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Q No 1 :- Difference between flexible and rigid Pavement?

Ans

Flexible pavement

Rigid pavement

- | | |
|--|---|
| (1) Bituman is used a binder in flexible pavement. | (1) Cement is used as binder in rigid pavements. |
| (2) Deformation in the subgrade is transfered to the upper layers. | (2) Deformation in the sub grade is not transfered to subsequent layers |
| (3) Load is transfered by then grain to grain contact | (3) No concept of grain to grain load transfer. |

(4) It have low initial construction costs but have high maintenance costs.

(4) It has low maintenance cost but have high initial construction costs.

(5) The life span is usually 10-15 yrs

(5) Life span is more than 30 yrs.

(6) Surfacing cannot be laid directly on the subgrade but sub base is needed

(6) Surfacing can be directly laid on the subgrade

(7) Road can be used for traffic with 24 hrs

(7) Road cannot be used untill 14 days of ~~wiring~~ curing

Q10) What are the advantages of water bound over wet mix macadam?

Ans Following are the advantages of water bound over wet mix macadam.

(1) WBM is slightly cheaper than the wet-mix macadam. The ~~reason~~ reason is WBM requires general labour while wet-max macadam requires mixer plant and paver

(3)
(2) Aggregates of WBM are or can be broken by hands while the WMM needs a crusher for the disintegration of aggregates.

(3) The interlocking of aggregate particles imparts adequate strength of the the materials for filling the voids. These ensure non-entry of the plastic materials of the sub-grade into voids.

(C) What is the difference b/w asphalt and bitumen?

Ans Bitumen is actually the liquid binder that holds asphalt together.

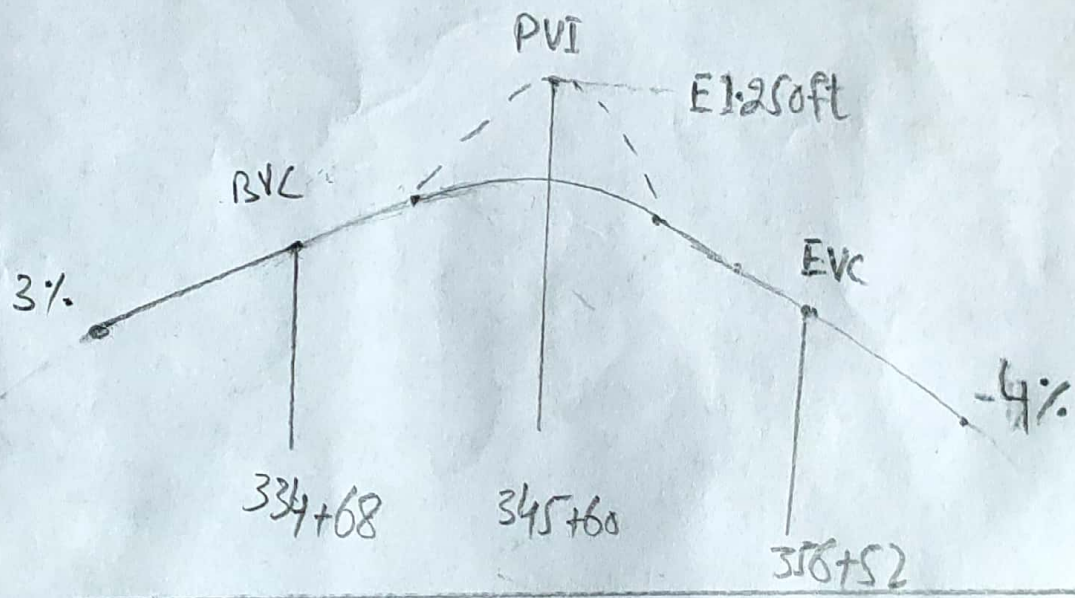
⇒ Asphalt is generally used as a term to refer to the combination of bitumen and gravel for road construction.

⇒ Bitumen is known for being strongly adhesive and resistant to damage from water and oil spills. This makes bitumen the ideal binder for asphalt because asphalt is commonly used as a surface for roads, car parks etc.

(4)

Q No 2

A crest vertical curve joining a +3 percent and a -4 percent grade is to be designed for 75 mi/h if the tangents intersect at station (345+60.00) at an elevation of 250 ft, determine the stations and elevations of the BVC and EVC. Also, calculate the elevations of intermediate points on the curve at the whole stations



Sol For a design speed of 75 mi/h, $K = 312$ (from table)

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

$$\text{station of BVC} = (345+60) - \frac{2184}{2} = 334+68$$

$$\text{station of EVC} = (334+68) + (2184) = 356+52$$

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

(5)

→ The remainder of the computation is efficiently done using the format shown below in the table.

Station	Distance from BVC (x) (ft)	Tangent Elevation (ft)	Offset $\left(y = \frac{Ax^2}{200}\right)$ (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
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
ENC 356+52	2184	282.76	76.44	206.32

Q No 3 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 within 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

- ⇒ Resilient modulus of asphalt concrete at 68°F $450,000 \text{ lb/in}^2$
- ⇒ CBR value of base course material 100, $M_R 31,000 \text{ lb/in}^2$
- ⇒ CBR value of subbase course material 22, $M_R 13,500 \text{ lb/in}^2$
- ⇒ CBR value of subgrade material 6

⇒ M_s of subgrade $6 \times 1500 \text{ lb/in}^2 = 9000 \text{ lb/in}^2$

step 01 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 line at point A.

step 02 Draw a line joining point A to the ESAL of 2×10^6 , 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, so here

$$\Delta \text{PSI} = 4.5 - 2.5 = 2$$

step 05 The structure number required to protect the base course and to find the thickness D_1 of the surface course is 2.6:

step 06 Determine the appropriate structure layer coefficient for each construction material. Resilient value of asphalt = $450,000 \text{ lb/in}^2$, 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 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 the value of a_2 from layer coefficient table and m_2 from drainage co-efficient table

→ Thickness of Base course (D_2)

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

$$D_2 = (3.8 - 2.64) / .14 \times 0.80$$

$$D_2 = 10.36''$$

Use 12''

So the thickness of base course 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 and D_3 (Subbase course) and also layer co-efficient a_3 and drainage co-efficient m_3 from their respective table

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

$$= (4.4 - 3.98) / .10 \times 0.80$$

~~(8)~~ (9)

$$D_3 = 5.24''$$

we will use 6'' as a sub base.

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

$$SN_3 = 4.46 > 4.4 \text{ okay!}$$

Final Design

⇒ Surface course = 6''

⇒ Base course = 12''

⇒ Sub base = 6''

⇒ Total pavement thickness = 24''

Q No 4 What are the different pavement distresses?

Explain in detail?

Ans Following are the different pavement distresses:

A) Alligator cracking

Possible causes

Repair

⇒ Over loading

⇒ Inadequate structural design

⇒ Poor construction

⇒ Crack sealing is in effective

⇒ Dig out and replace area

of poor subgrade

(2) Block Cracking

Problem Allows moisture infiltration

Possible causes

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

Repair

- ⇒ Low severity cracks ($< \frac{1}{2}$ " wide) crack seal to prevent entry of moisture
- ⇒ High severity cracks ($> \frac{1}{2}$ " wide) and cracks with revealed edges. Remove and replace the cracked pavement layer with an overlay.

(3) Potholes

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

Potholes are most likely to occur on roads with thin HMA surface (1"-2") and seldom occurs on road with 4" 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 vehicles drive over them.

Repair

⇒ Patching techniques

(4) Rutting

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

Possible cause

- ⇒ Insufficient compaction of HMA layers during construction
- ⇒ Subgrade rutting (e.g) as a result of inadequate pavement structure
- ⇒ Improper mix design (e.g excessive high asphalt content, excessive

Repair

⇒ Slight ruts (< 1/3" deep) can generally be left untreated. Pavement with deeper ruts should be levelled and overlaid.

(11) (12)
mineral filler, insufficient amount of angular aggregate particle).

(5) Bleeding

Problem :- loss of skid resistance when wet

Possible causes

- Excessive asphalt binder in the HMA
- Excessive application of asphalt binder during BST application low HMA air void content.

(6) Polished Aggregate

Possible cause

→ Repeated traffic application
This can occur quicker if the aggregate is susceptible to abrasion

Repair

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

(13)

Reveling

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/sturry seal or Remove the damaged pavement and overlay.