UNIVERSITY OF JOHANNESBURG

DEPARTMENT OF CIVIL ENGINEERING SCIENCE

COURSE	STRUCTURAL ENGINEERING (REINFORCED CONCRETE DESIGN)
CODE	SUS4A11
EXAM	SUPPLEMENTARY EXAM, 2019
DURATION	THREE (3) HOURS
EXAMINERS	Prof. SO. Ekolu Prof. Akeem Raheem

INSTRUCTIONS: Open Book - Lecture Notes, Design Tables etc. are Allowed

Calculators are Allowed. Computers/laptops, Tablets, Cellphones are <u>Not</u> Allowed

Attempt <u>All four</u> Questions

Take Note of Mark Allocations

AT THE END OF EXAM, STUDENTS ARE <u>REQUIRED</u> TO RETURN THIS PAPER TO THE INVIGILATOR, ALONG WITH ANSWER SCRIPTS

Total of 3 Pages

INFORMATION RELEVANT TO QUESTIONS 1 AND 2

A bridge overpass is to be constructed of a continuous RC deck slab 125 mm thick supported by transverse beams 1.8 m apart. The beams are carried on columns 6 m apart. The beams overhang the columns by 1.5 m at each end. The beam depth from the top of the slab is 750 mm and width of the web is 250 mm. Assume the flange width to be 10 times the slab thickness. Fig. 1 gives the floor plan layout of the bridge described.

Design information
Live loads = 15.0 kN/m^2
30 MPa concrete
High yield steel strength = 450 N/mm^2
Mild steel strength = 250 N/mm^2
Cover = 35 mm

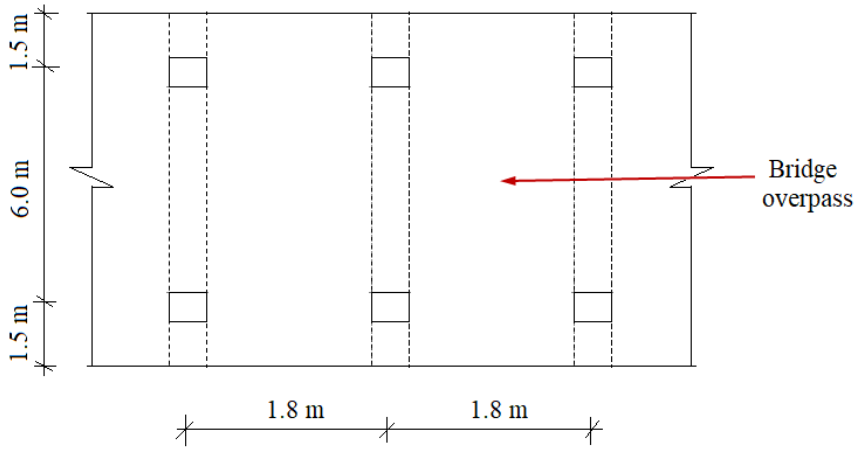
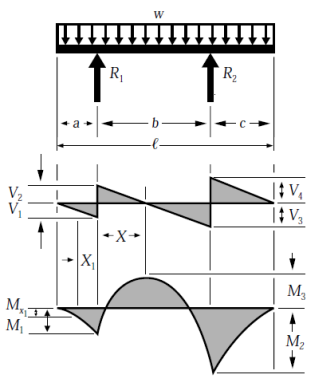


Fig. 1 Slab deck layout



$$R_1 = \frac{w\ell\,(\ell - 2c)}{2b}$$

$$R_2 = \frac{w\ell\,(\ell - 2a)}{2b}$$

$$V_1 = wa$$

$$V_2 = R_1 - V_1$$

$$V_3 = R_2 - V_4$$

$$V_4 = wc$$

$$V_{x_1} = V_1 - wx_1$$

$$M_1 = -\frac{wa^2}{2}$$

$$M_2 = -\frac{wc^2}{2}$$

$$M_3 = R_1\left(\frac{R_1}{2w} - a\right)$$

Fig. 2 Beam overhanging both supports

QUESTION 1. SLABS (ELO 3)

Referring to the design details in Fig.1. The slab reinforcement is to consist of 12 mm bars. Assuming simple supports and ignore finishes.

(i) Determine the type of slab. **[2]**

(ii) Design the bending steel reinforcement for the roof slab. **[13]**

(iii) Check for shear. **[6]**

(iv) Provide a clearly labelled layout sketch of the designed reinforcement. **[4]**

QUESTION 2. BEAMS (ELO 3)

Assume the RC beam in Fig.1 to be simply supported. The reinforcement is to consist of 8 mm and 16 mm bars high yield steel. Fig. 2 may be used as deemed appropriate.

(i) Sketch the beam's section, giving all its dimensions including effective depth **[4]**

(ii) Calculate the ULS design load and draw the BMD of the beam **[12]**

(iii) Design the bending steel reinforcement for the beam. **[9]**

QUESTION 3. COLUMNS (ELO 3)

A 300 mm square column is to be designed to carry ULS design loads of 1750 kN axial and 100 kN.m bending moment about the x-axis. Design suitable reinforcement and provide a sketch of the section showing placement of steel bars. f_y = 450 MPa, f_{cu} = 30 MPa, mild exposure. The reinforcement is to consist of 8 mm and 25 mm bars high yield steel.

[25]

QUESTION 4. FOOTINGS [ELO 3]

Design a 3.0 x 2.4 m rectangular footing for a centrally located rectangular column 550 x 450 mm, the 450 mm dimension being parallel to the 2.4 m side of footing. The ULS axial column load is 1870 kN. Cover 30 mm, fcu = 25 N/mm^2, fy = 450 N/mm^2. The reinforcement is to consist of 8 and 16 mm bars high yield steel. Assume the required footing thickness is 30% higher than the estimate obtained using the rule-of-thumb. Design the longitudinal and transverse tension reinforcements. Provide a clearly labelled sketch of the design.

[25]