PE Civil Exam 80- Geotechnical Questions & Answers (pdf Format)
For Depth Exam

PE Civil Depth Exam (Evening Session): This practice exam contains 80- Geotechnical questions, and answers each set from all Geotechnical & Soil Foundation Engineering:

Table Contents:

Total Number of Problems =80

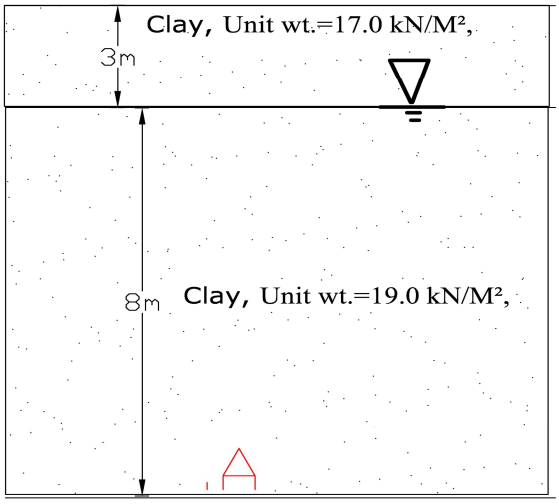
I. Site Characterization: Number of Questions-10

A. Interpretation of available existing site data, and proposed site development data (e.g., aerial photography, geologic, and topographic maps, GIS data, as-built plans, planning studies, and reports)
B. Subsurface exploration planning
C. Geophysics (e.g., GPR, resistivity, seismic methods)
D. Drilling techniques (e.g., hollow stem auger, cased boring, mud rotary, air rotary, rock coring, sonic drilling)
E. Sampling techniques (e.g., split-barrel sampling, thin-walled tube sampling, handling, and storage)
F. In situ testing (e.g., standard penetration testing, cone penetration testing, pressure meter testing, dilatometer testing, field vane shear)
G. Description, and classification of soils (e.g., Burmeister, Unified Soil Classification System, AASHTO, USDA)
H. Rock classification, and characterization (e.g., recovery, rock quality designation, RMR, weathering, orientation)

9. PROBLEM (In situ testing)

The following figure represent the cone penetration resistance q_c = 700 KN at A, with an electric friction cone electrometer. Determine the over consolidation ratio, OCR, where, N_k=15

A. 1.40
B. 1.70
C. 1.90
D. 1.20



9. SOLUTION:

q_c = 700 KN

σ_v = Total vertical effect= 3x17+8x19= 203.0 KN/m²

σ'_v = Effective vertical pressure =3x17+8(19-9.1)= 130.2 KN/m²

OCR=.37((q_c - σ_v)/ σ'_v=.37(700-203.0)/130.2= 1.41≐1.40

The Correct Answer is: (A)

II. Soil Mechanics, Laboratory Testing, and Analysis: Number of Questions **10**
A. Index properties, and testing
B. Strength testing of soil, and rock
C. Stress-strain testing of soil, and rock
D. Permeability testing properties of soil, and rock
E. Effective, and total stresses

11. **PROBLEM** (Index properties, and testing)

Field density test has done by sand replacement method. It has shown bulk density of a compacted road base to be 2.0 t/m^3 and water content of 12%. The specific gravity of the soil is 2.70. Calculate the void ratio.

A. 0.42
B. 0.67
C. 0.51
D. 0.34

11. **SOLUTION:**

Where, w=12%, Gs= 2.70, γm=2.00 t/m^3
w=Se/Gs=
$\therefore$ Se = (0.12)(2.70) = 0.324
$\gamma m=(Gs+Se)/(1+e)\gamma_w$
$\therefore$ 2.00=(2.7+0.32)/(1+e) x 1.0
$\therefore$ e = 0.51

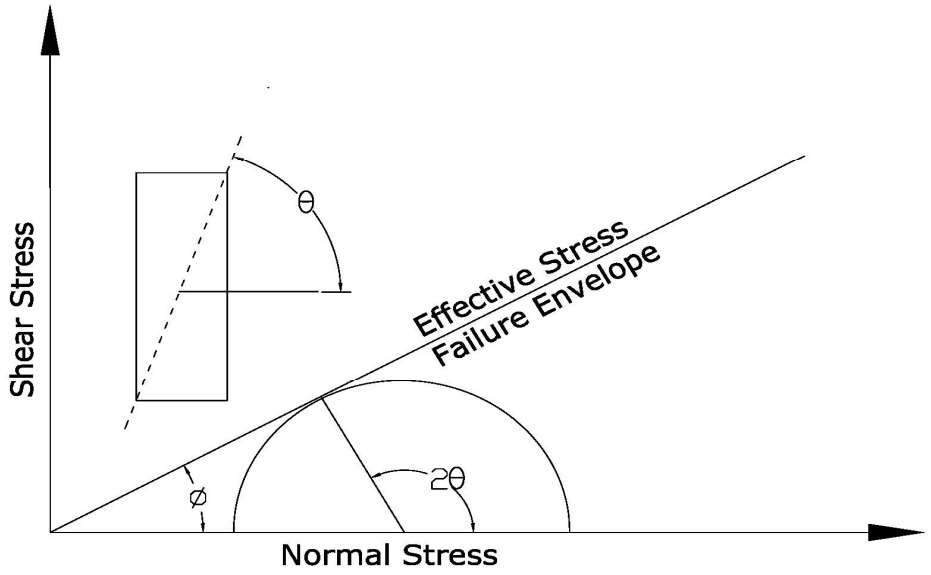
The Correct Answer is: (C)

15. **PROBLEM** (Strength testing of soil, and rock)

A drained triaxial test has performed for normally consolidated clay with the following data.
Chamber confining pressure, $\sigma h = 108$ KN/m^2
Vertical deviator pressure $\sigma v = 158$ KN/m^2
Pore water pressure, $U = 50$ KN/m^2

Find the angle of internal friction, Φ

A. 35^0
B. 26^0
C. 25^0
D. 22^0



15. SOLUTION:

$\sigma v = 158\ KN/m^2$
$\sigma h = 108\ KN/m^2$

Pore water Pressure, $U = 50\ KN/m^2$, will be deducted at drained condition

$\sigma_1 = \sigma h + \sigma v$
$\sigma_3 = \sigma h$
$\sigma'_1 = \sigma_1 - U = 108 + 158 - U = 266.00 - 50 = 216.00\ KN/m^2$

$\sigma'_3 = \sigma h - U = 108.00 - 50 = 58.0\ KN/m^2$

$Sin\Phi = (\sigma'_1 - \sigma'_3)/2\ /\ (\sigma'_1 + \sigma'_3)/2$

$\Phi = Sin^{-1}[\{(216-58)/2\}/\{(216+58)/2\}] = 35.21^0$

The Correct Answer is: (A)

III. Field Materials Testing, Methods, and Safety: Number of Questions **6**

A. Excavation, and embankment, borrow source studies, laboratory, and field compaction

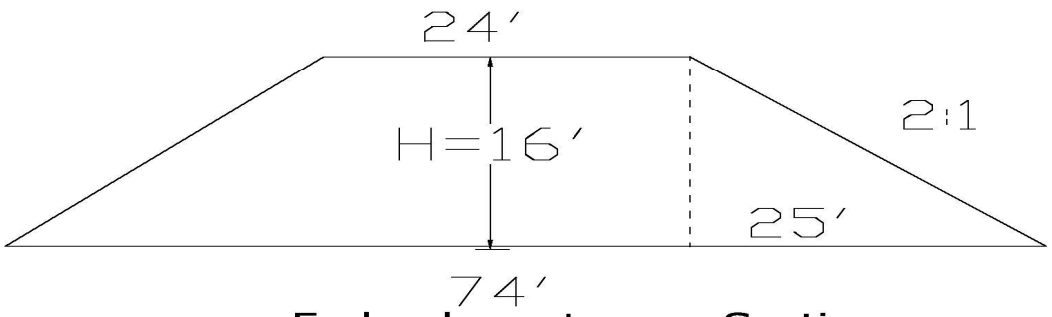
B. Trench, and construction safety

C. Geotechnical instrumentation (e.g., inclinometer, settlement plates, piezometer, vibration monitoring)

21. PROBLEM (Excavation, and embankment, borrow source studies, laboratory, and field compaction)

An embankment cross section, shown in the Figure. The soil in the embankment has compacted, and the soil dry unit weight is106 lb/ft^3, moisture content is12.5%. The borrowed soil has brought in a ten cubic yard truck at haul with a void ratio of 0.7, and a moisture content of 10%. The borrowed site soil has a void ratio of 1.0 & specific gravities, Gs=2.67. What will be a number of haul truck loads for 100 ft length of embankment construction?

A. 314 numbers of trucks
B. 414 numbers of trucks
C. 360 numbers of trucks
D. 276 numbers of trucks



Embankment cross Section

21. SOLUTION:

Vol. of Embankment per 100 ft length
$= \{(24+74)/2\} \times 16 \times 100 = 78400\ ft^3$

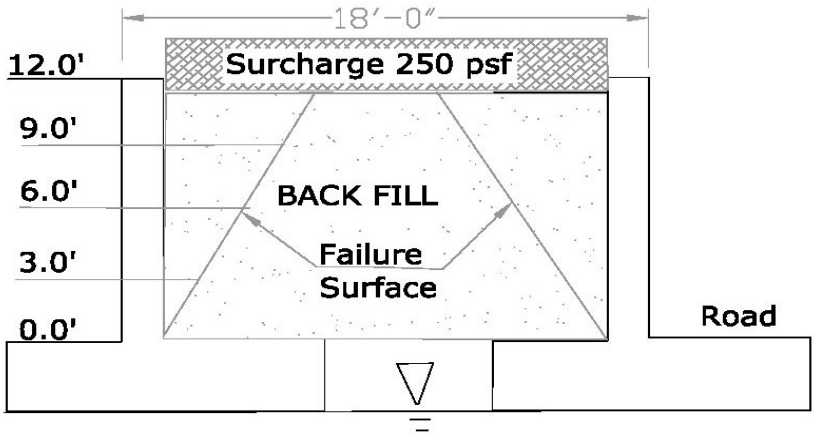
Moist unit weight of truck $\gamma = (1+w)Gs\ \gamma_w /(1+e)$
$= 2.67 \times 62.4(1+0.1)/(1+.70) = 107.80\ lb/ft^3$
The dry unit weight of truck $\gamma_d = \gamma /(1+w) = 107.8)/(1+.1) = 98.0\ lb/ft^3$
Weight of dry soil per truck= 10 x 27 x 98=26460 lb
Dry weight of Embankment compacted soil= 78400 x 106=8310400 lb
Number of truck= 8310400/26460=314 number of trucks

The Correct Answer is: (A)

55. PROBLEM (Rigid retaining wall stability analysis)

Determine the lateral active resultant force acting on the facing located from El. 0.0' to 6.0' on the road embankment retaining wall as shown in the Figure. The water table is below the foundation. Where, K_a=0.3, unit weight of backfill soil, γ_{soil}= 115 lb/ft^3.

A. 4.80 Kip/ft
B. 2.30 Kip/ft
C. 5.20 Kip/ft
D. 2.90 Kip/ft



55. SOLUTION:

Pressure at due to surcharge = 0.3 x 250 = 75.00 lb/ft^2
Pressure at 0.0' due to back fill=.3 x 115 x 12=414.00 lb/ft^2
Total pressure at 0.0'=414+75=489.00 lb/ft^2
Pressure at 6.0' due to back fill=.3 x 115 x 6= 207.00 lb/ft^2
∴ Total pressure at 6.0'=207+75= 282.00 lb/ft^2
Resultant Force between 0.0' to 6.0'
∴ F $_{(0.0' \text{ to } 6.0')}$= 1/2 x (489.00 +282.00) x 6=2313.00 lb/ft=2.31 K/ft

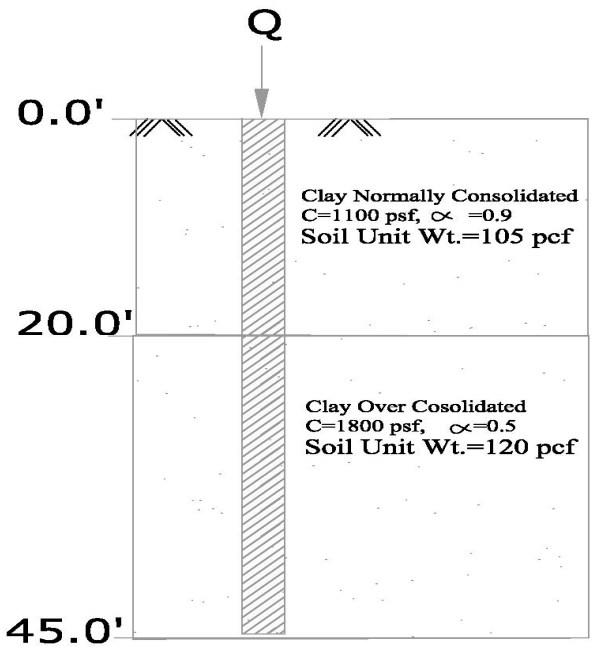
The Correct Answer is: (B)

X. Deep Foundations (ASD or LRFD) : Number of Questions **10**
A. Single-element axial capacity (e.g., driven pile, drilled shaft, micropile, helical screw piles, auger cast piles)
B. Lateral load, and deformation analysis
C. Single-element settlement
D. Down drag
E. Group effects (e.g., axial capacity, settlement, lateral deflection)
F. Installation methods/hammer selection
G. Pile dynamics (e.g., wave equation, high-strain dynamic testing, signal matching)
H. Pile, and drilled-shaft load testing
I. Integrity testing methods (e.g., low-strain impact integrity testing, ultrasonic cross-hole testing, coring, thermal integrity testing)

72. PROBLEM (Single-element axial capacity)

A 12 in diameter concrete pile has driven 45 ft shown in Figure. Determine the allowable capacity pile capacity with F.S=3.

A. 65.00 Kip
B. 54.00 Kip
C. 38.00 Kip
D. 48.00 Kip



72. SOLUTION:

$Q_{ult} = Q_{tip} + Q_{friction}$

$Q_{friction} = \alpha C A_{surface} = \alpha C(\pi DL)$

$Q_{friction} = 0.90 \times 1100 \times (3.14 \times 1 \times 20) + 0.5 \times 1800 \times (3.14 \times 1 \times 25)$

$Q_{friction} = 62172.00 + 70650.00 = 132822.00 = 132.82$ Kip

$Q_{tip} = 9CA_{tip} = 9 \times 1800 \times \pi/4(1)^2 = 12717.00\# = 12.72$ Kip

$Q_{ult} = Q_{tip} + Q_{friction} = 12.72 + 132.82 = 145.54$ Kip

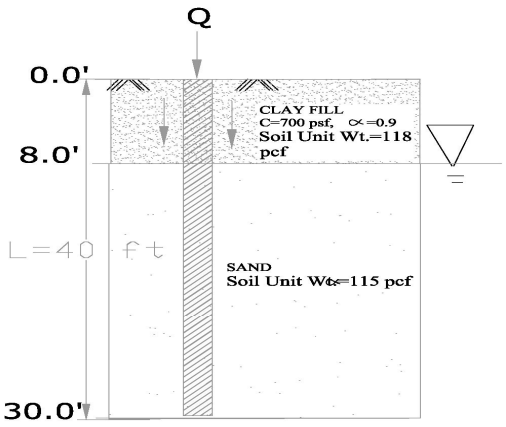
$Q_{allow} = Q_{ult} / F.S = 145.54/3 = 48.51$ Kip

The Correct Answer is: (D)

79. PROBLEM (Pile Drag Force)

Determine the pile drag force. The pile has an 18-inch diameter, and it is 40 ft long as shown in the Figure. Where, $\Phi=30^0$, soil, and pile friction angle, $\delta=.6\Phi$.

A. 3.40 kip
B. 5.50 kip
C. 1.70 kip
D. 2.90 kip



79. SOLUTION:

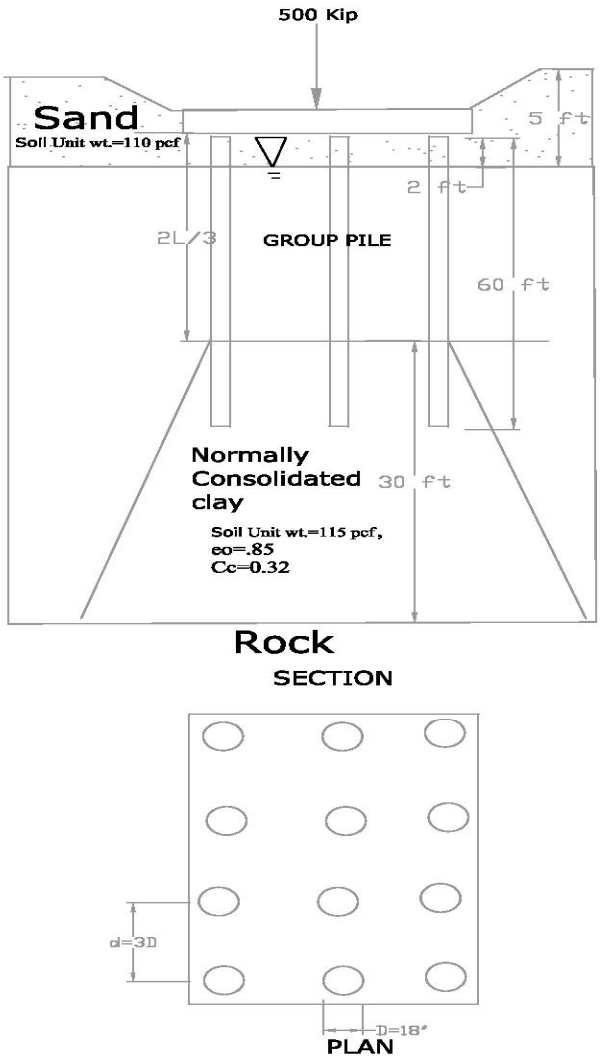
Where, $\Phi=30^0$, soil, and pile friction angle,
$\delta=0.6\Phi$, D=18"=1.5', γ_f =118 pcf
H_f =8 ft
$K=1-\sin\Phi=1-\sin30^0=0.50$
$p=\Pi D=3.14 \times 1.5=4.71$ ft
$\tan\delta=\tan(.6\Phi)=0.324$
Pile drag force, $Qn=(pK\gamma_f H^2_f \tan\delta)/2$
$\therefore$ $Qn=(pK\gamma_f H^2_f \tan\delta)/2=(4.71 \times .50 \times 118 \times 8^2 \times 0.324)/2$
=2881.11 lb=2.88 kip

The Correct Answer is: (D)

80. PROBLEM (Pile Group Settlement)

Determine the consolidation settlement in the clay layer of the pile group. Each pile has an 18-inch diameter, and 60 ft long as shown in the Figure.

A. 0.40 ft
B. 0.60 ft
C. 0.90 ft
D. 1.10 ft



80. SOLUTION:

Where, Qg=500Kip, n1=4, n2=3, d=3D, D=18"=1.5', Cc=0.32, e0=.85

d=3 x 1.5=4.5 ft

Lg=(n1−1)d+2(D/2)=(4−1)4.5+2(1.5/2)=15

Bg=(n2−1)d+2(D/2)=(3−1)4.5+2(1.5/2)=10.5

H1=30

Z=H1/2=30/2=15 ft

$\Delta\delta' = Qg/(Lg+z)(Bg+z) = 500/(15+15)(10.5+15) = 0.65$ Kip/ft^2

$\therefore\ \delta' = 5 \times 110 + (40-2+30/2)(115-62.4)$

$= 550 + (38+15)\times 52.5 = 3332.5$ lb/ ft^2 $= 3.33$ Kip/ft^2

$\Delta S = \{CcH1/(1+e0)\}\log[(\delta'+\Delta\delta')/\delta']$

$\therefore$ Settlement,

$\Delta S = \{0.32 \times 30/(1+.85)\}\log[(3.33+0.65)/3.33] = 5.19 \times 0.08 = 0.40$ ft

The Correct Answer is: (A)