Name	Waqas Hussain
ID#	7799
Section	"A"
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Paper	Final term
Submitted to	Engr Abdul Farhan Sir
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Question#01:

a) what is the difference between flexible and rigid pavement?

Flexible Pavement	Rigid Pavement
1) It is the type of Pavement whose surface course is made up of Asphalt or bitumen.	1) It is that type of Pavement in which the Surface course contain P.C.C or R.C.C.
2) Flexible pavement have low construction cost as compared to Rigid pavement	2) The construction cost of Rigid pavement is very high.
3) Maintenance cost of this pavement is high	3) It is having low maintenance cost.
4) This type of pavement have a life span of average 10-15 years.	4) The life span of Rigid pavement is more as compared to flexible Pavement.
5) Flexible pavements distribute wheel loads to the lower layer i-e base, sub base, Subgrade	5) Rigid Pavement distribute wheel loads over a wide are of the Sub grade of the Pavement.
6) Sub base must be constructed in flexible Pavement	6) Sub base is optional in this type of pavement.

7) Distresses like Rutting, top-down cracking etc occurs mostly in flexible pavements.	In Rigid pavements, Mud pumping, fatigue cracking etc occurs Sometimes.
8) Strength of the flexible Pavement mostly depend upon the strength of Sub-grade.	Strength of the pavement mostly depend upon the upper layer.

Question#01:

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

Answer:

Advantages of W.B.M over W.M.M:

1) The water bound macadam construction of base course is less costly than the Wet mix macadam as its specifications do not involve the use of mixing plant and paver.

2) water bound macadam requires ~~less~~ more time for construction.

3) Wet mix macadam roads are superior the water bound macadam in all aspects but the WBM is the old method

of construction having low construction cost because it has been traditionally a labour oriented specifications.

Question#01

c) what is the different between asphalt and bitumen.

Answer:

In general, we understand that the Asphalt and Bitumen are both the same but actually the Bitumen is the liquid binder that holds Asphalt together.

↳ Bitumen is a black, dark coloured cementitious material which can be natural and manufactured too, which composed of high molecular weight hydrocarbons found in Asphalts, Tar and pitches.

↳ while Asphalt is dark brown to black cementitious material in which the bitumens are the predominating constituents, it can occur in nature or can be manufactured or obtained in distillation of petroleum along

with certain mineral matterial.

↳ Asphalt can be in Solid or Semi Solid State or form while Bitumen is of Solid State.

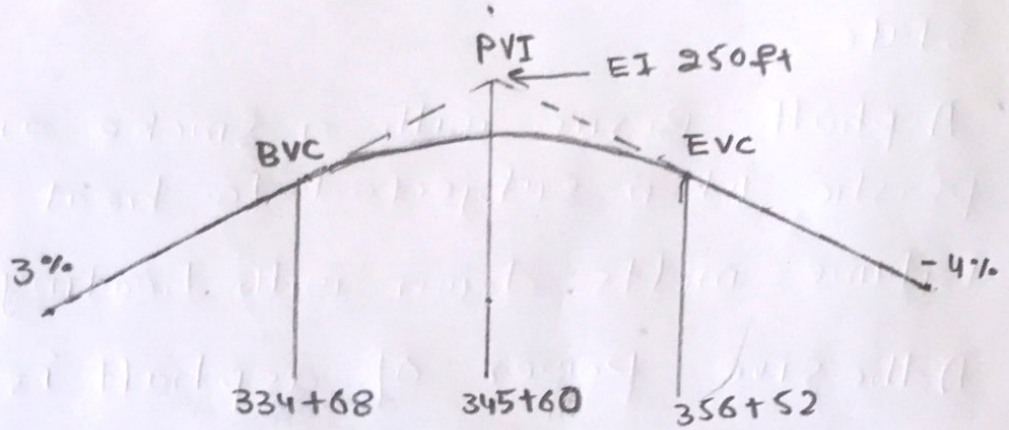
↳ Asphalt Burns with a Smoke and become plastic when subjected to heat while Bitume melts down with heating.

↳ Adhesive power of asphalt is less as compared to Bitumen.

↳ Resistance to acid is more in both the Asphalt and Bitumen.

Question#02:

A crest vertical curve joining a +3 percent and a -4 percent grade is to be designed for 75 mil/h. If the tangents intersect at section (345+60.00) at an elevation of 950 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.



Solution:

For a design speed of 75 mil/h,

$K = 312$

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

Station of BVC $= (345 + 60) - \left[\frac{2184}{2}\right]$

$= 334 + 68$

Station of EVC $= (334 + 68) + (2184)$

$= 356 + 52$

Elevation of BVC $= 250 - \left[0.03 \times \frac{2184}{2}\right]$

$= 217.24$ ft

Station	Distance from BVC (x) (ft)	Tangent Elevation (ft)	offset $[Y = \frac{Ax^2}{200L}]$ ft	Curve Elevation (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
BVC 356+52	2184	282.76	76.44	206.32

Question#03:

A flexible highway is to be designed to carry a design ESAL of $2 \times 10^{+6}$. 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, Mr 31,000 lb/in²

↳ CBR value of Subbase course material 22, Mr 13,500 lb/in²

↳ CBR value of Subgrade material 6.

↳ Mr of Subgrade 6×1500 lb/in²

$= 9000$ lb/in²

Solution:

Reliability level = R = 99%

Standard deviation = $S_o = 0.49$

Initial Serviceability index, $P_i = 4.5$

Terminal Serviceability index, $P_t = 2.5$

$\Delta PSI = 4.5 - 2.5 = 2.0$

Finding SN_1 and D_1 (surface course)

Step #1:-
Draw the line joining the reliability level of 99% and the overall standard deviation S_o of 0.49

Step# 2:
Draw a line joining point A to the ESAL of 2×10^6.

Step# 3:
Draw a line joining point B and resilient modulus (M_r) of Base course and ~~intersect~~ extend the 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

$$\Delta PSI = 4.5 - 2.5 = 2$$

↳ D_1 of surface course is 2.6. (SN_1)

Step#05:
Determine the appropiate structure layer coefficient for each construction material.
Resilient value of asphalt = 450,000 lb/in²

$\Rightarrow a_1 = 0.44$

Thickness of Surface course, D_1:

$$D_1 = SN_1/a_1 = \frac{2.6}{0.44}$$

$$\Rightarrow D_1 = 5.9'' \approx 6''$$

So thickness of Surface course is 6"

$$SN_1 = D_1 \times a_1$$

$$SN_1 = 6 \times 0.44$$

$$\Rightarrow SN_1 = 2.64$$

Finding SN_2 and D_2 (Base course)

$$D_2 = \frac{(SN_2 - SN_1)}{a_2 m_2} = \frac{3.8 - 2.64}{0.14 \times 0.80}$$

$$\Rightarrow D_2 = 10.36''$$

let use 12"

So, thickness of base course is 12"

$$SN_2 = 0.14 \times 0.80 \times 0.12 + SN_1$$

$$= 1.34 + 2.64$$

$$\Rightarrow SN_2 = 3.98$$

Finding SN_3 and D_3 (Sub base Course)

$$D_3 = \frac{(SN_3 - SN_2)}{a_3 m_3} = \frac{4.4 - 3.98}{0.10 \times 0.80}$$

$$\Rightarrow D_3 = 5.25''$$

we will use 6" as sub base

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

$SN_3 = 4.46 > 4.4 \rightarrow$ okay

↳ Final design:

Surface course = 6"

Base Course = 12"

Sub base = 6"

⇒ Total Pavement thickness = 24"

Question #04:

what are the different pavement distresses? Explain in detail.

Answer:

Pavement Distresses:

Pavement distress is a condition of the pavement structure in which it reduces the Serviceability or leads to a reduction in Service life.

↳ It is the irregularity (uneven) of the road Surface which affects the comforts and Safety of the people.

Different types of Distresses:-

The following are the different types of Surface pavement distresses

1) Alligator or Fatigue Cracking
2) Block Cracking
3) Potholes
4) Rutting
5) Bleeding
6) Polished aggregate
7) Raveling

1) Alligator (Fatigue) Cracking:-

Alligator cracking is commonly used to describe the distinctive appereance of asphalt Surface that has suffered fatigue damage. It is called Alligator or crocodile cracking because of the pattern of the cracks.

Causes:-

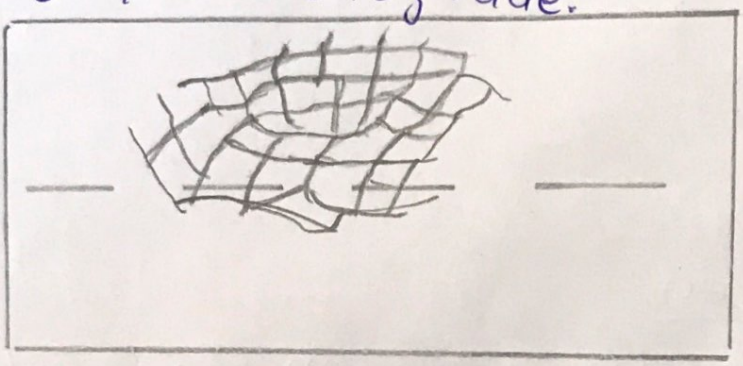
The main causes of this Cracking is;

1) Over loading
2) Poor construction
3) Inadequate Structural design.

Repair :-

Crack Sealing is an effective process of repairing the Alligator cracking.

↳ "~~Dig~~ we can also repair the Fatigue cracking by digging out and replacing area of poor subgrade.



2) Block Cracking:-

It is the type of Cracking which divide the pavement into rectangular pieces or blocks.

Causes:

↳ Poor choice of asphalt binder in the mix design

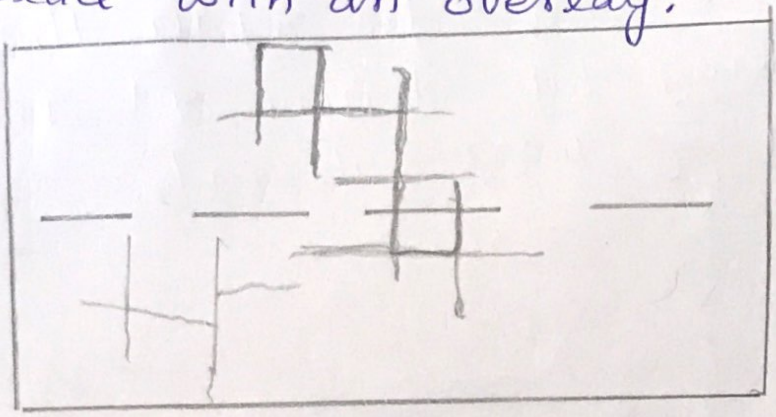
↳ Asphalt binder aging

↳ HMA Shrinkage

Repair:-

↳ For low severity cracks (less than $\frac{1}{2}$ inch wide), Cracks should be Seal to prevent the entry of moisture.

↳ For high Severity cracks (more than half inchs) and also cracks with raveled edges, the cracked pavement layer should be remove and Replace with an overlay.



3) Potholes:

Potholes mostly occur on roads where the HMA Surface is thin (1 to 2 inches).

↳ Pot holes are Small, bowl shaped depressions in the pavement Surface that penetrate all the way through the HMA layer down to the course (base course).

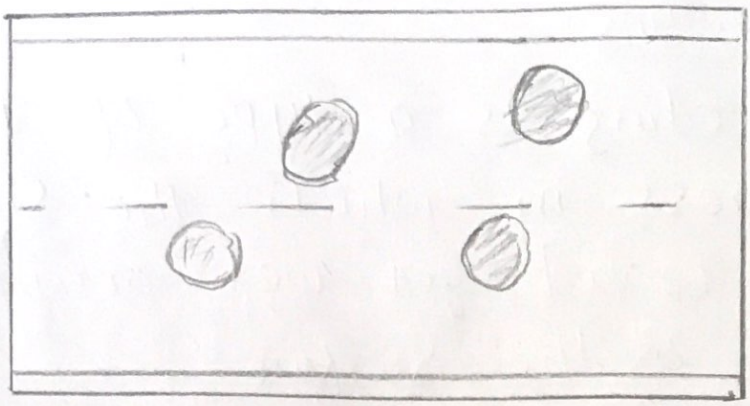
Causes:

Potholes most of the time occurs when we do not repair fatigue cracking.

Repair:

Potholes can be repair by the techniques of patching.

Potholes



4) Rutting:

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

Causes:

It occurs due to:

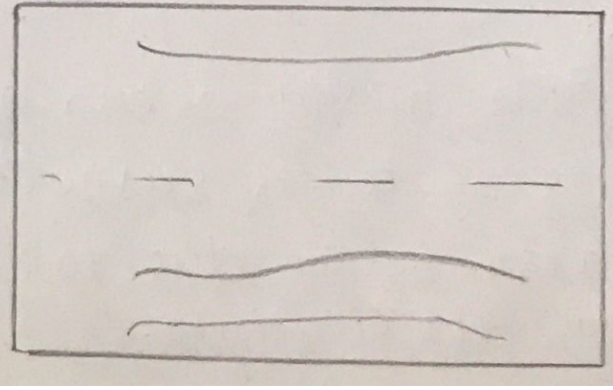
↳ Insufficient compaction of HMA layers during construction.

↳ Improper mix design

↳ indequate pavement structure.

Repair:

↳ Rutting or slight ruts (less than 1/3 inch deep) can generally be left untreated while deep rutts should be leveled and over layed.



5) Bleeding:

Bleeding is a type of pavement distress in which the surface of the road get wet or moisture comes out of the surface.

↳ Bleeding can result of serious accident.

Causes:

Its main causes are:

↳ Excessive asphalt binder in the HMA
↳ Excessive application of asphalt during BST application.
↳ Low HMA air void content.

6) Polished aggregate:

It occurs when area of pavement where the portion of aggregate extending above the asphalt binder or cement paste is either very small or there are no rough or angular aggregate particles.

Causes:

This mostly occur quickly when the aggregate is suspectible to abrasion.

↳ This also occur due to Repeated traffic applications.

Repair:-

This can be Repair by applying a skid-resistant Slurry seal, BST or non-structural overlay.

7) Raveling:

The deterioration of pavement by the loss of asphalt and rocks is known as Raveling.

↳ Loose debris on the pavement which increases pavement roughness and loss of skid resistence.

Causes:

↳ Dust Coating
↳ Aggregate Segregation
↳ Inadequate compaction
↳ Traffic dislodging
↳ Asphalt binder aging
↳ when fine particles are missing from ~~which~~ the aggregate matrix.

Repair:

Repair of raveled pavement depends on its severity and root cause

↳ if the raveling present is small, the construction team can remove and replace it.

↳ For larger area of ravelling, general asphalt damage is generally the culprit. the damaged pavement will be removed and and an overlay should be applied.

The End

Thank You