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QNo1 A ⇒ What is the difference between flexible and rigid pavement?

Ans ⇒ Flexible pavements typically distribute wheel loads to lower layers of the pavement section and consists generally of bituminous material.

⇒ Rigid pavements are typically distribute wheel loads over a wide area of the subgrade and consists generally of cement concrete and may be reinforced with steel.

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 subgrade is transferred to the upper layer.	2) Deformation in the subgrade is not transferred to subsequent layer.
3) Load is transferred by grain to grain contact.	3) No such phenomenon of grain to grain load transfer exists.

Flexible pavement	Rigid Pavement.
4) Flexible pavement have low Initial Construction costs but have high maintenance cost	4) Rigid pavement have low maintenance cost but have high Initial Construction costs.
5) Have low life span usually 10-15 years.	5) life span is more as compare to flexible usually 30+ years
6) Surfacing cannot be laid directly on the sub grade but a sub base is needed.	6) Surfacing can be directly laid on the subgrade.
7) In flexible pavements strength of road highly dependent on strength of subgrade.	7) Strength of road less dependent on strength of sub grade in rigid pavements
8) Road can be used for traffic within 24 hours.	8) Road cannot be used until 14days of curing.

QNo 18 => What are the advantages of water bound over wet mix macadam?

Ans => The main advantages of wet-mix macadam over Water bound macadam is that it is composed of a well graded mixture. This ensures good Interlock and high Stability.

=> Addition of water while mixing facilities 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.

=> The Compaction is greatly facilitated by the moisture added which lubricates the individual particles.

QNo1: C ⇒ What is the difference between asphalt and bitumen?

Ans **Asphalt** A dark brown to black Cementitious material in which the predominating constituents are bitumen which occure in nature or are obtained in Fractional distillation of petroleum alongwith Certain mineral matter.

⇒ In American Terminology

⇒ Both Asphalt and Bitumen are Same and are "Asphalt"

⇒ **Bitumen** ⇒

A Class of black or dark-colored (solid, Semi-Solid or viscous) Cementitions Substance, natural or manufactured Composed principally of high molecular weight hydrocarbons found in Asphalts, Tars, Pitches, and Asphalties are typical.

⇒ In some literature 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 specifically for road construction.

QNo2 ⇒ 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 station and elevation of the BVC and EVC. Also calculate the elevation of intermediate points on the curve at the whole stations.

Solution

For a design speed of 75 mi/h, K = 312 from table 15.5,

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

QNo3 ⇒ 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 lb/in²

⇒ CBR value of base course material 100, M_r 31,000 lb/in²

⇒ CBR value of subbase course material 22, M_r 13,500 lb/in²

⇒ CBR value of subgrade material 6

⇒ M_r of subgrade 6×1500 lb/in² = 9000 lb/in²

Solution

⇒ Relibability level (R) = 99 %.

⇒ Standard deviation (So) = 0.49

⇒ Initial Serviceability Index P_i = 4.5

⇒ Terminal Serviceability Index P_t = 2.5

⇒ ΔPSI = 4.5 − 2.5 = 2.0

⇒ Step 1 Draw a line Joining the reliability level of 99% and the overall Standered divation So of 0.49 and extend this line to Intersect the first TL line at point A.

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

Step 3 Draw a line Joining point B and resilient modulus (Mr) base cours and extend this line to Intersect the design Serviceability loss Chart at point C.

Step 4 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 5 The Structure number require to Protect the base Curve and to find the thickness D_1 of the Surface Coarse is 2.6.

~~Step 6 Determing the appropriate Structure Resilient value of asphalt = 450,000 lb/in²~~

Step 6 Determine the appropriate Structure layer Co-efficent 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 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 Coeffzicent table and m_2 from dranage Co-effzient table.

⇒ Thickness of base course (D_2)

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

$$D_2 = (3.8 - 2.64/1.4 \times 0.80$$

$$D_2 = 10.36$$

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 coeffient a_3 and drainage coeffieent m_2 from their 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 Sub base

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

$$SN_3 = 4.46 > 4.4 \text{ okey}$$

"Final design"

⇒ Surface Course = 6"

⇒ Base Course = 12"

⇒ Sub base = 6"

⇒ Total pavement thickness = 24"

QNo4 What are the different pavement distresses? Explain in detail?

Ans Distresses is a condition of the pavement structure the reduces serviceability or leads to a reduction in service life.

⇒ Distresses could in a pavement due to:

* Unstable mixes.
* Higher wheels loads than those considered in design.

Alligator Cracking

⇒ Possible Causes

* Overloading
* Inadequate Structural design
* Poor Construction

⇒ Repair

* Crack Sealing is in effective
* Dig out and replace area of poor subgrade.

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 (< 1/2 inch wide). Crack seal to Pavement entry of moisture.
* High Severity Cracks (< 1/2 inch wide) Crack seal to prevent entry of moisture.
* High Severity Cracks (> 1/2 inch wide and Cracks with raveled edges). Remove and replace the Cracked pavement layer with an ovelay.

Potholes ⇒

Small, bowl-Shaped depressions in the pavement Surface that penetrate all way through the HMA layer down to the base course.

⇒ Potholes are most likely to occure on roads with thin HMA Surfaces (1 to 2 inches) and seldom occure on roads with 4 inch or deeper HMA Surfaces.

⇒ **Problem** ⇒ Roughness (Serious vehiclar 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.

Rutting

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

⇒ Possible Causes

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

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 application. This can occur quicker if the aggregate is susceptible to abrasion.

⇒ **Repair**

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

Raveling

→ loose debris on the pavement which Increases Pavements 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.

The end