

# Case Study on Geometry of Four Lane Highway

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**Abstract** - In India, vehicular traffic is growing rapidly. Increased traffic volume leads to widening of existing roads & construction of new roads. Efficient geometry of road helps to reduce accidents, provide comfort to road users, reduce travel time, avoid traffic congestions, etc.

Previous studies have concluded that improper design of geometric elements of roads results in accidents, traffic congestions, uncomfortable journey, etc. Proper design of geometric elements of road shall be taken care at design & development stage of road to avoid redevelopment/reconstruction & to maintain cost efficiency.

**Key Words:** Horizontal Curve, Vertical Curve, Sight Distance, Camber, Cross Section, Carriageway, Shoulder.

## 1. INTRODUCTION

Geometric design of roads depends on traffic volume, weather conditions, terrain, etc. The geometric design of a highway deals with features of road which consists of cross section of roads, median width, intersections, horizontal & vertical curve, sight distance etc. General interpretations of some important geometric elements of road are mentioned below

**Horizontal Curve:** A horizontal highway curve is a plan to provide a change in direction in the centre line along the highway. Horizontal alignment includes the design of horizontal curves, super elevation, transition lengths, speed, extra widening. Simple curve, compound curve, reverse curve and spiral curve these are the types of horizontal curve.

**Vertical curve:** Vertical curve are provided to change the slope in the road. Sag/valley curve and summit curve are the types of vertical curve.

**Sight Distance:** Sight distance length of road is length visible ahead the driver at any instance.

**Camber:** Cross slope can be defined as the slope of a roadway perpendicular to the centre line. If a road were completely level, water would drain off it.

**Shoulder:** It is the part of formation width except carriage ways. They are used by the vehicular traffic as the emergency lanes or sometimes as service lanes.

**Superelevation:** The outer edge of the road with respect of the inner edge of road is raised, this is called superelevation.

**Median:** Median separates the opposite traffic and provides safety features as well as reduces headlight glare, improve comfort for night driving. Two types of medians provided on highways as per requirement i.e., raised and depressed median.

**Cross Section:** The cross section of a roadway is the view obtained in a section between the right-of-way lines cut perpendicular to the direction of travel along the road. It includes features on the travelled portion of the road used by vehicular traffic as well as on the roadside.

**Vertical & horizontal clearance at underpass:** Efficient vertical and horizontal clearance shall be provided at underpasses to allow safe passage to vehicle passing under

## 2. OBJECTIVE

- To examine the existing geometry of highway
- To identify the safety issues in highway design
- To provide the simple geometric design to meet all expectation of road at reasonable cost.

## 3. LITERATURE REVIEW

In past periods many studies have been done on geometric design elements of road to improve road safety and optimum efficiency of use. The study will help to minimize the errors occurring in roadway design which is helpful for the system to avoid future cost and difficulties with improved traffic operation.

Zhang Yingxue (2009), stated that it is important for traffic accident to bring high accident rate if the sight distance is not enough and this is visible on the places where have the bad visual distance of small horizontal curve radius, small crest vertical curve radius, intersection, and lack of overtaking sight distance on some road section. In order to ensure traffic safety, the traveling sight distance should be design enough when design horizontal or vertical alignment.

Vikas Golakot (2018) his thesis included that the aim of his study is to find the role of the geometric factors of road on accident rate in the case of plain terrain and also find the extent to which these factors affect the accident rate for rural

areas. The study aims to find the impact of factors like extra widening, horizontal radius, sight distance, K-value, super elevation, horizontal arc length, vertical arc length, vertical gradient on the accident rate and aims to study the significant factors causing accidents and to find the values for future design of roads.

Indian Road Congress SP 84: 2019. It gives the specification and standards for four laning highways.

#### 4. METHODOLOGY

It is proposed to study for the national highway starting from chainage Km. 270+000 near Shelad village and end at Km. 315.000 near Nandura village in Maharashtra State. Various factors are studied and verified with the relevant specification and standards. Detailed primary data for the selected road is collected from companies/organizations and verified the designed parameters with respect to IRC provisions.

#### 5. DATA ANALYSIS

Thorough study of plan and profile drawings & data collected, site visit to selected stretch, analysis of features, etc are done. Noted observations are listed below:

- Project stretch is located in Maharashtra state, India.
- The terrain of road through which it passing is plain terrain.
- The length of the project stretch is around 45 km.
- Justification with IRC provision - proposed key elements are checked with the IRC provisions to validate the design, the same are mentioned as below

**Table -1:** IRC Validations

Items	IRC Provision	Remarks
Carriage way	Carriage way width 7 mtr on each side [Fig 2.4 – IRC: SP: 84: 2019]	Followed
Camber	Crossfall on straight section, 2.5% for bituminous surface [Clause No 2.8, IRC: SP: 84: 2019]	Followed
Design speed	Minimum design speed for plain and rolling terrain 80 Km/h where ruling speed is 100 Km/h [Clause No 2.2, IRC: SP: 84: 2019]	Followed

**Horizontal Curve:** The horizontal alignment data based on the plan and profile is analysed step by step and the observation related to each design element is recorded.

On horizontal curves with radius up to 300 m, width of pavement and roadway in each carriageway shall be increased which is also analysed.

**Table -2:** Horizontal Curve Radius with Speed

Sr No	Chainage	Curve Radius	Remarks
1	Km. 270+154	400 m	100 Km/h (Maximum speed)
2	Km. 271+929	590 m	100 Km/h (Maximum speed)
3	Km. 274+506	7000 m	100 Km/h (Maximum speed)
4	Km. 274+938	400 m	100 Km/h (Maximum speed)

**Table-3:** Extra Width of Pavement and Roadway in Each Carriageway

Radius of curve (m)	Extra width (m)
75-100	0.9
101-300	0.6

**Vertical Curve:** The vertical curve data based on the plan and profile is analysed step by step and the observation related to each design element is recorded.

**Table -3:** Vertical Curve Radius with Type and Length.

Sr No	Chainage	Type of curve	Remarks
1	272+550	Summit	280 mt length
2	273+830	Valley	175 mt length
3	274+180	Summit	490 mt length

**Junction geometry:** Properly designed intersections shall be provided at all road crossings/junctions, so as to ensure that no intersection remains without safe and efficient design. Following Observations are recorded at minor junction at Ch. 275+238 and Ch. 282+740 & major intersections at Ch. 276+600.

- Visibility at junction location in approaches is a safety requirement which is designed for junction approaches and also maintained.

- Layout at intersections is channelized.
- Proper Sign boards are provided at location.

**Super elevation:** Super Elevation shall be limited to 7 percent, if radius of curve is less than desirable minimum radius. It shall be limited to 5 percent, if radius is more than desirable minimum and also at section where Project

Highway passes through an urban section or falls on an major junction. The super elevations provided at horizontal curves are analysed and recorded.

Sr No	Chainage	Super Elevation Provided
1	Km. 270+154	5%
2	Km. 271+929	5%
3	Km. 274+506	-
4	Km. 274+938	5%

**Vertical clearance at underpass:** Vertical clearances provided at underpasses are analysed and recorded

Sr No	Underpass Location	Vertical Clearance Provided
1	Km. 271+569 (VUP)	5.5 m
2	Km. 276+238 (VUP)	5.5 m

**Horizontal clearance at underpass:** Horizontal clearances provided at underpasses are analysed and recorded

Sr No	Underpass Location	Horizontal Clearance Provided
1	Km. 271+569 (VUP)	25 m
2	Km. 276+238 (VUP)	25 m

## 6.CONCLUSIONS

Following conclusions can be made from the research;

- Geometric elements of road are well designed and found in order as per requirements and guidelines of standard specifications.
- Proper geometric design of roads results in reduced road accidents, comfort to road users, reduced travel time and efficient traffic movement.
- The study would be helpful to examine the geometry of highway and can be used to improve or enhance the efficiency of road users.

- Additional care is required during design of elements like intersections, horizontal curves, vertical curves, etc.
- Previous studies have concluded that improper design of geometric elements of roads results in accidents, traffic congestions, uncomfortable journey, etc.
- Geometric design of highways is important factor to construct a cost efficient, useful & safe infrastructure.

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