2002 HIGHER SCHOOL CERTIFICATE EXAMINATION

Engineering Studies

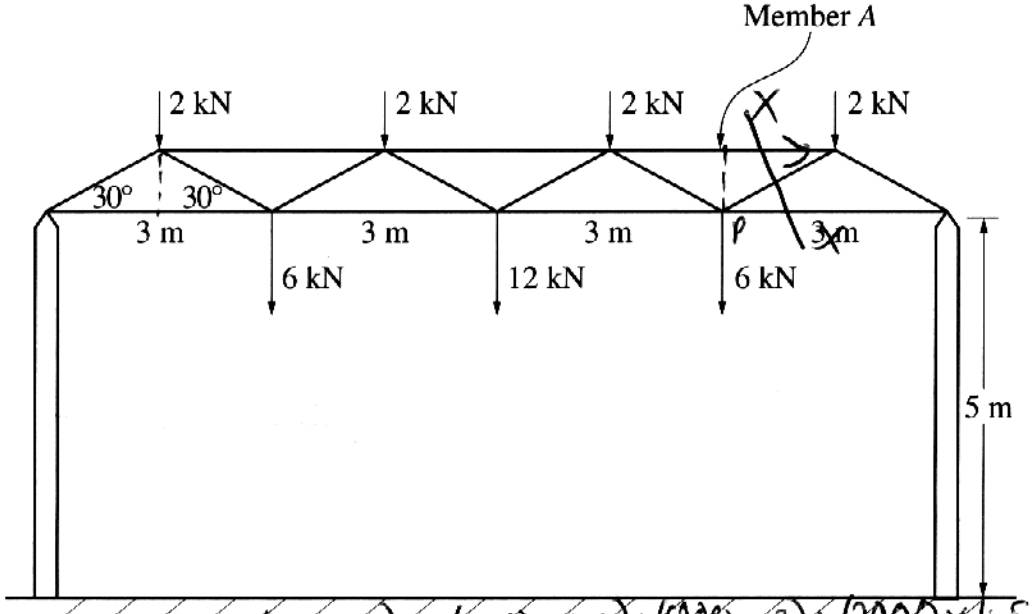
Section II (continued)

Marks

Question 12 — Civil Structures (10 marks)

(a) The truss shown is used to support overhead wires for an electric rail system. **3**

Determine the magnitude and nature of the force in Member *A*.



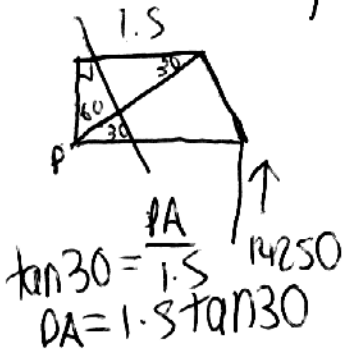
$\Sigma M_{R_L} \circlearrowleft = 0 = (R_R \times 12) + (2000 \times 1.5) + (6000 \times 3) + (2000 \times 4.5) + (12000 \times 6) + (2000 \times 7.5) + (6000 \times 9) + (2000 \times 10.5)$

$R_R = 14250\,N$

considering RHS of XX

$\Sigma M_P \circlearrowleft = 0 = -(14250 \times 3) + (1.5 \tan 30 \times A)$

$A = 49363.448\ldots$



$\tan 30 = \frac{A}{1.5}$

$A = 1.5 \tan 30$

Magnitude of the force in Member *A* = 49363 N

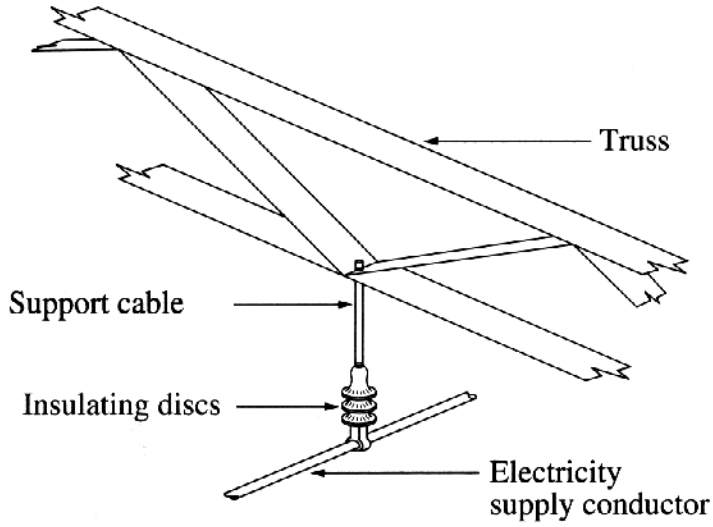
Nature of the force in Member *A* = compression

Question 12 continues on page 12

Marks

Question 12 (continued)

(b) A ∅10 mm cable is attached to the truss to support the electricity supply conductor as shown. The material currently used for the support cable has a Young's modulus of 180 GPa and must withstand a maximum tensile force of 6 kN.



(i) The support cable must not extend more than 0.5 mm when placed under the maximum tensile force. Calculate the maximum allowable length of the support cable. **3**

(You may use $E = \frac{PL}{eA}$)

$180 \times 10^9 = \frac{6000 \times 0.0005 L}{0.0005 \times (\pi \times 0.005^2)}$

$A = \pi \times 0.005^2$

$180 \times 10^9 \times (0.0005 \times \pi \times 0.005^2)$

$= 6000L$

$180 \times 10^9 \times 0.0005 \times \pi \times 0.005^2 = 6000L$

$6000L = 180 \times 10^9 \times 0.0005 \times \pi \times 0.005^2$

$L = 1.178...$

Maximum allowable length = 1178 mm

Question 12 continues on page 13

Marks

Question 12 (continued)

(ii) The support cable is to be replaced. Identify an appropriate metal for the new cable and give TWO reasons to justify your choice. **2**

Appropriate material = ~~mild steel~~ mild steel, medium carbon steel

1) The cable is in tension and needs a material like mild steel that can withstand ~~cyclic~~ tensile stress. Mild steel has a good tensile strength.

2) Formability - whilst mild steel is strong and hard, it can be formed relatively easily (it is still soft enough to be extruded) whilst retaining its tensile strength. and

(iii) Explain why a glazed ceramic material is preferred to either an unglazed ceramic or a polymeric material for the insulating discs. **2**

A glazed ceramic disc has two desirable properties that favour it over an unglazed: 1) Lower thermal expansion: since it is ~~glazed and~~ a high resistance situation it must be able to withstand high temperatures without doing damage to its structure. A glazed ceramic has a lower thermal expansion than an unglazed, which may crack and fail under high heats.

2) Higher electrical resistivity - the glassy surface of a glazed ceramic serves to insulate electricity to a higher degree than an unglazed. Therefore it is preferred over an unglazed.

End of Question 12