**Birla Institute of Technology & Science, Pilani- Pilani Campus**

**Second Semester 2022-2023**

**Comprehensive Exam**

Course No: CE G518 Course Title: Pav. Ana. Design
Nature of Exam: Closed Book Max. Marks: 85 (Weightage: 35%)
Duration: 180 Min Date of Exam: 17/05/2023

**Note:**

1. All questions are compulsory.
2. Assume the date from relevant code if required.
3. Figures to the right indicate full marks.

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Q. 1

A cement concrete pavement is to be designed for a four-lane divided national highway with two lanes in each direction in the state of Karnataka. Design the pavement for a period of 30 years. Lane width = 3.5 m; transverse joint spacing = 4.5 m. It is expected that the road will carry, in the year of completion of construction, about 5000 commercial vehicles per day in each direction. The proportion of traffic in predominant direction is 50%. Axle load survey of commercial vehicles indicated that the percentages of front single (steering) axle, rear single axle, rear tandem axle and rear tridem axle are 40%, 25%, 15% and 20% respectively. The percentage of commercial vehicles with spacing between the front axle and the first rear axle less than 4.5 m is 60%. Traffic count indicates that 65% of the commercial vehicles travel during night hours (6 PM to 6 AM). Details of axle load spectrum of rear single, tandem and tridem axles are given in Table 1. The average number of axles per commercial vehicle is 2.30. Subgrade CBR is 8%. Estimate the safe thickness of PQC layer using IRC 58:2015 method for debonded concrete pavement with tied concrete shoulder with doweled transverse joints. The thickness of granular sub-base and DLC layer are 225 mm and 150 mm, respectively. [45]

**Table 1: Axle load spectrum data**

| Single Axle | | Tandem Axle | | Tridem Axle | |
|---|---|---|---|---|---|
| Axle load class (kN) | Frequency (% of single axles) | Axle load class (kN) | Frequency (% of tandem axles) | Axle load class (kN) | Frequency (% of tridem axles) |
| 185-195 | 26 | 380-400 | 40 | 530-560 | 25 |
| 175-185 | 29 | 360-380 | 40 | 500-530 | 20 |
| 165-175 | 25 | 340-360 | 10 | 470-500 | 25 |
| 155-165 | 20 | 320-340 | 10 | 440-470 | 30 |
| | 100 | | 100 | | 100 |

Q. 2

The deflection values measured for a road section are given in the Table 2. The other data measured during the collection of deflection data is mentioned below.
Pavement temperature: 40°C
Sub-grade gravelly soil with PI>15
Moisture Content: 07%
Annual rainfall: 1500 mm
Existing traffic: 8000 cvpd
Design period: 10 years
Traffic growth rate: 7%
VDF: 4.2
Dual carriageway with dual 5 lane carriageway

**Table 2: Deflection Data**

| Sr. No. | $D_o$ | $D_i$ | $D_f$ |
|---|---|---|---|
| 1 | 100 | 80 | 75 |
| 2 | 100 | 61 | 60 |
| 3 | 100 | 88 | 84 |
| 4 | 100 | 56 | 53 |
| 5 | 100 | 74 | 71 |
| 6 | 100 | 89 | 86 |
| 7 | 100 | 71 | 67 |
| 8 | 100 | 73 | 71 |
| 9 | 100 | 59 | 57 |
| 10 | 100 | 73 | 67 |

Design the overlay for the pavement which is on a national highway. [20]

Q. 3 A 4 lane interstate pavement with doweled joints and concrete shoulders, has 7 inch thick cement treated subbase on subgrade with k = 150 pci, MR of concrete = 650 pci and expected load repetitions are given in Table 3. Assume trial thickness of 12 inch. Take LSF = 1.2. Estimate whether the 12 inch thickness of PQC layer is adequate by using PCC method. [20]

**Table 3: Expected load repetitions**

| Single axle load (kip) | Frequency (no. of repetitions) | Tandem axle load (kip) | Frequency (no. of repetitions) |
|---|---|---|---|
| 36 | 7000 | 70 | 30000 |
| 32 | 14000 | 65 | 55000 |
| 28 | 32000 | 60 | 80000 |
| 24 | 65000 | 55 | 3000000 |
| 20 | 125000 | 50 | 4000000 |
| 16 | 250000 | 45 | 2000000 |