International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 10 | Oct 2022 www.irjet.net p-ISSN: 2395-0072

COMPARATIVE ANALYSIS OF GEOMETRIC DESIGN OF HIGHWAY USING AUTOCAD CIVIL 3D AND MX ROAD

Prasanna P N[1], Dr. Prakash P.[2], Mr. Suhas R.[3].

[1]Prasanna P N, M. Tech Student, Department of Construction Technology & Management, Dayananda Sagar College of Engineering, Bangalore, Karnataka, India.
[2]Dr. Prakash P., Professor & HOD, Department of Construction Technology & Management, Dayananda Sagar College of Engineering, Bangalore, Karnataka, India.
[3]Mr. Suhas R., Assistant Professor, School of Civil Engineering., REVA University, Bangalore, Karnataka, India.

Abstract - *Roads have a significant social benefit and are essential to development and economic success. For a nation to expand and prosper, roads are essential. As more locations become accessible mainly with roads, social and economic development improves. The three main components of geometric design are cross-section, horizontal alignment, and vertical alignment. Since ancient times, transportation has been an issue. It has also seen a lot of advancements. Highways were constructed to facilitate convenient travel, allowing people to get from one location to another quickly and conveniently.*

The creation of the road alignment, the charting of the alignment profile using bearings or co-ordinates (easting and northing), stations, and elevations of points along the proposed route, the calculation of sight distances, radii of horizontal curves, and lengths of vertical curves, the computation of earthwork quantities, and numerous other studies and calculations are all part of the process of designing roadways. These calculations are made in order to determine the best alignment while meeting design criteria. Geometric design is incredibly laborious, time-consuming, and prone to costly mistakes when done manually. The use of computer software for designing roadway geometry is in demand right now. The software is extremely precise and offer significant time and effort savings. This study uses both AutoCAD Civil 3D and MX ROAD software to present a complete geometric design of a typical roadway. This saves time and money by enabling the 3D visualization of the design.

Keywords: (**AutoCAD Civil 3D, MX ROAD, Horizontal alignment, Vertical profile, Surface analysis, Alignment design**)

1. INTRODUCTION

In the last ten years, India's economy has risen tremendously, and transportation has had a big part in that progress. The road network is the foundation for any developing nation's continuous growth. A model that directs the designer to produce the most efficient design with high precision requirements is required due to the rapid expansion in road infrastructure and the resulting necessity, which in turn results in time, money, and material cost savings. There are several programmes that are utilised for designing highways thanks to the most recent developments in computer technology. Nova Point, Civil 3D, Auto Civil, MXROAD, Eagle Point, and Earth are in the list.

Road geometric design can be split into three basic components: horizontal alignment, vertical alignment and cross section. These components combined together to create a highway's three-dimensional layout.

i. The horizontal alignment of a highway defines its location and orientation in plan-view. Tangents (straight sections), circular curves, and spiral transitions between tangents and curves make up its three geometric components.
ii. The vertical alignment (or roadway profile) is the longitudinal section of the road, comprising such geometric elements as crest and sag curves, and the gradients (straight grade lines) connecting them.
iii. The roadway cross section shows the position and number of vehicle and bicycle lanes and sidewalks along with their cross slopes; shoulders, drainage ditches, etc.

In order to make road geometric design accessible to civil engineering experts working in developing countries, it must be shown how geometrical design may be carried out accurately and quickly. This study compares the geometric design of highways using MX ROAD and AutoCAD Civil 3D.

1.1 AutoCAD Civil 3D:

Autodesk Civil 3D software is a civil engineering design and documentation solution. Building Information Modelling (BIM) workflows are supported on a range of civil infrastructure project types, including roads and highways, land development, trains, airports, and water.

Civil 3D aids in the improvement of project delivery, the maintenance of more consistent data and processes, and the quick response to project changes. Additionally, users can use specialized tools and customizable design standards to speed up time-consuming operations including intersection, roundabout, and corridor design, parcel layout, pipelines, and grading.

1.2 MX ROAD:

MX ROAD is a software application for the Civil Engineering and associated industries, with the primary market being that of road design. In 1996, the UK-based Bentley System company developed this software, that has now been updated as required. It is an excellent string-based modelling tool that makes it possible to quickly and accurately construct all kinds of roadways. Civil engineers, designers, surveyors, and system designers can all use a single engineering application to access 3D modelling, construction driven engineering, and other analysis.

1.3. Objective of The Study:

i. Comparative study of geometric design of road using AutoCAD Civil 3D and MX ROAD Software.

ii. To upgrade or to improve the geometric features using both AutoCAD Civil 3D and MX ROAD.

iii. Reduce the cost of road development and it's designing.

iv. To improve the road life by efficient design.

v. Designing effective vertical and horizontal alignment.

vi. Designing of super elevation.

vii. Designing extra widening wherever required.

2. Methodology:

The work execution procedure is described in the flowchart. The steps adopted are well detailed in the figure 1. The collected point data is then used for geometric design and analysis in the AutoCAD Civil 3D software and MX ROAD software.

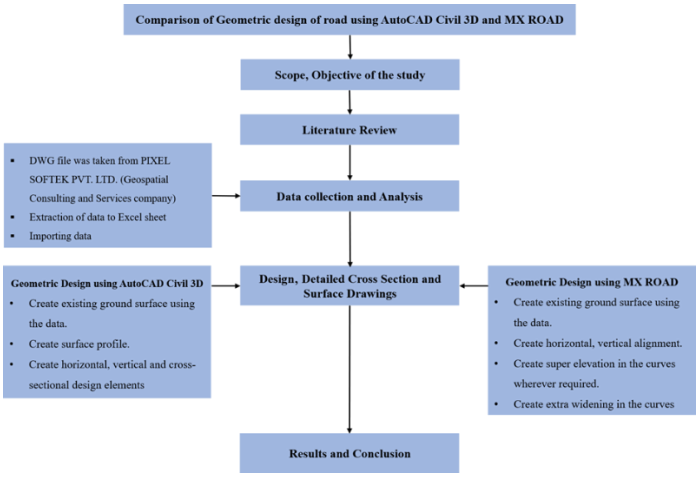

Chart-1: Flowchart of Methodology.

2.1 Project Location:

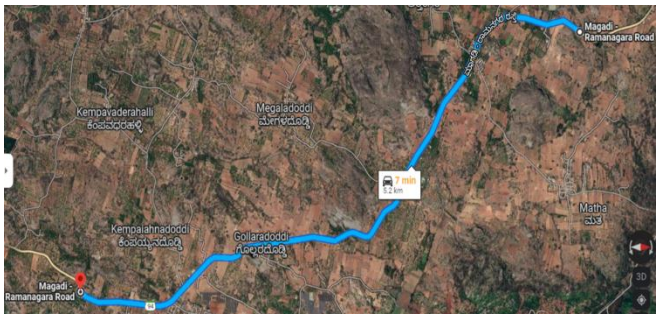

Fig-1: Google Map Image of The Project Location.

This project involves upgrading the SH-94 from intermediate to two lanes between Chikka-Sulikere to Hanchikuppe which lies in between Ramanagara-Magadi Road including CH 55.0 km and CH 60.2 km.

2.2 Data Collection and Analysis:

The data for this study was gathered from PIXEL and was made up of survey data of the current ground surface in .dwg (drawing) format. The study's point data was then extracted and saved in .csv (comma-separated values) format using the Microsoft Excel software. This point data contains the coordinates X, Y, and Z. (i.e., Northing, Easting and Reduced Level). The input was in PNEZ format i.e., Points, Northing, Easting, and Elevation.

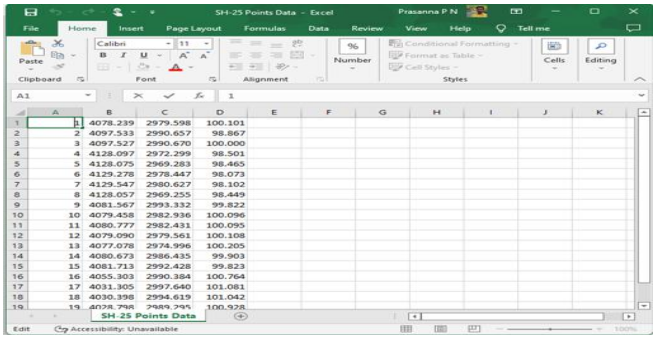

Fig-2: Point Data in PNEZ format.

2.3 Design Criteria

i. Design speed: 50km/h – 40kmp/h (project location falls under hilly terrain)
ii. Number of lanes: 2
iii. Total width of roadway: 8.8m
iv. Width of Carriageway: 7m
v. Width of Shoulder: 1m
vi. Horizontal curve radius: 80m (Ruling minimum)
vii. Super Elevation: 7% (Maximum)
viii. Minimum length of vertical curves: 30m
ix. Ruling gradient: 5% (Maximum)
x. Limiting gradient: 6% (Maximum)
xi. SSD (Stopping Sight Distance): 60m
xii. ISD (Intermediate Sight Distance): 120m
xiii. OSD (Overtaking Sight Distance): 235m

2.4 Geometric Design Procedure using AutoCAD Civil 3D

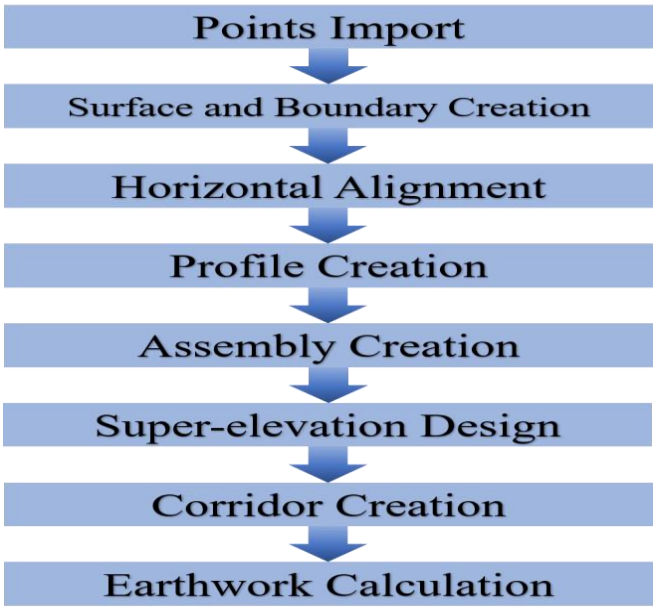

Chart-2: Flowchart of Design Procedure using AutoCAD Civil 3D.

2.4.1 Procedure in AutoCAD Civil 3D:

a. Import survey data from PNEZ file.
b. Create existing surface.
c. Mark Polyline on exiting center line of road
d. Designed according to design proposed alignment in design-based criteria selected in civil 3d similarly manually checked from IRC: 38-1988 for transition length for different speed, speed curve radii.
e. Generate existing profile by surface
f. Create road top level considering hydraulic calculation at structures by profile creation tools, primarily by Polyline.
g. Create assembly is an arrangement of cross-section features found on a roadway. It represents a typical section of the corridor that positions an alignment and a profile.
h. Create an assembly using subassembly for cross-section elements such as lanes, shoulders, and cross slopes.
i. Generate a corridor which in itself is a cross-sectional, horizontal design element of the 3D model used for cutting and filling calculations.
j. Generate quantity report.

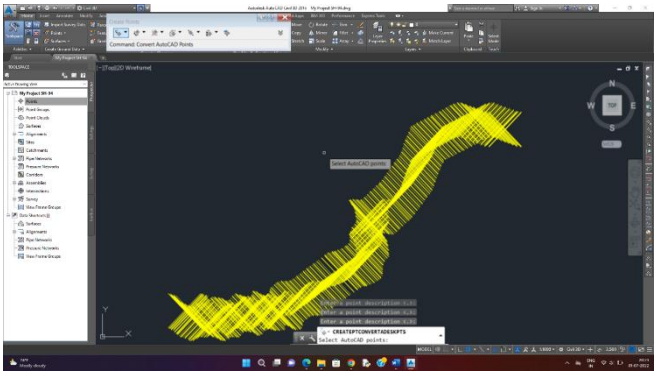

Fig-3: Importing of Points with Data Using Create Points Option in Civil 3D.

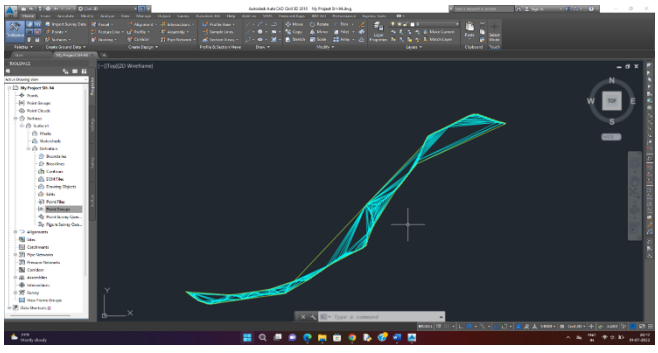

Fig-4: Boundary and Surface Created in AutoCAD Civil 3D.

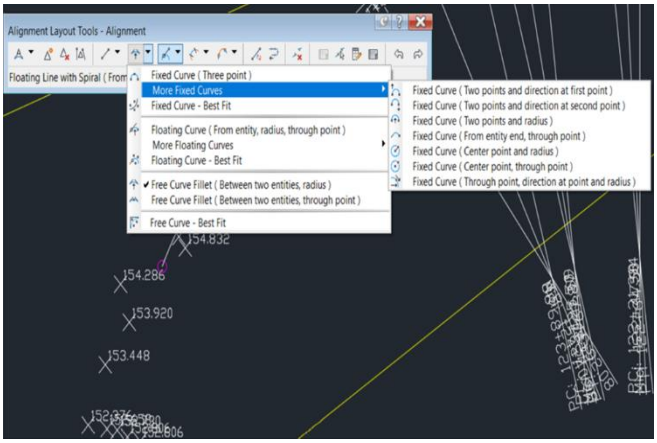

Fig-5: Horizontal Alignment Created Using Alignment Creation tool in Civil 3D.

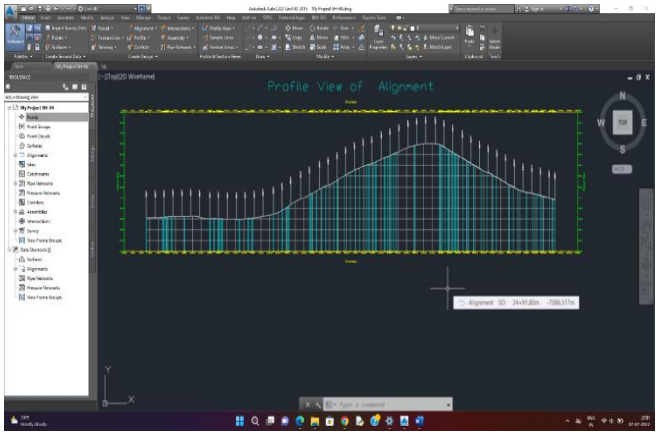

Fig-6: Vertical Alignment Created Using Profile tool in Civil 3D.

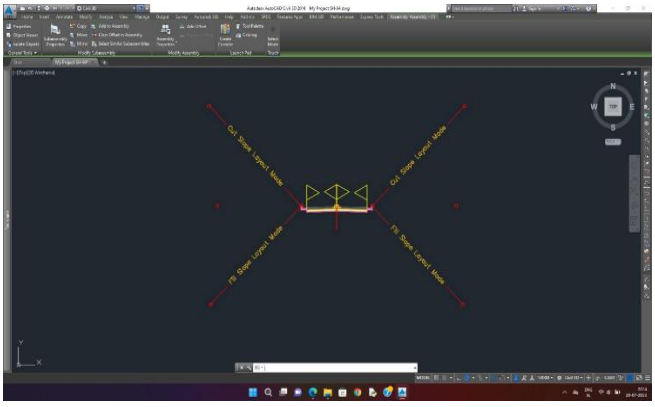

Fig-7: Assembly Showing the Cut and Fill Slopes in Civil 3D.

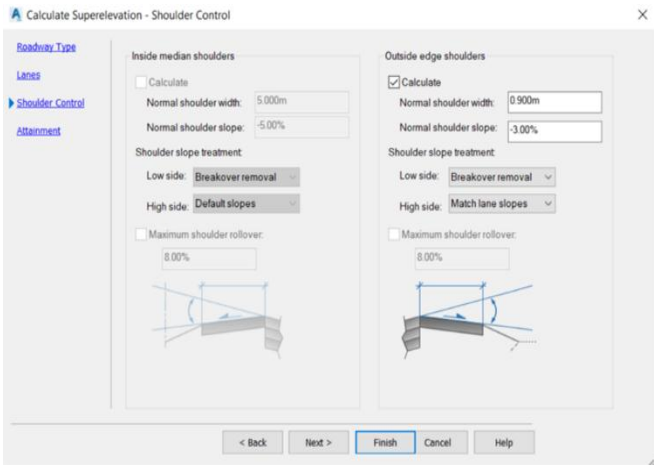

Fig-8: Design of Super Elevation with Shoulder Control in Civil 3D.

2.4.2 Corridor Creation:

Applying an assembly along the vertical and horizontal path established by the alignment and profile's combined information results in the creation of a corridor. Targets are set for daylighting in order to finish the corridor.

2.4.3 Earth work Calculation:

The earthwork needed for a project can be quickly calculated owing to a function in AutoCAD Civil 3D.

Table-1: Earthwork Volume Report Generated in Civil 3D.

Items	Quantity (m^3)
Volume of Cut	51627.75
Volume of Fill	3245.1
Bituminous Concrete (BC)	1824.7
Dense Bituminous Macadam (DBM)	3489.3
Wet Mix Macadam (WMM)	11947.18
Granular Sub-Base (GSB)	9018.71
Subgrade	22000.00

2.5 Geometric Design Procedure using MX ROAD

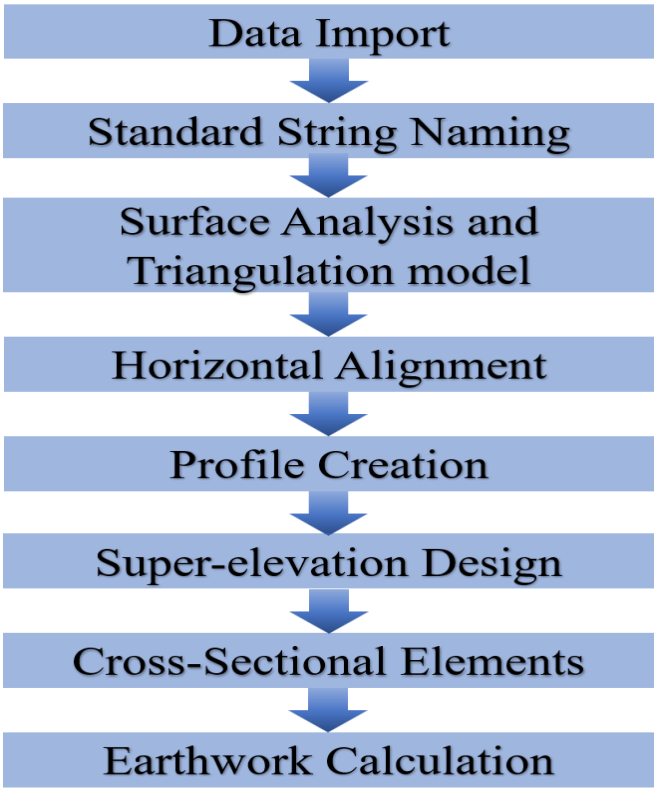

Chart-3: Flowchart of Design Procedure using AutoCAD Civil 3D.

2.5.1 Procedure in MXROAD:

a. Import survey data from PNEZ file.
b. Naming strings according to MX SNC i.e., MX Standard String Naming Convention.
c. Surface Analysis and Triangulation modeling according to IRC standards.
d. Designed in accordance with design-based criteria chosen in civil 3d and design-proposed alignment, with human verification of IRC: 38-1988 for transition length for various speeds and speed curve radii.
e. Horizontal Alignment was designed according to IRC: 38-1988, "Design of Horizontal Curves for Highway and Design Tables".
f. Vertical Alignment is designed according to IRC: SP:23-1993- "Vertical Curves for Highways".
g. Design of super-elevation.
h. Creation of Cross-sectionals elements.
i. Generation of Earthwork Volume Report.

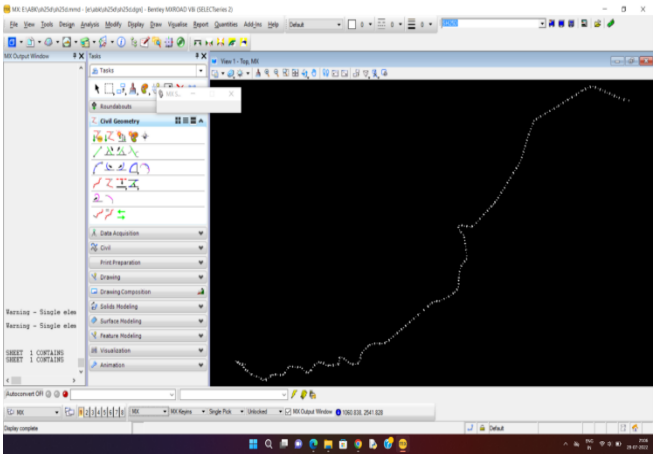

Fig-9: Importing the Data of Existing Road in MXROAD.

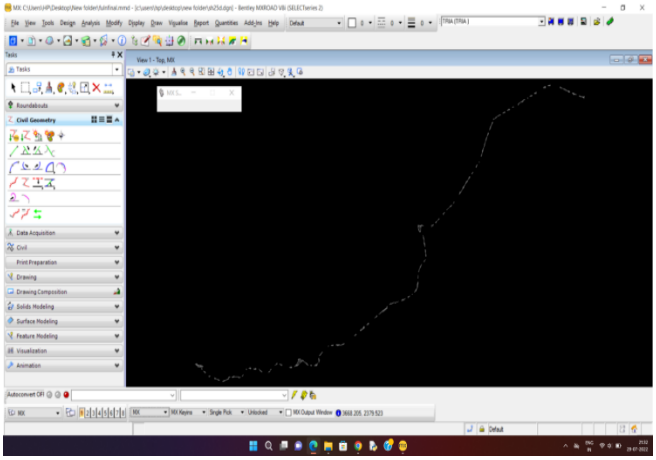

Fig-10: Analyzed surface and Triangulation Model Created using MXROAD.

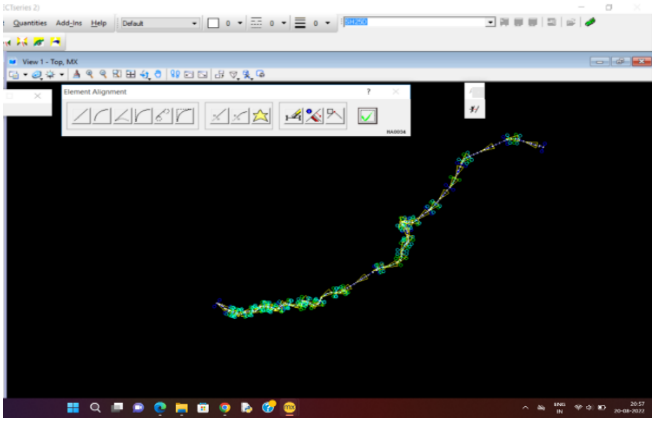

Fig-11: Horizontal Alignment Created in MXROAD using Element Method.

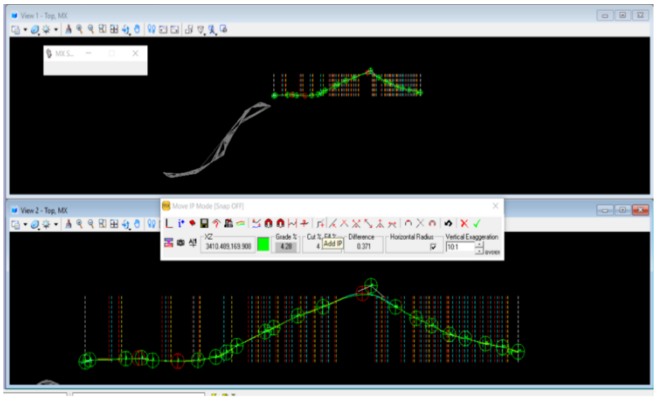

Fig-12: Vertical Alignment Created in MXROAD using Intersection Point (IP) Method.

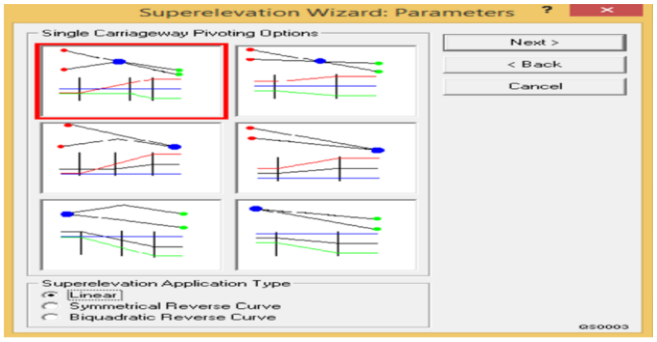

Fig-13: Superelevation Design Tool in MXROAD.

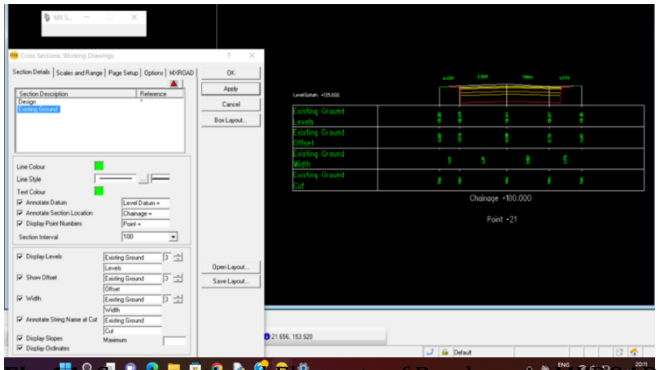

Fig-14: Cross-Sectional Elements of Roadway in MXROAD.

Table-2: Earthwork Volume Report Generated in MXROAD.

Items	Quantity (m^3)
Volume of Cut	40891.34
Volume of Fill	1581.101
Bituminous Concrete (BC)	2076.65
Dense Bituminous Macadam (DBM)	2832.25
Wet Mix Macadam (WMM)	10215.18
Granular Sub-Base (GSB)	8115.28
Subgrade	19648.06

3. Results and Conclusion:

3.1 Comparison of AutoCAD Civil 3D an MXROAD:

1. Users of the AutoCAD Civil 3D software can only make changes to those particular items that are impacted by modifications to object styles, command parameters, and design labels. Model-based software is created by MXROAD; object-oriented software is not. It is dependent on a background-developed design database. To modify design data, the whole set of instructions for recreating the model and database files must be executed once more. The writing must then be revised as well.

2. It is extremely difficult for a non-expert user to comprehend the meaning of existing strings and follow the convention for naming new strings because the use of input files for collaboration in MXROAD software necessitates string naming rules with strict character count limits.

3. String name rules with strict character count restrictions are required for input files used for collaboration in MXROAD software, making it extremely difficult for non-expert users to comprehend the meaning of existing strings and follow the convention for naming new strings.

4. AutoCAD Civil 3D software is driven by styles because objects are managed by collections of parameters that are bundled in a style. Civil 3D offers a variety of regionally-conforming styles in addition to international designs.

5. To handle any horizontal alignment geometry task, MXROAD software includes a robust collection of alignment design tools. For flexibility, it employs the fixed, free, and floating element Design techniques. By using a single set of tools for both creating and altering alignments, Civil 3D achieves this. The user uses MXROAD can see collections of connected strings that describe various pavement layers, sidewalks, benches, ditches, medians, and other features that must be kept up with and coordinated with design modifications to the master alignment and its single corresponding profile geometry.

6. For modelling roads, Autodesk Civil 3D employs a design object. This object is known as a corridor since most Civil 3D objects are built as generic engineering design objects that may be utilized for any purpose. A corridor can be used to model any geometry that, in general, follows a baseline or alignment.

Table-3: Comparison of Earthwork Volumes Generated Using Both Software.

Items	Earthwork volume (m3) using AutoCAD Civil3D	Earthwork volume (m3) using MXROAD
Subgrade	19648.06	22000.00
Granular Sub-Base (GSB)	8115.28	9081.71
Wet Mix Macadam (WMM)	10215.18	11947.18
Dense Bituminous Macadam (DBM)	2832.25	3489.30

3.2 Conclusion:

1. AutoCAD civil 3D is thought to be quite helpful and also user-friendly.
2. According to IRC, AASHTO and the highway geometrics were also taken into consideration as safety measures.
3. It produced horizontal alignment, created a vertical profile, and permitted for the establishment of cross-segment.
4. Road widening at horizontal geometry and super elevation should be planned carefully.
5. Every curve that is plotted in the project complies with the IRC Standard.

REFERENCES

[1] Upgradation of Geometric Design of NH163 (Uppal-Narapally) For Reduction in Traffic Congestion Based on Microscopic Traffic Simulation Model - Abida Mohammed Anwar, Mir Iqbal Faheem and Md. Faisal Khan.

[2] Study of Geometric Design, hydraulic and hydrology for Highways Using Civil 3D Software- A Case Study - Anil Kumar K.S.

[3] Design of Sub-Arterial Urban Road Using MX ROAD Software - Ali Asharf, Nishant Singh, Yashraj Shrivastava and J S Vishwas.

[4] Up Gradation of Geometric Design of Sh-131(Ch. 9.35km-15.575km) Using MX ROAD Software - Ashok Kumar, Dhananj A S, Agarwal Alkesh, Badage Ganesh Chavan Bhagatsinh, Devkar Anil and Kadam Shubham.

[5] Planning, Designing and Proposed a Flyover Road Using AutoCAD Civil 3D Software - Shivam Pandey, Er. Atul, Yogesh Bajpai.

[6] IRC:73-1980, "Geometric Design Standards for Rural (Non-Urban) Highways".

[7] IRC: SP:23, "Vertical curves For Highways".

[8] IRC: 38-1988, "Design of Horizontal Curves for Highway and Design Tables".

BIOGRAPHIES

Prasanna P. N., M.Tech Student, Department of Construction Technology & Management, Dayananda Sagar College of Engineering,

Bengaluru, Karnataka, India.

Dr. Prakash P., Professor and Head of Department of Construction Technology & Management, Dayananda Sagar College of Engineering, Bengaluru.

Mr. Suhas R., School of Civil Engineering, REVA University, Bengaluru.