



Printed Pages : 4

CE- 042

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0041

Roll No.

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B. Tech.

(SEM. VIII) EXAMINATION, 2006-07

CIVIL ENGINEERING

RELIABILITY BASED DESIGN

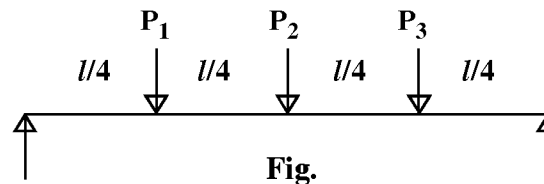
Time : 3 Hours]

[Total Marks : 100

1 Attempt any **four** of the following : **4×5=20**

- (a) Explain what do you understand by safety factors.
- (b) Discuss what you understand by random variable ?
What is function of random variable ?
- (c) Write short note on moments and expectations.
- (d) A simply supported beam is subjected to loads P_1 ,

P_2 and P_3 as shown



It is given that

$$E(P_1) = 20 \text{ kN} \quad \text{Vari}(P_1) = 2(\text{kN})^2$$

$$E(P_2) = 40 \text{ kN} \quad \text{Vari}(P_2) = 4(\text{kN})^2$$

$$E(P_3) = 50 \text{ kN} \quad \text{Vari}(P_3) = 10 (\text{kN})^2$$

Determine two expected value and standard deviation of the shear force at the left end if loads P_1 , P_2 , P_3 are statistically independent.

- (e) The cube strength of $M-20$ concrete follows the normal distribution with parameters $\mu = 29.16 \text{ N/mm}^2$ and $\sigma = 5.49$. What is the characteristics strength of concrete ?
- (f) If the ratio of mean value of the albe strength of M.15 concrete to its characteristic strength is 1.51 and the coefficient of variation of the strength of concrete is 0.24, determine the allowable stress for a reliability of 0.9999.

2 Attempt any **two** parts of the following : **2×10=20**

- (a) Two variable X and Y follow the lognormal distribution. If $z = XY$ and variables X and Y are statistically independent; prove that Z follows the log normal distribution.
- (b) The completion of water tank involves the successive completion of four stages. Let :
- A = Excauaton completed on time $P(A) = 0.9$
 B = Foundation completed on time $P(B) = 0.8$
 C = Column and bracings completed on time $P(C) = 0.7$
 D = Tank completed on time $P(D) = 0.7$
- If the events are statistically independent, what is the probability of the whole structure completed on time.
- (c) The cube strength of M-3T concrete, X_1 follows the normal distribution with parameter $\mu = 42.28 \text{ N/mm}^2$ and $\sigma = 5.6 \text{ N/mm}^2$ what is the probability of $X < 35$?

3 Attempt any **one** of the following : **20×1=20**

(a) If the probability density functions of resistance R and action S are

$$f_R = \lambda_R \exp(-\lambda_R r)$$

$$\text{and } f_S = \lambda_S \exp(-\lambda_S S)$$

derive an expression for reliability R_0 and prove that it is given by

$$R_0 = \frac{\lambda_S}{\lambda_R + \lambda_S}.$$

(b) A tension member of a steel truss is subjected to an axial load Q . The strength of the member is given by $f_y A$, where f_y is the yield strength of steel and A is the area of cross-section of the member. Given

$$\mu_Q = 20 \text{ kN}, \delta_Q = 0.4$$

$$\mu f_a = 286 \text{ N/mm}^2, \delta f_y = 0.1$$

find the area of the member for the specified reliability of 0.99865. That is $p_f = 1.35 \times 10^{-3}$

Assume variation in area is negligible.

4 Attempt any **one** part of the following : **20×1=20**

(a) The strength of an axially loaded short column is given by $R = 0.67 C A_C + A_S F$ where C is the cube strength of concrete F the yield strength of the reinforcing bars, A_C the area of concrete and A_S the area of steel.

Given size of the column = 250 mm×500mm

$$\mu_c = 19.59 \text{ N/mm}^2, \sigma_C = 4.1 \text{ N/mm}^2$$

$$\mu_F = 469 \text{ N/mm}^2, \sigma_F = 46.9 \text{ N/mm}^2$$

$$A_S = 1250 \text{ mm}^2$$

C & F are normally distributed. Determine the distribution of R using the Monte Carlo method.

- (b) Determine the reliability index for a steel tension member having tensile strength R, subjected to a tensile load Q . Given

$$\mu_R = 280 \text{ N/mm}^2, \sigma_R = 28 \text{ N/mm}^2$$

$$\mu_Q = 5000 \text{ N}, \sigma_Q = 2000 \text{ N}$$

$$\mu_D = 6 \text{ mm}, \sigma_D = 0.6 \text{ mm}$$

The members is circular in cross-section of diameter D .

5 Attempt any one part of the following :

- (a) A simply supported steel beam (RSJ) of span 8 m is designed for the following data :

<i>Variable</i>	$\frac{\text{Mean}}{\text{Nominal}}$	<i>Nominal Value</i>	δ	<i>Distribution</i>
X_1 : Yield strength of steel	1.10	250 N/mm ²	0.10	normal
X_2 : Dead wad	1.05	11.0 N/mm ²	0.10	normal
X_3 : Live wad	0.70	12.0 N/mm ²	0.40	normal

Determine the partial safety factors for the design variables X_i if the target reliability is 4.0.

- (b) Design cantilever steel beam of span (2.5, 0.015)M with a concentrated load of (180, 10) kN at the free end. Take the reliability level of 5. Assume normal distribution.

