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SECTION A

Semester 6th

Subject Highway & Traffic Engg

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Q.No 1

Part (a)

Answer:-

Flexible Pavements:- Flexible pavements typically distribute wheels loads to lower layers of the pavement section & consists generally of bituminous material.

Rigid Pavements:- are typically distribute wheel loads over a wide area of the subgrade & consists generally of cement concrete & may be reinforced with steel.

Differences b/w Flexible & Rigid Pavements

1. Bitumen is used a binder in Flexible Pavement.	1. cement is used as a binder in rigid pavement.
2. Deformation in the subgrade is transferred to the	2. Deformation in the sub grade is not transferred

upper layer.	to subsequent layers.
3. Load is transferred by grain to grain contact.	3. No such phenomenon of grain to grain load transfer exists.
4. Have low life span usually 10-15 years.	4. Life span is more as compare to flexible usually 30+ years.
5. Road can be used for traffic within 24 hours.	5. Road cannot be used until 14 days of curing.
6. Have low initial cost but have high maintenance cost.	6. Have low maintenance cost but have high initial construction cost.
7. Easy to locate the underground works like pipe location etc	7. Difficult to do the underground works.
8. Repair work is easy.	8. Repair work is tough.

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Part (b)

Advantages of W.B.M over W.M.M :-

→ The water bound macadam construction of base course is less costly than the wet mix macadam as its specifications do not involve the use of mixing plant & paver.

→ water bound macadam requires more time for construction.

→ Wet mix macadam roads are superior the water bound macadam in all aspects but the WBM is the old method of construction having low construction cost because it has been traditionally a labour oriented specifications.

→ water bound macadam is less costly as compared to bituminous base course

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Part (c)

Bitumen :-

→ A class of black or dark-colored (solid, semi-solid or viscous) cementitious substances, natural or manufactured, composed principally of high molecular weight hydrocarbons found in Asphalts. Tars, Pitches, & Asphaltites are typical.

→ The liquid binder that holds asphalt together.

→ Composition (Partially hydrogenated polycyclic aromatic compound) $C_{10}H_8$.

→ Density of bitumen => 1040 kg/m^3

→ Boiling point of bitumen => 525°C

Asphalt :-

→ A dark brown to black cementitious material in which the predominating constituents are bitumens which occur in nature or are obtained in fractional distillation of petroleum (crude oil) along with certain mineral matter.

→ Both Asphalt & Bitumen are same & are "Asphalt".

→ Asphalt is a composite mix of Aggregate, sand, stone dust, Bitumen.

→ 95% stone, sand & 5% as a binder bitumens.

→ In Plants

Temperature (150 to 190°C)
Density => 2330 kg/m^3
less Flexible pavement => (10-14mm)
more Flexible pavement => (5-10mm).

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Q.No 2

A crest vertical curve joining a +3 percent & a -4 percent grade is to be designed for 75 mi/h...... calculate the elevations of intermediate points on the curves at the whole station.

Solution:-

For a design of 75 mi/h, K = 312

Minimum length $= 312 \times [3-(-4)] = 2184$ ft.

Station of BVC $= (345+60) - \left(\frac{21+84}{2}\right)$

$= 334+68$

Station of EVC $= (334+68) + (21+84)$

$= 356+52$

Elevation of BVC $= 250 - \left(0.03 \times \frac{2184}{2}\right)$

$= 217.24$ ft.

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Station	Distance from BVC (x) (ft)	Tangent Elevation (ft)	Offset $\left[Y = \frac{Ax^2}{200L}\right]$ (ft)	Curve Elevation (Tangent Elevation Offset) (ft)
BVC 334+68	0	217.24	0.01	217.24
BVC 335+00	32	$217.24 + \frac{32}{100} \times 3$ = 218.20	0.02	218.18
BVC 336+00	132	221.20	0.28	220.92
BVC 337+00	232	224.20	0.86	223.34
BVC 338+00	332	227.20	1.77	225.43
BVC 339+00	432	230.20	2.99	227.21
BVC 340+00	532	233.20	4.54	228.66
BVC 341+00	632	236.20	6.40	229.80
BVC 342+00	732	239.20	8.59	230.61
BVC 343+00	832	242.20	11.09	231.11
BVC 344+00	932	245.20	13.92	231.28
BVC 345+00	1032	248.20	17.07	231.13
BVC 346+00	1132	251.20	20.54	230.66
BVC 347+00	1232	254.20	24.32	229.88
BVC 348+00	1332	257.20	28.43	228.77
BVC 349+00	1432	260.20	32.86	227.34
BVC 350+00	1532	263.20	37.61	225.59
BVC 351+00	1632	266.20	42.68	223.52

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BVC 352+00	1732	269.20	48.07	221.13
BVC 353+00	1832	272.20	53.79	218.41
BVC 354+00	1932	275.20	59.82	215.38
BVC 355+00	2032	278.20	66.17	212.03
BVC 356+00	2132	281.20	72.84	208.36
EVC 356+52	2184	282.76	76.44	206.32

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Q.No 3

Ans:- **Step # 01:-**

Draw a line joining the reliability level of 99 % & the overall standard deviation so of 0.49 & extend line to intersect the first T.L line at point A.

Step # 02:-

Draw a line joining point A to the ESAL of 2×10^6 & extend this line to intersect the first TL line at point B.

Step # 03:-

Draw a line joing point B & resilient modulus (M_R) of base course & extend this line to intersect the design serviceability loss chord at point C.

Step # 04:-

Draw a horizontal line from point C to intersect the design serviceability loss (PSI) curve at point D, where

$\Delta PSI = 4.5 - 2.5$
$= 2$

Step # 05:-

The structure number require to protect the base coarse & to find the thickness D_1 of the surface coarse is 2.6.

Step # 06:-

Determine the appropriate structure layer co-efficient for each construction material - resilient value of Asphalt = 4,50,000 lb/in³
therefore a_1 0.44

$D_1 = SN_1/a_1$

$= 2.6/0.44 = 5.9''$

Thickness should be taken to the nearest 0.5 inches so the thickness of the surface coarse is 6"

$SN_1 = D_1 \times a_1$
$= 6 \times 0.44$
$= 2.64.$

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Now to find SN_2 & D_2 (Base coarse) find the value of a_2 from layers coefficient table & m_2 from drainage co-efficient table.

Thickness of base coarse (D_2)

$D_2 = (SN_2 - SN_1)/a_2m_2$

$D_2 = (3.8 - 2.64)/0.14 \times 0.80$

$D_2 = 10.36''$

Use 12''

So the thickness of base coarse is 12''

$SN_2 = 0.14 \times 0.80 \times 12 + SN_1$

$SN_2 = 1.34 + 2.64$

$SN_2 = 3.98$

→ Finding SN_3 & D_3 (Subbase Coarse) & also layer co-efficient a_3 & drainage co-efficient m_3 from their respective table.

$D_3 = (SN_3 - SN_2)/a_3m_3$

$D_3 = (4.4 - 3.98)/0.10 \times 0.80$

$D_3 = 5.24''$

We will use 6" as a sub base

$SN_3 = 2.64 + 1.34 + 6" \times 0.10 \times 0.80$

$SN_3 = 4.46 > 4.4$ okay

Final design:-

Surface coarse = 6"
→ Base Coarse = 12"
→ sub base = 6"
→ Total pavement thickness = 24"

Q.No 4

Pavement Distresses:-

Distresses is a condition of the pavement structure that reduces serviceability or leads to a reduction in service life.

→ Distresses could occur in a pavement due to

⇒ Unstable mixes
⇒ Higher wheel loads than those considered in design.

Alligator (Fatigue) Cracking:-

→ **Possible Causes:**

⇒ Overloading
⇒ Inadequate structural design
⇒ Poor construction.

→ **Repair**

⇒ Crack sealing is in effective
⇒ Dig out & replace area of poor subgrade

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Block Cracking:-

→ **Problem:-**
Allow moisture in filtration

→ **Possible causes:**

⇒ HMA shrinkage
⇒ Asphalt binder aging.
⇒ Poor choice of asphalt binder in the mix design.

→ **Repair:-**

⇒ Low severity cracks (< 1/2 inch wide).
Crack seal to prevent entry of moisture.

⇒ High severity cracks (> 1/2 inch wide & cracks with raveled edges).
Remove & replace the cracked pavement layer with an overlay.

Potholes:-

→ Small, bowl-shaped depressions in the pavement surface that penetrate all the way through the HMA layer down to the base course.

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→ Potholes are most likely to occur on roads with thin HMA surfaces (1 to 2 inches) & seldom occur on roads with 4 inch or deeper HMA surfaces.

→ **Problem:-** Roughness (serious vehicular damage can result from driving across potholes at higher speeds); moisture infiltration.

→ **Possible causes:-** Generally, potholes are the end result of fatigue cracking. As fatigue cracking becomes severe, the interconnected cracks create small chunks of pavement, which can be dislodged as vehicle drive over them.

→ **Repair:-** Patching techniques.

Rutting:-

→ Surface depression in the wheel path, are particularly evident after a rain when they are filled with water.

→ Surface depression in the wheel path, are particularly evident after a rain when they are filled with water.

→ **Possible causes:-**

⇒ Insufficient compaction of HMA layers during construction.

⇒ subgrade rutting (e.g., as a result of inadequate pavement structure)

→ **Repair:-**

⇒ Slight ruts (< 1/3 inch deep) can generally be left untreated Pavement with deeper ruts should be leveled & overlayed.

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Bleeding:-

→ **Problem:-** Loss of skid resistance when wet.

→ **Possible Cause:-**

⇒ Excessive asphalt binder in the HMA

⇒ Excessive application of Asphalt binder during BST application

⇒ low HMA air void content.

Polished Aggregate:-

→ **Possible Causes:-** Repeated traffic applications. This can occur quicker if the aggregate is susceptible to abrasion.

→ **Repair:-** Apply a skid-resistant slurry seal, BST or non-structural overlay.

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Raveling:-

→ Loose debris on the pavement which increases pavement roughness & loss of skid resistance.

→ **Possible causes:-**

⇒ Asphalt binder aging

⇒ Aggregate segregation. If fine particles are missing from the aggregate matrix.

⇒ Inadequate compaction during construction.

→ **Repair:-** Fog Seal / slurry Seal or Remove the damaged pavement & overlay.