INSTITUTE OF TEXTILE TECHNOLOGY

CHOUDWAR

SUB-HIGHWAY ENGG.

BRANCH-CIVIL ENGG.

SEM-4th

PREPARED BY

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CHAPTER → 1

Introduction

INTERDUCTION :-

* Imp of Highway transportation.

⇒ Transpotetion means to move one place to another place of person, Goods and animal etc.

* Role of Transportation :-

→ Transpotetion contributes to the economic, Industrial, social and cultural development of any country.

→ Transpotation is vital for the economic development of any reason since every commodity produced whether it is food, clothing, Industrial products or medicine needs transport are all from production stages to distribution.

→ In the production stages, transportation is required for carrying raw materials likes :- seeds, coal and steel etc.

* Different mode of transportation :-

→ There are 3 basic mode of transpot are by Land, water, air.

→ Land has given scope for development of road and Rail transpot.

→ The 4 measure transpots of are :-

(i) Road ways / Highways
(ii) Rail ways
(iii) water ways
(iv) Air ways

→ Apart from these measured mode transportation other mode include Pipe lines, ceneveters, cable cars etc. Pipe lines are used for transpotion of

water, other buds etc.

AIR WAY :-

→ The transportation of air is the birstest amount the 4 modes.
→ Air travels also provied more cotract apart from living in transportation time bor the passenger and the Gods between the airport.

water way :-

→ Transportation by water is the slowest amount the 4 modes.
→ This modes is minimum energy to unit load through unit distance.
→ The transpotetion by water is possible between the ports in the sea out or along the rivers and cenal where inland bacility are available.

Rail way :-

→ The transportation along the railway track should be advantages by railways between the station both bor passenger and Gods bor a long distance.
Full Advatage of this mode should be taken bor the transpotetions of Gods allow Land where the railway bacilities are allow.

Road way / Highway :-

→ The transportation by road is the only mode which bood give maximum service to one

and all.
This mode has also the maximum bacilibility the travel with reference to root, direction, time and speed of travel.
It is also provided door to door service only by road transport.

CH → 2

D → 23-03-2020

Highway development and planning

Historical development of road construction

① Roman Road :-

→ During this period of roman civilgation many roads wear belt of stone blocks of consi-tenable thickness.

→ It was constructed in 312 BC and extending over 580/80 km the road building technis word by roman BC - Before Crist

main features of roman roads :-

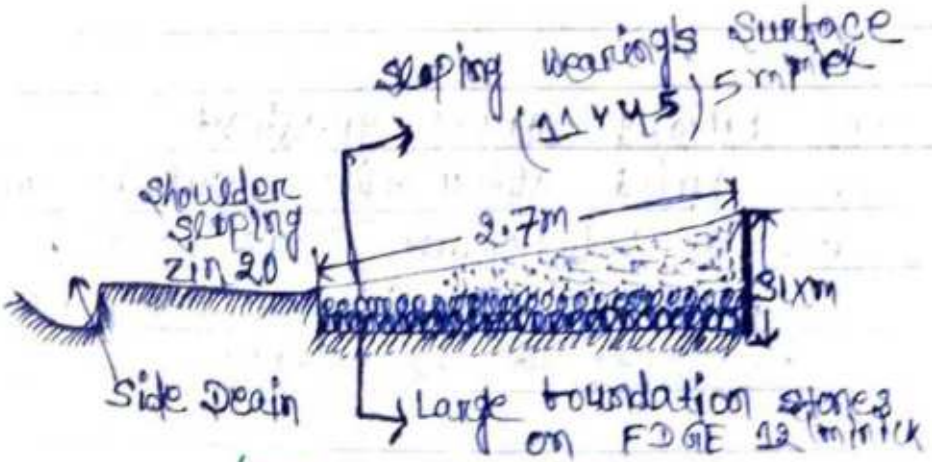
i) They were buildy streat gradient
ii) They were build after the subsoil was remove and a highstorium as rist.
iii) The total thickness of construction was as high as 0.75 to 1.2 metere

→ One Two layers of large stone were Laid in lime mortar at the bottom.
→ The thickness of the bottom layer from 10 to
→ The middle part of this road made from Rotin stones in Lime mortar 85 to 90 cm thickness.
→ The wearing c consist of large ston blocks sethin Lime mortar provide at the top.

Tresagued Road :-

pinetresagued develop and improve method & construction inbrance by the year 1964.

Tresagued develop Saverd methods of construction



(TYPical consSection of

→ The subgread was Prepared and the layer of Large foundation stones were Lade byhand.
→ The broken stones were baged to

a thickness of about 8.0 centimeter and compacted.

→ The top wearing course was made of smaller stones and given true slop or 1 in 45 to the surpoye so that the true slope drain the surface water.

Telebond road :-

→ Fom as telebond bigger his wall in 1900 senture.

Fetures :-

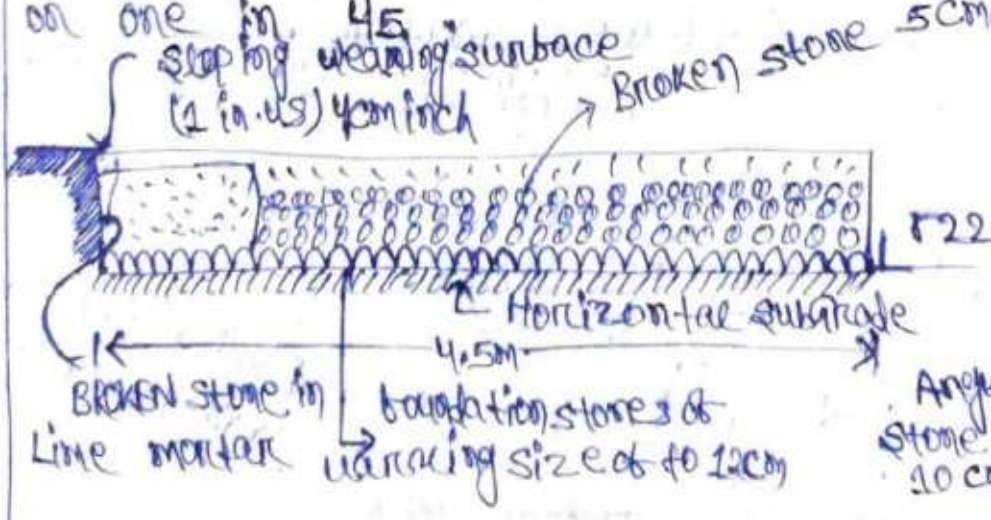
→ The level subgrade was prepared to design ^ of the width about 9meter's.

→ The large boundation stones developes 17 to 18 centimeter.

The emer layer between boundationsting were filled with smaller stone.

→ The binding layer of wearany course 4th centimeter thick was constructed on the top using graved.

The finish surface had a crush slope on one in 45



Macadem Load :-

→ John macadem put forward and entirely new method of road construction as compared to all the previous methods.

Features :-

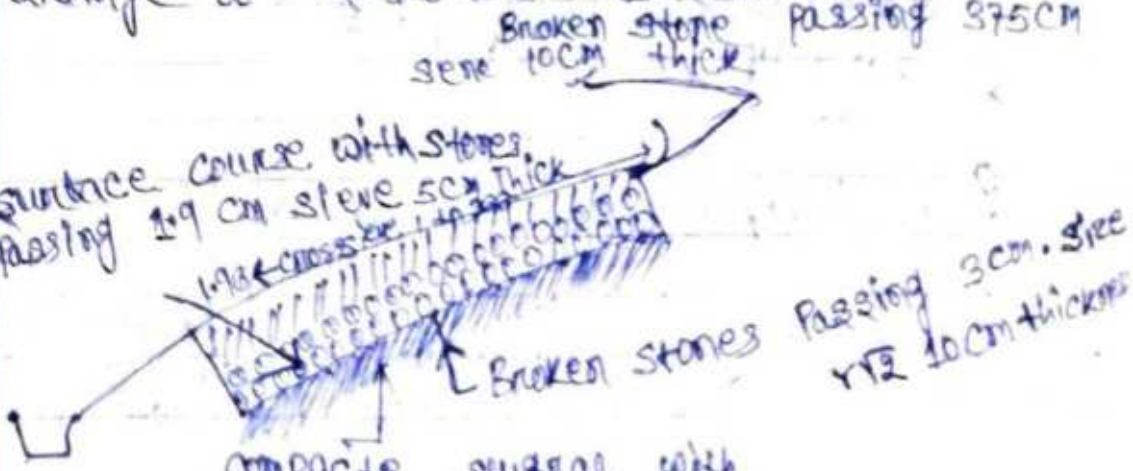
→ The importance of subgradench and compaction where recognized so the subgrade was compacted and was prepared with a cross slope of 1 in 36.

→ Macadem was the first person to suggest that heavy foundation stones are not necessary to be placed at the bottom layer of construction.

→ The thickness of construction was less than previous method.

→ The size of Broken stones for the top layer was divided based on the stability.

→ The pement surface was also prepared with a transiope of 1 in 36 for drainge of surface water.



Indian road congress :-

→ Indian road congress was formed in 1934
→ It is the one of the main constituented to Provide a better requirement in planning, construction and maintenance of road in India.

→ The IRC has played important road in the formation of (3-20) year road development plan in India.

Motar Vehicles Act :-

→ In 1950 the central road research institude has started at new delhi the is one of the national of ratories of the council of scientific and Industrial reasearch.

National Highway :- (NH)

→ National highways are main highway running through the length and breadth of India, connecting major ports, foreign highways, capitals of large states and large industrial roads.

→ The highway connecting Delhi - Ambala - Amritsar is denoted as NH-1.

(ii) State highway :-

→ These road connecting up with the national highways of adjacent state, district head-quater & important cities within the state.

→ The NH & SH have the same design specification

(iii) Major District Roads :- (MDR)

→ These are important roads within a district serving areas of production and markets and stations connecting those with each other or with the main highways of a district

→ The major district Road has lower speed & geometric design specifications their NH or SH.

iv) Other District Roads :- (ODR)

→ These are the roads serveying rural ares of production & providing them with outlet to market centres, These are up lower design specification than MDR.

(v) Village Roads (VR) :-

→ These roads are connecting village or groups of villages with each other to the nearest road of a higher category.

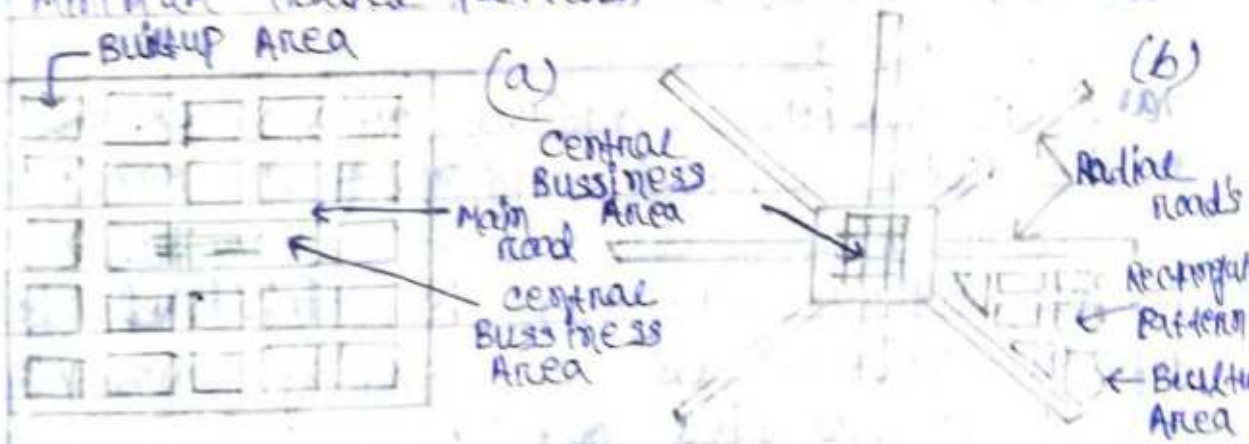
* Classification of urban Roads :-

The road system within urban areas are classified as urban road. The urban roads are classified as :-

(i) Arterial roads (ii) Sub-arterial roads
(iii) collector streets and (iv) Local streets

Road Patterns →

(a) Rectangular / block pattern
(b) Radial / star and block pattern
(c) Radial / star and circular pattern
(d) Radial / star and grid pattern
(e) Hexagonal pattern
(f) Minimum travel pattern



Object of highway planing →

→ To plane a road network for efficient & safe traffic operation at minimum cost.
→ To arrive at the road system & the length & different categories of roads which could provide maximum utility & could be constructed with in the available resources during plane period under consideration.
→ To plane for future requirement &

CH→2

Highway Alignment and Survey's

improvement of road's development

Highway geometric design :-

* Highway Alignment →

→ The position on the lay out of centre line of the highway on the ground is called the Alignment.

→ There are 2 types of alignment
1) Horizontal Alignment
2) vertical Alignment

1) Horizontal Alignment →

Horizontal alignment includs the state Path horizontal deviation & curve.

2) Vertical Alignment →

change in gradient & vertical curves are covered under vertical alignment of road.

* Engineering surveys for highway locations →

→ Before highway alignment is finalised in highway Project the engineering survey's are to be carried out.

→ The surveys may be compiled in 4 stages
i) Map study
ii) Reconnaissance
iii) Preliminary surveys
iv) Final location and detailed surveys.

① Map study :-

→ If the topographic map of the area is available, it is possible to suggest the likely routes of the road.

→ In india topographic maps are available from the survey of India, with 15 or 30 meter contour intervals.

→ In this survey it possible to have an idea of several possible alternate routes.

② Reconnaissance :-

The second stage of survey's for highway location is the reconnaissance to examine the general character of the area for deciding the most feasible routes for detailed studies.

③ Preliminary survey →

→ To survey the various alternate alignments proposed after the reconnaissance and to collect all the necessary physical information and details to topography, Drainage and soil.

→ To compare the different proposals in view of the requirements of a good alignment.

→ To estimate quantity of earth work materials and other construction aspects and to workout the cost of alternate proposals.

→ To finalise the best alignment from all considerations.

(iv) Detailed survey →

The alignment finilished at the design of its after the preliminary survey is to be first located on the field by establishing the centre line. Next detail survey should be carried out for colecting the imformation neccessary for the preparation of planes & construction details for the highway projects.

CH → 2

Highway Geometric Design

Introduction:

Imp of Geometric Design :-

The Geometric design of a highway deals with the dimensions and layout of visible features of the highway such as :- alignment, site distance and inter section.

The Geometric design of highway should be design to provided optimum efficiency in traffic operations with maximum safty reasonable cost.

The designer may be exposed to either planning of new highway or improving of existing highway to meet the requirement of the traffic.

Geometric design of highway deals with the following elements →

(1) Cross-section
(2) sight distance consideration
(3) Horizontal alignment details
(4) Vertical alignment details
(5) Inter section elements

→ Why super elevation is Provided in road curve ?

→ super elevation is Provided by raising the outer age of pevement to counter act the centrifugal force developed on a vechile traversing a horizontal curve.

* Design control :-

→ The Geometric design of highway depends upon several design factor.

1 → Design speed
2 → Topography
3 → Traffic factors
4 → Design hourly volume and capacity
5 → Environmental and other Factors.

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① Design speed :-

→ The design speed is the most important factor controlling the geometric design elements of highways.

→ The design speed is decided taking into account the overall requirements of the highway.

→ In India different speed standards have been assigned depending upon the imp of the class of the road such as National / state highways, Major / other district Roads and village Road etc.

→ Urban roads have a different set of design speeds.

② Topography →

→ The topography is the condition influence the Geometric design of highway.

→ The terrains are classified based on the general slope of the country. acc

the alignment. such as → Plane Rolling, mountain and steep terrains etc.

→ Design standards specified for different classes of roads are different depending on the terrain classification.

For ex:- The design or ruling speed of NH and SH the cross slop up to 10% is 100 kmp/h.

	Terrain	Cross slop
1-	Plane terrain	10% (100 kmp/h)
2-	Rolling terrain	10-25% (80 kmp/h)
3-	Mountainous "	25-60% (50 kmp/h)
4-	hilly "	above 60%

③ Traffic factor →

→ The factor associated with the traffic that affect geometric design of road's are the vehicular characteristics and human characteristics of road users.

→ It is difficult to decide the design vehicle or the standard traffic lane under the mixed flow condition.

→ This is a complex problem.

The imp human factors traffic behaviour include the physical, mental and psychological characteristics of drivers and Pedestrians.

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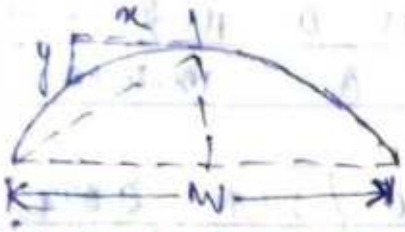
④ Design hourly volume and capasity :- (fluctuate)
The traffic volume keeps flatuating with time from a low value during off peak hours to the highest value to the peak hours.
It will be uneconomical to design the road way facilities for the peak traffic flow or the highest hourly traffic volume. reasonable
Therefore, A reasonable of traffic volume is a decided for the design and this is called design hourly volume.

⑤ Environmental factor :-
The environmental factor such as air pollution, noise pollution and other local condition should be given due consideration to the design on road Geometric.

Cross slope / camber :-
→ cross sloped camber is the slope provided to the road surface in the transpot direction to drain up the road water from the road surface
Drainch and quick disposal of water from the pigment pavement surface by avoiding cross slop.

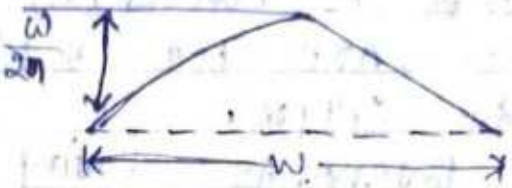
Shape of cross slope :-
→ The camber is given a parabolic, straight and also combination of parabolic and street line.

→ Parabolic shape is given so that the profile is flat at the middle and steeper towards the edges.

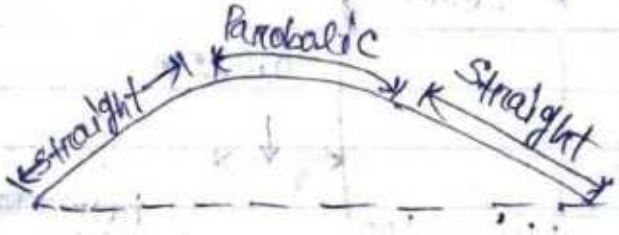


(a) Parabolic shape

$$\left[y = \frac{2x^2}{nW}\right]$$



(b) Straight line camber



(c) combination of straight & Parabolic shape.

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Forming a straight line cambe is very simple. But in case of Parabolic camber, the general equation $y = \frac{x^2}{a}$.

where $a = nW/2$

Carriage way →

→ The carriageway width depends on the width of traffic lane and number of lanes.

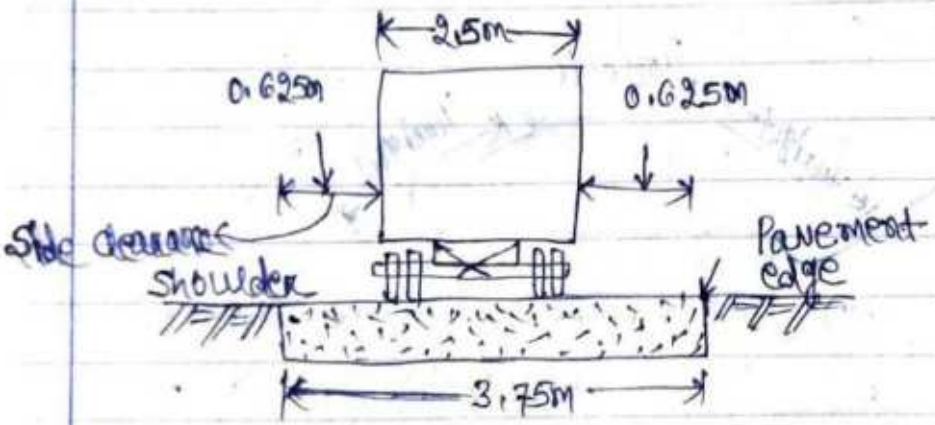
→ The carriage way intended for one line of traffic movement may be called a traffic Lane.

→ The lane width is determined on the basis

of the width of vehicle and the minimum side clearance which may be provided for the safety.

→ Keeping all these in view a width of 3.75 m is considered for a road having single lane for vehicles of maximum width 2.44 m.

→ For pavements having two / more lanes, width of 3.5 m per lane is considered.

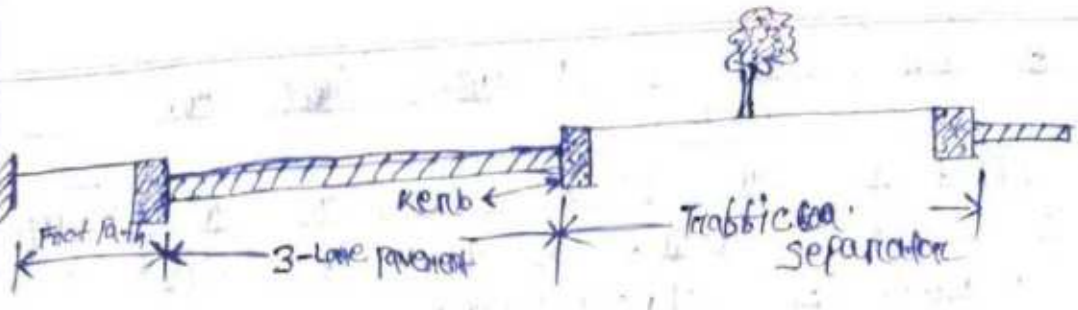


	Class of road	width of carriageway
(i)	Single lane	3.75 m
(ii)	Two lane, without raised kerbs	7.0 m
(iii)	Two lanes, with raised kerbs	7.5 m
(iv)	Intermediate carriageway	5.5 m
(v)	Multi-lane pavements	3.5 m per lane

Kerb :-

→ Kerbs indicate the boundary betw the pavement and shoulder.

→ It is desirable to provide kerbs on urban roads.



Kerb and traffic separator

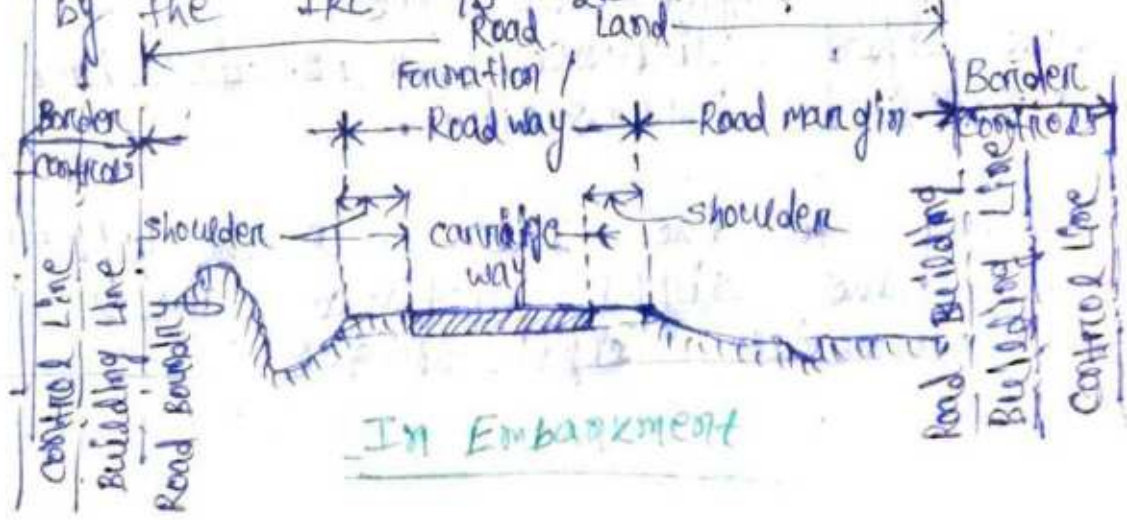
Road Margins :-

The various elements included in the road margins are shoulder, parking lane, driveway, cycle track, foot path and embankment slope.

→ Shoulders are provided along the road edge to serve as an emergency lane for vehicle compelled to be taken out of the pavement.

→ It is desirable to have a minimum shoulder width of 4.6 m so that a truck stationed at the side of the shoulder would have a clearance of 1.85 m from the pavement edge.

→ The minimum shoulder width recommended by the IRC is 2.5 m.



In Embankment

Right of way →

→ Right of way is the area of land acquired for the road, along its alignment.

→ The width of this acquired land is known as Land width & it depends on the imp. of the road & possible future development.

Sight Distance →

Introduction :-

sight distance available from a point is the actual distance along the road surface, which a driver from a specified height above the carriage way has visibility of stationary / moving objects.

→ In other words, sight distance is the length of road visible ahead to the driver at any instance.

→ There are 3 sight distance →

1) stopping or absolute minimum sight distance
2) overtaking sight distance
3) safe sight distance for entering into uncontrolled intersection.

* According to the IRC in the highway design the sight distance are →

Intermediate sight distance

(i) Intermediat sight Distance →

→ It is defined as the twice the stopping sight distance, when overtaking sight distance can not be provided.

(ii) Head light sight Distance →

→ This is the distance visible to a driver during night driving.

→ This sight distance is critical at up-gradients and at the ascending stretch of the valley curves.

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(iii) stoping sight Distance (SSD) →

→ The minimum sight distance available on a highway at any spot should be of sufficient length to stop a vehicle travelling at design speed, safely without collision with any other obstruction

→ This is also defined as absolute minimum sight distance is equal to the stopping sight distance, which is also some times called non-passing sight distance. eye

→ As per IRC the height of the level of driver is 1.2m and the height of the object as 0.15m above the road surface.

Total reaction time :-

Reaction time of the driver is the time taken from the instant the object is visible to

to the driver to the instant the brakes are effectively applied.

→ The amount of time gap depends on several factors.

→ During this time the vehicle travels a certain distance at the original design speed.

→ The stopping distance increase with increase in reaction time of the driver.

PIEV Theory :- According to this theory the total reaction time of the driver is split into 4 parts

1) P → Perception
2) I → Intellection
3) E → Emotion
4) V → Volition

1) Perception time →

→ Perception time is the time required for the sensations received by the eyes or ears to be transmitted to the brain through the nervous system.

→ In other words, it is the time required to perceive an object / situation.

2) Intellection time →

→ It is the time required for understanding the situation.

→ It is also the time required for comparing the different thoughts,

→ The total reaction time of an coverage driver may vary from 0.5 sec. For simple situation but it take 3 to 4 second or even more in complex problem

Lag distance :-

→ During the total reaction time or PIEV time the vehicle may be assumed to provide forward with a uniform speed at which the vehicle has been moving & this speed may be taken as the design speed.

→ If v is the design speed of in m/sec & t is the time of the driver in second, then lag distance = v x t m

→ If the design speed is N.K/h then the lag distance work out to

$$D = 0.278 \times Vt$$

→ The IRC has also recommended the value of reaction time $t = 2.5$ sec. for the calculations of stoping distance.

Braking distance :-

The co-efficient of friction (f) depend's upon several factor's such as

type & condition of pavement surface & tyres & also the value of F decreases with increase in speed.

Speed km/h	20-30	40	50	60	65	80	100
Longitudinal co-efficient of friction (f)	0.40	0.38	0.37	0.36	0.36	0.35	0.35

Stoping distance = lag distance + Breaking distance

Sleping distance in metre (m)

$$= vt \cdot \frac{v^2}{2gf}$$

$$\text{Sleping distance in (km)} = 0.278\, vt + \frac{v^2}{254f}$$

for stoping distance for n per-cent Gradient,

stoping distance v = m/sec

$$\Rightarrow 0.278\, vt + \frac{v^2}{254(f \pm 0.01n)}$$

Q→ Calculate the shape SSD for design seed of 50 km/h for :-

(a) Two way traffic in two way Length.

(b) (2) Two way traffic in single plane road.

2/04/22

Lag distance →

$v \cdot t$

Braking distance →

$$\frac{v^2}{2gf}$$

where v = m/sec

stoping distance = Lag distance + Braking distance

→ calculate the safe stopping distance for design of 50KM/h for →

1→ To way traffic to way le

2→ To way traffic / on a single plane road. Assume co-efficient of friction 0.37 & reaction time of over 2.57.

→

Given, $v = 50KM/h = 13.9$

$T = 2.57$

$g = 9.8$

$f = 0.37$

→ Lag distance $= v \cdot t = 50 \times 2.57 = 13.88 \times 2.57$

$= 35.6716$

→ Braking distance $= \frac{v^2}{2gf} = \frac{(13.88)^2}{2 \times 9.8 \times 0.37}$

$= \frac{192.6544}{7.252}$

$= 26.56$

→ stoping distance = Lag distance + Braking distance

= 35.67 + 26.56

= 61.2 m.

* V = K/h

Lag distance = 0.278 × V × t → Formula

Braking " = $\frac{V^2}{254f}$

$0.278 \times 50 = 13.9 \times 2.5 = 34.75$

$\frac{50^2}{254 \times 0.37} = 26.60$

Stoping distance = (Lag + Braking) $34.75 + 26.60 = 61.3$

a) Stoping sight distance where 2 lanes = 61.4 m.

b) Stopping sight distance for two-way traffic with single line = 2×61.4 = 122.8

2-11-4-22

Q→ Calculate the stopping sight distance for design speed of 70 km/h.

(a) Two way traffic on a two lane road.

(b) Two way " " " single plane road.

Assume co-efficient of friction 0.41 reaction time of driver 2.8 sec.

A→ Given,

$V = 70 \text{ km/h} = 70 \times \frac{1000 \text{ m}}{3600 \text{ sec}} = 19.44 \text{ m/sec}$

$f = 0.41$

$t = 2.8 \text{ sec}$

$g = 9.8$

Lag distance = $V \cdot t = 19.44 \times 2.8 = 54.432$

Braking " = $\frac{V^2}{2gf} = \frac{(19.44)^2}{2 \times 9.8 \times 0.41} = 47.02$

Stopping sight distance = Lag distance + Braking
= 54.43 + 47.02
= 101.45 m

* $v = k/h$

Lag distance = $v.t$ ~~× 0.278~~ $0.278vt$
= ~~29.40~~ → $0.278 \times 70 \times 2.8$
= 54.48

Braking distance = ~~$\frac{v^2}{2.g.f}$~~
= ~~$\frac{(70)^2}{2 \cdot 9.8 \cdot 0.41}$~~ = ~~609.75~~

$\frac{v^2}{254 f} = \frac{70^2}{254 \times 0.41} = 47.05$

Stoping sight distance = Lag distance + Braking distance
= 54.48 + 47.05
= 101.53

Q→ Calculate the minimum sight distance required to avoid a head on collision approaching from the opposite direction at 90 and 60 km/h. Assume the reaction time 2.5 sec, co-efficient of friction of 0.7

A→ Given,
$v = 90$ & 60
$t = 2.5$ sec
$f = 0.7$, $g = 9.8$

(i) Lag distance = $v.t = 90 \times 2.5 = 25 \times 2.5 = 62.5$
Breaking " = $\frac{v^2}{2.g.f} = 45.55$ m

Stopping sight distance = 62.5 + 45.55
= 108.05

(ii) Lag distance = $v_1 t$ = $\frac{18.6}{}$ × 2.5 = 41.5 m

Braking " = $\frac{v^2}{2gb}$

= $\frac{18.6^2}{2 \times 9.8 \times 0.7}$

= 20.08 m.

Stopping sight distance = 41.5 + 20.08
= 61.58

* opsite direction = ~~41.5 + 61.58~~
= ~~108.08~~
= 108.05 + 61.58
= 169.63

Stopping sight distance for n % Gradient

$= \left(vt + \frac{v^2}{2g(b \pm 0.01n)} \right)$

When speed in km/h SSD $= \frac{0.278 vt}{254(b \pm 0.01n)}$

Formula

Over taking sight distance :- (OSD)

If all the vehicles travel on a road at the design speed, then theoretically there should be no need for any over taking. In fact all vehicles do not move at the designed speed and this is particularly true under mixed traffic conditions. In such circumstances, it is necessary for fast moving vehicles to overtake / pass slow moving vehicles.

→ The minimum distance open to the vision of the driver of a vehicle intending to overtake slow vehicle a with safety against, the traffic of oppsite direction is known as the minimum overtaking sight distance (OSD) / the safe passing sight distance available.

→ The overtaking sight distance / OSD is the distance measured along the center of the road which a driver with his eye level 1.2m above the road surface can see the top of an object 1.2m above the road.

OSD depends :-

(a) speed of (i) overtaking vehicle
(ii) over taken "

(b) distance between the overtaking & overtaken vehicle

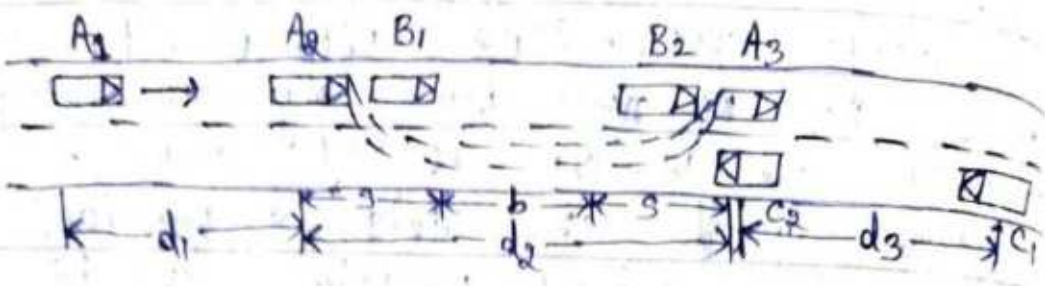
(c) Reaction time of the driver

(d) the rate of acceleration of overtaking vehicle

(e) Gradient of the road

OSD = $d_1 + d_2 + d_3$

fig. 8



(Over taking manoeuvre)

Q→ Calculate the stoping sight distance on a highway gradient of 4% design speed of 100 km/h assum other data as per IRC Recommended.

A→ Given data,

$v = 100 \text{ km/h}$

$n = 4\% = 0.04$

$g = 9.8$

$t = 2.5 \text{ sec}$

$f = 0.35$

$$SSD = 0.278 \cdot vt + \frac{v^2}{254(f + 0.01 \times n)}$$

$$= 0.278 \times 100 \times 2.5 + \frac{(100)^2}{254(0.35 + 0.04)}$$

$$= 69.5 + 100.94$$

$$= 170.44 \text{ m}.$$

Maximum/desirable → 5 × 0.30

$d_3 = 0.278\,VT$

$= 0.278 \times 96 \times 11.24$

$= 299.97$

$d_2 = 0.278\,v_b T + 2$

$= 0.278 \times 80 \times 11.24 + 2 \times 22$

$= 293.97$

one way ⇒ $d_1 + d_2$

$= 44.48 + 293.97$

$= 338.45$

two way ⇒ $d_1 + d_2 + d_3$

$= 44.48 + 293.97 + 299.97$

$= 638.42$ m

V = over taking vehicle

v_b = " taken "

Q→ The speed of over taking and over taken vehicle are 70 and 40 Km/h Respectibility on a two way traffic road. If the acceleration of over taking vehicle is 0.99 m/sec^2.

i) Calculate the over taking sight distance

ii) Mention the minimum Length of over taking zone.

iii) Desirable Length of over taking zone.

A→ $V = 70$ Km/h $= 70 \times \frac{1000}{3600} = 19.44$ m/sec

$v_b = 40$ Km/h $= 40 \times \frac{1000}{3600} = 11.11$ m/sec

Two way → $d_1 + d_2 + d_3$

$d_1 = V_b t = 11.11 \times 2 = 22.22$ m.

$d_2 = V_b T + 2 \times 13.77$

$= 110.30$ m.

$d_3 = VT = 19.44 \times 7.45$

$= 144.82$ m.

$T = \sqrt{\frac{4S}{A}}$

$= \sqrt{\frac{4 \times 13.77}{0.99}}$

$= 7.45$ sec

$S = 0.7 \times V_b + 6$

$= 0.7 \times 11.11 + 6$

$= 13.77$ m.

OSD $= d_1 + d_2 + d_3$

$= 22.22 + 110.30 + 144.82$

$= 277.34$ m.

Minimum $= 3 \times OSD$

$= 3 \times 277.34$

$= 832.02$ m.

Desirable $= 5 \times OSD$

$= 5 \times 277.34$

$= 1386.7$ m.

2) The speed of over taken and over taking are 90 km/h and 100 km/h on a one way traffic & acceleration of vehicle = 2.5 km/h/sec.

i) calculate over taking sight distance.

D - 13-4-22

superelevation :-

→ In order to counter the effect of centrifugal force and to reduce the tendency of the vehicle to overturn. The outer edge of the pavement is raised with respect to the inner edge.

→ This transverse inclination to the pavement surface is known as superelevation or cant or banking.

$$\text{Centrifugal force} \Rightarrow P = \frac{Wv^2}{gR}$$

W = weight of vehicle
v = speed " "
G = specific Gravity
R = Radius of the curve

Q→ calculate the centrifugal force acting upon a four wheeler car having weight of 12tons at a speed of 80 km/h. Acting upon a radius of the curve 200 m.

A→ Given, W = 12
V = 80 km/h
g = 9.8
R = 200m.

$$P = \frac{WV^2}{gR} = \frac{12 \times (80)^2}{9.8 \times 200} = 39.183$$

* If the speed of the vehicle is represented as V m/sec.

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

Where e = Rate of superelevation
g = Acceleration due to Gravity
R = Radius of the
f = design value of lateral friction or co-efficient = 0.15

* If the speed of the vehicle is represented as V KM/h.

$$e+f = \frac{(0.278V)^2}{9.8 \times R}$$

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

* equilibrium superelevation

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

$$\boxed{f = 0}$$

Q) The radius of the horizontal curve is 100 m. The design speed of 50 KM/h and the design speed co-efficient of the lateral friction = 0.15

(i) Calculate the superelevation required if

Q-16-4-22

equilibrium

Q→ Design the rate of super elevation for a horizontal highway curve of radius 500m speed 100 kmph.

A→ $e = \frac{V^2}{127R}$ $V = 100 km/h$ $R = 500$

$e = \frac{(100)^2}{127 \cdot 500} = \frac{10000}{63500} = 0.15$

Design superelevation :-

$e = \frac{0.75 V^2}{127R} = \frac{V^2}{225R}$

* The maximum superelevation is 0.07. If super elevation value is more than that the superelevation to be provided is restricted to 0.07.

Q→ Design the rate of superelevation for a horizontal Highway curve of radius 500 m & speed is 100 km/h.

A→ $V = 100 km/h$

$R = 500 m$

$e = \frac{V^2}{225R} = \frac{(100)^2}{225 \times 500} = \frac{10000}{112500}$

the maximum = 0.089

As the value of superelevation of 0.0 the actual superelevation to be provid is restricted to 0.07.

D-18-04-2022

Q) A measure district road with thin bituminous pavement surface in low rainfall area has horizontal curve of radius 1400 m. If the design speed is 65 km/h. what should be the design superelevation.

A) $R = 1400$ m,
$V = 65$ km/h

$$e = \frac{V^2}{225R} = \frac{(65)^2}{225 \times 1400} = 0.01$$

Widening of pavement on Horizontal curve :-

The widening of pavement on horizontal curve is devided into 2 parts :-
(i) Mechanical
(ii) Psychological

i) Mechanical :-

$$W_m = \frac{nl^2}{2R}$$

where, R is the Radius of curve
L is the Length of wheel base
n = Number of len's

ii) Psychological :-

$$W_{ps} = \frac{V}{9.5\sqrt{R}}$$

Q→ Calculate the extra windening required for a pavement of within 7m. on a horizontal curve of radius 250 m & at a design speed of 170 km/h.

A→ Given, $L = 7m$.

$R = 250m$

$n = 2$

$V = 170 km/h$

$We = Wm + Wps$

$= 0.19 + 0.46 = 0.665$.

$Wm = \frac{nl^2}{2R} = \frac{2 \times (7)^2}{2 \times 250} = 0.196$

$Wps = \frac{170}{9.5 \times \sqrt{250}} = 0.46$

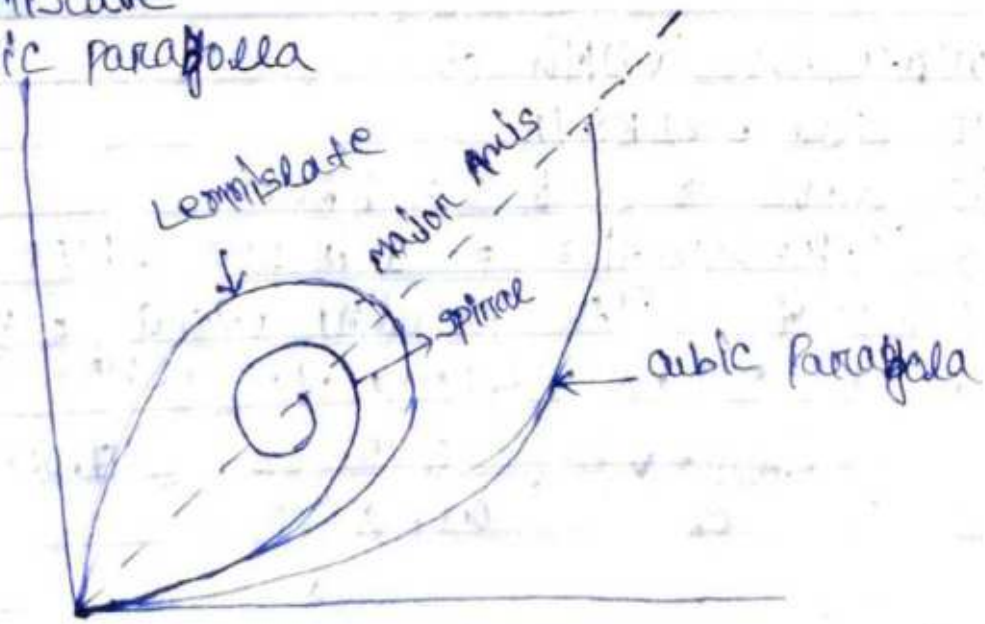
* Trandaction curve →

TYPES :-

1→ Spiral

2→ Lemniscate

3→ Cubic parabola



① Summit curve →

Summit curve are convexity occward, when L is greater than SSD.

$L < SSD \Rightarrow L = \frac{2S - 4.4}{N}$

$L > SSD \Rightarrow L = \frac{NS^2}{4.4}$

② Valley curve →

valley curves are in the bottom any one of the casess illustrated at the valley curve are centrifugal force is downward.

$\frac{LS^2}{9.6}$

where, $L > S$, $L = \frac{2S - 9.6}{N}$

$L < S$, $L = \frac{2S - 9.6}{N}$

Q→ A vertical summit curve at the intersection of 2 Gradient +3 & -5%. Design the length of summit curve to Provided a stopping sight distance.

A→ Given, $f = 0.35$

$t = 2.5$ sec

$N = 80$ KM/H

$SSD = 0.278 \times 80 \times 2.5 + \frac{80^2}{254 \times 0.35} = 127.6$ m.

To Gradients are

$N = 0.03 - (-0.05)$

$= 0.03 + 0.05$

$= 0.08$

Assume $L > SSD$

$L = \frac{LS^2}{4.4} = \frac{0.08 \times 127}{4.4}$

$= 296.032$

* Compensation in Gradient of horizontal curve :-

i) Grade compensation →

$$= \frac{30+R}{R}$$

where, R = Radius of the curve

ii) Maximum Limit of Grade Compensation →

$$= \frac{75}{R}$$

Both are expressed in (%) Percentage.

iii) Compensated Gradient = Rulling Gradient − Grade Compensation

Q→ While alling a hill road with a rulling Gradient of 6% A horizontal curve of radius 60m is encountered. Find the compensated Gradient.

A→ Given, Rulling Gradient = 6%
Radius (R) = 60m.

$$\frac{30+R}{R} = \frac{30+60}{60} = 1.5$$

$$\frac{75}{R} = \frac{75}{60} = 1.25$$

∴ compensated Gradient = Rulling − Grade
= 6 − 1.25
= 4.075

Highway/Road Material

Sub Grade soil →

→ Sub Grade soil is an intrigral part of road pavement structure As it Provide support to the pavement from beneath.

→ The main function of the Sub Grade is to give adequite support to the pavement so, sub Grade should posses sufficient stability under loading condition.

Characteristic of soil →

→ Soil consist mainly in the mineral matter formed by the disintrigation of Rock by the action of water, temp^{re}, Press by plant & animal Life.

→ Based on the size of Grain soil have been classified as ⓐ Gravel
ⓑ sand
ⓒ silt
ⓓ clay

Properties of soil →

① stability
② Incompressibility
③ strength
④ Minimum changes in volume
⑤ Good drainch
⑥ ease of compation.

Index properties of soil →

→ There are the wide range of soil type available as highway construction Material have made it obligetory on the part of highway Eng. to identify & classified the different soil.

→ The soil properties on which there identification & classification based are known as Index properties.

→ The index properties which are used are Grain size distribution, Liquid limit & plasticity index.

Grain size analysis :-

→ The Grain size distribution is found by mechanical Analysis.

→ The compont of soil which are course Grain may be analysed by seive Analysis.

Consistency Limit →

→ The physical properties of fine Grain soil especially of clay depen very much at diffet water content.

→ A clay may be almost in a liquid state.

→ It may so plastic behaviour / may be stiff depending on the moisture Content.

→ Plasticity is a property of outstanding

imp of clay soil.

→ Consistency limit is also known as atterberg limit.

Liquid Limit :- may be

→ Liquid limit is defined as the minimum water content at which soil will flow under the application of very small shearing force.

Plastic Limit :-

→ It is defined as the minimum moisture content at which the soil remains in a plastic state.
This lower limit is known as plastic limit.

Plasticity Index →

→ It is defined as the difference between the liquid & plastic limit.

$$P.I = LL - PL$$

Shrinkage Limit →

→ " " is the maximum moisture content at which further reduction in water content doesnot cause reduction in volume

D-26-4-22

Uniformity coefficient (Cu) →

$$C_u = \frac{D_{60}}{D_{10}}$$

$$C_g = \frac{(D_{30})^2}{D_{60} \times D_{10}}$$

PT = LL - PL

Test to soil strength = ① Shear test
② Bearing test
③ Penetration test

① Shear test :-

Shear test are usally carried out on relatively small soil sampl in the Labrotory In order to find the strength properties of soil a number of repreSantive. Some of the commonly non shear test are Carried out.

② Bearing test :-

Bearing test are loading test carried out on subgrade soils with a load bearing area To result of the bearing test are in twist by the variation in the soil properties with in the soil mass under neath & hence overal the stability of part of the soil mass could be studyed.

③ Penetration test :-

Penetration test may be consider as small scale bearing test in which the size of loaded area is relatively much smaller. The penetration test are carried at in the

field or Labrotory.

California bearing ratio test :- (CBR)

→ This is a penetration developed by California division of highway as a method for evaluating the ductability of soil subgrade & other texide pavement material.

The CBR test may be conducted in the Labrotory on a prepare specimen.

→ The Labrotory CBR apporats, consist of a mold 150mm diameter with plate & a collar.

→ According from is the cylindrical plunger 50 mm diameter
cylindrical plunger 15 mm diameter.

→ The penetration test consist of causing a cylindrical plunger of 15mm diameter to penetrate a pavement material of 1.25mm / minute. D-27-4-22

→ To Ladd value to cause 2.5 mm & 5mm penetrate as recorded.
This load's are expressed as % of standard load value's at recepetable obteted CBR values.

→ The standard load values is obtend from the average of a large number of test on crossed stone are 1370 kg

Test for road aggregate

i) Crushing test
ii) Abrasion test
iii) Impact test
iv) Soundness test
v) water absorption test

(i) Crushing Test :- For strength

→ The strength of course aggregate may be assis by aggregate crushing test. The aggrega crushing value provided resistance to applied compresive load.

→ The apparatus for the test consist of a steel cylinder 15.2cm diameter with a base plate & a plunger, compression testin machine, cylindrical measure of diameter 11.5cm & height 18cm, tampering rod & sieve.

→ Dry aggregate passing 12.5mm sieve & retained on 10mm sieve is filled in a cylindrical measure in 3 equal layers. Each layer being ramped 25 times by the tamper The test sample is weighed (W_1) & test in a cylinder.

→ The Plunger is placed on the top on the specimen & a load of 90 ton is applied at the rate of 4 ton per minute by compression machine.

→ The crushed material which passed this sieve is weighed (W_2).

→ The crushed aggregate is removed & sieve

on 2.36 mm sieve.

→ Aggregate Crushing value = $W_2/W_1 \times 100$

(ii) Abrasion test :- [For Hardness]

→ Abrasion test are carried out to test the hardness properties of stone & to decide wheather they are suitable for the different road construction work.

→ The test is carried out using 3 test
1) Los-Angles Abrasion test
2) Deval Abrasion test
3) Dorry Abrasion test

(1) Los Angle's Abrasion test :-

→ The principle of losangles abrasion test is to find the % wier due to the relative rubing action betn the aggregate & steel balls used as abrasion charge.

→ Loss angle mechine consist of hollow cylinder closed at both end. Having inside diametre 70cm & Length 50cm.

→ The abracis charge consist of cast iron spears of diametre 4.8cm. & each of weight (390-455) gm.

→ The number of spheans to be used as the abracis charge & total weight having specified based on grading of aggregate sample.

Procedure :-

→ The specified weight of aggregate specimen is placed in the machine along with abracis charge.

→ The machine is roteted at a speed of (30-33) R.P.M (Revolution per minute) for specified No° of revolution.

→ Then the aggregate is taken out & sieved 1.7 mm.

→ The weight of powder aggregate passing this sieve is found.

→ The result of abraction test is expressed as the % wear / the % passing on 1.7mm sieve in terms of original weight of sample.

3) Impact Test :- [Toughness]

→ The toughness of stone / the resistance aggregate fracture under repited impact is called Impact test.

→ The aggregate impact test machine consist of a metal base and a cylindrical steel cup of internal diameter 10.2 cm. & depth 5cm. in which the aggregate specimen is placed.

→ A metal hammer of weight (13.5 - 14.0) Having a free fall from a height of 38 cm. is arrange to drop to vertical.

Procedure :-

Aggregate passing 12.5mm sieved & retain 10mm sieve is filled in a cylindrical measure in 3 layer's by tamping, each layer 25 blow's.

The sample is transtored from the measu to the cup of the aggregate impact testi machine.

The hammer is raised to a height of 38cm above the up surface of the aggrega & is allow to fall freely on the specimen.

→ After subjecting the test specimen to 15 Blow's.

Then the aggregate is sieve on 2.36 mm sieve.

The aggregate impact value is expressed as the % of the fine from returns t total wight of sample.

(1) Soundness Test :-

→ Soundness test is to study the resistance of aggregate to weathering action by conducting weathering test cycle.

→ It is determined by using saturated solution of sodium salfet / magnesium salphet.

→ clean dry aggregate speciment of specified size range is weighed & counted.

→ It is most in the saturated on the sodium sulphet & magnesium salphet.

→ Then the specimen is dryed in an oven at

Hill Road

The terrain is classified into 4 types

Types of terrain		Cross slope (%)
Plane	———	0 – 10 %
Rolling	———	10 – 25 %
Mountainious	———	25 – 60%
Stiff	———	More than 60%

Alignment of hill Road :-

The hill road alingment should link of the obligatory & control points fitting well in the land scape & satisfying the geometric requirement.

The best alingment for a hill road is one where the total sum of ascend & descend betwn extreme points is the least. It is permissible increase the length as much as 50 times the hight.

The various state necessary in the alignment of a hill including map study, recognizans priliminary survey & detail survey.

It may be advantageous to start the survey from the higher obligatory points.

Alignment survey :-

The alignment of hill road is fixed in the 3 stages (i) Recognizance
(ii) Priliminary survey
(iii) Detail survey

Recognizance :-

The first topographical, geological, metrological maps of the area & areal photograph are studied. This may be followed by recognizance where it is necessary & pheasible.

Preliminary survey →

The route selected during the recognizance is translated on the ground during the preliminary survey so as to provide & asses for detail survey.

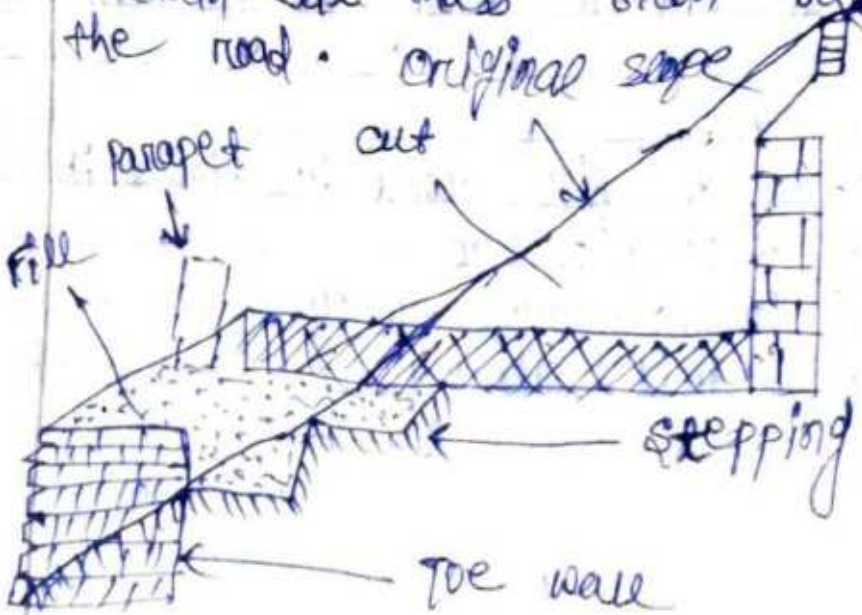
Detail survey →

During the detail survey bench marks are fixed & the longitudinal & crossectional are obtained. The centre line is marked by reference pillar & all the detail survey are carried out on the route.

Hill Roads partially cutting & filling →

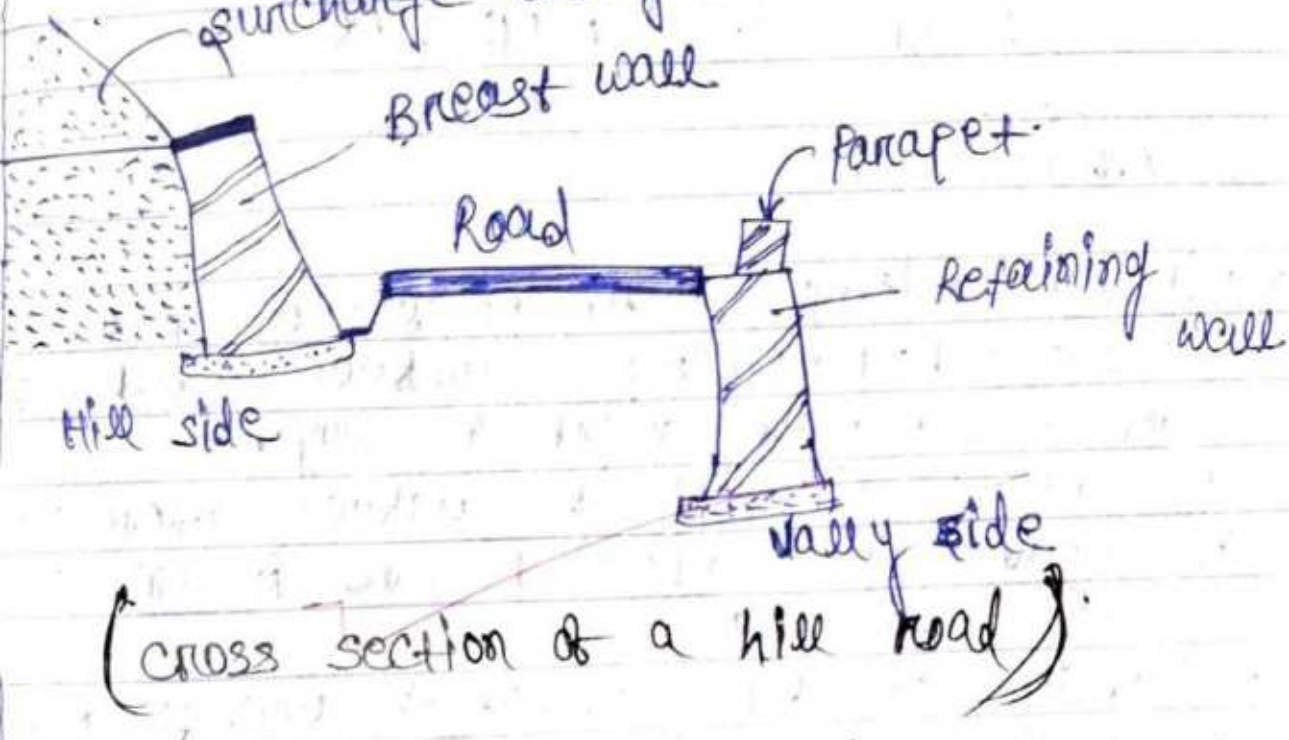
Retaining wall →

→ Retaining wall is constructed in the upstream side of the road formation to retain soil mass from coming down on the road.



Breast wall →

Breast wall is defined as the wall built to prevent the soil on a natural slope in embankment from sliding down the slope from the weather effect.



(Cross section of a hill road)

Retaining wall :-

Retaining wall is constructed on the upstream side of the road formation to retain soil mass from falling down on the road.

Hair pin bend :-

Because of rock, deep valley hair pin bends are unaccordable on hill roads. within the limit the available turning angles it is often very difficult & sometimes even impossible layout curve in Normal Geometric design.

A hair pin bend is located on a hill's side

having the minimum slop & maximum stability.

→ It must also be state from view point & rapid slide's.

New → CH → 14-5-2022

Road & Drainage

Introduction :-

→ Highway drainage is the procces of removing & controlling excess surface & sub soil water with in the right of way.

→ Removal & diversion of surface water from the road way & adjoining land is term was surface drainage.

→ Diversion or the removal of excess of soil water from the sub-Grade is termed as sub-surface Drainage.

Importance of highway drainage :-

→ An increase in moisture content causes decrease in strength or stability of sub soil

→ The variation in soil strength will moisture content depends, also soil type so highway drainage is important. Because -:

① Excess moisture in soil subgrade causes considerable lowering of its stability. The pavement is likely to fail, due to subgrade

failure.

(ii) Increase in moisture cause reduction in strength of many pavement material like soil & water bound macadam, one of the most causes of pavement failure by the formation of poor drainage.

Excess water added with mud pumping is due to the presence of water in the subgrade soil.

Requirement of highway drainage system:-

The surface water from carriage way & soldier should effectively drained off without allowing it to penetrate its subgrade The surface water from the additioning land capacity & longitudinal slop to carry away all the surface water collected. Seepage & other source of underground water should be drained off by the Sub-surface drainage system.

Surface drainage :-

The surface water is to be collected & then disposed of the water is first collected in longitudinal drain generally in side drain & then water is disposed of at a nearest stream valley & water course. Cross drainage, structures like culverts & small bridges may be necessary for the disposal of surface water from the road side drain.

Cross drainage :-

→ Whenever stream have to cross the road way facility for cross drainage is to be provided.

→ The water from the side drain is take a cross by these cross drain in order to divote the water away from the road to a water course. When a small stream crosses a road with a linear water nearly less than about 6m.

20-5-22

Sub-surface Drainage :-

→ Changes in moisture content of sub-grade are caused by fluctuation of Ground water table seepage flow percolation of Rainwater & moment of capilary water & even water vaper.

→ In subsurface drainage of highway it has to keep the variation of moisture in subgrade soil to a minimum.

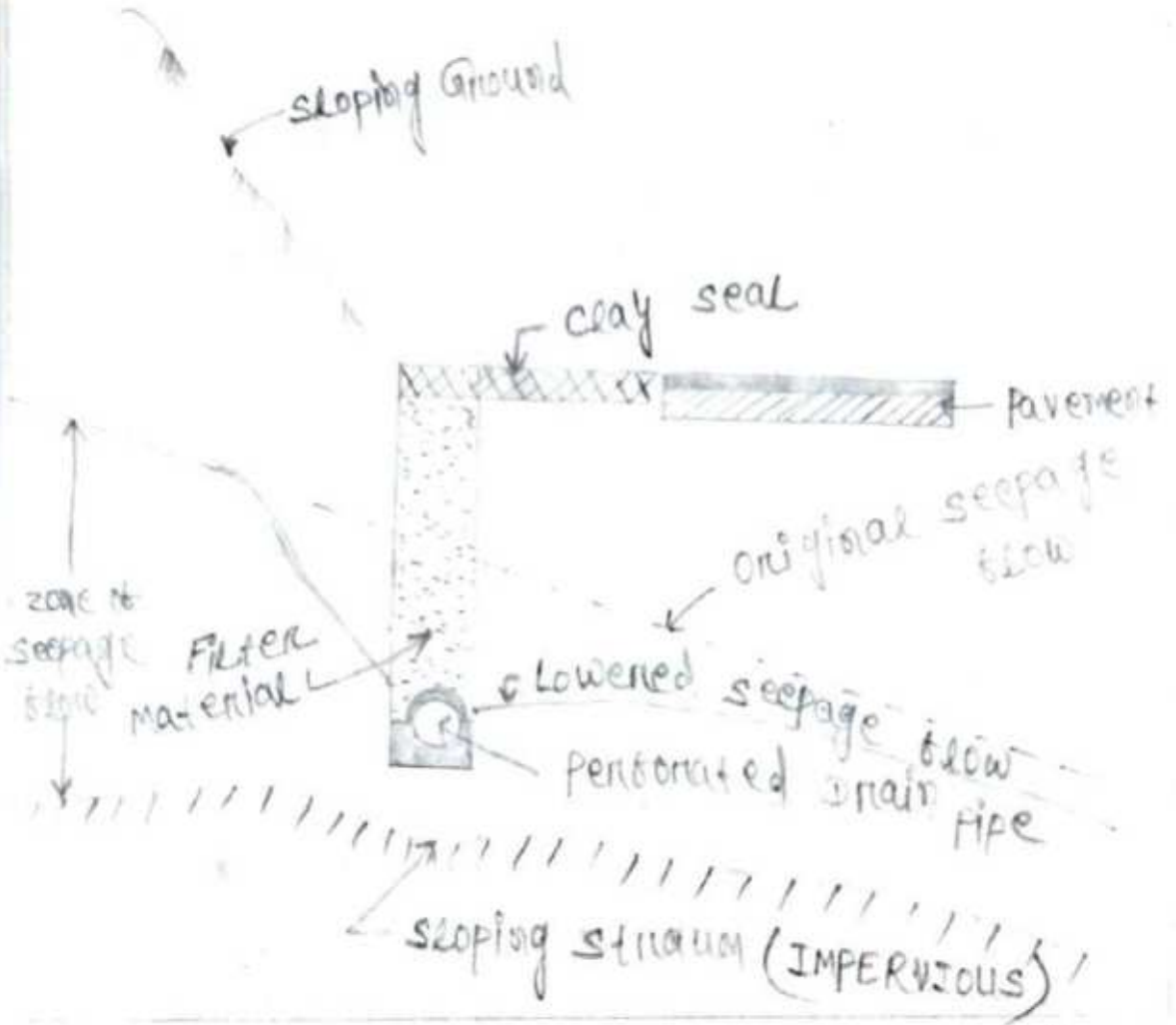
→ However only the gravitional water is drained by the usal drainage system.

Control of seepage flow :-

→ When the general Ground as well as the impervious data below are sloping seepage flow is lightly to exist.

→ If the seepage zone is at depth less than (0.6 to 0.9) m from the subGrade level

→ Longitudinal pipe drain in drainage filled with filter material.



(Control of Seepage flow)

Drainage of slop & erosion control :-

⇒ Drainge of slops of enbakment, cutting & hills side are of imp. to prevence instability of slop & slids.

⇒ socking of slop causes increase in stress & reduction in strength. Hence an efficient network of suntace drainage system constisite of enter sabting drain's & sloping drain's to keep the properly drain is very useful for stable.

⇒ The sloping drain's may be provied with lining & liching / may be filled with Gravel.

→ The water from sloping drainage is collected catchpits & divoted to across through the culvert at suaitable interval.

21-05-2022 New CH → 10

Highway Maintenance

* Need for highway maintenance :-

→ Road maintenance is one of the most imp. compenet of the enter road system.

→ The maintenance operation invalve the assessment of road condition.

* General cause of pevment failure :-

① Debtect in the quality of material use.
② Debtect in construction method.
③ surface / sub-surface drainage in the locality Resulting in the stagition of water in the sub-grade / in any of the peveren layer.
④ Increase in the magnitude of wheel load & the number of load repetetion due to increase in traffic valume.

* Classification of maintenance work :-

① Routin Mentenance →

→ These include filling of cut holes & patches Repairs.

② Periodic maintenance →

→ These include renewable of wearing cource of pevment surface & preventive maintenance of various item.

③ special Repair →

→ These include strengthing of pevement sub-structre or over lay construction, Reconstruction of pevment, widening of Road, Repair of damage caused by flood.

FAILURE

TYPES OF ROAD FAILUR :-

1) Shear failur
2) Longitudinal cracking
3) Reflection "
4) Lack of binding to the lower corse
5) Map cracking
6) consolidation of pevment layer

D→ 23-05-22

1) Shear failure :-

Shear failure is associated with the weakness of Pevement mixture.

→ The shearing resistance being low due to inadquate stability in hevey loading

2) Longitudinal cracking :-

→ Due to defferential volume changes in subgrade Longitudinal cracking is caused in pevment traversing through the full pevment thickness.

(3) Reflection Cracking :-

→ This type of cracking is observed in bituminous over lays provided over a cement concreted pavement.

→ The crack pattern on existing in cement concrete pavement are mostly reflected on bituminous surfacing in the same pattern.

→ In this cracking, the cracks appears at the surface these allows surface water to sipp through an cause damage to the soil subgrade or result in mud ~~concrete~~ pumping.

(4) Lack of binding with lower course :-

→ Slipping occurs when the surface course is not bound with the under laying base.

→ This result in opng of and the loss of pavement material forming pot holes.

→ The such condition are more frequent in case when the bituminous surfacing is provided over the cement concrete base.

(5) Map cracking :-

→ The general pattern of the map cracking of the bituminous

surfacing is the most common type of failure & occurs due to relative movement of pavement layer materials. This may be caused by the repeated action of heavy wing load.

Consolidation of pavement Layer :-

The repeated action of load along the same wheel path deformation resulting in consolidation deformation.

* Maintenance of bituminous surface :-

It consist of (1) Path repairs
(2) surface treatment
(3) Re-surfacing.

Path Repairs :-

" " are carried out on the damage of improper surface. Cut holes have cut to rectangular shape & the affected material in the section is remove until the sound materials are encounter.

The excavated paths are clean & painted with bituminous binder.

A premixed material is then placed in the section. generally cut back is used as a binder.

The material in cut hole is placed & is well compacted by Raming.

The material in cut holes are

laced in layer of 6 cm.
The finish level of the pavement is kept slightly above original

* Surface Treatment :-
→ If the surface has been seriously damage due to oxidisation of binding material it may be necessary to apply more than 1 layer of surface treatment.

* Re-surfacing →
→ When the pavement surface is totally worn out & developed a poor riding surface it may be more economical to provided in additional surface course on the existing surface.

* Maintenance of Concrete Road →
→ It may be stated very little maintenance such as maintenance of join only is needed for cement Concrete road.
→ If their well designed & constructed
→ main defect in these type of road is formation of crack.

* Treatment of Crack :-
→ The crack developed in cement concrete may be classified into 2 groups :-
① Temp. crack
② Structral crack

1) Temp^{r} crack →

which are initially fine cracks across the slab in between the pairs of Longitudinal joint

→ Dividing the slap length into two / more approximately equal parts due to the temp^{r} stress. like → shrinkage stress, working stress in the slap.

2) Structral crack →

This Crack from near the age & corner reasons of the slab.

Due to combine coneload & working stress.

→ The presents of fine only such as are not harmful & donot call emidiat maintenance.

* Maintenance of Joint →

→ Joint the weekest part in the cement concrete pavement.

→ The efficiancy of the pavement determine by the proper functing of th join.

→ measurity of the failur in the cement concrete pavements are observes at or near the Joints.

→ The open of join is clean with brush & refield with suitable joined siller material before the start of the rain.

2-24-05-22

* Basic concept of traffic study's :-

→ Traffic studys or surveys are carried out for analysis the traffic characteristics.
→ These study's helth is deciding the Geometric design future & traffic control for safe & efficient traffic movement.
→ The traffic survey for collecting traffic data are also called traffic census.

* Traffic volume study's →

→ Traffic volume is the number of vehicle crossing a section of road per unit time at any selected period.
→ Traffic volume is used as a quantity measure & the commonly measure units are vechile per day vehicle per hour.
→ There are variation of traffic flow from time to time.
→ Hourly traffic volume varies considerably during the day.
→ The pic hourly volume may be much higher than average hourly volume.
→ Daily traffic volume's vary considerably in a week & there are variation with seasons.

Spot speed :-

It is the instantaneous speed of a vehicle at a specified section on a location.

Average speed →

It is the average of the spot speeds of all vehicles passing at a given point on a highway.

1. Upper speed Limit for Regulation = 85^{th} Percentage speed = 60 km/h.

2. Lower speed Limit for Regulation = 15^{th} Percentage speed = 20 km/h.

3. Speed to check design element = 98^{th} Percentage speed = 84 km/h.

The traffic flow characteristics :-

The basic traffic characteristics are diverging, merging, crossing etc....

→ Diverging from the left is the merging causing least problem on the traffic concrete.
→ This is because traffic is regulated from left side merging traffic is also from left side.

2-27-5-2022

* Passenger car unit (PCU) :-

→ different classes such as car, vans, buses, truck, motor cycles, Rickshaw, bullock etc ... are bound to use common road way facilities without segregation on most of the road in developing country in India.
→ It is common to consider for passenger car as the standard vechile unit to convert the other vechile classes.
→ This is called common PCU.

Sl No.	vehicle class	Equivalency factor (unit)
1.	Passenger car, Tempo, Auto rickshaw, Tractor	1
2.	Bus, truck	3
3.	Motor cycle & scutter, Pedal cycle	0.5
4.	cycle rickshaw	1.5
5.	hand drawn vechile	4
6.	small bullock cart	6
7.	large " "	8

* Road pavement :-

* Traffic capacity studys :-

Traffic volume :-

- Traffic volume is the no of vechile moving in a specified direction on a given roadway, that pass a given point during specified unit of time.
- Traffic volume is expressed as vechiles per hour / vechiles per day.

* Traffic density :-

- Traffic density is number of vechiles occuping a unit length of lane of a road way at a given instant.
- Usually expressed as vechile/km.
- Traffic volume is the produce of
Traffic volume = Traffic density X Traffic speed
Q.

Traffic capacity :-

- It is the ability of road way to carry the traffic volume.
- It is expressed as a maximum number of vechile in a Road that can pass a given point in unit time.

* Basic capacity :-

- It is the maximum number of passengers cars that can pass a given point on a Length of road during one hour under the road way.

possible capacity :-

It is the maximum Number of vechiles that can pass a given point on a road way under traffic condition.

Determination of theoritical maximum capacity

$$\text{Capacity} = C = \frac{1000V}{S}$$

where, C = capacity on a single length vechile/hour
V = speed km/h
S = center to center specing of vechile.

Q) Estimate the theoritical capacity of a traffic lane at a traffic flow at a speed of 40 km/h. Assume average speed of the vechile 0.278 Vt.
T = the average reaction time
Assume the length of vechile.

A) Given data, $V = 40$
$T = 0.7$

$S = 0.278 \times 40 \times V + L$
$= 0.278 \times 40 \times 0.7 + 5$
$= 12.784$

$C = \frac{1000\ V}{S} = \frac{1000 \times 40}{12.784} = 3128.91 \simeq 3129$.

28-5-2022

Highway Pavement:-

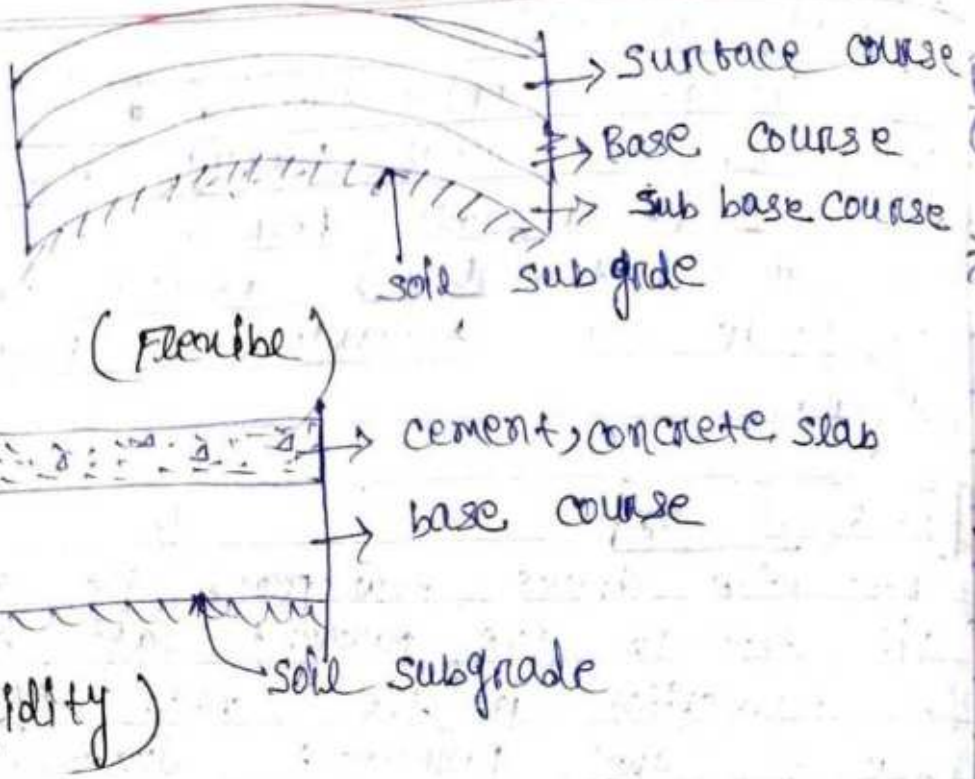
The pavement carries the wing's load's & transpered the road through the area on the soil-subgrade below.
The stress transtorred through the sub-grade soil through the pavement layer.

31-05-2022

Thus, the stress transpered to the sub-grade soil through the pavment layer.
The reduction in the wheel road stress due to the pavement depend's both on the thickness & the charetenstatics of pavement layer.
A " " is consider more efficient & suterier
It it is able to distribute wheel load's through a large area per unit depth of the layer. There will be a small amount of tempaenary deformation even a wood pavement surface when heavy wing's load's are applied.

TYPES OF PAVEMENT SURFACE :-

According to structural behaviour pavment are Jenerally classified into 2 category :-
① → Flexible pavement
② → Rigidity "



① Flexible pavement →

→ Fexible pavement are those which on the whole have low or negligible flexural strength & are rather flexible in their structural action under the load

→ The flexible pavement layers reflect the deformation of the lower layers on to the surface of the layer.

→ It the lower layer of the pavement or soil sub-grade is undulated.

→ The flexible pavement surface also gets undulated.

→ A tipical flexible pavement is 4 componet :- (i) soil subgrade
(ii) sub- surface course

Base course
surface course

The flexible pavement layer's transmit the vertical / compressive stress to the layer layer's by grain to grain transformed through the point's of contact in the Granular structure.
A well compacted " " consist of strong graded aggregate can transformed a compressive stress through a weather area & thus form a good flexible pavement layer.
The load spredding ability of this layer therefore depends upon on the type of the material & mixed design factor.
Bituminous concrete is one of the best flexible pavement layer materials.

Rigidity Pavement :-
Rigid pavement as those which possess flexural Rigidity.
The stress are not transpered from grain to grain to the lower layer. As in the flexible pavement case,
Rigid pavement's are made of Portland cement concrete either plane, reinforced & bridge stress concrete.

③ Try axial compression →

→ This test is consider as the most imp soil strength test.

→ Steel tire based is not very commonly used in structural design of pavement.

④ Plate bearing test →

→ This is carried out using the relatively a large diameter plate the load supporting capacity of pavement layer.

→ The load bearing test is used for determining the elastic modulus of sub-grade & other pavement layer.

* Function of sub base & base course :-

→ These layers are made of broken stone & aggregate.

→ Sometimes in sub base course a layer of stabilized soil or selected granular soil is used.

→ In some places boulder stones or bricks are also used as a sub base / soling course.

→ The sub base course is desirable to use smaller size graded aggregate / soil aggregate mixes / soft aggregate instate of large boulder stone soling course of brick on

end soiling course.

→ As these have no proper interlocking & therefore have lesser resistance to shifting into the week sub-grade soil when weight. when the sub-grade consist of fine grain soil. & when the pavement carries heavy wing load's there is a tendency for these boulder stone's / brick's to penetrate into the weight soil Resulting in the formation of undulation on

Wearing course :-

The purpose of wearing course is to give's smooth ridding surface.

→ It resist pressure exerted by & takes up wear & tear due to traffic.

→ wearing course is also often's a water layer against the surface water. in bituminous

→ In flexible pavement normally the bituminous surfacing is used as a wearing course.

→ In Rigid pavement the cement concrete acts like a base course as well as wearing course.

→ There is no test for evaluting the structural stability of the wearing course.

2 → 7-6-22

Mixed design in mechanical stabilization →

The factor to be consider in the design of mix of gradation design, index property & stability of these the gradation is the most imp. factor.

Gradation →

The particle size distribution that gives maximum density in generally is known as the theoritical Gradation.

Theoritical Gradation = $P = 100 \times \left(\frac{d}{D}\right)^n$

where P is the = Percentage finer than diameter
d is the material.
D = Diameter of the Largest particle.
n = Gradation Index Ranging from (0.5-0.3)
depending upon the shape.

soil cement stabilization →

A increase in cement contain generally course increase strength & durability Both normal & air entering cement gives almost the same results of stabilization.

~~compaction :-~~
~~Their is the optimum moisture content~~

* Sub-grade preparation :-

→ Preparation of sub-grade in builds all operation's before the pavement structure over it & compacted.

→ Thus the preparation of sub-grade included's sight clearance, Grading & compation.

→ The subgrade may be situted on embankment or excavation of the existing Ground. surface.

→ In all the caseas sight should be clear up & the top soil consisting of grass root & other organic matter are through be Removed.

→ The grading oparation is started vertical provied of the subgrade to design grade & camber. Bolldoun's, graders are usefull equipment to speed up this work.

→ It is most ettoral to compact to the top of surface upto a depth of about adequately before placing the pavement layer.

* Mechanical stabilization :-

→ When aggregate & soil adequately to get a mechanically stable layer the Method is known as mechanical stabilization.

→ The two basic principle's in the method of stabilization are :-

(1) Properity
(2) compaction.

→ It a granular soil containg negligible fines is mixed with a suitable proportion of binder soil.
It is possible to increase the stability similarly the stability of fine grain soil could be considerable increase by mixing a suitable proportion of a Granular material. to get a ~~proportion of~~ a suitable Gradation Mechanical stabilization is has been for sub base & base course construction.
→ It has been also used as surface course for low volume road such as village road's when the traffic ~~re~~ intensity are low.

Factor affecting Mechanical stability of soil

→ The stability of mechanical depending on following factor's :-

(i) Mechanical strength of aggregate
(ii) Gradation
(iii) Properties of soil
(iv) Present's of salt & mica
(v) compaction.

2- 20-6-2022

Construction Equipment's

Hot mixing plant :-

Hot mixing plant is one plant that is used for mixing the dry one aggregates & for homogenious mixture at the Require temp^{n}.
It is widly used to the construction of highway, city Road etc.
Working of the ashpled patch plant will include hidding & weing of the aggregates, widding & weing of bitumine, wearing of biuer material & in the end of in the end mixing aggregate, Bitumine & biuer material to produce Hot mix ashpled.
Hot mix plant is also known as ashpled drum mix Plant.
The ultimate mixture of ashpled, concrete fine aggregate, course aggregate, biuer material together, is final result of from mix plant output.
cold aggregate mixture from weight mix makadam plant is allow to spread to form base & minimum level of road & then this hot aggregate often from drum mix plant is used mainly to form final layer of Road.
Basically there are two different mode's of working of plant's.

(I) Batch type plant
(II) continue's " "

* Advantages:-

→ Fully autometic plant equived with control pannel box operation.
→ Due to variation is structure it can be to different site.
→ If one of the aggregates then it can be achieve with ashpled drum mix plant.
→ As all componet used as of high quality less mentainance is neded.
→ Easy to operate to highly
→ Economic plant.

2-21-06-2022

* Tipper:-

→ Tipper are used box the transpot box all material in the road construction.
→ Tipper's are suited box the rough & tumble of mining & quarring operation. As well as box carrying loads in construction & infra structure in Industrial.
→ It is common to see truck's.
→ It is used to litt & transpot loose building material's such as:- asphled, construction- aggregate, Gravel, sand, Grains & wood chips around a work site's.
→ A truck the rear platform of which can be raised at the front end to allow the load to the discharged by Gravity. Also called tip truck.

Tractor scraper :-

It is a heavy equipment used for earth moving application.
It is a machine use to remove/move, Gravel, dust, coal, mud & other unwanted materials from the Ground surface.
It is used for move Growth over short distance over smooth Area.

D → 22-06-2022

Bolldozar :-

Bolldozar are used for shall or digging & deaching, short rokge transportations & materide spreading soil dump from truck, rough gragging, remaning tress, stump bolldozars & cleaning & levering around loding equipment.

Bolldozar is a very powerbue Gralier that is equibed with a blead

Bolldozar have Great Ground hold & convert the power & Enggin into dragging avilty which allow's it to use its own weight to push heavy object & even remove things from the Ground.
The blead on the bolldozar is the heavy pice of metal plate that is instdsed on the front.

* Dumper :-

→ The dumper vechile design for carry buck material often on building size.

→ It is used the construction site dump truck are used for the transpotation of various loose material such as :- sand, gravel, earth.

D- 25-06-2022

* Shovel :-

→ These tool used with workers hand for lifting loose material consist of a curve container & a handle.

* Grader :-

→ A grader is a construction machine with a long blead used to create a flat surface during the grading process.

* Roller :-

→ A roller is a compactor.

→ It is used to compact soil, gravel, ~~etc~~ asphed in the construction of ~~Road~~ Road.

* Mixture :-

→ A concrete mixture is a device that homogeniously combin cement, aggregate such as :- sand / Gravel, & water to form concrete

→ A concrete mixture usess a river being drump to mix the componet.

AE 25/06/22