UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 2 Examination in Engineering: December 2015

Module Number: CE2302 **Module Name: Mechanics of Materials**

[Three Hour]

Answer **all questions** (Each question carries 12 marks)

All standard notations denote their regular meanings

Q1. A concrete retaining wall of 2 m high and 150 mm thick, which is supported by vertical concrete piles of 300 mm diameter, is shown in Figure Q1. Concrete piles are fixed at ground level. The lateral earth pressure is 20 kN/m^2 at the bottom of the wall.

a) Idealize the loading condition for the concrete wall and piles.

[3 Marks]

b) Assuming that the allowable tensile stress in the concrete is 3 MPa, calculate the maximum permissible spacing of the piles.

[9 Marks]

(Hint: Observe that the spacing of the piles may be governed by the load-carrying capacity of either the concrete wall or the concrete piles. Consider the concrete to act as simple beams between the piles.)

Q2. A built-up plywood box beam 200mm×600mm with blocking top and bottom is held together by nails along the top and bottom chords as shown in Figure Q2. The beam supports a 5 kN concentrated load at mid-span. The nails are capable of resisting 80N each in shear.

a) Draw the shear force diagram for the beam shown in Figure Q2.

[2 Marks]

b) Determine the second moment of area of beam cross-section.

[2 Marks]

c) Determine the shear stress acting on intersection between two plywood blocks.

[4 Marks]

d) Determine the suitable pitch (spacing) of the nails.

[4 Marks]

Q3. The in-plane normal and shear stresses acting on a small element in a structural body are shown in Figure Q3(a).

a) Draw the Mohr's circle to represent normal and shear stresses at any plane of the element at this stress point.

[5 Marks]

b) Determine the principal stresses at the point and mark them on a stress block showing the angle of rotation accurately.

[3 Marks]

c) Using Mohr's circle drawn in Part (a), determine the stress components σx, σy and τxy on the horizontal and vertical planes shown in Figure Q(b).

[3 Marks]

d) What is the maximum in-plane shear stress at the point?

[1 Mark]

Q4. a) State Mohr's theorems for determining the deflection of a beam using moment area method. Use neat sketches where necessary.

[3 Marks]

b) A simply support beam ABCD has three segments having different cross sections, as shown in Figure Q4(a). Cross sections of each beam section are shown in Figure Q4(b). Assume both segments are made of same material with the elastic modulus of 20 GPa. Using moment area method, determine the maximum deflection at the middle of the beam.

[9 Marks]

Q5. a) A hollow circular steel drive shaft has an outer radius of 40 mm and an inner radius of 20 mm. If the maximum allowable stress in the shaft is 80 N/mm^2, what is the maximum permitted torsional moment that can be transmitted by the shaft.

[3 Marks]

b) The hollow shaft in Part (a), is to be replaced by a solid circular shaft of identical material and the maximum allowable shear remains the same. If the shaft is required to transmit the same torsional moment, calculate the radius of this shaft.

[3 Marks]

c) If the length of the shaft is 400 mm, determine the work done by the torsional moment. Use shear modulus G = 80 GPa.

[4 Marks]

d) If the shaft is rolling at 2 Hz, determine the power transmited by the shaft.

[2 Marks]

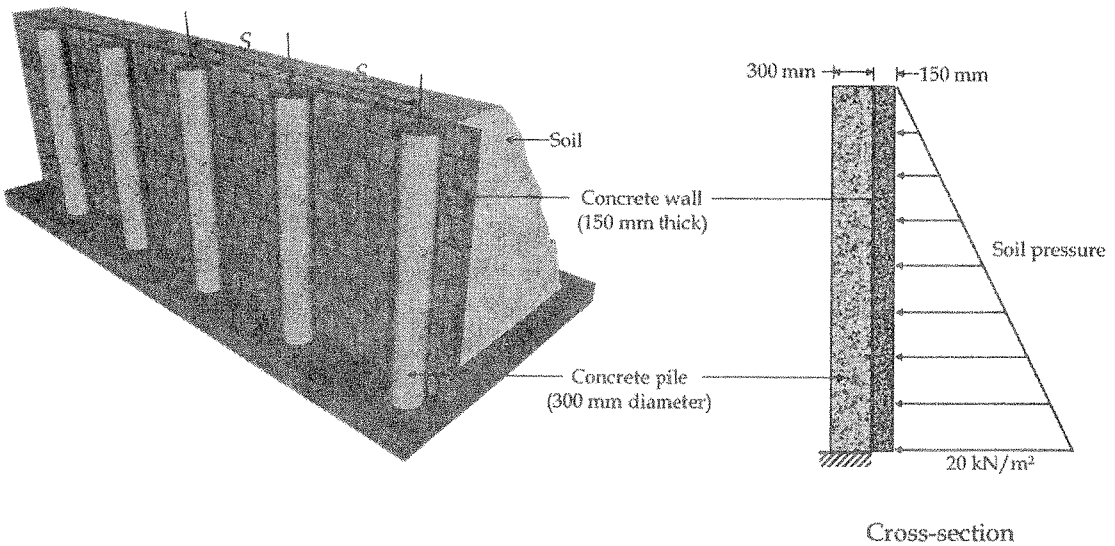


Figure Q1

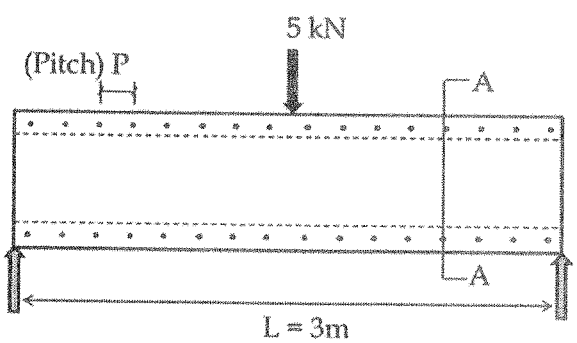
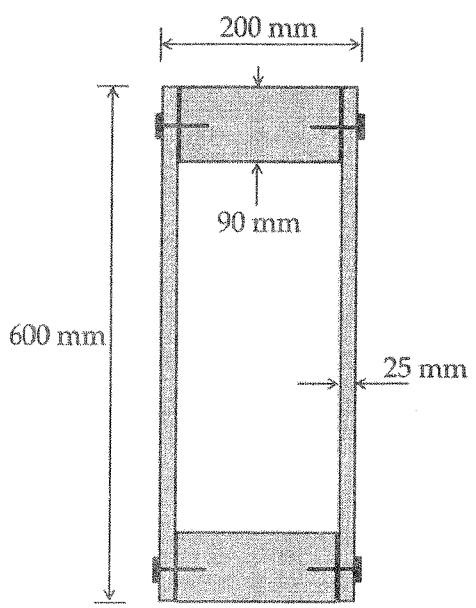


Figure Q2(a)



Section A-A

Figure Q2(b)

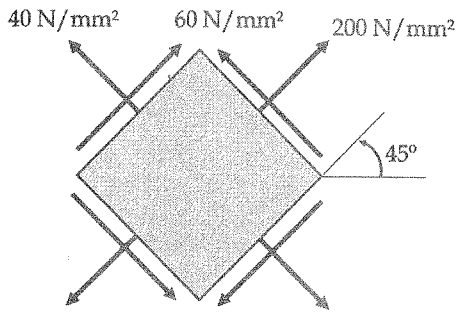


Figure Q3(a)

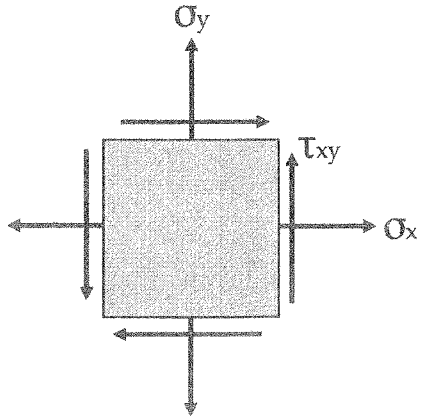


Figure Q3(b)

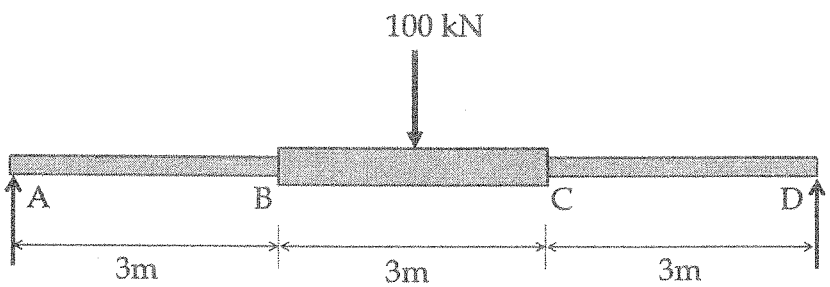
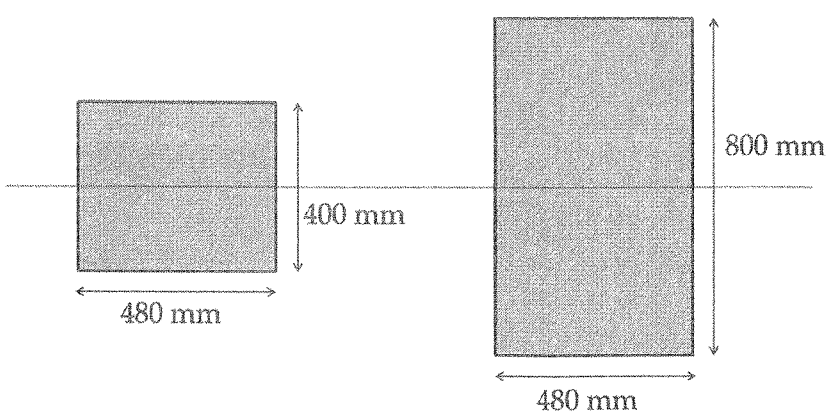


Figure Q4(a)



Cross section of beam segment AB & CD

Cross section of beam segment BC

Figure Q4(b)