Geotechnical Engineering–I

BSc Civil Engineering – 4th Semester

Lecture # 19

10-Apr-2015

by

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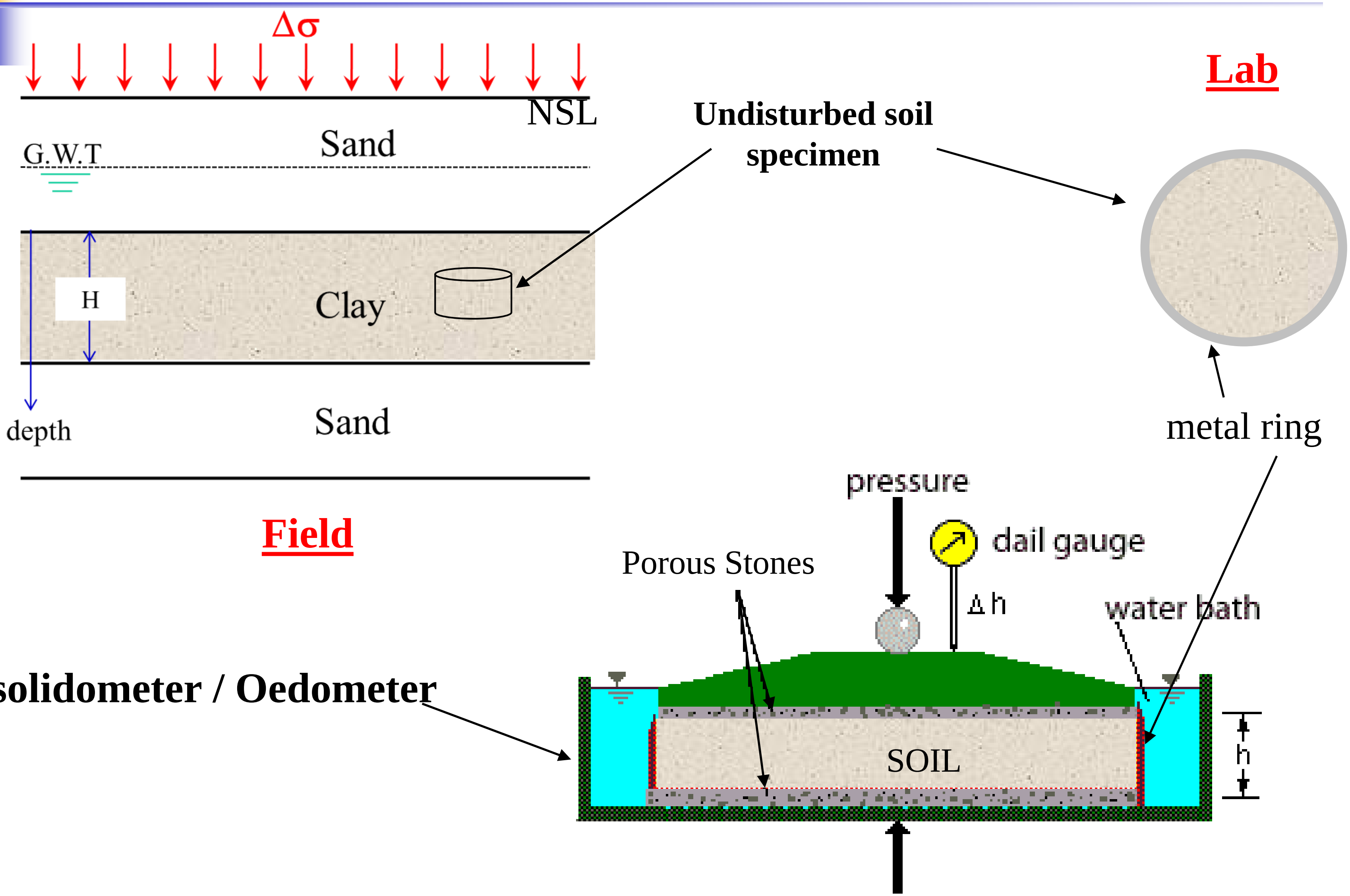
Lecture Handouts: https://groups.google.com/d/forum/geotec-1

Consolidation Test



Consolidometer / Oedometer

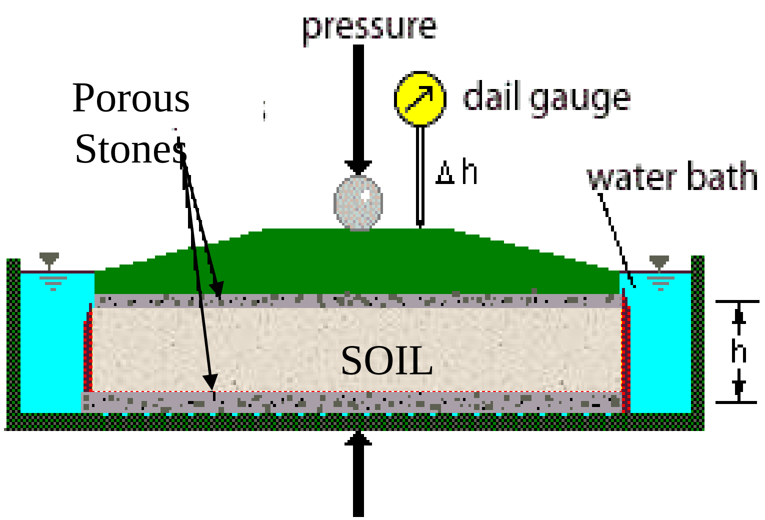
CONSOLIDATION TEST
Interpretation of Test Results

Magnitude of settlement → compression index *(Cc)*

Rate of consolidation → co-efficient of consolidation *(Cv)*

Time required for consolidation (Consolidation Time) → $t = \left(\frac{T \cdot H^2}{C_V} \right)$

1. Time ~ Deformation curve
   i. *Cv* (Coefficient of consolidation)
2. Pressure ~ Deformation curve
   i. *Cc* (Compression index)
   ii. *Cr* (Recompression index)
   iii. a_V (Coefficient of compressibility)
   iv. m_V (Coefficient of volume change)



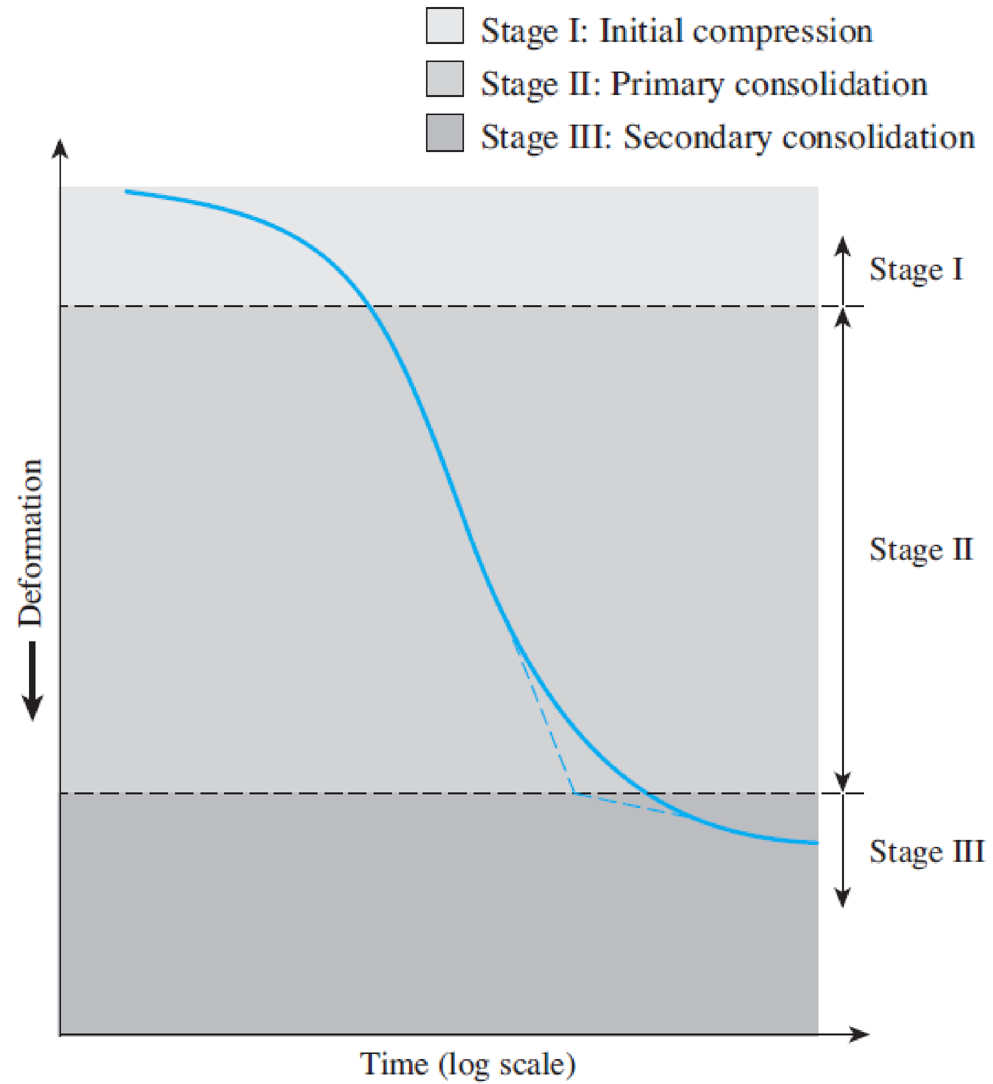
CONSOLIDATION TEST
Deformation ~ Time Plot

Used to determine *Cv* (coefficient of consolidation)

- Rate of consolidation
- Consolidation *Time*

<u>Methods of Determining *Cv*</u>

1. Casagrande's *log-time* method (1938)
2. Taylor's *Square root of time* method (1948)

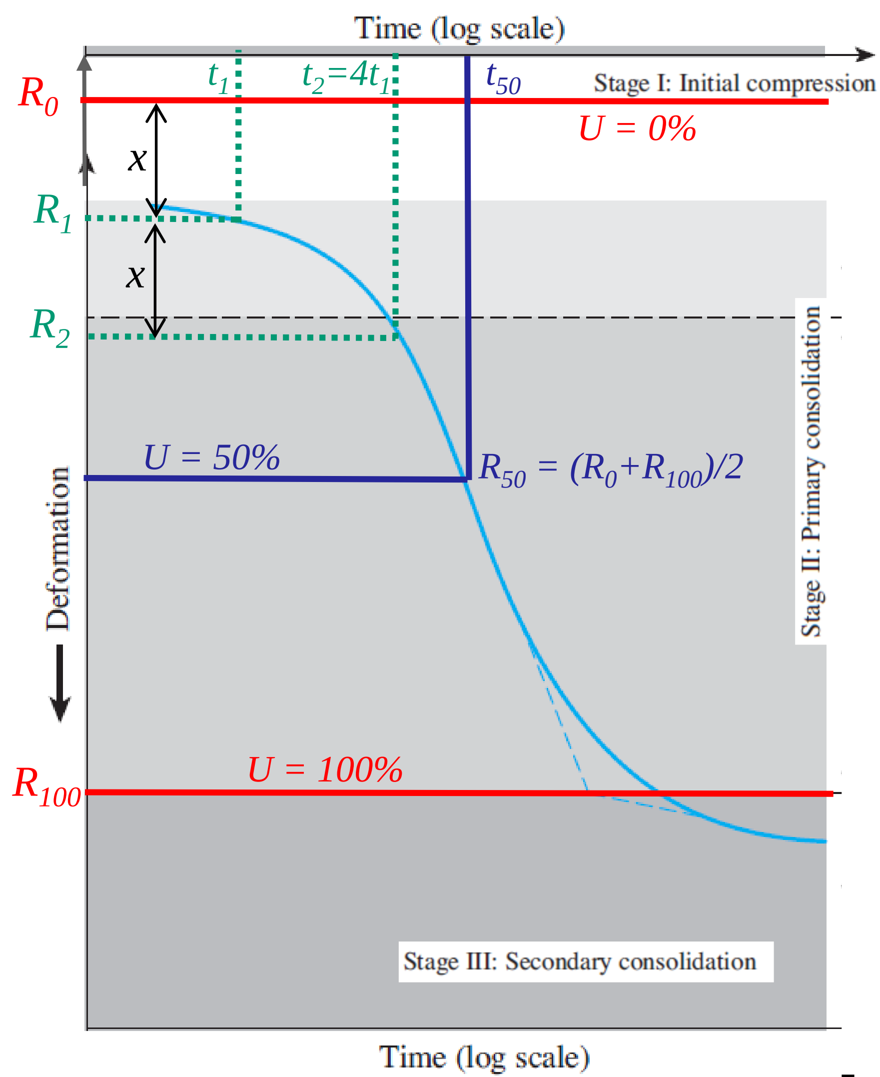


DEFORMATION ~ TIME PLOT
Casagrande's log-time method

Used to determine *Cv* (coefficient of consolidation)

- Rate of consolidation
- Consolidation Time

$$C_V = \left(\frac{T \cdot H^2}{t} \right)$$



t_{50}: obtained from deformation ~ time plot

H = t/2 (for two-way drainage)

t = height of specimen

T = Time factor = 0.197 (for u=50%)

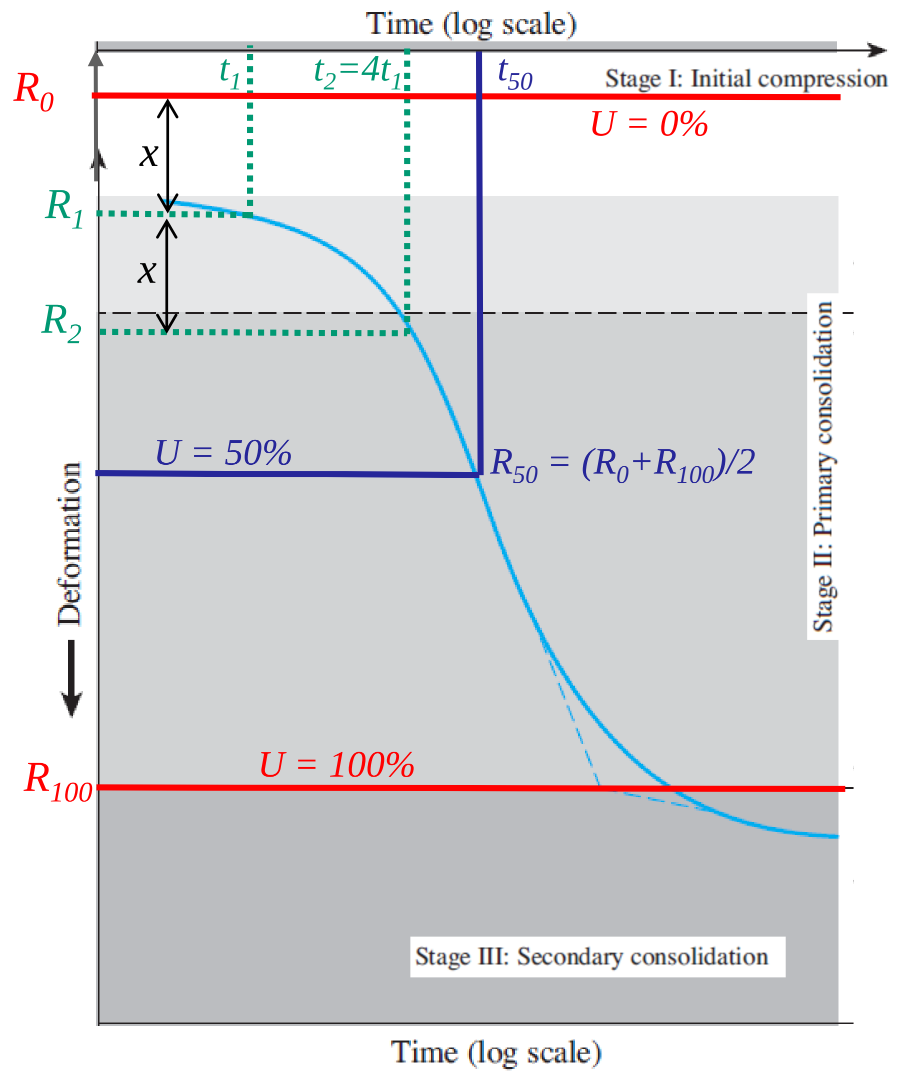
DEFORMATION ~ TIME PLOT
Casagrande's log-time method

- Plot specimen *deformation* against *log-of-time*
- R_0 and R_{100} represent dial readings for zero percent (U_0) and 100% (U_{100}) degree of consolidation respectively.

- <u>For determining U_{100}</u>
- Draw *two tangents* to the bottom part of curve. Intersection of these tangents represent U_{100}.
- The corresponding abscissa represent t_{100}.

- <u>For determining U_0</u>
- Choose any two times t_1 and t_2, such that $t_2 = 4t_1$
- The corresponding dial readings are R_1 and R_2
- Mark off vertical distance between R_1 & R_2 (say 'x')
- R_0 lies 'x' distance above R_1.

- *R_{50} represents 50% degree of consolidation (U_{50})*
- *R_{50} lies mid-way between R_0 and R_{100}.*
- *The time (t_{50}) is used for determination of Cv.*

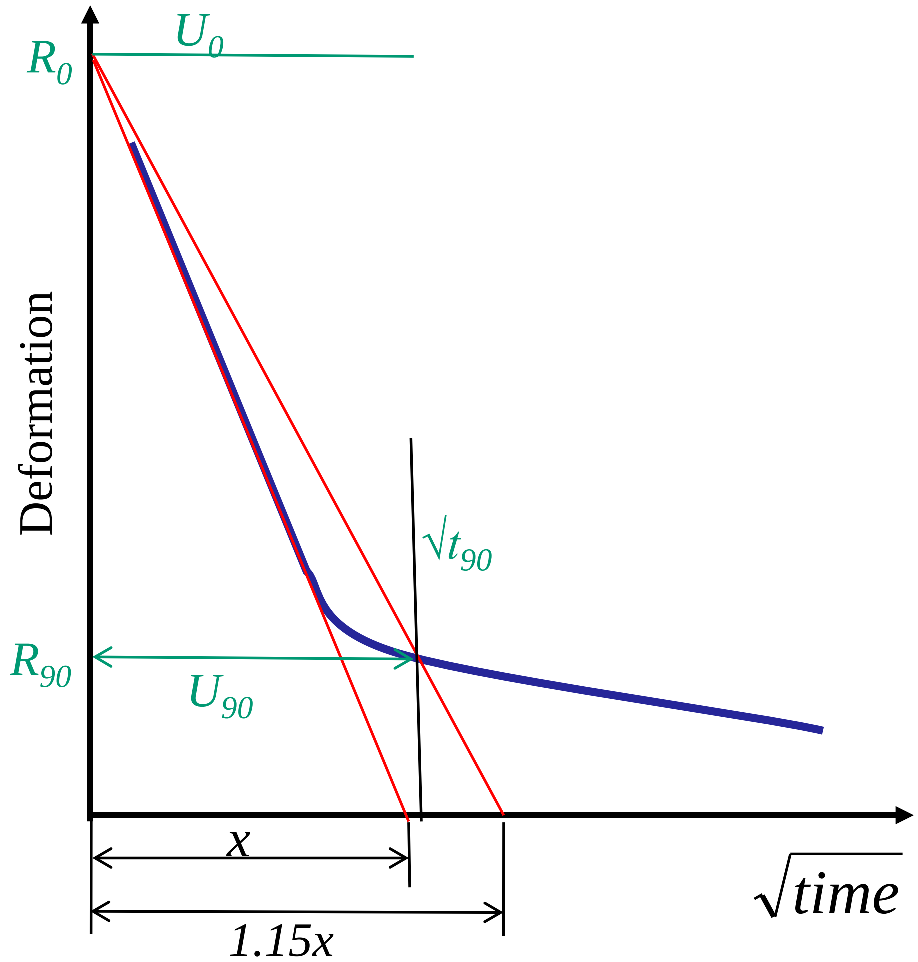


DEFORMATION ~ TIME PLOT
Taylor's Square-root of Time Method

Uses t_{90} for computing Cv

Plot *deformation ~ square root of time*.

- Project the straight line portion of the initial part of curve backward to zero time to define R_0 or U_0.
- Draw a second line from R_0 with abscissa 1.15 times as large as the corresponding values on the first line.
- The intersection of the second line with the laboratory curve defines R_{90} or U_{90}.



$$C_V = \left(\frac{T_{90} \cdot H^2}{t_{90}} \right)$$

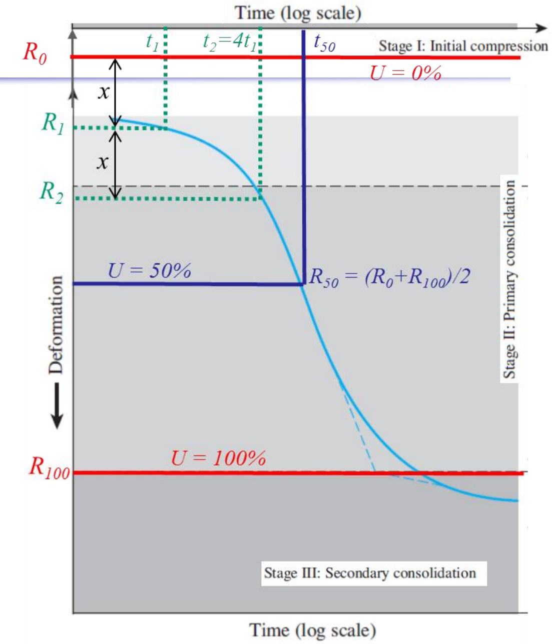
T_{90} = Time factor for 90% degree of consolidation (U_{90}).

$T_{90} = 0.848$

DEFORMATION ~ TIME PLOT
Summary

Used for determining *Cv*

Cv is used for determining *rate of consolidation*, and *consolidation time*.



<u>Casagrande's log-time fitting method</u>

Determines *Cv* corresponding to *U*=50%.

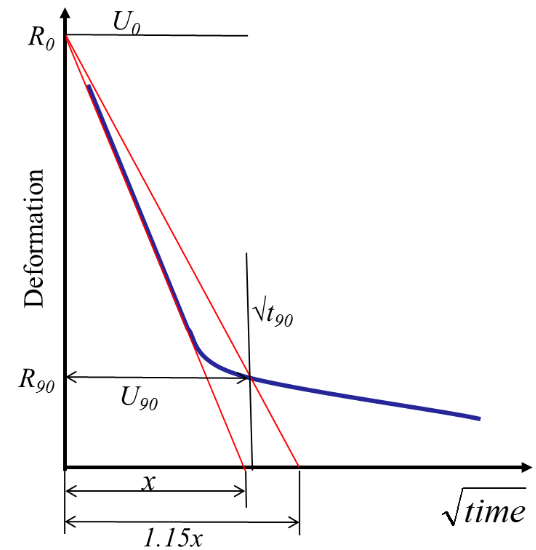
Deformation ~ log-time plot

$$C_V = \left(\frac{T_{90} \cdot H^2}{t_{90}} \right)$$

<u>Taylor's square root of time method</u>

Determines *Cv* corresponding to *U*=90%.

Deformation ~ square root of time plot



Cv determined from *√(time) method* is often *slightly greater* than the *log-time method*.

CONSOLIDATION TEST
Pressure ~ Deformation Curve

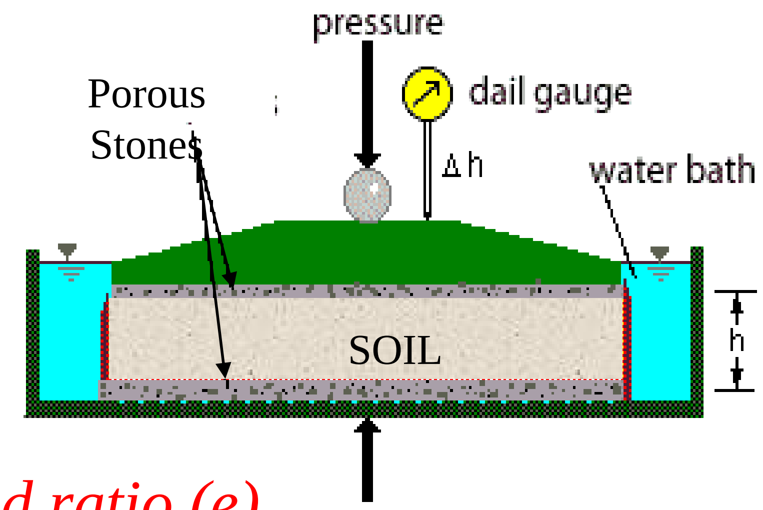
Pressure ~ Deformation curve

i. *Cc* (Compression index)

ii. *Cr* (Recompression index)

iii. a_V (Coefficient of compressibility)

iv. m_V (Coefficient of volume change)



Deformations plotted in terms of *void ratio (e)*

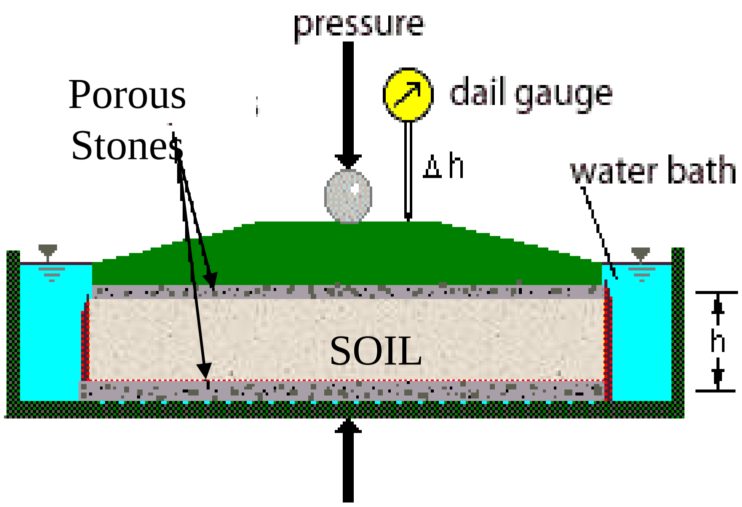
- Void ratio ~ pressure plot *(e ~ p* plot*)*
- Void ratio ~ log of pressure (*e ~ log p* plot)

CONSOLIDATION TEST

Pressure ~ Void Ratio Curve

Determination of e_0

e_o = initial (or in-situ) void ratio



$$e_0 = \frac{V_V}{V_S} = \frac{A \cdot H_V}{A \cdot H_S} = \frac{H_V}{H_S} \cdots\cdots\cdots(1)$$

$$H_V = H - H_S$$

$$V_S = \frac{W_S}{G_S \cdot \gamma_w}$$

$$A \cdot H_S = \frac{W_S}{G_S \cdot \gamma_w}$$

$$H_S = \frac{W_S}{G_S \cdot \gamma_w \cdot A}$$

$$H_V = H - \frac{W_S}{G_S \cdot \gamma_w \cdot A}$$

$$eq.(1) \Rightarrow \quad e_0 = \frac{H \cdot (G_S \cdot \gamma_w \cdot A) - W_S}{W_S} \cdots\cdots\cdots(2)$$

$$W_S = \frac{W_T}{1+w}$$

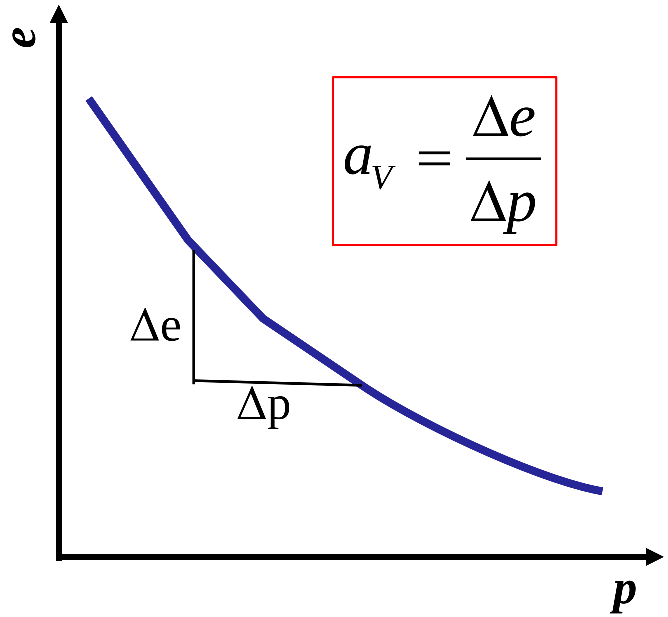
Ws = weight of soil solids

Determined from over drying the specimen at the end of consolidation test.

CONSOLIDATION TEST

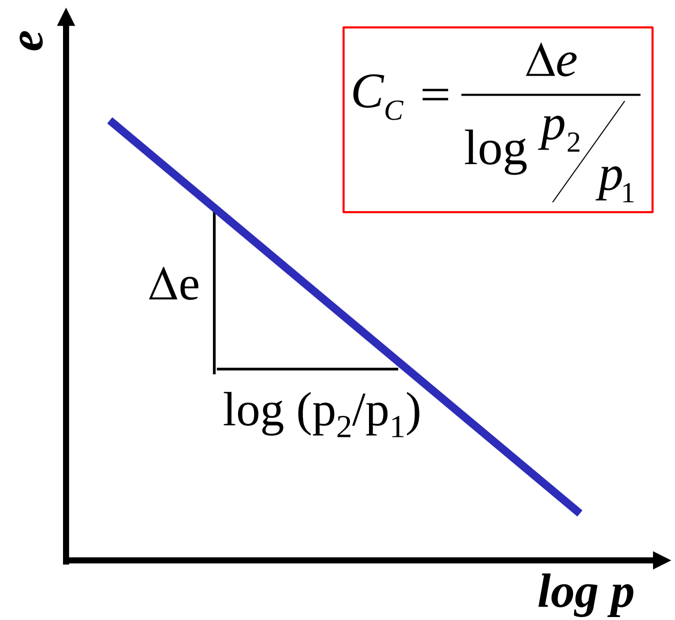
Pressure ~ Deformation Curve

***e ~ p* plot**



$$a_V = \frac{\Delta e}{\Delta p}$$

***e ~ log p* plot**



$$C_C = \frac{\Delta e}{\log {p_2}/{p_1}}$$

a_V = coefficient of compressibility

Cc = compression index

m_V = coefficient of volume change

$$m_V = \frac{a_V}{1+e}$$

CONCLUDED