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GEOMETRIC DESIGN OF A HIGHWAY USING MXROAD

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Abstract

Geometric design concerns the design of road alignment that conforms to the site constraints and standards. The basic objectives are to optimize efficiency and safety while minimizing cost and environmental damage. Once a road/highway engineer is familiar with the basics of road geometric design, the next step to enhance their value is by learning a software for the application of these basic knowledge. The intention of this study is import road geometric design into the software as well as relate with the design standards applied into the software. It will be able to design road geometric from checking of survey data, horizontal and vertical design, super-elevation and production of road cross sections. Bentley MXROAD is an advanced,string-based modeling tool that enables the rapid and accurate design of all road types. With MXROAD, you can quickly create design alternatives to build the ideal road system. After a final design alternative is selected, you can automate much of the design detailing process, saving time and money. At its core,MXROADuses 3D string modeling technology.A powerful yet concise method of creating 3D surfaces. The interoperable database allows engineers to create and annotate 3D project models in the most popular AEC platforms or in Windows. This means that you can work on the project within one environment, save it, and open it seamlessly in another environment with no loss of data.

***Keywords*:-Geometric design, road alignment, design standards, MXROAD software**

1. INTRODUCTION

Transportation plays an enormous role in our everyday lives. Each of us travels somewhere almost every day, whether it is to get to work or school, to go shopping, or for entertainment purposes. In addition, almost everything we consume or use has been transported from some point. There are so many ways of transportation, but in this document we concern on road transportation. Highways are the important part of our life, the economy of the society as well as it is Part of the infrastructure. The construction of a high quality road network directly increases a nation's economic output by reducing journey times and costs, making a region more attractive economically. The better of this structure is the faster, more effective and cheaper, can be the capacities of the society used.The development of effective road transport system is primary need of any developing country. Also upgrading of existing road network is essential for developed countries to carry out its transportation functions smoothly as with increasing traffic volume urban and non-urban roads reach to their saturation level in passage of time. The design of route alignment and pavement structure decide cost of project which totally depend on time taken for same. So for this job the best available Highway Geometric Design Software must be deployed. Keeping this in view we have used MXROAD Software for the geometric design to improve its geometric features and upgrading it from two lanes to four lanes. The Software uses 3D string modeling technology and gives the desired values of different components of geometric design such as Horizontal and Vertical Curves, Super elevation, Shoulder, etc.***Hong Sung-Jon, 2005***discussed is to evaluate the actual highway geometric design properly, and propose a well-balanced design policy especially considering the drivers perception and behavior. ***Blessing Alexander, 2009***have investigated the suitability of these modalities for road design, which makes heavy use of two dimensional visual representations.***Liao-Chen-Fu, 2014*** He has discussed the use of the highway geometric design package ROAD. The online tool helps students better understand the different aspects of geometric design as compared to the traditional approach. The objective of incorporating ROAD into the teaching of geometric design is not to reduce or ignore the importance of the underlying equations, ***Kumar Ashok, 2015***gave geometric design of existing road using MXROAD Software. Existing road used was state highway (SH 131) in Maharashtra to improve its geometric features and upgrading it from two lanes to four lanes. The Software uses 3D string

modeling technology and gives the desired values of different components of geometric design such as Horizontal and Vertical Curves, Super elevation, Shoulder, etc

2. MX ROAD SOFTWARE

MXROAD has been created by Bentley Systems, a UK based company in the year of 1996 which is then upgraded in later years as per requirement to get desired accuracy with rapid designing of highways. This is an advanced string based modeling tool that enables the rapid and accurate design of all types of road. By using MXROAD, highway designer can finalize design alternatives and can automate much of the design detailing processes, saving time and money. At its core MXROAD uses 3D stringmodeling technology a powerful yet simple method of creating 3D surfaces. The interoperable database allows engineers to create and annotate 3D project models in the most popular AEC platforms or in windows. In recent, highway projects in India are Public Private Partnership based where private investors are challenged to maintain high standards in design and construction. This scenario leads the design engineers to use specially designed software tools like MXROAD. It attains high precision in building the road with in the limited land width so as to minimize the land acquisition cost which is vital parameter that affects the total project cost directly. It also helps in fixing the horizontal alignment for an up gradation project to match up with the existing align of the cross drainage structure and in fixing the vertical profile to match up with the existing levels of the cross drainage structures. Various geometric design elements such as carriageways, shoulder can be designed effectively by using MXROAD. Other design controlling parameters such as design speed, horizontal curvature, super elevation and vertical curvature can also be effectively designed and controlled by MXROAD software.

3. RESEARCH METHODOLOGY

Step1: Case Study:A case study of a state highway is considered as shown in Figure 1. Degloor is situated near where the Telangana, Maharashtra and Karnataka boundaries meet lies in Coordinates: 18°32′52″N 77°34′38″E .The Telangana-Maharashtra state boundary is around 1.5 kilometersaway from the town center. The town borders several villages, including Taakli (North), Kawalgaon (West-South) and Mirzapur (East-South).With existing 2lane width of 7m is upgraded to 4lane width of 15m.

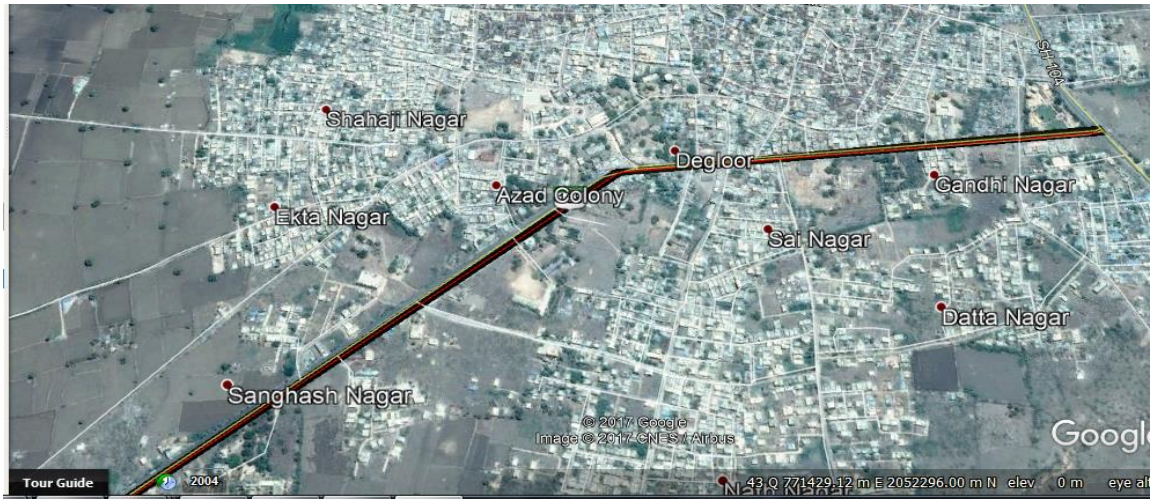

Figure1 Study Area

In order to carry out this research a different method is used for both Geometric and Pavement Design of highway. For Geometric Design of Highway MX ROAD software is used. In Geometric Design of Highway the following procedures are taken: - First the surveying data is collected from the field through the route. For each point three reading is taken that is Northing, Easting and Elevation. So depending on collected surveying data the traverse slope within 20m interval, vertical increment to horizontal increment is calculated by excel. The research process designed for the study is: site selection, problem identification, review literature, road geometric survey and design of road alignment using MXROAD.

Step 2: Data Collection: Topography survey for 8 km(Ch.67.73km-75.72km) at an interval of 10m along the alignment (Longitudinally) and 5m interval up to 20 m across the road on either side (Transverse) Which consist of X Y Z co-ordinates (i.e. Easting, Northing and Reduced Level) is done. Soil sample for every 1km and check the CBR is made. Traffic surveys includes: Traffic volume count , Turning movement survey, Axle load survey, Origin & destination survey, Speed & delay survey, Pedestrian count survey etc were made. Keeping in view the space constraint, data pertaining to traffic studies is not presented.

Step 3: Design Data: By considering all the IRC specification and existing features of project corridor the following design values are taken for executing the design of the project

work by using MXROAD software. Chainage:-67.73KM to 75.72KM, Length 7.990KM, Design Speed - 100 kmph and 30 kmph, Land width or right of way – 30m, Setback – 2 to 5 m., Roadway Width – 15.0 m, Carriageway Width – 7.5 m, Shoulder width – 2.5 m, Cross Slope or Camber– 2.5%, Earthen surface – 3.0%, Embankment slope –1 V : 2 H, Super Elevation – maximum 7% or 0.07, Radius of Horizontal Curve – Ruling Minimum 230 m, Radius at which no super elevation is required - > 1200 m, Radius at which 7% super elevation is achieved – 230 m, Extra Widening of Carriageway at Curves – 0.6 m, Gradient maximum – 3.3 %, Limiting Gradient maximum – 5%, Minimum Gradient – 0.3%, Minimum length of vertical curve – 50 m.

Step4: StandardStringNaming:-

The MX standard string naming convention (SNC) has been formed to give automatic integration to any design produced from any of the MXROAD option. Strings created by the MXROAD option are assigned names which store the following information, string type, associated master alignment which defines the string group, specific road features and side of master alignment on which the string was created.

Step5: Surface Analysis:-

This option is used for analyzing the surface on which the design has to be built.This is essential to confirmthat the imported data is correct and contains no errors. Typically the analys is will high light errors in level and will also provide a graphical representation of the existing surface.

Step 6: AlignmentDesign:-

The alignment design option are used to create the alignment for the road design byc hoosing Quickalignment option, Horizontal Design,Vertical profile can be done in limited time duration.The alignment is converted to amasterstring which is generally use das the Centreline alongwhicha carriage way and other features can be designed. Alignments are created in two stages. Figures 2 to 9 presents the screen shots of various geometric design elements of the road selected for the case study using MxRoad software.

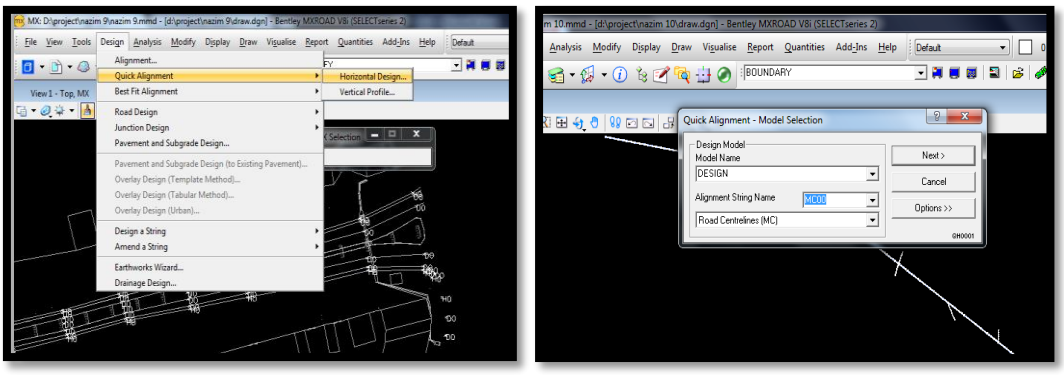

Figure 2 Screen for data input

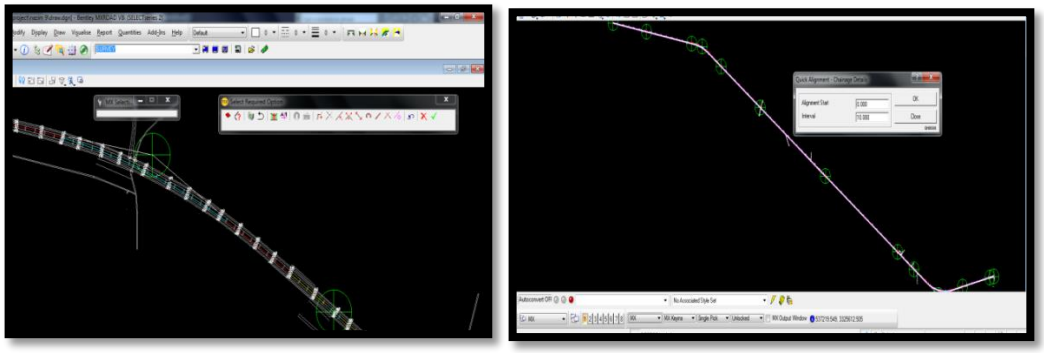

Figure3Horizontal Alignment

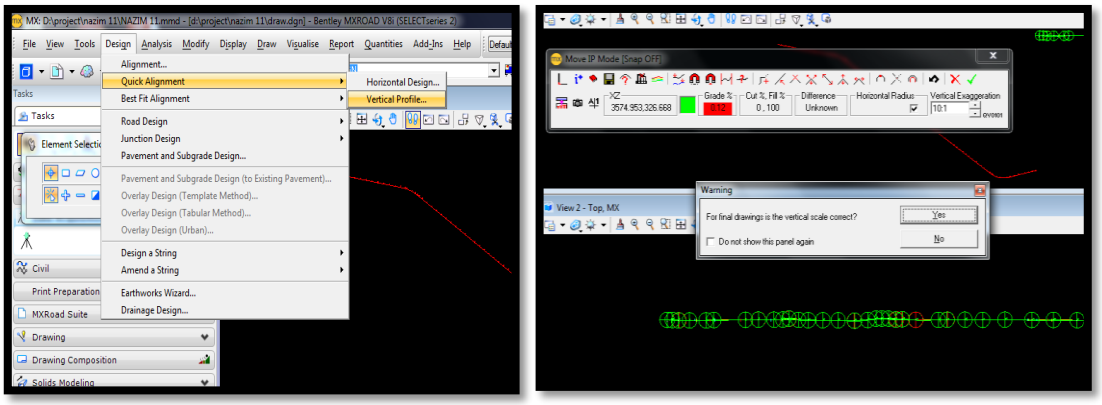

Figure 4Vertical Design

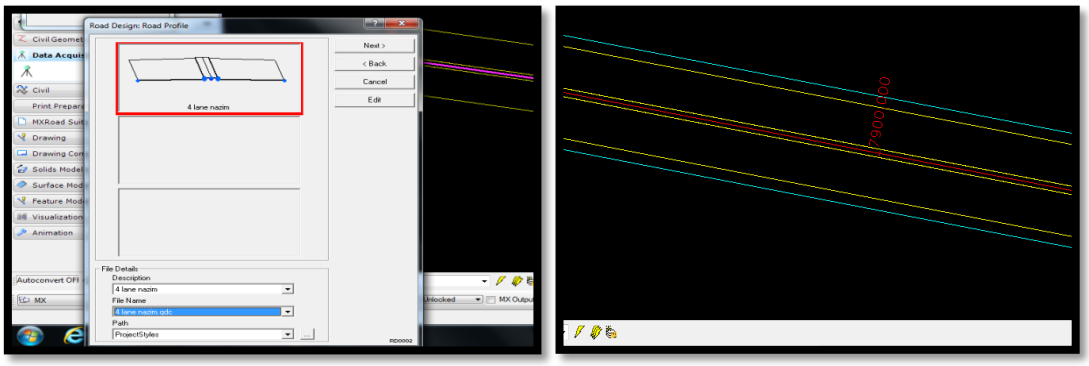

Figure5Carriageway Design

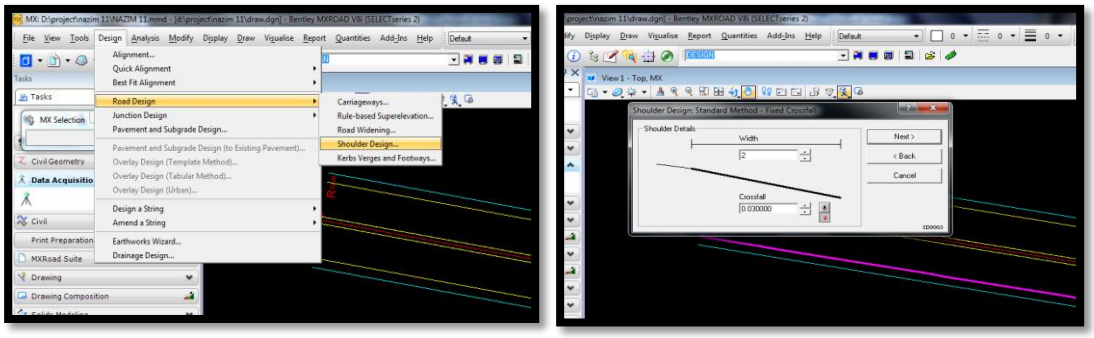

Figure6Shoulder Design

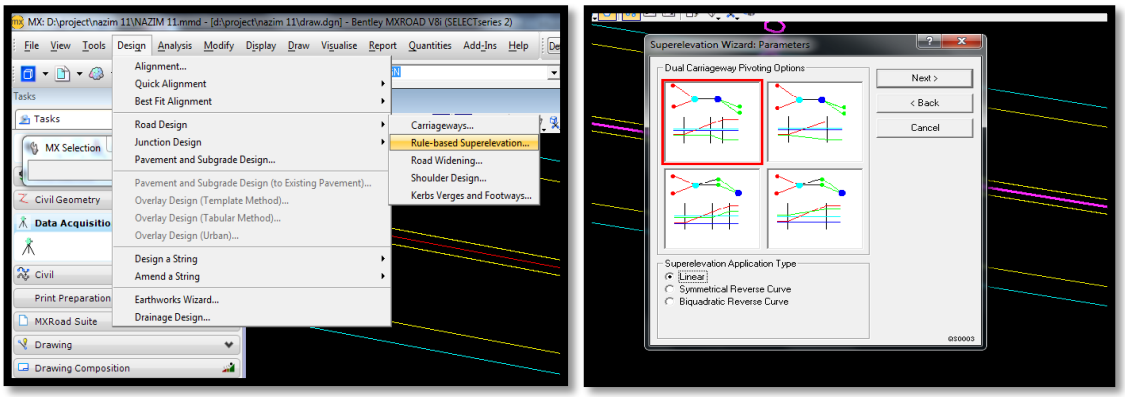

Figure7Super Elevation Design

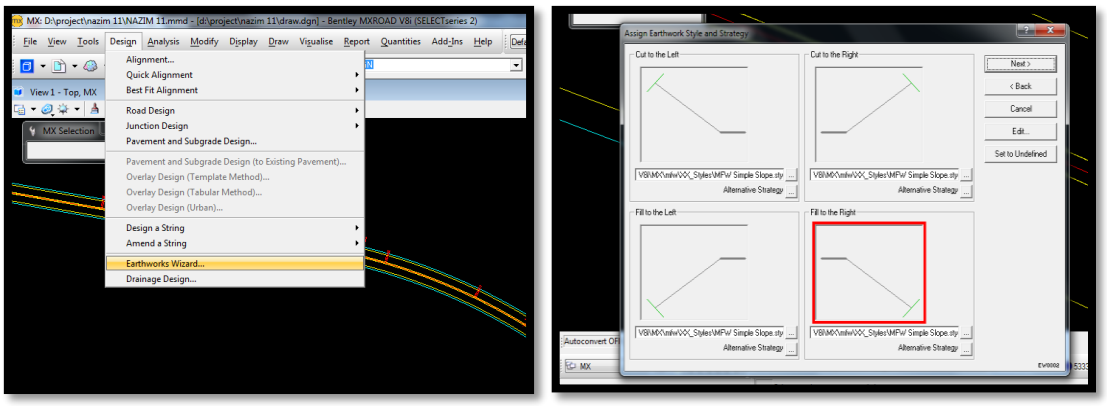

Figure8Earthwork Design

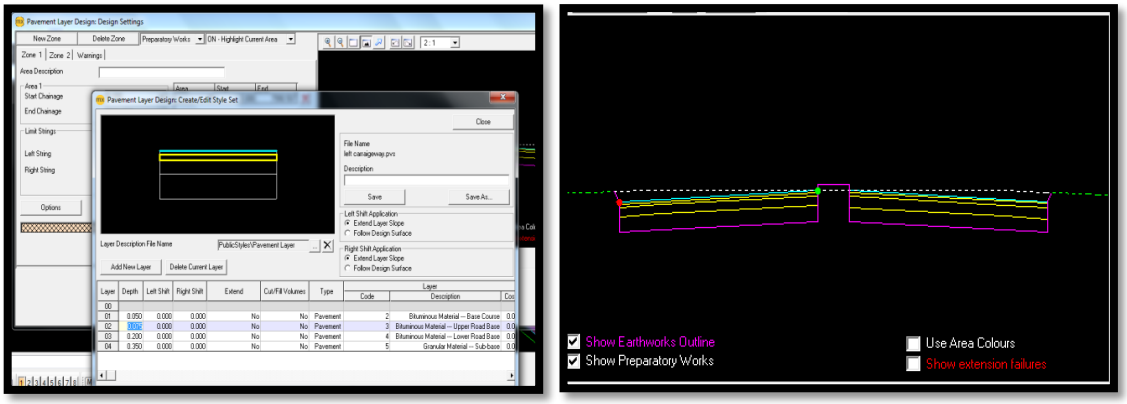

Figure9Pavement and Sub grade Design (Cross-Section)

4. RESULTS AND DISCUSSION

Alignment has designed for 100Kmph.Almost 80% of the existing road is utilized.geometrics of the road has been improvedRoad is designed as per IRC norms and also considered all safety measures.Horizontal plan has been developed.Vertical profile has been drafted.Working cross section are developed.Super Elevation has been calculated and applied. The results of the output of the study using MxRoad software is presented in Table 2.

Table 2 Results

Vertical Alignment Report	Model: DESIGN
String: MC00	Units: Metric
Date : 8/24/2017 1:44:14 AM	
	********Element 1 Grade********
	Gradient .281
Gradient Length 83.374	Begin on Gradient Chainage 0+000.000
Begin on Gradient Level 221.019	Gradient End Chainage 0+083.374
Gradient End Level 221.253	
********Element 2 Vertical Curve********	
Algebraic Difference -.873	
Curve End Gradient -.592	
IP Chainage 0+090.055	
High/Low Chainage 0+087.668	
Curve Length 13.361	
Curve Type Hog	
M Value -6.532	
Curve Start Chainage 0+083.374	

CONCLUSIONS

All the improvements are planned within the proposed right of way.The proposed alignment is designed to match with the existing alignment at major crossdrainage sections.Design speeds are formulated for ruling Design Speed of 100 kmph and minimum design speedof 30 kmph.The proposed alignment encounters minimum horizontal curve radius at two minor junctions,where the speeds are restricted to minimum.Limiting gradient values are adopted for few sections where site restriction prevails.The obtained base traffic volume data has

been projected to a period of 15 years (2017-2032).High design precision and saving in time were achieved by using MXROAD.

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