Transportation Engineering I

Introduction to Transportation Planning and Engineering

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Transportation Engineering I

1. Introduction to Transportation Planning and Engineering (4 hrs)
2. Highway Alignment and Engineering Survey (4 hrs)
3. Geometric Design of Highway (18 hrs)
4. Highway Drainage (4 hrs)
5. Hill Road (5 hrs)
6. Highway Materials (10 hrs)

Transportation Engineering I

1. Introduction to Transportation Planning and Engineering

1.1 Introduction

1.2 Modes of Transportation

1.3 Comparison between various modes of Transportation

1.4 Historical Development of Roads: Roman, Tresaguet, Teflord, Macadam

1.5 Road Construction in Nepal

1.6 Transportation Planning including Objectives of Planning

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

1.1 Introduction

Transportation refers to the movement of people and goods from one place to another.

A transportation system may be defined as consisting of the fixed facilities, the flow entities, and the control systems that permit people and goods to overcome the friction of geographical space efficiently in order to participate in a timely manner in some desired activity.

The transportation system as defined by ITE-Institute of Transportation Engineers can be summed up as the application of technology and scientific principles to the planning, functional design, operation and management of facilities for any mode of transportation to provide **safe, rapid, comfortable, convenient, economical and environmentally** compatible movement of people and goods.

Components of Transportation System

- A transportation system consists of different components which together along people and goods to overcome the hindrance of geography.
  - Fixed facilities
  - Flow entities
  - Control system

Components of Transportation System

- Fixed Facilities
  - Physical components of the system that are fixed in space.
  - Constitute the network of links and nodes.
  - Road, railway track, ocean or waterways, airports harbor, etc.

Components of Transportation System

- Flow entities
  - Components that traverse (travel through) the fixed facilities.
  - Includes vehicles and are considered on the basis of shape, size, weight, acceleration and deceleration abilities.
  - Example: road vehicles, trains, aircraft, ships, etc.

Components of Transportation System

- Control system
  - Consists of vehicle control and flow control.
  - Vehicle control – Technological way in which the vehicles are guided either automatically or manually.
  - Flow control – Consists of the means that permit the efficient and smooth operation of stream of vehicles and the reduction of conflicts between them.
  - Traffic control using traffic lights, at the intersection, road signs and markings, air traffic control, etc. help in the smooth flow of vehicles.

1.1 Introduction

Scope of Transportation Engineering

- Transportation Planning
- Geometric Design
- Pavement analysis and design
- Traffic Engineering
- Public Transportation
- Financial and Economic Analysis
- Environmental Impact Assessment (EIA)
- Accident analysis and reduction
- Intelligent Transport System (ITS)
- Development, Planning and location
- Materials, construction and maintenance
- Traffic operation and its control

1.1 Introduction

Role of Transportation in Society

- Inseparable part of society.
- The measure of the development of any society is characterized by how developed transportation system is.
- Advancement in transportation has made a vast change in the quality of life of people.
  - **Economic Role:**
    - Economies involves production, distribution, and consumption of goods and services which are inevitable without the transportation facility.
    - In a country like Nepal which has a wide gap between production and consumption, an effective mode of transportation can always be helpful for its economic growth.
    - Contribution to **GDP.**

Role of Transportation in Society

- **Social Role:**
  - Development of transportation system influences the formation of urban society.
  - It links rural areas with urban ones transporting goods from one place to other, eventually helping in overall development.
  - Transportation also promotes cultural and social exchanges.
  - It provides employment opportunities.

Role of Transportation in Society

- **Political Role:**
  - The world being divided into different political units for mutual protection, economic advantages and development of common culture is linked by transportation of both people and goods through different modes.
  - Transportation plays a vital role in functioning of these political units.

Role of Transportation in Society

- **Environmental Role:**
  - Environment is highly affected by transportation.
  - Its harmful aspect is more prominent than its useful aspects.
  - Air pollution, noise pollution, overuse of new-renewable energy, etc. are some of its impacts on the environment.
  - **Transportation safety (mainly road safety) is of major concern.**

Characteristics of Transportation

- **Multi-modal:** Land, air, water
- **Multi-sector:** Government, Private industry, and Public
- **Multi-problem:** National and international policy, location and design of facilities, carrier management issues, regulatory, institutional and financial policies
- **Multi-objective:** Aiming at national and regional economic development, urban development, environment quality and social quality
- **Multi-disciplinary:** The theories and methods of engineering, economics, operations research, political science, psychology, other natural, and social sciences, management and law.

Modes of Transportation

- **Primary Mode**
  - Land Transportation (Highway, Railway)
  - Air Transportation
  - Water Transportation
  - Pipeline Transportation
- **Secondary Mode**
  - Ropeway
  - Belt conveyors
  - Canal

Modes of Transportation

- **Primary Mode**
- Land Transportation (Highway, Railway): Highway
  - The major advantages of the highway is that it has high accessibility to almost all potential destinations, direct service with very low door-to-door travel times, moderate speeds and capacities.
  - Capital cost for physical facilities is also moderate.
  - Vehicles are small and readily available at a low cost.
  - However, operating cost tends to be higher.
  - Environmental impacts of the system as a whole are high and are a major social concern.

1.2 Modes of Transportation

Modes of Transportation

- **Primary Mode**
- Land Transportation (Highway, Railway): Highway

Advantages:
- Wide geographical coverage
- Large influential area
- Relatively small investment for the construction, motor vehicles are much cheaper
- For short distance travel, road transport saves time
- Maximum flexibility for travel
- Provides door to door service
- Quick and assured deliveries
- Road networks serves as feeder system for other modes
- Personalized travel and service
- Economical means of short travel

Disadvantages:
- Destroys agriculture land and natural terrain
- High energy and area use
- Main source of noise and air pollution in cities
- Subjected to a high degree of crashes
- Not economical for long distance travel

1.2 Modes of Transportation

Modes of Transportation

- **Primary Mode**
- Railway
  - The railway system provides moderate speeds and levels of accessibility.
  - Accessibility is only limited to railway stations.
  - A heavy capital must be invested in both physical facilities and flow entities.
  - This mode is very effective for transportation of a lot of goods through land.

Modes of Transportation

- **Primary Mode**
- Railway

Advantages:
- Trains move at much higher speed
- Steel tracks can take three to four times heavier axle loads than roads
- Less energy consumptionn
- Overall cost (initial cost, operating cost and maintenance cost) is less than roadways
- Safe in comparision to road transport

Disadvantages:
- Huge investment of capital
- No door to door service
- Not flexible
- Unsuitable and uneconomical for short distances and small traffic of goods
- Cannot be operated economically in rural areas
- Not operable with steeper gradient

Modes of Transportation

- **Primary Mode**
  - Air Transportation
    - The main advantage of air transport is its high speed and less time consumption.
    - Accessibility is limited but is of less importance as greater lengths of trips are made.
    - Capital investment as well as operating and maintenance cost for both fixed and flow entities are higher than other modes.
    - Environmental impacts are significant, air and noise pollution of commercial aviation but are of less concern than that of highways.

Modes of Transportation

- **Primary Mode**
- Airway

Advantages:
- Improves accessibility to otherwise inaccessible areas
- Provides continuous connectivity over land and water
- Saves productive time spent on journey
- Relief and rescue operation
- Maximum speed

Disadvantages:
- Heavy funds (investment and operation cost)
- Operations are highly dependent upon weather conditions
- High energy consumptions
- Noise

Modes of Transportation

- **Primary Mode**
  - Water Transportation
    - Water Transportation provides low speed and relatively low accessibility, but extremely high capacities.
    - The capital cost of vehicles, especially ships are very high but operating cost is low for a large distance.
    - So, if a lot of goods is required for transportation, this mode can be used for best results.
    - Environmental effects are relatively low but the chances of water pollution due to leakage of oil and petroleum products are high.

Modes of Transportation

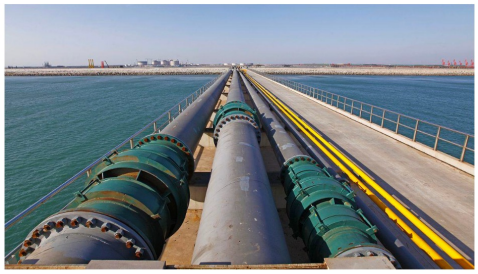
- **Primary Mode**
- Waterways

Advantages:
- Highly effective method of transporting large quantities of non-perishable goods
- Significantly less costly
- Natural route
- Little or no congestion
- Little pollution

Disadvantages:
- Slow, therefore not suitable to transport perishable goods
- Costly and time consuming for short distance travel
- Poor weather condition affects transport service
- Depth of waterways affects capacity of ship
- Dredging is expensive if required

Modes of Transportation

- **Primary Mode**
  - Pipeline Transportation
    - The transport of daily use products and wastes to the desired location encompass pipeline transportation.
    - They provide very low speed, but the high-capacity constant flow and involves a large amount of working storage.
    - Environmental impacts are generally low.



Modes of Transportation

- **Primary Mode**
- Pipeline Transportation

Advantages:
- Ideally suited to transport the liquids and gases
- Low capital cost and low operating cost
- Can be laid through difficult terrains as well as underwater
- Low energy consumption
- Little maintenance
- Safe and environmentally friendly

Disadvantages:
- Not flexible, can be used only for few fixed points
- Capacity can't be increased once it is laid
- Difficult to make security arrangements for pipelines
- Difficult to detect and repair leakage in underground pipes

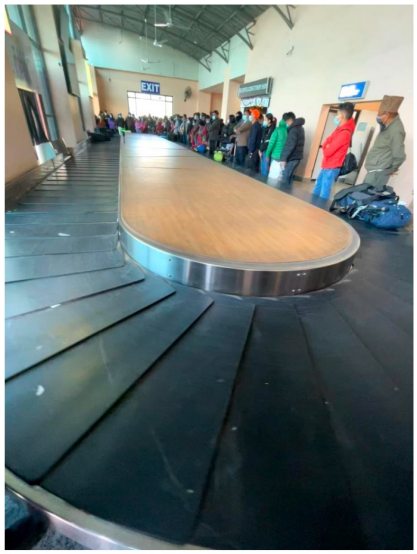
Modes of Transportation

- **Secondary Mode**
  - A variety of other modes also exists although they do not contribute in major transportation, however, are inevitable.
  - Ropeway refers to special type of carriers suspended from or simply attached to an overhead rope.
  - Ropeway is an effective, economic and environmentally friendly way of crossing hills.
  - Belt conveyors are belt supported on rollers that provides steady movement of materials.
  - Cable and belt are systems extensively used in industries for transportation of goods.
  - Canals are also used in transportation for irrigation system in rural areas.

1.2 Modes of Transportation

Modes of Transportation

- **Secondary Mode**



1.3 Comparison between Various Modes of Transportation

Comparison between Various Modes of Transportation

	Roadway	Railway	Airway	Waterway	Pipeline
Accessibility	High	Moderate	Low	Low	Low
Speed	Moderate	Moderate	High	Low	Very Low
Capacity	Moderate	Higher than roads	Capacity per vehicle is limited	High capacity per vehicle	High capacity
Initial Capital Cost	Moderate	High	High	High	Moderate to High
Operating Cost	High	Moderate to High	High	Low	Low (Depends mainly upon pumping cost)
Efficiency	Not High	High	Low	Very High	High

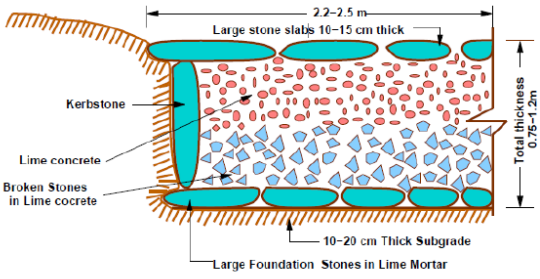
Historical Development of Roads

- The first mode of transportation was by foot. This led to the development of footpaths.
- The next major mode was the use of animals. This led to the development of trackways as the loaded animals required more horizontal and vertical clearances.
- The invention of wheel in Mesopotanian civilization led to the development of animal drawn vehicles.
- Then, it became necessary that the road surface should be capable of carrying greater loads. Thus, roads with harder surfaces emerged.

Historical Development of Roads

Roman Road

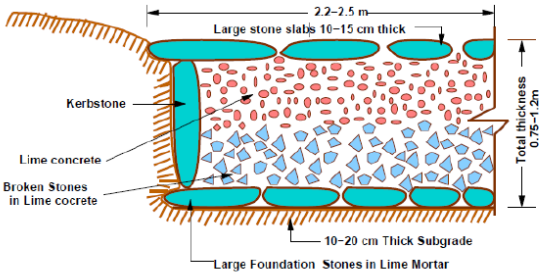
- Romans constructed an extensive system of roads radiating in many directions from Rome.
- Romans recognized that the fundamentals of good road construction were to provide **good drainage, good material and good workmanship.**
- Roads were constructed on a firm-ground subgrade strengthened where necessary with wooden piles.
- Roads were bordered with longitudinal drain.
- Construction of Agger:
  - Raised formation upto 1m high and 15m wide.
  - Constructed with materials excavated during side drain construction.
  - This was then topped with a sand levelling course.
  - Agger contributed greatly to moisture control in the pavement.
  - In case of heavy traffic, a surface of large 250mm thick hexagonal flag stones were provided.



Historical Development of Roads

Roman Road

- Main features
  - Built regardless of gradient.
  - Used heavy foundation at bottom.
  - Mortar made from lime and volcanic pozzolana and gravel added to make concrete.
  - Concrete was a major Roman Road making innovation.

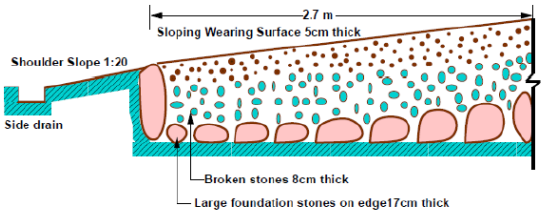


The roman road network built during seven centuries extended over a total length of 90000 km of which about 14000 km still exists.

Historical Development of Roads

Tresaguet Roads (French Roads)

- The next major development in the road construction occurred during the regime of Napolean.
- Construction were given by Tresaguet in 1764 and was implemented in 1775.
- He developed a cheaper method of construction than the lavish and locally unsuccessful revival of Roman practice.

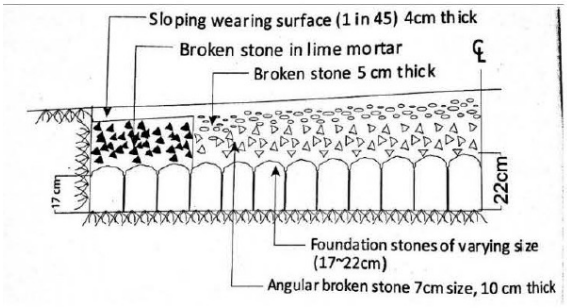


- Pavement used 200mm pieces of quarried stone of a more compact form and shape such that they had at least one flat side which was placed on a compacted formation.
- Small pieces of broken stones were then compacted into spaces between large foundations to provide a level surface.
- Running layer with 25mm sized broken stone was made.
- All this structure was placed on a trench to make running surface in level with the surrounding countryside.
- Drainage problems was counteracted by making the surfaces as impervious as possible, cambering the surface and providing deep side ditches.

Historical Development of Roads

Telford Construction

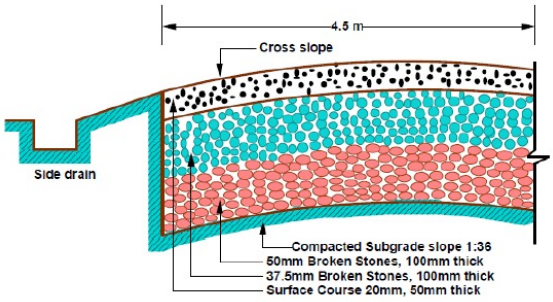
- Telford in England (1757-1834) proposed similar type of construction as Tresaguet in France.
- Slopping surface on the top was achieved by providing varying size of stones in foundation.
- For lateral confinement, Telford used a block made of broken stones in lime water.



Historical Development of Roads

Macadam Construction (British Roads)

- First scientific road construction method.
- Economical method of road construction.
- Stone size was an important element of macadam road construction.
- John Macadam (1756-1836), a Scottish road builder, is considered as the pioneer of modern road construction.



- Macadam came to realize that 250mm layers of well compacted broken angular stones would provide the same strength and stiffness and a better running surface than an expensive pavement founded on large stone blocks.
- The mechanical interlock between the individual particles provided strength and stiffness to the course.
- Inter particle friction abraded the sharp interlocking faces and partly destroyed the effectiveness of the course.
- The effect was overcomed by introducing good quality interstitial finer material to produce a well-grained mix.
- Such mix proved to be less permeable and easier to compact

1.4 Historical Development of Roads

Historical Development of Roads

Modern Roads

- Follows Macadam's construction method.
- Uses bituminous concrete and cement concrete.
- Various advanced and cost-effective construction technologies are used.
- Development of new equipment helps in the faster construction of roads.
- Easily and locally available materials are tested in laboratories.

1.5 Road Construction in Nepal

Road Construction in Nepal

- **Organizational Development**
  - Bato Kaj Goshwara and Chhembhadel Adda was established during Rana period for road construction and maintenance.
  - Naya Bato Kaj Goshwara and Purano Bato Kaj Goshwara was made in order to construct the new and maintain the old road network.
  - In 2007 B.S., these government agencies were combined, and Public Work Department (PWD) was formed.
  - In 2017 B.S., three subsections, Planning, Construction and Maintenance were created under road section of PWD.
  - In 2027 B.S., the Department of Roads (DoR) and the first Nepal Road Standard 2027 was formed.
  - In 2051 B.S., 25 divisions of road were formed under five regional offices.
  - In 2055 B.S., Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR), now Department of Local Infrastructure (DoLI) was established.

1.5 Road Construction in Nepal

Road Construction in Nepal

- **Road Construction**
  - Trails with hard surface during Malla's period.
  - 1924 AD - First motorable road in Kathmandu Valley.
  - 1929 AD – 42km long gravel road linking Amlekhganj with Bhimphedi.
  - Postal Road from Kechana Kawal, Jhapa in the East to Dodhara, Kanchanpur in the West was constructed during Rana period.
  - 1954 AD – Construction of Kanti Rajpath was started by Nepal Army.
  - 1956 AD – Tribhuvan Highway was constructed with the aid from India.
  - 1964 AD – 113-kilometer Araniko Highway was constructed with Chinese assistance.
  - 1964 AD – Siddhartha Highway was constructed with the aid from India.
  - 1961 AD – Construction of Mahendra Highway began.

1.5 Road Construction in Nepal

Road Construction in Nepal

Nepal Road Network
Road Length with Category and Pavement (In Kilometer)

Data Year 2020/021

Road Classification	Province	BT	GR	ER	Total	UC	PL
National Highway	Province 1	1274.45	182.38	436.03	**1892.86**	226.89	855.49
	Province 2	547.33	183.69	183.72	**914.74**	0.00	158.53
	Province 3	1359.74	268.90	261.05	**1889.68**	33.01	406.07
	Province 4	530.24	75.16	694.57	**1299.97**	32.01	191.51
	Province 5	1428.90	165.11	791.09	**2385.10**	94.33	72.59
	Province 6	664.47	161.00	615.72	**1441.19**	21.00	671.36
	Province 7	1031.32	80.12	243.94	**1355.38**	80.00	694.55
	Sub-Total	**6836.45**	**1116.36**	**3226.12**	**11178.92**	**487.24**	**3050.11**
Grand Total		**6836.45**	**1116.36**	**3226.12**	**11178.92**	**487.24**	**3050.11**

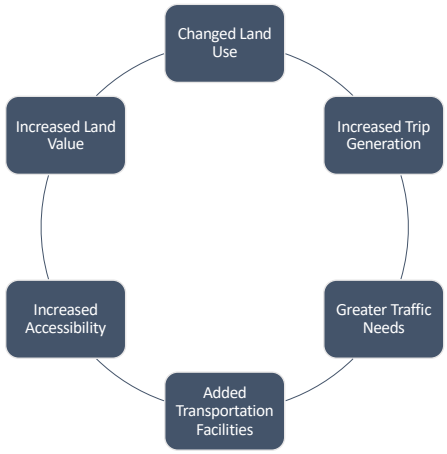
Summary Of Road Length

Road Classification	BT	GR	ER	Total	UC	PL
National Highway	6836.45	1116.36	3226.12	**11178.92**	487.24	3050.11
Total	**6836.45**	**1116.36**	**3226.12**	**11178.92**	**487.24**	**3050.11**

Source: DoR

1.6 Transportation Planning Including Objective of Road Planning

- Transportation system requires a continuous planning to optimally satisfy the mobility requirement of the society.
- Planning becomes significant when the resources available are limited and requirements are higher.
- The main objective of planning is to optimally utilize the available resources in the best possible way and in a very systematic manner.
- Failing to Plan is Planning to Fail !



Types of Planning

- Transportation planning can be divided into short term, medium term and long-term planning.
  - Short term (1-3 years) and medium-term (3-5 years) planning can be defined relatively in the same way.
    - They are less complex and put no great demand on construction activities and require less capital expenditure.
    - It includes Transportation System Management (TSM)
  - Long term (More than 5 years) planning is a complex problem and requires huge financial expenditure and involves large and extensive construction program which affect the environment in economic, social and natural aspects.
    - Desired solution is obtained through carefully constructed policy making at the multi-levels of government and administration involved which could be solved best through system approach.

1.6 Transportation Planning Including Objective of Road Planning

The System Approach

- The system approach is a decision-making process for complex problem solving composed of.
  - System analysis: A clever evaluation of the combinations of all the elements that structure the problem and those forces and strategies needed for the achievement of an objective.
  - System engineering: Organizing and scheduling complex strategies for problem-solving. It includes:
    - Identifying the problem
    - Tackling the problem considering all facts
    - Use of scientific methods
    - Working as per predetermined sequence
    - Scientific decision

1.6 Transportation Planning Including Objective of Road Planning

The System Approach

- In dealing with long term transportation planning, three basic elements should be considered:
  - Forecasting demand
  - Description of economic, social and environmental changes
  - An evaluation of the system in term of benefits and dis-benefits
- The planner should continuously deal with three different groups having their own vested interest namely operators, users and non-users.
  - The operator is concerned with capital costs, operating costs, operating revenues and the viability of the plan.
  - The user is concerned with monetary cost, journey time, safety and security, reliability and comfort and convenience.
  - Large number of people who neither travels nor causes goods or people to move are also affected by the proposals of the transportation panner. Such non-users are affected by land use changes, social disruption and economic effects.

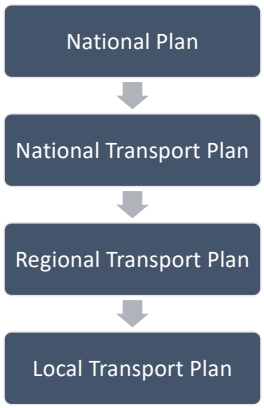
1.6 Transportation Planning Including Objective of Road Planning

Land Use-Transportation Model

- Land use transportation model is an effective way to study and design transportation plans.
- The land use-transportation model can be studied under two phases: calibration phase and projection phase.
- The calibration phase is followed by projection phase.
- In the calibration, phase models are built and tested using data from a base period and in the projection phase, the developed model is used to determine future transport design based on socio-economic projection for a design year.

1.6 Transportation Planning Including Objective of Road Planning

Road Plan/Highway Plan



1.6 Transportation Planning Including Objective of Road Planning

Objectives of Road Planning

- To establish an integrated network of road.
  - An integrated highway network capable of accommodating all highway travel in an orderly, safe, efficient and economical way is required.
  - Hence, highway development plan is an essential part of national transport plan.
  - For this following three processes should be followed:
    - Forecast the future requirement of roads needed.
    - Set up priorities and schedules of construction and renewal program in accordance with the available resources.
    - Financial planning and management
- To fulfill the needs of the society
    - Road planning is basically accepted as an outcome of the needs of the society.
    - The first step in planning is to identify all the present as well as the future need of the society.
    - These needs are to be fulfilled in the second step of planning.

1.6 Transportation Planning Including Objective of Road Planning

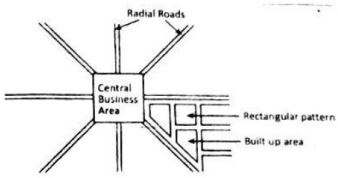
Objectives of Road Planning

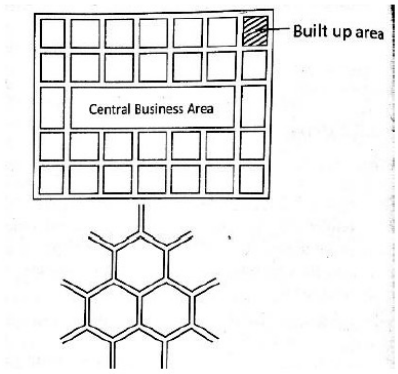
- Road planning can be grouped as:
  - National Road Network Planning
    - It is the planning of all roads to be developed in the national context and includes:
      - National Highways
      - Feeder Roads
    - Nepal's national road network plan is in the form of the linear pattern with the dead notes on hill district headquarters.
    - National highways run east to west and north to south to which feeder roads or district roads are connected to link district headquarters and major cities, towns, villages, etc.
  - Urban Road Network Planning
    - Urban areas must be developed in a suitable way so that the development remains intact for many years.
    - So, planning of road networks in urban areas is an integral part of its development.

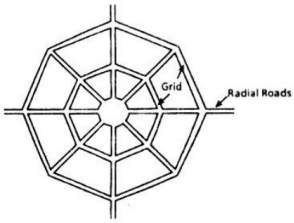
1.6 Transportation Planning Including Objective of Road Planning

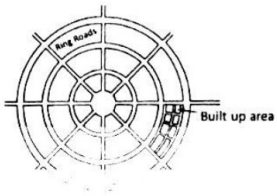
Objectives of Road Planning

- The major road patterns developed in modern urban areas are as follows:
  - Grid Iron Pattern
    - Rectangular or block
    - Hexagonal
  - Radial Pattern









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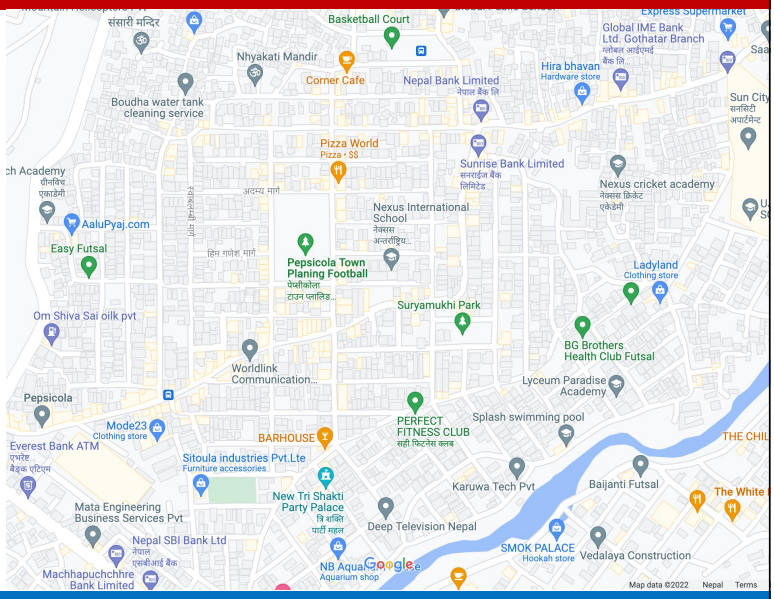


1.6 Transportation Planning Including Objective of Road Planning

Objectives of Road Planning

- Rectangular Grid Iron Pattern
  - The buildup area is obtained in a rectangular shape which is easy to develop
  - Suitable for flat terrain
  - Encourage spread of traffic over the grid, therefore reducing traffic congestion
  - Disadvantages
    - Produce monotonously long streets
    - Extra distances must be travelled when going in a diagonal direction

1.6 Transportation Planning Including Objective of Road Planning

Objectives of Road Planning

- Hexagonal
  - The basic figure of the road network is of hexagon.
  - Can save around 10% in infrastructure costs, including a 10% reduction in road per house.
  - Three-way intersections have improved sight lines, but awkward shaped plots created in hexagonal layouts.

1.6 Transportation Planning Including Objective of Road Planning

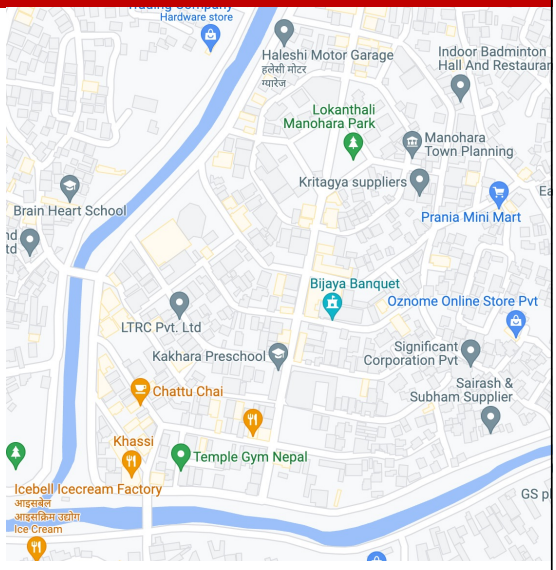
Objectives of Road Planning

- Grid Iron Pattern
  - Built-up area is obtained in a rectangular or hexagonal shape.
  - It can produce monotonously long streets and dull blocks of the building.
  - However, it encourages even spread of traffic over the grid and as consequence, the impact at a particular location is reduced.
  - Advantages
    - Low cost
    - Simple to plan
    - Gives good circulation plan and easy for plot subdivision
    - Efficient in providing drainage and sewerage network
  - Disadvantages
    - Offers limited urban design options
    - Produces constrained and rushed psychological effect
    - Can be confusing and frustrating

1.6 Transportation Planning Including Objective of Road Planning

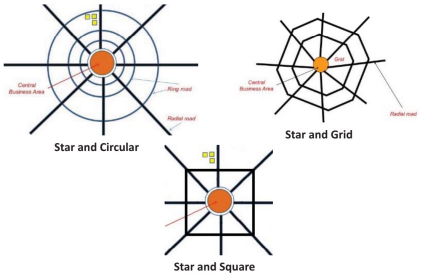
Objectives of Road Planning

- Radial Pattern
  - This system is widely used in many countries to join one town center to another town center.
  - Thus, any given town may have several roads radiating from its centre to other towns and villages around it.
  - As towns grow in size, they turned first to develop along the radial direction and fill in the spaces after that.
  - The main traffic generator is located within the centre area and all radiating roads converge on the main business area of the focal point.



1.6 Transportation Planning Including Objective of Road Planning

- Ring Roads
  - Ring road is a radial pattern of road which runs in circumference to an urban area so as to avoid excess traffic inside the area.
  - There may be doubling or tripling of rings depending upon the size of the urban area and requirement of population.
  - Due to ring roads there is a direct access to the town centre.
  - The town centre may be a core business area and may have banks, shopping complexes, entertainment centres, etc.
  - In Kathmandu, an inner ring road is already built.
  - Due to increasing population and increase in number of vehicles, an outer ring was proposed and now is in construction phase.



1.6 Transportation Planning Including Objective of Road Planning

Objectives of Road Planning

- Ring Roads

SALIENT FEATURES

SN	FEATURES	CHARACTERISTICS
GENERAL		
1	Name of Project	Kathmandu Outer Ring Road (ORR) Development Project
2	Type	Urban Road & Real Estate Development
3	Project Concept	Road Development (Right-of-Way 50 m) and Commercial hub development in certain section of the road
PROJECT LOCATION		
1	Province	Kathmandu Valley Outer Ring road
2	Project location	Province – 3. Chobhar, Gamcha, Satungal, Naikap-Purano Bhanjhang, Sitapaila, Nagarjun, Nepaltar, Gongabu, Tokhagaun, Chapali, Kapan, Jagdol, Sandol and Thalidachi in Kathmandu district. Similarly, Lubhu, Thaiba, Dhapakhel, Thecho, Bungamati and Chobhar in Lalitpur and for Bhakatpur ORR connects Gamphedi, Pakaunepati, Bansbari, Yangdol, Masandol, Bhatedhikuro, Naya Thimi and Dadhikot.
PROJECT COMPONENT/TECHNOLOGY		
1	72 km Outer Ring Road	Eight-lane road of 50 meters width (6 meter setback on either side), cycle tracks, greenbelts and pavements on both the sides, along with flyovers at major junctions.

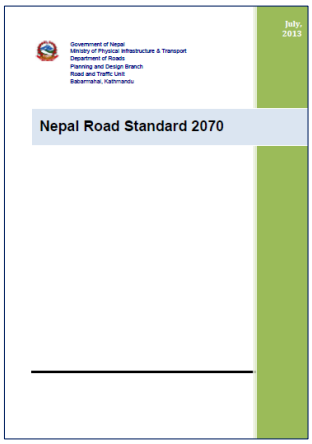
1.6 Transportation Planning Including Objective of Road Planning

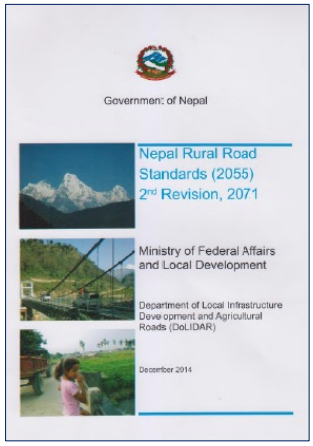
Road Transport

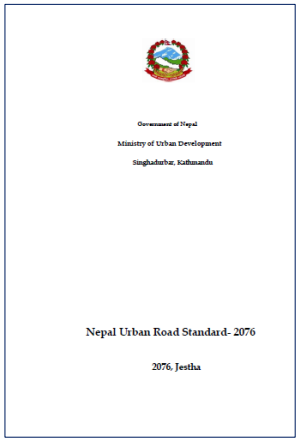
- Advantages
  - Wide geographical coverage
  - Large influential area
  - Low capital investment
  - Flexibility
  - Quick and assured deliveries
  - Highest employment opportunities
  - Low cost of packaging
  - Economy
  - Safety
- Disadvantages
  - Land coverage
  - Environmental Pollution
  - Poor safety records
  - Uneconomical for long distances

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Standards in Nepal



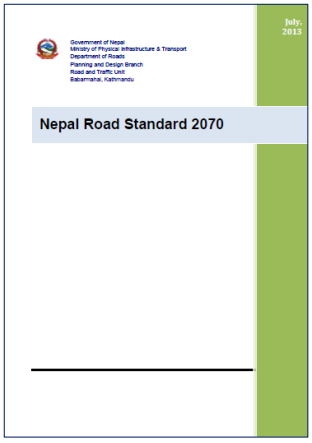




1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Classification in Nepal (As per NRS 2070)

- Administrative Classification
  - National Highways
  - Feeder Roads
  - District Roads
  - Urban Roads
- Technical/Functional Classification
  - Class I
  - Class II
  - Class III
  - Class IV



1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

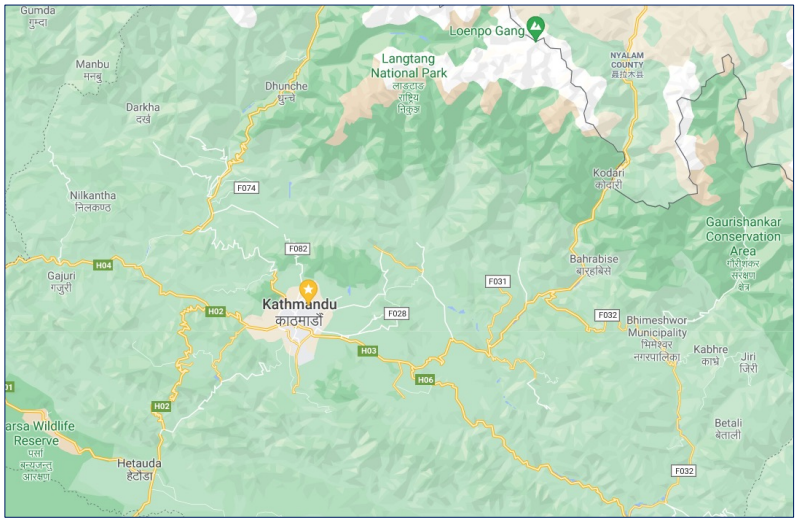
Road Classification in Nepal: Administrative Classification – National Highways

- Connecting East to West and North to South of the country.
- Consistent higher level of service in terms of travel speeds.
- Designated by letter 'H' followed by two-digit number.

Strategic Road Network (SRN) -DoR

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Classification in Nepal: Administrative Classification – Feeder Roads

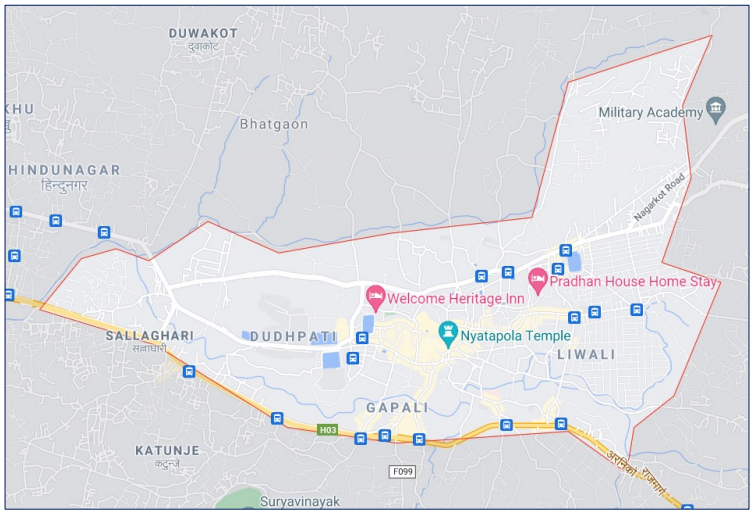


- Connects district headquarter, major economic centers, tourism centers to national highways or other feeder roads.
- Designated by letter 'F' followed by three-digit number.

Strategic Road Network (SRN) -DoR

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Classification in Nepal: Administrative Classification – District Roads

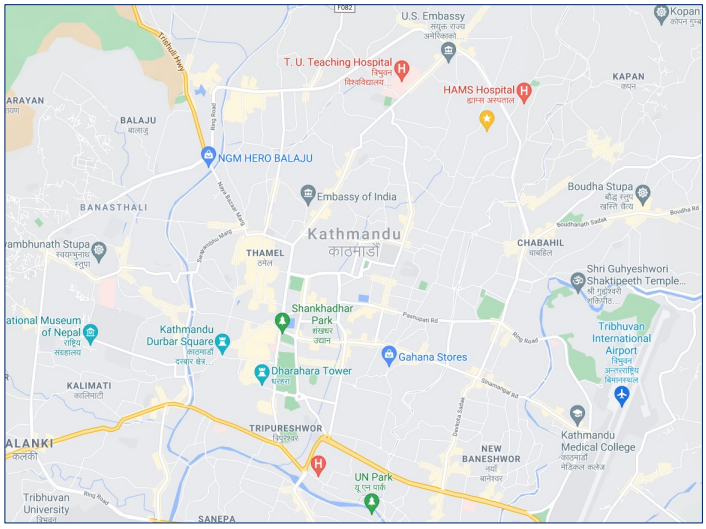


- Important roads within a district, serving areas of production and markets and connecting each other or with the main highway.

Department of Local Infrastructure (DoLI)

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Classification in Nepal: Administrative Classification – Urban Roads



- Roads serving within the urban municipalities.

Local Bodies

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Classification in Nepal: Technical/Functional Classification

Class (Approximate equivalence)	Design Speed (Plain terrain)	ADT (20 years perspective period)
I (Expressway)	120 kmph	20,000 PCU and above
II (Arterial)	100 kmph	5000-20000 PCU
III (Collector)	80 kmph	2000-5000 PCU
IV (Local roads)	60 kmph	Less than 2000 PCU

Perspective period of 20 years

Roads shall be designed with a capacity sufficient to cater for the estimated traffic volume for 20 years after the date of completion of the works.

Approximate Correlation between administrative and functional classification

	Plain and Rolling Terrain	Mountainous and Steep Terrain
National Highway	I, II	II, III
Feeder Roads	II, III	III, IV

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Classification in Nepal: Terminology

AADT – Average Annual Daily Traffic

ADT – Average Daily Traffic

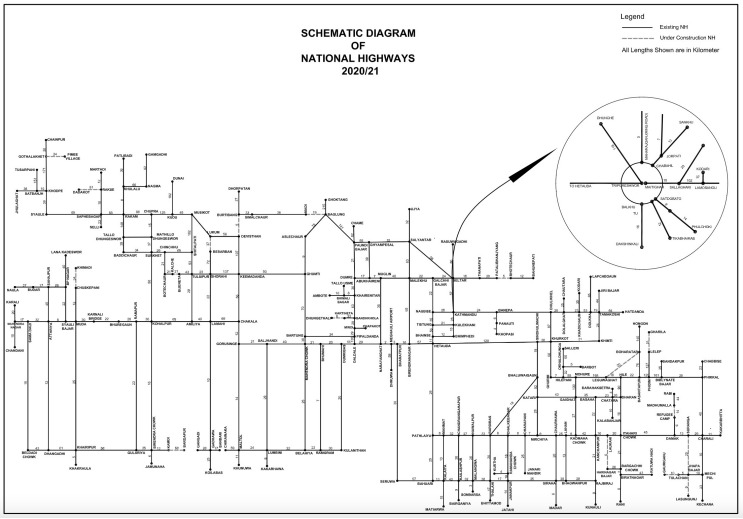
AAWT – Average Annual Weekday Traffic

AWT – Average Weekday Traffic

PCU – Passenger Car Unit

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

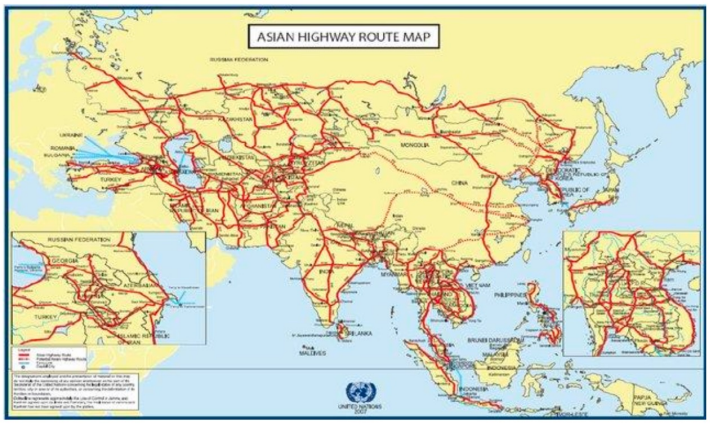
Road Classification in Nepal: SRN Network



Source: DoR

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Transportation in Nepal: Asian Highway (AH) [Optional]

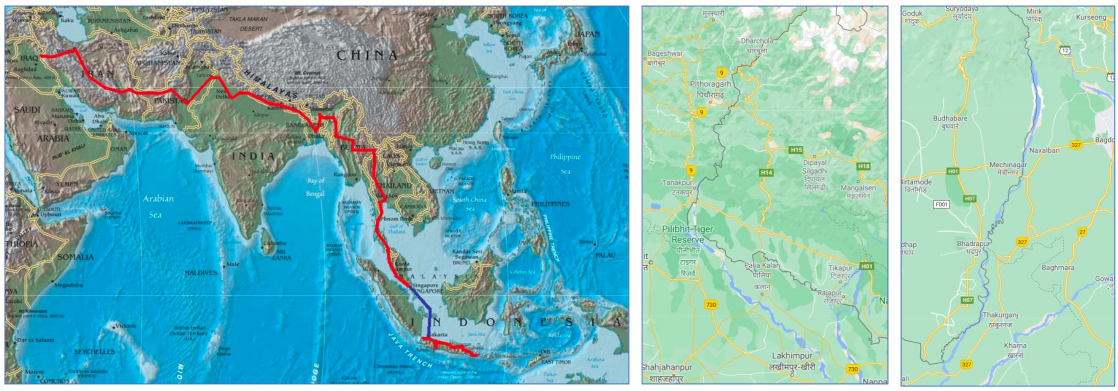


Asian Highway (AH)

- Cooperative projects among countries of Asia and Europe and UN ESCAP
- For the improvement of highway systems in Asia

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Transportation in Nepal: Asian Highway (AH) [Optional]

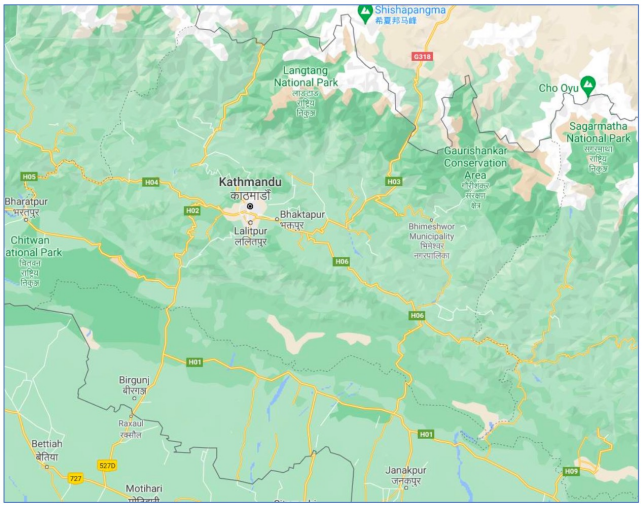


Asian Highway (AH2)

- India - NH 327, Nepal – Mahendra Highway (H01), India – NH 9

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Road Transportation in Nepal: Asian Highway (AH) [Optional]



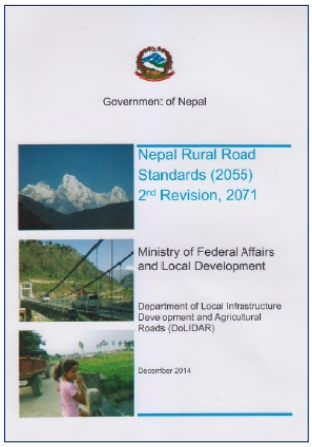
Asian Highway (AH42)

- China – G318
- Nepal – Tribhuvan Rajpath (H02), Araniko Highway (H03)
- India – NH 527D

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Rural Road Classification in Nepal

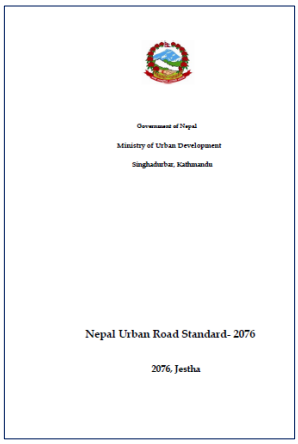
- District Road (Core Network)
  - Road joining VDC HQ's office or nearest economic center to the district headquarters, via either a neighbouring district headquarter or the SRN.
- Village Roads
  - Smaller roads not falling under DRCN.



1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Urban Road Classification in Nepal

- Based on function of the road and traffic level
  - Arterial roads (Path)
  - Sub-arterial roads (Sadak)
  - Collector roads (Marg)
  - Local roads (Upa-marg)


Government of Nepal

Ministry of Urban Development

Singhadurbar, Kathmandu

Nepal Urban Road Standard- 2076

2076, Jestha

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

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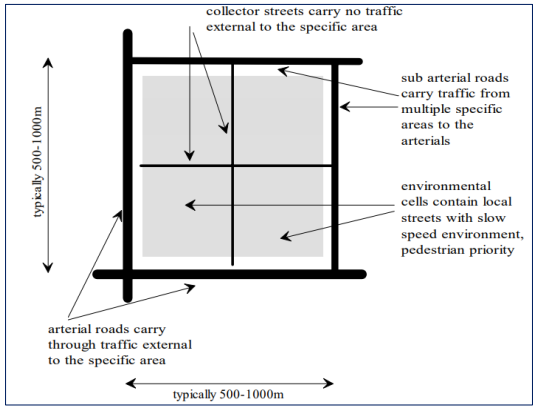

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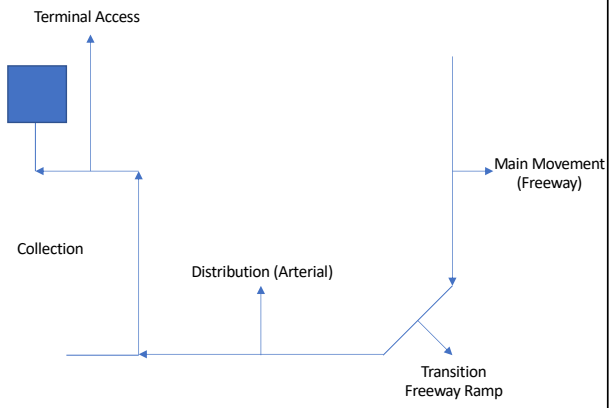

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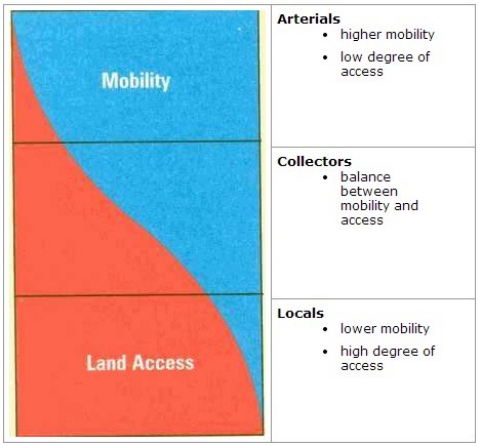

1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

Urban Road Classification in Nepal

Roads	Purpose	ROW	Pedestrian Crossing
Arterial	Through movement (High mobility)	50 m	Intersections or designated crossing
Sub-arterial	Lower mobility than arterial	30 m	Intersections or designated crossing
Collector	Collecting and distributing traffic to and from local roads and also providing access to arterial/sub-arterial roads	20 m	Full access from abutting properties
Local roads	Access	10 m	

Transportation Engineering I

Thank You!

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