

Geometric Design Of Flexible Pavement Using Openroad Designer Software

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Abstract

Geometric design plays a major role in every road and it is influential in the road alignment. The design of route alignment and pavement structure decide cost of project which totally depend on time taken. The geometric design manages the dimensions and layout of visible features of the road such as alignment, sight distance, cross-section and intersections. When geometric design is performed manually, it is very cumbersome, time-consuming and highly susceptible to very costly errors. In this present study OPEN ROAD software is used for proposed road alignment State Highway No.222 originates from Omalur in Salem district. , Project Stretch Starts near Omalur at its junction with SH-86 (Km.1.600 of SH-86) and terminates at Km.14.600 near Mecheri at its junction with NH-544H.The design methods include Road inventory survey, Traffic analysis, Geometric section is analysis by OPEN Road Software.

Keywords: *OPEN ROAD software, Geometric design, Horizontal alignment, Vertical alignment, Cross section*

1. Introduction

Transportation Engineering is the application of technology and scientific principles to the planning functional design operation and management of facilities for any load of transportation to provide safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible moment of people[1].

The geometric design of roads is the main part of highways anxious with the positioning of the physical elements of the roadway according to standards and constraints. The main parts of the geometric design of roadway are: alignment, profile, and cross-section. Thus by merging these will give three-dimensional layout of roadway. If geometric design elements is not proper then it leads to frequent traffic clashes and pose hazards to road users and induce cost overturn, delays, etc. The main point in this geometric designing of highway to accommodate optimum efficiency in the traffic and utmost safety at fair cost [2].

About OpenRoad

The OpenRoads are of three types namely OpenRoads Conceptstation, OpenRoads Designer and OpenRoads Navigator. Now we discuss about OpenRoads designer.

OpenRoads Designer CONNECT Edition, the replacement to Bentley's industry driving civil engineering brands Inroads, GEOPAK, MX Roads, and Power Civil, is a genuinely inventive design application, worked to address the requests of the present developing foundation industry. By mixing conventional engineering work processes for plan, profile, and cross-sections with 3D parametric modeling, Open Roads Designer empowers the model-driven making of all your structure expectations. This application gives total definite roadway configuration including study, geotechnical, seepage, subsurface utilities, corridor modeling, analysis, and measurement. It is a thorough, multi-discipline 3D displaying application that propels the conveyance of roadway ventures from conceptual design through development. OpenRoads Designer gives the most recent innovation and instruments you have to efficiently design, model, and produce venture expectations in a dynamic, intelligent, and parametrically empowered condition. Open

Roads is a transportation, civil analysis and design software, designed to enable the project delivery of road networks through construction-driven engineering and deliver all the information needed to support operational workflows.

Study Area Location

Project road is a section of SH-222 which lies in the State of Tamil Nadu. State Highway No.222 originates from Omalur in Salem district. , Project Stretch Starts near Omalur at its junction with SH-86 (Km.1.600 of SH-86) and terminates at Km.14.600 near Mecheri at its junction with NH-544H. Terrain of this project section can be predominantly termed as plain terrain. Land use pattern along the project road is generally built-up and Agricultural land.

2. Methodology



Figure 1. Flow Chart

3. Selection of study area

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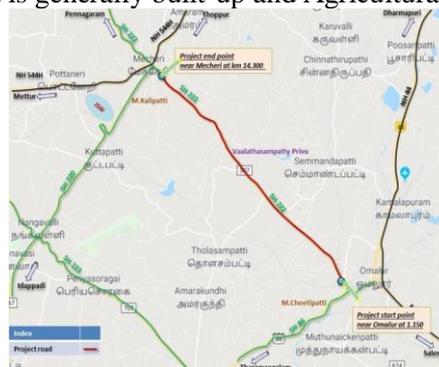


Figure 2. Study area

4. Literature Review

Ms. K. A. Kamthe, Ms. D. M. Chavan;(april 2018): Design of roadway using OpenRoads software

In this paper they mainly focused on the designing of roads using the software called OpenRoad Designer. This is the recent technology which is used for the geometric design of highways. The literature study from this paper is mainly about the comparison of designing of highways with conventional method and OpenRoad software method. In OpenRoad the geometric design can be

done in a simple manner and this software gives accurate results and the designing of can be done in both 2D and 3D view.

Neeraj and Mr.S.S Kazal;(july 2015): The paper deals with the objective and factors to be considered for geometric design of highway followed by the features such as highway cross section element, sight distance, horizontal alignment and vertical alignment on which the geometric design of highways is based. This paper mainly emphasizes on the importance of planning and designing of the highway. In this paper the author explained about the consideration of the future increase of the traffic and the road design speed is selected in the earlier stage only then it will be easy for designing the geometric elements of highway later it will be hard to design and it leads to increase the cost of the construction.

Karim Ismail, Tarek Sayed;(march 2012): Risk-Optimal highway design: Methodology and case studies. This paper explains about the risk of design of highway in hilly regions. In this the author explaining the problems they are facing in the highway of having short curves and restricted right of way by this design there is possible of collisions. For reducing the frequency of collisions they came with the new geometric design of highway by improving the right of way and in this paper they explained about the designer facing problems with the budget constraints for improvement of geometric design. For geometric design guidelines they followed the AASHTO for design requirements.

5. Objectives

The main objectives is

- The main objectives is To conduct Road inventory survey and collect alignment features.
- To conduct various Traffic survey on selected section of alignment.
- Analyse the Selected section by Open Road software.
- Elove geometric features for the alignment such as horizontal alignment and vertical alignment.
- Creating corridors and templates.
- To provide cross section using the software.
- To create plan and profiles.

6. Data Collection

Collecting the data is very important for developing any roadway. For this various surveys should be done to get the existing ground profile data and this data is used to upgrade the geometric design of that road section. The information is gathered from the survey company. Survey data includes easting, northing, and elevations.

6.1. Traffic Study

Traffic surveys were conducted to establish traffic and their loading along the project corridor at present and in future, which in turn will important input for pavement design. Classified Traffic Volume Count survey was conducted at one location. The survey was conducted for 7 consecutive days for 24 hours. The traffic growth rates are adopted for 20 years as per IRC: 108-1996. However, as per IRC:37, if the growth rate is less than 5 %, a minimum value of 5% shall be adopted. Traffic survey is done between Omalur to Mecheri at location Kamaneri.

Table 1. Traffic Figures

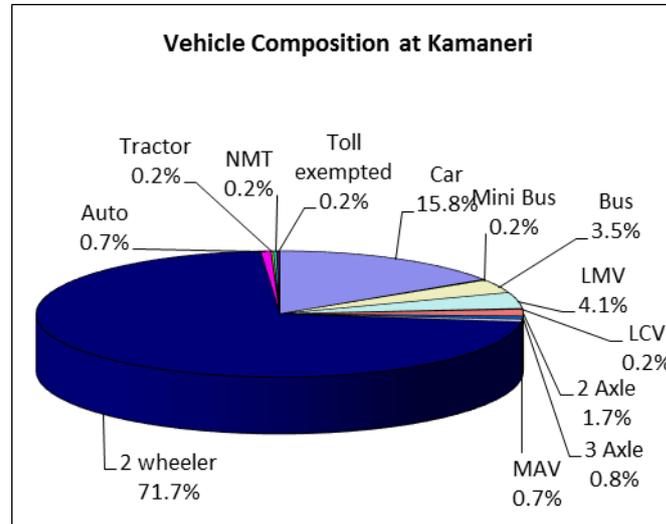


Figure 3. Vehicle composition

6.2. Computation of Design Traffic

Location	ADT		AADT	
	Nos.	PCUs	Nos.	PCUs
Kamaneri (SH 222)	16567	13118	16730	13503

For flexible pavement design The following design parameters are considered . By assuming 20 years as the design period . The MSA obtained for 20years is about 15MSA, for the flexible pavement design The following equations are used .

$$N = \frac{365 \times [(1+r)^n - 1]}{r} \times ADF$$

Where,

N = The cumulative number of standard axles to be catered for in the design in MSA

A = Initial traffic in the year of completion of construction in CVPD.

D = Lane distribution factor.

F = Vehicle damage factor. n = design life in years.

r = Annual growth rate of commercial vehicles.

$$A = P (1 + r)^x$$

Where,

P = Number of commercial vehicles as per last count.

x = Number of years between the last count and the year of completion of construction.

6.3. Pavement Thickness Design

Pavement design in the first stage, thickness pavement structure were determined in accordance with IRC 37-2012 using catalogues design and the following option of thickness pavement design combination was studied. With initial pavement design option

pavement thicknesses as per design catalogues are presented in table for period of 20 years for design life, design traffic of 15MSA and design CBR value of sub grade is 10.

Table 2. Pavement layers and thickness

PAVEMENT LAYERS	LAYER THICKNESS in mm
BC	40
DBM	90
WMM	250
GSB	200
Total	580

6.4. Topographical Survey Data

The Topographic surveys are carried out to find the accurate existing profile condition of land and the data is recorded and that land is about to under go some type of construction. Roadway Designer use a topo survey as the begining surface of their design and then they plan what the final surface proposed will be like. Having the original surface helps designers to calculate the earthwork that might be needed to bring the site to final level.

The important input required for the modelling of roadway in Open Road software is the ground surface data. The survey information of the proposed alignment data was collected from the Consultancy office. The recorded topo survey coordinates is transferred to the Excel sheet and from the excel sheet the points are imported to the Auto CAD to generate the existing profile of the ground. Topo survey data in Excel sheet.

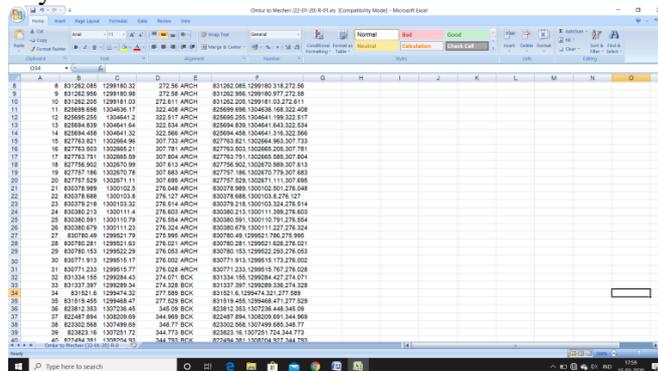


Figure 4. Topo survey coordinates in Excel format

Proposed Lane Configuration

From Capacity Augmentation, Project road is proposed for four lane divided carriageway.

Table 3. Proposed Lane Configuration

Chainage		Length, km
From	To	
1+150	14+320	13.170

Design Criteria

As per the IRC specification and existing features, the following design criteria were considered for modeling the alignment in Open Road software:

60m

As per the IRC specification and existing features, the following design criteria were considered for modeling the alignment in Open Road software:

- i. Design Speed = 100kmph
- ii. Cross Sectional Elements
 - (a) Road Margins
 - Right of way (RoW) = 60m to 45m
 - The Setback distance between building line and road boundary is = 3m to 5m
 - (b) Roadway width for four lane divided = 14.0m
 - (c) Cross Section Details of road way
 - Width of Carriageway = 7.0m (each direction)
 - Width of Paved Shoulder = 1.5m
 - Width of median = 1.5m
 - (d) Cross Slope/Camber
 - Bituminous Surface = 2.5%
- iii. Sight Distance
 - Stopping Sight Distance = 180m
 - Intermediate Sight Distance = 410m
 - Overtaking Sight Distance = 720m
- iv. Horizontal Alignment Design
 - (a) Super Elevation = Max. 9%
 - (b) Radius of Horizontal Curve
 - Ruling Minimum Radius = 360m
 - Absolute Minimum Radius = 230m
- V. Vertical Alignment Design
 - (a) Gradient for Plain Terrain
 - Ruling Gradient = 3.3%
 - Limiting Gradient = 5%
 - (b) Minimum Gradient for drains = 0.2% to 0.5%
 - (c) Minimum Length of Vertical Curve for design speed of 100 kmph = 60m

5. Design Procedure adopted in Open Road designer

- Topo survey data importing to Open Road designer software
- Display Counters/ Triangles/ Boundary in Open Road
- Horizontal alignment design
- Vertical alignment design
- Creating corridors and templates
- Creating cross sections
- Giving super elevation
- Creating plan and profile

Topo survey data import to Open road :

The Existing Ground profile Data is imported in AutoCAD in the form of dwg file format and the open road software is in DGN format. For that the Auto CAD file should be converted to DGN file format and then import the file to open road. 5km stretch is selected from the Road project stretch for modeling in the Open Road software using the AutoCAD tools. And Only main points and important features were considered and the below figure shows the imported file in open road software.

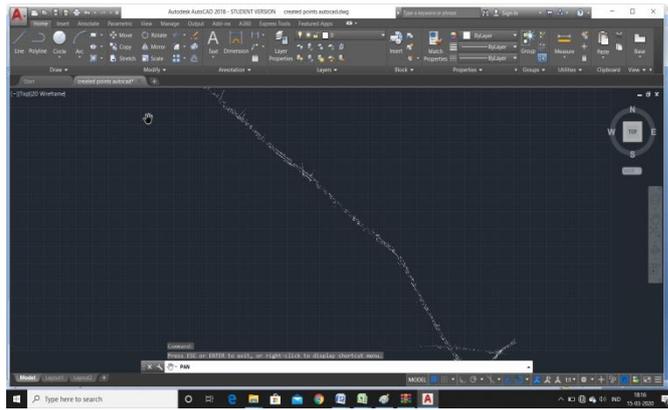


Figure 5. Toposurvey data imported to Auto CAD

5.1 Horizontal alignment

The horizontal alignment design starts with by creating new file and giving the model name in which horizontal alignment is to be placed. For this surface checked model string is named as DESIGN for example and this string model is selected for placing the alignment. The horizontal alignment design is done as per IRC: 38-1988 the transition curve specifications.

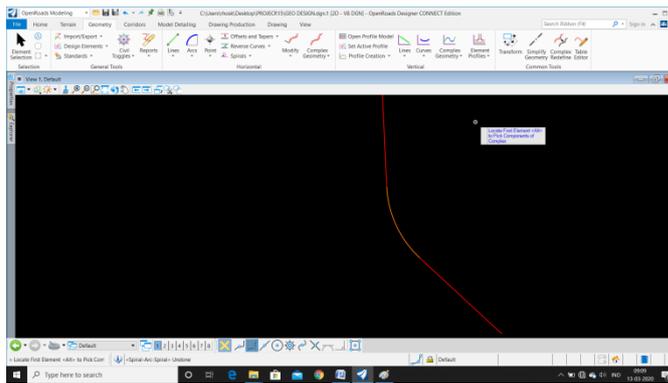


Figure 6. horizontal alignment design using arcs

5.1 Vertical Alignment design

The vertical alignment consists of grades or tangents connected by vertical curves. By doing vertical design we can to know the amount of earthwork to reduce to satisfy the constraints and grades.

The design of vertical alignment starts after the horizontal alignment design is completed. Then identify clearly on which the vertical design is to be carried out. Then the vertical alignment tool is used to generate the vertical alignment.

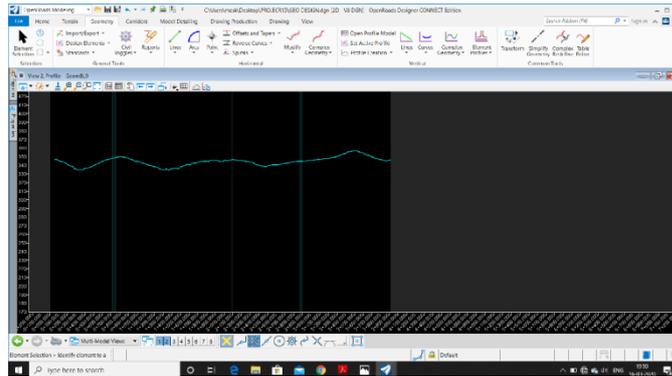


Figure 6. Vertical profile model view

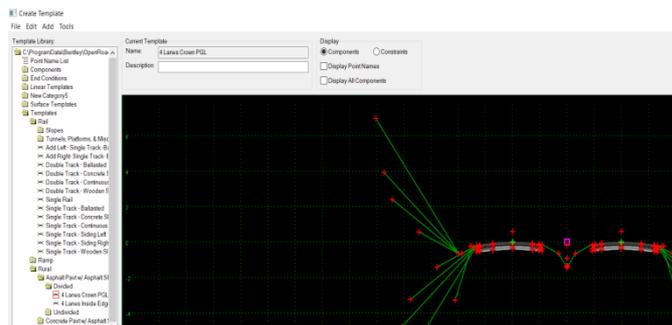


Figure 7. created sample

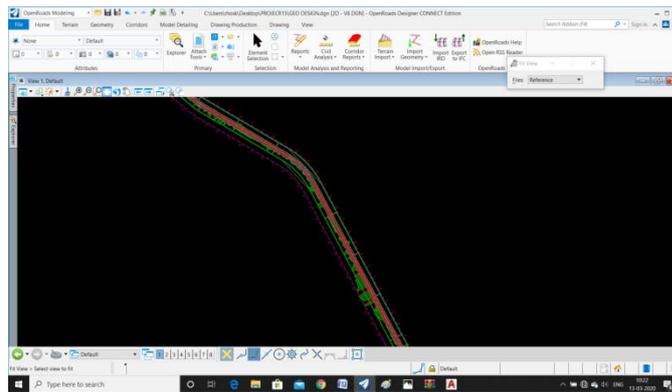


Figure 7. Corridor objects created in 2D view

7. Conclusions

For the projected traffic for 20 years design period, and CBR of 10%, the Flexible Pavement is designed as per IRC: 37-2012.

As per IRC standards, the ruling design speed suggested for State Highways in India with plain terrain is 100 kmph. And thus for this project under the prevailing conditions, the speed is maintained as 100kmph throughout the design.

The proposed alignment is designed to match the existing alignment at almost all locations.

A pavement crust thickness of 590mm is calculated as per IRC-37: 2012 and applied.

The Horizontal and Vertical Alignment was designed in OpenRoads Designer to achieve design precision and save time than being done manually.

Acknowledgments

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