NEPAL ENGINEERING COUNCIL LICENSURE EXAMINATION

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TRANSPORTATION ENGINEERING SYLLABUS OF NEC LICENSE EXAM

9. Transportation **(ACiE09)**

9.1 Highway planning and survey: Modes of transport, history of road development in Nepal; classification of roads; road survey; highway alignment and controlling factors; evaluating alternate alignments; Road Standards of Nepal. (ACiE0901)

9.2 Geometric design of highway: basic design control and criteria; elements of highway cross-section; highway curves; super elevation; average and ruling gradients; stopping sight distance; design considerations for horizontal and vertical alignments, extra widening, and set back distance; design of road drainage structures; design considerations for hill roads. (ACiE0902)

9.3 Highway materials: types of aggregates and tests on their gradation, strength, durability; binding materials and their tests; design of asphalt mixes; evaluation of subgrade soil. (ACiE0903)

9.4 Traffic engineering and safety: impact of human and vehicular characteristics on traffic planning; traffic operations and regulations; traffic control devices; traffic studies (volume, speed, O&D, traffic capacity, traffic flow characteristics, parking, accident, flow); road intersections (types, configurations, design); traffic lights; factors influencing night visibility, road safety measures. (ACiE0904)

9.5 Road pavement: different types of pavement; design methods for flexible and rigid pavements (DOR Guidelines); loads and other factors controlling pavement design; stress due to load, temperature. (ACiE0905)

9.6 Road construction & maintenance: activities, techniques, tools, equipment and plants used in road construction; preparation of road subgrade; field compaction control and soil stabilization; construction of asphalt concrete layers; construction procedure for penetration macadam, bituminous bound macadam and plain cement concrete pavements; road maintenance, repair and rehabilitation. (ACiE0906)

TRAFFIC CONTROL DEVICES

- Traffic control devices are the media by which traffic engineers communicate with drivers and road users
- Traffic control devices are placed in key locations to guide and regulate traffic movement, control vehicle speeds, and warn of potentially hazardous conditions
- Traffic control devices also provide important information to users about traffic delays
- Virtually every traffic law regulation or operating instruction must be communicated through the use of devices that fall into four broad categories:

1. Traffic sign
2. Traffic signals
3. Traffic markings
4. Traffic Island

TRAFFIC CONTROL DEVICES

1. **Traffic sign:**

- Measure to convey specific information to the driver quite in advance, so that he/she may become careful
- The three main functions of traffic signs are to regulate, warn and inform
- Sign should be placed such that they could be seen and recognized by the road users easily and in time
- Location is about 0.5m away from kerb edge
- On roads without kerb the nearest edge may be 2m to 3m from the edge of carriage way
- Sign post painted with 25cm black and white bands

TRAFFIC CONTROL DEVICES

1. Traffic sign Contd:

- There is a different group of signs for each function, and the signs in each group have a uniform shape to help drivers recognize them quickly

- The three groups are:

I. Regulatory Signs

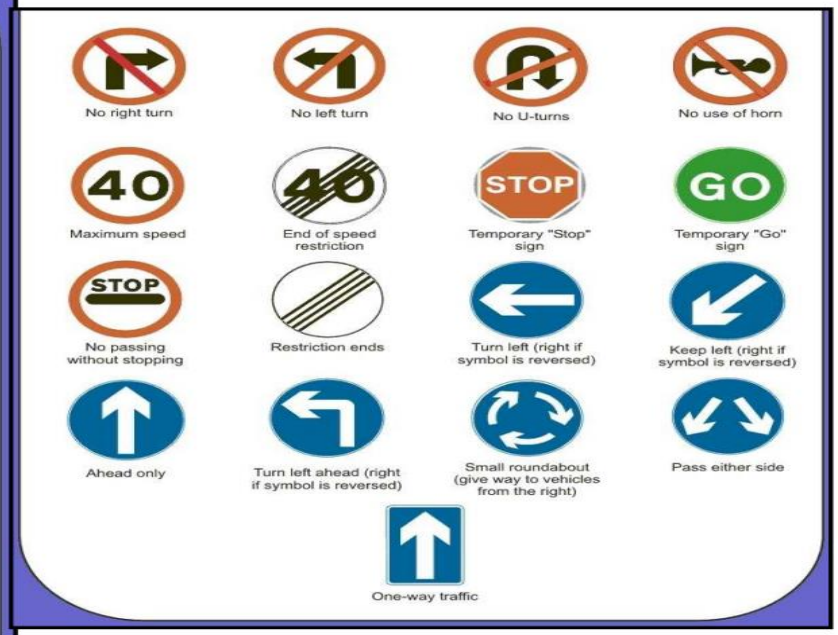
II. Warning Signs

III. Information Signs

TRAFFIC CONTROL DEVICES

I. Regulatory Signs Contd :

- Traffic Sign Manual (Published by DOR) schedule of regulatory signs (A1 – A33) thirty three types of signs



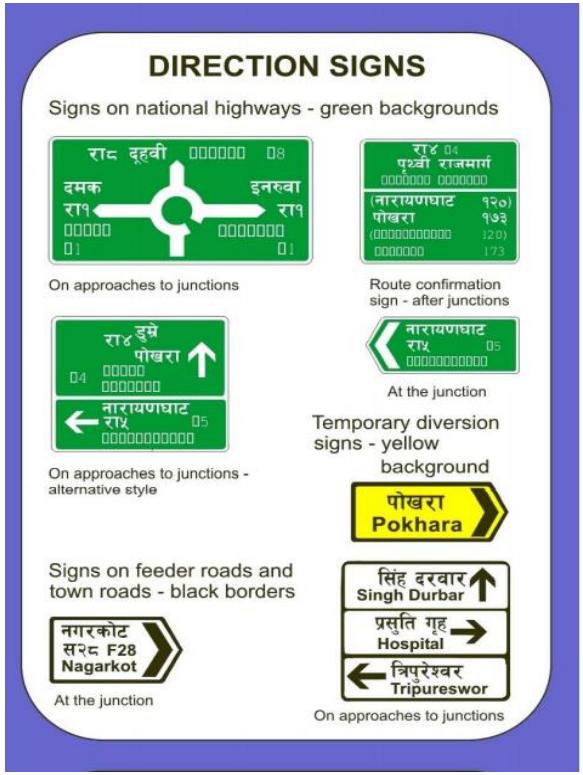
TRAFFIC CONTROL DEVICES

II. Warning Signs Contd:

The Traffic Sign manual describes about 48 warning signs (B 01 – B 48)

TRAFFIC CONTROL DEVICES

III. Information Signs Contd:



TRAFFIC CONTROL DEVICES

2. Traffic signals:

- Traffic signals are such control devices which can alternately direct the traffic to stop and proceed at level intersections
- The main requirements of traffic signals are to draw attention, provide meaning and time to response and to have minimum waste of time
- The primary purpose of a traffic signal installation at a road junction is to reduce conflict between traffic streams

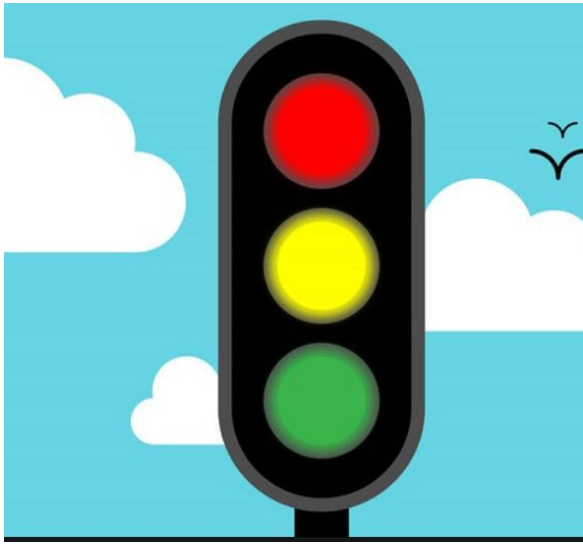
TRAFFIC CONTROL DEVICES

2. Traffic signals contd:

Advantages of Traffic Signals

- Traffic handling capacity of the intersection is increased
- Right angled collision points are reduced
- Traffic signals when subjected to automatic control prove more economical than manually operated signals
- Pedestrian can cross the roads safely at the signalized intersection
- Signals provide chance to crossing traffic of minor road to cross the path of continuous flow of traffic stream

TRAFFIC CONTROL DEVICES



Types of Traffic Signals

Traffic light signals

This group of signs comprise of two categories:

- Signs for the control vehicles
- Signs for the control of pedestrian crossing movement

Signs for the control vehicles

- **Red Light** :Traffic is prohibited from proceeding beyond the stop line
- **Green Light:** Vehicular traffic may proceed beyond the stop line
- **Amber Light** : Conveys same prohibited as red signals except where vehicles are so close to the stop line that they cannot safely stop before the stop line they should proceed

DESIGN OF TRAFFIC ROTARY

❖ Radius of Central Island

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

- f = 0.43 and 0.47 for speeds 40 kmph and 30 kmph respectively
- Minimum radius of central island should be greater than 1.33 times radius of entry curve

❖ Width of weaving

Where e_1 is the width of the carriageway at the entry and e_2 is the carriageway width at exit.

$$W_{weaving} = \left(\frac{e_1 + e_2}{2}\right) + 3.5m$$

❖ Weaving angle and length

- ✓ Small weaving angle but should not be less than 15degree.
- ✓ Weaving length at least 4 times the width of the weaving section.
- ✓ Minimum Recommended weaving length 45-90 m for 40 kmph 30-60 m for 30 kmph

DESIGN OF TRAFFIC ROTARY

❖ Entrance and Exit Curves

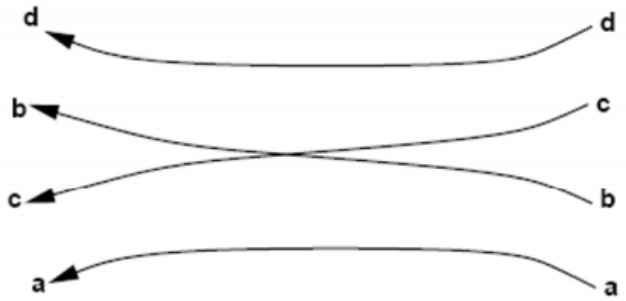
- For 40 kmph entry curve radius 20 – 35 m
- For 30 kmph entry curve radius 15 – 25 m
- Exit curves should be of a larger radius than entry curves, usually 1.5 to 2 times of radius of entry curve is considered reasonable

❖ Capacity of Rotary Roadway

$$Q_p = \frac{280W(1 + e/w)(1 - p/3)}{(1 + W/L)}$$

Proportion of weaving traffic is given by

$$p = \frac{b + c}{a + b + c + d}$$



1. If there are two wheels on one side of the axle, then it must be converted into
   a) EWL
   b) ESL
   c) ESWL
   d) EL

ESWL stands for equivalent single wheel load. It is used to represent the load when more than one wheel is present in one side of the axle. The equivalent of both wheel loads is represented as ESWL.

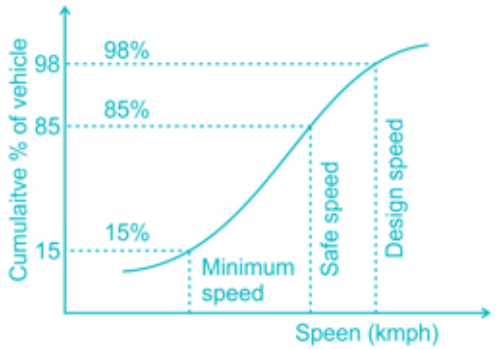
1. Which of the following is regulatory traffic sign?
a. Parking place (informatory)
b. Road narrow on both sides (warning)
c. Stop and Give way sign
d. None of these

1. The pedestrian may cross the road with care in
a. Red Standing Man
b. Green Walking Man
c. None
d. All of these

1. 'Give Way' is regulatory traffic sign with …….. shape.
a. Triangular
b. Circular
c. Octagonal
d. Rectangular

1. …… percentile speed is provided as safe speed limit in road.
a. 98^{th}
b. 85^{th}
c. 75^{th}
d. 25^{th}

The **98th percentile speed** is adopted for **geometric design of highway.**



Geometrical design speed = 98^{th} percentile speed

Safe speed limit = 85^{th} percentile speed

1. The average 24hrs traffic volume on weekdays over a full years is
a. AADT
b. AAWT
c. ADT
d. AWT

1. The ill effects of parking is
a. Congestion
b. Crash
c. Obstruction to the emergency vehicles
d. All of the above

1. Which of the following is ‘On street parking’ ?
a. Multi-storey parking
b. Underground parking
c. Kerb parking
d. None of above

1. Time mean speed (TMS) is ……. Space mean speed(SMS)
a. Slightly less than
b. Never less than
c. Never greater than
d. Equal to

$$V_t = V_s + \frac{\sigma_s^2}{v_s}$$

Shows that, the TMS is always greater than the SMS.

$$V_s = V_t - \frac{\sigma_t^2}{v_t}$$

1. The clearance time is indicated by
   a. Red
   b. Green
   c. Amber
   d. White

2. The number of vehicles crossing a section of road in a unit time at any selected period is called
   a. Traffic volume study
   b. Traffic density study
   c. Traffic mass study
   d. Traffic characteristic study

3. The instrument used to study ‘spot speed’ in traffic engineering is
   a. speedometer
   b. speed recorder
   c. enoscope
   d. enometer

1. The number of vehicles occupying a unit length of roadway at given instant is:
a. Traffic density
b. Traffic volume
c. Traffic capacity
d. Passenger car unit

1. The best type of angle parking is
a. 30°
b. 45°
c. 60°
d. 90°

1. Maximum number of vehicles can be parked with
   a. 30° angle parking
   b. 45° angle parking
   c. 90° angle parking
   d. parallel parking

1. The maximum number of vehicles beyond which rotary intersection is not effective from
a. 500 PCU/hr
b. 2000 PCU/hr
c. 5000 PCU/hr
d. 5000 PCU/day

1. If space mean speed of a vehicle is 50kmph, then the time mean speed will be
   a. Less than 50kmph
   b. Greater than 50kmph
   c. Equal to 50kmph
   d. Depends on the vehicle

VISIBILITY

❖Good visibility enables the motorist (and pedestrian) to quickly discern significant details of the roadway

❖ **Some factors that directly influence visibility are:**

- The brightness of an object on or near the roadway
- The size of objects and identifying details
- The contrast between an object and its surroundings

REQUIREMENTS OF LEVEL OF ILLUMINATION IN ROAD

- Distribution should be downwards
- It should produce maximum uniformity of pavement brightness
- It should cover the adjacent area 3 to 5 m beyond the pavement edge
- For main highways 30 lux
- For main roads 15 lux
- And for secondary roads 4 to 8 lux

DESIGN OF LIGHTENING SYSTEM

Design factors:

1. Lamps types and selection:

- Types
- Size
- Color

Type of Lamp	Initial Light Output lumes x 10^3
Incandescent	0.6 - 15
Clear Mercury	3.7 - 57
Phosphor-coated Mercury	4.0 - 63
Metal Halide	34 - 100
High Pressure Sodium	9.5 - 140
Low Pressure Sodium	1.8 - 33

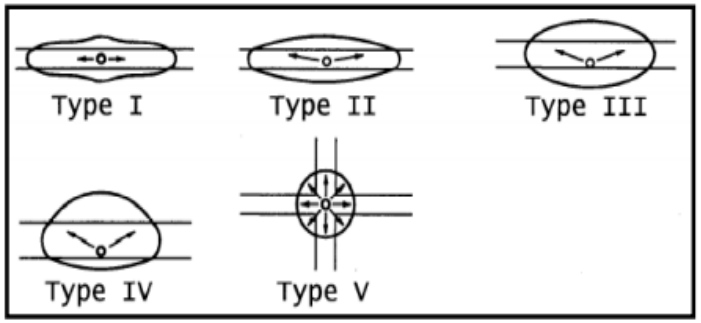
- Economical to use largest lamp size in a luminaire to provide uniform brightness
- Luminance- candela/sqm- how bright the roadway is
- Illuminance- in lux- the amount of light incident on road

DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

2. Luminous distribution of light:

- Proper distribution of light
- Downward- high % of light is utilized for illuminating the pavement area
- Kerb + area 3 to 5 m beyond pavement edge
- 20 to 30 lux= average lux- in urban area
- 15 lux- other main road
- 4 to 8 lux- secondary roads
- Indian code- average 30 lux



DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

3. Spacing of light units:

- The distance between successive lighting units measured along the centerline of the roadway
- In general spacing should be 35 to 45 m and should not exceed 55 m
- Spacing may be determined by the quality of illumination needed on different street
- The wider the spacing of lanterns, the lower the level of light

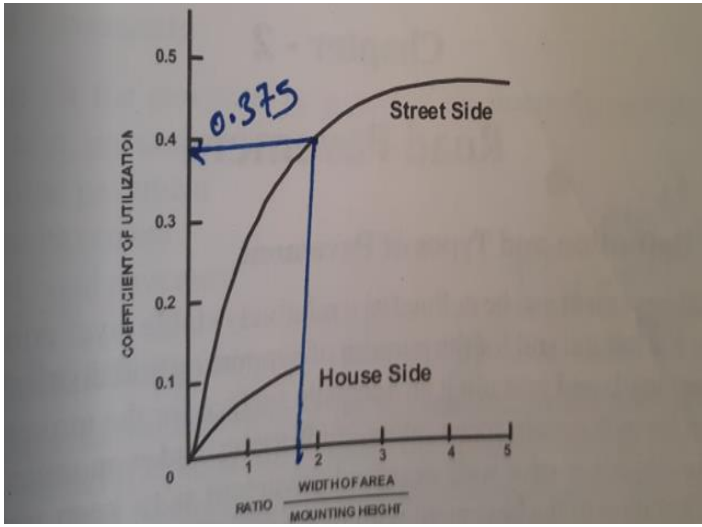
DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

3. Spacing of light units:

$$Spacing = \frac{Lamp\ Lumen * Coefficient\ of\ Utilization * Maintenance\ Factor}{Average\ Lux * Width\ of\ Road}$$

Where, Maintenance factor usually taken as 80%



DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

4. Height and overhang mounting:

- The vertical distance between the roadway surface and the center of the apparent light source of the luminaire
- The distance the lamp is mounted above the roadway will affect the illumination intensity, uniformity of brightness, area covered, and relative glare of the unit
- Higher mounted units will provide greater coverage, more uniformity, and reduction of glare
- The height of luminaires above the roadway surface varies from 15 feet to more than 100 feet
- Conventional roadway lighting utilized mounting height of 25 to 50 feet

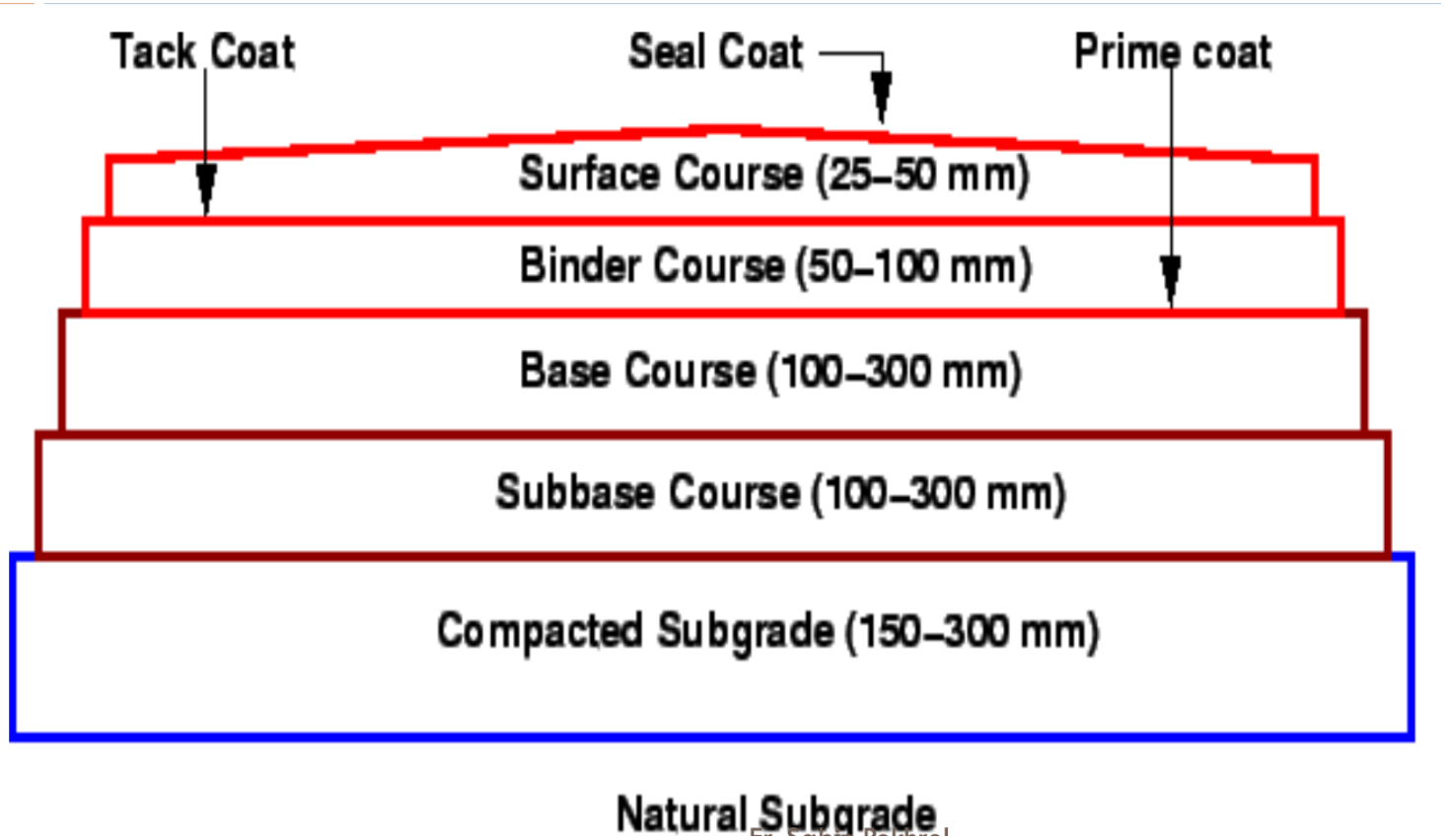
DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

5. Lateral placement:

- Horizontal distance from the edge of pavement
- Street lighting poles should not be installed close to the pavement edge
- IRC recommendations for roads with raised kerbs: min 0.3 m and desirable 0.6 m from the edge of raised kerb
- For roads without raised kerbs: minimum 1.5 m from the edge of the carriageway

COMPONENTS OF PAVEMENT



FUNCTIONS OF PAVEMENT STRUCTURE:

(I) Functions of surface course:

1.(a) To provide a smooth and uniform riding surface.

2.(b) To resist the abrasive forces of traffic

3.(c) To reduce the amount of surface water penetrating to the pavement.

4.(d) To provide a skid resistant surface.

(II) Functions of base course:

- To take load from the surface course and transfer to the base course.

(III) Functions of sub-base course:

- To take load from base course and transfer to sub- grade.
- To facilitate the **drainage** of free water.

(IV) Functions of sub-grade:

- To resist ultimate load of pavement.
- To provide support to the pavement.

Q. Base course is located at:

1.(a) Above the wearing course

2.(b) Below the sub-base course

3.(c) Above the sub-base course

4.(d) Below the sub-grade

Which of the following is top most layer:

(a) Wearing course (c) Sub-base course

(b) Base course (d) Subgrade

Which of the following is bottom most layer:

(a) Wearing course (c) Sub-base course

(b) Base course (d) Subgrade

Which of the following is known as drainage layer:

(a) Wearing course (c) Sub-base course

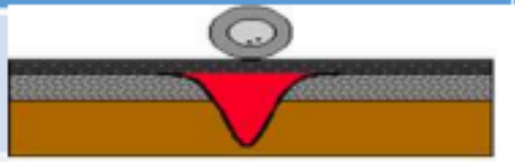
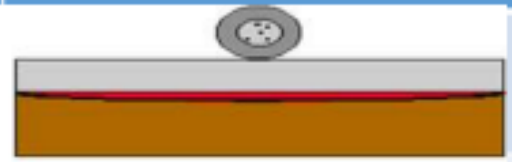
(b) Base course (d) Subgrade

The minimum thickness of base course is:

(a) 20 cm (c) 30 cm

(b) 25 cm (d) 35 cm

Comparison between Rigid and Flexible Pavement

	Flexible Pavement	Rigid Pavement
Load Distribution		
Surface	Bituminous Surface	Concrete Surface
Load carrying capacity	Load distribution capacity of the layered components	Load carrying capacity due to the higher flexural strength of the concrete slab itself
Design	• Based mainly on the strength of the subgrade • Mainly done through empirical methods	• Based on the flexural strength of Concrete • Precise design can be achieved

Comparison between Rigid and Flexible Pavement

	Flexible Pavement	Rigid Pavement
Life	Usually design life of 10 to 20 years with the requirement of periodic maintenance	Design life of 40 years can be achieved even with less maintenance
Maintenance	Higher rate of maintenance but low cost of maintenance	Lower rate of maintenance but higher cost of maintenance
Initial cost	Less capital requirement	Higher capital requirement*
Stage construction	Possible	Not possible

Factors Affecting Pavement Design

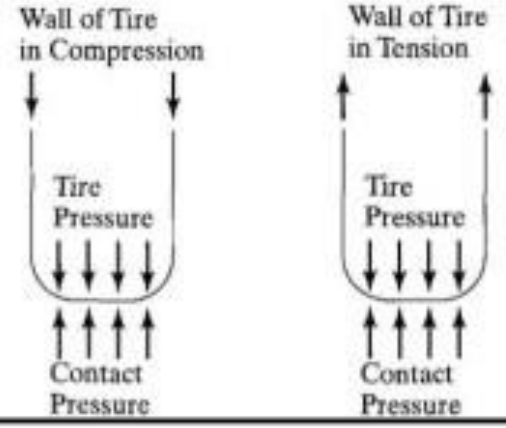
Traffic factors

- Depends upon the number of traffic and the wheel load (now axle load)
- Wheel Load = the load transferred to the pavement through tyres
- Standard design axle load – single axle load

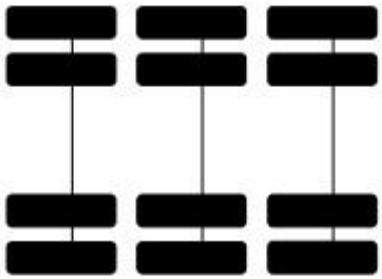
SN	Country	Standard Axle Load
1	Nepal	8.16 tonnes
2	India	8.16 tonnes
3	UK	10.17 tonnes
4	USA	8.2-10.2 tonnes
5	AASHTO	9.1 tonnes

Traffic factors

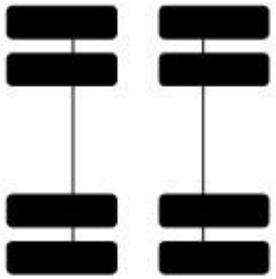
- However, for double axle (tandem configuration) 14.5 tonnes and 20.3 tonnes for tridem axles (triple axle) is considered to be standard
- Tyre pressure – It depends upon the total axle load, wheel configuration and contact area. This is responsible for causing damage to the pavement. A standard of 0.5 MN/m^2 (70-100 PSI)



Traffic factors



Tridem Axles with Dual Tires

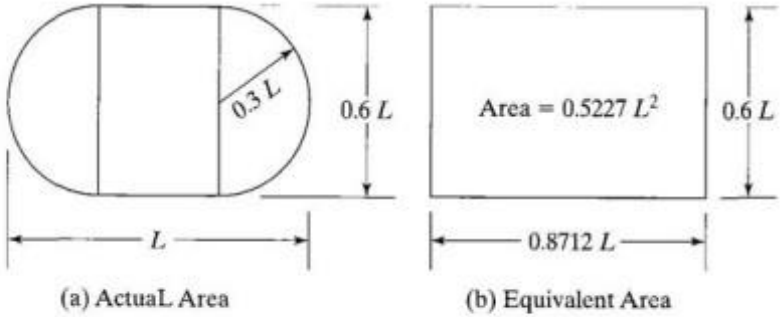


Tandem Axles with Dual Tires

Single Axle with Dual Tires

Single Axle with Single Tire

- Contact Area
- Equivalent Circular Area



Traffic Factors

- Repetition of axle load – Pavement distress accumulate with the repetition of axle load, so the number of repetition of axle load is one of the important for the pavement design

Traffic factors

- Equivalent Standard Axle Load & Equivalence Factor – It is essential to convert the variety of load into a standard axle load system of 80 kN. This is done with the help of equivalence factor,

$$F = \left(\frac{L}{L_S}\right)^4$$, Also known as fourth power law, here Ls = 80 kN

Standard axle load = 80 kN or 8 ton or 18000 lb

- Calculation of total number of ESAL is made at the base year per day with the help of the factor

Vehicle Damage Factor

- With no axle data available
- A multiplying factor that converts the vehicle number into number of standard axles

Vehicle Type	VDF
Heavy Truck (3 axle or more)	6.5
Heavy (2 axle)	4.75 (But in hilly 3.5)
Mini truck/tractor	1.0
Large bus	0.5
Bus	0.35

Pavement Design Guideline (Flexible Pavement) 2014 (DoR)

Traffic Volumes (CV/day)	VDF for Rolling/Plain	VDF for Hilly
0-150	1.5	0.5
150-1500	3.5	1.5
More than 1500	4.5	2.5

IRC 37: 2012 : Guidelines for the design of flexible Pavements

Traffic factors

- Pavement has to accommodate the total traffic till its design life. So, the calculated ESAL of the base year is not sufficient for the design of pavement. Consideration of growth of the traffic is most important. For this,

$$Cumulative\ no.of\ standard\ axle = \frac{[365 * ESAL_{base} * [(1+r)^n - 1]]}{r}$$

- Here, r = annual traffic growth rate,
- $ESAL_{base}$ = ESAL at base year per day
- n = number of years at the end of design year

Pavement Design Guidelines (DoR), 2020

- Pavement Design Catalogue
- Inputs are
  - CBR value
  - Cumulative number of standard axles
- The layers are composed of granular sub0basem granular base and bituminous course (bituminuous surface and bituminous binder course)
- Growth rate can be assumed to be 5%
- The Design catalogue has been provided for two ranges of cumulative standard axles (1-10 msa & 10-150 msa)

Calculation of CBR Value(EMPERICAL METHOD)

(I) Calculation of CBR value

- CBR is the penetration test developed by California Division of Highways.
- This test is done for calculating the stability of soil subgrade and other flexible pavement materials.

CBR (%) = (Load sustained by the specimen at 2.5 or 5 mm penetration)/(Load sustained by the standard aggregates at the corresponding penetration value) * 100 %

- The CBR values of 2.5 mm penetration is higher than that of 5 mm
- If the CBR values of 5 mm penetration is higher than that of 2.5 mm, then the test is repeated.
- **Three test is** conducted and the average of three is CBR values

$$\mathrm{CBR}_{\delta} = \frac{\mathrm{P}_{\delta} \text{ of soil}}{\mathrm{P}_{\delta} \text{ of standard crushed aggregate}} \times 100$$

δ = displacement in mm

P_δ = Load corresponding to 'δ' settlement

P_s = Load for standard crushed aggregate:

δ (mm)	P_{SCA} (kg)	P_{SCA} (kg/cm^2)
2.5	1370	70
5	2055	105

If CBR 2.5 > CBR 5 → Test Accepted

If CBR 5 > CBR 2.5 → Test Repeated

Empirical Method

- CBR Method
- It was introduced by California Division of Highways in USA in 1928
- The design curves provides thickness of pavement required for a given CBR of subgrade and for a given design load to be taken by the pavement. Three curves for *design wheel load* 3175 kg, 4082 kg and 5443 kg were developed
- The CBR method is based on the principle of requirement of sufficient thickness of material for a given CBR.

$$t = \sqrt{P}\left[\frac{1.75}{CBR} - \frac{1}{p\pi}\right]^{\frac{1}{2}}$$

Where P is wheel load in kg
And p is tyre pressure in kg/cm^2

Empirical Method (CBR method continue)

- IRC recommended (IRC: 37-1970), 7 curves for different volume of commercial heavy vehicles whose laden weight is greater than 3 tonnes
- To calculate the number of design commercial vehicle for the design year, it is recommended to use

$$A = P(1 + r)^n$$ in commercial vehicle per day, CVPD

IRC Method(Semi Emperical)

$$N = \left(\frac{365*(a+r)^n-1)}{r}\right) * A*D*F$$

Where,

r = annual growth rate of commercial traffic

n = design life in year

A = Initial traffic at the end of construction period,

$$A = P(1+r)^m$$

P= number of traffic at the beginning of construction

m = construction period

D = lateral distribution factor

F = Vehicle damaging factor

After obtaining the cumulative traffic and CBR values, the total thickness of pavement from sub-grade is calculated reading from graph given by IRC.

Theoretical Methods:

- It is the methods based on pavement response such as stress or strain due to loads.

(A) Boussinesq's Theory

➢ The vertical displacement at the surface under the centre of applied load is given by:

$$\Delta = \frac{2Pa}{E}(1 - v^2)$$

Where,

Δ = vertical displacement

v = Poisson's ratio

E = Modulus of elasticity of sub-grade soil

For v = 0.5

$$\Delta = \frac{2Pa}{E}(1 - 0.5^2)$$

$$\Delta = \frac{1.5\,Pa}{E}$$

The above equation is applicable for flexible plate only. For rigid plate, $\Delta = \frac{1.18\,Pa}{E}$

(II) Semi-Empirical Methods:

The final form of equation is given below:

$$Tp = \left(\left(\sqrt{\frac{3*P*x*y}{2*\pi*Es*\Delta}}\right)\Lambda^2 - a^2\right)\left(\frac{Es}{Ep}\right)^{1/3}$$

Where,

Tp = thickness of pavement

P = wheel load

Es = Modulus of elasticity of sub-grade soil

Ep = Modulus of Elasticity of pavement materials

a = radius of contact area

Δ = design deflection (0.25 cm)

x = traffic coefficient = 1.5

y = rainfall coefficient = 0.9

$\left(\frac{Es}{Ep}\right)$ = stiffness factor

Asphalt Institute Method:

$$\frac{tb}{tsc} = \left(\frac{Esc}{Eb}\right)\Lambda^{1/3} \qquad \frac{tsb}{tsc} = \left(\frac{Esc}{Esb}\right)\Lambda^{1/3}$$

Where,

tsc = thickness of surface course

tb = thickness of base course

tsb = thickness of sub-base course

Esc = Elastic modulus of surface course

Eb = Elastic modulus of base course

tsb= thickness of sub-base course

Rigid Pavement

Design of Rigid Pavement

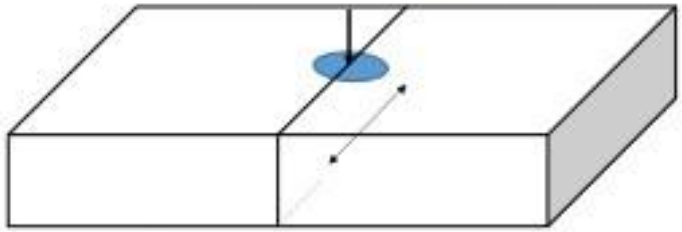
Stresses

- Stresses at different locations in rigid pavement occurs due to
  - Due to wheel load (traffic load)
  - **Temperature Stress**
    - Due to warping
    - And friction between pavement and the subgrade
- The critical combination is taken for the maximum stresses at different locations which should not exceed the strength of the concrete
- The load location usually for critical combination is taken as edge

1. Traffic Stresses

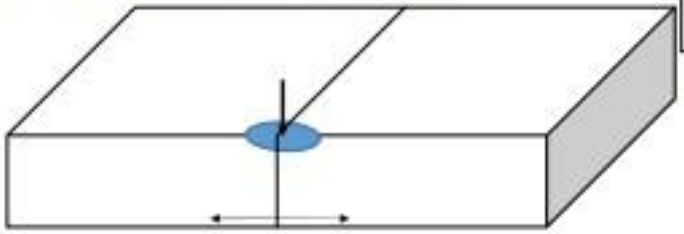
- On application of the traffic load, the slab tends to deflect like a beam and flexural stresses comes into play
- Westergaard considered three critical loading
  - Interior loading,
  - Edge loading,
  - Corner loading,
- At both the cases of interior and edge loading maximum tensile stress is acted on the bottom of the slab
- For corner loading maximum tensile stress is acted on the top of the slab

Location of tensile stresses generated for the three critical wheel load postion



Interior loading with tension at underside

Corner loading with Tension on top of the surface



Edge loading with tension at underside

3.Warping Stress (Temperature Stress)

- Temperature differential between the top and bottom of the slab causes curling (warping) stress in the pavement
- If the temperature of the upper surface of the slab is higher than the bottom surface then top surface tends to expand and the bottom surface tends to contract resulting in curl downward, and vice-versa
- The restraint due to weight, friction provides restraint to the curling producing stresses
- For interior region of the slab $\sigma_x = \frac{E\alpha_t t}{2(1-\mu^2)}(C_x + \mu C_y)$
- For edge region of the slab , $\sigma = Max\left(\frac{C_x E\alpha_t t}{2}, \frac{C_y E\alpha_t t}{2}\right)$
- For corner region of the slab, $\sigma = \frac{E\alpha_t t}{3(1-\mu)}\sqrt{\frac{a}{l}}$

4. Critical combination of stress

- During summer

At edges during mid day-

At the bottom fiber – load stress tension , warps downward resulting in tension in bottom and frictional stress being compressive

So, critical combination at edge : Load stress + Warping stress – Frictional stress

4. Critical Combination of stress

- During winter

At edges during mid day will be the most critical combination where

At the bottom fiber – load stress tension , warps downward resulting in tension in bottom and frictional stress being tensile

So, critical combination at edge : Load stress + Warping stress + Frictional stress

4. Critical combination of stress

- At corner

It occurs at night

At the top load stress at corner is tensile and warping stress when warping upward (facing upward) tensile stress is at the top

Most critical combination at corner – load stress + warping stress

[Here, frictional stress is not developed at the corner]

1. The maximum thickness of expansion joint in rigid pavements is
   a. 0
   b. 25 mm
   c. 50 mm
   d. 100 mm

1. Temperature variation produce heavy temperature stresses in
a. Flexible pavement
b. Rigid pavement
c. None
d. All of these

As per I.R.C, the maximum spacing of contraction joints is ..... in reinforced cement concrete slab of thickness 20cm.

- 4.5m
- 14m
- 45m
- 60 m

Categories of slab	Slab Thickness (cm)	Maximum Contraction Joint Spacing (m)
Unreinforced Slabs	20	4.5
	10	7.5
Reinforced Slabs	15	13.0
	20	14.0

1. As per flexible pavement guideline 2021, The VDF for vehicle type heavy two axle vehicle is taken as

a. 6.50
b. 4.75
c. 1.0
d. 0.35

Vehicle type	VDF	Remarks
Heavy truck (three axle or more)	6.50	
Heavy two axle	4.75	hilly terrain 3.5
Mini truck/tractor	1.0	
Large bus	0.50	
Bus	0.35	

1. Stage construction is not possible in

a. Flexible pavement
b. Semi-rigid pavement
c. Rigid pavement
d. None of these

1. The Maximum axle load for design of road pavement for Nepal is taken as

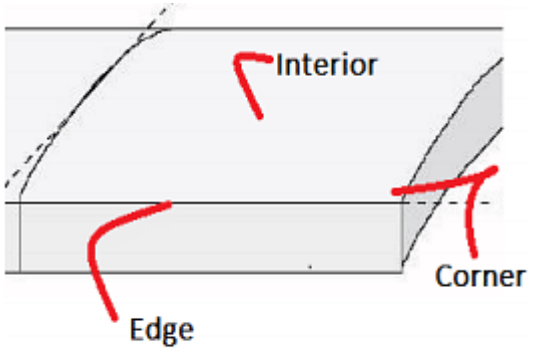
a. 10.2 tonnes
b. 8.2 tonnes
c. 8.16 tonnes
d. 82 tonnes

The permissible axle loads in Nepal is taken as 10.2tonnes, 19tonnes and 24 tonnesfor single axles, tandem axles and tridem axles respectively.

1. The permanent deformation along the wheel path in flexible pavement is known as

a. Fatigue cracking
b. Rutting
c. Thermal cracking
d. Frost heave

1. Which of the below is not a critical load position?
   a. Interior
   b. Corner
   c. Edge
   d. Center



Concrete Pavement slab

2. If there are two wheels on one side of the axle, then it must be converted into
   1.EWL
   2.ESL
   3. ESWL
   4.EL

3. The dowel bars are provided _____
   1. Longitudinally
   2.Laterally
   3.Any direction required
   4.In base of pavement