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iD 7868

Sec B

Semester 6th

Final Term Examination

Highway & Traffic Engineering

Comparison of Flexible vs Rigid Pavement.

	Flexible Pavement	Rigid Pavement
①	Bitumen is used a binder in Flexible Pavement	→ Cement is used as a binder in rigid pavement.
②	Deformation in the subgrade is transferred to the upper layers.	→ Deformation in the subgrade is not transferred to subsequent layers.
③	Load is transferred 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 pavements have low maintenance but have high initial construction costs.
⑤	Have low life span usually 10-15 years.	→ Life span is more as compare to flexible usually 30+ years.
⑥	Surfacing cannot be laid directly on the subgrade but a sub base is needed.	→ Surfacing can be directly laid on the subgrade.

②

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 Road can be used for traffic within 24 hours.	→ Road cannot be used until 14 days of curing.

Q.No.2 (b) What are the advantages of water bound over wet mix macadam?

Answer:- **Water Bound vs. Wet Mix Macadam**

→ The main advantage 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 mixtures.

→ The compaction is greatly facilitated by the moisture added which lubricates the individual particles.

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

ANo 1. (c)

Difference b/w Asphalt & Bitumen

Bitumen is actually the liquid binder that holds asphalt together.

A bitumen sealed road has a layer of bitumen sprayed and then recovered with an aggregate. This is then repeated to give a two-cost seal. Asphalt is produced in a plant that heats, dries and mixes aggregates bitumen and

Bitumen and sand into a composite mix.

→ In some literature Bitumen is actully the liquid binder that holds aphalt together.

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

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

→ Carbon (70 – 85 %)

→ Hydrogen (7 – 12 %)

→ Nitrogen (0 – 1 %)

→ Sulfur (1 – 7 %)

→ Oxygen (0 – 5 %)

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

Question 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 intersects at section (345 + 60.00) at an elevation of 250 ft. determine the stations and elevations of the BVC and EVC. Also, calculate the elevation of intermediate points on the curve at the whole stations.

Solutions:

For a design speed of 75 mi/h,

$K = 312$ From table

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

Question 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 ....

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

→ CBR value of base course material, 100
Mr 31000 lb/in²

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

→ CBR value of subgrade material 6

→ Mr of subgrade $6\times15,00$ lb/in² = 9000 lb/in²

Flexible Pavement Design :-

→ Reliability level (R) = 99%.

→ standard deviation $S_o = 0.49$

→ Initial Serviceability Index, $P_i = 4.5$

→ Terminal Serviceability Index, $P_t = 2.5$

→ $\Delta PSI = 4.5 - 2.5 = 2.0$

Step 01 :-
Draw a line joining the reliability level of 99% and the overall Standard deviation of 0.49, and extend the line to intersect the first at point A.

Find the value of SN_1 and D_1 :

Step 02 :- Draw a line joining point A to the ESAL 2×10^6, and this line to intersect the second II at line point B.

Step 03 :-
Draw a line joining point B and resilient modulus (Mr) of base course and extent 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_1

$\Delta PSI = P_i - P_t \quad = 4.5 - 2.5 = 0$

Step:05:-

So, the structure number required to protect the base course and to find the thickness D1, 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/in², therefore

$a_1 = 0.44$

9

Thickness of surface Course D1:

$D_1 = SN_1 / a_1$

$\because SN_1 = 2.6$

$a_1 = 0.44$

$= \frac{2.6}{0.4}$

$= 5.9''$

Thickness should be taken to the nearest 0.5 inch

So, thickness of surface course is 6"

$SN_1 = D_1'' \times a_1$

$= 6 \times 0.44$

$SN_1 = 2.64$

Finding SN_2 and D_2 (Base Coarse)

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

∵ SN_2 from table $= 3.8$

∵ $a_2 = 0.14$

∵ $m_2 = 0.80$

$$= (3.8 - 2.64) \; 0.14 \times 0.80$$

$$D_2 = 10.36''$$

Use 12"

So thickness of base Coarse 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

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

∵ $SN_3 = 4.4$

∵ $a_3 = 0.10$

∵ $m_3 = 0.80$

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

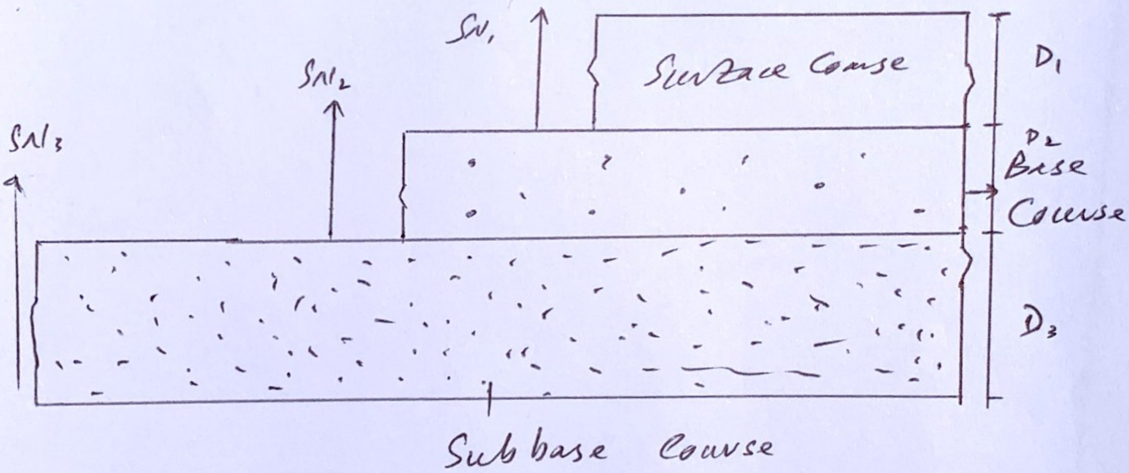
$$D_3 = 5.25''$$

We will use 6" as sub base

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

$SN_3 = 4.46 > 4.4$

Final design



AASHTO DESIGN EQUATION FOR SN

$$\log_{10} W_{18} = Z_R S_o + 9.36 \log_{10} [SN + 1] - 0.20$$

$$\frac{\log [\Delta PSI / 4.2 - 1.5]}{0.40 + [1094 / (SN + 1)^{5.19}]}$$

$$+ 2.32 \log_{10} M_R - 8.07$$

(13)

Ans104.

Different 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) Cracking

- Possible Causes
  - → overloading.
  - → Inadequate structural design.
  - → Poor Construction.

- Repair
  - → Crack sealing is ineffective
  - → Dig out and replace area of poor subgrade.

Block Cracking

→ Problem :- Allows moisture infilteration

→ Possible Causes

- HMA shrinkage
- Asphalt binder aging
- Poor choice of aphalt binder in the mix design.

Repair:

- low 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 overlay.

Potholes

→ Small, bowl-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 surfaces (1 to 2 inches) and seldom occur on roads with 4 inch or deeper HMA surfaces.

→ Problem :-
Roughness (service vehicular damage can result from driving across potholes at higher speeds) moisture infilteration.

→ 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 indequate 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 ~~solid~~ skid resistance when wet.

Possible Cause:-

- Excessive aphalt 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 ~~test~~ seal, BST or non-structural overlay.

Ravelling :-

→ Loose debris on the pavement which increses 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 or Remove the damaged pavement and overlay.