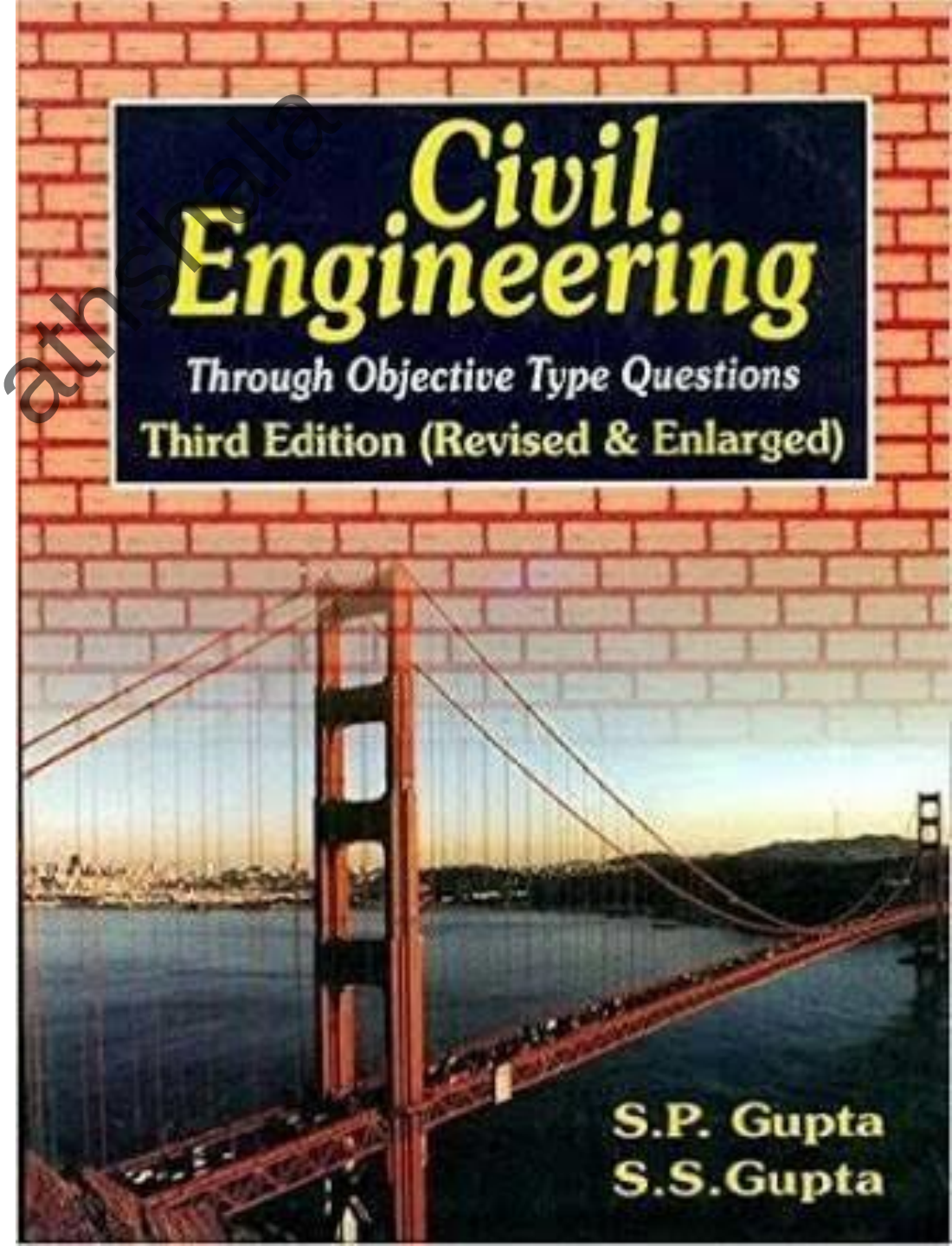
SSS-JE, AE(PSC), RRB etc.

Objective Questions (01 to 15)

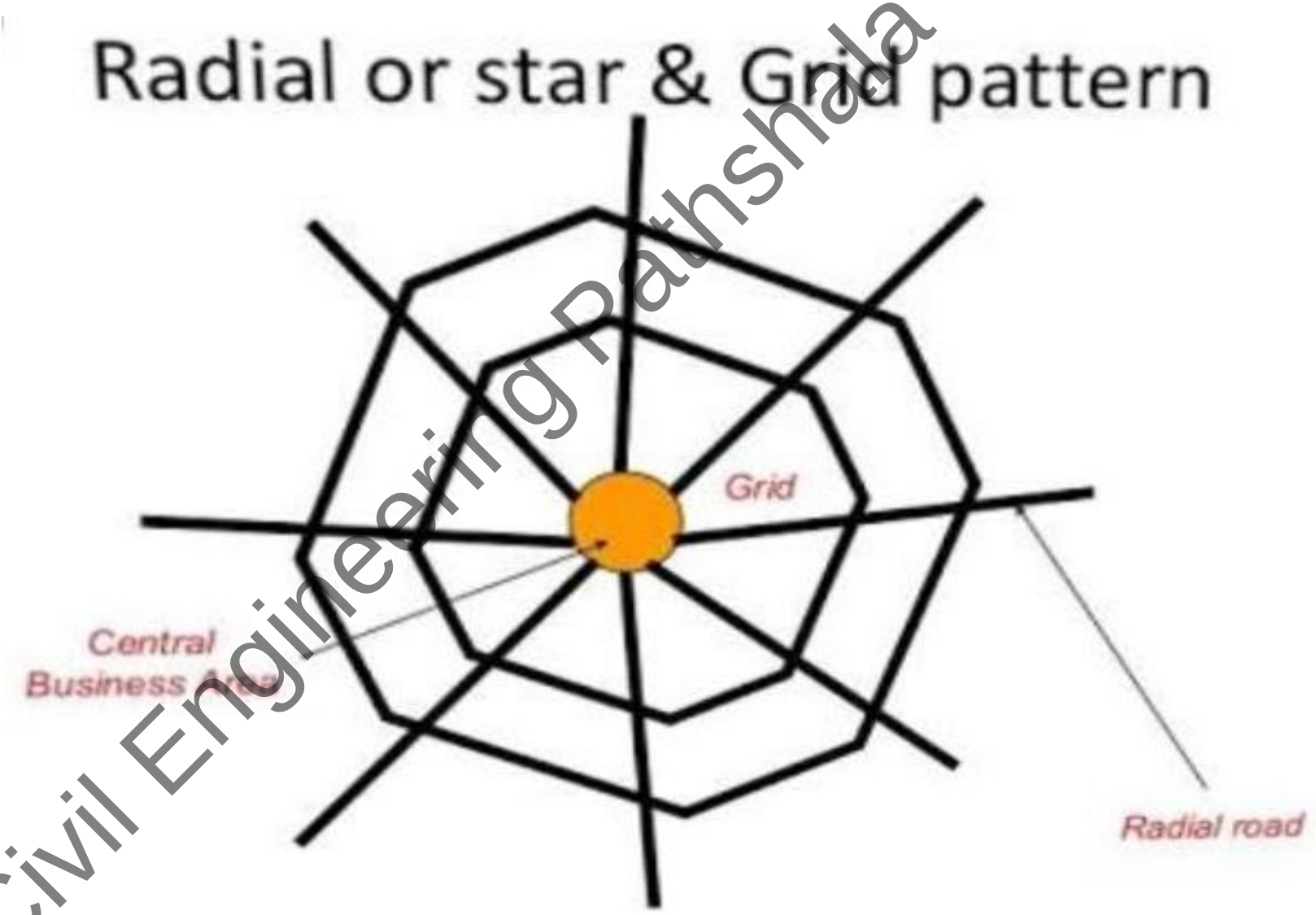
Highway Engineering



Q.1) Nagpur road plan formulae were prepared by assuming

a. Rectangular or block road pattern
b. Radial or star and block road pattern
c. Radial or star and circular road pattern
d. Radial or star and grid road pattern

Answer: D

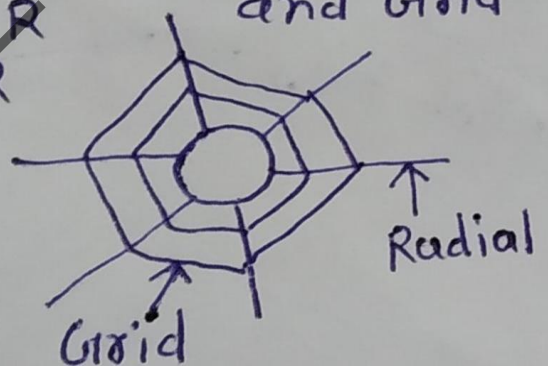


Q. 2) Select the correct statement

a. Nagpur road plan formulae take into account the towns with very large population.
b. Nagpur road plan has a target road length of 32km per 100 sq.m
c. Second 20-year plan has provided 1600km expressway out of the proposed national highway
d. Second 20-year plan allowed deduction of length of railway track in the area while caculating length of roads

Answer C

	1st	2nd	3rd
1. Year	1943-63	1961-1981	1981-2001
2. Venue	Nagpur	Bombay	Lucknow
3. Target	16 km/100 sq km	32	82
4. Total Road Length target	5.29 Lakh km	10.57	27.02
5. (i) NH (ii) SH (iii) MDR (iv) ODR (v) VR	(1) 1600 km of expressway		(i) Primary (a) EW (b) NH (ii) Secondary (a) SH (b) MDR (iii) Tertary (a) ODR (b) VR



Q. 3 The sequence of four stages survey in a highway alignment is

a. Reconnaissance, map study, preliminary survey and detailed survey
b. Map study, preliminary survey, reconnaissance and detailed survey
c. Map study, reconnaissance survey, preliminary survey and detailed survey
d. Preliminary survey, map study, reconnaissance survey and detailed survey.

Answer: C

The position of the center line on the highway in the ground is called highway alignment.

Engineering Survey and its stages:

1. Map Study - The study of the topographical map is done to find out the possible routes of the road.
2. Reconnaissance - Simple Survey Instruments are used in the reconnaissance procedure
3. Preliminary Survey -

To estimate the quantity of earthwork.
To finalize the best alignment.

4. Final Location and Detailed Survey

The data during the detailed survey should be elaborated and completed for the preparation of the plans, designing, and estimation of the project.

Q. 4) The shape of the camber, best suited for the cement concrete pavement is

a. Straight line
b. Parabolic
c. Elliptical
d. Combination of straight and parabolic

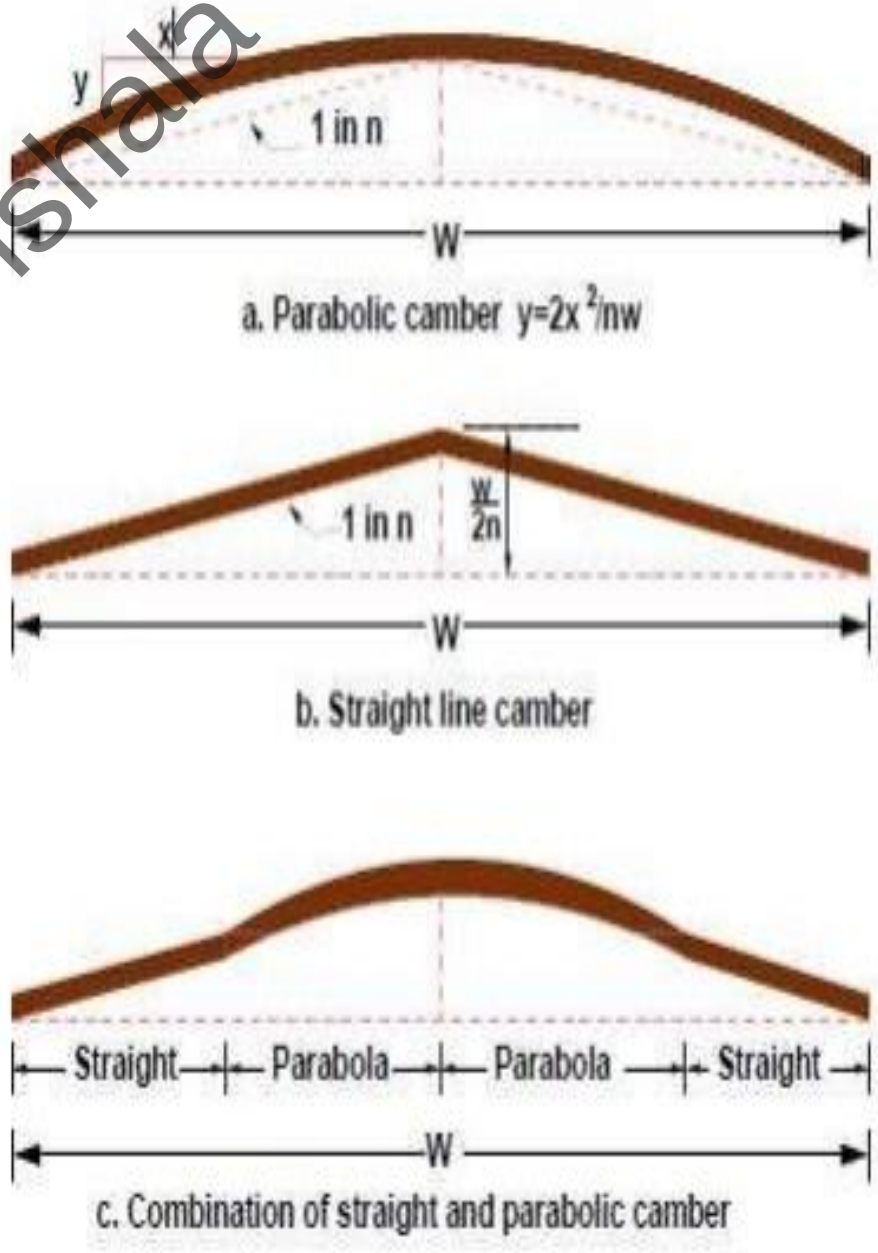
Answer: A

Camber - slope in transverse direction to drain of water from the road surface.
X% - X vertical and 100 horizontal
1 in n – 1 vertical and n horizontal

a. Straight line camber -
They are generally adopted for very flat slopes such as PCC or RCC Pavement.

b. Parabolic camber –
Designed for fast moving highways.
Adopted for Bituminous pavement.

c. Composite camber –
Design for mixed traffic.



Q. 5) For water bound macadam road in localities of heavy rainfall, the recommended value of camber is

a. 1 in 30
b. 1 in 33
c. 1 in 48
d. 1 in 60

Answer: B

- The values of camber recommended by IRC for different types of road surfaces are given below:

Sr.No	Type Of Road Surface	Range of camber in areas of	
		Heavy rainfall	Low rainfall
1	Cement concrete and thick bituminous surface	1 in 50 or 2 %	1 in 60 or 1.7 %
2	Thin bituminous surface	1 in 40 or 2.5%	1 in 50 or 2 %
3	Water bound macadam and gravel pavement	1 in 33 or 3%	1 in 40 or 2.5 %
4	Earth road	1 in 25 or 4%	1 in 33 or 3 %

Q. 6) The stopping sight distance depends upon

a. Total reaction time of driver
b. Speed of vehicle
c. Efficiency of brakes
d. All the above

Answer: D

SSD - It is the minimum distance open to the vision of the driver to stop the vehicle to avoid collision with an obstruction(moving or stationary) which is present on the carriage way

Factors affecting SSD = Lag distance + Braking distance

$$= \quad (0.278Vt) + V^2 / 254(f \pm n)$$

1. Total reaction time of the driver ↑
2. Speed of the vehicle ↑
3. Friction between the Tyre and the pavement surface ↓
4. Brake efficiency ↓
5. Gradient of the road → Up/ascending ↓ and down/descending ↑

Q. 7) When the path travelled along the road surface is more than the Circumferential movement of the wheels due to rotation, then it result is

a. Slipping
b. Skidding
c. Turning
d. revolving

Answer: B → Skidding

Q. 8) Coefficient of friction is less when the pavement surface is

a. Rough
b. Dry
c. Smooth and dry
d. Smooth and wet

Answer: D → Smooth and wet

Q. 9) The shoulder provided along the road edge should be

a. Rougher than the traffic lanes
b. Smoother than the traffic lanes
c. Of same colour as that of the pavement
d. Of very low load bearing capacity

Answer: A

1. The purpose of building a shoulder is that in the event of an emergency or breakdown a vehicles.

2. Shoulders help provide extra structural support of the roadway.

Q. 10) Camber in road provided for

a. Effective drainage
b. Counteracting the centrifugal force
c. Having proper sight distance
d. None of the above

Answer: A

a. Effective drainage – Camber

b. Counteracting the centrifugal force – Super elevation

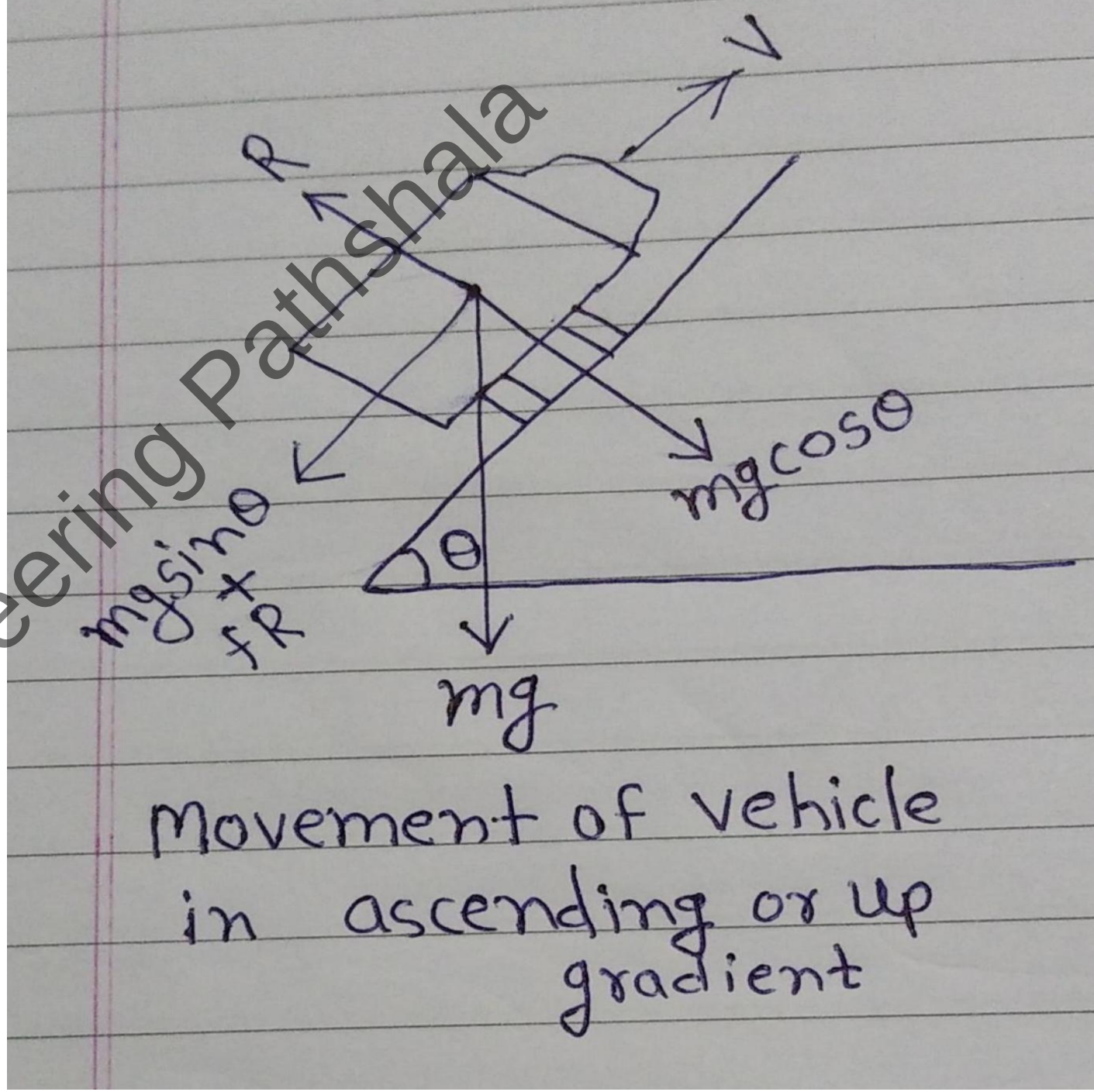
c. Sight distance – SSD, OSD etc

Q. 11) Compared to a level surface, on a descending gradient the stopping sight distance is

a. Less
b. More
c. Same
d. Dependent on speed

Answer: B

Descending gradient > Level > Ascending



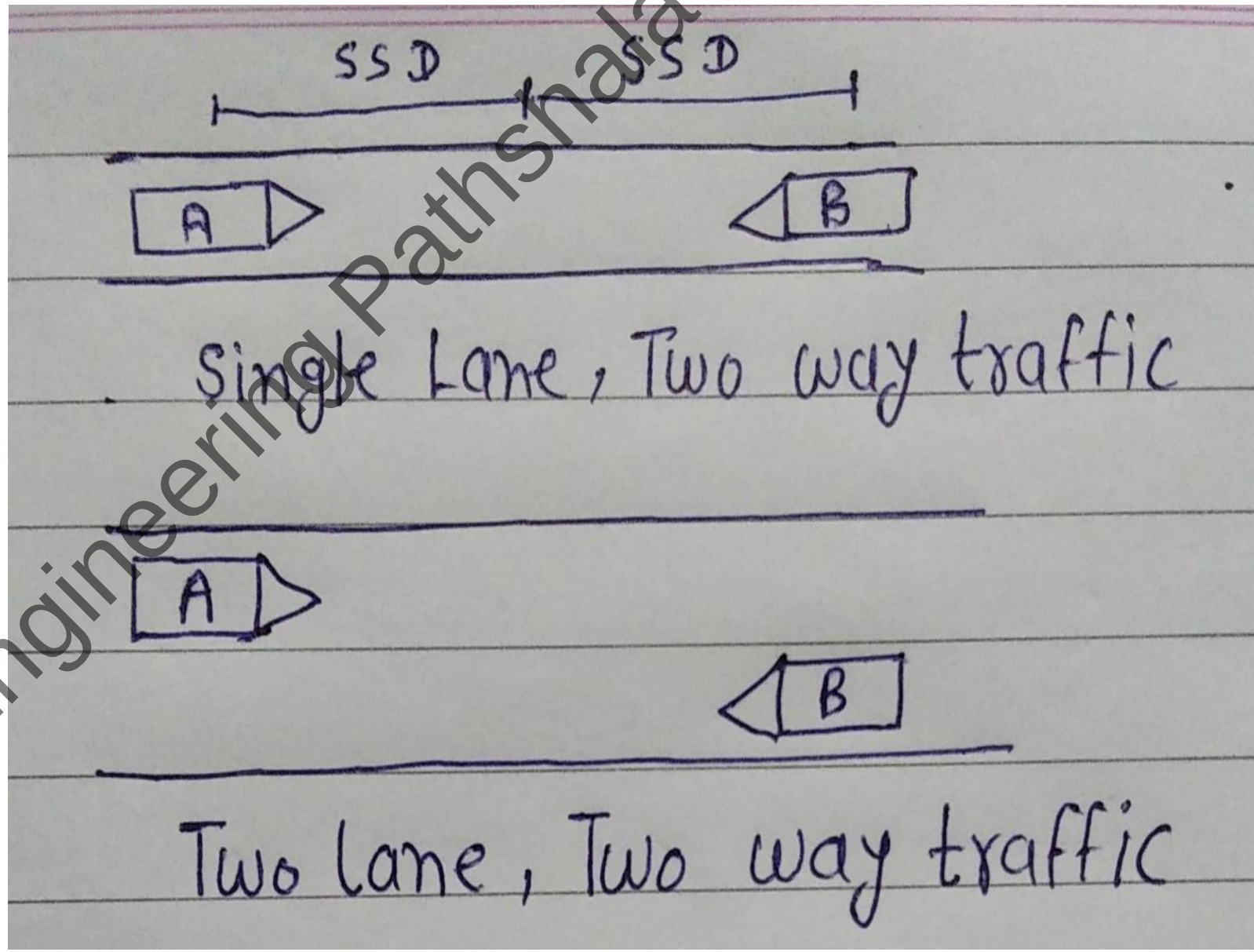
Q. 12) On a single lane road with two way traffic, the minimum stopping sight distance is equal to

a. Stopping sight distance
b. Two times the stopping distance
c. Half the stopping distance
d. Three times the stopping distance

Answer: B

Single lane two way traffic
= 2 × SSD

Two lane two way traffic
= SSD



Q. 13) The desirable length of overtaking zone as per IRC recommendation is equal to

a. Overtaking sight distance
b. Two times the overtaking sight distance
c. Three times the overtaking sight distance
d. Five times the overtaking sight distance

Answer: D

Overtaking zones are provided when OSD cannot be provided throughout the length of the highway

IRC recommendation

1. Desirable Length = 5 × OSD

2. Minimum Length = 3 × OSD

Q. 14) Stopping sight distance is always

a. Less than overtaking sight distance
b. Equal to overtaking sight distance
c. More than overtaking sight distance
d. None of the above

Answer A

Less than over taking sight distance

Q. 15) Reaction time of a driver

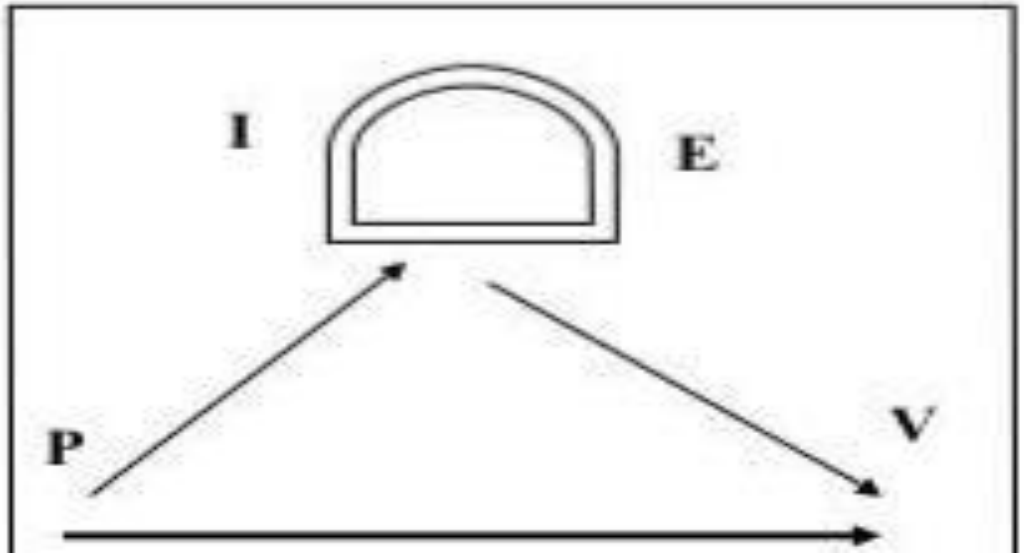
a. Increases with increase in speed
b. Decreases with increase in speed
c. Is same for all speeds
d. None of the above

Answer: B

PIEV Theory

According to this theory the total reaction time of the driver is split into four parts viz. time by the driver for

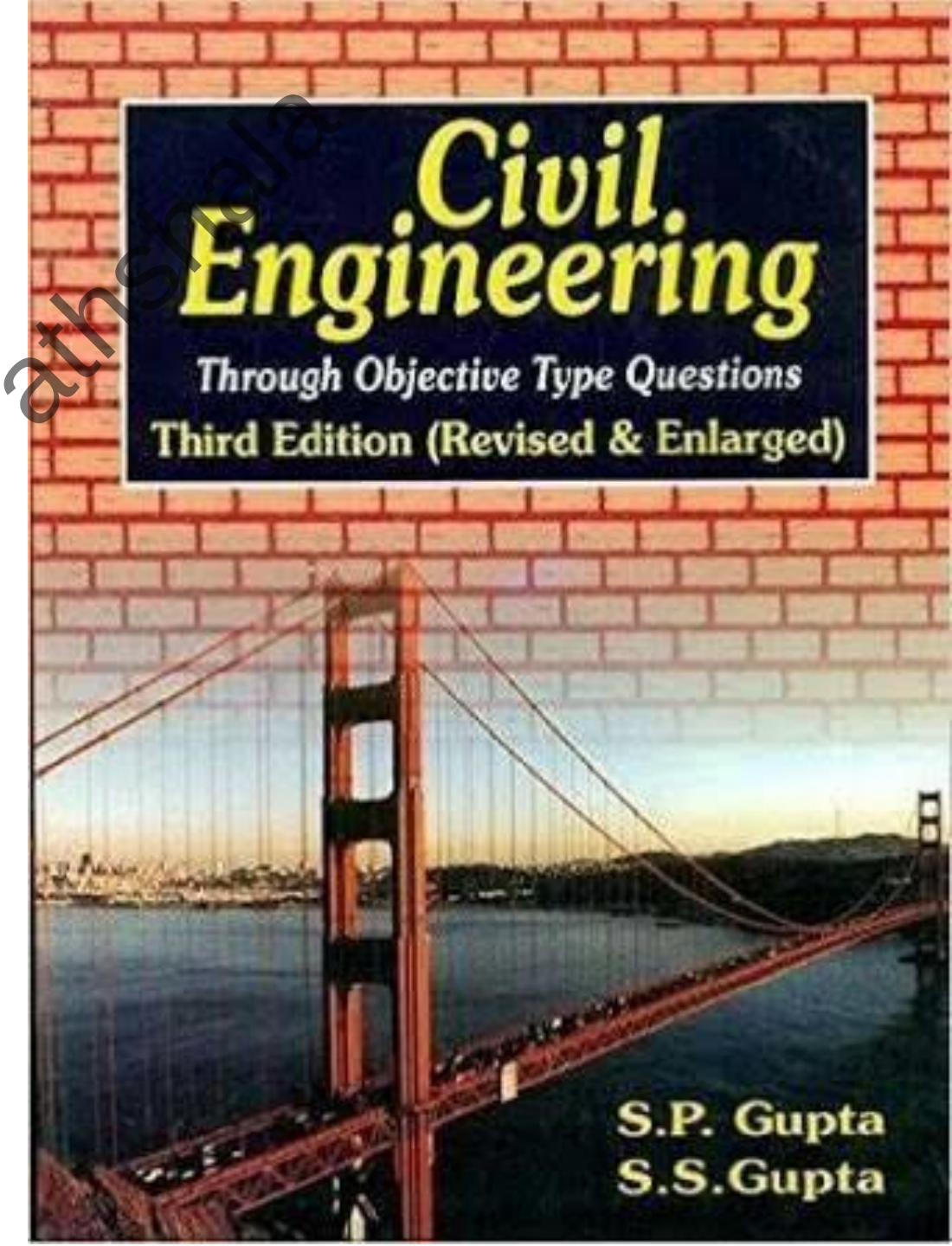
- Perception
  - It is time required for the sensation received to the eyes or ears to be transmitted to the brain through nervous system & spinal cord.
- Intellection
  - It is time required for understanding the situation
- Emotion
  - It is time elapsed during emotional sensations and disturbance such as fear, anger or other feelings.
- Volition
  - It is time taken for final action.



THANK  YOU

Objective Questions (16 to 30)

Highway Engineering



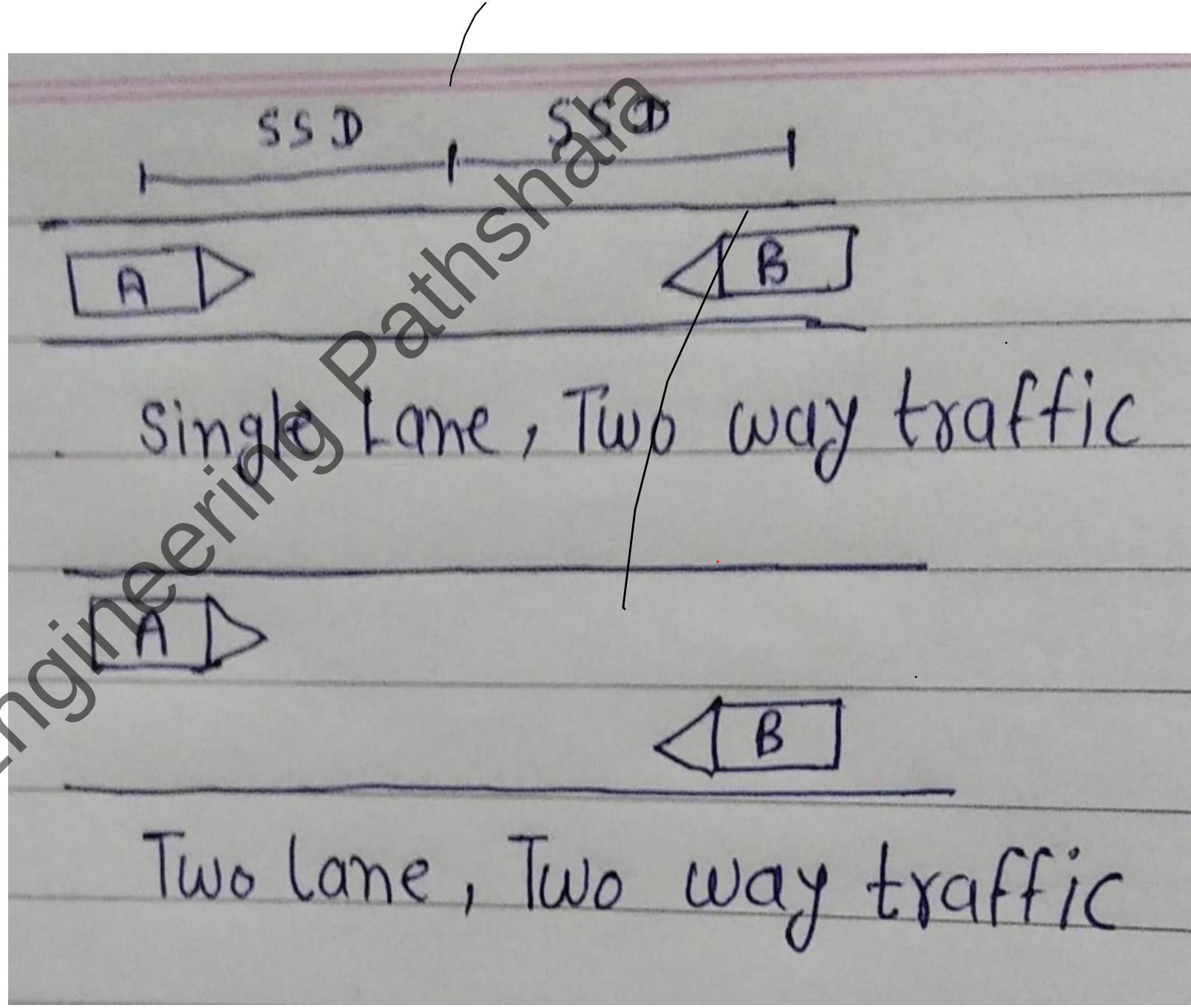
Q. 16) If the stopping distance is 60 metres, then the minimum stopping sight distance for two Lane, two way traffic is

a. 30m
b. 60m
c. 120m
d. 180m

Answer: B

For two lane two way traffic
= SSD

For One lane two way traffic
= 2 × SSD



Q. 17) The effect of grade on safe overtaking sight distance is

a. To increase it on descending grades and to decrease it on ascending grades
b. To decrease it on descending grades and to increase it on ascending grades
c. To increase it on both descending and ascending grades
d. To decrease it on both descending and ascending grades

Answer : C

OSD always increases either descending gradient or ascending gradient.

Q. 18) The ruling design speed on a National highway in plain Terrain as per IRC recommendation is

a. 60 kmph
b. 80 kmph
c. 100 kmph
d. 120 kmph

Answer:C

Table : Terrain classification	
Terrain classification	Cross slope (%)
Plain	0-10
Rolling	10-25
Mountainous	25-60
Steep	60

IRC specifications for Design Speed

Sr no	Type of Road	Design speed in km/hr							
		Plain area		Rolling area		Hilly area		Steep area	
		Ruling	Min	Ruling	Min	Ruling	Min	Ruling	Min
1	NH & SH	100	80	80	65	50	40	40	30
2	MDR	80	65	65	60	40	30	30	20
3	ODR	65	50	50	40	30	25	25	20
4	VR	50	40	40	35	25	20	25	20

Q. 19) The terrain may be classified as rolling terrain if the cross slope of land is

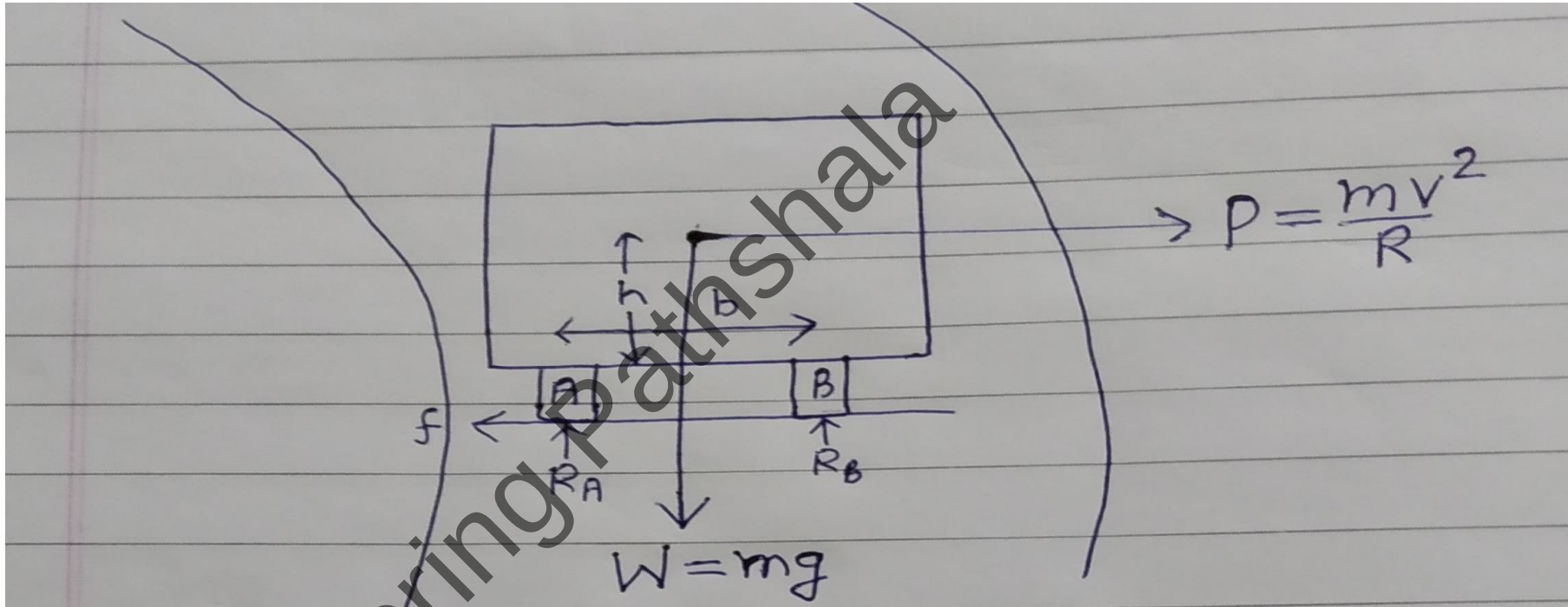
a. Upto 10%
b. Between 10% and 25%
c. Between 25% and 60%
d. More than 60%

Answer : B

Q. 20) If b is the wheel track of a vehicle and h is the height of centre of gravity above road surface, then the avoid overturning and Lateral skidding on horizontal curve, the centrifugal ratio should always be

a. Less than b/2h and greater than coefficient of lateral friction
b. Less than b/2h and also less than coefficient of lateral friction
c. Greater than b/2h and less than coefficient of lateral friction
d. Greater than b/2h and also greater than coefficient of lateral friction

Answer : B



① for No overtruning

$$W \times \frac{b}{2} \geq P \times h$$

$$\boxed{\frac{b}{2h} \geq \frac{P}{W}}$$

② for No Skidding

$$fR \geq P$$

$$fW \geq P$$

$$\boxed{f \geq \frac{P}{W}}$$

$\frac{P}{W}$ = Centrifugal Ratio

Q. 21) As per IRC recommendations, the maximum limit of superelevation for mixed traffic in plain Terrain is

a. 1 in 15
b. 1 in 12.5
c. 1 in 10
d. Equal to camber

Answer: A

Maximun super elevation

1. Plain and rolling terrain – 7% or 1 in 15

2. Hilly terrain - 10% or 1 in 10

Q. 22) For the design of superelevation for mixed traffic conditions, the speed is reduced by

a. 15%
b. 20%
c. 25%
d. 75%

Answer :C

Design of super elevation, $e + f = V^2/127R$

Step1. Calculate super elevation for 75% of design speed, neglecting the effect of friction

$$e = (0.75V)^2/127R$$

If e < emax. emax. (7% for plain and rolling 10% for hilly terrain), then provide e, other wise
Step2. Calculate coefficient of friction assuming maximum value of super elevation

$$0.70 + f = V^2/127R$$

If f < 0.15, then provide super elevation is 7% or 0.70, other wise

Step3. Reduce the speed

$$0.7 + 0.15 = V^2/127R$$

Q. 23) On horizontal curve if the pavement is kept horizontal across the alignment, then the pressure on the outer wheels will be

a. More than the pressure on inner wheels
b. Less than the pressure on inner wheels
c. Equal to the pressure on inner wheels
d. Zero

Answer: A

Q. 24) The equilibrium superelevation required to counteract the centrifugal force fully is given by

a. $V^2 / 27.5R$

b. $V^2 / 75R$

c. $(0.75V)^2 / 127R$

d. $V^2 / 127R$

Answer: D

Super elevation, $e + f = V^2/127R$

Equilibrium super elevation or super elevation to counteract fully centrifugal force, then f = o

Q. 25) For constant value of coefficient of lateral friction, the value of required superelevation increases with

a. Increase in both speed and radius curve
b. Decrease in both speed and radius of curve
c. Increase in speed and with decrease in radius of curve
d. Decrease in speed and with increase in radius of curve

Answer: C

Super elevation, $e + f = V^2/127R$

Q. 26) To calculate the minimum value of ruling radius of horizontal curves in Plains, the design speed is given by

a. 8 kmph
b. 12 kmph
c. 16 kmph
d. 20 kmph

Answer: C

Q. 27) The absolute minimum radius of curve for safe operation for a speed of 110 kmph is

a. 110 m
b. 220 m
c. 440 m
d. 577 m

Answer: C

Design speed(kmph)	30	40	50	60	70	80	90	100	110
Rmin in m	40	70	100	150	200	260	320	400	440

Q. 28) The attainment of superelevation by rotation of pavement about the inner edge of the pavement

a. Is preferable in steep terrain
b. Results in balancing the earth work
c. Avoids the drainage problem in flat terrain
d. Does not change the vertical alignment of road

Answer: C

Q. 29) select the correct statement

a. Psychological extra widening depends on the number of traffic lanes
b. Mechanical extra widening depends on the speed of vehicle
c. Psychological extra widening depends on the length of wheel base
d. Psychological extra widening depends on the speed of vehicle

Answer: D

When a vehicle takes a turn on horizontal curve, the rear wheels do not follow the same path as that of the front wheels.

The vehicle has occupies more width that it occupies on straight portion of the road.

To compensate this, the carriageway width increased on the entire curved portion of the road, which is called extra widening of pavement on curve.

Extra widening = Mechanical widening(Wm) + Psychological widening(Wps)

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

Where 'n' is the number of the traffic lane, l is the length of the wheelbase of the longer vehicle in m (generally taken as 6 m), V is the design speed of the vehicle in Kmph and R is the radius of the horizontal curve in m.

Q. 30) In case of Hill roads, the extra widening is generally provided

a. Equally on inner and outer sides of the curve
b. Fully on the inner side of the curve
c. Fully on the outer side of the curve
d. One fourth on inner side and three fourth on outer side of the curve

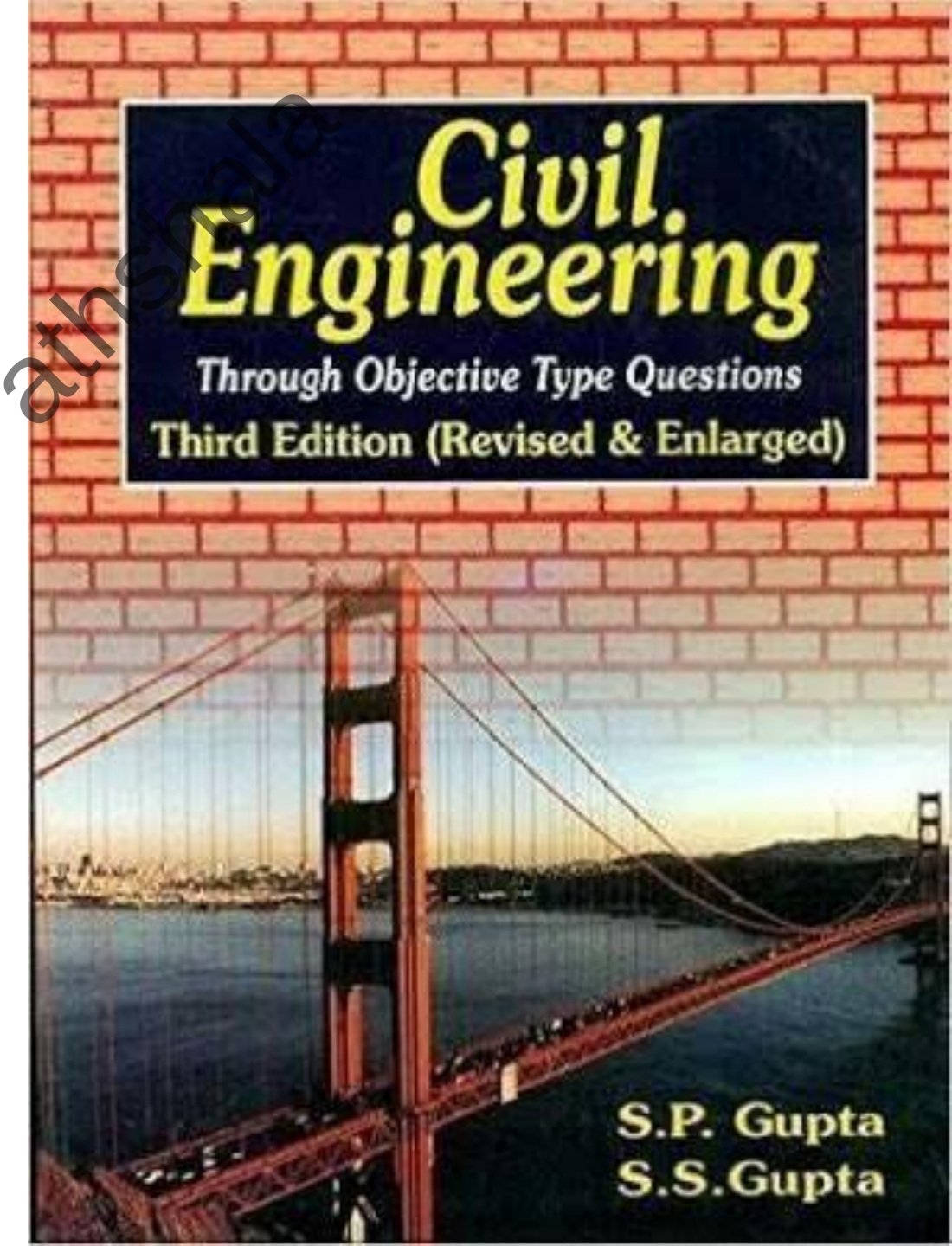
Answer: B

THANK  YOU

Objective Question

(31 to 45)

Highway Engineering



Q. 31) The mechanical extra widening required for 10.5m wide pavement on a horizontal curve of a radius R metre is given by

a. $L^2/2R$

b. $2L^2/3R$

c. L^2/R

d. $3L^2/2R$

Answer: D

Width of road or carriage way (1) Single lane = 3.75m
(2) Two lane = 7m
(3) Multi lane = number of lane × 3.5m

When a vehicle takes a turn on horizontal curve, the rear wheels do not follow the same path as that of the front wheels, is known as mechanical widening or off tracking. The vehicle has occupies more width that it occupies on straight portion of the road.

Extra widening = Mechanical widening(Wm) + Psychological widening(Wps)

$= \quad nl^2/2R \quad + \quad V/9.5\sqrt{R}$

Where 'n' is the number of the traffic lane, l is the length of the wheelbase of the longer vehicle in m (generally taken as 6 m), V is the design speed of the vehicle in Kmph and R is the radius of the horizontal curve in m.

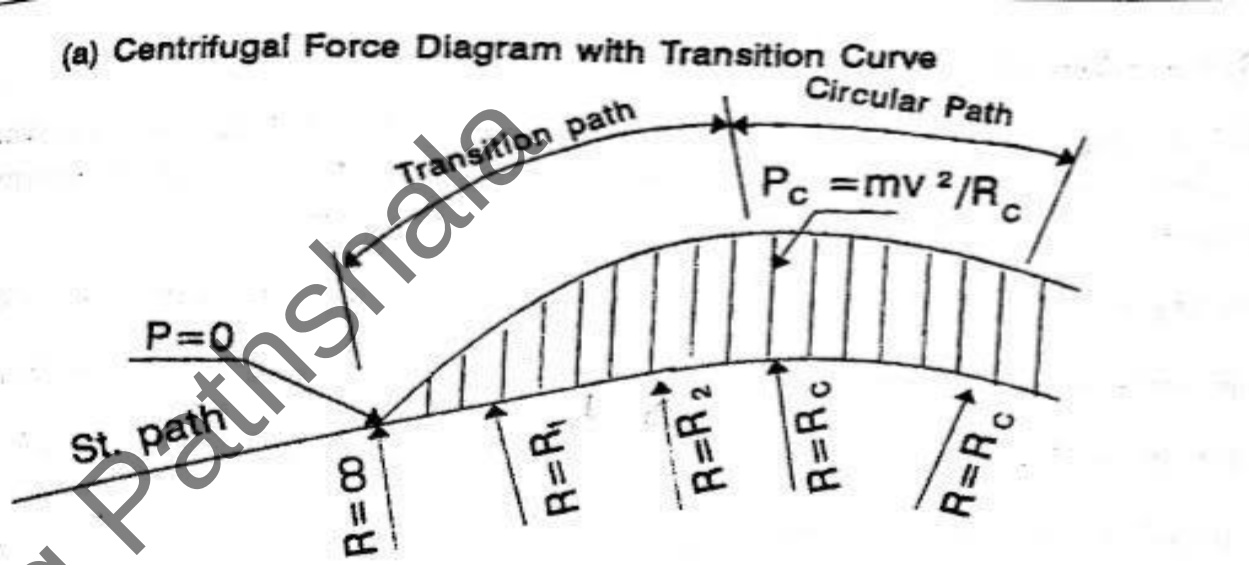
Given, Width of pavement = 10.5m means three lane road, the value of n = 3

Mechanical widening, $Wm = 3l^2/2R$

Q. 32) The transition curve used in the horizontal alignment of highways as per IRC recommendations is

a. Spiral
b. Lemniscate
c. Cubic parabola
d. Any of the above

Answer: A



A transition curve may be defined as a curve of varying radius of infinity to R

Objective:

1. To gradually introduce the centrifugal force between the tangent point and the beginning of the circular curve thereby avoiding sudden jerk on the vehicle.
2. To increase the comfort of passengers.
3. To introduce designed superelevation at a desirable rate
4. To enable the driver to turn the steering gradually for his own comfort and security
5. To introduce designed extra widening at a desirable rate
6. To enhance the aesthetic appearance of the road

IRC recommends spiral as the transition curve because, it fulfills the requirement of an ideal transition curve

Q. 33) For design, that length of transition curve should be taken which is

a. Based on allowable rate of change of centrifugal acceleration
b. Based on rate of change of super elevation
c. Higher of (a) and (b)
d. Smaller of (a) and (b)

Answer: C

1. Based on allowable rate of change of centrifugal acceleration, $Lc = V^3/cR$

2. Based on rate of change of super elevation, Lc

(a) If superelevation was provided by rotating the pavement surface about the inner edge

$$Lc = N \times e \times (W + We)$$

Where, e is the rate of superelevation, W is the width of the pavement, We are the extra widening and N are the gradient of terrain.

(b) f the pavement is rotated about the center line, double effect is achieved.

Therefore, $Lc = 0.5 \times N \times e \times (W + We)$

Higher value of 1 and 2

3. By Empirical formula

IRC suggest the length of the transition curve is minimum,

For plain and rolling terrain, $Ls = 2.7V^2/ R$

For steep and hilly terrain, $Ls = V^2/R$

Where, V is the design speed in kmph and R is the radius of the curve in meters.

Q. 34) The maximum design gradient for vertical profile of a road is

a. Ruling gradient
b. Limiting gradient
c. Exceptional gradient
d. Minimum gradient

Answer: A

Gradient - It is the rate of rise or fall of road level along the length.

Raise wrt horizontal distance is called Upward gradient or ascending gradient (+n %)

Fall wrt Horizontal distance is called Downward Gradient descending gradient (-n %)

Types of gradients

1. Ruling gradient - This is the maximum gradient which is generally used to design the vertical profile of highway. So it is also called as design gradient.

2. Maximum or Limiting gradient - This gradient is provided as shorter stretches in highways. Whenever ruling gradients costs high for the hilly terrains then limiting gradient is provided which will reduce the cost.

3.Exceptional gradient - These are very steeper gradients given at unavoidable situations and they are adopted for stretches not exceeding 100m of length.

4.Minimum gradient - To drain of rain water from the road minimum gradient is needed. Generally for lateral drainage Camber is provided. But for the longitudinal drainage along the side drains require some slope for smooth flow of water

S. No.	Type of Terrain	Gradient		
		Ruling	Limiting or Max.	Exceptional
1.	Plain or Rolling	1 in 30 (3.3%)	1 in 20 (5%)	1 in 15 (6.7%)
2.	Mountainous and steep terrain with elevation more than 3000 m.	1 in 20 (5%)	1 in 16.7 (6%)	1 in 14.3 (7%)
3.	Steep terrain up to 3000 m height	1 in 16.7 (6%)	1 in 14.3 (7%)	1 in 12.7 (8%)

Q. 35) The percentage compensation in gradient for ruling gradient of 4% and horizontal curve of radius 760 m is

a. 0.1%
b. 1%
c. 10%
d. No compensation

Answer: D

Grade Compensation

When a horizontal circular curve lies in vertical curve there will be an increased resistance offered by the circular curve in the form of curve resistance in addition to the component of gravity.

IRC specifications for grade compensations are:

1. For grades flatter than 4% - grade compensation is not required.

2. Grade compensation in% = (30 + R) /R

3. Maximum value of gradient compensation in% = 75/R

Where, R= radius of horizontal curve in metre

Q. 36) If ruling gradient is 1 in 20 and there is also a horizontal curve of radius 76m, then the compensated grade should be

a. 3%
b. 4%
c. 5%
d. 6%

Answer: B

1. Grade compensation in% = (30 + R) /R

= (30 + 76) /76

= 106/76 = 1.39%

2. Maximum value of gradient compensation in% = 75/R

= 75/76 = 0.99%

Minimum of 1 and 2 that is 0.99%

Given, ruling gradient is 1 in 20 means 5%

So Compensated grade = 5 – 0.99 = 4% approx.

Q. 37) The camber of road should be approximately equal to

a. Longitudinal gradient
b. Two times the longitudinal gradient
c. Three times the longitudinal gradient
d. Half of longitudinal gradient

Answer: D

Gradient $= 2 \times$ Camber

Q. 38) Which of the following shapes is preferred in valley curve

a. Simple parabola
b. Cubic parabola
c. Spiral
d. Lemniscate

Answer: B → Cubic parabola

Q. 39) The value of ruling gradient in plains as per IRC recommendation is

a. 1 in 12
b. 1in 15
c. 1 in 20
d. 1 in 30

Answer: D

The maximum, ruling and exceptional gradients as recommended by Indian Road Congress are given in Table 9.17.

Table 9.17.

S. No.	Type of Terrain	Gradient		
		Ruling	Limiting or Max.	Exceptional
1.	Plain or Rolling	1 in 30 (3.3%)	1 in 20 (5%)	1 in 15 (6.7%)
2.	Mountainous and steep terrain with elevation more than 3000 m.	1 in 20 (5%)	1 in 16.7 (6%)	1 in 14.3 (7%)
3.	Steep terrain up to 3000 m height	1 in 16.7 (6%)	1 in 14.3 (7%)	1 in 12.7 (8%)

Q. 40) In case of summit curves, the deviation angle will be maximum when

a. An ascending gradient meets with another ascending gradient

b. An ascending gradient meets with a descending gradient

c. A descending gradient meets with another descending gradient

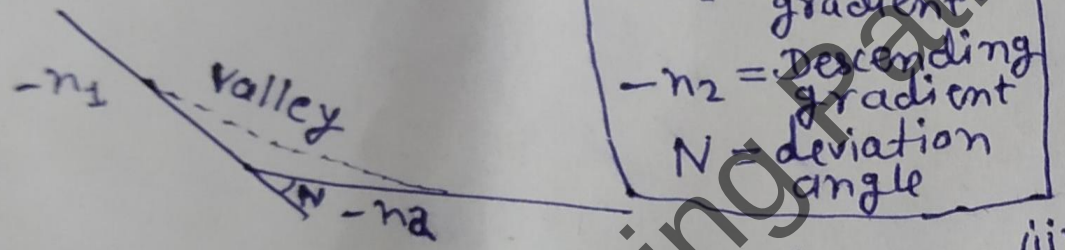
d. An ascending gradient meets with a level surface

Answer: B

Vertical

Valley Curve (cubic parabola)

(i) Descending meets Descending

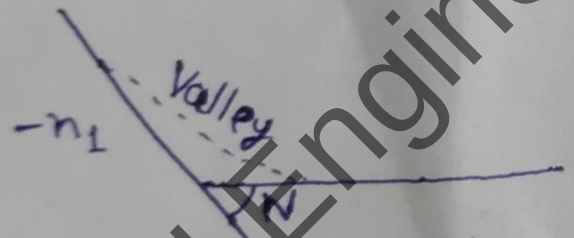


$+n_1$ = Ascending gradient

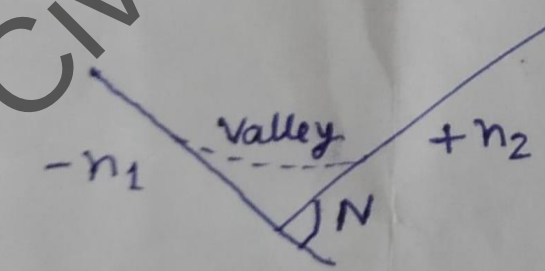
$-n_2$ = Descending gradient

N = deviation angle

(ii) Descending meets Horizontal

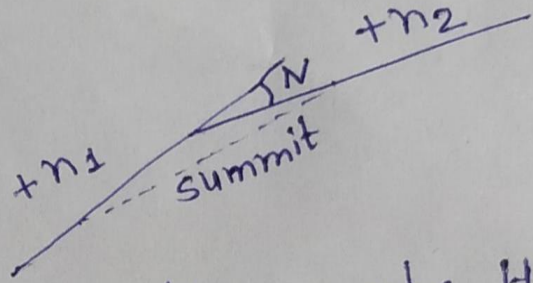


(iii) Descending meets Ascending

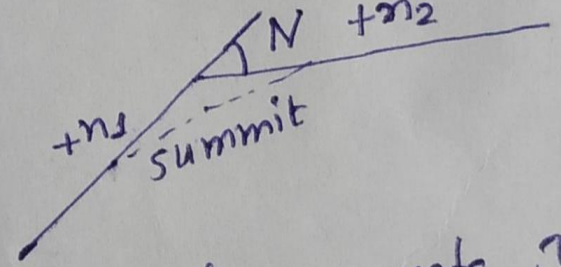


Summit Curve

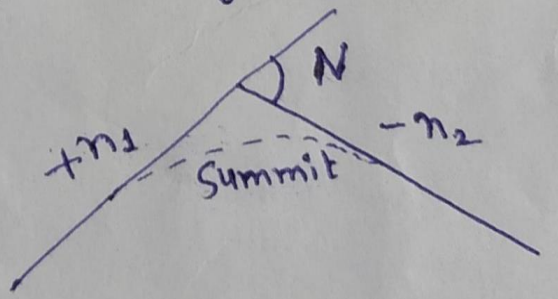
(i) Ascending meets Ascending



(ii) Ascending meets Horizontal



(iii) Ascending meets Descending



Q. 41) If the design speed is V kmph and deviation angle is N radians, then the total length of valley curve in metres is given by the expressions

a. 0.38NV^3/2

b. 0.38 (NV^3) ^1/2

c. 3.8 NV^1/2

d. 3.8 (NV^3) ^1/2

Answer: B

Q. 42) If an ascending gradient of 1 in 50 meets a descending gradient of 1 in 50, the length of summit curve for a stopping sight distance of 80 m will be

a. Zero
b. 64m
c. 80m
d.60m

$L > SSS \rightarrow L = NS^2/4.4$

$L < SSD \rightarrow L = 2S - 4.4/N$

Answer D

Given,

Ascending gradient, $+n_1 = 1 \text{ in } 50$

$+n_1 = 0.2$

Descending gradient, $-n_2 = 1 \text{ in } 50$

$-n_2 = -0.2$

Stopping sight distance = 80m

deviation angle, $N = n_1 - n_2$

$= 0.2 - (-0.2)$

$= 0.4$

Length of summit curve $= \frac{NS^2}{4.4}$

$= \frac{0.4(80)^2}{44}$

$= 60\text{m}$ approx

Q. 43) Highway facilities are designed for

a. Annual average hourly volume
b. Annual average daily traffic
c. Thirtieth highest hourly volume
d. Peak hourly volume of the year

Answer: C

Traffic volume may be defined as the number of vehicles crossing a selected section of the road per unit time. Unit is vehicle/hour

30^{th} highest hourly volume – It is that hourly volume which will be exceeded only 29 times in a year.

IRC consider 30^{th} highest hourly volume because it is economical and it suited Indian traffic conditions.

Q. 44) Enoscope is used to find

a. Average speed
b. Spot speed
c. Space mean speed
d. Time mean speed

Answer: B

Average speed – It is the average spot speed of all vehicles passing through a particular section or spot.

Spot speed - Spot speed is the instantaneous speed of a vehicle at a specified location. Find using Enoscope.

Space-mean speed is the distance traveled divided by an average travel time.

Time-mean speed is an average of individual vehicle speeds.

Q. 45) For highway geometric design purposes the speed used is

a. 15^{th} percentile
b. 50^{th} percentile
c. 85^{th} percentile
d. 98^{th} percentile

Answer: D

d. Design speed or 98th percentile speed – It is the speed at or below which 98% of vehicle are moving and only 2% exceeds that limit

a. 15th Percentile speed – It is lower safe speed.

b. 50th Percentile speed – It is mean speed.

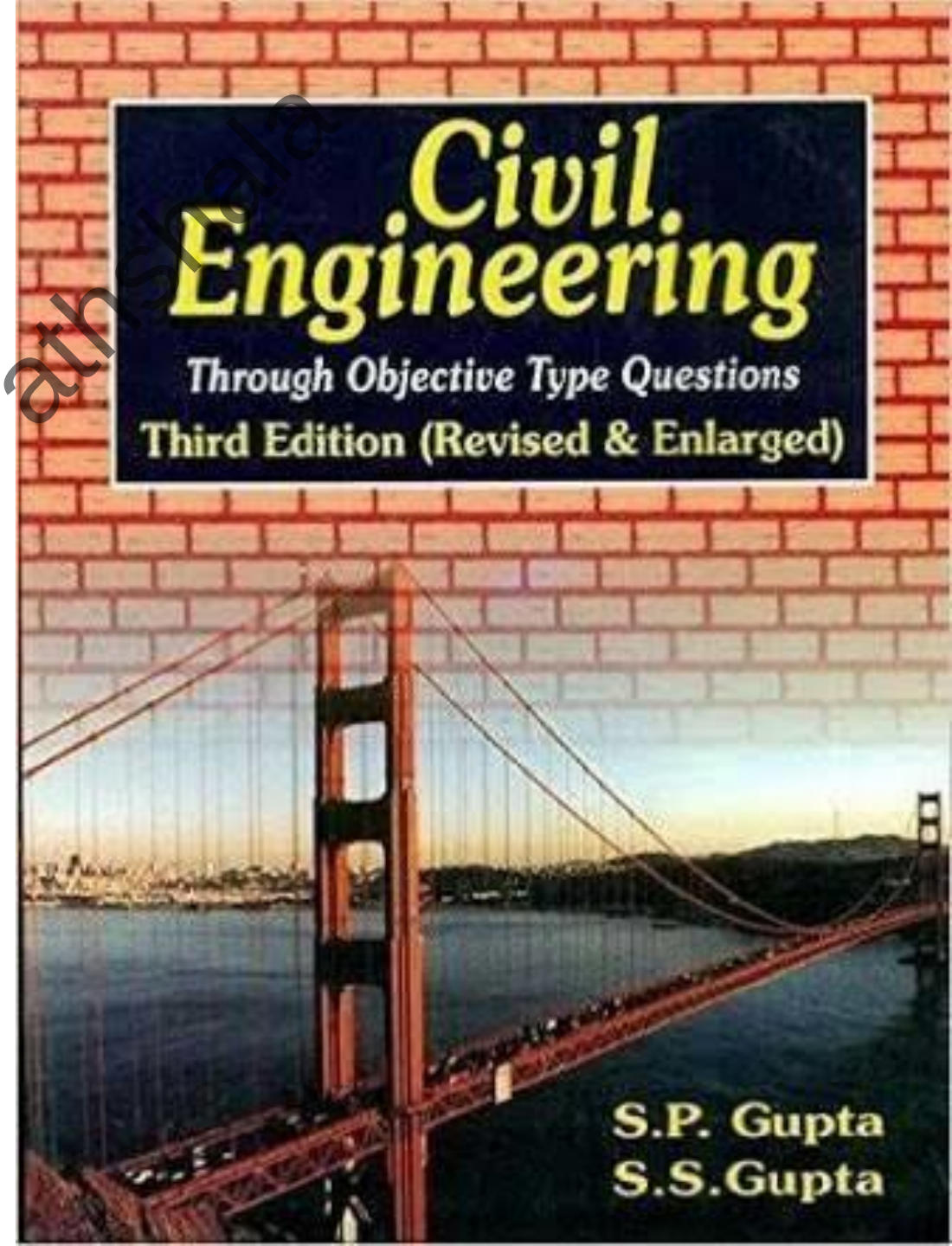
c. 85th Percentile speed – It is upper safe speed limit for regulation of traffic.

THANK  YOU

Objective Question

(46 to 60)

Highway Engineering



Q. 46) Select the correct statement

a. Traffic volume should always be more than traffic capacity
b. Traffic capacity should always be more than traffic volume
c. Spot speed is the average speed of a vehicle at specified section
d. 85^{th} percentile speed is more than 98^{th} percentile speed

Answer: B

Traffic volume is the numbers of vehicles that pass a point on a highway on a particular lane on particular direction in unit time, generally in per unit hour.

Traffic capacity is expressed as the maximum number of vehicle in a lane or a road that can pass a given point in unit time, usually an hour, i.e., vehicles per hour per lane.

Spot speed is the instantaneous speed of a vehicle at a specified location.

Design or 98th percentile speed - It is the speed at or below which 98% of vehicle are moving and only 2% exceeds that limit.

Q. 47) Length of a vehicle affects

a. Width of traffic lanes
b. Extra width of pavement and minimum turning radius
c. Width of shoulders and parking facilities
d. Clearance to be provided under structures overbridges, underbridges etc.

Answer: B

Length of vehicle affects:
Extra widening and radius of curve
Extra widening refers to the additional width of carriageway that is required on a curved section.
1.Mechanical widening or off tracking
2.Psychological widening

Width of vehicle affects:
Width of pavement, shoulder and parking facilities.

Height of vehicle affects:
Vertical clearance for road over bridge, electric line etc

Weight of vehicle affects:
Thickness of pavement

Q. 48) The maximum width of vehicle as recommended by IRC is

a. 1.85m
b. 2.44m
c. 3.81m
d. 4.72m

Answer: B

Maximum dimension and weight of a vehicle by IRC

Width = 2.44m
Height = 4.75m
Length = 18.0m
Weight = 52.2 tones

Q. 49) Desire lines are plotted in

a. Traffic volume studies
b. Speed studies
c. Accident studies
d. Origin and destination studies

Answer: D

a. Traffic volume may be defined as the number of vehicles crossing a selected section of the road per unit time.

Method of volume counting

(1) Mannual counts, (2) Automatic counters, (3) Moving car method

b. Speed studies are useful for establishing speed zones, traffic signals, regulatory signs, non-passing zones, warning zones etc.

c. The various steps involved in the traffic accident studies:

(1) Collection of accident data, (2) Preparation of report,

(3) Study of accident, (4) Suggestions for remedial measures.

d. Origin and Destination studies:

Desire line are prepared. (Two points connect by a straight line)

Thickness of desire line, show volume of that road.

Methods of collecting O and D study data

(1) Road side interview method, (2) License plate method, (3) Return post card method,

(4) Tag on car method, (5) Home interview method

Q. 50) Which of the following methods is preferred for collecting origin and destination data for a small area like a mass business Centre or large intersection

a. Road side Interview method
b. Licence plate method
c. Return postcard method
d. Home interview method

Answer: B

→ License plate method

51. The traffic manoeuvre shown in Fig. 4.1 represents

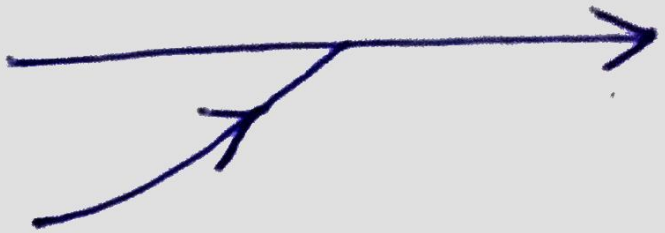
Fig. 4.1

a) diverging
b) merging
c) crossing
d) weaving

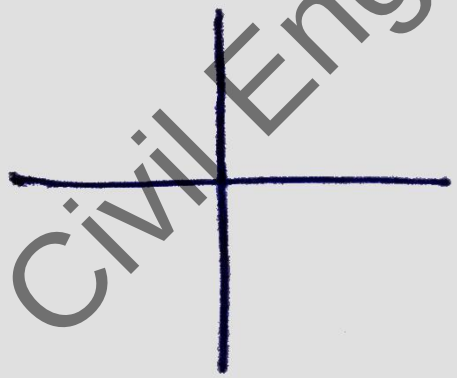
Answer D

a) diverging

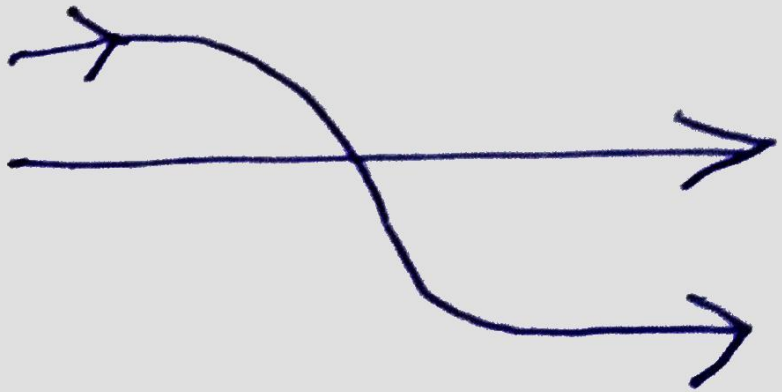
b) merging



c) Crossing



d) Weaving



Q. 52) The diagram which shows the approximate path of vehicles and pedestrians involved in accidents is known as

a. Spot maps
b. Pie charts
c. Condition diagram
d. Collision diagram

Answer: D

Accident record may be maintained by means of location files, spot maps, collision diagram and condition diagram.

- Location file record locations where accidents have taken place.

- Spot maps show, accidents by spots, pin or symbol on the road map of the locality

Collision diagram - Details of accident location and show approximate path of the vehicles and pedestrian involved in the accident and also other objects with which the vehicle have Collided.

- Condition diagram drawing of accident location showing important physical features of the road and adjoining area.

Pie chart showing segregation of fast moving traffic.

Q. 53) With increase in speed of the traffic stream, the minimum spacing of vehicles

a. Increases
b. Decreases
c. First decreases and then increases after reaching a minimum value at optimum speed
d. First increase and then decrease after reaching a maximum value at optimum speed

Answer: A

Q. 54) Traffic volume is equal to

a. Traffic density × Traffic speed
b. Traffic density/traffic speed
c. Traffic speed/traffic density
d. None of the above

Answer: A

Q. 55) which of the following is known as design capacity

a. Basic capacity
b. Theoretical capacity
c. Possible capacity
d. Practical capacity

Answer: D

Traffic capacity is expressed as the maximum number of vehicle in a lane or a road that can pass a given point in unit time, usually an hour, i.e., vehicles per hour per lane or roadway.

Basic capacity is the maximum number of vehicles(PCU) that can pass a given point on a lane or roadway during one hour under the most nearly **ideal** roadway and traffic conditions.

Possible Capacity is the maximum number of vehicles which can pass a given point on a lane or highway during one hour under the prevailing roadway and traffic conditions.
This means that the possible capacity of a highway will always be lower than the basic capacity unless the prevailing conditions of the traffic, approach the ideal conditions.

Practical Capacity is the maximum number of vehicle that can pass a given point on a lane or roadway during one hour, without traffic density

Q. 56) If the average Centre to Centre spacing of vehicles is 20 metres, then the basic capacity of a traffic Lane at a speed of 50kmph is

a. 2500 vehicles per day
b. 2000 vehicles per hour
c. 2500 vehicles per hour
d. 1000 vehicles per hour

Answer: C

Basic capacity (OR) Theoretical max^m capacity

$$C = \frac{1000 \cdot V}{S} = \frac{1000 \times 50}{20} = 2500$$

Where,

V = Speed in KMPH

S = Avg. C-C spacing of vehicles

(OR)

Safe SSD by rear vehicle

$S = S_g + L$

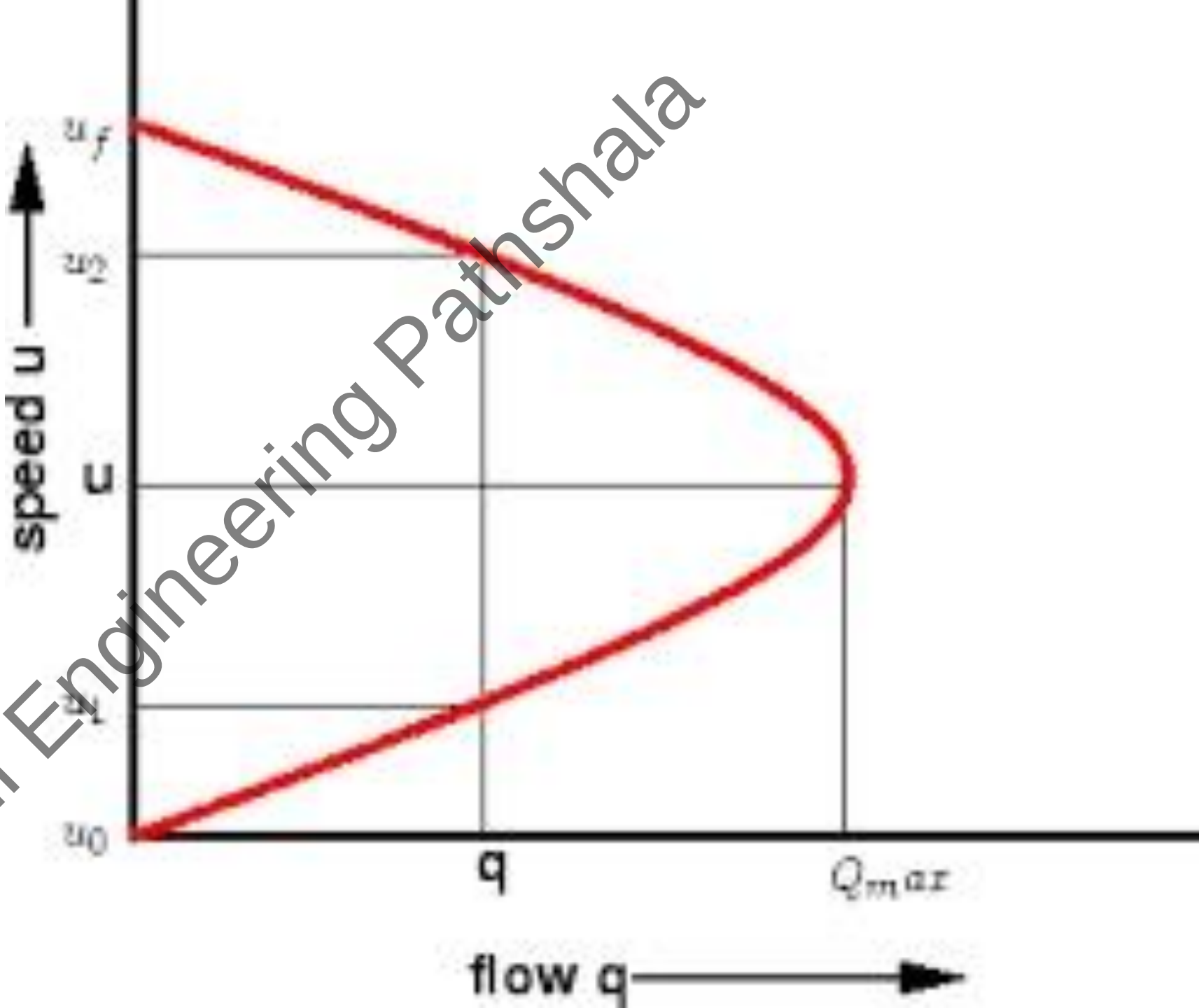
S_g = Space gap (Head to rear)

L = Avg length of the vehicles

Q. 57) With increase in speed of the traffic stream, the maximum capacity of the lane

a. Increases
b. Decreases
c. First increases and then decreases after reaching a maximum value at optimum speed
d. First decrease and then increase after reaching minimum value at optimum speed

Answer: C



Q. 58) Equivalent factor of Passenger car unit (PCU) for a Passenger car as per IRC is

a. 1.0
b. 2.0
c. 0.5
d. 10

Answer: A

S. No	Vehicle type	PCU-Equivalent factor
1	Motor cycle and scooter	0.50
2	Passenger car, van, auto rickshaw	1.00
3	Truck or bus	3.00
4	Truck-trailer / Tractor-trailer	4.50
5	Cycle	0.50
6	Cycle rickshaw	2.00
7	Handcart	3.00
8	Horse-drawn vehicle	4.00
9	Small bullock-cart	6.00
10	Big bullock-cart	8.00

Q. 59) If the stopping distance and average length of a vehicle are 18m and 6m respectively, then the theoretical maximum capacity of a traffic Lane at a speed of 10 m/sec is

a. 1500 vehicles per hour
b. 2000 vehicles per hour
c. 2500 vehicles per hour
d. 3000 vehicles per hour

Answer: A

Basic capacity (OR) Theoretical max^m capacity

$$C = \frac{1000 \cdot V}{S} = \frac{1000 \times 36}{18+6}$$

$$= 1500$$

Where,

V = Speed in KMPH $= 3.6 \times 1$

S = Avg. C-C spacing of vehicles

(OR)

Safe SSD by rear vehicle

$S = S_g + L$

S_g = Space gap (Head to rear)

L = Avg length of the vehicles

Q. 60) Scientific planning of transportation system and mass transit facilities in cities should be based on

a. Spot speed data
b. Origin and destination data
c. Traffic volume data
d. Accident data

Answer: B

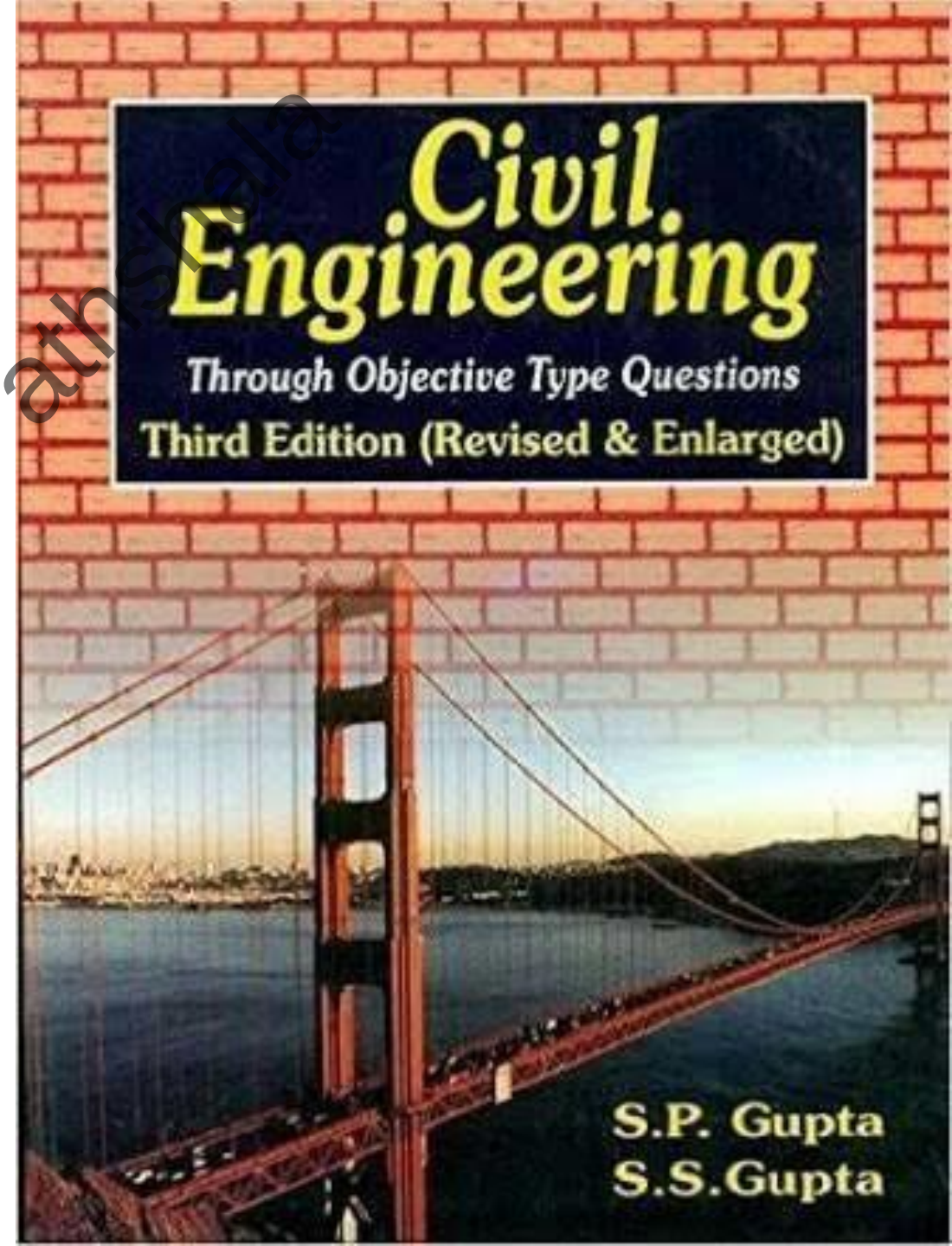
Origin and destination studies
These studies are very essential in planing of new highway facilities or for improving existing road system. It is also used for planing of mass rapid transit system.

Thank You For Watching ☺

Like, Comment, Share and Subscribe

Objective Questions (61 to 75)

Highway Engineering



Q. 61) The diagram which shows all important physical conditions of an accident location like roadway limits, bridges, trees and all details of roadway conditions is known as

A. Pie chart
B. Spot maps
C. Condition diagram
D. Collision diagram

Answer C

A. Pie chart showing segregation of fast moving traffic.

→Accident record may be maintained by means of location files, spot maps, collision diagram and condition diagram.
- Location file record locations where accidents have taken place.

B. Spot maps show, accidents by spots, pin or symbol on the road map of the locality

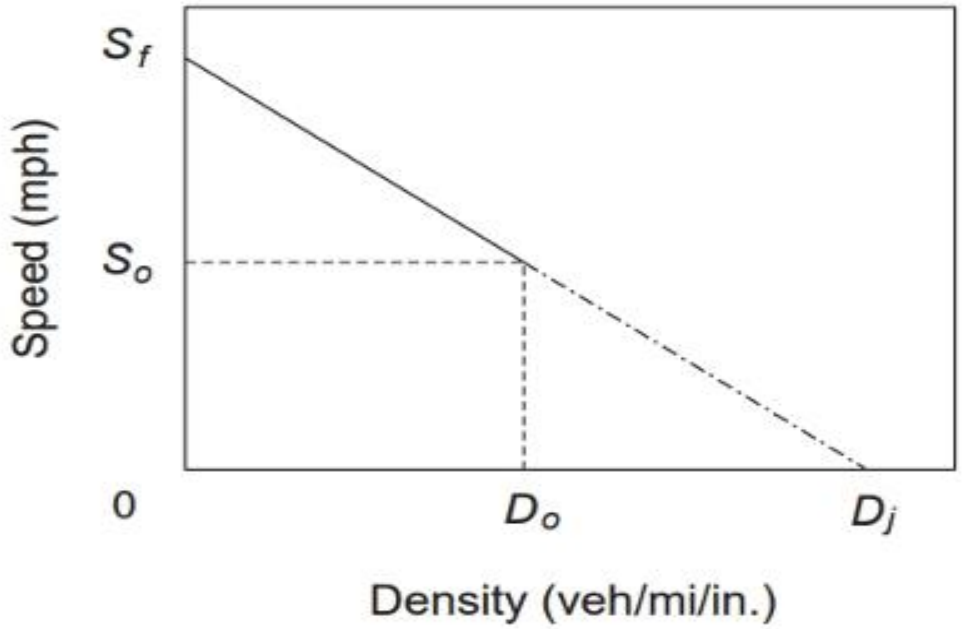
C. Condition diagram - drawing of accident location showing important physical features of the road and adjoining area.

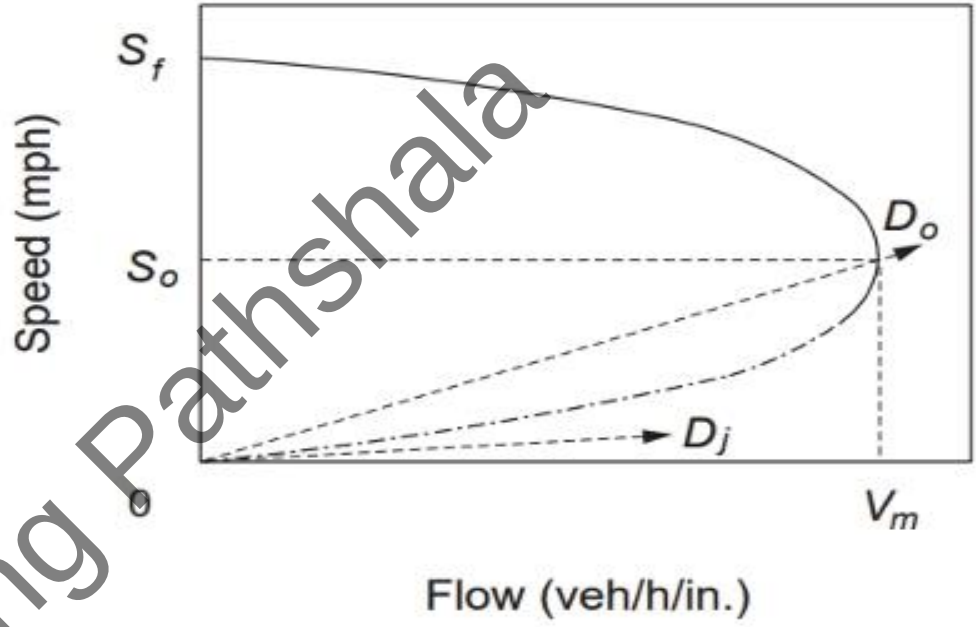
D. Collision diagram - Details of accident location and show approximate path of the vehicles and pedestrian involved in the accident and also other objects with which the vehicle have Collided.

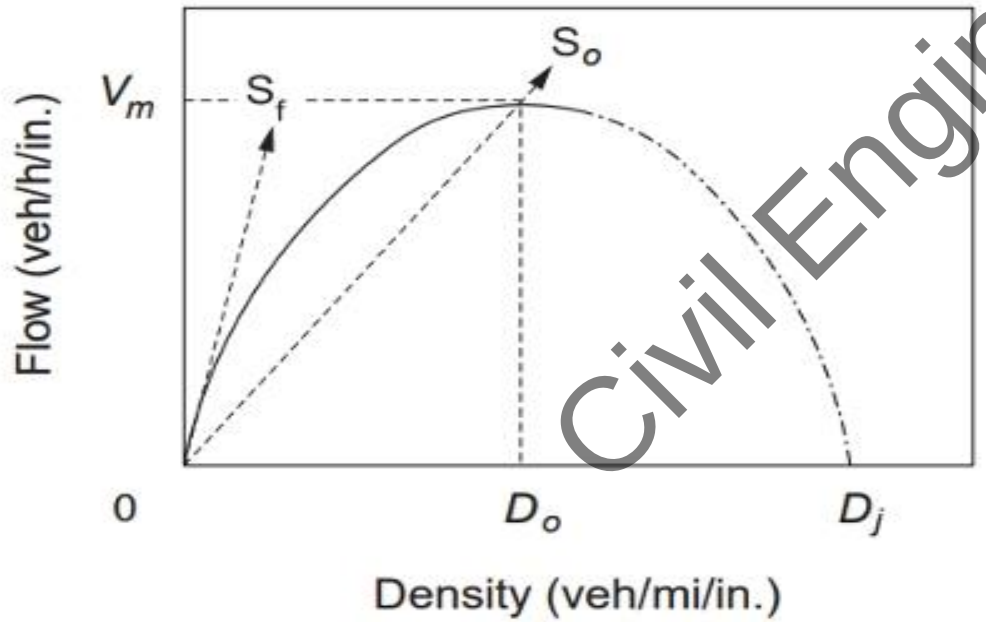
Q. 62) When the speed of traffic flow becomes zero, then

A. Traffic density attains maximum value whereas traffic volume becomes zero
B. Traffic density and traffic volume both attain maximum value
C. Traffic density and traffic volume both become zero
D. Traffic density becomes zero whereas traffic volume attains maximum value

Answer A







Legend

Oversaturated flow

V_m = Maximum flow

D_o = Optimum density (sometimes called critical density)

D_j = Jam density

S_o = Optimum speed (often called critical speed)

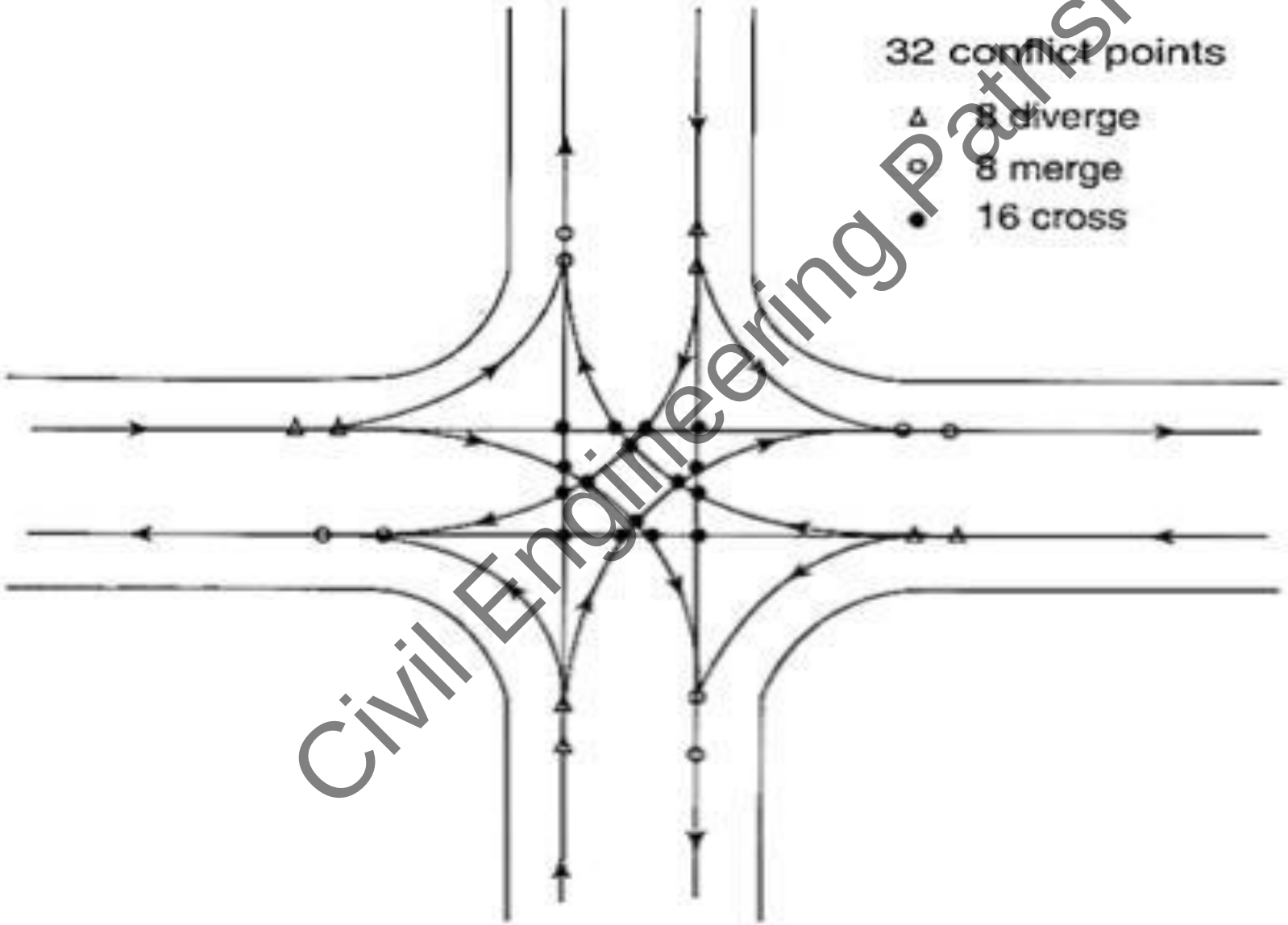
S_f = Theoretical speed selected by the first driver entering a facility (i.e., under zero density and zero flow rate conditions)

Q. 63) On a right angled road intersection with two way traffic, the total number of conflicts points is

A. 6
B. 11
C. 18
D. 24

Answer D

Conflict point - Point at which a highway user crossing, merging with, or diverging from a road or driveway conflicts with another highway user using the same road or driveway.



Conflict Points

No. of Lanes → / Road A	B	A = 2 Way, B = 2 Way	A = 1 Way, B = 2 Way	A = 1 Way, B = 1 Way
2	2	24	11	6
2	3	24	11	8
2	4	32	17	10
3	3	24	13	11

Q. 64) The background colour of the informatory sign board is

A. Red
B. Yellow
C. Green
D. White

Answer B

Traffic control device is the medium used for communicating between traffic engineer and road users.The major types of traffic control devices used are- traffic signs, road markings , traffic signals and parking control.

Types of traffic sign: -

Regulatory signs

These signs are also called mandatory signs because it is mandatory that the drivers must obey these signs.
White background and circular in shape with red borders.

Warning signs

Warning signs or cautionary signs give information to the driver about the road condition.
White background and shape is upward triangular or diamond shape with red bordsigns

Informatory signs

Informative signs also called guide signs, are provided to assist the drivers to reach their desired destinations.
examples are route markers, destination signs, mile posts, service information, recreational and cultural interest area signing etc.
They are written black letters on yellow background.

Q. 65) Which of the following is indicated by a warning sign

A. Level crossing
B. No parking
C. End of speed limit
D. Overtaking prohibited

Answer A

Figure 5B-1. Regulatory Signs on Low-Volume Roads

R1-1

R1-2

R2-1

OR

R4-1

R4-2


R4-7

R5-1

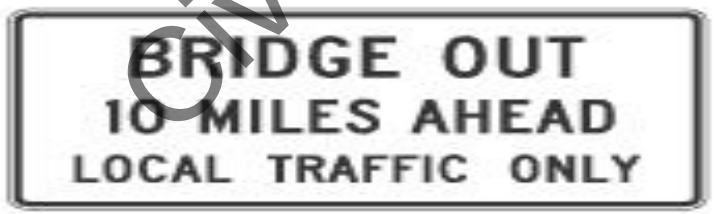

R5-2

R6-2

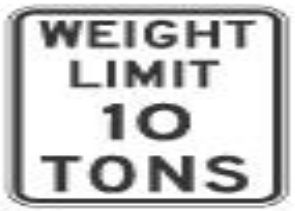
R11-2

R11-3a

OR



R11-3b



R12-1

OR

R12-6

Right Hand Curve

Left Hand Curve

Right Hair Pin Bend

Left Hair Pin Bend

Right Reverse Bend

Left Reverse Bend

Steep Ascent

Steep Descent

Narrow Road Ahead

Road Wideness Ahead

Narrow Bridge

Slippery Road

Loose Gravel

Cycle Crossing

Pedestrian Crossing

School Ahead

Men at Work

Cattle

Falling Rocks

Ferry

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INFORMATIVE SIGNS

PARKING

HOSPITAL


GASOLINE


TELEPHONE

NO PARKING
BUS STOP


RESTAURANT


PEDESTRIAN
CROSSING


MEDICAL


TRAIN STATION


AIRPORT


BUS STATION


MARINA

REST AREA


CYCLE LANE

ONE WAY

AREA CLOSED

PARK & RIDE

POLICE

Q. 66) “Dead Slow” is a

A. Regulatory sign
B. Warning sign
C. Informatory sign
D. None of the above

Answer A

Q. 67) The most efficient traffic signal system is

A. Simultaneous system
B. Alternate system
C. Flexible progressive system
D. Simple progressive system

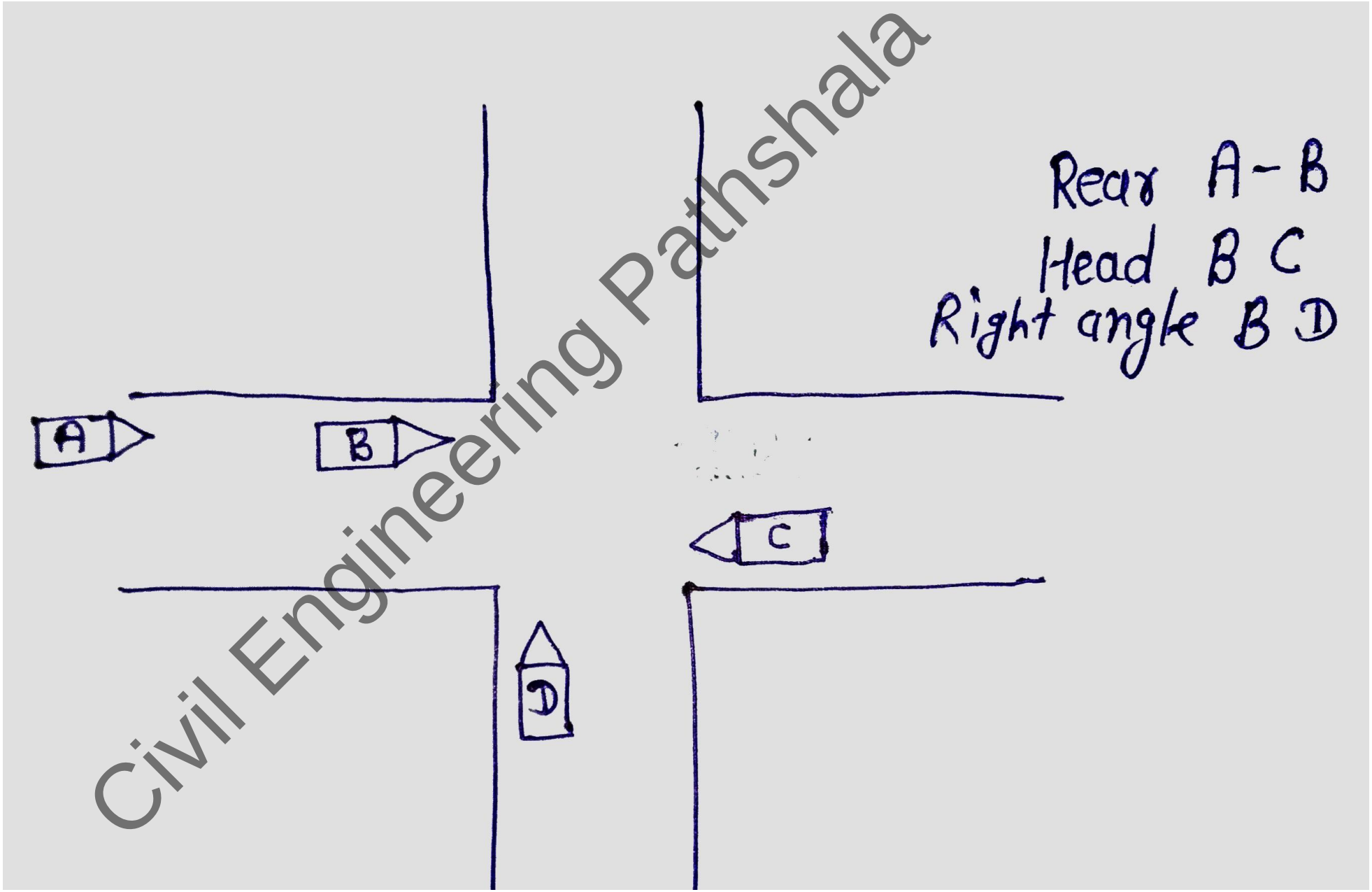
Answer C

Flexible system –
It is possible to automatically vary the length of signal cycle at intersection with the help of sensors to detect vehicle arrival and connecting to the master computer.
This is the most efficient system.

Q. 68) The provision of traffic signals at intersections

A. Reduces right angled and rear end collisions
B. Increases right angled and rear end collisions
C. Reduces right angled collisions but may increase rear end collisions
D. Reduces rear end collisions but may increase right angled collisions

Answer C



Q. 69) Select the incorrect statement

A. Stop or red time of a signal is the sum of go and clearance intervals for the cross flow
B. Go or green time of a signal is the sum of stop and clearance intervals for the cross flow
C. Clearance time is generally 3 to 5 seconds
D. The cycle length is normally 40 to 60 seconds for two phase signals.

Answer B

1. Red for stop
2. Green for go
3. Amber (yellow) for proceed

G + Y = R

Q. 70) Center Line markings are used

A. To designate traffic lanes
B. To roadways meant for two way traffic
C. To indicate that overtaking is not permitted
D. To designate proper lateral placement of vehicles before turning to different directions

Answer B

Traffic marking are special signs used to regulate the traffic.

1. Centre line – used to separate two way traffic. 5 m long and 8 m space

2. Lane line – indicate traffic lanes and used to guide the traffic

3. No passing zone marking – Overtaking is not permissible

4. Stop line – Made near the pedestrians crossings, signalized intersections etc. to indicate that vehicles have to stop before this line and then proceed.

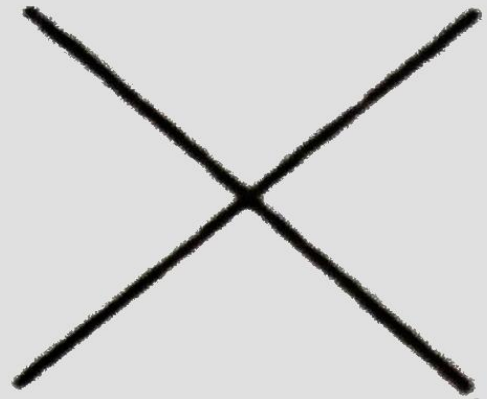
A) Cross walk – Where the pedestrian have to cross the pavement
B) Parking space limit – indicate the space for parking and its proper utilisation

Q. 71) The particular places where pedestrians are to cross the pavement are properly marked by the pavement marking known as

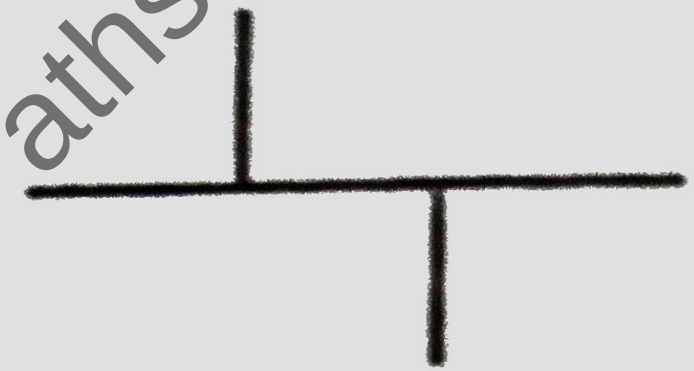
A. Stop lines
B. Trun markings
C. Crosswalk lines
D. Lane lines

Answer C

72. **Which of the following shows skewed and staggered form of intersection ?**



(a)



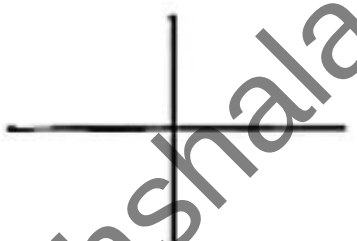
(b)

(c)

(d)

Answer C

T-Junction



Cross Roads

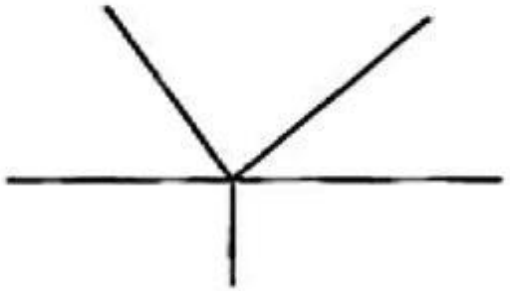
Y-Junction

Scissors or skewed-cross

Skewed junction

Staggered junction

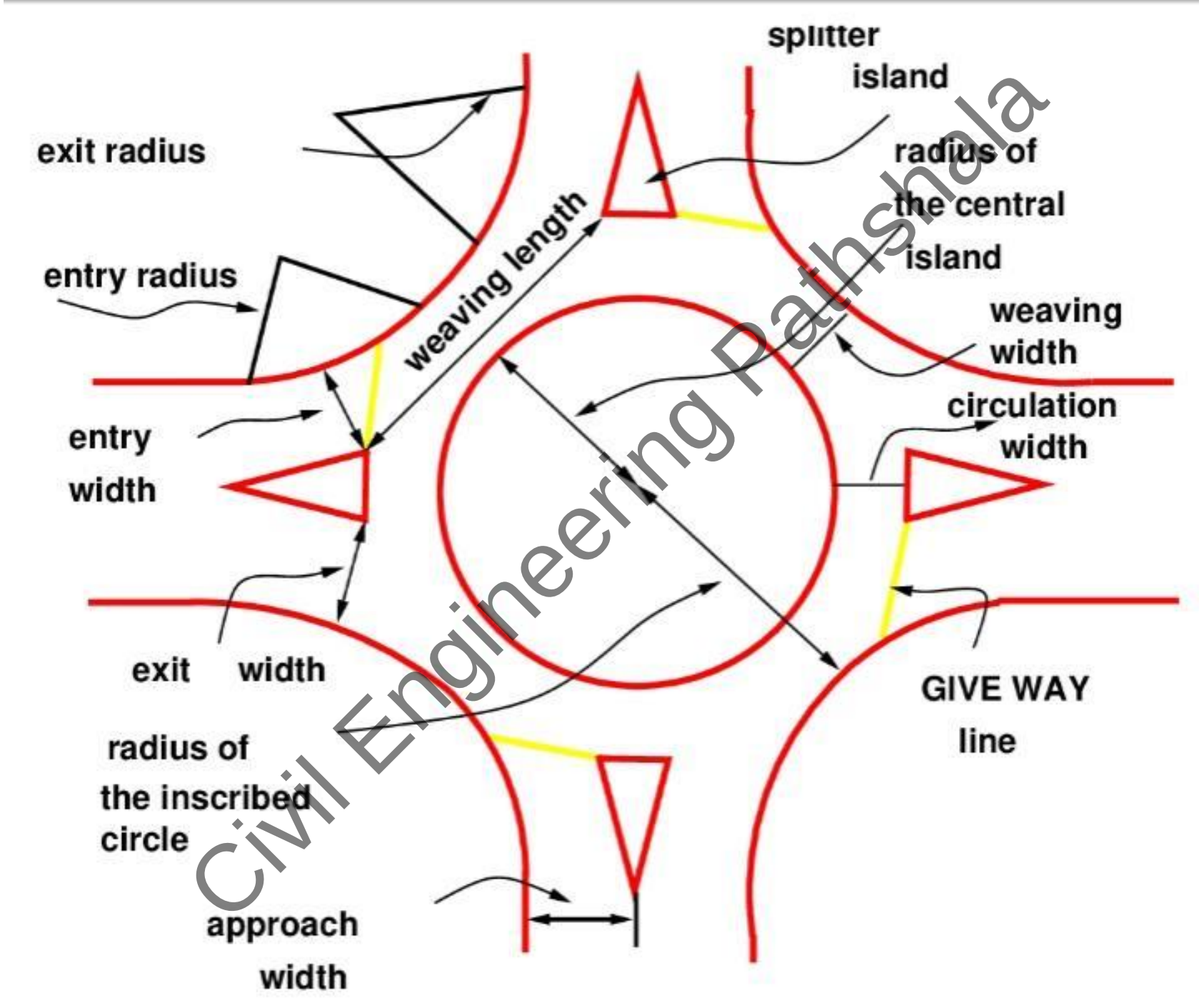
Staggered and skewed junction



Multi-leg junction

Q. 73) The entrance and exit curves of a Rotary have

A. Equal radii and equal widths of pavement
B. Equal radii but pavement width is more at entrancethean at exit curve
C. Equal pavement widths but radiis is more at entrance curve than at exit curve
d. Different radii and different widths of pavement



Answer D

Rotary intersection is an enlarged Road intersection where all converging vehicles are forced to know around large central Island in One Direction before they are allowed to weave out of traffic flow.

1. Radius of curve at entrance = 30.5m for 40kmph speed and 18.3 m for 32 kmph
at exit = 47 m for 40kmph speed and 30.5m for 32 kmph

2. The width of the carriageway at entry and exit will be lower than the width of the carriageway at the approaches to enable reduction of speed.
IRC suggests that a two lane road of 7 m width should be kept as 7 m for urban roads and 6.5 m for rural roads.
Further, a three lane road of 10.5 m is to be reduced to 7 m and 7.5 m respectively for urban and rural roads.

Q. 74) When two equally important roads cross roughly at right angles, the suitable shape of Central Island is

A. Circular
B. Elliptical
C. Tangent
D. Turbine

Answer A

Shape of Central island

a. Circular - Suitable when roads of equal importance and cross each other at right angle.

b. Elliptical – When four or more than four intersecting roads.

c. Turbine – reduce speed at entry and increase at leaving.

d. Tangent – One road is important.

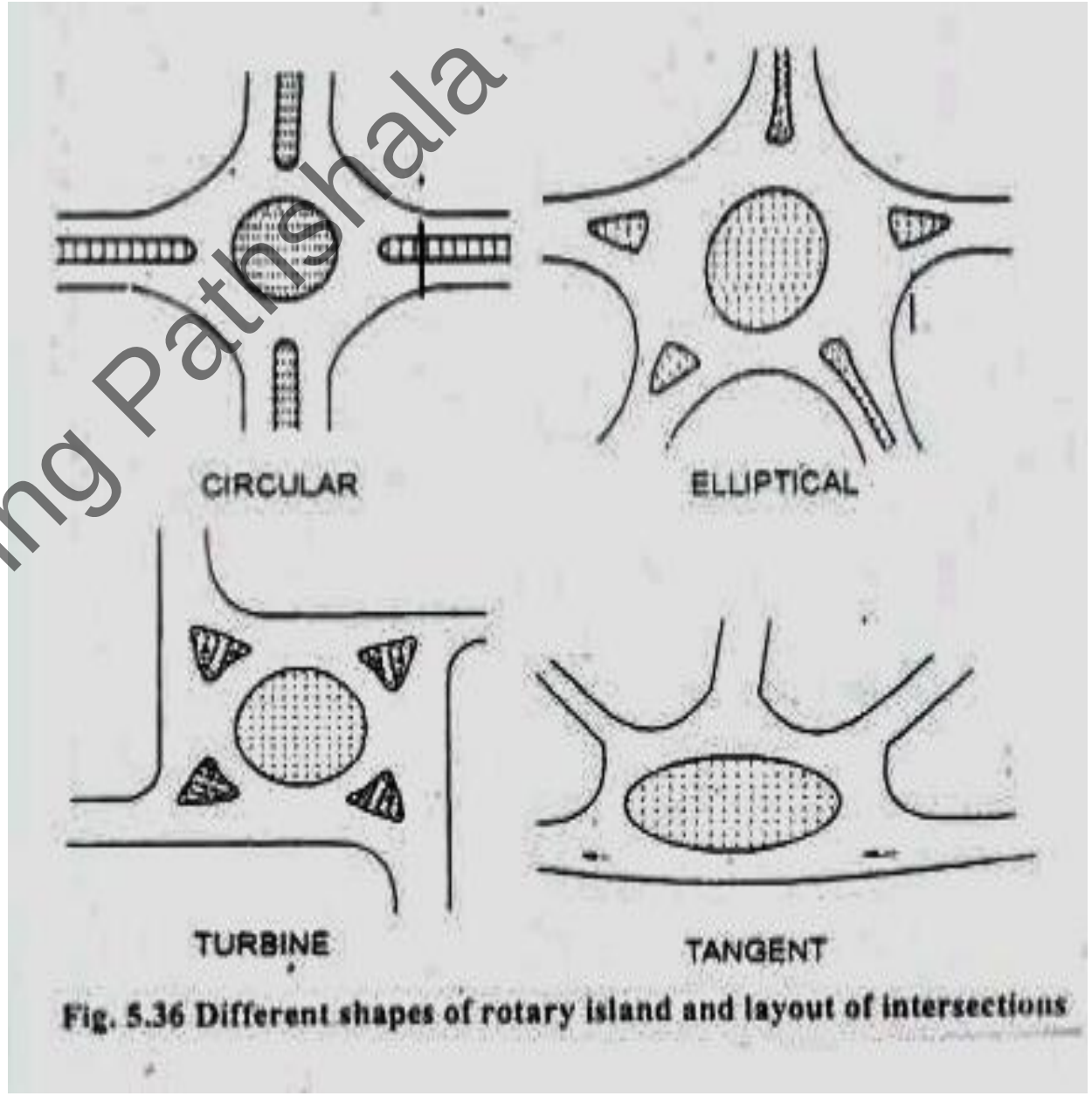


Fig. 5.36 Different shapes of rotary island and layout of intersections

Q. 75) the maximum number of vehicles beyond which the Rotary may not function efficiently is

A. 500 vehicles per hour
B. 500 vehicles per day
C. 5000 vehicles per hour
D. 5000 vehicles per day

Answer C

As per IRC

1. Volume of traffic is between 500 to 3000 Vehicles per hour
2. Number of intersecting roads between 4 to 7

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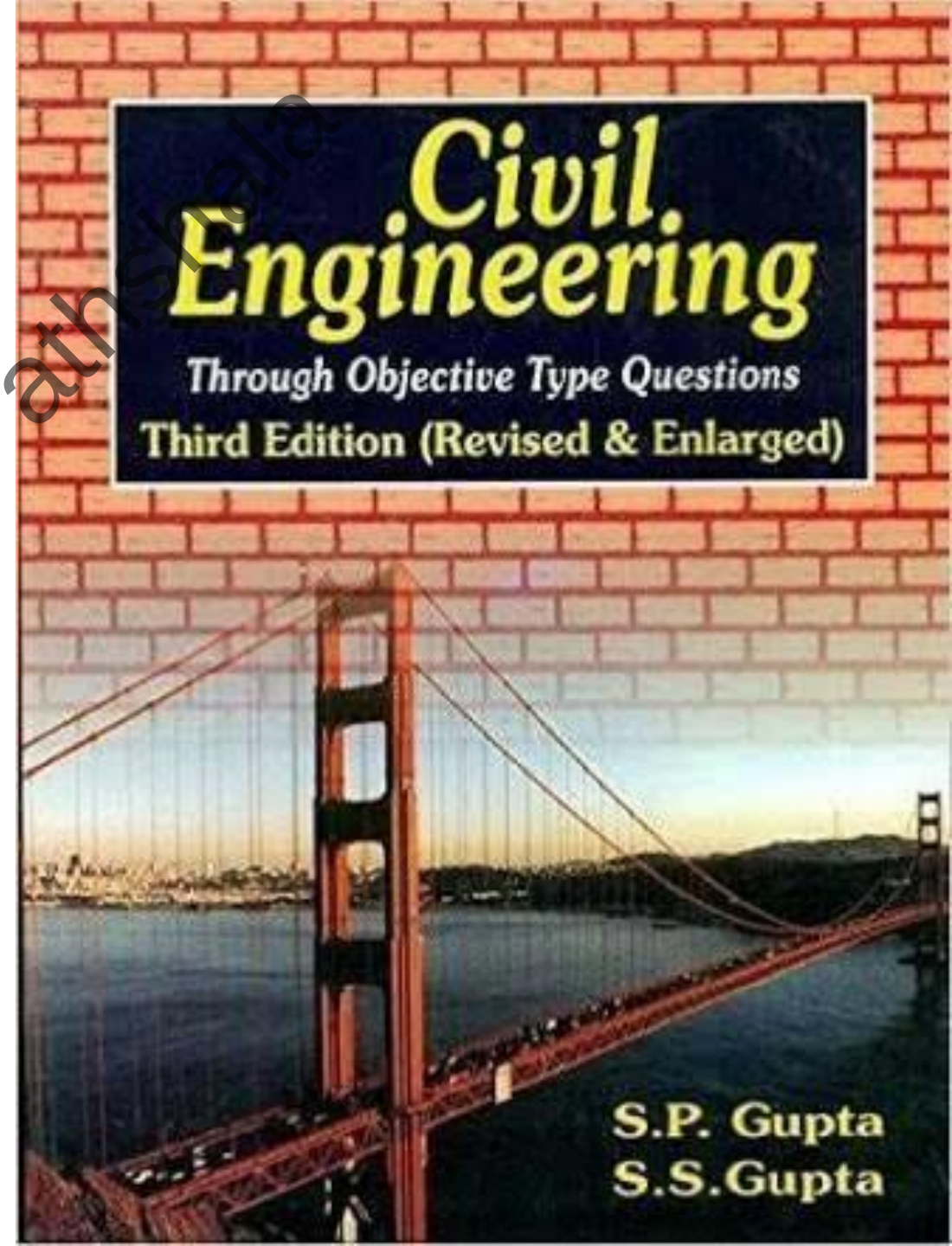
Objective Questions (76 to 90)

Highway Engineering



Q. 76) A traffic rotary is justified where

A. Number of intersecting roads is between 4 and 7
B. Space is limited and costly
C. When traffic volume is less than 500 vehicles per hour
D. When traffic volume is more than 5000 vehicles per hour

Answer A

1. As per IRC traffic volume for rotary 500 to 3000 Vehicles per hour

2. Number of intersecting roads is between 4 to 7

3. Rotary requires large area of land hence cost of its construction may be very high.

Q. 77) When a number of roads are meeting at a point and only one of the roads is important, then the suitable shape of rotary is

A. Circular
B. Tangent
C. Elliptical
D. Turbine

Answer B

Shape of Central island

a. Circular - Suitable when roads of equal importance and cross each other at right angle.

b. Elliptical – When four or more than four intersecting roads.

c. Turbine – reduce speed at entry and increase at leaving.

d. Tangent – One road is important.

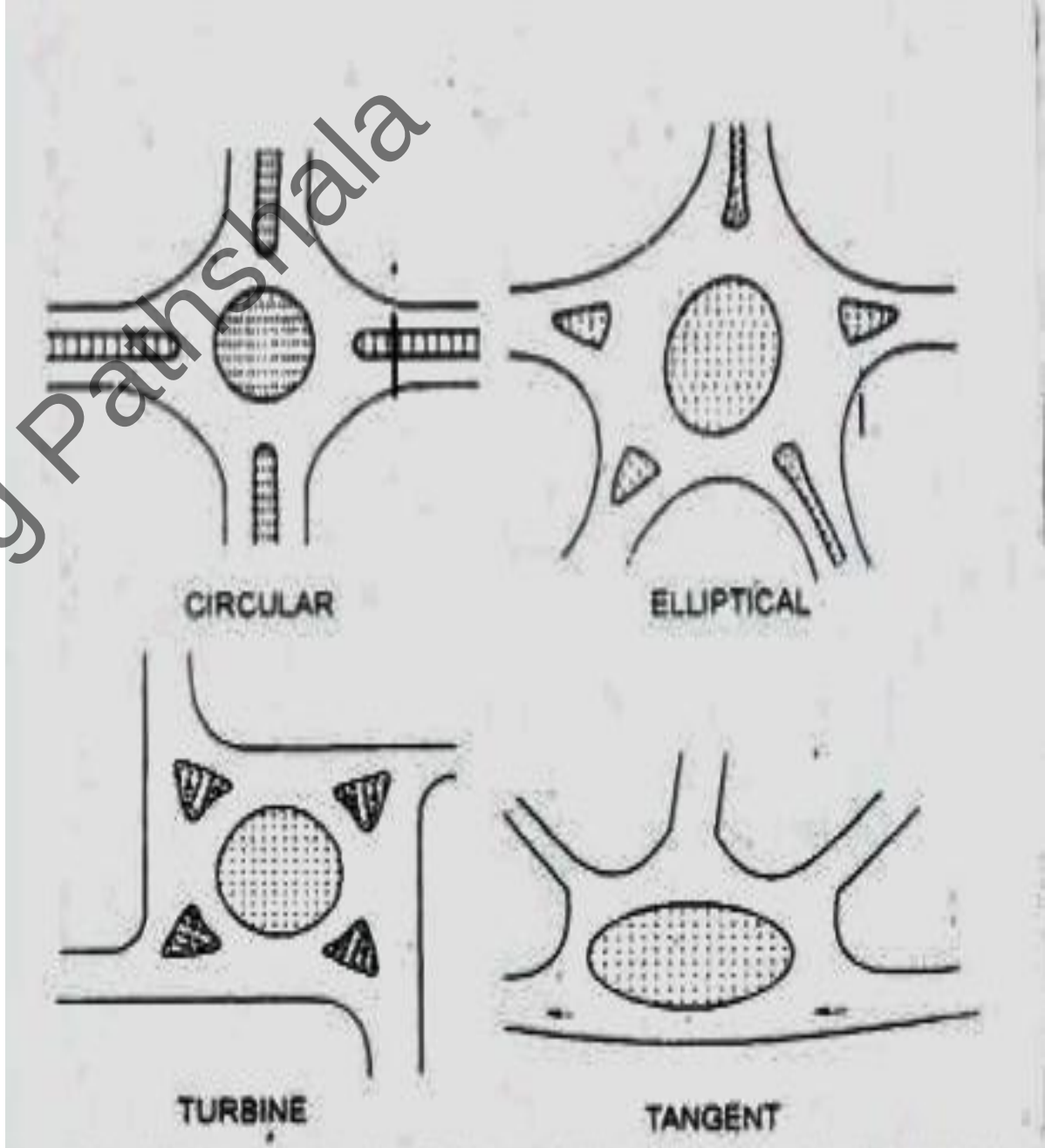


Fig. 5.36 Different shapes of rotary island and layout of intersections

Q. 78) Maximum number of vehicles can be parked with

A. Parallel parking
B. 30° angle parking
C. 45° angle parking
D. 90° angle parking

Answer D

Q. 79) When the width of kerb parking space and width of Street are Limited, generally preferred parking system is

A. Parallel parking
B. 45° angel parking
C. 65° angel parking
D. 90° angel parking

Answer A

Q. 80) As per IRC recommendations, the average level of illumination on important roads carrying fast traffic is

A. 10 lux
B. 15 lux
C. 20 lux
D. 30 lux

Answer D

Q. 81) The most economical lightning layout with the suitable for narrow roads is

A. Single side lightning
B. Staggered system
C. Central lightning system
D. None of the above

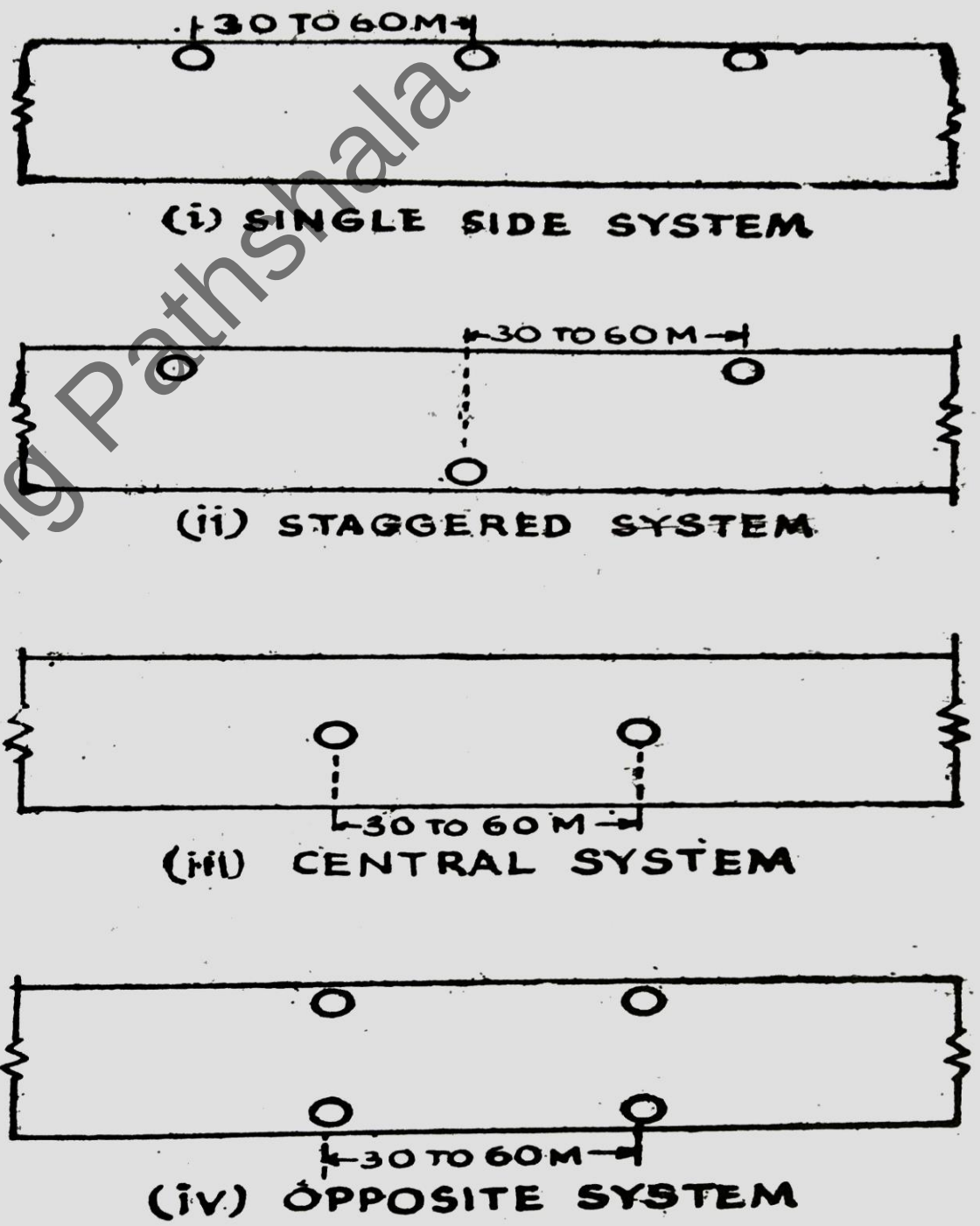
Answer A

Lighting layout
1. Single side system–
Suitable only for narrow pavements.
Spacing of poles 30m to 60m

2. Staggered system -
Wider roads with three or more lanes.
Spacing of poles 30m to 60m

3. Central system -
For three or more lanes with narrow Central strip and heavy traffic conditions

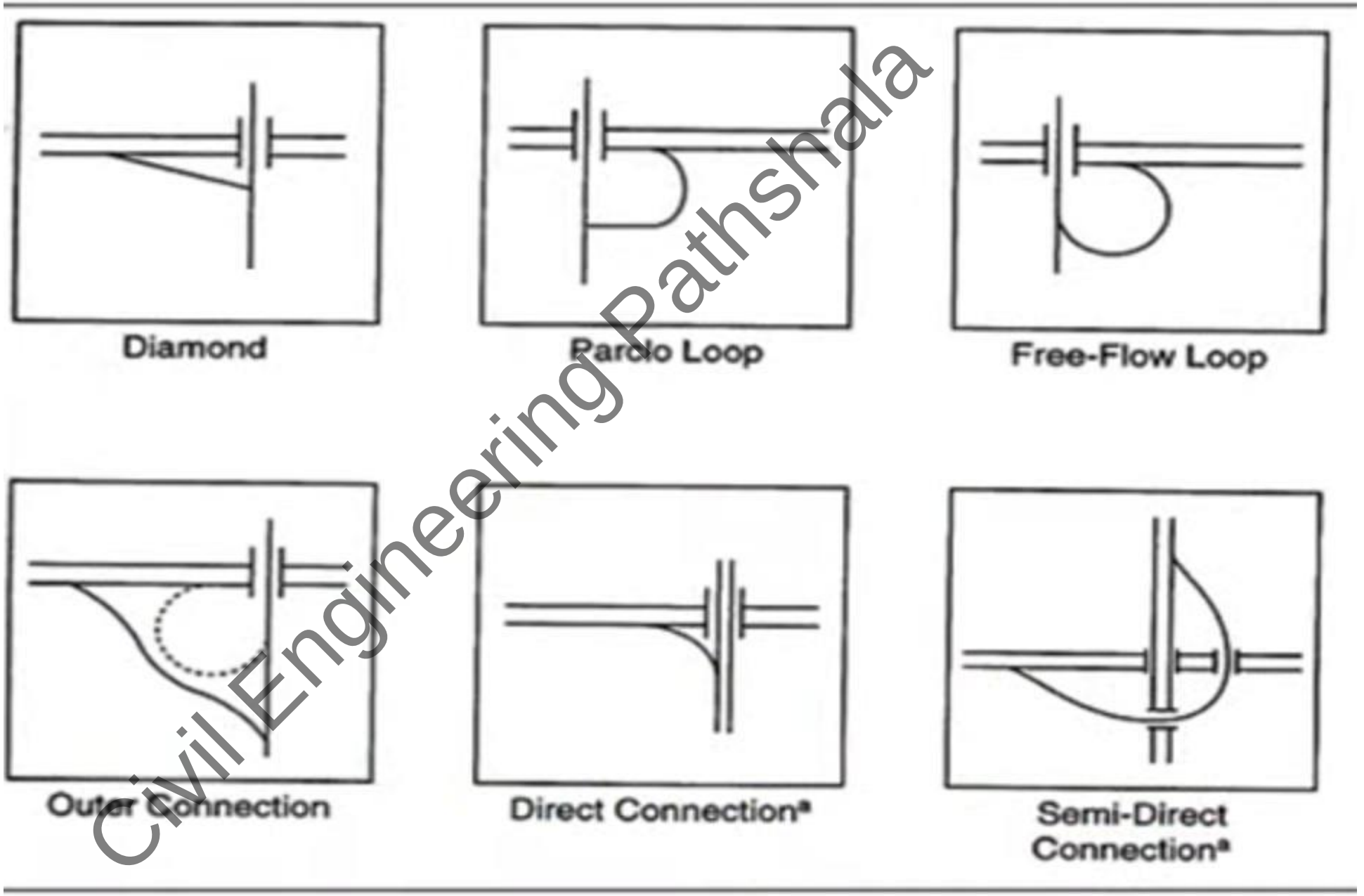
4. Opposite system -
For Wider roads depending upon situation.



Q. 82) The direct interchange ramp involves

A. Diverging to the right side and merging from left
B. Diverging to the left side and merging from right
C. Diverging to the right side and merging from right
D. Diverging to the left side and merging from left

Answer C



Q. 83) In soils having same values of plasticity index, if liquid limit is increased, then

A. Compressibility and permeability decrease and dry strength increases
B. Compressibility, permeability and dry strength decrease
C. Compressibility, permeability and dry strength increase
D. Compressibility and permeability increase and dry strength decreases

Answer D

Plasticity index = Liquid limit – Plastic limit

Q. 84) Which of the following tests measures the Toughness of road aggregates

A. Crushing strength test
B. Abrasion test
C. Impact test
D. Shape test

Answer C

A. Crushing test – Strength of coarse aggregate
Procedure
1. Aggregate specimen 10 mm to 12.5mm
2. Test cylinder filled with three layers and tamped each layer 25times (W2)
3. 4 t/m up to 40 Tonnes (CTM)
4. Weight Finer than 2.36 mm IS sieve (W2)

Aggregate crushing value = W2/W1

B. Abrasion test (By Los Angeles machine) – Hardness

C. Impact test – Toughness

D. Shape test – Flakiness index and Elongation index

Q. 85) Los Angeles testing machine is used to conduct

A. Abrasion test
B. Impact test
C. Attrition test
D. Crushing strength test

Answer A

Attrition – This is action of mutual rubbing of stones or aggregate. Tested by Abrasion test.

Q. 86) If in a Dorry abrasion test the loss in weight is 21 grams, then the coefficient of hardness is

A. 9.5
B. 13
C . 17
D. 21

Answer B

Coefficient of hardness = 20 – (Loss in gms)/3)

= 20 – (21/3)

= 20 – 7

= 13

Q. 87) In CBR test the value of CBR is calculated at

A. 2.5 mm penetration only
B. 5.0 mm penetration only
C. 7.5 mm penetration only
D. Both 2.5 mm and 5.0 mm penetrations

Answer D

- Calculate the CBR value using following formula.

$$CBR\% = \frac{Corrected\ Load\ Value}{Standard\ Load} \times 100$$

PENETRATION(MM)	TOTAL STANDARD LOAD (Kgf)	UNIT STANDARD LOAD (kg/cm2)
2.5	1370	70
5.0	2055	105

Q. 88) If aggregate impact value is 20 to 30%, then it is classified as

A. Exceptionally strong
B. Strong
C. Satisfactory for road surfacing
D. Unsuitable for road surfacing

Answer C

Procedure
1. Aggregate specimen 10 to 12.5 mm filled in three layers and tamped each layer by 25 blows (W1)
2. Sample transfer in impact test apparatus and compacted by tamping road 25 times
3. Hammer drop freely from 38 cm and give 15blows
4. Finer than 2.36 mm IS (W2)
Impact value = (W2/W1) × 100

Impact value < 10% Exceptionally strong
Impact value 10-20% Strong
Impact value 20-30% Satisfactory for road construction

For surface or wearing courses IV should not be more than 30%
For base courses allowed up to 45%

Q. 89) The maximum allowable Los Angeles abrasion value for high quality surface course is

A. 10%
B. 20%
C. 30%
D. 45%

Answer C

Abrasion value

1. CC construction < 16%
2. Bituminous (a) Surface course up to 30%
   (b) Base course up to 50%

Q.90) Percentage of free carbon in Bitumen is

A. More than that in tar
B. Less than that is tar
C. Equal to that in tar
D. None of the above

Answer B

Bitumen is obtained by fractional distillation of crude petroleum (in the presence of air).
It have less free carbon content

Tar is a viscous black liquid which is derived through the process of destructive distillation of crude petroleum (in the absence of air).
It have more free carbon

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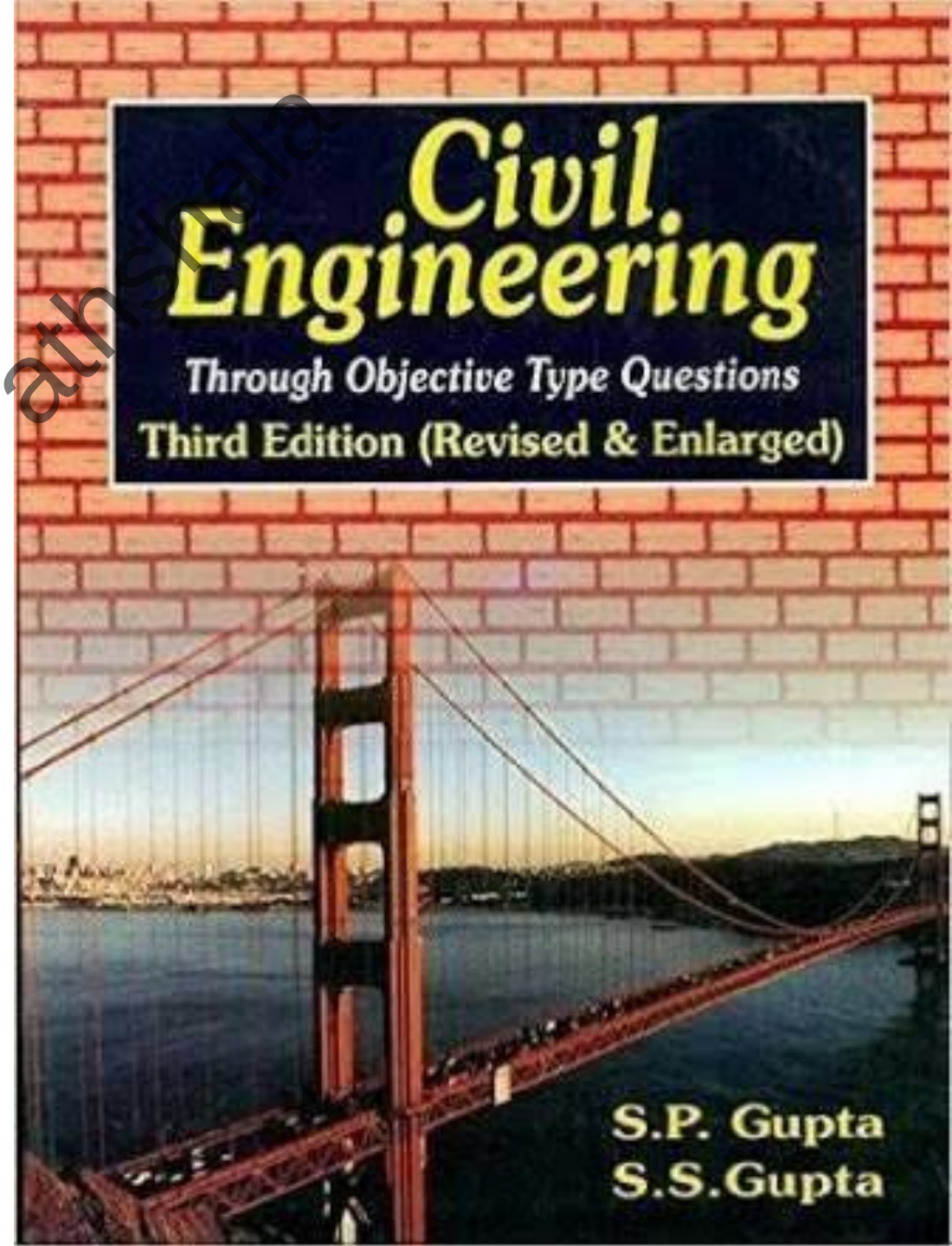
Objective Questions (91 to 105)

Highway Engineering



Q. 91) The ductility value of bitumen for suitability in road construction should not be less than

A. 30 cm
B. 40 cm
C. 50 cm
D. 60 cm

Answer C

Ductility is a measure of elasticity of bitumen. It is expressed as the distance in centimetre to which standard briquette of bitumen can be stretched before the thread breaks

The ductility of bitumen 5 to 100 cm
For satisfactory performance should not be less than 50 cm

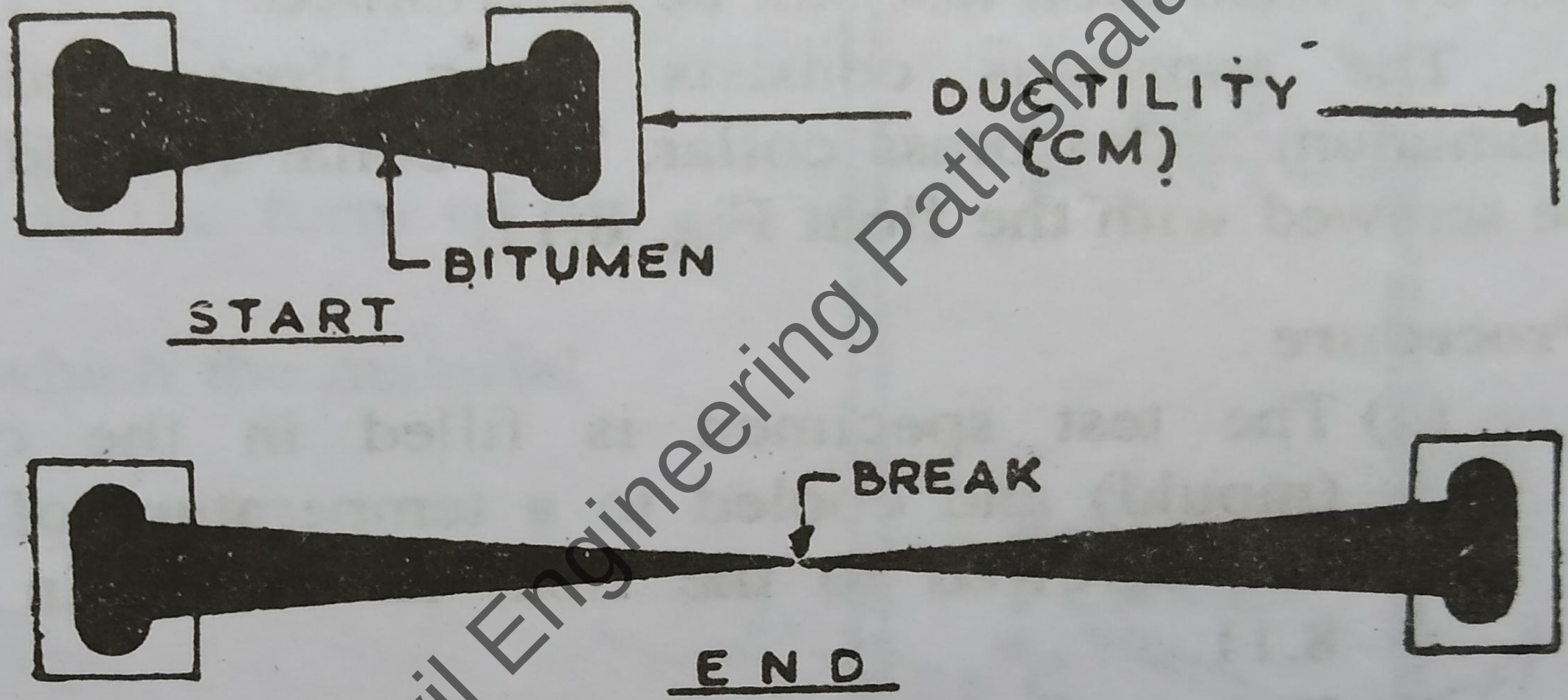


Fig. 8.9. Ductility test

Q. 92) The maximum limit of water absorption for aggregate suitable for road construction is

A. 0.4%
B. 0.6%
C. 0.8%
D. 1.0%

Answer B

As per IRC Water absorption shall not be more than 0.6%.

Q. 93) Which of the following represents hardest grade of bitumen

A. 30/40
B. 60/70
C. 80/100
D. 100/120

Answer A

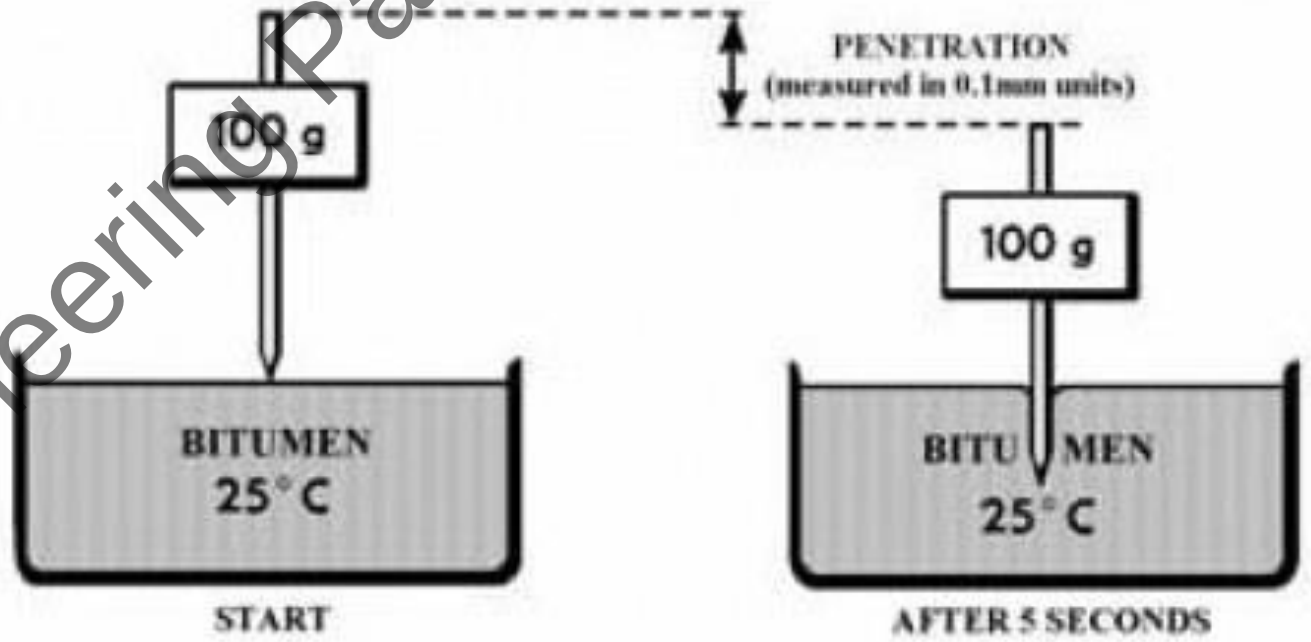
Penetration test: -

It measures the **hardness or softness** of bitumen by measuring the depth in tenths of a millimeter to which a standard loaded needle will penetrate vertically in 5 seconds.

The penetrometer consists of a needle assembly with a total weight of 100gm

A grade of 40/50 bitumen means the penetration value is in the range 40 to 50 at standard test conditions.

In hot climates, a lower penetration grade is preferred.



Q. 94) Penetration test on bitumen is used for determining its

A. Grade
B. Viscosity
C. Ductility
D. Temperature susceptibility

Answer A

Q. 95) Bitumen of grade 80/100 means

A. Its penetration value is 8 mm
B. Its penetration value is 10 mm
C. Its penetration value is 8 to 10 mm
D. Its penetration value is 8 to 10 cm

Answer C

It measures the hardness or softness of bitumen by measuring the depth in **tenths of a millimeter** to which a standard loaded needle will penetrate vertically in 5 seconds.

Q. 96) RC-2, MC-2 and SC-2 correspond to

A. Same viscosity
B. Viscosity in increasing order from RC-2 to SC-2
C. Viscosity in decreasing order from RC-2 to SC-2
D. None of the above

Answer A

Normal practice is to heat bitumen to reduce its viscosity.
Cut Back Bitumen: - Whose viscosity has been reduced by addition of some volatile dilutent.
-Cut back mix and volatile matter evaporates.
Types of cutback bitumen
1. Rapid curing cut back (RC) – Evaporate quickly
2. Medium curing cut back (MC) - slowly
3. Slow curing cut back (SC) – very slowly

The grade of cut back designated by RC-0, MC-0, SC-0.
Suffix numericals as 0,1,2,3 etc designate more viscous as the number increases.

Q. 97) The recommended grade of tar for grouting purpose is

A. RT-1
B. RT-2
C. RT-3
D. RT-4

Answer D

Grouting - injection of pumpable materials into a soil or rock formation to change its physical characteristics

Tar: - it is viscous liquid obtained by the destructive distillation of wood or coal in absence of air.

Grade of Tar
RT-1 used for surface painting in exceptionally cold weather.
RT-2 standard surface painting under normal conditions.
RT-3 can be used for surface painting, renewal coats for light carpets and premix chips for top surface.
RT-4 used for premixing macadam in base courses.
RT-5 used for grouting purposes.

Q. 98) Softening point of bitumen to be used for road construction at a place where maximum temperature is 40°C should be

A. Less than 40°C
B. Greater than 40°C
C. Equal to 40°C
D. None of the above

Answer B

Softening point is defined as the temperature at which a substance attains a particular degree of softening under specified conditions of test.

Q. 99) For Rapid curing cutbacks, the oil used is

A. Gasoline
B. Kerosene oil
C. Light diesel
D. Heavy diesel

Answer A

Kerosene oil - Mediun curing cut back

Q. 100) The method of design of flexible pavement as recommended by IRC is

A. Group index method
B. CBR method
C. Westergaard method
D. Benkelman method

Answer B

Q. 101) The group index for a soil, whose liquid limit is 40%, plasticity index is 10% and percentage passing 75 Micron IS sieve is 35, is

A. 0
B. 3
C. 5
D. 7

Answer A

$$GI = 0.2a + 0.005\,a.c. + 0.01b.d$$

where,

a= p – 35 (p = percentage of soil finer than 0.075 mm or 75micron)

b= p – 15

c= LL - 40

d= PI - 10

$$GI = 0.2a + 0.005\ a.c. + 0.01b.d$$

$$GI = 0.2 \times (35\text{-}35) + 0.005 \times (35\text{-}35) \times (40\text{-}40) + 0.01\ (35\text{-}15) \times (10\text{-}10)$$

$$GI = 0$$

Greater the value of group index poor will be the quality of soil.

0 – 2	*Good*
2 – 5	*Fair*
5 – 10	Poor
10 – 20	Very poor

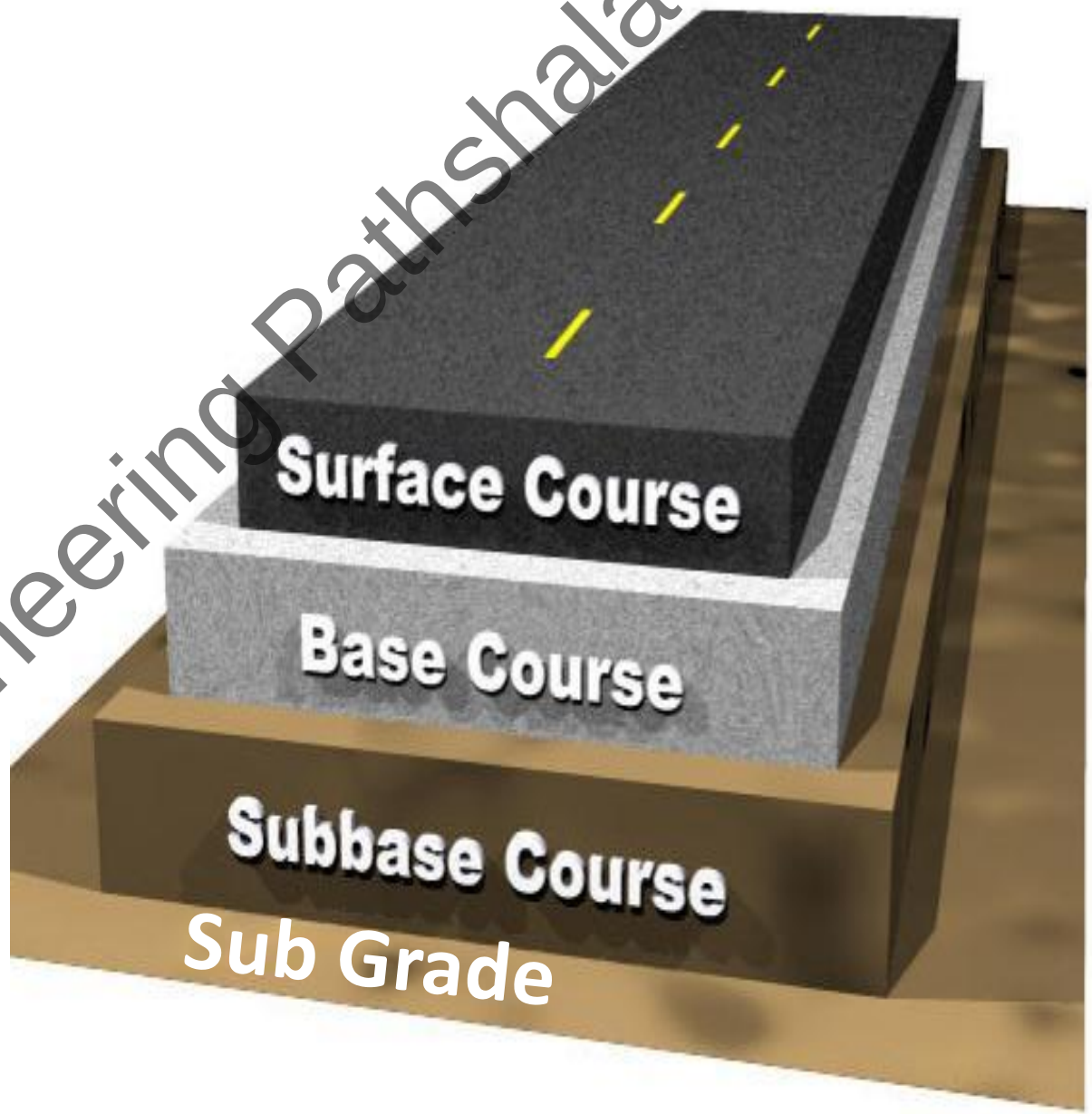
Q. 102) Bottom most layer of pavement is known as

A. Wearing course
B. Base course
C. Sub-base course
D. Subgrade

Answer D

Flexible pavement
1. Sub grade
2. Sub base course
3. Base course
4. Surface course

Rigid pavement
1. Sub Grade
2. Base course
3. Surface course



Q. 103) Flexible pavement distribute the wheel load

A. Directly to subgrade
B. Through structural action
C. Through a set of layers to the subgrade
D. None of the above

Answer C

Flexible pavements will transmit wheel load stresses to the lower layers by grain-to-grain.

Rigid pavement, load is distributed by the slab action and directly to the sub grade.

Q. 104) The number of repetitions, which the pavement thickness designed for a given wheel load should be able to support during the life of pavement is

A. 1,000
B. 10000
C. 100000
D. 1000000

Answer D

Q. 105) Group index mthod of design of flexible pavement is

A. A theoretical method
B. An empirical method based on physical properties of subgrade soil
C. An empirical method based on strength characteristics of subgrade soil
D. A Semi empirical method

Answer B

Group Index method of flexible pavement design is an empirical method which is based on the physical properties of the soil sub-grade.

To design the thickness of the pavement you have to go through the following steps:

1.Find out the Group Index Value(GI) of the soil: -
Group Index is a number assigned to the soil based on its physical properties like particle size, Liquid limit and plastic limit.
It varies from a value of 0 to 20, lower the value higher is the quality of the sub-grade and greater the value, poor is the sub-grade.

$$GI = 0.2a + 0.005\,a.c. + 0.01b.d$$

2. Use the design charts to find out the thickness of the pavement and layers.

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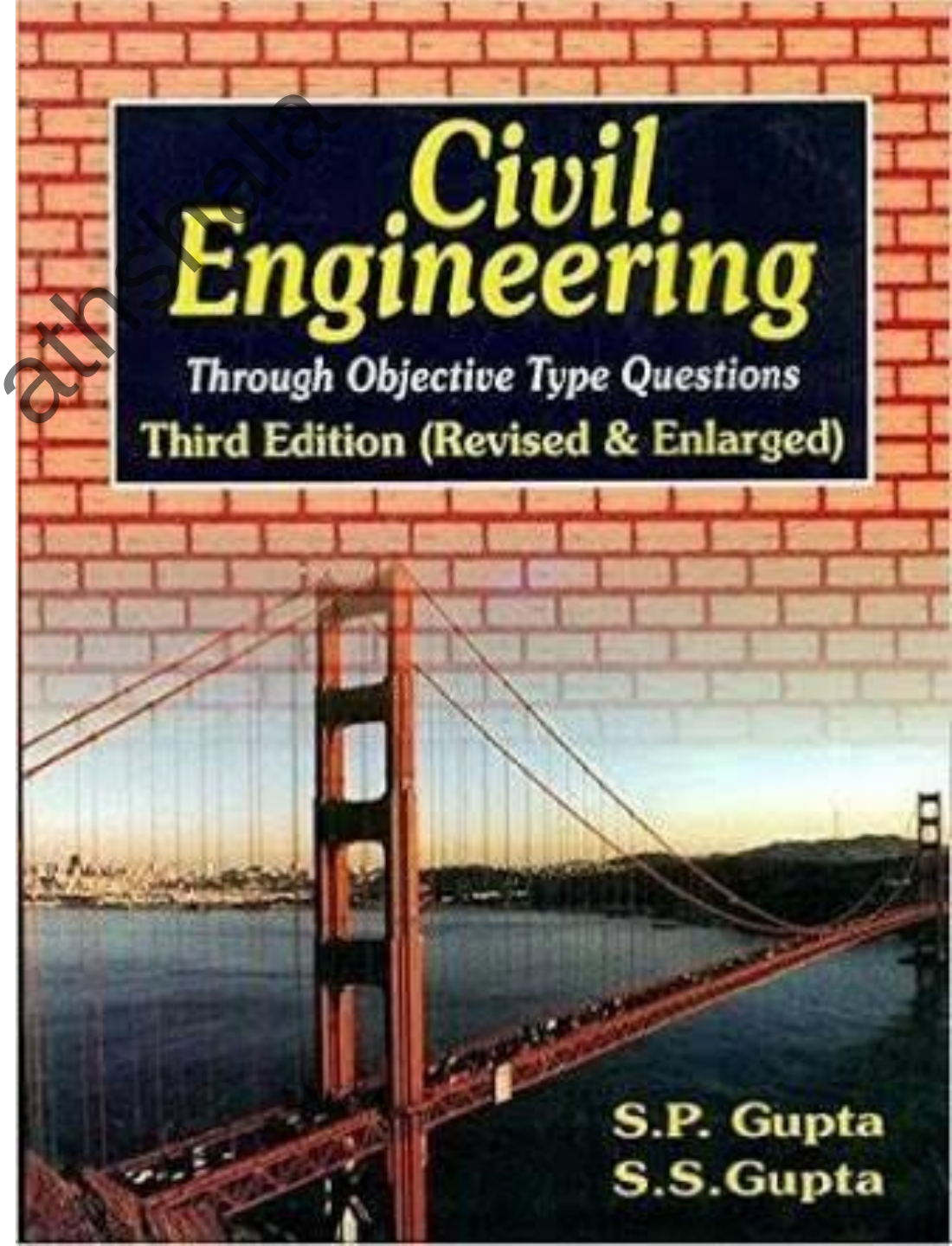
Objective Questions (106 to 120)

Highway Engineering



Q. 106) Select the correct statement

A. More value of group index, less thickness of pavement will be required
B. More value of CBR, greater thickness of pavement will be required
C. Minimum and maximum values of group index can be zero and 20 respectively
D. All of the above

Answer C

Greater the value of group index poor will be the quality of soil.
GI is between 0 to 20.

Good (0 – 2)
Fair (2 – 5)
Poor (5 – 10)
Very poor (10 – 20)

Q. 107) If the group index value of subgrade is between 5 and 9, then the subgrade is treated is

A. Good
B. Fair
C. Poor
D. Very poor

Answer C

Q. 108) Tyre pressure influences the

A. Total depth of pavement
B. Quality of surface course
C. Both of the above
D. None of the above

Answer B

-Influence of tyre pressure is Predominant in the upper layers.

-Upper layers of pavements should be of high quality materials.

-Tyre pressure does not affect total depth(thickness) of the pavements.

-Distribution of wheel load is assumed on a circular area, but by actual measurement of the imprint of tyre in many cases has been found as elliptical in shape.

Q. 109) Rigidity factor for tyre pressure greater than 7 kg/cm^2

A. Equal to 1
B. Less than 1
C. Greater than 1
D. Zero

Answer B

Contact pressure = Wheel load / Contact area

Contact area = (0.9 × Wheel load) / Tyre pressure

The contact area can also be found by taking actual impression of the tyre imprint.

Rigidity factor = Contact pressure / Tyre pressure

When tyre pressure = 7 kg/cm² RF = 1

When tyre pressure < 7 kg/cm² RF > 1

When tyre pressure > 7 kg/cm² RF < 1

Q. 110) In a dual wheel assembly if P is equal to each wheel load, S is the centre to centre distance of dual wheels and d is the distance between walls of wheels, then

A. Each wheel load acts independently upto a depth d
B. Total stress due to the dual wheels at any depth greater than 2S is equivalent to a single wheel load of magnitude 2P
C. Total stress due to the total dual wheels at any depth greater than S is equivalent to a single wheel load of magnitude 2P
D. Total stress due to the dual wheels at any depth greater than 2D is equivalent to a single wheel load of magnitude 2P

Answer B

Wheels act independently at depth approximately d/2

Beyond d/2 the stresses induced in the pavement result from each wheel load are overlap.

As depth increase the overlap of stresses also increases, but after a certain limit, the overlap is negligible.

By experiments observed that this limit starts at a depth of about twice the center to center distance (2S) between the wheels and the equivalent single wheel load is equal to the load on whole assembly that is 2P.

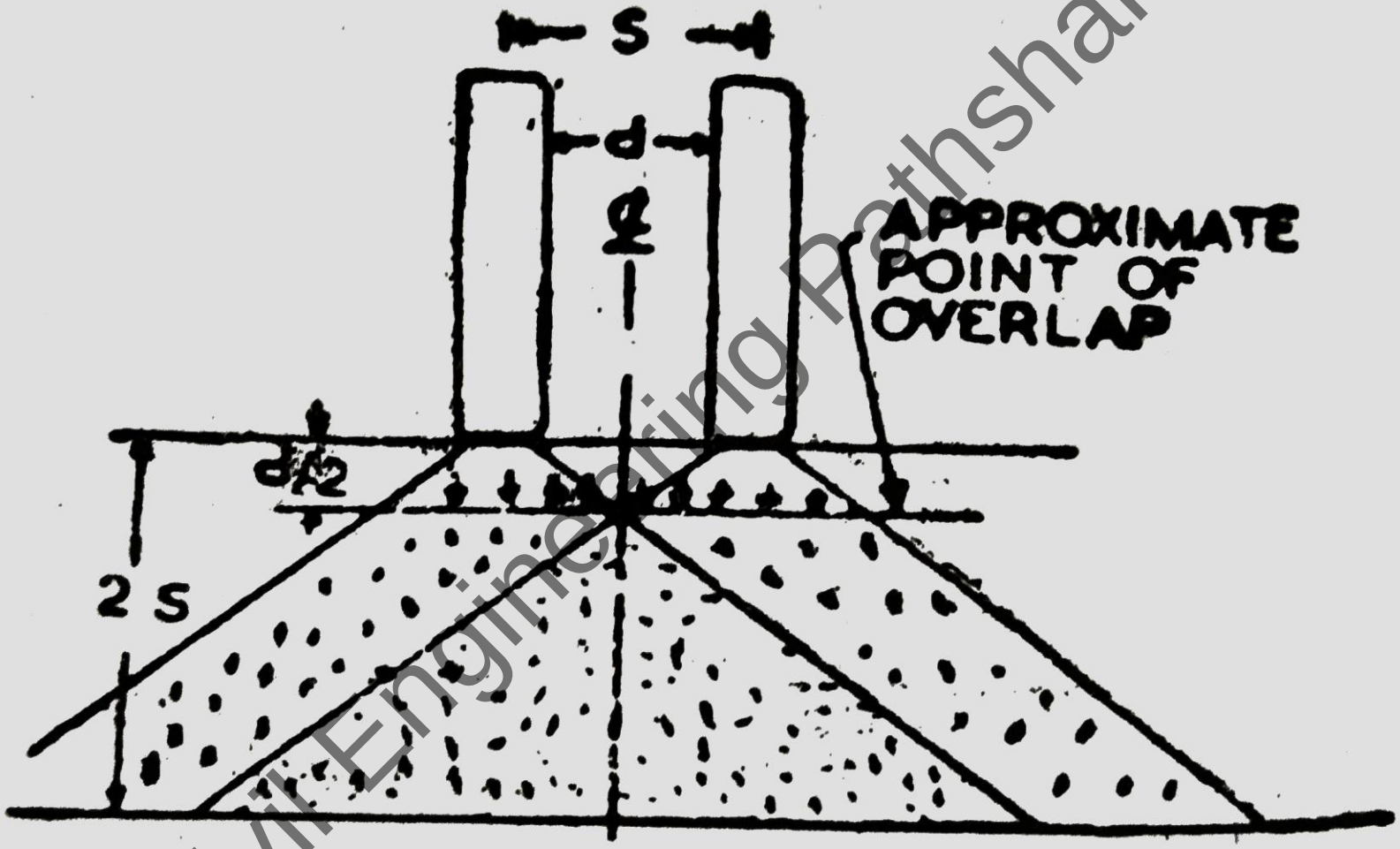


Fig. 16.3. Stress overlap due to dual wheels

Q. 111) Main drawback of CBR method is that it

A. Does not consider the strength characteristics of subgrade soil
B. Is a complex method
C. Give the total thickness which remains the same irrespective of the quality of materials used in the component layers.
D. Does not give the thickness of individual layers

Answer C

112. Radius of relative stiffness in cm is given by

a) $\left[\frac{Eh^3}{12(1-\mu)K}\right]^{1/4}$

b) $\left[\frac{Eh^3}{12(1-\mu^2)}\right]^{1/4}$

c) $\left[\frac{Eh^3}{12(1-\mu^2)K}\right]^{1/3}$

d) $\left[\frac{Eh^3}{12(1-\mu^2)K}\right]^{1/4}$

where, E = modulus of elasticity of cement concrete, kg/cm^2

μ = Poisson's ratio for concrete

h = slab thickness, cm

k = subgrade modulus, kg/cm^3

Answer D

A certain degree of resistance to slab deflection is offered by the sub-grade.

The sub-grade deformation is same as the slab deflection.

Hence the slab deflection is direct measurement of the magnitude of the sub-grade pressure.

This pressure deformation characteristics of rigid pavement lead Westergaard to the define the term radius of relative stiffness.

Q. 113) Critical load position in a rigid pavement design is taken as

A. Interiors loading
B. Edge loading
C. Corner loading
D. Interior, edge and corner loading

Answer D

16.18. WESTERGAARD'S STRESS EQUATION FOR WHEEL LOADS

For wheel loads, stress developed at three critical locations can be found below—

(*a*) Interior loading $$Si = \frac{0.316P}{h^2}\left[4\log_{10}\left(\frac{L}{b} + 1.069\right)\right]$$

(*b*) For Edge loading $$Se = \frac{0.572P}{h^2}\left[4\log_{10}\left(\frac{L}{b} + 0.359\right)\right]$$

(*c*) For Corner loading $$Sc = \frac{3P}{h^2}\left[1 - \left(\frac{a\sqrt{2}}{L}\right)^{0.6}\right]$$

*114. If the radius of wheel load distribution is 30 cm and slab thickness is 15 cm, then the equivalent radius of resisting section is

a) $\left(\sqrt{1.6\times(30)^2+15^2}-0.675\times15\right)$cm

b) $\left(\sqrt{1.6\times(30)^2+15^2}+0.675\times15\right)$cm

c) 30 cm

d) none of the above

Answer C

Radius of wheel load 30 > 1.724 × 15

Because the radius of wheel load distribution is more than 1.724 times slab thickness, hence radius of resisting section is equal to the radius of wheel load distribution.

(ii) $$b = \sqrt{1.6a^2 + h^2} - 0.675\,h$$

where,

b = equivalent radius of resisting section in cms. when a is less than $1.724\,h$.

a = radius of wheel load distribution in cms.

h = slab thickness in cms.

Q. 115) The critical combination of stresses for corner region in cement concrete roads is

A. Load stress + warping stress – fictional stress
B. Load stress + warping stress + frictional stress
C. Load stress + warping stress
D. Load stress + frictional stress

Answer C

Temperature stresses:- developed in CC pavement due to variation in slab temp.

This is caused by

(i) Daily variation resulting in a temperature gradient across the thickness of the slab is known as warping stresses

(ii) Seasonal variation resulting in overall change in the slab temperature is known as frictional stresses.

At interior and edge

1. During Summer → Load stress + warping stress – frictional stress
2. During Winter → Load stress + warping stress + frictional stress

At corner → Load stress + warping stress

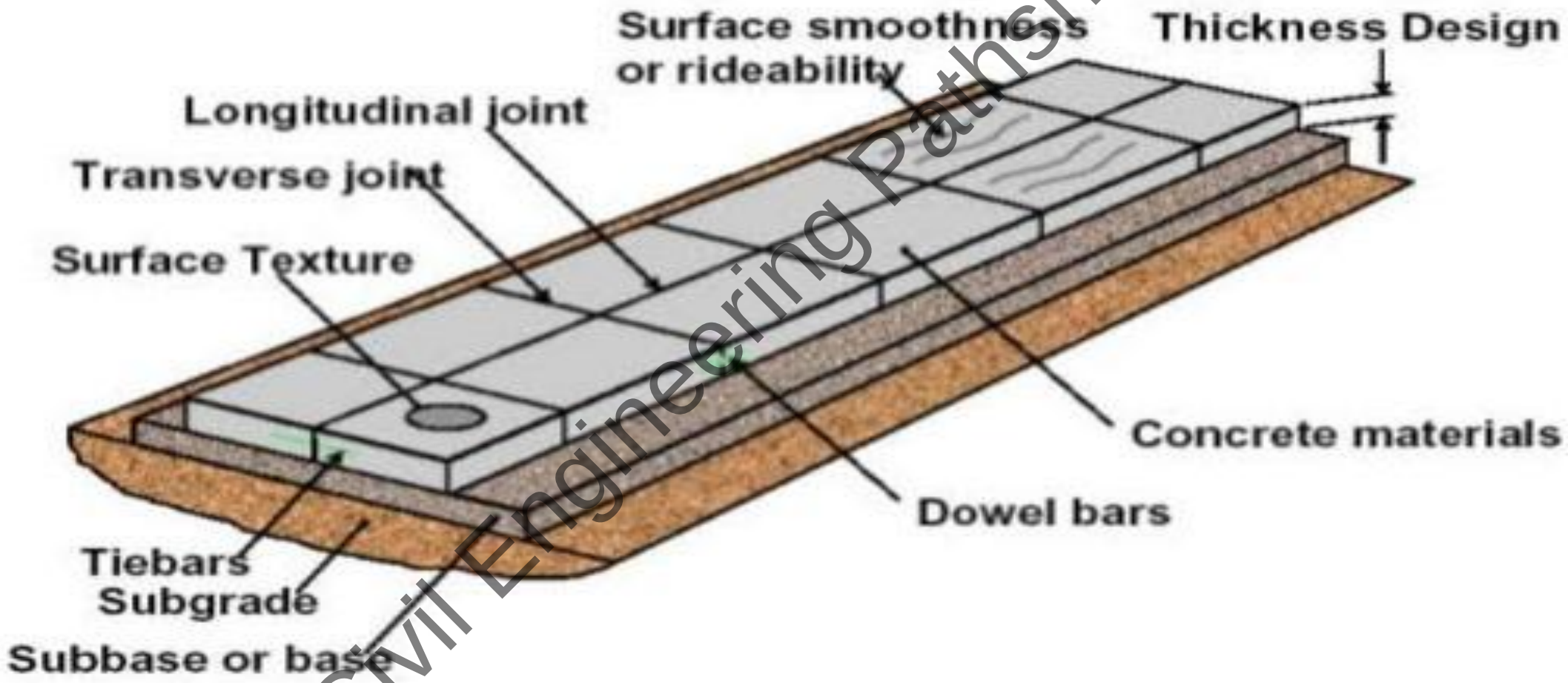
Q. 116) Tie bars in cement concrete pavements are at

A. Expansion joints
B. Contraction joints
C. Warping joints
D. Longitudinal joints

Answer D

1. Transverse joints
(a) Construction joints(b) Expansion joints(c) Contraction joints
(d) Warping joints
2. Longitudinal joints or tie bars

Tie bars- tie bars are not load transfer devices, but serve as a means to tie two slabs
They are smaller than dowel bars and placed at large intervals.
They are provided across longitudinal joints.



Dowel bars - The purpose of the dowel bar is to effectively transfer the load between two concrete slabs and to keep the two slabs in same height

The dowel bars are used in Contraction and Expansion joints.

The design consideration are:-

1. Mild steel rounded bars,
2. bonded on one side and free on other side

Q. 117) The maximum spacing of contraction joints in rigid pavement is

A. 2.5 m
B. 3.5 m
C. 4.5 m
D. 5.5 m

Answer C

Contraction joints

The purpose of the contraction joint is to allow the contraction of the slab due to fall in slab temperature below the construction temperature.

Maximum spacing of 4.5 m as per IRC

Q. 118) The maximum thickness of expansion joint in rigid pavements is

A. 0
B. 25 mm
C. 50 mm
D. 100 mm

Answer B

Expansion joints

The purpose of the expansion joint is to allow the expansion of the pavement due to rise in temperature with respect to construction temperature.

Expansion joint thickness 2 to 2.5 cm specified by IRC

Provided at interval of 18 m to 21 m

Q. 119) The function of an expansion joint in rigid pavements is to

A. Relieve warping stresses
B. Relieve shrinkage stresses
C. Resist stresses due to expansion
D. Allow free expansion

Answer D

Q. 120) A traffic survey revealed the present average daily traffic of commercial vehicles as 1000. The annual rate of growth of traffic is found to be 8 percent. The pavement construction is to be completed in three years after the last traffic count. Then the number of vehicles for design of rigid pavements will be taken as

A. $1000(1.08)^{13}$
B. $1000(1.08)^{23}$
C. $1000(0.92)^{13}$
D. $1000(1.08)^{3}$

Answer D

No. of Vehicles for design of pavement

$$A = P\left(1 + \frac{r}{100}\right)^{x}$$

Where,

P = no. of commercial vehicle per day or initial traffic volume

x = Construction Period

r = Growth rate

$$A = 1000\left(1 + \frac{8}{100}\right)^{3}$$

$$A = 1000\,(1.08)^{3}$$

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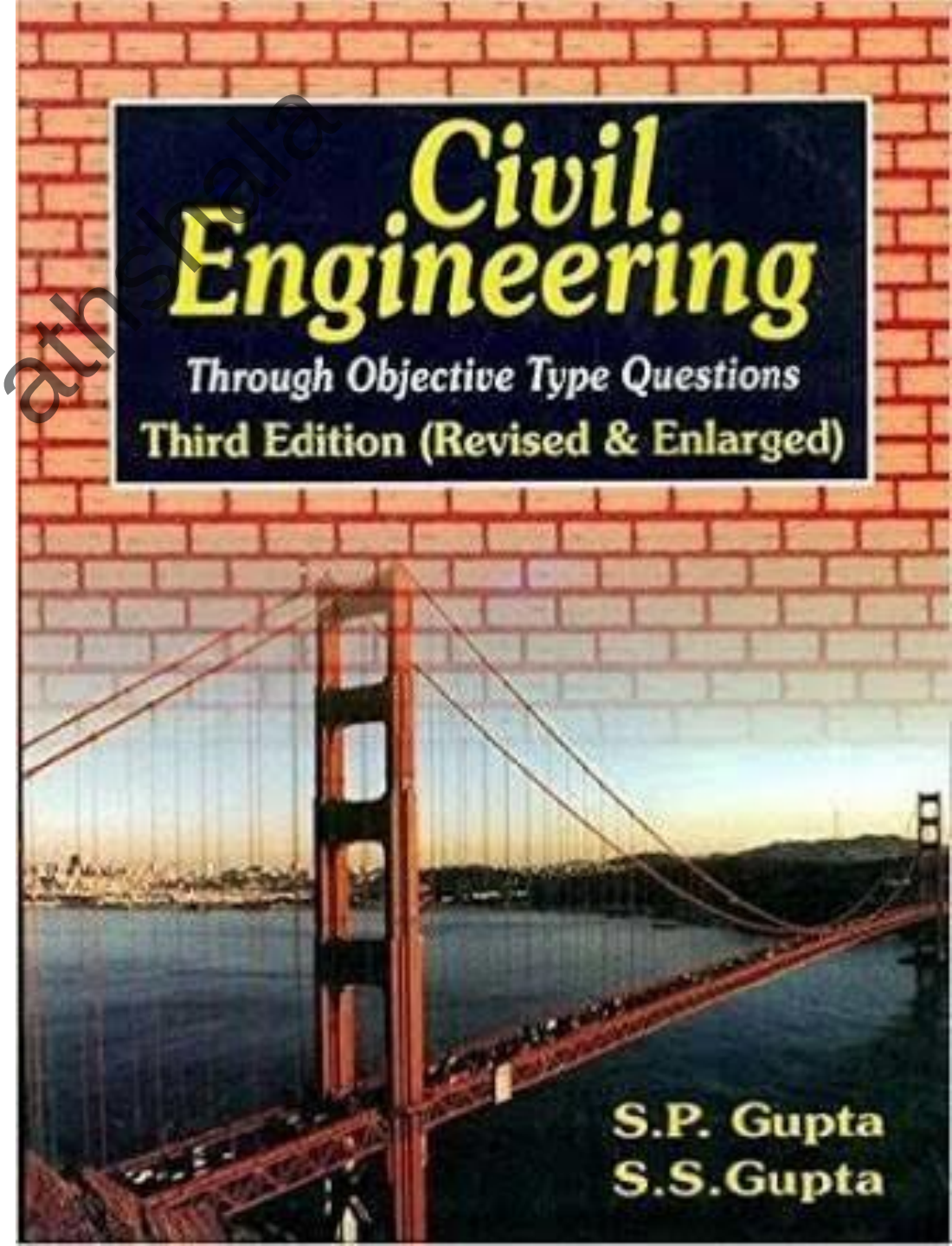
Objective Questions
(121 to 135)

Highway Engineering



Q. 121) The fundamental factor is the selection of pavement type is

A. Climatic condition
B. Type and intensity of traffic
C. Subgrade soil and Drainage conditions
D. Availability of funds for the construction construction project

Answer B

Selection of type of pavement:- the most important factors is the traffic volume or intensity.

-If traffic intensity is 30 to 200 tonnes per day then low cost road, i.e. Earth and soil stabilized road used.

-If traffic intensity up to 500 tonnes per day for WBM

-Bituminous road upto 1500 tonnes per day

-Cemenet concrete road over 2000 tonnes per day

Q. 122) Most suitable material for Highway embankments is

A. Granular soil
B. Organic soil
C. Silts
D. Clays

Answer A

Raising the grade of a roadway (or railway) above the level of the existing surrounding ground surface is known as **embankment.**

For highway embankments, generally granular soil are preferred, clay and silt is less desirable while organic soils are unsuitable.

Granular soil means gravel, sand, or silt (coarse grained soil) with little or no clay content.

For economic considerations generally best locally available soil should be used.

Q. 123) Maximum daily traffic capacity of bituminous pavements is

A. 500 tonnes per day
B. 1000 tonnes per day
C. 1500 tonnes per day
D. 2000 tonnes per day

Answer C

Q. 124) The most suitable equipment for compacting clayey soils is a

A. Smooth wheeled roller
B. Pneumatic tyred roller
C. Sheep foot roller
D. Vibrator

Answer C

A. Smooth wheeled roller

B. Pneumatic tyred roller

C. Sheep foot roller

Q. 125) The aggregates required for one kilometre length of water bound macadam road per metre width and for 10 mm thickness is

A. 8 cubic metre
B. 10 cubic metre
C. 12 cubic metre
D. 15 cubic metre

Answer C

Quantity of aggregate = Area × Thickness

$$= (1000 \times 1) \times (1/1000)$$

$$= 10\ m^3$$

20% extra broken stones on volume basis are recommended

Total quantity of aggregate = 1.2 × 10

$$= 12\ m^3$$

126) The camber of shoulders in water bound macadam roads is

A. Equal to the cross slope of pavement
B. Less than the cross slope of pavement
C. Greater than the cross slope of pavement
D. Zero

Answer A

The term macadam in the present time means the road surfaces and bases constructed of crushed or broken aggregates cemented together by the action of rolling and water.

Camber for pavement and shoulder is 1 in 36 to 1 in 48

Q. 127) The Binder normally used in flexible pavement construction is

A. Cement
B. Lime
C. Bitumen
D. None of the above

Answer C

Q. 128) In highway construction, rolling starts from

A. Sides and proceed to centre
B. Centre and proceed to sides
C. One side and proceed to Other Side
D. Any of the above

Answer A

Rolling is started from edges toward the centre. When half surface is rolled, then rolling again is started from the other edge.

Q. 129) For the construction of water bound macadam roads, the correct sequence of operations after spreading coarse aggregate is

A. Dry rolling, wet rolling, application of screening and application of filler
B. Dry rolling, application of filler, wet rolling and application of screening
C. Dry rolling, application of screening, wet rolling and application of Filler
D. Dry rolling, application of screening, application of filler and wet rolling

Answer C

Construction procedure of macadam road

1. Preparation of subgrade
The site is cleared and weak spot corrected and rolled.

2. Pavement construction
Coarse aggregate is Spread on the prepared surface of subgrade

3. Dry rolling
After spreading the coarse aggregate, the rolling is done.

4. Application of screenings

Screening is generally used to fill about 50% of total voids and rest 50% voids are filled with filler materials.

5. Wet rolling

After the spreading the screenings, the surface of the layer is sprinkled with water and rolled again.

6. Application of filler

After the application of the filler, water is sprinkled on the surface and slurry is allowed to fill the voids.

7. Surface finishing

Q. 130) The penetration macadam construction, the bitumen is

A. Sprayed after the aggregates and spread and compacted
B. Premixed with aggregates and then spread
C. Sprayed before the aggregates are spread and compacted
D. None of the above

Answer A

Grouted or Penetration macadam:- In water bound macadam (WBM) the strength is developed due to mechanical interlocking and bond due to soil binder. The stresses induced due to heavy mixed traffic destroys these surface very soon. Thus in order to increase the stability of such road, bitumen is used as a binder.

-Bitumen is spread over the compacted aggregate surface.
-Bitumen penetrates into voids from the surface, filling up a part of voids and binding the aggregate together.
1. Semi grouted - When bitumen penetrates up to half of the thickness of the road
2. Full grouted – Bitumen penetrates upto full depth

Q. 131) When the bituminous surfacing is done on already existing black top Road or over existing cement concrete Road, the type of treatment to be given is

A. Seal coat
B. Tack coat
C. Prime coat
D. Spray of emulsion

Answer B

1. Prime coat: - It is recommended when the first coat of bituminous surfacing is done on an existing previous texture base such as WBM Road.
2. Tack coat: - It is usually recommended when the bituminous surfacing is done over an existing cement concrete top or already existing black top surface road.
3. Seal coat: - it is usually recommended as a final coat over certain pervious bitumen the pavements.

Main function of seal coat

1. To develop the skid resistance.
2. To make the surface water proof.
3. To increase the life of the surface.

Q. 132) Which of the following premix methods is used for base course

A. Bituminous carpet
B. Mastic asphalt
C. Sheet asphalt
D. Bituminous bound macadam

Answer D

Premix method:- The aggregate and binder is mixed prior to placing and spreading over the desired surface.

1. Bitumen bound macadam: -

Binder and aggregate are mixed prior to placement.

In hilly region, the WBM have been found more resistant to frost action than normal base courses.

In regions of high water table, the WBM offers an impervious cut off.

2. Bituminous carpet: -

It is construction is usually recommended for surface course layer only.

Premix prepared from 10 to 12 mm size chhipings with sand and bitumen.

Q. 133) Select the correct statement

A. Quantity of Binder required for tack coat is less than that required for prime coat
B. Prime coat treatment is given for plugging the voids in water bound macadam during bituminous road construction
C. Seal coat is the final coat over certain pervious bituminous pavements
D. A bitumen primer is a high viscosity cutback

Answer D

Bitumen Primer is a locally manufactured bitumen solution suitable for sealing and priming porous and non-porous surfaces.

Used on concrete, metal and timber surfaces.

Q. 134) The suitable surfacing material for a bridge deck slab is

A. Sheet asphalt
B. Bituminous carpet
C. Mastic asphalt
D. Rolled asphalt

Answer C

Mastic asphalt on bridges as protection, decking (deck is the surface of a bridge) and finishing layers.

Mastic asphalt is an ideal construction material for absorbing dynamic stresses that occur on bridges.

Q. 135) Which of the following is considered to be the highest quality construction in the group of Black top pavements

A. Mastic asphalt
B. Sheet asphalt
C. Bituminous carpet
D. Bituminous concrete

Answer D

Bituminous concrete: -

Bituminous concrete premix pavement surface construction is the best and used for heavier and mixed traffic

Coarse and fine aggregates are used along with bitumen to give dense mass.

Tickness depends on the traffic intensity and the quality of the base course.

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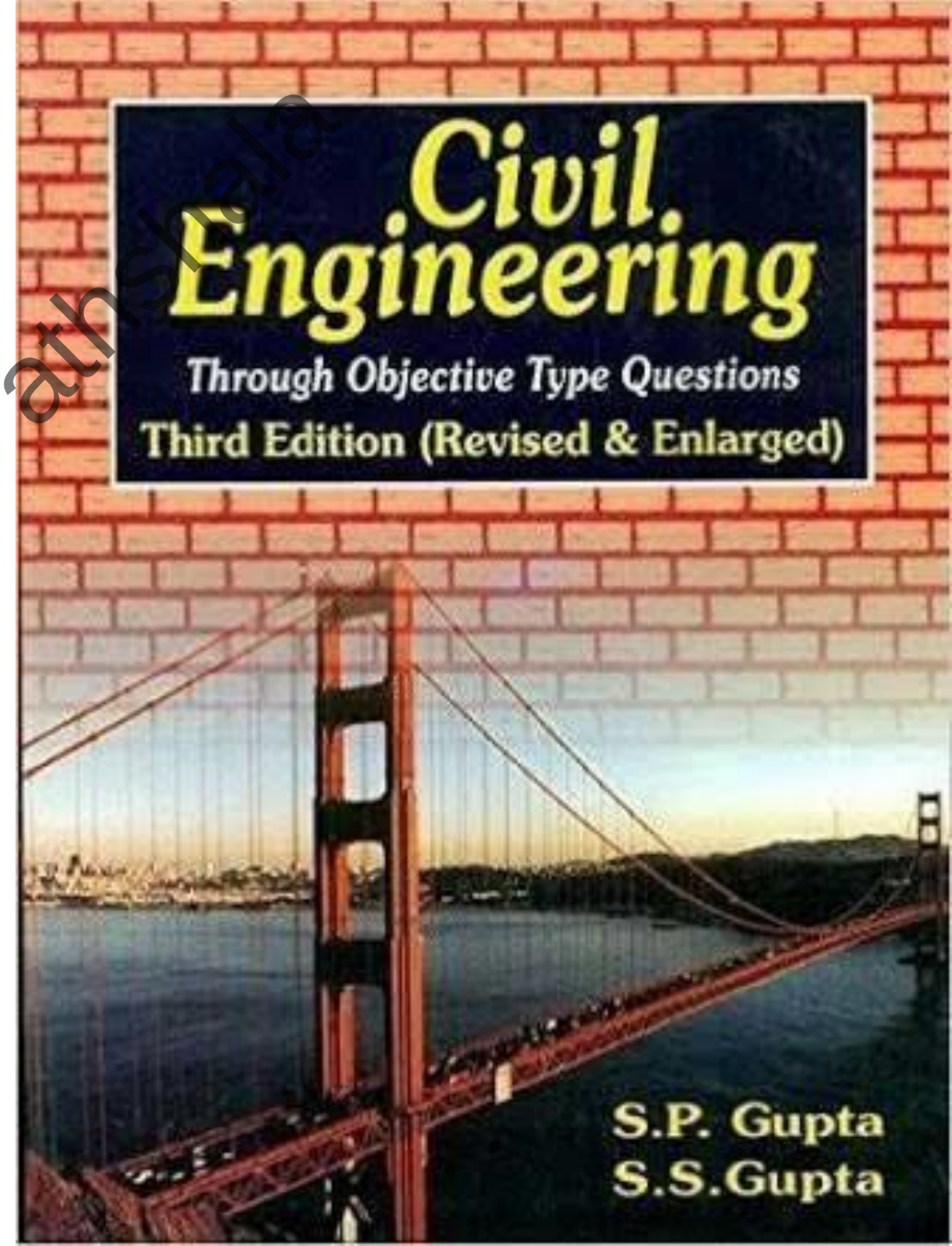
Objective Questions
(136 to 150)

Highway Engineering



Q. 136) The thickness of bituminous carpet varies from

A. 20 to 25 mm
B. 50 to 75 mm
C. 75 to 100 mm
D. 100 to 120 mm

Answer A

Premix method of bitumen construction
The aggregates and binder is mixed prior to placing and spreading over the desired surface.

1. Bitumen bound macadam

Binder and aggregates are mixed prior to placement and finishing
Thickness is kept from 5 to 7.5 cm.

2. Bituminous carpet

Recommended for surface course layer only.
Premix of 10-12 mm size chippings with sand and bitumen binder.
The tickness varies from 2 cm to 2.5 cm

3. Bituminous concrete

Coarse and fine aggregates are used along with bitumen to give dense mass.

This is the best and used for heavier and mixed traffic

4. Sheet asphalt

A premix of bitumen and sand

5. Mastic asphalt

Mastic asphalt is a mixture of a bitumen binder, stone filler and mineral powder heated and mixed in the hot state.

Q. 137) Which of the following represents a carpet of sand-bitumen mix without coarse aggregate

A. Mastic asphalt
B. Sheet asphalt
C. Bituminous carpet
D. Bituminous concrete

Answer B

Q. 138) In highway construction on superelevated curves, the Rolling shall proceed from

A. Sides towards the centre
B. Centre towards the sides
C. Lower edge towards the upper edge
D. Upper edge towards the lower edge

Answer C

Superelevated curve: - The rolling shall proceed from lower edge towards uper edge.

Level surface: - Rolling is started from edges toward the centre. When half surface is rolled, then rolling again is started from the other edge.

Q. 139) Expansion joints in cement concrete pavements are provided at an interval of

A. 10 m
B. 15 m
C. 18 m to 21 m
D. 25 m to 30 m

Answer C

Expansion joints: -

These joints are provided to allow the expansion of concrete slab due to temperature rise.
Provided at interval of 18 m to 21 m
Approximate gap width of joints is provided between 2 to 2.5 cm

Contraction joints: -

The purpose of the contraction joint is to allow the contraction of the slab due to fall in slab temperature below the construction temperature.
Maximum spacing of 4.5 m as per IRC

Q. 140) Select the incorrect statement

A. Contraction joints are spaced closer than Expansion joints
B. Longitudinal joints are provided in cement concrete roads to prevent longitudinal cracking
C. Dowel bars are provided in longitudinal joints
D. Warping joints are provided to relieve stresses induced due to warping

Answer C

1. Transverse joints

(a) Construction joints (b) Expansion joints (c) Contraction joints (d) Warping joints

2. Longitudinal joints or Tie bars

Longitudinal joints Or Tie bars

This are provided in CC roads if their width is more than 4.5 m.
Provided to keep the two portion of slab in same level.

Dowel bars: - Are used in expansion and contraction Joints.

Warping joints:- Provided to relieve stresses developed due to warping

Q. 141) Hill Road is one which passes through a terrain with a cross slope

A. 0 to 10%
B. 10 to 25%
C. 25 to 60%
D. None of the above

Answer C

Types of terrain	Cross slope in%
1. Plain terrain	< 10
2. Rolling terrain	10 to 25
3. Hilly terrain	25 to 60
4. Steep terrain	> 60

142. Fig. 4.3 shows a longitudinal section AB of a hill road. The resisting length L_r is given by

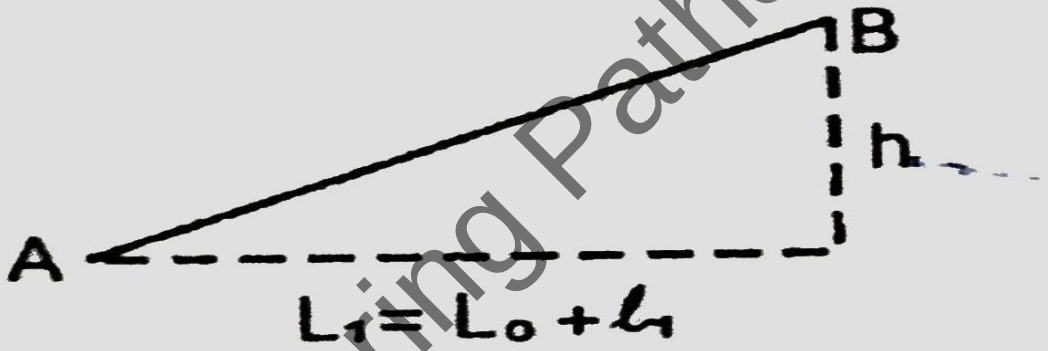


Fig.4.3

a) $L_r = L_o + h/f$

b) $L_r = L_1 + h/f$

c) $L_r = L_o - h/f$

d) $L_r = L_o + L_1 - h/f$

where f is the coefficient of frictional resistance

Answer B

The resisting length of a road is its effective length.
If two points are to be connected by the shortest distance in a straight line, the gradient may be steeper than the ruling gradient; therefore, it becomes necessary to increase the length so as to have the desired ruling gradient.

Resisting length = Actual length of route + (Rise and fall) / Coefficient of friction bt tyre and pavement

$$Lr = L1 + h/f$$

Q. 143) In hill roads if several alternate alignments are surveyed which fulfill to Geometric standards, then the preferred alignment is the one which is resisting length as

A. Maximum
B. Minimum
C. Very near to average resisting length of all the alignments
D. Zero

Answer B

Since, in hill roads, ineffective rises and falls are unavoidable, the particular alignment for which the resisting length is the minimum is the most desirable one.

The following surveyed for fixing the alignment: -
(a) Reconnaissance survey
(b) Preliminary survey
(c) Determination of final centre line
(d) Final location survey.

Q. 144) The camber for hill roads in case of bituminous surfacing is adopted as

A. 2%
B. 2.5%
C. 3%
D. 4%

Answer B

Camber is the slope, provided in the transverse direction of the road to drain off the rain water from the road surface

1.	High quality bituminous surfacing or concrete surfacing	1.7% to 2.0% (1 in 60 to 1 in 50)
2.	Thin bituminous surfacing	2.0% to 2.5% (1 in 50 to 1 in 40)
3.	W.B.M. or Gravel surface	2.5% to 3.0% (1 in 40 to 1 in 33)
4.	Earth roads	3% to 4% (1 in 33 to 1 in 25)

Q. 145) The superelevation to be provided in horizontal curves of radius R in hill roads is given by

A. $V^2/127R$

B. $V^2/17.5R$

C. $V^2/225R$

D. $(V+8)^2/127R$

Answer C

Super elevation: - It is the ratio of the height of outer edge with respect to horizontal width.
In hill roads super elevation is

$$e = V^2 / 225R$$

Where,

e = super elevation
V = design speed in kmph
R = radius of curve in metre

Q. 146) The minimum design speed for hair pin bends in hill road is taken as

A. 20 kmph
B. 30 kmph
C. 40 kmph
D. 50 kmph

Answer A

For design of hair pin bend following criteria may be adopted

1. **Minimum design speed = 20 kmph**
2. Minimum length of transition curve = 15 m
3. Gradients
   (a) Maximum = 1 in 40 (2.5%)
   (b) Minimum = 1 in 200 (0.5%)
4. Super elevation = 1 in 10 (10%)

Q. 147) The drain which is provided parallel to roadway to intercept and divert the water from hill slopes is known as

A. Sloping drain
B. Catchwater drain
C. Side drain
D. Cross drain

Answer B

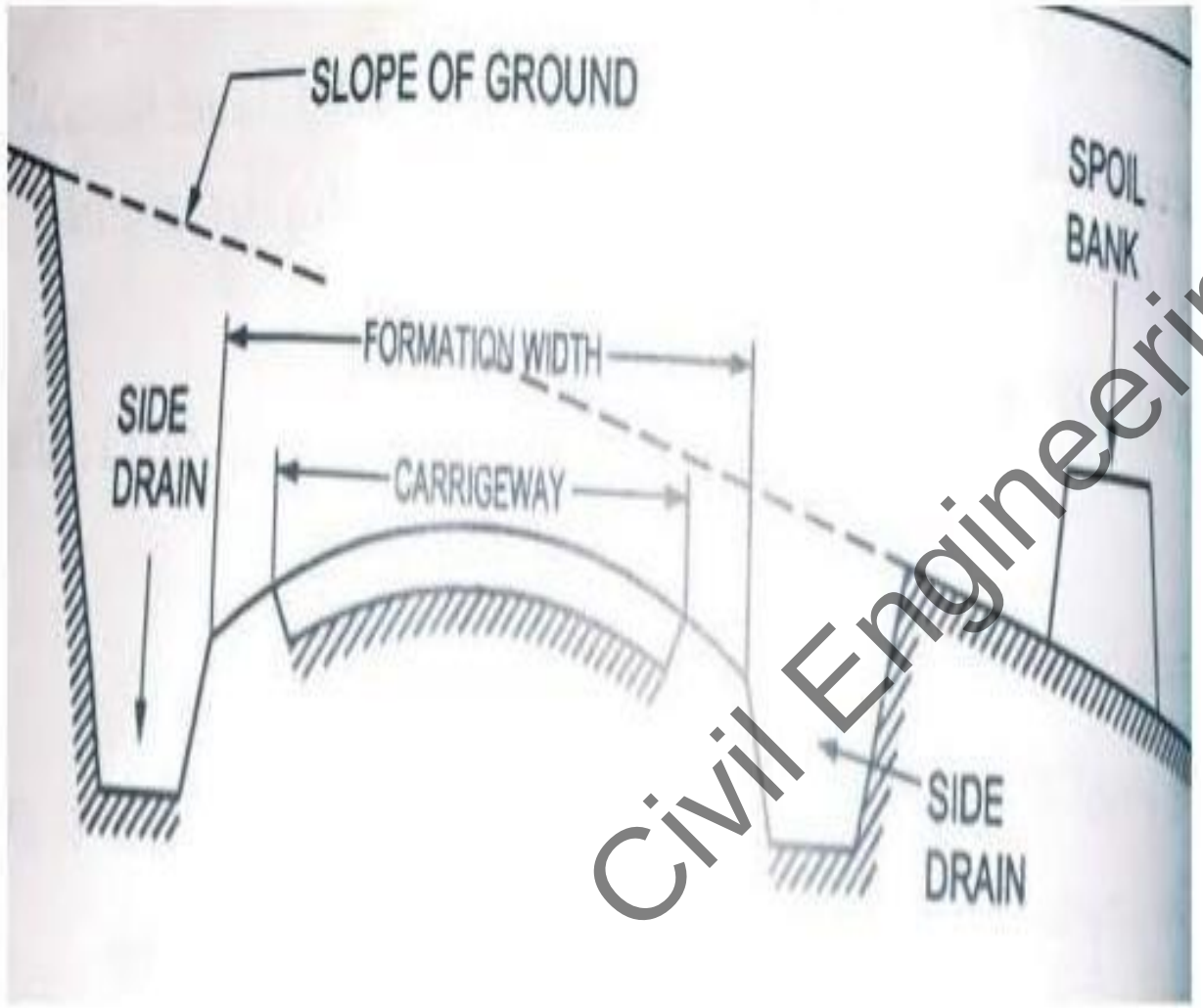
Hill roads, drains on both sides of the road can only be provided if the road runs wholly through cutting.
In the case of side cutting, drains are provided only on one side, usually on the Hill side.

Catch drain: -
When the road runs in steep side Hill, the water from the upper slopes comes to the road surface and causes major damage of the road.

Divert the water from the hill slope, catch water drains are provided on the same side as the side drains, running parallel to the road.

The water from this catch water drain is diverted to the nearest cross drainage work such as culvert or to a natural stream.

A. Drain on both side



B. Drain on hill side

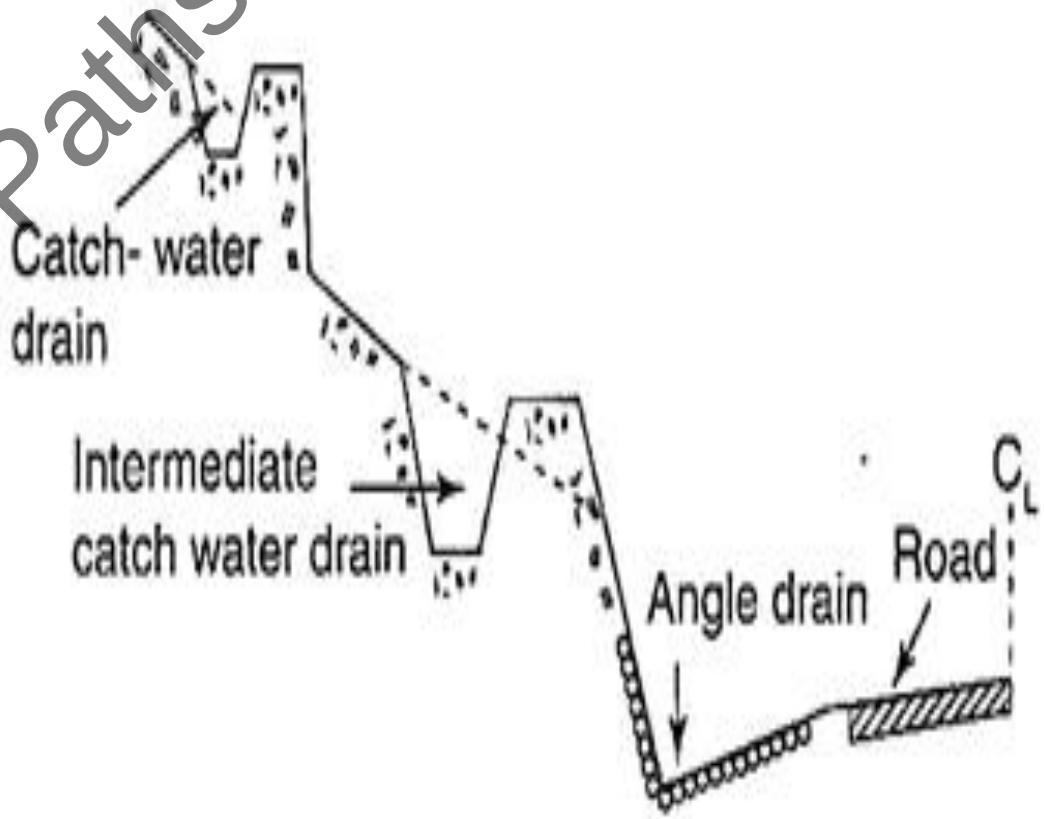


FIG. 9.10 *Catch-water drains*

Q. 148) The walls which are necessary on the hill side of roadway where earth has to be retained from slipping is known as

A. Retaining wall
B. Breast wall
C. Parapet wall
D. None of the above

Answer B

Breast wall

A breast is wall constructed to prevent the soil on a natural slope of embankment from sliding down the slope due to effects of weather, erosion etc.

Retaining wall

A retaining wall is used when artificial excavation is done

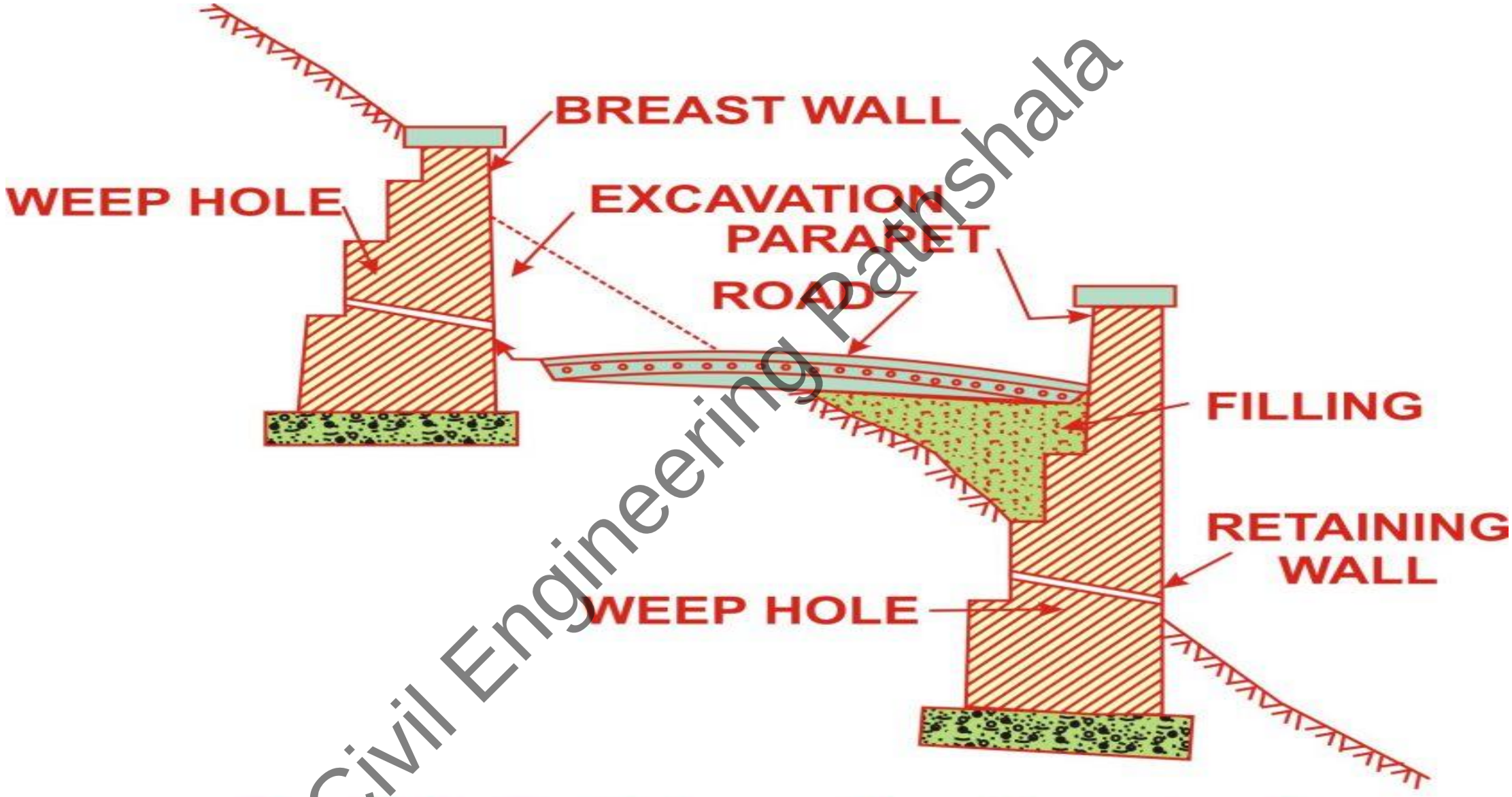


Fig. 2.50. Retaining wall and breast wall.

Q. 149) In hill roads the side drains are provided

A. Only on the hill side of road
B. Only on the opposite side of Hill
C. On both sides of the road
D. None of the above

Answer A

Q. 150) select the incorrect statement

A. Emulsion is used for stabilizing desert sand
B. Soil lime stabilization is very effective for stabilizing black cotton soils
C. Soil lime stabilization is quite effective in warm regions
D. Soil cement stabilization is quite durable for surface course

Answer D

Stabilisation is the process of improving the engineering properties of the soil before construction.

A. Desert sand is a very light and very weakly saturated reddish yellow colour which corresponds specifically to the coloration of sand.

D. Uses Of Cement In Soil Stabilization for subgrade or road base.

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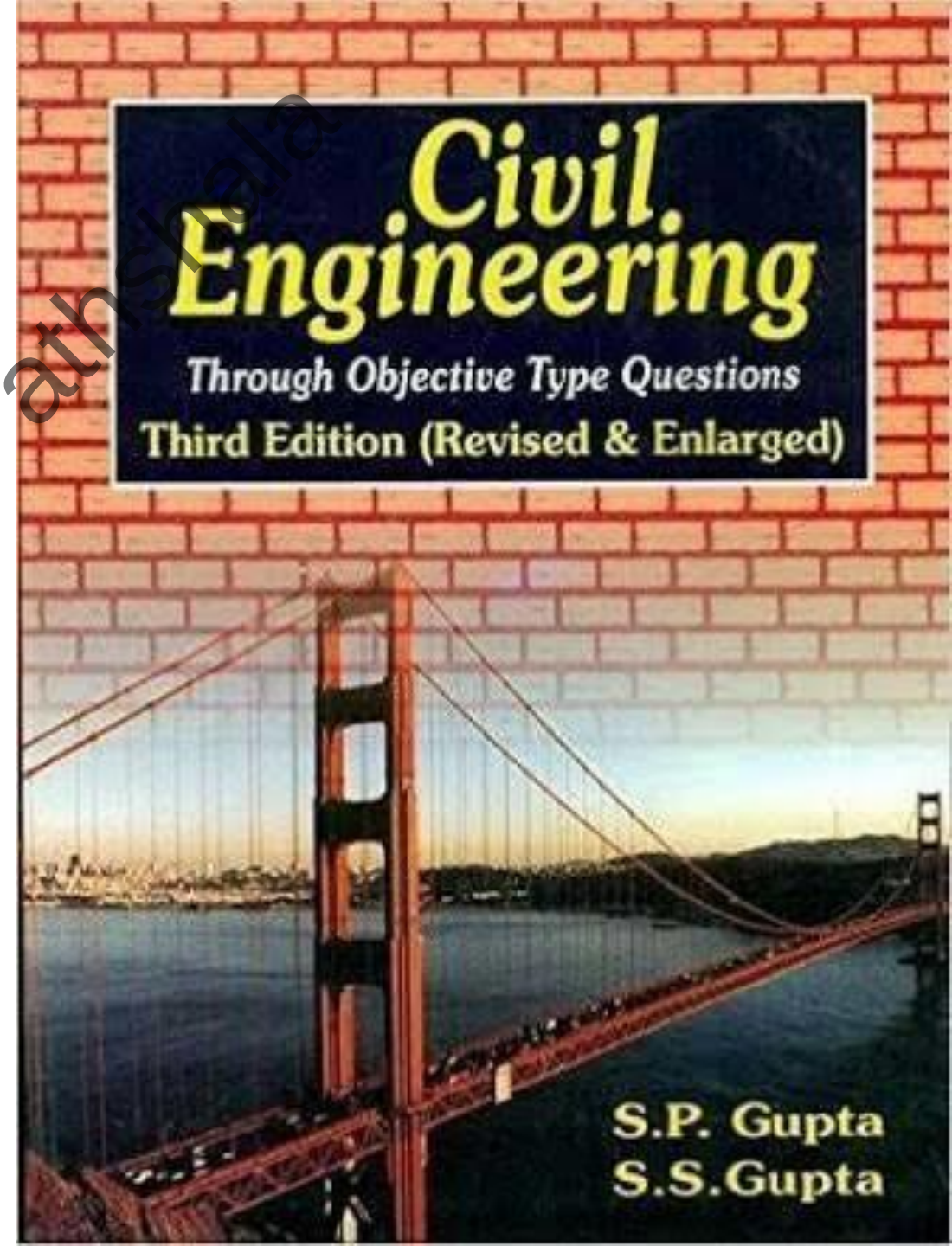
Objective Questions
(151 to 160)

Highway Engineering



Q. 151) For sandy soils the most common method of stabilization is

A. Soil cement stabilization
B. Mechanical stabilization
C. Soil lime stabilization
D. Soil bitumen stabilization

Answer D

Soil stabilization is the process of improving the engineering properties of soil and making it more stable.

1. Cement Stabilization: -

Is done by mixing pulverised soil and portland cement with water and compacting the mix to attain a strong material.

2. Mechanical Stabilization: -

Is the process of improving the soil by changing its gradation. Two or more types of natural soils are mixed to obtain a composite material which is superior to any of its components. It is also known as granular stabilization.

3. Lime Stabilization:-

Is done by adding lime to a soil. It is useful for stabilization of clayey soils.

4. Bitumen Stabilization: -

Is generally done with asphalt as binder. Emulsion are also used but in this form they require a longer drying period.

The amount of bitumen is 4% to 7%. The actual amount is determined by trial.

Q. 152) In which one of the following types of bituminous Constructions is proportioning of materials determined from laboratory tests?

A. Grouted macadam
B. Premix carpet
C. Bituminous or asphalt concrete
D. Bituminous macadam

Answer C

1. Grouted or penetration macadam: -

The strength is developed due to mechanical interlocking and bond due to soil binder. The stresses induced due to heavy mixed traffic order to increase the stability of such roads, bitumen is used as a binder.

The bitumen is spread over the compacted aggregate surface. The bitumen penetrates into voids from the surface, filling up a part of voids and binding the aggregate together.

2. Premix Carpet: -

is usually recommended for surface courses layer only. Bituminous carpet or premix carpet is a premix prepared from 10 to 12 mm size chipping with sand and bitumen binder.

3. Bituminous or asphalt concrete: -

Best and can be used for heavier and mixed traffic. In this method coarse and fine aggregates are used along with bitumen to give dense mass. The premix is carefully designed and the aggregates and bitumen heated separately upto specified temperature and mixed together till all particles are coated with bitumen.

4. Bitumen Macadam: -

The binder and aggregates are mixed prior to placement and the finished thickness is kept from 5 to 7.5 cm.

153. A road camber is given in Fig.4.4.

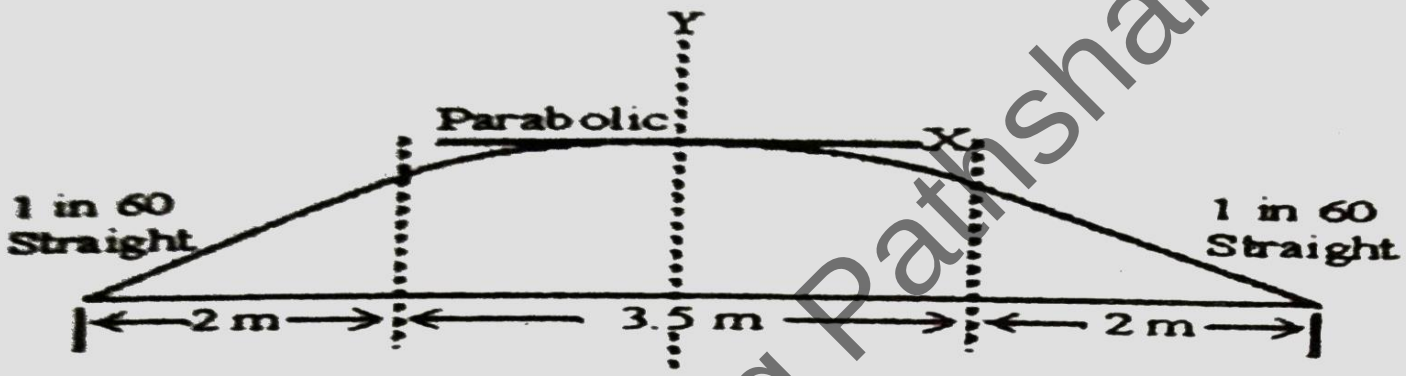


Fig.4.4

For designing this camber, the equation to be used is

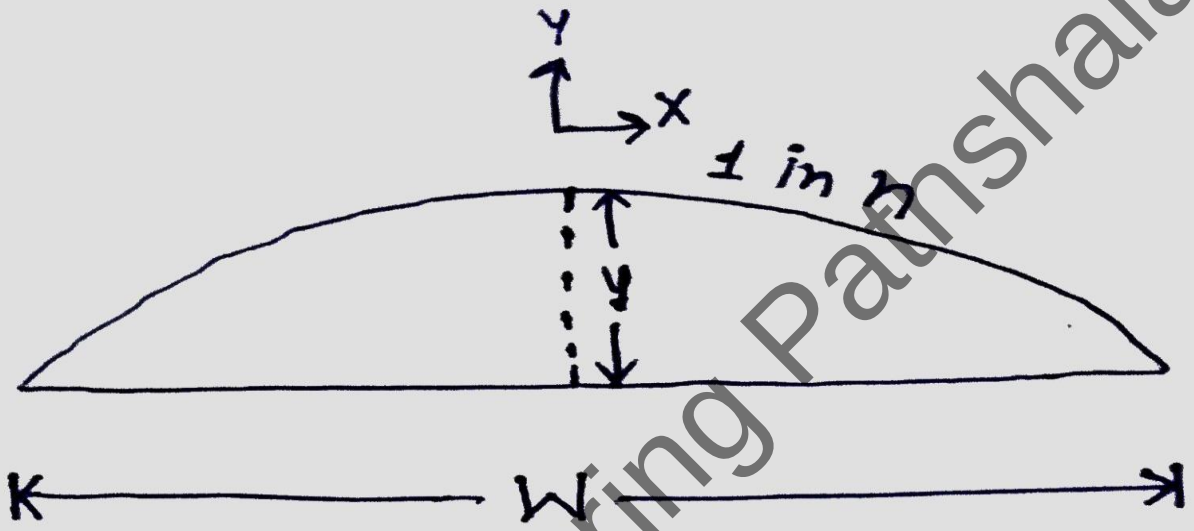
a) $y = \frac{x^2}{60}$

b) $y = \frac{x^2}{120}$

c) $y = \frac{x^2}{210}$

d) $y = \frac{x^2}{225}$ [ES 93]

Answer D



$$y = \frac{2x^2}{nW}$$

Where, x = distance from edge of the point Where camber is calculated

W = Width of the pavement

n = cross slope 1 in n

$$y = \frac{2x^2}{60(2+3.5+2)} = \frac{x^2}{225}$$

Q. 154) Which one of the following is associated with “Limiting Gradient” on highways?

A. Requirement of maximum tractive effort for a short distance
B. Requirement of minimum tractive effort on the whole gradient
C. Efficient drainage conditions
D. Alignment design in general

Answer A

Gradient: - It is the rate of rise or fall of road level along its length.

1. Maximum gradient: - It is the maximum or steepest or limiting gradient which is allowed to be provided in a road and which must never be exceeded in any part of the road as steeper gradient are very inconvenient to the traffic, more specially for slow moving traffic.

2. Ruling or desing gradient: - This is desirable upper limit or permissible limit of gradient in the alignment of the road.

3. Minimum gradient: - Provided on flat or level road to drain off rain water.

4. Exceptional gradient: - Provided in exceptional situations such as in approaches to cause way or near hairpin bends etc.

Q. 155) While aligning a hill road with a ruling gradient of 1 in 20, a horizontal curve of radius 80 m is encountered. The compensated gradient on curve will be

A. 1 in 15
B. 1 in 17
C. 1 in 25
D. 1 in 27

Answer C

Grade compensation

1) According IRC $= \frac{30+R}{R}$ in $\% = \frac{30+80}{80} = 1.375\%$

2) Maximum compensation $= \frac{75}{R}$ in $\% = \frac{75}{80} = 0.9375\%$

Lesser Value taken

Given, Ruling gradient $= 1$ in 20

$= \frac{1}{20} \times 100 = 5\%$

Grade compensation $= 5 - 0.9375 = 4.06 \approx 4\%$ OR $\frac{1}{25}$

Q. 156) While designing the superelevation of a highway, its maximum value is fixed considering the need to

A. Avoid toppling of slow moving vehicles in mixed traffic flow
B. Avoid tranverse skidding
C. Provide drainage
D. Counteract centrifugal force due to 75% of design speed

Answer A

Design of superelevation

Superelevation is designed for the particular vehicle called design vehicle which has some standard weight and dimensions. But in the actual case, the road has mixed traffic conditions. Different vehicles require different values of superelevation.

Example

1. Heavily loaded trucks require the small value of superelevation otherwise toppling may occur.
2. Fast moving vehicles may be provided with high superelevation while slow moving ones require small superelevation.

Q. 157) In a Group Index method of flexible pavement design, which one of the following factors decides the thickness of base and surface course?

A. Percentage of subgrade soil passing 75 Micron sieve
B. Type of surface and base course materials
C. Daily volume of commercial vehicles
D. Percentage of liquid limit of subgrade soil

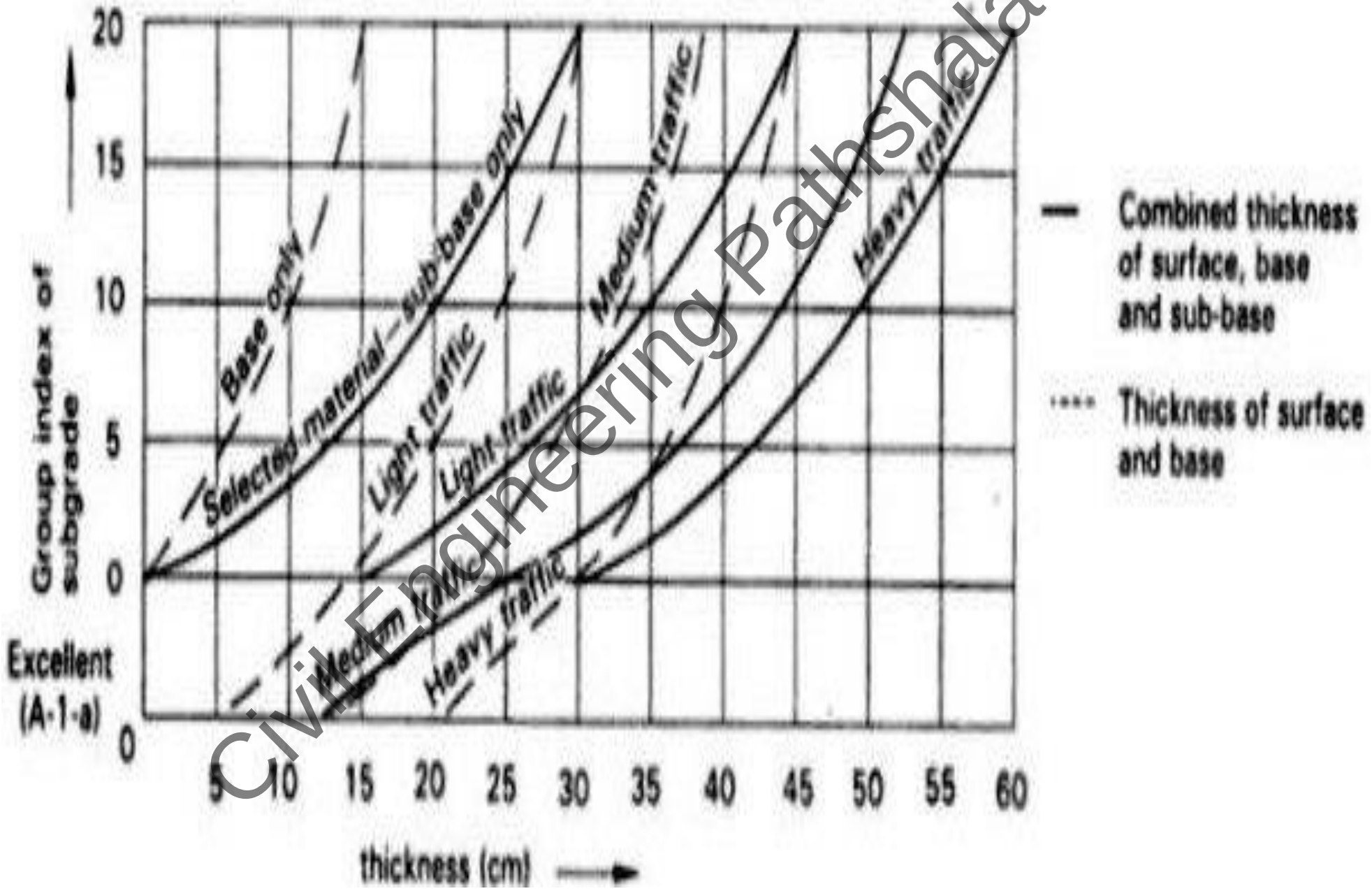
Answer C

Step 1. First the value of group index is found out by equation

$$GI = 0.2a + 0.005ac + 0.01bd$$

Step 2. Traffic is estimate and classified as
light (< 50 commercial vehicles per day),
medium (40-300) and
heavy (>300)

Step 3. Appreciate curve is choosen and the total thickness of pavements is calculated.



Q. 158) In a bituminous pavement, alligator cracking is mainly due to

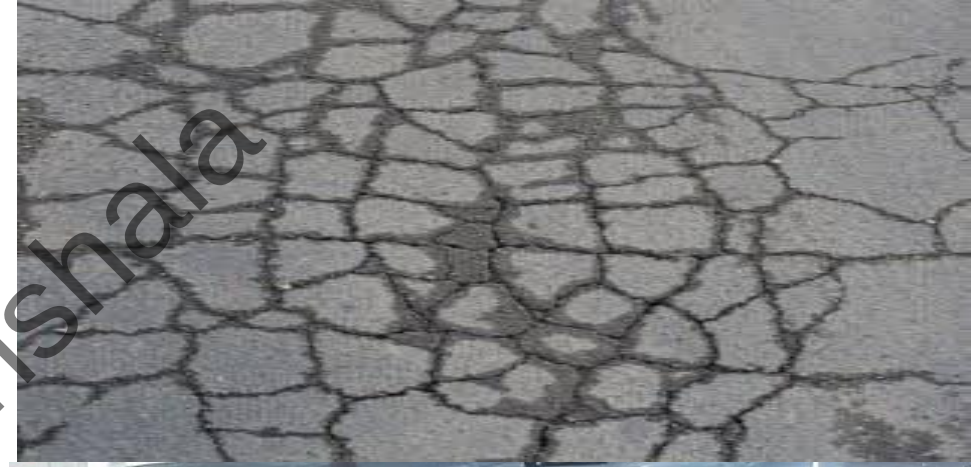
A. Inadequate wearing course
B. Inadequate thickness of subbase course of pavement
C. Use of excessive bituminous material
D. Fatigue arising from repeated stress applications

Answer D

Failure of flexible pavements
1. Map or Alligator cracking:
-Occurs due to fatigue.

2. Consolidation of pavement layers: - Repeated loads on same location of the road causes consolidation, deformation, causing depression (ruts) on the road

3. Shear failure: - Weakness of pavement mixtures. The shear failure causes upheaval of the pavement material forming cracking or fracture.



4. Frost heaving: - Shear or other failure the upheaval of the pavement is followed by a depression while in frost heaving it is a localized upheaval

5. Longitudinal cracking: -
Due to differential volume changes or other reasons such as frost action, settlement of embankment etc

6. Lack of cohesion in different layers: - Whene there is no proper bond between them wearing course and underlying base course etc.

7. Formation of waves and corrugation: -
The sequence of such depression and heaving up.

Q. 159) The main function of prime coat is to

A. Provide bond between old and new surfacing
B. Improve riding quality of pavement
C. Provide bond between the existing base and surfacing of new construction
D. Control dust nuisance

Answer C

1. Prime coat: - It is recommended when the first coat of bituminous surface is done on an existing pervious texture base such as WBM road.

2. Tack coat: - It is usually recommended when bituminous surfacing is done over an existing cement concrete top or already existing black top surface road.

3. Seal coat: - It is usually recommended as a final coat over certain pervious bitumen pavements.
-To make the surface water-proof.
-To increase the life of the surface.

Q. 160) The design of horizontal transition curve length of highways should take into account

A. Three factors namely, allowable values of rate of change of centrifugal acceleration and superelevation and the minimum length formula given by the IRC
B. Two factors, namely, comfort and rate of change of superelevation
C. Two factors, namely, rate of change of superelevation and minimum length formula given by the IRC
D. Only one factor, namely, the rate of change of centrifugal acceleration

Answer A Length of the transition curve maximum of three

1. Rate of change of centrifugal acceleration

$$L = \frac{v^3}{CR} \quad \text{OR} \quad L = \frac{0.021V^3}{CR}$$

Where, L = Length of transition curve in metres

v = Speed in m/sec V in kmph

C = Rate of change of centrifugal acceleration in m/sec^2

$$C = \frac{80}{75+V} \quad (0.5 \leq C \leq 0.8)$$

2. Rate of change of superelevation

(i) Pavement raised w.r.t. inner edge, $L = en(W+We)$

(ii) Pavement rotated about centre line, $L = \frac{en}{2}(W+We)$

Where, e = Super elevation, W = Width of pavement

We = Extra widening, 1 in n = Rate of super elevation

3. Empirical formula given by IRC

(i) For Plain and rolling terrain, $L = \frac{2.7V^2}{R}$

(ii) For Mountainous and steep terrain, $L = \frac{V^2}{R}$

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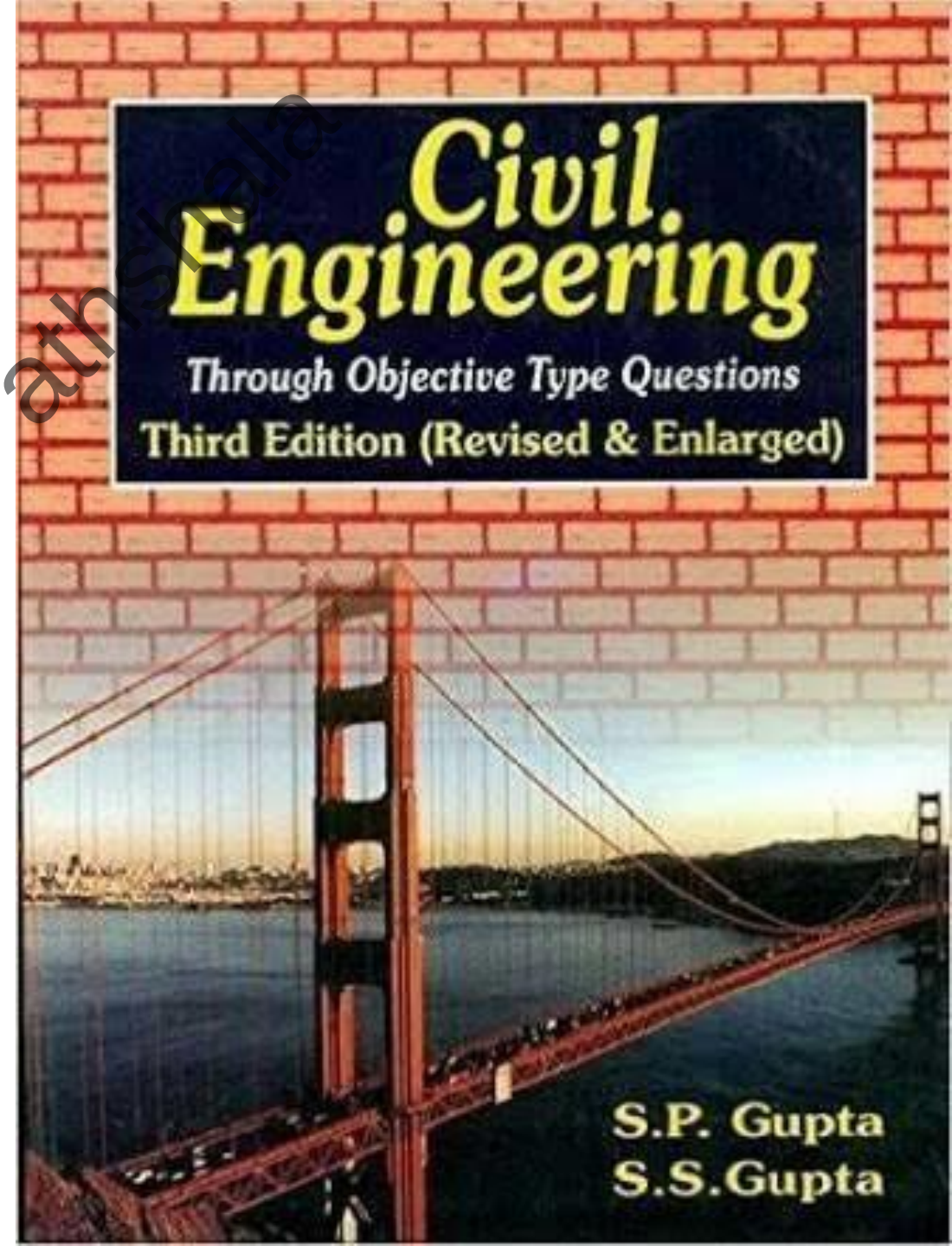
Objective Questions (161 to 175)

Highway Engineering



Q. 161) The radius of horizontal curve is 100 metres. The design speed is 50 kmph and design coefficient of lateral friction is 0.15. What would be the rate of superelevation if full lateral friction is considered?

A. 1 in 21.2
B. 1 in 15.8
C. 1 in 25.0
D. 1 in 32.6

Answer A

$$e + f = \frac{V^2}{127R}$$

Where, e = Rate of Superelevation

f = lateral friction

V = design speed in Kmph

R = Radius of curve

full lateral friction is considered means maximum value is taken

$$f_{max} = 0.15$$

$$e + 0.15 = \frac{50^2}{127 \times 100}$$

$$e = 0.04685$$

$$e = 1 \text{ in } 21.34$$

Q. 162)

Match List I with List II and select the correct answer using the codes given below the Lists:

List I		List II
A.	Penetration test	1. Design of bituminous concrete mix
B.	Marshal test	2. Overlay design
C.	Ring and ball test	3. Gradation of asphalt cement
D.	Benkelman beam test	4. Determination of softening point

Codes:

	A	B	C	D
a)	3	2	4	1
b)	A	B	C	D
	3	1	4	2
c)	A	B	C	D
	2	3	1	4
d)	A	B	C	D
	4	2	3	1

[ES 94]

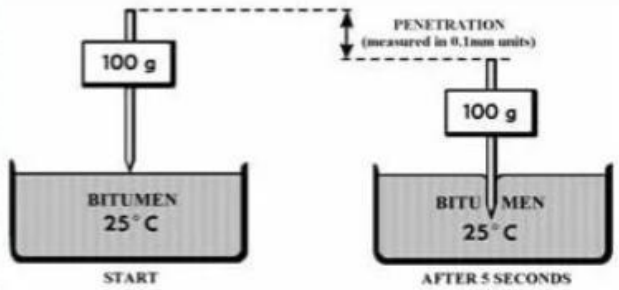
Answer B

A. The penetration value of bitumen is measured by distance in tenths of mm that a standard needle would penetrate vertically into bitumen sample under standard conditions of test.

By this test we can determine the hardness or softness value of bitumen.

Penetration test is a commonly adopted test on bitumen to grade the material in terms of its hardness.

A 80/100 grade bitumen indicates that its penetration value lies between 80 & 100.



B. Bituminous concrete mix is commonly designed by Marshall Method.

C. Softening point of bitumen indicates the point at which bitumen attains a particular degree of softening under specified conditions of the test. Take small amount of bitumen sample and heat it up to 75-100^{o}C. Ring and ball apparatus is used to conduct this test.

D. The Benkelman beam method is one of the methods for measuring surface deflections in field.
Method to access pavement condition and overlay design.

Q. 163) In the design of highways, expansion and contraction joints should respectively be provided at

A. 50 m and 32 m
B. 50 m and 10 m
C. 25 m and 10 m
D. 25 m and 32 m

Answer B

Expansion joints: - The purpose of the expansion joint is to allow the expansion of the pavement due to rise in temperature with respect to construction temperature.
Spacing between 50 to 500 ft (15 to 150 m)

Contraction joints: - The purpose of the contraction joint is to allow the contraction of the slab due to fall in slab temperature below the construction temperature.
The joint spacing should be 24 to 30 times the pavement thickness.
The maximum joint spacing is 30 ft (9.0 m)

Q. 164) Reflection cracking is observed in

A. Flexible pavement
B. Rigid pavement
C. Bituminous overlay over cement concrete surface
D. Rigid overlay over flexible pavement

Answer C

Reflective cracking can include cracks that occur away from an underlying joint.

Reflection cracking is observed in Bituminous overlay over CC surface

Problem: Allows moisture infiltration and can cause roughness in the pavement ride.

165. Psychological widening on road curves is given by (symbols have the usual meaning)

a) $\frac{nL^2}{2R}$

b) $\frac{0.1V}{\sqrt{R}}$

c) $\frac{0.1nV}{\sqrt{R}}$

d) $\frac{0.1V}{\sqrt{R}} + \frac{nL^2}{2R}$ [ES 94]

Answer B

1. Psychological widening (Wep):

While negotiating a horizontal curve, the driver has a tendency to follow the inner of the pavement. This reduces the effective width of the pavement at curves. In order to have a smooth operation at curves, you need to provide an extra widening at the curve of the road.

The IRC recommended a value of extra widening formula for psychological reasons

$$Wep = V / 9.5\sqrt{r}$$

2.Mechanical Widening (Wem):

While negotiating a curve, rear wheels have a tendency to follow the inner track. To accommodate this, there will be a widening is provided called mechanical widening have to be provided. This is due to the offtracking of the vehicle.

The off-tracking in a highway is one the main criteria during curve widening design.

The IRC value for the mechanical widening is given by

$$Wem = nL^2 / 2R$$

Q. 166) Which one of the following items of Hill Road Construction does not help in the prevention of landslides in the monsoon season

A. Retaining walls
B. Catch water drains
C. Breast wall
D. Hair-pin bends

Answer D

Breast wall:- A breast is wall constructed to prevent the soil on a natural slope of embankment from sliding down the slope due to effects of weather, erosion etc.

Retaining wall:- A retaining wall is used when artificial excavation is done.

Catch drain: - When the road runs in steep side Hill, the water from the upper slopes comes to the road surface and causes major damage of the road.

Divert the water from the hill slope, catch water drains are provided on the same side as the side drains, running parallel to the road.

The water from this catch water drain is diverted to the nearest cross drainage work such as culvert or to a natural stream.

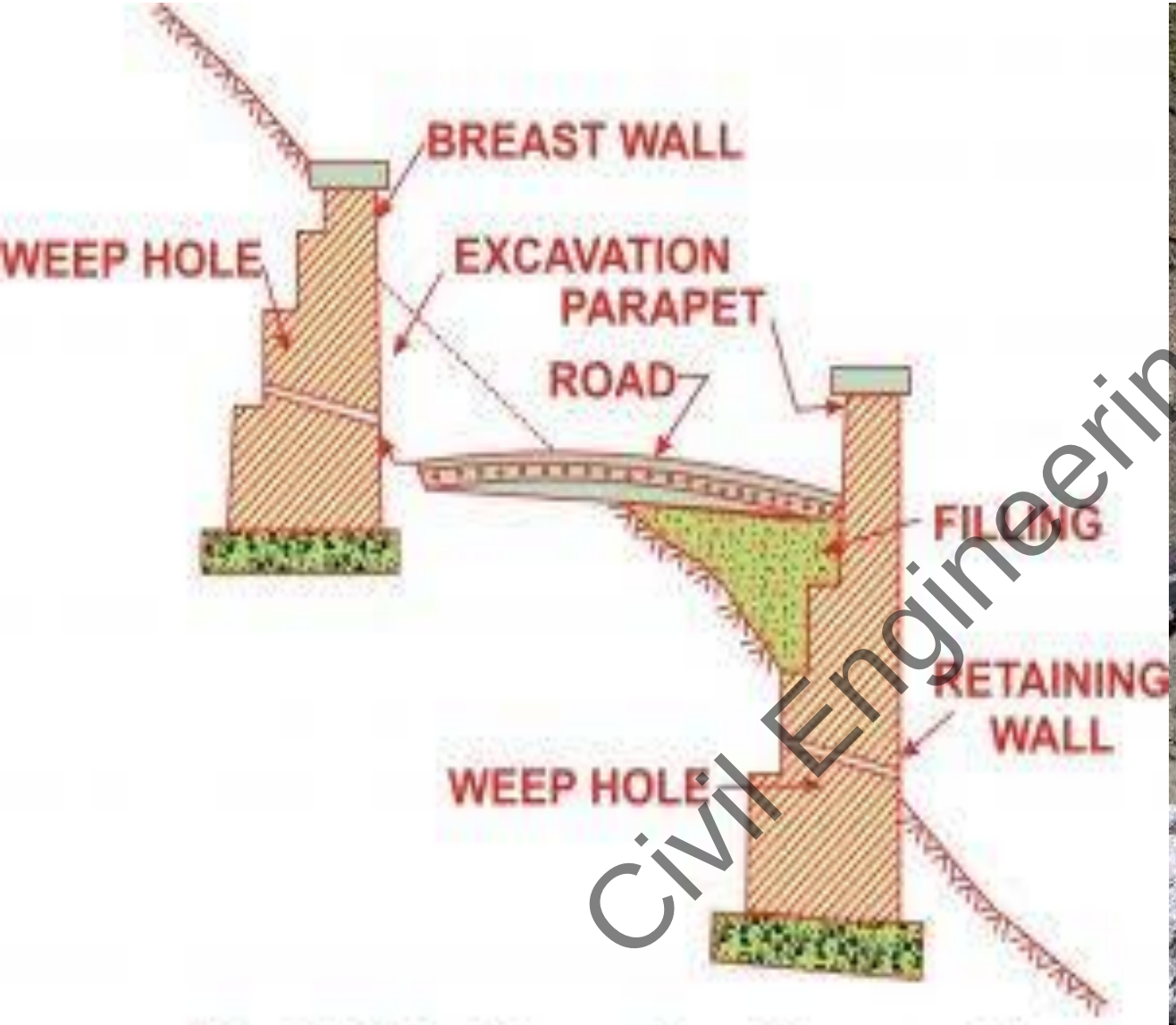


Fig. 2.50. Retaining wall and breast wall.

Q. 167) In the Los Angeles Abrasion test on aggregate, if the speed of the drum is increased to 50 rpm, then the abrasion value will

A. Increase
B. Decrease
C. Remain unchanged
D. Be unpredictable

Answer A

Los Angeles Abrasion Test:- It consists of a hollow cylindrical machine closed at both ends having 70 cm internal diameter and 50 cm long, mounted on supports so that it may rotate about its horizontal axis. Steel spherical balls 4.5 cm diameter and weight 390 grams to 445 grams. The weight and number of balls per charge of aggregate depends upon the grading of aggregate simple.

Procedure:-

1. Sample 5 kg or 10 kg depending on the grading of aggregate sample.
2. Machine is rotated at a speed of 30 to 33 r.p.m. For 500-1000 r.p.m depending on grading.
3. Sample is taken out and sieved through 1.7 mm I.S. Sieve and weight of aggregate passing through it.

Abrasion value = $W_2/W_1 \times 100\%$

W_1 is the weight of sample put in the machine.

Q. 168) The maximum superelevation to be provided on a road curve road is 1 in 15. If the rate of change of superelevation is specified as 1 in 120 and the road width is 10 m, then the minimum length of the transition curve on either end will be

A. 180 m
B. 125 m
C. 80 m
D. 30 m

Answer C

Length of Transition curve ⇒

1) By the rate of change of centrifugal acceleration

$$L = \frac{V^3}{CR}$$

L = Transition length
C = rate of chang of centrifugal acceleration in m/sec^2
R = Radius of circular curve in m.
V = speed in m/sec

2) Rate of change of Super elevation

(i) Total raising of pavement w.r.t. inner edge

$$= en\,W = \frac{1}{15} \times 120 \times 10 = 80\,m$$

(ii) Pavement is assumed to e rotated about centre line

$$= \frac{en}{2}.W$$

Where, e = Super elevation
1 in n = rate of super elevation
W = Pavement width (including Extra widening)

3) Empirical formula (for minimum Length)

(i) For Plain and rolling terrain, $L = \frac{2.7V^2}{R}$

(ii) For Mountainous and steep terrain, $L = \frac{V^2}{R}$

Q. 169) A summit curve is formed at the intersection of a 3% up gradient and 5% down gradient. To provide a stopping distance of 128 m, the length of summit curve needed will be

A. 271 m
B. 298 m
C. 322 m
D. 340 m

Answer B

Length of summit curve ⟹

1) According to Stopping sight distance (SSD)

(a) When $L > SSD$ $\quad$ (b) When $L < SSD$

$$L = \frac{NS^2}{4.4} \qquad L = 2S - \frac{4.4}{N}$$

2) According to overtaking sight distance (OSD)

(a) When $L > OSD$ $\quad$ (b) When $L < OSD$

$$L = \frac{N(OSD)^2}{9.6} \qquad L = 2OSD - \frac{9.6}{N}$$

Where, L = Length of summit curve in metres
N = deviation angle in radians
S = Stopping sight distance

$N = 3\% - (-5\%) = 8\% = 0.08$

$S = 128\ m$

Assume $L > SSD$, then $L = \frac{NS^2}{4.4} = \frac{0.08\,(128)^2}{4.4}$

$$L \approx 298\ m$$

Q. 170) Which one of the following causes ravelling in bituminous pavement?

A. Use of soft bitumen
B. Excessive bitumen content
C. Low bitumen content
D. Use of open graded aggregates

Answer C

Disintegration in Bituminous Pavements and their Causes

Caused by insufficient compaction of the surface, insufficient asphalt in the mix, loss of adhesion between the asphalt coating and aggregate particles, or overheating of the mix.

The most common type of disintegration in bituminous pavements is raveling. Raveling is the wearing away of the pavement surface caused by the dislodging of aggregate particles and the loss of asphalt binder. As the raveling continues, larger pieces are broken free, and the pavement takes on a rough appearance.

Q.171) In desire-line diagram

A. Width of desire-line is proportional to the number of trips in one direction
B. Length of the desire-line is proportional to the number of trips in both directions
C. Width of desire-line is proportional to the number of trips in both directions
D. Both length and width of desire-line are proportional to the number of trips in both directions

Answer C

The origin and destination studies give idea of the number of vehicular traffic, their origin and destination in each zone of study.

Desire-line are ploted.

Thickness or width of desire-line, shows volume (Number of trips on both directions) on that road.

Q. 172) A typical Marshall test graph is shown in fig. 4.5. The variable on the y-axis is

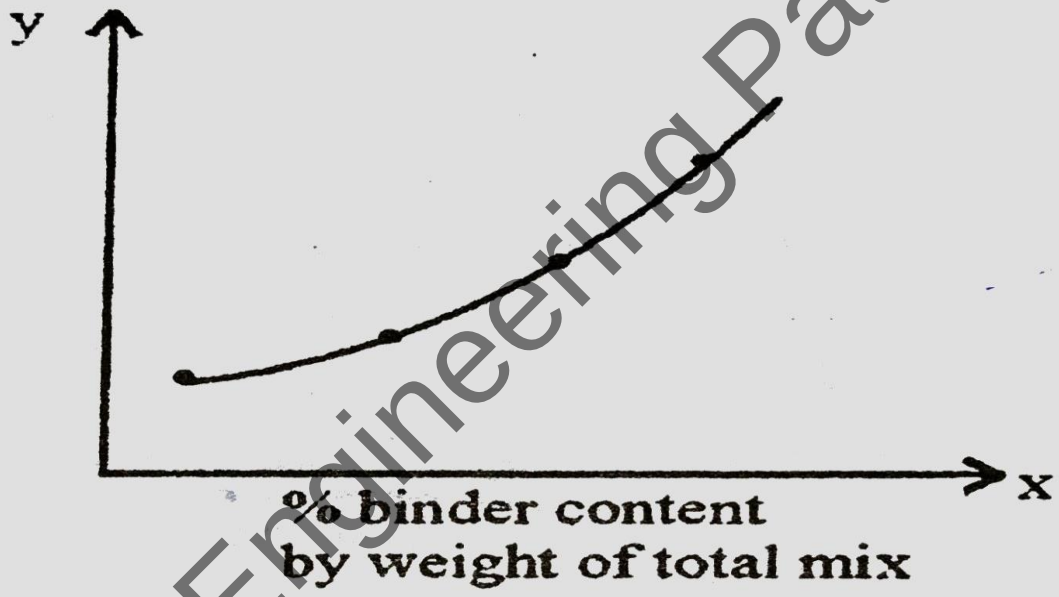


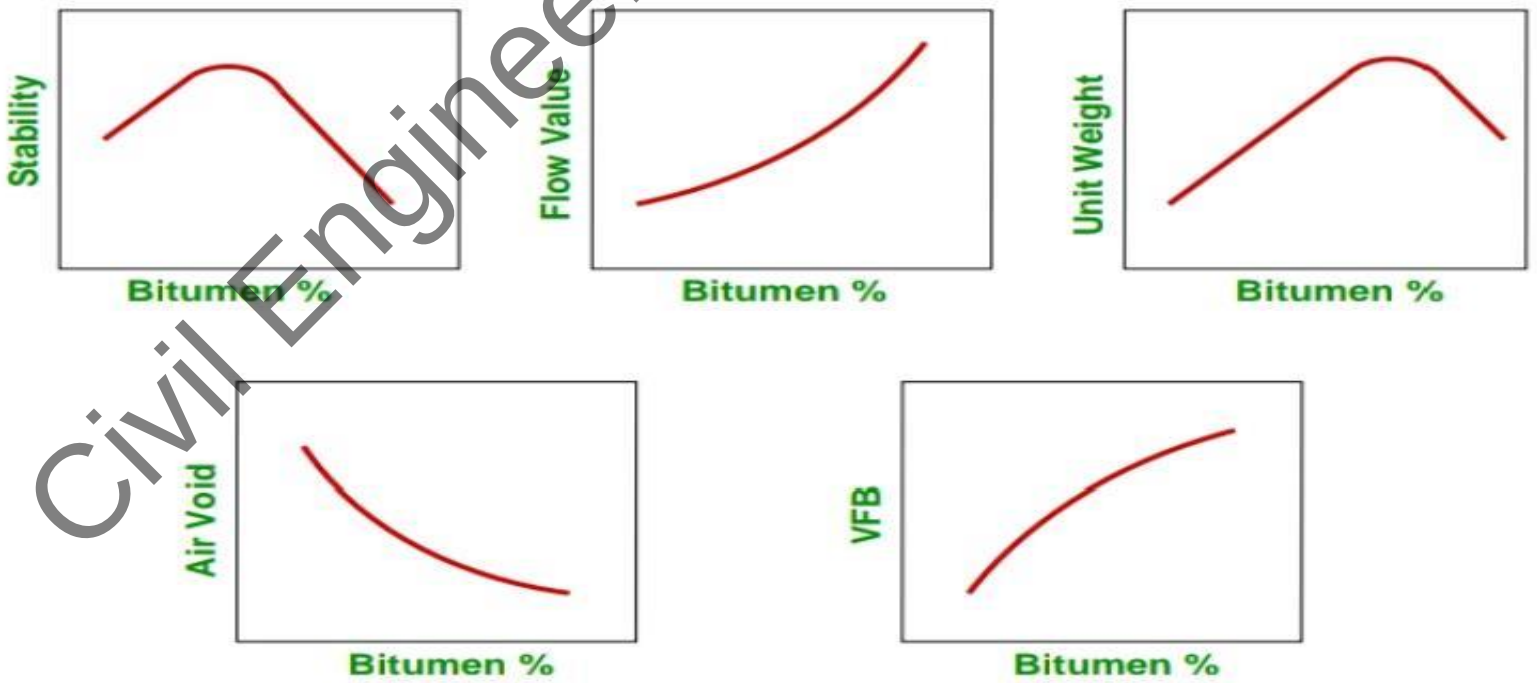
Fig.4.5

a) stability value
b) flow value
c) percentage of voids
d) unit weight [ES 95]

Table 26:2: Marshall mix design specification

Test Property	Specified Value
Marshall stability, kg	340 (minimum)
Flow value, 0.25 mm units	8 - 17
Percent air voids in the mix $V_v\%$	3 - 5
Voids filled with bitumen $VFB\%$	75 - 85

Answer B



Q. 173) Given that

r = radius of load distribution, E = Modulus of elasticity of concrete

K = modulus of subgrade reaction, u = poisson's ratio of concrete

h = thickness of slab, P = wheel load

The combination of parameters required for obtaining the radius of relative stiffness of cement concrete slab is

A. E, K, u, r

B. h, K, u, r

C. E, h, K, u

D. P, h, K, u

Answer C

$$L = \left[\frac{Eh^2}{12(1 - \mu^2)K} \right]^{1/4}$$

Where,

L = Radius of relative stiffness in cms

E = Modulus of elasticity of cement concrete kg/cm²

u = Poisson ratio of cement concrete = 0.15

h = Slab thickness in cms

K = Subgrade modulus or modulus of subgrade reaction kg/cm²

Q. 174) Consider the following situations
1. Traffic volume entering from all roads is less than 3000 vehicles per hour
2. Pedestrian volume is high
3. Total right turning traffic is high
4. A road in a hilly region

A rotary will be more suitable than control by signals, in situations listed against

A. 1 and 3
B. 1 and 4
C. 2 and 4
D. 2 and 3

Answer A

Guidelines for the selection of rotary:-

1. Traffic volume entering from all roads is 500 to 3000 vehicles per hour.
2. Total right turning traffic is high.
3. If the number of intersecting roads is between 4 and 7 then rotaries can be constructed with advantage

175. Match List I with List II and select the correct answer using the codes given below the lists:

	List I		List II
A.	Disintegration of aggregates due to weathering	1.	Attrition
B.	The removal of material from the surface of the road by grinding action	2.	Crazing
C.	Mutual rubbing or grinding within the mass under the action of traffic	3.	Soundness
D.	Breaking up of road surface layer through cracking into irregular shaped areas.	4.	Abrasion
		5.	Disinteg-ration

Codes:

a)	A	B	C	D
	3	1	5	2
b)	A	B	C	D
	2	5	1	4
c)	A	B	C	D
	3	4	1	2
d)	A	B	C	D
	1	4	3	5

[ES 96]

Answer C

Durability:- Aggregates used in pavements have to withstand the adverse action of weather such as physical and chemical action of rain and ground water and effects of atmosphere etc. The durability of aggregates is determined by soundness test.

Abrasion:- The aggregates used in the surface course are subjected to constant abrasion due to moving vehicles. The removal of material from the surface of the road by grinding action is known as abrasion.

Attrition:- The mutual rubbing of stones also causes wear in the aggregates. This action of mutual rubbing or grinding of stones is known as attrition.

Crazing:- Breaking up of road surface layer through cracking into irregular shaped areas.

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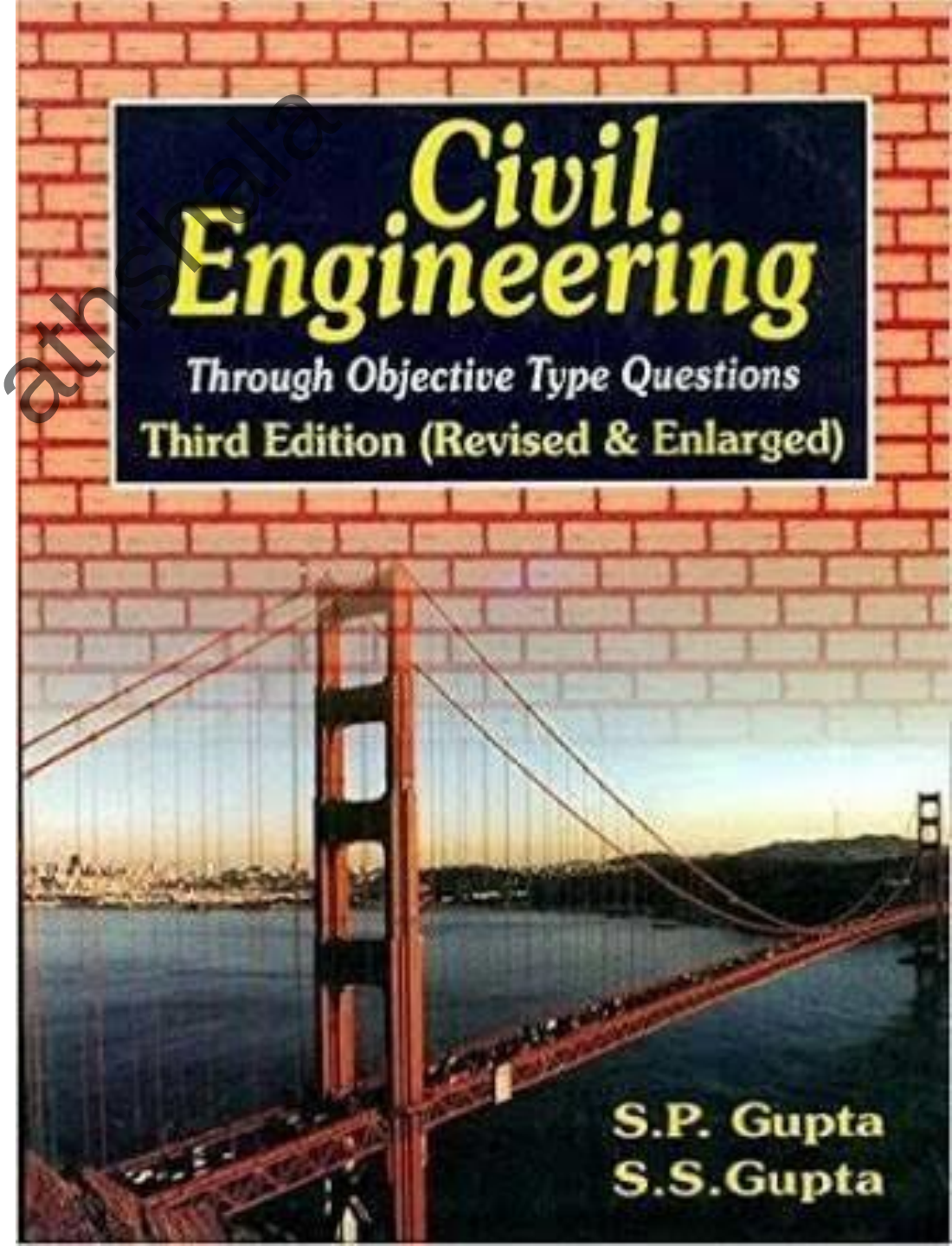
Objective Questions (176 to 190)

Highway Engineering



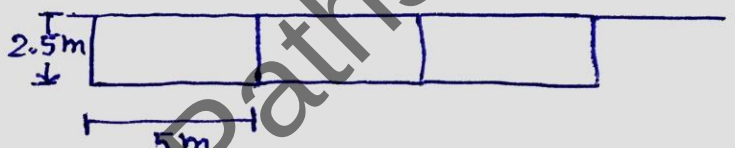
Q. 176) Ratio of the width of the car parking area required at kerb for 30° parking relative to 60° parking is approximately

A. 0.5
B. 0.7
C. 0.8
D. 2.0

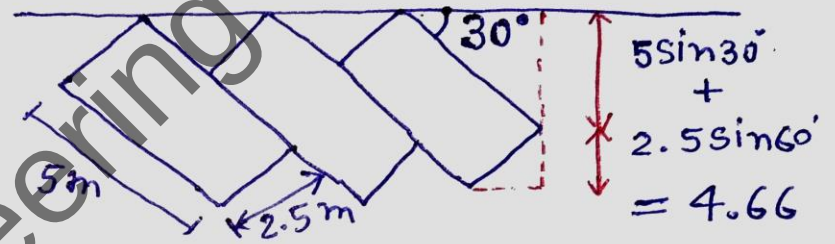
Answer C

As per IRC, dimensions of car = 5 X 2.5 metres

① Parallel Parking



② 30° Parking



③ 45° Parking. Width of Kerb required = 5.31m

④ 60° Parking Width of Kerb required = 5.58

⑤ Right angle parking Width of Kerb required = 5m

Width of car parking area required at kerb of 30° parking relative to 60°

$$= \frac{4.66}{5.58} = 0.79 \approx 0.80$$

Q. 177) Consider the following statements with reference to pavements
1. Flexible pavements are more suitable then rigid pavements in regions where subgrade strength is uneven.
2. Load carrying capacity of rigid pavements depends more on the properties of concrete then the strength of subgrade.
3. Compared to flexible pavements, rigid pavements are more affected by temperature variations.

Of these statements

A. 1 and 2 are correct
B. 1 and 3 are correct
C. 2 and 3 are correct
D. 3 alone is correct

Answer C

Load carrying capacity of rigid pavement is mainly due to the rigidity and high modulus of elasticity of the slab itself.

Q. 178) For the relationship u = 55 – 0.44 k, where u is this speed in kmph and k is the density in vpkm, what will be the maximum flow in vph?

A. 1718
B. 1250
C. 625
D. 125

Answer A

Flow (VPh) = Density (VPKm) x Speed (Kmph)

$\boxed{q = K.u}$ (given $u = 55 - 0.44K$)

$$q = K(55 - 0.44K)$$

$$q = 55K - 0.44K^2$$

for maximum flow

$$\frac{dq}{dK} = 55 - 0.88K \qquad K = 62.5 \text{ VPKm}$$

$$q = 55 \times 62.5 - 0.44(62.5)^2$$

$$q = 1718.75 \approx 1718 \text{ VPh}$$

Q. 179) Consider the following statements:
Collision diagram is used to
1. Study accident pattern
2. Eliminate accidents
3. Determine remedial measures
4. Make statistical analysis of accidents

Of these statements

A. 1 and 2 are correct
B. 1 and 3 are correct
C. 3 and 4 are correct
D. 2 and 4 are correct

Answer B

Collision diagrams are used to display and identify similar **accident patterns.** They provide information on the type and number of accidents; including conditions such as time of day, day of week, climatic conditions, pavement conditions, and other information.

Collision diagram are most useful to compare the accident pattern before and after the **remedial measures** have been taken.

Q. 180) In which one of the following grades of highway is an emergency escape ramp provided

A. 1 in 200
B. Zero grade
C. Down grade
D. Up grade

Answer C

Runaway truck ramp / Runaway truck lane / Escape lane / Emergency escape ramp / Truck arrester bed:- is a traffic device that enables vehicles which are having braking problems to safely stop. It is typically a long, sand or gravel-filled lane connected to a steep **downhill grade** section of a main road, and is designed to accommodate large trucks or buses.

Q. 181) The Plasticity Index of the fraction passing 425 micron I.S. Sieve in case of sub base/base course would be

A. Less than 6
B. Greater than 6
C. Greater than 9
D. Between 15 and 30

Answer A

According to IS:2720 the plasticity index of binding material in WBM for Base / sub base Should be less than 6%

Q. 181) Assuming the safe stopping sight distance to be 80 m on a flat Highway section and with a setback distance of 10 m, what would be the radius of the negotiable horizontal curve?

A. 800 m
B. 160 m
C. 80 m
D. 70 m

Answer C

182. It is given by $R = \frac{S^2}{8M} = \frac{80 \times 80}{8 \times 10} = 80m$

Q. 183) If the CBR value obtained at 5 mm penetration is higher than that at 2.5 mm, then the test is repeated for checking; and if the check test reveals a similar trend trend, then the CBR value is to be reported as the

A. Mean of the values for 5 mm and 2.5 mm penetrations
B. Higher value minus the lower value
C. Lower value corresponding to 2.5 mm penetration
D. Higher value obtained at 5 mm penetration

Answer D

It is the ratio of force per unit area required to penetrate a soil mass with standard circular needle at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material.

C.B.R. = Test load/Standard load × 100

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

The C.B.R. values are usually calculated for penetration of 2.5 mm and 5 mm. Generally the C.B.R. value at 2.5 mm will be greater that at 5 mm and in such a case the former shall be taken as C.B.R. for design purpose. If C.B.R. for 5 mm exceeds that for 2.5 mm, the test should be repeated. If identical results follow, the C.B.R. corresponding to 5 mm penetration should be taken for design.

Q. 184) A vehicle was stopped in two seconds by fully Jamming the brakes. The skid marks measured 9.8 metres. The average skid resistance coefficient will be

A. 0.7
B. 0.5
C. 0.4
D. 0.25

Answer B

Given,

Braking duration $t = 2.0$ sec.

Braking distance $L = 9.8\,m = S$

Using the fundamental relations of motion

$$V = u + at \quad \text{(final velocity } V = 0\text{)}$$

$$u = -at \quad \text{---(i)}$$

and $v^2 - u^2 = 2as$

$$0 - \frac{u^2}{2a} = s \Rightarrow 2sa = -u^2 \quad \text{---(ii)}$$

from equation (i) and (ii)

$$2sa = -(-at)^2 \qquad \boxed{a = \frac{2s}{t^2}}$$

Average skid resistance coefficient, $f = \frac{a}{g}$

$$f = \frac{2s}{t^2 g} = \frac{2 \times 9.8}{(2)^2 \times 9.8} = 0.5$$

Q. 185) Which one of the following is the chronological sequence in regard to road construction/design development?

A. Telford, Tresaguet, CBR, Macadam
B. Tresaguet, Telford, Macadam, CBR
C. Macadam, CBR, Tresaguet, Telford
D. Tresaguet, Macadam, Telford, CBR

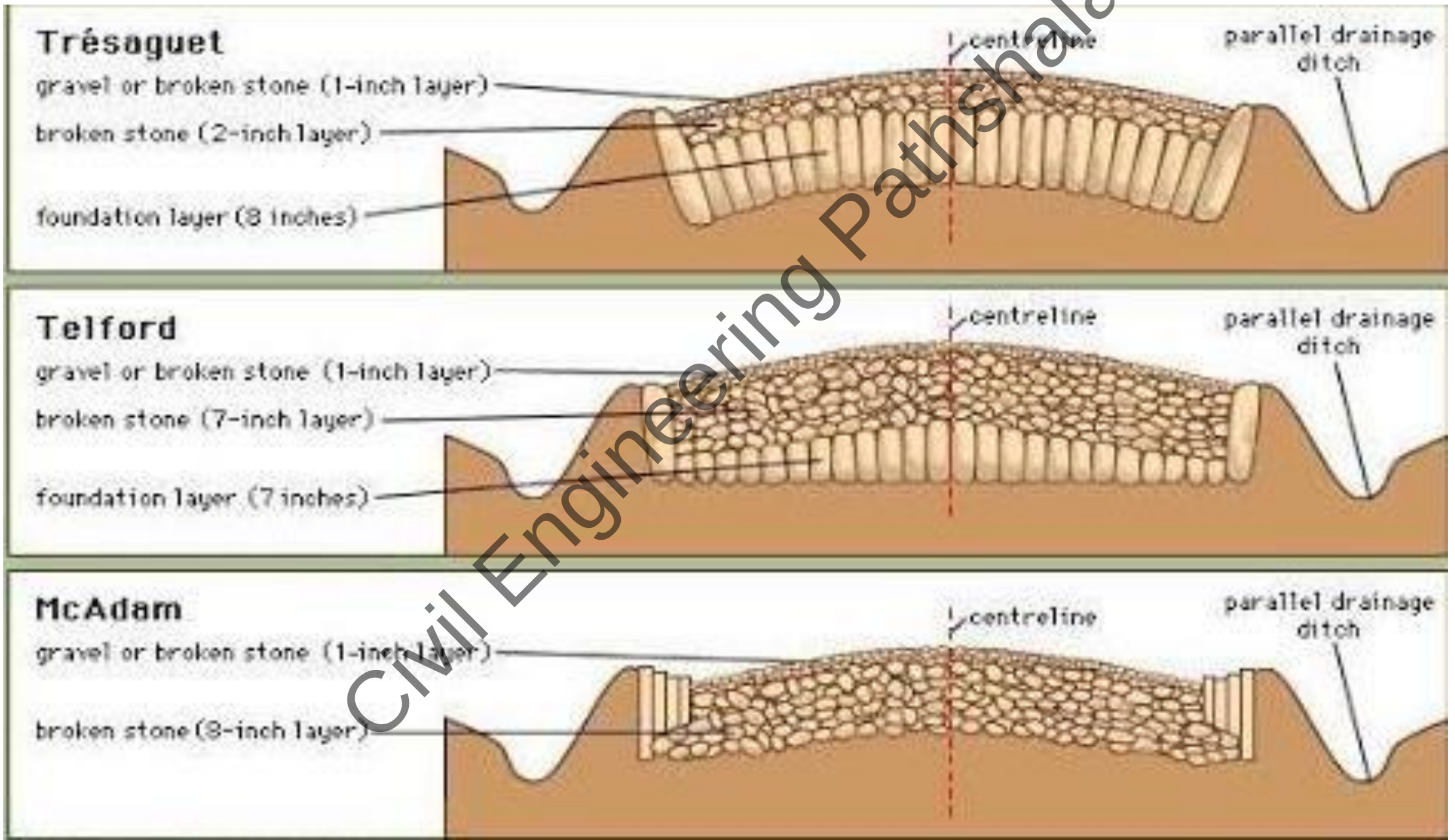
Answer B

Tresaguet construction was started in 1764 AD in France.

Telford construction was started in 1803 AD in London (England).

Macadam construction was started in 1815 AD in England.

CBR construction was started in 1928 AD in USA.



Q. 186) The general requirement in constructing a reinforced concrete road is to place a single layer of reinforcement

A. Near the bottom of the slab
B. Near the top of the slab
C. At the middle
D. Equally distributed at the top and bottom

Answer B

The greater quantity of reinforcement should be place In the longitudinal direction. Further the reinforcement should either be placed in the mid depth or towards top of the pavement for better functioning.

Q. 187) It is a common practice to design a highway to accommodate the traffic volume corresponding to

A. 30^{th} hour
B. Peak hour
C. ADT
D. 15-min peak period

Answer A

Design Hour Volume (DHV) is the hourly traffic volume used in the design of highways.
The 30^{th} highest hourly volume Is the hourly volume that will be exceeded only 29 times In a year and all hourly volumes of the year will be less than this value.

Q. 188) The amount of mechanical energy imposed on the aggregate during aggregate impact test is of the order of

A. 5320 kg-cm
B. 6750 kg-cm
C. 7980 kg-cm
D. 11400 kg-cm

Answer C

Procedure of Impact test
1. Sample 10 mm to 12.5 mm using sieve.
2. Sample transferred to the cup of the impact test apparatus and compacted by tamping road 25 times.
3. Now the hammer is raised to a height of 38 cm above the surface of the aggregate in the cup and is allowed to fall freely on the specimen.
4. 15 blows are given.
5. Sieved through 2.36 mm IS sieve and passing fraction is weighed (W1) .

Impact value = W2/W1 × 100

Where W2 is the weight of sample.

In impact test 15 blows of 14 kg hamer with a drop of 38 cm are given. Therefore mechanical energy imposed on aggregate is

= 15 × 14 × 38 = 7980 kg.cm

Q. 189) Which one of the following binders is recommended for a wet and cold climate?

A. 80/100 penetration asphalt
B. Tar
C. Cutback
D. Emulsion

Answer D

Bitumen emulsion is a mixture of water & bitumen. The bitumen content in the emulsion is around 60% and the remaining is water.

1. Emulsion can be used in wet weather even when it is raining.
2. Also emulsions have been used in soil stabilization, particularly for stabilization of sands in desert areas.
3. Emulsion are used in maintenance and patch repair works.

Q. 190) With reference to the Marshall mix design criteria for highways, which one of the following pairs is not correctly matched?

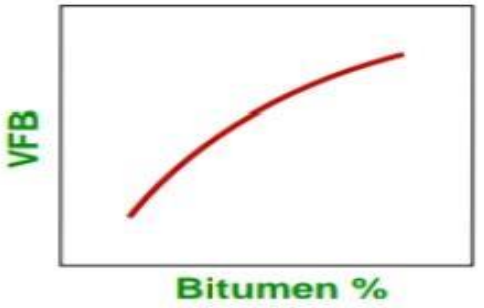
A. Stability value..... 340 min
B. Flow value..... 8-16
C. VFB..... 50-75
D. % Air voids..... 3-5

Answer C

Marshall method
Used for bituminous design mix.

Table 26:2: Marshall mix design specification

Test Property	Specified Value
Marshall stability, kg	340 (minimum)
Flow value, 0.25 mm units	8 - 17
Percent air voids in the mix $V_v\%$	3 - 5
Voids filled with bitumen $VFB\%$	75 - 85



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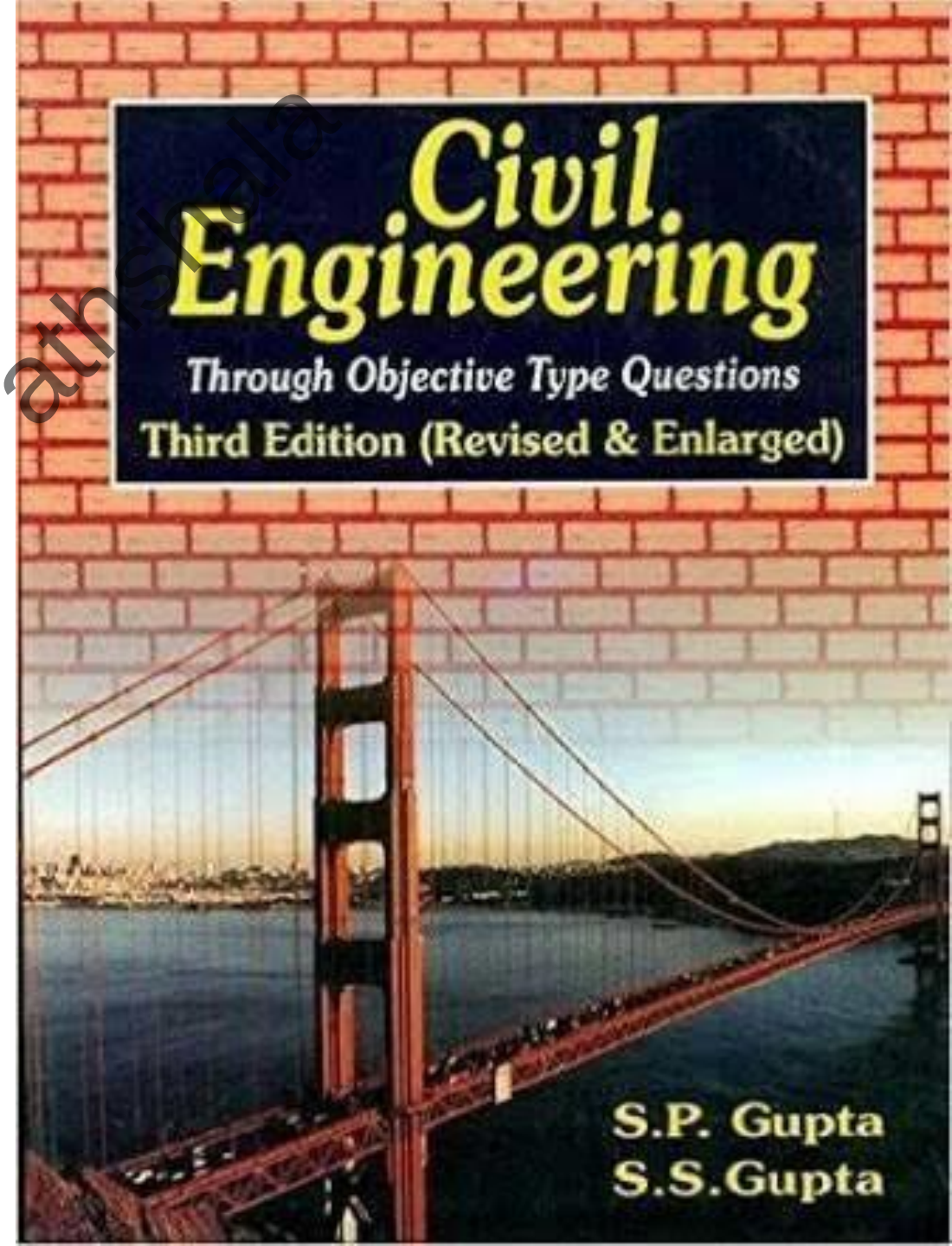
Objective Questions
(191 to 200)

Highway Engineering



Q. 191) It was noted that on a section of road, the free speed was 80 kmph and the jam density was 70 kmph. The maximum flow in vph that could be expected on this road is

A. 800
B. 1400
C. 2800
D. 5600

Answer B

$$\text{Maximum flow} = \frac{\text{Free Speed} \times \text{Jam density}}{4}$$

$$= \frac{80 \times 70}{4}$$

$$= 1400 \text{ veh/hr}$$

Q. 192) Which of the criteria given below are used for the design of valley vertical curves on road?

1. Rider comfort.
2. Headlight sight distance
3. Drainage

Select the correct answer using the codes given below

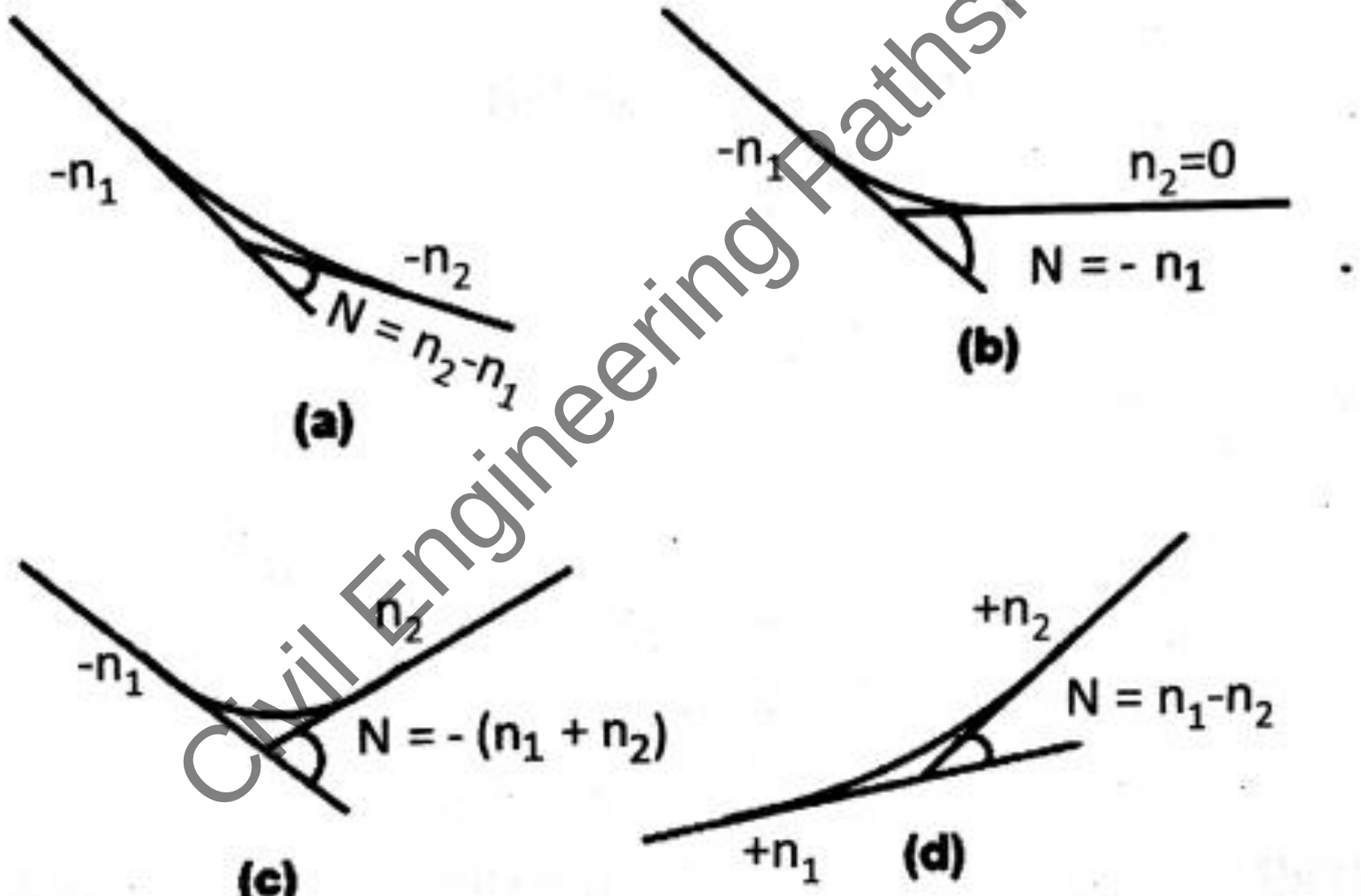
A. 1,2 and 3
B. 1 and 3
C. 2 and 3
D. 1 and 2

Answer A

Valley (Sag) curves are those curves which have convexity downwards.
They are formed under the four following conditions:

1. When a negative gradient meets another mild negative gradient
2. When a negative gradient meets a level zero gradient
3. When a negative gradient meets with a positive gradient
4. When a positive gradient meets another steeper positive gradient

During day time the visibility in valley curves are not hindered but during night time the only source of visibility becomes headlight in the absence of street lights.
And in valley curves, the centrifugal force generated by the vehicle moving along a valley curve acts downwards along with the weight of the vehicle and this adds to the stress induced in the spring of the vehicle which causes jerking of the vehicle.



193. Match List I (Pavement deficiency) with List II (Explanation) and select the correct answer using the codes given below the lists:

	List I		List II
A.	Bird baths	1.	A steep-sided, bowlshaped cavity caused by loss of surfacing as well as base course erosion.
B.	Pot holes	2.	Deformations which may be caused by localized or variable subgrade failure
C.	Ravelling	3.	Irregular deformations which may be the result of differential settlement.
D.	Subsidence	4.	Removal of larger surface aggregates leaving craters.
		5.	Abrupt lowering of the road surface due to poor drainage.

Codes:

a)	A	B	C	D
	1	4	5	3
b)	A	B	C	D
	2	1	3	5
c)	A	B	C	D
	5	2	4	3
d)	A	B	C	D
	2	1	4	5

[ES 98]

Answer D

A. Bird baths:- form typically as the result of settlement due to inadequate compaction of the material under the asphalt during construction and are particularly noticeable after a rain.

B. Potholes:- this type of failure occurs when there is no proper bond between the wearing course and underlying base course etc. This results in opening up and loss of material forming pot holes. This type of failure generally takes place when the bituminous surfacing is provided over the existing cement concrete base course etc.

C. Ravelling:- is caused by the continued infiltration of water and the degradation of an asphalt top coat. Once the top layer of asphalt bitumen wears down water and sunlight will continue to damage the asphalt surface causing the bond between asphalt bitumen and aggregate rock to break. When water begins to intrude into an asphalt surface it will cause further cracks and pavement failure to occur.

D. Subsidence:- Abrupt (Sudden) lowering of the road surface due to poor drainage.

Q. 194) For carrying out bituminous patch work during the rainy season, the most suitable binder is

A. Road tar
B. Hot bitumen
C. Cutback bitumen
D. Bituminous emulsion

Answer D

Patching is the process of filling potholes or excavated areas in the asphalt pavement.

Bitumen emulsion is a mixture of water & bitumen. The bitumen content in the emulsion is around 60% and the remaining is water.

1. Emulsion can be used in wet weather even when it is raining.
2. Also emulsions have been used in soil stabilization, particularly for stabilization of sands in desert areas.
3. Emulsion are used in maintenance and patch repair works.

Q. 195) The corrected characteristic rebound deflection on a pavement, using Benkelman beam study 2 mm. The equivalent granular overlay thickness required for an allowable deflection of 1 mm as per original IRC guidelines is

A. 33 mm
B. 66 mm
C. 133 mm
D. 166 mm

Answer D

Corrected rebound deflection, $D_c = 2\,mm$

Allowable deflection, $D_a = 1\,mm$

Overlay thickness, $h = 500 \log_{10}\left(\frac{D_c}{D_a}\right)$

$= 500 \log_{10} 2$

$= 166\,mm$

Q. 196) For a circular curve of radius 200 m, the coefficient of lateral friction is 0.15 and the design speed 40 kmph. The equilibrium superelevation (for equal pressure on inner and outer wheels) would be

A. 21.3
B. 7
C. 6.3
D. 4.6

Answer C

For equal pressure on inner and outer wheels,

$$e = \frac{v^2}{127R} = \frac{40 \times 40}{127 \times 200}$$

$$\boxed{e = 6.3}$$

Q. 197) If a descending gradients of 1 in 25 meets an ascending gradient of 1 in 40, then the length of valley curve required for head light distance of 100 m will be

A. 30 m
B. 130 m
C. 310 m
D. 630 m

Answer B

Head light sight distance is the distance visible to a driver during night driving under the illumination of head lights.

As per IRC 73 1980 length of Valley curve

1. When $L > S$, $L = \frac{NS^2}{1.50 + 0.035S}$

2. When $L < S$, $L = 2S - \frac{1.5 + 0.035S}{N}$

Where,

N = deviation angle

L = Length of valley curve in m.

S = headlight sight distance in m.

Deviation angle, $N = \frac{1}{40} - \left(\frac{-1}{25}\right) = 0.065$

Assuming $L > S$, $L = \frac{0.065 \times 100^2}{1.5 + 0.035 \times 100}$

$\boxed{L = 130\text{m}}$

Q. 198) An ascending gradient of 1 in 100 meets a descending gradient of 1 in 50. The length of summit curve required to provide overtaking sight distance of 500 m will be

A. 938 m
B. 781 m
C. 470 m
D. 170 m

Answer B

Length of Summit curve

1) for Safe Stopping sight distance (SSD = S)

$L > S$ $\quad \boxed{L = \frac{NS^2}{4.4}}$ $\qquad L < S$ $\quad \boxed{L = 2S - \frac{4.4}{N}}$

2) For intermediate or overtaking sight distance (OSD = S)

$L > S$ $\quad \boxed{L = \frac{NS^2}{9.6}}$ $\qquad L < S$ $\quad \boxed{L = 2S - \frac{9.6}{N}}$

Deviation angle, $N = \frac{1}{100} - \left(-\frac{1}{50}\right) = 0.03$

Assuming $L > OSD\ (S)$

$$L = \frac{0.03 \times 500^2}{9.6} \approx 781\,m$$

Q 199) Which one of the following pairs is not correctly matched?

A. Horizontal curves..... Superelevation
B. Origin and destination studies... Desire lines
C. Los Angeles test..... Hardness of aggregates
D. Soundness test..... Purity of bitumen

Answer D

Durability:- Aggregates used in pavements have to withstand the adverse action of weather such as physical and chemical action of rain and ground water and effects of atmosphere etc.
The durability of aggregates is determined by soundness test.

Solubility test:- is used to measure purity of bitumen. Pure bitumen is completely soluble in solvents like carbon disulphide and carbon tetrachloride.

Q. 200) Which one of the following expressions gives intermediate sight distance as per IRC standards? (SSD: stopping sight distance; OSD: overtaking sight distance)

A. 2 SSD
B. (SSD + OSD) / 2
C. (OSD – SSD) / 2
D. 2 OSD

Answer A

Intermediate sight distance (ISD) is defined as twice SSD.

Thank You For Watching

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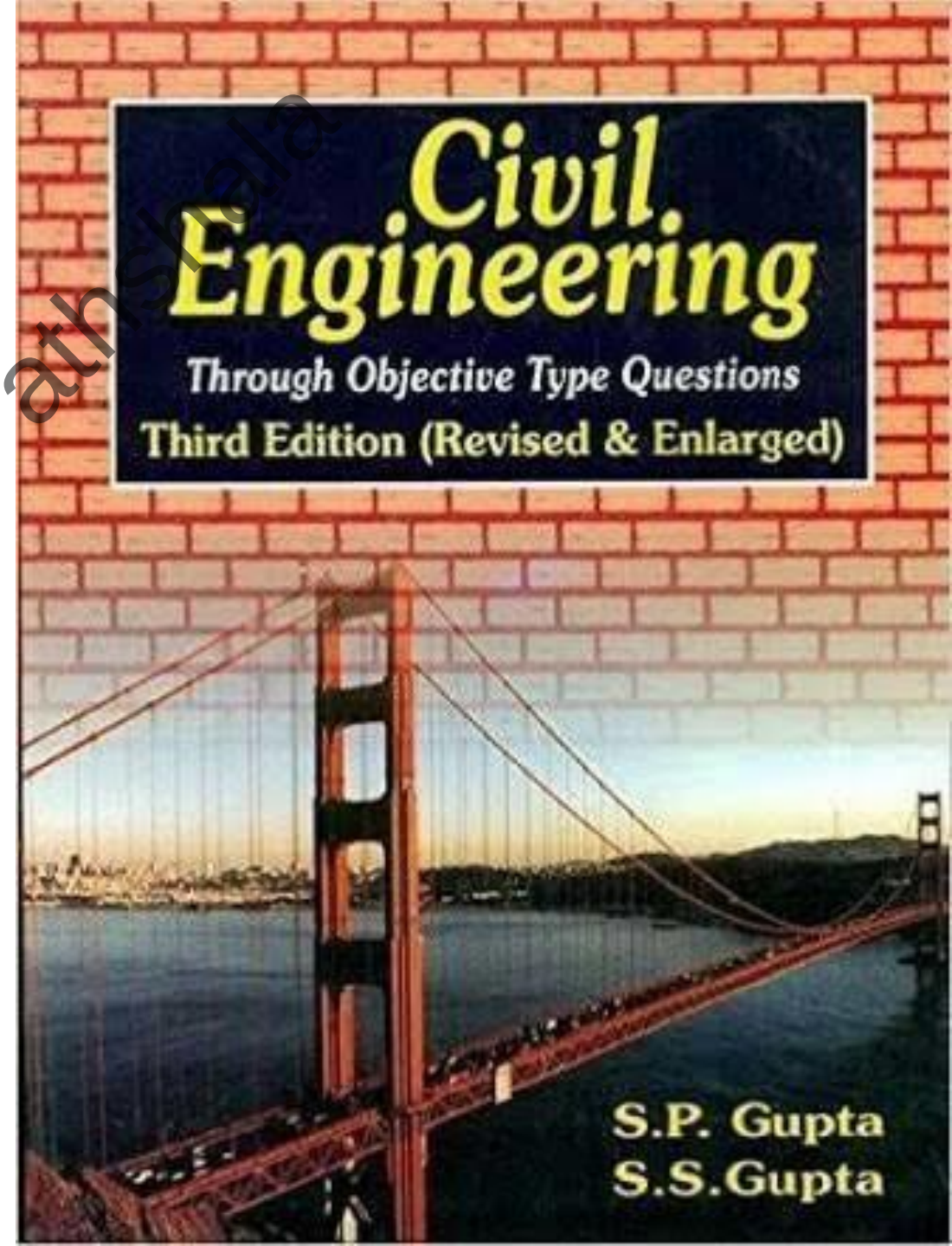
SSS-JE, AE(PSC), RRB etc.

(201 to 207 END)

Last Part

Highway Engineering



Q. 201) Consider the following:
1. L.L. of soil,
2. P.L. of soil,
3. S.L of soil
4. Annual average rainfall,
5. Temperature of soil

As per the latest IRC guidelines, the set of essential data required to determine moisture correction factor of clayey subgrade soil in Benkelman beam study would include

A. 1,2 and 4
B. 1,2,3 and 4
C. 2,3 and 5
D. 4 and 5

Answer A

The seasonal variation cause variation in subgrade moisture. The plasticity index (LL – PL) and annual average rainfall are the data required to determine moisture correction factor.

Temperature correction is separately applied.

Q. 202) As per latest IRC guidelines for designing flexible pavement by CBR method, the load parameter required is

A. Number of commercial vehicles per day
B. Cumulative standard axles is msa
C. Equivalent single axle load
D. Number of vehicles (all types) during design life

Answer B

Indian roads congress has specified the design procedures for flexible pavements based on:-
1. Design traffic in terms of cumulative number of standard axles and
2. CBR value of subgrade.

The method considers traffic in terms of the cumulative number of standard axles (8160 kg) to be carried by the pavement during the design life.

MSA Means million standard axle.

Q. 203) If the load, warping and frictional stresses in a cement concrete slab are 210 N/mm², 290N/mm² and 10N/mm² respectively, the critical combination of stresses during summer midday is

A. 290 N/mm²
B. 390 N/mm²
C. 490 N/mm²
D. 590 N/mm²

Answer C

Combination of Stresses

1. Summer Mid-day, Edge ~~Stress~~ region

$$\sigma_{critical} = \sigma_e + \sigma_{te} - \sigma_f$$

2. Winter Mid-day, Edge ~~stress~~ region

$$\sigma_{critical} = \sigma_e + \sigma_{te} + \sigma_f$$

3. Winter Mid-night. Corner region

$$\sigma_{critical} = \sigma_e + \sigma_{te}$$

Where,

σ_e = load Stress

σ_{te} = warping Stress

σ_f = friction Stress

In Question, Summer mid-day

$$\sigma_{critical} = 210 + 290 - 10$$

$$= 490 \text{ N/mm}^2$$

Q. 204) Brake is applied on a vehicle which then is skids a distance of 16 m before coming to stop. If the developed average coefficient of friction between the tyres and the pavement is 0.4, then the speed of the vehicle before skidding would have been nearly

A. 20 kmph
B. 30 kmph
C. 40 kmph
D. 50 kmph

Answer C

Average skid resistance, $f = \frac{V^2}{2gL}$

$V = \sqrt{2gfL}$

$= \sqrt{2 \times 9.8 \times 0.4 \times 16}$

$= 11.2$ m/sec

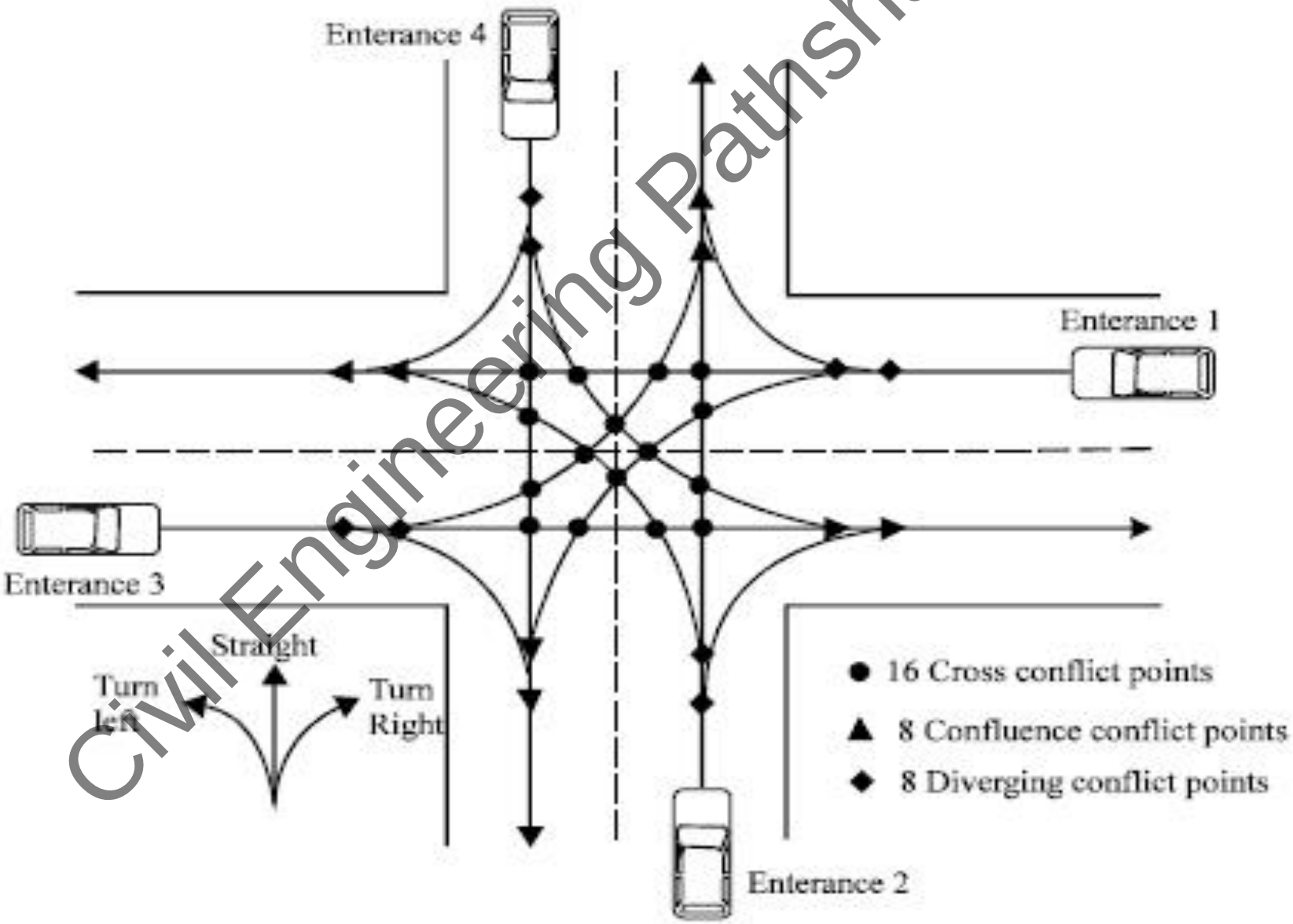
$= 11.2 \times 3.6$ Kmph

$= 40.32 \approx 40$ Kmph

Q. 205) When two roads with two-lane, two-way traffic, cross at an uncontrolled intersection, the total number of potential major conflict points would be

A. 32
B. 24
C. 16
D. 4

Answer A



Q. 206) Rapid curing cutback bitumen is produced by blending (admixture) bitumen with

A. Kerosene
B. Benzene
C. Diesel
D. Petrol

Answer D

Cutback bitumen:- Normal practice is to heat bitumen to reduce its viscosity. In cutback bitumen suitable solvent is used to lower the viscosity of the bitumen. From the environmental point of view also cutback bitumen is preferred. The solvent from the bituminous material will evaporate and the bitumen will bind the aggregate.

The distillates used for preparation of cutback bitumen are naphtha, kerosene, diesel oil, and furnace oil.

There are different types of cutback bitumen like
1. Rapid curing (RC)- Petrol
2. Medium curing (MC) – Kerosene
3. Slow curing (SC)

Q. 207) A two lane single carriage-way is to be designed for design life period of 15 years. Total two way traffic intensity in the year of completion of construction is expected to be 2000 commercial vehicles per day. Vehicle damage factor = 3.0, land distribution factor = 0.75. Assuming annual rate of traffic growth as 7.5%, design traffic, expressed as cumulative number of standard axles, is

A. 42.9×10^6
B. 22.6×10^6
C. 10.1×10^6
D. 5.3×10^6

Answer A

207. It is given by $\frac{365 \times A\left[(1+r)^{\eta}-1\right]}{r} \times F$

where, A = traffic in year of construction in terms of CVD modified for lane distribution.

r = annual growth rate

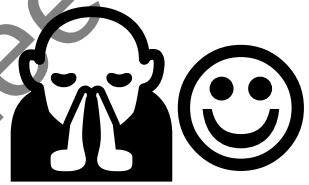
η = design life in years

F = Vehicle damage factor

So $\frac{365 \times 2000 \times 0.75\left[(1+0.075)^{15}-1\right]}{0.075} \times 3.0 = 42.9 \times 10^{6}$

The End

Thank You For Watching



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