

## 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 18 mm in diameter and 6 metres in length. A force of 30 kN 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

$$E = \frac{\text{Stress}}{\text{Strain}} = 210 \times 10^9 \quad \text{Strain} = \frac{\text{extension}}{\text{length}} = \frac{e}{6}$$

$$\text{Stress} = \frac{F}{A} = \frac{30 \times 10^3}{\pi (18 \times 10^{-3})^2}$$

$$\frac{30 \times 10^3}{\pi (18 \times 10^{-3})^2} \times \frac{6}{e} = 210 \times 10^9$$

$$e = \frac{30 \times 10^3 \times 6}{\pi \times (18 \times 10^{-3})^2 \times 210 \times 10^9}$$

$$e = 8.42 \times 10^{-4} \text{ m} \quad \text{Extension} = 0.84 \text{ mm}$$

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

It uses less steel to support the concrete.

It has increase in strength or impact

strength as ~~the~~ the force must overcome the

compressive forces of the prestressed concrete.

Question 12 continues on page 12

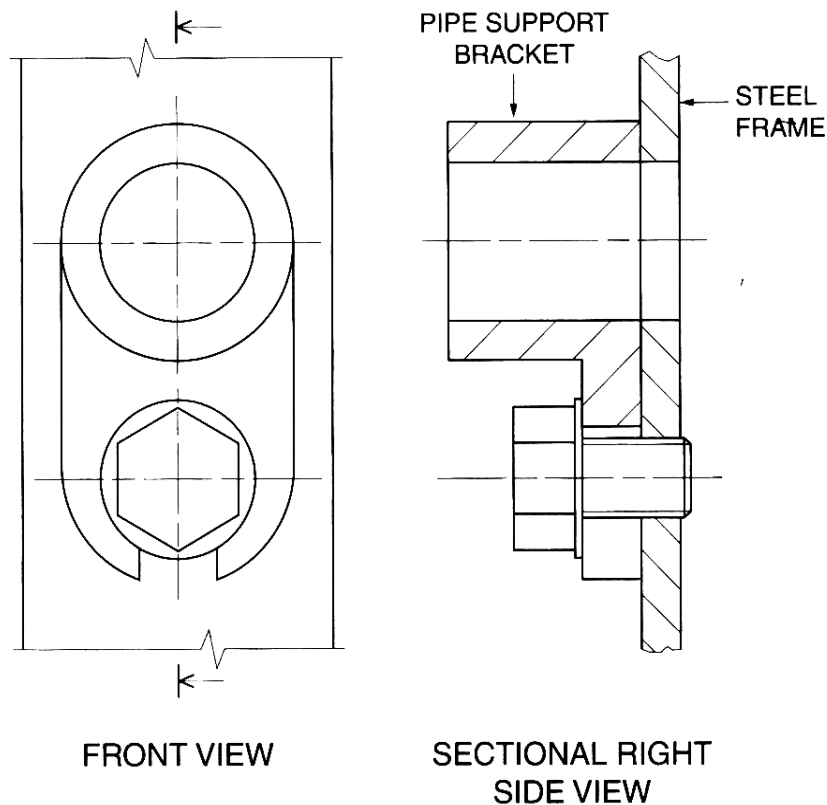
Question 12 (continued)

- (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

It is pre-fabricated ∴ less time wasted in setting and curing as with the concrete and less <sup>time wasted</sup> ~~work~~ for workers.

Timber is a natural resource which is readily available and can be recycled ∴ timber-laminate may be the better option.

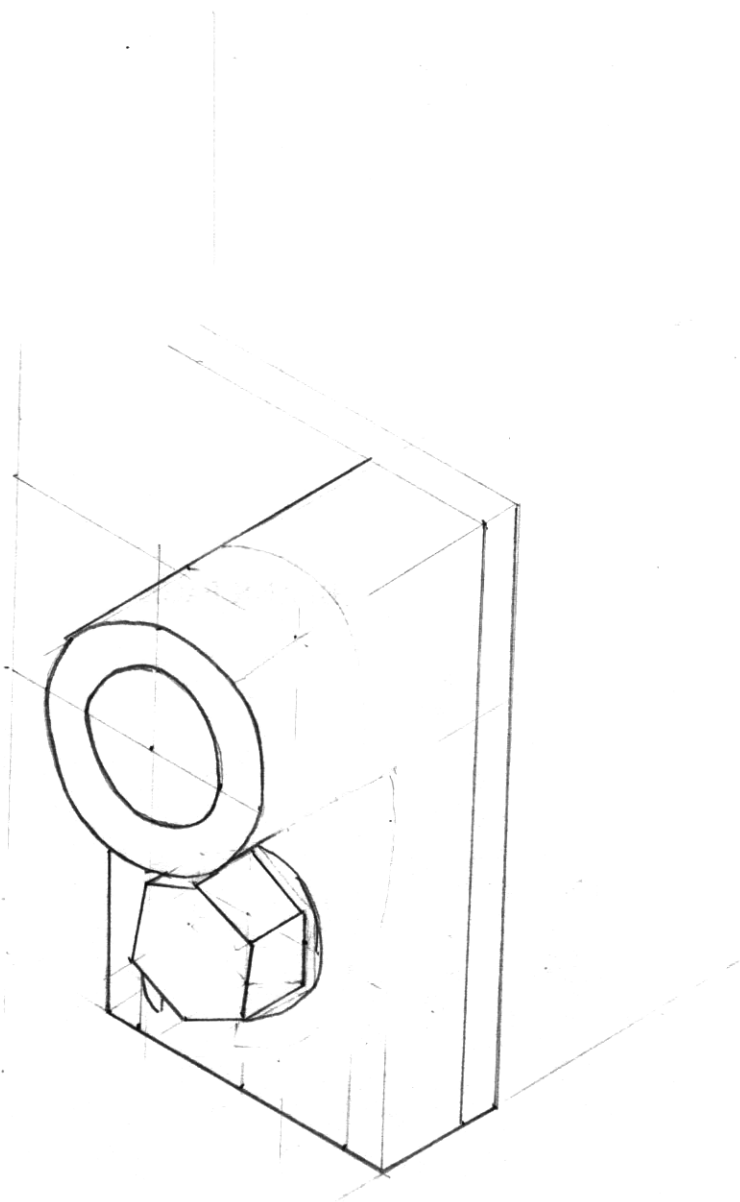
- (b) The following orthogonal assembly drawing gives details of a pipe support bracket attached to a steel frame, drawn to a scale of 1 : 1. 3



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.

Question 12 continues on page 13

Question 12 (continued)



**End of Question 12**