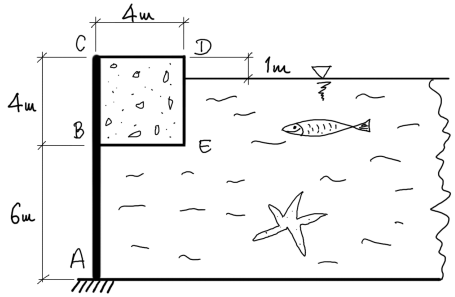
CIV100F/APS160F – Mechanics: Final Exam 2016

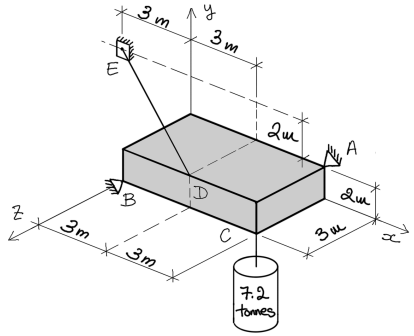
Question 1

The structure *ABCDE* is used to prevent fresh water from flowing out of the long channel on the right. The weight of vertical panel *ABC* may be neglected and *BCDE* is made of reinforced concrete with a density of 2,400 kg/m³. Determine the reaction force components at the fixed base *A*.



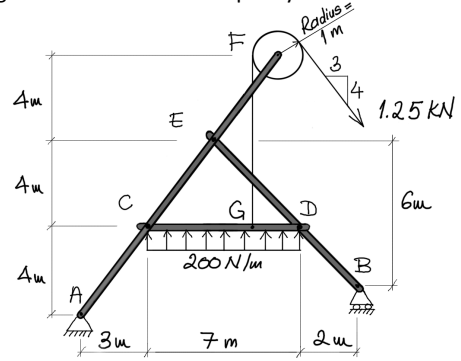
Question 2

The rectangular prism is made of a solid, homogenous material having a density of 1,400 kg/m³ and must support a cylindrical container at *C*. The prism is supported by a cable *DE* and by ball-and-socket joints at *A* and *B*. The support at *E* lies in the *x*-*y* plane. Determine the magnitude of the force in cable *ED*. Express the force in cable *ED* in Cartesian vector format.



Question 4

The three straight members in the structure shown are pin-connected and the pulley is frictionless. The rope is attached at one end to member *CD*, at *G*. Determine the components of all the forces acting on member *ACEF*. Present your answers on a separate free-body diagram of member *ACEF*. Neglect the weight of the members and pulley.

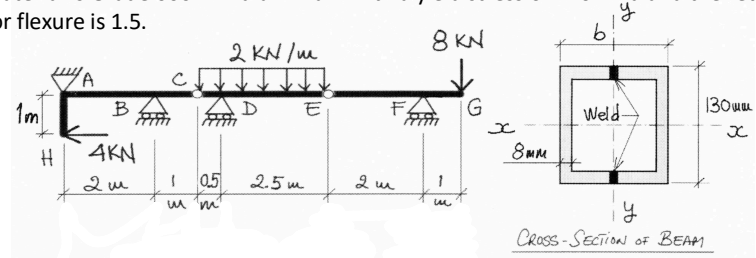


Question 3

The hinged beam illustrated below is made of three rigid segments, connected by pins at *C* and *E*.

(a) Draw the shear force and bending moment diagrams in the space reserved below, indicating the values at *A*, *B*, *C*, *D*, *E*, *F* and *G*, as well as any potential local maxima and minima;

(b) The beam is made of two *identical* C-shaped bent plates, welded 'toe-to-toe' to form a hollow rectangle, as shown in the cross section. Before bending, each plate can be cut in multiples of 10 mm. Determine the width, *b*, of the beam such that it can safely carry the loads applied. The beam material is Grade 6061-T4 aluminium with a yield stress of 110 MPa and the required load factor for flexure is 1.5.



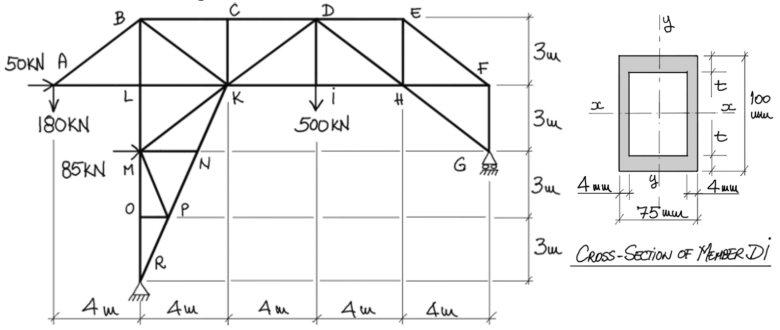
Question 5

Illustrated below is a portal crane used in a ship-building yard. While lifting materials, the crane is also affected by wind loading. The forces acting on the crane from both lifting and wind are as illustrated.

(a) Find the forces in members *DE*, *DI*, *IK* and *KL* of the truss;

(b) Member *DI* is to be constructed from a built-up steel hollow section constructed from four plates welded together, as indicated in the cross section. Determine the minimum plate thickness, t, considering that the material is available in one millimetre intervals. The yield stress for steel is 350 MPa and the load factor for axial tension is 1.1;

(c) Knowing that the modulus of elasticity for steel is 200,000 MPa, determine the elongation of member *DI*, as designed.



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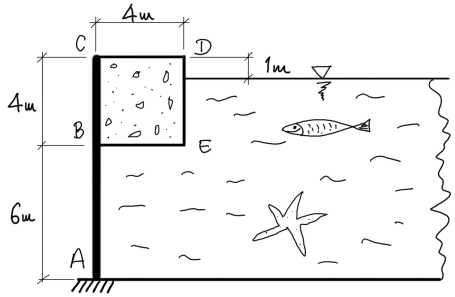

Answers:

A_x = 397 kN/m →
A_y = 259 kN/m ↑
M_A = 674 kNm/m ↻

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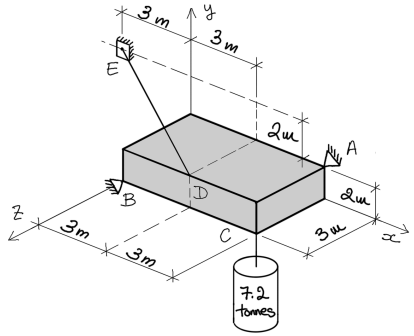

Answers:

T_{ED} = 123.6 kN (Tension)

$\overrightarrow{T_{ED}} = -105.9\vec{\imath} + 35.3\vec{\jmath} - 53.0\vec{k}\ kN$

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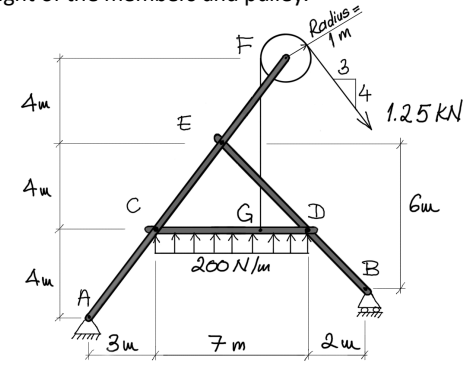
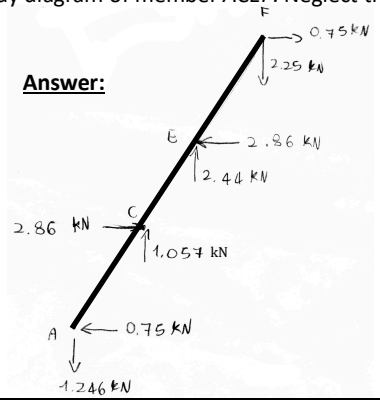


Answer:



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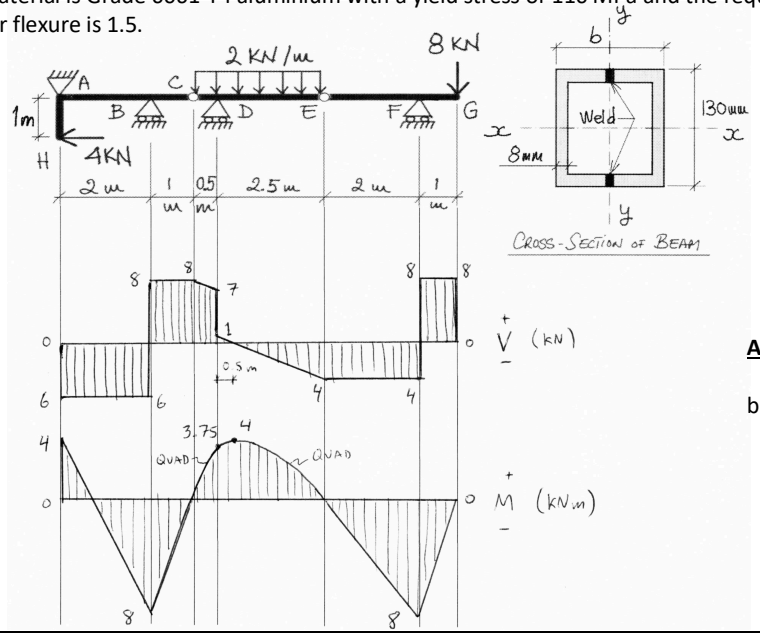

Answer:

b = 90.0 mm

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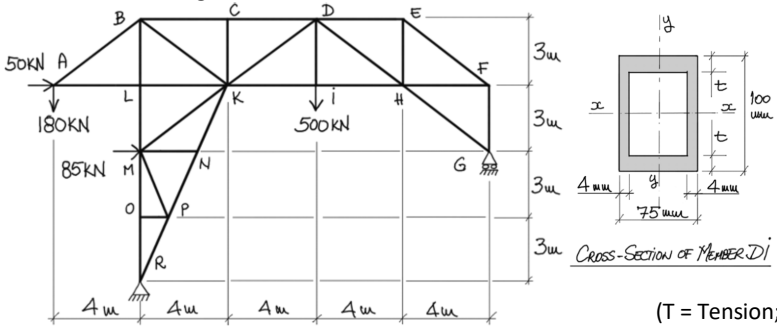

Answers:

F_{DE} = 353 kN (C)
F_{DI} = 500 kN (T)
F_{IK} = 707 kN (T)
F_{KL} = 290 kN (C)

t = 6.00 mm
Δ_{DI} = +4.68 mm
(T = Tension; C = Compression)