

NATIONAL EXAMS – May 2015

07-Str-A5, Advanced Structural Design

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 a “**CLOSED BOOK**” examination. Any Textbooks are permitted as well as Design handbooks. **NO notes or sheets are allowed.** Candidates may use one of two calculators, the Casio or Sharp approved models.
- 3.
4. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.
5. All questions are of equal value.
6. **All loads shown are unfactored.**

USE THE FOLLOWING DESIGN DATA

Design in	SI
Concrete	$f_c = 30 \text{ MPa}$
Structural Steel	$f_y = 350 \text{ MPa}$
Rebar	$f_y = 400 \text{ MPa}$
Prestressed Concrete	$f_c \text{ (at transfer)} = 35 \text{ MPa}$ $f_c = 50 \text{ MPa}$ $n = 6$ $f_{ult.} = 1750 \text{ MPa}$ $f_y = 1450 \text{ MPa}$ $f_{initial} = 1200 \text{ MPa}$ Losses in prestress = 240 MPa

Marks for:

- Question 1: (12 + 5 + 3)
Question 2: (10 + 5 + 2 + 3)
Question 3: (15 + 5)
Question 4: (14 + 6)
Question 5: (14 + 6)
Question 6: (15 + 5)
Question 7: (12 + 4 + 4)

1. Figure 1 shows a loaded steel rigid frame. The plastic moment capacities of the members are shown. Use the Plastic Method of design to:

- (a) Select the steel sections for all the members; and
- (b) Estimate a size for the concrete footing at base A, given the soil bearing capacity as 400 kPa.

[Assume lateral support is provided where necessary. Ignore effects of shear and axial deformations.]

2. (a) Design the welded corner at joint B for the steel frame in Fig. 1.
- (b) Carry-out the necessary calculations to check whether the sections chosen in Question 1 for beam columns AB and DF are adequate.

3. (a) Design a section for the three-span continuous welded plate girder, ABCD, Figure 2. The section must satisfy flexure, shear and their interaction.

[Assume adequate size for the load-base plates.]

- (b) Estimate the long-term vertical displacement at mid-point of member BC.

4. Composite steel-concrete construction is to be used to design a pedestrian bridge, 20 m in span, 5 m wide, supported by a 220 mm r.c. slab and two steel beams, placed 4 m apart. Assuming 100% interaction between concrete and steel:

- (a) Design the bridge to carry a live load of 14 kPa as well as its dead load;
- (b) Calculate the required number of shear connectors.

[Assume that the steel beams are adequately braced.]

5. Figure 3 shows a loaded prestressed concrete tee-beam:

- (a) Design the cross-section allowing no tension.
- (b) Determine the required area of prestressing steel strands and their profile along the beam.

[Moments of inertia can be based on the gross-cross-section.]

6. The rigid frame in Fig. 4 is to be designed in reinforced concrete construction. Using the Limit States Design method, design member BC, for: (a) Flexure; and (b) Shear. Also, sketch the reinforcing details for member BCD. Assume the same stiffness for all members.

[Assume lateral support is provided where necessary.]

7. Having analyzed the r.c. frame in Fig. 4, design member AB as a beam-column and sketch the reinforcing details.

