

**“WIDENING AND RENOVATION OF HILL ROAD”**

**A PROJECT REPORT**

*Submitted in partial fulfillment of the requirements for the award of the degree*

*of*

**BACHELOR OF TECHNOLOGY**

**IN**

**CIVIL ENGINEERING**

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**HIMACHAL PRADESH, INDIA**

**May, 2017**

## CERTIFICATE

This is to certify that the work which is being presented in the project report titled “**WIDENING AND RENOVATION OF HILL ROAD**”, in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Wagnaghat is an authentic record of work carried out by Sachin Gautam (131612) and Akshay Kumar (131691) during a period from July, 2016 to May, 2017 under the supervision of **Dr. Ashish Kumar**, Associate Professor, Department of Civil Engineering, Jaypee University of Information Technology, Wagnaghat.

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## ABSTRACT

The geometric outline of any street works in the measurements and design of unmistakable qualities of the pavement. The need of the geometric plan is to distinguish necessity of driver and the vehicle, for example, wellbeing, accommodation, proficiency, and so forth. The qualities ordinarily taken are the cross section components, sight distance, elevations, horizontal curve and intersection. The plan of these attributes relies upon driver behavior and mindset, vehicle qualities, traffic attributes for example, speed and volume. An exact geometric plan will limit the mischance and their significant outcomes. Subsequently, the motivation behind geometric plan is to give perfect effectiveness in activity operation and more safety at profitable cost. Hilly regions have diverse sort of climatic conditions, troublesome and dangerous landscape, geology and incomprehensible high elevation zone. The roads are influenced by surge ensuing to exuberant rainfall, land slide and so forth. The outline details are given independently from that of in plane for the arrangement of well being and comfort for the geometric plan of hill road. In our project, a current hill road stretch is picked. We will going to check it against required geometric plan benchmarks according to rules by the Indian Roads Congress (IRC). For any deficiencies in the geometric outline of the picked stretch, an enhanced geometric plan is proposed. We will do it by utilizing **Autodesk InfraWorks 360** programming and furthermore by manual computations. The cost examination for this enhanced geometric plan for this road is additionally done. The report gives the brief introduction about the geometric design of hill road and the selected road stretch. It explains the terminology related to our project and table of IRC recommendation is also included. The report shows the method and equipment used by the author. Methodology of the work and the detail working of the instruments are also included in this report.

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# **CHAPTER-1**

## **INTRODUCTION**

To provide ideal efficiency in the traffic operations having maximum safety at considerable cost is the main purpose to design the geometrics of highway. It is conceivable to plan and develop the pavement of the road in steps. Yet it is too expensive and somewhat difficult to do any change in the geometric components of road in later stages. That is why, during the initial alignment itself, it is important to design the geometric components of the road.

Geometric design of pavement tackles with following elements:

- 1) Cross section
- 2) Sight distance
- 3) Horizontal alignment
- 4) Vertical alignment
- 5) Intersection

Beneath the cross section elements, the consideration for the breadth of the pavement, making of land, the surface characteristics and cross slope of the pavement is included. The sight distance visible in front of a driver at horizontal, intersection and at vertical curves provides safe movements of vehicle.

Road directions can be changed by introducing horizontal curves. Cant is given by elevating the external edge of road to counteract the centrifugal force formed on a vehicle negotiating a horizontal curve. Horizontal curve is also provided with an extra pavement width. In order to introduce the centrifugal force and cant gradually, transition curves are introduced between the straight and circular curves.

The aim of our present study is widening of the existing rural road and design the new rural road in which primarily focus is given to geometric design. Cost estimation is also done for the existing as well as for new road. Following are the main objectives of the present work.

- (i) We will check the geometric design of existing road against the specifications of IRC standards.
- (ii) We will propose an improved geometric design for this road stretch, and
- (iii) We will estimate cost occurs for improved geometric design.

Geometric design of road includes design speed, horizontal curves, super-elevation, set-back distance, widening which we have discussed below under design of horizontal alignment.

## **1.1 DESIGN OF HORIZONTAL ALIGNMENT**

One of the most important features affect the safety and efficiency of a road is horizontal alignment. Highway performance will be reduced as a result of poor design, lower speeds in terms of safety and comfort. The highway capacity also lowers down and the cost of vehicle operations increases. Design of horizontal alignment includes the understanding on the design aspects such as design speed and also the effect of horizontal curves on the vehicles.

Design elements to be considered under Horizontal Alignment are as follows:

- 1) Design speed
- 2) Horizontal curve
- 3) Super-elevation
- 4) Type and length of Transition curve
- 5) Set-back distance
- 6) Extra widening

### **1.1.1 Design speed**

Factor which affect the design of horizontal curve is the design speed. The design speed depends on the type of road. The design speed observed for a national highway will be much higher than a rural road. Hence geometry will vary significantly. The plan speed likewise relies upon the sort of landscape. Terrain can bear to have any geometry, yet for a similar standard in an uneven territory requires general cutting and filling and significant cost and in addition security concern as a result of unstable slopes. The design speed is decreased for terrain having steep slopes.

IRC has classified the terrains into four categories. They are plain, rolling, mountainous, steep based on the cross slope. The design speed varies based on the type of road and type of terrain. The ruling speed as well as minimum suggested design speed for hill roads is shown in Table 2.2 according to IRC: 52-2001

Terrain Classification	Cross Slope (%)
Plain	0-10
Rolling	10-25
Mountainous	25-60
Steep	>60

Table 1.1 Terrain Classifications

Sr.No.	Road Classification	Mountainous Terrain		Steep Terrain	
		Ruling	Minimum	Ruling	Minimum
1.	National and state Highways	50	40	40	30
2.	Major District Roads	40	30	30	20
3.	Other District Roads	30	25	25	20
4.	Village Roads	25	20	25	20

Table 1.2 Design Speed (km/hr)

### 1.1.2 Horizontal curve

At the point when a vehicle navigates a horizontal curve, the divergent drive ( $P - Wu^2/gR$ ) acts outward through the center of gravity of the vehicle. Centrifugal drive relies on upon speed and radius of the curve. It is neutralized to a specific extend by transverse friction between the tire and the pavement surface. On a curve, this force makes vehicle to topple outward about the external wheels or slip the vehicle outward.

Various forces acting on the vehicle is illustrated in Figure 2.1. Force consists of centrifugal force (P) act outward. Weight of the vehicle (W) act downward. The reaction coming from ground on the wheels (RA and RB). The centrifugal and weight is assumed to be from the center of gravity which is at h units from the ground. Wheel base is assumed as b units. The centrifugal force 'P' in kg/sq. m is given by.

$$P = Wu^2/gR$$

'W' is the weight of the vehicle in kg. u is the speed of vehicle in m/s and g is the acceleration due to gravity in m/square sec and R is the radius of curve in meter.

So centrifugal ratio or impact factor is given by  $P = Wu^2/gR$

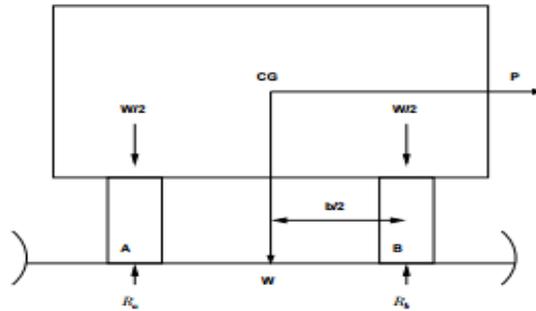


Figure 1.1 Effect of Horizontal curve

There are two effects of centrifugal force:

- 1) It can overturn the vehicle about the external wheel.
- 2) It can skid the vehicle laterally outward.

Resolve moments of the force with respect to the other when the vehicle is just about to over side is given as.

$$Ph = Wb/2 \text{ or } P/W = b/2h$$

Over turning is possible at equilibrium when

$$u^2/gR = b/2h$$

For the safety concern the following conditions should be satisfy.

$$u^2/gR < b/2h \text{ (if the equation is not satisfied vehicle will overturn at the horizontal curve)}$$

The second possibility of the vehicle is for transverse sliding. i.e. at the point when the outward force P is more than maximum transverse skid resistance because of frictional force between the road surface and the tire.

The transverse skid resistance (F) is given by

$$\begin{aligned} F &= F_A + F_B \\ &= f (R_A + R_B) \\ &= fW \end{aligned}$$

Where  $F_A$  and  $F_B$  are the frictional force at tire A and B.  $R_A$  and  $R_B$  are the reaction at tire A and B.  $f$  is the lateral coefficient of friction and  $W$  is the weight of the vehicle. This is counteracted by centrifugal force P. By equating:

$$P = fW \text{ or } P/W = f$$

At equilibrium when skidding takes place

$$P/W = f = u^2/gR$$

And for the safety the following condition must be satisfy:

$$F > u^2/gR \text{ (if the equation is violated, vehicle will skid at the horizontal curve)}$$

Some of the DONT's to be considered while designing horizontal curve are as follows:

- 1) It should be fluent with the surrounding topography.
- 2) Small deflection angle should be avoided for short curves.
- 3) Curves in same heading isolated by short tangents must be replaced with a big single curve.
- 4) Introduction of sharp curves at the end of long tangents should be avoided.
- 5) Compound curve should be avoided. When value of the ratio for horizontal curve radius and sharper curve radius is 1.5:1 (IRC).

The ruling and absolute minimum value of radii of horizontal curve of various classes of roads in different terrain are given in Table 2.3 as per IRC: 52-2001.

Classification of Road	Mountainous Terrain				Steep Terrain			
	Area not affected by Snow		Snow-bound areas		Area not affected by Snow		Snow-bound areas	
	Ruling Min.(m)	Absolute Min.(m)	Ruling Min.(m)	Absolute Min.(m)	Ruling Min.(m)	Absolute Min.(m)	Ruling Min.(m)	Absolute Min.(m)
National and state Highways	80	50	90	60	50	30	60	33
Major District Roads	50	30	60	33	30	14	33	15
Other District Roads	30	20	33	23	20	14	23	15
Village Roads	20	14	23	15	23	14	23	15

Table 1.3 Minimum Radii for horizontal curves for different terrain conditions

### 1.1.3 Super-elevation

To check the impact of outward centrifugal force and to decrease the possibility of the vehicle to topple or slip, the external edge of the pavement is raised with respect to the internal edge. This inclined transverse in the pavement surface is known as super-elevation.

**Analysis of super-elevation:**

The force acting up on a vehicle while following a curve with cant is appeared in Figure 1.2.

The force acting on horizontal curve of radius R m at a speed of u m/sec is:

- 1) (P) Centrifugal force acting horizontally outward through the center of gravity.
- 2) (W) Weight of the vehicle acting downward through the center of gravity.
- 3) (F) Frictional force between the pavement and wheel, along the surface inward.

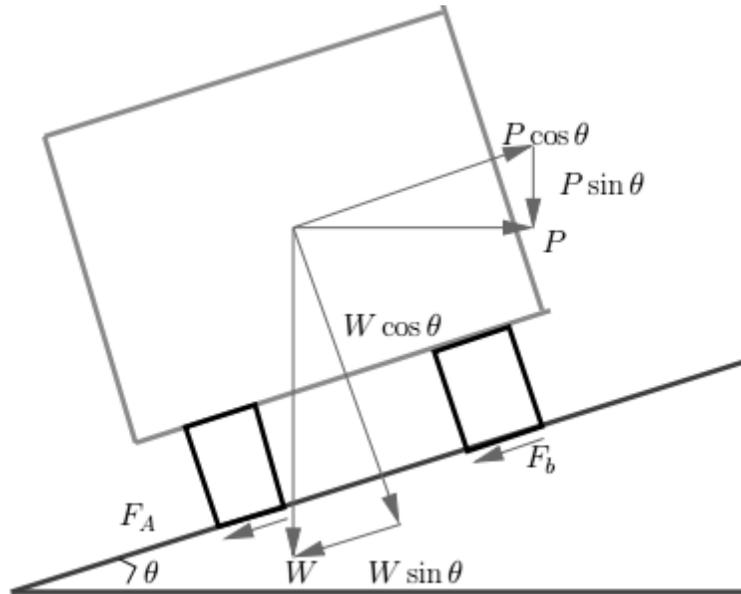


Figure 1.2. Analysis of super-elevation

At equilibrium, by resolving the forces parallel to the surface of the pavement we get:

$$\begin{aligned}
 P \cos \theta &= W \sin \theta + F_B + F_A \\
 &= W \sin \theta + f (R_A + R_B) \\
 &= W \sin \theta + f (W \cos \theta + P \sin \theta)
 \end{aligned}$$

Where W is the weight of the vehicle. P is the centrifugal force. f is the coefficient of friction.  $\theta$  is the transverse slope due to super-elevation. Dividing by  $W \cos \theta$ , we get:

$$P \cos \theta / W \cos \theta = W \sin \theta / W \cos \theta + \{f (W \cos \theta + P \sin \theta) / W \cos \theta\}$$

$$P/W = \tan \theta + f + f P/W \tan \theta$$

$$P/W (1 - f \tan \theta) = \tan \theta + f$$

$$P/W = (\tan \theta + f) / (1 - f \tan \theta)$$

$$\text{Since } P/W = u^2/gR,$$

$$u^2/gR = (\tan \theta + f) / (1 - f \tan \theta)$$

This is an expression for cant. But normally  $f = 0.15$  and  $\theta < 4^\circ$  and  $1 - f \tan \theta$  approximately equal to 1, and for small  $\theta$ ,  $\tan \theta = \sin \theta$   $E/B = c$ , so we have:

$$c + f = u^2/gR = u^2/127R$$

where  $c$  is the rate of super-elevation,  $f$  is the coefficient of friction:  $u$  is the speed in m/sec,  $R$  is the radius of curve in m and  $g$  the acceleration due to gravity in  $\text{m/sec}^2$ .

Three particular cases that can emerge from condition  $c + f = u^2/gR$  is as follows:

1. If there is no friction due to some practical reason, then  $f = 0$  and equation becomes  $c = u^2/gR$ . These results are in situation where the pressure on the external and inner wheels is same. It requires very high super elevation  $c$ .
2. If there is no cant provided due to some practical reason, then  $c = 0$  and equation becomes  $f = u^2/gR$ . This results in very high coefficient of friction.
3. If  $c = 0$  and  $f = 0.15$  then for safe traveling speed from the equation is given by  $u' = \sqrt{fgr}$ , where  $u'$  is the restricted speed.

### 1.1.3.1 Maximum and Minimum super-elevation (IRC)

Maximum allowable super-elevation of

- 1) For plain and rolling terrain it is 7%
- 2) For mountainous terrain not bounded by snow it is 10%

Minimum super-elevation

If the calculated super-elevation is equal or less than camber, then minimum elevation equal to camber should be provided from drainage consideration.

The IRC recommendation giving the radii of horizontal curves beyond which normal cambered section may be maintained and no super-elevation is required for curves, are presented in Table 2.4, for various design speed and cross slope.

Design Speed (kmph)	Radii (meters) for camber of				
	4%	3%	2.5%	2%	1.7%
20	50	60	70	90	100
25	70	90	110	140	150
30	100	130	160	200	240
35	140	180	220	270	320
40	180	240	280	350	420
50	280	370	450	550	650

Table 1.4 Radii beyond which super-elevation is not required

**Steps for super-elevation design:**

Various steps in the design of super-elevation in practice may be summarized as given below:

1. Super-elevation for 75% of design speed is calculated neglecting the friction

$$c_{cal} = U^2/225R$$

2. If  $c_{cal}$  is less than  $c_{max}$  then provide  $c_{cal}$ . If  $c_{cal}$  is greater than  $c_{max}$  proceed with step 3 and step 4

then provide  $c_{max}$ , and proceed with step 3 and step 4.

3. Check the coefficient of friction developed with  $c_{max}$  at full value of design speed

$$f = \{(U^2/127R) - 0.07\}$$

if the value of 'f' thus calculated is less than 0.15 then ok, else calculate the restricted speed as given in step 4.

4. Calculate the allowable speed.

$$c+f = 0.07+0.15 = 0.22 = U^2/127R$$

## **CHAPTER-2**

### **METHODS AND EQUIPMENT**

In this part the approach and equipment/programming utilized by the creators for project work have been portrayed alongside their working guideline, step wise methods, and so forth.

The road stretch selected for our project (widening of hill road) falls under village road category in area of hills which is 0.5 km (Waknaghat-Gamberpul road) starting from Peepal Tree near Jaypee University towards Domehar Village, district Solan, H.P. Construction of this road was started on Gandhi Jayanti i.e. October 2<sup>nd</sup>, 1962. This was completed on 31<sup>st</sup> March, 1963, when the area was in Punjab.

#### **Problems faced by Total Station at the time of surveying**

- Because of the bad weather conditions our surveying got delayed.

#### **Shortcomings of the selected stretch**

- Traffic Signs: On our stretch Road signs is not there which earlier also have caused many accidents
- Drainage Path: We got to see that the existing drainage lines are full of trash. They are poorly maintained.
- Longitudinal Gradient: On some specific point of our stretch violation of longitudinal gradients is observed.



Figure 2.1 Alignment of the selected road stretch from Google Earth [2]



Figure 2.2 Pictures of an existing road stretch

## 2.1 METHODOLOGY

A leveling survey has been done for the selected road stretch to generate the topography of the stretch. Data obtained from the survey has been inputted in excel sheet and elevation corresponding to data obtained has been drawn in AutoCAD software for required check like horizontal alignment, section of the alignment, carriageway width, shoulder, roadway width drain, etc. as per IRC standards.

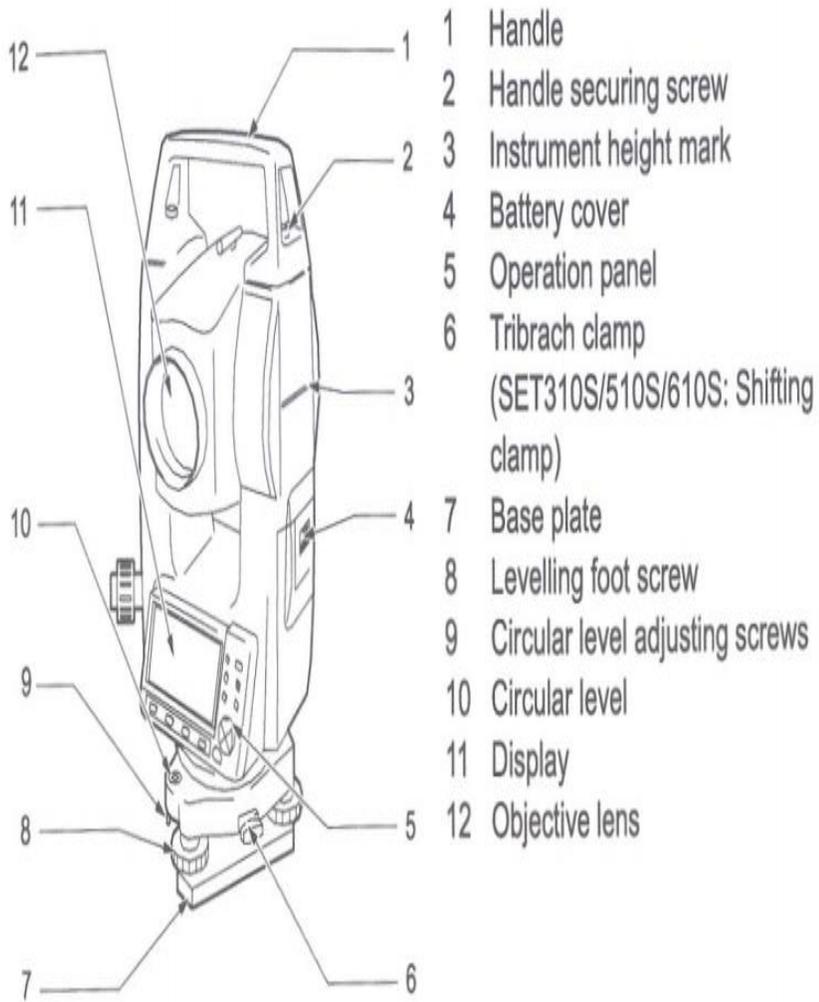
Information got has been checked for any short comings in the geometric outline of the picked road stretch. An enhanced geometric design is proposed, which is done utilizing **Autodesk InfraWorks 360** programming. Cost estimation for the road stretch has also done.

### 2.1.1 Total Station

A total station is an electronic/optical instrument used in modern surveying. It is an electronic theodolite integrated with an electronic distance meter to read slope distances to a specific point. Sokkia Total Station (SET610) version has been used.



Figure 2.3 Sokkia Total Station (SET610)



Plum Bob



Tripod

Figure 2.4 Parts of Total Station <sup>[3]</sup>

### 2.1.2 Working steps

Refer section 2.1.1:- For parts of total station.

1. Level the instrument using bubble on the base and then bubble above the screen. The bubble on the base is used for leveling. The tripod and bubble above the screen is used for leveling the instrument.

2. For centering the instrument Plum bob is used. After the instrument have been centered and leveled, press turn ON button on the operation panel.

3. From operation panel press MEAS followed by TILT. Which are displayed on the display screen. Press FUNC key on the operational panel to scroll menu complete fine leveling adjustments.

4. Prior to the start of survey one either need to fit the back sight. Coordinate of the previous point in the instrument or one have to set north angle. For our survey work we have oriented north angle.

5. North angle is oriented using compass fitted on the top of total station. Press OSET on operational panel and set the horizontal angle to zero.

6. After setting the north angle one need to input certain specific information's about the bench mark (northing, easting & elevation coordinate), height of instrument and height of reflector in total station instrument. To do this one need to press COORD Stn. Orientation — Stn. Coordinate on optional panel.

7. Once all the required information has been entered one is ready to proceed with the survey by sighting on the reflector.



Figure 2.5 Station orientation of total station

## 2.2 InfraWorks 360 Software

InfraWorks 360 software is a piece of Autodesk. It is a propelled demonstrating tool that empowers the fast and precise plan of roads, bridges, drainage system. With InfraWorks 360 one can make outline contrasting options to accomplish the perfect roads, bridges, drainage patterns. Make better decisions throughout the project with tools for sight distance, flood simulation, dynamic site analysis, and more.

### 2.2.1 Basic concepts of InfraWorks 360

- A framework for the accumulation, era, investigation and showing of three dimensional information.
- All data are stored in \*.sqlite format.
- No practical limit on number of models.
- Files of infraworks 360 are .fbx, .imx, which can be exported to other software.
- InfraWorks 360 supports FBX, IMX, 3DS, OBJ, DAE, and DXF survey input files.

### 2.2.2 Working steps

In InfraWorks 360 software, either survey data can be imported from sources like FBX, IMX, DAE or plan can be generated using model builder present in the software. Model builder generates the model that is selected from the map in software.

For our project we have used model builder to generate plan of hill road(waknaghat – domehar road). Our main focus is on road design and culvert design.

To generate a plan use *Model builder > Search > Area of interest > Enter model name > Create model* from software as shown in figure 2.6 and 2.7.

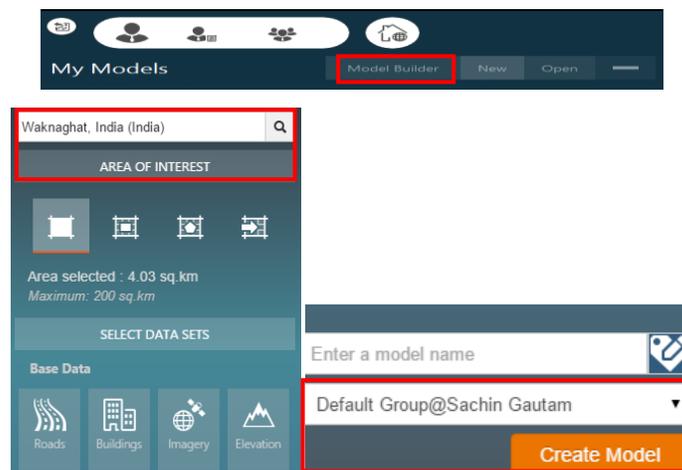


Figure 2.6 To create a model



Figure 2.7 Generation of model

### 2.2.3 To design a road in selected model

From Menu select *Road icon* > *Design roadways*. Different types of roads (i.e. component roads, highway roads etc.) will be shown. It's up to you which road you want to design for.

We have selected here component roads. *Component* > *Assembly* > *Two lanes* as shown in figure 2.8. Now draw the road line on the model where road is to be constructed.

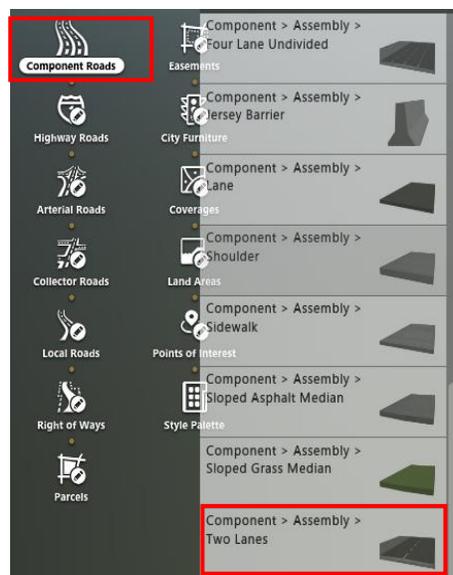


Figure 2.8 Road selection



Figure 2.9 Road design on selected model

Road is constructed as shown in figure 2.9. Features can be changed according to the requirement of the terrain.

On selecting road its attributes, geometry etc . is seen, shown in figure 2.10. Accordingly they can also be changed.

<b>Attributes</b> <span>⬆</span>		<b>Type</b> <span>⬆</span>	
Function	Local <span>⬇</span>	Material	
Speed	45.0 km/h	Material/Roadway/Surface Dark Grey ...	
Design Standards	AASHTO_Metric_20...	<b>Attributes</b> <span>⬆</span>	
Superelevation	<input type="checkbox"/> <span>●</span>	Start station	0+000m
Lane Marking	<input type="checkbox"/> <span>●</span>	End station	0+932.670m
<b>Geometry</b> <span>⬆</span>		<b>Geometry</b> <span>⬆</span>	
Length	932.67 m	Length	932.670m
Elevation Range	1472.492m - 1543.3...	Width	3.5 m
Grade Range	1.87 % - 18.29 %	Depth	0.2 m
		Slope	-2.0 %

Figure 2.10 Road details

## 2.2.4 Inserting Road components

Select the road > Right click > Insert road component > select the component as shown in figure 2.11A

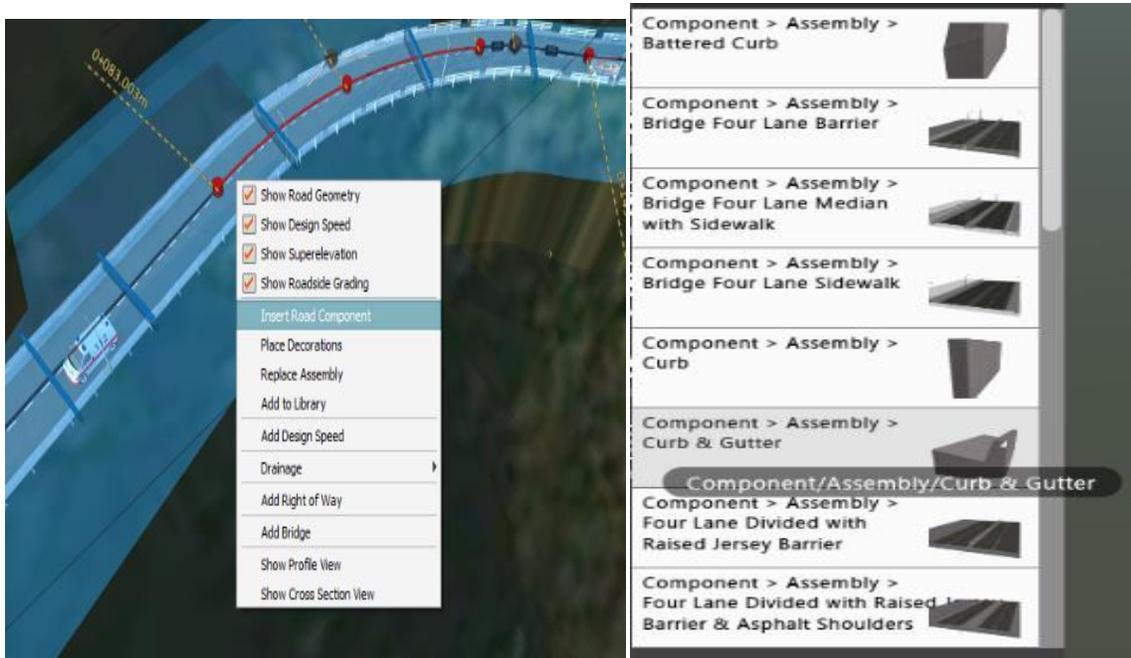


Figure 2.11A Inserting road component

Choose the position where you want to place it. Shown in figure 2.11B

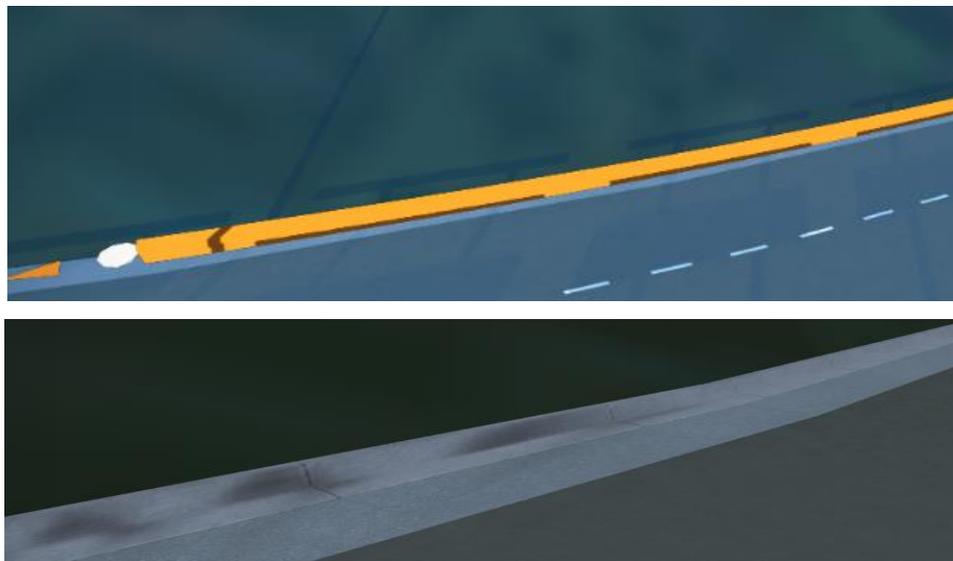


Figure 2.11B Placing the component

## 2.2.5 Placing decorations on road

Select the road > Right click > Place decorations > select. Select the decorations (i.e. street lights, vehicles, guard rails, people etc.). Shown in figure 2.12

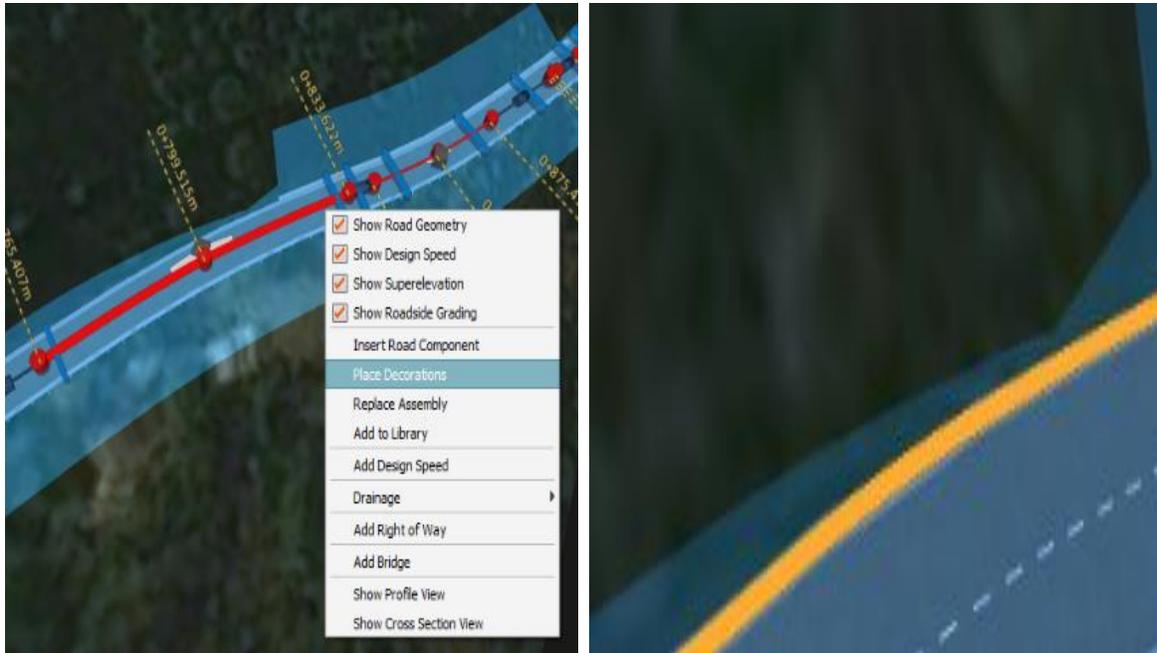


Figure 2.12 Placing the decorations

## 2.2.6 Analysis

Sight distance analysis is done which includes stopping sight analysis and passing sight analysis.

*Click on road icon > Review and modify roadway designs > Sight distance > select road > Select method, direction, lane > Analyze.* Shown in figure 2.13A and 2.13B

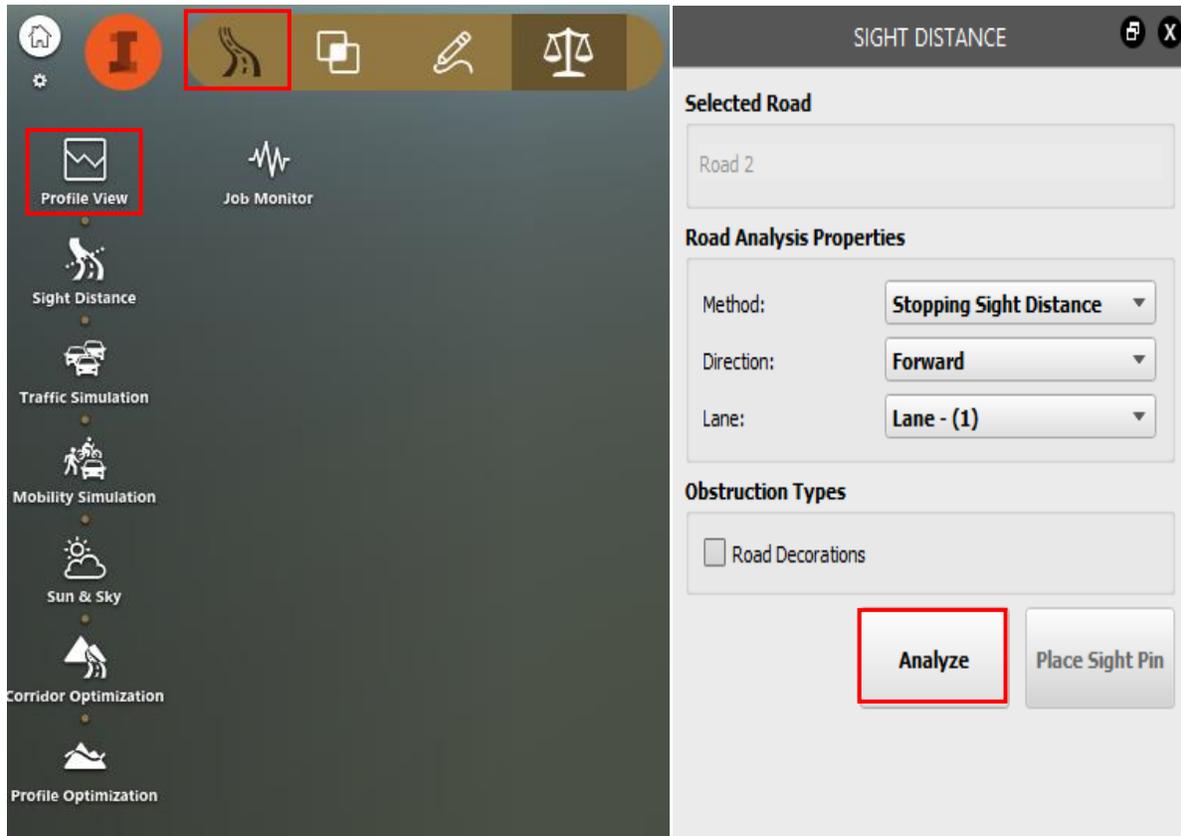


Figure 2.13A Stopping sight distance analysis

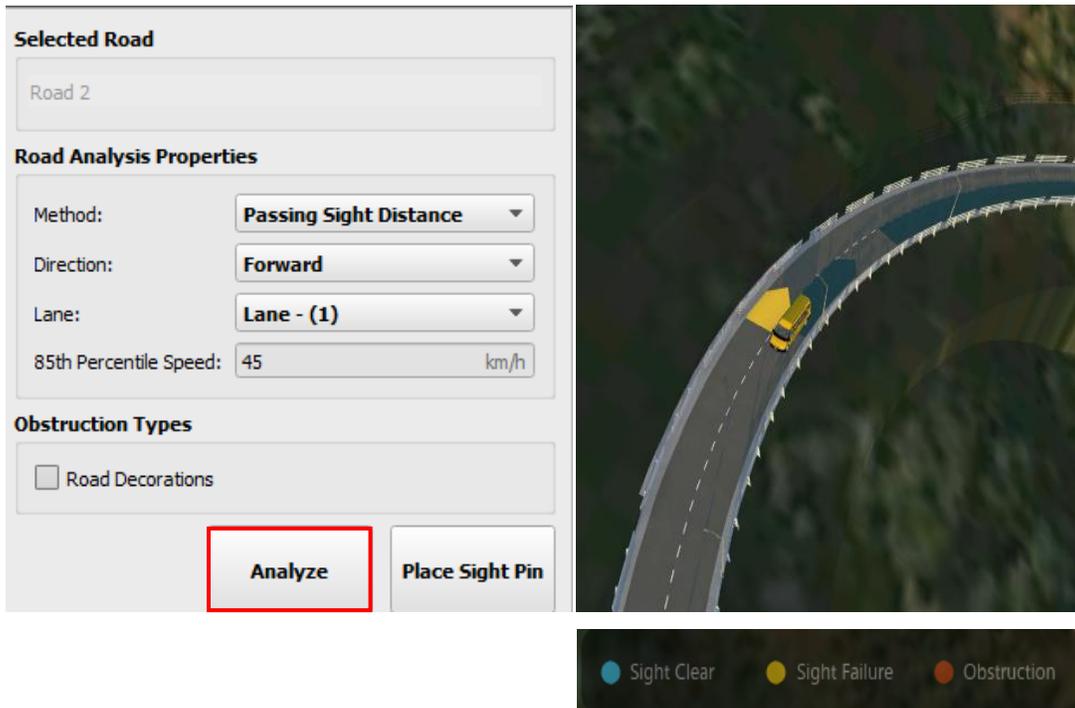


Figure 2.13B Passing sight distance analysis

## 2.2.7 Profile view of road

Select road > right click > Show profile view. This can be seen in figure 2.14A 2.14B and 2.14C.

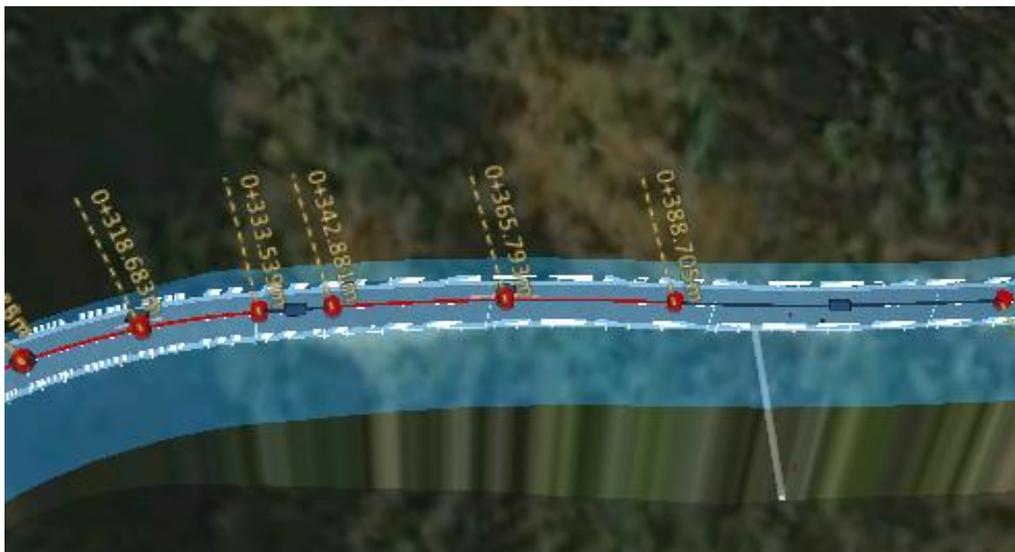


Figure 2.14A Selecting the road



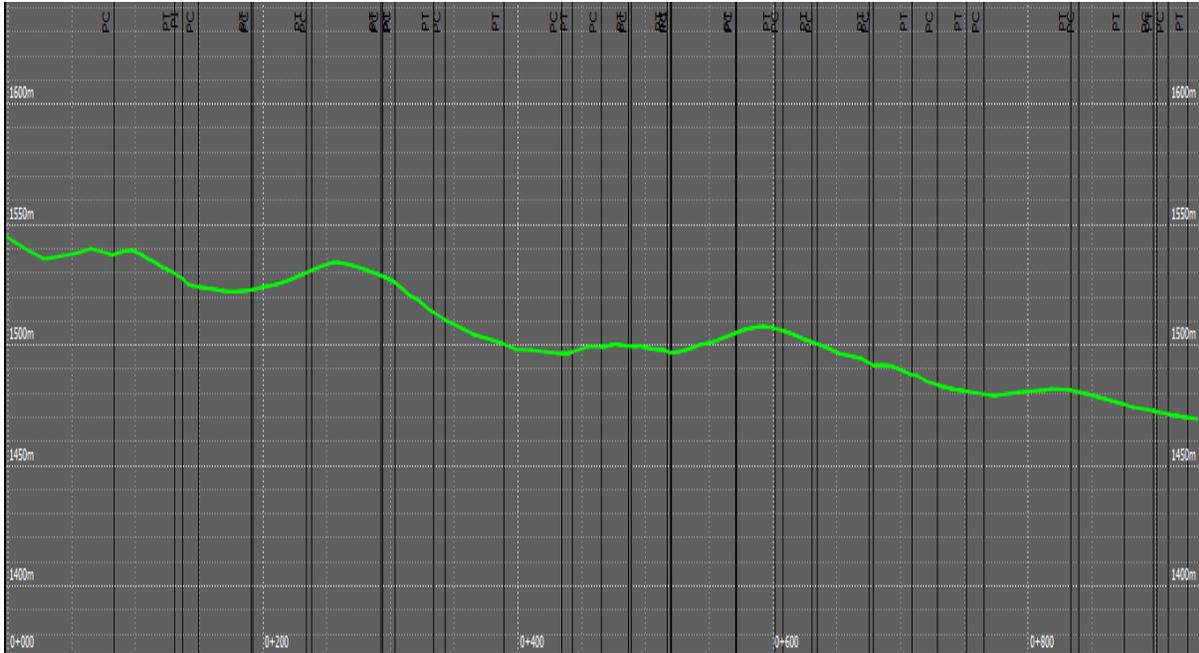


Figure 2.15 Profile view of existing ground

Profile view of a finished ground shown in figure 2.16

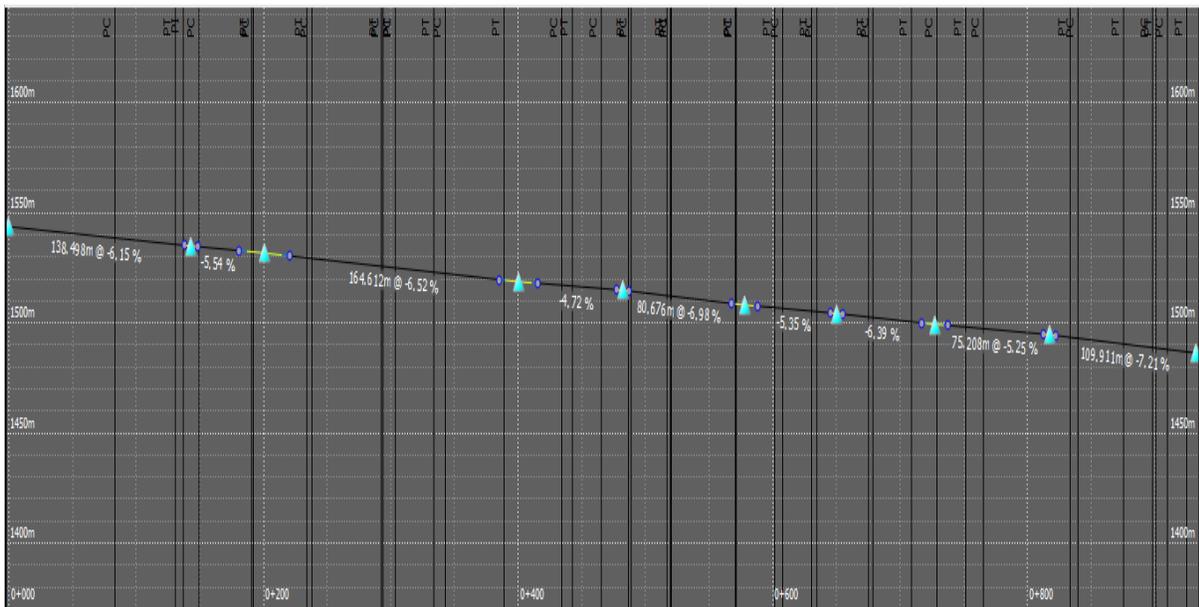


Figure 2.16 Profile view of a finished ground

### 2.2.8 Cross-sectional view of road

To have a cross-sectional view of a road, *Select the road > Right click > Show cross-section view > Road assembly view*. Cross-sectional view can be seen in figures below.



Figure 2.17A Shows cross-section view

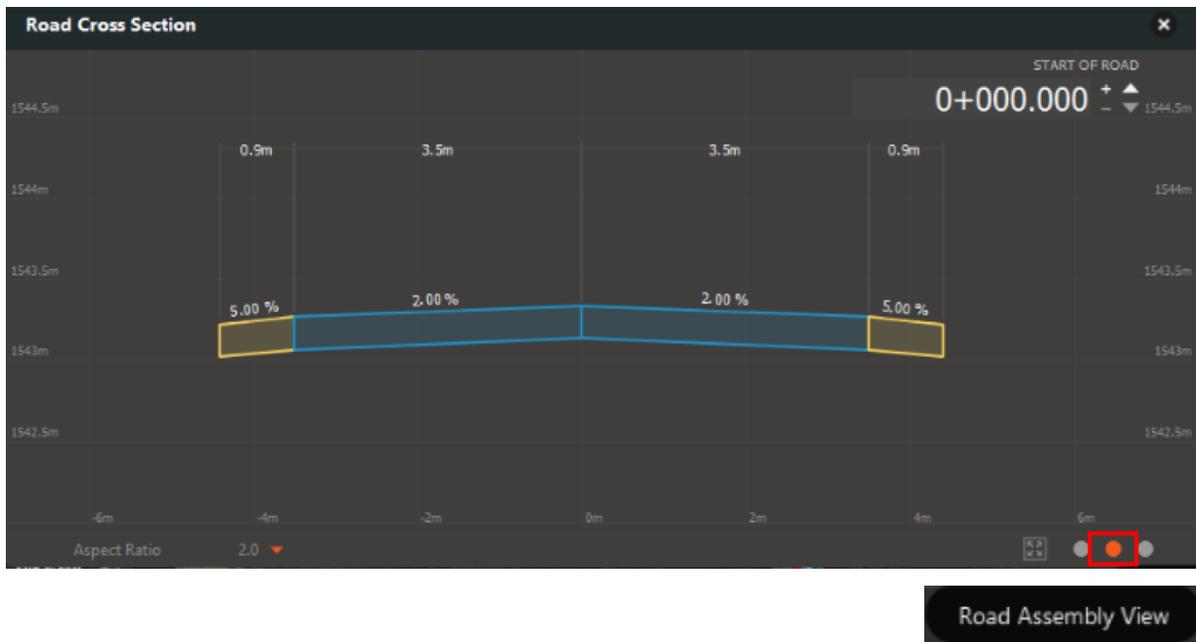


Figure 2.17B Cross- section of road

Cross-sections of a road at different stations can be seen in the figures below

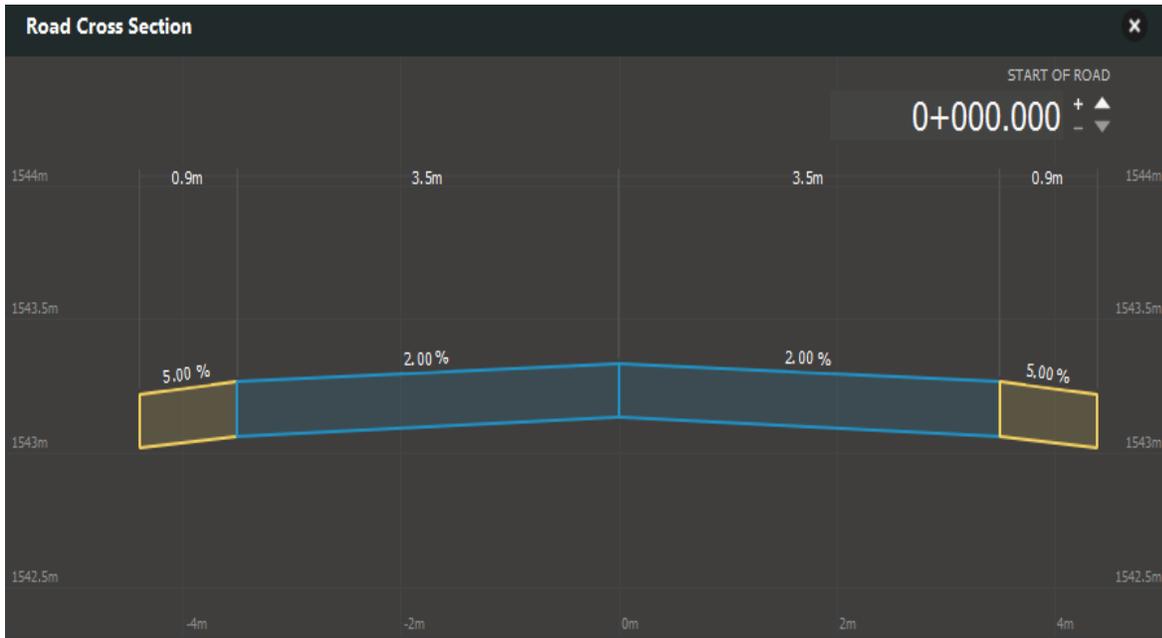


Figure 2.18A Cross-section at station 0+000.000

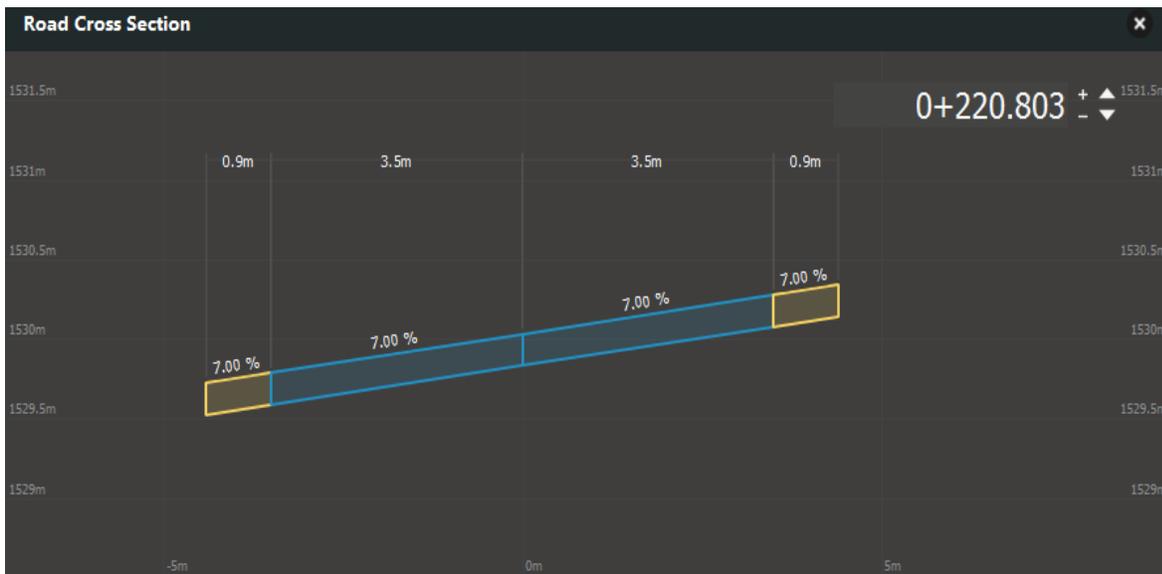


Figure 2.18B Cross-section at station 0+220.803

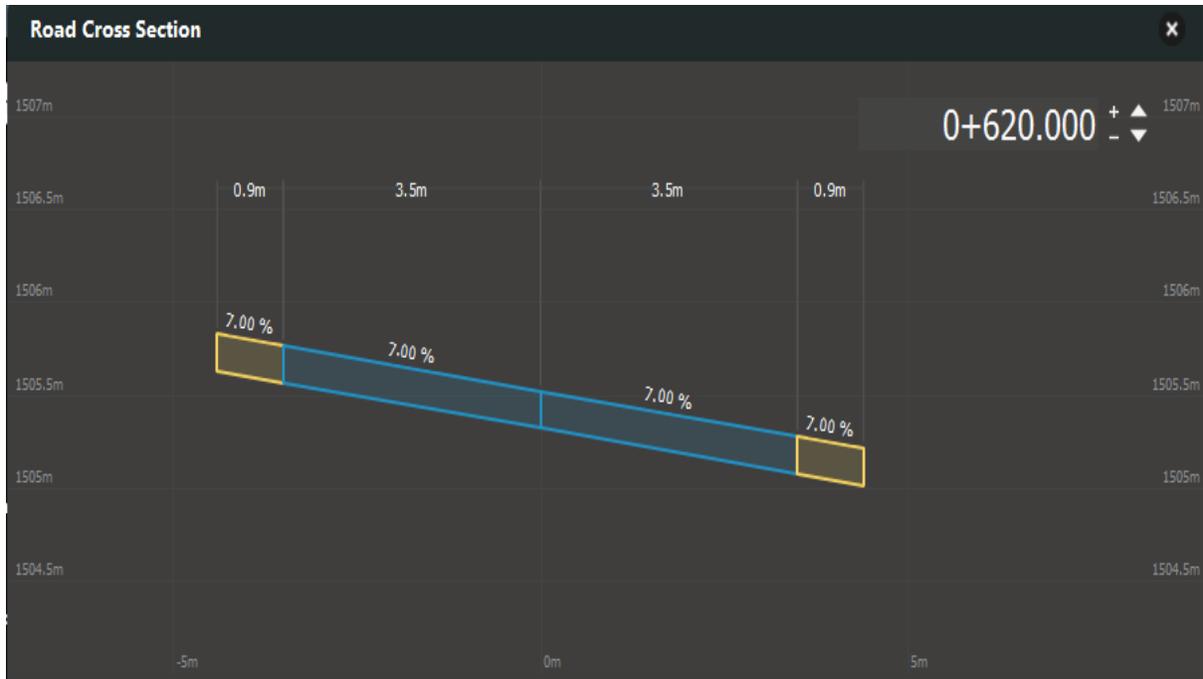


Figure 2.18C Cross-section at station 0+620.000

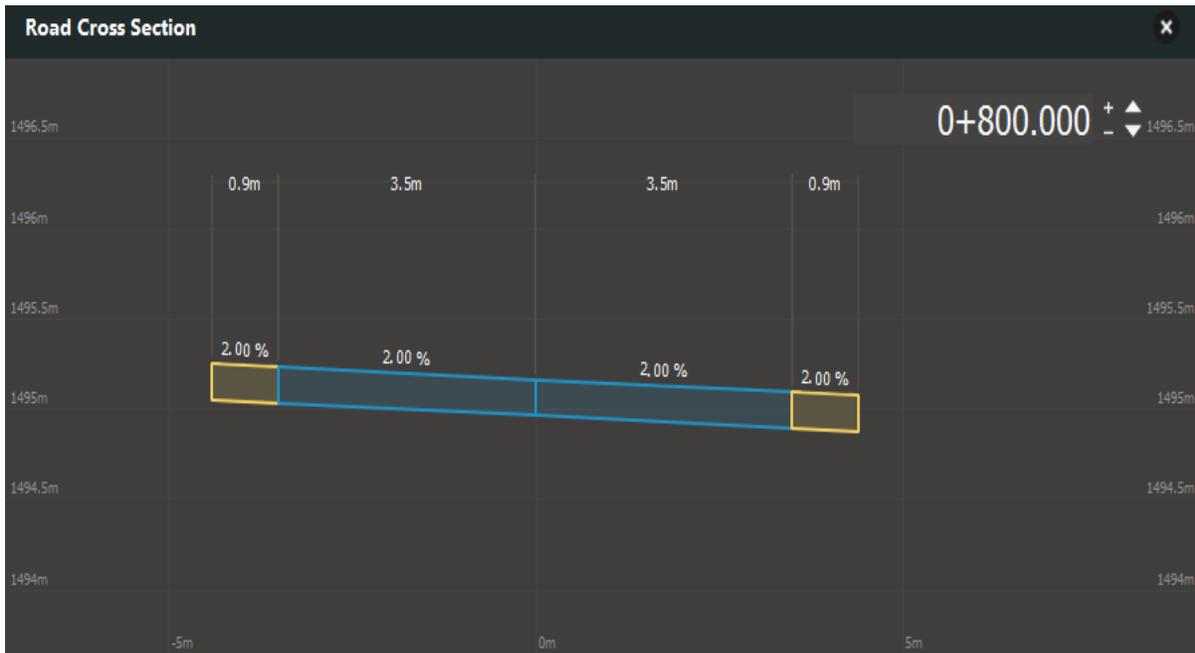


Figure 2.18D Cross-section at station 0+800.000

Refer file Infra provided in CD. *Infra > Files > Road design. Sqlite*

Open *road design. Sqlite* in InfraWorks 360 and view cross-section at different stations.

## 2.2.9 EARTHWORK

Earthwork Calculations can be done in the software very easily. Select the road. In road properties bar, go to grading option and then define grading method, limit and cut-fill slope. Here we have taken 2:1 as cut and fill slope.

Then below this cut and fill icon is there. Click that icon and generate the report. Earthwork calculation is done easily.

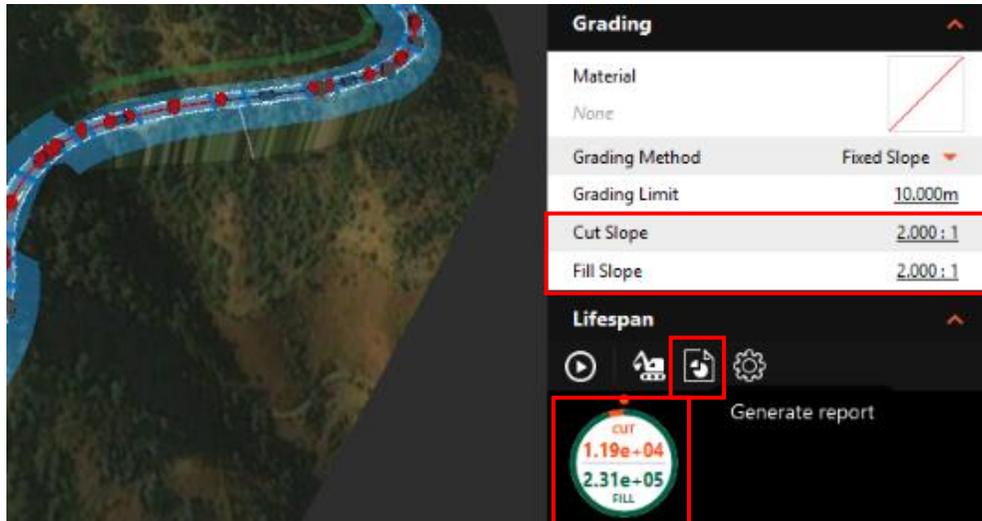


Figure 2.19 Earthwork Estimation

For earthwork calculations, *Open infra > Files > Earthwork*, provided in the CD.

Station-wise cut-fill areas can be seen in the software. *Select the road > Right click > Show cross-section view > Cut-fill areas*.



Figure 2.20A Shows cross-section views



Cut Fill Areas

Figure 2.20B Cut-Fill area

Refer file Infra provided in CD. *Infra > Files > Road design. Sqlite*

Open *road design. Sqlite* in InfraWorks 360 and view cut-fill areas at different stations.

Some of the cut-fill areas are shown below

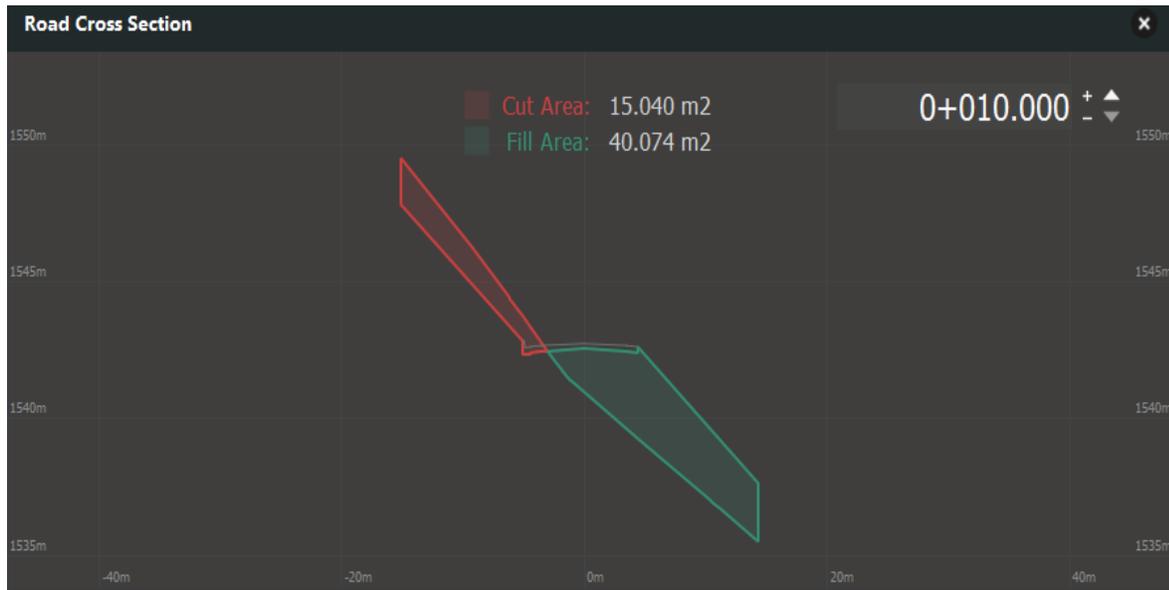


Figure 2.21A Cut-fill area at station 0+010.000

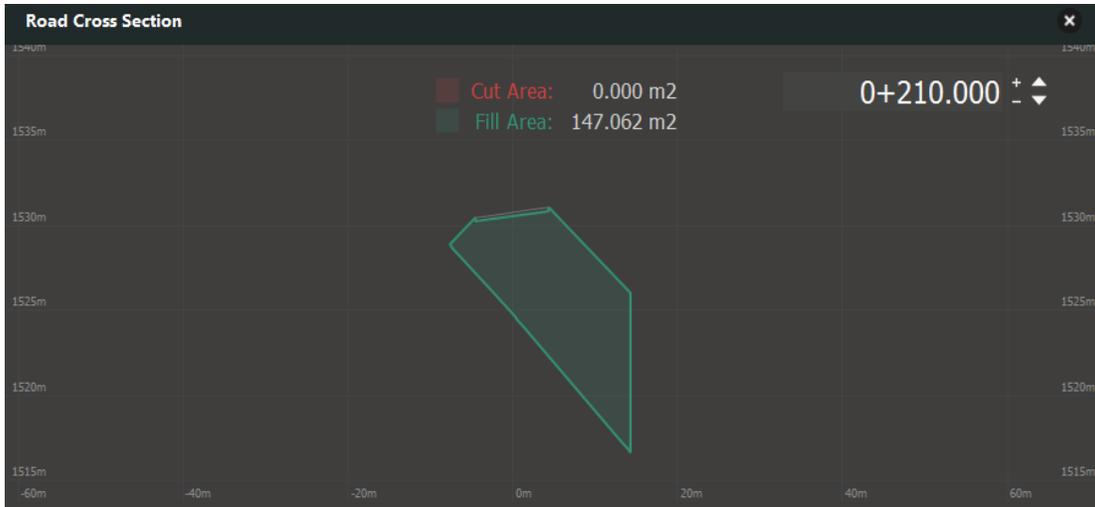


Figure 2.21B Cut-fill area at station 0+210.000



Figure 2.21C Cut-fill area at station 0+582.122

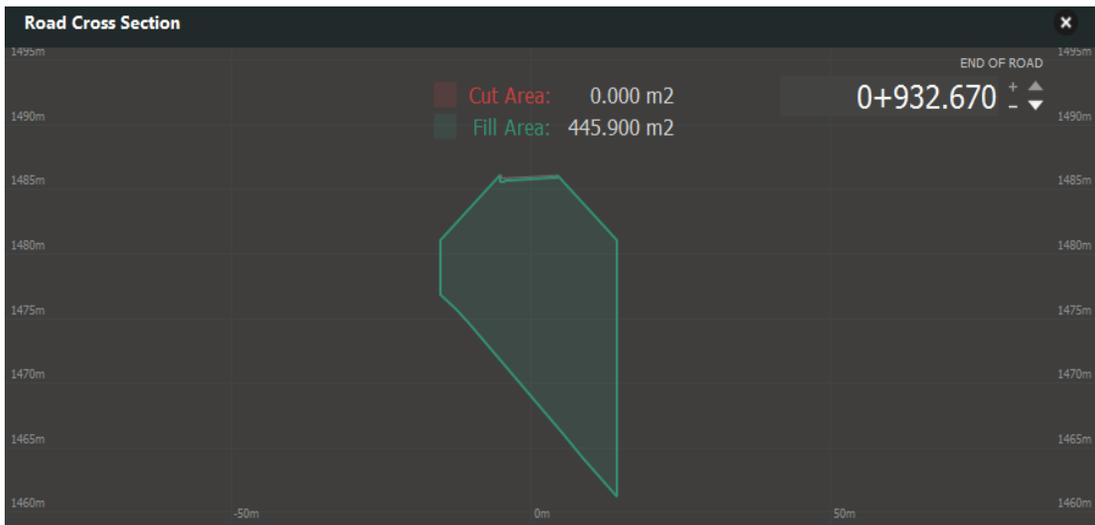


Figure 2.21D Cut-fill area at station 0+932.670

## 2.2.10 CULVERT DESIGN

For drainage purposes, culvert is provided at the minimum of longitudinal and transverse gradient.

With the help of profile view culvert's location is best known.

Click on *Drainage icon on home screen* > *Design drainage* > *Culverts*. Shown in the figures.

Place the culvert at the best location where flowing water can be collected easily.

Click on Culvert. Properties of it will be shown on left side. Properties can be changed according to the flow.

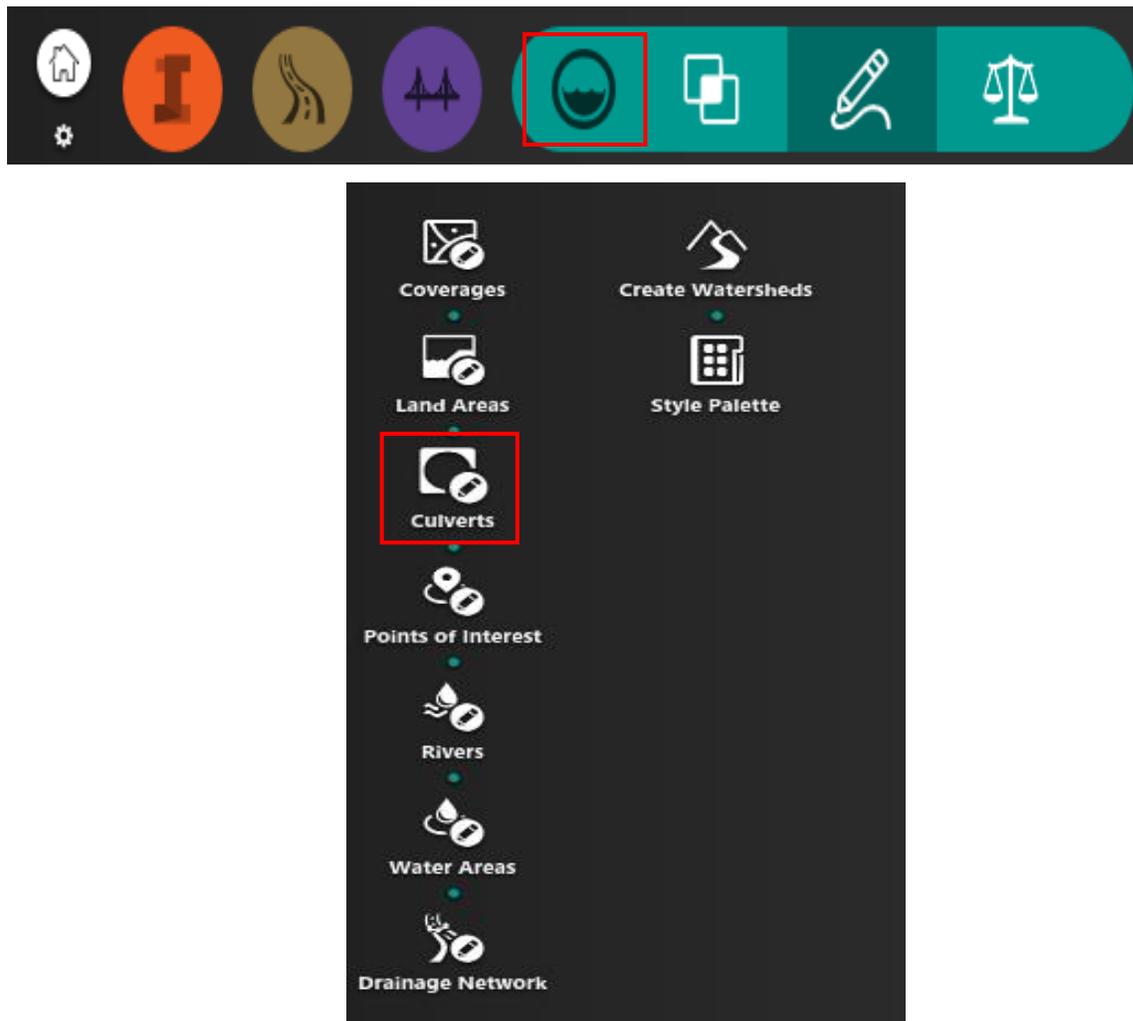
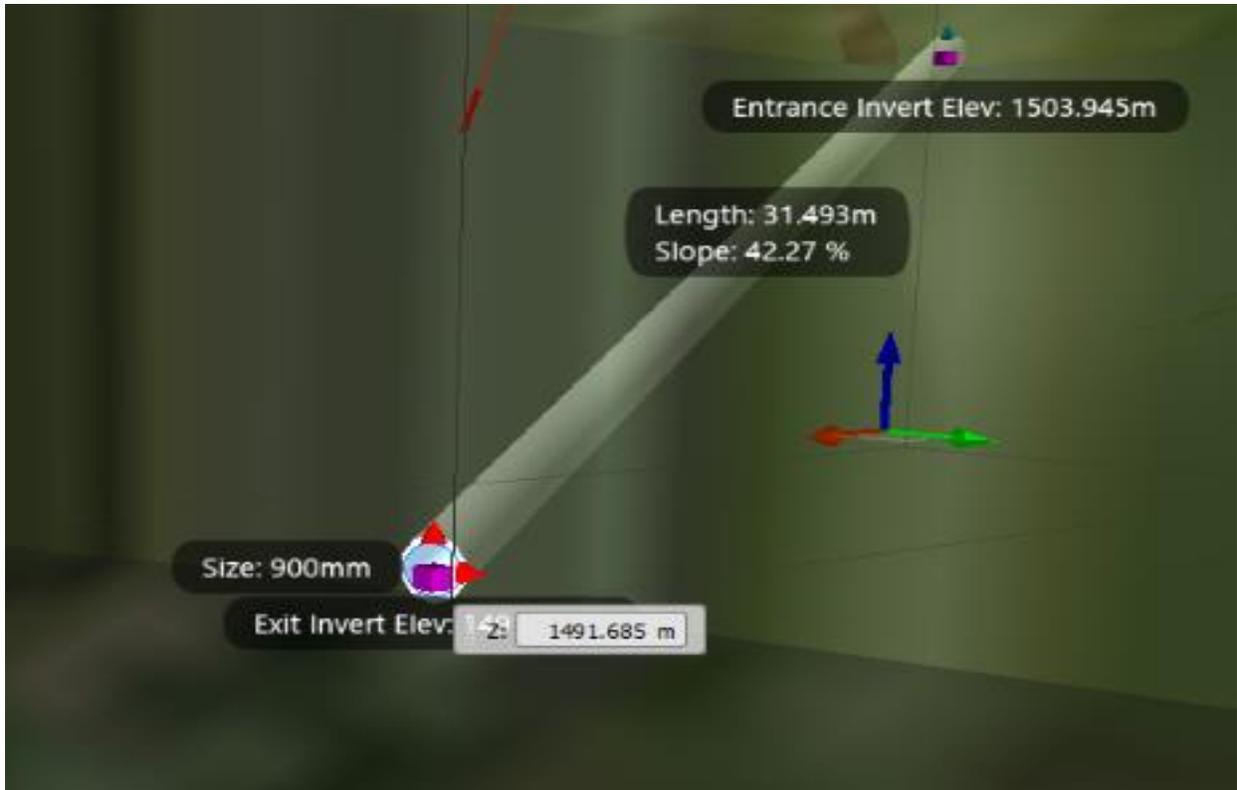


Figure 2.22 To select the culvert



Geometry <span style="float: right;">▲</span>	
Size	900mm
Culvert Length	31.493 m
Entrance Invert Elevation	1503.945 m
Exit Invert Elevation	1491.685 m
Barrel Slope	42.266 %
Barrel Skew Angle	0.68° (Left)

Figure 2.23 Culvert Specifications

Culvert Report is generated through Autodesk InfraWorks 360 given in CD.  
 Refer file Infra provided in CD. *Infra > Files > Culvert report.*

## **CHAPTER-3**

### **TRAFFIC SIGNS**

**Traffic signs** which are kept along the edges of kerbs to give directions and give imperative data to road users. The prior signs were of wooden or of stone milestones. Later, directional arms signs were introduced. Traffic signs which are used in India are same to those which used in other countries like UK. The only difference is that that they are in different language. The majority of the urban and state highways have road signs in English Language. National expressways have road signs in the neighborhood language of specific state, as in Hindi or English.

#### **3.1 CLASSIFICATION:**

The traffic signs have been divided into three categories. As per the motor vehicle act of India – 1988 three categories are objective regulating, warning and guiding the user of motor vehicles. Accordingly the Indian Roads Congress has standardized and classified the different ‘Traffic Signs’ into the following categories:

- I. Regulatory signs
- II. Warning signs
- III. Informatory signs.

The regulatory signs in general are circular in shape with two exceptions. One octagonal in shape and another inverted triangle. The warning signs are triangular in shape whereas the informatory signs are rectangular in shape.

##### **3.1.1 Materials used for signs**

Standard specification for various components of traffic signs such as posts, mounting, plates, supports, different types and grades of retro-reflective sheeting, etc. have been made available by BIS and ASTM. There are also IRC recommendations for some of items such as size of the sign, height, etc. IRC 67 – 2010. That contains details of specifications for road signs.

### **3.1.2 Size of signs and letters**

Three sizes of regulatory and cautioning signs have been determined, to be specific Small size, Normal size, Large size. The small size signs are of 600 mm size. Normal signs are 900 mm size and large signs are of the 1200 mm size. The size refers to the diameter of the circular signs. It can refer to the height of octagonal sign. And it can also refer to the side of triangular sign. The specified font sizes of lettering on small, normal, large signs are 100, 150, 225 mm respectively. The small signs are normally installed on minor roads. Especially when the design speed is less than 60 kmph. The ordinary signs are introduced on imperative urban roads where the design speeds are in the range of 60 to 100 kmph. The large signs are installed on expressways and on urban roads where the design speeds goes beyond 100 kmph.

### **3.1.3 Placement of the signs**

The signs should be set with the end goal that they could be seen and perceived effectively. It should be seen by the road users going travelling at the design speed. The transverse area of the signs should be at least 0.6 meter far from the edge of the kerb. On streets without kerbs the closest edge might be 2.0 to 3.0 meter from the edge of carriageway. The signs ought to be painted with 250 mm black and white bands. The shape, size, color code and symbols used and the location of the signs should be as specified by the IRC. The reverse side of all the sign plates should be painted grey. The warning signs should be located on non-urban roads at the following distances in advance:

- Rural roads: In rolling and plain terrains 90 m and 45 m in hilly terrain.
- Major district roads: In rolling and plain terrains 120 m and 60 m in hilly terrain.
- National and state highways: In rolling and plain terrains 150 m and 75 m in hilly terrain.
- Expressways: In rolling and plain terrains 200 m and 100 m in hilly terrain.



Figure 3.1 Mandatory signs<sup>[4]</sup>



Figure 3.2 Cautionary signs<sup>[4]</sup>



Parking

Figure 3.3 Informatory signs<sup>[4]</sup>

## CHAPTER-4

### WIDENING OF HILL ROAD

The road stretch selected for our project (“Widening and Renovation of Hill Road”) falls under village road category in hilly area, which is 0.5 km (Waknaghat-Gamberpul road) starting from Peepal Tree near Jaypee University towards Domehar Village. Construction of this road was started on Gandhi Jayanti i.e. 2<sup>nd</sup>October, 1962. This was completed on 31<sup>st</sup> March, 1963, when the area was under Punjab.

#### 4.1PROCEDURE:

- Reference point taken in project is “Jaypee Thank You Gate”, reduced level (R.L.) = 600m (assumed).
- Reduced Distance (R.D.) taken is 0/550 to 1/060 (K m/m).
- Station orientation is done by entering the coordinates i.e. N=0, E=0, Z=0 at ref. point.
- North angle is oriented and set to 0°.
- With the help of N, E with respect to reference point, plan is drawn.
- With Reduced Level (R.L.) of different points, longitudinal and cross-sections are drawn.

#### 4.1.1 READINGS:

R.D.(Km/m)	Northing(N)	Easting(E)	Elevation(Z)	R.L.(metre)	Remarks
0/550	-105.37	-345.62	-31.57	568.43	
0/565	-92.90	-348.81	-32.30	567.70	
0/580	-127.63	-361.12	-33.59	566.41	
0/595	-138.45	-371.25	-34.83	565.20	
0/610	-150.12	-380.01	-36.00	564.00	
0/625	-162.03	-388.82	-37.20	562.80	
0/640	-173.53	-398.78	-38.30	561.70	
-	-191.25	-420.61	-40.00	560.00	C.P.
0/655	-183.86	-409.96	-39.30	560.70	
0/670	-193.23	-425.14	-40.56	559.40	
0/685	-199.14	-439.10	-41.30	558.70	
0/700	-201.06	-454.44	-42.10	557.90	

0/715	-200.20	-474.20	-43.30	556.70	
0/730	-197.50	-484.50	-43.50	556.50	
-	-176.92	-496.47	-44.73	555.27	C.P.
0/745	-185.34	-494.65	-44.55	555.45	
0/760	-176.32	-505.32	-45.55	554.45	
0/775	-173.70	-509.23	-46.20	553.80	
0/790	-169.62	-534.56	-46.60	553.40	C.P.
0/805	-156.61	-543.50	-47.50	552.50	
0/820	-144.10	-551.20	-48.60	551.40	
-	-133.38	-553.50	-48.80	551.20	C.P.
0/835	-133.46	-561.11	-49.60	550.40	
0/850	-123.98	-572.70	-50.40	549.60	
0/865	-114.22	-583.85	-51.20	548.80	
0/880	-104.60	-595.60	-51.70	548.30	
0/895	-91.10	-603.00	-52.80	547.20	
0/910	-80.30	-611.80	-53.30	546.70	C.P.
0/925	-71.5	-623.24	-53.80	546.20	
0/940	-63.34	-635.72	-54.48	545.52	
0/955	-58.59	-648.80	-55.20	544.80	
-	-53.20	-653.90	-55.40	544.60	C.P.
0/970	-56.70	-662.80	-55.80	544.20	
0/985	-57.80	-677.60	-56.60	543.40	
1/000	-58.80	-691.80	-56.90	543.10	
1/015	-58.90	-701.50	-57.30	542.70	
1/030	-60.00	-713.50	-58.00	542.00	
1/045	-61.00	-726.00	-58.70	541.30	
1/060	-62.50	-738.50	-59.60	540.40	

Table 4.1 Survey Readings

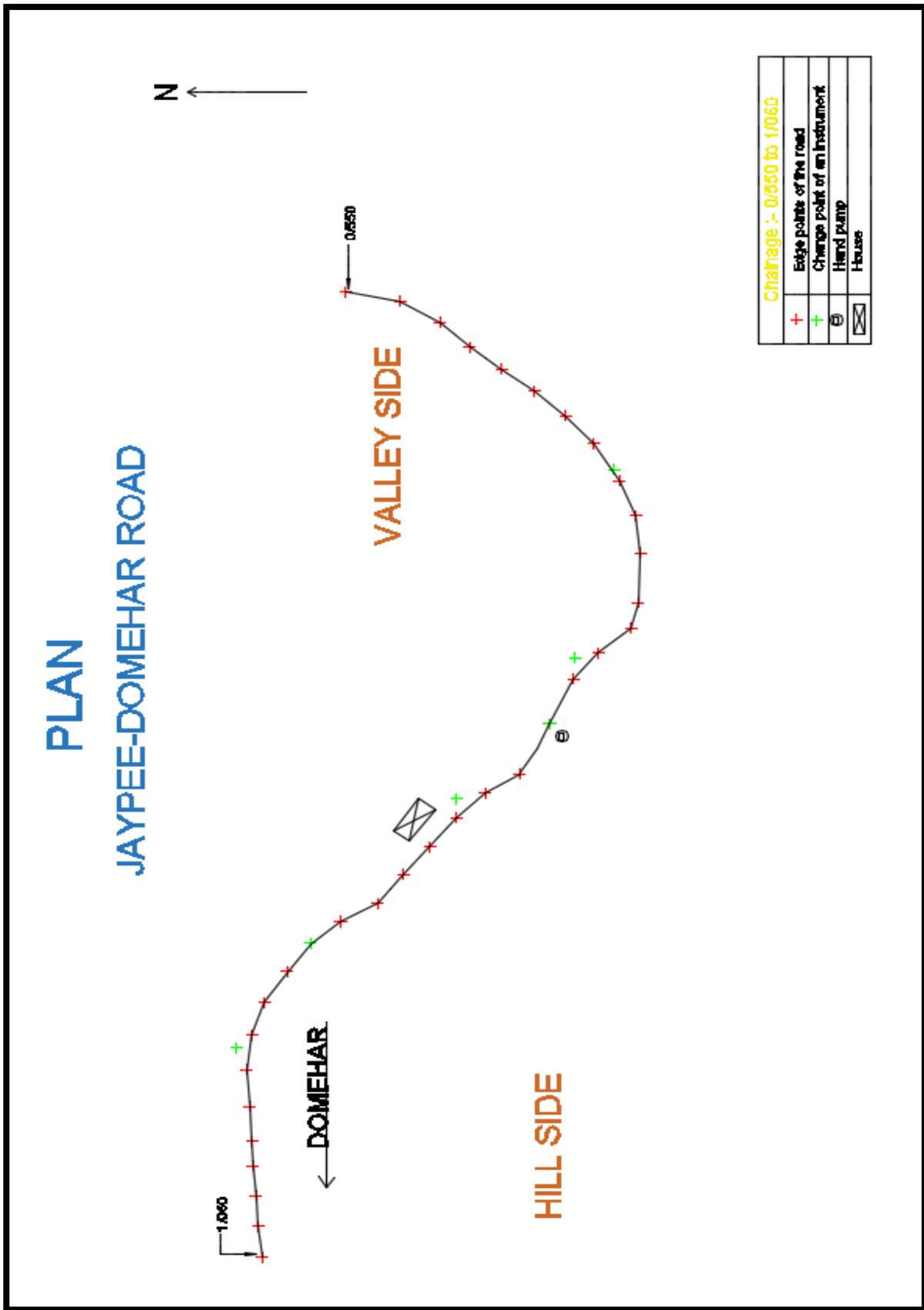


Figure 4.1 Plan of hill road

## 4.2 EARTHWORK CALCULATIONS:

R.D.(Km/m)	X-section(m <sup>2</sup> )	Length(m)	Quantity(m <sup>3</sup> )	P.W.
0/550	43.10	15	646.50	100%
0/565	42.55	15	638.25	100%
0/580	32.30	15	484.50	100%
0/595	37.20	15	558.00	100%
0/610	29.10	15	436.50	100%
0/625	30.30	15	454.50	100%
0/640	58.72	15	880.80	100%
0/655	8.50	15	127.50	100%
0/670	7.15	15	107.25	100%
0/685	15.90	15	238.50	100%
0/700	7.40	15	111.00	100%
0/715	16.80	15	252.00	100%
0/730	10.85	15	162.75	100%
0/745	24.10	15	361.50	100%
0/760	28.11	15	421.65	100%
0/775	24.35	15	365.25	100%
0/790	23.00	15	345.00	100%
0/805	17.84	15	267.60	100%
0/820	23.56	15	353.40	100%
0/835	39.71	15	595.65	100%
0/850	15.70	15	235.50	100%
0/865	13.30	15	199.50	100%
0/880	19.01	15	285.15	100%
0/895	25.60	15	384.00	100%
0/910	22.50	15	337.50	100%
0/925	35.10	15	526.50	100%
0/940	34.67	15	520.05	100%
0/955	44.40	15	666.00	100%
0/970	52.00	15	780.00	100%
0/985	31.00	15	465.00	100%
1/000	28.83	15	432.45	100%
1/015	30.14	15	452.10	100%
1/030	36.20	15	543.00	100%
1/045	35.96	15	539.40	100%
1/060	40.00	15	600.00	100%

Table 4.2 Earthwork Calculations

Total Quantity to be excavated =14774.25 m<sup>3</sup>.

#### 4.2.1 COST ESTIMATION OF EXCAVATION :

(No filling is done on valley side)

Unit =m<sup>3</sup>

Total output=14774.25 m<sup>3</sup>

Description of item	Unit	Qty	Rate(Rs)	Amount(Rs)
a.)Machiny: Hydraulic Excavator 0.9 m <sup>3</sup> bucket capacity @ 40 m <sup>3</sup> per hour	Hour	14774.25/40=369.4	1500/hr	554100
Dumper 20 m <sup>3</sup> bucket capacity @ 40 m <sup>3</sup> per hour.	Hour	14774.25/40=369.4	300/hr	110820
b)Labour: Mate(@ 2 person)	Day	2	200/day	800
Mazdoor(@ 4 person)	Day	16	200/day	12800
c)Contractor Profit @ 10%				0.1(a+b)
<b>Total=(a+b+c)</b>				<b>746372</b>

Table 4.3 Cost estimation for excavation without filling

#### 4.2.2 COST ESTIMATION FOR EXCAVATION USING SOFTWARE: (Cut-Fill method is adopted)

Cut and fill is done by InfraWorks 360. We put our start and end point in software and it gave us amount of cut which will going to take place for constructing two lane road with more perfection and side by side it fills the soil from hill side to the valley side. The software kept the safe cut slope 2:1 in both side. As soil is more of cohesion no retaining wall is required.

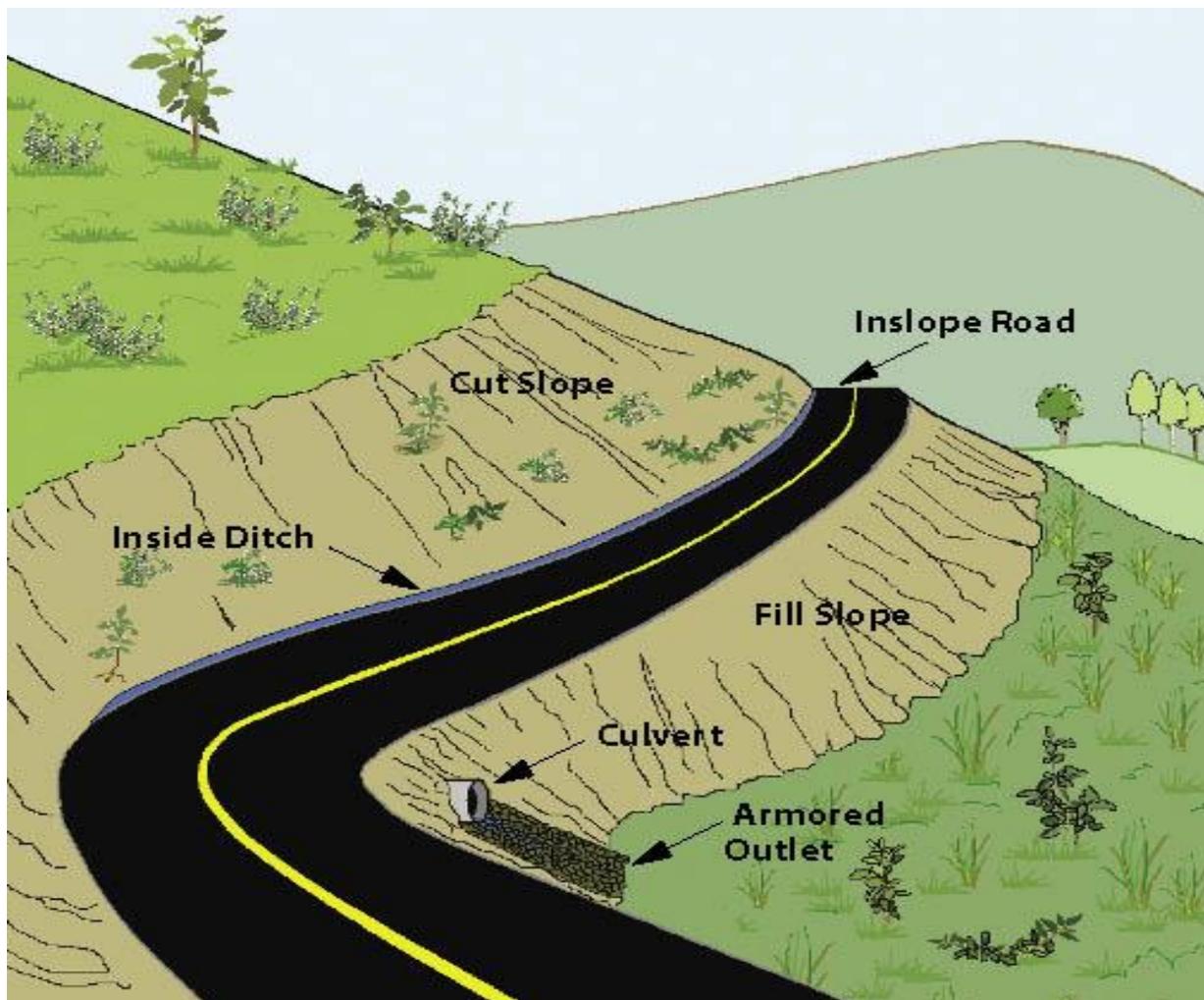


Figure 4.2 Animated view of Waknaghat-Gamberpul road <sup>[5]</sup>

Unit = m<sup>3</sup>

Total output = 6720.11m<sup>3</sup>

Description of item	Unit	Qty	Rate(Rs)	Amount(Rs)
a.)Machinery: Hydraulic Excavator 0.9 m <sup>3</sup> bucket capacity @ 40 m <sup>3</sup> per hour	Hour	6720.11/40=168	1500/hr	252000
Dumper 20 m <sup>3</sup> bucket capacity @ 40 m <sup>3</sup> per hour.	Hour	6720.11/40=168	300/hr	50400
b)Labour: Mate(@ 2 person)	Day	2	200/day	800
Mazdoor(@ 4 person)	Day	16	200/day	12800
c)Contractor Profit @ 10%				0.1(a+b)
<b>Total=(a+b+c)</b>				<b>347600</b>

Table 4.4 Cost estimation for excavation with filling

### 4.3 COST ESTIMATION FOR PAVEMENT:

Description of item	Unit	Qty	Rate(Rs)	Amount(Rs)
a.)Machinery: Bitumen boiler oil fired 1 m <sup>3</sup> @ 2 m <sup>3</sup> /hour	Hour	$(1.05*30*7)/(2)=110.25$	1133/hr	124913.25
b)Labor: Bitumen Sprayer (2 person)	Day	$110.25/8=14$	170/day	4760
Driver (2 person)	Day	$110.25/8=14$	225/day	6300
c)Material Well graded Gravel/soil base material of maximum size 10 mm	Cum	1102.5	839/cum	924997.5
Aggregate – Grading 2. 5 mm and below for binder course	Cum	441	873/cum	384993
Stone crushed aggregate 11.2 mm to 0.09 mm for surface course and base course	Cum	$2*110.25 = 220.5$	935/cum	206167.5
<b>Total=(a+b+c)</b>				<b>1652131</b>

Table 4.5 Cost estimation for pavement

Thickness of surface course = 30mm

Thickness of binder course = 60mm

Thickness of base course = 150mm

Thickness of compacted sub grade = 150mm

## CONCLUSION

We have conducted a detailed examination on existing road stretch , which is 0.5 km (Waknaghat-Gamberpul road) starting from Peepal Tree near Jaypee University towards Domehar Village. On existing road stretch after finishing the physical examination, programming investigation and configuration (InfraWorks 360). With the visual inspection and geometric calculations we have found problems like there was no road signs on our selected stretch which may cause severe accidents. There was no railing at the valley side which can also cause a major loss of life. Drainage lines were full of trash and short sight distances were violating at some points. We have found solutions to all these problems. It is essential to upgrade the drainage lines, because the existing drainage lines are blocked by debris and trash. For this we have designed some culverts at desirable places where it is required. It is important to give some important road signs like speed limit, right and left bend and so forth as indicated by the request of the stretch. Providing guardrails on valley side of the road, so to minimize the severe accidents. We have corrected the short sight distances by installing speed limit sign because it was harder and was uneconomical to change the trajectory of road. Longitudinal gradient is also violating at a point we have changed it according to the IRC and brought it to the limit of rural road.

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