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SECTION	'A'
SEMESTER	6th
SUBJECT:	HIGHWAY and TRAFFIC ENGINEERING
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QUESTION: 01

PART: (a)

FLEXIBLE PAVEMENT	RIGID PAVEMENT
1. It typically distribute weight loads to lower layers of pavement section	1. It typically distribute wheel load over a wide area of sub-grade
2. It consists generally of bituminous material	2. It generally consists of cement concrete and may be reinforced with steel
3. Deformation in subgrade is transferred to upper layers.	3. Deformation in subgrade is not transferred to subsequent layers.
4. It has low initial construction cost but high maintainance cost	4. It has low maintainance cost, but high initial construction cost.
5. Load is transferred by grain to grain contact.	5. No such load transfer by grain to grain contact exists.
6. Surfacing can not be laid directly on to subgrade therefore subbase is required.	6. Surfacing can be laid directly on sub grade
7. Life span is low i.e usually 10-15 years.	7. Long life span as compared to flexible pavement i.e 30+ years.
8. Strength of road is highly dependent on strength of subgrade	8. Strength of road is less dependent on strength of subgrade
9. Roads can be used for traffic within 24 hrs.	9. Roads can't be used till 14 days of curing.

PART: C b)

The advantage of water bound over Wet mix Macadam is that water bound macadam is cheaper as less costly as compared to wet. Mix Macadam which is costlier. The reason for high cost of Wet mix macadam is that specification involve the use of mixing plant and paver while water bound Macadam is a labour oriented specification.

PART: (c)

ASPHALT	BITUMEN
1. A dark brown to black cementitious material in which predominating constituents are bitumen which occur in nature or obtained in fractional distillation of petroleum (crude oil) along with certain Mineral Matter	1. A class of black or dark coloured cementitious substance which might be solid, semi-solid or viscous, natural or manufactured, composed principally of high Molecular weight hydrocarbons found in Asphalts.
2. Asphalt refer to combination of bitumen and gravel specifically for road construction.	2. Bitumen is actually liquid binder that holds asphalt together.
3. Surface of made of Asphalt is smoother & more skid resistant, ensuring drivers safety.	3. Loose fragments on bitumen pavement make driving experience noisier and can wear down tires. therefore cause safety issues.
4. Reduced friction between tire and car, meaning better fuel economy and minimization of CO_2 emission.	4. Higher frictional resistance of bitumen pavement means less efficiency in energy utilization
5. Installation is relatively costlier	5. Cheap to install as compared to asphalt.

QUESTION: 02

REQUIRED:

Station of BVC = ?
Station of EVC = ?
Elevation of BVC = ?
Elevation at intermediate points on curve at whole station.

SOLUTION:

For a design speed of 75 mi/h.

K = 312

We know

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

	Station	Distance from BVC, x ft	Tangent Elevation (ft)	offset $r = \left[\frac{Ax^2}{200L}\right]$ (ft)	Curve Elevation (Tangent elevation − offset) x ft
BVC	334+68	0	217.4	0.01	217.24
BVC	335+00	32	$217.4+\frac{32}{100}\times 3 = 218.20$	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
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
BVC	356+52	2184	282.76	76.44	206.32
BVC	356+82				

QUESTION: 03

Given Data:

Resilient Modulus of Asphalt concrete at 68°F
450,000 lb/in²

CBR value of Base course 100 . Mr 31,000 lb/in²

CBR value of sub base course Material 22
Mr. 13,500 lb/in²

CBR value of subgrade material = 6
Mr of subgrade 6 = 1500 lb/in² = 9000 lb/in².

ANSWER :

Step:1 Draw a line joining the reliability level of 99% and overall standard deviation So of 0.49. and extend line to intersect the first TL line at point A.

STEP: 02

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

STEP: 03

Now, Draw a line joining point B and resilient Modulus (MR) of base course and extend this line to intersect the design serviceability loss chart at point C.

STEP : 04

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

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

STEP: 05

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

STEP: 06.

Determine appropriate structure layer co-efficient for each construction material. Resilient value of asphalt = 450,000 lb/in² 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" so the thickness of surface course is 6".

$$SN_1 = D_1 \times a_1$$

$$= 6 \times 0.44 = 2.64$$

Now find SN_2 and D_2 (Base course)

find value of a_2 from layer co-efficient table and m_2 from drainage coefficient table

→ Thickness of Base course (D_2)

$$D_2 = (SN_2 - SN_1) / a_2 m_2$$

$$= (3.8 - 2.64) / 14 \times 0.80$$

$$D_2 = 10.36''$$

Now use 12"

So thickness of Base course is 12"

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

$$= 1.34 + 2.64$$

$$SN_2 = 3.98$$

→ Finding SN_3 and D_3 (sub base) and also layer co-efficient a_3 and drainage co-efficient m_2 from their respective table.

$$D_3 = (SN_3 - SN_2) / a_3 m_3$$

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

$$D_3 = 5.24$$

We will use 6" as a sub base

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

$$SN_3 = 4.46 > 4.4 \quad \text{okay.}$$

FINAL DESIGN:-

⇒ Surface course = 6"

⇒ Base course = 12"

⇒ sub base = 6"

⇒ Total pavement thickness = 24".

QUESTION : 04

PAVEMENT DISTRESS: It can be defined as condition of pavement structure that reduces servicibility or may lead to reduction in service life.
It might occur due to unstable mixes or Higher wheel loads than those considered in design.

TYPES: The types include following:

1. **ALLIGATOR CRACKING:** Alligator cracks are interconnected cracks that are found on roads subjected to heavy traffic or severe climate. It resembles chicken wire or alligator skin, therefore called as alligator cracking.

CAUSES: The possible causes include

1. poor construction
2. overloading
3. Inadequate structural design
4. Severe climatic changes.

REPAIR: Repair is possible in following ways.

1. Dig out and replace area of poor subgrade
2. Crack sealing is in effective

2. **BLOCK CRACKING:**

It's a pattern of cracks that divide the pavement into approximately rectangular pieces. This is called Block cracking.

It allows moisture infilteration.

CAUSES: It may be caused due to

1. poor choice of asphalt Binder
2. Asphalt Binder aging
3. HMA shrinkage

REPAIR: It can be repaired by

1. Low severity cracks (< 1/2 inch wide)
   → crack seal to prevent entry of moisture
2. High severity cracks (> 1/2 inch crack with raveled edges)
   → Remove and replace cracked pavement layer with overlay

3 **BLEEDING:** It occurs due to loss of skid resistance when wet.

CAUSES: The causes of Bleeding include

1. Low HMA air void content
2. Excessive Asphalt Binder in HMA
3. Excessive application of Asphalt Binder during BST application

4. POLISHED AGGREGATE

It occurs when portion of aggregate extending above asphalt is either very small or there are no rough or angular aggregate particles to provide good skid resistance.

CAUSES:

- Repeated Traffic application
- This occur quicker if aggregate is susceptible to abrasions.

REPAIR:

Apply a skid resistant slurry seal, BST or non structural overlay.

5. **RUTTING:** Rutting is the surface depression in wheel path, are particularly evident after a rain when filled with water

CAUSES:

1. Improper Mix design (e.g Excessive high asphalt content)
2. subgrade rutting (e.g inadequate pavement structure).
3. Insufficient compaction of HMA layer during construction.

REPAIR:

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

6. **POTHOLES:**

These are small, bowl shaped depressions in the pavement surface that penetrate all the way through HMA layer down to the base course.

Roughness and Moisture infilteration occurs.

CAUSES: It generally occurs due to fatique cracking. When fatique cracking becomes severe, interconnected cracks create small chunks of which can be dislodged as vehicle passes.

REPAIR:

patching technique is used for repair

7 **RAVELING:** Raveling is basically loose debris on pavement which increase pavement roughness and result in loss of skid resistance.

CAUSES: ① Asphalt Binder aging,
② Inadequate compaction during construction
③ Aggregate segregation

REPAIR: - Fog seal / slurry seal
- Remove damaged pavement & overlay