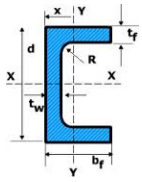


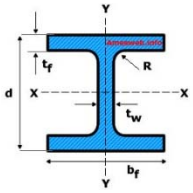
18) Referring to the figure, adding a horizontal force P at point C and considering the combination of all loads will:

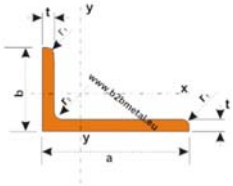
A) Increase the forces in
B) Decrease the forces in
C) Increase the force in A
D) Decrease the force in

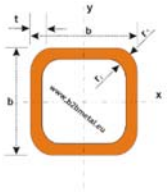


19) If a design engineer wants to use one of the following sections as a simple beam, which section has biaxial bending moment even if the load applies along the Y direction?

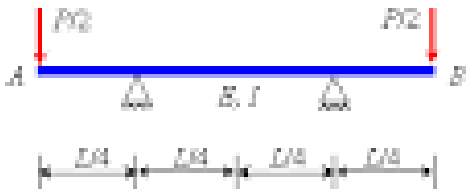
A) 

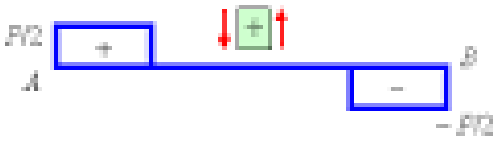
B) 

C) 

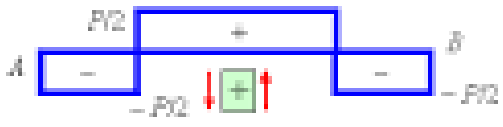
D) 

20) For the beam in the referred picture which one shows the correct bending moment diagram?

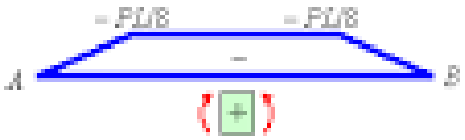




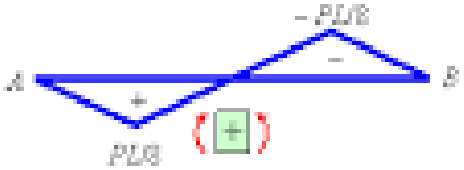
A



B



C



D

21) The rate of change of bending moment is equal to

A) Shear force
B) Slope
C) Deflection
D) None of these

22) For an existing concrete water reservoir the contractor has tested the existing compressive strength of concrete in 50 different location. The average of these tests shows the value of 4.1 KSI and the standard deviation shows the value of 0.5 KSI. If the contractor wants to take the risk of 10% for the rehabilitation of the structure, find the target strength of the structure that should be considered for the new design? (Use normal distribution function.)

A) 3.43 KSI
B) 4.77 KSI
C) 4.1 KSI
D) 4.6 KSI

23) Proper proportioning of concrete, ensures

A) Desired durability and workability
B) Water tightness of the structure
C) Adequate strength
D) A & C

24) The shear force at the center of a simply supported beam of span l carrying a uniformly distributed load of w per unit length over the whole span is

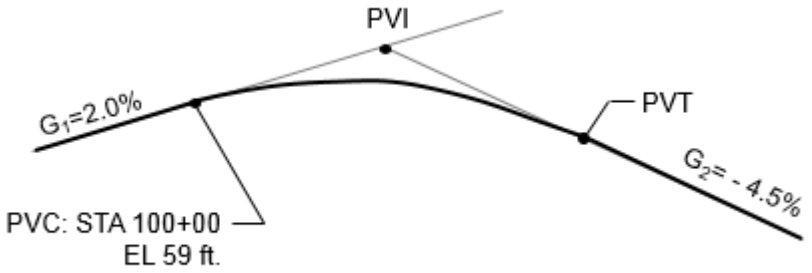
A) Wl

B) $\frac{Wl}{2}$

C) $\frac{Wl}{4}$

D) Zero

25) A 400 ft. equal tangent crest vertical curve has a PVC station of 100+00 at 59 ft. elevation. The initial grade is 2.0 percent and the final grade is -4.5 percent. Determine the elevation of the high point of the curve.



A) 60.23 ft.
B) 54.00 ft.
C) 50.43 ft.
D) 104+00 ft.

26) A car is traveling at 30 mph in a county at night on a flat wet road. Find the stopping sight distance.

A) 300 ft.
B) 197 ft.
C) 112 ft.
D) 241 ft.

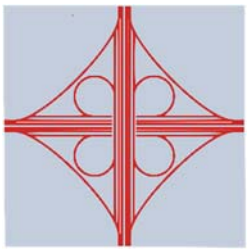
27) A roadway is being designed using a 45 mph design speed. One section of the roadway must go up and over a small hill with an entering grade of 3.2 percent and an existing grade of -2.0 percent. How long must the vertical curve be?

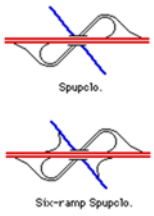
A) 115 ft.
B) 450 ft.
C) 317 ft.
D) 270 ft.

28) A horizontal curve is designed with a 1500 ft. radius. The tangent length is 400 ft. and the PT station is 20+00. What is the PI station?

A) 16+16.3
B) 12+16.3
C) 12+18.2
D) 16+18.2

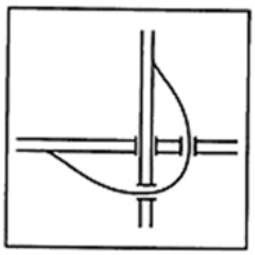
29) In the following intersections layouts, which one is strongly recommended in the urban area and not recommended in the rural areas for the collectors.


A



B


C


D

30) A district road with a bituminous pavement (friction coefficient=0.16) has a horizontal curve of 500 ft. If the design speed is given equal to 45 mph find the super-elevation.

A) 1 in 10
B) 1 in 20
C) 1 in 30
D) 1 in 40

31) Design of horizontal and vertical alignments, super-elevation, sight distance and grades, is worst affected by

A) length of the vehicle
B) height of the vehicle
C) width of the vehicle
D) speed of the vehicle

32) First operation during the detailed survey of a hill road, is

A) hydrological and soil surveys
B) adjustment of alignment along with curves
C) derivation of longitudinal and cross-sections
D) fixation of Bench Marks

33) A syphon is used

A) to fill up a tank with water at higher level from a lower level
B) to connect water reservoirs at different levels intervened by a hill
C) to supply water to a town from higher level to lower level
D) none of these

34) A 2h storm over a 111 km^2 area produces a total runoff volume of $4*10^6$ m^3 With a peak discharge of 260 m^3/Sec. What is the total excess precipitation?

A) 1.4 cm
B) 2.6 cm
C) 3.6 cm
D) 4.0 cm

35) A 2h storm over a 111 km^2 area produces a total runoff volume of 4*106 m^3 with a peak discharge of 260 m3/Sec., find the unit hydrograph discharge?

A) 72 $m^{3/}$s.cm
B) 120 $m^{3/}$s.cm
C) 210 $m^{3/}$s.cm.
D) 260 $m^{3/}$s.cm

36) What is the flow rate for a rectangular finished (clean) concrete channel with a base width of 8', channel slope of 0.5%, with a "normal" water depth of 2'?

A) 140 cfs
B) 8.5 cfs
C) 100 cfs
D) 200 cfs

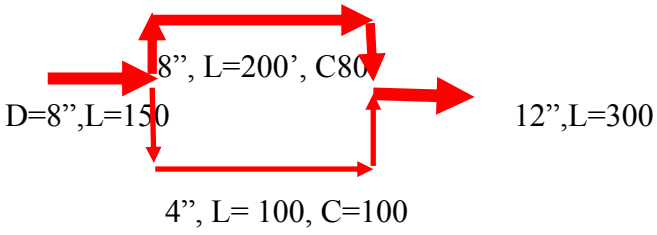
37) The ratio of the depth of flow to the hydraulic radius for the most economical trapezoidal section, in open channel flow is

A) 0.5
B) 1
C) 2
D) 1.2

38) When does the silt fence barrier (below picture) be used for the sediment control?

A) It may be constructed of hay and it operates by intercepting and ponding sediment-laden runoff.
B) It may be constructed of fence and it operates by intercepting and ponding sediment-laden runoff.
C) It is a mechanical system spillway
D) It is a silt fence ditch check and shall be used at 100' spacing.

39) 5 MGD (million gallon per day) of water flows into the new schedule-40 steel pipe network as shows below. Find the rate of flow in the upper branch.



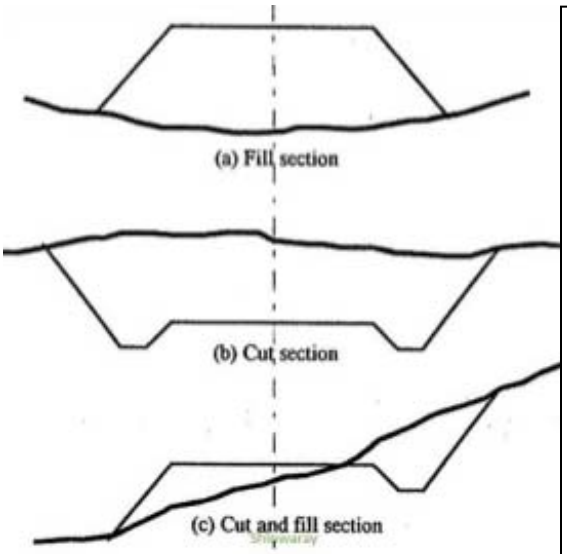
A) 1.1 MGD
B) 3.9 MGD
C) 5.0 MGD
D) 1.95 MGD

40) Which one is not correct for design a bridge?

A) Live (truck) loads distribution is prorated to the tributary width (distance between girders) only.
B) Truck loads shall be multiplied by the impact factor.
C) A bridge in the horizontal curve shall be designed for the centrifugal force.
D) For design of the bridge piers, all vertical and horizontal loads shall be combined according to the AASHTO code.

Solutions
Second Style Exam

1) Find the net excavation in cubic yard.



STA 12+10

Fill = 50 cf, C=0 cf

STA 12+40

Fill= 0, C= 60 cf

STA 12+70

Fill = 35 cf, C=20 cf

A) 31 B) 10 C) 20 D) 50

The Answers is A

This method is used widely and most of the estimators use this method where length is much greater than width.

Earthworks Formulas

$$Average\ End\ Formula\ V = \frac{L(A_1+A_2)}{2}$$

L=Distance between A_1 *and* A_2

Also, 1 mile = 5280 ft. = 1760yards and 1 yard = 3 ft.

Each station introduce with the distance from the origin in feet, so STA 12+10 means: 1210 ft. Then distance between 2 stations in this problem is given equal to 30 ft. using the average area method:

Vcut(a-b)= (0+60)/2 * 30 = 30*30 = 900 cf

Vfill(a-b)= (50+0)/2*30 = 25*30= 750 cf

Vcut(b-c)= (20+60)/2 * 30 = 40*30 = 1200 cf

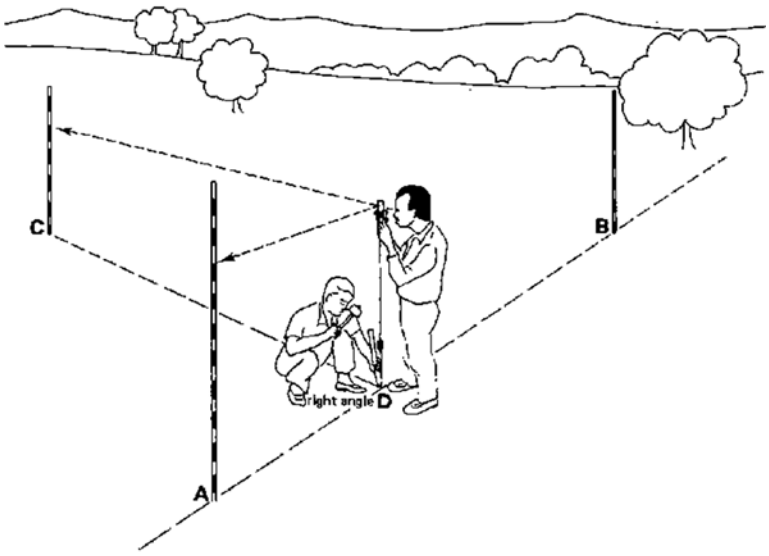
Vfill(b-c)= (0+35)/2*30 = 17.5*30= 525 cf

Total volume of excavation = 900+1200 = 2100 cf = 77.8 cy

Total volume of embankment = 750+525= 1275 cf = 47.2 cy

Net excavation= excavation – embankment = 77.8 - 47.2 = 30.6 cy

2) The elevation of station C is given equal to 01+20. If the back sight on A is 3.5 ft. and the foresight for C in 5.1, another foresight reading on B shows 2.2 ft. Find the elevation of the point B.



A) 1+20.5 B) 1+22.9

C) 1+17.1 D) 1+18

The Answers is B

The height between two points are given equal to: Back sight (BS) - Foresight (FS) = height, positive answer means FS is higher than the BS.

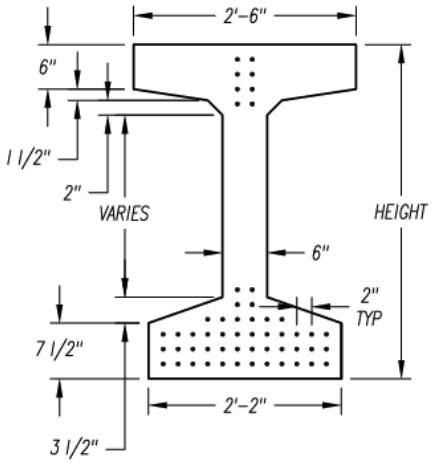
This is a tricky question! Since we have the elevation of point "C" and FS at C and B, we can consider BS for C and FS for B and no need for the information about A, so:

BS at C= 5.1 FS at B= 2.2

BS-FS= 5.1-2.2= +2.9

Elevation at B = Elevation at C + height = 120 + 2.9 = 122.9=1+22.9

3) For the pre-stressed concrete bridge girder which one is the most likely closer to the required volume of concrete for this girder if the length of girder is given equal to 30 ft. Height = 3 ft.



A) 3.95 cf

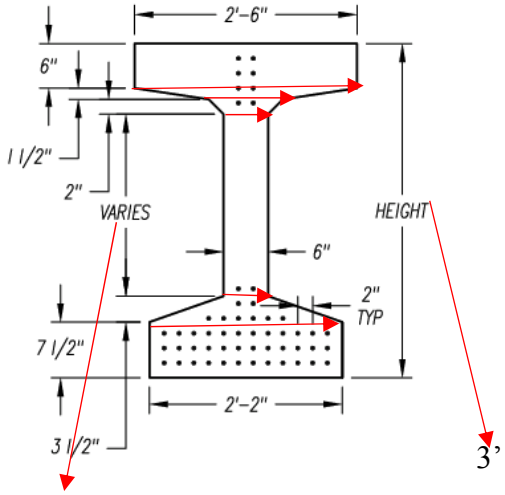
B) 152.3 cf

C) 118.8 cf

D) 145.8 cf

The Answers is C

To find the answer the section can be divided in the certain geometric shapes. Then the area of each section can be found. Volume is equal to the area multiplied by the length of girder. All dimensions in inches have been converted to ft by dividing by 12.



3'

1.29'

A=
2.5*0.5+((2.5+(6+2+2)/12)*0.5*1.5/12)+(6+(6+2+2))/12*0.5*2/12)+0.5*1.29+(6/12+2+2/12)*0.5*3.5/12+(2+2/12)*7.5/12 = 3.95 sf

Volume = 3.95*30= 118.725 cf

4) A precast concrete wall with the thickness of 8", height of 8' and width of 6'. A hauler truck should carry these precast walls. The capacity of the hauler is 20 US tons. How many pieces of wall can be transported by the hauler?

A) 10 B) 8

C) 12 D) 3

The Answers is B

Concrete density is equal to 150 pcf, ASCE 7-10, table C3. So the weight of each piece will be equal to:

W= 150 * (8/12 * 8 * 6) = 4800 lbs

1 US Ton = 2000 lbs, each wall = 4800/2000=2.4 ton,

Therefore; 20/2.4 = 8.33, so the truck can take 8 walls.

5) A project is described by the following precedence table. The project manager wants to decrease the normal project time by 4 days. Most nearly, how much will it cost to reduce the project completion time by three days?

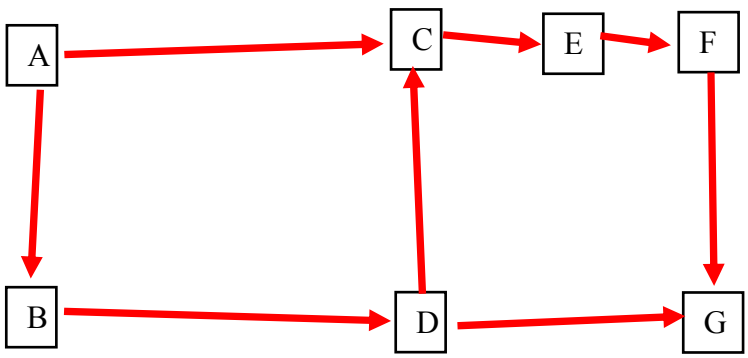
Activity	Predecessors	Normal time (days)	Crash time	Normal cost daily	Crash cost daily
A	-	8	6	50	100
B	A	2	1	80	140
C	A	6	4	80	100
D	B	2	1	100	150
E	C	6	3	90	200
F	E	3	1	80	160
G	D,F	4	2	120	300

A) $200 B) $120

C) $180 D) $140

The Answers is D

According to the table the CPM chart represents the following free floats:



Free floats are:

Path 1: A-B-D-G= 16

Path 2: A-B-D-E-F-G=25

Path 3: A-C-E-F-G= 27 critical path

In order to reduce the overall project duration by 4 days, the most inexpensive operation is to allocate additional resources (crash) to activities C, D, and A.

For 4 days we can consider C for 2 days and A for the other 2 days. So

The critical path with be equal to 27-4 = 23 days.

The additional costs will be equal to:

For C: 100-80 = $20 daily, 2*20=$40 for two days

For A: 100-50 = $50 daily, 2*50=$100 for two days.

The total additional cost due the project crash = 100+40= $140

6) The amount of sales for contract has given equal to $1,000,000 including $100,000 for tax and $70,000 for the insurance. At the end of the project contractor has owned $50,000 of equipment and tools (assets) in addition $400000 assets that he does. Contractor paid $650,000 for the man power, equipment, and materials for this project. Find the gross profit, operation profit, net profit, and return on assets.

Choice	Gross profit	Operational profit	Net profit	Return on assert
A	18%	40%	83%	35%
B	35%	83%	18%	40%
C	40%	18%	35%	83%
D	83%	35%	40%	18%

The Answers is B

Net income= 1000000-650000-100000-70000 = $180000

Total Assets = $50000+400000=$450000

Return on assets=net income/total assets = 180000/450000= 0.4*100= 40%

Operation profit margin ratio = earnings before interest and taxes/sales= (1000000-100000-70000)/1000000=0.83*100= 83%

Net profit margin ratio=net income/sales = 180000/1000000=0.18*100 = 18%

Gross profit margin ratio = gross profit/sales= (1000000-650000)/1000000= 0.35*100=35%

7) The test strength of the 4 by 8 in. cylinder sample is taken as the average of the strength of

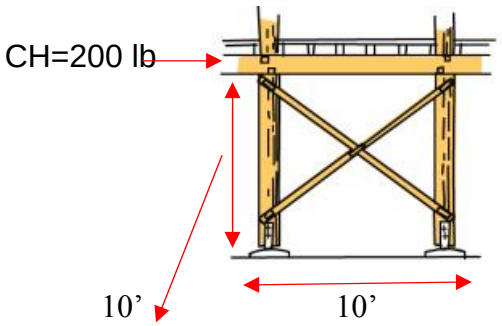
A) 2 specimens
B) 3 specimens
C) 4 specimens
D) 5 specimens

The Answers is B

P70-71, ACI 318-08, 5.6.2.1 and 5.6.2.4.

Based on the code instructions, 3 specimens are required for the 4 by 8 in cylinder samples and 2 for the 6 by 12 in.

8) For the scaffolding as shown in the picture estimate the axial force in the bracings.



A) 200 lb.

B) 141lb

C) 100 lb.

D) 282 lb.

The Answers is B

Height = 10’, width = 10’, so the angle of bracing is equal to:

Arc tan (10/10) = 45 degree

F= (200/2(since there are 2 bracings)) / Cos 45 = 141.4 lb. say 141 lb.

9) In a proctor test the maximum dry density is given equal to 125 lb/cf with 20% of water content. If the sample dry density of the road pavement equal to 123, what is the amount of the relative compaction?

A) 90%

B) 95%

C) 98%

D) 100%

The Answers is C

RC or relative compaction is the relation between dry density of the specimen to the maximum dry density. Maximum dry density can be obtained through test in the lab by adding the certain amount of water. So in fact the water content is just the additional data.

So, RC=123/125*100 = 98.4%

10) The water content of soil is defined as the ratio of

A) Volume of water to volume of voids in soil
B) Volume of water to volume of given soil
C) Weight of water to weight of air in voids
D) Weight of water to weight of solids of given mass of soil.

The Answers is D

This is the definition for the water content.

$w = m_w/m_s * 100\%$

11) Design of a footing on the loose sand requires which one of the following activities:

A) It is not possible
B) Loose sand should always be compacted prior to put footing on it.
C) No need for compaction because we design the footing based on the soil strength.
D) Compaction is required if the modified proctor test is less than 50% for the natural ground.

The Answers is D

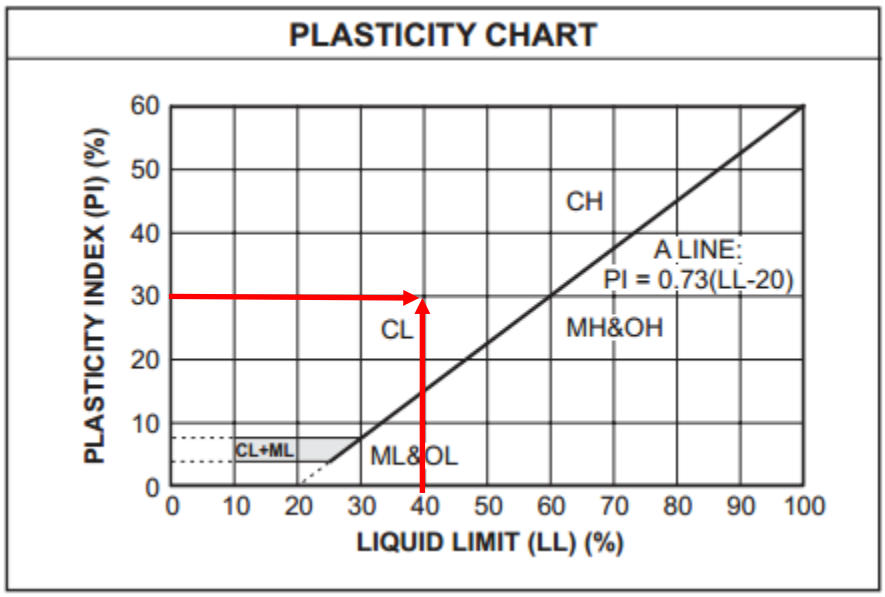
The compaction is required if the modified proctor test RC<50% for the natural ground or RC<90% for the compacted fills. Choice B is not correct because it is not always required and the RC value should be evaluated.

12) A fine grained soil has a Liquid Limit (LL) of 40% and a plasticity Index of 30%. The soil can be classified as:

A) CL
B) CI
C) CH
D) MI

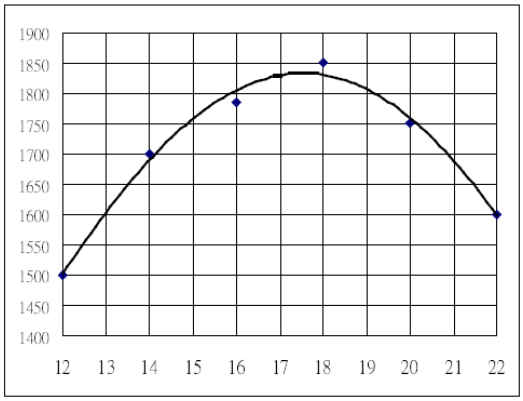
The Answers is A

For the fine grained soil according to the unified chart easily the soil classification can be defined as follows:



So the soil is classified as CL.

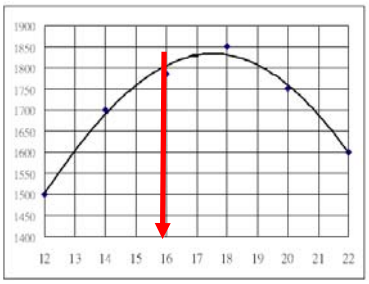
13) The diagram below shows the results of a standard compaction test. The Optimum Moisture Content (O.M.C.) of the soil is



A) 12%
B) 17.5%
C) 18%
D) 22%

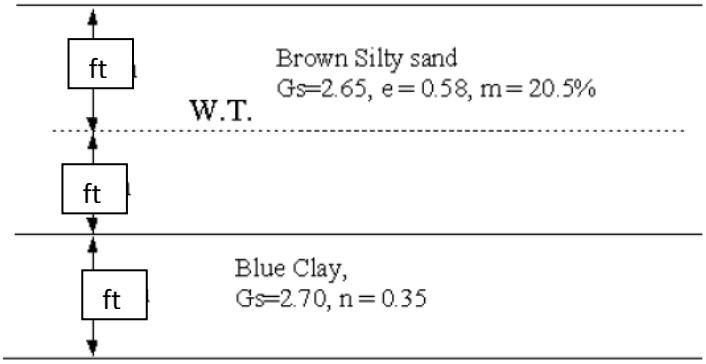
The Answers is B

A typical proctor test curve shows the moisture content with the optimum water content to make the zero air void and maximize the compaction effects. So, to find the optimum water content the highest amount of density which represents compaction shall be considered.



So, the maximum density happens when the water content is 17.5%.

14) The ground water level is at 9ft. below ground. What is the total stress at the bottom of the blue clay (i.e. at 23ft. below ground)?



A) 2200 psf
B) 1759 psf
C) 1200 psf
D) 1860 psf

The Answers is B

To solve the problem, the amount of density for each layer shall be estimated.

For the first layer (Brown Silty Sand):

$$\rho_{dry} = Gs.\rho_w \frac{1}{(1+e)} = 2.65 * 62.4 \frac{1}{1+0.58} = 104.65\ lb/cf$$

$$\rho_{wet} = \rho_{dry}(1+m) = 104.65 * (1+0.205) = 125.32\ lb/cf$$

For the second layer (Blue Clay):

$$e = \frac{n}{(1-n)} = \frac{0.35}{(1-0.35)} = 0.538$$

$$\rho_{dry} = Gs.\rho_w \frac{1}{(1+e)} = 2.70 * 62.4 \frac{1}{1+0.538} = 109.54\ lb/cf$$

Effective stresses are equal to:

No effective stress for the first layer shall be considered since it is not saturated, but for the next two layers which are located below water table the effective stress can be estimated. Water density = 62.4 lb/cf.

So, the effective stress = total stress – pore pressure

$$\sigma_{(0-9)} = \gamma h = 125.32 * 9 = 1127.88\ psf$$

$\sigma_{(9-15)} = \gamma h = 104.65 * 6 - 62.4 * 6 = 253.5\ psf$

$\sigma_{(15-23)} = \gamma h = 109.54 * 8 - 62.4 * 8 = 377.12\ psf$

Effective Stress = 1127.88+253.5+377.12 = 1758.5 psf

15) A soil sample has 70% passing the No. 4 sieve and 10% passing the No. 200 sieve. The coefficient of uniformity is 4 and the fines are non-plastic. Classify the soil according to the Unified Soil Classification System.

A) SP-SM
B) SW-SM
C) SP
D) GW-GM

The Answers is A

According to the Unified Soil classification table the soil can be classified as SP-SM. See the below table.

10% passing Sieve #200 70% passing through #4 means less than 50% on #4

Unified soil classification [Casagrande (1948)]

Major divisions			Group symbols		Typical names	Laboratory classification criteria	
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{10}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting C_u or C_c requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM*	*d*	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or I_P less than 4	Limits plotting in hatched zone with I_P between 4 and 7 are *borderline* cases requiring use of dual symbols.
				u			
			GC		Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line with I_P greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines	Not meeting C_u or C_c requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM*	*d*	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or I_P less than 4	Limits plotting in hatched zone with I_P between 4 and 7 are *borderline* cases requiring use of dual symbols.
				u			
			SC		Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with I_P greater than 7	

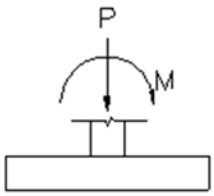
Determine percentages of sand and gravel from grain-size curve. Depending on percentages of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% *Borderline* cases requiring dual symbols†

Uniformity is 4 the fines are non-plastic

10% passing means more than 50% larger than #200 sieve and 70% passing from #4 means more than half is smaller than #4 so the soil can be (SW, SP, SM, or SC). The uniformity of 4 shows the soil is classified between SP-SM because it is not between 1 and 3 or greater than 4. So, clearly from these information the soil is SP-SM.

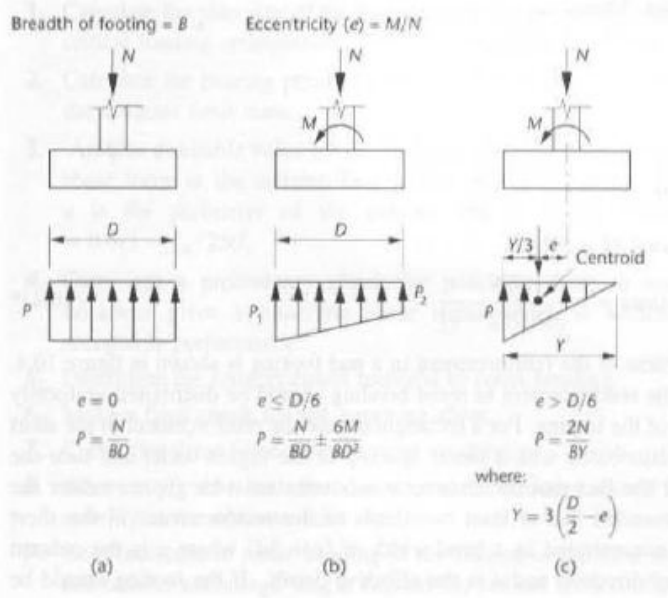
16) For the shown footing, find the maximum compressive stress. (P= 1000 lb. M= 3000 lb-ft. B=D=width of footing = 9 ft.)

A) 60 psf
B) 30 psf
C) 49 psf
D) 12 psf



The Answers is C

To find the stresses under the foundation three different conditions might be happened which are shown in the below picture.



So, the eccentricity is equal to:

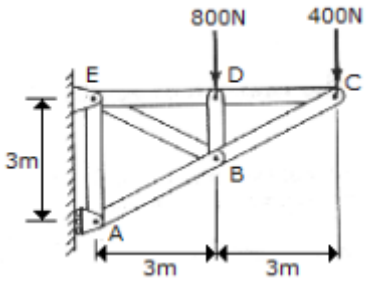
e= M/P = 3000/1000 = 3 > D/6 = 9/6= 1.5

So, the method in "C" shall be used because the footing has tension.

Y=3(9/2-3) = 4.5 , Stress = 2*1000/(9*4.5)= 49.38 psf

17) Referring to the figure, find the force in the member DB.

A) 1200 N
B) 800 N
C) 400 N
D) 600 N

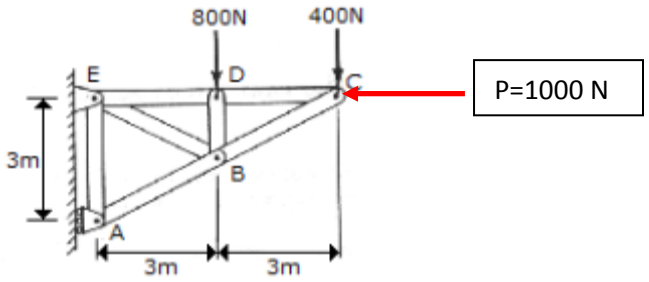


The Answers is B

The member DB is perpendicular to ED and DC, so with no calculation, $\Sigma F_y=0$, then $F_{DB} = 800N$.

18) Referring to the figure, adding a horizontal force P at point C and considering the combination of all loads will:

A) Increase the forces in
B) Decrease the forces in
C) Increase the force in A
D) Decrease the force in

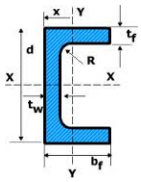


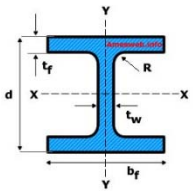
The Answers is B

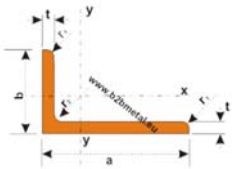
This load combination shows:

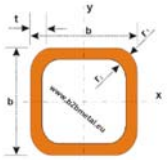
The effect of vertical forces create tension force in the EC and the P force creates compression. Tension force = (800*3+400*6)/3 = 1600 N, adding a 1000 N compressive force will decrease the force in EC without effect on AC. So, the actual force in EC after combination is: 1600-1000=600 N

19) If a design engineer wants to use one of the following sections as a simple beam, which section has biaxial bending moment even if the load applies along the Y direction?

B) 

B) 

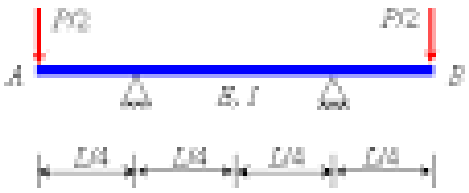
C) 

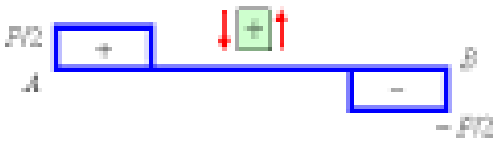
D) 

The Answers is C

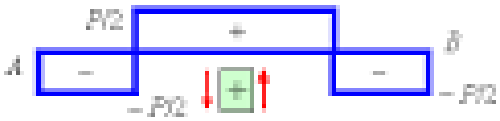
Angles have 2 principle axis other than the X and Y axis, because are asymmetric sections. So, when a load applies in Y direction, because of the angle between principle axis and Y axis, forces will be apply on both axis and create the biaxial forces and thus biaxial bending moment.

20) For the beam in the referred picture which one shows the correct bending moment diagram?

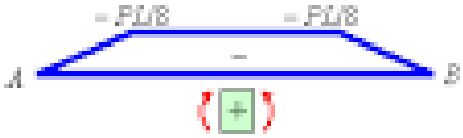




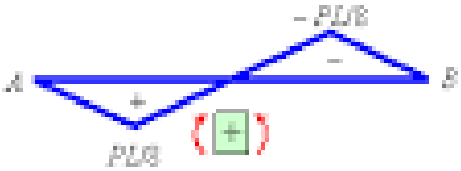
A



B



C



D

The Answers is C

Forces are applied at the end of the overhangs and creates equal amount of the bending moment at the end of the beam. So, “C” is correct.

21) The rate of change of bending moment is equal to

A) Shear force
B) Slope
C) Deflection
D) None of these

The Answers is A

This is the definition in the strength of materials. Slope= dy/dx (derivation of deflection y), Bending Moment = M = ds/dx (derivation of slope), Shear force= dM/dx (derivation of bending moment),

So the shear force is the rate of changes (differential) of the bending moment.

22) For an existing concrete water reservoir the contractor has tested the existing compressive strength of concrete in 50 different location. The average of these tests shows the value of 4.1 KSI and the standard deviation shows the value of 0.5 KSI. If the contractor wants to take the risk of 10% for the rehabilitation of the structure, find the target strength of the structure that should be considered for the new design? (Use normal distribution function.)

A) 3.43 KSI
B) 4.77 KSI
C) 4.1 KSI
D) 4.6 KSI

The Answers is A

P67, ACI 318-08, 5.3.2.1

The required compressive strength for the f'c<5 KSI is given by the following formula:

$$f'_{cr} = f'_c + 1.34S_s$$

S_s = to the standard deviation of the samples and 1.34 according to the normal distribution function represents the 90% success in the samples and 10% failure. That formula is used for design the concrete mixes and so, the safety margin in concrete mixes will be 1.34 Ss. Inversely for the existing structures the formula should be written as:

$$f'_{cr} = f'_c - 1.34S_s$$

This will give the safety factor with the 90% probability of success for the existing concrete, because for the existing concrete the 1.34Ss will make the safety margin and the existing average should be decreased prorate to the probability of failure.

So:

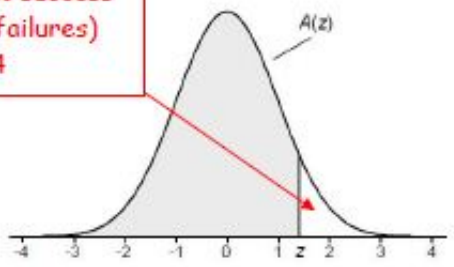
$$f'_{cr} = 4.1 - 1.34 * 0.5 = 3.43 \text{ KSI}$$

Note: in the normal distribution function, for Z=1.34, the probability of success is given as 0.9099. (See next page.)

TABLE A.1

Cumulative Standardized Normal Distribution

Example
For 95% success
(ie 5% failures)
Z = 1.64



$A(z)$ is the integral of the standardized normal distribution from $-\infty$ to z (in other words, the area under the curve to the left of z). It gives the probability of a normal random variable not being more than z standard deviations above its mean. Values of z of particular importance:

z	$A(z)$	
1.645	0.9500	Lower limit of right 5% tail
1.960	0.9750	Lower limit of right 2.5% tail
2.326	0.9900	Lower limit of right 1% tail
2.576	0.9950	Lower limit of right 0.5% tail
3.090	0.9990	Lower limit of right 0.1% tail
3.291	0.9995	Lower limit of right 0.05% tail

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	[illegible]	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	[illegible]	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999							

23) Proper proportioning of concrete, ensures

A) Desired durability and workability
B) Water tightness of the structure
C) Adequate strength
D) A & C

The Answers is D

P63, ACI 318-08, 5.1.1

This is the general definition in the code that the proportioning of the concrete shall maintain the required strength, durability and workability. Water tightness may be considered as an additional requirements that may be maintained by using some admixtures.

24) The shear force at the center of a simply supported beam of span l carrying a uniformly distributed load of w per unit length over the whole span is

A) Wl

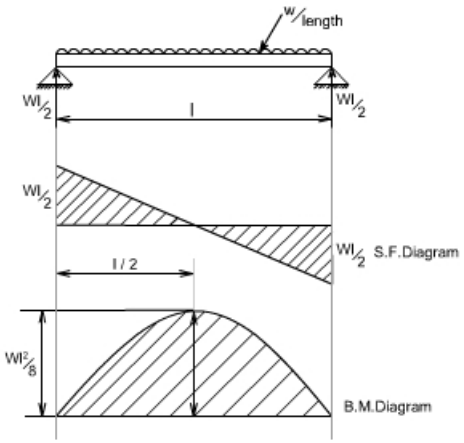
B) $\frac{Wl}{2}$

C) $\frac{Wl}{4}$

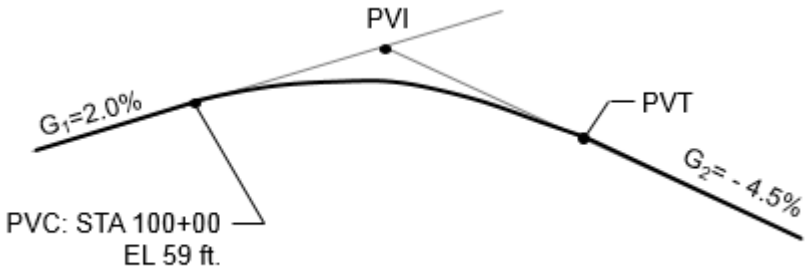
D) Zero

The Answers is D

The shear force diagram for the simple beam is shown in the figure, so the shear force = 0.



25) A 400 ft. equal tangent crest vertical curve has a PVC station of 100+00 at 59 ft. elevation. The initial grade is 2.0 percent and the final grade is -4.5 percent. Determine the elevation of the high point of the curve.



A) 60.23 ft.
B) 54.00 ft.
C) 50.43 ft.
D) 104+00 ft.

The Answers is A

P3-149, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.4.6.

400 ft. vertical curve, therefore:

- PVI is at STA 102+00 and PVT is at STA 104+00

Elevation of the PVI is 59' + 0.02(200) = 63 ft.

Elevation of the PVT is 63' – 0.045(200) = 54 ft.

High point elevation requires figuring out the equation for a vertical curve

- At x = 0, y = c => c=59 ft.
- At x = 0, dY/dx = b = G_1 = +2.0%
- a = (G_2 – G_1)/2L = (-4.5 – 2)/(2(4)) = - 0.8125
- $y = -0.8125x^2 + 2x + 59$
- High point is where dy/dx = 0
- dy/dx = -1.625x + 2 = 0
- x = 1.23 stations

Find elevation at x = 1.23 stations

- $y = -0.8125(1.23)^2 + 2(1.23) + 59$
- y = 60.23 ft.

26) A car is traveling at 30 mph in a county at night on a flat wet road. Find the stopping sight distance.

A) 300 ft.
B) 197 ft.
C) 112 ft.
D) 241 ft.

The Answers is B

P3-2, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.2.2.

According to the AASHTO 2004 code, the stopping sight distance for horizontal curves is equal to:

$$S = 1.47.(2.5).V + \frac{V^2}{30(0.347 + G)}$$

G is the slope of the road, for the flat road = 0

Friction coefficient = f = 0.1

V= 30 mph

S= 1.47 . 2.5 . 30 + 30^2/(30*0.347) = 196.71 ft.

27) A roadway is being designed using a 45 mph design speed. One section of the roadway must go up and over a small hill with an entering grade of 3.2 percent and an existing grade of -2.0 percent. How long must the vertical curve be?

A) 115 ft.
B) 450 ft.
C) 317 ft.
D) 270 ft.

The Answers is C

P3-149, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.4.6.

The K-value method of analysis used in the green book is a simplified method of choosing a stopping sight for the crest vertical curve.

$$K = \frac{L}{|G_2 - G_1|} = \frac{L}{A}$$

For 45 mph we get K=61, therefore L = KA = (61)(5.2) = 317.2 ft.

28) A horizontal curve is designed with a 1500 ft. radius. The tangent length is 400 ft. and the PT station is 20+00. What is the PI station?

A) 16+16.3
B) 12+16.3
C) 12+18.2
D) 16+18.2

The Answers is D

P3-18, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.3.

Since we know R and T we can use T = R.tan(delta/2) to get delta

400=1500 tan(delta/2) then delta = 29.86 degrees

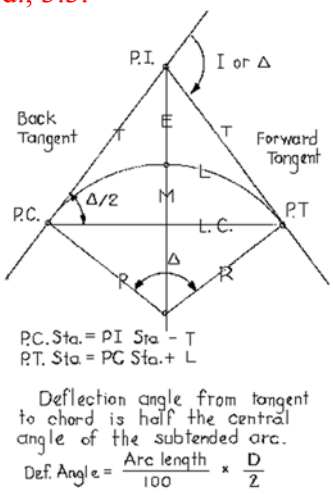
D = 5729.6/R. Therefore D = 3.82

L = 100(delta)/D = 100(29.86)/3.82 = 781 ft.

PC = PT – PI = 2000 – 781 = 12+18.2

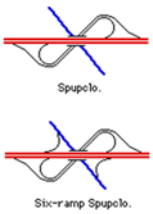
PI = PC +T = 12+18.2 + 400 = 16+18.2.

Note: cannot find PI by subtracting T from PT!



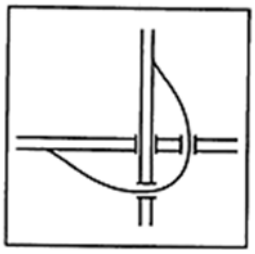
29) In the following intersections layouts, which one is strongly recommended in the urban area and not recommended in the rural areas for the collectors.

A



B

C



D

The Answers is C

P10-1, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 10.2.

According to the AASHTO definitions, the full and half cloverleaf intersections and trumpet are recommended for the rural highways (A, B, and D), and the diamond (C) is recommended for the urban.

30) A district road with a bituminous pavement (friction coefficient=0.16) has a horizontal curve of 500 ft. If the design speed is given equal to 45 mph find the super-elevation.

A) 1 in 10
B) 1 in 20
C) 1 in 30
D) 1 in 40

The Answers is A

P3-43, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed., 3.3.5.

For 45 mph, f = 0.16

$R_v = V^2/15(f+e)$ or $e + f = V^2/15\ R$, then: e (super elevation) = 45^2/(15*500)-0.16 = 0.11 say 0.1

31) Design of horizontal and vertical alignments, super-elevation, sight distance and grades, is worst affected by

A) length of the vehicle
B) height of the vehicle
C) width of the vehicle
D) speed of the vehicle

The Answers is D

P3-18, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed.

This is the definition in AASHTO code. Super elevation, curves, stopping sight distance are all have relation with the speed of vehicle. There is no relation between them and the choices A, B, and C.

32) First operation during the detailed survey of a hill road, is

A) hydrological and soil surveys
B) adjustment of alignment along with curves
C) derivation of longitudinal and cross-sections
D) fixation of Bench Marks

The Answers is D

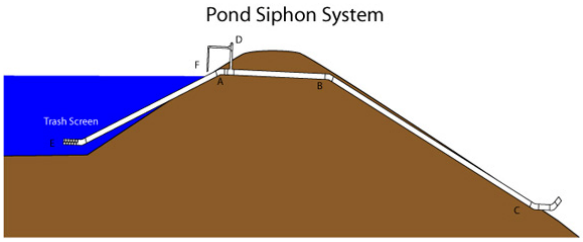
This is the definition in job site and surveying order. It is required to first fix the Bench Marks (BM) according to local agencies files. B and C will be conducted with reference to the BMs. A is an individual action but to do so, the proper location for tests shall be chosen based on the BMs.

33) A siphon is used

A) to fill up a tank with water at higher level from a lower level
B) to connect water reservoirs at different levels intervened by a hill
C) to supply water to a town from higher level to lower level
D) none of these

The Answers is B

A siphon is a bent or curved tube that carries fluid from a container at a high elevation to another container at lower elevation however, the fluid seems to flow "uphill" in a siphon. See the following picture.



34) A 2h storm over a 111 km^2 area produces a total runoff volume of $4*10^6$ m^3 With a peak discharge of 260 m^3/Sec. What is the total excess precipitation?

A) 1.4 cm
B) 2.6 cm
C) 3.6 cm
D) 4.0 cm

The Answers is C

According to the unit hydrograph definition:

V=total volume of runoff = Ad(area of the drainage watershed) * Pave(average precipitation)

Pave= V/Ad = $4*10^6$/ $(111)*10^6$ = 0.036 m = 3.6 cm

35) A 2h storm over a 111 km^2 area produces a total runoff volume of 4*106 m^3 with a peak discharge of 260 m3/Sec., find the unit hydrograph discharge?

A) 72 $m^{3/}$s.cm
B) 120 $m^{3/}$s.cm
C) 210 $m^{3/}$s.cm.
D) 260 $m^{3/}$s.cm

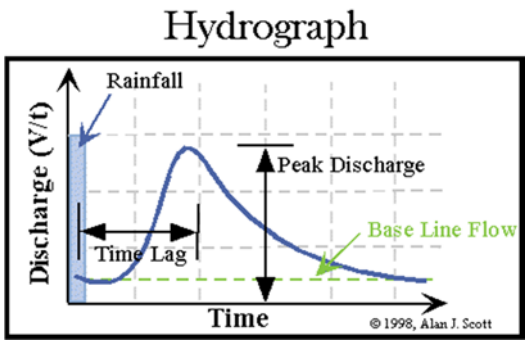
The Answers is A

According to the unit hydrograph definition:

V=total volume of runoff = Ad(area of the drainage watershed) * Pave(average precipitation)

Pave= V/Ad = $4*10^6/ (111)*10^6$ = 0.036 m = 3.6 cm

According to the unit hydrograph definition:



$Q_{p,unit}$ = Peak discharge/P_{ave} = 260/3.6 = 72.2

36) What is the flow rate for a rectangular finished (clean) concrete channel with a base width of 8', channel slope of 0.5%, with a "normal" water depth of 2'?

A) 140 cfs
B) 8.5 cfs
C) 100 cfs
D) 200 cfs

The Answers is A

$$V = \frac{1.49}{n} R_h^{2/3} S^{1/2}$$

n is 0.015, Rh is 8*2 sq.ft./(2+8+2) ft, S is 0.005 ft/ft, so

V = 8.5 ft/sec

Q = V*A= 8.5 ft/sec*16 sq.ft. = 140 cfs

37) The ratio of the depth of flow to the hydraulic radius for the most economical trapezoidal section, in open channel flow is

A) 0.5
B) 1
C) 2
D) 1.2

The Answers is C

The most efficient open channel cross section will maximize the flow for the given Manning coefficient, slope, and flow area. The most efficient trapezoid channel is always one which the flow depth is twice the hydraulic radius. If the side slope is adjustable, the sides of the most efficient trapezoid should be inclined at 60 degree.

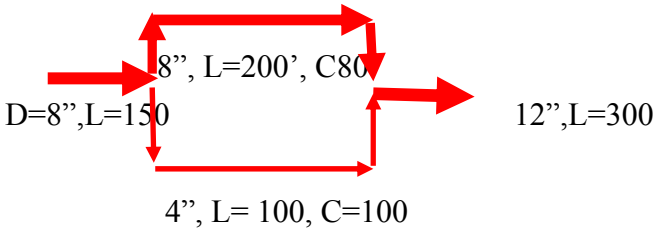
38) When does the silt fence barrier (below picture) be used for the sediment control?

A) It may be constructed of hay and it operates by intercepting and ponding sediment-laden runoff.
B) It may be constructed of fence and it operates by intercepting and ponding sediment-laden runoff.
C) It is a mechanical system spillway
D) It is a silt fence ditch check and shall be used at 100' spacing.

The Answers is B

Choice "A" is the definition for bale slope barrier, "C" is the definition of a spillway, "D" is the ditch with silt fencing. The barrier should be used at the toe of a slope when the ditch does not exist.

39) 5 MGD (million gallon per day) of water flows into the new schedule-40 steel pipe network as shows below. Find the rate of flow in the upper branch.



a. MGD
B) 3.9 MGD
C) 5.0 MGD
D) 1.95 MGD

The Answers is B

Parallel pipes have three principles that govern the distribution of flow between the two branches. 1- head loss are the same for each branch 2- head loss at each junction is the same as each branches, 3- the total flow rate is the sum of the flow rates in the two branches. According to the 3rd principle, $V_t = V_a + V_b$

So:

Diameter = 8" flow area = 50.24 in^2

Diameter = 4" flow area = 12.56 in^2

Using the Hazen-Williams expression for the velocity of flow in the pipe:

$V= (0.55CD^{0.63}hf^{0.54})/L^{0.54}$

$V1= 0.55 * 80 * (8/12)^{0.63} * hf^{0.54} / 200^{0.54} = 1.95\ hf^{0.54}$

The same for lower branch:

$V2=2.28\ hf^{0.54}$

. hf1=hf2

V1*A1/V2*A2 = (1.95 * 50.24) / (2.28*12.56) = 3.42, V2=0.29 V1

Vt =V1+V2 = V1.A1+0.29 V1.A2 = 1.29 V1.A1=1.29 Q1, then Q1= 5MGD/1.29 = 3.87MGD

40) Which one is not correct for design a bridge?

A) Live (truck) loads distribution is prorated to the tributary width (distance between girders) only.
B) Truck loads shall be multiplied by the impact factor.
C) A bridge in the horizontal curve shall be designed for the centrifugal force.
D) For design of the bridge piers, all vertical and horizontal loads shall be combined according to the AASHTO code.

The Answers is A

P4-33, AASHTO LRFD Bridge Design Specification 2010, 5th ed. 4.6.2.

Live load distribution is prorated to the tributary width, slab, and girders' stiffness in the AASHTO bridge design manual, 2010. Dead loads are distributed only with the tributary width. So A is not correct. All other choices are definitions and correct.

Third PE Style Exam (AM) Questions

1) For the given following data on precedence relationship and duration network, find the project duration (total float) by using the critical path method (CPM).

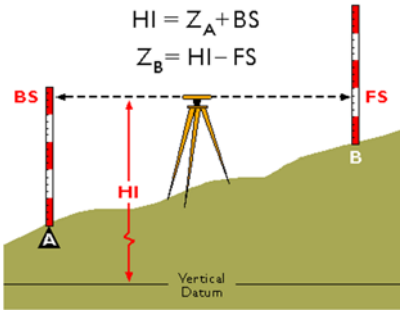
Activity	Description	Predecessors	Duration
A	Field Surveying	-	10
B	Soil studies	-	15
C	Conceptual design	A	12
D	Structural Basic design	A	14
E	Architectural Basic Design	B,C	20
F	Landscape Basic Design	B,C	10
G	Structural Detail Design	D,E	10
H	Architectural Detail Design	D,E	20
I	Material take off	F,G	5

A) 116 B) 44

C) 57 D) 55

2) A surveyor recorded the following leveling measurements. Then he changed the position of the level with the new height of the level and read 2 new numbers for the BS and FS for the same spots (A&B) that he read in the first measurements. If the height of level in the first measurement was 3.5 ft and in the second reading was 4.5 ft, find the elevation of "B" for both measurements.

Station	BS	FS
A, Elevation = 130	3.3	
B		1.5



A) 1+30

B) 1+31.2

C) 1+33

D) 1+31.8

3) You are a contractor and have made a bid sheet for a construction project as follows. Excavation for this project is to occur in the winter meaning it will take more time for the crew to complete this task. You have calculated that this extra time will increase the labor cost by 27%. How much are you charging the client for the excavation work given the new situation?

RECAP SHEET FOR UNIT PRICE BID

Project: Holloman Taxiways and Aprons **Bid Date:** August 9, 20-- **Estimator:** GAS

Item No.	Bid Item	Unit	Estimated Quantity	Labor Cost	Equipment Cost	Material Cost	Subcontract Cost	Direct Cost	Bid	
									Unit	Total
1	Clearing	l.s.	job	$5,139	$11,097	-	-	$16,236	$20,132.64	$20,133
2	Demolition	l.s.	job	$5,726	$7,383	-	-	$13,109	$16,255.16	$16,255
3	Excavation	c.y.	127,000	$75,636	$175,194	-	-	$250,830	$311,029.20	$311,029
4	Base Course	ton	79,500	$352,670	$651,995	$159,479	-	$1,164,144	$1,443,538.56	$1,443,539
5	Concrete Pavement, 9"	s.y.	90,000	$1,001,795	$202,708	$791,063	-	$1,995,566	$2,474,501.84	$2,474,502
6	Concrete Pavement, 11"	s.y.	115,400	$1,572,819	$318,252	$1,241,967	-	$3,133,038	$3,884,967.12	$3,884,967
7	Asphalt Concrete Surface	ton	150	$1,035	$1,304	$2,208	-	$4,547	$5,638.28	$5,638
8	Concrete Pipe, 12"	l.f.	1,000	$5,183	$5,439	$15,477	-	$26,099	$32,362.76	$32,363
9	Concrete Pipe, 36"	l.f.	300	$2,937	$3,756	$6,809	-	$13,502	$16,742.48	$16,742
10	Inlet	ea.	2	$111	$164	$801	-	$1,076	$1,334.24	$1,334
11	Fiber Duct, 4-way	l.f.	600	$3,278	$10,367	$5,126	-	$18,771	$23,276.04	$23,276
12	Fiber Duct, 8-way	l.f.	1,200	$9,035	$20,576	$16,095	-	$45,706	$56,675.44	$56,675
13	Electrical Manhole	ea.	6	-	-	-	$9,315	$9,315	$11,550.60	$11,551
14	Underground Cable	l.f.	34,000	-	-	-	$255,957	$255,957	$317,386.68	$317,387
15	Taxiway Lights	ea.	120	-	-	-	$45,710	$45,710	$56,680.40	$56,680
16	Apron Lights	ea.	70	-	-	-	$26,313	$26,313	$32,628.12	$32,628
17	Taxiway marking	l.s.	job	$3,560	$675	$4,683	-	$8,918	$11,058.32	$11,058
18	Fence	l.f.	26,000	$28,506	$7,977	$129,477	-	$165,960	$205,790.40	$205,790
			Totals	**$3,067,430**	**$1,416,887**	**$2,373,185**	**$337,295**	**$7,194,797**		**$8,921,548**
						Job Overhead		$272,091		
								$7,466,888		
						Markup, 15%		$1,120,033		
								$8,586,921		
						Bond		$71,815		
								$8,658,736		
						Sales Tax		$259,762		
						Total Project Bid		**$8,918,498**		

Factor = $8,921,548 / $7,194,797 = 1.240

A) $271,252

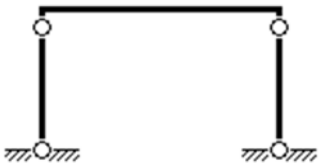
B) $318,553

C) $336,352

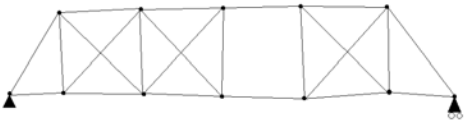
D) $395,007

4) Which one is a stable structure?

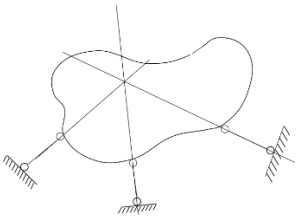
A)



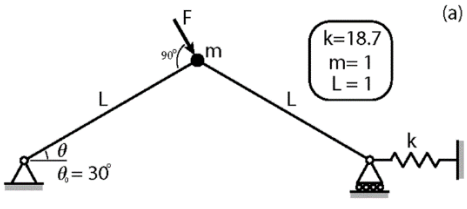
B)



C)



D)



5) For a retaining wall with 9’ height find the maximum lateral pressure on the wall forms.

A) 150 psf B) 1350 psf

C) 1500 psf D) 1000 psf

6) The following formwork should support the 22’ by 20’ slab. Find the live load from personnel and equipment acting temporary during construction on this formwork if it is classified as heavy duty construction.

A) LL=75 psf B) LL= 73 psf

C) LL= 37.5 psf D) LL=70 psf

7) An auger works on the pile foundations as shown in the following picture. The pile diameter is given equal to 4’ and pile depth is 60’. If price of auger including the freight expenses is $1,000,000. The expected cost including 20% profit for each cubic yard is determined as $100 per cubic yard. How many piles should this auger make to compensate the original price from the profit?

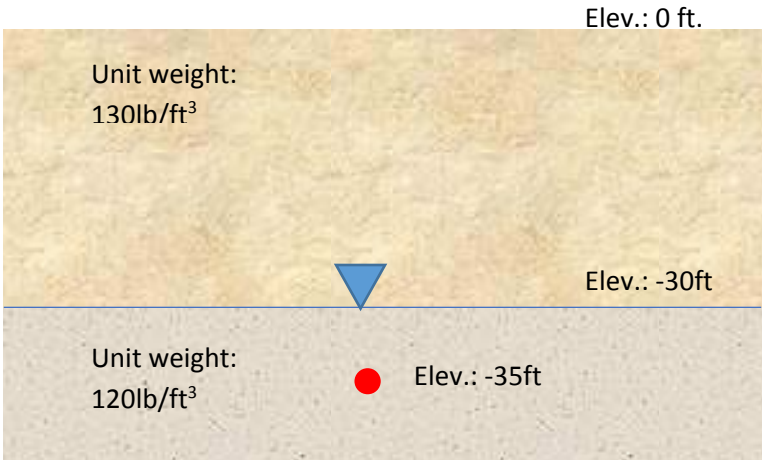
A) 1200 pile

B) 2000 piles

C) 1786 piles

D) 2500 piles

8) The clay stratum is shown in the profile below. It is known that the voids ratio of the red point is 0.9. Assume the compression index is known to be 0.64. Determine the value of pressure when voids ratio is 0.8.



A) 3000lb/ft^2 B) 4000lb/ft^2 C) 6000lb/ft^2 D) 5000lb/ft

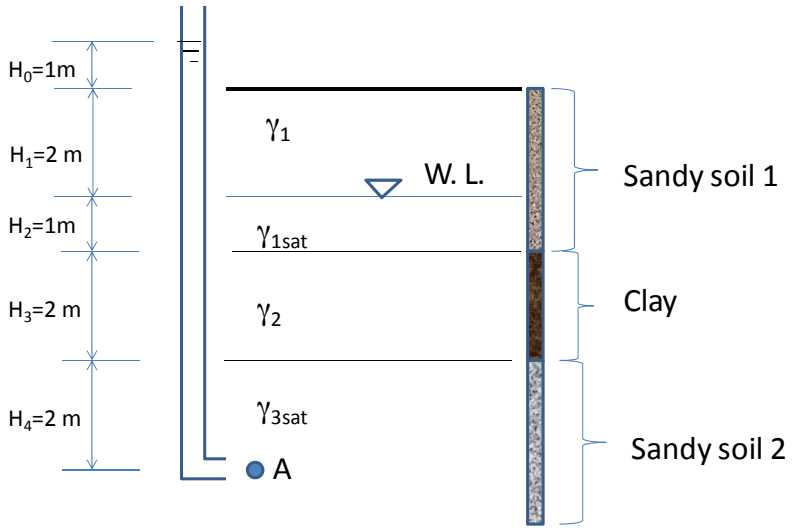
9) A shallow foundation is to be constructed below the ground surface in a uniform cohesionless sand. It is found that the bearing capacity ratio for cohesion of soil below the foundation, N_c, is 50. What is the bearing capacity ratio for the vertical effective stress at the elevation of the foundation base, N_q?

A) 38 B)43 C) 60 D)74

10) In which condition the soil may have the maximum consolidation?

A) Soil with passing less than 30% from sieve #4
B) Soil with passing more than 80% from sieve #200 with high plasticity index
C) GC
D) ML

11) As shown in the figure below, a clay layer exists between two sandy soil layers. The underground water level is 1 m below the ground. The second sandy soil layer contains confined water. At a point A, which is 7 m below the ground (in the second sandy soil layer), the head of water pressure is 1 m above the ground. It is known that the unit weight of soil above the water level is 16.5 kN/m3, the saturated unit weight of the first layer of sandy soil below the water level is 19.2 kN/m3, the saturated unit weight of the second layer of sandy soil is 20.2 kN/m3, the saturated unit weight of the clay soil is 18.4 kN/m3, Determine the effective vertical soil pressure at point A.

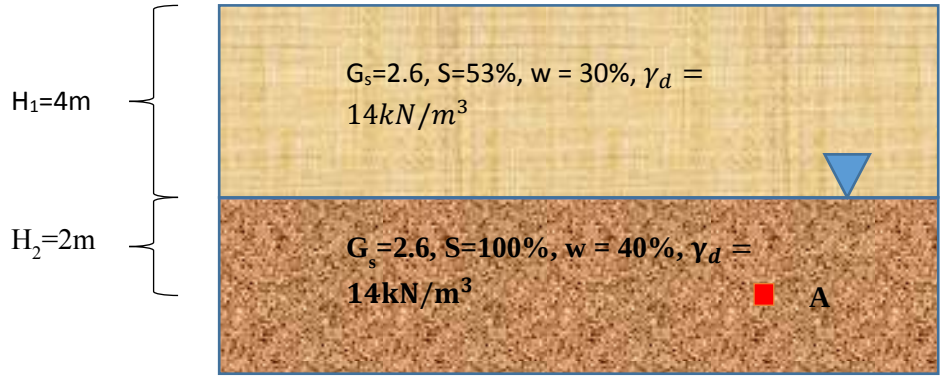


A) 23 kPa B) 35 kPa C) 51 kPa D) 88 kPa

12) What is the cause for the swell of soils during the excavation?

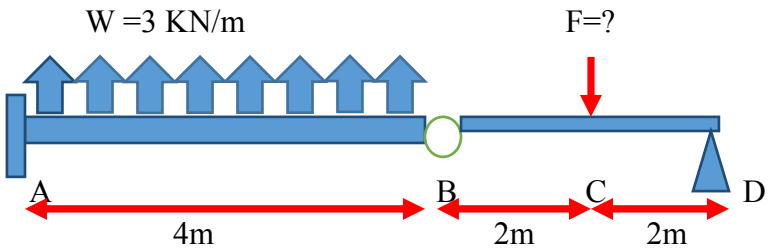
A) Occures in the clayey soil when a higher moisture content existed than pior to excavation.
B) Occures in the fine sand during excavation becasuse of increasing the void ratios
C) Occures in all type of soils due to increasing the prosity
D) Swell is just an assumption to have safety factor for the earth work estimations.

13) An uniform desposit soil is shown in the following diagram. Information of soil in each layer is given. Calculate the effective stress for a soil element at point A.



A) 90kPa B) 80kPa C) 85kPa D) 75kPa

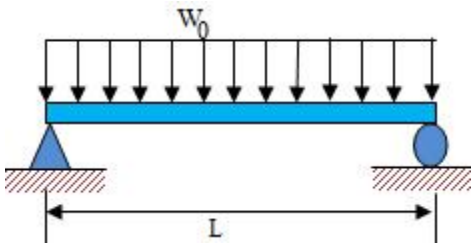
14) For the following beam if load w=3 KN/m what force should apply on BD so that the shear Force at A is zero?



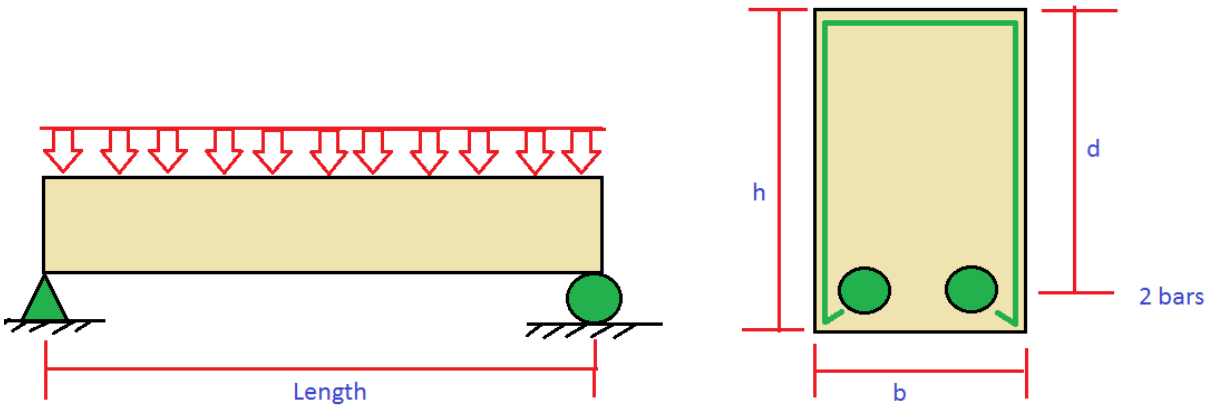
A) 24KN.
B) 44KN.
C) 64KN.
D) 84KN.

15) In the below picture, find the maximum shear and moment in a simply supported beam that is loaded with uniform load of w0.

A) V= w0L, M= w0L2/4
B) V= w0L/2, M= w0L/8
C) V= w0L/2 , M= w0L2/8
D) V= 2 w0L, M= w0L2/12

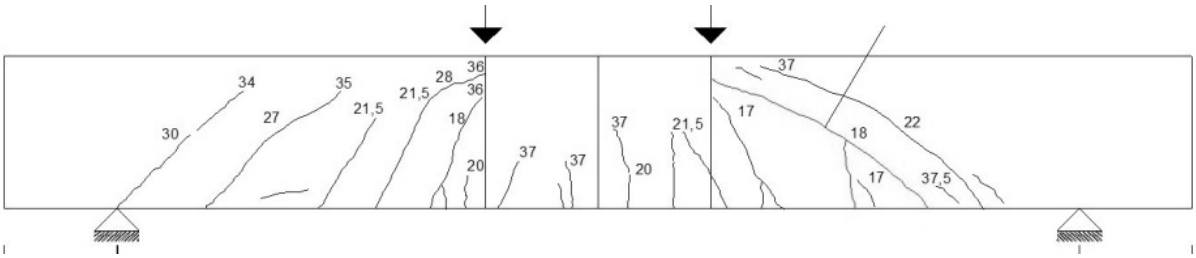


16) A 10 ft long simply supported concrete beam subject to a uniformly distributed load is reinforced with two #6 bars at a depth of 13 in. The cross section is 6 in wide and 16 in tall. The factored shear load at the supports is 6.6 kips. Assume # 3 stirrups are used for shear support. $f_y = 60000$ psi, $f'_c = 4000$ psi. Determine the required spacing for shear reinforcement at the supports in the beam.



A) 8 in B) 44 in
C) 6.5 in D) 24 in

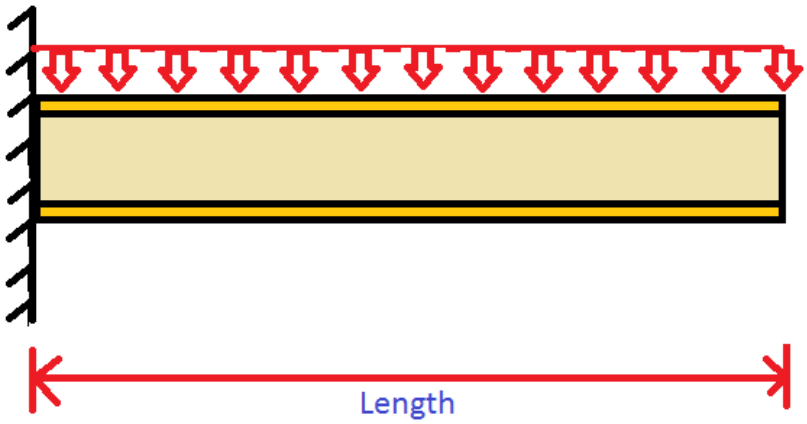
17) Refer to the picture below, which pattern shows the pure shear crack in the reinforced concrete beam test results?



A) 37 B) 18

C) 28 D) 30

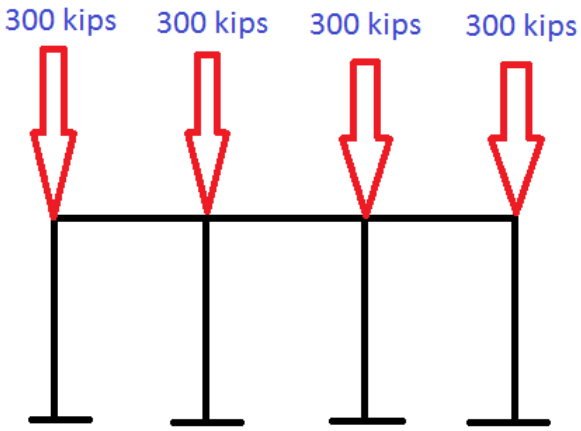
18) A circular beam with 6" diameter that is 20 ft long is fixed to a wall at one end and free at the other. A uniformly distributed load of 0.3 kip/ft respectively are applied to the beam. The beam is fully braced. Find the maximum elastic stress.



A) 25 KSI B) 50 KSI

C) 41 KSI D) 34 KSI

19) A set of interior columns are being designed. The columns are continuously braced perpendicular to the frame. The girders between the columns are W 16 X 45 members and the Columns are W 12 X 79. The columns span 35 feet apart and are 20 feet in height. Assume Fy = 50ksi and Fu = 65ksi. Columns are not braced in plane. The base of each column is tied to the foundation and all other connections are rigid. Determine the available critical stress assuming K = 1.2.



A) 29.5 ksi B) 27 ksi

C) 25 ksi D) 23.5 ksi

20) A gutter at the side of a street has a curb height of 8 inches, slope along the length of the street of 0.7%, and Manning n=0.032. The pavement slopes from the center of the street to the gutter at 5%. What is the flow capacity of this gutter?

A) 4.9 cfs
B) 8.0 cfs
C) 11.1 cfs
D) 14.7 cfs

21) Water from a 175-ac light industrial watershed is collected and drained by a trapezoidal open channel. The channel (Manning' roughness coefficient, n = 0.02) has a 4.5-ft-wide bottom and 1:1 sides. The channel direction is perpendicular to a road where twin, side-by-side 54-in-diameter corrugated metal pipe (CMP) culverts take the water under the roadway. The average slope of the channel and culverts is 0.75% (i.e., 0.0075 ft/ft). The time for runoff from the farthest part of the watershed to begin contributing to the flow is 35 min. - Using the rational method and assuming the intensity after 35 min is 2 in/hr, what is the runoff?

A) $308\ \frac{ft^3}{sec}$ B) $180\ \frac{ft^3}{sec}$

C) $228\ \frac{ft^3}{sec}$ D) $340\ \frac{ft^3}{sec}$

22) A parking lot adjoining a shopping center has a surface area of 3.5 acres. A rainstorm that delivers rainfall at a rate of 2.5 inches/hour occurs. The parking area has a runoff coefficient C=0.7. What is the peak runoff from the parking lot during this rainstorm?

A) 0.62 cfs B) 2.5 cfs C) 6.13 cfs D) 25 cfs

23) A 10 acre basin stores approximately 7.0 inches of water. What is the runoff for the given basin for a 2-hr storm with an average of 0.5 in/hr of rainfall?

A) 0 inches B) 0.02 inches C) 0.05 inches D) 0.10 inches

24) A horizontal pipeline carries water at a discharge of 13.5 cfs. Upstream of a contraction the pipe diameter is 24 inches and pressure is 14 psi, while downstream of the contraction the diameter is 18 inches. Neglecting head loss, what is the pressure downstream?

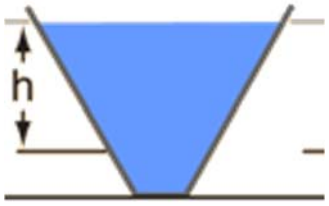
A) 11.2 psi

B) 13.7 psi

C) 14.2 psi

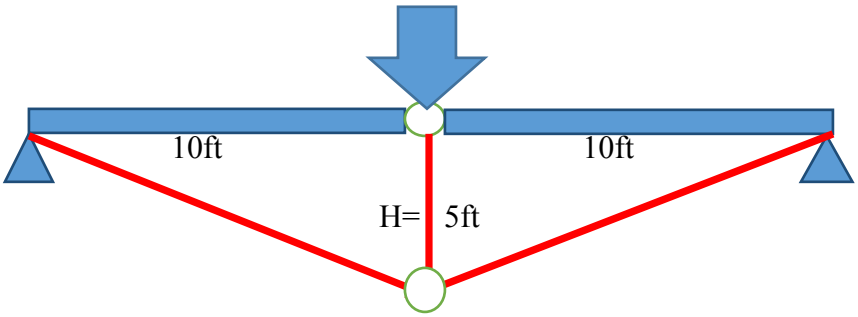
D) 15.9 psi

25) Which one has more pressure at the depth of h = 10 ft? (the inclined surfaces has the measure of angle of 60 degree.)



A) 624 psf B) 62.4 psf C) 312 psf D) 1248 psf

26) Find the bending moment in the below beam for the concentrated load given equal to 5 Kips?

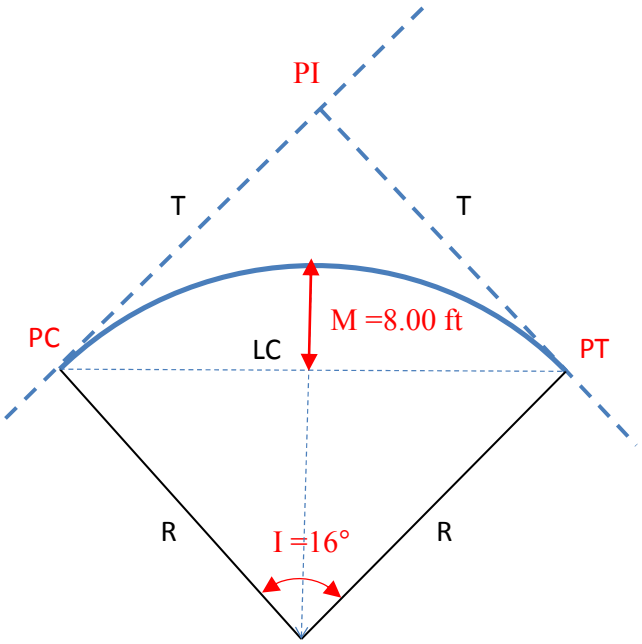


A) 25 Kips-ft B) 5 kips-ft
C) 0.00 Kips-ft D) none of them

27) An equal-tangent crest vertical curve is to connect grades of +2.0% and -3%. The design sight distance on the curve is 645 ft. Determine the minimum length of the curve to meet the sign distance requirement. (Assume the height of driver's eyes above the roadway surface is 3.5 ft, and the height of object above the roadway surface is 2.0 ft.)

A) 689.50 ft B) 963.91 ft C) 734.30 ft D) 878.40 ft

28) A horizontal circular curve has an intersection angle of 16°. The length of middle ordinate (M) is 8.00 ft. The radius (ft) of the curve is most nearly



A) 401.9 B) 786.4 C) 4.0 D) 822.0

29) Given the following traffic count data:

Time Interval	No. of Vehicles
8:00-8:15	1400
8:15-8:30	1600
8:30-8:45	2200
8:45-9:00	1800

The peak hour factor is closest to:

A) 0.795 B) 0.880

C) 0.650 D) 0.945

30) A sieve analysis on a non-organic soil reveals that 82% of the soil passes No. 200 sieve (0.075 mm). The liquid limit of the soil is 24%, and the soil has a medium toughness and a very slow dilatancy. Classify the soil according to the Unified Soil Classification system (USCS).

A) GC B) ML C) CL D) CH

31) In a falling head permeability test on a soil sample, the following data are available:

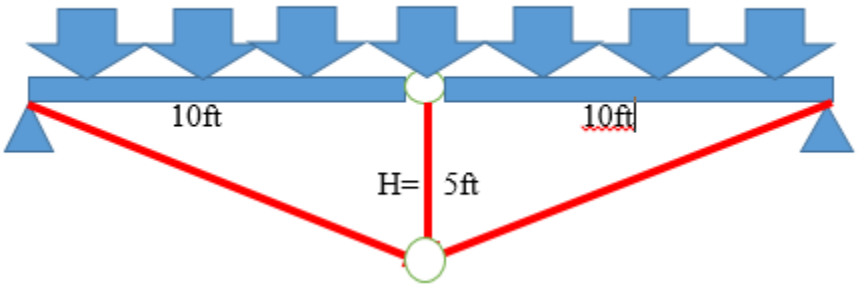
Cross-sectional area of soil = 60 cm^2
Length of soil = 10 cm
Initial head =120 cm
Final head = 108 cm
Duration of test = 20 minutes
Diameter of tube = 8 mm
Determine the coefficient of permeability of the soil, k.

A) 7.4 cm/sec B) 7.36×10^{-6}cm/sec
C) 5.8×10^{-6}cm/sec D) 4.60×10^{-6}mm/sec

32) A concrete mixture has a 60:40 ratio of coarse aggregates to fine aggregates. When mixed separately, 250lbs of coarse aggregates are capable of fitting in a 3ft3 container and 200lbs of fine aggregates are capable of fitting in a 2ft3 container. Determine the bulk density of the concrete mixture with a 50:50 ratio.

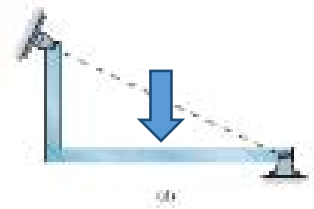
A) 80lb/ft3
B) 87lb/ft3
C) 90lb/ft3
D) 97lb/ft3

33) Find the bending moment in the below beam for the uniform load given equal to 5 Kips/ft?



A) 250 kips-ft
B) 125 kips-ft
C) 62.5 kips-ft
D) 500 kips-ft

34) For the shown structure, the horizontal length is 10ft and vertical length is given as 8 ft. The force applied at the mid-span and is equal to 20 Kips. The inclined support is a roller support. Find the bending moment in the structure?

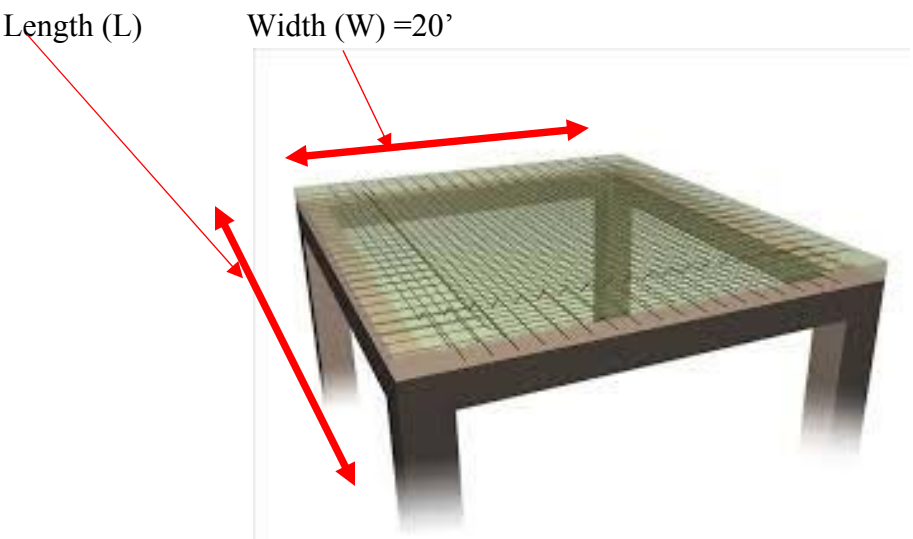


A) 50 kips-ft B) 40 kips-ft C) 0.00 kips-ft D) 60 kips-ft

35) Given a soil fill sample with a weight of 62 lbs and a total volume of 864 in3 and a water content of 15%, determine the percent relative compaction of the sample if the maximum dry unit weight is 115pcf.

A) 93.8% B) 95.2%
C) 102% D) 127%

36) For the reinforced concrete slabs like the following picture, if the width is given equal to 20', then what would be the maximum length of the slab if the designer wants to have two way slab and have the following reinforcement arrangement?



A) 40' B) 10'

C) 20' D) 50'

37) For the following excavation shown below the contractor has used the nailing system to secure the project. Who should be the first person for inspection of the nailing system?

A) Trained person B) Site supervisor

C) Competent person D) anyone in the site with engineering degree

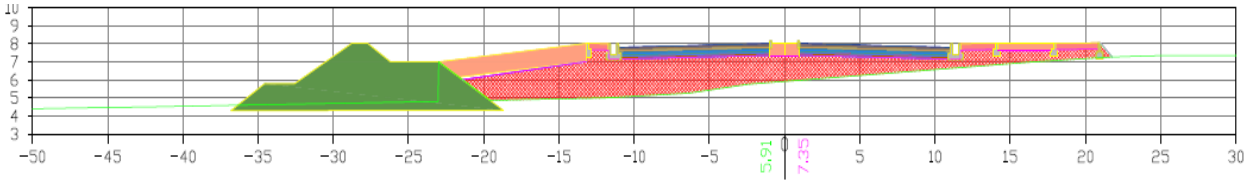
38) Find the zone of influence for the following excavation where there is no soldier piles. Neglect the brick made counterforts.

Depth of excavation = 30 ft

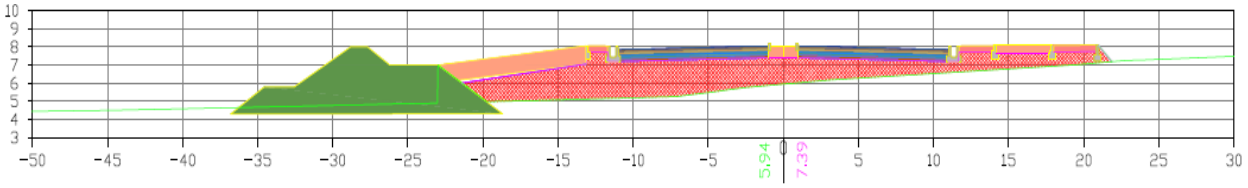
A) 22.6 ft B) 30 ft C) 32 ft D) 21.2 ft

39) Refer to the figures, the net excavation (yd3) from section 78 (14+20) (100s of ft) to section 80 (15+80) is most nearly:

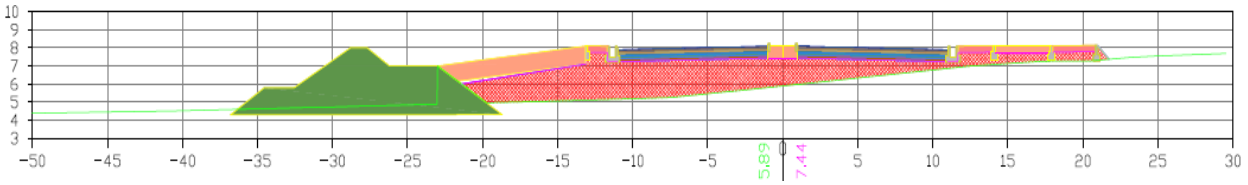
Cut= 0.00 ft^2 Fill=555.6 ft^3 Sec. 80, 15+80



Cut= 0.00 ft^2 Fill=680.2 ft^3 Sec. 79, 15+00



Cut= 421.3 ft^2 Fill=0.00 ft^3 Sec. 78, 14+20



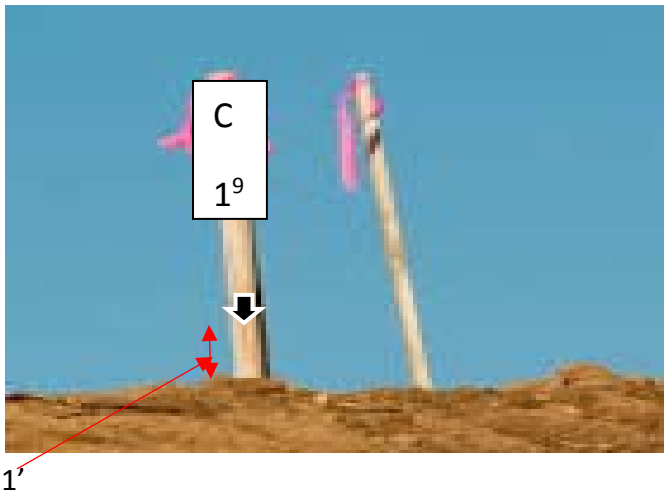
A) 3462

B) 59788

C) 4000

D) 2214

40) The site manager put the mark of "C" and the following numbers on the lath stake. The ground elevation is given equal to +20.00. The surveyor measured 1' for the distance between horizontal line and the ground surface. With that sign what would be the final elevation:



A) +21.90

B) +19.10

C) +17.10

D) +18.10

Solutions

Third Style Exam

1) For the given following data on precedence relationship and duration network, find the project duration (total float) by using the critical path method (CPM).

Activity	Description	Predecessors	Duration
A	Field Surveying	-	10
B	Soil studies	-	15
C	Conceptual design	A	12
D	Structural Basic design	A	14
E	Architectural Basic Design	B,C	20
F	Landscape Basic Design	B,C	10
G	Structural Detail Design	D,E	10
H	Architectural Detail Design	D,E	20
I	Material take off	F,G	5

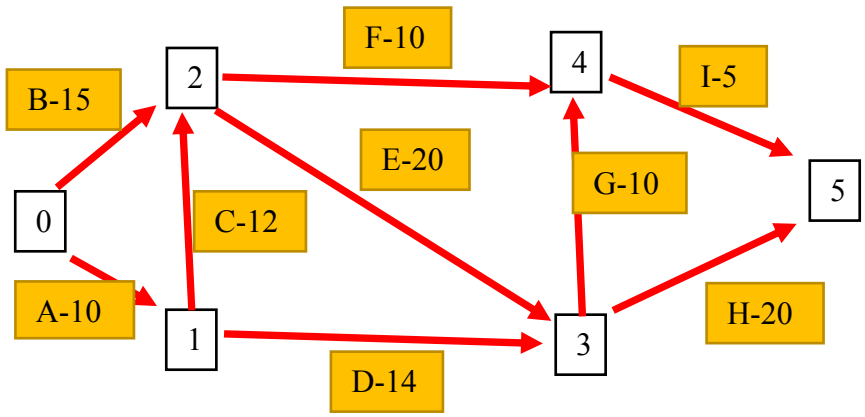
A) 116 B) 44

C) 57 D) 55

The Answers is C

This is the project scheduling problem.

The Activity on Branch representation for this project including durations is:



Project duration can be calculated as:

Path 0-1-2 = 22

Path 0-2 = 15 <22, this is a interfering float (subsequent task)

So, the total float for 0-1-2 is 22 days

Path 2-3-4=20+10= 30

Path 1-3=14 <20, this is a interfering float (subsequent task)

Path 2-4= 10 <30, this is a interfering float (subsequent task)

So the total float for 2-3-4 is 30 days

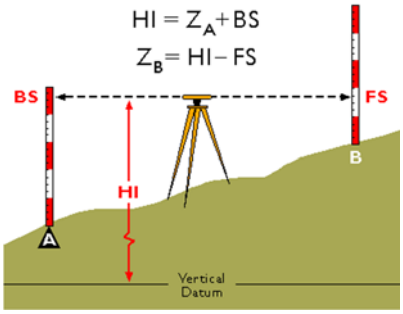
Path 2-3-4-5 =35

Path 1-3-5=34 <35 so the total float for 2-3-4-5 is 35 days

So the project total float (0-1-2-3-4-5) will be: 22+35= 57 days

2) A surveyor recorded the following leveling measurements. Then he changed the position of the level with the new height of the level and read 2 new numbers for the BS and FS for the same spots (A&B) that he read in the first measurements. If the height of level in the first measurement was 3.5 ft and in the second reading was 4.5 ft, find the elevation of "B" for both measurements.

Station	BS	FS
A, Elevation = 130	3.3	
B		1.5



A) 1+30 B) 1+31.2

C) 1+33 D) 1+31.8

The Answers is D

This is the surveying problem for the using of the level measures. The height between two points are given equal to: Back sight (BS) - Foresight (FS) = height, positive answer means FS is higher than the BS.

The tricky part is the height of the level does not effect on the elevation measurements, so there is no relation between the heights of level for different readings.

A to B = BS-FS= 3.3-1.5= +1.8

Elevation at B = Elevation at A + height = 130 + 1.8 = 131.8=1+31.8

3) You are a contractor and have made a bid sheet for a construction project as follows. Excavation for this project is to occur in the winter meaning it will take more time for the crew to complete this task. You have calculated that this extra time will increase the labor cost by 27%. How much are you charging the client for the excavation work given the new situation?

RECAP SHEET FOR UNIT PRICE BID

Project: Holloman Taxiways and Aprons **Bid Date:** August 9, 20-- **Estimator:** GAS

Item No.	Bid Item	Unit	Estimated Quantity	Labor Cost	Equipment Cost	Material Cost	Subcontract Cost	Direct Cost	Bid	
									Unit	Total
1	Clearing	l.s.	job	$5,139	$11,097	-	-	$16,236	$20,132.64	$20,133
2	Demolition	l.s.	job	$5,726	$7,383	-	-	$13,109	$16,255.16	$16,255
3	Excavation	c.y.	127,000	$75,636	$175,194	-	-	$250,830	$311,029.20	$311,029
4	Base Course	ton	79,500	$352,670	$651,995	$159,479	-	$1,164,144	$1,443,538.56	$1,443,539
5	Concrete Pavement, 9"	s.y.	90,000	$1,001,795	$202,708	$791,063	-	$1,995,566	$2,474,501.84	$2,474,502
6	Concrete Pavement, 11"	s.y.	115,400	$1,572,819	$318,252	$1,241,967	-	$3,133,038	$3,884,967.12	$3,884,967
7	Asphalt Concrete Surface	ton	150	$1,035	$1,304	$2,208	-	$4,547	$5,638.28	$5,638
8	Concrete Pipe, 12"	l.f.	1,000	$5,183	$5,439	$15,477	-	$26,099	$32,362.76	$32,363
9	Concrete Pipe, 36"	l.f.	300	$2,937	$3,756	$6,809	-	$13,502	$16,742.48	$16,742
10	Inlet	ea.	2	$111	$164	$801	-	$1,076	$1,334.24	$1,334
11	Fiber Duct, 4-way	l.f.	600	$3,278	$10,367	$5,126	-	$18,771	$23,276.04	$23,276
12	Fiber Duct, 8-way	l.f.	1,200	$9,035	$20,576	$16,095	-	$45,706	$56,675.44	$56,675
13	Electrical Manhole	ea.	6	-	-	-	$9,315	$9,315	$11,550.60	$11,551
14	Underground Cable	l.f.	34,000	-	-	-	$255,957	$255,957	$317,386.68	$317,387
15	Taxiway Lights	ea.	120	-	-	-	$45,710	$45,710	$56,680.40	$56,680
16	Apron Lights	ea.	70	-	-	-	$26,313	$26,313	$32,628.12	$32,628
17	Taxiway marking	l.s.	job	$3,560	$675	$4,683	-	$8,918	$11,058.32	$11,058
18	Fence	l.f.	26,000	$28,506	$7,977	$129,477	-	$165,960	$205,790.40	$205,790
			Totals	**$3,067,430**	**$1,416,887**	**$2,373,185**	**$337,295**	**$7,194,797**		**$8,921,548**
						Job Overhead		$272,091		
								$7,466,888		
						Markup, 15%		$1,120,033		
								$8,586,921		
						Bond		$71,815		
								$8,658,736		
						Sales Tax		$259,762		
						Total Project Bid		**$8,918,498**		

Factor = $8,921,548 / $7,194,797 = 1.240

A) $271,252

B) $318,553

C) $336,352

D) $395,007

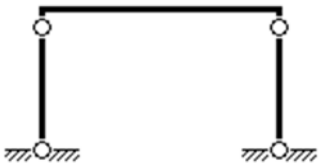
Answer "C" is correct:

The new labor cost for the excavation = $75,636+$75,636*27% = $96057.72 The cost of the equipment stay the same, thus the direct cost of the excavation is = $96057.72+$175,194 = $271,251.72.

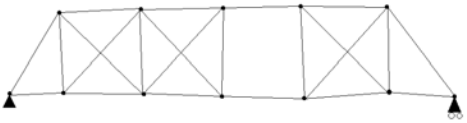
The charge to the client is $271,251.72*1.24=$336,352.13

4) Which one is a stable structure?

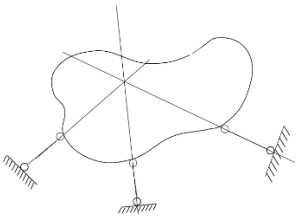
A)



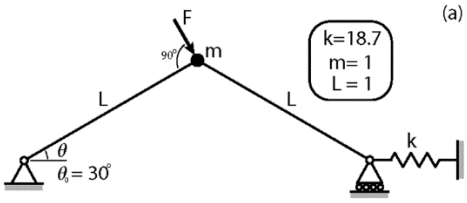
B)



C)



D)



The Answers is D

Choice "A" is a mechanism because of 4 pinned connections.

Choice "B", Calculations shows that it is an indeterminate structure and thus stable, but it is not correct, because one of the bays without diagonals make a mechanism.

Choice "C" is the definition for the geometric instability, if all reactions passes through one point although it satisfies the number of equations.

Choice "D" is the answer, the spring represents the fact of material stiffness in the calculations.

5) For a retaining wall with 9’ height find the maximum lateral pressure on the wall forms.

A) 150 psf B) 1350 psf

C) 1500 psf D) 1000 psf

The Answers is B

This is the job site work problem. ASCE 37-02, 4.7.1

According to the ASCE 37-02 the lateral pressure from fresh concrete is to be taken as the hydrostatic pressure:

$$C_c = w * h$$

W= concrete density = 150pcf so, Cc=150*9 =1350 psf

6) The following formwork should support the 22’ by 20’ slab. Find the live load from personnel and equipment acting temporary during construction on this formwork if it is classified as heavy duty construction.

A) LL=75 psf B) LL= 73 psf

C) LL= 37.5 psf D) LL=70 psf

The Answers is B

ASCE 37-02

Area of the formwork = 22*20 = 440 sf > 400 sf

So, the following reduction may be used for the actual live load on the form work:

$$C_p = L_o\left(0.25 + \frac{15}{\sqrt{A_I}}\right)$$

For the heavy duty construction Lo = 75 psf

AI =the influence area greater than 400 sf = 440 sf

So, Cp= 0.96*75 = 72.4 psf

7) An auger works on the pile foundations as shown in the following picture. The pile diameter is given equal to 4' and pile depth is 60'. If price of auger including the freight expenses is $1,000,000. The expected cost including 20% profit for each cubic yard is determined as $100 per cubic yard. How many piles should this auger make to compensate the original price from the profit?

A) 1200 pile

B) 2000 piles

C) 1786 piles

D) 2500 piles

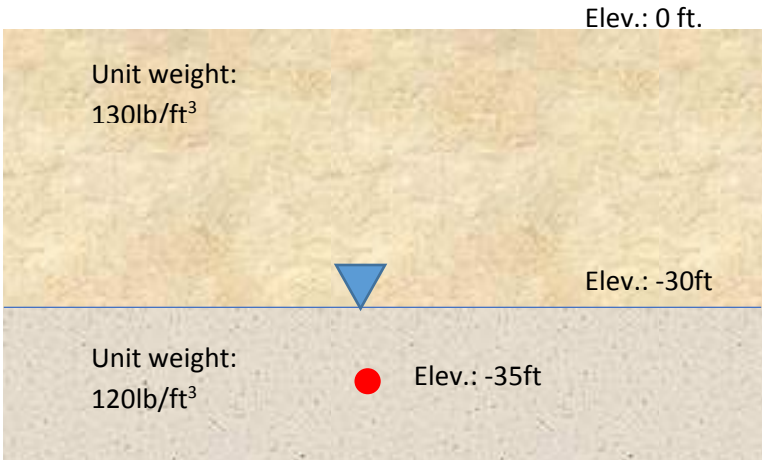
The Answers is C

Volume of each pile = $A = \pi r^2 * h = 3.14 * 2^2 * 60 = 753.6\ cf = 27.9\ say\ 28\ CY$

Cost of each pile = 28*100 = $2800, Profit = 20%, So Profit = $2800*0.2 = $560

Number piles = $1,000,000 /$560 = 1785.7 = 1786 piles

8) The clay stratum is shown in the profile below. It is known that the voids ratio of the red point is 0.9. Assume the compression index is known to be 0.64. Determine the value of pressure when voids ratio is 0.8.



A) 3000lb/ft^2 B) 4000lb/ft^2 C) 6000lb/ft^2 D) 5000lb/ft

The Answers is C

Step1: Initial effective consolidation stress can be calculated based on the information mentioned above,

$p_0 = \gamma_1{}' H_1 + \gamma_2{}' H_2$

$p_0 = (130lb/ft^3)(30ft) + (120lb/ft^3 - 62.5lb/ft^3)(35ft - 30ft) = 4188lb/ft^2$

Step2: Based on the equation shown below, the voids ratio can be solved by,

$p_2 = p_1 10^{\frac{e_1 - e_2}{C_c}} = (4188lb/ft^2)10^{\frac{0.9-0.8}{0.64}} = 6000lb/ft^2$

~6000lb/ft2

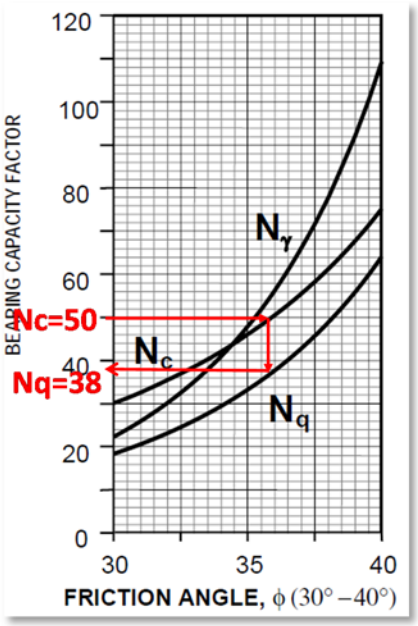
9) A shallow foundation is to be constructed below the ground surface in a uniform cohesionless sand. It is found that the bearing capacity ratio for cohesion of soil below the foundation, N_c, is 50. What is the bearing capacity ratio for the vertical effective stress at the elevation of the foundation base, N_q?

A) 38 B)43 C) 60 D)74

The Answers is A

Step 1:

From the figure shown, it can be found that when $\mathbf{N_c = 50}$, the friction angle is 36°.



Step2:

For a friction angle of 36°, the bearing capacity ratio for the vertical effective stress at the elevation of the foundation base, $\mathbf{N_q}$, is 38.

10) In which condition the soil may have the maximum consolidation?

A) Soil with passing less than 30% from sieve #4
B) Soil with passing more than 80% from sieve #200 with high plasticity index
C) GC
D) ML

The Answers is B

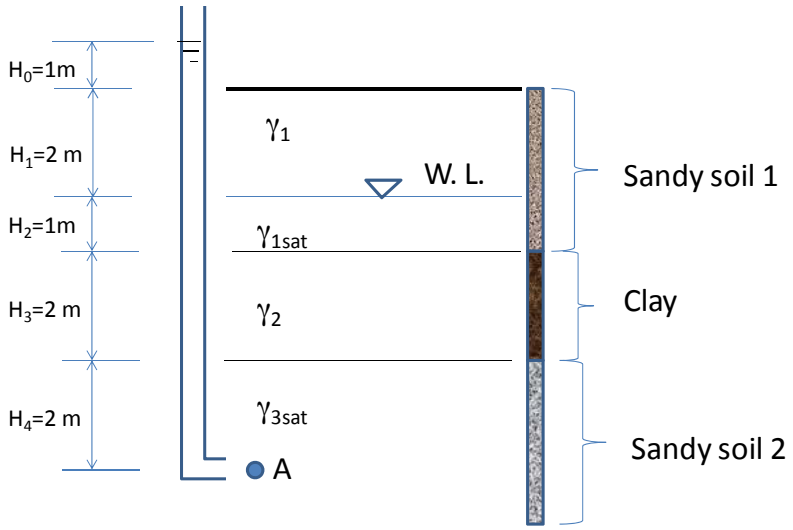
Choice “A” Less than passing from Seive #4 means the soil is granular and no consulidation will occure for these kind of soils. Elastic setlemnt expected which is not the question, however it is usually less than consulidation.

Choice “C” is in the same concept with “A”

Coice “D” shows silt, consulidation is likely but the it is less than clay.

Choice “B” shows Clay soil because of size and the plasticity, so the consolidation of this soil has the maximum value.

11) As shown in the figure below, a clay layer exists between two sandy soil layers. The underground water level is 1 m below the ground. The second sandy soil layer contains confined water. At a point A, which is 7 m below the ground (in the second sandy soil layer), the head of water pressure is 1 m above the ground. It is known that the unit weight of soil above the water level is 16.5 kN/m3, the saturated unit weight of the first layer of sandy soil below the water level is 19.2 kN/m3, the saturated unit weight of the second layer of sandy soil is 20.2 kN/m3, the saturated unit weight of the clay soil is 18.4 kN/m3, Determine the effective vertical soil pressure at point A.



A) 23 kPa B) 35 kPa C) 51 kPa D) 88 kPa

The Answers is C

Effective stress σ' is equal to the total stress σ minus pore water pressureu. $\sigma' = \sigma - u$.

The total stress σ is calculated by $\sigma = \gamma_1 H_1 + \gamma_{1sat} H_2 + \gamma_2 H_3 + \gamma_{3sat} H_4 = (16.5\ kN/m^3)(2\ m) + (19.2\ kN/m^3)(1\ m) + (18.4\ kN/m^3)(2\ m) + (20.2\ kN/m^3)(2\ m) = 129.4\ kPa$

The pore water pressure u is calculated by $u = \gamma_w H = (9.8\ kN/m^3)(1\ m + 2\ m + 1\ m + 2\ m + 2\ m) = 78.4\ kPa$

The effective stress σ' is

$$u = \sigma - u = 129.4\ kPa - 78.4\ kPa = 51\ kPa$$

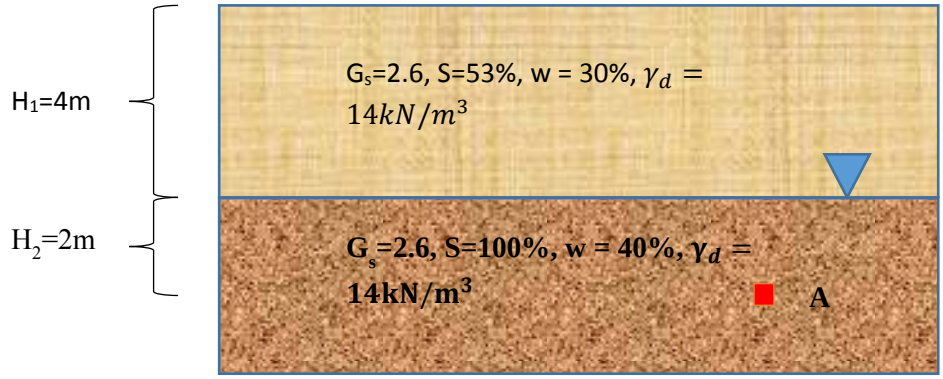
12) What is the cause for the swell of soils during the excavation?

A) Occures in the clayey soil when a higher moisture content existed than pior to excavation.
B) Occures in the fine sand during excavation becasuse of increasing the void ratios
C) Occures in all type of soils due to increasing the prosity
D) Swell is just an assumption to have safety factor for the earth work estimations.

The Answers is A

Choice "A" is the definition.

13) An uniform desposit soil is shown in the following diagram. Information of soil in each layer is given. Calculate the effective stress for a soil element at point A.



A) 90kPa B) 80kPa C) 85kPa D) 75kPa

The Answers is C

Step 1: From the diagram, we can see that there are two layers of soil. For each layer, we need to calculate the unit weight. Equation about unit weight is given as,

$$\gamma = \left(\frac{G_s + Se}{1 + e}\right)\gamma_w$$

The voids ratio is unknown. Therefore, we need to calculate voids ratio of each layer first.

Step 2: Equation of void ratio of soil is shown as,

$$e = \frac{V_v}{V_s}$$

To determine the value of void ratio, we need to find volume of voids,V_v, and volume of solids,V_s. To determine the voids ratio, we can deduce its equation by,

$$e = \frac{V_v}{V_s} = \frac{\frac{V_w}{S}}{V_s} = \frac{\frac{W_w}{\gamma_w S}}{V_s} = \frac{\frac{wW}{\gamma_w S}}{V_s} = \frac{W}{V_s}\frac{w}{\gamma_w S} = \gamma_d \frac{w}{\gamma_w S}$$

Therefore, for each layer, the voids ratio can be calculated by,

$$e_1 = \gamma_d \frac{w_1}{\gamma_w S_1} = (14kN/m^3)\frac{30\%}{(9.8kN/m^3)(53\%)} = 0.80$$

$$e_2 = \gamma_d \frac{w_2}{\gamma_w S_2} = (14kN/m^3)\frac{40\%}{(9.8kN/m^3)(100\%)} = 0.57$$

Step 3: For the layer above groundwater level, the unit weight is equal to,

$$\gamma_1 = \left(\frac{G_s + Se}{1+e}\right)\gamma_w = \left(\frac{2.6 + (53\%)(0.8)}{1+0.80}\right)(9.8kN/m^3) = 16.5kN/m^3$$

For the layer below groundwater level, the unit weight is equal to,

$$\gamma_2 = \left(\frac{G_s + Se}{1+e}\right)\gamma_w = \left(\frac{2.6 + (100\%)(0.57)}{1+0.57}\right)(9.8kN/m^3) = 19.8kN/m^3$$

Step 4: The total stress at point A can be then calculated as,

$$\sigma = \gamma_1 H_1 + \gamma_2 H_2 = (16.5kN/m^3)(4m) + (19.8kN/m^3)(2m) = 105.6kPa$$

The pore water pressure is given as,

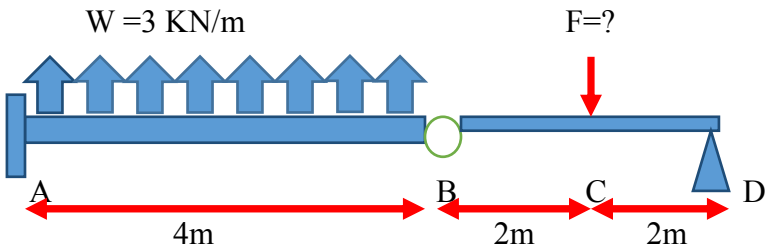
$$u = \gamma_w H_2 = (9.8kN/m^3)(2m) = 19.6kPa$$

Effective pressure at point A can be finally calculated by,

$$\sigma' = \sigma - u = 105.6kPa - 19.6kPa = 86kPa$$

~85kPa

14) For the following beam if load w=3 KN/m what force should apply on BD so that the shear Force at A is zero?



A) 24KN.
B) 44KN.
C) 64KN.
D) 84KN.

The Answers is A

To solve the problem the typical solution is to writ the equation of equilibrium, but a short cut method is given as follows:

$V_B = F/2$,

Because the beam BD is symmetric.

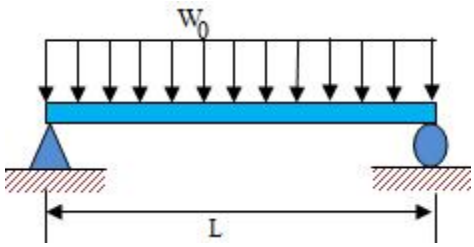
Then for the shear force at A we can write: $V_A = -WL+F/2 = 0$

$-3*4 + F/2 = 0$

So; F=24 KN

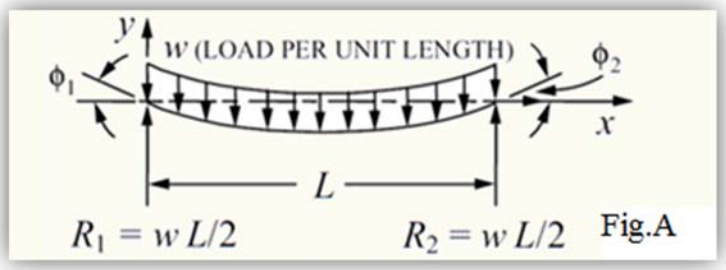
15) In the below picture, find the maximum shear and moment in a simply supported beam that is loaded with uniform load of w0.

A) V= w0L, M= w0L2/4
B) V= w0L/2, M= w0L/8
C) V= w0L/2 , M= w0L2/8
D) V= 2 w0L, M= w0L2/12



The Answers is C

Step 1: Free body diagram:



Step 2: Find the reactions:

from symmetry, $R_1 = R_2$. And summing vertical forces:

$$\sum F_y = 0, \qquad R_1 = R_2 = w_0 L/2$$

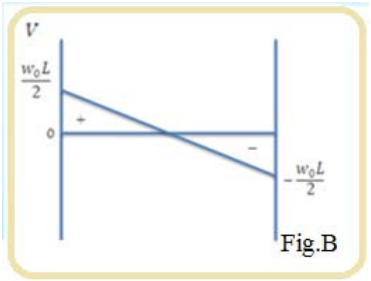


Fig.B

Step 3: Draw the Shear diagram

The load $q = -w_0$ and Shear diagram is result of integration of loud diagram (Fig. B):

$$V = V_0 - \int_0^x w_0 dx = \frac{w_0 L}{2} - w_0 x$$

So the maximum shear occurs when x=0

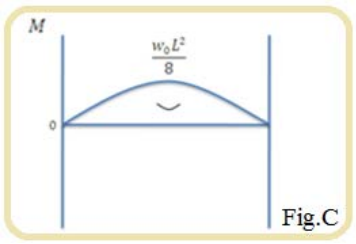


Fig.C

$$V = w_0 L/2$$

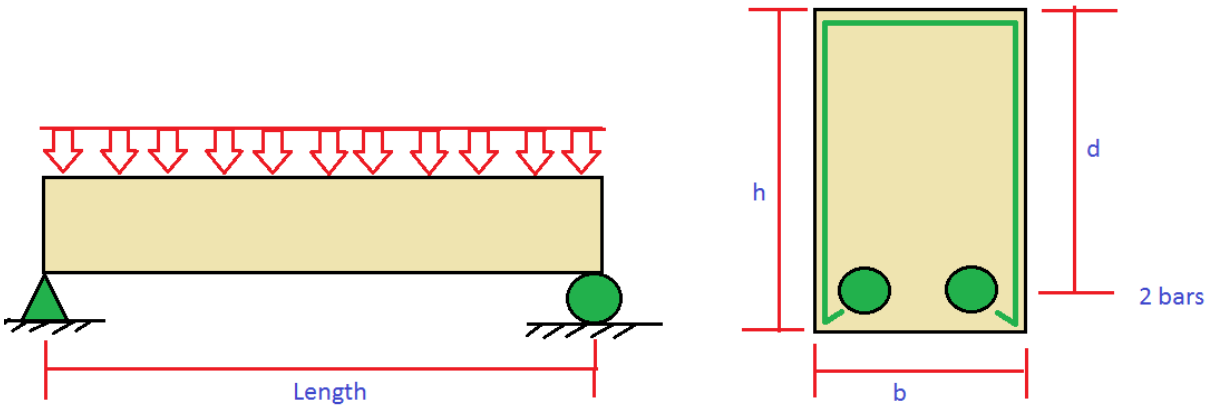
Step 4: Draw the Moment diagram; Moment diagram is result of integration of shear diagram. Nothing that the moment at x = 0 is zero.

$$M = M_0 - \int_0^x \left(\frac{w_0 L}{2} - w_0 x\right) dx = 0 + \frac{w_0 L x}{2} - \frac{w_0 x^2}{2} = \frac{w_0 x}{2}(L - x)$$

It can be seen that the maximum bending moment occurs at the center of the beam where the shear stress is zero (at the middle of the beam).

When $x = \frac{L}{2}$ $\qquad$ $M = \frac{w_0 L^2}{8}$

16) A 10 ft long simply supported concrete beam subject to a uniformly distributed load is reinforced with two #6 bars at a depth of 13 in. The cross section is 6 in wide and 16 in tall. The factored shear load at the supports is 6.6 kips. Assume # 3 stirrups are used for shear support. $f_y = 60000$ psi, $f'_c = 4000$ psi. Determine the required spacing for shear reinforcement at the supports in the beam.



A) 8 in B) 44 in

C) 6.5 in D) 24 in

The Answers is C

ACI 318-08, 11.1 & 11.2

Step 1: Determine the shear condition of the beam by comparing the given factored shear force to the shear capacity of the concrete. Use the appropriate equation.

$$V_c = 2b_w d\sqrt{f'_c} = 2(6\ in)(13\ in)\sqrt{4000\ psi}\left(\frac{1kip}{1000\ lb}\right) = 9.87\ kips$$

Now determine the factors to be tested based on an applied load factor. According to The resistance factors table a factor of 0.75 is to be used for shear and torsion.

$$\phi V_c = (0.75)(9.87\ kips) = 7.4\ kips$$

$$\frac{\phi V_c}{2} = \frac{(0.75)(9.87\ kips)}{2} = 3.7\ kips$$

$$3.7\ kips < 6.6\ kips < 7.4\ kips$$

Use the required spacing equations

Step 2: Determine the required spacing at the supports and check to make sure this does not exceed the maximum. If it does then the maximum spacing will be used in place of the required spacing. The area of the shear reinforcing steel(A_v) will be 2 times the area of a # 3 bar since shear reinforcement passes through the cross section twice. The area of a # 3 bar can be found on the appropriate table Use A = 0.11 in^2.

$$A_v = (2)(0.11in^2) = 0.22in^2$$

$$s = \frac{A_v f_y}{50 b_w} = \frac{(0.22\ in^2)(60000\ psi)}{(50\ psi)(6\ in)} = 44\ in$$

$$s = \frac{A_v F_y}{0.75 b_w \sqrt{f_c'}} = \frac{(0.22\ in^2)(60000\ psi)}{0.75(6\ in)\sqrt{4000\ psi}} = 46\ in$$

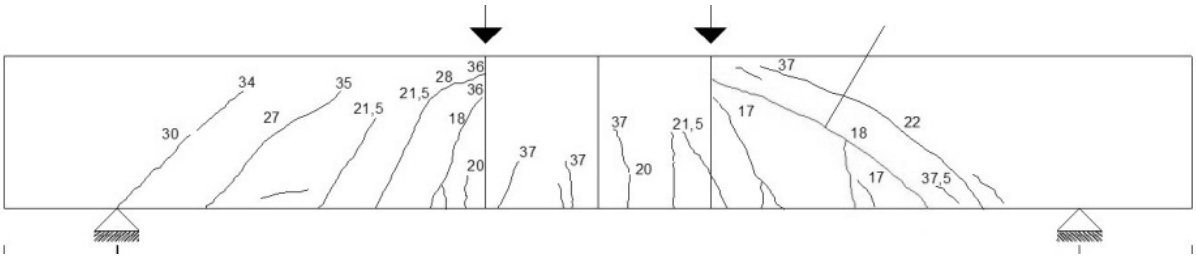
Now calculate the maximum allowed spacing.

$$s_{max} = \frac{d}{2} = \frac{13\ in}{2} = 6.5\ in\ or\ 24\ in$$

6.5 in spacing controls the spacing at the supports cannot exceed this

6.5 in

17) Refer to the picture below, which pattern shows the pure shear crack in the reinforced concrete beam test results?



A) 37 B) 18

C) 28 D) 30

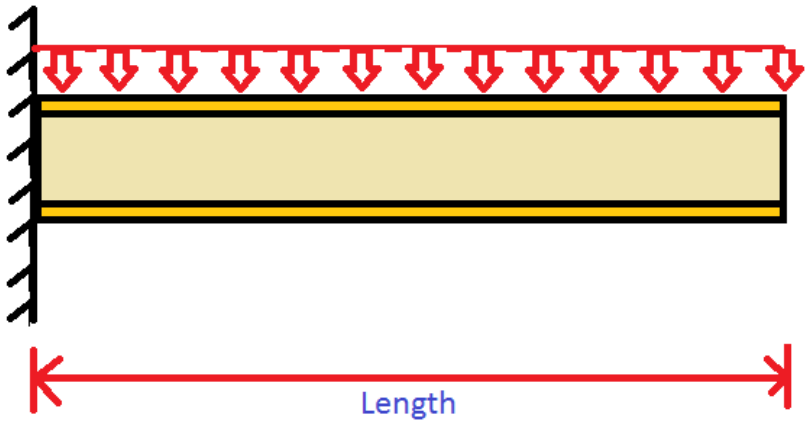
The Answers is D

The pure shear crack happens at the supports and at the web of the beam. It is inclined. Bending crack is vertical and shear-flexure cracks have the inclined to vertical pattern.

So, Choice "D" shows the pure shear crack pattern.

Choice "A" shows the pure flexural crack, Choices "B" and "C" shows the shear-flexure interaction pattern.

18) A circular beam with 6" diameter that is 20 ft long is fixed to a wall at one end and free at the other. A uniformly distributed load of 0.3 kip/ft respectively are applied to the beam. The beam is fully braced. Find the maximum elastic stress.



A) 25 KSI B) 50 KSI

C) 41 KSI D) 34 KSI

The Answers is D

Step 1: The maximum moment will be at the fixed end of the beam. Equations for moment for beams can be found in AISC table 3-23.

$$M_{max} = \frac{wL^2}{2}$$

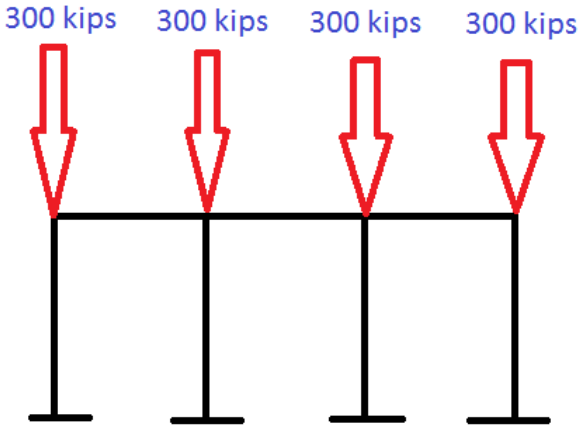
Step 2: Calculate the bending moment, moment of inertia, and section modulus:

$$M_{max} = \frac{\left(0.3\frac{kip}{ft}\right)(20\ ft)^2}{2} = 60\ kip - ft$$

$I_x = \pi d^4/64 = 63.617$, $S_x = I/C = 63.617/(6/2) = 21.205\ in^3$

$F_b = M/S_x = 60 * 12 / 21.205 = 33.95$ KSI

19) A set of interior columns are being designed. The columns are continuously braced perpendicular to the frame. The girders between the columns are W 16 X 45 members and the Columns are W 12 X 79. The columns span 35 feet apart and are 20 feet in height. Assume Fy = 50ksi and Fu = 65ksi. Columns are not braced in plane. The base of each column is tied to the foundation and all other connections are rigid. Determine the available critical stress assuming K = 1.2.



A) 29.5 ksi B) 27 ksi

C) 25 ksi D) 23.5 ksi

The Answers is D

Step 1: We need to determine the slenderness ratio for our column. First determine the effective length of the column and the radius of gyration for our member. The effective length is Kl = 24 ft for our column. Find the appropriate radius of gyration.

Shape	Area	Depth	Web	Flange		Compact section		r_{ts}	h_o	Tors. Prop.		Axis X-X				Axis Y-Y	
	A	d	t_w	b_f	t_f					J	C_w	I	S	r	Z	I	r
	$in.^2$	in.	in.	in.	in.	$b_f/2t_f$	h/t_w	in.	in.	$in.^4$	in^6	$in.^4$	$in.^3$	in.	$in.^3$	$in.^4$	in.
W12X79	23.2	12.4	0.470	12.1	0.735	8.22	20.7	3.43	11.6	3.84	7330	662	107	5.34	119	216	3.05
W12X72	21.1	12.3	0.430	12.0	0.670	8.99	22.6	3.40	11.6	2.93	6540	597	97.4	5.31	108	195	3.04
W12X65	19.1	12.1	0.390	12.0	0.605	9.92	24.9	3.38	11.5	2.18	5780	533	87.9	5.28	96.8	174	3.02

For a W 12 X 79 member r = 3.05 in.

Calculate the slenderness ratio as a function of the effective length and the radius of gyration using appropriate equation.

$$\frac{Kl}{r} = \frac{(1.2)(20ft)(12\frac{in}{ft})}{3.05in} = 94.4$$

Step 2: Using the appropriate table we can associate the slenderness ratio of our column with an available critical stress.

$\frac{KL}{r}$	ϕF_{cr} ksi	$\frac{KL}{r}$	ϕF_{cr} ksi	$\frac{KL}{r}$	ϕF_{cr} ksi	$\frac{KL}{r}$	ϕF_{cr} ksi	$\frac{KL}{r}$	ϕF_{cr} ksi
1	45.0	41	39.8	81	27.9	121	15.4	161	8.72
2	45.0	42	39.5	82	27.5	122	15.2	162	8.61
3	45.0	43	39.3	83	27.2	123	14.9	163	8.50
4	44.9	44	39.1	84	26.9	124	14.7	164	8.40
5	44.9	45	38.8	85	26.5	125	14.5	165	8.30
6	44.9	46	38.5	86	26.2	126	14.2	166	8.20
7	44.8	47	38.3	87	25.9	127	14.0	167	8.10
8	44.8	48	38.0	88	25.5	128	13.8	168	8.00
9	44.7	49	37.7	89	25.2	129	13.6	169	7.89
10	44.7	50	37.5	90	24.9	130	13.4	170	7.82
11	44.6	51	37.2	91	24.6	131	13.2	171	7.73
12	44.5	52	36.9	92	24.2	132	13.0	172	7.64
13	44.4	53	36.7	93	23.9	133	12.8	173	7.55
14	44.4	54	36.4	94	23.6	134	12.6	174	7.46
15	44.3	55	36.1	95	23.3	135	12.4	175	7.38
16	44.2	56	35.8	96	22.9	136	12.2	176	7.29
17	44.1	57	35.5	97	22.6	137	12.0	177	7.21
18	43.9	58	35.2	98	22.3	138	11.9	178	7.13

If we interpolate between a slenderness ratio of 94 and 95 on this table we can approximate the available critical stress to be 23.5 ksi.

~23.5 ksi

20) A gutter at the side of a street has a curb height of 8 inches, slope along the length of the street of 0.7%, and Manning n=0.032. The pavement slopes from the center of the street to the gutter at 5%. What is the flow capacity of this gutter?

A) 4.9 cfs
B) 8.0 cfs
C) 11.1 cfs
D) 14.7 cfs

The Answers is B

Step 1: When the gutter is full, the water extends a distance =8/0.05=160 inches=13.3 feet from the curb. The cross sectional area A=0.5(13.3)(8/12)=4.44 ft^2, and wetted perimeter P= 8/12+13.3 = 14 ft, hydraulic radius R_h=(4.44)/(14)=0.317 ft.

Step 2: Manning's equation for the discharge $Q = \frac{K}{n} A R_h^{2/3} S^{1/2}$, where K=1 for metric units, K=1.49 for USCS units, n = Manning roughness coefficient

R_h=A/P = hydraulic radius, A = cross sectional area, P = wetted perimeter, S = channel slope, so Q=(1.49/0.032)(4.44)(0.317)$^{2/3}$ (.7/100)$^{1/2}$ = 8.0 cfs.

21) Water from a 175-ac light industrial watershed is collected and drained by a trapezoidal open channel. The channel (Manning' roughness coefficient, n = 0.02) has a 4.5-ft-wide bottom and 1:1 sides. The channel direction is perpendicular to a road where twin, side-by-side 54-in-diameter corrugated metal pipe (CMP) culverts take the water under the roadway. The average slope of the channel and culverts is 0.75% (i.e., 0.0075 ft/ft). The time for runoff from the farthest part of the watershed to begin contributing to the flow is 35 min. - Using the rational method and assuming the intensity after 35 min is 2 in/hr, what is the runoff?

A) 308 $\frac{ft^3}{sec}$

B) 180 $\frac{ft^3}{sec}$

C) 228 $\frac{ft^3}{sec}$

D) 340 $\frac{ft^3}{sec}$

The Answers is C

The runoff is given by the rational formula.

$$\boldsymbol{Q_p = CIA_d = (0.65)\left(2\frac{in}{hr}\right)(175\ ac) = 228\frac{ft^3}{sec}}$$

22) A parking lot adjoining a shopping center has a surface area of 3.5 acres. A rainstorm that delivers rainfall at a rate of 2.5 inches/hour occurs. The parking area has a runoff coefficient C=0.7. What is the peak runoff from the parking lot during this rainstorm?

A) 0.62 cfs B) 2.5 cfs C) 6.13 cfs D) 25 cfs

The Answers is C

Step 1: The rational formula is

$Q = C\,i\,A$

where Q is the discharge, C is the runoff coefficient, i is the rainfall intensity in inches/hour, and A is the drainage area in acres.

Step 2: Solve for $Q = (0.7)\,(2.5)\,(3.5) = 6.13$ cfs

23) A 10 acre basin stores approximately 7.0 inches of water. What is the runoff for the given basin for a 2-hr storm with an average of 0.5 in/hr of rainfall?

A) 0 inches B) 0.02 inches C) 0.05 inches D) 0.10 inches

The Answers is B

Use the NRCS Rainfall-Runoff method to determine the amount of runoff.
Step 1: Define all variables

$$\boldsymbol{S = 7.0\ inches}$$

$$\boldsymbol{P = 2\ hr * 0.5\ \frac{in}{hr} = 1\ in}$$

Step 2: Solve for runoff (Q)

$$\boldsymbol{Q = \frac{(P-0.2S)^2}{P+0.8S} = \frac{(1-0.2*7)^2}{1+0.8*7} = \frac{0.16}{7.6} = 0.02\ inches}$$

24) A horizontal pipeline carries water at a discharge of 13.5 cfs. Upstream of a contraction the pipe diameter is 24 inches and pressure is 14 psi, while downstream of the contraction the diameter is 18 inches. Neglecting head loss, what is the pressure downstream?

A) 11.2 psi

B) 13.7 psi

C) 14.2 psi

D) 15.9 psi

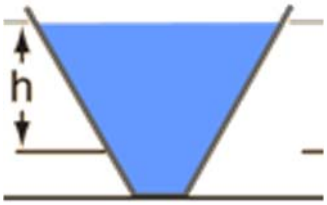
The Answers is B

Step 1: The Bernoulli equation states that $z_1 + \frac{p_1}{\gamma} + \frac{V_1^2}{2g} = z_2 + \frac{p_2}{\gamma} + \frac{V_2^2}{2g}$, where z = elevation, p = pressure, V = average velocity, g = acceleration of gravity , and γ = specific weight of water. Let point 1 be upstream of the contraction, and point 2 downstream.

Step 2: Since pipe is horizontal, z1=z2. Area A1=πD2/4 = 3.14 ft2, A2= 3.14(18/12)2/4= 1.77ft2. V1=Q1/A1= (13.5)/(3.14)= 4.3 ft/sec, V2=Q2/A2= (13.5)/(1.77)=7.63 ft/sec. Also p1=14 psi = 14(144)=2020 lbs/ft2, p1/γ=4900/62.4 = 32.3 ft.

Step 3: Rearranging the Bernoulli Eq gives $\frac{p_2}{\gamma} = \frac{p_1}{\gamma} + \frac{V_1^2}{2g} - \frac{V_2^2}{2g}$ =32.3 + (4.3)2/2/32.2 - (7.63)2/2/32.2 = 31.7 ft; p2=31.7(62.4 lbs/ft3)/144=13.7 psi.

25) Which one has more pressure at the depth of h = 10 ft? (the inclined surfaces has the measure of angle of 60 degree.)



A) 624 psf B) 62.4 psf C) 312 psf D) 1248 psf

The Answers is A

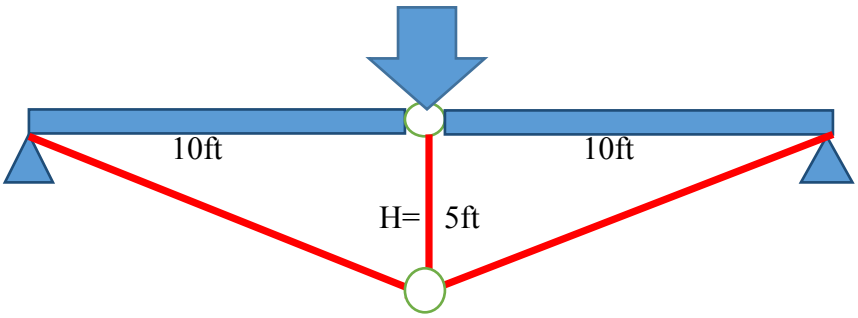
This question is about the fluid mechanics.

According to the fluid mechanic principles, the pressure is not related to the shape, so at the depth of "h" the amount of pressure is:

$P = \gamma \cdot h$

So, $62.4 * 10 = 624$ lb/ft^2

26) Find the bending moment in the below beam for the concentrated load given equal to 5 Kips?



A) 25 Kips-ft
B) 5 kips-ft
C) 0.00 Kips-ft
D) none of them

The Answers is C

This is a tricky question!

This is not a beam, so there is not a bending moment. This is a truss with axial forces.

So M=0.00

27) An equal-tangent crest vertical curve is to connect grades of +2.0% and -3%. The design sight distance on the curve is 645 ft. Determine the minimum length of the curve to meet the sign distance requirement. (Assume the height of driver's eyes above the roadway surface is 3.5 ft, and the height of object above the roadway surface is 2.0 ft.)

A) 689.50 ft B) 963.91 ft C) 734.30 ft D) 878.40 ft

The Answers is B

P 3-152, AASHTO Geometric Design-Green Book 2011, 2011, 6th Ed.

Step 1:

If we assume that the curve length (L) is greater than the sight distance (S), under the standard criteria of the heights of driver's eyes and objects above the roadway surface, the minimum curve length is

$$L = \frac{AS^2}{2{,}158}$$

Step 2:

The grades of the two tangents are g1=+2.0% and g2=-3.0%, respectively. Therefore, the absolute value of algebraic difference in grades (%) is

$$A = |g_1 - g_2| = |2 - (-3)| = 5$$

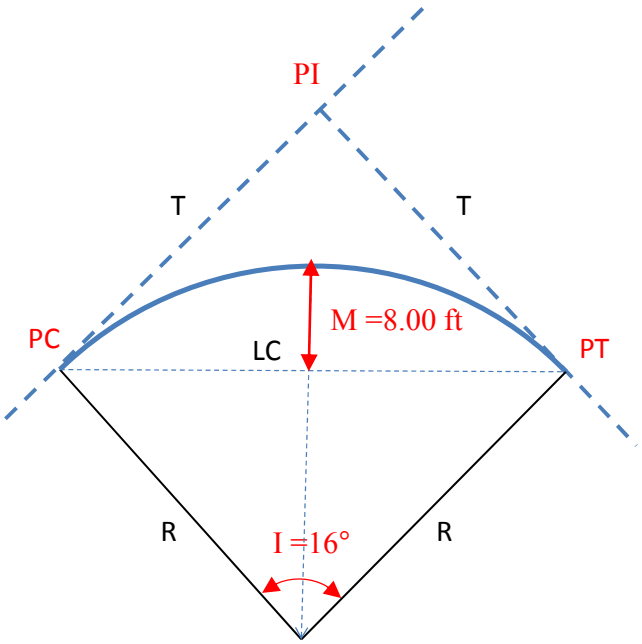
Step 3:

The minimum curve length is

$$L = \frac{AS^2}{2{,}158} = \frac{(5)(645)^2}{2{,}158} \cong 963.91\ ft$$

which is greater than the sight distance, so the assumption that $L > S$ is correct.

28) A horizontal circular curve has an intersection angle of 16°. The length of middle ordinate (M) is 8.00 ft. The radius (ft) of the curve is most nearly



A) 401.9 B) 786.4 C) 4.0 D) 822.0

The Answers is D

The relationship between the length of middle ordinate (M), radius of the curve (R), and intersection angle (I) is $M = R\left[1 - \cos\left(\frac{I}{2}\right)\right]$, which can be arranged into

$$R = \frac{M}{1 - \cos\left(\frac{I}{2}\right)} = \frac{8\text{ ft}}{1 - \cos\left(\frac{16°}{2}\right)} \cong 822.04\text{ ft}$$

29) Given the following traffic count data:

Time Interval	No. of Vehicles
8:00-8:15	1400
8:15-8:30	1600
8:30-8:45	2200
8:45-9:00	1800

The peak hour factor is closest to:

A) 0.795 B) 0.880

C) 0.650 D) 0.945

The Answers is A

Page 4-4, Equations 4-2 and 4-3, HCM 2010

Equation 4-2

$$PHF = \frac{V}{4 \times V_{15}}$$

where

PHF = peak hour factor,

V = hourly volume (veh/h), and

V_{15} = volume during the peak 15 min of the analysis hour (veh/15 min).

Solution for Question 1:

$$PHF = \frac{V}{4 \times V_{15}} = \frac{1400 + 1600 + 2200 + 1800}{4 \times 2200} = 0.795,$$

30) A sieve analysis on a non-organic soil reveals that 82% of the soil passes No. 200 sieve (0.075 mm). The liquid limit of the soil is 24%, and the soil has a medium toughness and a very slow dilatancy. Classify the soil according to the Unified Soil Classification system (USCS).

A) GC B) ML C) CL D) CH

The Answers is A

Step 1:

Because 82% of the soil is smaller than No. 200 sieve size, which is larger than 50%, the soil is fine-grained according to the Unified Soil Classification table

Step 2:

Because the liquid limit (24%) is less than 50%, the soil is low plastic. Therefore, the second letter of the USCS group symbol is L.

Step 3:

Because the soil is non-organic, the first letter of the USCS group symbol is not O. Because the soil has a medium toughness and a very slow dilatancy, it contains more clay than silt. The first letter of the USCS group symbol is C according to the Unified Soil Classification table.

Therefore, the soil is classified as CL according to USCS.

31) In a falling head permeability test on a soil sample, the following data are available:

Cross-sectional area of soil = 60 cm^2
Length of soil = 10 cm
Initial head =120 cm
Final head = 108 cm
Duration of test = 20 minutes
Diameter of tube = 8 mm
Determine the coefficient of permeability of the soil, k.

A) $7.4\ cm/sec$ B) $7.36 \times 10^{-6} cm/sec$
C) $5.8\times 10^{-6} cm/sec$ D) $4.60 \times 10^{-6} mm/sec$

The Answers is B

Step 1:

From a falling head test, coefficient of permeability, k, is calculated by

$$k = \frac{2.303aL}{At_E}\log_{10}(\frac{h_1}{h_2})$$

Where a = area of reservoir tube; L = length of flow; A=cross-sectional area of soil; t_E=elapsed time during falling head test; h_1=initial head; h_2=final head.

Step 2:

From the given information, it is known that

$a = \frac{\pi D^2}{4} = \frac{\pi(8\ mm)^2}{4} = 0.503\ cm^2$, $L = 10\ cm$, $A = 60\ cm^2$, $t_E = 20\ minutes = 20\ minutes \times 60\frac{seconds}{minute} = 1200\ seconds$, $h_1 = 120\ cm$, $h_2 = 108\ cm$.

Therefore,

$$k = \frac{2.303aL}{At_E}\log_{10}\left(\frac{h_1}{h_2}\right) = \frac{2.303(0.503cm^2)(10\ cm)}{(60\ cm^2)(1200\ seconds)}\log_{10}\left(\frac{120\ cm}{108\ cm}\right)$$

$$= 7.36 \times 10^{-6} cm/sec$$

32) A concrete mixture has a 60:40 ratio of coarse aggregates to fine aggregates. When mixed separately, 250lbs of coarse aggregates are capable of fitting in a 3ft3 container and 200lbs of fine aggregates are capable of fitting in a 2ft3 container. Determine the bulk density of the concrete mixture with a 50:50 ratio.

A) 80lb/ft3
B) 87lb/ft3
C) 90lb/ft3
D) 97lb/ft3

The Answers is C

Step 1. Determine the bulk unit weights of each type of aggregate with the following formula:

$$\gamma_{aggregate} = \frac{Mass}{Volume}$$

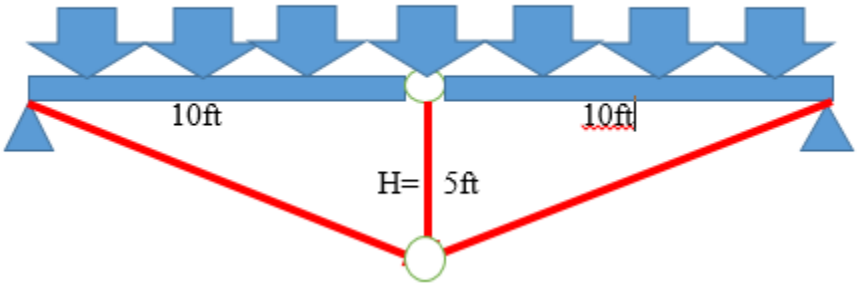
$$\gamma_{coarse} = \frac{250lb}{3ft^3} = \frac{83lb}{ft^3}$$

$$\gamma_{fine} = \frac{200lb}{2ft^3} = \frac{100lb}{ft^3}$$

Step 2. Since it's a 60:40 ratio, simply take the percentage of each density and divided by 2.

$$\gamma_{mixture} = 0.6(83) + 0.4(100) = 90\frac{lbs}{ft^3}$$

33) Find the bending moment in the below beam for the uniform load given equal to 5 Kips/ft?



A) 250 kips-ft
B) 125 kips-ft
C) 62.5 kips-ft
D) 500 kips-ft

The Answers is C

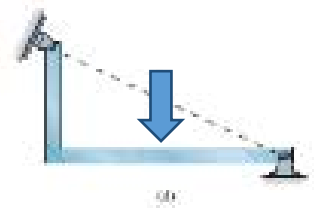
This is a tricky question!

In general this is a truss and technically there is not bending moment in whole structure. But the members may get the flexure if the forces are not applied on the joints.

In this case, there is uniform force on the 2 members of the truss. So each member individually will have bending moment. Therefore,

$M= 5*10^2/8 = 62.5$ kips-ft

34) For the shown structure, the horizontal length is 10ft and vertical length is given as 8 ft. The force applied at the mid-span and is equal to 20 Kips. The inclined support is a roller support.
Find the bending moment in the structure?

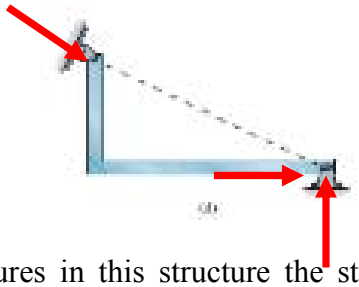


A) 50 kips-ft B) 40 kips-ft C) 0.00 kips-ft D) 60 kips-ft

The Answers is C

This question shows the condition for the instable structure. If all reactions of a structure passes through one point then we cannot write the equation of equilibrium and we will lose one equation.

So, this is the instable structure:



Then before any actions occures in this structure the structure will fail and thus there is no bending moment in this structure.

35) Given a soil fill sample with a weight of 62 lbs and a total volume of 864 in3 and a water content of 15%, determine the percent relative compaction of the sample if the maximum dry unit weight is 115pcf.

A) 93.8%
B) 95.2%
C) 102%
D) 127%

The Answers is A

Step 1

The relative compaction cannot exceed 100%. That being known answers C and D are eliminated. To determine the relative compaction we must determine the dry unit weight of the fill sample. Then we can compare it to the maximum dry unit weight.

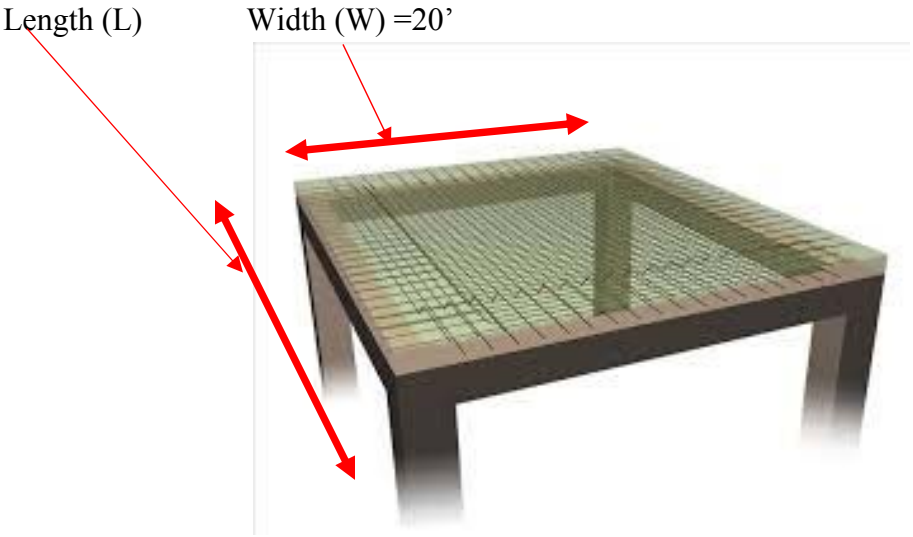
$$\gamma_d = \frac{\frac{W_T}{V_T}}{1+\frac{\omega,\%}{100\%}} = \frac{\frac{62\ lb}{864\ in^3\left(\frac{1ft}{12in}\right)^3}}{1+\frac{15\%}{100\%}} = \frac{\frac{62\ lb}{0.5ft^3}}{1.15} = 107.8pcf$$

Step 2

The relative compaction is the dry unit weight of the sample divided by the maximum unit weight:

$$\frac{\gamma_d}{\gamma_{d,max}} \times 100\% = \frac{107.8pcf}{115pcf} \times 100\% = 93.8\%$$

36) For the reinforced concrete slabs like the following picture, if the width is given equal to 20', then what would be the maximum length of the slab if the designer wants to have two way slab and have the following reinforcement arrangement?



A) 40'

B) 10'

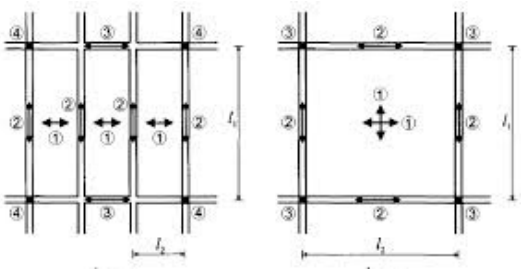
C) 20'

D) 50'

The Answers is A

ACI 318-08, 13.6.1.2. : Panels shall be rectangular with a ratio of longer to shorter span less than or equal to 2 for the 2 way slabs. (Also see below picture)

According to the code, $\frac{L}{W} \leq 2$



So, $L = 2 * 20' = 40'$

The slab can have 40' to be considered as a two way slab. Thus the distribution of bending moment in both direction needs reinforcement for negative and positive bending moment in both directions.

37) For the following excavation shown below the contractor has used the nailing system to secure the project. Who should be the first person for inspection of the nailing system?

A) Trained person

B) Site supervisor

C) Competent person

D) anyone in the site with engineering degree

The Answers is A

The competent person is not necessarily have sufficient knowledge about the nailing. Choices "B" and "D" are also are not correct. For all excavations a trained person should be the first who enter.

38) Find the zone of influence for the following excavation where there is no soldier piles. Neglect the brick made counterforts.

Depth of excavation = 30 ft

A) 22.6 ft

B) 30 ft

C) 32 ft

D) 21.2 ft

The Answers is A

Adjacent Construction Project Manual, Office of Joint Development & Adjacent Construction, September 16, 2013 (Revision 5)

An envelope starting at a point two feet below the lowest point of the underground structure or excavation continuing upward at a forty five (45) degree angle from the horizontal at the vertical projection of the outside limits of the Public structure.

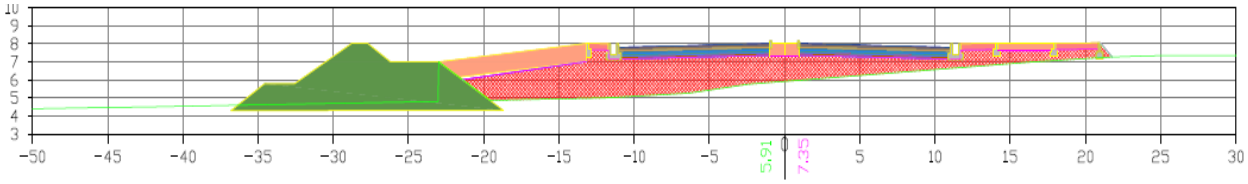
An envelope starting at a point two feet below the lowest point of Public structure continuing upwards at a forty five (45) degree angle from the horizontal, up to the horizontal projection of the outside limits of the adjacent underground structure or excavation, projected at grade level.

So, depth of excavation = 30 and according to the code 2' should be added so, 30+2 =32

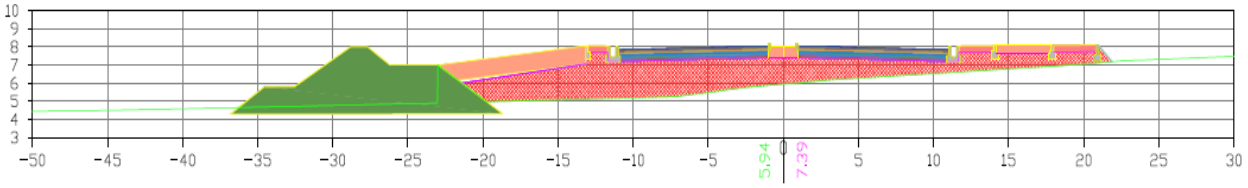
Horizontal distance considering the 45 degree = 32*Cos (45) = 22.6 ft

39) Refer to the figures, the net excavation (yd3) from section 78 (14+20) (100s of ft) to section 80 (15+80) is most nearly:

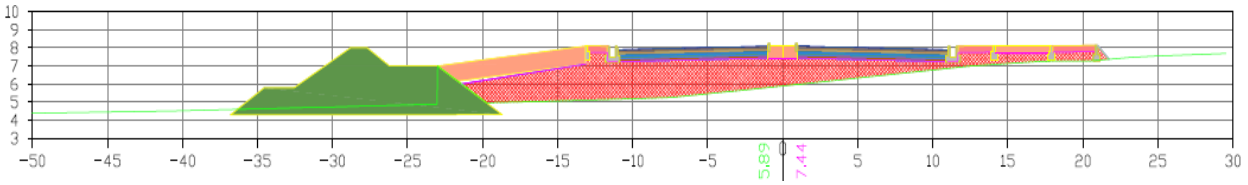
Cut= 0.00 ft^2 Fill=555.6 ft^3 Sec. 80, 15+80



Cut= 0.00 ft^2 Fill=680.2 ft^3 Sec. 79, 15+00



Cut= 421.3 ft^2 Fill=0.00 ft^3 Sec. 78, 14+20



A) 3462 B) 59788

C) 4000 D) 2214

The Answers is D

Use Average End Area Method (NCEES P. 167, Earthwork Formula):

Sec 80 & 79: No excavation, both sections shows embankment:

$$V_{fill} = \frac{(555.6+680.2)}{2} * (1580 - 1500) = 49432\ ft^3$$

Sec 79 & 78: There is excavation and embankment between these two sections:

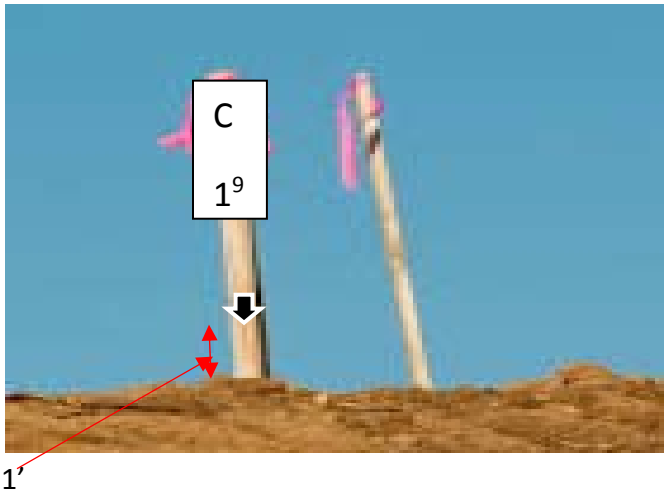
$$V_{fill} = \frac{(680.2+0)}{2} * (1500 - 1420) = 27208\ ft^3$$

$$V_{Cut} = \frac{(421.3+0)}{2} * (1500 - 1420) = 16852\ ft^3$$

Net excavation: $V_{Net} = \sum V_{fill} - \sum V_{Cut} = 49432 + 27208 - 16852 = 59788\ ft^3$

Net excavation in yd^3= $\frac{59788}{27} = 2214.37$ yd^3

40) The site manager put the mark of "C" and the following numbers on the lath stake. The ground elevation is given equal to +20.00. The surveyor measured 1' for the distance between horizontal line and the ground surface. With that sign what would be the final elevation:



A) +21.90

B) +19.10

C) +17.10

D) +18.10

The Answers is B

The sign of "C" means: Cut is required. And the horizontal line shows the reference point for it. The number on stake shows the required cut below the horizontal line.

So, the final elevation will be equal to 1.9' below the horizontal line. Since the distance between the ground and the horizontal is 1', then it is necessary for the (1.9-1) =0.9' for excavation. The final ground elevation will be: +20.00 – 0.9 = 19.10

Fourth PE Style Exam (AM) Questions

1) The Building Cost Index (BCI) for structural iron work developed by which formula?

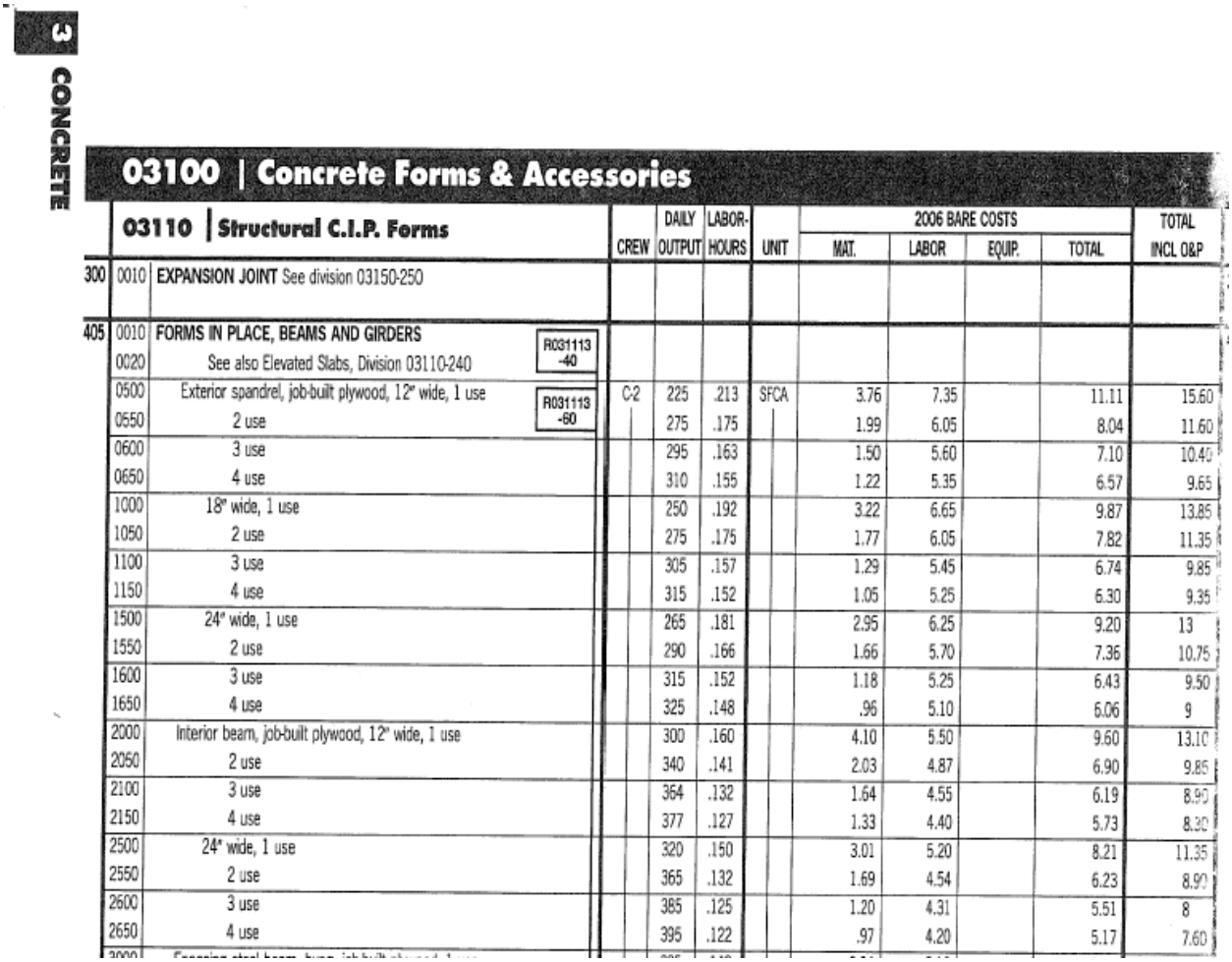
A) BCI = 68.36 hours of skilled worker at 20-city average of bricklayers + carpenters + structural ironworkers rate+25 cwt of standard steel shapes at the mill price prior to 1996.

B) BCI = 200 hours of common labor at 20-city average of common labor rates + 25 cwt of standard steel structural shape prior to 1996

C) Fabricated 20-city price from 1996+1.128 tons of Portland cement + 1088 board-ft of 2x4 lumber

D) Both A & C

2) You are replacing 12, 18" wide 2 use beams and 10, 24" wide 1-use beams. How much does labor cost for this project?



3 CONCRETE

03100 | Concrete Forms & Accessories

		03110 | Structural C.I.P. Forms		CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	2006 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
300	0010	**EXPANSION JOINT** See division 03150-250										
405	0010	**FORMS IN PLACE, BEAMS AND GIRDERS**	R031113 -40									
	0020	See also Elevated Slabs, Division 03110-240										
	0500	Exterior spandrel, job-built plywood, 12" wide, 1 use	R031113 -60	C-2	225	.213	SFCA	3.76	7.35		11.11	15.60
	0550	2 use			275	.175		1.99	6.05		8.04	11.60
	0600	3 use			295	.163		1.50	5.60		7.10	10.40
	0650	4 use			310	.155		1.22	5.35		6.57	9.65
	1000	18" wide, 1 use			250	.192		3.22	6.65		9.87	13.85
	1050	2 use			275	.175		1.77	6.05		7.82	11.35
	1100	3 use			305	.157		1.29	5.45		6.74	9.85
	1150	4 use			315	.152		1.05	5.25		6.30	9.35
	1500	24" wide, 1 use			265	.181		2.95	6.25		9.20	13
	1550	2 use			290	.166		1.66	5.70		7.36	10.75
	1600	3 use			315	.152		1.18	5.25		6.43	9.50
	1650	4 use			325	.148		.96	5.10		6.06	9
	2000	Interior beam, job-built plywood, 12" wide, 1 use			300	.160		4.10	5.50		9.60	13.10
	2050	2 use			340	.141		2.03	4.87		6.90	9.85
	2100	3 use			364	.132		1.64	4.55		6.19	8.90
	2150	4 use			377	.127		1.33	4.40		5.73	8.30
	2500	24" wide, 1 use			320	.150		3.01	5.20		8.21	11.35
	2550	2 use			365	.132		1.69	4.54		6.23	8.90
	2600	3 use			385	.125		1.20	4.31		5.51	8
	2650	4 use			395	.122		.97	4.20		5.17	7.60

A) $135.10
B) $72.60
C) $75.00
D) $145.50

3) A project is described by the following precedence table. The project manager wants to decrease the normal project time by 4 days. Most nearly, how much will it cost to reduce the project completion time by four days?

Activity	Predecessors	Normal time (days)	Crash time	Normal cost daily	Crash cost daily
A	-	8	6	50	100
B	A	2	1	80	140
C	A	6	4	80	100
D	B	2	1	100	150
E	C	6	3	90	200
F	E	3	1	80	160
G	D,F	4	2	120	300

A) 200 B) 120

C) 180 D) 140

3) A dump-hauler has a purchase price of $109,000. Freight for delivery is $1000. Tires are an additional 21,000 with the estimated life time of 4500 hours. The hauler expected to operate 1500 hours annually and for 11 years. Maintenance fees for the hauler is estimated at $18000. What is the before-tax estimated hourly cost of operation excluding operator labor cost?

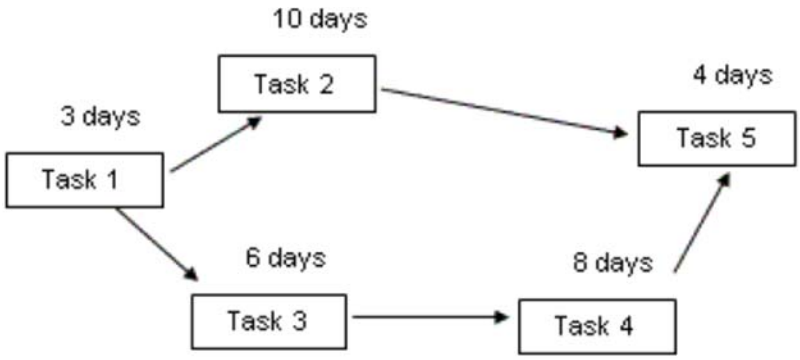
A) 35 B) 41

C) 24 D) 15

4) In the activity network below, what is the total float of Task 5?

A) 0 B) 1

C) 2 D) 3



5) The Figure below shows a scaffolding for a bridge as a heavy construction. If the deck thickness of the bridge is given equal to 4', and the span length between scaffolding columns is given equal to 4', find the axial force in those columns for the dead and personnel and equipment combination. (No variable material on the scaffolding will be stored.)

A) P= 2400 lbs

B) P=13440 lbs

C) P= 9600 lbs

D) P= 1200 lbs

6) If the weight of the white car is 1.5 US tons, for lifting up by a crane like the left figure, find the minimum safe resistive moment for the crane to prevent of an accident shown in the right figure if the required lever arm is 30'. If the weight of crane is given equal to 10 tons, then find the required distance between cranes jacks on the ground

A) $M_R < 90{,}000$ lb-ft
B) $M_R = 90{,}000$ lb-ft
C) $M_R \geq 90{,}000$ lb-ft
D) None of the answers

7) For the following haul road crown what is the maximum possible slope?

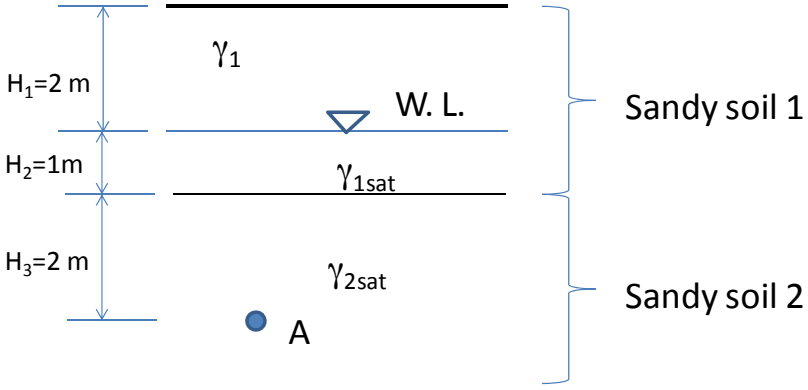
A) 6%

B) 12%

C) 3%

D) 1%

8) Point A is 5 m below the ground. The underground water level is 2 m below the ground. There are two deposits of sandy soil at the site. The first deposit of soil has a depth of 3 m, and a total unit weight (above the water level) of 13.2 kN/m3, a saturated unit weight of 16.5 kN/m3. The second deposit of soil has a saturated unit weight of 17.6 kN/m3. Determine the effective vertical soil pressure at point A.



A) 23.5 kPa B) 48.7 kPa C) 53.2 kPa D) 72.4 kPa

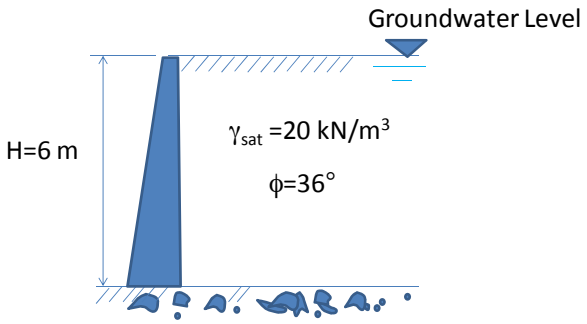
9) A footing is founded at the depth of D_f below the ground surface as embedded foundation. Another footing with the same size is on top of the soil. Which one shows more bearing capacity?

A) No changes in bearing stress because the area is important
B) Buried one has more bearing stress
C) Surface one has more bearing stress
D) It depends on the soil parameters.

10) A 2.4m thick clay layer is between two saturated 3m sand layers. The average effective vertical stress in the clay (at the depth of 5.4 m) is given equal to 30 kPa. Determine the total stress at the depth of 5.4m.

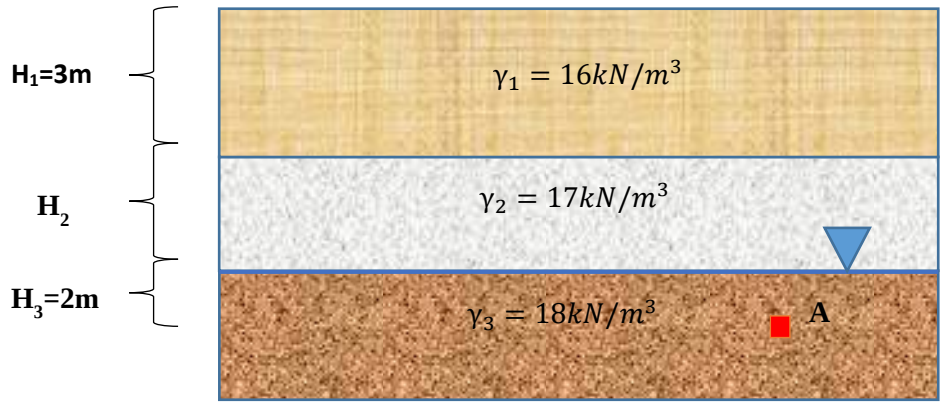
A) 54 B) 84 C) 79 D) 30

11) Determine the lateral force (per unit length of wall) on the frictionless retaining wall, as shown in the figure below. The soil behind of the wall is clean sand with a saturated unit weight of 20.0 kN/m3 and angle of internal friction of 36°. Groundwater level is at the surface of the ground.



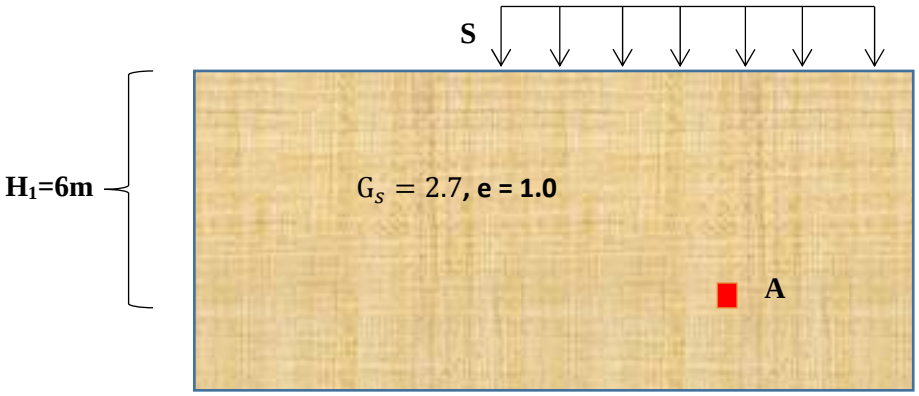
A) 124.1 kN/m B) 202.1 kN/m
C) 224.1 kN/m D) 420.1 kN/m

12) A uniform deposit soil is shown in the following diagram. Information of soil in each layer is given. Assume that the effective stress at point A is 100kPa, determine the value of H2.



A) 2.00m B) 2.50m C) 3.00m D) 3.50m

13) Information of a soil is shown in the following diagram. Assume that the surcharge is 40kPa acting at the top of soil as shown in the diagram. If the effective pressure at point A is 150kPa. Determine the water content of this soil.



A) 15.6% B) 14.2% C) 13.3% D) 12.1%

14) A load of 12000 lb is going to put 10 ft from the left support on a **30 ft** long beam. If the maximum permissible bending stress is 24,000 psi. Determine the minimum section modulus for the supposed beam. E = 30 × 106 psi.

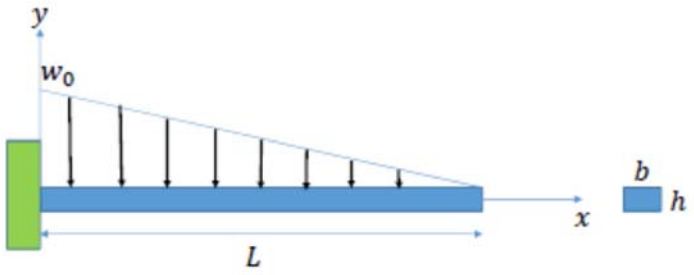
A) 12 in^3

B) 35 in^3

C) 40 in^3

D) 25 in^3

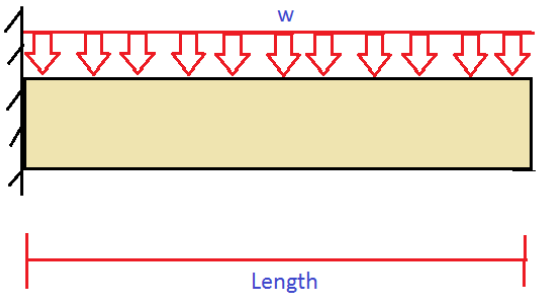
15) Determine h if the maximum slope on the beam shown below is measured as -0.02 rad.

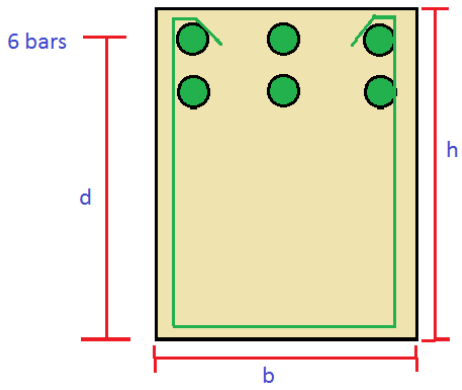


$b = 4$ in $E = 200$ kpsi $w = 100$ lb/in $L = 3$ ft

A) 4.38 in
B) 5.26 in
C) 6.15 in
D) 7.07 in

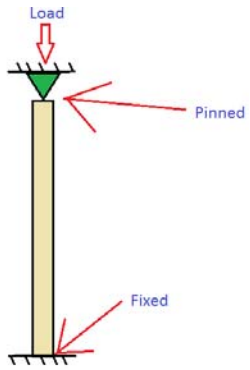
16) A 15 ft long reinforced concrete cantilever beam is subject to factored shear of 105 kips at the fixed end. The shear support from the concrete is 57 kips. The beam cross section is 18 in by 28 in. $f_y = 60000$ psi, $f'_c = 4000$ psi. The depth of the steel is 25 in. #3 stirrups are used. Determine the required spacing for the shear reinforcement at the support.





A) 12 in B) 4.4 in
C) 12.5 in D) 3.9 in

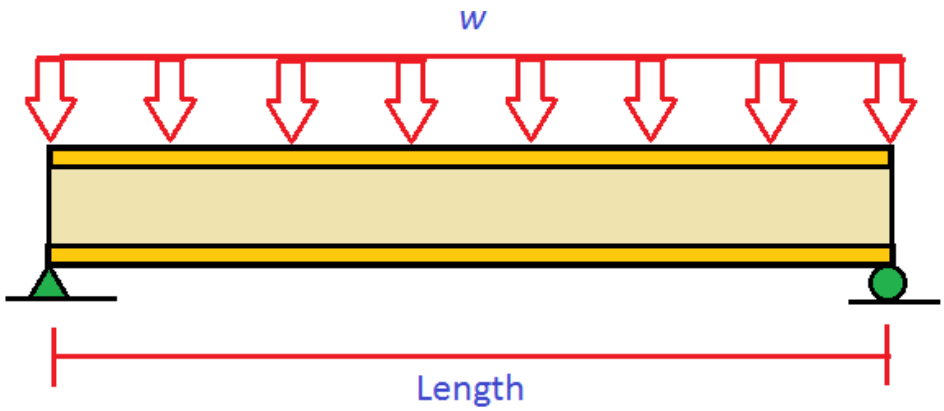
17) The column shown is a W 21 X 50 steel member. The applied dead load is 7 kips. Neglect self-weight. The column length is 12 ft tall. The column is not braced along the length. Assume Fy = 50ksi. Determine the effective length of the column.



A) 12 ft B) 14.4 ft

C) 24.2 ft D) 9.5 ft

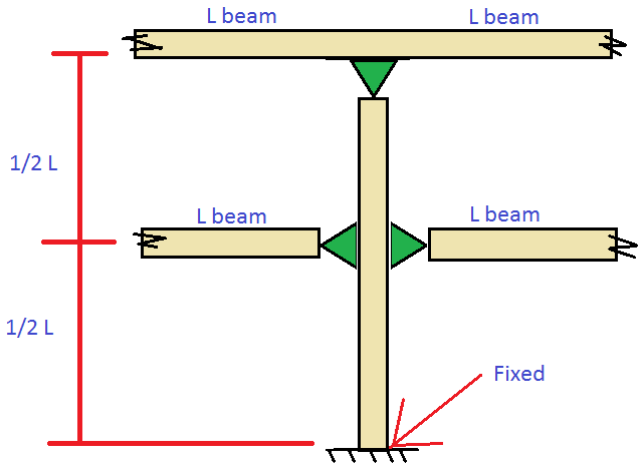
18) A simply supported and fully braced beam spans 30 ft and carries a dead and live distributed load of 0.5 kip/ft and 0.8 kip/ft respectively. Using the 1.2D + 1.6L combination. If the Plastic section modulus is given equal to 55 in^3 for the assumed section, find the maximum stress in the section. (The beam made of steel with 50 KSI strength.)



A) 50 KSI B) 46 KSI

C) 30 KSI D) 38 KSI

19) The top beam of the system is a W 18 X 60 members, the column is a W 14 X 74 members, and the middle two beams are W 21 X 73 members. The total height of the column is 30 ft. The length of all beams is 35 ft. Assume Fy and Fu are 50 ksi and 65 ksi respectively. Assume there is no reduction in stiffness for inelastic buckling and connections are pinned. Assume sidesway is not prevented. Determine the effective length factor for the column top half of the column.



A) k = 2.1 B) k = 1.33

C) k = 1.0 D) k = 1.2

20) Three rain gages are located within or nearby a watershed, whose total area is 1100 acres. Using the Thiessen polygon method, the portions of the watershed associated with gages A, B, and C are 520, 310, and 270 acres, respectively. For a particular storm, it is determined that the excess rainfall for these 3 portions of the watershed is 0.95, 1.23, and 1.44 inches, respectively. What is the volume of runoff from this watershed for this storm?

A) 19.2 MG

B) 28.3 MG

C) 34.3 MG

D) 44.7 MG

21) At the design discharge, an existing single circular culvert has the following characteristics: headwater elevation = 5.5 ft above invert, culvert diameter= 2.5 ft, critical depth = 1.9 ft, uniform depth = 1.7 ft, and the outlet is free. Which of the following describes the culvert flow under these conditions?

A) Inlet control, inlet is not submerged, critical flow at the inlet

B) Inlet control, inlet is submerged with orifice flow control

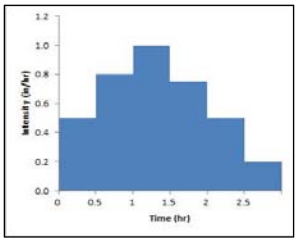
C) Outlet control, inlet is submerged

D) Outlet control, inlet is not submerged

22) Runoff from a 3-acre site is to be drained by a channel. The time of concentration for this site is 40 minutes. The site has a runoff coefficient C=0.2. Rainfall quantities to be used for design are 0.5 inches for a storm of duration 20 minutes, 0.7 inches for duration 40 minutes, and 0.9 inches for duration 60 minutes. For what discharge should this channel be designed?

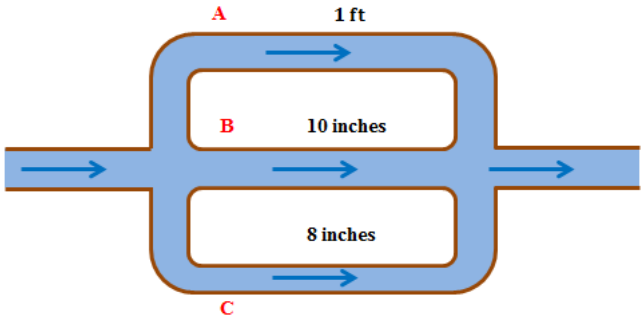
A) 0.7 cfs B) 0.63 cfs C) 1.04 cfs D) 40 cfs

23) Given the following hyetograph what is the total precipitation?



A) 1.4 inches B) 1.9 inches C) 3.8 inches D) 5.0 inches

24) All three pipes in the figure below have the same length and are connected in parallel. The diameters are given. Determine the ratio of velocities in the branches. Assume the friction factor for all the lines to be the same.



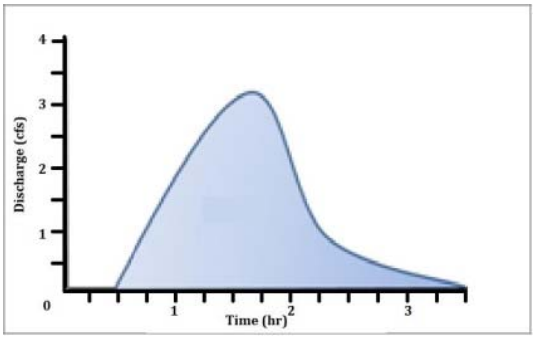
A) V_C to V_B to V_A = 1 to 1.223 to 1.684

C) V_C to V_B to V_A = 1 to 1.118 to 1.224

B) V_C to V_B to V_A = 1 to 2.3 to 3.1

D) V_A to V_B to V_C = 1 to 1.118 to 1.224

25) What is the approximate runoff for a watershed with the given hydrograph?



A) 4.7 ft^3 B) 14,500 ft^3 C) 17,000 ft^3 D) 23,500 ft^3

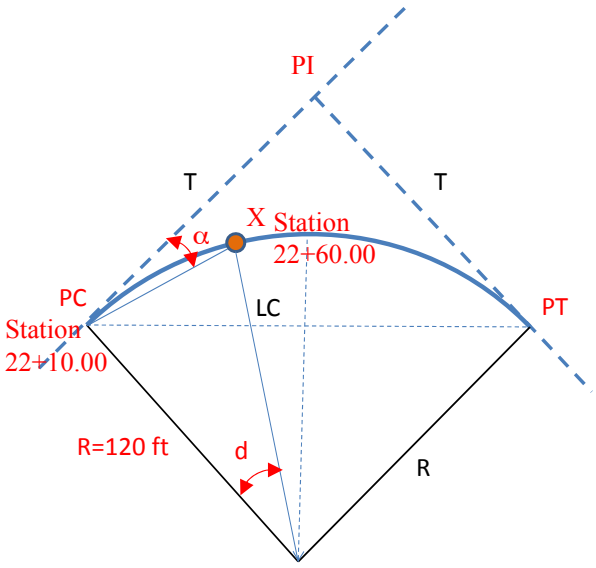
26) Two pipelines carry water from a common starting point to a common end point. The two pipes have the same friction factor f and diameter, but pipe 1 is twice as long as pipe 2. What fraction of the discharge between the start and end points flows through pipe 1?

(A) 34% (B) 41% (C) 50% (D) 67%

27) A 600 ft long equal-tangent crest vertical curve connects grades of +4.0% and -2.5%. The point of vertical intersection (PVI) is located at station 123+00 with an elevation of 62.80 ft. What is the elevation of the PVT?

A) 55.30 ft B) 70.30 ft C) 73.50 ft D) 65.30 ft

28) A horizontal circular curve has a radius of 120 ft. The station of PC is sta 22+10.00. At point X (station 22+60.00) on the curve, a stake is to be placed. The deflection angle between tangent PI-PC and chord X-PC is most nearly



A) 14°56′12" B) 13°06′12"
C) 11°56′12" D) 11°44′43"

29) What is the minimum Average Daily Traffic (ADT) passing in one lane with the speed of 50 mph in the level terrain?

A) 1500-2000 B) 400-1500

C) >2000 D) = 2000

30) Particle size analysis was carried out on a soil with the results shown in the following table. Classify the soil according to the Unified Soil Classification system (USCS).

Size	Percent Passing
12.5 mm	100
9.5 mm	60
No. 4 (4.75 mm)	40
No. 20 (0.85 mm)	30
No. 60 (0.25 mm)	10
No. 200 (0.075 mm)	4

A) GC B) GP C) SP D) SM

31) The subgrade of a highway is compacted from a natural soil layer. It is known that the natural soil has a total unit weight of 20 kN/m3, and a dry unit weight of 18 kN/m3. It needs to be compacted to attain a dry unit weight of 19 kN/m3 and a water content of 15%. What is the total unit weight of the compacted soil?

A) $21.85\frac{\text{kN}}{\text{m}^3}$ B) $22.85\frac{\text{kN}}{\text{m}^3}$ C) $23.85\frac{\text{kN}}{\text{m}^3}$ D) $24.85\frac{\text{kN}}{\text{m}^3}$

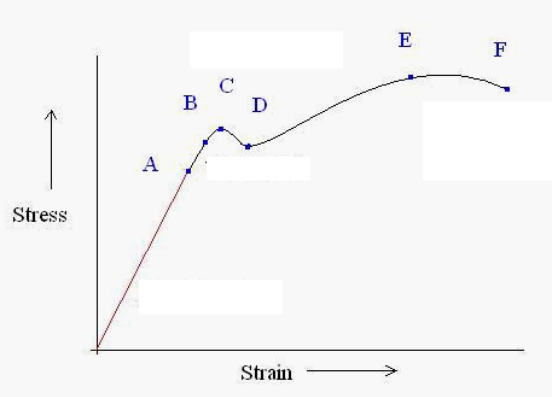
32) An engineer specifies that the concrete structure must have a strength to withstand an object with a diameter of 0.75 inches and a force of 2500 lbs. Determine the required average compressive strength for a plant where the standard deviation is unknown given the equations. The following table may be consulted:

$$\boldsymbol{f'cr = f'c + 1.34s} \quad \boldsymbol{f'cr = f'c + 2.33s - 500}$$

Specified Compressive Strength, f'c (psi)	Required Average Compressive Strength, f'cr (psi)
< 3000	f'c + 1000
3000 to 5000	f'c + 1200
> 5000	f'c + 1400

A) 5659 psi
B) 6259 psi
C) 6659 psi
D) 7059 psi

33) The stress-strain test of a steel bar shows in the following graph. Which point shows the yield stress?



A) C
B) B
C) A
D) D

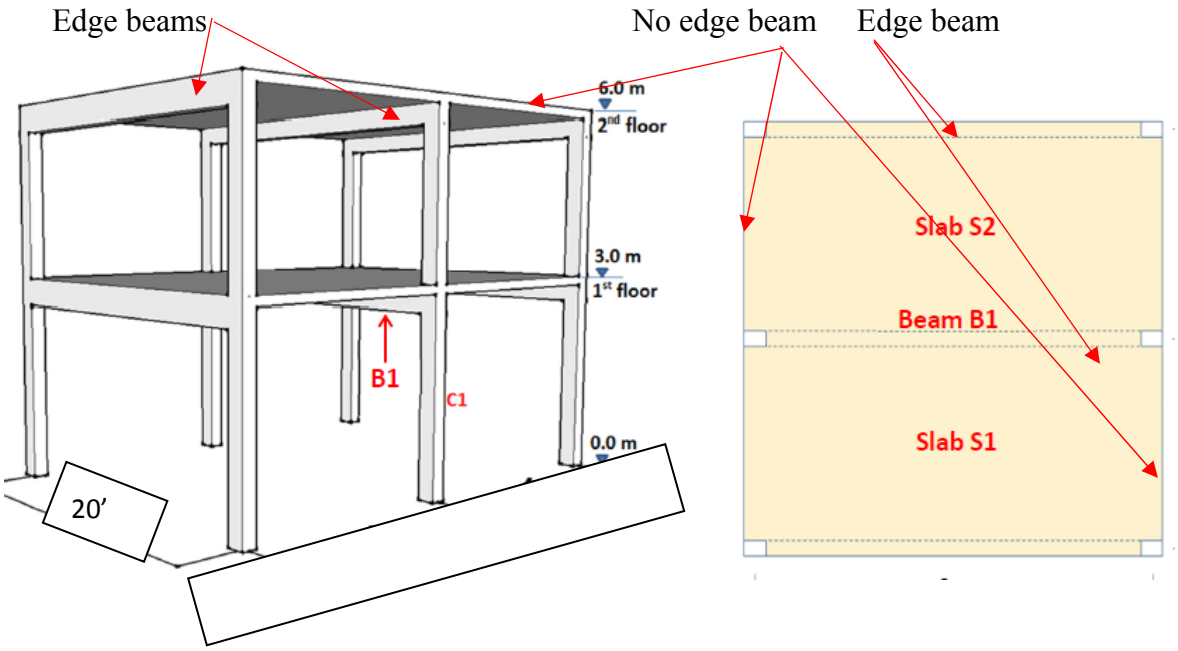
34) A circular foundation on the soil with a diameter of 10 feet is tested to find the allowable bearing capacity. If the soil fails under a force of 500,000 lb, and the factor of safety considered as 3, find the allowable stress of soil.

A) 14.7 psi B) 44.2 psi C) 56.7 psi D) 113.4 psi

35) A new roadway construction requires the sub base soil to have a dry density of 125 pcf and optimum moisture content (OMC) of 12.5%. A smooth drum roller will be used to compact the soil in 4-inch-thick lifts while the width is 32 ft. The soil has been tested in place and the results show moisture content of 6%. The water must be added to the stationing length of 100ft to obtain the required moisture content for compaction. How many gallons per yard must be added to meet the requirements?

A) 3.42 gal/yd^2
B) 5.63 gal/yd^2
C) 2.34 gal/yd^2
D) 2.93 gal/yd^2

36) For the reinforced concrete slabs like the following picture, if the width is given equal to 20', then what would be the maximum length of the slab if the designer wants to have two way slab and have the following reinforcement arrangement? (The slab supported by edge beam in two sides and there is no edge beam at the other sides.)



A) 40' B) It's impossible to have two way slab

C) 20' D) 55

37) For the following bridge shown in the following picture, what is the maximum distance between the net and the bridge deck that a fall can be arrested by that net?

A) 10’ B) 15’

C) 30’ D) 20’

38) For the excavation shown in the below figure, find the lateral earth pressure on each supporting structures if the spacing of them are about 10'. (Ka=0.3, Soil density = 150 pcf)

Spacing=10' 20' including height of foundation

A) 11250 lb/ft B) 1125 lb/ft

C) 9000 lb/ft D) 900 lb/ft

39) 100 yd3 of bank run soil is excavated and stockpiled before being transported and subsequently compacted. Swell and shrinkage factors for the soil are given equal to 0.30 and 0.12 respectively. The final volume of the compacted earth is most nearly.

A) 130 B) 65

C) 88 D) 112

40) For the following picture which shows a ditch checks for erosion control, which answer is the best description of both ditches?

Figure 1

Figure 2

A) 1: Rock ditch for grade <6%, 2: Bale ditch for grade >6%
B) 1: Bale ditch for grade >6%, 2: Rock ditch for grade <6%,
C) 1: Rock ditch for grade >6%, 2: Bale ditch for grade <6%
D) 1: Rock ditch for grade >2%, 2: Bale ditch for grade <2%

Solutions

Fourth Style Exam

1) The Building Cost Index (BCI) for structural iron work developed by which formula?

A) BCI = 68.36 hours of skilled worker at 20-city average of bricklayers + carpenters + structural ironworkers rate+25 cwt of standard steel shapes at the mill price prior to 1996.

B) BCI = 200 hours of common labor at 20-city average of common labor rates + 25 cwt of standard steel structural shape prior to 1996

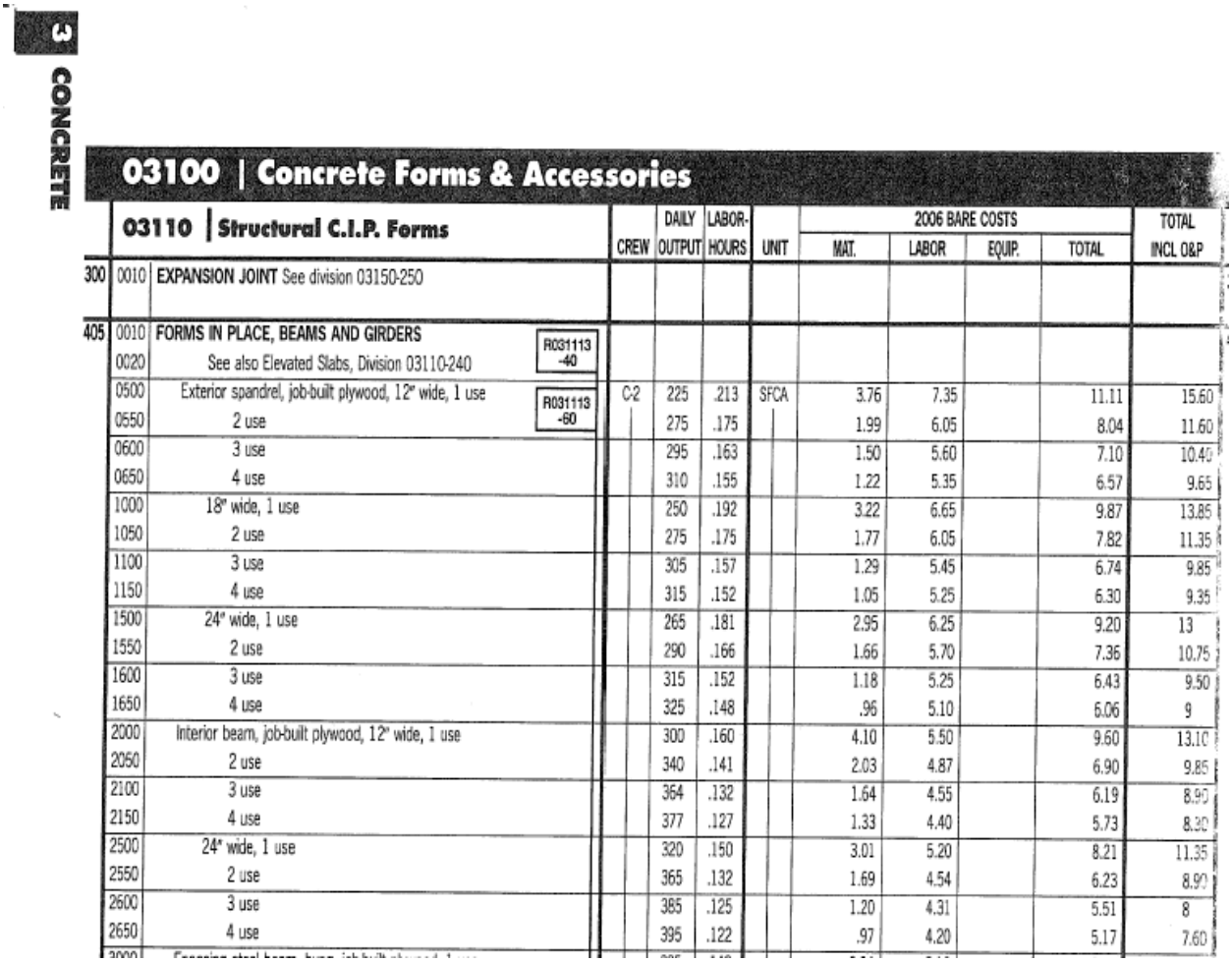
C) Fabricated 20-city price from 1996+1.128 tons of Portland cement + 1088 board-ft of 2x4 lumber

D) Both A & C

The Answers is D

The Engineering News-records BCI is developed with the explanation of both A & C. The explanation of "B" is about the Construction Cost Index (CCI).

2) You are replacing 12, 18" wide 2 use beams and 10, 24" wide 1-use beams. How much does labor cost for this project?



3 CONCRETE

03100 | Concrete Forms & Accessories

03110 | Structural C.I.P. Forms

				CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	2006 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
300	0010	**EXPANSION JOINT** See division 03150-250										
405	0010	**FORMS IN PLACE, BEAMS AND GIRDERS**	R031113 -40									
	0020	See also Elevated Slabs, Division 03110-240										
	0500	Exterior spandrel, job-built plywood, 12" wide, 1 use	R031113 -60	C-2	225	.213	SFCA	3.76	7.35		11.11	15.60
	0550	2 use			275	.175		1.99	6.05		8.04	11.60
	0600	3 use			295	.163		1.50	5.60		7.10	10.40
	0650	4 use			310	.155		1.22	5.35		6.57	9.65
	1000	18" wide, 1 use			250	.192		3.22	6.65		9.87	13.85
	1050	2 use			275	.175		1.77	6.05		7.82	11.35
	1100	3 use			305	.157		1.29	5.45		6.74	9.85
	1150	4 use			315	.152		1.05	5.25		6.30	9.35
	1500	24" wide, 1 use			265	.181		2.95	6.25		9.20	13
	1550	2 use			290	.166		1.66	5.70		7.36	10.75
	1600	3 use			315	.152		1.18	5.25		6.43	9.50
	1650	4 use			325	.148		.96	5.10		6.06	9
	2000	Interior beam, job-built plywood, 12" wide, 1 use			300	.160		4.10	5.50		9.60	13.10
	2050	2 use			340	.141		2.03	4.87		6.90	9.85
	2100	3 use			364	.132		1.64	4.55		6.19	8.90
	2150	4 use			377	.127		1.33	4.40		5.73	8.30
	2500	24" wide, 1 use			320	.150		3.01	5.20		8.21	11.35
	2550	2 use			365	.132		1.69	4.54		6.23	8.90
	2600	3 use			385	.125		1.20	4.31		5.51	8
	2650	4 use			395	.122		.97	4.20		5.17	7.60

A) $135.10
B) $72.60
C) $75.00
D) $145.50

The Answers is A

12 – 18", 2 use = $6.05 * 12 = $72.6

10 – 24", 1 use = $6.25*10 = $62.5

Total = $72.6+$62.5 = $135.1

3) A project is described by the following precedence table. The project manager wants to decrease the normal project time by 4 days. Most nearly, how much will it cost to reduce the project completion time by four days?

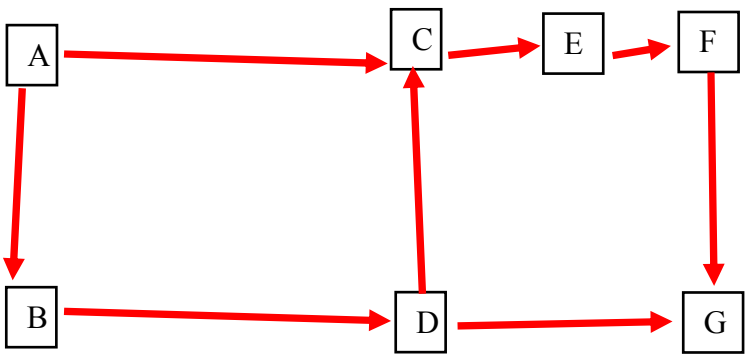
Activity	Predecessors	Normal time (days)	Crash time	Normal cost daily	Crash cost daily
A	-	8	6	50	100
B	A	2	1	80	140
C	A	6	4	80	100
D	B	2	1	100	150
E	C	6	3	90	200
F	E	3	1	80	160
G	D,F	4	2	120	300

A) 200 B) 120

C) 180 D) 140

The Answers is D

According to the table the CPM chart represents the following free floats:



Free floats are:

Path 1: A-B-D-G= 16

Path 2: A-B-D-E-F-G=25

Path 3: A-C-E-F-G= 27 critical path

In order to reduce the overall project duration by 4 days, the mot inexpensive operation is to allocate additional resources (crash) to activities C, D, and A.

For 4 days we can consider C for 2 days and A for the other 2 days. So

The critical path with be equal to 27-4 = 23 days.

The additional costs will be equal to:

For C: 100-80 = $20 daily, 2*20=$40 for two days

For A: 100-50 = $50 daily, 2*50=$100 for two days.

The total additional cost due the project crash = 100+40= $140

3) A dump-hauler has a purchase price of $109,000. Freight for delivery is $1000. Tires are an additional 21,000 with the estimated life time of 4500 hours. The hauler expected to operate 1500 hours annually and for 11 years. Maintenance fees for the hauler is estimated at $18000. What is the before-tax estimated hourly cost of operation excluding operator labor cost?

A) 35 B) 41

C) 24 D) 15

The Answers is C

The best way to estimate the hourly cost is to find all expenditures and cost for a year, then the hourly cost can be estimated prorate:

The total hauler cost = 109000+1000= $110,000

The hauler price per year: 110,000+/11= $10,000 per year

Tires will work 4500 hr and every year 1500 years of operation is expected so: 4500/1500=3 years is the life time for the tires

Therefore, tire costs for a year is become: 21000/3 = $7000

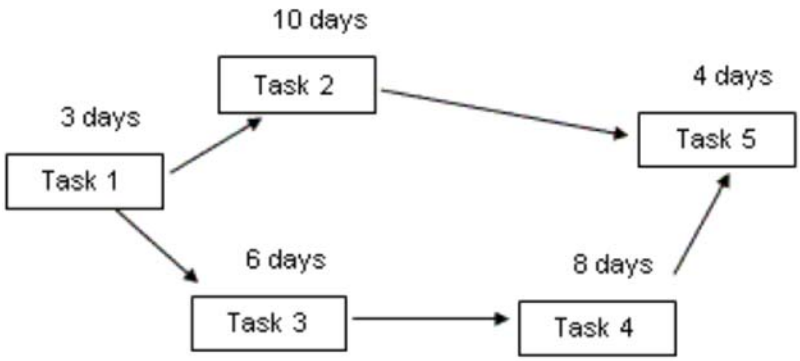
Total annual expenditures = $10,000+$7,000+$18000 = $35,000

Hourly rate = 35000/1500 hr/year = 23.3 say $24.00

4) In the activity network below, what is the total float of Task 5?

A) 0 B) 1

C) 2 D) 3



The Answers is A

The complete solution to this problem requires calculating the ES, LS, EF, LF, and the float (as follows).

	ES	LS	EF	LF	Float
1	0	0	3	3	0
2	3	7	13	17	4
3	3	3	9	9	0
4	9	9	17	17	0
5	17	17	21	21	0

Therefore, task 5 has a total float of 0.

Short Cut

There is no need to calculate anything in this problem. Task 5 is the finishing task of this project and therefore, must be on the critical path. All tasks that are on critical path have always zero floats. Therefore, (A) is the correct answer.

5) The Figure below shows a scaffolding for a bridge as a heavy construction. If the deck thickness of the bridge is given equal to 4', and the span length between scaffolding columns is given equal to 4', find the axial force in those columns for the dead and personnel and equipment combination. (No variable material on the scaffolding will be stored.)

A) P= 2400 lbs

B) P=13440 lbs

C) P= 9600 lbs

D) P= 1200 lbs

The Answers is B

According to the load classification, the 75 psf live load is used for the heavy construction with motorized buggies and heavy equipment. There is no variable material on scaffolding so only the live load of the personnel and their equipment shall be considered.

The area on each column is less than 400sf so no reduction of live loads shall be considered.

Concrete density = 150 pcf

So, Dead load = 4*150= 600 lb/sf

Live load= 75 lb/sf

U=1.2D+1.6L = 1.2*600+1.6*75= 840 lb/sf

For the 4'*4' scaffolding grid the axial force will be equal to: 840*4*4= 13440 lbs

6) If the weight of the white car is 1.5 US tons, for lifting up by a crane like the left figure, find the minimum safe resistive moment for the crane to prevent of an accident shown in the right figure if the required lever arm is 30'. If the weight of crane is given equal to 10 tons, then find the required distance between cranes jacks on the ground

A) $M_R < 90{,}000$ lb-ft
B) $M_R = 90{,}000$ lb-ft
C) $M_R \geq 90{,}000$ lb-ft
D) None of the answers

The Answers is C

The resistive moment should be equal to or bigger than the overturning moment.

$M_{overturning}$= Force * Lever arm = 1.5* 2000 lbs * 30' = 90,000 lb-ft

So, to have the safe lifting the resistive moment (M_R) should be bigger than the overturning moment: $M_R \geq 90{,}000$ lb-ft

7) For the following haul road crown what is the maximum possible slope?

A) 6%

B) 12%

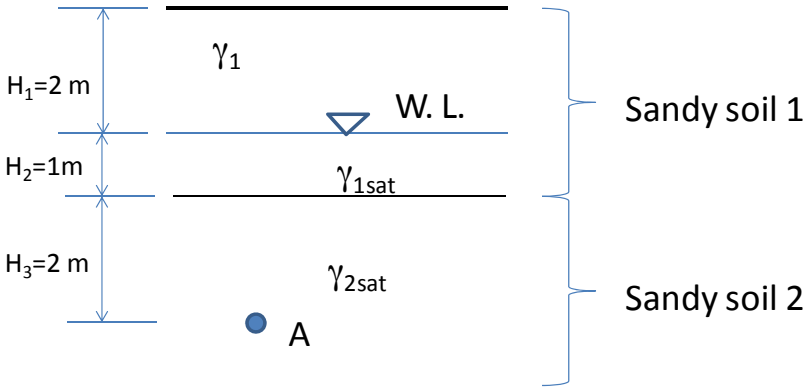
C) 3%

D) 1%

The Answers is C

The ideal crown slope is 3%. Lower slopes my allow water to pool on the road and more than 3% cause the uneven tire wear.

8) Point A is 5 m below the ground. The underground water level is 2 m below the ground. There are two deposits of sandy soil at the site. The first deposit of soil has a depth of 3 m, and a total unit weight (above the water level) of 13.2 kN/m3, a saturated unit weight of 16.5 kN/m3. The second deposit of soil has a saturated unit weight of 17.6 kN/m3. Determine the effective vertical soil pressure at point A.



A) 23.5 kPa B) 48.7 kPa C) 53.2 kPa D) 72.4 kPa

The Answers is B

Effective stress σ' is equal to the total stress σ minus pore water pressure $\mathbf{u}$.$\sigma' = \sigma - \mathbf{u}$.

Step 1:

The total stress σ is calculated by$\sigma = \boldsymbol{\gamma_1 H_1 + \gamma_{1sat} H_2 + \gamma_{2sat} H_3 = (13.2\ kN/m^3)(2\ m) + (16.5\ kN/m^3)(1\ m) + (17.6\ kN/m^3)(2\ m) = 78.1\ kPa}$

Step 2:

The pore water pressure $\mathbf{u}$ is calculated by$\mathbf{u = \gamma_w H_2 = (9.8\ kN/m^3)(1\ m + 2\ m) = 29.4\ kPa}$

Step 3:

The effective stress $\sigma'$is

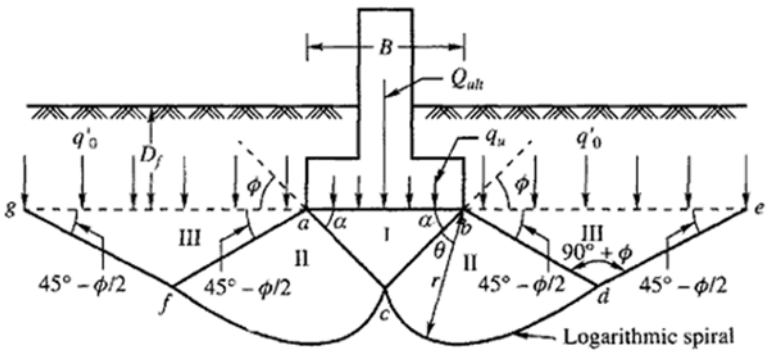
$$\mathbf{u = \sigma - u = 78.1\ kPa - 29.4\ kPa = 48.7\ kPa}$$

9) A footing is founded at the depth of D_f below the ground surface as embedded foundation. Another footing with the same size is on top of the soil. Which one shows more bearing capacity?

A) No changes in bearing stress because the area is important
B) Buried one has more bearing stress
C) Surface one has more bearing stress
D) It depends on the soil parameters.

The Answers is B

According to the below picture and using any different expressions to find the ultimate bearing stress (i.e. Terzaghi's theory, Hansson, etc.) , the more depth of footing increase the q0 and thus the bearing pressure. So the more depth, the more bearing stress. So the footing which is embedded shows more bearing more than the on surface footing with the same size.



10) A 2.4m thick clay layer is between two saturated 3m sand layers. The average effective vertical stress in the clay (at the depth of 5.4 m) is given equal to 30 kPa. Determine the total stress at the depth of 5.4m.

A) 54 B) 84 C) 79 D) 30

The Answers is B

The relation between total stresses, pore pressure, and effective stresses are described as:

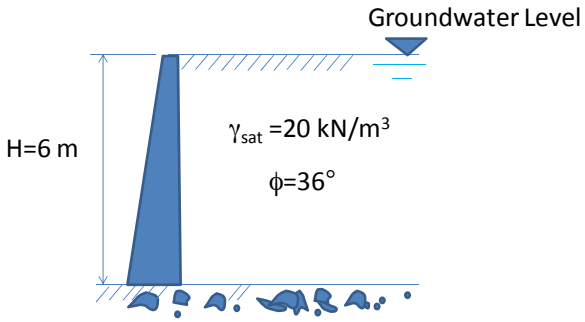
$$\boldsymbol{\sigma'_v = \sigma_v - u = (\gamma_{sat} - \gamma_w)H}$$

At the depth of 5.4m the pore water pressure = $u = 5.4 * 10 = 54$ KPa.

Total stress = effective stress + pore pressure

Total stress = 30+54 = 84 KPa

11) Determine the lateral force (per unit length of wall) on the frictionless retaining wall, as shown in the figure below. The soil behind of the wall is clean sand with a saturated unit weight of 20.0 kN/m3 and angle of internal friction of 36°. Groundwater level is at the surface of the ground.



A) 124.1 kN/m B) 202.1 kN/m
C) 224.1 kN/m D) 420.1 kN/m

The Answers is C

Step 1:

Based on the Rankine theory, the Rankine active earth pressure coefficient $K_A = \tan^2\left(45° - \frac{\phi}{2}\right) = \tan^2\left(45° - \frac{36°}{2}\right) = 0.260$.

Step 2:

At the surface of the ground, the vertical effective stress and the pore water pressure are both zero, $\sigma'_v = u = 0$.

At the base of the wall,

$$\sigma'_v = \sigma_v - u = (\gamma_{sat} - \gamma_w)H = \left(20\frac{kN}{m^3} - 9.8\frac{kN}{m^3}\right)(6\ m) = 61.2\ kPa$$

$$u = \gamma_w H = \left(9.8\frac{kN}{m^3}\right)(6\ m) = 58.8\ kPa$$

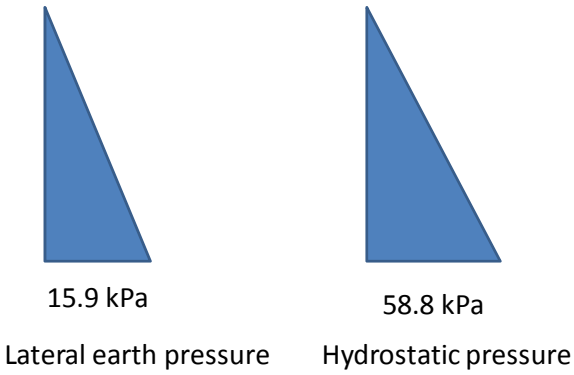
Step 3:

The active lateral earth pressure at the base of the wall, σ_a, is

$$\sigma_a = K_A\sigma'_v = 0.260 \times 61.2\ kPa = 15.9\ kPa$$

Step 4:

Based on the distributions of lateral earth pressure and pore water pressure,

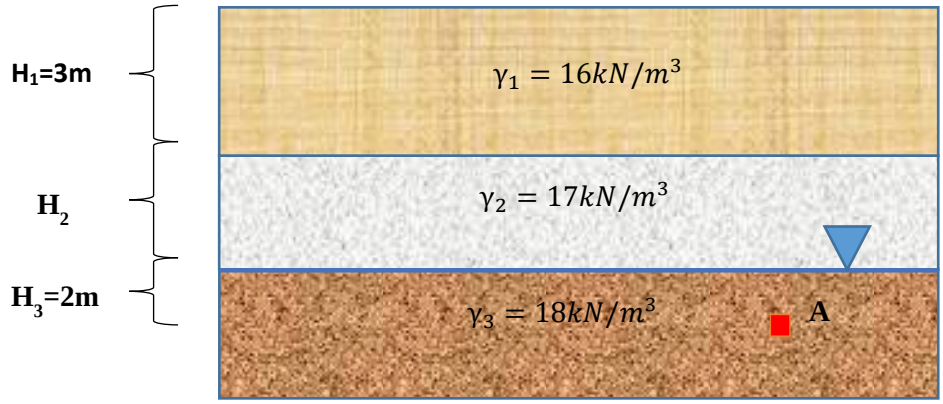


the lateral force (per unit length of wall) on the wall, P_a, is

$$P_a = P_s + P_w = \frac{1}{2}\sigma_a H + \frac{1}{2}uH = \frac{1}{2}(\sigma_a + u)H = \frac{1}{2}(15.9\ \text{kPa} + 58.8\ \text{kPa})(6\ \text{m}) = 224.1\ \text{kN/m}$$

where P_s is the lateral force due to soil solids and P_w is the lateral force due to the pore water.

12) A uniform deposit soil is shown in the following diagram. Information of soil in each layer is given. Assume that the effective stress at point A is 100kPa, determine the value of H2.



A) 2.00m B) 2.50m C) 3.00m D) 3.50m

The Answers is A

Step 1: From the diagram, we can see that there are three layers of soil. For the first layer above groundwater level, the unit weight is equal to,

$\gamma_1 = 16kN/m^3$

For the second layer above groundwater level, the unit weight is equal to,

$\gamma_2 = 17kN/m^3$

For the third layer below groundwater level, the unit weight is equal to,

$\gamma_3 = 18kN/m^3$

Step 2: The total stress at point A can be then calculated as,

$$\sigma = \gamma_1 H_1 + \gamma_2 H_2 + \gamma_3 H_3 = (16kN/m^3)(3m) + (17kN/m^3)H_2 + (18kN/m^3)(2m)$$
$$= (84 + 17H_2)kPa$$

The pore water pressure is given as,

u $= \gamma_w H_2 = (9.8kN/m^3)(2m) = 19.6kPa$

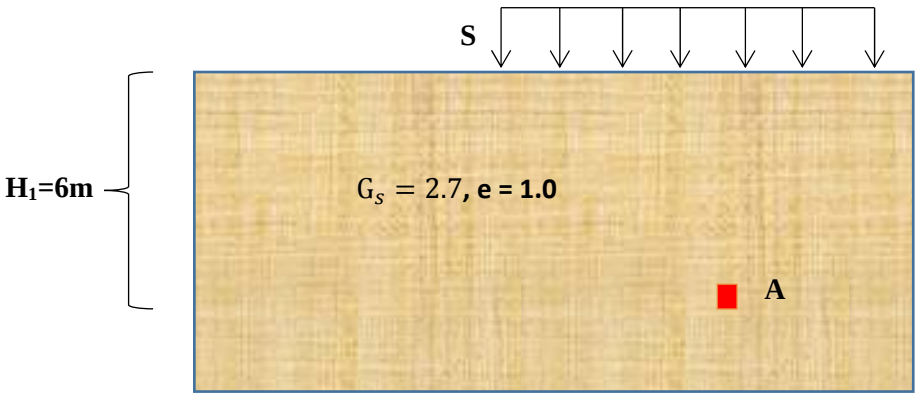
Effective pressure at point A can be finally calculated by,

$\sigma' = \sigma - u = (84 + 17H_2)kPa - 19.6kPa = 100kPa$

Solve the equation above,

$H_2 = 2m$

13) Information of a soil is shown in the following diagram. Assume that the surcharge is 40kPa acting at the top of soil as shown in the diagram. If the effective pressure at point A is 150kPa. Determine the water content of this soil.



A) 15.6% B) 14.2% C) 13.3% D) 12.1%

The Answers is C

Step 1: From the diagram, we can see that there is only one layer of soil. The effective pressure at point A can be calculated by,

$$\sigma = S + \gamma H_1 = 40kPa + \gamma(6m) = 130kPa$$

Solving this equation, we can know the value of density of this soil as,

$$\gamma = 15kN/m^3$$

Step 2: According to equations of the density of this soil can be described as,

$$\gamma = \left(\frac{G_s + Se}{1 + e}\right)\gamma_w$$

Therefore,

$$\gamma = \left(\frac{G_s + Se}{1 + e}\right)\gamma_w = \left(\frac{2.7 + S}{1 + 1}\right)(9.8kN/m^3) = 15kN/m^3$$

$$S = 36\%$$

According to the following equation water content of soil is,

$$w = \frac{Se}{G_s} = \frac{(36\%)(1.0)}{2.7} = 13.3\%$$

14) A load of 12000 lb is going to put 10 ft from the left support on a **30 ft** long beam. If the maximum permissible bending stress is 24,000 psi. Determine the minimum section modulus for the supposed beam. E = 30 × 106 psi.

A) 12 in^3

B) 35 in^3

C) 40 in^3

D) 25 in^3

The Answers is C

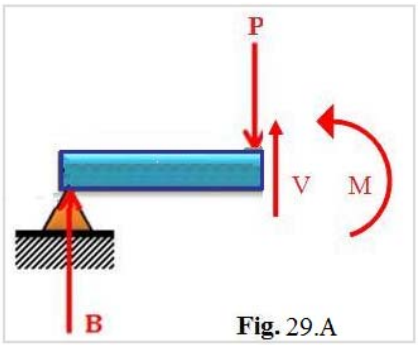


Fig. 29.A

Step 1: Reaction at point B, the left support:

$\sum M_A = 0$ (point A is the right support)

$0 = - R_B (30) + P (20)$

$R_B = 12000(20)/30$

$R_B = 8000$ lb

Step 2: Draw free body diagram of the section under the load and determine the maximum moment:

$\sum M_V = 0$ $\quad 0 = - R_B (10) + M$

$M = 8000\ lb\ (10\ ft)$

$\Rightarrow M_{max} = 80{,}000\ lb{\cdot}ft$

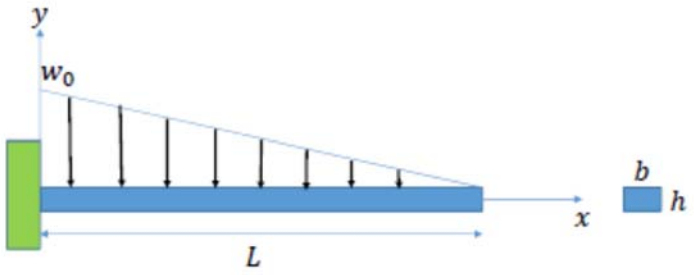
Step 3: Calculate the S, Section Modulus, from the maximum normal stress:

$$\sigma_{max} = \frac{M}{S} < 24000\ psi$$

$$S > \frac{M}{2400\ psi} = \frac{80{,}000\ lb{\cdot}ft\ (12\ \frac{in}{ft})}{24000\ psi}$$

$\Rightarrow S > 40\ in^3$

15) Determine h if the maximum slope on the beam shown below is measured as -0.02 rad.



$\mathrm{b} = 4\ \mathrm{in}$ $\mathrm{E} = 200\ \mathrm{kpsi}$ $\mathrm{w} = 100\ \mathrm{lb/in}$ $\mathrm{L} = 3\ \mathrm{ft}$

A) 4.38 in
B) 5.26 in
C) 6.15 in
D) 7.07 in

The Answers is B

Step 1: The slope at the free end of cantilever beam is the maximum. Using any mechanics of material book, the maximum slope can be calculated as

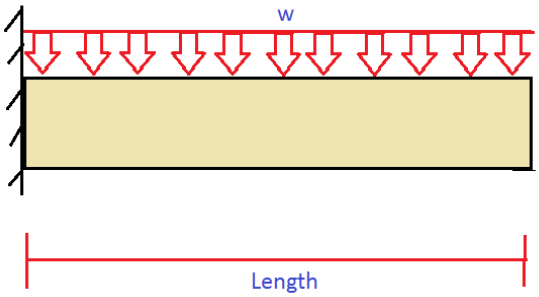
$$\theta_{max} = \frac{-w_0 L^3}{24EI} = \frac{-w_0 L^3}{24E\frac{bh^3}{12}} = \frac{-w_0 L^3}{2Ebh^3} = -0.02$$

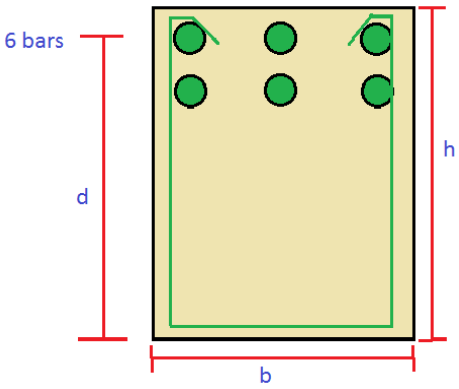
Step 2: determine h

$$h^3 = \frac{w_0 L^3}{(0.02)2Eb} = \frac{(100\ lb/in)(36\ in)^3}{(0.02)2\left(200 \times 10^3 \frac{lb}{in^2}\right)(4\ in)} = 145.8\ in^3$$

$$h = 5.26\ in$$

16) A 15 ft long reinforced concrete cantilever beam is subject to factored shear of 105 kips at the fixed end. The shear support from the concrete is 57 kips. The beam cross section is 18 in by 28 in. $f_y = 60000$ psi, $f'_c = 4000$ psi. The depth of the steel is 25 in. #3 stirrups are used. Determine the required spacing for the shear reinforcement at the support.





A) 12 in B) 4.4 in

C) 12.5 in D) 3.9 in

The Answers is D

ACI 318-08, 11.1 & 11.2

Step 1: The given ultimate shear at the support is greater than the shear that the concrete can support. Knowing this we will calculate required spacing using the appropriate relationships. Determine the shear that will need to be carried by the steel and the spacing to do so. This will require a resistance factor to be considered. Use the resistance factor table. For shear use 0.75.

$$V_s = \frac{V_u}{\phi} - V_c = 84.33\ kips$$

#3 stirrups are used for this system. Look up the area for a #3 bar at the appropriate table. The area is 0.11 in^2 the total shear area will be double since it crosses the cross section twice.

$$A_v = (2)(0.11\ in^2) = 0.22\ in^2$$

Determine the required spacing.

$$s = \frac{A_v f_y d}{V_s} = \frac{(0.22\ in^2)(60000\ psi)(25\ in)}{(84330\ lb)} = 3.91\ in$$

Step 2: Calculate the maximum spacing and make sure they are not less than the required spacing calculated. To know which set of maximums to use calculate the limit and test against V_s.

$$4b_w d\sqrt{f_c'} = 4(18\ in)(25\ in)\sqrt{4000\ psi}\left(\frac{1kip}{1000lb}\right) = 113.84\ kips$$

$$113.84 > 84.33\ kips$$

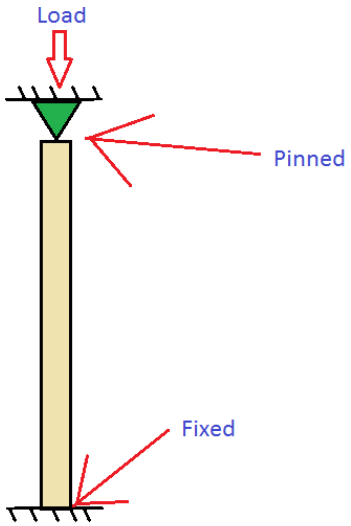
Use first set of maximums.

$$s = \frac{d}{2} = 12.5\ in\ or\ 24\ in$$

Both of these are greater than the value we calculated for spacing.

~3.9 in

17) The column shown is a W 21 X 50 steel member. The applied dead load is 7 kips. Neglect self-weight. The column length is 12 ft tall. The column is not braced along the length. Assume Fy = 50ksi. Determine the effective length of the column.



A) 12 ft B) 14.4 ft

C) 24.2 ft D) 9.5 ft

The Answers is D

TABLE C-C2.2
APPROXIMATE VALUES OF EFFECTIVE LENGTH FACTOR, *K*

BUCKLED SHAPE OF COLUMN IS SHOWN BY DASHED LINE.	(a)	(b)	(c)	(d)	(e)	(f)
THEORETICAL *K* VALUE	0.5	0.7	1.0	1.0	2.0	2.0
RECOMMENDED DESIGN VALUE WHEN IDEAL CONDITIONS ARE APPROXIMATED	0.65	0.80	1.2	1.0	2.10	2.0
END CONDITION CODE	*ROTATION FIXED AND TRANSLATION FIXED* *ROTATION FREE AND TRANSLATION FIXED* *ROTATION FIXED AND TRANSLATION FREE* *ROTATION FREE AND TRANSLATION FREE*					

Step 1: We first need to determine an effective length factor for the column. The top end of our system is fixed in translation but free in rotation, and the bottom end is fixed in both translation and rotation. See the appropriate table which is shown above. For our system select an effective length factor of 0.8 for design.

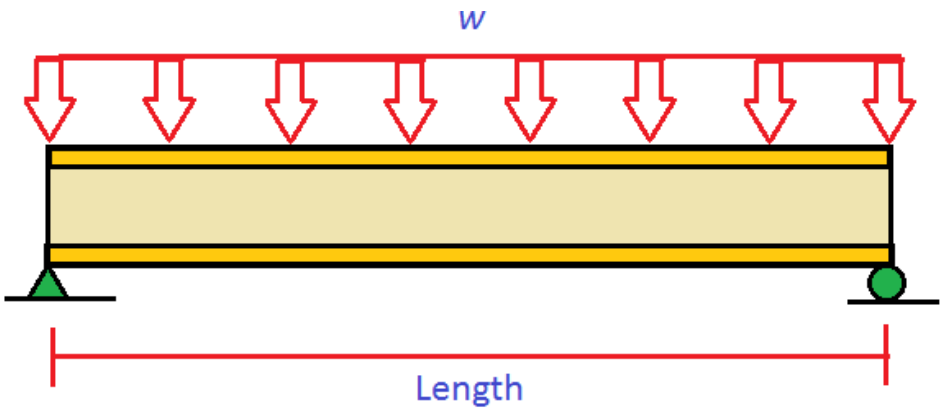
Step 2: Calculate the effective length for our column.

$$\mathrm{KL} = (0.8)(12\ \mathrm{ft}) = 9.6\ \mathrm{ft}$$

The column size and applied load are extra information.

~9.5 ft

18) A simply supported and fully braced beam spans 30 ft and carries a dead and live distributed load of 0.5 kip/ft and 0.8 kip/ft respectively. Using the 1.2D + 1.6L combination. If the Plastic section modulus is given equal to 55 in^3 for the assumed section, find the maximum stress in the section. (The beam made of steel with 50 KSI strength.)



A) 50 KSI B) 46 KSI

C) 30 KSI D) 38 KSI

The Answers is B

Step 1: Substitute the distributed dead load (w_D) and distributed live load (w_L) into the equation to get the factored distributed load (w_u).

$$w_u = 1.2w_D + 1.6w_L = 1.2\left(0.5\frac{kip}{ft}\right) + 1.6\left(0.8\frac{kip}{ft}\right) = 1.88\frac{kip}{ft}$$

Now we calculate the maximum moment on the beam. Maximum moment equations for a distributed load on a simple beam can be found in AISC table 3-23.

$$M_u = \frac{w_u L^2}{8} = \frac{\left(1.88\frac{kip}{ft}\right)(30\ ft)^2}{8} = 211.5\ kip - ft$$

$.\phi M_n = \phi M_p$

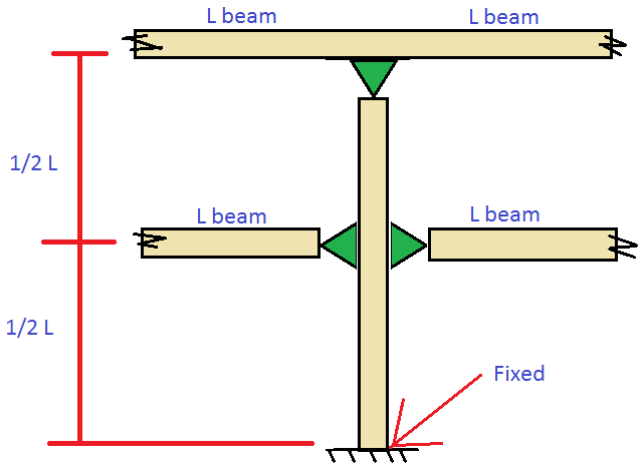
$$\phi M_p = \phi F_y Z_x = Stress\ .\ Z_x$$

Take the maximum moment on the beam and set this equal to our moment capacity then find a required section modulus.

$$M_u = 211.5 \text{ kip} - \text{ft}\left(12\frac{\text{in}}{\text{ft}}\right) = \text{stress } .55$$

$$Fb = 46.1 \text{ KSI}$$

19) The top beam of the system is a W 18 X 60 members, the column is a W 14 X 74 members, and the middle two beams are W 21 X 73 members. The total height of the column is 30 ft. The length of all beams is 35 ft. Assume Fy and Fu are 50 ksi and 65 ksi respectively. Assume there is no reduction in stiffness for inelastic buckling and connections are pinned. Assume sidesway is not prevented. Determine the effective length factor for the column top half of the column.



A) k = 2.1 B) k = 1.33

C) k = 1.0 D) k = 1.2

The Answers is A

In fact the question is tricky!

Since all connections are pinned there is no stiffness for the beams and the frame is sidesway permitted and we do not need to use the following expressions:

$$G_{top} = \tau \frac{\sum(\frac{I_c}{L_c})}{\sum(\frac{I_g}{L_g})} =$$

$$G_{bottom} = \tau \frac{\sum\left(\frac{I_c}{L_c}\right)}{\sum\left(\frac{I_g}{L_g}\right)} =$$

So, none of the beams are considered in this frame and just a cantilever column shall be considered and we may use the following table:

BUCKLED SHAPE OF COLUMN IS SHOWN BY DASHED LINE	(a)	(b)	(c)	(d)	(e)	(f)
THEORETICAL K VALUE	0.5	0.7	1.0	1.0	2.0	2.0
RECOMMENDED DESIGN VALUE WHEN IDEAL CONDITIONS ARE APPROXIMATED	0.65	0.80	1.2	1.0	2.10	2.0
END CONDITION		ROTATION FIXED AND TRANSLATION FIXED ROTATION FREE AND TRANSLATION FIXED ROTATION FIXED AND TRANSLATION FREE ROTATION FREE AND TRANSLATION FREE				

So for the cantilever column: K= 2.1

20) Three rain gages are located within or nearby a watershed, whose total area is 1100 acres. Using the Thiessen polygon method, the portions of the watershed associated with gages A, B, and C are 520, 310, and 270 acres, respectively. For a particular storm, it is determined that the excess rainfall for these 3 portions of the watershed is 0.95, 1.23, and 1.44 inches, respectively. What is the volume of runoff from this watershed for this storm?

A) 19.2 MG

B) 28.3 MG

C) 34.3 MG

D) 44.7 MG

The Answers is C

Step 1: The volume of runoff is equal to the product of the watershed area and the excess rainfall depth.

Step 2: Here the volume = (0.95 in)(1/12 ft/in)(520 acres)(43560 ft^2/acre)+ (1.23 in)(1/12 ft/in)(310 acres)(43560 ft^2/acre) + (1.44 in)(1/12 ft/in)(270 acres)(43560 ft^2/acre)=$4.59x10^6$ ft^3 = 34.3 MG (million gallons)

21) At the design discharge, an existing single circular culvert has the following characteristics: headwater elevation = 5.5 ft above invert, culvert diameter= 2.5 ft, critical depth = 1.9 ft, uniform depth = 1.7 ft, and the outlet is free. Which of the following describes the culvert flow under these conditions?

A) Inlet control, inlet is not submerged, critical flow at the inlet

B) Inlet control, inlet is submerged with orifice flow control

C) Outlet control, inlet is submerged

D) Outlet control, inlet is not submerged

The Answers is B

Step 1: Since the critical depth is greater than the uniform depth, the culvert slope is steep. Therefore the culvert is under inlet control.

Step 2: Since the headwater elevation above the invert is more than 1.2 times the pipe diameter, the inlet will be submerged, and an orifice flow condition exists at the inlet.

22) Runoff from a 3-acre site is to be drained by a channel. The time of concentration for this site is 40 minutes. The site has a runoff coefficient C=0.2. Rainfall quantities to be used for design are 0.5 inches for a storm of duration 20 minutes, 0.7 inches for duration 40 minutes, and 0.9 inches for duration 60 minutes. For what discharge should this channel be designed?

A) 0.7 cfs B) 0.63 cfs C) 1.04 cfs D) 40 cfs

The Answers is B

Step 1: Apply the rational formula:

$Q = C\ i\ A$

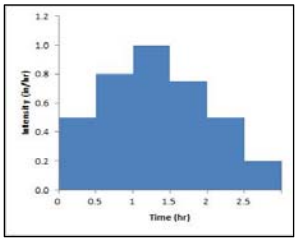
where Q is the discharge in cfs, C is the runoff coefficient for the watershed, i is the rainfall intensity in inches/hour, and A is the watershed area in acres.

Step 2: In applying the rational method, rain falling over a time period equal to the time of concentration of the watershed should be used. In this case, the time of concentration is given as 40 minutes, or 0.67 hours, and the corresponding rainfall amount is 0.7 inches. So the rainfall intensity is

$i = (0.7 \text{ inches})/(0.67 \text{ hour}) = 1.04 \text{ inches/hour}$

Step 3: Solver for the discharge $Q = C\ i\ A = (0.2)\ (1.04)\ (3) = 0.63$ cfs

23) Given the following hyetograph what is the total precipitation?



A) 1.4 inches B) 1.9 inches C) 3.8 inches D) 5.0 inches

The Answers is B

The total precipitation is the sum of all the rainfall over a given period of time for a watershed.

Step 1: Determine the time interval
The time frame given is in half hour increments.

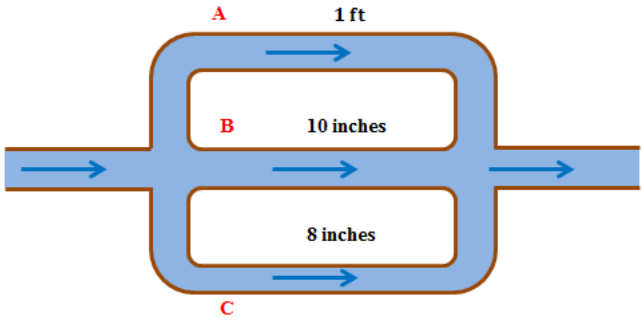
Step 2: Determine the rainfall for each interval

Time (hr)	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0
Intensity (in/hr)	0.5	0.8	1.0	0.8	0.5	0.2
Rainfall (in)	0.25	0.40	0.50	0.38	0.25	0.10
Total Rainfall (in)	0.25	0.65	1.15	1.53	1.78	1.88

Rainfall (hr 0-0.5)= $0.5\frac{in}{hr} * 0.5\ hr = 0.25\ in$
Rainfall (hr 0.5-1.0)= $0.8\frac{in}{hr} * 0.5\ hr = 0.40\ in$ etc.

Step 3: Determine total rainfall
Total rainfall = 0.25+0.40+0.50+0.38+0.25+0.10=1.88 inches

24) All three pipes in the figure below have the same length and are connected in parallel. The diameters are given. Determine the ratio of velocities in the branches. Assume the friction factor for all the lines to be the same.



A) V_C to V_B to V_A = 1 to 1.223 to 1.684

C) V_C to V_B to V_A = 1 to 1.118 to 1.224

B) V_C to V_B to V_A = 1 to 2.3 to 3.1

D) V_A to V_B to V_C = 1 to 1.118 to 1.224

The Answers is C

$h_{L,A} = h_{L,B} = h_{L,C}$

$h_L = f(\frac{L}{D})(\frac{v^2}{2g})$

$f_A(\frac{L_A}{D_A})(\frac{v_A^2}{2g}) = f_B(\frac{L_B}{D_B})(\frac{V_B^2}{2g}) = f_C(\frac{L_C}{D_C})(\frac{V_C^2}{2g})$

$(\frac{V_A^2}{D_A}) = (\frac{V_B^2}{D_B}) = (\frac{V_C^2}{D_C})$

$(\frac{V_A^2}{1}) = (\frac{V_B^2}{0.8333}) = (\frac{V_C^2}{0.667})$

$1\ V_A^2 = 1.2\ V_B^2 = 1.5 V_C^2$

Let $V_c = 1$

Then

$1.5\ (1)^2 = 1.2\ V_B^2$

$V_B = [\frac{1.5\ (1)^2}{1.2}]^{\frac{1}{2}}$

$V_B = 1.118$

Also

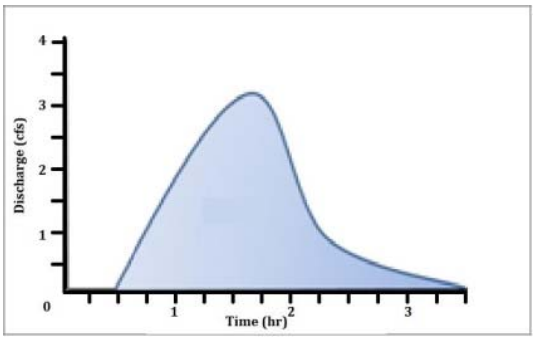
$1.5\ (1)^2 = V_A^2$

$V_A = [\frac{1.5\ (1)^2}{1.2}]^{\frac{1}{2}}$

$V_A = 1.224$

V_C to V_B to V_A = 1 to 1.118 to 1.224

25) What is the approximate runoff for a watershed with the given hydrograph?

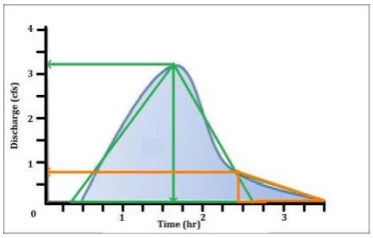


A) 4.7 ft^3 B) 14,500 ft^3 C) 17,000 ft^3 D) 23,500 ft^3

The Answers is C

Runoff volume is the area under a hydrograph

Step 1: Divide the area under the hydrograph into easily calculable areas



Triangle 1 $= \frac{3.5\ cfs*(1.6-0.3)hr}{2} * 3600\frac{s}{hr} = 8190\ ft^3$

Triangle 2 $= \frac{3.5\ cfs*(2.6-1.6)hr}{2} * 3600\frac{s}{hr} = 6300\ ft^3$

Triangle 3 $= \frac{1.5\ cfs*(3.5-2.5)hr}{2} * 3600\frac{s}{hr} = 2700\ ft^3$

Step 2: Determine the total area

Total $= 8190 + 6300 + 2700 = 17190\ ft^3$

This is an approximate due to triangle approximation.

26) Two pipelines carry water from a common starting point to a common end point. The two pipes have the same friction factor f and diameter, but pipe 1 is twice as long as pipe 2. What fraction of the discharge between the start and end points flows through pipe 1?

A) 34% B) 41% C) 50% D) 67%

The Answers is B

Step 1: For 2 pipes in parallel, the head loss in each pipe is equal.

Step 2: Using the Darcy Weisbach equation, equating the head losses in pipes 1 and 2 gives $f_1 (L_1/D_1) V_1^2/2g = f_2 (L_2/D_2) V_2^2/2g$

Step 3: Given that $f_1 = f_2$, $D_1 = D_2$, we get that $V_1^2/V_2^2 = (L_2/L_1)=0.5$, or $V_1/V_2 =(0.5)^{1/2} = 0.71$. Since the diameters and pipe areas are the same $Q_1/Q_2 = 0.71$. Then $Q_1/(Q_1+Q_2)= 1/(1+1/0.71)=0.41 = 41\%$

27) A 600 ft long equal-tangent crest vertical curve connects grades of +4.0% and -2.5%. The point of vertical intersection (PVI) is located at station 123+00 with an elevation of 62.80 ft. What is the elevation of the PVT?

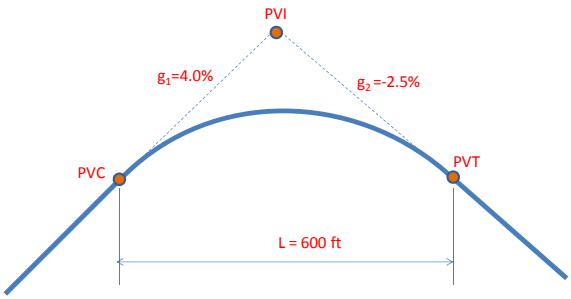
A) 55.30 ft B) 70.30 ft C) 73.50 ft D) 65.30 ft

The Answers is A

P3-151, AASHTO Geometric Design-Green Book 2011, 2011, 6th ed

Step 1:

The horizontal distance between the vertex (PVI) and the Point of Vertical Tangency (PVT) is half of the curve length.



$$\frac{L}{2} = \frac{600\ ft}{2} = 300\ ft$$

Step 2:

The grade between PVI and PVT is g_2=-2.5%. Therefore, the vertical distance between PVI and PVT is

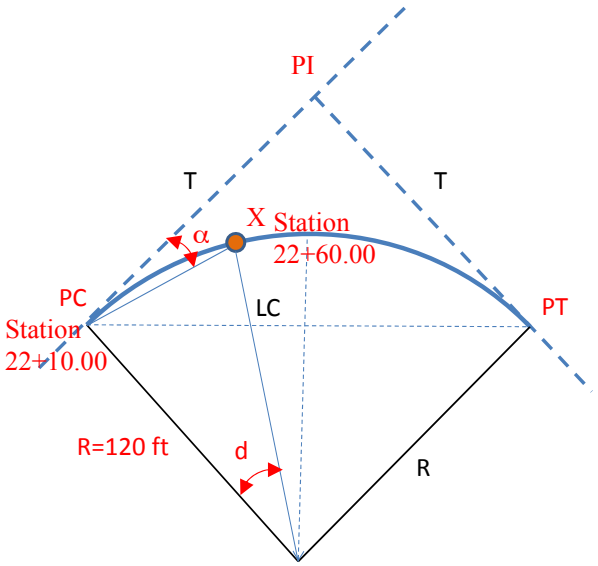
$$\Delta h = g_2\left(\frac{L}{2}\right) = (-2.5\%) \times 300\ ft = -7.50\ ft$$

Step 3:

The elevation of PVT is

$$PVI\ elevation + \Delta h = 62.80\ ft - 7.50\ ft = 55.30\ ft$$

28) A horizontal circular curve has a radius of 120 ft. The station of PC is sta 22+10.00. At point X (station 22+60.00) on the curve, a stake is to be placed. The deflection angle between tangent PI-PC and chord X-PC is most nearly



A) 14°56′12" B) 13°06′12"
C) 11°56′12" D) 11°44′43"

The Answers is C

Step 1:

The curve length between X and PC is

$$l = (\text{sta } 22 + 60.00) - (\text{sta } 22 + 10.00) = 50 \text{ ft}$$

Step 2:

The angle for curve length l is $d = \frac{180°l}{R\pi} = \frac{180°(50 \text{ ft})}{(120 \text{ ft})\pi} = 23.873°$.

Step 3:

The deflection angle between tangent PI-PC and chord X-PC is half of the angle for curve length l

$$\alpha = \frac{1}{2}d = \frac{23.873°}{2} = 11.9366° \cong 11°56′12"$$

29) What is the minimum Average Daily Traffic (ADT) passing in one lane with the speed of 50 mph in the level terrain?

A) 1500-2000

B) 400-1500

C) >2000

D) = 2000

The Answers is C

AASHTO, A policy on Geometric design of Highways and Streets, Table V-I

This is the definition in the code.

For the 50 mph in the level terrain, or 40 mph in the rolling terrain, and 30 mph in the mountanious terrain the design volume for each lane (ADT) is considered as: >2000

30) Particle size analysis was carried out on a soil with the results shown in the following table. Classify the soil according to the Unified Soil Classification system (USCS).

Size	Percent Passing
12.5 mm	100
9.5 mm	60
No. 4 (4.75 mm)	40
No. 20 (0.85 mm)	30
No. 60 (0.25 mm)	10
No. 200 (0.075 mm)	4

A) GC B) GP C) SP D) SM

The Answers is B

Step 1:

Because only 5% of the soil is smaller than No. 200 sieve size, the soil is coarse-grained according to the Unified Soil Classification table

Step 2:

The gravel fraction of the soil is those larger than No. 4 sieve size, which is (100-40)=60. The sand fraction of the soil is those larger than No. 200 sieve size but less than No. 4 sieve size, which is (40-5)=35. Since 60>35, there are more gravels than sands in the coarse fraction of the soil. The first letter of the USCS group symbol is G according to the Unified Soil Classification table

Step 3:

Because the clay+silt fraction of the soil (fraction smaller than No. 200 sieve size) is very small (4%), the gravel contains little fines (clean). Therefore, the second letter of the USCS group symbol is either W or P.

Step 4:

From the gradation curve table, it is known that the grain size corresponding to 10% finer on grain size curve (D_{10}) is 0.25 mm, the grain size corresponding to 30% finer on grain size curve (D_{30}) is 0.85 mm, the grain size corresponding to 60% finer on grain size curve (D_{60}) is 9.5 mm. Therefore, the coefficient of uniformity (C_U)is

$$C_U = \frac{D_{60}}{D_{10}} = \frac{9.5\ mm}{0.25\ mm} = 38$$

The coefficient of curvature (C_C)is

$$C_C = \frac{(D_{30})^2}{D_{10}D_{60}} = \frac{(0.85\ mm)^2}{(0.25\ mm)(9.5\ mm)} = 0.30$$

Step 5:

Because C_C is outside of the range of 1 to 3, the soil is poorly graded. Therefore, the second letter of the USCS group symbol is P.

Therefore, the soil is classified as GP according to USCS.

31) The subgrade of a highway is compacted from a natural soil layer. It is known that the natural soil has a total unit weight of 20 kN/m3, and a dry unit weight of 18 kN/m3. It needs to be compacted to attain a dry unit weight of 19 kN/m3 and a water content of 15%. What is the total unit weight of the compacted soil?

A) $21.85\frac{\text{kN}}{\text{m}^3}$ B) $22.85\frac{\text{kN}}{\text{m}^3}$ C) $23.85\frac{\text{kN}}{\text{m}^3}$ D) $24.85\frac{\text{kN}}{\text{m}^3}$

The Answers is A

Step 1:

From the given information, it is known that after compaction the subgrade soil has a dry unit weight (γ_D) of 19 kN/m^3 and a water content (ω) of 15%.

Step 2:

The total unit weight of the compacted soil is

$$\boldsymbol{\gamma = \gamma_D(1+\omega) = 19\frac{kN}{m^3}\times(1+15\%) = 21.85\frac{kN}{m^3}}$$

Note: It can be calculated to see that the water content of the compacted soil is higher than that of the uncompacted soil, therefore water must be added during compaction. However, this is irrelevant to the question in this problem.

32) An engineer specifies that the concrete structure must have a strength to withstand an object with a diameter of 0.75 inches and a force of 2500 lbs. Determine the required average compressive strength for a plant where the standard deviation is unknown given the equations. The following table may be consulted:

$$\boldsymbol{f'cr = f'c + 1.34s} \quad \boldsymbol{f'cr = f'c + 2.33s - 500}$$

Specified Compressive Strength, f'c (psi)	Required Average Compressive Strength, f'cr (psi)
< 3000	f'c + 1000
3000 to 5000	f'c + 1200
> 5000	f'c + 1400

A) 5659 psi
B) 6259 psi
C) 6659 psi
D) 7059 psi

The Answers is D

Step 1. Determine the pressure exerted on the structure with the following equation:

$$f'c = \frac{Force_{object}}{Area_{object}}$$

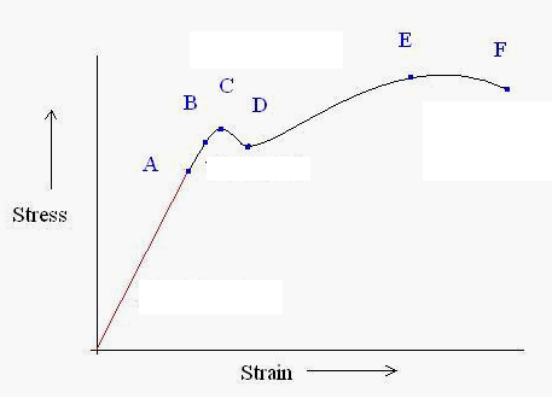
$$f'c = \frac{2500lbs}{\frac{\pi * 0.75^2}{4}} = 5659\ psi$$

Step 2. Use the chart provided to calculate the required average compressive strength.
NOTE: f'c > 5000psi.

$$f'cr = f'c + 1400$$

$$f'cr = 5659 + 1400 = 7059psi$$

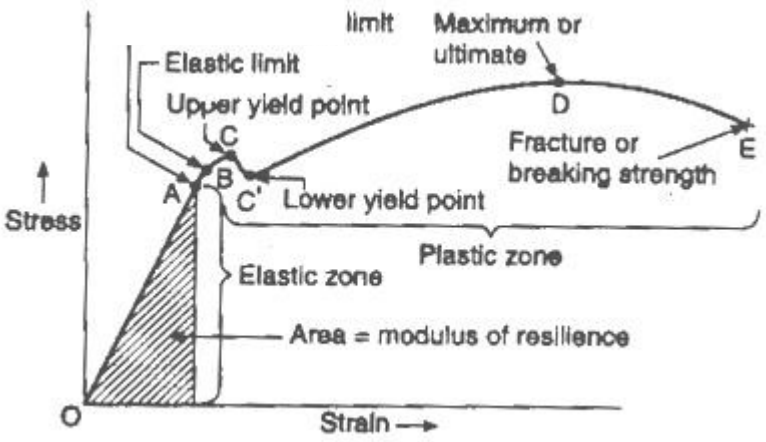
33) The stress-strain test of a steel bar shows in the following graph. Which point shows the yield stress?



A) C
B) B
C) A
D) D

The Answers is D

This is the definition for the strain stress curve. All practice codes consider lower yield point as the yield stress.



34) A circular foundation on the soil with a diameter of 10 feet is tested to find the allowable bearing capacity. If the soil fails under a force of 500,000 lb, and the factor of safety considered as 3, find the allowable stress of soil.

A) 14.7 psi B) 44.2 psi C) 56.7 psi D) 113.4 psi

The Answers is A

Step 1:

The normal stress at failure, $\boldsymbol{\sigma_N}$, is calculated by $\boldsymbol{\sigma_N = \frac{P}{A}}$, where P= normal force at failure; A=cross-sectional area of sample over which force acts.

Step 2:

From the given information, it is known that $\boldsymbol{P = 500000 lbf}$, $\boldsymbol{A = \frac{\pi D^2}{4} = \frac{\pi(10 * 12\ inches)^2}{4} = 11309.7\ in^2}$. Therefore, $\boldsymbol{\sigma_N = \frac{P}{A} = \frac{500000\ lbf}{11309.7\ in^2} = 44.209\ psi}$.

Step 3:

The ultimate compressive strength, $\boldsymbol{q_u}$, is equal to the normal stress at failure. $\boldsymbol{q_u = \sigma_N = 44.209\ psi}$.

Step 4:

The allowable stress of soil = qu/FS = 44.209/3 = 14.73 psi

35) A new roadway construction requires the sub base soil to have a dry density of 125 pcf and optimum moisture content (OMC) of 12.5%. A smooth drum roller will be used to compact the soil in 4-inch-thick lifts while the width is 32 ft. The soil has been tested in place and the results show moisture content of 6%. The water must be added to the stationing length of 100ft to obtain the required moisture content for compaction. How many gallons per yard must be added to meet the requirements?

A) 3.42 gal/yd^2
B) 5.63 gal/yd^2
C) 2.34 gal/yd^2
D) 2.93 gal/yd^2

The Answers is D

$$\boldsymbol{Gallons\ of\ Water} =$$

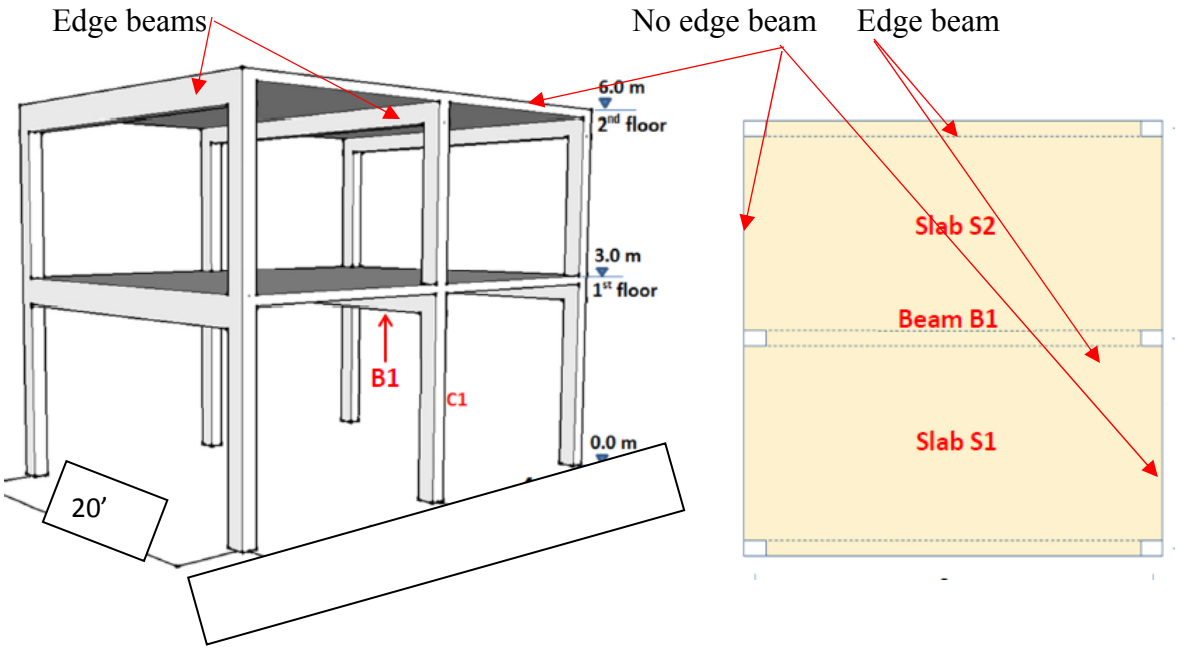
$$= Desired\ dry\ density\ (pcf) \times \frac{Compacted\ cubic\ feet\ of\ soil}{8.33\ lb/gal} \times \frac{Goal\ water\ content\% - Existing\ water\ content\ \%}{100}$$

$$= 125\ pcf \times \frac{32ft \times 100ft(sta.) \times (4in/12\ in/ft)}{8.33\ lb/gal} \times \frac{12.5\% - 6\%}{100} = 1040.42\ gal\ /sta.$$

$$Gallonsyd^2 = \frac{1040.42\ gal/sta.}{(32ft \times 100ft/sta)/9\ ft^2\ /yd^2} = 2.93\ \ gal\ /yd^2$$

*See Fundamentals of Building Construction: Materials and Methods Wiley

36) For the reinforced concrete slabs like the following picture, if the width is given equal to 20', then what would be the maximum length of the slab if the designer wants to have two way slab and have the following reinforcement arrangement? (The slab supported by edge beam in two sides and there is no edge beam at the other sides.)



A) 40' B) It's impossible to have two way slab

C) 20' D) 55

The Answers is B

ACI 318-08, 13.6.1.6. & 7: For panel with beams between supports on all sides moment distribution is permitted.

According to the code the stiffness of beams will create the support on all sides, therefore the two way slab can be created. Panels with beams on two parallel edges is the one way slab so at no circumstances the designer cannot create the two way slab unless the designer add two beams on other edges or design the slab without beams on all edges. (i.e., according to the code 13.2.4., beams should be monolithic (or fully composite with slab) to make the two way slab, or according to 13.2.1., the slabs without beams on all sides the slab can have the two way slab behavior.

So, in this question the slab is the one way slab at all conditions.

37) For the following bridge shown in the following picture, what is the maximum distance between the net and the bridge deck that a fall can be arrested by that net?

A) 10’ B) 15’

C) 30’ D) 20’

The Answers is C

OSHA 29 CFR 1926.502(c)

According to the code: 30’

38) For the excavation shown in the below figure, find the lateral earth pressure on each supporting structures if the spacing of them are about 10'. (Ka=0.3, Soil density = 150 pcf)

Spacing=10' 20' including height of foundation

A) 11250 lb/ft B) 1125 lb/ft

C) 9000 lb/ft D) 900 lb/ft

The Answers is A

Adjacent Construction Project Manual, Office of Joint Development & Adjacent Construction, September 16, 2013 (Revision 5)

Lateral Earth Pressure and Groundwater Pressure. The basic horizontal earth pressures shall be computed using the active earth pressure. The resultant or total active earth pressure shall be multiplied by a stiffness factor depending upon the required stiffness. The resulting load shall be redistributed on the cofferdam in a trapezoidal pressure diagram. The stiffness factors shall be applied to both the cofferdam design and the bracing system. The stiffness factors shall be assigned as follows:

1. Use stiffness factor = 1.25 for a soldier pile and lagging or a sheet pile support system.

2. Use stiffness factor = 1.5 for a slurry wall, secant and tangent pile wall support system.

So: $P = \gamma * h * k_a * 1.25$ = 150*20*0.3*1.25=1125 psf

Pressure * spacing of the soldiers = 1125*10 = 11250 lb/ft

39) 100 yd3 of bank run soil is excavated and stockpiled before being transported and subsequently compacted. Swell and shrinkage factors for the soil are given equal to 0.30 and 0.12 respectively. The final volume of the compacted earth is most nearly.

A) 130 B) 65

C) 88 D) 112

The Answers is C

Swell is measures with respect to the banked condition. The stockpiled and transported volume will be: $Vt = (1 + Swell\ coefficient) * bank = (1 + 0.30) * 100 = 130\ yd^3$

Shrinkage coefficient gives the compacted volume, so the answer is:

$$Vc = (1 - Shirnkage\ Coefficient) * bank = (1 - 0.12) * 100 = 88\ yd^3$$

40) For the following picture which shows a ditch checks for erosion control, which answer is the best description of both ditches?

Figure 1

Figure 2

A) 1: Rock ditch for grade <6%, 2: Bale ditch for grade >6%
B) 1: Bale ditch for grade >6%, 2: Rock ditch for grade <6%,
C) 1: Rock ditch for grade >6%, 2: Bale ditch for grade <6%
D) 1: Rock ditch for grade >2%, 2: Bale ditch for grade <2%

The Answers is C

Experiences show that for the grade< 6% the bale ditch check the erosion, and the rock ditch works for grade >6%.