GX 489

OLLSCOIL NA hÉIREANN, GAILLIMH
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B.E. DEGREE EXAMINATION

INELASTIC STRUCTURAL ANALYSIS

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Time allowed : ***Two*** hours

Answer ***Two*** questions

NOTE
The use of an electronic calculator is allowed.

Question 1

(a) Figure Q1 shows a prismatic beam with fully fixed end supports*(encastré)*, subject to the factored loading shown. It is also fully restrained laterally. This beam is made from a linear-elastic-perfectly-plastic material with $\mathbf{M_p = 375kNm}$. Analyse the beam on a step-by-step hinge-by-hinge basis and plot (and annotate) the load-deflection history to collapse. The material elastic modulus is **E**, and the second moment of area is **I**.

(b) Summarize, in tabular format, the progression of the bending moment diagram from the elastic stage to the ultimate collapse bending moment diagram.

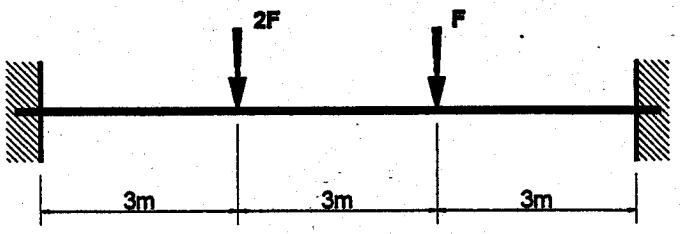

Figure Q1

Question 2

(a) Derive, from first principles, an expression for the partially-plastic moment of resistance of a beam, $\mathbf{M_p}$, of a linear-elastic perfectly-plastic material. The beam is rectangular in cross-section.

(b) Sketch your expression in a graph of $\mathbf{M_p}$ versus ε, the extreme fibre strain.

(c) Sketch a modified stress bock which includes the effects of strain hardening. Assume that a maximum strain hardening stress of $\mathbf{0.5\sigma_y}$ is achieved. From this modified stress bock, estimate approximately the extra ultimate plastic moment of resistance of a beam due to the effects of strain hardening.

(d) Sketch moment-rotation curves of beams of the following cross-sectional shapes, assuming a constant stiffness for the linear elastic portion of the curves: I-section, Circular tube, Rectangular tube, Rectangular solid, Diamond solid, Triangular solid.

Question 3

(a) Figure Q3 shows a pitched portal frame, which is of uniform cross-section throughout with a plastic moment of resistance of **Mpl=800kNm** and which has pinjointed feet. Find the value of **H**, which causes ultimate plastic collapse of the frame.

(b) Calculate and draw the corresponding ultimate plastic collapse bending moment diagram.