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Sec :- "B"

Semister :- 6th

SUBJECT :- Highway and Traffic Engineering

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Q No 1
Part (a)

Highway and Traffic Engineering:

Difference Between Flexible and Rigid Pavement

	Flexible Pavement	Rigid Pavement
1	Bitumen is used a binder in flexible Pavement	1. Cement is used as a binder in rigid Pavements.
2.	Deformation in the sub grade is transfered to the upper layers.	Deformation in the sub grade is not transfered to subsequent layers.
3.	Load is transfered by grain to grain contact.	No such Phenomenon of grain to grain load transfer exists.
4.	Flexible Pavements have low initial construction costs but have high maintenance cost.	Rigid Pavement have low maintenance cost bu have high initial construction costs.
5.	Have low life Spin usually 10–15 years.	Life Spin is more as compare to to @ flexibl usually 30+ years

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	Flexible Pavement	Rigid Pavement
6.	Surfacing cannot be laid directly on the sub grade but a sub base is needed.	Surfacing can be directly laid on the sub grade.
7.	In flexible pavements strength of road highly dependent on strength of subgrade.	strength of road less dependent on strength of sub-grade in rigid Pavements.
8.	Load can be used for traffic within 24 hours	Road cannot be used until 14 days of curing

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Question # 01

Part (b)

Advantages of water bound over wet mix macadam

1. The main advantage of ~~water~~ wet-mix macadam over water-bound macadam is that it is composed of well-graded mixture. This ensures good interlock and high stability.
2. Addition of water while mixing facilitates the handling of the mixture. The operation of laying is much simpler than that of water-bound macadam, where the screenings and binding material have to be added in stages and forced into voids. If a crusher-run material is used, there is no possibility of Plastic fines entering into the mixture.
3. The compaction is greatly facilitated by the moisture added which lubricates the individual particles.

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4. One disadvantage of the wet mix macadam is that it is slightly costlier than water-bound macadam. This is because the specification involves the use of mixing plant and paver. On the other hand, water-bound macadam has been traditionally a labour oriented specification.

5. The aggregates for wet mix macadam will have to be crusher-run, whereas the aggregates for water-bound macadam are generally hand-broken.

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Question No# 07

Part "C"

Difference Between Asphalt and Bitumen

BITUMEN:

1 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, and Asphaltites are typical.

ASPHALT:

1 A dark brown to black cementious 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.

In American Terminology

Both Asphalt and Bitumen are same and are "Asphalt"

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Asphalt and Bitumen

* 1. In some literature Bitumen is actually the liquid binder that holds asphalt together.
* 2. Asphalt is generally used as a term to refer to the combination of bitumen and gravel specifically for road constructions.

Asphalt Composition

* Some generalizations can be made, however, with regard to the chemical composition of the semi-solid materials. According to simpson they generally consist of.

1	Carbon	(70-85%)
2	Hydrogen	(7-12 %)
3	Nitrogen	(0-1 %)
4	Sulfur	(1-7 %)
5	oxygen	(0-5 %)

and small amounts of metals either dispersed in the form of oxides and salts or in metal containing organic compounds.

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Question No 2.

Solution:-

For a design speed of 75 m/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 = $250 - \left(0.03 \times \frac{2184}{8}\right) = 217.24$ ft

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Question No : 03

A flexible highway is to be designed to carry a design ESAL of 2×10^{-6}. It is estimated that it takes about a week for water to be drained from with in the pavement and the Pavement structure will be exposed to moisture levels approaching saturation for 30% of the time.

The following additional information is available.

↳ Resilent modulus of asphalt concrete at 68°F 450,000 lb/in².

↳ CBR value of subbase curse material 2. 13500, lb/in²

↳ CBR value of subgrade material 6.

↳ Mr of subgrade $6 \times 15,00$ lb/in² = 9000 lb

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Solution:-

Flexible pavement design

- Reliability level (R) = 99%.
- Standard deviation So = 0.49
- Initial serviceability index, $p_i = 4.5$

Terminal serviceability index, $P_t = 2.5$

$\Delta PSI = 4.5 - 2.5 = 2.0$

Step : 1

Draw a line Joining the reliability level of 99% and the overall standard deviation interested the firt T_1 at point 1

Find value of SN_1 and D_1:

Step : 02:

Draw a line Joining point A to the $E_S A_2$ 2×10^6, and the this line TO interest the second, the T_2 line at point B.

Step 03:

Draw a line Joining point B and and resilent this line to interested the design servicability loss chart at point C.

Step 04:-

- Draw a horizental line from point C to intersect the design service.
- Loss (PS_I) curve at point D,

$$\Delta Psi = P_i^o - Pt = 4.5 - 2.5 = 2.0$$

Step 05:-

So the structure number required to protect the base course and to find the thickness of surface course is 2.6

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Step 06:-

Determine the appropriate structure layer coefficient for each construction material

Resilent value of asphalt = 450,000 lb/in^2,

therefor $a_1 = 0.44$

Thickness of surface coarse D_1:

$$D_1 = SN_1 / a_1 \quad :: \quad SN_1 = 2.6, \quad a_1 = 0.44$$

$$= \frac{2.6}{0.4}$$

$$= 5.9''$$

Thickness should be taken to the nearest 0.5 inch

So, thickness of surface coarse is 6"

$$SN_1 = D_1'' \times a_1$$

$$= 6 \times 0.44$$

$$SN_1 = 2.64$$

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Finding SN_2 and D_2 (Base course)

$D_2 = (SN_2 - SN_1)/a_2 m_2$ ∵ SN_2 from table = 3.8

$= (3.8 - 2.64)0.14 \times 0.80$ ∵ $a_2 = 0.14$

$D_2 = 10.36''$ ∵ $m_2 = 0.80$

Use 12"

So thickness of base course 12"

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

$SN_2 = 1.34 + 2.64$

$= 3.98$

Finding SN_3 and O_3

$D_3 = (SN_3 - SN_2)/a_3 m_3$ ∵ $SN_3 = 4.4$

$= (4.4 - 3.98)/0.10 \times 0.8$ ∵ $a_3 = 0.10$

∵ $m_3 0.80$

$D_3 = 5.25''$

we will use 6" as sub base

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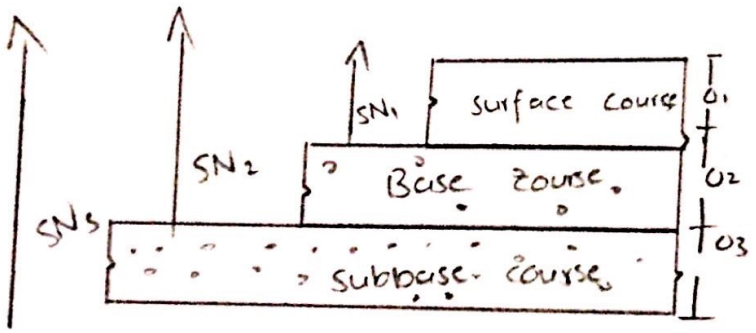
$SN_3 = 2.64 - 11.34 - 16'' \times 0.10 \times 0.80$

$SN_3 = {}^{x}2.64 - 11$

$SN_3 = 4.46 > 4.4$ okay

Final Design :



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Question No# 4

PAVEMENT DISTRESSES:

↳ Distress 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) CRAKING:

> Possible Causes:

- Overloading
- Inadequate structural design
- Poor construction

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> Repair :-

- Crack sealing in effective.
- Dig out replace area of poor subgrade.

Block Cracking :-

> Problem:

Allow moisture infiltration

> Possible Causes:

- HMA shrinkage
- Asphalt binder aging.

BLOCK CRAKING :-

> Problem:

Allows moisture infiltration.

> Possible Causes:

- HMA shrinkage

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RUTTING:-

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

> Possible Causes,

- Insufficent compaction of HMA layers during construction.
- Subgrade rutting (e.g, as result of inadequate pavement structure).
- Improper mix design (e.g. excessively high asphalt content, excessive mineral filler, insufficent amount of angular aggregate particles).

> Repair:

- Slight ruts (<1/3 inch deep) can generally be left untreated. Pavement with deeper ruts should be leveled and 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 occu quicker if the aggregate is susceptible to abrasion.

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Repair:

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

Raveling

> Loose debris on the pavement which increases pavement roughness and 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.

For seal/slurry seal or Remove the damaged pavement and overlay.

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> Problem:

Roughness (serious vehicular damage can result from driving across potholes at higher speed). moistu infiltration.

> Possible Causes:-

Generally, potholes are the end result of fatigue cracking. As fatigue cracking becomes servere, the interconnecte cracks create small chunks of pavement which can be dislodged as vehicles drive over them

> Repair:

Patching techniques.

- Asphalt binder aging
- Poor choice of asphalt binder in the mix design

> Repair:-

- Low severity cracks (< ½ inch wide). Crack seal to prevent entry of moisture
- High severity cracks (> ½ inch wide and cracks with raveled edges). Remove and replace the craked pavement layer with an overlay.

POTHOLES

> Potholes are most likely to occur on roads with thin HMA surface (1 to 2 inches) and seldom occur on roads with 4 inch or deeper HMA surface.

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