INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Midsem

Date: 27.02.17 **Time:** 2 hrs. **Full Marks:** 80 **No. of Students:** 169

Sub. No.: ESO202A/204 **Sub. Name:** Mechanics of Solids **2016-17, II Semester**

Instructions: i) Neatly draw the free body diagram, ii) Assume suitable data if not mentioned, iii) Show the calculations properly, iv) Neglect the friction and self-weight if not mentioned

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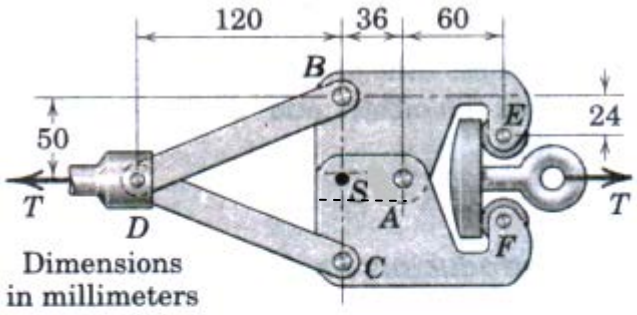
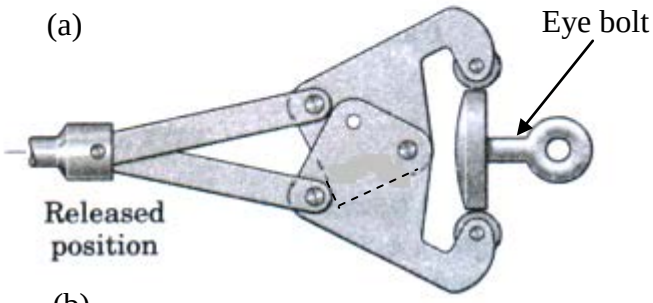
1. The machine shown in Fig. 1a is designed as an overload protection device that releases the load when it exceeds a predetermined value *T*. A soft metal shear pin *S* (Fig. 1c) is inserted in a hole in the lower half and is acted on by the upper half. When the total shear force on the pin exceeds its strength, it will break. The two halves then rotate about *A* under the action of the tensions in *BD* and *CD*, as shown in Fig. 1b, and rollers *E* and *F* release the eye bolt. Determine the maximum allowable tension *T* if the pin *S* will fail when the total shear force on it is 800 N. Also compute the corresponding shear force on the hinge pin *A*.

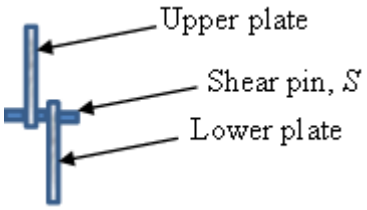
(20)



(a)



(b)



(c) Details of shear pin

Fig. 1

2. Compute the force in each member of the loaded cantilever truss as shown in Fig. 2. Neglect the self-weight of the members as compared to the force carried by them.

(20)

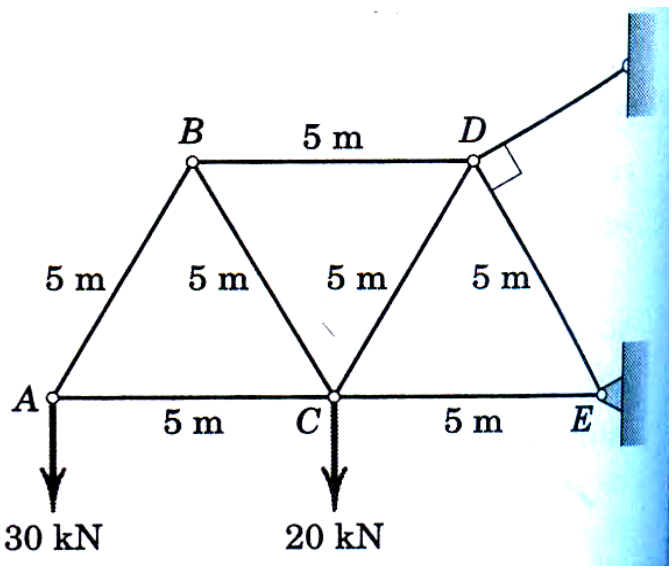


Fig. 2

3. Fig. 3 shows a thin *Fe250* steel plate and a rigid block connected to two springs. When the plate is stress free (before loading), there is a clearance of 1 mm between the edge of the plate and the rigid block. The plate is then subjected to a uniform compressive load in the *Y* direction of 1500 kN/m on both top and bottom edges. Once the block is in contact with the plate, a uniformly distributed normal load along the *X* direction is transmitted to the plate. Take *E* of plate material as 200 × 10^6 kN/m^2, plate thickness as 2.5 mm, Poisson's ratio as 0.33 and spring constant of the springs (k) = 5000 kN/m. Find the force in each spring.

(20)

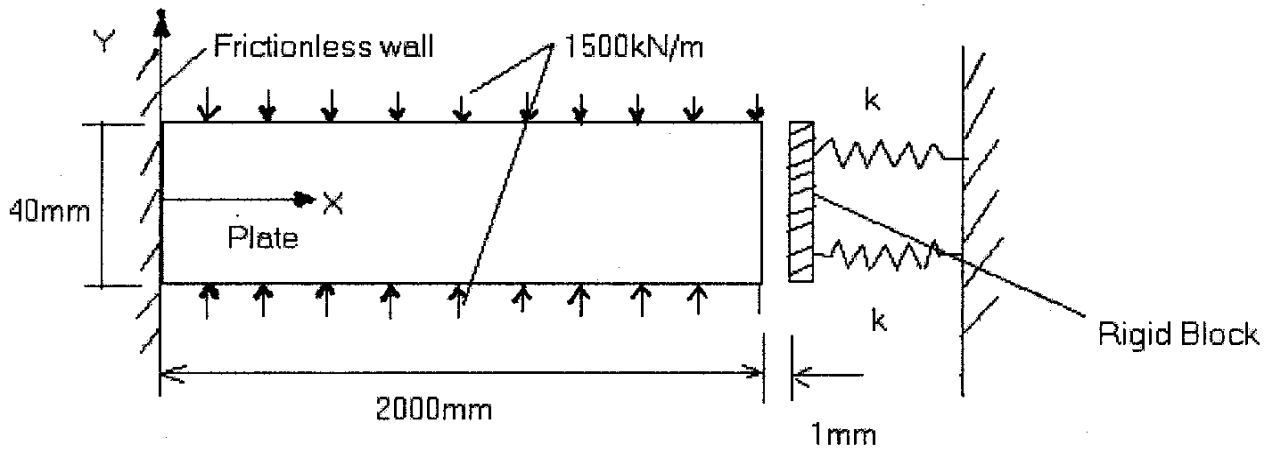


Fig. 3

4. A long beam AB is loaded as shown in Fig. 4. Draw the FBD, shear force and bending moment diagrams for the beam, and label the key points. Neglect the self-weight of the beam.

(20)

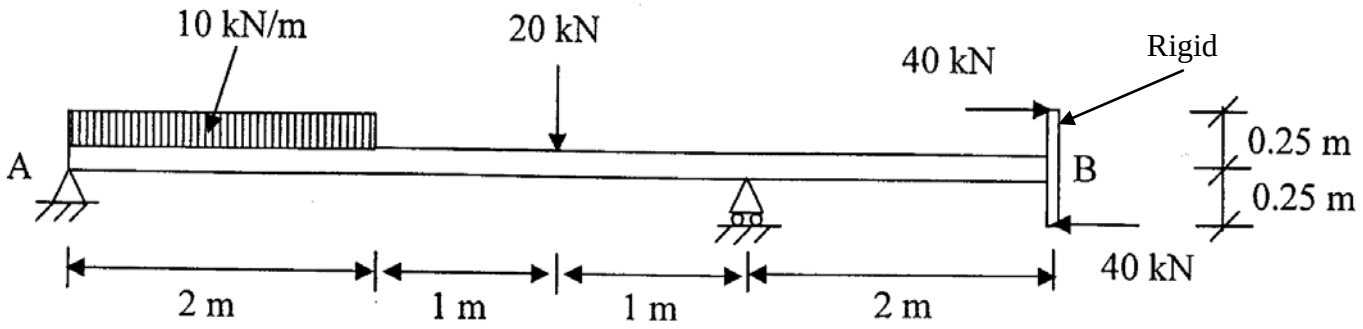


Fig. 4