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Geometric Improvements in the Horizontal Alignment and Vertical Profile of Lohapathar Ghat Section in Bhopal-Salkanpur Road using Autodesk Civil 3D Software

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Abstract: ***Geometric highway design involves the creation of visible elements like horizontal alignment, vertical profile, cross-sectional features, sight distances, curves, and superelevation, all vital components in maintaining road safety. Concentrating on the stretch of road from Bhopal to Salkanpur, specifically the area around Salkanpur Ghat in Madhya Pradesh, India, this research aims to enhance the horizontal and vertical geometry using Civil 3D Software. Spanning approximately 1.860 km in hilly terrain, this section poses significant risks with sharp curves and steep vertical gradients ranging from 6.5% to 7%. These conditions contribute to its status as an accident-prone area, resulting in both physical and economic losses. The outputs demonstrate that both improved alignments have shorter lengths compared to the existing road, with smoother curves and reduced maximum gradients (5.3% compared to 7%). Moreover, the minimum design speed has significantly increased from 20 kmph to 65-80 kmph, indicating enhanced safety and efficiency for vehicular traffic."***
Keywords: Civil 3D Software, Geometric Design, Road, Manual Method, IRC, Design Speed, Superelevation Introduction.

I. INTRODUCTION

Highway geometry elements are expected to be selected, sized and positioned in a way that satisfies such design criteria as sight distance, vehicle stability, driver comfort, drainage, economy, and aesthetics. The road design procedure using AutoCAD Civil 3D has been presented. Manual geometric design of the same road was also performed, the results of which was compared favourably with that of AutoCAD Civil 3D.

Objectives of the project-

1) To study the various geometric features of road.
2) To design geometric features by using civil 3D Software.
3) To determine safe geometric features of a road to minimize the accident rate.

II. STUDY AREA LOCATION-

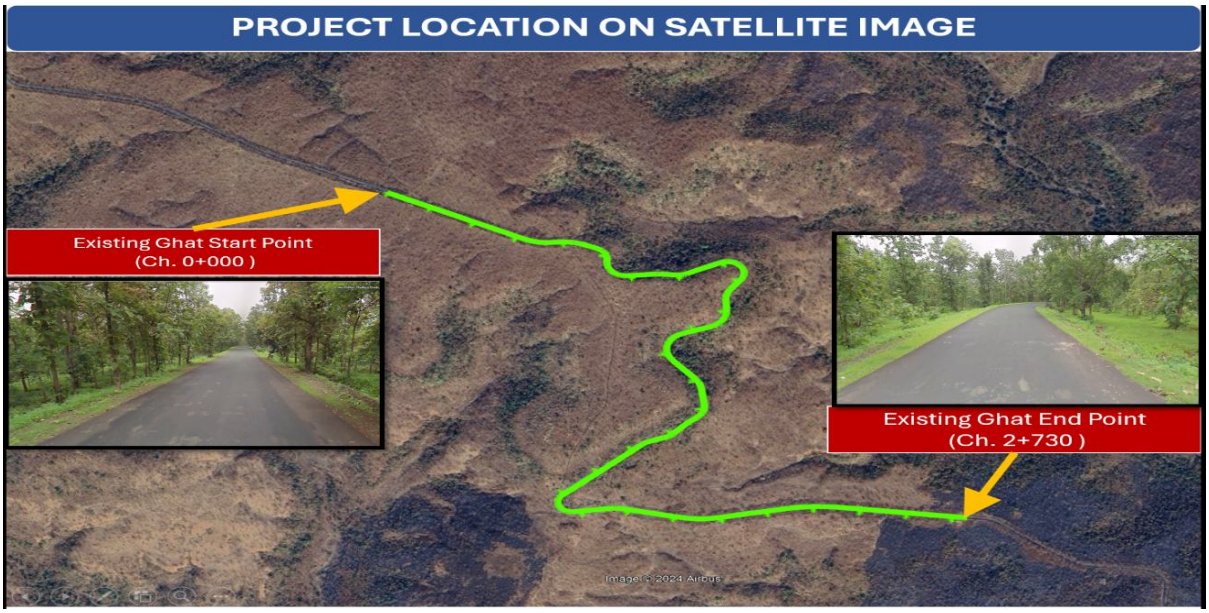
The study area is located in Sehore district Ichhawar taluka, the project road start from Bhopal to Salkanpur road. Length of stretch is 2.8 km. Project area passes through Hilly and Mountainous terrain. Existing study area consists of asphalt road and Soil Road. The alignment comprises of significant Sharpe horizontal curves which would require geometric corrections

III. DATA COLLECTION

Gathering information and systematically analysing data from a survey conducted within the study area to gain a comprehensive understanding of the chosen area. This process enables thorough evaluation of outcomes and responses to research inquiries.

A. Surveying

Data from reconnaissance surveys are typically used to plan detailed surveys and investigations, aiding in the selection of potential alignments for alterations or adjustments. During preliminary surveys, survey specialists utilize total stations to gather essential data such as latitude, longitude, elevation, and other necessary measurements along proposed alternate alignments. Finally, the centreline of the ground is determined during the final location survey.



B. Traffic Volume Count

To decide the number of lanes and roadway width, pavement design, economic analysis traffic surveys are conducted. The main focus of traffic survey is to determine of vehicle composition in traffic stream which helps to design geometric features of the road. Cumulative ESAL applications over 20 years @ 5% growth rates.

$$N = \frac{T_0 \times 365 \times (1+r)^n - 1 \times L}{r}$$

Where,

T_0 = ESAL per day = number of commercial vehicles per day in the year of opening × VDF

L = Lane distribution factor = 1 for single lane / intermediate lane

Assuming a uniform annual growth rate "r" of 6% over the design life (n) of 10 years

Cumulative ESAL applications (N) over the design life can be computed by substituting the values,

IV. DESIGN OF FLEXIBLE PAVEMENT FOR 20 YEARS AS PER IRC 37:2018

Data,

1. Two Lane carriageway
2. PCU = 3645
3. No. of commercial vehicles as per last count (P) = 241 CVPD
4. Traffic growth rate per annum (r) = 5%
5. Design life (n) = 20 years
6. Vehicle damage factor (F) = 3.1
7. CBR of subgrade soil = 8%
8. Lane distribution factor (D) = 0.50
9. Initial Traffic in the year of completion of construction in terms of the number of commercial vehicles per day (A) =265

Calculation of MSA is given by formula,

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

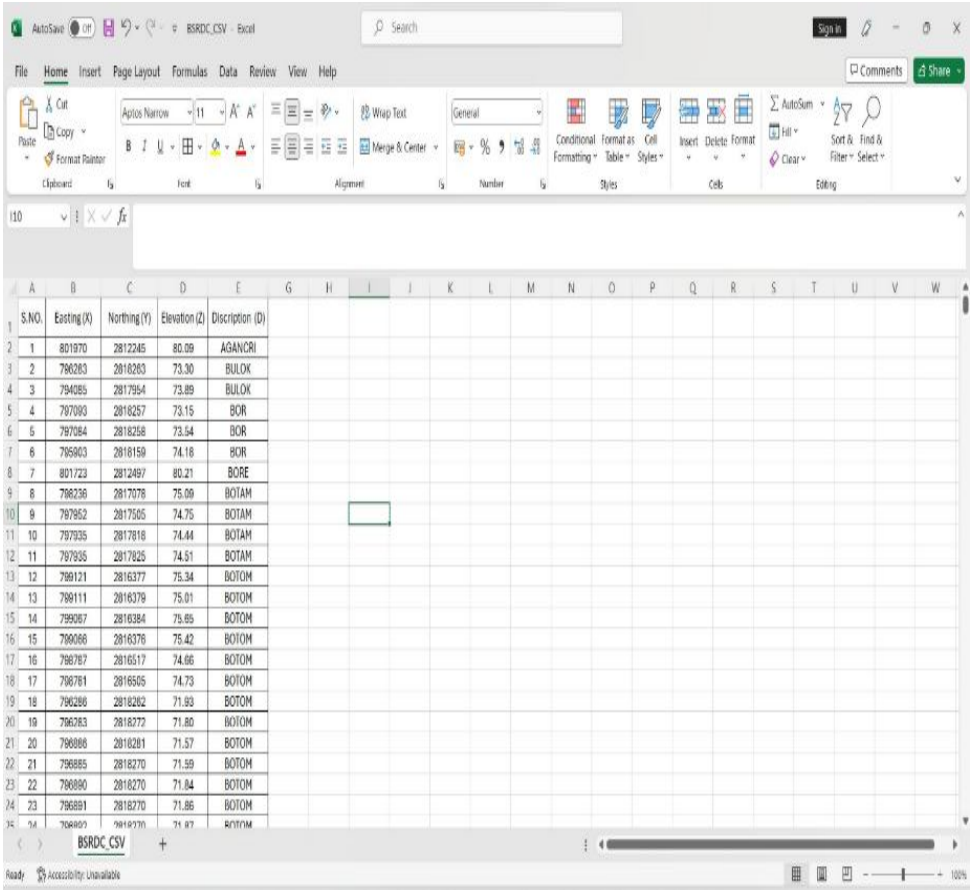
N=4.9 MSA (Say 5 MSA)

For traffic adopted 5 MSA design crust composition is considered as per IRC 37:2018- Fig. 12.4 Catalogue for Pavement with Bituminous Surface Course with Granular Base and Sub-base - Effective CBR 8% (Plate-4)

Pavement Layers	Design Crust
BC	30
DBM	50
Granular Base	250
Granular Sub Base	150

V. TOTAL STATION

Total Station is a combination of Electromagnetic Distance Measuring (EDM), Theodolite and Microprocessor used to measure horizontal angles, vertical angles and sloping distances of the objects. It gives high accuracy, easy to work and tasks can be completed in time. For each point or station, codes are created and entered and surveying is started at different stations. Northing, easting, elevation of the ground co-ordinates was obtained along the proposed alignment. These co-ordinates enroll for map making and plotting contour and cross section in AutoCAD civil 3D. At end of the work/ the details stored in the instrument is downloaded to computer further used for AutoCAD civil 3D.



S.NO.	Easting (X)	Northing (Y)	Elevation (Z)	Discription (D)
1	801970	2812245	80.09	AGANCRI
2	796283	2818263	73.30	BULOK
3	794085	2817954	73.89	BULOK
4	797090	2818257	73.15	BOR
5	797084	2818258	73.54	BOR
6	795903	2818159	74.18	BOR
7	801723	2812497	80.21	BORE
8	796236	2817078	75.09	BOTAM
9	797952	2817505	74.75	BOTAM
10	797935	2817818	74.44	BOTAM
11	797935	2817825	74.51	BOTAM
12	799121	2816377	75.34	BOTOM
13	799111	2816379	75.01	BOTOM
14	799087	2816384	75.65	BOTOM
15	799066	2816376	75.42	BOTOM
16	796787	2816517	74.66	BOTOM
17	796781	2816505	74.73	BOTOM
18	796286	2818262	71.93	BOTOM
19	796283	2818272	71.80	BOTOM
20	796886	2818281	71.57	BOTOM
21	796885	2818270	71.59	BOTOM
22	796890	2818270	71.84	BOTOM
23	796891	2818270	71.86	BOTOM

Figure-02 CSV File for import survey in Civil 3D Software

VI. AUTOCAD CIVIL 3D

AutoCAD civil 3D is a tedious process but after several rehearsal it will be easy, needs a training, taken a lot of practices to become fluent, and prepared to get this technique right. Below flow chart shows the general review of AutoCAD civil 3D design procedure.

Figure-03 Flow chart of Geometric design in Civil 3D Software

Select the file of the survey points which is saved in notepad or in excel sheet to import the points to AutoCAD civil 3D. Create the surface for the existing ground surface, create alignment for the profile and select criteria-based design, create corridor to run corridor in 3D view, develop sample lines and assembly to create cross sections and to generate volume report. All these can be viewed in object viewer. The below figures show the design procedure-

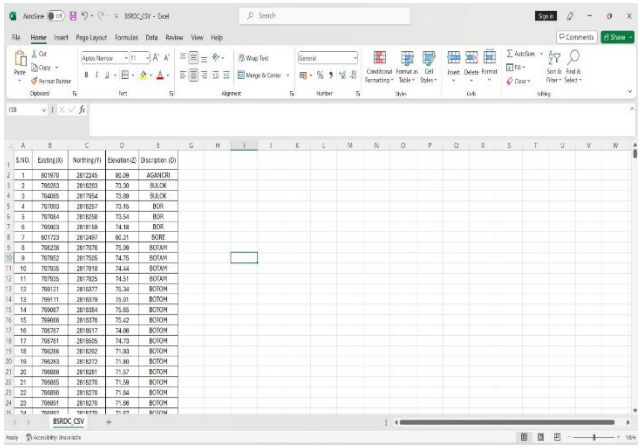


Figure: - 04 Survey File in CSV file format.

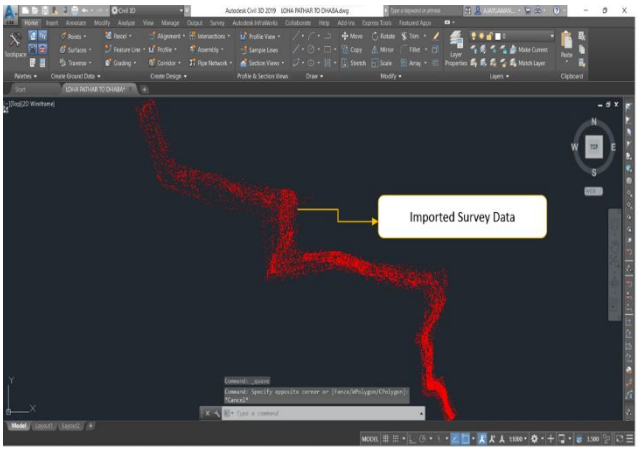


Figure: - 05 Imported Survey Data Output.

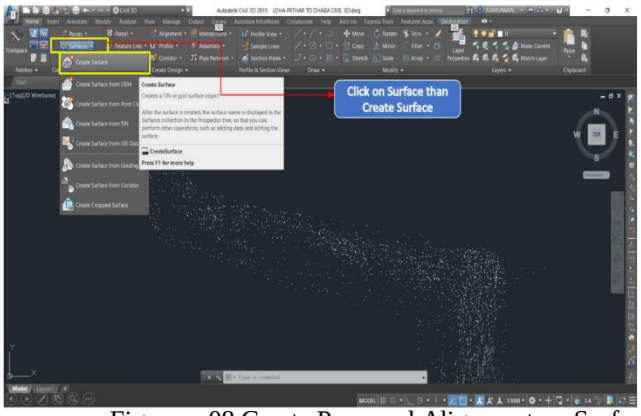


Figure: - 08 Create Proposed Alignment on Surface.

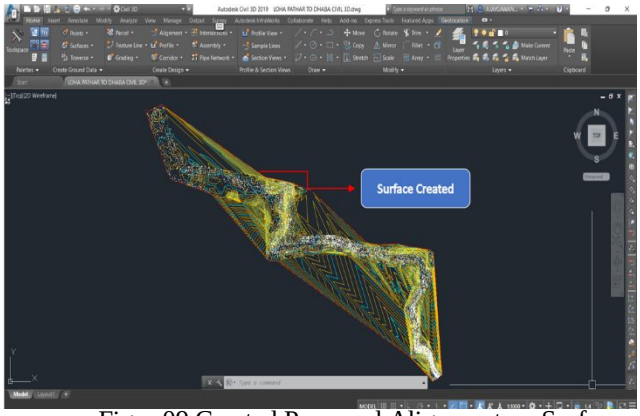


Fig: - 09 Created Proposed Alignment on Surface.

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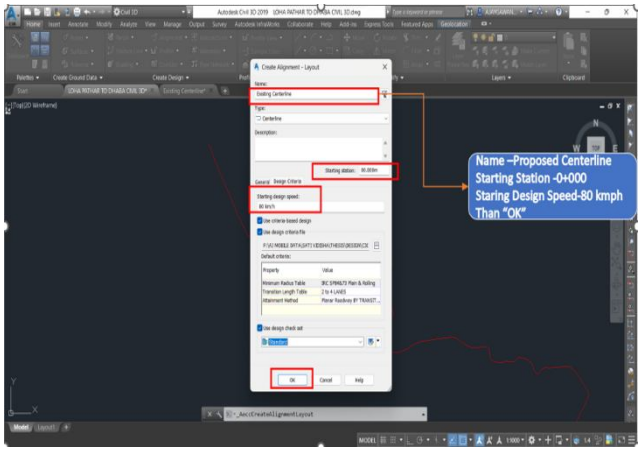

Figure: - 10 Create L-Section of Alignment

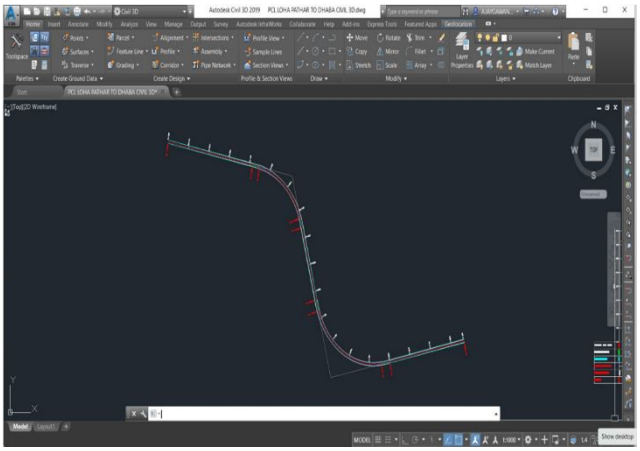

Figure: - 11 Created Alignment

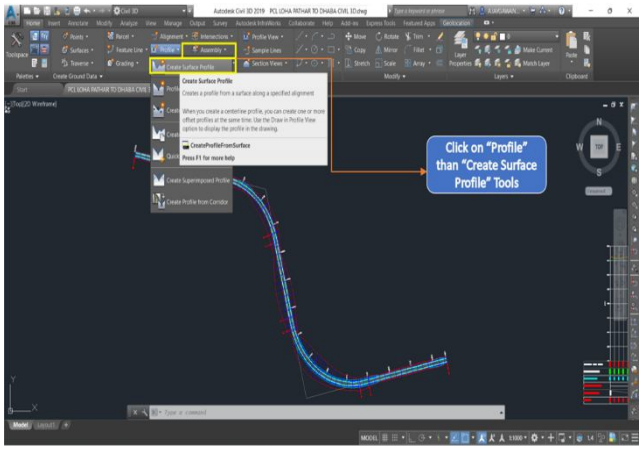

Figure: - 12 Create L-Section of Alignment

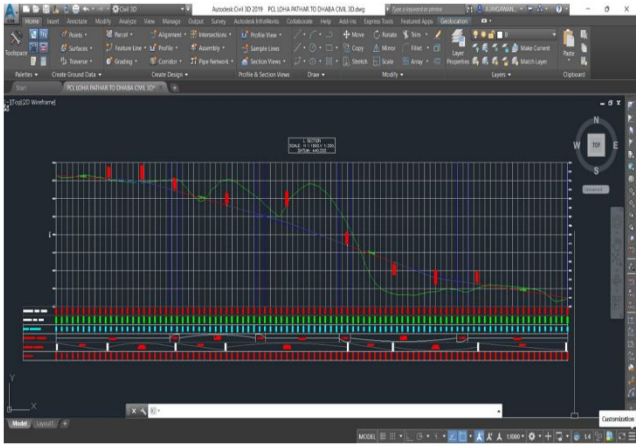

Figure: - 13 Created L-Section

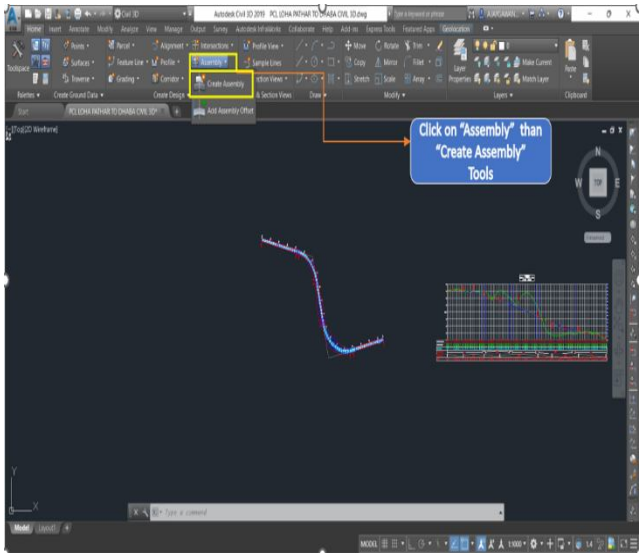

Figure: - 14 Create a Assembly

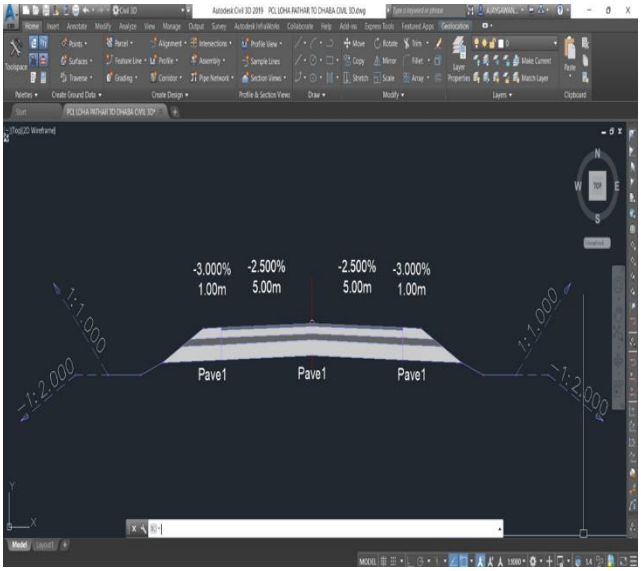

Figure: - 15 Created a Assembly

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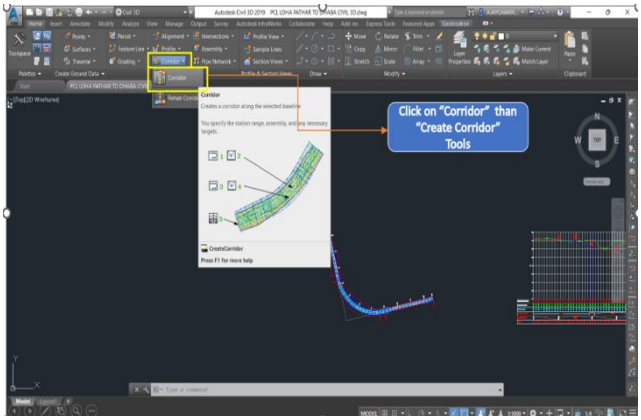


Figure: - 16 Create a Corridor

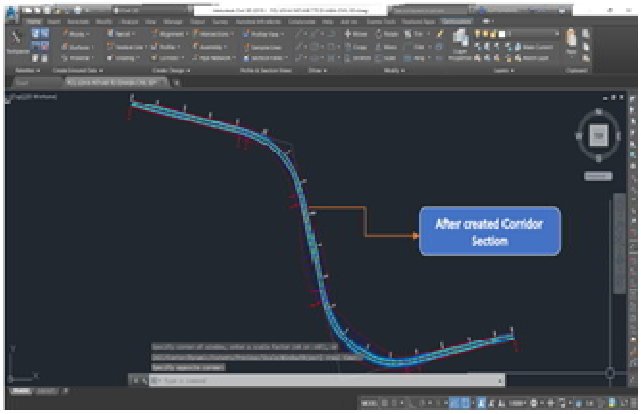
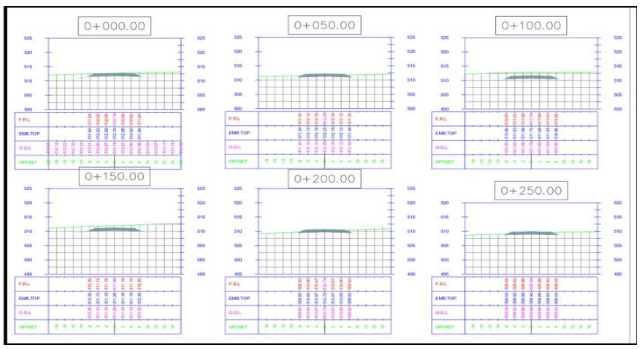
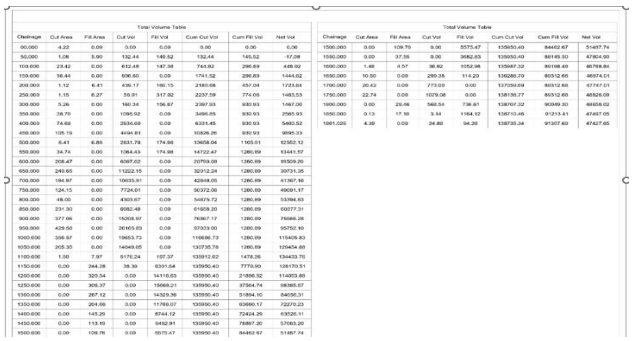


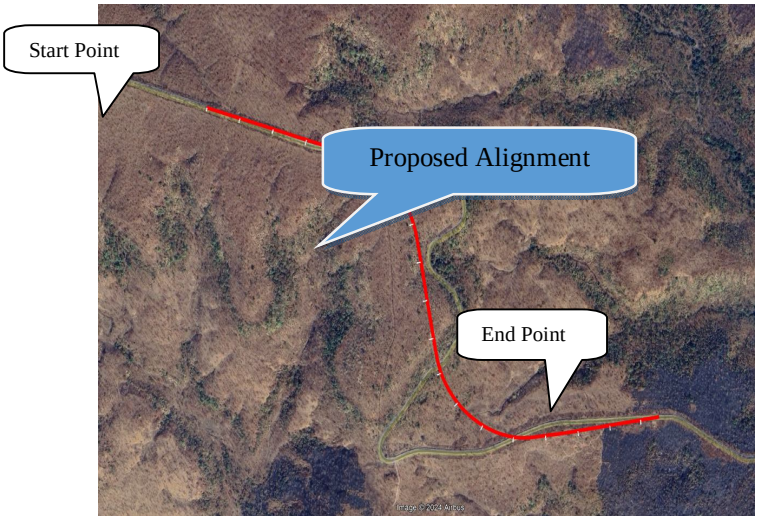
Figure: - 17 Created Corridor





VII. OUTPUT OF THE DESIGN

The aim of re-alignment of the Salkanpur ghat section (Bhopal – Salkanpur Road) is to improve the horizontal geometry and vertical geometry as per IRC specification and also increase the speed on that section with more safety. Improvement plan on google earth of the road section is given below-



VIII. CONCLUSION

The objective of the study was to improve the horizontal alignment and vertical profile of the Salkanpur Ghat Section along the Bhopal-Kolar Dam-Salkanpur Highway in Madhya Pradesh, following IRC recommendations. The project aimed to implement two enhancements to the current roadway in line with IRC guidelines, while also addressing high-risk zones for accidents.

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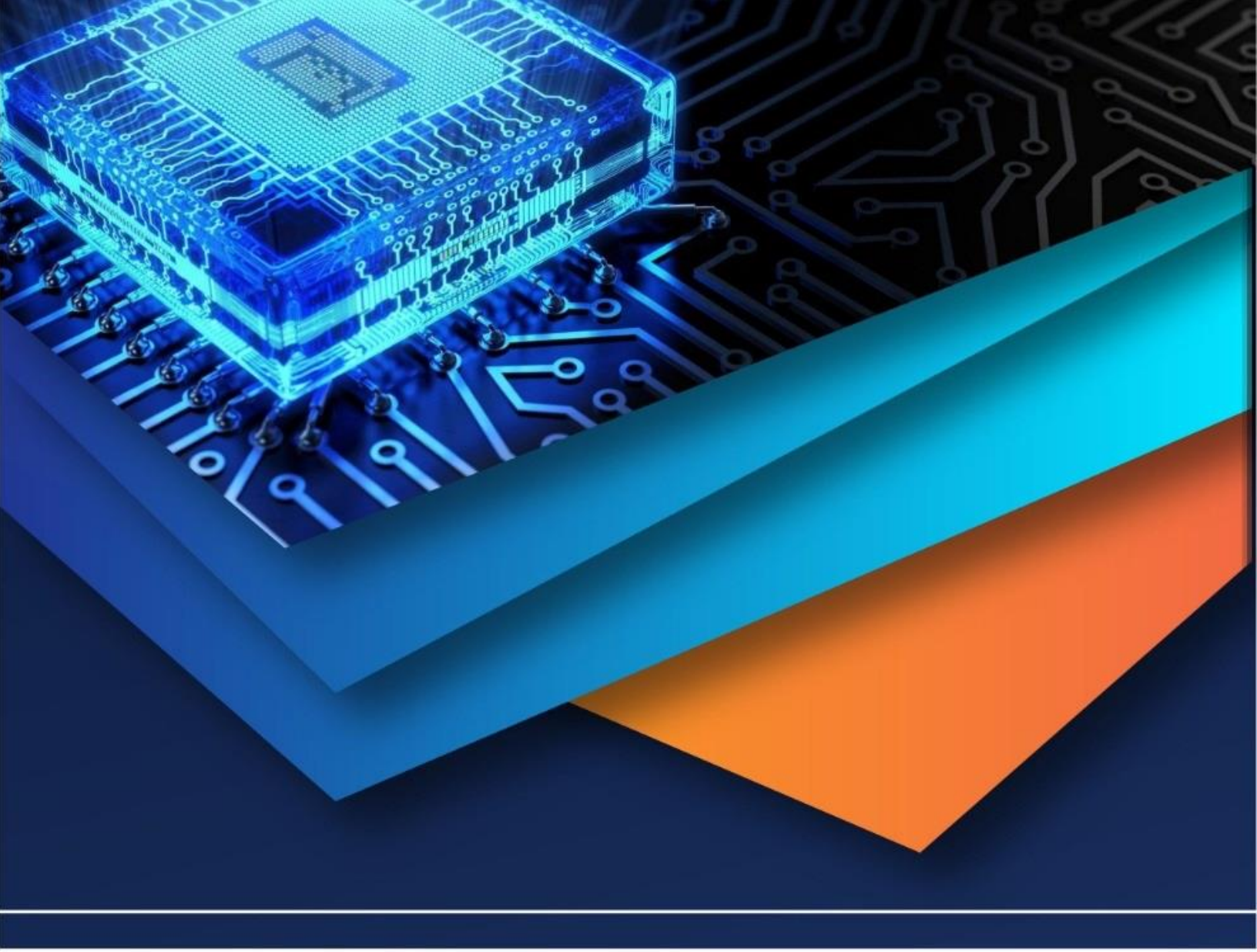

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