Engineering Studies

Section II (continued)

Marks

Question 12 — Civil Structures (10 marks)

(a) A pre-stressed concrete beam is to be used in the construction of a ferry wharf.

The steel tendons used to pre-stress the beam are <u>18 mm in diameter</u> and <u>6 metres</u> in length. A force of <u>30 kN</u> is to be applied to each tendon.

(i) If the Young's modulus for the steel used in the tendons is 210 GPa, calculate the extension of each tendon. **2**

$$E = \frac{F \, l}{A x} \implies x = \frac{F \, l}{A E} = \frac{30 \times 10^3 \times 6}{\pi (9 \times 10^{-3})^2 \times 210 \times 10^9}$$

$F = 30 \times 10^3$

$l = 6 \, m$

$A = \pi (9 \times 10^{-3})^2$

$E = 210 \times 10^9$

$$= 3.368... \times 10^{-3} \, m$$

$$= 3.37 \, mm$$

Extension = ...3.37 mm......

(ii) Explain TWO benefits of using pre-stressed concrete beams in preference to reinforced concrete beams. **2**

- The beam is already placed in compression so To break beam this force must be overcome thus beam is stronger in tension as well as compression
- Since it is stronger less concrete is needed to fulfil the req'd strength ∴ costs are brought down in construction. (for materials)
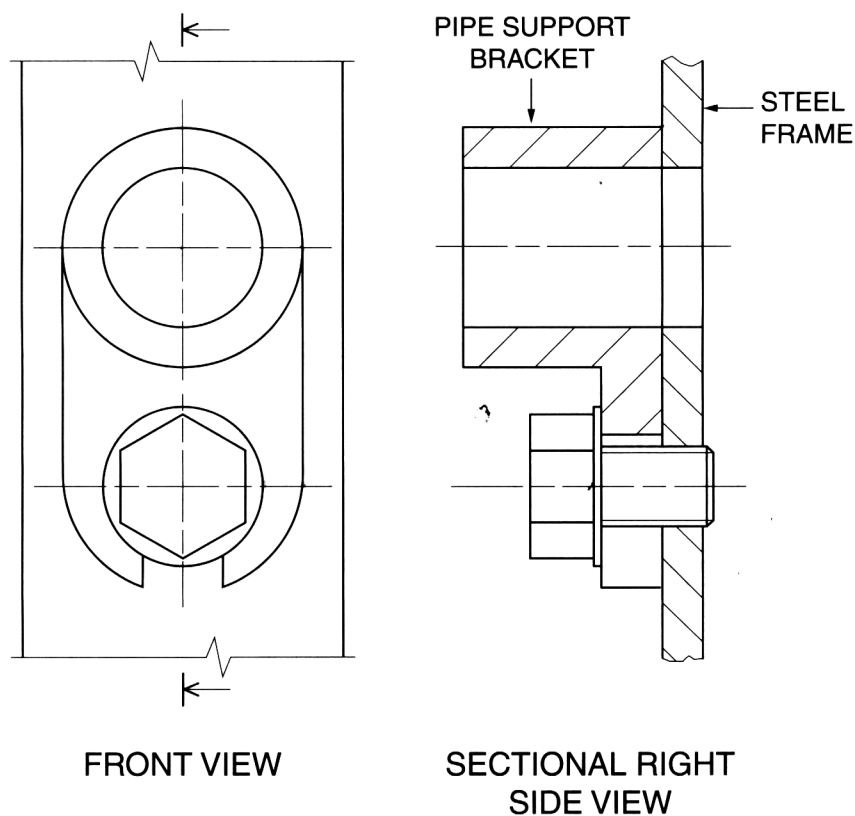
Question 12 continues on page 12

Question 12 (continued)

(iii) A timber-laminate beam is an alternative to the pre-stressed concrete beam. Discuss TWO factors, other than strength and cost, an engineer would consider in choosing the best option.

3

Aesthetic appeal - which material looks nicer and appears more 'appealing' to human eye. Important as society will need to look at it. Weathering resistance - ferry wharf is near water so corrosive & erosion issues are important as it determines lifespan of material
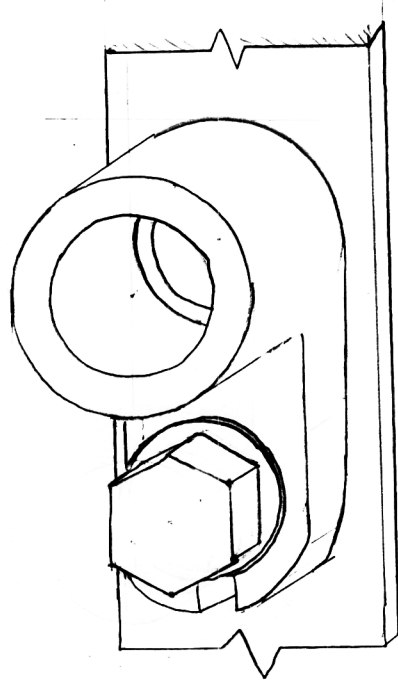
(b) The following orthogonal assembly drawing gives details of a pipe support bracket attached to a steel frame, drawn to a scale of 1 : 1.

3

PIPE SUPPORT
BRACKET

STEEL
FRAME

FRONT VIEW   SECTIONAL RIGHT
SIDE VIEW

On page 13, sketch a full-size pictorial view of the bracket and frame when viewed from the front. Do NOT include hidden outline. Do NOT section the sketch.

End of Question 12