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Improvements in the Horizontal Alignment and Vertical Profile of Balampur Ghat Section in Bhopal-Vidisha State Highway Road (SH-18) using MXRoad Software

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Abstract: ***Geometric design of highway deals with designing of physical visible features of highway those comprise of horizontal alignment, vertical profile, circular and transition curves, superelevation, Summit and valley curves, cross sectional elements, sight distances and other features. From the safety point of view, road geometric features should be well designed as per the IRC recommendation. In this research work, the horizontal alignment and vertical profile have designed of Balampur Ghat section in the Bhopal-Vidisha Road which is in the Madhya Pradesh State of India. The objective of this research work is "Improvements in the Horizontal alignment and Vertical profile of Balampur Ghat Section in Bhopal-Vidisha State Highway Road (SH-18) using MX Road Software". The design of horizontal alignment and vertical profile have been done for Balampur ghat section approx. 2.0 km in length of State highway no. 18 (SH-18) of Madhya Pradesh. SH-18 is connected to Vidisha from Bhopal in the state of Madhya Pradesh and having heavy commercial traffic. Balampur ghat section is hilly terrain and have two improper horizontal curves along with 6.5% of vertical gradient and because of this reason that section is not safe for deriving therefore it has become an accident-prone area and the accident-prone area have the human and economical losses so it should be improved and re design of the horizontal and vertical alignment for safe design speed. The proposed methodology is on the basis of inventory survey (preliminary survey), topographic survey and MX Road software. In inventory survey take the data of existing road and find the suitable route of alternative alignment if re-alignment is required in the road. Then the topographic survey done on the existing road and alternative alignment. Import the topographic data of the road in MX Road software for generate existing surface of the road for design of horizontal alignment and vertical profile. As per IRC recommendations, there are two alternative alignments designed of the existing ghat section. As per the outputs of this research work, the length of both improved alignments is short as compare to existing road. There are no improper curves at improved alignment and maximum gradient is 4.2% which is less than the existing gradient (6.5%). The minimum design speed is 40-50 kmph which was 20 kmph in existing road. The both two improved alignments are safer as compare to existing alignment and the design speed of the vehicle has been increased. The improved alignment 2 is straighter than the improved alignment The improved alignment has also reduced the human and economic losses.***

Keywords: Horizontal Alignment, Vertical Profile, Improvements, Design, Design Speed, MX Road Software.

I. INTRODUCTION

For the balanced development of any country, it is essential to provide a well-planned road network connecting all the villages and towns. The development of the infrastructure in India is very fast and there are many developments have been done in last few years. The development in transportation infrastructure plays a vital role in Indian economy. The road network plays an important role for development of the country in steady growth. It is necessary to provide good road links between the villages and market centers. The transport system affected directly to the developing countries. If the economic transport system is available from the villages to other district headquarters and also for commercial stations than the overall economy can be grow easily. For the uninterrupted movement of fast vehicles, the express ways give the full support to make the strong road network in India. In last it will have to say that, for the fast growth of any countries the transportation systems should be strong in both terms of length and quality to meet their demand for the developments.

A. Bhopal - Vidisha Highway Road

The Bhopal-Vidisha State Highway (SH-18) connected to Vidisha from Bhopal. This State Highway is in the State of Madhya Pradesh. The Highway started from Bhanpur square at Ayodhya Bypass (From km 0+000) in Bhopal and terminating at its junction with NH-146 near Sanchi (To km 36+150). The total length of the road is approx. 36.150 km. This State Highway develop a junction with NH-46 (Gwalior – Betul Road) at its km 6+300 and also cross tropic of cancer at its km 24+400. In this research work, the alignment problem of Balampur Ghat section is discussed and the improvements are also done in the horizontal alignment along with the vertical profile of the section from km 13+000 to km 15+000.

Figure 1: Bhopal Vidisha state Highway

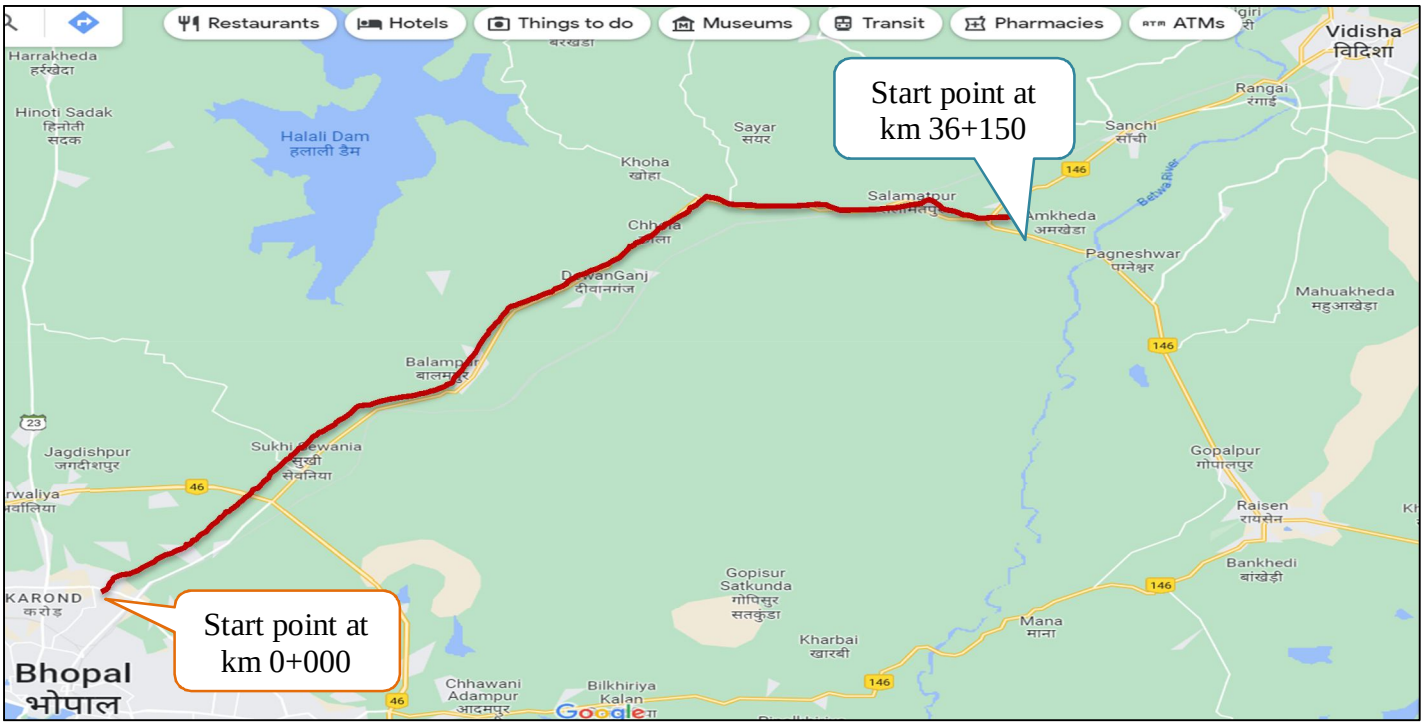

Figure 2: Bhopal Vidisha state Highway

B. Problem Identification

The existing ghat section has many problems which have identified in preliminary survey. Geometry of Balampur ghat section is not as per IRC recommendations. The problems are given below-

1) There are many improper curves in existing ghat section and there is one horizontal curve has radius < 75 m. but as per IRC: SP:73-2018 (Table 2.5), it should be min. 75 m in Mountainous terrain.

Table 2.5 Minimum Radii of Horizontal Curves

Nature of Terrain	Desirable Minimum Radius	Absolute Minimum Radius
Plain and Rolling	400 m	250 m
Mountainous and steep	150 m	75 m

Table 1: Minimum radius of horizontal curves

Geometric Problem Of Balampur Ghat Section (Detail of "A")

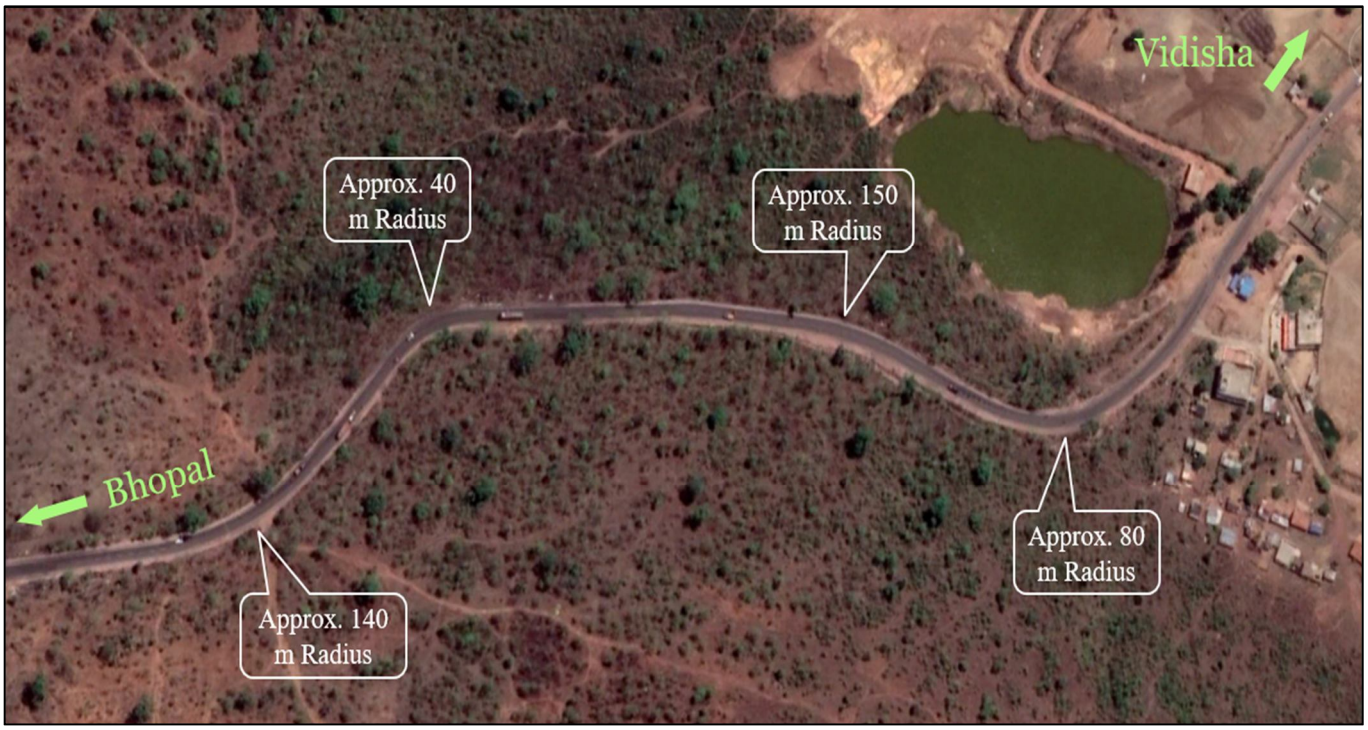

Figure 3: Horizontal curves deficiencies

2) The profile gradient is > 6.0 % but as per IRC: SP:73-2018 (Table 2.7), it should be max. 5% in Mountainous terrain.

Table 2.7 Gradients

Nature of Terrain	Ruling Gradient	Limiting Gradient
Plain and Rolling	2.5%	3.3%
Mountainous	5.0%	6.0%
Steep	6.0%	7.0%

Table 2: Gradients on vertical curves

Geometric Problem Of Balampur Ghat Section

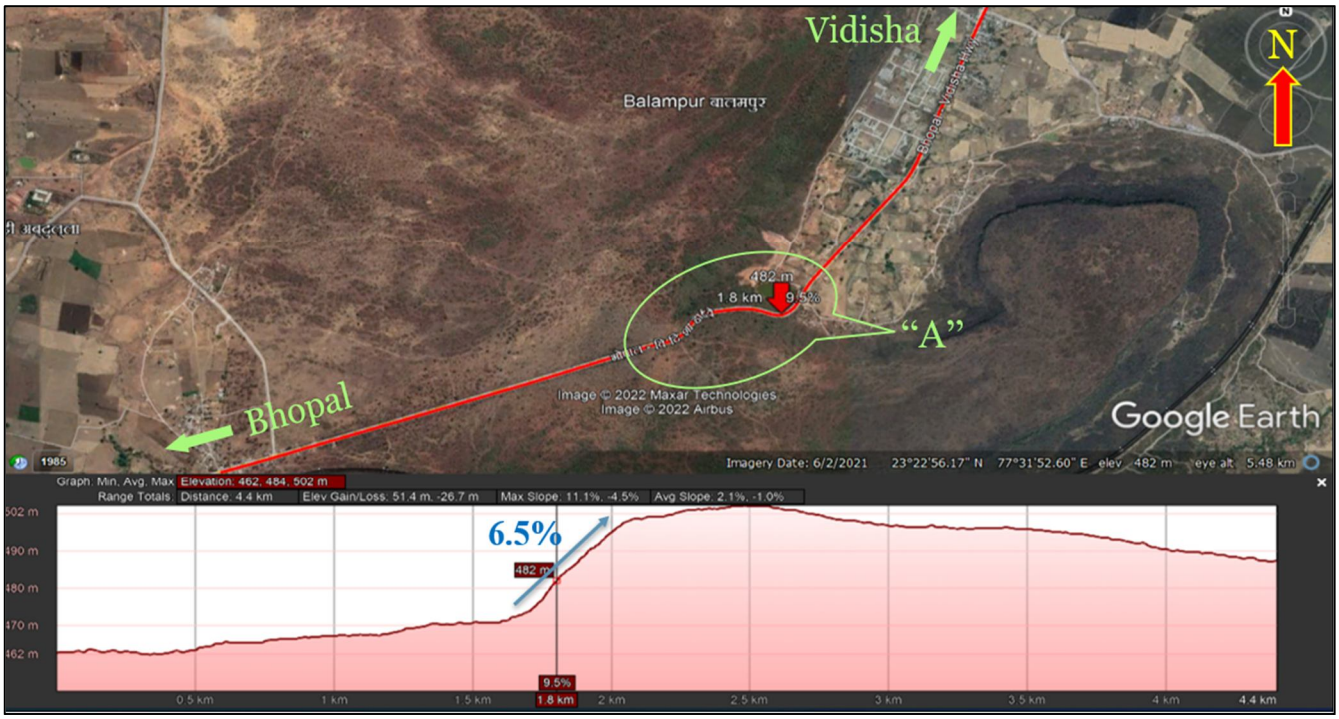

Figure 4: Vertical gradient deficiencies

3) If vertical gradient > 4 % at horizontal curve than grade compensation is required. As per IRC guideline for grade compensation, it should be -

$$\text{Percent grade compensation} = \frac{30+R}{R} \text{ subjected to maximum of } \frac{75}{R}.$$

Where R - Radius of horizontal curve in m.

4) The existing ghat section is unsafe for road users and it is accident prone area.
5) The speed of the vehicle found 20 kmph.

C. Bentley MXROAD

The Mx software was initially developed by three local authorities in the United Kingdom, in the late 1970s. Back then, it was known as MOSS till 1998. MXROAD software evolved subsequently with the merging of Infra soft Limited and Bentley System Limited during January 2003.

Bentley MXROAD is an advanced, string-based modeling tool that enables rapid designing of all road types with accuracy. Using MXRAOD, creation of design alternatives for the construction of an ideal road system can be managed with ease. Once a design alternative has been authenticated, further details that are to be added to be design process can also be automated while using MXROAD modeling tool, saving both time as well as money.

1) Features of Bentley MXROAD

a) Design Creativity.
b) Junction Design.
c) Super-elevation Design.
d) Pavement Layer and Sub-Grade Design.
e) Final Drawings.
f) MX Command Language and Input Files.

2) Advantages of Bentley MXROAD

a) Time saving.

b) Higher accuracy.

3) Uses of Bentley MXROAD

a) Design of Horizontal and Vertical alignment of all types of Roads and Highways.

b) Design of Junctions.

c) Pavement and Subgrade Design

d) Earthwork Calculation-Volumetric Analysis.

II. PROPOSED METHODS

A. Preliminary Survey Photographs






Figure 5: Balampur Ghat Section

B. Design of Horizontal Alignment and Vertical Profile using Bentley MXRoad

Design the horizontal alignment and vertical profile of the Balampur ghat section as per IRC recommendations by using Bentley MXRoad. Design steps of MXRoad software are given below-

1) Importing Survey Data

For importing survey data follow the steps which are given below-

- Importing topographic survey data (csv excel file) from the main menu bar, select File > Import > ASCII Import.

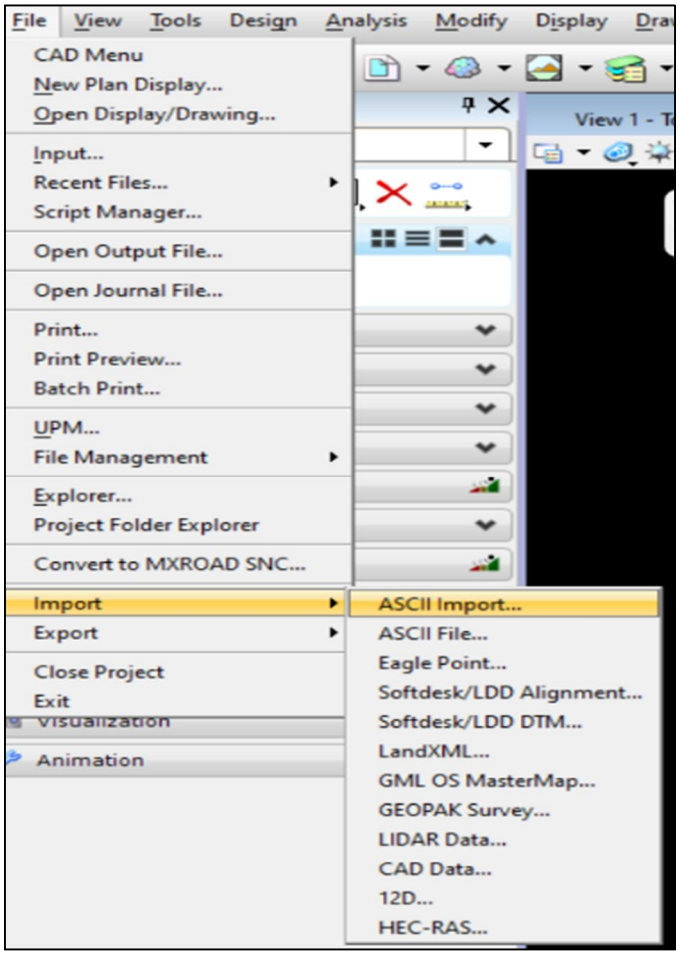

Figure 6: Main menu bar for ASCII Import

- Select csv excel file in ASCII File and Select Use an existing file format if you have any existing Format otherwise Select Define a new file format.

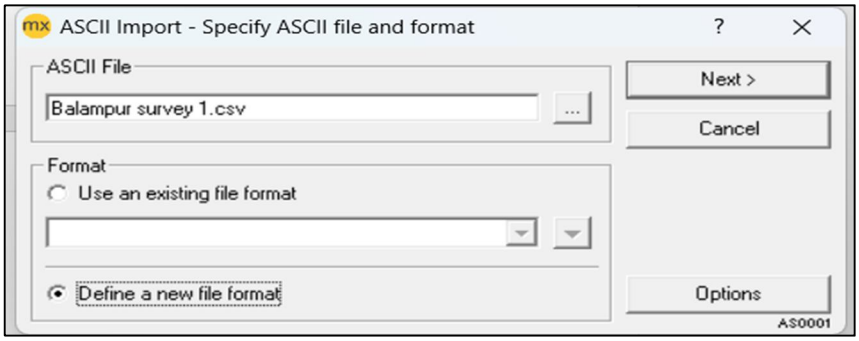

Figure 7: Specify ASCII file and format for ASCII Import

- Select Easting, Northing and Level in Type of data tool and click Next.

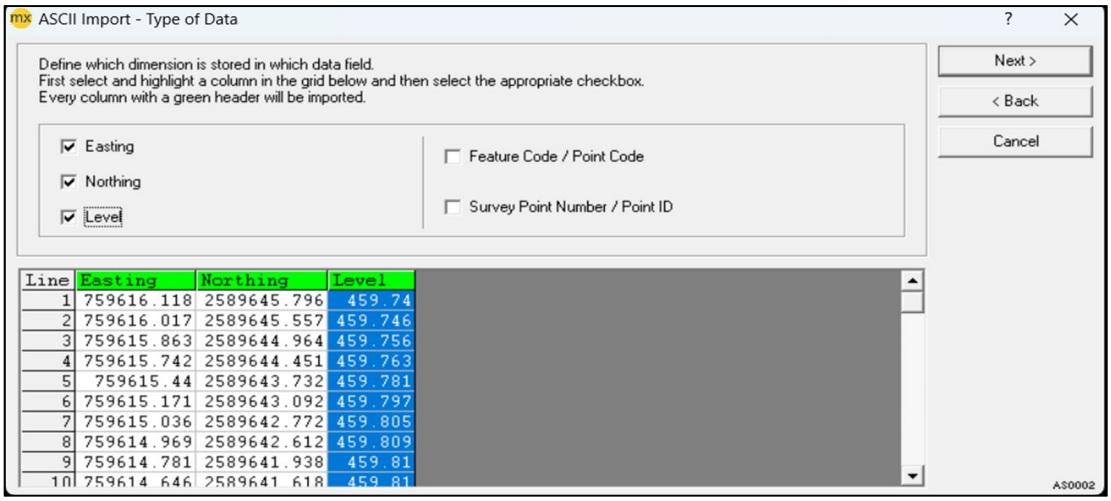

Figure 8: Type of Data for ASCII Import

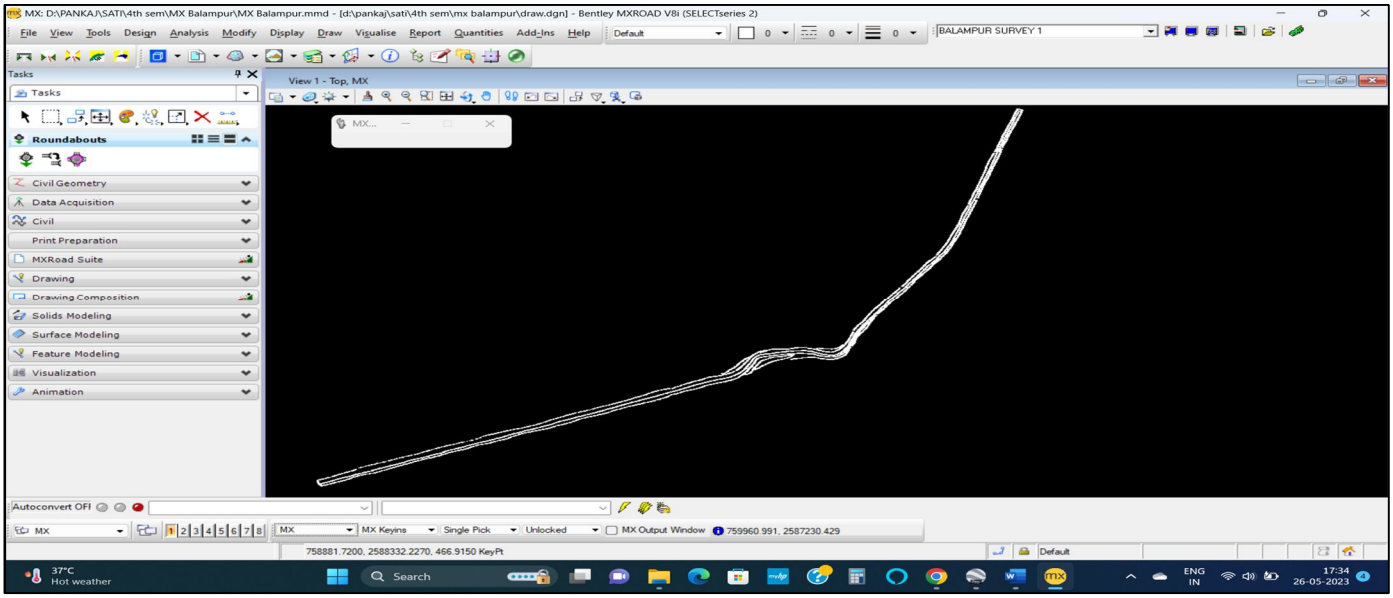

Figure 9: Imported survey output

2) Make Triangulation from Survey Data

For making triangulation follow the steps which are given below-

- First create model for Triangulation from the main menu bar, select Modify > Edit Models > Create Model

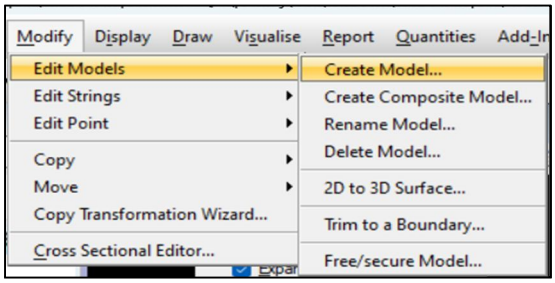

Figure 10: Main menu bar for Create Model

- Then make triangulation from the main menu bar, select Analysis > Triangle > Triangulation from a String Model.

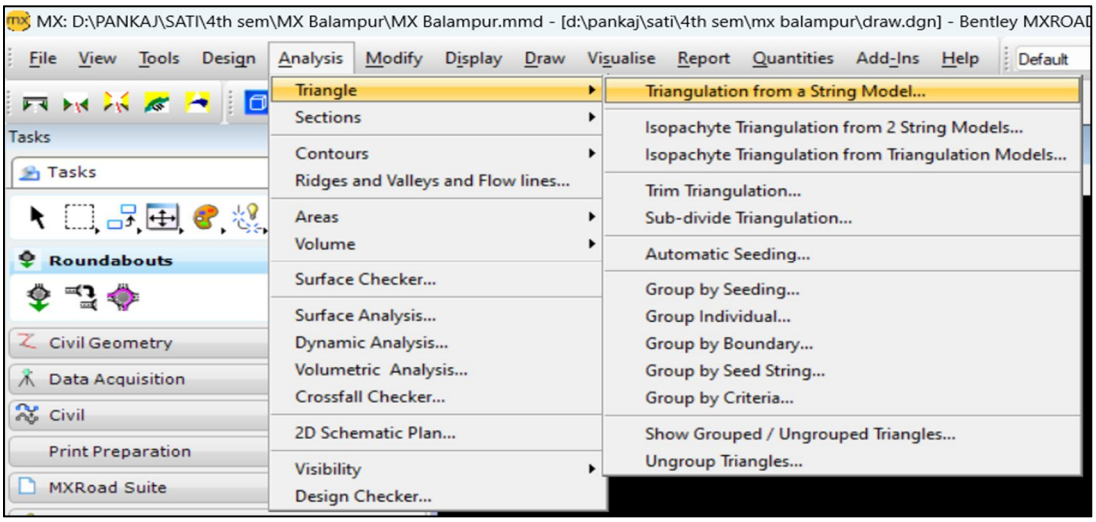

Figure 11: Main menu bar for Triangulation

- Select csv excel file in Model to triangulate and select Model in Model to store Triangulation. Give Triangulation string name TX00 and click OK.

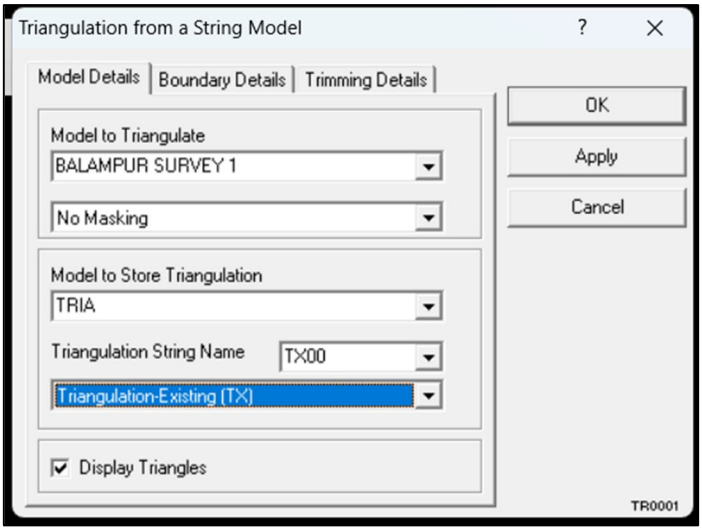

Figure 12: Triangulation from String Model

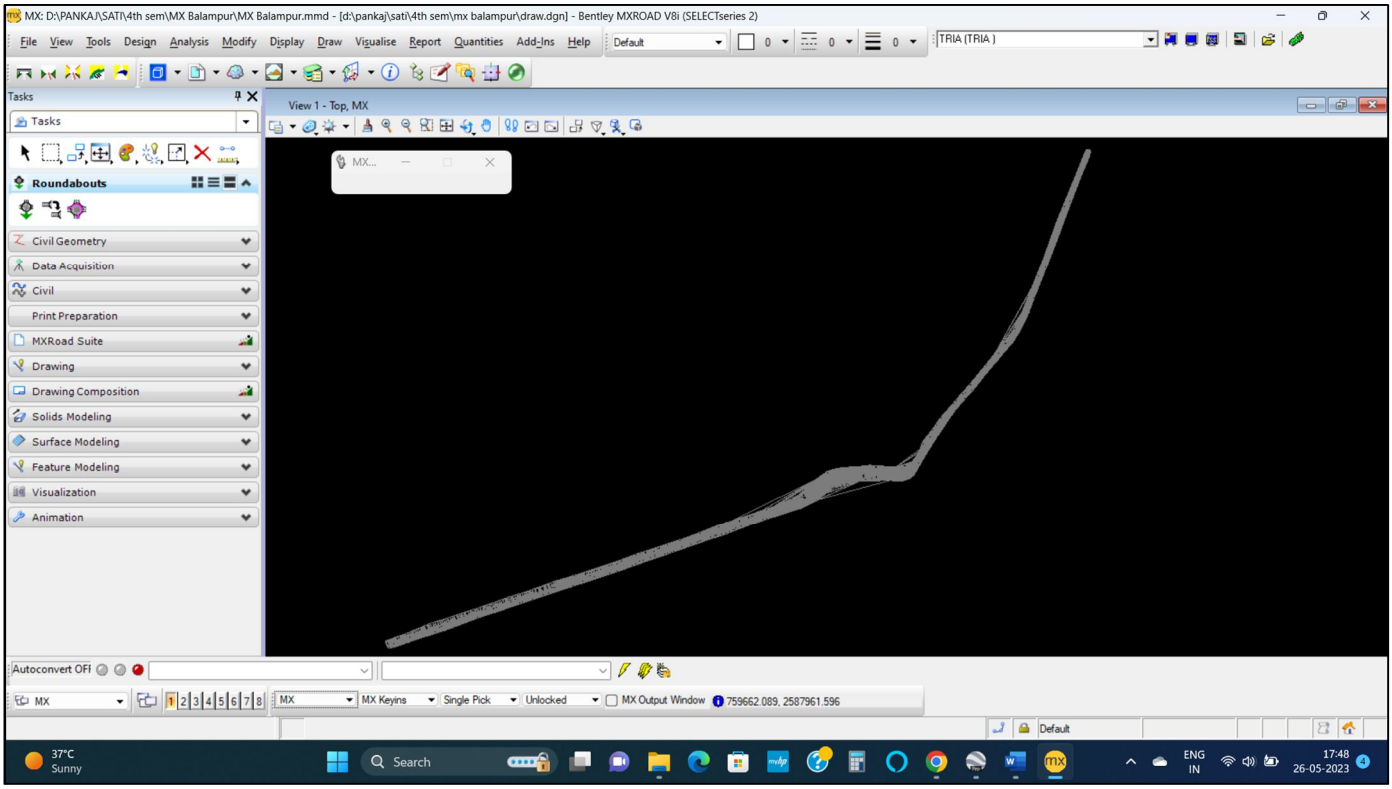

Figure 13: Triangulation output

3) Design Horizontal Alignment

For design the horizontal alignment follow the steps which are given below-

- From the main menu bar, select Design > Quick Alignment > Horizontal Design.

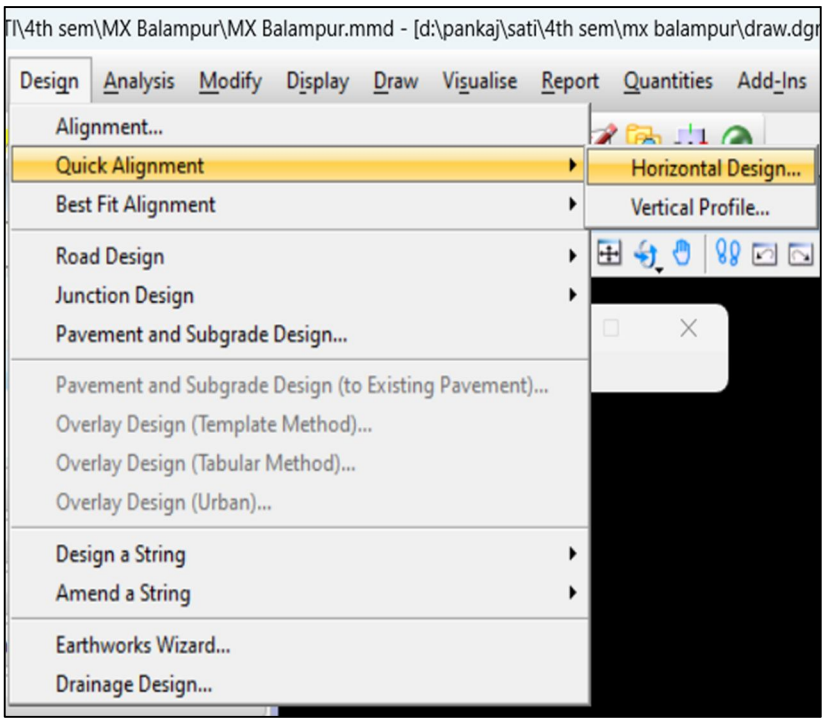

Figure 14: Main menu bar for Horizontal Design

- Select Design model in Model Name and select MC00 in Alignment string Name and click Next.

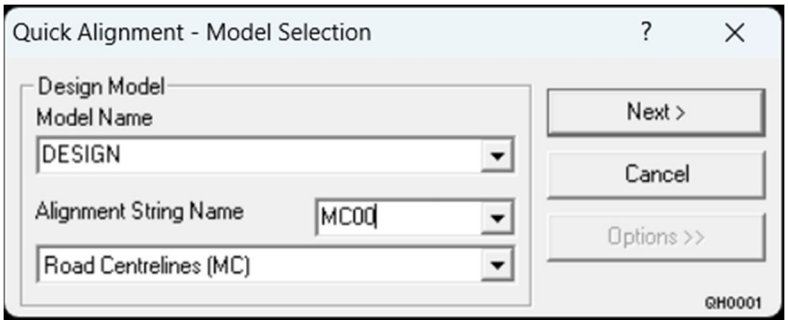

Figure 15: Model selection for Quick Alignment

- Then open a designing tool and with the help of this designing tool, will design horizontal alignment of the road.

Figure 16: Tool bar for Horizontal Design

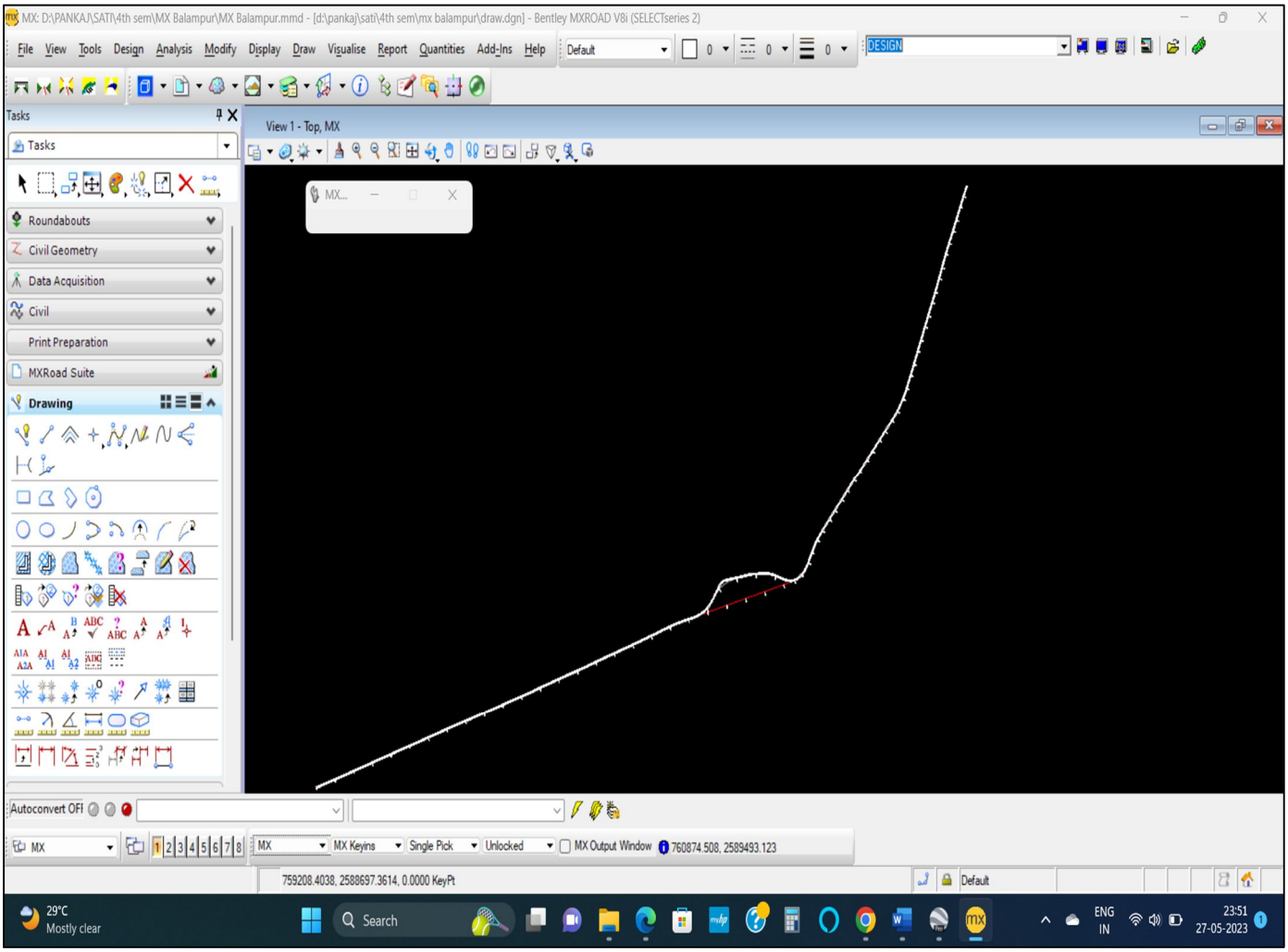

Figure 17: Horizontal design output

4) Design Vertical Profile

For design the vertical profile follow the steps which are given below-

- From the main menu bar, select Design > Quick Alignment > Vertical Profile.

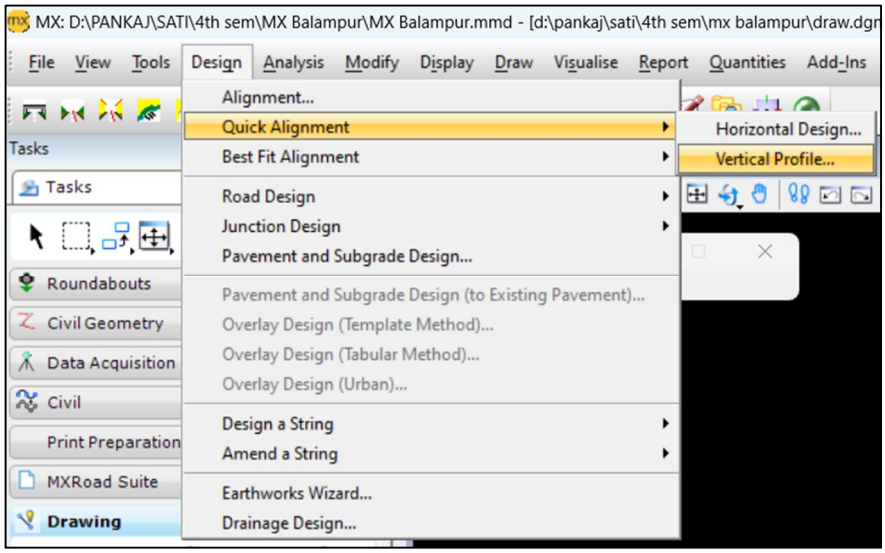

Figure 18: Main menu bar for Vertical Profile Design

- Select Design model in Model Name and select MC00 in String Name and click Next.

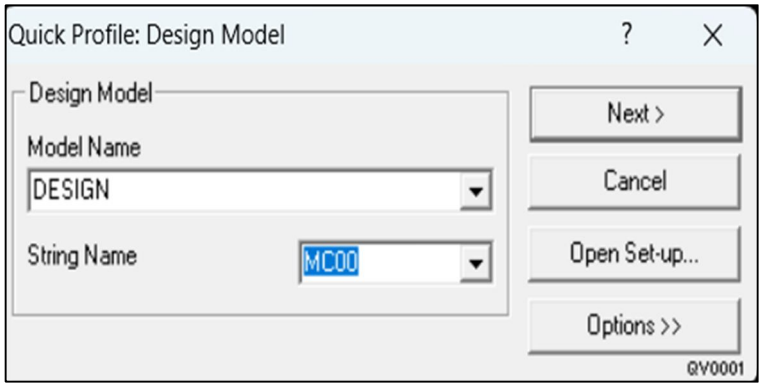

Figure 19: Model selection for Quick Profile

- Select Triangulation model in Model Name and select MC00 in String Name and click Next.

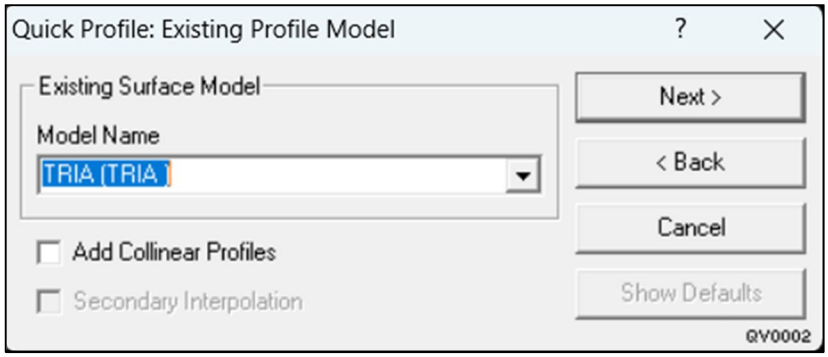

Figure 20: Triangulation selection for Quick Profile

- Then open a designing tool and with the help of this designing tool, will design vertical profile of the road.

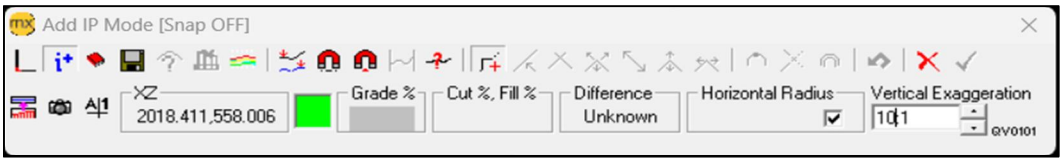

Figure 21: Tool bar for Vertical Profile

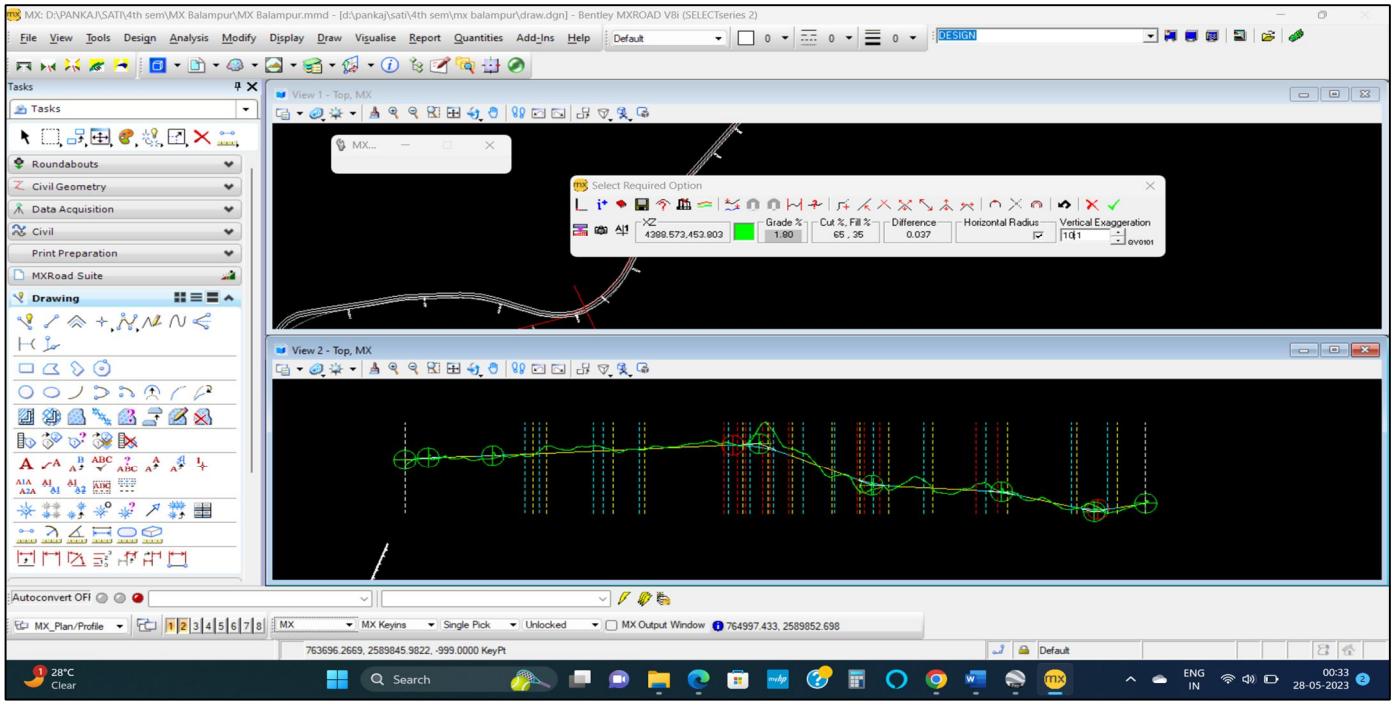

Figure 22: Vertical Profile with tool bar

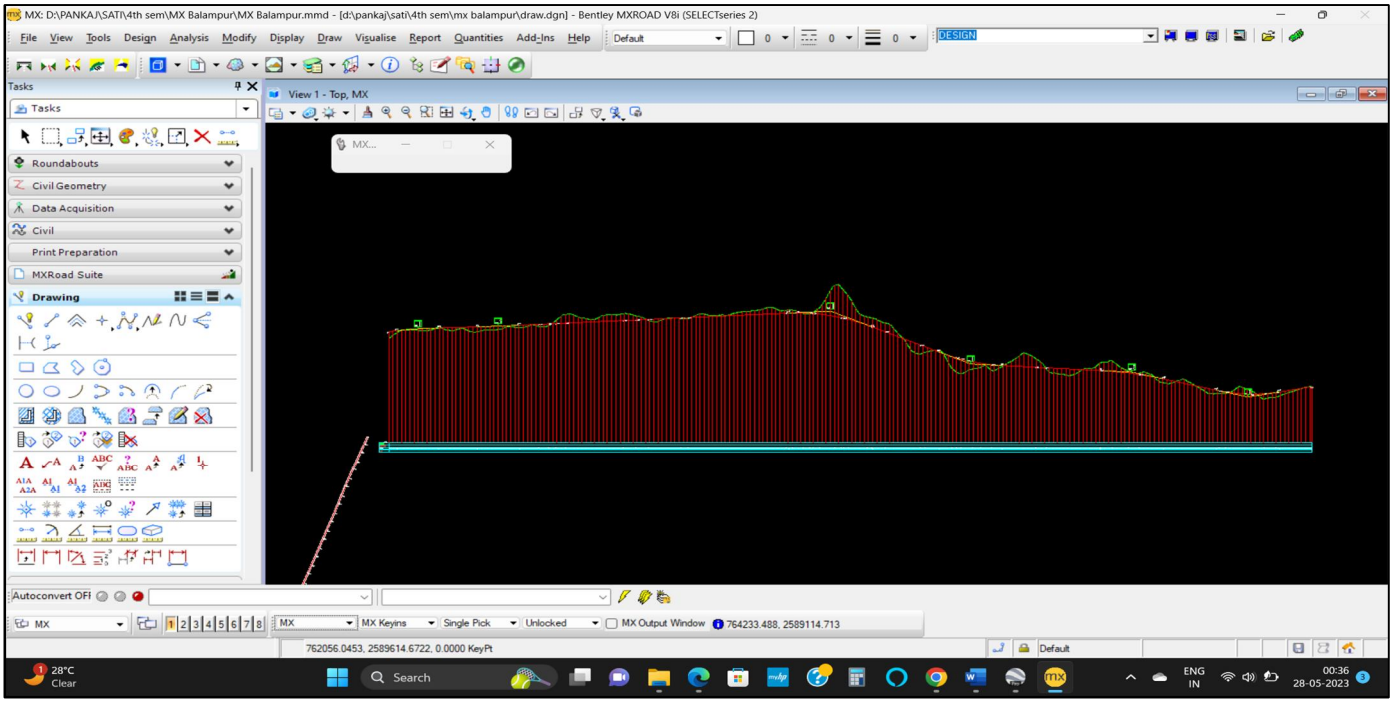

Figure 23: Vertical Profile output

5) Horizontal Alignment Report

For Horizontal alignment report follow the steps which are given below-

- From the main menu bar, select Report > Alignment Reports > Horizontal Alignment Report.

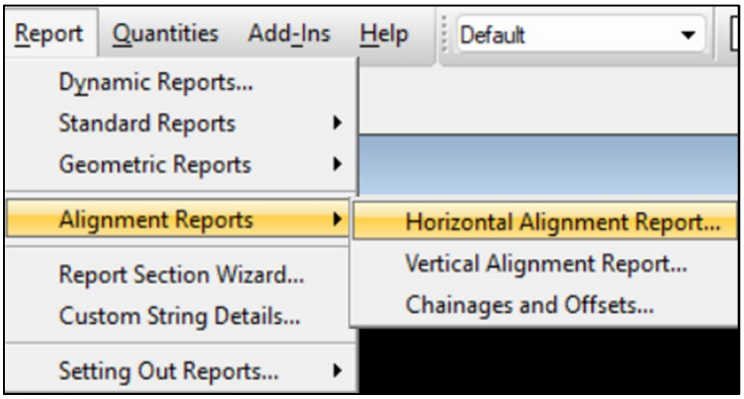

Figure 24: Main menu bar for Horizontal Alignment Report

- Select Design model in Model Name and select MC00 in String Name and click Next.

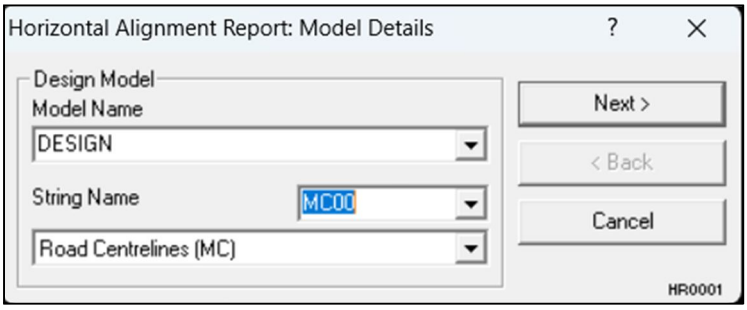

Figure 25: Model selection for Horizontal Alignment Report

- Tick on details which you want to need and click Next.

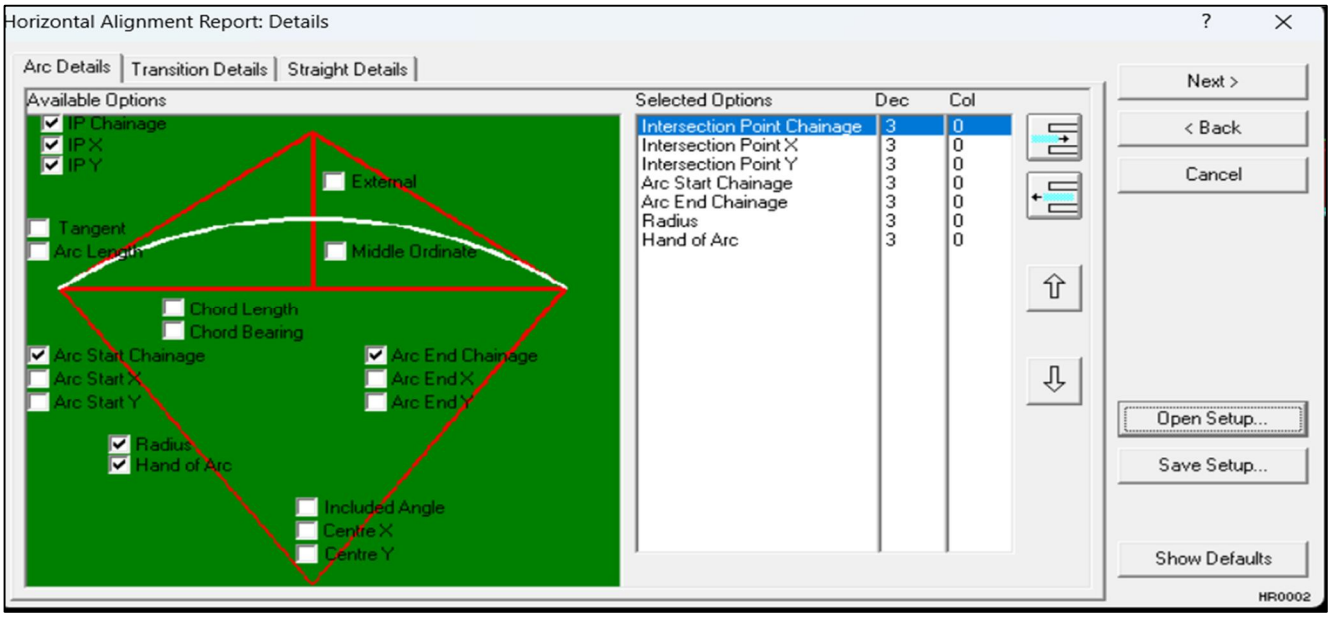

Figure 26: Details selection for Horizontal Alignment Report

- Save the report and click finish.

Figure 27: Horizontal Alignment Report

6) Vertical alignment report-

For Vertical alignment report follow the steps which are given below-

- From the main menu bar, select Report > Alignment Reports > Vertical Alignment Report.

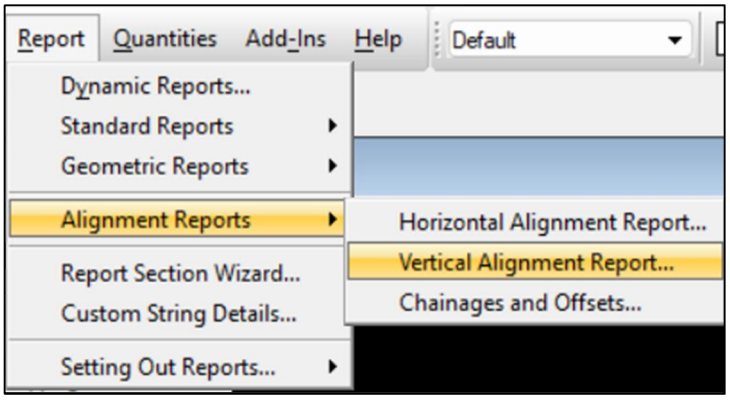

Figure 28: Main menu bar for Vertical Alignment Report

- Select Design model in Model Name and select MC00 in String Name and click Next.

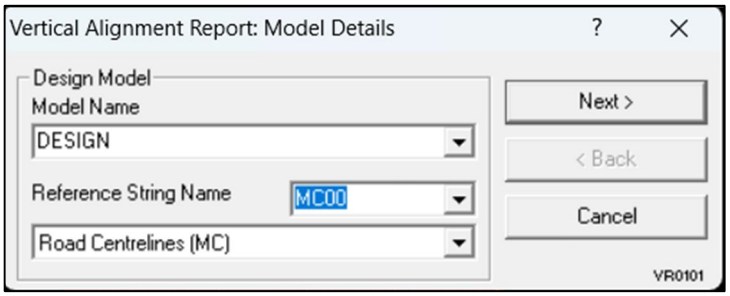

Figure 29: Model selection for Vertical Alignment Report

- Tick on details which you want to need and click Next.

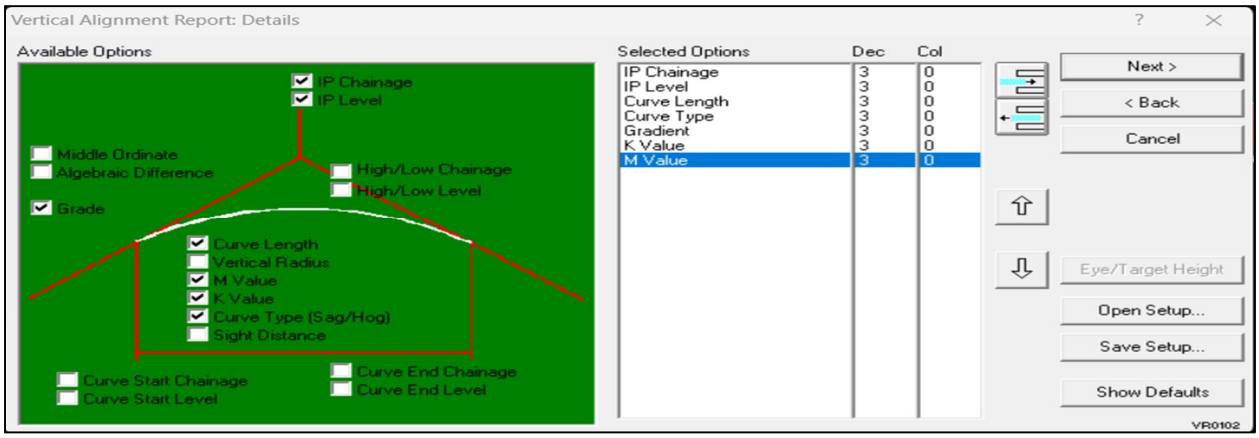

Figure 30: Details selection for Vertical Alignment Report

- Save the report and click finish.

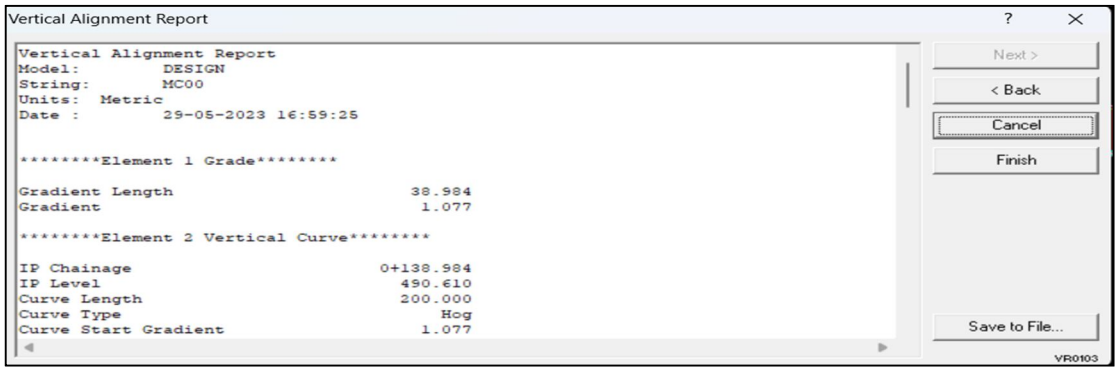

Figure 31: Vertical Alignment Report

III. RESULTS AND DISCUSSION

Plan Of The Balampur Ghat Section On Google Earth

Figure 32: Plan of Existing Alignment

Figure 33: Plan of Improved alignment-1

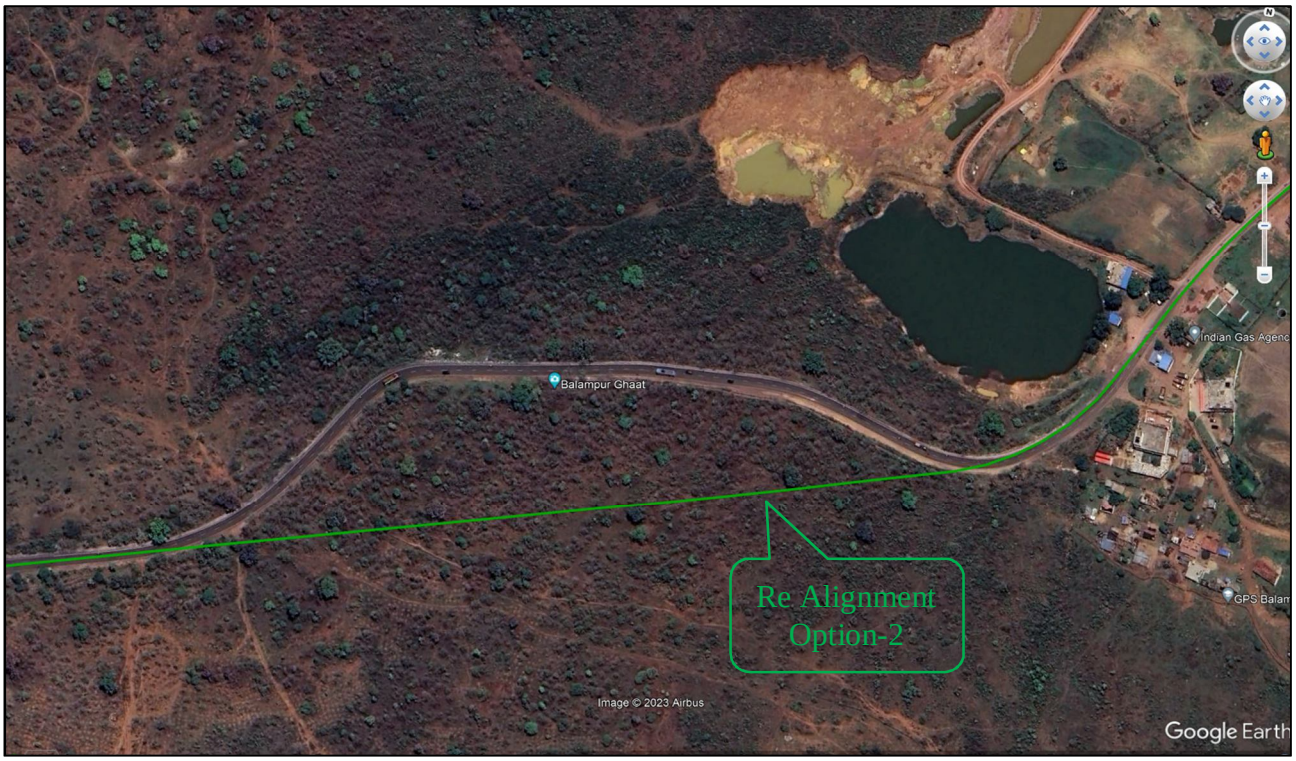

Figure 34: Plan of Improved alignment-2

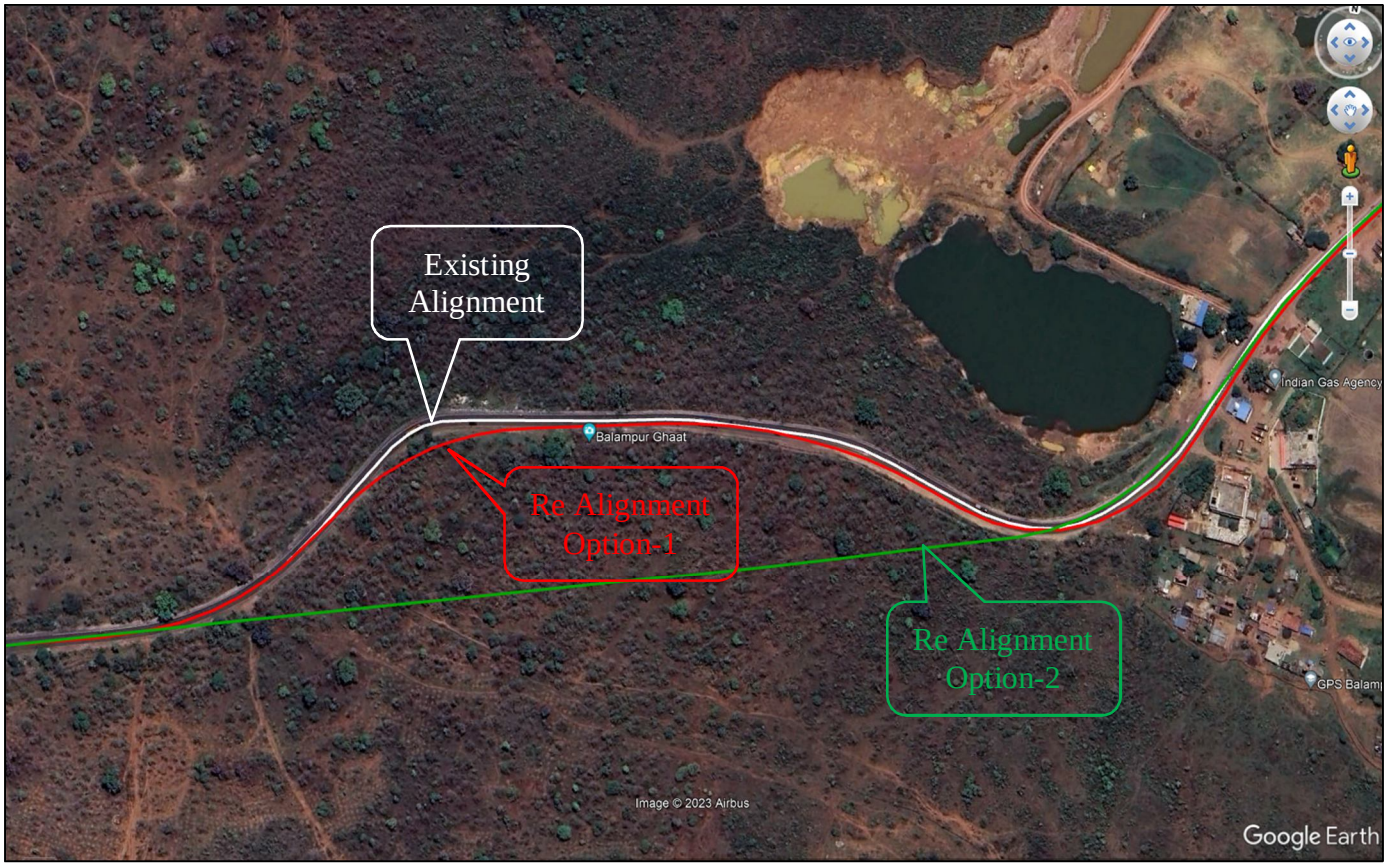

Figure 35: Plan of both improved alignment with existing road

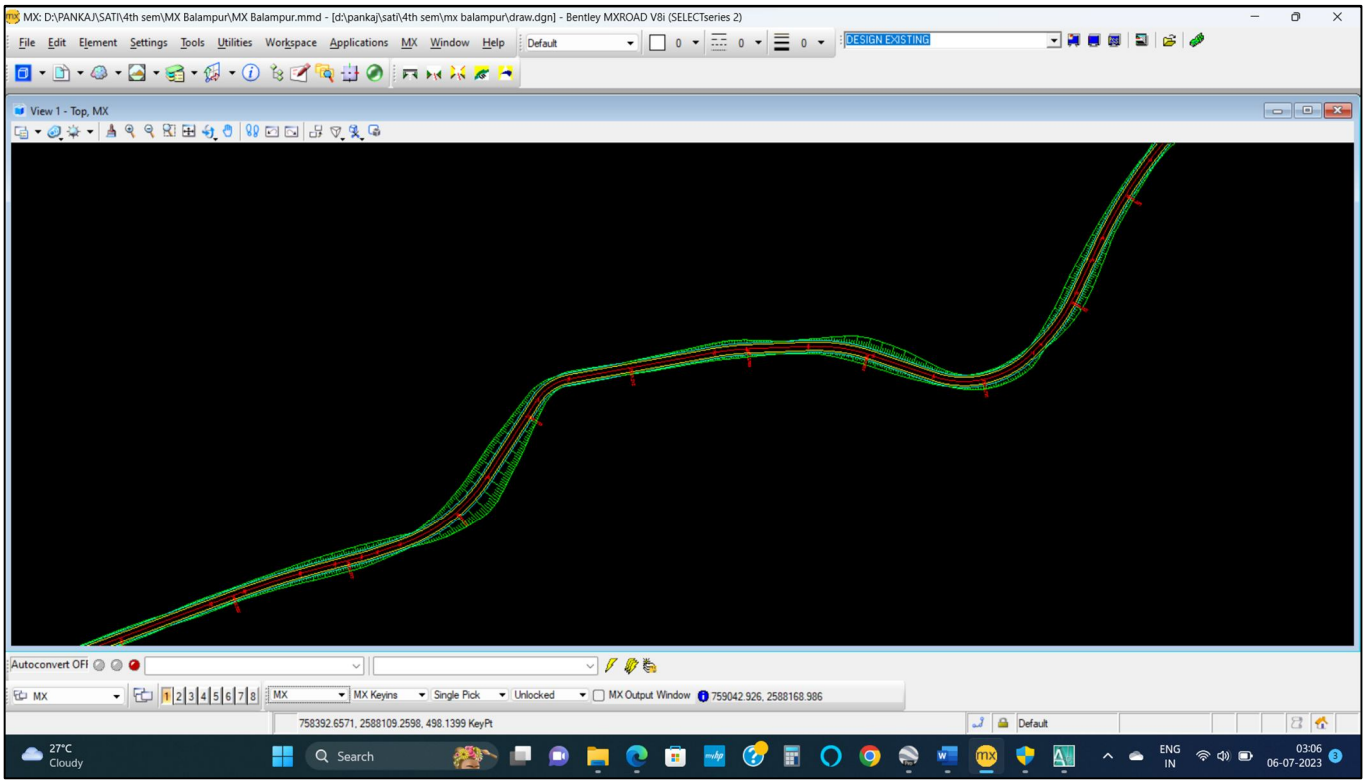

Figure 36: Plan of Existing ghat section in AutoCAD

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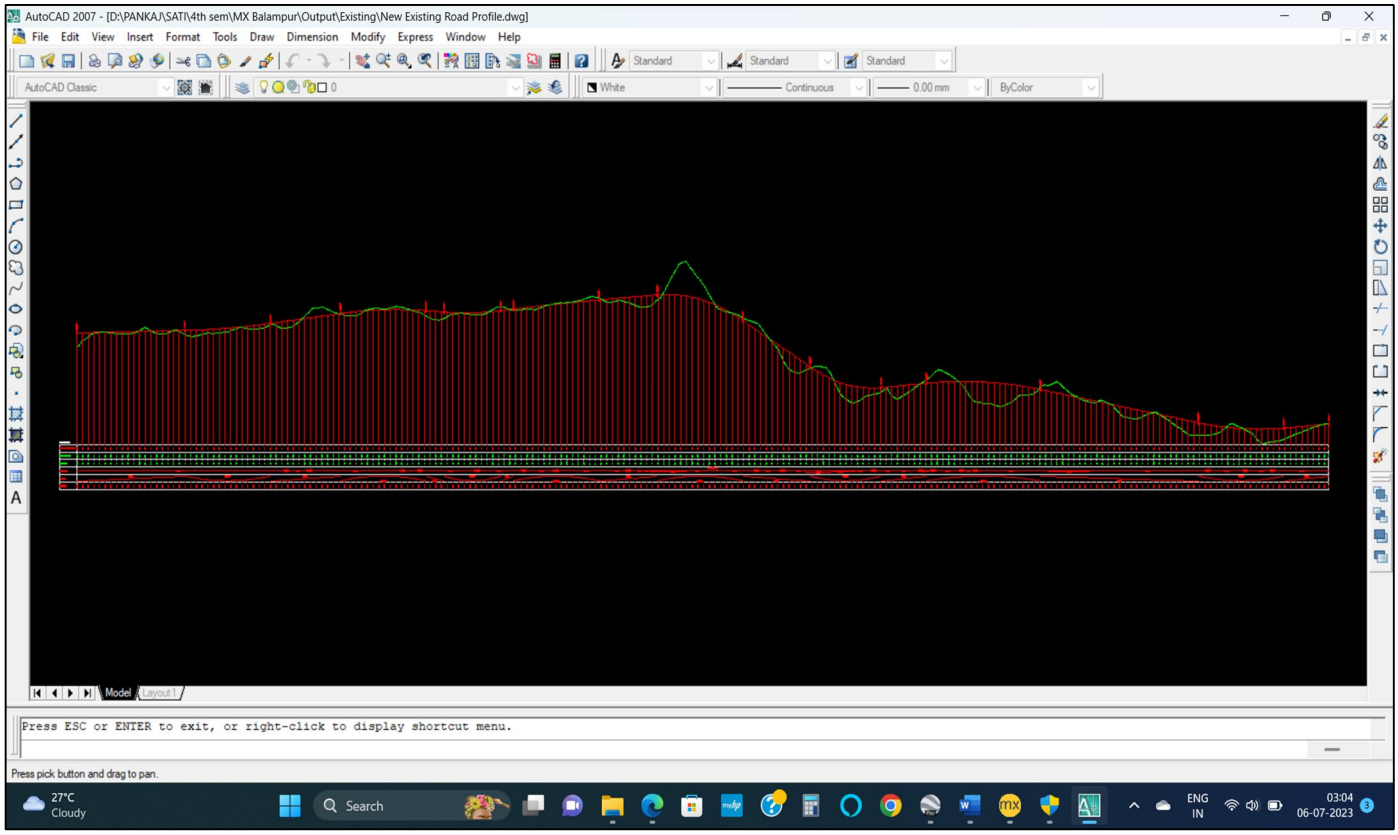


Figure 37: Profile of Existing ghat section in AutoCAD

Table 3: Horizontal Alignment report of existing ghat section

Sl.	Easting, X	Northing, Y	Radius	Transition Length, L_s	Start Chainage of		End Chainage of		HIP Chainage	Hand of Arc	Design Speed, V	Superelevation, e
					Transition	Curve	Curve	Transition				
1	757012.123	2587547.760	2000.000	0.000		12+314	12+359		12+336	Right	100	NR
2	757089.095	2587572.395	2000.000	0.000		12+395	12+440		12+417	Left	100	NR
3	757399.028	2587679.322	2000.000	0.000		12+715	12+775		12+745	Left	100	NR
4	757456.068	2587700.906	2000.000	0.000		12+777	12+835		12+806	Right	100	NR
5	757645.713	2587766.388	2000.000	0.000		12+989	13+024		13+007	Left	100	NR
6	757799.517	2587822.558	4000.000	0.000		13+142	13+199		13+170	Right	100	NR
7	757905.441	2587859.550	2000.000	0.000		13+264	13+302		13+283	Left	100	NR
8	758143.055	2587946.935	800.000	30.000	13+481	13+511	13+560	13+590	13+536	Right	80	3.56%
9	758224.394	2587968.949	200.000	0.000		13+613	13+627		13+620	Left	30	NR
10	758295.977	2587993.044	140.000	0.000		13+647	13+740		13+694	Left	25	NR
11	758373.623	2588111.536	40.000	0.000		13+816	13+849		13+833	Right	20	4.44%
12	758525.487	2588138.804	200.000	0.000		13+972	14+000		13+986	Right	30	NR
13	758618.267	2588142.691	150.000	0.000		14+051	14+106		14+078	Right	25	NR
14	758742.071	2588100.844	80.000	0.000		14+159	14+248		14+204	Left	20	NR
15	758802.516	2588161.653	150.000	0.000		14+258	14+310		14+284	Left	25	NR
16	758852.266	2588265.607	400.000	20.000	14+341	14+361	14+437	14+457	14+399	Right	50	2.78%
17	758954.132	2588394.292	800.000	0.000		14+551	14+574		14+563	Right	60	NR
18	758982.663	2588427.812	1000.000	0.000		14+590	14+624		14+607	Left	60	NR
19	759044.313	2588505.441	500.000	0.000		14+693	14+718		14+706	Right	50	NR
20	759076.389	2588541.886	1000.000	0.000		14+738	14+770		14+754	Left	60	NR
21	759282.928	2588798.132	400.000	55.000	14+992	15+047	15+120	15+175	15+083	Left	80	7.00%
22	759463.122	2589249.804	2000.000	0.000		15+542	15+598		15+570	Left	100	NR
23	759507.740	2589374.469	2000.000	0.000		15+674	15+731		15+702	Right	100	NR
24	759542.124	2589462.560	2000.000	0.000		15+786	15+808		15+797	Right	100	NR

Table 4: Vertical Profile report of existing ghat section

Sr. No.	IP Chainage	IP Level	Curve Length	Curve Type	n1	n2	%Grade Diff. (n1-n2)	K Value	Design Speed
1	12129.489	491.159	300	Sag	0.216	1.337	-1.121	267.727	100
2	12675.6	498.458	300	Hog	1.337	-0.725	2.062	145.497	100
3	12987.998	496.192	200	Sag	-0.725	1.191	-1.916	104.35	100
4	13282.531	499.701	300	Hog	1.191	0.824	0.367	816.851	100
5	13787.735	503.864	300	Hog	0.824	-6.5	7.324	40.961	80
6	14298.454	470.667	250	Sag	-6.5	0.932	-7.432	33.639	80
7	14782.532	475.178	400	Hog	0.932	-1.981	2.913	137.311	100
8	15686.844	457.262	300	Sag	-1.981	0.811	-2.792	107.446	100

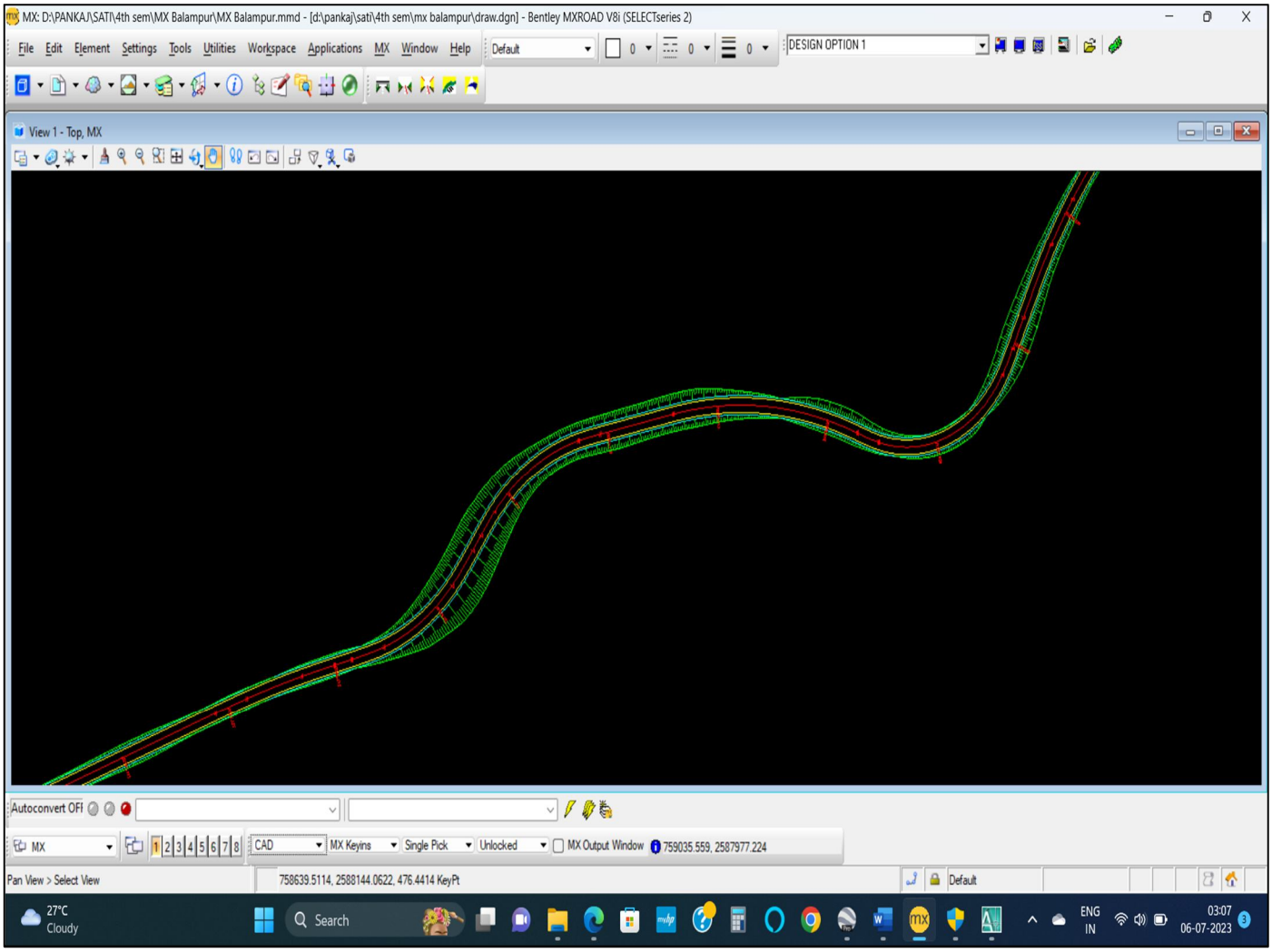


Figure 38: Plan of Improvement-1 in AutoCAD

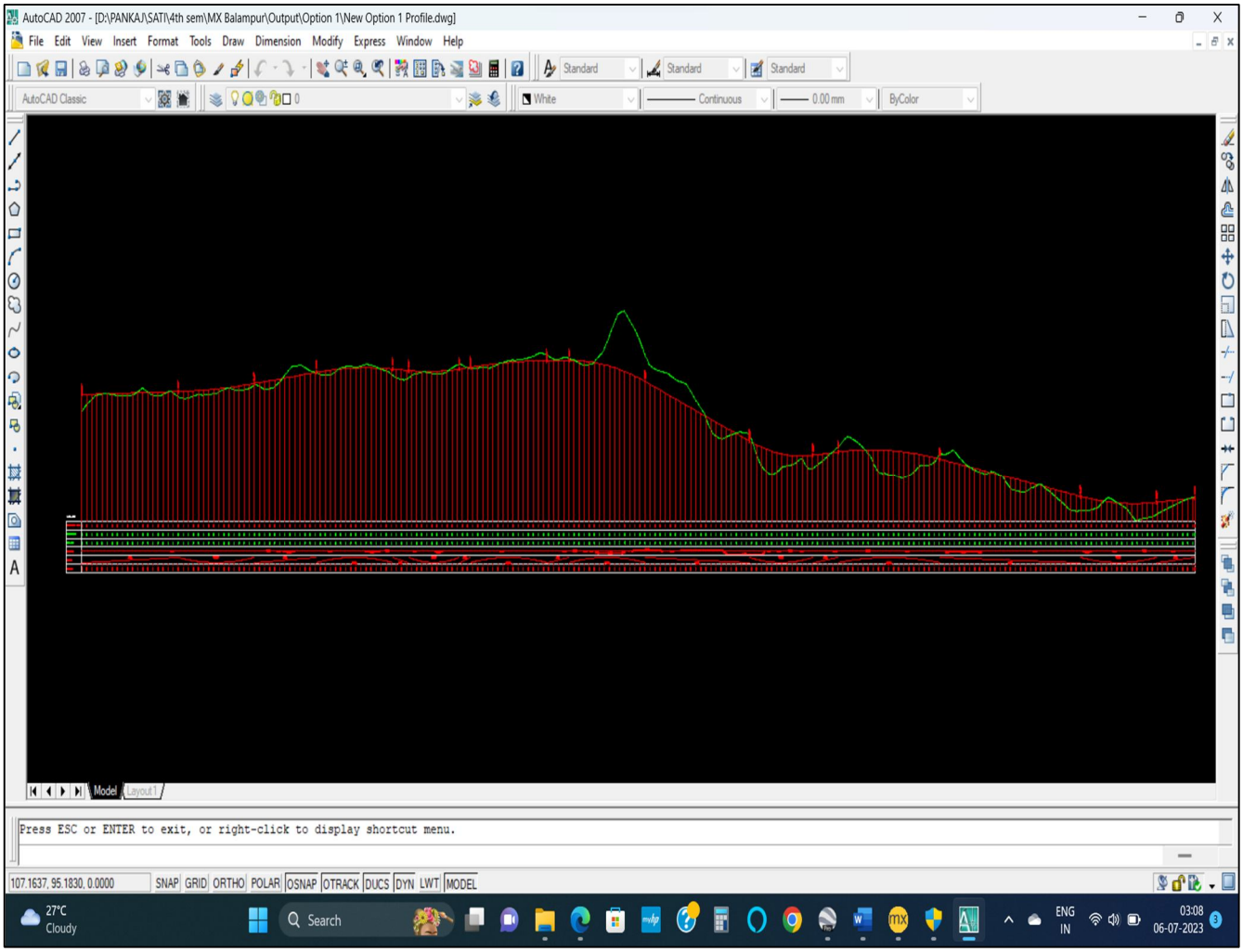


Figure 39: Profile of Improvement-1 in AutoCAD

Table 5: Horizontal Alignment report of Improvement-1

Sl. No.	Easting, X	Northing, Y	Radius	Transition Length, L_s	Start Chainage of		End Chainage of		HIP Chainage	Hand of Arc	Design Speed, V	Super elevation, e
					Transition	Curve	Curve	Transition				
1	757012.123	2587547.76	2000	0		12314.12	12358.59		12336.353	Right	100	NR
2	757089.095	2587572.4	2000	0		12394.71	12439.63		12417.169	Left	100	NR
3	757399.028	2587679.32	2000	0		12715.49	12774.56		12745.025	Left	100	NR
4	757456.068	2587700.91	2000	0		12776.73	12835.29		12806.008	Right	100	NR
5	757645.713	2587766.39	2000	0		12990.45	13022.82		13006.638	Left	100	NR
6	758151.568	2587949.56	800	30	13488.868	13518.87	13570.39	13600.391	13544.63	Right	80	3.56%
7	758285.593	2587988.95	150	30	13616.432	13646.43	13720.87	13750.868	13683.65	Left	50	7.00%
8	758378.828	2588103.17	150	20	13763.457	13783.46	13874.46	13894.46	13828.959	Right	40	4.74%
9	758593.108	2588150.92	300	0		13961.13	14128.64		14044.883	Right	40	NR
10	758765.285	2588095.7	100	20	14128.764	14148.76	14277.33	14297.333	14213.049	Left	40	7.00%
11	758856.338	2588263.86	400	55	14320.518	14375.52	14412.11	14467.113	14393.816	Right	80	7.00%
12	759044.313	2588505.44	2000	0		14675.01	14724.9		14699.958	Right	100	NR
13	759282.64	2588797.57	400	55	14984.955	15039.96	15113.96	15168.963	15076.959	Left	80	7.00%
14	759463.122	2589249.8	2000	0		15547.52	15580.22		15563.87	Left	100	NR
15	759542.124	2589462.56	2000	0		15763.26	15818.37		15790.817	Right	100	NR

Table 6: Vertical Profile report of Improvement -1

Sr. No.	IP Chainage	IP Level	Curve Length	Curve Type	n1	n2	%Grade Diff. (n1-n2)	K Value	Design Speed
1	12129.489	491.159	300	Sag	0.216	1.337	-1.121	267.618	100
2	12675.39	498.458	300	Hog	1.337	-0.725	2.062	145.506	100
3	12987.998	496.192	200	Sag	-0.725	1.191	-1.916	104.376	100
4	13282.49	499.701	300	Hog	1.191	0.082	1.109	270.422	100
5	13670.863	500.019	300	Hog	0.082	-4.2	4.282	70.061	80
6	14356.779	471.211	250	Sag	-4.2	0.932	-5.132	48.715	80
7	14782.478	475.177	400	Hog	0.932	-1.981	2.913	137.321	100
8	15686.844	457.262	300	Sag	-1.981	0.811	-2.792	107.45	100

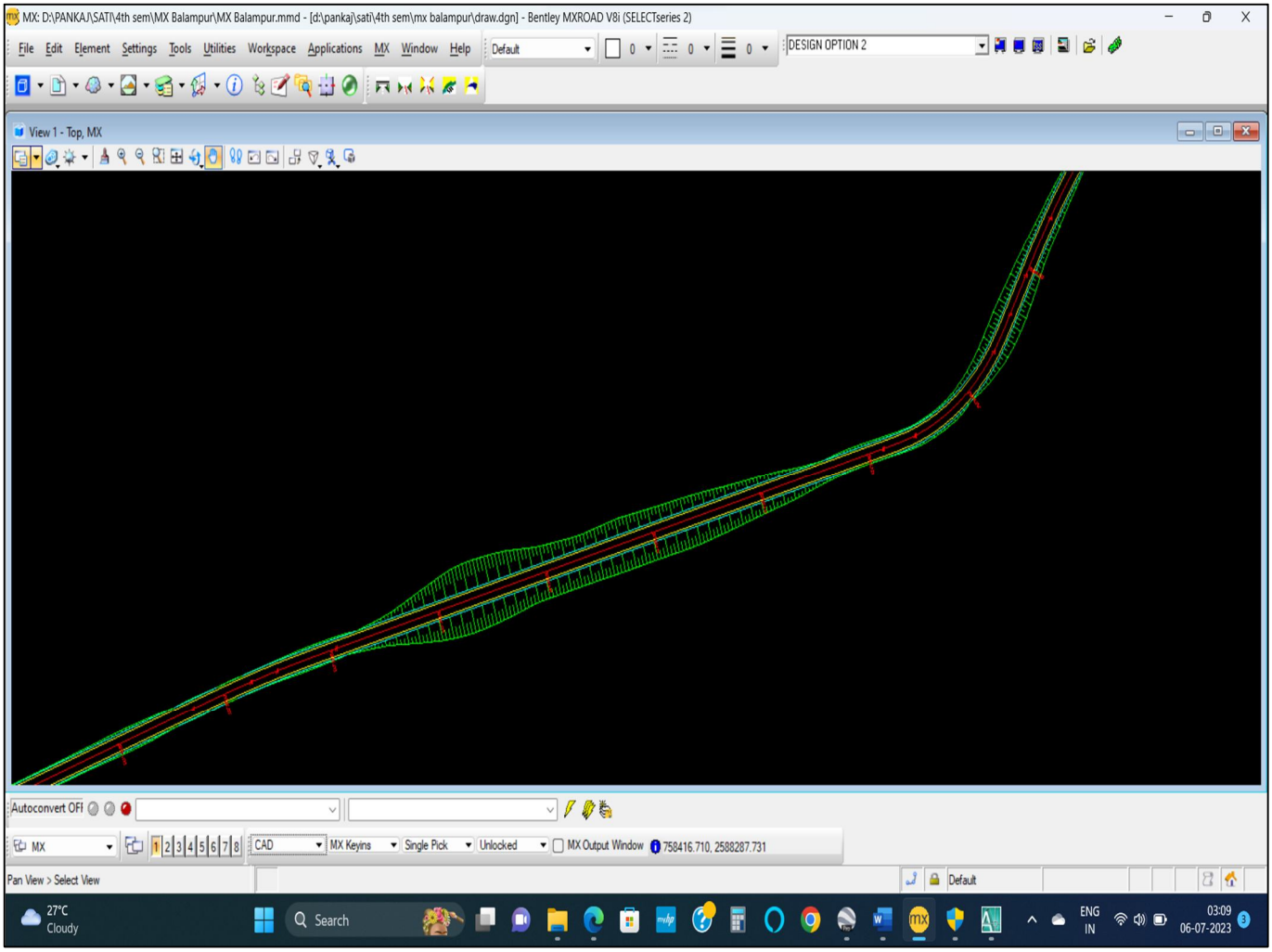


Figure 40: Plan of Improvement-2 in AutoCAD

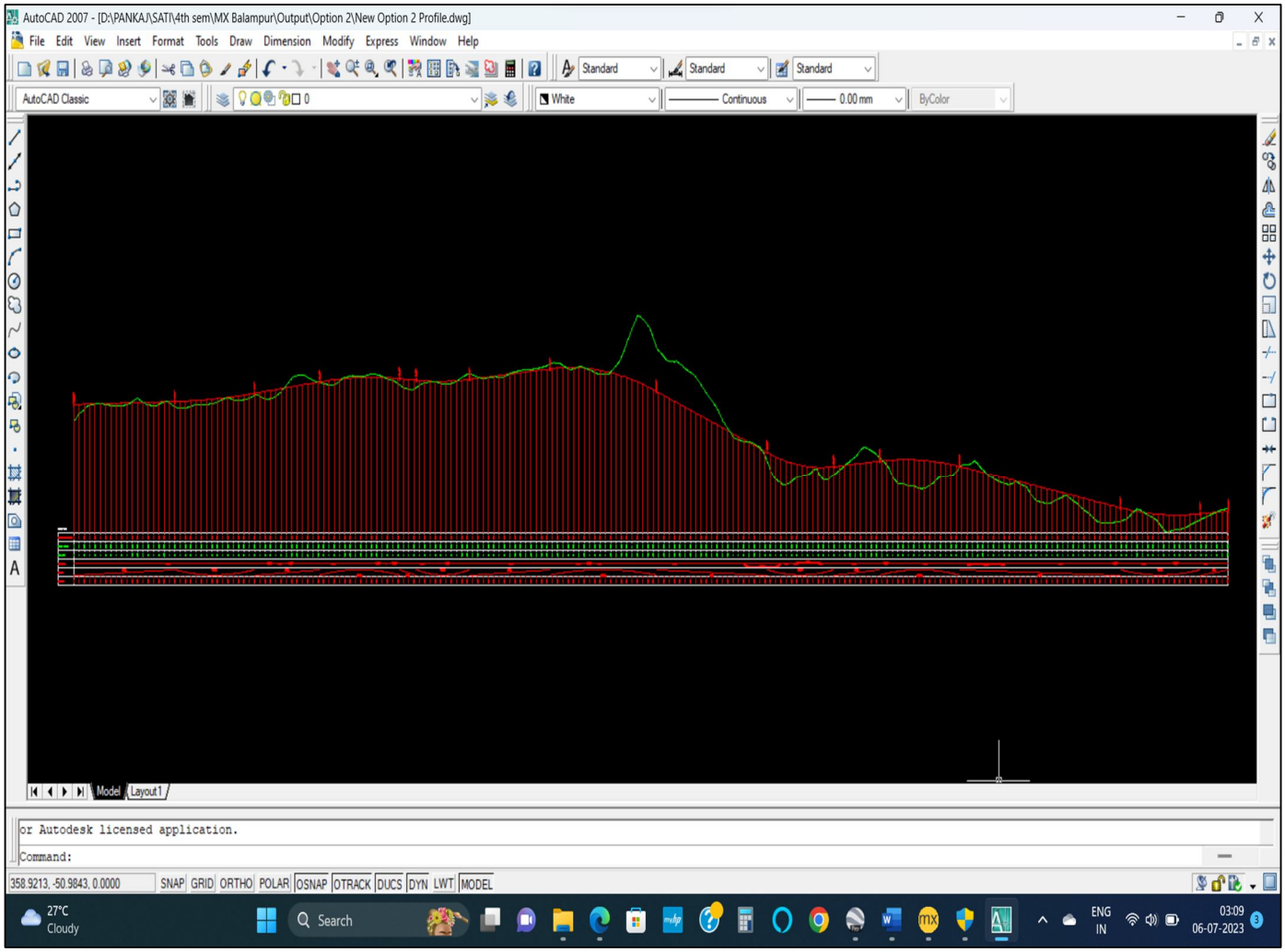


Figure 41: Profile of Improvement-2 in AutoCAD

Table 7: Horizontal Alignment report of Improvement-2

Sl. No.	Easting, X	Northing, Y	Radius	Transition Length, L_s	Start Chainage of		End Chainage of		HIP Chainage	Hand of Arc	Design Speed, V	Super elevation, e
					Transition	Curve	Curve	Transition				
1	757012.123	2587547.76	2000	0		12314.12	12358.59		12336.353	Right	100	NR
2	757089.095	2587572.4	2000	0		12394.71	12439.63		12417.169	Left	100	NR
3	757399.028	2587679.32	2000	0		12715.49	12774.56		12745.025	Left	100	NR
4	757456.068	2587700.91	2000	0		12776.73	12835.29		12806.008	Right	100	NR
5	757645.713	2587766.39	2000	0		12990.37	13022.91		13006.638	Left	100	NR
6	758146.304	2587947.51	1000	55	13471.682	13526.68	13551.31	13606.306	13538.994	Right	100	4.44%
7	758773.447	2588127.26	150	30	14114.539	14144.54	14235.8	14265.798	14190.169	Left	50	7.00%
8	758862.817	2588277.76	500	45	14294.928	14339.93	14387.79	14432.789	14363.859	Right	80	5.69%
9	759044.313	2588505.44	2000	0		14639.63	14670.45		14655.04	Right	100	NR
10	759282.64	2588797.57	400	55	14940.037	14995.04	15069.05	15124.046	15032.042	Left	80	7.00%
11	759463.122	2589249.8	2000	0		15502.6	15535.31		15518.953	Left	100	NR
12	759542.124	2589462.56	2000	0		15718.35	15773.45		15745.9	Right	100	NR

Table 8: Vertical Profile report of Improvement-2

Sr. No.	IP Chainage	IP Level	Curve Length	Curve Type	n1	n2	%Grade Diff. (n1-n2)	K Value	Design Speed
1	12129.489	491.159	300	Sag	0.216	1.337	-1.121	267.618	100
2	12675.479	498.459	300	Hog	1.337	-0.725	2.062	145.465	100
3	12988.092	496.191	200	Sag	-0.725	0.989	-1.714	116.662	100
4	13591.702	502.161	400	Hog	0.989	-4.2	5.189	77.086	100
5	14333.732	470.996	250	Sag	-4.2	0.932	-5.132	48.714	80
6	14782.458	475.178	300	Hog	0.932	-1.981	2.913	102.987	100
7	15686.844	457.262	300	Sag	-1.981	0.811	-2.792	107.45	100

A. Improvement Analysis

The improvement benefits of the Balampur ghat section of SH-18 (Bhopal – Vidisha Road) are given in Table 4.7.

Table 9: Improvement Analysis

S. No.	Description	Before Improvement	After Improvement
1	Length of the section	2.000 km	1.940 km
2	Horizontal alignment	Before improvements the horizontal alignment was unsafe for road users.	The horizontal alignment has been safe for the road users.
3	Vertical alignment	The vertical alignment was steeper (> 6.4%) before the improvement.	The vertical alignment has less than 4.3% gradient after improvement.
4	Improper horizontal curves	There were 7 nos. of improper horizontal curves and 7 nos. of curves which has no transition curves as per IRC recommendations.	There is no improper curve. The all curves are as per IRC recommendations.

B. Cost Analysis

The existing road stretch is in hilly terrain and for the improvement of the existing road stretch of the Balampur ghat section will have to cut and The normative cost analysis of the both improved alignments are done as per the Ministry of Road transport and Highways (MoRTH) Letter no. RW/NH-24036/27/2010-PPP, Dated 25/04/2018 for flexible pavement. Cost analysis of the both improved alignments is given below in Table 4.8.

Table 10: Cost Analysis

S. No.	Description	Unit	Improvement - 1	Improvement - 2
1	Total length of the section	km	1.990	1.940
2	Length of cutting portion (Greenfield alignment) in Hilly terrain	km	1.180	1.440
3	Length of widening section in plain terrain	km	0.810	0.500
4	Normative cost for greenfield alignment 2 lane + paved shoulder as per Table no. 2 (Amount - Rs in Crore)	km	9.60	9.60
5	Normative cost for widening to 2 lane + paved shoulder as per Table no. 1 (Amount - Rs in Crore)	km	3.19	3.19
6	Amount for greenfield alignment 2 lane + paved shoulder (Amount - Rs in Crore)	-	11.328	13.824
7	Amount for the widening of the road stretch (Amount - Rs in Crore)	-	2.584	1.595
8	Total amount (Amount - Rs in Crore)	-	13.912	15.419

C. Summary of the Analysis

From the design outputs, summery of the improved alignments of the existing road is given below in Table 4.9

Table 11: Summary of the Analysis

Sl. No.	Description	Existing Alignment	Improved alignment-1	Improved alignment-2
1	Length of alignment	2.000 km	1.990 km	1.940 km
2	Terrain	Hilly	Hilly	Hilly
3	Min. design speed	20 kmph or less	40 kmph	50 kmph
4	No. of improper horizontal curves	7	-	-
5	No. of horizontal curves at which speed < 40 kmph.	7	-	-

6	No. of horizontal curves at which radius < 75 m.	1	-	-
7	Max. gradient in vertical profile	6.5 %	4.2 %	4.2 %
8	Utilization of Existing road	2.000 km	0.810 km	0.500 km
9	Civil cost in crore	6.38	13.912	15.419
10	Merits	-	1. Radius and design speed are as per IRC recommendations.	1. Radius and design speed are as per IRC recommendations.
		-	-	2. Less No. of curves and Geometry is generally straight.
11	Demerits	1. Alignment passes through forest	1. Alignment passes through forest	1. Alignment passes through forest
		2. It has safety issues	-	-
		3. It has more curves	3. It has more curves	-

IV. CONCLUSION

A. *Conclusion*

The objectives of the study were "Improvements in the Horizontal Alignment and Vertical Profile of Balampur ghat section in Bhopal - Vidisha SH-18 (From km 13.000 to km 15.000) in Madhya Pradesh as per IRC recommendations. There are designed two improvements of the existing road from km 13.000 to km 15.000 as per IRC recommendations. Improved alignment-1 is slightly inner side or right side of the existing road and improved alignment-2 is straight from km 13.650 to km 14.050 in inner side or right side.

The conclusion of the research work for designing of the horizontal alignment and vertical profile of the existing ghat section are given below-

1) All the improvements are adopted as per IRC recommendations.
2) Desirable minimum radius is adopted in horizontal curves in both improved alignments. Only at chainage km 14.213 in improved alignment – 1, the curve radius is less than the desirable minimum but that is more than the absolute minimum radius values.
3) Ruling gradient values are adopted in improved vertical alignment.
4) The adopted design speeds for mountainous terrain are 60 kmph and 40 kmph for ruling design speed and minimum design speed respectively.
5) The both improved alignments are designed to reduce consistency of accidents as well as delay time at existing road and to increase the safe design speed for road users.
6) After the improvements of the existing alignment, the human and economic losses will be reduced.
7) The travel time will be reduced at the ghat section and the maintenance of the vehicles will also reduce.
8) The goods transport will be easier and faster for the supply of the product.
9) The improved alignment – 2 is the better option for the existing road stretch improvements.
10) High accuracy in the design with saving the time were achieved by using MXROAD.

B. Study Benefit After Improvements

As per this research study, after improvements in the existing road section many types of benefits will meet to the road users which are given below-

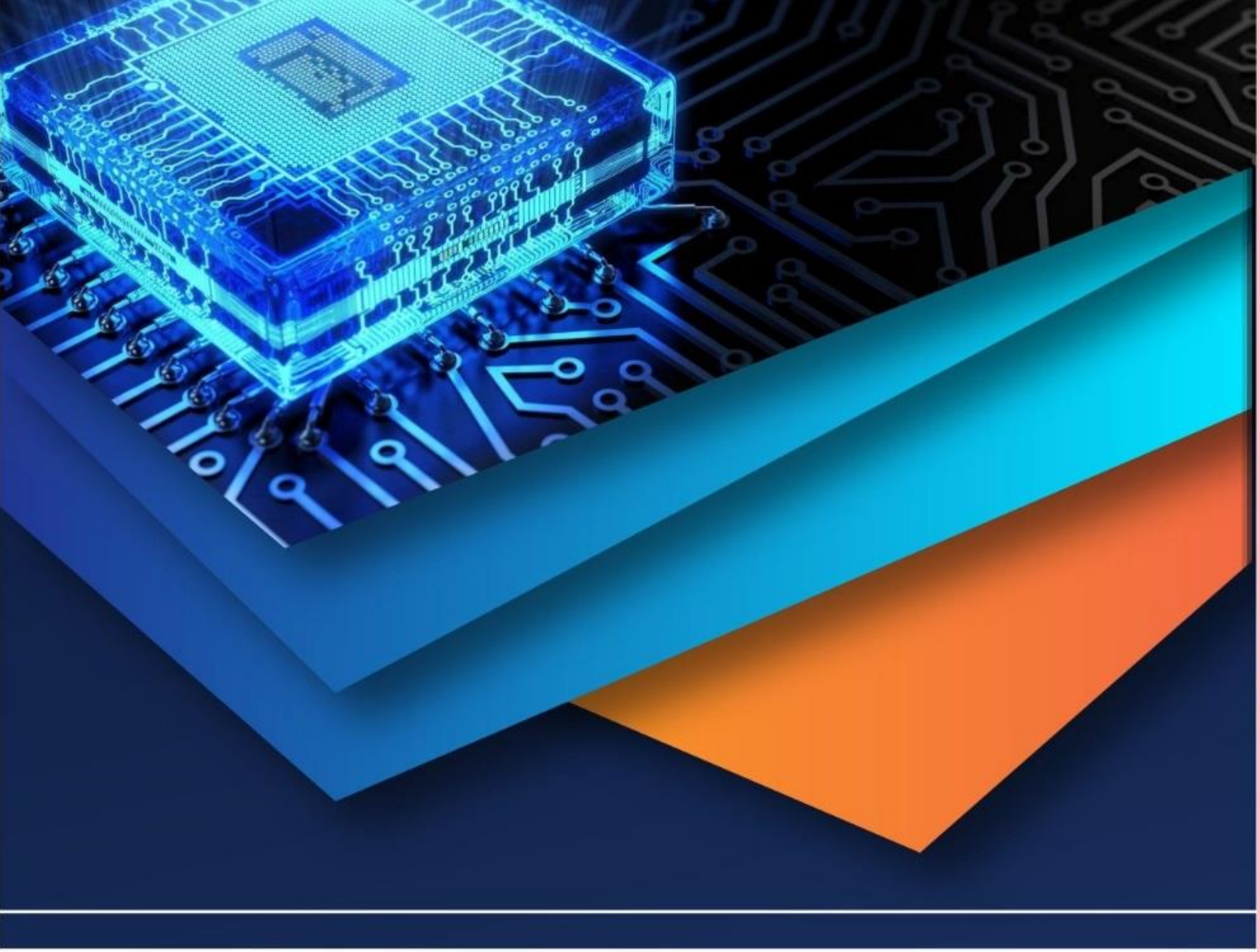
1) The design speed of the ghat section will be > 40 kmph.
2) The alignment will be safer for road users.
3) The delay time due to slow speed of the commercial vehicles at the ghat section will be minimized.
4) The accident-prone area will be over.

C. Scope for the Future

1) Further studies need to be traffic studies and design carriageway of the road.
2) Further studies need to be pavement design.
3) Further studies need to be preparation of cost estimate.

REFERENCES

[1] Highway Engineering by S.K Khanna, C.E.G. Justo & A, Veeraragavan
[2] IRC SP 73-2018 “Manual of Specification and Standards for Two Laning of Highways with Paved Shoulder”
[3] IRC 38-1988 “Design of Horizontal Curves for Highway and Design Tables”. Indian Road Congress, New Delhi, 1988”.
[4] IRC SP 23-1983 “Design of Vertical Curves for Highway”. Indian road Congress, New Delhi, 1983.
[5] IRC 52-2019 “Hill Road Manual”.
[6] Ministry of Road transport and Highways (MoRTH) Letter no. RW/NH-24036/27/2010-PPP, Dated 25/04/2018
[7] AASHTO, A policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation officials: Washington, D.C.
[8] Bentley, MXROAD Introduction Manual, Bentley System, Inc
[9] Ashok Kumar et al [2021], Up gradation of geometric design of sh-131 Maharashtra (ch. 9.35 km - 15.575 km) using mx road software - a study. International Journal of Civil Engineering and Technology (IJCIET), Pp. 67-78.
[10] R. D. K. Shallam et al [2018], Operating Speed Modeling for the Rural Highways Passing through Hilly Terrain. J. Transp. Eng., Part A: Systems, 147(5): 04021015.
[11] Matthew G. Karlaftis and Ioannis Golias [2020], Effects of road geometry and traffic volumes on rural roadway accident rates. Elsevier Science Ltd. Accident Analysis and Prevention 34: 357–365.
[12] George Kanellaidis and Sophia Vardaki [2020], Highway Geometric Design from the Perspective of Recent Safety Developments. J. Transp. Eng., 137(12): 841-844.
[13] Clarkson H. Oglesby and H. M. ASCE [2019], Consistency in Design for Low-Volume Rural Roads. J. Transp. Eng., 111(5): 510-519.
[14] B. K. Roy [2019], Geometric Design of Compound Horizontal Curves. J. Transp. Eng., 120(4): 674-683.
[15] Natacha E. Thomas et al [2019], Revised Design Parameters for Vertical Curves. J. Transp. Eng., 124(4): 326-334



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