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# RURAL ROAD DESIGN ENHANCEMENT USING CIVIL 3D

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**Abstract-** *Efficiently designing rural roads is crucial for the Indian road network, despite their lower traffic volume. Ensuring the safety of commuters requires proper road design. Developing these roads, which constitute a significant portion of the overall road network, will contribute to the country's overall development. In this research paper, we utilized Civil 3D software to design a 600-meter road, generating outputs such as tabular columns for curves, profile sections, and road alignment. The objective of this work is to demonstrate the user-friendly nature of Civil 3D in rural road design. By improving transportation infrastructure nationwide, the economic activities of the country will be greatly enhanced*

***Key Words***: AutoCAD Civil 3D, Geometric Design, Total Station

## 1. INTRODUCTION

The geometric design of roads is crucial as it involves determining the dimensions and visible features of the road. This design plays a critical role in establishing the requirements for drivers and vehicles, with a focus on efficiency and safety. Elements such as cross-sections, sight distance, intersections, vertical alignment, and horizontal alignment are key considerations in geometric design. Implementing proper geometric design significantly contributes to reducing accidents and their severity. The primary objective is to achieve optimal traffic operation efficiency and ensure maximum safety while being cost-effective. This paper demonstrates a typical road design using AutoCAD Civil 3D, a software tool that offers time and energy-saving capabilities. By utilizing 3D modeling, challenges in road design, particularly in computing cut and fill volumes, can be effectively addressed. AutoCAD Civil 3D enables more efficient and accurate volume calculations, enhancing overall design precision.

## 2. SURVEYING AND DATA COLLECTION

Prior to commencing the design of the project road, a survey was conducted to gather essential information. This survey included activities such as location study, reconnaissance, preliminary survey, final location survey, map study, and reconnaissance survey. Using a total station, survey points were acquired at the project site situated in Beekanahalli, Chikkamagalur.

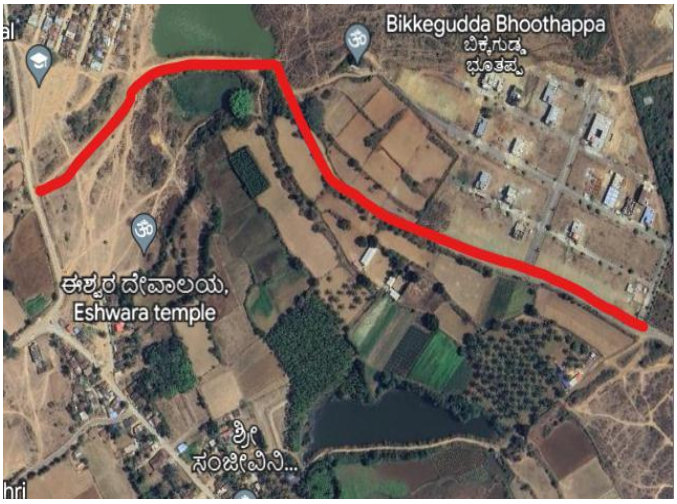
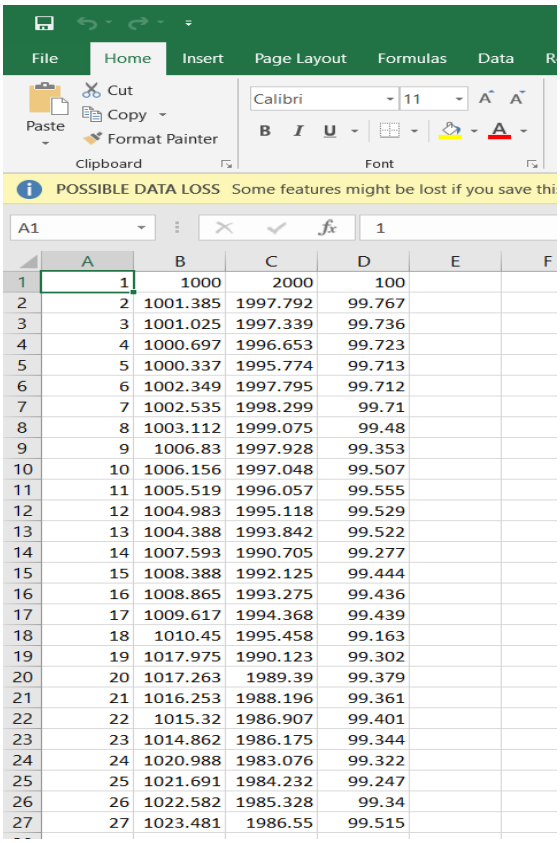



**Figure 1- Satelite image of a selected area of the project**




| | A | B | C | D |
|---|---|---|---|---|
| 1 | 1 | 1000 | 2000 | 100 |
| 2 | 2 | 1001.385 | 1997.792 | 99.767 |
| 3 | 3 | 1001.025 | 1997.339 | 99.736 |
| 4 | 4 | 1000.697 | 1996.653 | 99.723 |
| 5 | 5 | 1000.337 | 1995.774 | 99.713 |
| 6 | 6 | 1002.349 | 1997.795 | 99.712 |
| 7 | 7 | 1002.535 | 1998.299 | 99.71 |
| 8 | 8 | 1003.112 | 1999.075 | 99.48 |
| 9 | 9 | 1006.83 | 1997.928 | 99.353 |
| 10 | 10 | 1006.156 | 1997.048 | 99.507 |
| 11 | 11 | 1005.519 | 1996.057 | 99.555 |
| 12 | 12 | 1004.983 | 1995.118 | 99.529 |
| 13 | 13 | 1004.388 | 1993.842 | 99.522 |
| 14 | 14 | 1007.593 | 1990.705 | 99.277 |
| 15 | 15 | 1008.388 | 1992.125 | 99.444 |
| 16 | 16 | 1008.865 | 1993.275 | 99.436 |
| 17 | 17 | 1009.617 | 1994.368 | 99.439 |
| 18 | 18 | 1010.45 | 1995.458 | 99.163 |
| 19 | 19 | 1017.975 | 1990.123 | 99.302 |
| 20 | 20 | 1017.263 | 1989.39 | 99.379 |
| 21 | 21 | 1016.253 | 1988.196 | 99.361 |
| 22 | 22 | 1015.32 | 1986.907 | 99.401 |
| 23 | 23 | 1014.862 | 1986.175 | 99.344 |
| 24 | 24 | 1020.988 | 1983.076 | 99.322 |
| 25 | 25 | 1021.691 | 1984.232 | 99.247 |
| 26 | 26 | 1022.582 | 1985.328 | 99.34 |
| 27 | 27 | 1023.481 | 1986.55 | 99.515 |

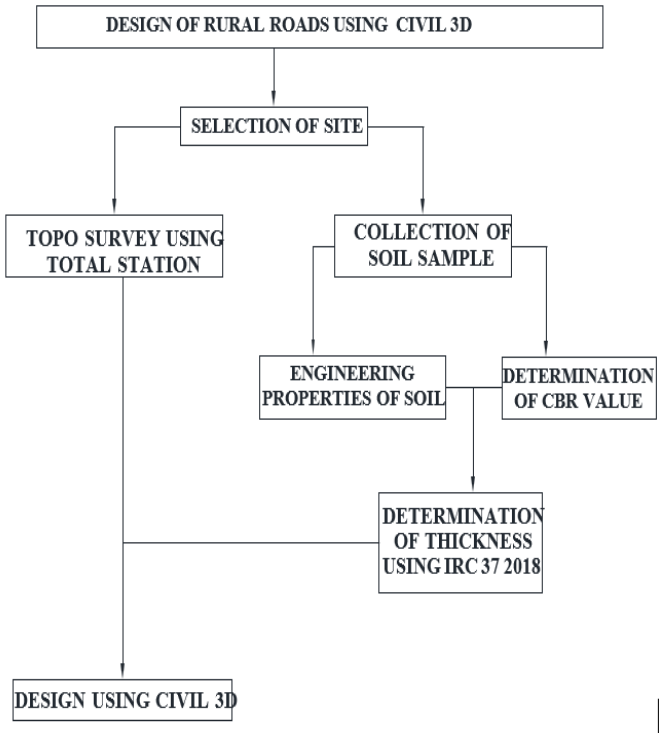
**Figure 2- Co-ordinates of total station**

## 3. DESIGN CRITERIA

The following design criteria based on the Geometric design standards manual (IRC: SP: 20 – 2002) were assigned to the horizontal geometry of the center line and the profile and cross-section of the roadway.

I. Design speed = 80 km/h
II. Super elevation rate = max 5%
III. Coefficient of Friction = 0.15
IV. Minimum K for sag curves = 21
V. Minimum K for crest curves = 15
VI. Roadway width = 3.75 m
VII. Carriageway width = 1.875 m
VIII. Shoulder width = 1.000 m

## 4. Methodology




Although AutoCAD Civil 3D initially requires some effort, with repeated practice and training, it becomes easier to use. Becoming proficient in this technique requires dedication and a willingness to invest time in learning and perfecting the software. The following flow chart provides an overview of the general process involved in reviewing AutoCAD Civil 3D designs.

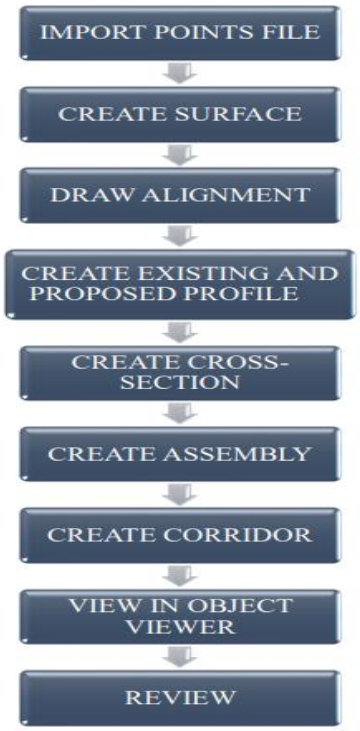



**Figure 3 – Flow chart of Autocad Civil 3D**

The survey points are imported with a compatible file format such as CSV, TXT, or LAND XML files. Using this survey points surface were created which represents terrain or ground model, an alignment has been created on the surface, and existing and proposed profile are created With the help of various tools inside Civil 3D cross-section, assembly, corridors were created. The below figures show the design procedure;

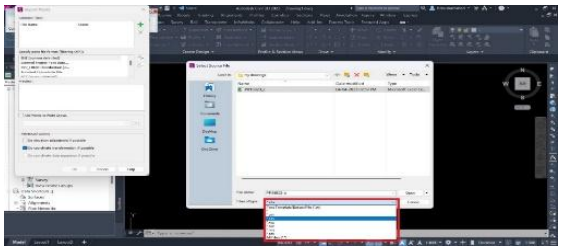


**Figure 4 – Import Points File**

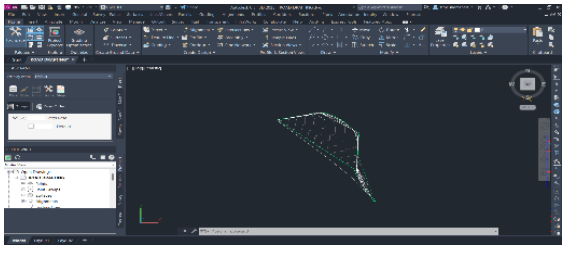


**Figure 5 – surface creation**

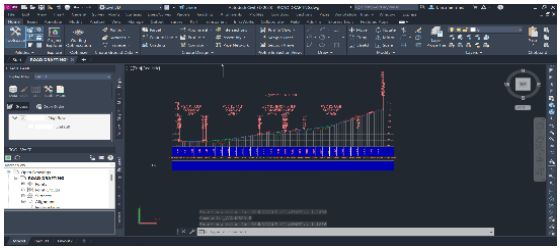


**Figure 6 - Profile creation**

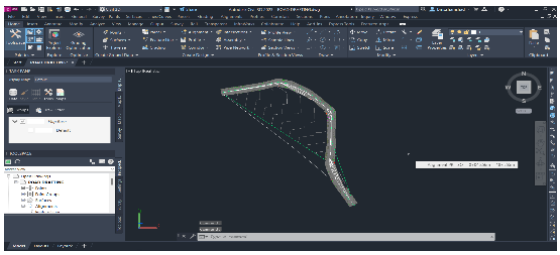


**Figure 7 - Corridor Creation**

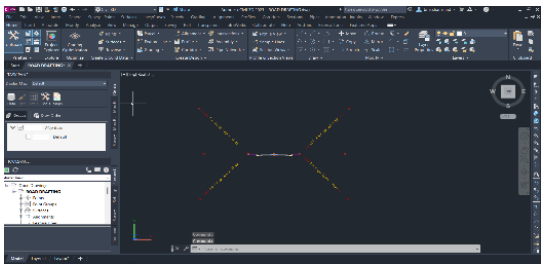


**Figure 8 - Assembly Creation**

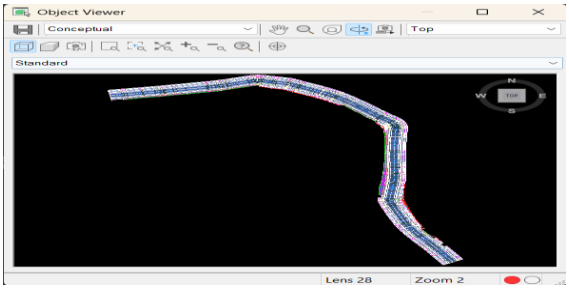



**Figure 9 – Object Viewer**

## 5. Output of the design

**Table-1 Contour Table**

| Contours Table | | |
|---|---|---|
| Number | Minimum Elevation | Maximum Elevation |
| 1 | 98.264 | 99.322 |
| 2 | 99.322 | 99.767 |
| 3 | 99.767 | 102.452 |
| 4 | 102.452 | 110.749 |

**Table-2 Direction Table**

| Directions Table | | | |
|---|---|---|---|
| Number | Minimum Direction | Maximum Direction | Color |
| 1 | N0° 52' 59"E | N57° 28' 07"E | |
| 2 | N57° 28' 07"E | S51° 59' 17"E | |
| 3 | S51° 59' 17"E | S23° 50' 47"W | |
| 4 | S23° 50' 47"W | S52° 20' 27"W | |
| 5 | S52° 20' 27"W | S63° 47' 36"W | |
| 6 | S63° 47' 36"W | S73° 54' 57"W | |
| 7 | S73° 54' 57"W | N83° 17' 24"W | |
| 8 | N83° 17' 24"W | N2° 13' 19"W | |

**Table-3 Elavtion Table**

| Elevations Table | | | | |
|---|---|---|---|---|
| Number | Minimum Elevation | Maximum Elevation | Area | Color |
| 1 | 98.26 | 99.12 | 334.48 | |
| 2 | 99.12 | 99.32 | 486.42 | |
| 3 | 99.32 | 99.47 | 480.13 | |
| 4 | 99.47 | 99.77 | 696.65 | |
| 5 | 99.77 | 101.44 | 3798.66 | |
| 6 | 101.44 | 102.45 | 3218.72 | |
| 7 | 102.45 | 103.41 | 5802.03 | |
| 8 | 103.41 | 110.25 | 16864.41 | |

**Table-4 Slope Table**

| Slopes Table | | | | |
|---|---|---|---|---|
| Number | Minimum Slope | Maximum Slope | Area | Color |
| 1 | 0.46% | 3.30% | 8170.29 | |
| 2 | 3.30% | 4.88% | 16420.66 | |
| 3 | 4.88% | 6.11% | 3029.23 | |
| 4 | 6.11% | 7.70% | 755.95 | |
| 5 | 7.70% | 10.70% | 1409.57 | |
| 6 | 10.70% | 13.99% | 1212.02 | |
| 7 | 13.99% | 20.67% | 431.86 | |
| 8 | 20.67% | 130.73% | 251.93 | |

**Table-5 Slope Arrows Table**

| Slope Arrows Table | | | |
|---|---|---|---|
| Number | Minimum Slope | Maximum Slope | Color |
| 1 | 0.46% | 3.30% | |
| 2 | 3.30% | 4.88% | |
| 3 | 4.88% | 6.11% | |
| 4 | 6.11% | 7.70% | |
| 5 | 7.70% | 10.70% | |
| 6 | 10.70% | 13.99% | |
| 7 | 13.99% | 20.67% | |
| 8 | 20.67% | 130.73% | |

**Table-6 watershed table**

Watersheds Table

| ID | Type | Drains Into | Description | Segment Display | Area Display | Area |
|---|---|---|---|---|---|---|
| 1 | Bouncary point | | Description 1 | | 0.48sq.m | 0.48 |
| 2 | Bouncary point | | Description 2 | | 0.21sq.m | 0.21 |
| 3 | Bouncary point | | Description 3 | | 677.59sq.m | 677.59 |
| 4 | Bouncary point | | Description 4 | | 1.15sq.m | .15 |
| 5 | Bouncary point | | Description 5 | | 22561.14sq.m | 22561.14 |
| 6 | Bouncary point | | Description 6 | | 156.56sq.m | 156.56 |
| 7 | Boundary segment | | Description 7 | | 1.31sq.m | 1.31 |
| 8 | Boundary segment | | Description 8 | | 8.57sq.m | 8.57 |
| 9 | Boundary segment | | Description 9 | | 7.58sq.m | 7.58 |
| 10 | Boundary segment | | Description 10 | | 8.70sq.m | 8.70 |
| 11 | Boundary segment | | Description 11 | | 10.58sq.m | 10.58 |
| 12 | Boundary segment | | Description 12 | | 167.63sq.m | 167.63 |
| 13 | Boundary segment | | Description 13 | | 39.55sq.m | 39.55 |
| 14 | Boundary segment | | Description 14 | | 307.45sq.m | 307.45 |
| 15 | Boundary segment | | Description 15 | | 1220.83sq.m | 1220.83 |
| 16 | Boundary segment | | Description 16 | | 37.97sq.m | 37.97 |
| 17 | Boundary segment | | Description 17 | | 55.18sq.m | 55.18 |
| 18 | Boundary segment | | Description 18 | | 171.33sq.m | 171.33 |
| 19 | Depression | 3 | Description 19 | | 108.51sq.m | 108.51 |
| 20 | Depression | 21 | Description 20 | | 252.88sq.m | 252.88 |
| 21 | Depression | 20 | Description 21 | | 875.42sq.m | 875.42 |
| 22 | Depression | | Description 22 | | 550.14sq.m | 550.14 |
| 23 | Multi-drain | 20, 21 | Description 23 | | 14.09sq.m | 14.09 |
| 24 | Multi-drain | 14, 21 | Description 24 | | 602.81sq.m | 602.81 |
| 25 | Multi-drain | 5, 22 | Description 25 | | 430.32sq.m | 430.32 |
| 26 | Multi-drain | 5, 25, 26 | Description 26 | | 2233.05sq.m | 2233.05 |
| 27 | Multi-drain | 18, 26 | Description 27 | | 1180.50sq.m | 1180.50 |

## 6. CONCLUSIONS

The geometry of the road is in accordance with IRC and all safety measures are considered. Horizontal alignment, vertical profile, cross-section, and superelevation was calculated and implemented. To streamline the design process and to save time AutoCAD Civil 3D has been found to be an efficient tool. The capability of AutoCAD Civil 3D offers a greater advantage for manual design, with its user-friendly interface designers can work in three-dimensional roadway design. Hence from this study, it has been proved that Civil 3D is a highly effective tool for highway geometric design.

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