LESSON 7

TOPIC 1

Spread Footing Design – Bearing Capacity

Structural Foundation Topics

- ***Shallow Foundations (Spread Footings)***
  - ***Bearing Capacity***
  - ***Settlement***
- ***Deep Foundations***
  - ***Load Capacity***
  - ***Settlement***
  - ***Negative Skin Friction***

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SPREAD FOOTING DESIGN

Lesson 7 - Topic 1
Bearing Capacity

Slide 7-1-2

SPREAD FOOTING DESIGN
Bearing Capacity

1. Explain How Footing Embedment, Width and Water Table Effect Footing Bearing Capacity

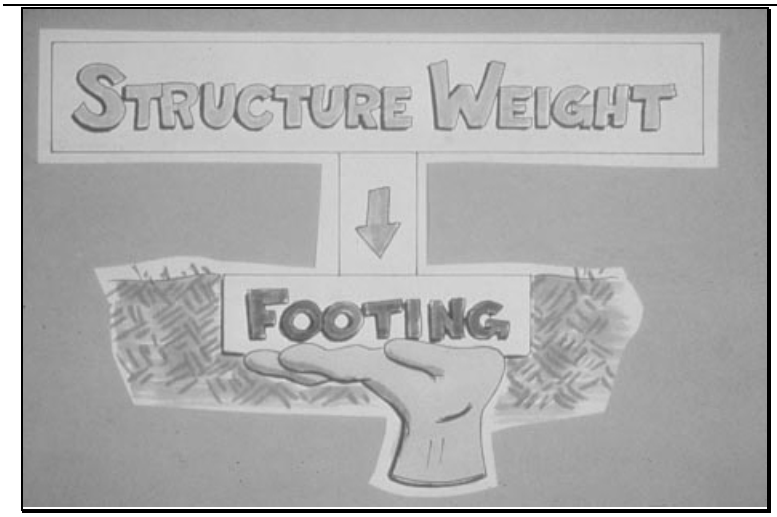
ACTIVITY: Bearing Capacity Analysis

Slide 7-1-3

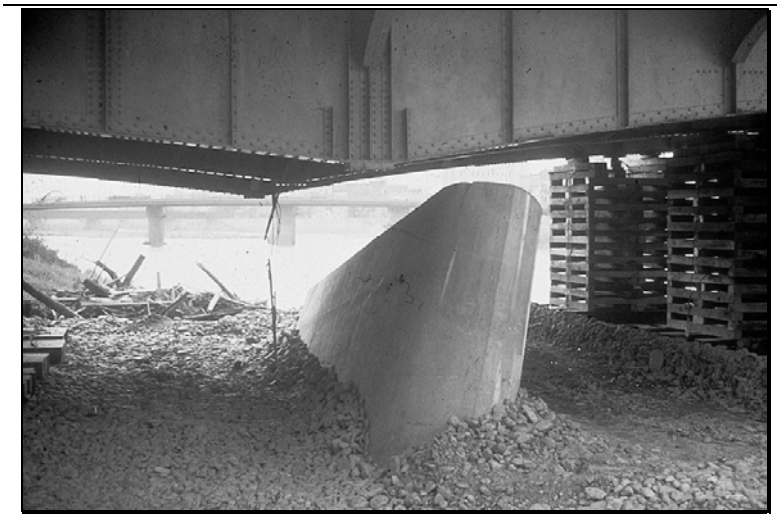
SOILS AND FOUNDATIONS WORKSHOP

What is the Effect on Bearing Capacity if the Soil Cover Over a Spread Footing is Removed?

Slide 7-1-4

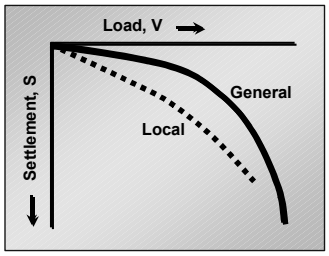


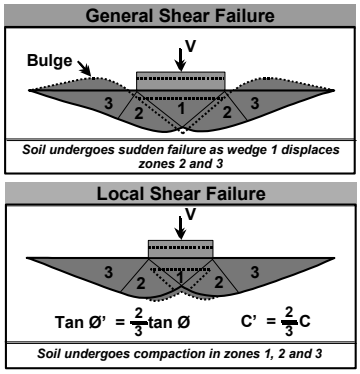
Slide 7-1-5



Slide 7-1-6

Failure Modes





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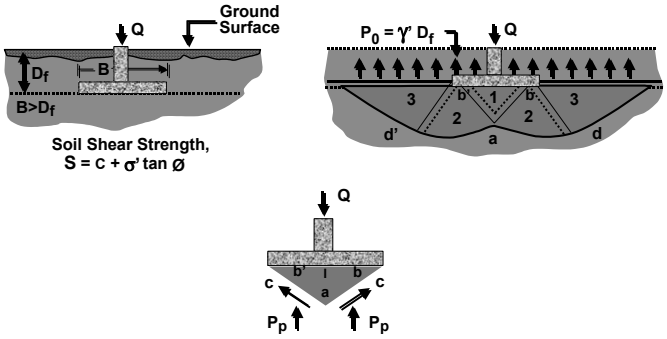
Bearing Capacity Mechanism



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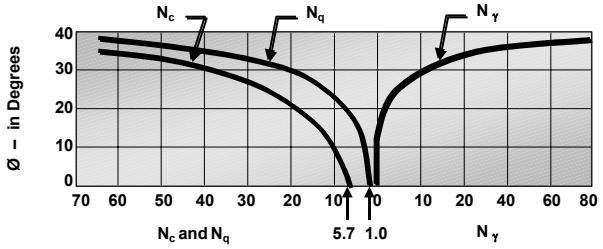
Bearing Capacity

Terzaghi Bearing Capacity Equation

$$q_u = cN_c + p_0N_q + \tfrac{1}{2}\gamma' BN_\gamma$$



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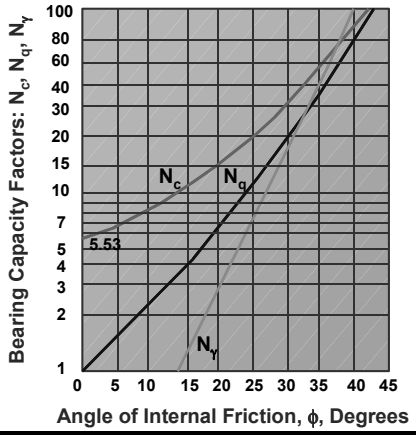
Bearing Capacity Equations

- ***Terzaghi:***
  - $q_{ult} = cN_c + P_oN_q + 1/2\gamma BN_\gamma$
- ***Brinch Hanson***
  - $q_{ult} = cN_c\, s_cd_ci_c + P_o\, N_qs_qd_qi_q + 1/2\gamma BN_\gamma s_\gamma d_\gamma i_\gamma$

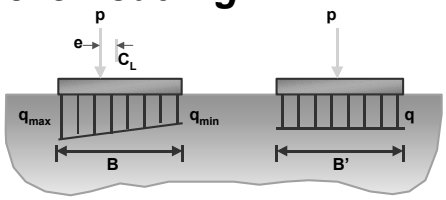
Slide 7-1-10

Bearing Capacity Factors

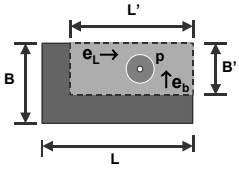


Slide 7-1-11

Eccentric Loading



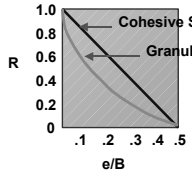
$B' = B - 2e$



$B' = B - 2e_b$

$L' = L - 2e_L$

Use B' and L' in place of B and L in Bearing Capacity Eq.

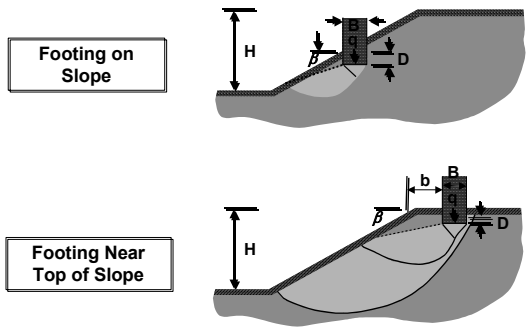


$q'_{ult} = Q_{ult}(R)$

Where R is a reduction factor for eccentric loading

Slide 7-1-12

Bearing Capacity – Slope Effects



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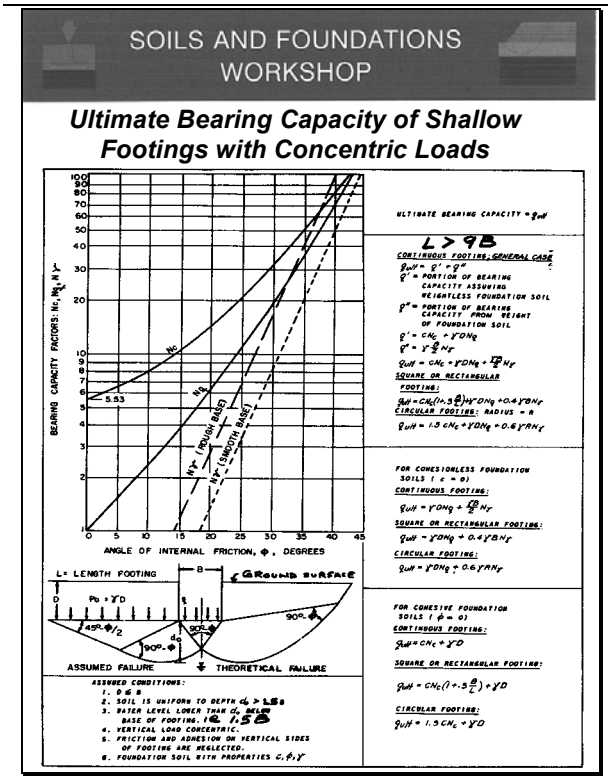
Slide 7-1-14

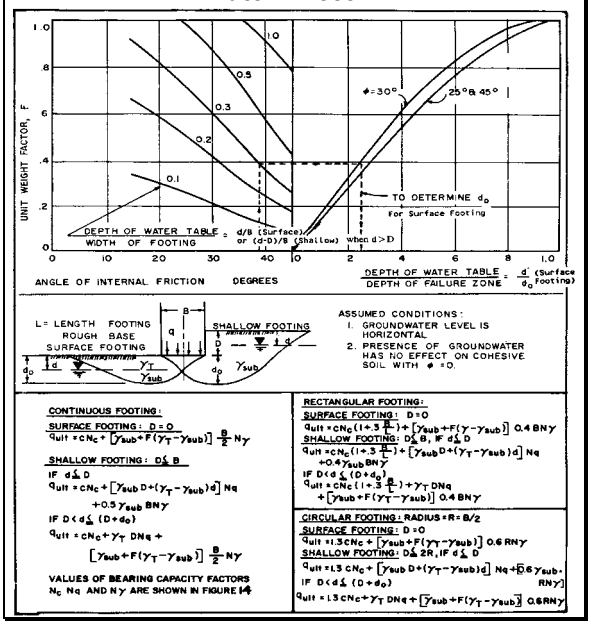
Slide 7-1-15



Slide 7-1-16

SOILS AND FOUNDATIONS WORKSHOP

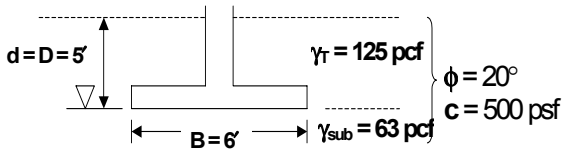
Ultimate Bearing Capacity with Ground Water Effect



Slide 7-1-17

SOILS AND FOUNDATIONS WORKSHOP

Example: Determine the Allowable Bearing Capacity for A Rough Base Square Footing Using A Safety Factor Of 3.



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SOILS AND FOUNDATIONS WORKSHOP

Solution: Assuming A General Shear Condition, Enter the Bearing Capacity Chart for $\phi = 20^\circ$ and Read $N_c = 14$, $N_q = 6$, $N_\gamma = 3$. Also note that formula for bearing capacity must account for the square footing and the water table within the failure zone.

$$q_{ult} = (1 + 0.3\frac{B}{L})CN_c + [\gamma'_{sub}D + (\gamma_T - \gamma_{sub})d]N_q + 0.4\gamma'_{sub}BN\gamma$$

$$= (1.3)(500)14 + [63(5) + (125 - 63)5]6 + 0.4(63)(6)(3)$$

$$= 9100 + 3750 + 450$$

$$q_{ult} = 13{,}300\text{psf}$$

$$q_{all} = \frac{q_{ult}}{3} = \frac{13{,}300}{3} \cong 4{,}430\text{psf}$$

Slide 7-1-19

SOILS AND FOUNDATIONS WORKSHOP

What is the Effect on Bearing Capacity of Excavation of Soil Cover Over a Spread Footing?

Slide 7-1-20

SOILS AND FOUNDATIONS WORKSHOP

Student Mini-Exercise on Bearing Capacity

$$q_{ult} = cN_c + P_oNq + 1/2\gamma BN_\gamma$$

Properties and Dimensions (Assume Continuous Rough Footing)	*Cohesive Soil*	*Cohesionless Soil*
γ = Unit Weight D = Footing Embedment B = Footing Width	$\phi = 0°$ c = 1000psf	$\phi = 30°$ c = 0
	q_{ult} (psf)	q_{ult} (psf)
A. Initial Situation γ_T = 120 pcf, D = 0, B = 5', deep water table	5530	5400
B. Effect of embedment D = 5', γ_T = 120 pcf, B = 5', deep water table		
C. Effect of width, B = 10', γ_T = 120 pcf, D = 0', deep water table		
D. Effect of water table at surface, γ_{sub} = 57.6 pcf, D = 0', B = 5'		

Slide 7-1-21

SOILS AND FOUNDATIONS WORKSHOP

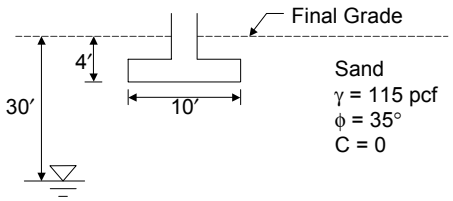
STUDENT EXERCISE NO.5

Footing Bearing Capacity

Objective:

Find the Allowable Bearing Capacity Using a Safety Factor = 3, for the Condition Shown Below.

Rough Base Footing 10′ × 50′



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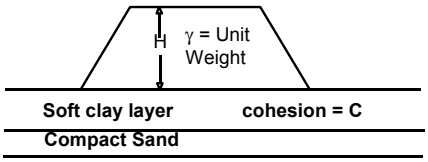
SOILS AND FOUNDATIONS WORKSHOP

How is bearing capacity theory related to the "rule of thumb" equation for stability;

$$\textit{SAFETY FACTOR} = \frac{6C}{\gamma H}$$



Slide 7-1-23

SOILS AND FOUNDATIONS WORKSHOP

Spread Footing Design Bearing Capacity

- ***Explain how footing embedment, width, and water table affect footing bearing capacity***

Activities: Bearing capacity analysis

Slide 7-1-24

SOILS AND FOUNDATIONS WORKSHOP

Student Mini-Exercise on Bearing Capacity

$$q_{ult} = cN_c + P_oNq + 1/2\gamma BN_\gamma$$

Properties and Dimensions ***(Assume Continuous Rough Footing)***	***Cohesive Soil***	***Cohesionless Soil***
γ = Unit Weight **D = Footing Embedment** **B = Footing Width**	**ϕ = 0°** **c = 1000psf**	**ϕ = 30°** **c = 0**
	q_{ult} (psf)	**q_{ult} (psf)**
A. Initial Situation γ_T = 120 pcf, D = 0, B = 5', deep water table	**5530**	**5400**
B. Effect of embedment D = 5', γ_T = 120 pcf, B = 5', deep water table		
C. Effect of width, B = 10', γ_T = 120 pcf, D = 0', deep water table		
D. Effect of water table at surface, γ_{sub} = 57.6 pcf, D = 0', B = 5'		

SOILS AND FOUNDATIONS WORKSHOP

Student Mini-Exercise on Bearing Capacity

$$q_{ult} = cN_c + P_oN_q + 1/2\,\gamma BN_\gamma$$

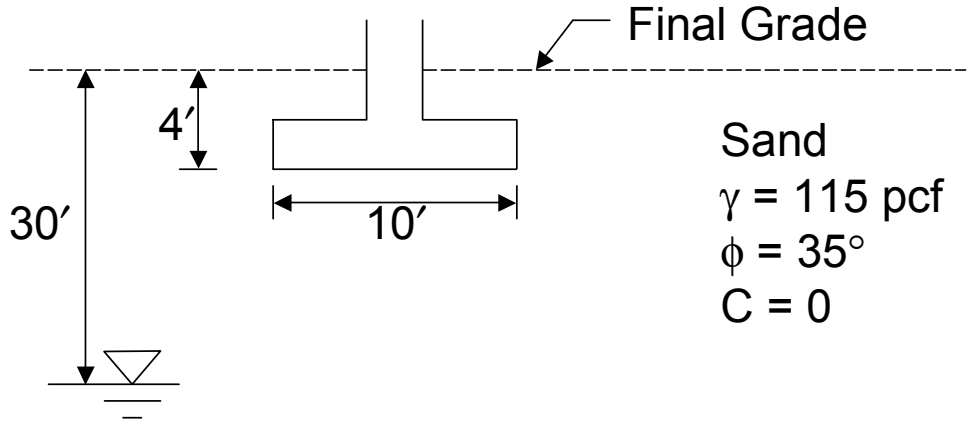
Properties and Dimensions ***(Assume Continuous Rough Footing)***	***Cohesive Soil***	***Cohesionless Soil***
γ = Unit Weight **D = Footing Embedment** **B = Footing Width**	**ϕ = 0°** **c = 1000psf**	**ϕ = 30°** **c = 0**
	q_{ult} (psf)	**q_{ult} (psf)**
A. Initial Situation γ_T = 120 pcf, D = 0, B = 5', deep water table	**5530**	**5400**
B. Effect of embedment D = 5', γ_T = 120 pcf, B = 5', deep water table	**6130**	**17400**
C. Effect of width, B = 10', γ_T = 120 pcf, D = 0', deep water table	**5530**	**10800**
D. Effect of water table at surface, γ_{sub} = 57.6 pcf, D = 0', B = 5'	**5530**	**2592**

SOILS AND FOUNDATIONS WORKSHOP

STUDENT EXERCISE NO.5

Footing Bearing Capacity

Objective:

Find the Allowable Bearing Capacity Using a Safety Factor = 3, for the Condition Shown Below.

Rough Base Footing 10′ × 50′