Final Paper :-

ID : 7224

Module : 2012 Batch

Subject : Highway and traffic Engineering

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Question # 1 :- Part # a :-

Flexible Pavement	Rigid Pavement
① It consist of a series of layer with the highest quality materials at or near the surface of pavement.	① It consist of one layer portland cement concrete slab or relatively high flexural strength.
② It reflects the deformation of subgrade and subsequent layers on the surface.	It is able to bridge over localized failures and area of inadequate support.
③ Its stability depends upon the aggregate interlock, particle friction and cohession	Its structural strength is provided by the pavement slab itself by its beam action
④ Pavement design is greatly influenced by the subgrade strength.	flexural strength of concrete is a major factor for design.
⑤ It functions by a way of load distribution through the component layers.	⑥ It distributes load over a wide area of subgrade because of its regidity and high modulus of elasticity.
⑥ Temperature variation due to change in atmospheric conditions dont produce stresses in flexible pavements.	Temperature changes include heavy stresses in regid pavements.

Question # 1 part b:.
What are the advantages of water bound over wet mix macadam?

Water bound macadam:-

Defi:- The concept of water bound macadam was suggested by John Macadam, who was a Scottish engineer. The road whose wearing course consists of clean crushed aggregates, mechanically interlocked by rolling and bound together with filler material and water laid on a well compacted base course is called bound macadam (W.B.M) road.

Advantages of bound macadam:-

1) water bound macadam is superior in quality because the materials are carefully graded and the resulting mass is almost void less compacted mass.

2) The interlocking of aggregate particles impacts adequate strength of the materials selected for filling the voids.

3) water bounds macadam is less so costly as compared to bitumenous base course.

Question # 1 Part # "C"

What is the difference between asphalt and bitumen?

Difference between Asphalt and bitumen:-

following are the difference between asphalt and bitumen.

Asphalt	Bitumen
Asphalt pavements are durable; with a layer depth of 26-40mm and life span of 20+ years.	Bitumen pavements are less durable; with a layer depth of 10-20mm and lifespan of 5-10 years.
Surface made of Asphalt is smoother and more skid-resistant, ensuring the driver's safety and minimal noise	The loose fragments on bitumen pavements make the driving experience noiser and can wear down tries, consequently causing safety issues.
Reduced friction between tyre and car; meaning better fuel economy and minimization of carbon dioxide emission.	Higher frictional resistance of a bitumen pavement means less efficiency in energy utilization.
installation is comparatively Costlier.	cheap to install compared to ash asphalt.
cost effective. An asphalt surface doesn't require regular maintenance like bitumen surface, rather a routine check periodically is enough	They require regular maintenance especially when resurfacing a pavement with greater traffic volume. So not cost effective in long run.

Question #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 intersect at station (345+60.00) at an elevation of 250 ft, determine the station and elevations of intermediate points on the curve - at the whole stations.

Solution :- For a design speed of 75 mi/h, K = 312

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

Station for BVC = $(345+60) - \left(\frac{21+84}{2}\right) = 334+68$

Station for EVC = $(334+68) + (21+84) = 356+52$

Elevation of BVC = $250 - \left(0.03 * \frac{2184}{2}\right) = 217.24$ ft

Solution	Distance from BVC (x) (ft)	Tangent Elevation (ft)	offset $\left[y = \frac{Ax^2}{2KL}\right]$ ft	curve Elevation (Tangent Elevation − offset) ft.
BVC 334+68	0	217.24	0.01	220.92
BVC 335+00	32	217.24 + 32/100 × 3 = 218.20	0.02	223.34
BVC 336+00	132	221.20	0.028	225.43
BVC 337+00	232	224.20	0.86	2127.21
BVC 338+00	332	227.20	1.77	2128.66
BVC 339+00	8432	230.20	2.99	2129.80
BVC 340+00	532	233.20	4.54	230.61
BVC 341+00	632	236.20	6.40	231.11
BVC 342+00	732	239.20	8.59	231.22
BVC 343+00	832	242.20	11.09	231.13
BVC 343+00	932	245.20	13.92	230.66
BVC 344+00	1032	248.20	17.07	229.88

BVC 345+00	1132	2·51·20	~~20·54~~	230·66
BVC 346+00	1232	254·20	24·32	229·88
BVC 347+00	1332	257·20	28·43	228·77
BVC 348+00	1432	260·20		
BVC 349+00	1532	263·20	32·86	227·44
BVC 350+00	1632	266·20	97·61	225·59
BVC 351+00	1732	269·20	42·68	223·52
BVC 352+00	1832	272·20	48·07	221·13
BVC 353+00	1932	275·20	53·79	218·41
BVC 3435+00	2032	278·20	59·82	215·38
BVC 355+00	2132	281·20	66·17	212·03
BVC 356+00	2184	282·76	~~72·84~~ 72·84	208·36
			76·44	206·32

Question # 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 ~~wet wood~~ water to be drained from within the pavement and the pavement structure will be exposed to moisture levels approaching saturating 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/in^2 = 9000 lb/in2.

Answer:

Step#1: Draw a line joining the reliability level of 99% to the overall standered diviation so of 0.49, and extend line to intersect 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 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 have

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

Step#5:-

The structure number require to protect the base course and to find the thickness D1 of the surface course is 2.6.

Step # 6 :-

Determine the appropriate structure layer co-efficient for each construction material -
Resilient Value of asphalt = ~~40~~ 450,000 lb/in².
Therefore,

$$D_1 = SN_1 / a_1$$

$$2.6 / 0.44 = 5.9''$$

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

$$SN_2 = D_2 * a_1$$

$$= 6 \times 0.44 = 264$$

→ Now find SN_2 and D_2 (Base Course) find the value of a_2 from layers coefficent table and m_2 from layer drainage co-efficient table.

→ Thickness of base course (D_2)

$$D_2 = (SN_2 - SN_1)\, a_2 m_2$$

$$D_2 = (3.8 - 2.64) \cdot 14 \times 0.80$$

$$D_2 = 10.36''$$

Vs 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 & P_3 (subbase course) and also layer coefficient a_3 and drainage coefficient 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

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

$SN_3 = 4.46 > 4.4$ okey

"Final design"

→ Surface course = 6"

→ Base course = 12"

→ Sub base = 6"

→ Total Pavement = 24".

Question No 4 :-

what are the different pavement distresses? Explain in detail.

Pavement Distresses :-

→ Distress is a condition of the pavement structure that reduces serviceability or leads to re 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 in effective
- Dig out and replace area of Subgrade

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 (< ½ inch wide). Crack seal to prevent entry of moisture.
- High severity cracks (> ½ inch wide and crack 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)

> Problem:

Roughness (serious vehicular damage can result from driving accross 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 vehicle 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.

> ~~Surface depression~~

> Possible Causes:-

- Insufficient compaction of HMA layers during construction.

- Subgrade rutting (e.g, as a result of inadequate Pavement structure)
- Improper mix disign (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. ~~Preve~~ pavement with deeper ruts should be leveled and overlayed.

Bleeding :-

⇒ Problem :- (oss of skid resistance when we

⇒ Possible cause :-

* Excessive asphalt binder in the HMA.
* Excessive application of asphalt binder during BST application.
* Lower HMA air void content.

Polished Aggregate :-

⇒ Possible Cause :-

repeated traffic applications. This can occur quicker if the aggregate is susceptible to abrasion.

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

Raveling :-

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

Possible Cause :-

- Asphalt binder aging.
- Aggregate segregation.
- Inadequate compaction during construction.

⇒ Repair :-

For seal/slurry seal or Remove the damaged pavement and overlay.