BLOCK I STRENGTH OF MATERIALS (30 PTS)

Question I.1 **(12 points)**

The observations represented in Table I.1 and Figure I.1 are made when a 100 mm length of 10 mm development steel bar is loaded in tension.

Calculate the following:
a. the Young's modulus
b. the 0.2% proof stress
c. the yield stress
d. the ultimate stress

Table I.1 – Data for the test

Load kN	Extension mm
0	0
1.57	0.01
4.71	0.03
7.85	0.05
9.42	0.06
15.7	0.1
18.84	0.12
21.98	0.14
23.55	0.15
24.5	0.2
25.5	0.3
25.9	0.365
26.5	0.5
28.5	1
31.5	1.9

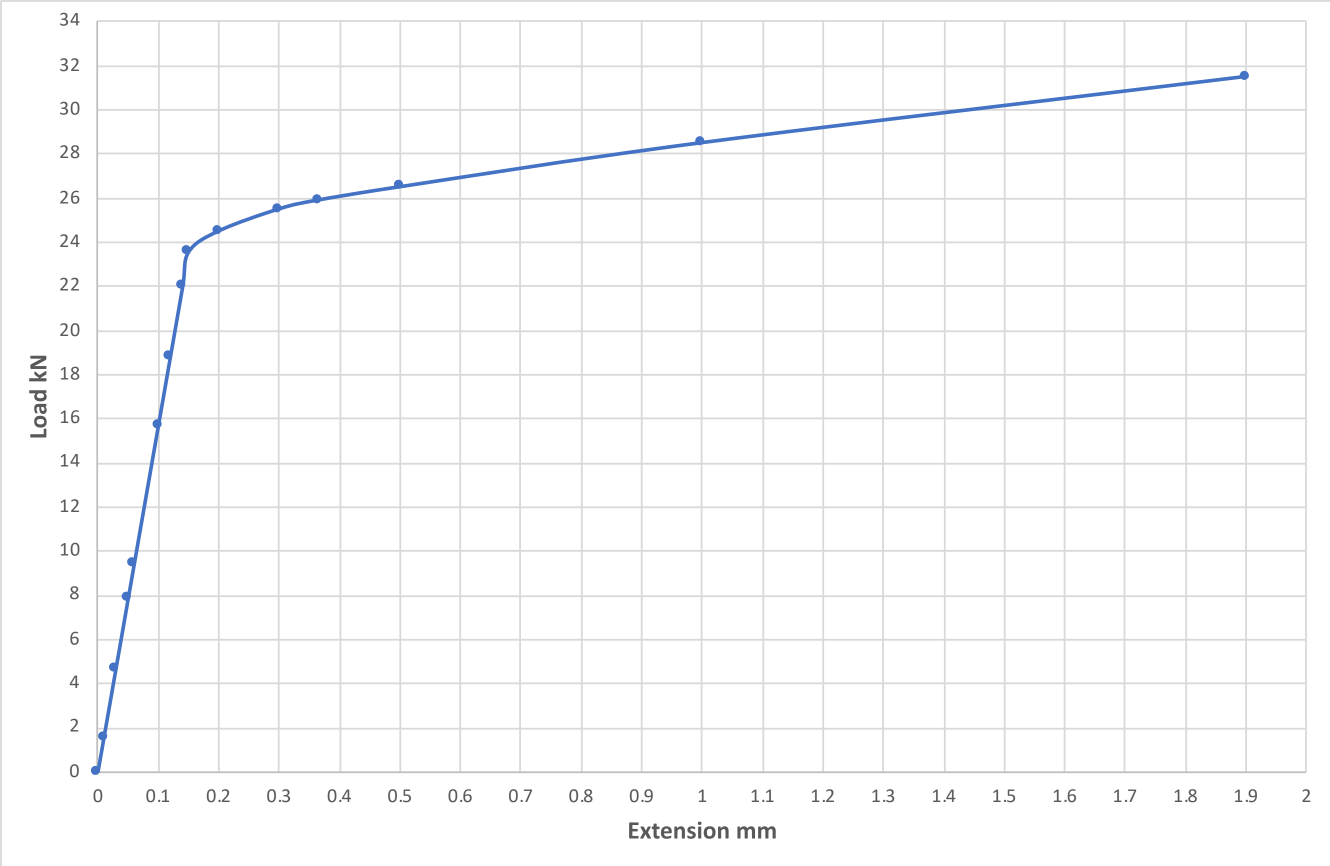

Figure I.1 – Graph for the test

Question I.2 **(9 points)**

a) A concrete cylinder has a length of 300 mm and a diameter of 100mm. If the length when supporting a load of 4700 Kg is 299.93 mm what is the Young's modulus?

b) If the diameter of the cylinder becomes 100.004 mm when the load is applied what is the Poisson's ratio?

c) If the characteristic strength of the cylinder is 35 MPa and a factor of safety of 1.4 is used what is the load, in tonnes, that the cylinder will support?

Question I.3 **(9 points)**

Consider a concrete cylinder that is being tested to compression until failure, retrieving the data plotted in the figure below. Explain the failure mechanism expected to observe in such a sample.

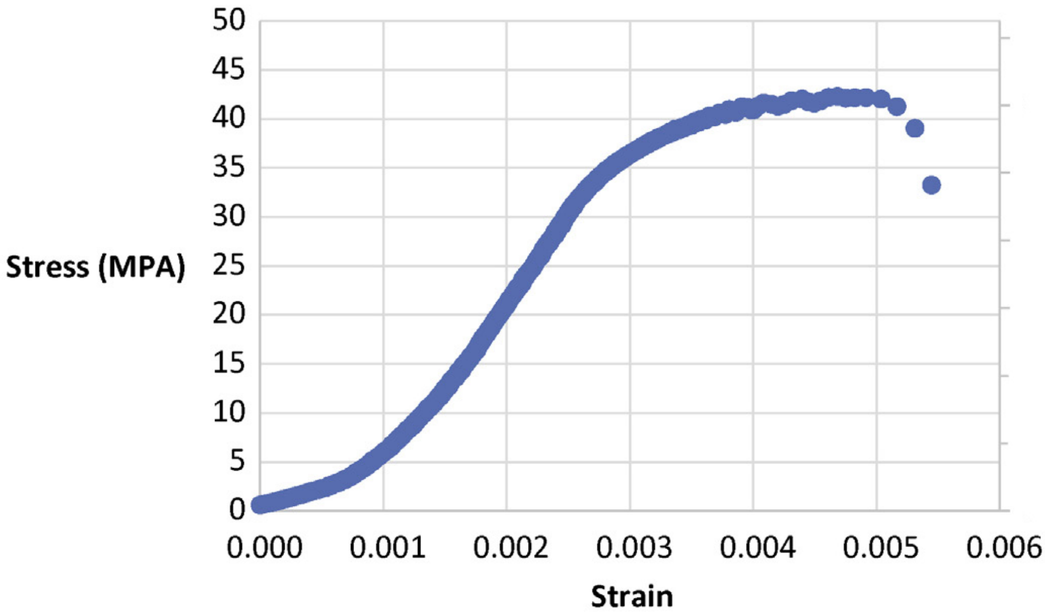

Figure I.3 – Graph for the compression test

BLOCK II CEMENT AND CONCRETE (15 PTS)

Question II.1 **(10 points)**

An office block is to be constructed for a commercial client, and the start of construction is to take place in six months' time. The client has been very impressed by a company advertising the use of High Alumina Cement with Blast Furnace Slag in the concrete for the frame.

a. Why would there be a commercial benefit from using this concrete mix?

b. Why should the client be concerned about the long-term performance of the concrete?

Question II.2 **(5 points)**

Three samples of aggregate are sieved to obtain the grading curves. A set of sieves of different sizes is stacked with the coarsest mesh at the top. The aggregate is then placed in the top sieve and the stack is placed in a sieve shaker. The amount remaining in each sieve after they have been shaken is shown in Table II.2 and Figure II.2 shows the grading curves for the compositions tested.

a. Identify which samples are (i) sand, (ii) gap-graded aggregate, and (iii) all in aggregate.

b. For the sand, calculate the percentage passing a 600 mm sieve.

Table II.2 – Mass retained in each sieve

	Mass retained in sieve (g)		
Sieve	**Sample A**	**Sample B**	**Sample C**
19 mm	0	0	0
9.5 mm	150	1200	0
4.75 mm	200	0	0
2.36 mm	170	0	100
1.18 mm	150	0	200
600 mm	250	150	200
300 mm	200	200	100
150 mm	50	100	100
Base	35	54	16

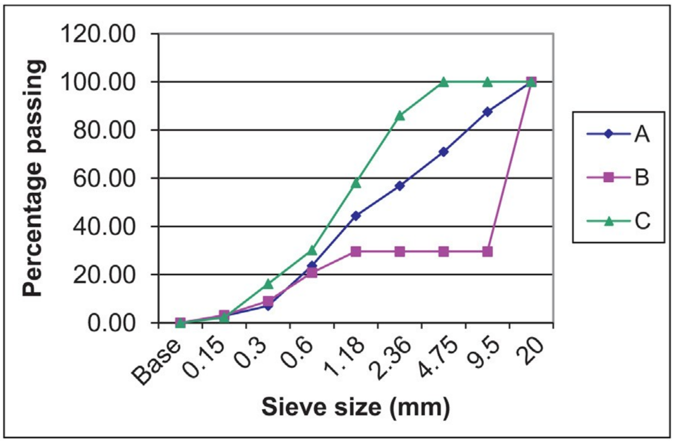

Figure II.2 – Grading curves for samples A, B and C

BLOCK III TESTING CONCRETE (25 POINTS)

Question III.1 **(6 points)**

a) Describe when can heat of hydration be useful for curing and pouring concrete.

b) Explain how can heat of hydration be measured?

Question III.2 **(9 points)**

a) Name the main advantages and disadvantages of using cubes and cylinders for testing concrete under compression.

b) Define the different types of creep and what type can be obtained from the experimental data.

c) What are the main effects of creep in construction?

Question III.3 **(10 points)**

A concrete structure has been built, and a few months after the concrete has been cast, 10 cores are taken from it. The cores are tested in compression, and they show four results below the characteristic strength for the concrete. Describe how a decision should be made about the benefit of further testing.

BLOCK IV METALS AND TIMBER (30 PTS)

Question IV.1 **(10 points)**

From the tensile stress-strain behaviour for the brass specimen shown in Figure IV.1, determine the following:

a) The modulus of elasticity
b) The yield strength at a strain offset of 0.002
c) The maximum load that can be sustained by a cylindrical specimen having an original diameter of 12.8 mm
d) The change in length of a specimen originally 250 mm long that is subjected to a tensile stress of 345 MPa

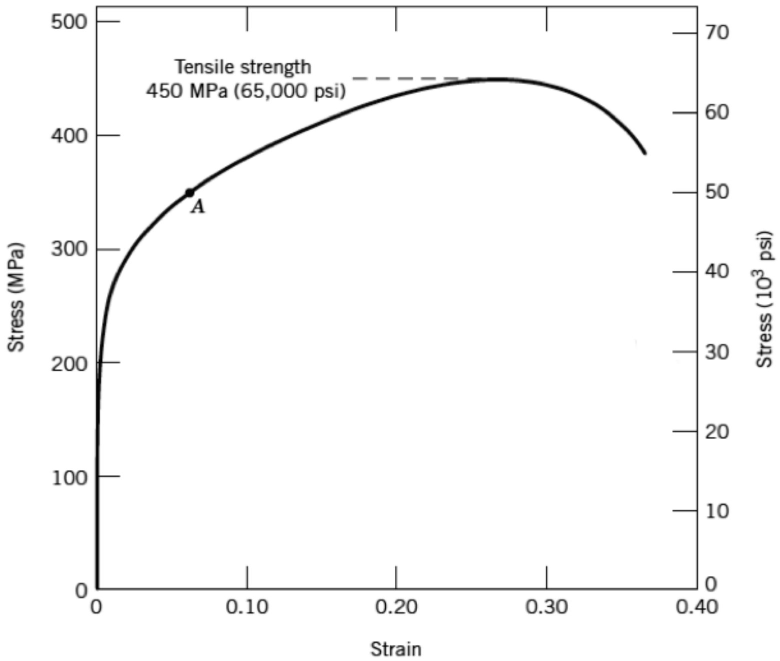

Figure IV.1 - The stress-strain behaviour for the brass specimen

Question IV.2 **(10 points)**

A cylindrical specimen of steel having an original diameter of 12.8 mm is tensile-tested to fracture and found to have an engineering fracture strength of 460 MPa. If its cross-sectional diameter at fracture is 10.7 mm, determine:

a) The ductility in terms of percentage of reduction in area
b) The true stress at fracture

Question IV.3 **(10 points)**

a) A simple lab test for specific gravity, G, on two samples of lumber indicates that sample A has G=0.4 and sample B has G=0.5. Based on this information alone, which wood sample would you choose as a structural member for your construction project? Briefly explain why.

b) Draw a graph to show the typical stress-strain curve for wood. On the graph, show the modulus of elasticity. State three different factors that affect this relationship.