

## Q No 1 Part (a)

What is the difference b/w flexible and Rigid Pavement.

ANSWER:

### Flexible Pavement

1. Bitumen is used as binder in flexible pavement
2. Load is transferred by grain to grain contact
3. Have life span of 10-15 years
4. Road can be used for traffic within 24 hours

### Rigid Pavement

1. Cement is used as a binder in rigid pavement.
2. No such phenomena of grain to grain load transfer exists.
3. Life span is more as compare to flexible usually 30+ years.
4. Road can't be used until 14 days of curing

Q No 1 (b)

advantages

What are the advantages of water bound over wet mix macadam?

ANSWER:

ADVANTAGES OF WATER BOUND OVER WET MIX MACADAM:-

- 1- The main advantage of wet-mix macadam over water bound is that it is composed of well graded mixture. This ensure good interlock and high stability.
- 2- The compaction is greatly facilitated by moisture added which lubricates the individual particles
- 3- The aggregate for wet mix macadam will have to be crushed run, whereas the aggregates for water bound macadam are generally hand broken.

Q No 1 (c)

What is the difference between asphalt and bitumen?

ANSWER:

DIFFERENCE BETWEEN ASPHALT AND BITUMEN:

BITUMEN

- 1- A class of black or dark colored (solid, semi solid or viscous) cementitious substance natural or manufactured, composed of highly molecular weight

In American Terminology bitumen are same.

- 1- In some literature Bitumen is actually the liquid binder that hold asphalt together

ASPHALT:

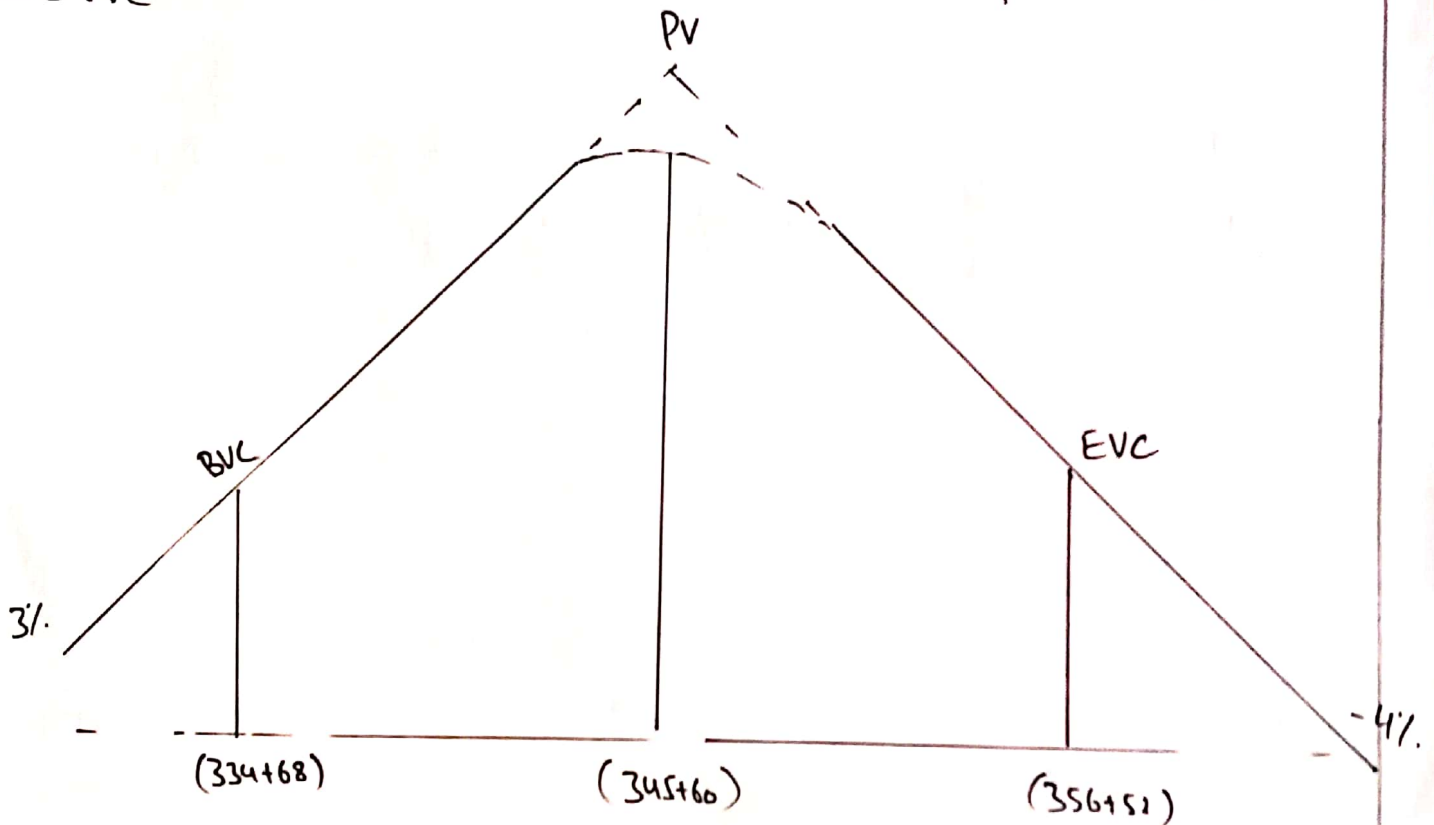
- 1- A dark Brown to black cementitious material in which predominating constituent are bitumen which occur in nature or obtained by fractional distillation both asphalt and

- 2- Asphalt is generally used as term refer to the combination and gravel specifically for road construction.



Q No 2

A crest vertical curve joining +3 percent and a -4 percent grade is to be designed for 75 mi/h. If the tangent (345+60.00) at an elevation of 250 ft. determine the station and elevation of the BVC. Also calculate intermediate point on curve



SOLUTION

For design speed of 75 mi/h  
value of  $k$  from table

$$k = 312$$

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$$\begin{aligned}\text{Minimum Length} &= K \times (3 - (-4)) \\ &= 312 \times (3 - (-4)) \quad K = 312 \\ &= 2184 \text{ ft}\end{aligned}$$

$$\text{Station of BVC} = \text{Tangent intersection station} - \left(\frac{21+84}{2}\right)$$

$$\begin{aligned}\therefore \text{tangent intersection} \\ \text{Station} &= (345 + 60)\end{aligned}$$

$$\text{Station of BVC} = (345 + 60) - \left(\frac{21+84}{2}\right) = 334 + 68$$

$$\text{Station of EVC} = (334 + 68) + (21 + 84) = 356 + 52$$

$$\begin{aligned}\text{Elevation of BVC} &= 250 - \left(0.03 \times \frac{2184}{2}\right) \\ &= 217.24 \text{ ft}\end{aligned}$$

Q No 3

A flexible pavement for an urban interstate highway is to be designed using 1993

available.

Resilient modulus of asphalt concrete at 68°F 450,000 lb/in<sup>2</sup>

CBR value of base course material, 100  
Mr 31,000 lb/in<sup>2</sup>

CBR value of sub base course material  
22, Mr 13,500 lb/in<sup>2</sup>

CBR value of subgrade material 6

Mr of subgrade  $6 \times 15,000 \text{ lb/in}^2 = 9000 \text{ lb/in}^2$

Flexible Pavement Design:

Reliability level (R) = 99%

Standard deviation  $S_0 = 0.49$

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  $S_o$  of 0.49, and extend this line to intersect the first TL at point A.

Find value of  $SN_1$  and  $D_1$ :

Step: 02

Draw a line joining point A to the ESAL  $2 \times 10^6$ , and extend this line to intersect the second TL line at point B.

Step: 03

Draw a line joining point B and resilient modulus ( $M_r$ ) of base course and extend this line to intersect the design serviceability loss chart at point C.

Step: 04

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

Loss (PSI) curve at point D,

$$\Delta PSI = P_i - P_e = 4.5 - 2.5 = 2.0$$



Step: 05

So the structure number required to protect the base course and to find the thickness  $DI_1$  of surface course is 2.6.

Step: 06

Determine the appropriate structure layer coefficient for each construction material. Resilient value of asphalt = 450,000 lb/in<sup>2</sup>, therefore  $a_1 = 0.44$



Thickness of surface Coarse  $D_1$ :

$$D_1 = SN_1 / a_1$$

$$\begin{aligned} \therefore SN_1 &= 2.6 \\ a_1 &= 0.44 \end{aligned}$$

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

$$= 5.9''$$

Thickness should be taken to the nearest 0.5 inch

So, thickness of surface Coarse is 6''

$$\begin{aligned} SN_1 &= D_1'' \times a_1 \\ &= 6 \times 0.44 \end{aligned}$$

$$SN_1 = 2.64$$

Finding  $SN_2$  and  $D_2$  (Base course)

$$D_2 = (SN_2 - SN_1) / a_2 m_2$$
$$= (3.8 - 2.64) / 0.14 \times 0.80$$

$\therefore SN_2$  from table = 3.8

$\therefore a_2 = 0.14$

$\therefore m_2 = 0.80$

$$D_2 = 10.36''$$

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  $D_3$

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

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

$\therefore SN_3 = 4.4$

$\therefore a_3 = 0.10$

$\therefore m_3 = 0.80$

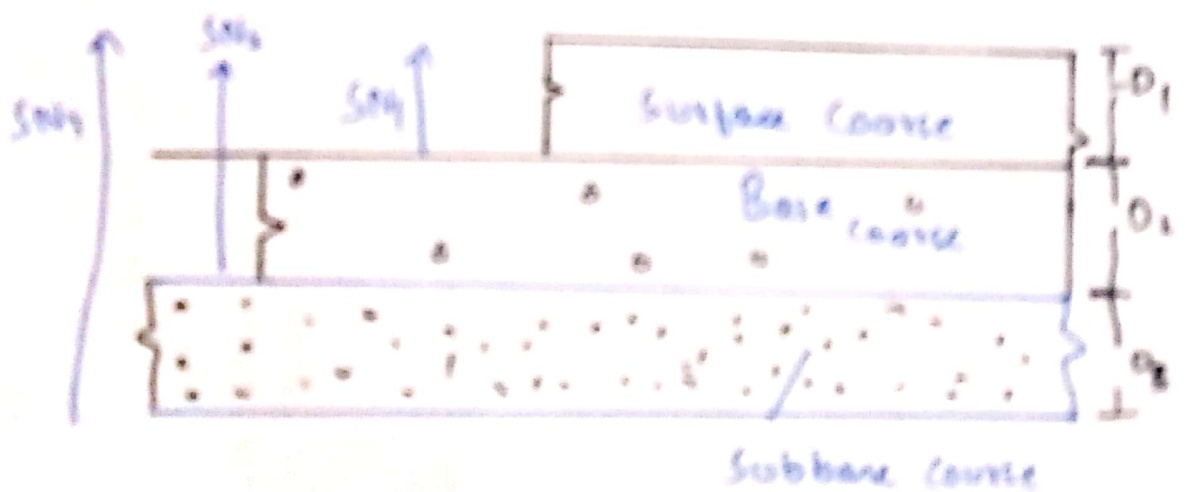
$$D_3 = 5.25''$$

We will use 6" as sub base

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

$$SN_3 = 4.46744 \text{ okay}$$

Final Design:



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QNO(4)

What are different Pavement distress? Explain in detail.

ANSWER:

PAVEMENT DISTRESS:

Distress is a condition of the pavement structure that reduces serviceability or lead to reduction in service life

Distress in pave occur due to

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

Aligator Cracking:

> Cause:

overloading

Inadequate structure

Repair:

- crack sealing is in effective
- Dig out and replace poor area.



## BLOCK CRACKING:

Problem: Allow moisture infiltration

Possible cause:

- HMA Shrinkage
- Asphalt binder aging

## Repair

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

High severity crack ( $> 1/2$  inch wide) and crack with revealed edges.

Remove and replace the cracked pavement layer with an overlay.

## POTHHOLES:

- Small bowl-shaped depression in the pavement surface that penetrates all the way through HMA layer down to the base course.
- Potholes are most likely to occur on road with the HMA surface (1 to 2 inch) and seldom occur on road with 4 inch or deeper HMA surfaces.

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 Cause

- In sufficient compaction of HMA layer during construction.
- Improper mix design (e.g as a result of inadequate pavement structure)
- Subgrade rutting (as a result of inadequate pavement structure)

Repair:

slight ruts (< 1/3 inch deep) can generally be left untreated

## Bleeding:

### Problem:

Loss of skid resistance when wet.

### Possible Cause:

- Excessive asphalt binder in the HMA.
- Low HMA air void.

## Raveling:

- Loose debris on the pavement which increase pavement roughness and loss of skid resistance

### Possible Cause:

- Asphalt binder aging
- Inadequate compaction during construction.

### Repair:

Fog Seal/ Slurry Seal or Remove the damaged Pavement overlay.

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Transportation - II

Semester 6<sup>th</sup>