

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.

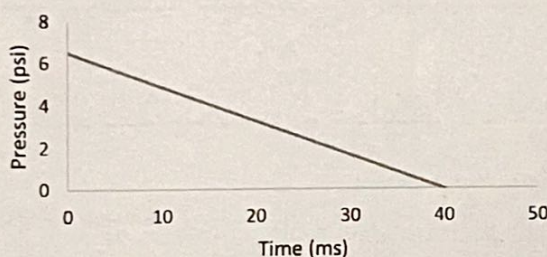
Problem 1 It is assumed that the strength of a RCC column is given by the sum of the strengths of concrete, C , and reinforcing bars B . C and B follow normal distributions with parameters given by

$$\mu_C = 25 \text{ N/mm}^2, \sigma_C = 5 \text{ N/mm}^2, \mu_{B_l} = 460 \text{ N/mm}^2, \sigma_{B_l} = 46 \text{ N/mm}^2$$

If the size of the column is 250 x 400 mm and if it is provided with four 20 mm diameter bars, determine the mean value and standard deviation of the strength of the column. The column is subjected to a dead load, D , and live load, L , with distributions $N(1500, 200)$ kN and $N(500, 200)$ kN respectively. Compute the reliability of the column.

Problem 2 A simply supported steel beam of span 17' with a spacing of 4.5" has the section W12x16 with the following sectional properties:

Section	$W(\text{lb/ft})$	$A(\text{in}^2)$	$D(\text{in})$	$I_x(\text{in}^4)$	$Z_x(\text{in}^3)$	$S_x(\text{in}^3)$	$r_x(\text{in})$	$I_y(\text{in}^4)$	$Z_y(\text{in}^3)$	$S_y(\text{in}^3)$	$r_y(\text{in})$
W12x16	16	4.71	12	103	20.1	17.1	4.67	2.82	2.26	1.41	0.773



The beam is subjected to an overhead explosion with the given pressure time history. Find out the maximum deflection at midspan when bending about x-axis is considered. $f_y = 36 \text{ ksi}$, $E = 30 \times 10^3 \text{ ksi}$

Problem 3

Consider two plank benches in which the top plank is 3m long made of metal alloy. The side planks are made of a rigid material not prone to buckling or yielding. Bench 1 has a top plank with a section 500 mm x 10 mm and a yield strength of 400 MPa. On the other hand bench 2 has a top plank with a section 300 mm x 15 mm and a yield strength of 393 MPa.



The buyer wants the bench to ideally accommodate six persons with an average weight of 80 kgs. Consider a 5 percent standard deviation for resistance and 20 percent standard deviation for load. Which plank bench should be purchased if cost is not an issue?

Problem 4

Design for flexure a cantilever steel roof beam of rectangular cross-section for a span of 5 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. $f_y = 500 \text{ MPa}$, $E = 2 \times 10^5 \text{ MPa}$, $\rho = 7860 \text{ kg/m}^3$

