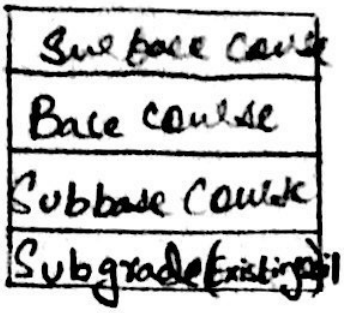
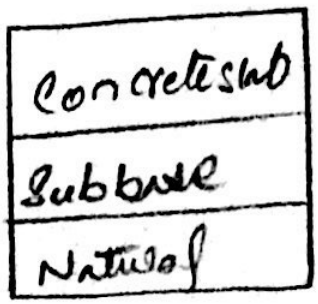
Question #01:-

(a)

	Flexible Pavement	Rigid Pavement
		
1)	Consist of generally bituminous material	Consist of cement concrete and may be reinforced with steel.
2)	Load distribution is primarily based on layered system	Most of load carries by slab itself and slight load goes to the underlying strata (Natural / Subbase).
3)	Deflection basin is very deep because it is dependent on underlaying layer.	Deflection basin is shallow because it is independent on underlying layer.
4)	have low life span 10-15 years	life span is more then 30 years.

Question #01

(b)

Advantages:-

⇒ water bound macadam is less costly as compared wet mix macadam
Compared to wet mix macadam

⇒ The aggregate for wet mix macadam will have to be crushed-run where as the aggregate for water bound are generally hand-broken

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

Question #1:

(c)

	Asphalt	Bitumen
1)	Asphalt is basically a Product that refers to the combination of gravel and bitumen for the construction of roads	Bitumen is a natural Product used for road construction.
2)	Asphalt is a mixture of products used for manufacturing of roads	Bitumen is a single component of an asphalt.
3)	Asphalt is a name of a mixture made up of different item used for manufacturing of roads.	Bitumen is a liquid Binder which is used to hold the Asphalt Product together.

Question #02:-

Solution:-

for a design speed of 75 miles/hour the value of "K" will be chosed from the table on next page i-e **K = 312**

Now,

1- Minimum length $= 312 \times (3 - (-4)) =$ **2184 ft**

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

3- Station EVC $= (334+68) + (21+84) =$ **356+52**

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

(Ans)

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	217.24 + 32/100 × 3 = 218	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	42.86	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:

SOLUTION:

Initial Serviceability Index (P_i) = 4.5
Terminal Serviceability Index (P_t) = 2.5
Standard Deviation (S_o) = 0.49
Reliability level (R) = 99%
ΔPSI = 4.5 − 2.5 = 2.0.

Step # 1:-

Draw a line joining the reliability level of 99% and the ~~exact~~ overall Standard deviation (S_o) of 0.49, and extend this 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 Second 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.

$$\Delta PSI = 4.5 - 2.5 = 2.0.$$

So the structure number required to protect the base course and to find the thickness D_1 of the surface course is 2.6.

Step #5:-

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

Resilient value of Asphalt = 450,000 lb/in²

Thereforce $a_1 = 0.44$.

Thickness of surface course:-

By formula,

$$D_1 = SN_1 / a_1$$

$$= 2.6 / 0.44 = 5.9'' \simeq 6''$$

As thickness should be taken to nearest 0.5"
So The thickness of the surface course is 6"
Now,

$$SN_1^* = D_1 \times a_1$$

$$= 6 \times 0.44$$

$$\boxed{SN_1^* = 2.64}$$

Thickness of Base Course (D_2):-

Also by formula:

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

$$= \frac{3.8 - 2.64}{0.14 \times 0.80} \Rightarrow \boxed{D_2 = 10.36"}$$

Rounding D_2 to nearest whole number, ie 12"
So thickness of base course is 12"

$$\Rightarrow SN_2^* = 0.14 \times 0.80 \times 12 + SN_1^*$$

$$= 1.34 + 2.64$$

$$\boxed{SN_2^* = 3.98}.$$

Thickness of Sub-Base Course (D_3):-

$$\Rightarrow D_3 = \left(\frac{SN_3 - SN_2^*}{a_3 m_3}\right) = \frac{(4.4 - 3.98)}{0.10 \times 0.80}$$

$$\boxed{D_3 = 5.25}$$

We take 6" instead of 5.25" $\Rightarrow \boxed{D_3 = 6"}$

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

$SN_3^* = 4.46.$

As $4.46 > 4.4 \longrightarrow$ O.K !

Final Design:

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

Question #04:-

Different Pavement Distresses:-

A condition of the pavement structure that reduces serviceability or leads to a reduction in service life. occurance of Distress is because of : unstable mixes & High loads considered in design

1) ALLIGATOR CRACKING:

⇒ Causes:- over loading, Inadequate structural design
poor construction.

⇒ Repair:-
Dig out and replace area of poor subgrade.

2) BLOCK CRACKING:

⇒ Problems: Allow moisture infiltration

⇒ Causes: Poor choice of asphalt binder in mix design

⇒ Repair: If cracks are < 1/2 inch wide. crack seal to prevent moisture entry.
If cracks are > 1/2 inch and with beveled edges

Remove and replace the cracked pavement layer with an overlay.

3) Potholes:

Small bowl-shapped depressions in the pavement surface that penetrate all the way through HMA layer down to the base course.

⇒ **Problem:** Roughness, Moisture infiltration.

⇒ **Possible causes:** Potholes are the end of fatigue cracking.

⇒ **Repair:** Patching techniques.

4 Rutting:

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

⇒ **Possible causes:**

Insufficient compaction of HMA layers during construction.

⇒ **Repair:**

Slight ruts (< 1/3 inch deep) can generally be left untreated.

5. Bleeding:-

⇒ Problem: Loss of skid resistance when wet.

⇒ Possible Causes: Low HMA air void Content.

6. Polished Aggregate:-

⇒ Possible Causes: Repeated traffic applicatio

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

7. Raveling:

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

⇒ Possible Causes: Inadequate compaction during construction.
Asphalt binder aging.

⇒ Repair: Remove the damaged pavement and overlay.