# AJAY KUMAR GARG ENGINEERING COLLEGE, GHAZIABAD

## DEPARTMENT OF CIVIL ENGINEERING

## SOLUTION SESSIONAL TEST –2

Course: B.Tech.
Session: 2017-18
Subject: Transportation Engineering-1
Max Marks: 50

Semester: V
Section: CE-1 & CE-2
Subject code: NCE502
Time: 2 hour

## Section A

Ques1(a) Explain the spot speed, running speed, SMS and TMS.

Ans: Spot speed → It is the instantaneous speed of vehicle. spot speed is used to design horizontal and vertical curves.

Running speed → $\frac{\text{Distance}}{\text{Running time}}$ (It excludes stop delay)

SMS → Average speed of vehicle over a certain stretch at any instant of time.

$$\boxed{SMS = \frac{nL}{\sum_{i=1}^{n} \frac{L}{V_i}} = \frac{n}{\sum_{i=1}^{n} \frac{1}{V_i}}}$$

TMS → It is the average speed of vehicle at a given point or cross section of road in a given period of time

$$\boxed{TMS = \frac{\sum V_i}{n}}$$

→ TMS is arithmetic mean whereas SMS is harmonic mean

TMS > SMS

(b) Explain the terms basic capacity, possible capacity and practical capacity.

Ans: Basic capacity → It is the maximum capacity of road to accomodate vehicle under most ideal traffic and roadway condition, also known as theortical capacity.

Possible capacity → It is the capacity under prevailing traffic or roadway conditions.

Practical capacity → It is also known as design capacity. It is capacity of road when on road density is not very low and not very high.

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(c) A road is having hor. curve of radius 400m radius on which a e = 0.07 is provided. What is μ for v = 100 Kmph

Ans

$$V = 100 \times \frac{5}{18} = 27.78\ m/s$$

$$e + f = \frac{v^2}{gR}$$

$$f = \frac{(27.78)^2}{9.81 \times 400} - 0.07 = \underline{0.13}$$

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(d) An ascending gradient of 1 in 100 meets $n_2 = -(1 \text{ in } 50)$. Calculate the length of summit curve required to provide OSD = 600m.

Ans:

$$n_1 = \frac{1}{100}, \quad n_2 = -\frac{1}{50}$$

$$N = |n_1 - n_2| = \left|\frac{1}{100} + \frac{1}{50}\right| = 0.03$$

Assume $L > OSD$

$$L = \frac{NS^2}{9.6}$$

$$= \frac{0.03 \times (600)^2}{9.6}$$

$$\boxed{L = 1125\ m} \rightarrow$$ assumption is correct.

e) List the various traffic engineering studies.

Ans: (1) Traffic volume study.

(2) Traffic speed study

(3) Origin and destination study

(4) Traffic flow characteristics

(5) Traffic capacity studies

(6) Parking study

(7) Accident study

## Section B

(a) Explain superelevation. Enumerate the steps for practical design of superelevation considering mixed traffic.

Ans: Superelevation is the transverse slope provided at horizontal curve to counteract centrifugal force by raising outer edge of the pavement w.r. to the inner edge throughout the length of horizontal curve.

Steps for designing →

(i) Calculate equilibrium superelevation for 75% of design speed i.e.

$$e = \frac{(0.75v)^2}{gR}$$

if $e < 0.07$ → provide calculated e value.

However if $e > 0.07$ provide $\boxed{e = 7\%}$

(ii) Now cal. f value for the calculated ($< 7\%$) e value

$$e + f = \frac{v^2}{gR}$$

if $f < 0.15$ → consider the calculated value
else fix it to 0.15

(iii) Now cal. v.

(b) Calculate the extra width of pavement required on a horizontal curve of radius 800m on a two lane highway, v = 80kmph. Assume l = 6m.

Ans.
$$W_e = \frac{nl^2}{2R} + \frac{V}{9.5\sqrt{R}}$$
$$= \frac{2 \times 6^2}{2 \times 800} + \frac{80}{9.5\sqrt{800}}$$
$$= 0.045 + 0.298$$
$$= \underline{0.343m}$$

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c) Explain ruling, maximum and exceptional gradient. Specify the values recommended by IRC for plains and hill.

Ans: Ruling gradient -> It is called the maximum design gradient at which designer attempts to design the vertical profile.

1 in 30 -> in plain and Rolling terrain
1 in 20 -> mountaneous terrain
1 in 16.7 -> steep terrain

Limiting gradient -> Adopted when ruling gradient will lead to enormous increase in cost. It will be greater than ruling gradient.

Exceptional gradient -> It is very steep gradient but the stretch should not exceed 100m and on both side of it there should be milder gradient for a min. length of 100m.

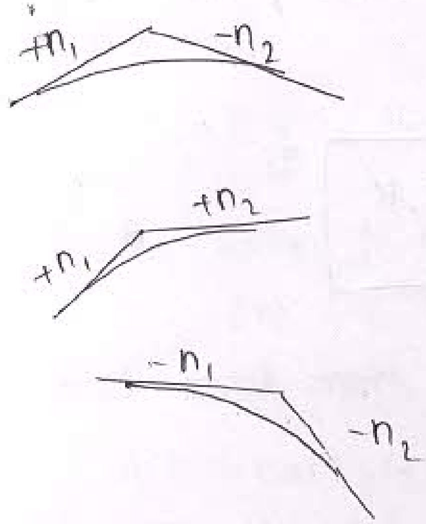
| Terrain | Ruling | Limiting | Exceptional |
|---|---|---|---|
| Plain & Rolling | 3.3% | 5% | 6.7% |
| Mountaneous | 5% | 6% | 7% |

d) Explain the summit and valley curves and the various cases when these are formed when two different gradient meets.

Ans

**Summit curve**

→ It has convexity upward.



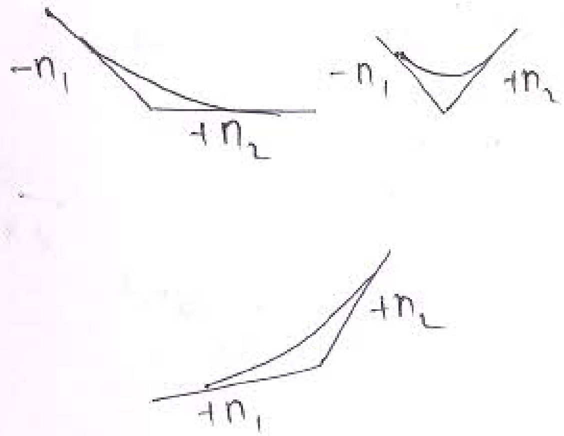

→ Parabolic shape is the most commonly used.

→ When $L > SSD$ $\qquad L = \frac{NS^2}{4.4}$ | $L < SSD$ $\qquad L = 2S - \frac{4.4}{N}$

→ When $L > OSD$ $\qquad L = \frac{NS^2}{9.6}$ | $L < OSD$ $\qquad L = 2S - \frac{9.6}{N}$

**Valley curve**

→ It has convexity downward.




→ No restriction of sight distance during day time

→ Best shape adopted is cubic parabola.

→ For comfort condⁿ

$$\boxed{L_s = 2\sqrt{\frac{NV^3}{C}}}$$

→ For head light sight distance

$L > SSD$

$$L = \frac{NS^2}{1.5 + 0.035S}$$

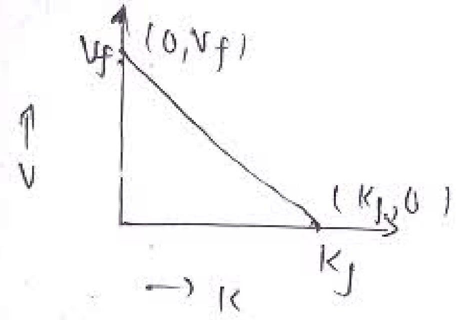
$L < SSD$

$$L = 2S - \frac{1.5 + 0.035S}{N}$$

e) Explain graphically the relationship between traffic volume, traffic speed and traffic density.

Ans- $Q = KV$

Relationship b/w speed and density → As per greenshield this relationship is linear.

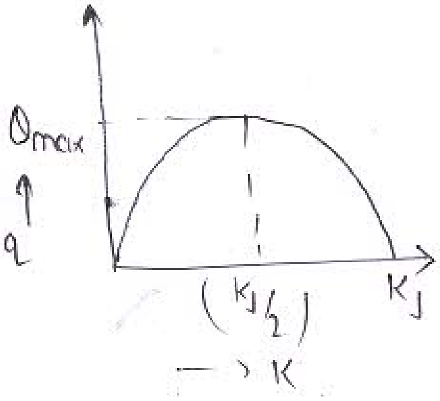



$$\boxed{V = V_f - \frac{V_f}{K_J} \cdot K}$$

$$q = KV$$

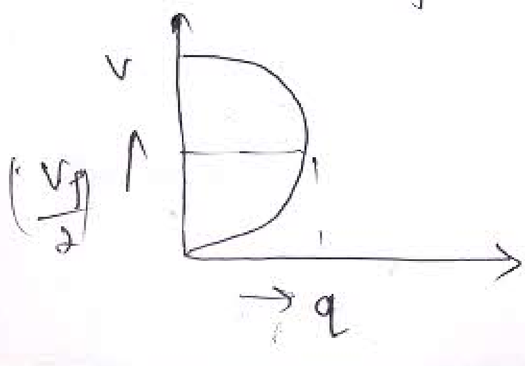
$$q = K\left[V_f - \frac{V_f}{K_J} \cdot K\right]$$

$$\boxed{q = KV_f - \frac{V_f \cdot K^2}{K_J}}$$




$$q = KV = \left[(V_f - V)\frac{K_J}{V_f}\right] \times V$$

$$q = K_J V - \left(\frac{K_J}{V_f}\right) V^2$$



## Section C

Q) A horizontal curve portion of a 4 lane undivided carriageway, a transition curve is to be introduced to attain equilibrium superelevation. $V = 60 kmph$, $R = 245m$, $l = 6m$, $e = 0.05$

$N = 150$

Ans: $n = 4$

$v = 60 \times \frac{5}{18} = 16.67 \, m/s$

$R = 245m$ | $e = 0.05$

$l = 6m$ | $N = 150$

Rotated about inner edge.

$l = eN(W + W_e)$

$W_e = \frac{nl^2}{2R} + \frac{V}{9.5\sqrt{R}}$

$= \frac{2 \times 6^2}{2 \times 245} + \frac{16.67}{9.5\sqrt{245}}$

$= 0.44 + 0.404$

$= 0.844 m.$

$W = 4 \times 3.5 = 14m$

$l = 0.05 \times 150 \times (14 + 0.844)$

$= 111.33m$

$\boxed{l = 110.2m}$

b) A valley curve of state highway is formed by a $n_1 = -1/20$ and $n_2 = 1/30$, $V = 80$ kmph, $C = 0.6\, m/sec^3$, $t = 2.5$ sec, $f = 0.35$

Ans: $N = |n_1 - n_2|$

$= \left| -\frac{1}{20} - \frac{1}{30} \right| = 0.083$

$V = \frac{80 \times 5}{18} = 22.22$ m/sec

(i) comfort condition.

$l = \frac{v^3}{CR}$

$N = \frac{L_s}{R} \Rightarrow R = \frac{L_s}{N}$

$l = \frac{v^3 \times N}{C \times L_s}$

$L_s = 2 \times \sqrt{\frac{Nv^3}{C}}$

$= 2 \times \sqrt{\frac{0.083 \times (22.22)^3}{0.6}}$

$\boxed{L_{s_1} = 77.91\,m.}$

(ii) Head light sight distance criteria

$SSD = vt + \frac{v^2}{2gf}$

$= 22.22 \times 2.5 + \frac{(22.22)^2}{2 \times 9.81 \times 0.35}$

$= 127.45\,m$

$L > SSD$

$L = \frac{NS^2}{1.5 + 0.035 \times S}$

$= \frac{0.083}{1.5 + 0.035 \times 127.45}$

$= 226.18\,m$