/Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH. (STRUCTURAL ENGINEERING)

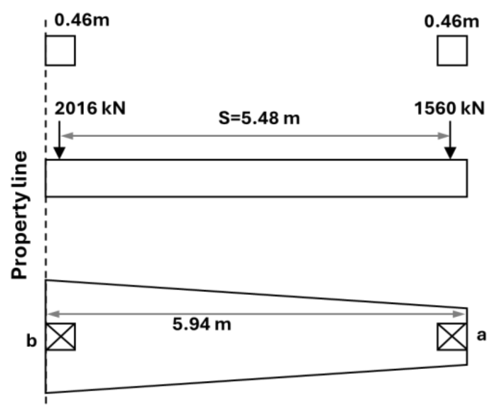
END SEMESTER EXAMINATIONS, APRIL/MAY 2024-25

SUBJECT: ADVANCED FOUNDATION ENGINEERING **[CIE – 5419]**

(/ 05 /2024)

Time: 3 Hours MAX. MARKS: 50

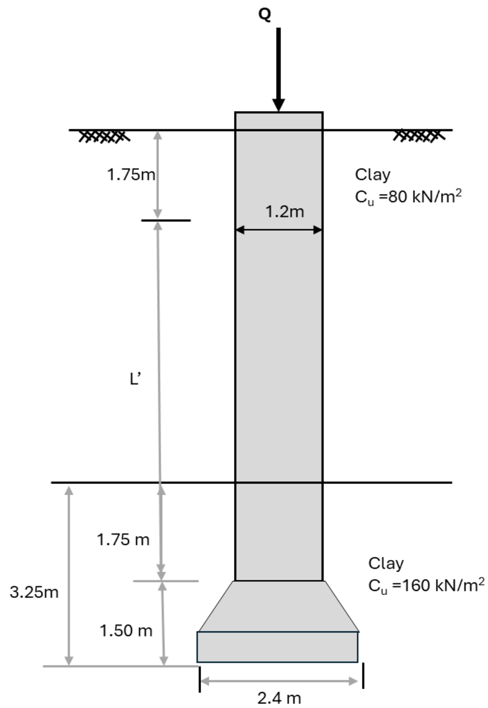
Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data, if any, may be suitably assumed.

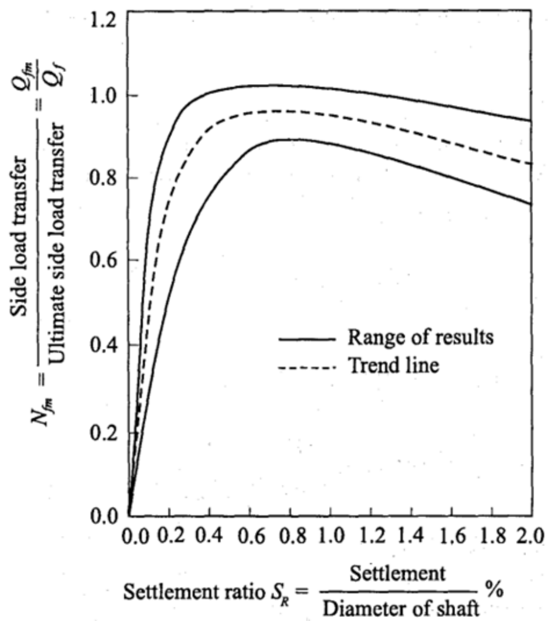
<table>
<tr><th>Q No</th><th></th><th>Marks</th><th>CO</th><th>BT</th></tr>
<tr><td>1A</td><td>Estimate the dimensions of the trapezoidal footing based on the given loading conditions using the conventional method. Allowable bearing capacity is 190 kPa. Ultimate load is 1.4DL+1.7LL.
<table>
<tr><th>DL (kN)</th><th>LL (kN)</th></tr>
<tr><td>1200</td><td>816</td></tr>
<tr><td>900</td><td>660</td></tr>
</table>


</td><td>03</td><td>CO1</td><td>5</td></tr>
<tr><td>1B</td><td>A square footing carrying a load of 600 kN is to be built on sand and is embedded 1m below the ground surface. To ensure a limit state is not reached, the settlement is limited to 25 mm. An SPT was conducted with a safety hammer with the following results: (assume B = 2m)
<table>
<tr><th>Depth (m)</th><th>N_{60}</th></tr>
<tr><td>1</td><td>14</td></tr>
<tr><td>2</td><td>18</td></tr>
<tr><td>3</td><td>17</td></tr>
<tr><td>4</td><td>19</td></tr>
<tr><td>5</td><td>22</td></tr>
<tr><td>6</td><td>24</td></tr>
<tr><td>7</td><td>26</td></tr>
</table>
</td><td>02</td><td>CO1</td><td>5</td></tr>
</table>

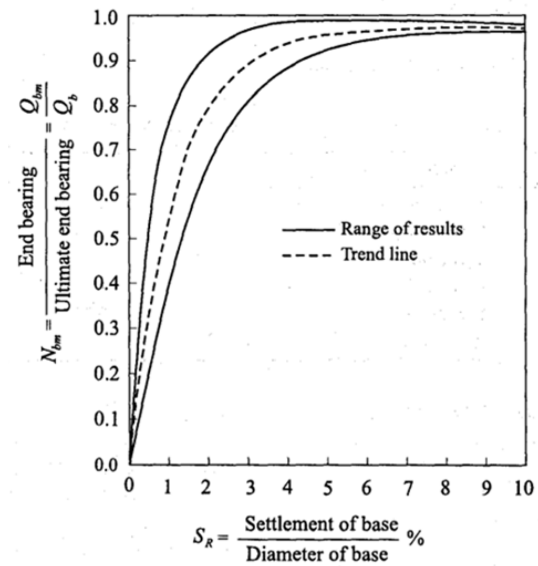
P.T.O.

1C	A concrete pile of 50 cm diameter was driven into a loose to medium dense sand for a depth of 18m. The following properties are known: the average unit weight of soil along the length of the pile is 18 kN/m^3, the average friction angle is 30°, and k =1. Estimate the ultimate bearing capacity of the pile and the allowable load with a factor of safety 2.5, assuming water table is at a greater depth is using the Berezantsev method. Additionally, calculate the ultimate load and allowable load if the water table is at the ground surface and the saturated unit weight is 19.5 kN/m^3.	**05**	**CO2**	**5**
2A	Illustrate the equation for the allowable horizontal force for well foundation using Terzaghi's analysis and provide a clear diagram to illustrate the derivation.	**03**	**CO3**	**4**
2B	Illustrate a brief note discussing any two types of machine foundations categorized by the type of loading they are designed to withstand.	**02**	**CO3**	**4**
2C	Illustrate the equation for the natural frequency and maximum amplitude of vertical vibration for a block foundation, accompanied by a clear sketch.	**05**	**CO4**	**4**
3A	A block vibration vertical test was conducted on a concrete block measuring 1.5m x 0.75m x 0.70m (height) to estimate the dynamic elastic constants (C_u, C_τ, and C_ϕ) for designing a machine foundation with base area $10m^2$. The test was performed at a depth of 7 m below the ground surface in clay soil with low to intermediate compressibility. The weight of the oscillator motor used in the test was 3.1 kN. Evaluate the damping factor given that the weight of the block and oscillator assembly is 24 kN, and the maximum dynamic force of the oscillator at 50 Hz is 8 kN. Note that the amplitude of vibration of the block is 0.18mm at a natural frequency of 44 cps.	**05**	**CO4**	**5**
3B	A straight shaft drilled pier is built in homogenous loose to medium dense sand. The pile and soil characteristics is as follow: pile length-24m, diameter-1.45m, friction angle - 35°, N_q is 30, and soil unit weight-18.5 kN/m^3. Evaluate using Vesic's equation. (a) The ultimate load capacity. (b) The allowable load with a factor of safety of 2.5.	**05**	**CO5**	**5**
4A	The details of a drilled pier with belled bottom foundation and soil properties are shown in the below figure. Evaluate the ultimate load and allowable load with a factor of safety of 2.5. Also, estimate the allowable load for a settlement of 8mm.	**05**	**CO5**	**5**

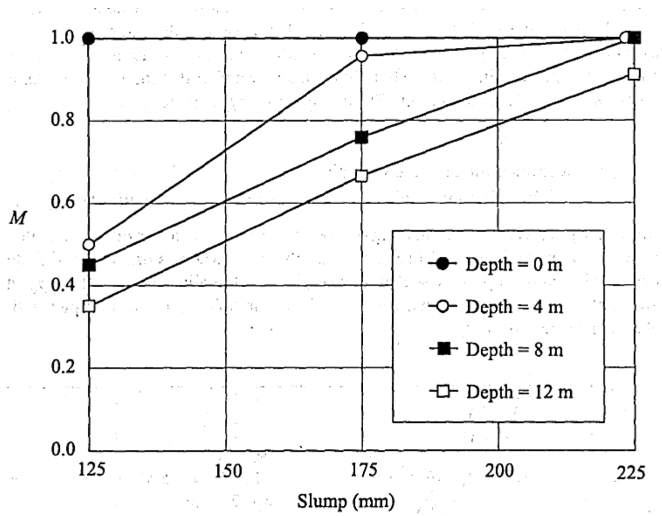
				
4B	Evaluate the uplift capacity of the drilled pier with a diameter of 1.25 m, length 20 m with an undrained shear strength of the soil 130 kN/m^2. Neglect the weight of the pier.	**03**	**CO5**	**5**
4C	Illustrate the load transfer mechanism of drilled pier foundations, including relevant equations and graphical representations.	**02**	**CO5**	**4**
5A	It is proposed to build a 40-story building with a footprint of 1350 m^2 on a piled raft foundation, with 1.0 m diameter bored piles placed at 3.0 m center to center. The average loading per floor is about 12 kN/m^2. For the preliminary design, it can be assumed that the bored piles are distributed evenly. (a) Estimate how many bored piles will be required? What is the load per bored pile? (b) Assuming uniform ground conditions, with a constant Young's modulus and Poisson's ratio of 0.25, estimate the pile-raft interaction factor $\boldsymbol{\alpha_{rp}}$, assuming the bored piles are 25 m long	**03**	**CO5**	**5**
5B	Illustrate the load-settlement plots for unpiled and piled rafts under various design conditions, accompanied by graphical illustrations.	**02**	**CO5**	**4**
5C	A drilled pier penetrates through sedimentary rock (Clay shale) to a depth of 10m, encountering joints within the rock layer. The pertinent data includes: a 10m length of pile within the rock, and a 20m length within soft clay, with a diameter of 1.8 m. The ultimate bearing capacity of the rock is $3X10^3$ kN/m^2, with E_{rock} = $600X10^3$ kN/m^2. Additional factors include a concrete slump of 175mm, unit weight of concrete as 24 kN/m^3, and $E_{concrete}$ = $435x10^6$ kN/m^2. Using RQD as 70%, and the ultimate bearing capacity of concrete as 40 MPa, Evaluate the ultimate frictional load Q_f.	**05**	**CO5**	**5**



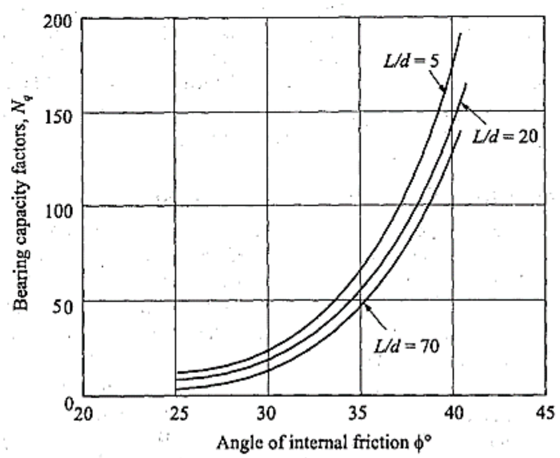
Normalized side load transfer for drilled shaft in cohesive soil (O'Neill and Reese, 1999)



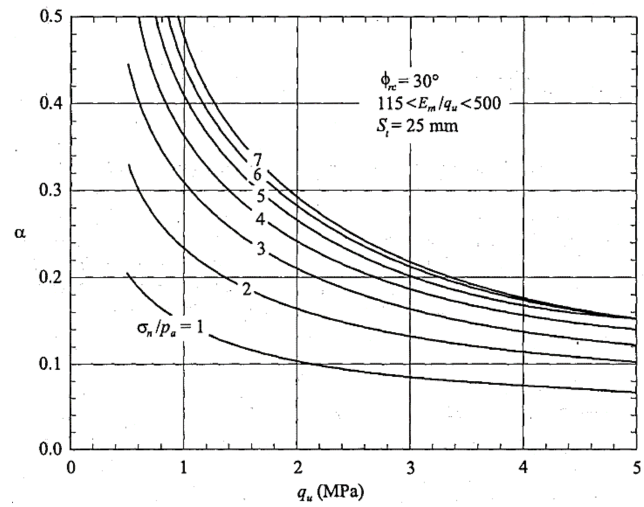
Normalized side load transfer for drilled shaft in cohesive soil (O'Neill and Reese, 1999)



Factor M vs. Concrete slump (O'Neill et. al , 1996)



Berezantsev's bearing capacity factor, N_q (after Tomlinson, 1986)


$\phi_{rc} = 30°$
$115 < E_m/q_u < 500$
$S_t = 25$ mm
7
6
5
4
3
2
$\sigma_n/p_a = 1$
α
q_u (MPa)
0.0
0.1
0.2
0.3
0.4
0.5
0
1
2
3
4
5