Guide to Passing the Civil PE Exam
Geotechnical AM

Edition 1

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TOPICS

Topic **Page**

TOPIC III: Soil Mechanics 1-67

TOPIC IV: Structural Mechanics..... 68-88

TOPIC VII: Materials 89-141

TABLE OF CONTENTS

How to Use This Guidebook v
Geotechnical Cheat sheet ..... vi-vii
References viii

TOPIC III: Soil Mechanics

1. Lateral Earth Pressure 3-16
2. Soil Consolidation 17-26
3. Effective and Total Stresses 27-37
4. Bearing Capacity 38-49
5. Foundation Settlement 50-58
6. Slope Stability 59-67

TOPIC VII: Structural Mechanics

7. Retaining Walls 68-88

TOPIC VII: Materials

8. Soil Classification and boring log interpretation 91-110
9. Soil Properties 111-126
10. Material test methods and spec conformance 127-133
11. Compaction 134-141

READ FIRST:
How to Use This Guidebook

This guide for the Geotechnical AM Module and is intended to help walk you through studying for the Civil PE exam. You will find all of the study material needed for the AM geotechnical portion of the exam. We have spent countless hours reviewing material from the Civil Engineering Reference Manual (CERM), reference manuals below, study guides, the internet, and other engineering textbooks to ensure that we have provided you with the most up-to-date and accurate resource available.

When you begin studying from this book use the following approach:

1. Print out e-book and place in 3" binder. Label the Binder Geotechnical Engineering and tab each chapter.

2. Make sure the geotechnical engineering cheat sheet is in the front of the binder. Add to it as needed.

3. Once you complete each chapter, solve as many problems as you can that relate to the chapter you just covered. Do at least three problems from other sources. If you have any questions on a technique or a concept, ask the question at www.engineerboards.com.

4. Place those problems inside the geotechnical binder behind the chapter and make a tab labeled "Problems". If you use another reference manual when solving problems, make sure to tab them as well. Write all the references you used and problems you solved in the space provided at the end of each section.

If you follow this approach, you will have solved multiple problems for every section and you will have all your references, notes pages, and problems fully tabbed for the geotechnical portion so that you can easily reference them during the actual exam.

To report errors in this text, write to learncivilengineering2012@gmail.com

Geotechnical Cheat Sheet

Lateral Earth Pressure

$\sigma_h' = K_o\sigma_v'$ (Rankine) $K_{o(NC)} = 1 - \sin\phi'$ $K_p = 1 / K_a$

$K_a = \tan^2(45 - \phi/2) = [1 - \sin(\phi)] / [1 + \sin(\phi)]$ (Rankine) $K_p = \tan^2(45 + \phi/2) = [1 + \sin(\phi)] / [1 - \sin(\phi)]$

$P_a = ½K_a\gamma_t H^2$ $P_p = ½K_p\gamma_t H^2$ $P_Q = K_aQH$ $P_w = ½\gamma_w(H-d)^2$

Soil Consolidation

$C_c = 0.009(LL – 10)$ $c_v = k(1+e) / (a_v\gamma_w)$ $T = (c_vt)/H_{dr}^2$ $OCR = \sigma'_p/\sigma'_v$

OCR > 1 (when $\sigma'_p > \sigma'_v + \Delta\sigma$)	$s_c = [(C_r \times H_o) / (1 + e_o)] \times \log_{10}[(\sigma'_v + \Delta\sigma) / \sigma'_v]$
OCR > 1 (when $\sigma'_p < \sigma'_v + \Delta\sigma$)	$s_c = [(C_r \times H_o) / (1 + e_o)] \times \log_{10}[(\sigma'_p) / \sigma'_v] + [(C_c \times H_o) / (1 + e_o)] \times \log_{10}[(\sigma'_v + \Delta\sigma) / \sigma'_p]$
OCR = 1	$s_c = [(C_c \times H_o) / (1 + e_o)] \times \log_{10}[(\sigma'_v + \Delta\sigma) / \sigma'_v]$
OCR < 1	$s_c = [(C_c \times H_o) / (1 + e_o)] \times \log_{10}[(\sigma'_v + \Delta\sigma + \Delta\sigma'_v) / \sigma'_v]$

Effective and Total Stresses

$\sigma_v = \gamma_t z$ $\gamma_{tot} = \gamma_{dry} (1 + w.c.)$ $\sigma'_v = \sigma – u$ $u = \gamma_w \times z_w$

$\sigma_z = \Delta\sigma_v = 3Qz^3 / 2\pi(r^2 + z^2)^{5/2}$ (point load) $\sigma_z = 2Qz^3 / \pi(r^2 + z^2)^2$ (line load)

$\sigma_z = P / (B + z)$ (strip footings) $\sigma_z = P / [(B + z) \times (L + z)]$ (square footings)

Bearing Capacity

$q_{all} = q_{ult} / FS$ $q_{max} = Q(B + 6e) / B^2$ $q_{min} = Q(B – 6e)/ B^2$ $6e_B/B + 6e_L/L \leq 1$

$q_{net(ult)} = 5.14c_u[1 + (0.195 \times B)/L][1 + (0.4 \times D_f)/B]$ (cohesive)

$q_{net}(kN/m^2) = (N_{60}/0.08) \times [(B + 0.3)/B]^2 \times F_d(S_e/25)$ (sand)

$q_{ult} = cN_c + 0.5\gamma_t BN_\gamma + \gamma_t D_f N_q$ (strip footings) $q_{ult} = 1.3cN_c + 0.4\gamma_t BN_\gamma + \gamma_t D_f N_q$ (square footings)

$q_{ult} = 1.3cN_c + 0.3\gamma_t BN_\gamma + \gamma_t D_f N_q$ (circular footings)

Foundation Settlement

$s_i = qBI(1 – v^2) / E_u$ $s_s = C_\alpha H_o \Delta\log t$ $\Delta H = 4qB^2 / K_v(B + 1)^2$ (sand)

Slope Stability

$FS = \tan\phi / \tan\beta$ (infinite slope-cohesionless) $FS = c / \gamma z \sin\beta \cos\beta$ (infinite slope-cohesive)

$FS = N_o(c) / \gamma_t(H)$ (Taylor chart)

Soil Classification and Boring Log Interpretation

$GI = (F^{200} - 35)[0.2 + 0.005(LL - 40)] + 0.01(F^{200} - 15)(PI - 10)$ $PI = LL - PL$

$\gamma_d = \gamma_t / (1 + w.c.)$ $\gamma_{sat} = \gamma_w (G + e) / (1 + e)$ $N_{60} = E_m C_b C_s C_r N / 0.6$

Area Ratio $= 100 \times (D_o^2 - D_i^2) / D_i^2$ Inside Clearance Ratio $= 100 \times (D_i - D_s) / D_s$

$(s_u \text{ or } c_u) = q_u/2$ w.c. = 100 × (mass of water/dry mass of soil)

Soil Properties

$\gamma_b = \gamma_{sat} - \gamma_w = \gamma_w(G_s - 1) / (1 + e)$ $e = V_v/V_s = n/(1-n)$ $n = V_v/V = e/(1+e)$

$S = 100 \times V_w/V_v$ $G_s = W_s/(V_s+\gamma_w) = Se/\text{w.c.}$

$\tau = \sigma\tan\phi$ (cohesionless) $\tau = c + \sigma\tan\phi$ (mixed)

$v = ki$ $v_s = v/n = ki/n$ $Q = kiA = k(\Delta h/L)A = k\Delta h(n_f/n_d)$

$k = (2.3aL/At)\log_{10}(h_o/h_f)$ (falling-head) $k = QL/\Delta hAt$ (constant-head) $u = h_p\gamma_w$

Compaction

$RC = (\gamma_{d(field)} / \gamma_{d(max)}) \times 100$ $D_r = (e_{max} - e) / (e_{max} - e_{min}) \times 100$

Retaining Walls

$FS = \Sigma M_r / \Sigma M_o$ (gravity wall-overturning) $FS = \Sigma F_r / \Sigma F_D$(gravity wall-sliding) $\sigma_h = k_a\gamma_t H$

$FS = Q_{ult} / Q_v$ (gravity wall) $Q_{ult} = B'(cN_c d_c i_c + \gamma D N_q d_q i_q + ½\gamma B' N_\gamma i_\gamma)$ (gravity wall)

$FS = (W\tan\delta + P_P) / P_A$ (cantilever wall-sliding analysis and neglecting friction)

$FS = (N\tan\delta + P_P) / P_H$ (cantilever wall-sliding analysis and including friction)

$FS = \Sigma M_r / \Sigma M_o$ (cantilever wall-overturning) $Mo = P_{a(H)}y_o$ $M_R = W_{stem}(y_o) + W_{base}(y_o) + W_{soil}(y_o)$

$Q_{ult} = B'(\gamma D N_q d_q i_q + ½\gamma B' N_\gamma i_\gamma)$ (cantilever wall-bearing capacity) $FS = Q_{ult} / V$

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