Loughborough University

Structures and Materials
24CVA137

Semester 2 2025 In-Person Exam paper

This examination is to take place in-person at a central University venue under exam conditions. The standard length of time for this paper is **2 hours**.

You will not be able to leave the exam hall for the first 30 or final 15 minutes of your exam. Your invigilator will collect your exam paper when you have finished.

Help during the exam

Invigilators are not able to answer queries about the content of your exam paper. Instead, please make a note of your query in your answer script to be considered during the marking process.

If you feel unwell, please raise your hand so that an invigilator can assist you.

You may use a calculator for this exam. It must comply with the University's Calculator Policy for In-Person exams, in particular, that it must not be able to transmit or receive information (e.g. mobile devices and smart watches are **not** allowed).

Answer the **FOUR** questions.

All questions carry equal marks.

Continues/…

Q1. (a) Explain the concepts of stress and strain in materials and indicate how you calculate stress and strain in a deformable body.

[8 marks]

(b) A steel rod with an original length (L_0) of 500 mm is subjected to a tensile force, causing it to elongate by 2.5 mm (ΔL). Using these values, calculate the strain (ε) experienced by the rod.

[4 marks]

(c) Draw a typical stress-strain (σ-ε) curve for a medium-carbon structural steel and label the following key points in the sketch: the elastic region, the plastic region, the yield point, the ultimate strength, and the rupture strength. Explain what each of these key points represents.

[13 marks]

Q2. (a) Explain the importance of the water-to-cement (w/c) ratio in concrete. How does an increase in this ratio affect the strength and durability of hardened concrete?

[8 marks]

(b) A concrete mix has a cement content of 350 kg/m³ and a water content of 175 kg/m³:

i) Calculate the water-to-cement ratio (w/c) of this mix.

ii) Based on typical values, classify whether this ratio would lead to high-strength or low-strength concrete and justify your answer.

[7 marks]

(c) Upon the arrival of a concrete delivery truck on site, several tests must be performed to ensure the concrete complies with the (fresh) workability and (hardened) performance requirements.

i) Name the most common test for each of the two performance requirements performed on-site for quality control.

ii) Briefly explain the purpose of each of these two tests and how its results help ensure concrete quality.

iii) Describe the potential consequences of poor workability in fresh and hardened concrete.

[10 marks]

Continues/…

Q3. (a) CLT and SIPS are two examples of structural timber systems. State what CLT and SIPS stand for, and what the main differences between them are. According to these differences, which would be the most appropriate approach to build a new 3-storey hotel made from timber in Loughborough. Justify your answer.

[7 marks]

(b) Describe how is brickwork constructed and name and sketch three different brickwork bonding (laying) arrangements. As skilled human labour reduces, novel technologies such as bricklaying robots that automate the bricklaying process have emerged. What are the benefits and limitations of this approach compared with conventional manual bricklaying?

[10 marks]

(c) Sustainable development is increasingly important in construction. Describe, compare, and contrast the triple bottom line of sustainability with that of one planet living, using a diagram for each.

[8 marks]

Q4. A beam is a structural member subjected to bending, and it is probably the most common structural element that designers must cope with. Figures Q1(a,b) show two beams with different supports.

i) Under the assumption that the material used is concrete, *explain* why steel reinforcement is needed, with regards to the material properties of the concrete and the steel and the stresses generated within these materials.

[10 marks]

ii) The beams in Figures Q4(a,b) are subjected to the same load. *Sketch* how each beam deforms under the considered loading condition.

[5 marks]

iii) For each beam in Figures Q4(a,b), *identify* the tension and compression sides and *sketch* where the steel reinforcement is strictly needed.

[10 marks]

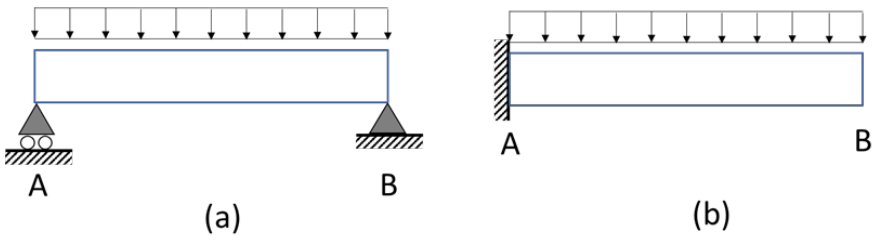

Figure Q4 – (a) Simply supported beam; (b) Cantilever beam

A Blanco Alvarez