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No 1 (A) Flexible pavement:-

A typical flexible pavement consists of a bituminous surface course over base course and sub-course. The surface course may consist of one or more bituminous or Hot Mix Asphalt (HMA) Layers. These pavements have negligible flexure strength and hence undergo deformation under the action of loads. The structural capacity of flexible pavements is attained by the combined action of the different layers of the pavement. The load from truck is directly applied on the wearing course, and it gets dispered width and width in the base, sub base, and subgrade courses, and then ultimately to the ground. Flexible pavements are designed in such a way that the load that reaches the subgrade does not exceed the bearing capacity of the subgrade soil.

Rigid pavements:

Rigid pavements are named so because of the high flexural rigidity of the concrete slab and hence the pavement structure deflect very little under loading due to high modulus of elasticity of thier surface course. The concrete slab is capable of disturbing the traffic load into a large area with small depth which minimize the need for a number of layers to help reduce the stress. The most common type of rigid pavement consist of dowel bars and tie bars. They may provide some minimal amount of load transfer they are not designed to act as load transfer devices and are simply used to 'tie' the two concrete slabs together. Any excessive deformations occuring due to heavier wheel loads are not recoverable i.e settlements are permanent.

QNo1
part (b-) What are the advantages of water bound over wet mix macadam?

Ans:

1- Because of the carefully graded materials, water bound is superior in quality and the resulting mass is almost used less compacted mass.

2- water bound ensures non-entry of the plastic materials of the sub-grade in to the voids because of the interlocking of aggregate particles that imparts adequate strength of the materials selected for filling the voids.

3- The water bound is constructed by spreeding loose metal which gives a consolidated thickness of 25-100mm

4- Water bound is cheaper that wet-mix macadam because of the specifications involves the use of mixing point and paver.

5- The aggregate for water bound macadam are generally hand-broken where as for wet mix macadam, the aggregate are crushed.

6- water bound has been traditionaly a labour oriented specifications.

QNo 1: Part C

(1) Bitumen: Bitumen is one of the derivatives of oil in black and pasty from which has many applications in asphat, road construction, insulation and roof water proofing.

1- Bitumen is by- product obtained from fractional Distillation of crude oil.

2 Bitumen is actually the Liquid binder that holds Asphalt together.

3- A Bitumen sealed road has a layer of bitumen sprayed and then covered with an aggregate This is then repeated to give a two coat seal.

2) Asphalt

Asphalt is a mixture of Bitumen and coarse & fine aggregate.

2- Asphalt is a strong cement that is readily adhesive and highly water proof and durable making it particularly useful in road construction

3- It is applied through a paving machine on site as a solid material at required thickness, relative to end use. It is smoother and more durable surface than a bitumen sealed road.

Question No 2

Q2 A crest vertical curve joining a +3 percent and a -4 percent grade is to be designed for 75mi/h if the tangets at station (34.5 + 60.00) at an elevation of 250 ft. Determine the stations and elevation of the BVC and EVC. Also calculate the elevations of intermediate points on the curve at the whole stations.

Solution: For a design speed of 75mi/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 $= 250 - \left(.03 \times \frac{2184}{2}\right)$

$= 217.24$ ft

Stations	Distance from BVC (x) (ft)	Tangent elevation (ft)	offset $\left[Y = \frac{Ax^2}{200L}\right]$ (ft)	Curve elevation
BVC 334+68	0	217.24	0.01	217.24
BVC 335+00	32	218.20	0.02	218.18
BVC 336+00	132	221.20	0.28	220.92
BVC 337+00	232	224.20	0.88	223.34
BVC 338+00	432	227.20	1.77	225.43
BVC 339+00	532	230.20	2.99	227.21
BVC 340+00	632	233.20	4.54	228.66
BVC 341+00	732	236.20	6.40	229.80
BVC 342+00	832	239.20	8.59	230.61
BVC 343+00	932	242.20	11.09	231.11
BVC 344+00	1032	245.20	13.92	231.28
BVC 345+00	1132	248.20	17.07	231.13
BVC 346+00	1232	251.20	20.54	230.66
BVC 347+00	1332	254.20	24.32	229.88
BVC 348+00	1432	257.20	28.43	228.77
BVC 349+00	1532	260.20	32.86	227.34
BVC 350+00	1632	263.20	37.61	225.59
BVC 351+00	1732	266.20	42.68	223.52
BVC 352+00	1832	269.20	48.07	221.13
BVC 353+00	1932	272.20	53.79	218.41
BVC 354+00	2032	275.20	59.82	215.38
BVC 355+00	2132	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

QNo3) A flexible highway is to be designed to carry a design ESAL of 2×10^{6}. It is estimated that it make take 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:

→ Resulent modulus of asphalt concrete at 68°F 450,000 lb/in²

→ CBR value of base course material 100, M, 31,000 lb/in²

→ CBR value of sub base course material 22, Mr 13,500 lb/in²

→ CBR value of sub grade material 6.

Ans: <u>Step # 1</u> Draw a line joining the reliability level of 99% & the over all standard deviation So of 0.49 and extand 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 extand this line to intersect the first TL line at point B.

Step # 03

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

Step#04: Draw a horizental 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 the thickness D_1 of the surface course is 2.6.

Step # 06

Determine the appropriate structure layer co-efficient for each construction material Resilent value of asphalt = 450,000 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 Layers co-efficient table and m_2 from drainage co-efficient table.

→ Now the thickness of base course (D_2)

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

$D_2 = (38 - 2.64/.14 \times 0.80$

$D_2 = 10.36''$

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 & D_3 (sub base course) and also layer co-efficient a_3 and drainage co-efficient m_3 from thier respective table.

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

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

$D_3 = 5.24"$

we will use 6" as a subbase

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

$SN_3 = 4.46 > 4.4$ okey

"Final design"

Surface course = 6"

Base course = 12"

Sub base = 6"

Total pavement thickness = 24"

QNo 4. What are the different pavements distresses? Explain in detail?

Ans

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

1- unstable mixes
2- Higher wheel loads than those considered in design.

⇒ Alligator (Fatigue) cracking:

Possible causes

- over loading
- inadequate structural design
- poor construction.

Repair

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

⇒ Block cracking:

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.

⇒ Patholes

pathole s 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 surfaces.

Possible cause.

Generally, potholes are the end result of fatigue cracking. As fatigue cracking becomes severe, the inter connected cracks create small chunks of pavements. which can be dislodged as vehicle drive over them.

Repair patching techniques.

⇒ Rutting

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

Repair

slight rutts (< 1/3 inch deep) can generally be left untreated pavement with deepers ruts should be leveled and overlayed.

⇒ Bleeding:

Problem: Loss of skid resistance when wet.

Possible cause:

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• 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 occure quicker if the aggregate is susceptible to abrasion.

Repair:

Apply a skid-resistance slurry seal, BST or non-structural over lay.

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

Fog, Seal / slurry seal or Remove the damaged pavement and overlay.