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Submitted To Dr. Nadeem Anwer

Subject Highway and Traffic Engineering

Section "B"

Module 12th.

Q1:-

(a) What is the difference b/w Flexible and Rigid pavement?

Flexible pavement	Rigid pavement
Bitumen is used as a binder in flexible pavement	cement is used as a binder in rigid pavement.
Have low flexural strength	Have more flexural strength
Load is transferred by grain to grain contact.	No such phenomena of grain to grain load transfer exists.
surfacing cannot be laid directly on the subgrade but a sub base is needed.	surfacing can be directly laid on the sub grade.
No thermal stresses are induced.	Thermal stresses are induced.
Expansion joints are not needed.	Expansion joint are needed
Design life 10-15 years	Design life is 30 years
Initial cost of construction is low.	initial cost of construction is high
Maintanance cost is high	Less maintenance cost.
Road can be used for traffic within 24hrs.	Road cannot be used until 14 days of curing.

(5) What are the advantage of water bound over wet mix macadam?

Ans:- The advantage of water bound over wet mix macadam is following below.

(1) Wet mix macadam is that it is slightly more expensive than water based macadam. This is because the specification includes the used of compound plant and pure water related mechanisms on the other hand have traditionally been labour intensive.

(2) The aggregates for wet mix macadam will have been crusher-run. while The aggregates for water bound macadam are generally broken by hand.

(3) it is composed of a well-graded mixture this ensure good interlock and right stability.

(4) The compaction is greatly facilitated by the moisture added which lubricates the individual particles.

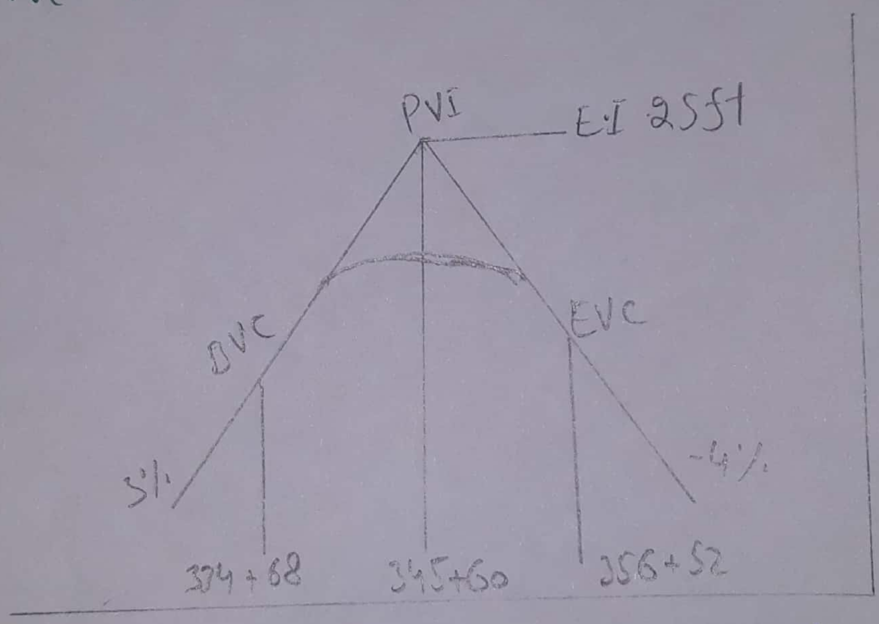
(5) The interlocking of aggregates particles inparts adequate strength of material for filling the voids. These ensure non-entry of the plastic material of the sub grade into voids.

(c) What is the difference b/w asphalt and Bitumen?

Ans:- ~~Asphalt~~ • Asphalt is produced in a plant ~~that~~ heats, dries and mixed aggregate, baitumen and sand into a composite mix.

- Bitumen is actually the liquid binder that holds asphalt together.
- Asphalt is used as a term to refer to the combination of bitumen and gravel specification for road construction.
- Bitumen is known for being strongly adhesive and resistant to damage from water and oil spills, This make bitumen the idea binder for asphalts because asphalt is commonly used as a surface for road, car, parks etc.

Q2:- A crest verticle curve joining a +3% and -4% grade is to be designed for 75 mi/h, if the tangents intersect at Section (345+60) at an elevation of 250 ft determine the sations and elevation 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)

Minimum length $= 312 \times \{3-(-4)\}$

$= 2184$ ft

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

$=$ ~~356+68~~

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

The remainder of the computation is effeciently done using the formate show in the table.

Station	Distance from BVC (x) ft	Tangent Elevation (ft)	Offset $\left[Y = \frac{Ax^2}{200L}\right]$ (ft)	Curve Elevation (Tangent elevation - offset) (ft)
BVC 334+68	0	217.24	0.00	217.24
BVC 335+0	32	$217.24 + \frac{32}{100} \times 3$ = 218.20	0.02	218.18
BVC 336+0	132	221.20	0.28	220.92
BVC 337+0	232	224.20	0.86	223.34
BVC 338+0	332	227.20	1.77	225.43
BVC 339+0	432	230.20	2.99	227.21
BVC 340+0	532	233.20	4.54	228.66
BVC 341+0	632	236.20	6.40	229.80
BVC 342+0	732	239.20	8.59	230.61
BVC 343+0	832	242.20	11.09	231.11

Station	Distance from BVC	Tangent elevation	Offset	Curve elevation
BVC 344+0	932	245.20	13.92	231.28
BVC 345+0	1032	248.20	17.07	231.13
BVC 346+0	1132	251.20	20.54	230.66
BVC 347+0	1232	254.20	24.32	229.88
BVC 348+0	1332	257.20	28.43	228.77
BVC 349+0	1432	260.20	32.86	227.34
BVC 350+0	1532	263.20	37.61	225.59
BVC 351+0	1632	266.20	42.68	223.52
BVC 352+0	1732	269.20	48.07	221.13
BVC 353+0	1832	272.20	53.79	218.41
BVC 354+0	1932	275.20	59.82	215.38
BVC 355+0	2032	278.20	66.17	212.03
BVC 356+0	2132	281.20	72.84	208.36
BVC 356+52	2184	282.76	76.44	206.32

Q3:- 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 approching 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, Mr 31,000 lb/in²

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

→ Mr of subgrade 6x1500 lb/in² = 9000 lb/in²

Ans:- step1:- Draw a line joining the reliability level of 99% and the overall stand deviation So of 0.49, and extend this line to intersect the TL line at point A.

step2:- 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 3:- Draw a line joining point B and resilient modulus (Mr) of base course and extend this line to intersect the design Serviceability loss chart at Point c.

Step 4:- Draw a horizontal 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 required to protect the base curve to find the thickness D_1 of the surface course is 2.6

Step 6:- Determine the appropriate structure layer coefficient for each construction material. Resilient value of asphalt = 450,000 lb/in²

there force $a_1 = 0.44$

$$D_1 = SN_1 / a_1$$

$$\frac{2.6}{0.44} = 5.9''$$

Thickness should be taken to the nearest 0.5 inches. So the thickness of the surface course is 6"

$SN_1 = D_1 \times a_1$

$SN_1 = 6 \times 0.44 = 2.64$

Now find SN_2 and D_2 (Base course)
find the value of a_2 from layer coefficient table and M_2 from Drainage coefficient table.

Thickness of Base course (D_2)

$D_2 = (SN_2 - SN_1) / a_2 M_2$

$D_2 = (3.8 - 2.64) / (0.14 \times 0.80)$

$D_2 = 10.36"$

use 12"

so 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 coefficient a_3 and drainage coefficient M_3 from there respective table.

$$D_3 = (SN_3 - SN_2)/a_3 M_3$$

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

$$D_3 = 5.25''$$

we will used 6" as a sub base

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

$$SN_3 \ 4.46 > 4.4 \ \text{(ok)}$$

Final design:

Surface course = 6"

Base course = 12"

sub base = 6"

Total pavement thickness = 24"

Q4:- What are the different pavement distresses? Explain in detail.

Ans:- Different pavement distresses are the following.

① Alligator cracking :- ⊙ Positive Cause :-

→ overloading
→ inadequate structural design
→ poor construction.

⊙ Repair :-

→ Crack sealing is in effective
→ Dig out and replace area of poor subgrade

② Block cracking :- Problem :- Allow moisture infiltration

Possible cases:-

→ HMA Shrinkage
→ Asphalt binder aging
→ poor choice of asphalt binder in the mix design

Repair :-

→ Low Severity cracks

(< 1/2 inch wide). cracks 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.

(3):- Potholes :-

→ Small, bowl-shaped depressions in the pavement surface that ~~peene~~ penetrate all the way through the HMA layer down to the base course.

→ potholes are most likely to occurs on roads with thin HMA (1 to 2 inches) and Seldom occure on roads with 4 inches or deeper HMA surface

Problems:- 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.

~~→ surface~~ possible causes :- → insufficient compaction of HMA layers during construction

→ subgrade rutting

→ Improper mix design

Repair :- → slight ruts (< 1/3 inch deep) can generally be left untreated. Pavement with deeper ruts should be leveled and overlayed.

(5) Bleeding :- Problem :- Loss of skid resistance when wet.

possible cause :- → Excessive asphalt binder in HMA.

→ Excessive application of asphalt binder during BST application.
→ Low HMA air void content.

6) Polished aggregate :- Possible causes :- Repeated traffice applications.

This can occur quicker if the aggregate is susceptible to abrasion

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

7) Raveling :- Loose debris on the pavement which increases pavement roughness and loss of skin resistance

Possible causes: → Asphalt binder aging
→ inadequate compaction during construction.

Repair :- For seal / slurry ~~sl~~ seal or remove the damaged pavement and overlay.

End