**II Btech II sem Civil engineering**

**TRANSPORTATION ENGINEERING - I**

**Lecture notes**

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**UNIT I :: HIGHWAY ENGINEERING**

**1.1** **Importance of transportation::** Mobility is a basic human need. From the times immemorial, everyone travels either for food or leisure. A closely associated need is the transport of raw materials to a manufacturing unit or finished goods for consumption. Transportation fulfils these basic needs of humanity. Transportation plays a major role in the development of the human civilization. For instance, one could easily observe the strong correlation between the evolution of human settlement and the proximity of transport facilities. Also, there is a strong correlation between the quality of transport facilities and standard of living, because of which society places a great expectation from transportation facilities. In other words, the solution to transportation problems must be analytically based, economically sound, socially credible, environmentally sensitive, practically acceptable and sustainable. Alternatively, the transportation solution should be safe, rapid, comfortable, convenient, economical, and eco friendly for both men and material.

In the last couple of decades transportation systems analysis has emerged as a recognized profession. More and more government organizations, universities, researchers, consultants, and private industrial groups around the world are becoming truly multi-modal in their orientation and are opting a systematic approach to transportation problems.

**1.2 Modes of transportation::** We find that basically transport is possible through land, air or water, which are called the different modes of transport. On land we use trucks, tractors, etc., to carry goods; train, bus, cars etc. to carry passengers. In air, we find aeroplanes, helicopters to carry passengers as well as goods. Similarly in water we find ships, steamers, etc., to carry goods and passengers. All these are known as various means of transport.

**Land Transport**:

Land transport refers to activities of physical movement of goods and passengers on land.

This movement takes place on road, rail, rope or pipe. So land transport may further be

divided into Road transport, Rail transport, Ropeway transport, pipeline transport.

1. **Road Transport**

Roads are the means that connect one place to another on the surface of the land. You must

have seen roads in your village, in towns and cities. Not all of them look alike. Some of them

are made of sand and some may be of chips and cement or coaltar. You find different

vehicles plying on roads like bullock carts, cycles, motorcycles, cars, truck, buses, etc. All

of these constitute different means of road transport.

1. **Rail transport**

Transportation of goods and passengers on rail lines through trains is called rail transport. It

occupies an important place in land transport system of our country and is the most dependable

mode of transport to carry goods and passengers over a long distance. Besides long distance,

local transport of passengers is also provided by local trains or metro-rail in some metropolitan cities. Rail transport is available throughout the country except some hilly or mountainous regions. In India two types of trains are found. One is passenger train and other is goods train. While passenger trains carry both human beings and a limited quantity of goods, the

goods trains are exclusively used for carrying goods from one place to another. These trains

are driven by rail engines and they use steam, diesel or electric power to move.

1. **Pipelines transport**

In modern times, pipelines are used for various purposes. Water supply to residential and

commercial areas is carried on with the help of pipeline. Petroleum and natural gas are also

transported from one place to another through pipelines. This is the most convenient as well

as economical mode of transport for petroleum as well as natural gas in comparison to road

and rail transport, provided the volume to be transported is large. But the cost of installation

and maintenance requires large capital investment.

1. **Ropeway transport**

Ropeway refers to a mode of transport, which connects two places on the hills, or across a

valley or river. In the hilly areas, trolleys move on wheels connected to a rope and are used

for carrying passengers or goods, especially building materials, food, etc. The famous “Uran

Katella Jagdamba” in Gujarat that carries pilgrims to the temple is an example of ropeway

transport, which carries more than 100 passengers at a time.

**Water transport**

Water transport refers to movement of goods and passengers on waterways by using various means like boats, steamers, launches, ships, etc. With the help of these means goods and passengers are carried to different places, both within as well as outside the country. Within the country, rivers and canals facilitate the movement of boats, launches, etc. Since the goods and passengers move inside the country, this type of transport is called inland water transport. When the different means of transport are used to carry goods and passengers on

the sea route it is termed as ocean transport.

1. **Inland water transport**

Inland water transport use boats, launches, barges, streamers, etc., to carry goods and

Passengers on river and canal routes. These routes are called inland waterways and

are used in domestic or home trade to carry bulky goods. Passenger transport through

Waterways is not so popular in our country. Inland water transport system exists only

in few states like. West Bengal, Andhra Pradesh, Assam, Tamil Nadu, etc.

1. **Ocean transport**

Ocean transport refers to movement of goods and passengers with the help of ships

Through sea or ocean waterways. It plays an important role in the development of

International trade. It is also used for transporting goods and passengers in the coastal

Areas. Ocean transport has its fixed route, which links almost all the countries of the world.

Sea transport may be of the following two types.

**Air transport**

This is the fastest mode of transport. It carries goods and passengers through airways by

using different aircrafts like passenger aircraft, cargo aircraft, helicopters, etc. Besides

passengers it generally carries goods that are less bulky or of high value. In hilly and

mountainous areas where other mode of transport is not accessible, air transport is an

important as well as convenient mode. It is mostly used for transporting

goods and passengers

during natural calamities like earthquake and floods, etc. During war, air transport plays an

important role in carrying soldiers as well as supplies to the required areas.

**1.3 Characteristics of road transport ::**

In India About 65% of freight and 80% passenger traffic is carried by the roads.

* National Highways constitute only about 1.7% of the road network but carry about 40% of the total road traffic.
* Number of vehicles has been growing at an average pace of 10.16% per annum over the last five years. About 65% of freight and 80% passenger traffic is carried by the roads.
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India has the second largest road network in the world, with over **3.314** million kms of roadways spread across the length and breadth of the country. The roads are primarily made of bitumen, with some Indian National Highways having concrete roads. The concept of expressway roads is also catching up in India, and the **Mumbai – Pune expressway** and **Delhi Gurgaon expressway** are the finest examples. **Yamuna-expressway** which connects **Delhi to Agra** is also good.

**1.4.Classification of roads:: (PPT Enclosed)**

**1.5. Highway alignment::** The highway alignment can be either horizontal or vertical

The position or the layout of the central line of the highway on the ground is called the alignment. Horizontal alignment includes straight and curved paths. Vertical alignment includes level and gradients.

Alignment decision is important because a bad alignment will increase the construction, maintenance and vehicle operating costs. Once an alignment is fixed and constructed, it is not easy to change it due to increase in cost of adjoining land and construction of costly structures by the roadside.

**Requirements of an ideal Alignment:**

There are some basic requirements of the highway alignment in the plain and hill roads which must be fulfilled. In general the basic requirements are
(1) Short: The alignment must be the shortest of the various alternatives available. Of course the shortest path between any two points is a straight line but the topography of the area or other factors may necessitate it do divert and take some other route, but as far as possible it should be kept minimum.
(2) Easy: Alignment should be such that the road must be easy to construct and easy to maintain or repair.
(3) Safe: Safety is again the basic requirement of the highway alignment and special care must be taken to align the road in such a way that it must have the safe or minimum Sight distances.
(4) Economical: Road alignment must be designed to have the initial cost of construction, maintenance cost and the vehicle operation cost to a minimum. Also the locally available materials .

Hill roads have some other basic requirements also which govern the alignment of the hill roads:
(1) Drainage: Drainage of the road must be kept in mind and it must be insured that enough drainage structures can be built on the route. As far as possible alignment must avoid the drainage works means it must have the minimum numbers of the drainage works.
(2) Economy: Economy is governed by the numbers of the drainage works, cutting filling and the gradient.
(3) Safety: Safety is governed by the sight distance, super-elevation and the design radius of the curves. It must be kept in mind that gradient must be kept below the ruling gradient. In hill roads special attention must be given to the side slopes, and thorough geological surveys must be carried out to ensure the safety while construction as well as while traffic movement.
(4) Minimum resisting length: The un-necessary rise and fall of the gradient must be minimized to reduce the cost and length of road.

**Factors Governing Alignment::** The various factors that control the alignment are as follows:

**Obligatory points:** These are the control points governing the highway alignment. These points are classified into two categories. Points through which it should pass and points through which it should not pass.

 Some of the examples are:

**Bridge site:** The bridge can be located only where the river has straight and permanent path and also where the abutment and pier can be strongly founded. The road approach to the bridge should not be curved and skew crossing should be avoided as possible. Thus to locate a bridge the highway alignment may be changed.

**Mountain:** While the alignment passes through a mountain, the various alternatives are to either construct a tunnel or to go round the hills. The suitability of the alternative depends on factors like topography, site conditions and construction and operation cost.

**Intermediate town:** The alignment may be slightly deviated to connect an intermediate town or village nearby.

**ENGINEERING SURVEYS FOR HIGHWAY LOCATION:**

 Before a highway alignment is finalised in highway project, the engineering surveys are to be carried out. The survey may be completed in four stages i.e.

(a) Map study

(b) Reconnaissance

(c) Preliminary surveys

(d) Final location and detailed surveys

(a) **Map study:** With the help of topographic map it is possible to suggest the likely routes of the road. In India, topographic maps are available from the survey of India with 15 of 30 m contour interval. The main features like rivers, hills, valleys, etc., are also shown on these maps.

(b) **Reconnaissance:** It is a rapid and rough survey. During the survey, the physical characteristics of the areal are inspected and the proposed route is thoroughly examined. it is done without accurate instruments. Clinometers are used to determine the slopes of the ground. It provides additional information not available in top sheets.

Objects: -

i). To study the feasibility or practicability of the proposed route

ii). To reduce the number of alternative routes to the minimum to select the best 2 or 3 routes.

iii) Source of construction materials, water and location of stone quarries.

iv) Number and type of cross drainage structure, maximum flood level and natural ground water level along the probable routes.

(c) **Preliminary Survey**: This survey can be started on the basis of reconnaissance. It consists of detailed survey of the alternative routes selected. After reconnaissance. It is done by using the instruments such as chain, compass, tape, level & theodolite.

Objects: -

a. To select the best route.

b. To determine the centre line to be followed

c. To collect are additional information found necessary after reconnaissance.

d. To estimate quantity of earthwork materials and other construction aspects and to work out the cost of alternate proposals

(d) **Final Location and Detailed Survey**: The alignment finalized after the preliminary survey is to be first located on the field by established the centre line.

This is done accurately by using instruments. The final route selected after the preliminary survey is surveyed and located on the ground.

Objects:-

1. To establish temporary bench marks

2. To collect information required for

3. The preparation of working drawings

4. The preparation of detailed estimates

5. The design of road & bridges

6. Preparing specifications

7. Land acquisition