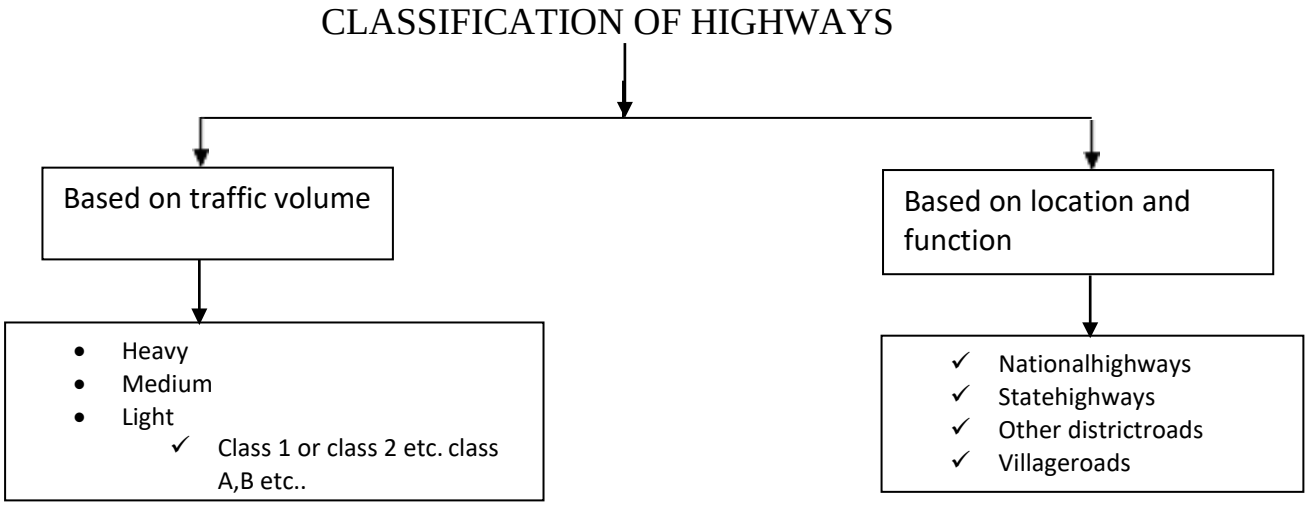
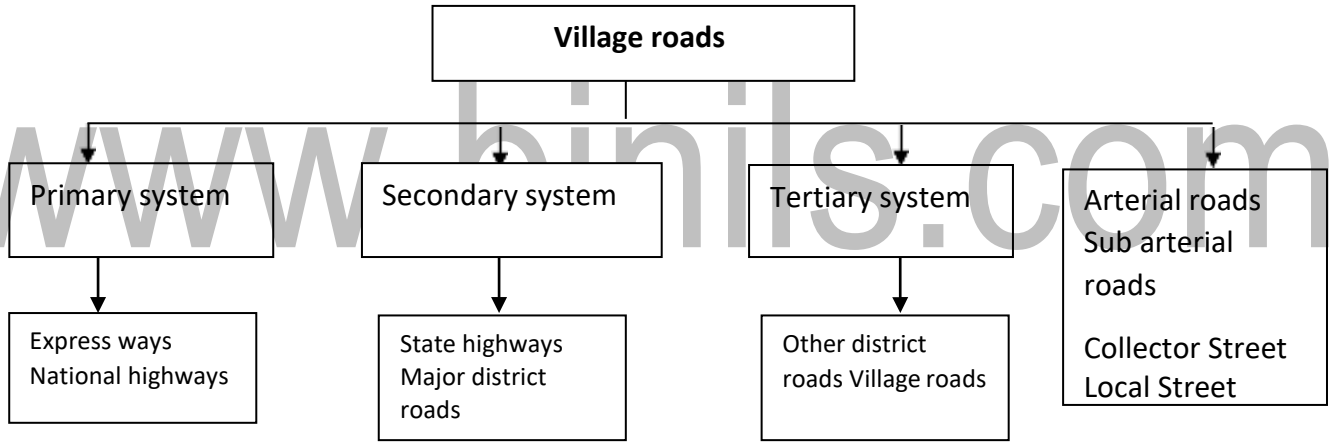
## 1.3 CLASSIFICATION OF HIGHWAYS




## CLASSIFICATION OF RURAL ROADS






### Expressways

- Heavy traffic at high speed (120km/hr)Land Width(90m)
- Full access control
- Connects major points of traffic generation
- No slow moving traffic allowed
- No loading, unloading, parking.

**National Highways**

- India has a huge network of national highways.
- The national highways have a total length of **70,548 km**. Indian highways cover **2%**
- of the **total road network** of India and carry **40%** of the **total traffic**.
- The longest highway in India is **NH7** which stretches from **Varansi in Uttar Pradesh to Kanyakumari** in the southern most point of Indian mainland.
- The shortest highway is **NH47** A which stretches from **Ernakulam to Kochi** and covers total length of 4Kms.

**State Highways**

- They are the arterial roads of a state, connecting up with the national highways of adjacent states, district head quarters and important cities within thestate.
- Total length of all SH in the country is**1,37,119 Kms**.



**Major District Roads**

- Important roads with in a district serving areas of production and markets, connecting those with each other or with the major highways.
- India has a total of **4,70,000 kms** of MDR.

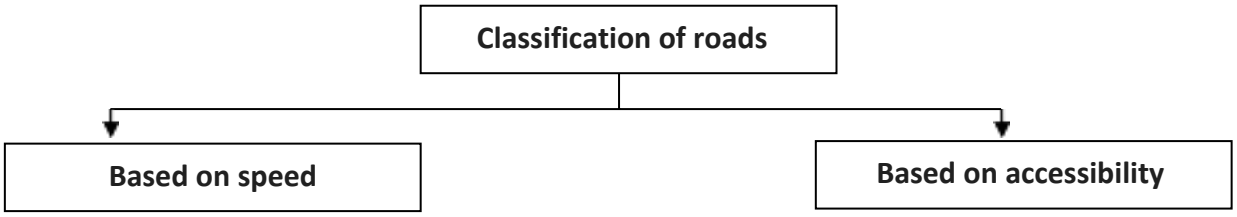
**Other District Roads**

- Roads serving rural areas of production and providing them with outlet to market centers or other important roads like MDR or SH.

**Village Roads**

- They are roads connecting villages or group of villages with each other or to the nearest road of a higher category like ODR or MDR.
- India has **26,50,000kms** of ODR+VR out of the total 33,15,231 kms of all type of roads.

## CLASSIFICATION OF URBAN ROADS




**Freeways:**

- It is access-controlled divided highways.
- Freeways are 4 lanes and 2 lanes each direction.
- It depends upon the kind of intersecting road way (rural roads, another freeway etc.)

**Expressways:**

- It is designed for high speed (120 km/hr), high traffic volume and safety.
- Provided with grade separations at intersections.
- Not allowed for parking, loading and unloading of goods and pedestrian traffic.

**Highways:**

It is divided into two types,

Rural highways: passing through rural areas(villages)

Urban highways: passing through large cities and towns.

**Arterials:**

- It is divided into fully or partially controlled access.
- Parking. Loading and unloading activities are regulated.
- Pedestrians are allowed to cross only at intersections/designated pedestrian crossings.
- No frontage access, no standing vehicle, very little cross traffic.
- Design Speed : 80km/hr
- Land width : 50 –60m
- Spacing 1.5km in CBD & 8km or more in sparsely developed areas.
- Divided roads with full or partial parking
- Pedestrian allowed to walk only at intersection

**Local streets:**

- It is intended for access to residence, business or abutting property.

**Collector streets:**

- It is intended for collecting and distributing traffic to and from local streets.
- Providing access to arterial streets.
- Full access is provided on these streets.

**Sub-arterial**

- Bus stops but no standing vehicle.
- Less mobility than arterial.
- Spacing for CBD : 0.5km
  Sub-urban fringes:3.5km
  Design speed : 60 km/hr Land width: 30 – 40 m

**Collector Street**

- Collects and distributes traffic from local streets
- Provides access to arterial roads
- Located in residential, business and industrial areas.
- Full access allowed.
- Parking permitted.
- Design speed : 50km/hr
- Land Width:20-30m

**Local Street**

- Design Speed: 30km/hr.
- Primary access to residence, business or other abutting property
- Less volume of traffic at slow speed
- Origin and termination of trips.
- Unrestricted parking, pedestrian movements. (with frontage access, parked vehicle, bus stops and no waiting restrictions)

**Cul-De-Sac**

- Dead End Street with only one entry access for entry and exit.
- Recommended in Residential areas.

## 1.5 ENGINEERING SURVEYS FOR HIGHWAY ALIGNMENT

### Stages of Engineering Surveys

Before a highway alignment is finalised in a new highway project, engineering surveys are to be carried out. These engineering surveys may be completed in the following four stages:

a) Map Study

b) Reconnaissance Survey

c) Preliminary Surveys

d) Final Location and Detailed Surveys

### Map Study

It is possible to suggest the likely routes of the roads if the topographic map of the area is available. In India, topographic maps are available from the Survey of India, with 15 or 30 metre contour intervals. The main features like rivers, hills valleys, etc. are also shown on these maps.



The probable alignment can be located on the map from the following details available on the map.

- Alignment avoiding valleys, ponds or lakes
- When the road has to cross a row of hills or mountains, possibility of crossing through a mountain pass.
- Approximate location of bridge site for crossing rivers, avoiding bend of the river, if any
- When a road is to be connected between two stations, one of the top and the other on the foot of the hill, then alternate routes can be suggested keeping in view the design or ruling gradient and the maximum permissible gradient.

  Thus, from the map study alternate routes can be suggested. It may also be possibly from map study to drop a certain route in view of any unavoidable obstructions or undesirable ground and map study gives a rough guidance of the routes to be further surveyed in the field.

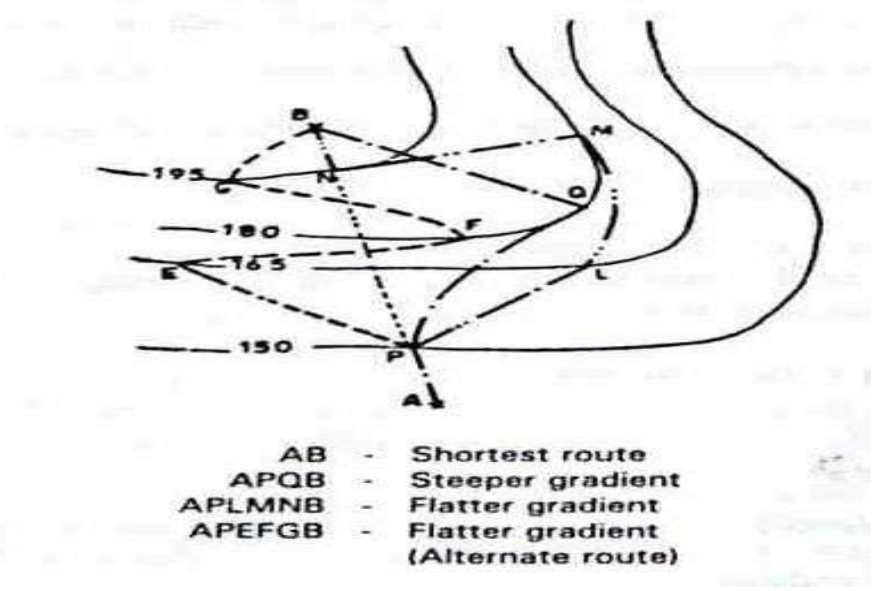



**Figure 1.5.1 Roman Roads**

*[Source: "Highway Engineering" byS.K.Khanna,C.E.G.Justo, Page: 56]*

**Reconnaissance Survey**

The second stage of engineering surveys for highway alignment is the reconnaissance survey. During the reconnaissance, the engineer visits the site and examines the general characteristics of the area before deciding the most feasible routes for detailed studies. A field survey party may inspect a fairly broad stretch of land along the proposed alternative routes of the map in the field, very simple survey instruments are used by the reconnaissance party to collect additional details rapidly, but not accurately. All relevant details which are not available in the map are collected and noted down. Some of the details to be collected during reconnaissance are given below

a) Valleys, ponds, lakes, marshy land, ridge, hills, permanent structures and other obstructions alone the route which are not available in the map
b) Approximate values of gradient, length of gradients and radius of curves of alternate alignments.
c) Number and type of cross drainage structures, maximum flood level and natural ground water level along the probable routes.
d) Soil type along the routes from field identification tests and observation of geological features
e) Sources of construction materials, water and location of stone quarries

f) When the road passes through hilly or mountainous terrain, additional data regarding the geological formation, type of rocks, dip of strata, seepage flow etc. may be observed so as to decide the stable and unstable sides of the hill for highway alignment A rapid reconnaissance of the area, especially when it is vast and the terrain is difficult and it may be done by aerial survey. From the details collected during the survey the alignment proposed may be altered or even changes completed.

**Preliminary Survey**

The main objectives of the preliminary survey are

- To survey the various alternate alignment proposed after the reconnaissance and to collect all the necessary physical information and details of topography, drainage and soil
- To compare the different proposals in view of the requirements of a good alignment.
- To estimate quantity of earthwork materials and other construction aspects and to work out the cost of alternate proposals.



The preliminary survey may be carried out by of following methods

a) Conventional approach, in which a survey party carries out surveys using the required field equipment, taking measurements, collecting topographical and other data and carrying out soil survey

b) Rapid approach, by aerial survey taking the required aerial photographs and by photogrammetric methods and photo-interpretation techniques for obtaining the necessary topographic and other maps including details of soil and geology

c) Modem techniques by use of Global Positioning System (GPS)

The procedure of the conventional methods of preliminary survey is given in following steps:

a) Primary Traverse

b) Topographical Features

c) Levelling Work

d) Drainage Studies and Hydrological Data

e) Soil Survey

f) Material Survey

g) Traffic Studies Primary Traverse

**Primary Traverse**

The first step in the preliminary survey is to establish the primary traverse, following the alignment recommended in the reconnaissance. For alternate alignments either secondary traverses or independent primary traverses may be necessary. As these traverses are open traverses and adjustment of errors is not possible later, the angles should be very accurately measured using a precision theodolite.

**Topographic Features**



After establishing the centre lines of preliminary survey, the topographical features are recorded. All geographical and other man-made features along the traverse and for a certain width on either side are surveyed and plotted. The width to be surveyed is generally decided by the survey party, but the absolute minimum width is the land width of the proposed alignment.

**Levelling work**

Levelling work is also carried out side by side to give the centre line profiles and typical cross sections. Permanent and temporary bench marks should be first established at appropriate locations and the levels should be connected to the GTS datum. The levelling work in the preliminary survey is kept to a minimum just sufficient to obtain the approximate earth work in the alternate alignments. To draw contours of the strip of land to be surveyed, cross section levels should be taken at suitable intervals, generally 100 to 200 m in plain terrain, up to 50 m in rolling terrain and up to 30 m in hilly terrain.

**Drainage Studies and Hydrological Data**

Drainage investigations and hydrological data are collected so as to estimate the type, number and approximate size of cross drainage structures. Also, the vertical alignment of the highway, particularly the grade line is decided based on the hydrological and drainage data, such as HFL. ponded water level, depth of water table, amount of surface runoff, etc.

**Soil Survey**

Soil survey is an essential part of the preliminary survey as the suitability of the proposed location is to be finally decided based on the soil survey data. The soil survey conducted at this stage also helps in working out details of earth work, slopes, suitability of materials, subsoil and surface drainage requirements and pavement type and the approximate thickness requirements. All these details are required to make a comparative study of alternate proposals. A detailed soil survey is not necessary. Post-hole auger or any other suitable types of hand augers may be used depending on the soil type to collect the soil sample up to a depth of 1 to 3 metre below the likely finished road level or the existing ground level, whichever is lower. When the road is expected to be constructed over an embankment, the depth of exploration should extend up to twice the height of embankment from the ground level. During the soil exploration if the ground water table is struck, the depth from the ground surface is also noted. The types of soils encountered along the route up to the depth under consideration are marked on the soil profile either symbolically or by suitable colour coding.



**Material Survey**

The survey for naturally occurring materials like stone aggregates, soft aggregates, etc. and identification of suitable quarries should be made. Also, availability of manufactured materials like cement, lime, brick, etc. and their locations may be ascertained.

**Traffic Survey**

Traffic surveys conducted in the region form the basis for deciding the number of traffic lanes and roadway width, pavement design and economic analysis of the highway project. Traffic volume counts of the classified vehicles are to be carried

out on all the existing roads in the region, preferably for 24 hours per day for seven days. Origin and destination surveys are very useful for deciding the alignment of the roads. This study may be earned out on a suitable sample of vehicle users or drivers. In addition, the required traffic data may also be collected so that the traffic forecast could be made for 10 to 20 year periods.

**Determination of Final Centre Line**

After completing the preliminary surveys and conducting the comparative studies of alternative alignments, the final centre line of the road is to be decided in the office before the final location survey. For this, the preliminary survey maps consisting of contour plans, longitudinal profile and cross sections of the alternate alignments should be prepared and carefully studied to decide the best alignment satisfying engineering aesthetic and economical requirements. After selecting the final alignment, the grade lines are drawn and the geometric elements of the horizontal and vertical alignments of the road are designed.

**Rapid method using aerial survey and modern technique using GPS**

Aerial photographic surveys and photogrammetric methods are very much suited for preliminary surveys, especially when the distance and area to be covered are vast, The survey may be divided into the following steps:

Taking aerial photographs of the strips of land to be surveyed with the required longitudinal and lateral overlaps. Vertical photographs are necessary for the preparation of mosaics.



a) The photographs are examined under stereoscopes and control points are selected for establishing the traverses of the alternate proposals. The control points are located on the maps
b) Using stereo-pair observations, the spot levels and subsequently contour details may be noted down on the maps
c) Photo-interpretation methods are used to assess the geological features, soil conditions, drainage requirements etc.

**Final Location and Detailed Survey**

The alignment finalised at the design office after the preliminary survey is to be first located on the field by establishing the centre line. Next detailed survey should be

carried out for collecting the information necessary for the preparation of plans and construction details for the highway project.

**Location**

The centre line of the road finalised in the drawings is to be transferred on the ground during the location survey. This is done using a transit theodolite and by staking of the centre line. The location of the centre line should follow, as closely as practicable, the alignment finalised after the preliminary surveys. Major and minor control points are established on the ground and centre pegs are driven, checking the geometric design requirements. However, modifications in the final location may be made in the field, if found essential. The centre line stakes are driven at suitable intervals, say at 50 metre intervals in plain and rolling terrains and at 20 metre in hilly terrain.

**Detailed Survey**



- Temporary bench marks are fixed at intervals of about 250 m and at all drainage and under pass structures. Levels along the final centre line should be taken at all staked points.
- Levelling work is of great importance as the vertical alignment, earth work calculations and drainage details are to be worked out from the level notes.
- The cross-section levels are taken up to the desired width, at intervals of 50 to 100 m in plain terrain, 50 to 75 m in rolling terrain, 50 m in built-up areas and 20 m in hilly terrain.
- The cross sections may be taken at closer intervals at horizontal curves and where there is abrupt change in cross slopes.
- All river crossing, valleys etc. should be surveyed in detail up to considerable distances on either side.
- All topographical details are noted down and also plotted using conventional signs. Adequate hydrological details are also collected and recorded.

- A detailed soil survey is carried out to enable drawing of the soil profile. The depth up to which soil sampling is to be done may be 1.5 to 3.0 m below the ground line or finished grade line of the road whichever is lower. However, in case of high embankments, the depth should be up to twice the height of the finished embankment. The spacing of auger borings very much depends upon the soil type and its variations.
- • CBR value of soils along the alignment may be determined for designing the pavement.
- • The data during the detailed survey should be elaborate and complete for preparing
- detailed plans, design and estimates of the project.

## 1.4HIGHWAY ALIGNMENT

The position or the layout of the central line of the highway on the ground is called the alignment. Highway Alignment includes both

a) Horizontal alignment includes straight and curved paths, the deviations and horizontal curves.

b) Vertical alignment includes changes in level, gradients and vertical curves.

A new road should be aligned very carefully as improper alignment will lead to increase in construction, maintenance and vehicle operation cost. Once the road is aligned 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**

The requirements of an ideal alignment are



a) **Short:** The alignment between two terminal stations should be short and as far as possible be straight, but due to some practical considerations deviations may be needed.

b) **Easy:** The alignment should be easy to construct and maintain. It should be easy for the operation of vehicles. So, to the maximum extend easy gradients and curves should be provided.

c) **Safe:** It should be safe both from the construction and operating point of view especially at slopes, embankments, and cutting. It should be safe for traffic operation with safe geometric features.

d) **Economical:** The alignment should be economical and it can be considered so only if the total life cycle cost considering the initial cost, maintenance cost, and vehicle operating cost is lowest.

**Factors Controlling Alignment**

For an alignment to be shortest, it should be straight between the two terminal stations, but this is not always possible due to various practical difficulties such as intermediate obstructions or topography. A road which is economical with low initial investment may not be the most economical in terms of maintenance or vehicle operation cost(VOC). Thus, is may be seen that an alignment can fulfil all the requirements simultaneously, hence a judicial choice is made considering all the factors.

The various factors that control the alignment are as follows:

a) Obligatory Points
b) Traffic
c) Geometric Design
d) Economics
e) Other Considerations

**Obligatory Points**

These are the control points governing the highway alignment. These points are classified into two categories.

1) Points Through Which the Alignment Should Pass
2) Points Through Which the Alignment Should Not Pass.



**Points Through Which the Alignment Should Pass**

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

d) Intermediate town: The alignment may be slightly deviated to connect an intermediate town or village nearby. These were some of the obligatory points through which the alignment should pass.

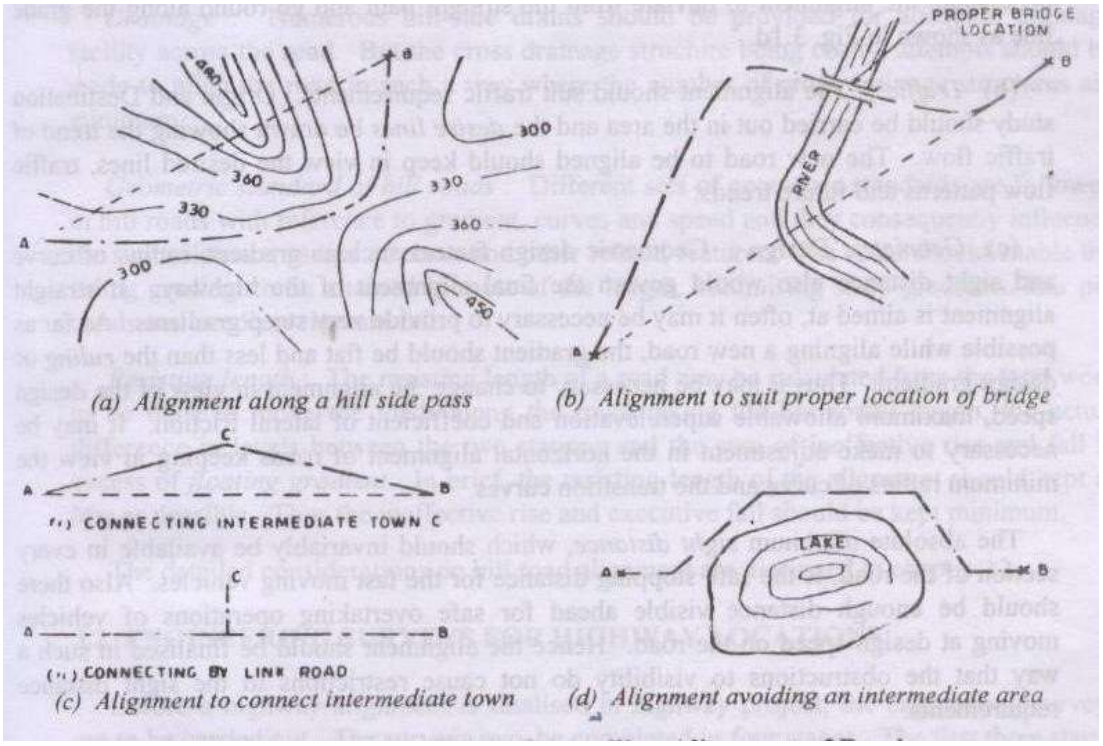



**Figure 1.4.1 Points Through Which the Alignment Should Pass**

*[Source: "Highway Engineering" byS.K.Khanna,C.E.G.Justo, Page: 53]*



**Points Through Which the Alignment Should Not Pass.**

a) Religious places: These have been protected by the law from being acquired for any purpose. Therefore, these points should be avoided while aligning.

b) Very costly structures: Acquiring such structures means heavy compensation which would result in an increase in initial cost. So, the alignment may be deviated not to pass through that point.

c) Lakes/ponds etc.: The presence of a lake or pond on the alignment path would also necessitate deviation of the alignment.

**Traffic**

The alignment should suit the traffic requirements. Based on the origin- destination data of the area, the desire lines should be drawn. The new alignment should be drawn keeping in view the desire lines, traffic flow pattern etc.

**Geometric design**

Geometric design factors such as gradient, radius of curve, sight distance etc. also governs the alignment of the highway. To keep the radius of curve minimum, it may be required to change the alignment of the highway. The alignments should be finalized such that the obstructions to visibility do not restrict the minimum requirements of sight distance. The design standards vary with the class of road and the terrain and accordingly the highway should be aligned.

**Economics**

The alignment finalized should be economical. All the three costs i.e. construction, maintenance, and operating cost should be minimum. The construction cost can be decreased much if it is possible to maintain a balance between cutting and filling. Also try to avoid very high embankments and very deep cuttings as the construction cost will be very higher in these cases.

**Other Considerations**

The various other factors that govern the alignment are drainage considerations, political considerations and monotony. The vertical alignment is often guided by drainage considerations such as sub surface drainage, water level, seepage flow, and high flood levels. A foreign territory coming across the alignment will necessitate the deviation of the horizontal alignment. In flat terrain, even though it is possible to have a very long stretch of road which is absolutely straight may be monotonous for driving. Hence it is recommended to have a slight bend or road side amenities to break monotony.

## 1.2 HIGHWAY PLANNING

Highway Planning involves the planning, design, construction, operation, and maintenance of roads, bridges, and tunnels to ensure safe and effective transportation of people and goods.

### SIGNIFICANCE OF HIGHWAY PLANNING

The significance are,

- ✓ To provide safe, efficient, economic, compatible and speedy moment of people and goods
- ✓ To plan for expected features development and social needs to fix update wise properties for development of each road link based on utility
- ✓ To optimise the usage of roads with available resources
- ✓ To work out financing system

### Objectives of Highway Planning

- ✓ A highway should be safe and secure.
- ✓ The highway develop must be efficient, but at a minimum cost, especially in cases of developing and underdeveloped countries.



### Objectives of Highway Research Board

- ✓ To collect and analyze results on research
- ✓ To coordinate and conduct the correlation services in transport research
- ✓ To evaluate the nature and extend of research required.
- ✓ To regulate the conductive services.

### DIFFERENT MODES OF TRANSPORTATION

Transportation has developed along three basic modes of transport

a) Land
b) Water
c) Air

Land has given scope for development of transportation by road and rail transport. Water and air media have developed waterways and airways respectively. The roads or the highways not only include modern highway system but also includes the urban

arterials, city streets, feeder roads and village roads catering for a wide variety of vehicles and pedestrians. Railways have been developed both for long distance travel and also urban travel. Waterways include transportation by oceans, rivers, canals and lakes for the movement of ships and boats. The airways help in faster transportation by aircrafts and carriers. Apart from these major modes of transportation, other modes include pipelines, elevators, belt conveyors, cable cars, aerial ropeways and monorails. Pipe lines are used for the transportation of water, other fluids and even solid particles The four major modes of transportation are:

a) Roadways or highways for road transportation
b) Railways for rail transportation
c) Waterways for water transportation
d) Airways for air transportation

**ROADWAYS**

Transportation by road is the only mode which could give maximum service to one and all. Road transport mode has the maximum flexibility for travel with reference to choice of the route, direction, time and speed of travel. This is only mode which caters for the movement of passengers and goods independently right from the place of origin up to the destination of any trip along the route. The other three modes (railways; water ways; airways) have to depend on transportation by road for the service to and from their respective terminals. Therefore, the roadway essentially serves as a feeder network. It is possible to provide door to door service by road transport. Ultimately, road network is therefore needed not only to serve as feeder system for other modes of transportation and to supplement them, but also to provide independent facility for road travel by a well-planned network of roads throughout the country.



**Advantages:**

1) Flexibility: It offers complete freedom to the road users.
2) It requires relatively smaller investments and cheaper in construction with respect to other modes.
3) It serves the whole community alike the other modes.
4) For short distance travel, it saves time.

5) The road network is used by various types of vehicles.

**Disadvantages:**

1) Speed is related to accidents and more accidents results due to higher speed and is usually not suitable for long distance travel 2) Power required per tonne is more.

**RAILWAYS**

The concept of rail transportation is movement of multiple wagons or a train of wagons passenger's bogies on two parallel steel rails. The resistance to traction along the railway track for the movement of steel wheels is much lower than that along more uneven road surface for the movement of road vehicles with rubber tyres. The transportation along the railway track could be advantageous by railways between the stations both for the passengers and goods, particularly for longer distances. The energy requirement to haul unit load through unit distance by the railway is only a fraction (one fourth to one sixth) of the required by road. Hence, full advantage of this mode of transportation should be taken for the transportation of bulk goods along land where the railway facilities are available. The Indian railways is one of the world's largest Railway network in the world. It was introduced in 1853 and it is spread over 1,09,221 km covering 6906 stations.



**Advantages:**

1) Can transport heavy loads of goods at higher speed

## 1.1 HISTORY OF ROAD DEVELOPMENT IN INDIA

The excavation of the Mohenjo-Daro and Harappa civilization shows the traces of the roads in the ancient Indian times, in a period of 35th to 25th B.C.

The Aryan Period and Road Construction:

- ✓ "Arthashastra" written by Kautilya (Chanakya), the prime minister of the Chandra Gupta Mourya, discusses the depth of the road construction for different purposes in the **4thcentury.**
- ✓ **5th century A.D** - The emperor Ashoka has improved the quality of the roads in India for the travelers, in his ruling period.

**Roman Roads:**

- ✓ They were built straight regardless of gradient
- ✓ They were built after the soft soil was removed and a hard stratum was reached
- ✓ Thickness varies from 0.75m to1.2m.



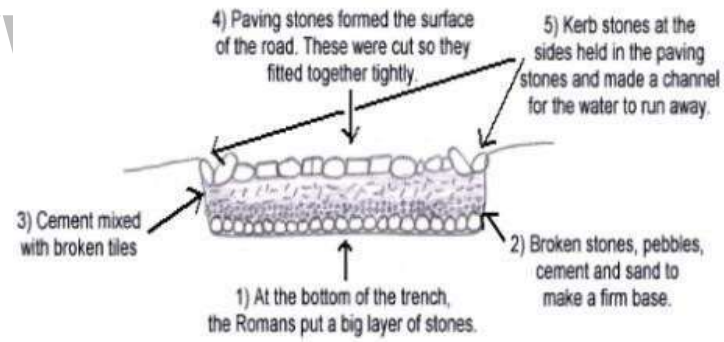



**Figure 1.1.1 Roman Roads**

*[Source: "Highway Engineering" byS.K.Khanna,C.E.G.Justo, Page: 10]*

**Other oldest road transports are,**

- ✓ Macadam construction
- ✓ Tresaguet construction
- ✓ Metcalf construction
- ✓ Telford construction

**Mughal period and Road Construction:**

- The Mughal and Pathans improved the quality of the roads inIndia.
- Sher Shah Suri is still remembered for the construction of the Grand Trunk

Road(GT Road) from Bangladesh-India to Kabul in Afghanistan.

**19th Century and Road Construction in India:**

- ✓ After the fall of the Mughal Empire in India in 19th century the Britishers participated in the road construction for the military and administrativepurposes.
- ✓ The work was carried out by the British MilitaryEngineers.
- ✓ Railway was introduced later but the existing roads were metaled and bridges were provided.
- ✓ The governor general of India i.e. Lord Dalhousie in the mid of 19th century introduced the PWD (Public works department), which still runs the various public works in India.

**TRESAGUET CONSTRUCTION:**

Pierre Tresaguet (1716-1796) developed an improved method of construction in France by the year 1964.The main feature of his proposal was that the thickness of construction need be only in the order of 30cm.



Tresaguet was the inspector General of roads in France from 1775 to 1785.So his method of construction was implemented in that country in1775.

The typical cross section of Tresaguets road construction and the construction steps may be enumerated as below.

- The sub grade was prepared and layers of large foundation stones were laid on edge by hand. At the two edges of the pavement large stones were embedded edge wise to serve as submerged kerbs stones.
- The corners of the heavy foundation stones were hammered and then the interstices filled with smaller stones.
- The top-wearing course was made of smaller stones and compacted to a thickness of about 5 cm at the edges and gradually increased towards the center.
- The shoulders were also provides cross slope to drain the surface water to the side drain.

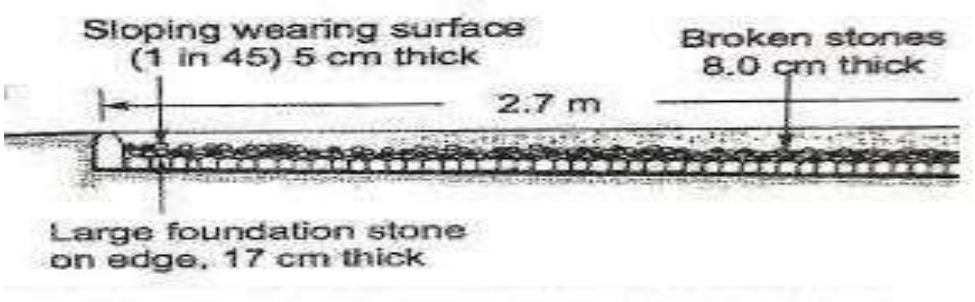



**Figure 1.1.2 Tresaguet Roads**

*[Source: "Highway Engineering" byS.K.Khanna,C.E.G.Justo, Page: 11]*

## MACADAM CONSTRUCTION:

John Macadam put forward an entirely new method of road constructionas Compared to all the previous methods. A typical cross section of Macadam construction:

- The importance of sub grade drainage and compaction were recognized and the sub grade was compacted and was prepared with a cross slope of 1 in36.
- Macadam was the first person to suggest the heavy foundation stones are not at all necessary to be placed at the bottom layer ofconstruction.
- Though the total thickness of construction was less than previous methods. This technique could serve the purpose in a betterway.
- The size of broken stones for the top layer was decided based on the stability under animal drawn vehicles.



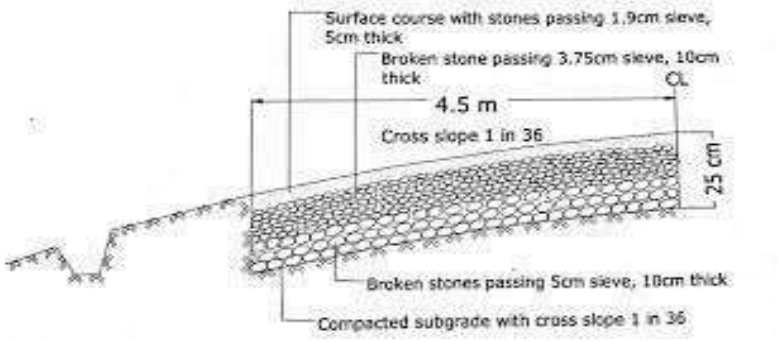



**Figure 1.1.3 Macadam Roads**

*[Source: "Highway Engineering" byS.K.Khanna,C.E.G.Justo, Page: 13]*

**Jayakar Committee:**

It was formed by the both chambers of the Indian Legislature in the year 1927 to examine the roads in the India and ways of theirdevelopment.

The number of vehicles on the Indian roads increased after the First World War, so it was to develop a good network ofthe roads inIndia.

**Indian Road development committee** was formed in the year **1927**, with M.R.Jayakar as its chairman. The committee **submitted** its report in the year **1928**,

The recommendations are,

1. An extra tax should be put on the petrol consumers to develop a road development fund, called the **Central RoadFund.**
2. A semi-official body should be formed to pool technical ideas, knowledge from the various parts of the country and to act as an advisory body on various aspects of roads.
3. A research organisation should be organised to carry out the research and developmentwork.



**Central Road Fund (1929):**

Central Road Fund was formed in the year **1929,** This fund was kept separate for the use in the road development inIndia.

About 20% of the fund was kept to be used for the expenses of the administrative meetings and the research work of the highways of the national importance in the country.

80% of the funds were distributed for the road users and development of the roads by the stategovernments.

**Indian Roads Congress (1934):**

*I Background:*

The IRC was set up by the government of India in **December 1934** in consultation with state government as per **Jayakar** committee's recommendations. It is the premier body of highway engineer's in India.

A semi-government organization named, Indian Roads Congress was

formed in the year December 1934, and was registered in the year 1937 under the registration act.

The main functions of IRC are,

It provides a channel for expression of collective opinion of its members for all matters affecting the planning, construction and maintenance of roads inIndia.

It promotes the use of the standard specification and to proposespecification.

IRC is a registered society under the registration of societies act and is financed by contributions from central government and various state government.

*II Committee and sub-committee:*

The IRC has many Committees

Bituminous

Cementconcrete

Road transportdevelopment

Transport operationcost

Specifications andstandards



The IRC has many sub Committees

Cement concrete roadsurfacing

Education of roadengineers

Prevention of ribbondevelopment

Soilresearch

Traffic engineering

**Motor vehicle Act (1939):**

Increased numbers of vehicle on the Indian roads demanded for the rules and regulations.

This Act was passed in 1939 - Rules for the road users and also for the identity of the vehicles.

## NAGPUR ROAD PLAN (OR) FIRST 20-YEAR ROAD PLAN

The conference of civil engineer held at nagpur in 1943 finalized the first twenty year road development plan for India called Nagpur plan the period **1943-63**.The road network inthe country was classified into five categories.

Nationalhighway

Statehighway

Major districtroad

Other districtroad

Village road

Two-plan formulas were finalized at the Nagpur conference for deciding two categories of road length for the country as a whole as well as for individual areas. The two plan formula assumed the star and Grid pattern of road network. The total length of the first category or metalled roads for national and state Highways and major District Roads in km.

$$NH+SH+MDR\ (km) = \left[\frac{A}{8} + \frac{B}{32} + 1.6N + 8T\right] + D\text{-}R$$



Where,

A=Agricultural area, $km^2$

B = Non-agricultural area, $km^2$

N=Number of towns and villages with population range 2001-5000 T= Number of towns and villages with population over 5000

D= Development allowance of 15 percent of road length calculated to be provided for agricultural and industrial development during the next 20 years.

R= Existing length of railway track, km.

The total length of second category roads for other District road and village Roads in km ODR + VR (km) = [0.32 V + O.8 Q +1.6 P +3.2 S] +D

Where,

V = Number of villages with population 500 or less

Q = Number of villages with population range 501-1000

P = Number of villages with population range 1001-2000

S = Number of villages with population range 2001-5000

D = Development allowance of 15 % for next 20 years.

**Salient Features of Nagpur Road Plan:**

The responsibility of construction and maintenance of national highways was assigned to the centralgovernment.

It was a 20-year plan intended for the period 1943-63 aiming to provide for about two-lakh km of surfaced roads and remaining unsurfacedroads.

The formulae were based on star and grid pattern of road network. But the existing irregular pattern of roads and obligatory points not fitting in the geometric pattern were to be given dueconsideration.

The second category roads are meant to provide internal road system linking small villages with first categoryroads.

An allowance for agricultural and industrial development during the next 20 years was estimated as 15 percent and this allowance was to be provided while calculating the road length for both the categories ofroads.



**Classification of roads in Nagpur plan**

- **National highways** which would pass through states, and places having national importance for strategic, administrative and other purposes.
- **State highways** which would be the other main roads of a state.
- **District roads** which would take traffic from the main roads to the interior of the district.
- **Village roads** which would link the villages to the road system.

**Central Road Research Institute (1951):**

A series of laboratories, known as the Central Science and Industrial Research Center situated at Delhi.

It contains the research center for the research work of the road construction in India.

The main function of the CRRI

- To do the research work for the road construction
- To provide the consultation services for the state government.

**Bombay Road Congress(1961)**

The length of roads envisaged under the Nagpur plan was achieved by the end of it, but the road system was deficient in many respects. The changed economic, industrial and agricultural conditions in the country warranted a review of the Nagpur plan. Accordingly a 20-year plan was drafted by the Roads wing of Government of India, which is popularly known as the Bombay plan.



- It was the second 20 year road plan(1961-1981)
- The total road length targeted to construct was about 10 lakhs.
- Rural roads were given specific attention. Scientific method of construction was proposed for the rural roads. The necessary technical advice to the Panchayats should be given by StatePWD's.
- They suggested that the length of the road should be increased so as to give a road density of 32kms/100sq.km
- The construction of 1600 km of expressways was also then included in the plan.

## 1.6 ROAD ECOLOGY

Road ecology is the study of the ecological impacts (both positive and negative) of roads and highways (public roads). It include local effects, such as on noise, water pollution, habitat destruction/disturbance and local air quality; and wider effects such as habitat fragmentation, ecosystem degradation, and climate change from vehicle emissions.

- ✓ The design, construction and management of roads, parking and other related facilities as well as the design and regulation of vehicles can change the impacts to varying degrees.
- ✓ Roads are known to cause significant damage toforests, prairies, streams and wetlands.
- ✓ Roads are a form of linear infrastructure intrusion that has some effects similar to infrastructure such as railroads, power lines, and canals, particularly in tropical forests.
- ✓ Air pollution from fossil (and some biofuel) powered vehicles can occur wherever vehicles are used and are of particular concern in congested city street conditions and other low speed circumstances.
- ✓ Emissions include particulate emissions from diesel engines, NO*x*, volatile organic compounds, CO and various other hazardous air pollutants including benzene.
- ✓ Concentrations of air pollutants and adverse respiratory health effects are greater near the road than at some distance away from the road.
- ✓ Road dust kicked up by vehicles may trigger allergic reactions.
- ✓ $CO_2$ is non-toxic to humans but is a major greenhouse gas and motor vehicle emissions are an important contributor to the growth of $CO_2$ concentrations in the atmosphere and therefore to global warming.

**Positive Impacts**

- ✓ The construction of new roads which divert traffic from built-up areas can deliver improved air quality to the areas relieved of a significant amount of traffic.
- ✓ The *Environmental and Social Impact Assessment Study* carried out for the development of the Tirana Outer Ring Road estimated that it would result in improved air quality in Tirana city center.
- ✓ A new section of road being built near Hindhead, UK, to replace a four-mile section of the A3 road, and which includes the new Hindhead Tunnel, is expected by the government to deliver huge environmental benefits to the area including the removal of daily congestion, the elimination of air pollution in Hind head caused by the congestion, and the removal of an existing road which crosses the environmentally sensitive Devil's Punchbowl area of outstanding natural beauty.

## 1.7 Soil Suitability Analysis

It is the process of understanding existing site qualities and factors which will determine the locating of a particular highway. The following parameters can be considered for the analysis:

1. Land use/ land cover.
2. Proximity to major road.
3. Proximity to city/ urban built-up land.
4. Soil salinity.
5. Ground water table depth
6. Ground water quality.
7. Slope of the terrain.

Areas with less fertile soil and poor quality of groundwater offer a good choice for the highway development.

**Procedure to carry out the analysis**



i. A detailed soil survey is carried out by groundwater obtaining soil samples 1.5-3m below the ground level.

ii. Sampling should be done to a depth equal to the twice of the height of final embankment.

iii. Spacing of sampling and type of sampling depends on the soil type or location.

iv. During survey one may cross areas where land is loose or is subjected to slides or may be stretches of rocky strata, all these details are to be recorded.

v. Preparation of highway formation, the primary operation involves excavation and embankments.

vi. Formation of pavements involves construction of embankments. vii. Soil is obtained from the adjoining areas of the highway within the highway land itself.

vii. For this additional land may be acquired temporarily and after completion of the project, it may be handed over.