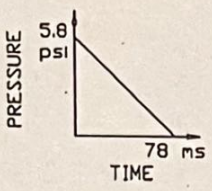
Instructions

1) Read the instructions carefully and sign the answer sheet. 2) Use a straight-edge to to draw labelled section details 4) Use the units given in the problem. Do not change from SI units to US Customary Units and Vice Versa. 5) Present your solutions in a clear, legible and logical manner. 6) Use the conventional units. 7) Assume data if not provided in the problem.

Problem 1 Consider a two bay pinned base rigid steel plane frame of height 15′2″ and bay width 16′6″. The frame is designed for a blast load represented by the given pressure time plot. The top beam, interior column and exterior column have the sections W 14 x 30, W 16 x 26 and W 16 x 40 respectively. $f_y = 36\ ksi$, $E = 30000\ ksi$



Designation Imperial *(in x lb/ft)*	Depth h *(in)*	Width w *(in)*	Web Thickness t_w *(in)*	Flange Thickness tr *(in)*	Sectional Area *(in^2)*	Weight *(lb/ft)*	Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
							I_x *(in^4)*	I_y *(in^4)*	S_x *(in^3)*	S_y *(in^3)*
W 14 x 30	13.84	6.730	0.270	0.385	8.85	30	291	19.6	42.0	5.8
W 16 x 26	15.69	5.5	0.250	0.345	7.68	26	301	9.6	38.4	3.5
W 16 x 40	16.01	6.995	0.305	0.505	11.8	40	518	28.9	64.7	8.3

Find

(i) The sidesway deflection δ as a fraction of the total height of the frame H

(ii) Find the rotations in individual members.

Problem 2

(i) A steel sphere of diameter 20 mm strikes a steel beam with a velocity of 30 m/s . The beam is simply supported with a length of 2 m and cross section 400 mm x 400 mm. $f_y = 500MPa$, $E = 2 \times 10^5\ MPa$, $\rho = 7830\ kg/m^3$

(a) Calculate the total time of contact.

(b) Sketch the contact force vs time plot for at least five pairs of values.

(ii) Calculate the reliability index of the beam in (i). Consider the C.O.V. for resistance and load be 10% and 20% respectively. (Hint : Consider the maximum contact force as a static load acting at the midspan of the beam and write the limit state function in terms of applied and resisting moment.)

Problem 3 Design a 1.5m x 3m steel panel with all four sides simply supported which is to be exposed to a blast load from an overhead explosion of 50 kg TNT at a height of 2m from the centre of the slab. Design such that maximum deflection exceeds 3 times the elastic deflection. $f_y = 550MPa$, $E = 2 \times 10^5\ MPa$, $\rho = 7830\ kg/m^3$

Problem 4 Design for flexure a simply supported steel roof beam of rectangular cross-section for a span of 7 m. The beam should withstand the shock wave from an air burst such that there is no residual deflection after the event. The design pressure is 300 kPa and the positive phase duration of the shock wave is 6 ms. $f_y = 500MPa$, $E = 2 \times 10^5\ MPa$, $\rho = 7830\ kg/m^3$

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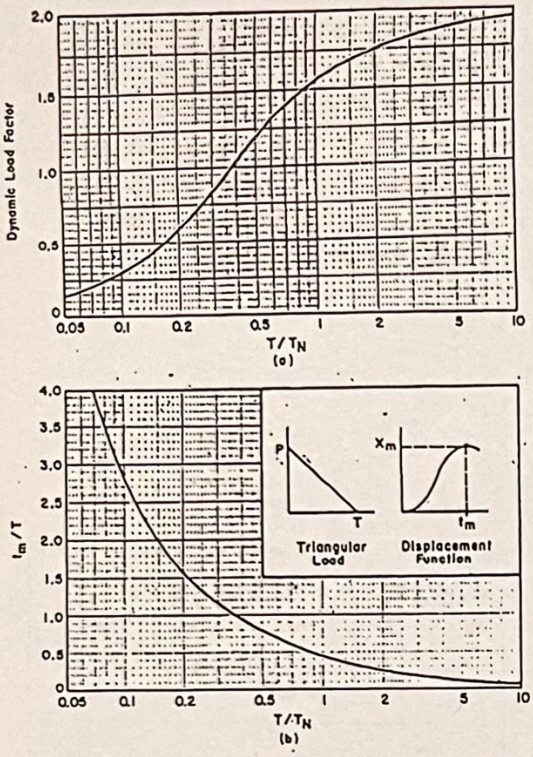

Figure 3-49 Maximum response of elastic one-degree-of-freedom system for triangular load

Figure 2-7 Positive Phase Shock Wave Parameters for a Spherical TNT Explosion in Free Air at Sea Level

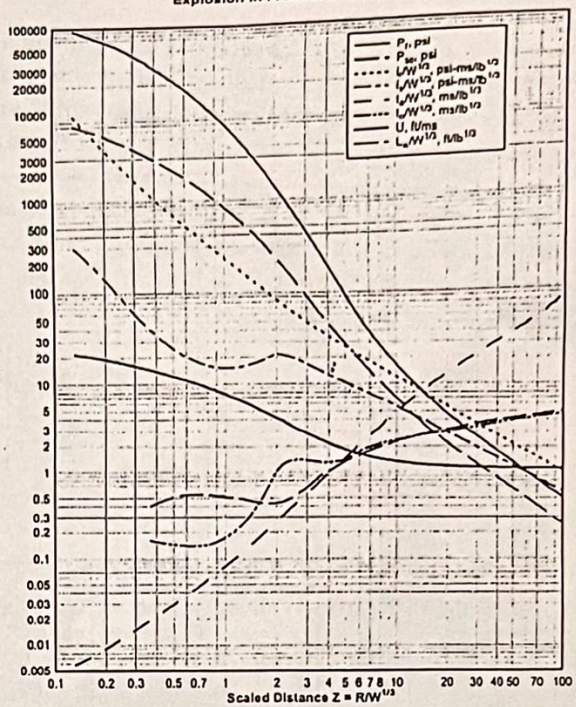

Figure 3-54 Maximum Deflection of Elasto-Plastic, One-Degree-of-Freedom System for Triangular Load