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Subject: Highway & Traffic Engineering

Section "A"

Ans 1:

(a)

Flexible Pavements	Rigid Pavements
1) Bituman is used as a binder.	1) Cement is used as a binder.
2) Grain to grain load transfer	2) Slabs action takes place
3) Initial cost is low	3) Initial cost is high.
4) Joints are not required.	4) Joint are required.
5) Durability is less.	5) Durability is high.
6) Life span is short ~ 15 years.	6) Life span is high ~ 30 years.
7) Repair work is easy	7) Repair work is tough.
8) Maintinace cost is high.	8) Maintinace cost is low.
9) Requires less curing time.	9) Requires much curing time.
10) No glare due to sunlight	10) High glare due to sunlight.
11) Design depends upon the subgrade strenght.	11) Design does not depends on subgrade.
12) IRC 37	12) IRC 58

ANS 1 (b)

Advantages of water bound over water mix macadam:

* water bound macadam is superior over mix macadam because the stone aggregate used in WBM is larger in size from 9cm to 20 cm, depending on the grade, whear as the aggregate use in WMM are from 4.75mm to 20mm, which are very small.

* There is sufficient interlocking between the aggregate particles, which fills the voids completely & give it high strenght.

* water bound macadam materials are carefully graded and the resulting mass is almost voidless.

* water mix macadam is slightly cheap compound to water bound macadam.

* water bound macadam aggregate can be easily hand brooken, while the aggregate for water mix macadam have to be crusher-run.

* In water bound macadam materials are carefully graded as a result of which is superior.

* water bound mecadam requires more time for construction.

(c)

Asfalt:-

A dark brown to black cementious material, which is produced in a plant that heats, dries & mixes aggregate, bituman and sand into a composite.

* Durable with a life span of 20+ years.
* It is energy efficient, reduce friction between tire and car.
* Reduced wear and tear on vehicals.
* More expensive to install compared to bituman.
* Requires a well prepared surface before paving is done.

Bitumen:

Bitumen is the liquid binder that holds alsphalt together.

A bituman sealed surface is a layer of bitumen sprayed and then covered with an aggregate.

* It is cheap to install compare to asphalt.

* can be recycled instead of going to land fill.

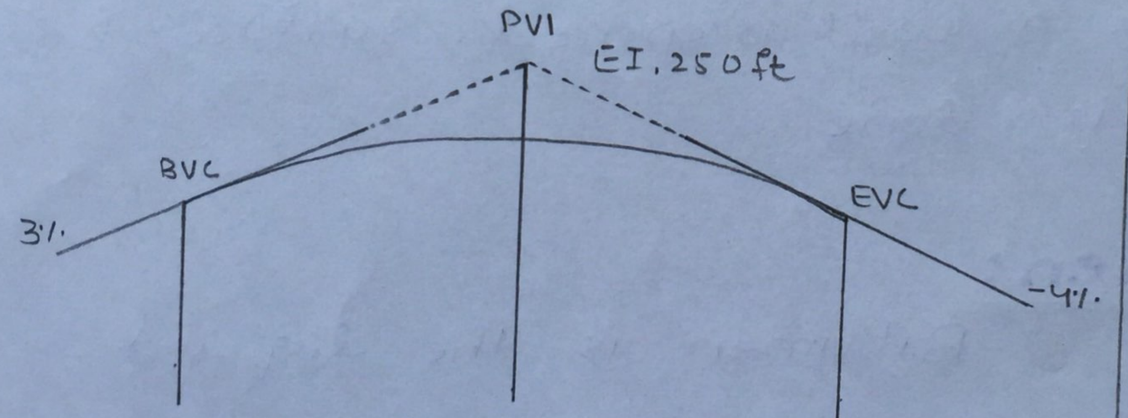
* It is less durable.

* The loose rock on bitumen pavements make the driving experience noiser and wear down tires.

* can cause pollution to soil and groundwater.

ANS 2:

Given:-



Solution:

For a design speed of 75 mi/h

K = 312 (from table)

Minimum lenght

$= 312 \times [3 - (-4)]$

$= 2184$ 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

The remainder of the computation is efficiently done using the format on next page in 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	0.01	217.24
BVC 335+00	32	$217.4 + \frac{32}{100} \times 3 = 218.20$	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	20.59	230.66
BVC 347+00	1232	254.20	24.32	229.88
BVC 348+00	1332	257.20	28.32	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	208.86
EVC 356+52	2184	282.76	76.44	206.32

Ans 3:

Step 1:

Draw a line joining the relibility level of 99% and the overall standard deviation of 0.49 and extend line to intsert 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 reslient modulus (M_r) of base coarse and extend this line to intersect the design servicability loss at point C.

Step 4:

Draw a horizontal line from point C to intersect the design serviceability.

* loss (PSI) curve at point D,

so

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

Step 5:

The structure number require to protect the base coarse and to find the thickness D_1 of the surface coarse is 2.6

Step 6:

Determine the appropriate structure layer co-efficient for each construction material

Resilient 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 thickness of the surface course is 6"

$$SN_1 = D_1 \times a_1$$
$$= 6 \times 0.44$$
$$= 2.64$$

Now we find SN_2 & D_2 (Base coarse)

find the value of a_2 from layers co-efficient table and M_2 from drainage co-efficient table.

Thickness of base course (D_2):

$$D_2 = \frac{(SN_2 - SN_1)}{a_2 m_2}$$

$$= \frac{(3.8 - 2.64)}{0.14 \times 0.80} = 10.36''$$

Use 12"

So the thickness of base coarse is 12"

$$SN_2 = 0.14 \times 0.80 \times 12 + SN$$
$$= 1.34 + 2.64$$
$$= 3.98$$

Finding SN_3 & D_3.

$$D_3 = \frac{(SN_3 - SN_2)}{a_3\ m_3}$$

$$D_3 = \frac{4.4 - 3.98}{0.10 \times 0.80}$$

$D_3 = 5.24''$

we will use 6'' as a sub base

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

$SN_3 = 4.46 > 4.4$

Hence ok.

Final Design:

surface course = 6''

Base course = 12''

sub base = 6''

Total pavement thickness = 24''

ANS 3:(4)

Different Pavement distresses:

It is the irregularity (uneven) of the road surface which it affects the user confort and safety.

1) Pathole:

small bowl shape depression in the pavement surface that penetrate all the way through the HMA layer down the base course.

Problem:

* Roughness
* Moisture infiltration

Repair:

In accordance with patching techniques.

Causes:

It is a result of fatigue cracking when it become severe and create small chunk of pavement

2) Alligator (fatigue) cracking:

A series of interconnected cracks. caused by fatigue failure of the HMA surface under repeated traffic loading.

Problem:

* Roughness
* Indicator of structure failure, cracks allow moisture infiltration.

Causes:

* overloading
* Inadequate structural design
* poor construction.

Repair:

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

3) Block cracking:

Interconnected cracks that divide the pavement upto into rectangular pieces.

Problem:

* Allow moisture infiltration
* Roughness

Causes:

* HMA shrinkage
* Daily temperature cycling
* Asphalt binder aging

Repair:

* low severity cracks (< 1/2 inch wide), crack seal to prevent entry of moisture
* High severity cracks (> 1/2 inch wide), Remove and replace the cracked pavement layer.

4) Rutting:

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

Problem:

* Rust filled with water can cause vehical hydroplaning.
* Pulls the vehicals towards the rut path.

Cause:

* subgrade rutting
* Insufficient compaction of HMA layer
* 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:

A film of asphalt binder on the pavement surface, which create a shiny, glass like reflecting surface.

Problem:

* loss of skid resistance when wet, slightly.

causes:

* Excessive asphalt binder in the HMA
* Low HMA air void content

Repair:

* Minor bleeding can often be corrected by applying coarse sand to blot up the excess asphalt binder.
* Major bleeding can be corrected by cutting of excess asphalt.

6) Polished aggregate: Area of HMA pavement where the portion of aggregate extending above the asphalt binder is either very small or there are no rough or angular aggregate particle.

Problem:

* Decreased skid resistance.

Causes:

* Repeated Traffic application that can occur quiker if the aggregate is susceptable to abrasion

Repair:

* Apply a skid resistance slurry seal.
  * BST
* Non-structural overlay.

7) Raveling: The progressive disintegration of an HMA layer from the surface.

Problem:

* loose debris on the pavement which increases pavement roughness & loss

off skid resistance.

Causes:

* Inadequate compaction during constructio
* Asphalt binder aging
* Aggregate segragation.

Repair:

Fog seal, slurry seal or remove the damaged pavement & overlay.