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(Q1):→
a):→
Ans:→

Flexible pavement	rigid Pavement
i.→ Bitumen is used a binder in flexible pavement	i→ cement is used as a binder in rigid pavement.
ii→ Deformation in the sub grade is transferred to the upper layers.	ii→ Deformation in the sub-grade is not transferred to subsequent layers.
iii→ Load is transferred by grain to grain contact.	iii→ No such phenomenon of grain load transfer exists.
iv→ Have low life span usually 10-15 years	iv→ Life span is more as compare to flexible usually 30+ years.

Q1
(b):→

Ans:→ Advantages of water bound over wet mix macadam:→

→ The main advantage of wet mix macadam is that it is composed of a well graded mixture. This ensures good ~~interlock~~ interlock and high stability.

→ Addition of water while mixing facilities the handling of the mixture. The operation of laying is much simpler than that of water-bound macadam, where the screeings and binding material have to be added in stages and forced into voids. If a crusher-run material is used, there is no possibility of plastic fines entering into the manture.

→ The compaction is greatly facilitated by the moisture added which lubricates the individual particles.

Q1) :→
(c) :→
Ans :→

Bitumen	Asphalt
→ A class of black or dark-colored (solid, semi-solid or viscous) cementitious substance, natural or manufactured, composed principally of high molecular weight hydro-carbons found in Asphalts, Tars, Pitches, and Asphaltics are typical.	→ A dark brown to black cementitious materials in which the predominating constituents are bitumens which occur in nature or are obtained in fractional distillation of petroleum along with certain mineral matter.
→ In some literature Bitumen is actually the liquid binder that holds asphalt together.	→ Asphalt is generally used as a term to refer to the combination of bitumen and gravel specifically for road construction

Q2:→

Sol:→ Design speed 75 mi/h, K = 312

minimum length = 312 × [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 - (0.03 × $\frac{2184}{2}$) = 217.24 ft

Station	Distance from BVC (x) (ft)	Tangent elevation	Offset $\left[y = \frac{Ax^2}{200L}\right]$	curve elevation (tangent - offset)
BVC 334+68	0	217.24	0.01	217.24
BVC 335+00	32	217.24 + $\frac{32}{100}$ × 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	[illegible]
BVC 347+00	1232	254.20	24.32	230.66 → 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	282.20	76.44	206.32

Q3:→

Ans:→

step #01:→ Draw a line Joining the reliability level of 99% and the overall standared divation so of 0.49, and extend line to intersect the first "TL" line at point "A"

step #02:→ Draw a Line Joining the 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 (Mr) of base course and extend this line to intersect the design serviceability loss chart at point "C"

step #04:→

Draw a horizontal 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:→

Determine the appropriate structure layer 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 nearset 0.5 inches so the Thickness of the surface course is 6".

$SN_1 = D_1 \times a_1$

$SN_1 = 6 \times 0.44 = 2.64$

→ 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)

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

$$D_2 = (3.8 - 2.64) / 0.14 \times 0.80$$

$$D_2 = 10.36''$$

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 and D_3 (Sub-base course) and also Layer co-efficent a_3 and drainage co-efficent 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

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

$SN_3 = 4.46 > 4.4$

Final design:→

Surface course = 6"

→ Base course = 12"

→ sub base = 6"

→ Total pavement thickness = 24"

Q4

Ans 4:→ Pavement distresses:→

Distress is the condition of pavement structure that reduce serviceability or leads to a reduction in serivce life. Distresses could occur in a pavement due to

✓ unstable mixes.

✓ Higher wheel loads than those considered in design.

*):→ Different kind of pavement Distresses:→

i):→ Alligator cracking:→

→ over loading

→ Inadequate structural design

→ Poor construction.

Repair:→ crack sealing is in effective.

→ Dig out and replace area of poor subgrate.

ii):→ Block cracking:→

Possible cause:→ Allows moisture infiltration

→ HMA shrinkage

→ Asphalt binder aging

→ Poor choise of asphalt binder in the.

Repair:→

low severity cracks (<½ inch wide)

Crack seal to prevent entry of moisture

High severity crack (>½ in and crack with mudlued edges): Remove and Replace the craked pavement layer with an overlay.

iii):→ Runtting:→

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

Possible causes:→ Insufficient of HMA layers during construction.

→ Sub grade rutting

→ Improper mix design.

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

iv):→ **Bleeding:→** Loss of skid resistance when wet.

Possible cause:→ Excessive asphalt binder in the HMA.

→ low HMA air void content.

v):→ **Polished Aggregate:→**

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

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

vi): → Raveling :→

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

→ Possible cause :→

→ Asphalt binder aging.

→ Inadequate compaction during construction.

Repair :→ Fog seal / slurry seal or Remove the damaged pavement and overlay.