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Sec :- A

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Final Term Exam.

Q1) a) What is difference b/w Flexible & rigid pavement?

Flexible Pavement	Rigid Pavement
1) Bitumen is used a binder in flexible pavement -	1) Cement is used as a binder in rigid pavement.
2) Deformation in the sub grade is transferred to the upper layer	2) Deformation in the subgrade is not transferred to subsequent layer.
3) Load is transfered by grain to grain contact	3) No such phenomenon of grain to grain load transfer exists.
4) Flexible pavement have low initial construction cost but have high maintenance cost	4) Rigid pavement have low maintance cost but have high initial construction costs.
5) It have low life span usually 10 to 15 years.	5) Life span is more as compare to flexible usually 30 + year.
6) Surfacing cannot be laid directly on the subgrade but a sub base is needed.	6) Surfacing can be directly laid on the sub grade.
7) Road can be used for traffic within 24 hours.	7) Road cannot be used until 14 days of curing.

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

Ans: Following are the advantage of water bound over wet mix macadam;

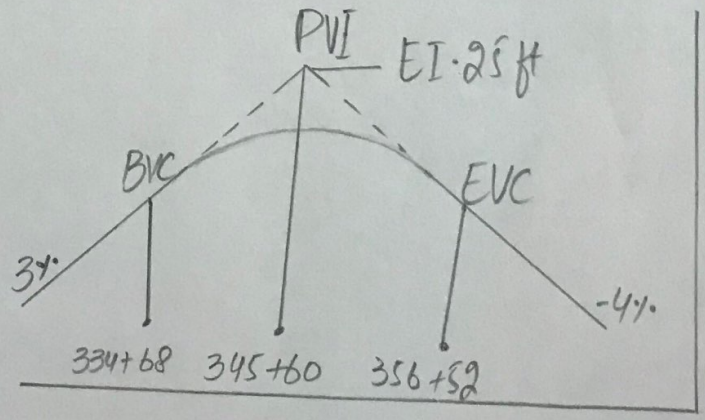
1) Water bound macadam is slightly cheaper then the wet-mix macadam. the reason is WBM requires general labours while wet-mix macadam requires mixer plant and paver.
2) Aggregate of WBM can be broken by hands while the WMM need a crusher for the disintegration of aggregates.
3) The interlocking of aggregate particles imparts adequate strength of a material for filling the voids. These ensure non-entry of the plastic materials of the subgrade into voids.

c) What is the difference b/w asphalt & bitumen? (2)

Ans:- Bitumen is actually the liquid binder that hold asphalts together.

- Asphalts is used as a term to refer to the combination of bitumen and gravel specifically for load construction.
- Bitumen is known for being strongly adhesive and resistant to damage from water and oil spills, this make bitumen the ideal binder for asphalt because asphalt is commonly used as a surface for roads, car, parks etc.

(Q2) A crest vertical curve joining a +3 percent and a -4% grade is to be design for 75 mi/h. If the tangents intersects at section (345+60.00) at an elevation of 250 ft. determine the station and elevations of the BVC & EVC. Also calculate the elevation of intermediate point on the curve at the whole station.



Solution:- 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

- The remainder of the computation is efficiently done using the format shown in table.

Station	Distance from BVC (x) (ft)	Tangent Elevation (ft)	Offset $\left[r = \frac{Ax^2}{200L}\right]$ (ft)	Curve elevation (Tangent elevation − offset) (ft)
BVC 334+68	0	217.24	0.01	217.24
BVC 335+00	32	217.24 + 32 × 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
EVC 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 would take 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 sub Base 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

Ans Step#01:-
Draw a line joining the reliability level of 99% & the overall standered divation so of 0.49, and extend line to intersect the first TL line at point A.

"Step#02:-" 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#03:-" Draw a line joining point B and resilient modulus (M_r) of base course and extend this line to intersect the design serviceability loss chart at point C.

Step#04:- 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#05:-" The structure number require to protect the base course and to find the thickness D_1 of the surface course is 2.6

"Step#06:-" Determine the appropriate structure layer Co-efficent 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 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 coefficent table and m_2 from drainage Co-efficent 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 & D_3 (Subbase Course) and also layer Coefficant a_3 and drainage Coefficant 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"

Q4) What are the different pavement distresses? Explain in detail?

Ans:- Following are different pavement distresses.

1) "Alligator Cracking:-"

→ Possible Causes:

- Overloading.
- Inadequate structural design.
- Poor Construction.

→ "Repair:"

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

2) "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 ($< \frac{1}{2}$ inch wide) - Crack seal to prevent entry of moisture.
- High severity cracks ($> \frac{1}{2}$ inch wide & crack with ravelled edges) Remove and replace the cracks pavement layer on overlay.

3) "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 mostly likely to occurs on roads with thin 2in the thin HMA surface and seldom occur with 4 inch or deeper HMA surfaces.

Problem:- Roughness, moisture infiltration.

→ "Problem Causes:-" Generally, potholes are the end result of fatigue cracking - As fatigues cracking becomes severs. the interconnected cracks creates 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 depression in the wheel path, are particular evident after a rain then they are filled with water.

Possible Causes:-

→ Insufficient compaction of HMLA layer during construction.

→ Subgrade rutting (e.g a result of adequate

pavement structure.
→ 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 Causes:-

→ Excessive asphalt binder in the HMA.
→ Excessive application of asphalt binder during BST application.
→ low HMA air void content.

6) **"Polished Aggregate:-"**

Possible Causes:- Repeated traffic application. This can occur quicker if the aggregate is susceptible to abrasion.

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

7) **"Raveling:-"**

→ loose debris on the pavement which increase pavement roughness and loss of skid resistance.

"Possible Cause:-"

→ Asphalt binders aging

→ Aggregate segration - 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.