KSCP Examination
2020/2021 Academic Session

September 2021

EAS152 – Strength of Materials

Duration : 2 hours

Please ensure that this examination paper contains **SEVEN (7)** printed pages before you begin the examination.

Instructions: This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions.

All questions **MUST BE** answered on a new page.

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1. The mast in **Figure 1** is connected to a pin support at A. A pair of ties are connected to the vertical mast through a pin connection at B. Each of the tie has rectangular cross section of 75 mm×12.5 mm. End D of the ties is pin connected to a support at D. The thickness of the end plate at D is 20 mm. Details of pinned connection at A, B and D are also shown in **Figure 1**. Diameters of pins at A, B and D are respectively 25 mm, 17.5 mm and 20 mm. A horizontal load of 75 kN acts at end C of the mast.

   Determine:

   (a) maximum normal stress in the tie (state whether the stress is tensile or compressive)

   (b) shear stress in pin at B

   (c) bearing stress between bolt and tie at B

   (d) bearing stress between bolt and end plate at D

   (e) whether the bolt at D is safe to be used given that the allowable shear stress in bolt at D is 75 MPa.

   [25 marks]

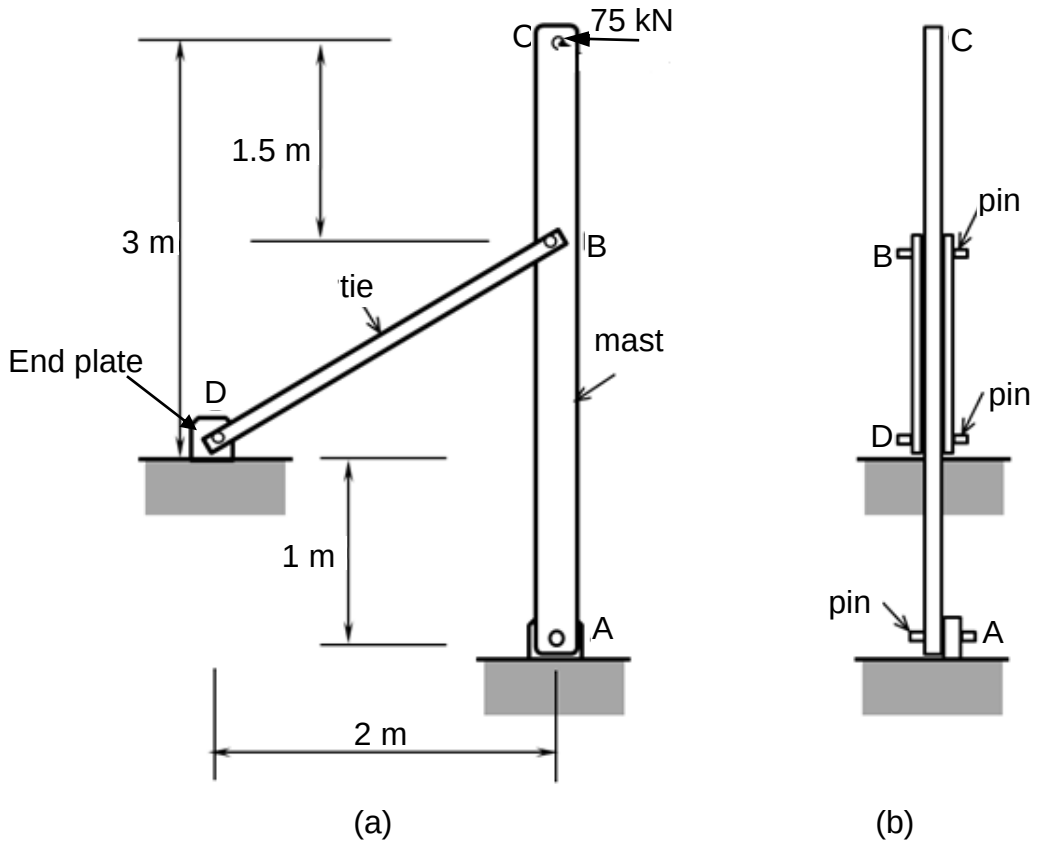

Figure 1

2. A rectangular rigid bar ABCDE is supported by two pairs of vertical links at B and D as shown in **Figure 2**. Loads of 75 kN, 40 kN and 25 kN act at point A, C and E, respectively. Each of the vertical link joining B and F has rectangular cross-section of 75 mm × 17.5 mm whilst that joining D and G has rectangular cross-section of 50 mm × 17.5 mm. Elastic modulus for links BF and DG are 110 GPa and 80 GPa, respectively. Details of connection of vertical links BF and DG are given in **Figure 3**.

Determine:

(a) vertical deflection of point B

(b) vertical deflection of point D

(c) vertical deflection of point E

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(d) vertical deflection of point A (indicate if the deflection is upwards or downwards)

(e) whether thickness of vertical link BF is safe to be used if member shortening is limited to 0.5% of member length.

[25 marks]

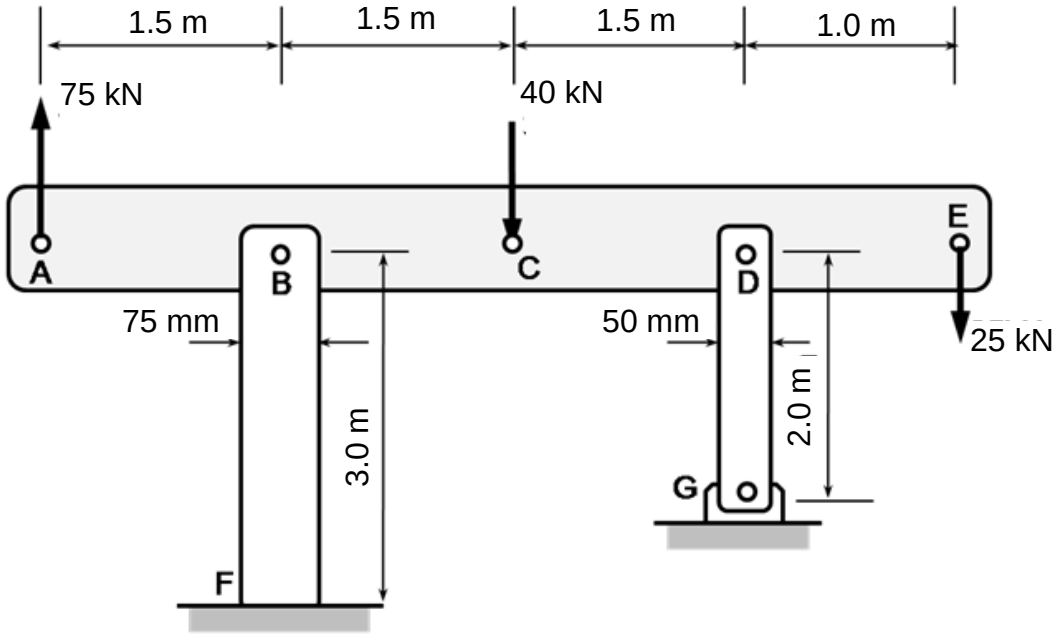

Figure 2

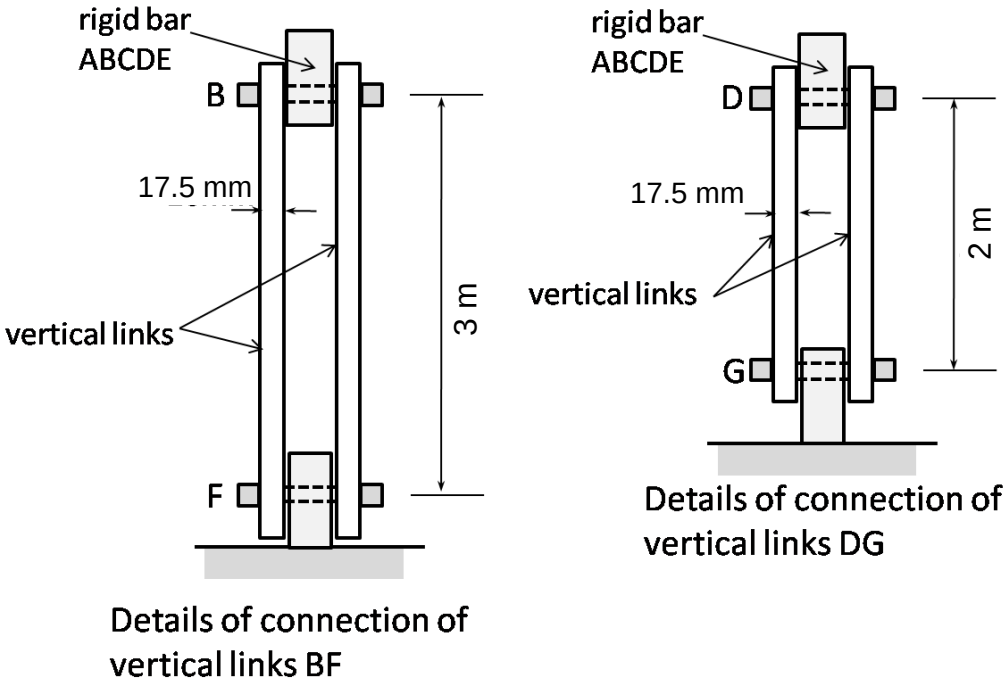

Figure 3

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3. A 3.6 m long simply supported timber beam AB is to carry the distributed load and concentrated moment as shown in **Figure 4**. The cross-section of the timber beam is 75 mm x 250 mm. For the timber beam with loading shown in **Figure 4**,

(a) Determine shear force and bending moment equations using cut section method

(b) Draw the shear force and bending moment diagrams for beam AB

(c) Determine the maximum normal stress due to bending and maximum shearing stress in the beam.

[25 marks]

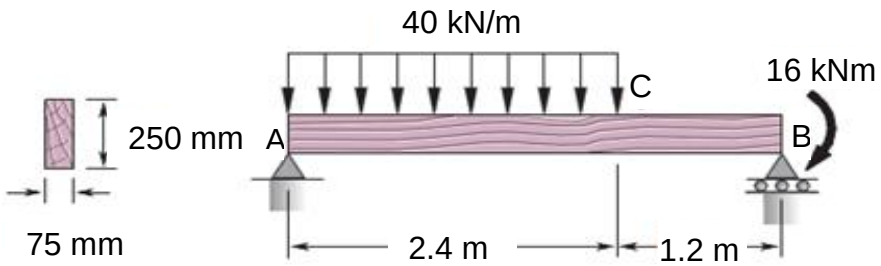

Figure 4

4. (a) A stepped shaft ABCD consisting of two hollow circular segments AB and BC and a solid circular segment CD is subjected to three pairs of forces which act at distances as shown in **Figure 5**. Segments AB and BC have outer diameters of 55 mm and 30 mm, respectively, with 6 mm thick. The diameter of segment CD is 20 mm. End A is fixed and the shear modulus of elasticity for the shaft is 32 GPa. Calculate:

(i) the maximum shear stress of each segment in the shaft, and

(ii) the angle of twist at end D.

[20 marks]

(b) What is the smallest diameter for segment CD if the allowable shear stress in the shaft is 30 MPa and the allowable rate of twist at end D is 3.5^o/m ?

[5 marks]

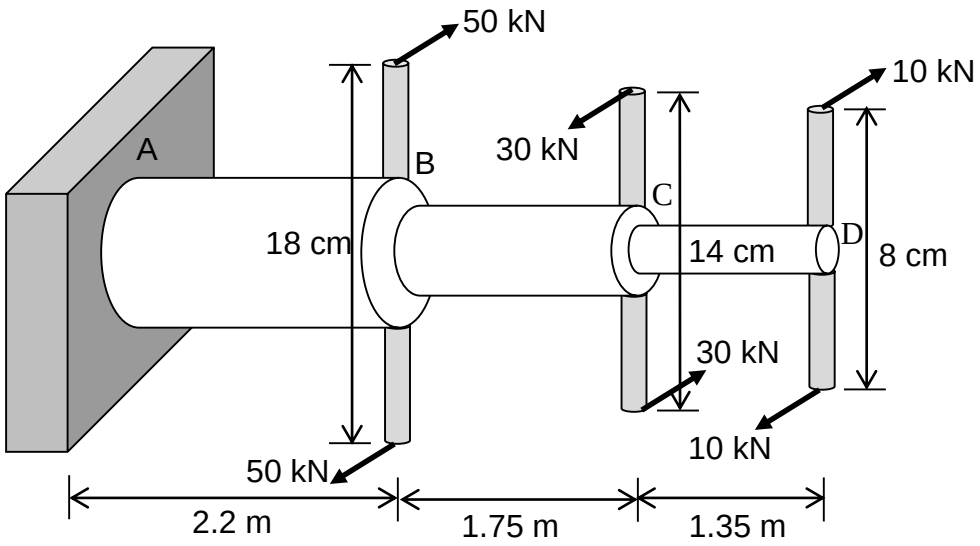

Figure 5

5. Determine the equivalent state of stress on an element at the same point for the following cases with respect to the element shown in **Figure 6** using Mohr's circle. Nominal stress in x and y directions are 300 N/mm^2 and 400 N/mm^2, respectively, while shear stress is 400 N/mm^2.

Sketch the corresponding element for each result.

(a) The principal stress and the corresponding orientation.

(b) The maximum in-plane shear stress and the associated average normal stress, as well as the corresponding orientation.

[25 marks]

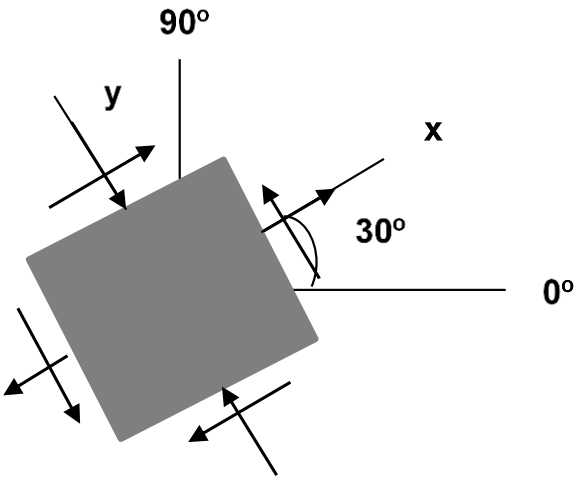

Figure 6

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