Submitted by 7870

Submitted to Engr. Farhan

Subject Highway and traffic engineering.

Section B

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: 7870

Q1: (A) What is the difference between flexible and rigid pavement?

| | FLEXIBLE PAVEMENT | Rigid PAVEMENT. |
|---|---|---|
| ① | Deformation in the Sub grade is transfered to the upper layer. | · Deformation in the Sub grade is not transfered to Sub-sequent layers. |
| · | It has low initial construction costs but have high maintenance costs. | · It has low maintenance costs and have high initial construction costs. |
| · | Bitumen is used a binder in a flexible pavement. | · Cement is used as binder in rigid pavement. |

: 7870

| | |
|---|---|
| • Load is transferred by grain to grain contact. | • No concept of grain to grain load transfer. |
| • Road can be used for traffic with 24 hrs. | • Road cannot be used until 14 days of wring. |
| • Surfacing cannot be laid directly on the sub grade but sub base is needed. | • Surfacing can be directly laid on the sub grade. |
| • The life span is usually 10–15 yrs. | • Life span is more than 30 years. |

: 7870

Q1: (b) What are the advantages of water bound over wet mix macadam?

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

- WBM is slightly cheaper than the wet mix macadam. The reason is WBM requires general labour while wet-mix macadam requires mixer plant and paver.
- Aggregates of WBM are or can be broken by hands while the WMM needs a crusher for the disintegration of aggregates.

: 7870

- The interlocking of aggregate particles imparts adequate strength of the materials for filling the voids. These ensures non-entry of the plastic material of sub-grade into voids.

© **What are the difference between asphalt and bitumen?**

Ans: Bitumen is actually the liquid binder that holds asphalt togather.

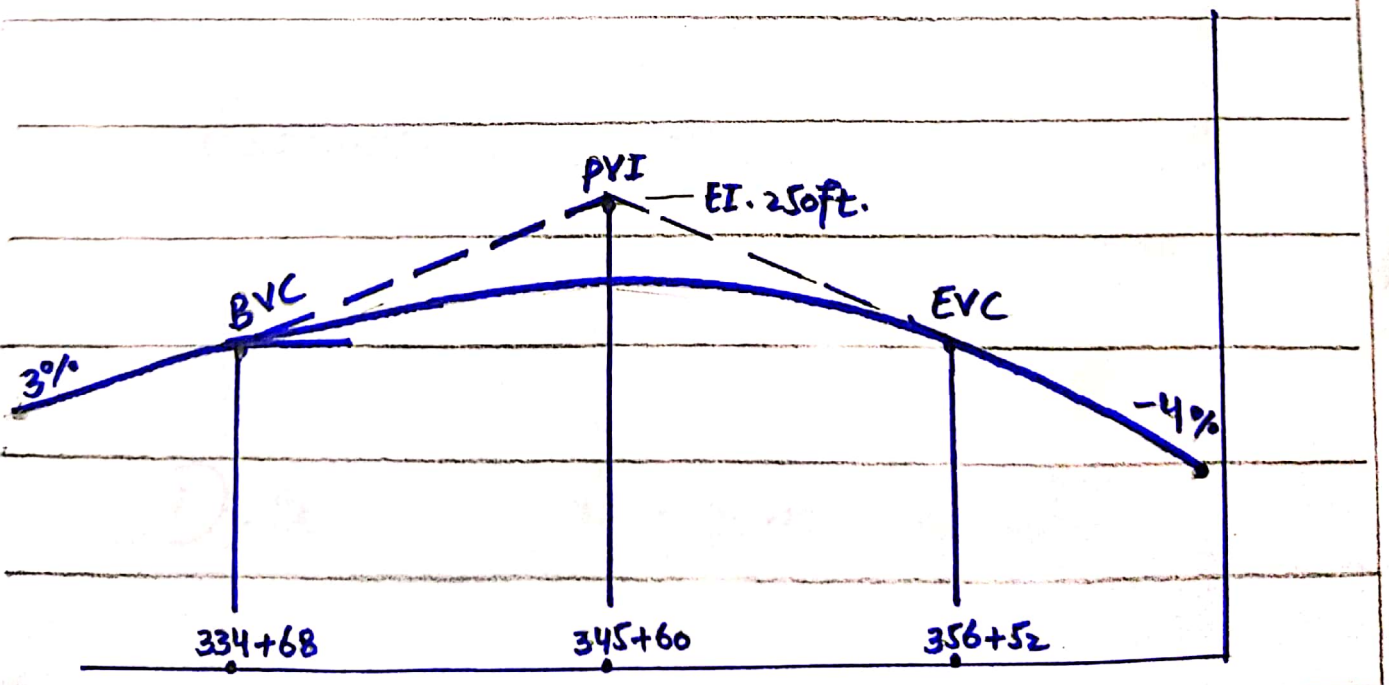
- Asphalt is generally used as a term to refer to the combination of bitumen and gravel for road construction.

:7870

Bitumen is known for being strongly adhesive and resistant to damage for water and oil spills. This makes bitumen the ideal binder for asphalt because asphalt is commonly used as a surface for roads, car parks etc.

:7870

Q2: A crest verticle curve joining a+3 percent and a-4 percent grade is to be designed for 75 mi/h. If the tangent intersect at station (345+60.00) at an elevation of 250ft. Determine the station and elevations of the BVC and EVC. Also calculate the elevations of intermediate points on the curve at the whole stations?



: 7870

Sol: For a design speed of 75 mi/h, K
= 312 (From table).

= Minimum Length = 312 x [3 - (-4)] 2184 ft.

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

= Station of EVC = (334+68) + (21+84) = 356 + 52.

= Elevation BVC = 250 - $\frac{(0.03 \times 2184)}{2}$ = 217.24 ft.

* The reminder of the computation is efficiantly done using the formate showing below in the table.

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: 7870

| Station | Distance from BVC (x) (ft) | Tangent Elevation (ft) | offset $\left[\frac{4 \times \Delta x^2}{2}\right]$ - (ft) | CURVE elevation (Tangent Elevation - offset) ft. |
|---|---|---|---|---|
| BVC 334+68 | 0 | 217.24 | 0.01 | 217.24 |
| BVC 335+00 | 32 | $217.24 + \frac{32}{100} \times 3 = 218.20$ | 0.02 | 218.18 |
| BVC 336+00 | 132 | 221.20 | 0.028 | 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 |

: 7870

| | | | | |
|---|---|---|---|---|
| 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. |

: 7870

Q 3: A flexible highway is to be designed to carry a design ESAL of $2 \times 10^6$. It is estimated that it takes about a week for water to be drained from within the pavement and the pavement structure will be exposed to moisture levels approaching situation for 30% of the time. The following additional information is available:

⇒ Resiliant 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 Subbase course material 22, $M_r$ 13,500 lb/in2.

⇒ CBR value of Subgrade material 6.

:7870

Sol: **Step 01:** Draw a line joining the reliability level of 99% and the overall standard deviation, so of 0.49 and extend this line to intersect the first TL line at point A.

**Step 02:** Draw a line joining point A to the ESAL $2 \times 10^6$ and extend this line to intersect the second TL line at point B.

**Step 03:** Draw a line joining point B and resiliant modulus (MR) of base course and extend this line to intersect the design serviceability loss chart at point C.

Use 12"

So the thickness of base course is 12"

$SN_2 = 0.14 \times 0.80 \times 12 + Sn_1$

$SN_2 = 3.98$

⇒ Finding $SN_3$ and $D_3$ (Sub base course) and also layer coefficiant $a_3$ and drainage co-efficiant $m_3$ from their respective table.

$D_3 = (SN_3 - SN_2) / a_3 m_3$

$= (4.4 - 3.98) / 0.10 \times 0.80$

$D_3 = 5.24"$.

We will use 6" as a Sub base

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

$SN_3 = 4.46 > 4.4$ Okay!

**FINAL Design:**

→ Surface Course = 6"

→ Base course = 12"

→ Sub base = 6"

→ Total pavement thickness = 24".

:7870

Q4: What are the different pavement distresses? Explain in Detail?

Ans: Following are different pavement distresses:

1: **ALLIGATOR CRACKING:**

| Possible cracking | Repair |
|---|---|
| * Over Loading<br>* Inadequate structural design:<br>* Poor Construction | * Crack sealing is in effective.<br>* Digout and repair area of poor subgrade. |

## 2: Block Cracking:

**Problem:** Allows moisture infiltration.

| Possible Causes | Repair |
|---|---|
| * HMA shrinkage<br>• Asphalt binding Aging<br>• Poor choise of asphalt binder in the mixture design. | * low severity cracks (< ½ wide) crack seal to prevent entry of moisture.<br>• High severity cracks (> ½ wide) and cracks with revealed edges. Remove and replace the crack Pavement layer with an overlay. |

3: **POTHOLES:**

These are 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 surface (1"–2") and seldon occurs on road with 4" or deeper HMA surfaces.

⇒ **Problem:** Roughness (serious vehicular drainage can result from driving across potholes at higher speeds) moisture infiltration.

: 7870

| Possible Causes | Repair |
| --- | --- |
| 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 | • Patching techniques. |

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

: 7870

| Possible Causes | Repair |
| --- | --- |
| • Insufficiant compaction of HMA layers during construction.<br>• Subgrade rutting (e.g as a result of inadequate pavement structure).<br>• Improper mixe design (e.g excessive high asphalt content, excessive mineral filler, insufficiant amount of angular aggregate particle). | • slight ruts (< 1/3" deep) can generally be left untreated. Pavement with deeper ruts should be levelled and overlayed. |

: 7870

## 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 | Repair |
|---|---|
| • Repeated traffic applications. This can occur quicker if the aggregate is susceptible to abrassions. | • Apply a skid-resistant slurry seal, BST or non-structural overlay. |

: 7870

* **Revealing**: loose debris on the pavement which increases Pavement roughness and loss of skid resistance.

| Possible Causes | Repair |
| --- | --- |
| • Asphalt binder aging. | • Fog seal / slurry seal or remove the damaged Pavement and overlay. |
| • Aggregate Segregations of fine particles are missing from the aggregate matrix. | |
| • Inadequate compaction during construction. | |