Final Term Exam

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Paper # Highway and Traffic

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Q No #01 part (A) (1)

Comparison of Flexible vs Rigid Pavement

Flexible Pavement	Rigid Pavement
1) Bitumen is used a binder in Flexible Pavement	Cement is used as a binder in rigid Pavement
2) Deformation in the sub grade is transferred to the upper layyers.	Deformation in the sub grade is not transferred to subsequent layers.
3) Load is transferred by grain to grain contact.	No such Phenomenon of grain to grain load transfer exists.
4) Flexible Pavement have low initial construction costs but have high maintenance cost.	Rigid Pavement have low maintance cost but have high initial construction Costs.
5) Have ~~life~~ low life span usually 10-15 years	Life span is more as compare to flexible usually 20+ years.
6) Surfacing cannot be laid directly on the sub grande but a sub base is needed.	Surfacing can be directly laid on the sub grade.
7) In flexible pavement strength	Strength of road less dependent on.

Q No # 01 Part (B)

Advantages of water bound over wet mix macadam.

Ans:-

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

2) The interlocking of aggregate particles imparts adequate strength of the materials selected for filling the voids. These ensure non-entry of the plastic materials of the sub-grade into the voids.

3) Water bound macadam is less costly as compared to bituminous base course.

Q No #01 Part (c)

Ans:- Bitumen is actually the liquid binder that holds asphalt together. The term bitumen is often mistakenly used to describe asphalt. A bitumen-sealed road has a layer of bitumen sprayed and then covered with an aggregate. This is then repeated to give a two-coat seal.
Asphal is produced in a plant that heats, dries and mixes aggregate, bitumen and sand into a composite mix. It is then applied through a paving machine on site as a solid material at a nominated or required thickness, relative to the end use.
Asphalt result in a smoother and more durable asphalt road surface than a bitumen-sealed road.
Bitumen is often misused as a term when describing asphalt and can be confusing for many people. In the UK, most people will say bitumen when describing an aggregate mixture of bitumen, stones or gravel and sand. In Australia, we call the mixture asphalt.
While bitumen is mostly used in a mixture, it can also be used as a binder for roads. So you may sometimes hear the term "bitumen road". This refers to a layer or layers of bitumen that is used in the road to adhere or seal other layers.

Q No # 02

Q.No(02).

Solution:- For a design Speed of 75 mi/h, K = 312, From Table 15.5,

Maximum 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 BVE = $250 - \left(0.03 \times \frac{2184}{2}\right) = 217.24\,ft$

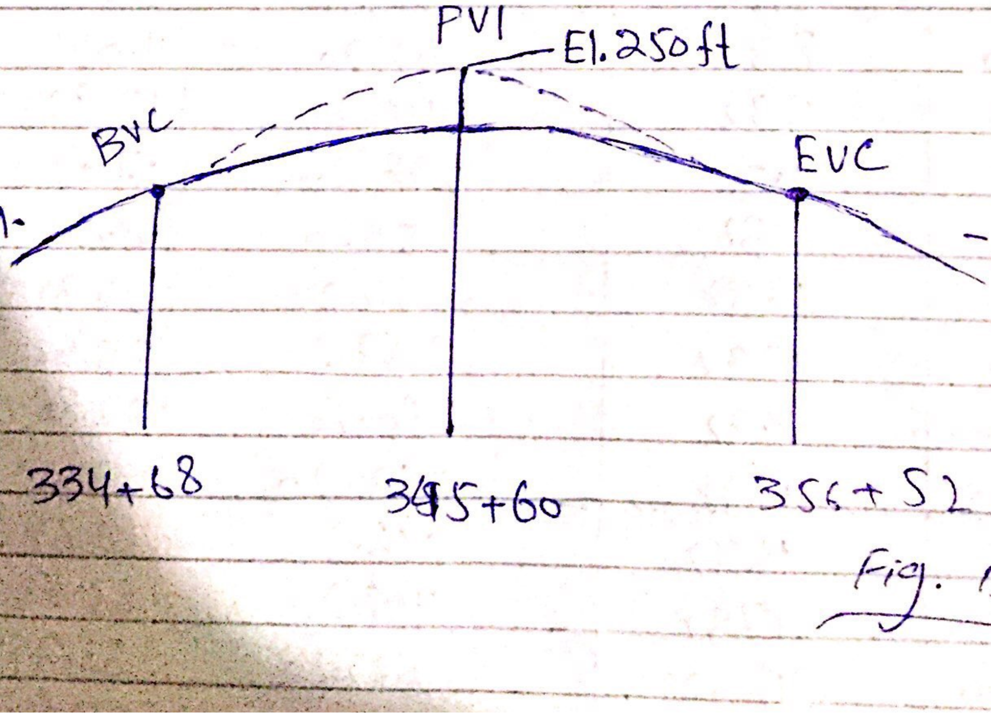

Fig. 15.16,

Station	Distance from BVC (x) (ft)	Tangent Elevation	offset $\left[y = \frac{A x^2}{200L} \right]$	Curve Tangent Elevation offset (ft)
BVC 334+68	0	217.24	0.01	217.24
BVC 335+00	32	$217.24 + \frac{32}{100} \times 3 = 218.24$	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	231.28
BVC 344+00	932	245.20	13.92	231.13
BVC 345+00	1032	248.20	17.07	231.66
BVC 346+00	1132	251.20	20.54	230.66 229.88
BVC 347+00	1232	254.20	24.32	228.77
BVC 348+00	1332	257.20	28.43	227.34
BVC 349+00	1432	260.20	32.86	225.59
BVC 350+00	1532	263.20	37.61	223.52
BVC 351+00	1632	266.20	42.68	221.13
BVC 352+00	1732	269.20	48.07	218.41
BVC 353+00	1832	272.20	53.79	215.38
BVC 354+00	1932	275.20	59.82	
BVC 355+00	2032	278.20	66.17	212.03
BVC 356+00	2132	281.20	72.84	208.36
BVC 356+00	2184	282.20	76.44	206.32

Q No # 03

A Flexible highway is to be desiged to Carry a design ESAL of 2×10^6. Its estimated that it make take about a week for water to be drained from within the pavement and the pavement struture will be exposed to moisture levels approching saturation for 30% of the time. The following additional information is avalible.

→ Resilent modulus of asphalt conerete at 68% 450,000 lb/in^2

→ CBR value of base course material 100, Mr 31,000 lb/in^2

→ CBR value of subgrade material 6 -

→ CBR value of subBase course material 22, Mr 13,500 lb/in^2

→ Mr of subgrande $6 \times 1500 \, lb/in^2 = 9000 \, lb/in^2$

Step No :- 01

Ans :- 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 No : 02 :- Draw a line joing point A to the ESAL of 2×10^6 and extent this line to ~~extend~~ intersect the first TL line at point B.

Step No: 03 :- Draw a line joining B and resilient modulus (Mr) of

Base course and extend this line to intersect the desgin ~~se~~ sericeability loss chart at point C.

Step #04 Draw a horizontal line from point C to intersct the design serviceability.
→ loss (PSI) Curve at point D.
So have ΔPSI = ~~30~~ 4.5 − 2.5 = 2

Step #05 The structure number require to protect the base course and to find the thickness D. of the surface course is 2.6.

Step #06 Determine the appropriate struture layers co-efficent for each construction material.
Resilient value of asphalt = 450,000 lb/in²
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 in ches so the thickness of the surface courese is 6''

$$SN_1 = D_1 \times a_1$$

$$= 6 \times 0.44 = 2.44$$

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)

$$D_2 = (SN_2 - SN_1)/a_2 m_2$$

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

$$D_2 = 10.36''$$

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 (Sub base course) and also layer coffecient a_3 and drainage coffient m_3 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

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

$$SN_3 = 4.46 > 4.4$$

Final design :-

Surface Course = 6"

- Base Course = 12"
- Sub base = 6"
- Total pavement thickness = 24"

Q No # 04 (10)

Pavement Distresses :- Distresses is a Condition of the pavement structure that reduces serviceability or leads to 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 Structure design
- poor Construction

→ Repair
- Crack sealing is in effective
- Dig out and replace area of poor 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 (< 1/2 inch wide). ~~et~~ crack 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.

Potholes :- Small, bowl-shaped depressions in the pavement surface that penetrate all the way through the HMA layer to the base course.

- Potholes are most likely to occur on road with thin HMA surfaces 1 to 2 Inches) and seldom occur on roads with 4 inch or deeper HMA surface.

Problem :- Roughness (serious vehicular damage can result from driving across potholes at higher speeds), moisture infiltration.

Possible Causes :- Generally, Potholes are the end result of ~~figure~~ fatigue cracking. As fatigue cracking becomes severe, the interconnected cracks creats small chunks of pavement, which can be dislodged as vehicles ~~d~~ 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.

Possibles :- Insufficient compaction of HMA layers during construction

- Subgrade (e.g. excessively high asphalt content, excessive mineral filler, insufficient ~~amont~~ amount of angular aggregate particles)

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

Bleeding :-

Problem :- loss of ~~Skn~~ Skid resitance when wet

Possible Cause:

- Excessive asphalt binder in the HMA
- Excessive application of asphalt binder during BST application
- low HMA air void Content

Polished Aggregate :-

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

Repair :- Apply a Skid-resistan slurry seal, BST or non-structural overlay.

Raveling :-

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

Possible Causes :- • Asphalt binder aging
• Aggregate segregation, if fine particles are missing from aggregate matrix.

Repair :- Fog seal / Slurry seal or Remove the damaged pavement and overlay.