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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

First Semester, M. Tech - Civil Engineering (MCAD)

Semester End Examination; Jan. - 2020

Reliability Analysis and Design of Structural Elements

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

ii) Use of statistical table is allowed. iii) Missing data, if any, may be suitable assumed.

UNIT - I

1 a. The compressive strength in N/mm^2 of 20 concrete cubes from a building project is as follows: Find range, mean, variance and standard deviation. 10

17.24	19.73	17.60	19.85	21.42	13.60	13.96	13.87	15.65	13.96
16.18	17.24	18.76	20.07	22.31	14.98	15.64	15.75	16.27	15.58

b. Following are the results obtained in an experiment. Calculate mean, standard deviation and coefficient of variation. Plot a histogram. Determine the chance of getting a value; 10

i) Less a than 6

ii) Between 12 and 18

iii) Greater than 24

2	7	9	10	20	21	22	13	14	13	19	26	28	15	16

2 a. The cube strength of concrete X follows the normal distribution with parameter μ_x = 30 N/mm^2 and σ_x = 4 N/mm^2. Calculate the probability of getting a value for a strength, 10

i) Less than 40 N/mm^2

ii) Greater than 25 N/mm^2

b. The compressive strength Y of M_{15} concrete follows the log normal distribution. It is given that μ_y = 24.04 N/mm^2, σ_y = 5.76 N/mm^2. Determine the probability of getting strength less than the specified value of 15 N/mm^2. 10

UNIT - II

3 a. Fit a straight line to the following data: 10

x	71	68	73	69	67	65	66	67
y	69	72	70	70	68	67	68	64

b. For the data given below, find the equation to the best fitting exponential curve of the form $y = ae^{bx}$. 10

x	1	2	3	4	5	6
y	1.6	4.5	13.8	40.2	125	300

4 a. List the properties of correlation coefficient. 5

b. Write a note on skewness and kurtosis. 5

Contd....2

c. The field data of soil samples collected from various depths is given below. Obtain the correlation coefficient between the depth and soil shear strength. 10

Depth (m)	2	3	4	5	6	7
Shear Strength (kN/m^2)	14.8	20.3	32.2	39.0	42.0	56.2

UNIT - III

5 a. 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, $\mu_Q = 30$ kN, $\delta_Q = 0.4$, $\mu_{fy} = 280$ N/mm^2, $\delta_{fy} = 0.2$ 10

Find the area of the member for the specified reliability of 0.99865. Neglect the variation in area.

b. A simply supported beam of span 'l' is subjected to a uniformly distributed load of 'ω' kN/m throughout the span. Establish the statistics of maximum deflection. 10

Given; l = N (4.3.0.35) m, ω = N (32, 2.6) kN/m

E = N ($2x10^5$, $0.2x10^5$) N/mm^2 I = N ($4.5x10^7$, $230x10^6$) mm^4

6 a. It is assumed that the strength of a RCC column is given by the sum of the strengths of concrete f_{ck} and reinforcing bars f_y, f_{ck} and f_y follows normal distributions with parameters given by,

$\mu_{fck} = 29$ N/mm^2 $\sigma_{fck} = 5$ N/mm^2 $\mu_{fy} = 460$ N/mm^2 $\sigma_{fy} = 46$ N/mm^2

If the size of the column is 250 mm × 400 mm and if it is provided with four bars of 20 mm diameter, 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. 10

b. The strength of a column is given by $R = \dfrac{\pi^2 EI}{a^2}$

Given; $\mu_E = 2.03 \times 10^5$ N/mm^2 and $\delta_E = 0.1$

$\mu_I = 12.5 \times 10^6$ mm^4 and $\delta_I = 0.05$

$\mu_a = 5000$ mm and $\delta_a = 0.05$ 10

$\mu_Q = 700$ kN and $\delta_q = 0.3$

Where Q is the total load on the column. All the variables are log normally distributed. Determine the probability of failure and reliability of the column.

UNIT - IV

7. Determine the reliability index for a steel tension member having tensile strength R. Subjected to a tensile load Q by FOSM method. The safety margin is given by,

i) $M = \dfrac{\pi D^2}{4} - \dfrac{Q}{R}$ ii) $M = D - 2\sqrt{\dfrac{Q}{\pi R}}$ 20

All the variables are normally distributed.

Given; $\mu_R = 280$ N/mm^2 $\sigma_R = 28$ N/mm^2

$\mu_Q = 5000$ N $\sigma_Q = 2000$ N

$\mu_D = 6$ mm $\sigma_D = 0.6$ mm

Contd….3

8. Determine the reliability index by AFOSM method for a simple supported I beam in the limit state of shear. The beam carries a point load 'Q' at mid span. All the variables are normally distributed. 20

$\mu_Q = 4000$ N	$\sigma_Q = 1000$ N
$\mu_{FS} = 95$ N/mm^2	$\sigma_{FS} = 10$ N/mm^2
$\mu_D = 50$ mm	$\sigma_D = 2.5$ mm
$\mu_{tw} = 1.25$ mm	$\sigma_{tw} = 0$

UNIT - V

9. Determine the reliability index by AFOSM method for a steel member having tensile stress R subjected to a tensile load Q. The failure function is given by, $R - \frac{4Q}{\pi D^2} = 0$ 20

Given;

R = N (280, 28) N/mm^2

Q = N(5000, 2000)N

D = N(6, 0.6) mm

10. The strength of an axially loaded short column is given by $R = 0.67CA_c + A_s.F$ 20

Where C is the cube strength of concrete, F is the yield strength of reinforcing bars, A_C is the area of concrete and As is the area of steel.

Given;

C = N(19.54, 4.1) N/mm^2	F = N(469, 46.9) N/mm^2
$A_c = 125000$ mm^2	$A_s = 1250$ mm^2

Generate the statistics of R (10 values). Compare the values with the theoretical values and find the percentage error.

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