Bearing Capacity of Shallow Foundations – Pre-Simulation Activity

Instructions: This activity will help reveal what you already know about soil bearing capacity. Answer the following questions on your own:

1. What is bearing capacity?

2. Explain why understanding the bearing capacity of soil is important in the design of shallow foundations.

3. Regarding the factors that affect the bearing capacity of shallow foundations, select the CORRECT alternative:

a) Only the soil's strength properties (cohesion and friction angle) influence it; the dimensions and shape of the foundation do not affect it.
b) The water table level influences bearing capacity because it changes the effective stresses, while the embedment depth is irrelevant since failure always occurs near the surface.
c) Bearing capacity depends simultaneously on soil parameters (cohesion, friction angle, unit weight), geometric characteristics of the foundation (width, shape, and depth), and loading conditions (inclination and eccentricity).
d) Normal ambient temperature variations (10–30°C) significantly change bearing capacity since they affect the viscosity of water in soil pores.

4. When designing a foundation for a structure, it is important to consider the factor of safety. Which option correctly defines the factor of safety in relation to bearing capacity?

a) The ratio between the applied stress and the ultimate bearing capacity.
b) The ratio between the applied stress and the settlement.
c) The ratio between the applied stress and shear strength.
d) The ratio between the applied stress and the tangent of the friction angle.

5. True or False: Increasing the embedment depth of a shallow foundation always guarantees an increase in its allowable bearing capacity, regardless of soil type or drainage conditions.

After answering, share your ideas with your group.

Bearing Capacity of Shallow Foundations – Simulation Activity

Learning Objectives:

1. Understand the factors that influence the bearing capacity of shallow foundations.
2. Apply critical thinking and problem-solving skills in foundation design.
3. Develop practical engineering skills for real-world applications.

Key Questions:

1. How do variations in factors such as foundation shape, soil type, and water table level impact the bearing capacity of shallow foundations? How can this knowledge be applied to optimize design?
2. What critical geotechnical parameters should be considered when designing shallow foundations, and how can students use practical experimentation to gain insights into foundation performance and stability?

Materials:

- Electronic device: computer, smartphone, or tablet.
- Shallow Foundation Simulation: https://scratch.mit.edu/projects/894072681/

Open Exploration:

1. Explore the simulation for 5 minutes to understand what it is about and describe your observations.

Data Collection and Analysis:

Continue exploring the simulation and answer the following questions:

2. What soil properties are available when the selected soil deposit is Clay? Why does this happen?

3. What soil properties are available when the selected soil deposit is Sand? Why does this happen?

4. How would you analyse the simulation results to determine whether a foundation design is safe? Describe the method or criteria you would use to evaluate whether the foundation can safely support the applied load.

5. Compare square and circular footings with identical dimensions. What is the effect of their shape on the soil bearing capacity? Describe the analysis you performed to reach your conclusion.

6. If you have two footings: one square and one circular, both with the same dimensions (i.e., width and diameter, respectively), which one would be more suitable for supporting the applied load? Describe the analysis you performed to reach your conclusion.

7. Do the dimensions of a foundation have the same effects on soil bearing capacity in both clay and sand? Describe the analysis you performed to reach your conclusion.

8. What is the influence of foundation depth on bearing capacity? Describe the analysis you performed to reach your conclusion.

9. Considering Terzaghi's classic bearing capacity equation for shallow foundations, which of the following parameters does NOT explicitly appear nor is embedded in the bearing capacity factors Nc, Nq, and $N\gamma$?
a) Unit weight of the soil
b) Foundation embedment depth
c) Soil deformability modulus
d) Soil cohesion

10. An engineer aims to increase the ultimate bearing capacity of a square footing under centred vertical loading, resting on a homogeneous deposit of saturated loose sand. Only one of the following adjustments can be made; all other parameters remain unchanged. According to Terzaghi's classical theory (drained conditions, $\phi > 0$), which alternative tends to produce the smallest gain in bearing capacity?
a) Compact the soil, increasing the internal friction angle φ from 28° to 35°.
b) Permanently lower the water table to 1.5 m below the foundation base.
c) Increase the embedment depth of the foundation from 1 m to 2 m.
d) Replace the square footing with a circular footing with a diameter equal to the side of the square footing.
e) Increase the footing width by 25% (keeping it square).