

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

WINTER EXAMINATIONS, 2005
SEMESTER I 2005-2006

B.E. DEGREE EXAMINATION

CE405
DESIGN OF STRUCTURES

Paper II
Design of Steel Structures

Professor Margaret O'Mahony;
Professor P. E. O'Donoghue;
Dr. P. Ó hEachteirn;

Time allowed : *Two* hours

Answer *Two* questions

NOTES

The use of electronic calculators is allowed.

The use of the SCI Steel Handbook is allowed.

The use of BSI codes of practice is allowed.

*All dimensions are in **mm**, unless noted otherwise.*

Assume all steelwork to be Grade S275, unless noted otherwise.

Member capacity tables in the steel handbook may be used to select members initially, but the capacity of the final choice of sections must be verified by calculation in accordance with the Codes.

An accuracy, in calculations, of two significant figures is adequate for the purposes of this examination.

Sketches, with dimensions, of your designs as they progress are particularly welcome.

All loadings shown are factored, and have been calculated from dead and imposed loads of equal magnitude.

Quantities without relevant accompanying units are unacceptable.

Question 1

The beam shown in **Figure Q1** is part of a rigid-design multi-storey framework. The factored point loads arising from reactions from pairs of simply-supported **152x152UC37** secondary beams are applied into the web through flexible end-plates (on both sides). The rigid-design double extended end-plate connections at end-supports **A** and **D** are to **914x419UB388** columns. The beam is effectively laterally and torsionally restrained only at the supports and load points.

- (a) Sketch and annotate the bending moment diagram and the shear force diagram. (3 marks)
- (b) Design the beam in Grade S275 steel. Ignore self-weight and the design of connections. (12 marks)
- (c) Redesign the beam in Grade S275 steel, on the basis that the beam is effectively laterally and torsionally restrained now only at the supports, i.e., the beam is now laterally unrestrained at the load points. Ignore all design checks other than lateral-torsional buckling. (5 marks)
- (d) Design the rigid-design double extended end-plate connection at **A** fully. (Sketch and annotate fully your design details for the joint, indicating type and location and dimensions of all components of the joint, e.g., sections, plates, bolts, welds etc.) (5 marks)

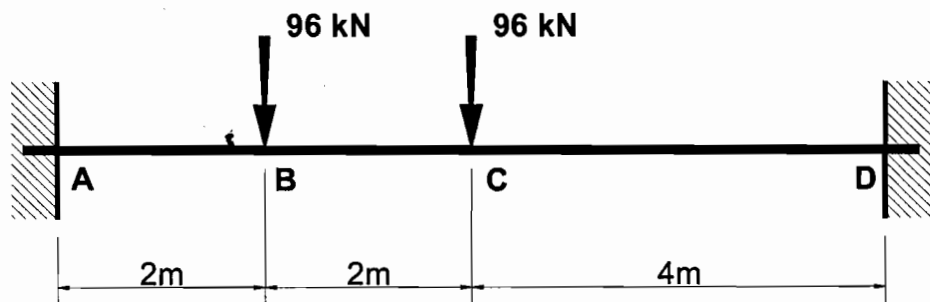


Figure Q1

Question 2

A simply-supported plate girder, with factored loads as shown in Figure Q2, is laterally restrained along its length by a concrete floor slab. This plate girder is part of a simple-construction multi-storey framework at first floor level, and it supports a 305x305UC283 column, thus creating the point loading shown in Figure Q2.

- Sketch and annotate the bending moment diagram and the shear force diagram. (3 marks)
- Design a suitable cross-section for this girder in grade S275 steel, subject to the overall depth restriction of 2000 mm. Explore a variety of solutions using the different methods available in the code. Summarise your results (in a tabular format) commenting on relative advantages of your various solutions. Ignore self-weight and the design of connections. The *detailed* design of intermediate transverse stiffeners and end posts may be ignored. (15 marks)
- Provide sketches of your designs, including suitable trial dimensions of intermediate transverse stiffeners and end posts. Do not complete the design of these stiffeners. (6 marks)
- The maximum transportable girder length is 15m. Where should it be spliced and why? (1 mark)

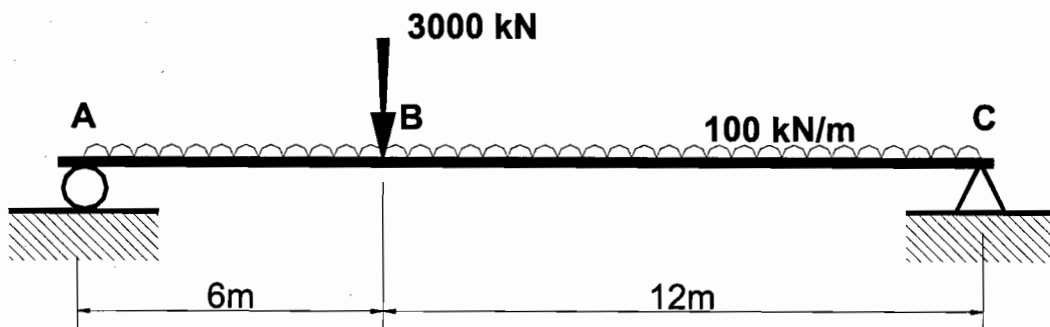


Figure Q2

Question 3

- Classify a 457x152UB52-S275 section when subject to major-axis bending only. (3 marks)
- Classify the same 457x152UB52-S275 section when subject to major-axis bending and an axial compressive load of 800 kN. (12 marks)
- The same 457x152UB52-S275 section is still subject to major-axis bending and the axial compressive load of 800 kN. Determine its *maximum* major-axis moment of resistance. (12 marks)