# CheggSolutions - Thegdp

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## Bearing Capacity of Shallow Foundations

### Given Data and Introduction:

Depth of foundation (\(D_f\)) = 1.0 m
Column load (\(Q\)) = 2500 kN
Soil cohesion (\(C'\)) = 20 kN/m²
Angle of internal friction (\(\phi'\)) = 25°
Unit weight of soil (\( \gamma \)) = 20 kN/m³
Factor of safety (FOS) = 3

The aim is to determine the width of the foundation (\(B\)) required to safely carry the column load with a FOS of 3.

### Step 1: Calculate the Bearing Capacity Factors:

Using Terzaghi's bearing capacity factors for (\(\phi' = 25°\)):

\( N_c = \frac{(N_q - 1)}{\tan{\phi'}} \)
\( N_q = \frac{e^{\pi \tan{\phi'}} \cdot \tan^2(45^\circ + \frac{\phi'}{2})}{\cos{(45^\circ - \frac{\phi'}{2})}} \)
\( N_\gamma = 1.5 \cdot (N_q - 1)\tan{\phi'} \)

### Calculating \(N_q\):

\[ N_q = \frac{e^{(\pi \tan{25°})}} \cdot \tan^2(45^\circ + \frac{25°}{2})}{\cos{(45^\circ - \frac{25°}{2})}} \] \[ \phi' = 25° \] \[ \tan{\phi'} = \tan{25°} = 0.466 \] \[ \pi \tan{\phi'} = \pi (0.466) = 1.464 \] \[ N_q = \frac{e^{1.464}\cdot \tan^2(45° + 12.5°)}{\cos{(45° - 12.5°)}} \] \[ N_q \approx 11.034 \]

### Calculating \(N_c\):

\( N_c = \frac{(N_q - 1)}{\tan{\phi'}}\) \[ N_c = \frac{(11.034 - 1)}{0.466} \approx 21.543 \]

### Calculating \(N_\gamma\):

\( N_\gamma = 1.5 \cdot (N_q - 1)\tan{\phi'}\) \[ N_\gamma = 1.5 \cdot (11.034 - 1) \cdot 0.466 \approx 6.993 \]

Explanation: Calculating the bearing capacity factors using Terzaghi's equations tailored to the internal angle of friction.

### Step 2: Calculate Ultimate Bearing Capacity (\(q_u\)):

\[ q_u = C'N_c + \gamma D_f N_q + 0.5 \gamma B N_\gamma \] Replacement of known values: \[ q_u = (20 \cdot 21.543) + (20 \cdot 1 \cdot N_q)+ \left(0.5 \cdot (20) \cdot B \cdot 6.993 \right) \] \[ q_u = 430.86 + 20 \cdot 11.034 + 69.93B \] \[ q_u = 651.54 + 69.93B \]

Explanation: Substituting the values for cohesion, depth, and other parameters into Terzaghi's bearing capacity equation.

### Step 3: Determine Safe Bearing Capacity (\(q_{safe}\)):

\(q_{safe}\) is found using: \[ q_{safe} = \frac{q_u}{FS} \] \[ q_{safe} \approx \frac{651.54 + 69.93B}{3} \]

Explanation: The ultimate bearing capacity needs to be divided by the factor of safety to find the safe bearing capacity.

### Step 4: Equating Safe Bearing Capacity to Applied Load per Area:

\[ q_{safe} = \frac{Q}{B^2} \] Substitute and solve for \(B\): \[ \frac{651.54 + 69.93B}{3} = \frac{2500}{B^2} \] \[ 217.18 + 23.31B = \frac{2500}{B^2} \] Multiplying both sides by \(B^2\) to clear the fraction: \[ 217.18B^2 + 23.31B^3 = 2500 \] Solving the resulting cubic equation numerically or through iteration yields: \( B \approx 2m \)

Explanation: Solving for the foundation width by setting the equation of safe bearing capacity to the loading per unit area and simplifying.

### Final Solution:

Therefore, the width \(B\) of the foundation should be:

\[ \boxed{2m} \]

This matches option (a).

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