National Exams December 2016

04-Env-A3, Geotechnical and Hydrogeological Engineering

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value. Marking scheme on page 8.

5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Question 1 (20 marks):

A sample of soil weighing 30.6 kg had a volume of 0.0183 m^3. When dried out in an oven its weight was reduced to 27.2 kg. The specific gravity of the solids was found to be 2.65. Determine the following:

a) Bulk Density
b) Dry density
c) Moisture content
d) Saturated Density
e) Void Ratio

Question 2 (20 marks):

A tunnel runs inside an embankment that supports a highway, as shown in Figure 1. The equivalent hydraulic conductivity of the embankement soil is $k = 8 \times 10^{-5}$ cm/s.

a) Draw the flownet within the embankment soil for the worst-case scenario.

b) Determine the uplift force per unit length at the base of the tunnel.

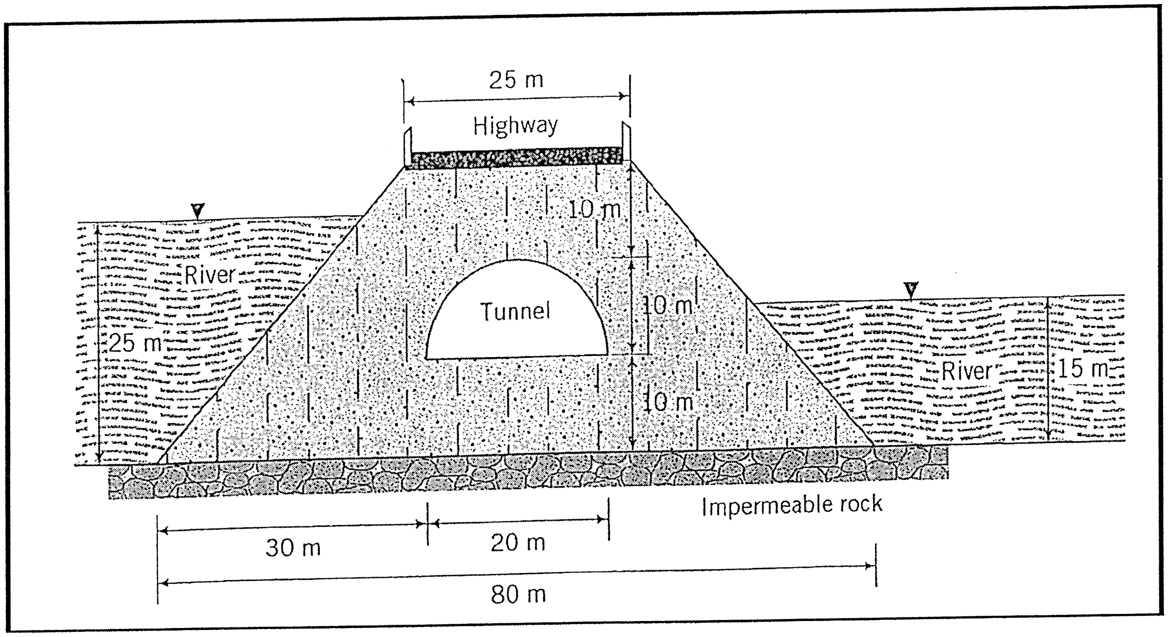

Figure 1: Cross-section of the highway embankment

Question 3 (20 marks):

The two foundations support the columns of a building as shown in Figure 2. An extensive soil investigation was not carried out, and it was assumed in the design of the foundations that the clay layer had a uniform thickness of 1.2 m. Two year after construction the building settled, with a differential settlement of 10 mm. Walls of the building began to crack. The doors have not jammed, but by measuring the out-of-vertical distance of the doors it is estimated that they would become jammed if the differential settlement exceeded 24 mm. A subsequent soil investigation showed that the clay layer was not uniform but varies, as shown in Figure 2.

a) Calculate the expected total differential settlement; and
b) How long it will take before the doors become jammed?

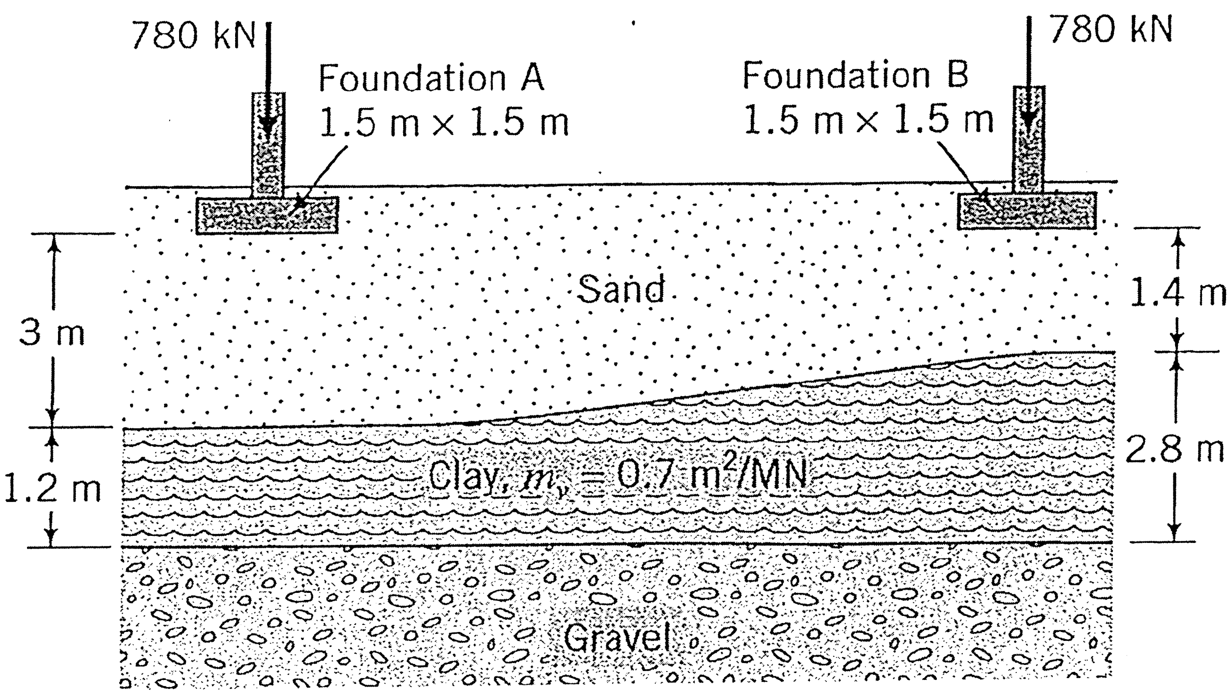

Figure 2: The two foundations that support the columns of a building.

Question 4 (20 marks):

In a falling head permeameter test on a silty clay sample, the following results were obtained: sample length 120 mm; sample diameter 80 mm; initial head 1100 mm; final head 420 mm; standpipe diameter 4 mm. Assume the soil sample to be in three layers 20 mm, 60 mm and 40 mm thick, with permeabilities 3 x 10^{-3} mm/s, 5 x 10^{-4} mm/s, and 17 x 10^{-4} mm/s, respectively.

a) Calculate time for fall in head from initial head of 1100 mm to final head of 420 mm.
b) Calculate average permeability through this three-layer soil sample.

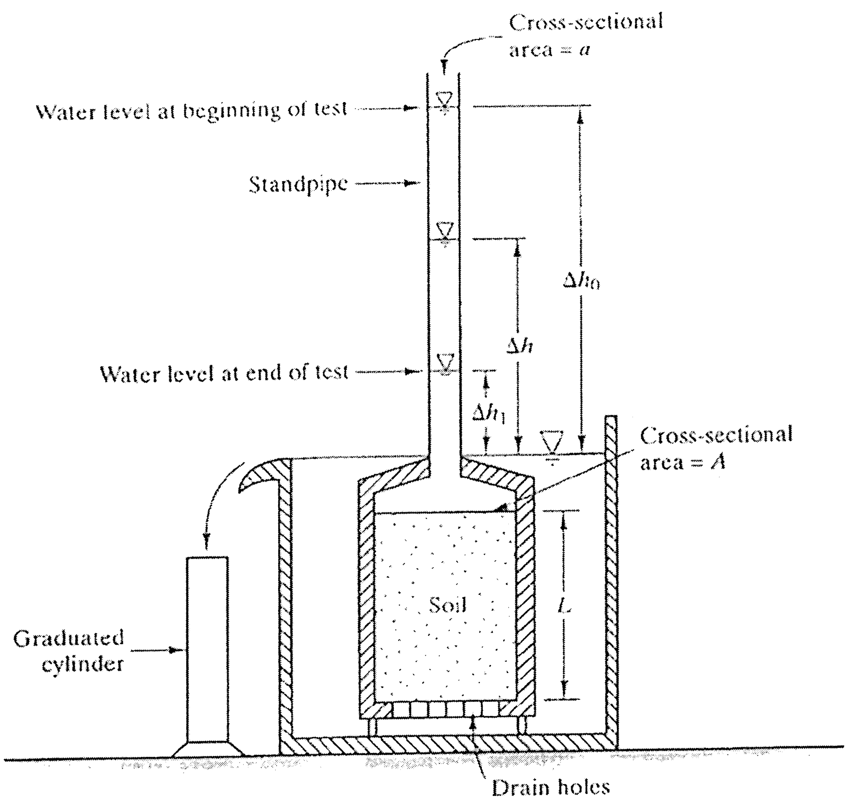

Figure 3: The falling head permeameter test apparatus.

Question 5 (20 marks):

An anchored sheet-pile wall, shown in Figure 4, retains soil of height 6 m, the piles having a total length of 9.75 m. The soil has a bulk density of 1900 kg/m^3, a negligible cohesion and an angle of shearing resistance of 30°. The anchor tie rods are at 1.25 m below the surface of the soil.

a) Find the active thrust on the piling in kN per horizontal meter.
b) Find the tension in the tie rods if they are spaced at 5 m centers.

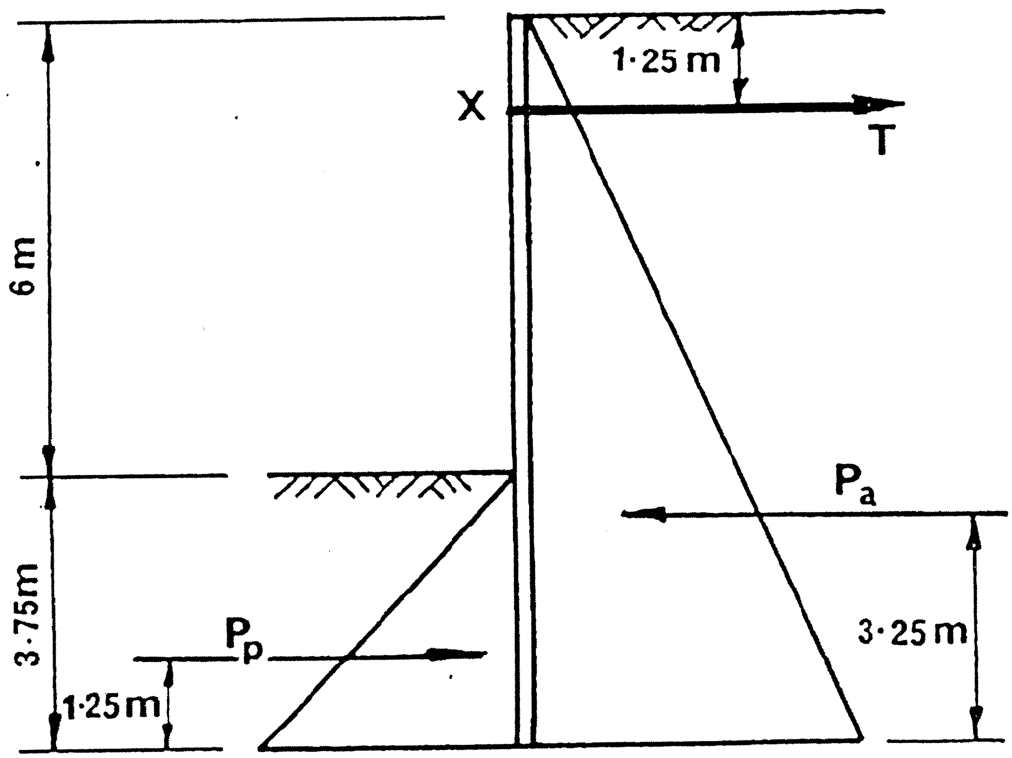

Figure 4: The anchored sheet-pile wall.

Question 6 (20 marks):

A vertical section through a building foundation at a site is shown in Figure 5. The average modulus of volume compressibility of the clay is $m_v = 5 \times 10^{-5}$ m^2/kN.

a) Calculate the effective initial vertical stresses within the clay layer at depths 2, 4, 6, 8, and 10 m below ground surface, immediately after the 200 kPa load is applied; and
b) Determine the primary consolidation settlement of the building foundation.

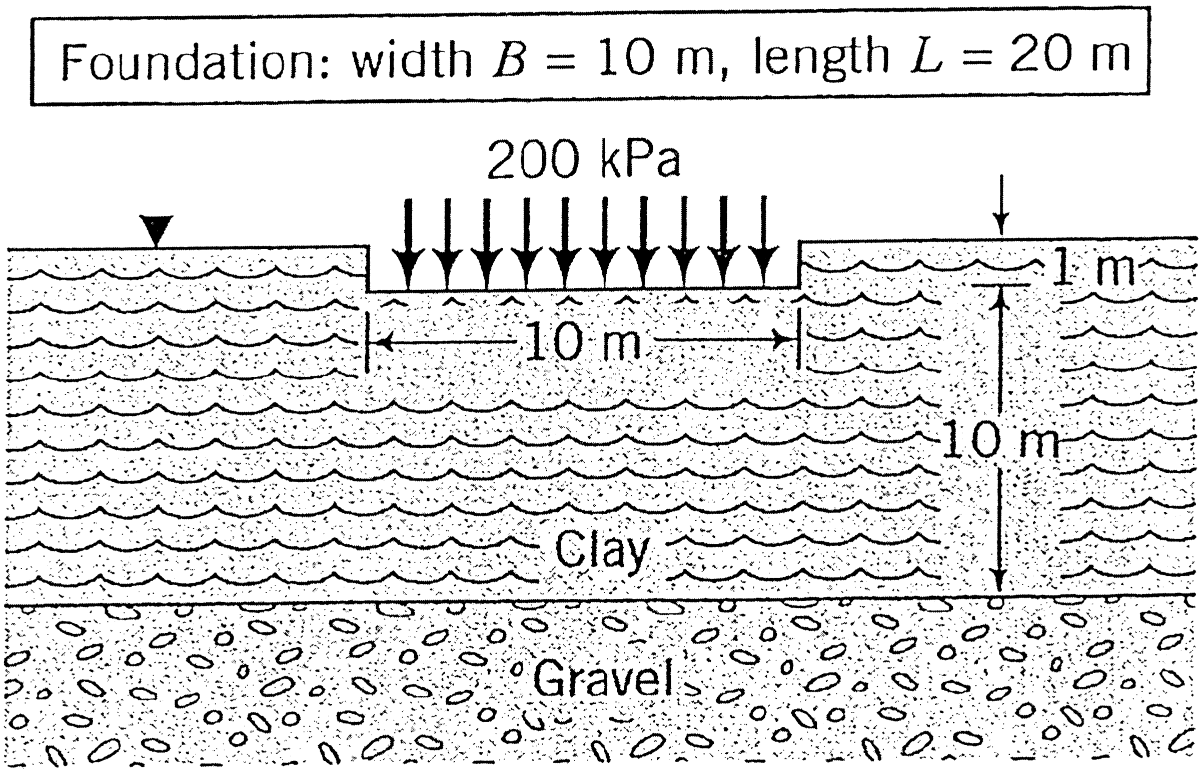

Figure 5: The vertical section through a building foundation.

Marking Scheme

1.	20 marks total	(5 items times 4 marks each)
2.	20 marks total	part (a) 10 marks and part (b) 10 marks
3.	20 marks total	part (a) 10 marks and part (b) 10 marks
4.	20 marks total	part (a) 10 marks and part (b) 10 marks
5.	20 marks total	part (a) 10 marks and part (b) 10 marks
6.	20 marks total	part (a) 10 marks and part (b) 10 marks