

2003 HIGHER SCHOOL CERTIFICATE EXAMINATION  
**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

$$\begin{aligned} \text{Stress} &= \frac{\text{Load}}{\text{Area}} \\ &= \frac{30000}{\pi \times 0.009^2} \\ &= 11789255.3 \text{ Pa} \end{aligned}$$

$$\begin{aligned} \text{Young's modulus} &= \frac{\text{stress}}{\text{strain}} \\ \therefore 210 \times 10^9 &= \frac{11789255.3}{\text{strain}} \\ \therefore \text{strain} &= 0.000561393 \\ &= \frac{\text{extension}}{\text{original extension}} \\ \therefore \text{Extension} &= \dots\dots\dots 0.0034 \text{ m} \\ &= 3.4 \text{ mm} \end{aligned}$$

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

Pre-stressed concrete beams are manufactured so that they have a constant compressive force holding them very strongly together, (rather than having steel simply inserted, the steel is 'tensioned' to create the compressive force during use).

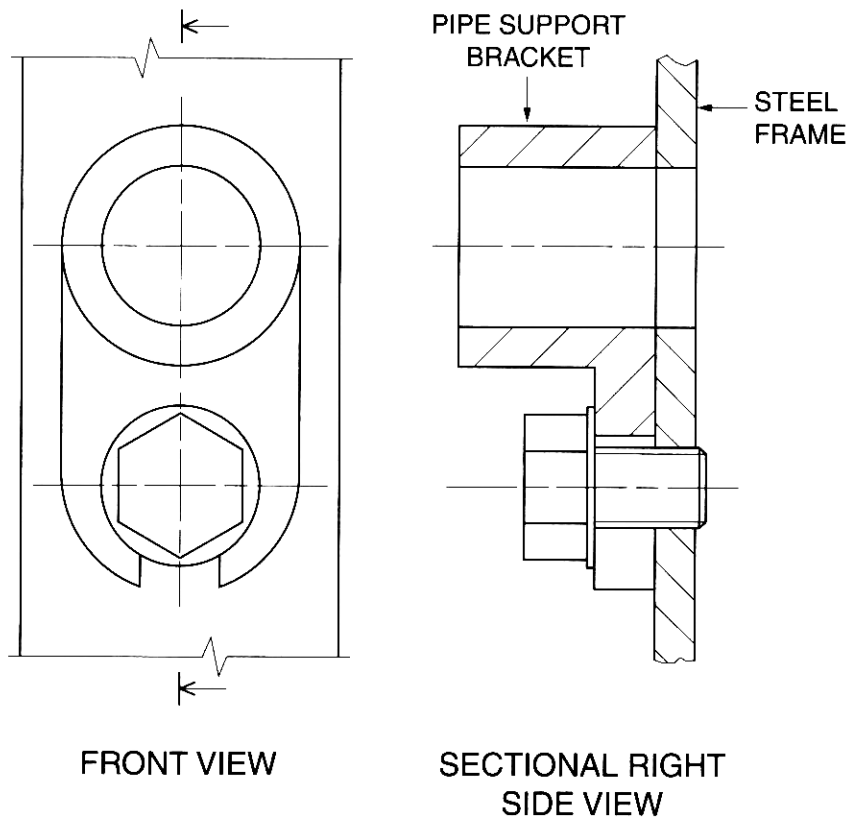
**Question 12 continues on page 12**

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

Timber laminate beams are lighter than pre-stressed concrete beams. They are also able to 'accept' bending more easily, and they do not suffer corrosion problems such as <sup>the</sup> 'rust' in reinforcing steels.

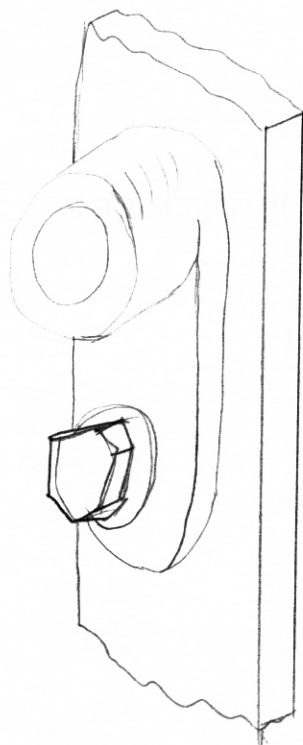
- (b) The following orthogonal assembly drawing gives details of a pipe support bracket attached to a steel frame, drawn to a scale of 1 : 1. 3



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**