A. Material Initially Distributed

2) 1st set of HO Notes = Cover Sheet + p1-3 (attached)
3) Home Problem No. 1 & Solution (Self graded)

B. Approximate Class Schedule

<table>
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<tr>
<th>Class No.</th>
<th>Coverage &amp; Remarks</th>
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</thead>
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<tr>
<td>B 1</td>
<td>*NC Simple Clay via class discussion (p1-46), including Use of Principle II to predict Wc = f(kc) / CAC ESP (Fig II-12, 13); prediction of WC test from 1 CI 0 C test (use given 1.36) II-2-3.2.</td>
</tr>
<tr>
<td>B 2</td>
<td>*You need to study Chap III of SC Notes &amp; do most of HP #1</td>
</tr>
<tr>
<td>B 3</td>
<td>*OC Simple Clay via class discussion (p5-8), including Horler parameters &amp; State Boundary Surface (not in SC Note) andChannel extension. *You need to study Chap III - IV</td>
</tr>
<tr>
<td>B 4</td>
<td>*Distribute MCC Notes &amp; HP #2 (due to class #5)</td>
</tr>
<tr>
<td>B 5</td>
<td>*Cover MCC Notes, mostly via &quot;lectures&quot;</td>
</tr>
<tr>
<td>B 6</td>
<td>*Distribute HP #3 *Distribute C-I Notes</td>
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<tr>
<td>B 7</td>
<td>*Either complete Part B or start Part C</td>
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</tbody>
</table>

X 1st Class = 1st or 2nd hr, Tues. 2/20/01 (Mon. class = Tues. due to Monday Holiday)
### Handout on Basic Strength Principles of "Simple Clay"

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<td>V 1-3.2</td>
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<td>3</td>
<td>NC CIQC Tests</td>
<td>IV 4-6</td>
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<td>NC CIUC Tests</td>
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<td>4b</td>
<td>Three factors controlling $\sigma$</td>
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<td>Prediction of UC data from CIQC test on NC clay</td>
<td>V 1-3.7</td>
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<td>OC CIQC Tests</td>
<td>IV 4-6</td>
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<td>6</td>
<td>OC CIUC Tests</td>
<td>V 1-3.3 to 3.6</td>
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<td>6a</td>
<td>SHANSEP Eqn. &amp; Hvorslev Parameters</td>
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<td>7</td>
<td>State Boundary Surface (SBS)</td>
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<td></td>
<td>NOTE: This plot replaces Eq.IV-4.15 and Fig.IV-2 that SC Notes used to obtain Hvorslev parameters</td>
<td></td>
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<tr>
<td>8</td>
<td>Effect of changing from CIUC to CIUE (TC→TE)</td>
<td></td>
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</table>
### BASIC STRENGTH PRINCIPLES & STRESS-STRAIN-STRENGTH BEHAVIOR OF "SIMPLE CLAY"

#### INTRODUCTION

1.1 Types of Shear Tests (Restricted now to TC & TE)

- CD
- CU
- UV

1.2 Basic Principles (For given b, 8, i.e., treat TC & TE separately)

<table>
<thead>
<tr>
<th>Principle</th>
<th>Limitation</th>
<th>Independent Of</th>
</tr>
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<tbody>
<tr>
<td>I Unique Failure Envelope</td>
<td>NC vs OC</td>
<td>Drainage (CD, CU, U)</td>
</tr>
<tr>
<td>[ q_f = \sigma_f' + \bar{p} (\tan \phi' = \sin \phi) ]</td>
<td></td>
<td>T : S : P = L vs U</td>
</tr>
<tr>
<td>II Unique w - q - \bar{p}' (q = 0 \rightarrow q_f)</td>
<td>NC vs OC</td>
<td>Same as above</td>
</tr>
<tr>
<td>(NEW)</td>
<td>( \Delta q \geq 0 )</td>
<td></td>
</tr>
</tbody>
</table>

**Corollary (1.36):** Unique w-log stress

\[ \sigma_c' = \sigma_t' = \bar{p}_t \]

For NC

\[ w \rightarrow \log \text{stress} \]

**Hvorslev Parameters (NEW):**

| III Unique w_f - q_f - \bar{p}_f \rightarrow \bar{a} | None | Same as above |

**Note:** Will lead to concept of "State Boundary Surface" (pf)
1.3 Why Study These 3 Strength Principles?

1) Reasonable approximation for many insensitive clays
2) Frequently assumed/used in practice
3) Framework for more complex behavior
4) Background for discussion of "generalized Soil Model" à la MCC = Modified Cam Clay

1.4 Simple Clay

1) Developed as teaching aid for home problems with clay having perfect "normalized behavior"
2) Behavior reasonably typical of insensitive plastic clays (for $K_c=1$ consolidation)
3) Not intended for direct use in practice

1.5 Variables Considered by Simple Clay

1) Drainage (CO→CU→UU)
2) OCR
3) TSP, e.g., L vs U
4) $K_c = \sigma_{nl}/\sigma_{n0}^t$
5) $\sigma_2$, e.g., TC vs TE

NOTE: Sheets 3 & 4 = start of OCR-1 Simple Clay behavior
A) C10C Tests - N.C. Simple Clay

Mohr-Coulomb failure criteria

\[ q_f = P_f \tan \phi' = P_f (\sin \phi' = 0.3916) \]

B) Perfect Normalized Behavior

Why different \( \sigma - \varepsilon \) for \( U \)?

\[ L \quad + \Delta q' \rightarrow \]
\[ + \Delta P' \rightarrow \]
\[ U \quad + \Delta q \rightarrow \]
\[ - \Delta P' \rightarrow \]

\[ \frac{2q}{\sigma_c} = \frac{\varepsilon}{m + n\varepsilon} \] (Hyperbolic)

m \rightarrow initial modulus \( \left( \frac{E/\sigma_c}{1/m} \right) \)

\[ \frac{\varepsilon \cdot \sigma_c}{2q} \]

\[ 1.2875 \]

\[ 2.2875 \]

2.65

-
See (A) for $w$-log stress

$\sigma_e / \sigma_c'$

$\Delta u / \sigma_c'$

$\sigma_0 / \sigma_c'$

$\sigma_0'^{'} / \sigma_c''$

$\sigma_5 / \sigma_c''$

$\varepsilon$

$\varepsilon_0$

$\rho' / \rho''$

$\sigma_0$ / $\sigma_5$

$\Delta u_b$ (L)

$\Delta u_b$ (U)

$TSP_u$ (L)

$TSP_u$ (U)

$21.4^\circ$

$\text{What changes for } U?$

$S_{100%}$

$B=1.00$

$L$

$U$

$\rho' / \rho''$

$u_b / \sigma_c'$

$\sigma_c'$
Principle II: Unique $w - q - p'$ for $\Delta q > 0$

Defined by ___________ for NC SC

a) Fig II-12: Prediction of $\Delta w$ for CIUC (L) & (R) tests

b) Fig II-13: Prediction of ESP, $q_f/\sigma_{vc}$, etc. for CK2 UC test

c) Prediction of Parameters from CIUC Stress-Strain Data Given $\sigma_{vc}'$ & $\sigma_{hc}'$ ($K_r < 1$)

1) Compute $R = \sigma_v'/\sigma_h' = 1/K_r$; $\sigma_c' = (\sigma_{vc}' - \sigma_{hc}')$

2) Scale $2q_c/\sigma_c'$ at $R$

3) Equivalent $\sigma_e' = \sigma_e = \frac{2q_c}{(2q_c/\sigma_c')}$ $\rightarrow$ value of $\sigma_c$

4) For CAUC, $q_f = (0.29)(\sigma_e') \rightarrow q_f/\sigma_{vc}$

5) ... also can get $q_f/\sigma_{hc} \rightarrow A_f$, etc.
Three Factors Controlling $\sigma_u = q_f$

1) $\sigma_0' \leq u_0$
2) $\Delta \sigma_c' \leq p_f'$
3) $q_f$
4) $\Delta u_f$
5) $\theta_f$
6) ESP
7) $q \approx E_a$

CAUC: $K_c = \frac{\sigma_{uc}'}{\sigma_{uc}} \geq 1$

\[
\frac{q_f}{\sigma_{uc}} = \frac{c'/\sigma_{uc} + [K_c + (1-K_c)A_f] \sin \phi'}{1 + (2A_f - 1) \sin \phi'}
\]

Prediction of UUC Test from CIDC ($\rho' = \sigma_c'$) Data on NC Clay ($K_c = 1$, no disturbance)
(Fig. III-5) C10C Tests - Effect of OCR

OCR = 1
OCR = 12

(Fig. III-2) Increasing OCR:
- $q_t / q_c$
- $R_f$
- $\Delta w$
- Post-peak $q$-$e$

Causes of Dilution (Discussion)
CIUC Tests - Effects of OCR

What is main reason for OCR ->
incr. $s_u/\sigma_c$?

Summary (Fig III-17,18,19)

Effect of inc. OCR on:
- $s_u/\sigma_c$
- $\epsilon_f$
- $R_f$

$\gamma_0 = \gamma_f$

$\epsilon_f(Y)$

$A_f$
Hvorslev Parameters

1) Hvorslev's Contributions \( \sigma_t = K \sigma_c^c + \sigma_{t}^{d} \tan \phi' \)

2) Golden Rule

3) Revised determination presentation for CIUC/UCOC data
   \[ q_t = \beta \sigma_c^c + p_t' \] (tangent = sinh c) where \( \beta \sigma_c^c = a_c^c \) (iv)

4) Table with data from CIUC and/or CIUC at varying OCR
   \[ w_t \quad q_t \quad p_t' \quad \sigma_c^c \quad \sigma_t^{d} \quad p_t^{d} \]

5) Hvorslev Envelope (p7)

6) State Boundary Surface (Hvorslev + Rocca = NC CIUC ESP)

7) Discussion
COMMENTS ON SIMPLE CLAY TE vs TC


\[ \Delta u = \Delta \sigma_{oc} + \alpha \Delta \tau_{oct} \]

\[ \Delta \tau_{oct} = \left( \frac{1}{3} \right) \sqrt{(\Delta \sigma_1 - \Delta \sigma_3)^2 + (\Delta \sigma_2 - \Delta \sigma_3)^2 + (\Delta \sigma_1 - \Delta \sigma_2)^2} \]

For \( b = 0 \):

- \( A = \frac{A_1 + A_3}{3} \)
- \( 0.5 \): \( A = \frac{A_1 + A_3}{2} \)
- \( 1.0 \): \( A = \frac{A_1 + A_3}{2} + \frac{1}{3} \)

2) CIUE vs CIUC: NC --- CIUC ---- CIUE

- Change in \( s_u / \sigma_c \)? Why?
- Comparison MCC

3) Effect of OCR (III-19)

- \( s_u(OC) / s_u(NC) \) vs OCR - How compare to CIUC?

4) What happens to Principle II relationships?

5) What happens to Korsvly Parameters for SC?
   (Actually don't know for real clays)