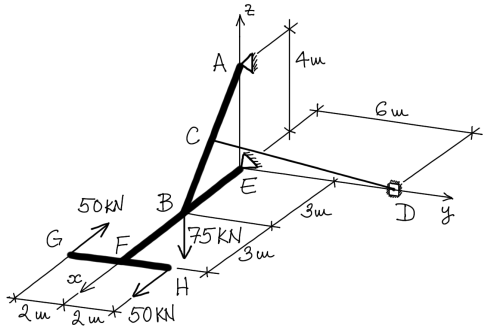
CIV100F/APS160F – Mechanics: Final Exam 2015

Question 1

The rigid frame ABCEFGH is supported by ball-and-socket supports at A and E. The support at A has been modified to allow free movement along the z-axis. A cable is also attached between C and D. Point C is at the mid-point of AB. Determine the force in the cable and the reaction force components at E.

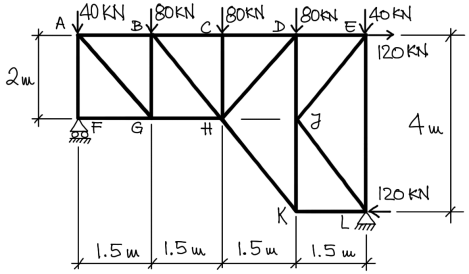


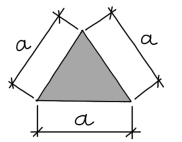
Question 2

The truss shown is supported by a pin at L and a roller at F. Indicate the zero-force members in the truss, if any.

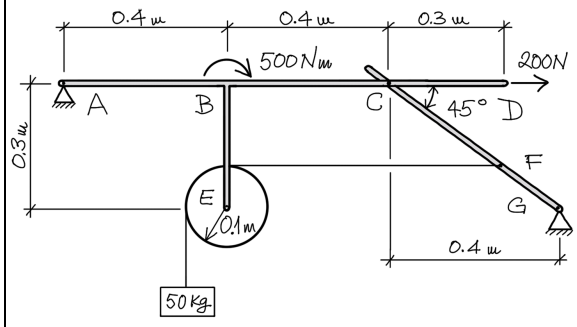
(a) Determine the force in members BC, CH, DH and HK, and indicate whether they are in tension or compression.

(b) Member EJ has a tension force of 125 kN and is to be constructed from steel having a solid equilateral triangular cross-section of size a, which is readily available in 5 mm increment sizes. Knowing that the yield stress for steel is 300 MPa, the load factor for axially loaded bars in tension is 1.25 and the modulus of elasticity for steel is 200,000 MPa, determine dimension a for the required section. Also, determine the elongation of member EJ as designed.





CROSS-SECTION OF MEMBER EJ

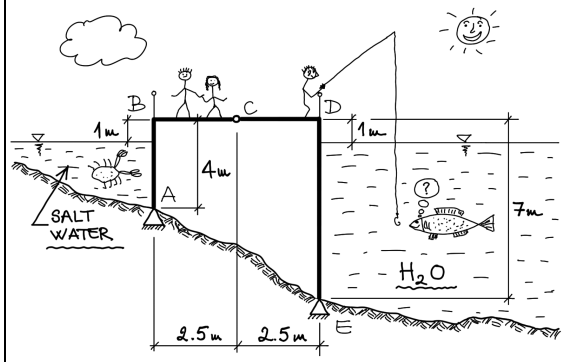


Question 5

Determine the reaction force components at pins A and G, for the structure illustrated. Member BE is attached rigidly to member ABCD, at B, and member CFG is pinned to member ABCD, at C. Neglect the mass of the members and frictionless pulley.

Question 3

The long dam and pedestrian walkway ABCDE is made of continuous (perpendicular to the page) rigid walls and slabs ABC and CDE, which are continuously pinned at A, C and E. The structure separates and retains salt water to the left of the vertical wall AB and fresh water to the right of the vertical wall DE. Neglecting the self-weight of the structure as well as that of the people walking on it, determine the reaction force components at pins A and E. The density of salt water is 1,050 kg/m^3.

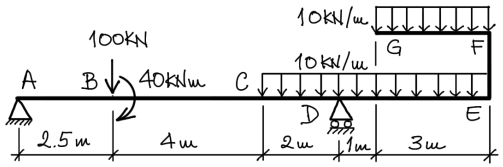


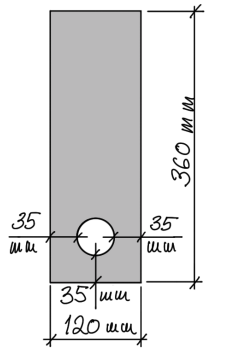
Question 4

As an engineer in a consulting firm you have been tasked to verify the design of beam ABCDE subject to the loads illustrated, which was performed by a younger colleague. Member EFG is attached rigidly to the beam at E. For this purpose, you have to:

(a) Draw the shear force and bending moment diagrams for the beam in the space reserved below, indicating the values at points A, B, C, D and E, as well as any potential local maxima or minima.

(b) Your colleague has proposed a solid rectangular cross-section for the beam with a circular hole at the bottom for electrical conduits, as shown. The beam is constructed of Grade 6061-T4 aluminium with a yield stress of 110 MPa and the required load factor for flexure is 1.5. Determine if the beam proposed is safe. The second moment of area for circular areas is $(\pi r^4)/4$, where r is the radius of the circle.





CROSS-SECTION OF BEAM

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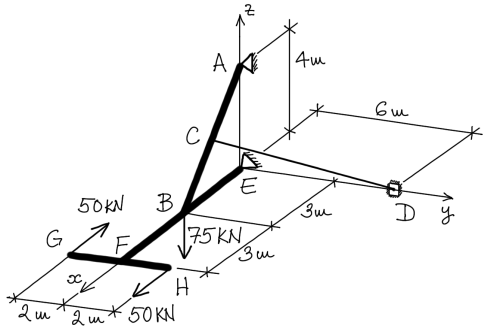

Answers:

T_{CD} = 144.0 kN (Tension)
E_x = 89.5 kN ↙
E_y = 66.4 kN ←
E_z = 119.0 kN ↑

Question 2

The truss shown is supported by a pin at L and a roller at F. Indicate the zero-force members in the truss, if any.

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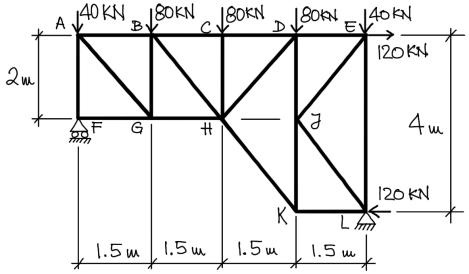
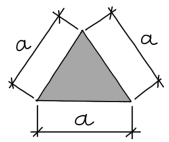


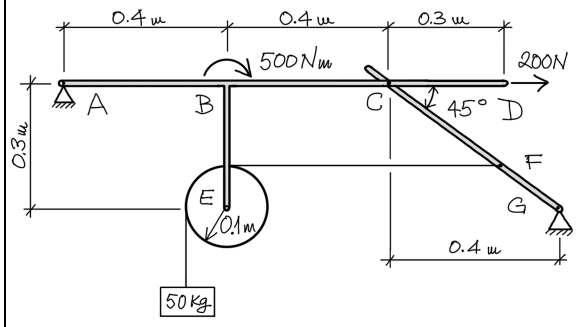


CROSS-SECTION OF MEMBER EJ

Answers:

F_{BC} = 0 kN
F_{CH} = 80.0 kN (Compression)
F_{DH} = 75.0 kN (Tension)
F_{HK} = 75.0 kN (Compression)

a = 35.0 mm
Δ_{EJ} = +2.95 mm



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Answers:

A_x = 241 N → G_x = 441 N ←
A_y = 195.8 N ↓ G_y = 686 N ↑

Question 3

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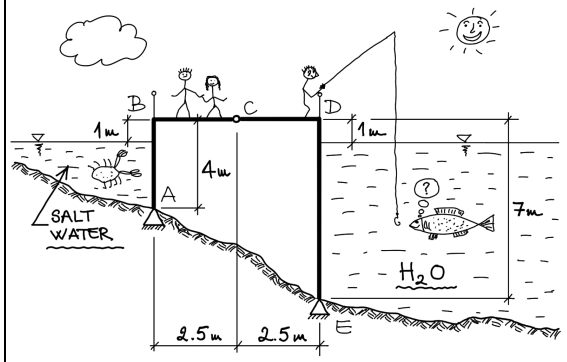

Answers:

A_x = 10.03 kN/m ← E_x = 140.3 kN/m →
A_y = 39.6 kN/m ↑ E_y = 39.6 kN/m ↓

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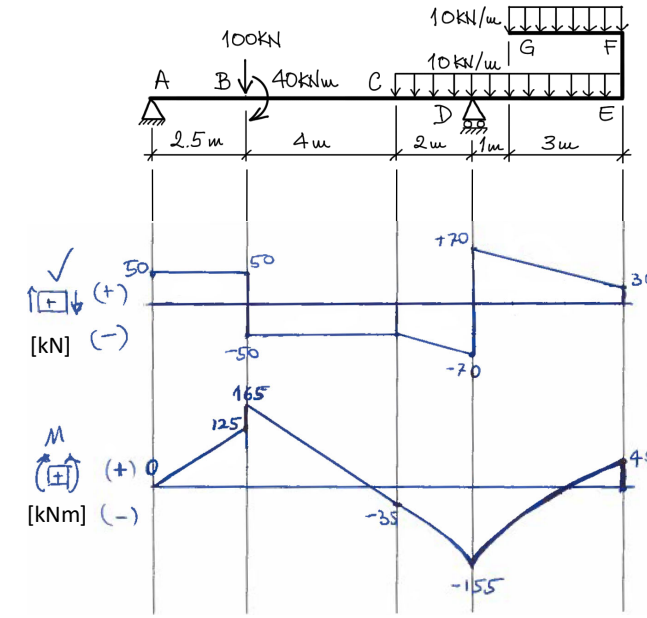

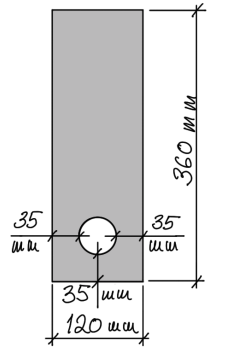

CROSS-SECTION OF BEAM

Answers:

σ_{max} = 105.3 MPa
The beam is safe.