

# DEEP FOUNDATIONS

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# 3. Settlements

**Are usually small:**

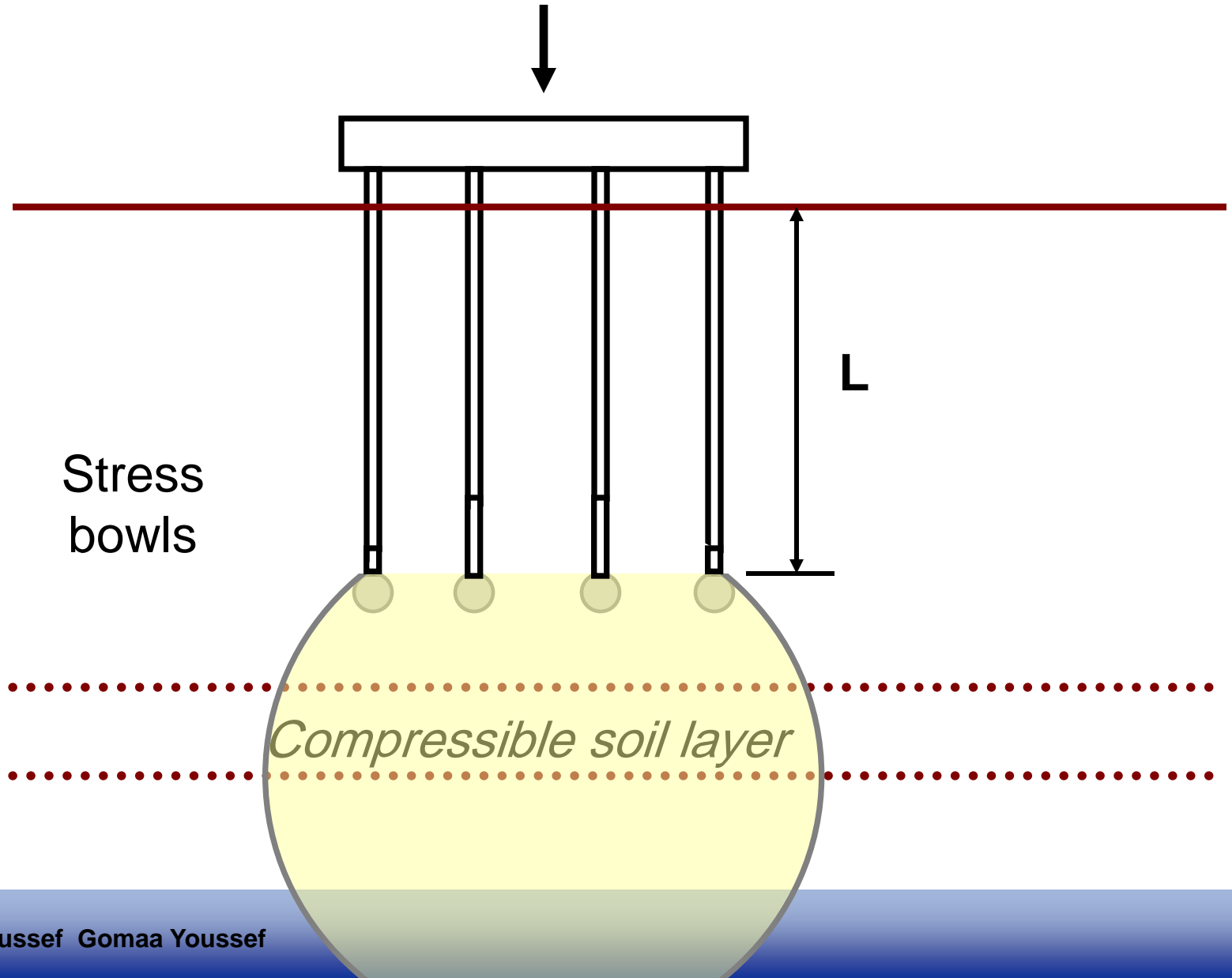
- Slip should be included
- Pile elastic compression can dominate

Refer: Poulos for settlement calculations

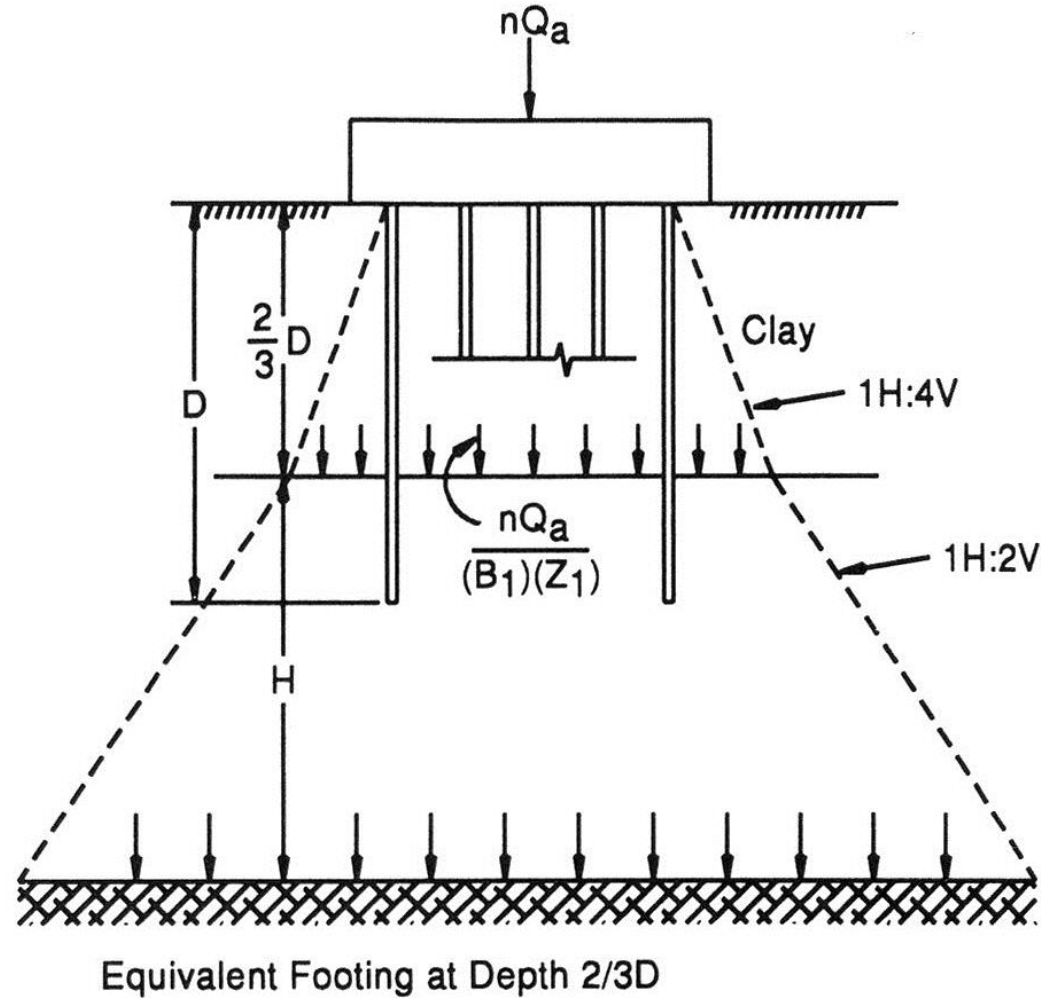
Caution: Block action of groups may stress far deeper than any pile in the group

– **greater settlements!**

# Settlements of Blocks



# Pile Group Settlement



# LOAD TEST ON PILES

- To obtain back-figured soil data that will enable other piles to be designed.
- To confirm pile lengths and hence contract costs before the client is committed to over all job costs.
- To counter-check results from geotechnical and pile driving formulae
- To determine the load-settlement behavior of a pile, especially in the region of the anticipated working load that the data can be used in prediction of group settlement.
- To verify structural soundness of the pile.

# Types of Pile Load Test

- Compression test
- Uplift test
- Lateral-load test
- Torsion-load test

# Types of Loading Procedures

- ***CRP (constant rate of penetration)***

Test pile is jacked into the soil, the load being adjusted to give constant rate of downward movement to the pile. This is maintained until point of failure is reached.

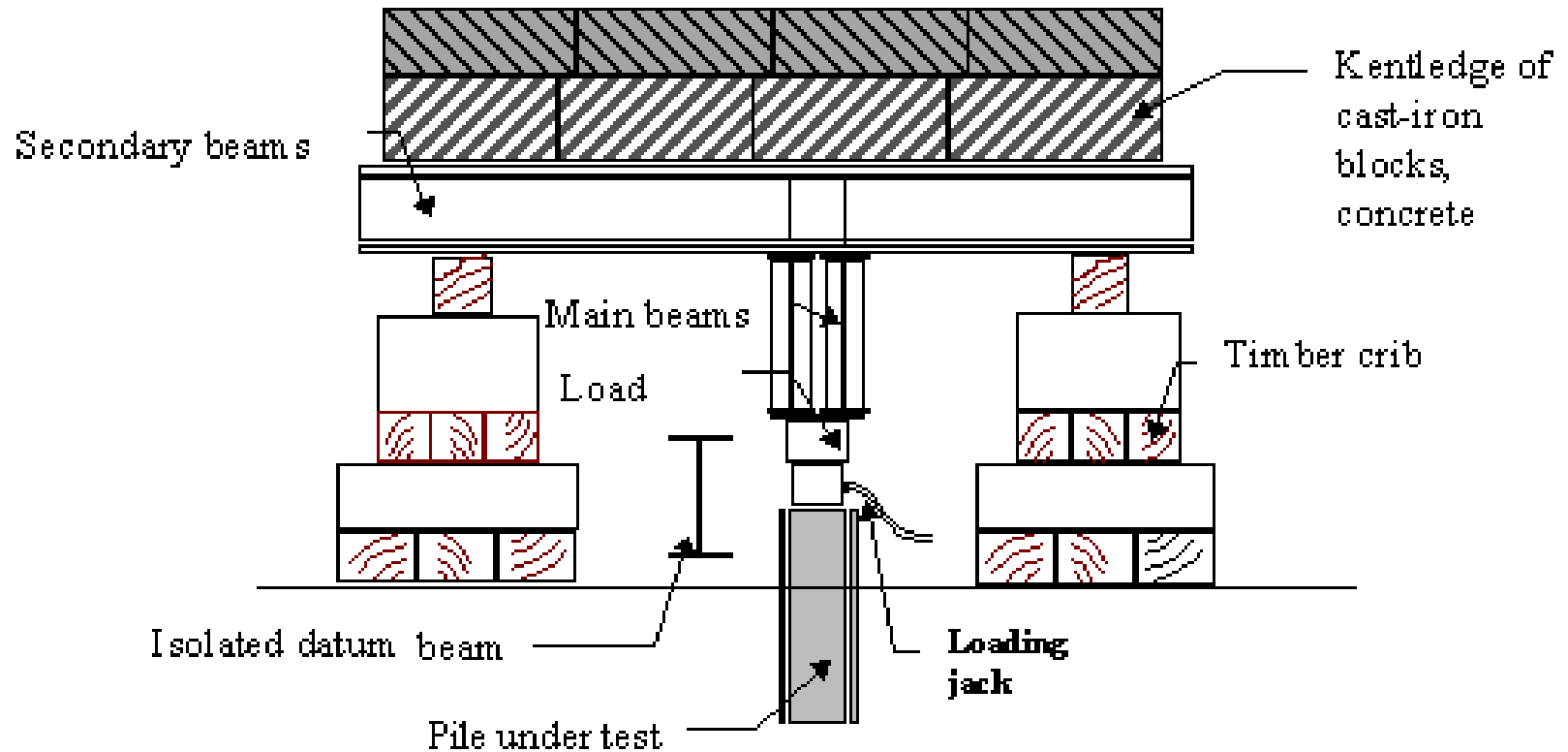
# Types of Loading Procedures

- ***MLT, (the maintained increment load test)***

The load is increased in definite steps, and is sustained at each level of loading until all settlements has either stop or does not exceed a specified amount of in a certain given period of time.



# LOAD TEST ON PILES



# LOAD TEST ON PILES



- Kentledge or adjacent tension piles or soil anchors are used to provide a reaction for the test load applied.
- By jacking(s) placed over the pile being tested. The load is increased in definite steps, and is sustained at each level of loading until all settlements has either stop or does not exceed a specified amount of in a certain given period of time.

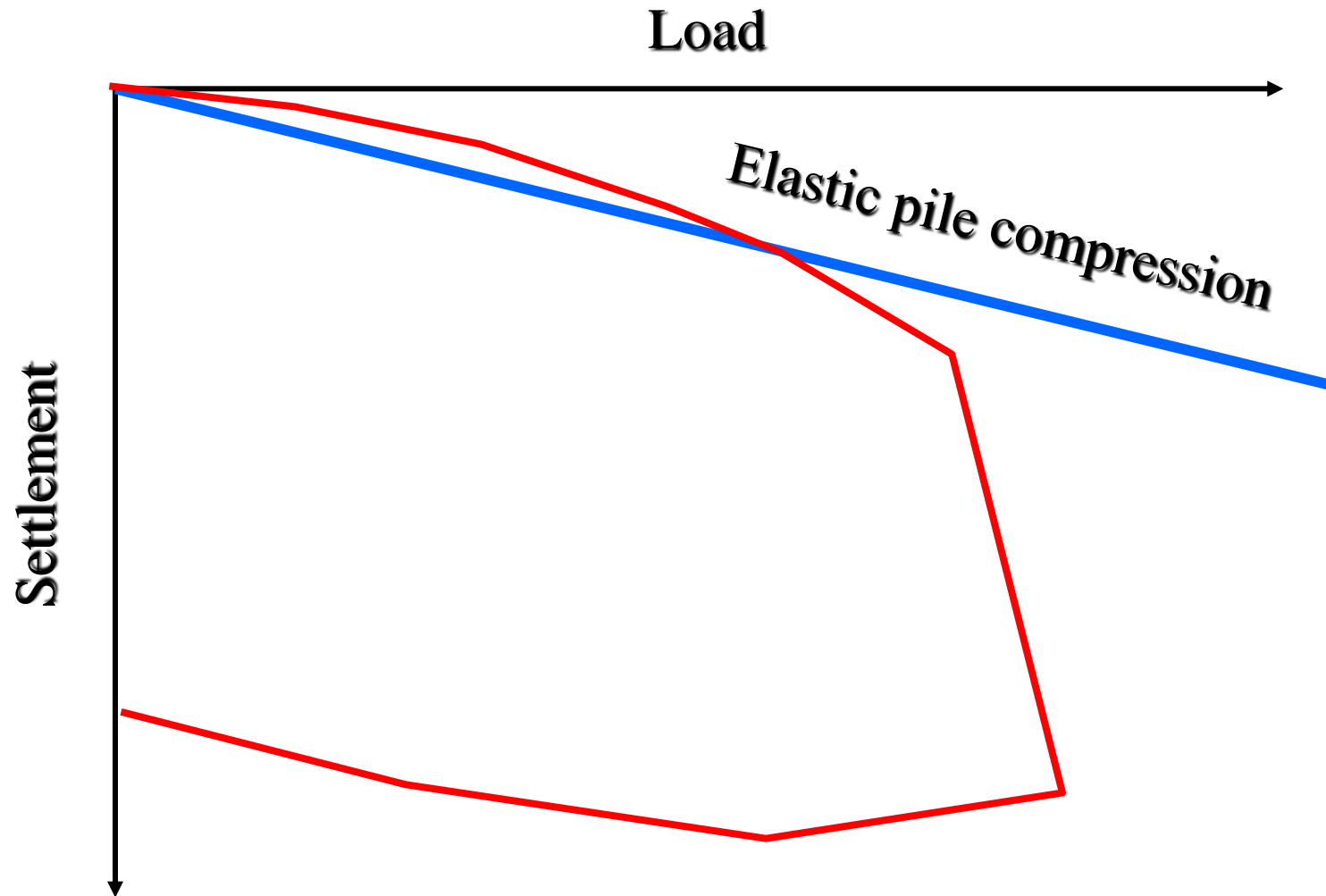
# LOAD TEST ON PILES



# Static Load Test

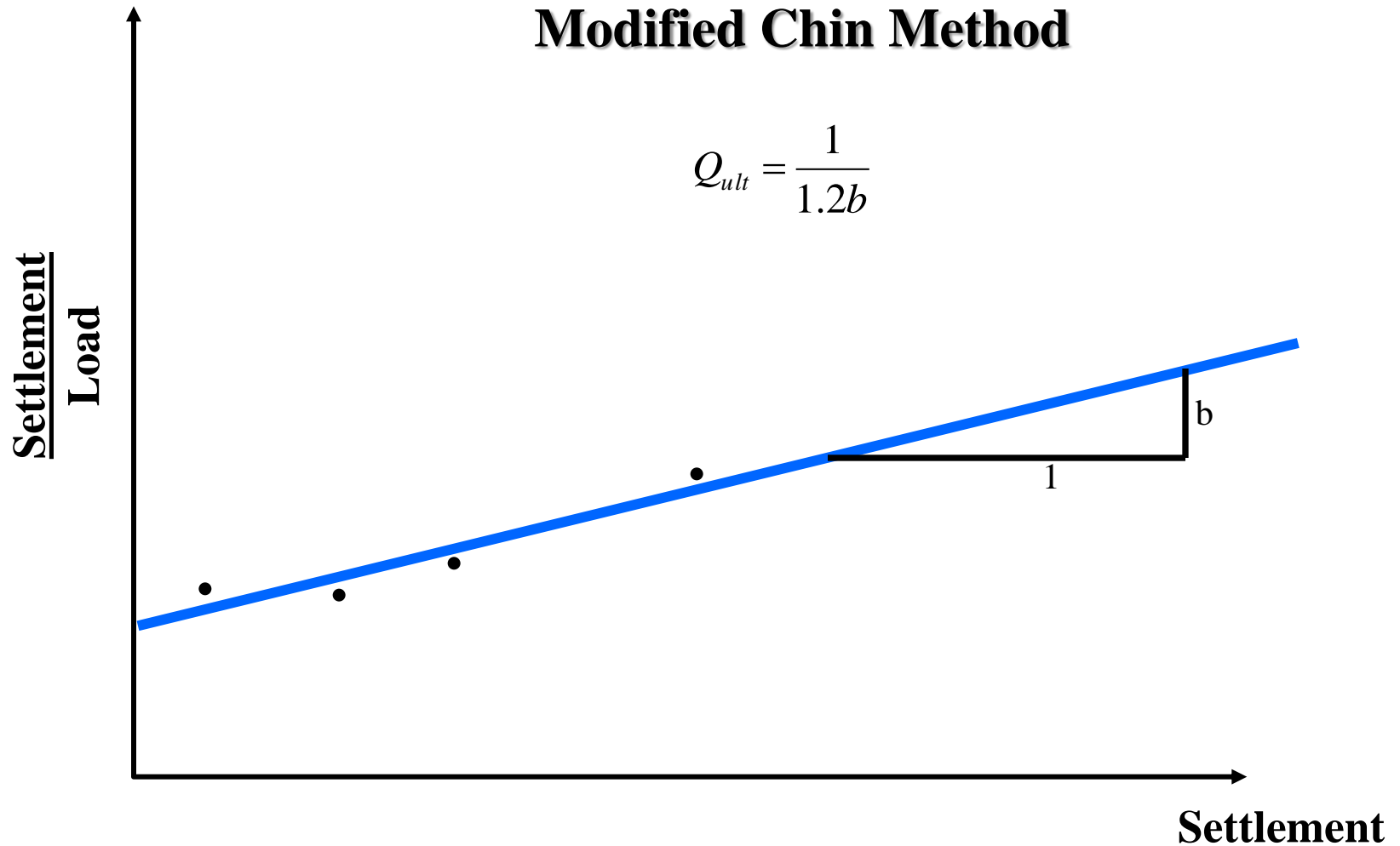


# Pile Load Test Results



# Estimation of Pile Capacity

## Modified Chin Method



# Estimation of Allowable Pile Capacity

$$Q_{all} = \frac{Q_{ult}}{F.S.}$$

Factor of safety, F.S.:

- If considering dead and Live loads only

$$***F.S. = 2.0***$$

- If considering dead, Live and wind loads

$$***F.S. = 1.75***$$

- If considering dead, Live, wind and earthquake loads

$$***F.S. = 1.50***$$

# Estimation of Allowable Pile Capacity

$$S_{1.50Q_{all}} \leq S_Q$$



$S_{1.50Q_{all}}$ : Settlement at 1.50 design load (form Load-settlement curve)

$S_Q$ : Allowable settlement

$$S_Q = 0.02d + \frac{0.5QL}{EA}$$



Design geotechnical strength,  $R^*$

$$R^* = \Phi_g R_u \geq S^*$$

(design action effect)

# Reduction factor $\Phi_g$ on Geotechnical Strength

## How good are the soil / pile data?

- Have piles been *proof loaded*?
- Is design based on site investigation?  
“Static analysis”
- Is design based on driving instrumented piles?  
“Dynamic pile testing”
- Is design based on driving records?  
“Dynamic analysis”

# Reduction factor $\Phi$

Pile load testing	0.7 to 0.9
Static analysis	0.4 to 0.65
Dynamic load testing	0.5 to 0.85
Dynamic analysis*	0.45 to 0.65
<b>*caution on clay sites</b>	

# STRUCTURAL STRENGTH

## Reduction factor, $\Phi_s$

Concrete - *from ECP*

Steel - *from ECP*

Timber - compression 0.85

- tension 0.7

- bending 1