National Exams December 2017

16-Civ-B11: Structural Materials

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit a clear statement of any assumptions made with the answer paper.

2. This is an OPEN BOOK examination. **One *Text Book*** of candidate's choice is allowed. *NO Hand Written* **materials are permitted**.

3. Please answer all 5 (FIVE) questions. All questions carry equal weight.

4. In case of numerical problems, the candidate needs to show all works. For non-numeric questions, clarity and organization of the answer are important.

5. Any non-communicating calculator is permitted

6. The exam has five pages including this one, Please check that your exam has all pages.

Q.1

(a) Define static and dynamic load application with examples. What do you mean by time-dependent response of materials? Explain Creep and viscous flow with specific examples. (3+3+4 = 10 points)

(b) Figure below shows the stress-strain relationships of metals A and B during tension test until fracture. Determine the following for the two metals.

   I. Proportional limit
   II. Yield stress at an offset stain of 0.002 in/in
   III. Ultimate strength
   IV. Modulus of resilience
   V. Toughness
   VI. Which metal is more ductile and why?
(10 points)
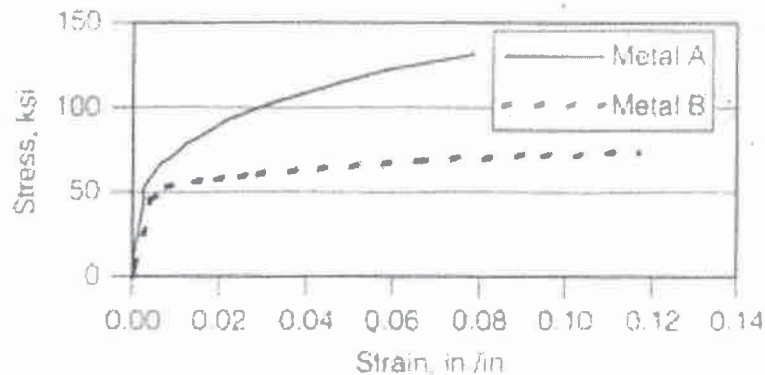
Q.2

(a) The following laboratory tests were performed on aggregate samples:

   I. Specific gravity and absorption
   II. Soundness, and
   III. Sieve analysis test

List the significance and use of each of these tests. (6 points)

(b) Perform the sieve analysis of the following aggregate and determine the fineness modulus (FM) for the aggregate sample. Plot percent passing versus sieve size graph and comment on the gradation based on the shape of graph. (14 points)

Sieve Size, mm	Amount Retained, gm
25	0
9.5	35.2
4.75	299.6
2.00	149.7
0.425	125.8
0.075	60.4
Pan	7.3

Q.3
(a) Define curing of Portland cement concrete and its importance. What do we mean by alternatives to conventional concrete? Identify any four alternative concrete with their application and advantages. (2+2+6 =10 points)

(b) In a ready mix plant, cylindrical samples are prepared and tested periodically to detect any mix design problems and to ensure that the compressive strength is higher than the lower specification limit. The minimum target value for compressive strength was set at 4000 psi. The following compressive data were collected.

Sample No.	Compressive Strength, psi	Sample No.	Compressive Strength, psi
1	4915	14	5772
2	4732	15	4270
3	5670	16	5096
4	4310	17	4670
5	6110	18	5174
6	4316	19	5434
7	5240	20	3692
8	4950	21	4510
9	5230	22	3680
10	4190	23	4100
11	5770	24	3680
12	4524	25	3910
13	4056		

Calculate the mean, standard deviation, confidence interval (CI), and the coefficient of variation of the test data. Is the plant production meeting the specification requirement? If not, comment on possible reasons. Comment on the quality of data. (10 points)

Q.4
(a) For asphalt concrete, define (6 points)
    i. Air voids (VTM)
    ii. Voids in the mineral aggregate (VMA)
    iii. Voids filled with asphalt (VFA)

(b) The Marshall method was used to design an asphalt concrete mix. An AC-30 asphalt cement with a specific gravity (G_b) of 1.031 was used. The mix contains a 9.5 mm nominal maximum particle size aggregate with a bulk specific gravity (G_{sb}) of 2.696. The theoretical maximum specific gravity of the mix (G_{mm}) at asphalt content of 5.0% is 2.470. Trial mixes were made with average results as shown in the following table.

Asphalt Content P_b (% by Weight of Mix)	Bulk Specific Gravity (G_{mb})	Corrected Stability	Flow (0.25 mm)
4.0	2.360	6.3	9
4.5	2.378	6.7	10
5.0	2.395	5.4	12
5.5	2.405	5.1	15
6.0	2.415	4.7	22

Determine the design asphalt content using the Asphalt Institute design criteria for medium traffic. Use design air void content of 4% to find minimum VMA. (14 points)

Q.5
(a) A wood specimen was prepared with actual dimensions of 1 inch x 1 inch x 4 inch and grains parallel to the length. The specimen was subjected to compression parallel to the grains to failure. The load-deformation results are given below.

Load-Deformation Table

Load, lb	Displacement, inch
0	0
7	0.012
10	0.068
87	0.164
530	0.180
1705	0.208
2864	0.236
3790	0.268
4606	0.300
5338	0.324
5116	0.360
4468	0.384
4331	0.413

Plot the stress-stain relationship and calculate the modulus of elasticity. What is the failure stress? (11 points)

(b) The following laboratory tests are performed on steel specimen:

 i. Tension Test
 ii. Charpy V notch test
 iii. Bend test

What are the significance and use of these tests? (9 points)

Semi-Logarithmic
3 Cycles x 10 to the inch