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)

INTRODUCTION TO TRANSPORTATION SYSTEM

TRANSPORTATION

☐ Movement of people and goods from one place to another place with safe, easy, comfort, economical is known as transportation.

☐ Movement of people is known as passenger transportation whereas movement of goods is known as freight transportation.

Modes of Transport

Primary Mode of Transportation

Secondary Mode of Transportation

MODES OF TRANSPORTATION

☐ There are two modes of transportation:

(I) Primary Modes: (4 types)

(A) Landways:

(a) Roadways: Roads, Highway,Street (Bus,Car,Container,truck,etc)

(b) Railways: Rails (Wagon,train,container)

(B) Waterways: River,Lake,sea,ocean

(Ship,Boat,etc)

(C) Airways : Air-route (Plane,Aircraft,Helicopter)

(D) Spaceways: Space-route (Satellite,Rocket)

(II) Secondary Modes: (4 types)

(A) Ropeways: Cable (car,carriage,cabin,chair,gondola)

(B) Pipeline: Pipe (Water,gas,sewer)

(C) Canal : Irrigation canal (Water)

(D) Belt Conveyor : Belt (Aggregate in crusher plant)

SELECTION OF MODE OF TRANSPORT -ADVANTAGES

Road Transportation	Rail Transportation	Water Transportation	Air Transportation
Wide geographical coverage • Large influence area • Low capital investment • Door to door service • Flexibility • Quick and assured deliveries • Highest employment potential • Personalized travel and service • Economy • Overall development of the country	• Less energy consumption (1/4th – 1/6th of highway) • Comfortable journey • Transport goods in large journey • Provide employment in large scale • Safe in comparison to road transport • Non polluting(Electric) • Cheap mode • Reasonable good speed	• Less Maintenance Cost • Cheap • Useful for Bulky Goods • Useful During Natural Calamities • Use minimum energy to haul unit load through unit distance	• Saving in travel time • Improving in economy of several countries • Very useful in aerial photography and remote sensing. • High speed (1000km/h) • Relief and useful for rescue operation

SELECTION OF MODE OF TRANSPORT -DISADVANTAGES

Road Transportation	Rail Transportation	Water Transportation	• Air Transportation
• Environmental pollution • Rate of accident is high • Energy consumption • Uneconomical (due to accident and environmental effect) • Delay and congestion Parking problem	• Steeper gradient cant be applicable • High maintenance cost or periodic inspection is required. • Stops at longer time at junction and station. • No flexibility	• Not suitable in landlocked countries like Nepal • Not suitable in high current rivers • Not suitable in shallow rivers	• Not accessible to all • High maintenance and operating cost • High energy consumption • High safety provisions are required • Noise pollution • Highly sophisticated instrument and machinery are needed.

COMPARISION BASED ON MOBILITY, UBIQUITY AND EFFICIENCY

Comparison

	Roads	Rail	Air	Water	pipe flow
Ubiquity	very high, direct access to a road	limited by large investment	Accessibility is low due to high cost	limited by availability of waterways	limited to few routes and access points
Mobility	limited by human factors and speed limits	speed and capacity can be higher than roads	speed are highest but capacity per vehicle is limited	low speed, very high capacity per vehicle	low speed, high capacity
Efficiency	Not high	generally high	fairly low	very high, low cost, low energy use, safety varies	generally high, use of low cost energy

Q Which of the following is fixed facility ?

(a) Bus
(b) Car
(c) Both (a) & (b)
(d) Highway

. Movement of …… from one place to another place with safe, easy, comfort,

economical is known as transportation.

(a) People

(b)Goods

(c) Both (a) & (b)

(d) All of above

Which modes of transportation provides door to door service?

(a) Airways
(b) Waterways
(c) Roadways
(d) Railways

Which modes of transportation is feasible (Appropriate or best) in case of Nepal?

(a) Waterways
(b) Railways
(c) Airways
(d) Roadways

HISTORICAL DEVELOPMENT OF ROAD IN NEPAL

History of road in Nepal can be divided into three periods:

1. During Rana Regime or before Democracy of 2007 B.S.
2. Between 2007 B.S. to 2027 B.S.
3. After 2027 B.S.

DOR – 2027 BS

DoLIDAR (**Department of Local Infrastructure Development and Agricultural Roads**)

ESTD:2055 Bhadra 08

OBJECTIVE: Construction of local level road

Road Board Nepal- 2058 BS. Objective –To look after funding of road maintenance activities

HISTORICAL DEVELOPMENT OF ROAD IN NEPAL

☐ During Rana regime, there were two offices named "**Batokaj Goswara**" and "**Chhembhadel Adda**" for road works and other civil engineering Construction works respectively.

☐ There were branch office named " **Banaune Adda**" in other parts of the country.

☐ In 1918 AD, "**Nayabatokaj Goswara**" office was established for the construction of new road and the name of Batokaj Goswara was changed to "**Purano Batokaj Goswara**"

HISTORICAL DEVELOPMENT OF ROAD IN NEPAL

- The main responsibilty of "Purano Batokaj Goswara" was to look after the maintenance of existing road.
- An Army Unit "**Samarjung**" was used to carry out routine maintenance under "Purano Batokaj Goswara"
- The new and old office were merged into one as **Public Work Directive (PWD**) in 1950 AD.
- PWD had two sections named as Normal road and bridge section.

HISTORICAL DEVELOPMENT OF ROAD IN NEPAL

☐ In 1970 AD (2027 B.S) , PWD was split into separate department named as "Department of Road" and "Department of Building"

☐ In 1956 AD, **Tribhuvan Highway was** constructed.

☐ In 1963 AD, **Araniko Highway** was constructed.

☐ In 1964 AD, **Siddhartha highway** was constructed.

☐ In 1993 AD, 6 regional office and 25 division office of DOR were created.

CLASSIFICATION OF ROADS

Administrative classification

National Highway

Feeder Road

District Road

Urban Road

NATIONAL HIGHWAY

National Highways are main roads connecting East to West and North to South of the Nation.

These serve directly the greater portion of the longer distance travel, provide consistently higher level of service in terms of travel speeds, and bear the inter-community mobility.

They are designated by letter „H" followed by a two-digit number.

H01- Mahendra Highway-1027.67 km (638.56 mile)

Eg:- Araniko highway, Prithivi highway, Tribhuwan rajpath

Number of National Highway-80

Oldest Highway-Tribhuwan Highway

#	National Code	Name	Asian Code	Length	Starting Point	Ending Point
1	रा०१ H01	Mahendra Highway	AH2 AH2	1027.67 km	Kakarbhitta, Jhapa NH 327B	Gaddachowki border, Kanchanpur
2	रा०२ H02	Tribhuvan Highway	AH42 AH42	189.66 km	Kathmandu	Sirsiya bridge, Birgunj, Parsa NH 527D
3	रा०३ H03	Araniko Highway	AH42 AH42	112.83 km	Maitighar Mandala, Kathmandu	Friendship Bridge, Kodari, Sindhupalchok G318 Road
4	रा०४ H04	Prithvi Highway		173.43 km	Naubise, Dhading	Prithvi Chowk, Pokhara, Kaski
5	रा०५ H05	Madan Ashrit Highway		36.16 km	Narayanghat, Chitwan	Mugling, Chitwan
6	रा०६ H06	B.P. Koirala Highway		160 km	Bardibas, Mahottari	Dhulikhel, Kavrepalanchok
7	रा०७ H07	Mechi Highway		268 km	Kechana, Jhapa	Taplejung
8	रा०८ H08	Koshi Highway		111.46 km	Rani border, Biratnagar, Morang	Kimathanka border, Sankhuwasabha
9	रा०९ H09	Sagarmatha Highway		178.97 km	Kadmaha, Saptari	Solusalleri, Solukhumbu
10	रा१० H10	Siddhartha Highway		146.94 km	Sunauli border, Siddharthanagar, Rupandehi NH24, Uttar Pradesh	Prithvi Chowk, Pokhara, Kaski

11	रा११ H11	Rapti Highway		168.68 km	Ameliya, Dang	Musikot, Rukum
12	रा१२ H12	Ratna Highway		113.08 km	Jamuniya border, Nepalgunj, Banke	Bangesimal, Surkhet
13	रा१३ H13	Karnali Highway		233 km	Bangesimal, Surkhet	Chandannath, Jumla
14	रा१४ H14	Mahakali Highway		415.15 km	Mohana Bridge, Dhangadhi, Kailali	Mahakali, Darchula
15	रा१५ H15	Seti Highway		65.96 km	Amargadhi, Dadeldhura	Dipayal Silgadhi, Doti
16	रा१६ H16	Kathmandu Ringroad		28 km	within Kathmandu valley	
17	रा१७ H17	Postal Highway		1005 km	Kechana, Jhapa	Dodhara, Kanchanpur
18	रा१८ H18	Pushpa Lal Highway		1776 km	Chiyo Bhanjyang, Panchthar	Jhulaghat, Baitadi
19	H19	Shabha – Bramhadev Highway		13.30 km	Shabha, Kanchanpur	Bramhadev, Kanchanpur
20	H20	Kathmandu–Terai Expressway		76.2 km	Khokana, Lalitpur	Nijgadh, Bara

FEEDER ROADS

A **feeder road** may refer to:

a short road which provides specific access to one place, such as a sports venue or major business hub

A secondary road which "feeds" traffic to main highways

Feeder roads are important roads of localized nature.

These serve the community's wide interest and connect District Headquarters, Major economic centers, Tourism centers to National Highways or other feeder roads.

They are designated by letter „F" followed by 3-digit number.

Eg:- Bhaktapur- Nagarkot Road , balkhu- dakchhinkali road, satdobato tikathali road

Number of feeder roads: 208

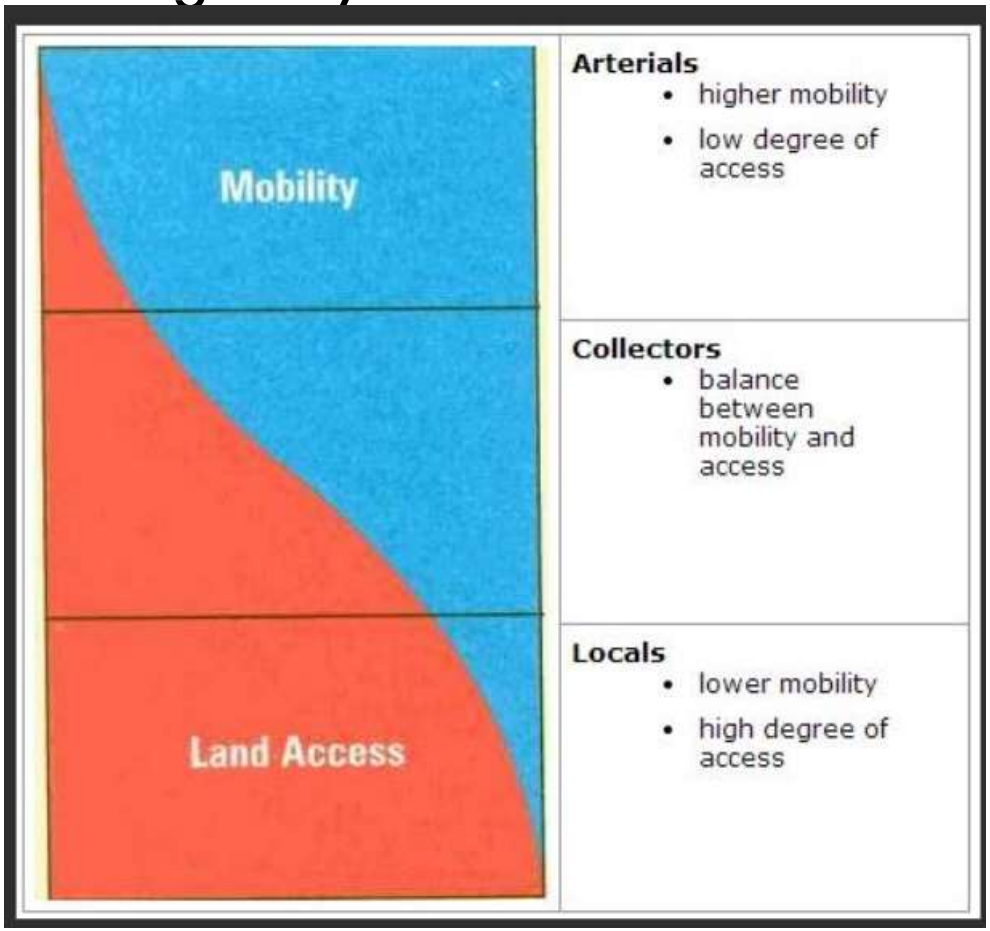
Road Code	Name	Length	Starting Point	Ending Point
F1	Birtamod – Bhadrapur Road	12.53 km	Birtamod	Chandragadhi
F2	Padajungi Damak – Gaurigunj Road	21.96 km	Padajungi	Gaurigunj
F3	Bhardaha – Hanumannagar – Rajbiraj Road	17.75 km	Bhardaha	Rajbiraj
F4	Rupani – Rajbiraj – Kunauli Road	23.1 km	Rupani	Kunauli border
F5	Chuharwa – Siraha – Madar Road	26.66 km	Chauharwa	Madar border
F6	Nawalpur – Malangawa Road	26.63 km	Nawalpur	Malangawa border NH 22 NH 22
F7	Chandranigahapur – Gaur Road	44.14 km	Chandranigahpur	Gaur border
F8	Bardaghat – Pratappur – Surajpur Road	23.05 km	Bardaghat	Harpur (Surajpur) border
F9	Sunawal – Parasi Road	8.95 km	Sunawal	Parasi
F10	Jitpur – Taulihawa – Khunuwa Road	33.39 km	Jitpur	Khunuwa, Taulihawa border
F11	Gorusinge – Sandhikharka Road	69.13 km	Gorusinge	Sandhikharka
F12	Chanauta – Krishnanagar Road	20.06 km	Chanauta	Krishnanagar
F13	Bhaluwang – Pyuthan Road	68 km	Bhaluwang	Khalanga
F14	Chakchake, Pyuthan – Rolpa Road	64.79 km	Chakchake	Rolpa Liwang
F15	Lamahi – Ghorahi – Tulsipur Road	46.62 km	Lamahi	Tulsipur
F16	Bhurigaun – Gulariya Road	32.31 km	Bhurigaun	Gulariya
F17	Junga – Rajapur Road	28.12 km	Junga	Rajapur
F18	Birgunj – Kalaiya Road	11.66 km	Birgunj	Kalaiya
F19	Bhainse – Bhimphedi Road	12.00 km	Bhainse	Bhimphedi
F20	Palung – Kulekhani – Balaju bypass Road	20.57 km	Palung	Kulekhani
F21	Kathmandu – Trisuli – Dhunche Road	118.26 km	Tripureshwor	Dhunche
F22	Balkhu – Dachhinkali Road	16.39 km	Balkhu, Ring Road	Dakshinkali

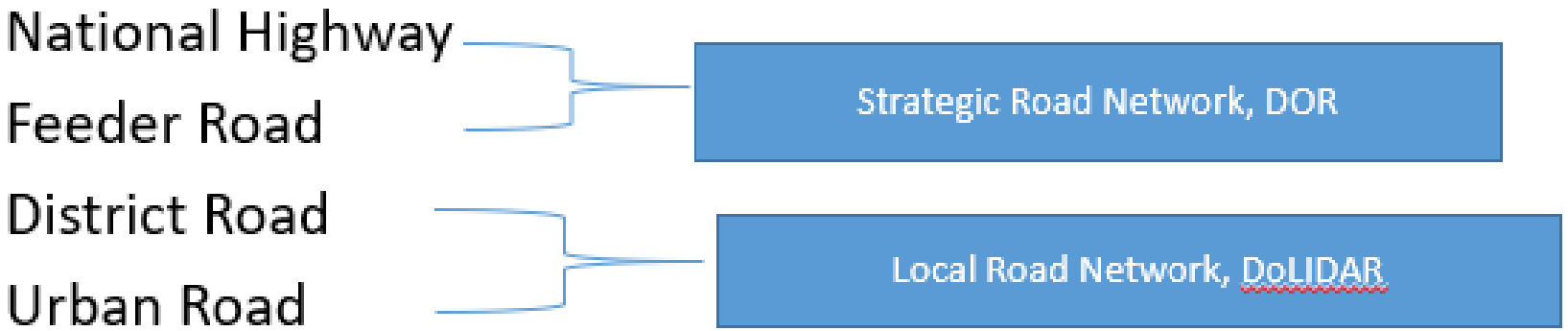
DISTRICT ROADS

District Roads are important roads within a district serving areas of production and markets, and connecting with each other or with the main highways.

Urban Roads

Urban Roads are the roads serving within the urban municipalities




National Highway
Feeder Road
District Road
Urban Road
Strategic Road Network, DOR
Local Road Network, DoLIDAR

TECHNICAL/ FUNCTIONAL CLASSIFICATION

Class I

Class II

Class III

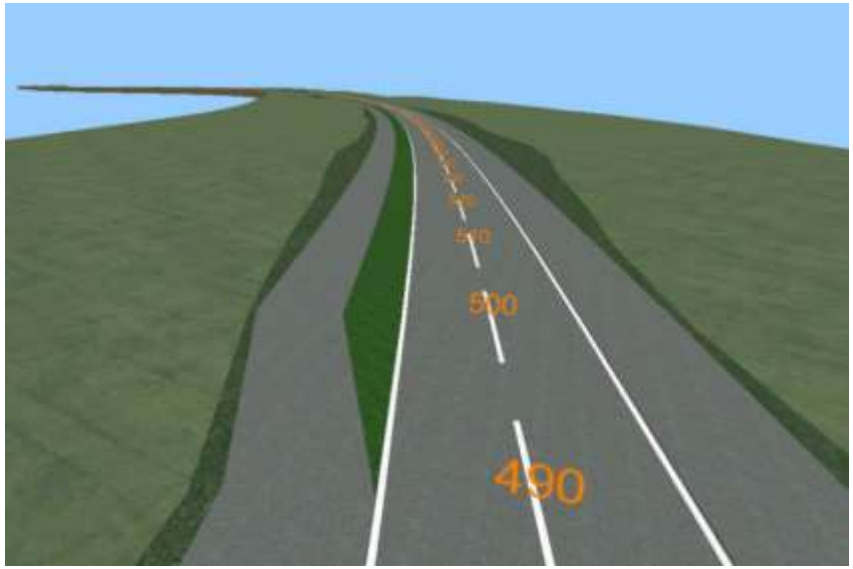
Class IV

Road Type	ADT in 20 yr Perspective Period (PCU)	Design Speed in Plain Terrain (Km/hr)
Class I	20000 or more	120
Class II	5000 - 20000	100
Class III	2000 - 5000	80
Class IV	less than 2000	60

ADT (Average Daily Traffic): The total traffic volume during a given time period, ranging from 2 to 364 consecutive days, divided by the number of days in that time period, and expressed in vpd (vehicles per day).

HIGHWAY ALIGNMENT AND ROAD SURVEY

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



THERE ARE TWO TYPES OF ALIGNMENT:

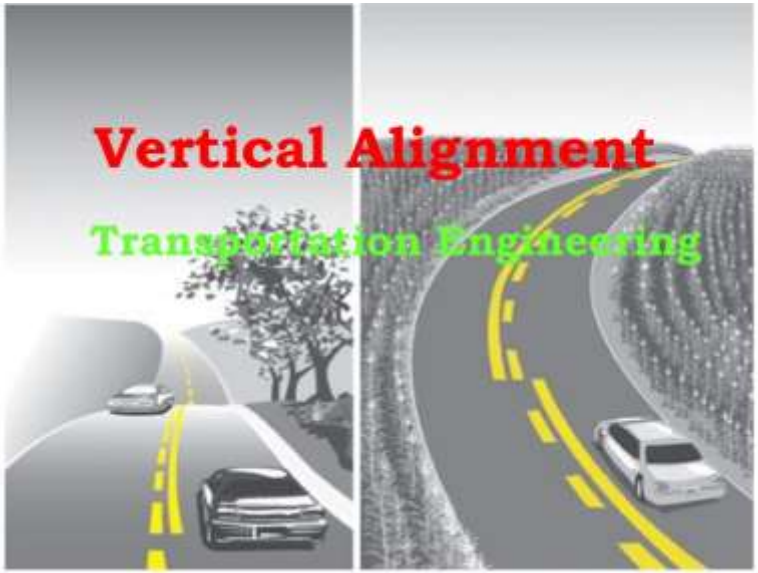
- Horizontal Alignment
- Vertical Alignment

❑Horizontal alignment

The projection of highway alignment in horizontal plane is called horizontal alignment. Include straight path, the horizontal deviation and curve

❑Vertical alignment

The projection of highway alignment in vertical plane is known as vertical alignment. Alignment must be selected in such a way that the overall cost during construction, operation and maintenance is minimum.
Include change in gradient and vertical curve.



REQUIREMENTS OF HIGHWAY ALIGHMENT

- Short (S)
- Easy (E)

Safe (S)

- Economical (E)
- Comfort (C)

The requirements can be memorized as SECSE

❑**Short:** The distance between the initial and final point need to be short so as to reduce the construction cost.
Minimum travel distance

❑**Easy:** The construction materials if present at the place of construction makes the construction easier. Similarly, it should be easy during the operation of vehicles with easy gradients and curves.
Alignment should be easy to construct and maintain and operation of vehicle (easy gradient) and curve should be provided.

❑**Safe:** The alignment need to be safe during construction, operation and maintenance especially at slopes, embankments and cutting.
Safe geometric design, gradient, curve etc.

- ❑ **Economical:** The alignment should be economical during construction, operation, and maintenance.
- ❑ **Comfort:** The alignment should be fixed such that it provides comfort to the drivers and the passengers.

FACTOR CONTROLLING HIGHWAY ALIGNMENT

Obligatory points

Availability of construction materials and labor

Traffic composition

Geometric Design

Economic Factors

Geological Features/condition

Other Considerations

OBLIGATORY POINTS (CONTROL POINT)

point through which the alignment should pass or not.

It is divided into two parts:

Points through which the alignment should pass.

Points through which alignment should not pass.

❑Points through which the alignment should pass.

Industrial area

(d) Alignment avoiding an intermediate area

❑Points through which alignment should not pass

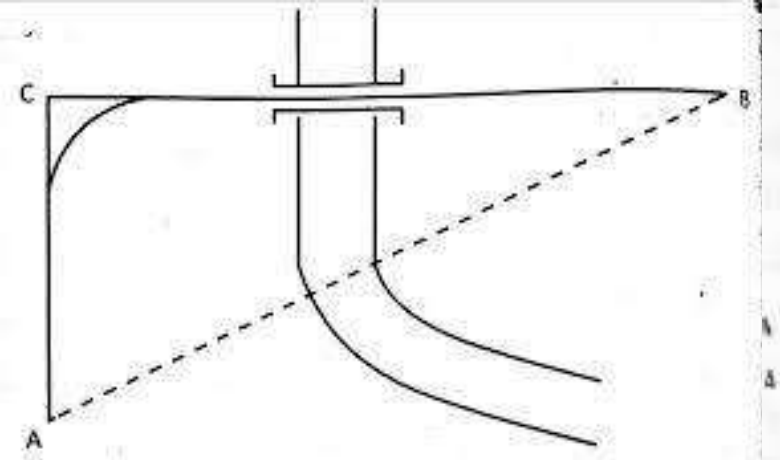
Marshy land/place

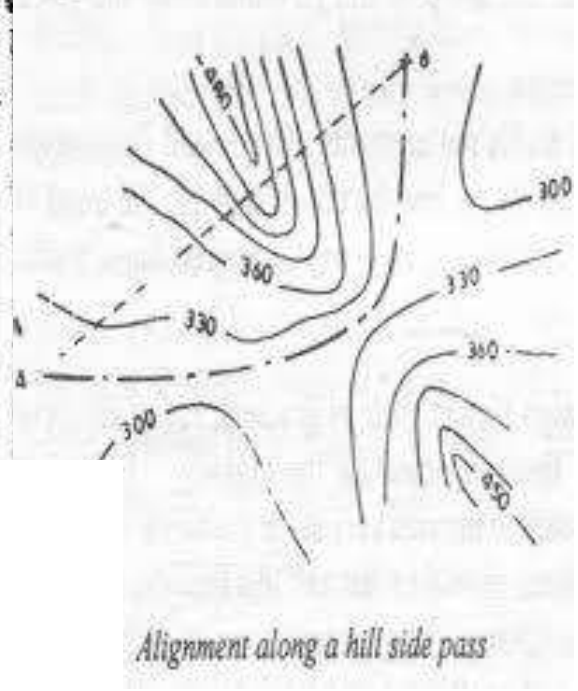
Archeologically and historically important places

• Conservation areas and restricted zones.

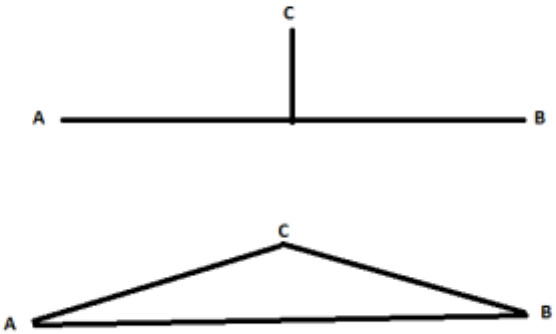
Lakes, ponds

Valleys, ponds, and marshy land need to be avoided.





Alignment along a hill side pass



Obligatory points in a road alignment are points through which:

(a) The road alignment is to pass

(b) The road alignment should not pass

(c) Both of above

(d) None of the above

(d) Alignment avoiding an intermediate area

TRAFFIC COMPOSITION

New road to be aligned should keep in view the desired lines, traffic flow pattern and future trends.

Determined by OD survey and classified counts along with trend analysis

GEOMETRIC DESIGN

Geometric design factor such as gradient, radius of curve, sight distance etc also govern the alignment of the highway.
To keep the no of curve minimum. It may be required to change the alignment.

GEOLOGICAL CONDITION

Geologically stable hill slope must be considered while selecting the highway alignment.

ECONOMY

Final alignment should be economical
Initial cost, maintenance cost and operating cost should be minimum.
Cutting and filling should be balanced for low cost
Avoid high embankment and very deep cutting to minimize construction cost.

Other considerations

Drainage
Political pressure
Necessity to brake monotony (for flat ground)
Foreign territory

ROAD SURVEY

- **Map Study**
- **Reconnaissance Survey**
- **Preliminary Survey**
- **Final Location and Detailed Survey**

Following information are obtained from the map study:

- Alignment avoiding valley, ponds, lakes.
- Approximate location of the bridge site.

Give rough idea

RECONNAISSANCE SURVEY

To examine the general character of area.

Field survey team inspect a land/survey area along the proposed alternative routes of the map in the field.

Simple Survey Instruments are used in the reconnaissance procedure.

Valley, pond, lakes and other features that were not present in the topographical map.

- A number of cross drainage structures, High Flood Level (HFL), Natural Ground Level.
- Values of the gradient, the length of gradients and radius of the circular curve.
- Soil type along the routes from field identification tests and observation of the geological features.
- Sources of construction materials.

PRELIMINARY SURVEY

Objective of preliminary survey are:

To survey the various alternative alignments proposed after the reconnaissance and to collect all the necessary physical information and detail of topography, drainage and soil.

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

- To estimate quantity of earthwork materials and other construction aspect and to workout the cost of the alternate proposals.

a) Conventional approach - survey party carries out surveys using the required field equipment, taking measurement, collecting topographical and other data and carrying out soil survey.

- Longitudinal and cross sectional profile.

b) Modern rapid approach-

By Aerial survey taking the required aerial photographs for obtaining the necessary topographic and other maps including details soil and geology.

Finalize the best alignment from all considerations by comparative analysis of alternative routes.

FINAL LOCATION AND DETAILED SURVEY

Location of center line

Transfer center line onto the ground. Pegs are driven along the center line of final alignment.

Setting out the geometric design consist of :-

- Fixing of TBM
- Levelling work
- Topographical details
- Hydrological details
- Soil survey

. The first stage of road survey is:

(a) Reconnaissance Survey

(b) Preliminary Survey

(c) Detailed (Location) Survey

(d) All of the above

The stages of road survey is:

(a) Map study-Preliminary survey Reconnaissance survey-Detailed Survey

(b) Map study- Detailed Survey - Preliminary survey-Reconnaissance survey

(c) Detailed Survey - Map study-Preliminary survey-Reconnaissance survey

(d) Map study- Reconnaissance survey Preliminary survey- Detailed Survey

EVALUATING ALTERNATE ALIGNMENTS

evaluation is used in planning and engineering to refer to the merits of alternative proposals.

EVALUATION OF ALTERNATIVES

Impact Assessment

Equity

Economic Efficiency

Financial Feasibility

Legal and Administrative Feasibility

Sensitivity of Findings to Uncertainties

Economic Evaluation Methods

- An economic evaluation of a transportation project is completed using one of the following methods:
  - Present Worth (PW)
  - Equivalent Uniform Annual Cost (EUAC)
  - Benefit-Cost Ratio (BCR)
  - Internal Rate of Return (ROR)

ROAD STANDARDS OF NEPAL

NRS : Nepal Road Standard (2027 B.S., 2045 B.S. and latest is 2070 B.S.)

NRRS : Nepal Rural Road Standard (2055 B.S., 2069 B.S. and latest is 2071 B.S.)

NURS : Nepal Urban Road Standard- 2076 B.S.

☐ NRS is used for the design of Strategic road (Highway+ Feeder Roads), District road, Urban

road.

☐ NRRS is used for the design of Rural road, Agricultural road, Village road, etc.

☐ NURS is especially used for the design of Urban road.

Q For the design of Rural road, which standard is

used?

(a) NRS

(c) IRC

(b) NRRS

(d) Local standard

Q For the design of Urban road, which standard is used?
(a) NRS
(c) Both of above
(b) NURS
(d) IRC

Q For the design of Urban road, which standard is used?
(a) NRS
(c) IRC
(b) NRRS
(d) Local standard

NEPAL RURAL ROAD STANDARD 2071

According to **Nepal Rural Road Standard 2055, 2nd revision 2071**, the rural roads in Nepal are classified as below:

District Road Core Network (DRCN)

Village Road

1. District Road Core Network (DRCN)

It is an important road joining a VDC HQ's office or nearest economic center to the district headquarters, via either a neighboring district headquarters or the Strategic Road Network.

2. Village Road

Smaller roads not falling under District Road Core Network category are Village Roads, including other Agricultural Road.

NEPAL URBAN ROAD STANDARD 2076

According to **Nepal Urban Road Standard 2076**, the urban roads are classified as follows:

- **Arterial Roads (Path)**
- **Sub-arterials Roads (Sadak)**
- **Collector Roads (Marg)**
- **Local Roads (Upa-Marg)**

1. Arterial Roads (Path)

These are the roads generally meant for through traffic usually on a continuous route.

2. Sub-arterial Roads (Sadak)

These are the roads of the somewhat lower levels of travel mobility than the arterial roads.

3. Collector Roads (Marg)

A collector road is one intended for collecting & distributing traffic to and from local roads & also providing the access to arterial/sub-arterial roads.

4. Local Roads (Upa-Marg)

A local road is one primarily intended for access to the residence, business, and other abutting property.

The number of National highway, in current operation, in Nepal are

a. 13

b. 85

c. 21

d. 80

Department of Road DOR was established in Nepal in

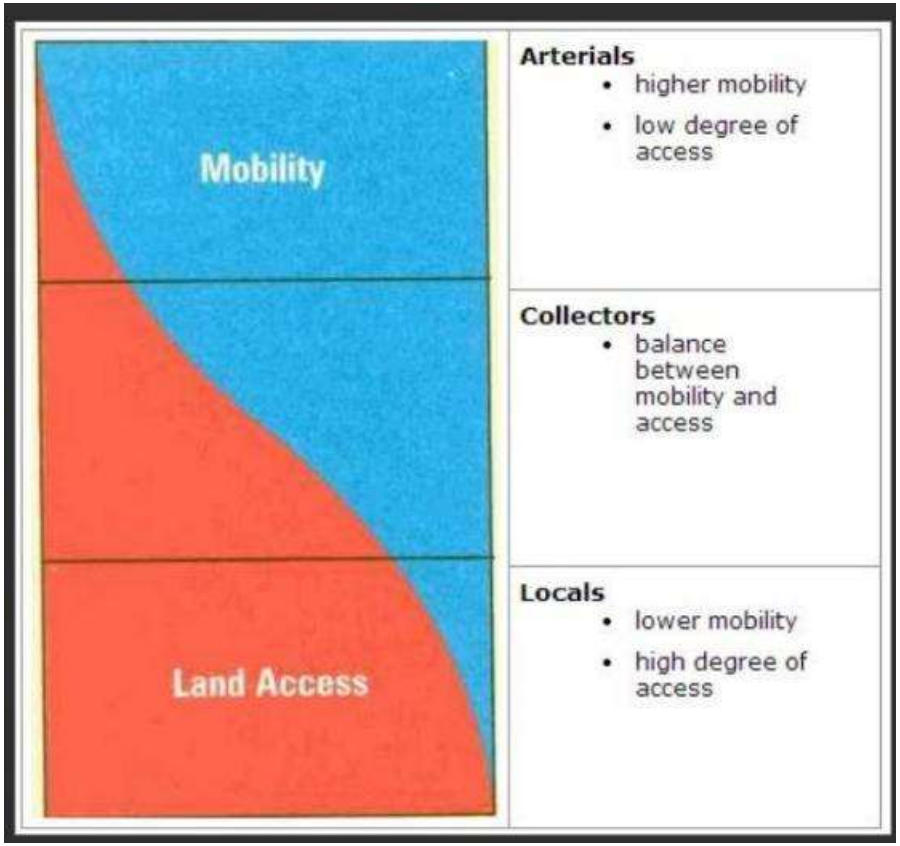
a. 2007 BS
b. 2017 BS
c. 2027 BS
d. 2037 BS

The topographical survey is conducted to estimate which of the following characteristics?

a. Engineering
b. Traffic
c. Financial
d. Soil

. The roads with lowest travel mobility are

a. Arterial roads
b. Sub-Arterial roads
c. Collector
d. Local roads



Design speed of the class III roads in Rolling topography is

e. 100 kmph

f. 80 kmph

g. 60 kmph

h. 40 kmph

Which of the following is positive obligatory point during highway alignment?
a. Religious places
b. Commercial places
c. Water logged area
d. Both a and b

. The first National Highway of Nepal is
a. Mahendra highway
b. Tribhuvan Highway
c. Araniko Highway
d. Prithivi Highway

If the average daily traffic of certain road is 10,000 PCU, then the type of road is
a. Class I road
b. Class II road
c. Class III road
d. Class IV road

The improper alignment will not result in
a. Decrease in construction cost
b. Decrease in maintenance cost
c. Decrease in population
d. Decrease in accident

The survey of highway alignment are completed in

a. One stage

b. Two stages

c. Three stages

d. Four stages

For class II roads, the design speed should be
A) 120 Km/hr
B) 80 km/hr
C) 60km/hr
D) None of the above

For class IV roads, the design speed should be
a) 120 Km/hr
b) 80 km/hr
c) 60km/hr
d) 40 km/hr

The ADT is taken for
a) 10 Years perspective period
b) 20 Years perspective period
c) 15 Years perspective period
d) 18 Years perspective period