# The Ultimate Civil PE Review Course

## Geotechnical – Depth

(Ctrl)

CEA

Subsurface Exploration and Sampling 7.5%
Drilling and sampling procedures, Soil classification, General rock characterization (e.g., RQD, description, joints and fractures), Boring log interpretation (e.g., soil profile), In situ testing

II Engineering Properties of Soils and Materials 12.5%
Index properties, Phase relationships, Permeability, Geosynthetics, Pavement design criteria, Shear strength properties, Frost susceptibility

III. Soil Mechanics Analysis 12.5%
Pressure distribution, Lateral earth pressure, Consolidation, Compaction, Expansive soils, Effective and total stresses

IV. Earthquake Engineering 5%
Liquefaction, Pseudo-static analysis and earthquake loadings, Seismic site characterization

IV Earth Structures 10%
Slope stability, Slabs-on-grade, Earth dams, Techniques and suitability of ground modification

VI. Shallow Foundations 15%
Bearing capacity, Settlement, Mat and raft foundations

"The knowledge areas here are not exclusive or exhaustive…" NCEES

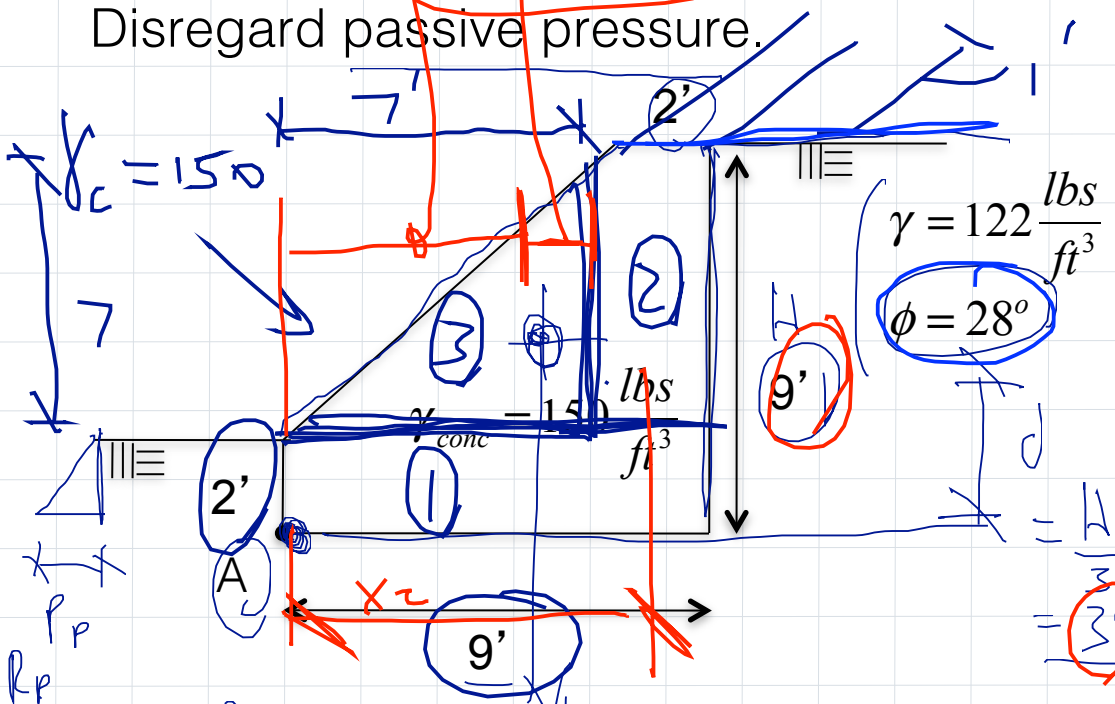
VII Earth Retaining Structures, & Temp. Structures 17.5%
Gravity walls and cofferdams, Cantilever walls, Stability analysis, Mechanically stabilized earth walls E. Braced and anchored excavations, Soil and rock anchors, Temporary structures, including shoring and re-shoring

VIII Deep Foundations 10%
Axial capacity (single pile/drilled shaft), Lateral capacity and deflections (single pile/drilled shaft), Settlement, Behavior of pile and/or drilled shaft group, Pile load test, Pile installation, Pile dynamics (e.g., wave equation, high-strain dynamic testing)

IX. Other Topics 10%
Groundwater and well fields & Seepage, Quality control process (QA/QC) (e.g., when digging, confirming quality; writing QA processes), Concrete maturity and early strength evaluation Worker health, safety, and environment, including OSHA regulations

# Problem 251

What is the factor of safety against overturning for the wall shown? Disregard passive pressure.




$\frac{2 \cdot 7}{3} = 4.67$

$7/3$

$W = \gamma \cdot V$

$\gamma_c = 150$

$K_a = \frac{1 - \sin\phi}{1 + \sin\phi}$ 28

$= .36$

$P_a = K_a \gamma H$

$R_a = \frac{1}{2} K_a \gamma H^2$

$R_{a,h} = \frac{1}{2}(.36)(122)9^2$

$= 1780$ lbs/ft

$= \frac{H}{3} = 3'$

$P_p$

$R_p$

$\frac{1}{2} K_p \gamma h^2$

$P_p = K_p \cdot \gamma H$

$FS = \frac{M_{RES}}{M_{OT}} = \frac{\Sigma W_i \cdot X_i}{(R_a)(d)} = \frac{W_1 \cdot X_1 + W_2 X_2 + W_3 X_3}{R_a \cdot d}$

$W_1 = (1)(2)(9)(150) = 2700$

$W_2 = (2)(7)(150) = 2100$

$W_3 = (1/2)(7)(7)(150) = 3675$

$X_1 = 4.5$

$X_2 = 8'$

$X_3 = 4.67$

$= \frac{(2700)(9.5) + \ldots}{(1780)(3)}$

$= \frac{46110}{5340} = 8.63$

# Problem 252

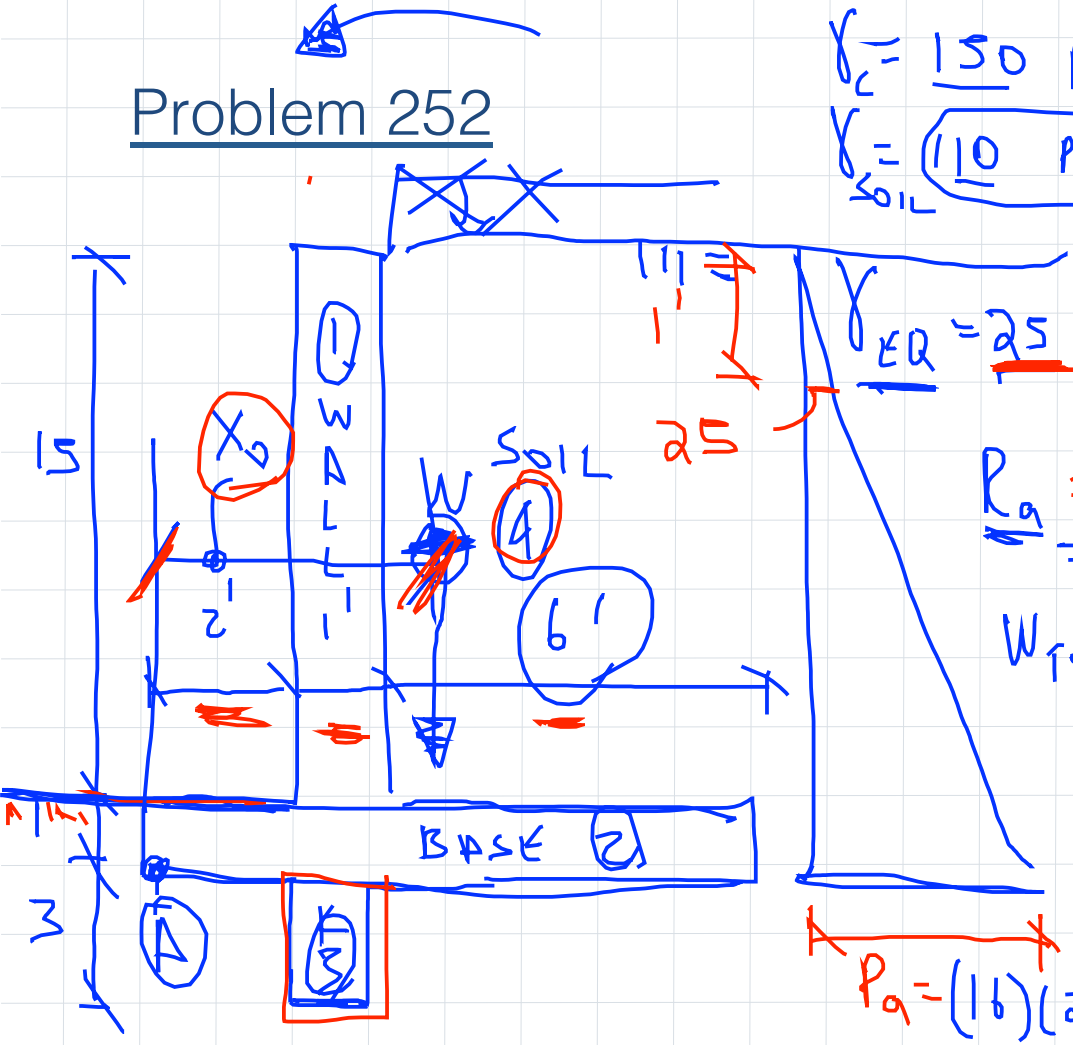
$\gamma_c = 150$ PCF

$\gamma_{soil} = 110$ PCF

FIND: PRESSURE MAX & MIN

A) 2200, 300

B) ___ ___




$\gamma_{EQ} = 25$ PSF/FT

$P_a = \frac{1}{2} \cdot 400 \cdot 16'$ $\left(\gamma_{EQ} H^2/2\right)$

$= 3200$

$W_{TOTAL} = \Sigma W_{1-4}$ (VERTICAL F)

$= (1)(15)(150) + (9)(1)(150) + (1)(3)(150) + (6)(15)(110)$

$= 2250 + 1350 + 450 + 9900$

$= \boxed{13950}$

$P_a = (16)(25) = 400$

$\Sigma W_i d_i = (2250)(2.5) + (1350)(4.5) + (450)(2.5) + (9900)(6)$

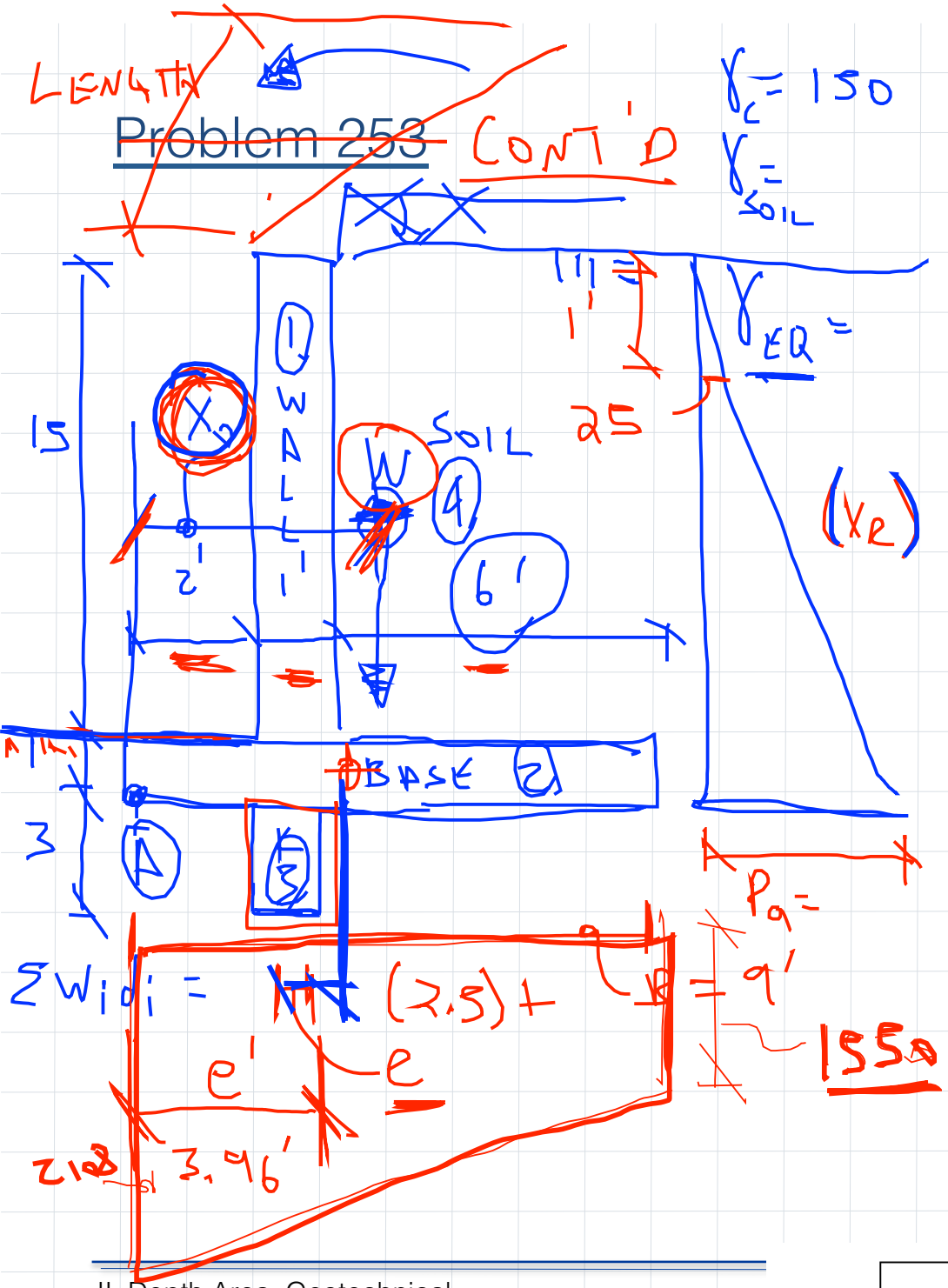
$= 72225$

$\boxed{X_0} = \frac{\Sigma W_i d_i}{\Sigma W} = \frac{72225}{13950} = \boxed{5.18}$

$FS_{OT} = \frac{\Sigma M_R}{\Sigma M_O} = \frac{X_0 \cdot W}{(3200)(16/3)} = \frac{72225}{17067}$

$= 4.2 > 1.5$

# Problem 253 CONT'D




$$P_{MAX\,MIN} = \frac{\Sigma W(1 \pm 6e/B)}{B \cdot L_{WALL}}$$

$$= \frac{(13950)(1 \pm 6(.54)/9')}{9' \cdot 1'}$$

$$e' = \frac{X_o W_T - M_{OT}}{\Sigma W_T}$$

$M_{TOE\,NET}$

$$= \frac{(5.18)(13950) - 17067}{13950}$$

$$= 3.96$$

$$e = \frac{B}{2} - e'$$

$$= \frac{9}{2} - 3.96' = .54'$$

2108, 1550

# Problem 253

$\phi_{soil} = 30°$

$\delta = \frac{2}{3}(30) = 20°$ – FIND THE RESISTANCE TO SLIDING

– IGNORE PASSIVE PRESSURE

$C = C_A = 0$

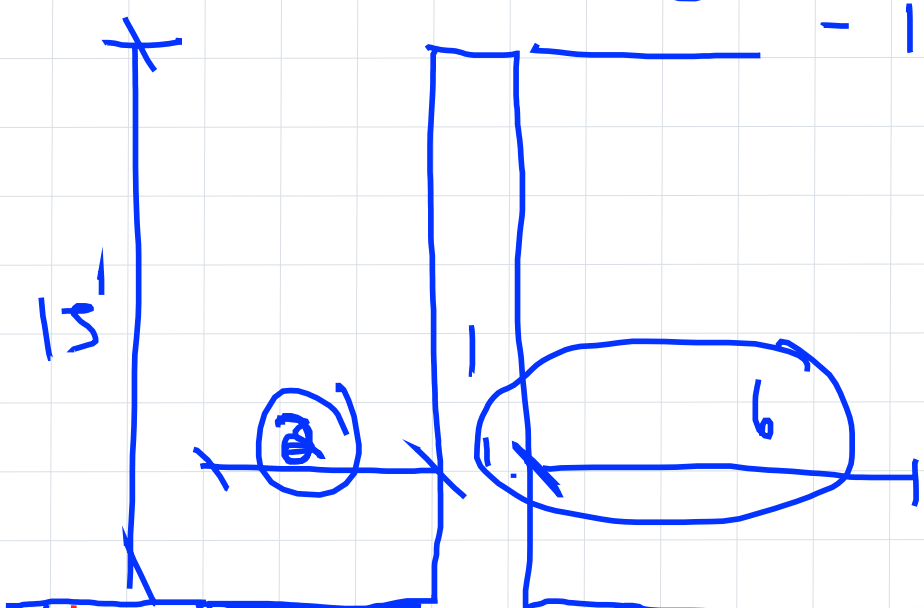
$F_\perp \cdot U$ $\quad D \geq 0$

$F_\perp \cdot \tan\delta + F_\perp \tan\phi + (B_1 \cdot C + B_2 C_A)$

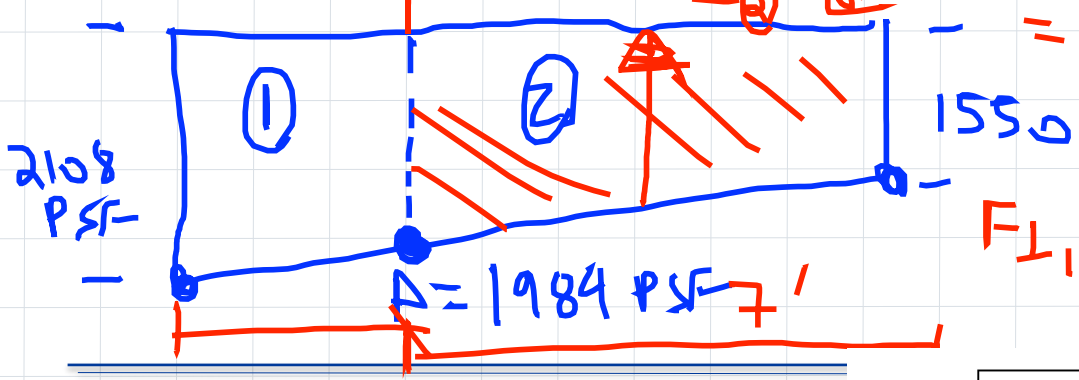
$F_{\perp 2} \tan 20 + F_{\perp 1} \tan 30$

$(12369)(.36) + (4092)(.58)$

$= 4453 + 2373 = \boxed{6826}$ lbs



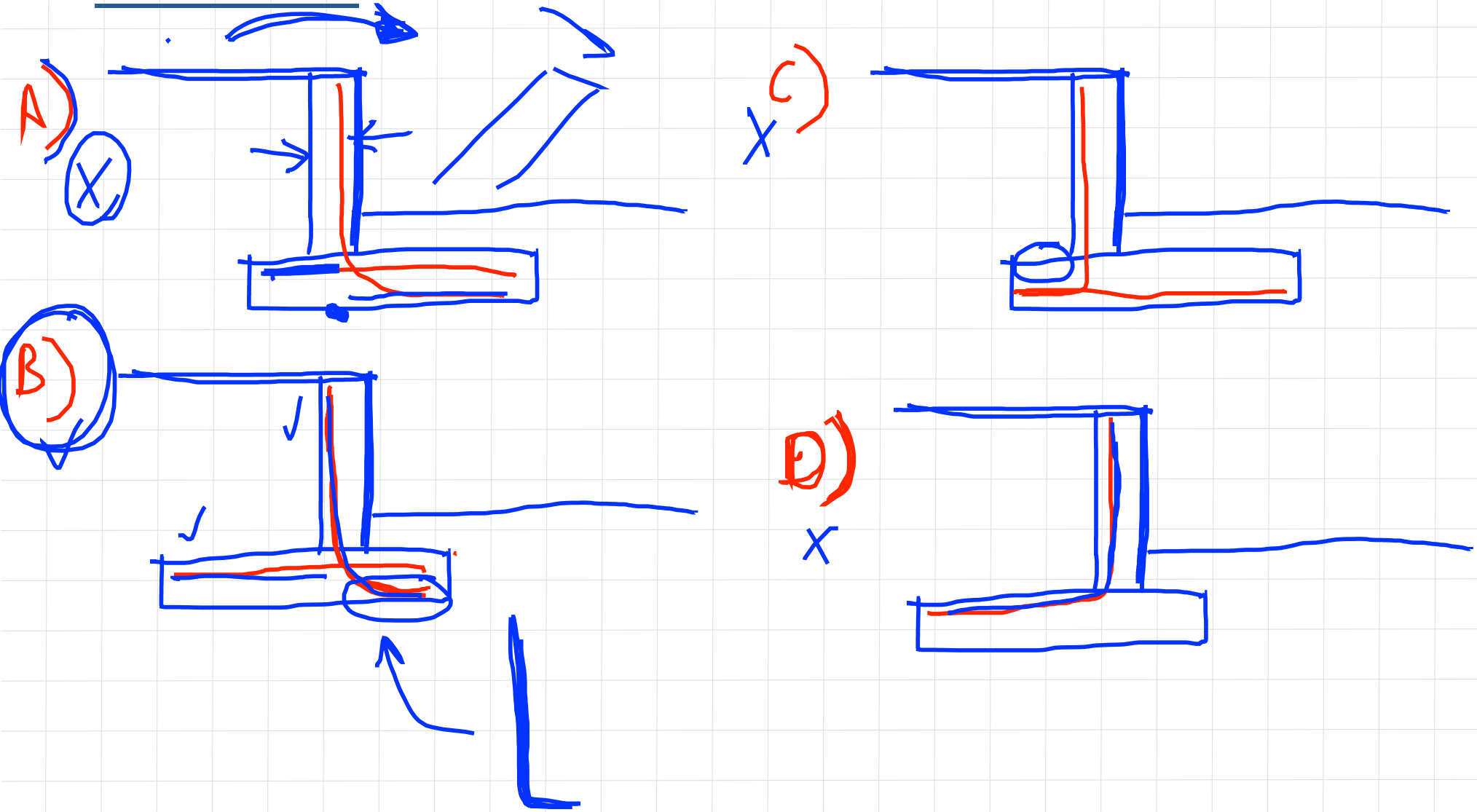

$F_{\perp 2} = [(1550 + 1984)/2](7) = 12369$




$F_{\perp 1} = (2046)(2) = 4092$

# Problem 254

BEST USE OF REINF & CONC?



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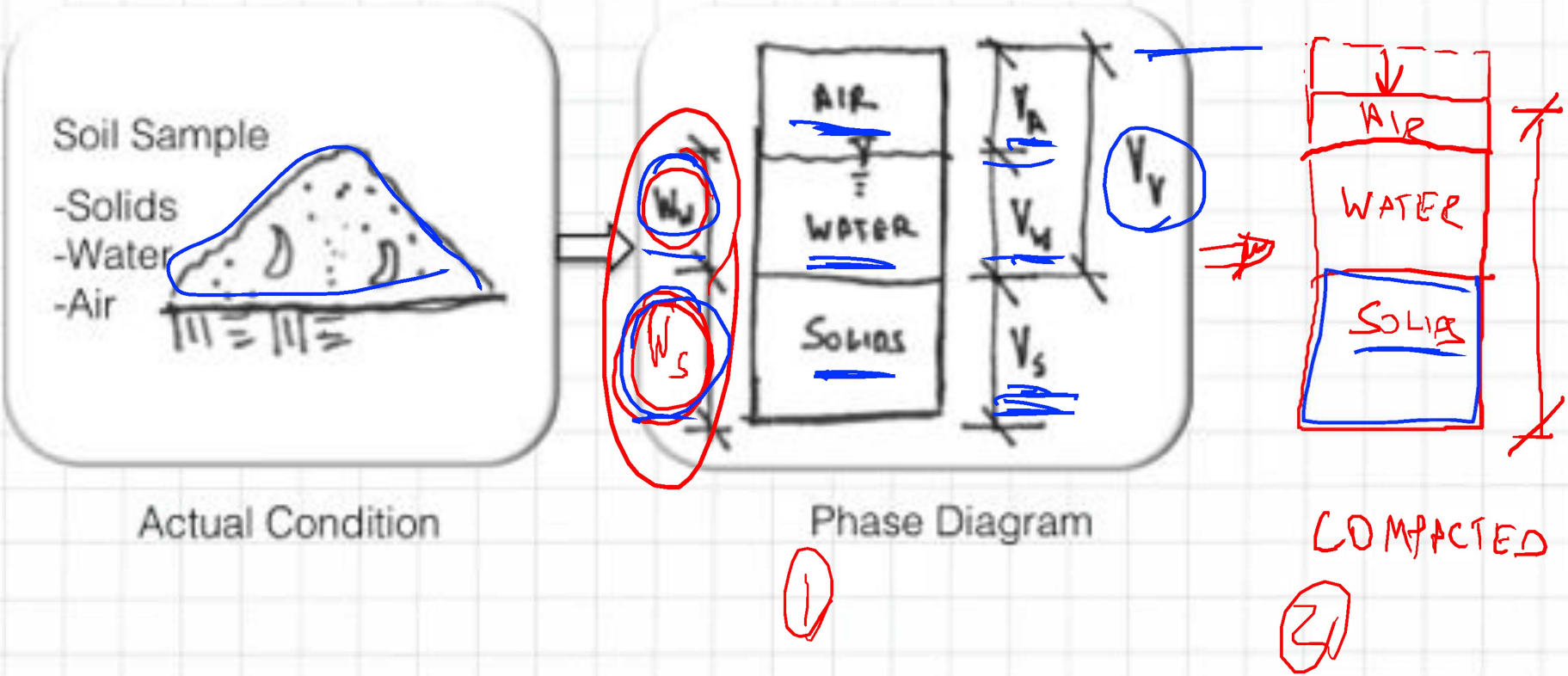
# Q&A Number 3

$$\rho = \frac{m_t}{\forall_t} \qquad \frac{W_t}{\forall_t}$$

# Fundamental Soil Properties (Background)

## Soil Phase Diagram




Actual Condition

Phase Diagram

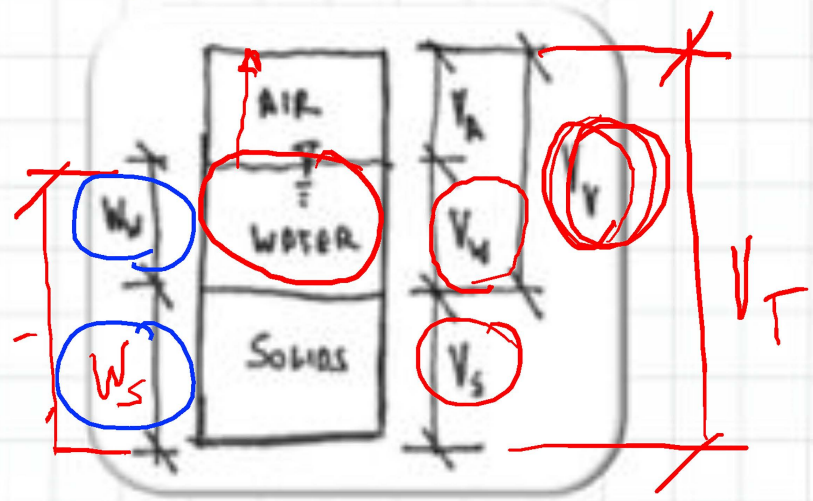
COMPACTED

1

2

(2) $W_W = (w)(W_S)$

# Fundamental Soil Properties




Total Weight

$$W_T = W_S + W_W$$

Total Volume

$$V_T = V_S + V_V = V_S + (V_A + V_W)$$

Moist Unit Weight:

$$\rho \sim \gamma = \frac{W_T}{V_T} = \frac{lbs}{ft^3}$$

Dry Unit Weight:

$$\gamma_d = \frac{W_S}{V_T} = \frac{\gamma}{1+w}$$

Water Content:

(1) $$\boxed{w = \frac{W_W}{W_S}}$$

Specific Gravity of solids

$$SG_S = \frac{\gamma_S}{\gamma_W}$$

$$\gamma_W = \boxed{62.4\ \text{lbs/ft}^3\ \text{(typically)}}$$

Weight of Solids:

$$W_s = SG_S \cdot \gamma_W$$

Weight of Water

$$W_w = w \cdot SG_S \cdot \gamma_w$$

Volume of Water:

$$V_W = w \cdot SG_S$$

Volume of Solids:

$Vs$ = can be assumed as 1, then validated.

Degree of Saturation

$$S = \frac{V_W}{V_V}$$

Void Ratio

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

Porosity

$$\eta = \frac{V_V}{V_T}$$

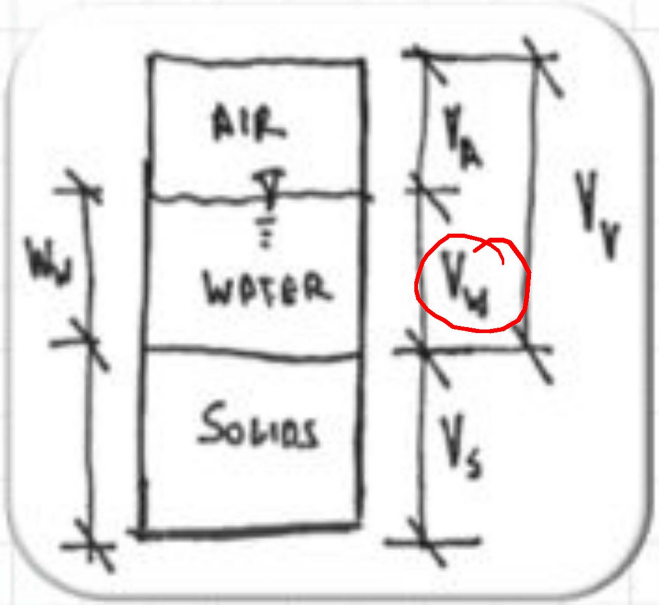
# More Soil Property Relationships

$$e = \frac{n}{1-n} \qquad n = \frac{e}{1-e}$$

$$\gamma = \frac{SG_s \cdot \gamma_w + w \cdot SG_s \cdot \gamma_w}{1+e}$$

$$= \frac{SG_s \cdot \gamma_w (1+w)}{1+e}$$

$$\gamma_d = \frac{SG_s \cdot \gamma_w}{1+e} \qquad S = \frac{SG_s \cdot w}{e}$$




## Relationships for Saturated Soils ( S=100%)

$$\boxed{S = 100\%}$$

$$\gamma = \gamma_{sat} = \frac{\gamma_w (SG + e)}{1+e} = \frac{\gamma_w (SG_s + wSG_s)}{1 + wSG_s}$$

e @ S = 100%

35.7

## Problem 205

A soil sample was weighed at 53.6 pounds with a volume of 0.45 ft³, a moisture content of 16.4%, a maximum dry density of 107.5 lbs/ft³, and a void ratio of 0.56. Find a) the unit weight of the soil b) the dry unit weight c) the relative compaction d) the Specific Gravity of the Solids e) the porosity of the sample, f) the degree of Saturation, and g) The weight of the water in the soil.

W

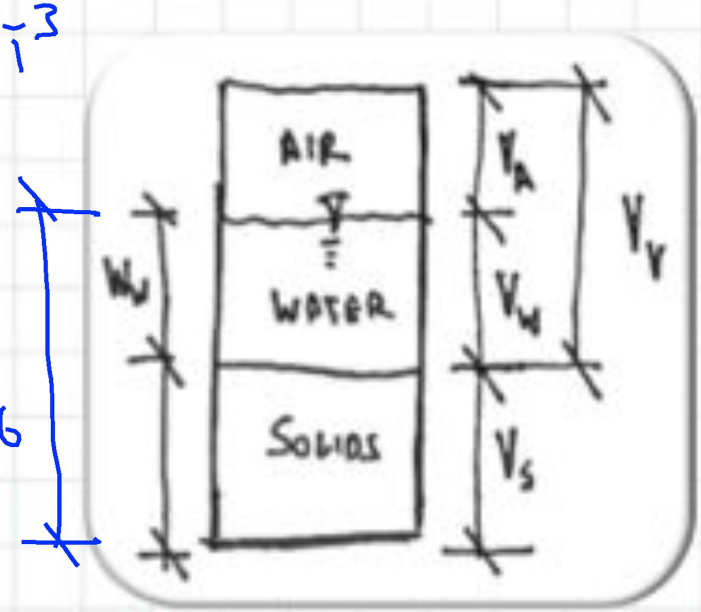
$\gamma_d^*$

A) $\gamma = \frac{W_T}{V_T} = \frac{53.6 \text{ lbs}}{.45 \text{ FT}^3} = \boxed{119.1}$ lb/FT³

B) $RC = \frac{\gamma_d}{\gamma_d^*} \times 100 = \frac{102.3}{107.5} = 95.2\%$

B) $\gamma_d = \frac{\gamma}{1+w} = \frac{119.1}{1.164} = 102.3$ lb/FT³

$\left(\frac{\gamma}{(P/(1+w))}\right) \left(\frac{SG\, P_w}{(1+e)}\right)$



D) $SG_s$ :

$$\boxed{e = \frac{SG_s \forall_T \gamma_w}{W_s} - 1}$$

$$\boxed{= \frac{SG \forall_T \rho_w}{M_s} - 1}$$

$$\boxed{\begin{array}{c} lbm \approx lbf \\ \rho \approx \gamma \end{array}}$$

$$\therefore SG_s = \frac{(e+1)(W_s)}{\forall_T \gamma_w} \longrightarrow \gamma_d = \frac{W_s}{\forall_T} \quad \left\{\frac{M_s}{\forall_T}\right\}$$

$$= \frac{(.56+1)(46.04)}{(.45\ ft^3)(62.4\ lb/ft^3)}$$

$$= \boxed{2.56}$$

$$W_s = \gamma_d \forall_T$$
$$= (102.32)(.45)$$
$$= 46.04\ lbs$$
$$= (2.56)(.164)/.56$$

E) $n = \frac{e}{1+e} = \frac{.56}{1+.56} = .36$

F) $S = \frac{SG_s \cdot w}{e} = .75$

9) $W_w = W_T - W_s$

$= 53.6 - 46.64$

$= \boxed{7.56 \text{ lbs}}$

$w = \frac{W_w}{W_s} = 16.4\%$ !!

$\gamma_d$

$w$

$\boxed{\gamma = \gamma_d (1 + w)}$

# GEOTECHNICAL – REFERENCES

Thanks to:

Cover Image:

http://www.flickr.com/photos/savannahcorps/8476083793/


14th Edition of the Civil Engineering Reference Manual

NAVFAC 7.02

Braja M Das Principles of Geotechnical Engineering

Structural Engineeering Reference Manual (PPI)

Reference: http://en.wikipedia.org/wiki/Cofferdam

MSE Walls: Publication No. FHWA-NHI-10-024