A STUDY- GEOMETRIC DESIGN OF HIGHWAY WITH THE HELP OF AUTOCAD CIVIL 3D

Payal Gaikawad[1] ,Sujesh. D. Ghodmare[2], Prashant Sandel[3]

[1]PG Student,[2]Assistant Professor,[3]Design Engineer,
[1]M-Tech, Transportation Engineering, G.H.Raisoni College of Engineering, Nagpur, Maharashtra,
[2]Assistant Professor, Transport Engineering, G.H.Raisoni College of Engineering, Nagpur, Maharashtra,
[3]Design Engineer, R.S. Infrastructure, Pune, Maharashtra.

Abstract: *Roads offer a vital contribution to sustainability and economic growth, offering major social benefits. Roads are important for growth and development. Roads to open more regions and promote socio-economic development. The location of design for the centreline of highway on the surface is called alignment. The primary requirement for alignment is to be short, easy, safe, and economical. Horizontal alignment, vertical alignment, and cross-section are the three main components of geometric design. This paper demonstrates the usual design of the roadway with the assistance of AutoCAD Civil 3D. It is modelling software helps to accomplish modelling in a convenient and relaxed way. Civil 3D modelling is quick and easy to understand to construct alignment, AutoCAD civil 3D uses topography and survey data obtained from LIDAR or related technologies. Once alignment has been demarcated, geometry can be tested and evaluated using the IRC model and specifications of the civil 3D built-in program. Vertical geometry can be enhanced once horizontal geometry has been achieved. Civil 3D avails integrated checks for transition length & sight distance to analyze horizontal geometry and vertical geometry, thus avoiding tiresome calculations. Civil 3D also helps to make use of catchment and contours in drainage design. Thus AutoCAD Civil 3D is therefore very useful and even user-friendly.*

Index Terms -LIDAR, AutoCAD Civil 3D, Horizontal and Vertical geometry.

I. INTRODUCTION

Roads are required to ensure comfort and protection for users, to enable efficient movement of traffic. The geometric structure of the roads has three fundamental parts, which are horizontal, vertical, cross-sectional orientation. Which, when combined, give a 3-dimensional road layout. Horizontal alignment consists of three geometric components, including curves, tangents, and transitions. Vertical alignment is a longitudinal section, together with geometric additives such as crest curves, sag curves, and gradients. Highway geometry formulations depend on selection, estimated and thus act by certain design standards as sight distance, vehicle stability, driver consolation, drainage, economy, and aesthetics. Numerous Computations and Measurements pursue design process. The undertakings performed shall incorporate the alignment and tracing the profile of the roads consisting of coordinates and elevations, horizontal radii curves, vertical curve length, sight distance calculation, and earth quantity calculation, with various calculations and analyzes planned for optimum alignment while complying with design standards and limitations. In the early years of auto cad, the concept was carried out separately from the drawing and development of the final drawings. The civil 3D upgrade has modified this paradigm so that both design and development are carried out concurrently. When performed manually, geometrical design can be very cumbersome, time-consuming, and quite helpless to costly blunders, the traditional technique is also based, in particular, on a two-dimensional analysis that does not ensure a pleasant layout. The goal of this study is to show how geometrical design is done quickly and perfectly in a short period to enable professionals from those in the developing world to use road design. This paper shows a typical design of the highway with the support of AutoCAD Civil 3D that saves time and energy. Highway design faces tremendous challenges without 3D modeling. It consumes a lot of effort to cut and fill that amounts. The volume computing approach can be used.

II. SOFTWARE DESCRIPTION

This is a summary of the workflows for basic road construction with the help of AutoCAD Civil 3D.

- Creation of existing surface using a notepad files which includes Northing, Easting, and Levels Co-ordinates.
- Model Alignment- Alignment is the primary horizontal route usually reflecting the road's baseline.
- Apply design based criteria-This includes variables of speed, super elevation etc. Warning alerts when planning an alignment adhering.
- Produce existing profile and design grades-display existing surface data and create finished levels for design alignment. Using profile evolution tools finished profiles can be created graphically.
- Create assemblies- A cross-sectional pattern on a lane or other corridor is a montage. It is a standard portion of the corridor with an orientation and a profile. To cross-sections like lanes, curbs, sidewalks, shoulders and side slopes, you create an assembly with sub-assembly elements. A subassembly is the basic construction block of an assembly. One or both sides of the basis of the assembly shall be attached to a subset and subsequent subassemblies shall be attached at the appropriate points of the previously attached subassemblies. By adding all sub-assemblies on one side and then reflecting them, an assembly can be described.
- Design the horizontal geometry, vertical geometry and cross-sectional design features in the corridor-combination.
- Analysis of corridors used to calculate embankments, cutting and filling volumes, conduct visual study, extract information for site.
- Generate Drive perspective View.
- Generate Drive perspective View.

III. Literature Review

Matthew G. Karlaftis and Ioannis Golias. They considered connections between road geometric qualities, mishap rates and their forecast dependent on regression technique. The principal objective is to build up a method that quantitatively surveys the impacts of different interstate geometric attributes on pavement condition, accident rates, and geometric design factors

Ali Aram . Author contemplated, higher accident rates on horizontal curve. Roadway and geometric highlights that impact well being at even curve segments are: Traffic volume, Curve highlights, for example level of curve, curve length, super elevation, and nearness of progress curve, Cross sectional curve component, Roadside hazard features like rigidity, clear slope, and types of obstacles on curve section, SSD at curve, Vertical alignment on horizontal curve, Distance to contiguous curves, Distance of curve to the closest convergence, driveway, so forth, Pavement friction.

Anitha Jacoba1, Dhanya Rb, Anjaneyulu,M.V.L.Rc .They Present geometry control speed of vehicles. Instant change in alignment causes crash. Inconsistency in alignment causes unnecessary speed variation leads crashes. Technique used for modeling is multiple linear regressions.

Hameed aswad mohammed. Lane and shoulder conditions legitimately influence run-off roads and accidents. Median deals to reducing specific accidents, for example head-on collisions. A median, barriers, reduces the accidents. Accident on two-lane rural roads has high probability at horizontal curves, intersections and bridges.

Asok kumar et.Al . They present Mx-road has geometric design with excessive precision.

Vikas Golakoti . They study geometric factor role on the road to rate of accident for plain terrain also aims to know impact of horizontal curve, vertical curve, extra widening, sight distance, horizontal radius, super elevation, vertical gradient, value of k at the accident rate.

S.A.RAJI .They present typical highway design with the help of civil 3D which makes the process of design short and easy with amazing precision as compares to manually.

Nisargak .They studied of rural highways design using civil 3d. Illustrate the proposed alignment comfortably generates a volume report sheet with curves such as tabular form.

Manoj Mandal . Presenting geometric layout of road the usage of AutoCAD civil 3D.

IV. Study Area

SH50 Project Corridor is one of the key Roadways inMaharashtra State highway network.

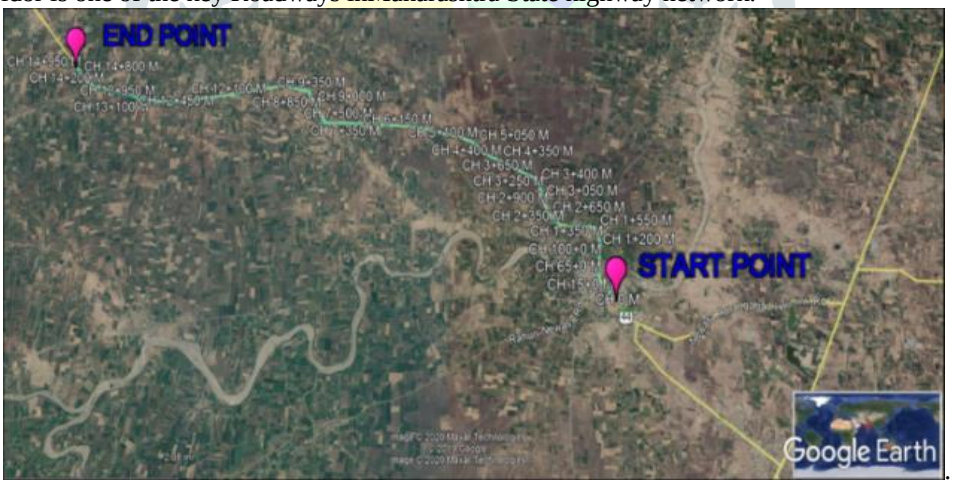


Fig.1. Satellite image of study corridor

V. Objective of Study

- To give arrangement of a road that is protected to go on for all road users at the appropriate travel speed
- To give Vertical and Horizontal geometry improvement
- To plan geometric structure of study corridor with all required calculation and Analysis.

VI. DESIGN METHODOLOGY

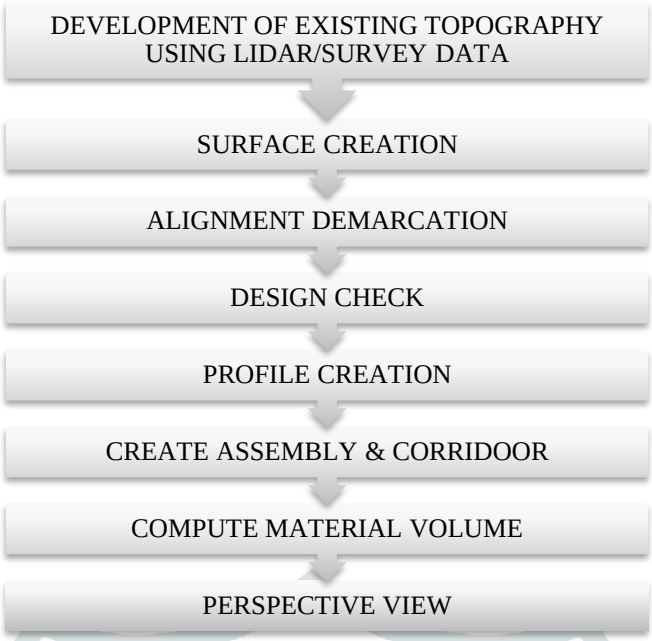


Fig.2. Methodology schematic

6.1 Data collection

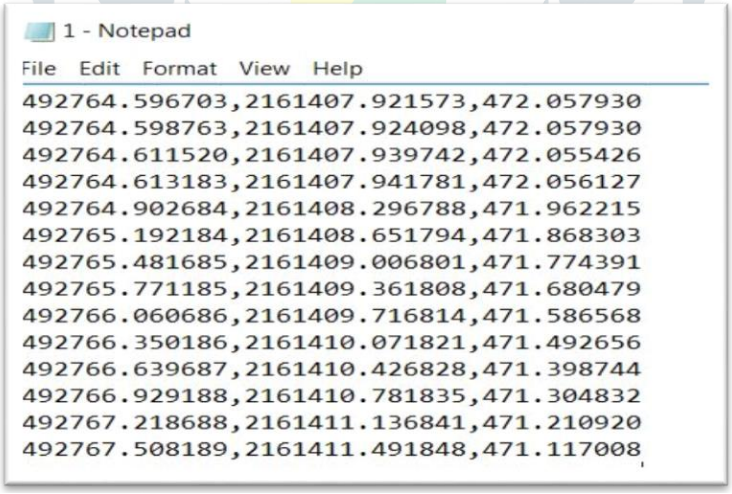
Survey Data Collection, the existing surface data is needed for the highway design. The survey data on the current route is received from of the company which performed the road development. The survey data covered Easting, Northing and points elevations across the planned route.

6.2 Surveying

The survey was conducted before the typical design of project road started e.g. Location study, Reconnaissance, Preliminary, Final location survey. Location study is about getting a general idea of the field.

The Reconnaissance survey is available for viewing and points at the main features of the field but does notclarify them.

The reconnaissance data are generally used for planning and scheduling detailed studies and inquiries and a few suitable alignments can also be selected for any modifications or changes in the preliminary survey, Preliminary surveys use the field surveying duties to classify the LIDAR and collect all required data such as Easting, Northing, Elevations, etc. and alternative alignment of the data.



1 - Notepad

File Edit Format View Help

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492765.481685,2161409.006801,471.774391
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492766.350186,2161410.071821,471.492656
492766.639687,2161410.426828,471.398744
492766.929188,2161410.781835,471.304832
492767.218688,2161411.136841,471.210920
492767.508189,2161411.491848,471.117008
```

Fig.3. CSV Notepad File

6.3 Traffic Survey and Analysis

Traffic surveys have been carried out on the study project road in order that identify present and likely future traffic scenarios so as to propose suitable measures and to evolve appropriate design methods. The primary objectives of these traffic surveys are to establish and assess the characteristics of traffic movement on the study road, pavement design, capacity augmentation proposals, junction improvement etc.

Traffic survey is carried out by Videography method, Surveys are necessary to gather base data about existing traffic and travel pattern on surrounding roads, Peak Hour Traffic and Composition of Vehicle. Traffic survey was conducted for 24 hours to understand the hourly traffic variation for the roads.The classified traffic count data collected has been analyzed for Hourly and Daily Traffic Intensity, Traffic Composition, PHF, Directional Distribution, ADT and AADT by applying the seasonal correction factors. The AADT factor is considered as 1.02 from the prevailing studies in the state.

TABLE I Total No. of Vehicles in CVPD

Vehicle Category	No. of Vehicles (AADT)
LCV	892
BUS	221
Mini Bus	18
2-Axle	371
3-Axle	117
MAV	57
Total No. of Vehicles (CVPD)	1676

Design CVPD	1676
Add for Induced Traffic @ 5%	84
Add for Developmental Traffic @ 5%	84
Total Added Traffic	168

Here,
Initial Traffic in both directions in the Year of Construction (P)
P =Po* (1+r)^n
P=1676*(1+5%) ^2+168
P = 2016

6.4 Pavement Analysis

Pavements are usually classified as rigid and flexible. Rigid pavements are typically built of Portland cement concrete. In the other side, flexible pavements surface is typically made of bituminous materials in such a way that Stay in touch with the underlying substrate even though small deviations arise. Flexible Pavement is usually made up of a bituminous base underlay with a granular content overlay and an appropriate combination of coarse and fine materials. Traffic loads were transferred from the surface to that of the underlying assisting materials through the interlocking to aggregates, the frictional influence of granular materials and the cohesion of fine materials. Flexible pavements are also classified into three sub-groups: large form, moderate style and low form. High style pavements have surfaces that sufficiently bear the planned traffic load without noticeable discomfort due to exhaustion and are not prone to weather conditions. The intermediate form of pavement has a coating that varies from the coating handled to those with a consistency far below that of the strong level of pavement.

In the study considered a design of rigid pavement
Criteria for Design of Rigid Pavement are based upon Axle Load spectrum obtained from Axle load data.

Carriageway Type: Two Lane Paved Shoulder
Design Life – 30 Years

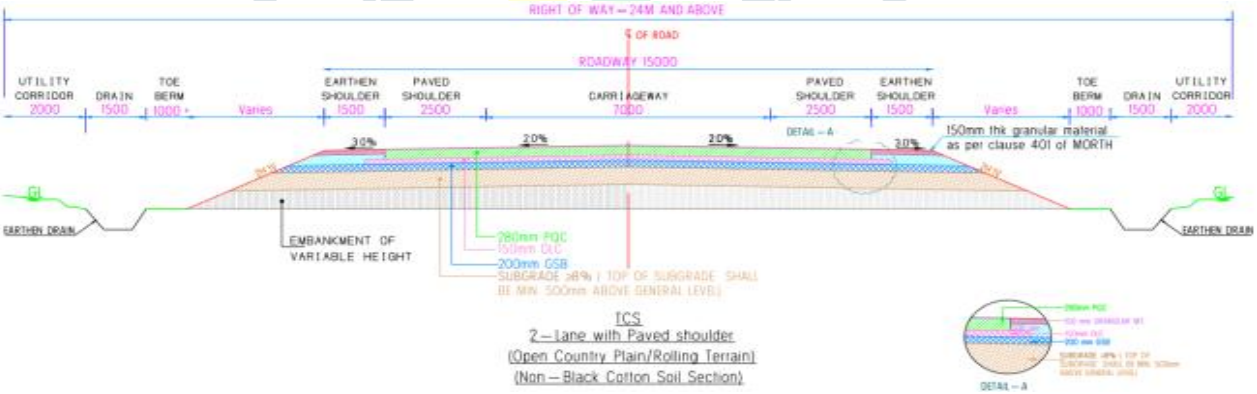


Fig.4. Typical Cross Section consider of study corridor

6.5 AutoCAD civil 3d Design

It is a multipurpose highway supported computer software tool. Civil 3D is used to conduct the whole design process, beginning with data analysis from electronic measurement instruments and finishing with full plan sheets, model drawings and earthwork volume calculations. Software design constructing horizontal and vertical roads geometry, linear and cross-sections of specifically built items. Objects are generated in a very basic way, along with their characteristic design. For illustration, a route would be generated at the same time with stakeouts and horizontal curve details. Interactive 3D models enable the user to computerize design processes.

The design Method Choose to import the coordinates CSV files to AutoCAD Civil 3D.

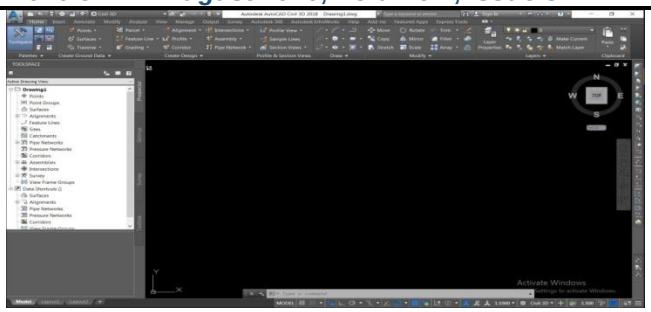


Fig.5. AutoCAD Civil 3D Interface

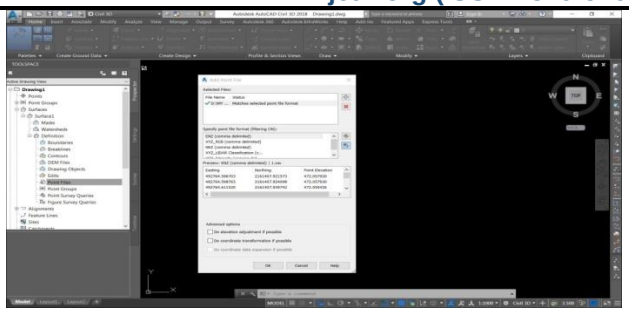


Fig.6. Import survey file

6.51Horizontal Alignment Design

The alignment design tool is used to develop anAlignment for the road design via using a convenient alignment Option For design the horizontal orientation of a road defines its placement in the view of the plan. This consists of three design elements namely, circular curves, tangents, and transition spirals, etc. The correct alignment design increases traffic and thereby improves performance at design speed.

Super elevation calculated by following equation based on design speed and curve radius defined inthe design criteria.

$$e = \frac{V^2}{225R} \qquad (6.1)$$

Where

e = Super elevation,V = minimum speed of design, Km / h, R = minimum radius of horizontal curve in metres.

Minimum Transition Length checked for design speed and curve radius according to IRC design based criteria

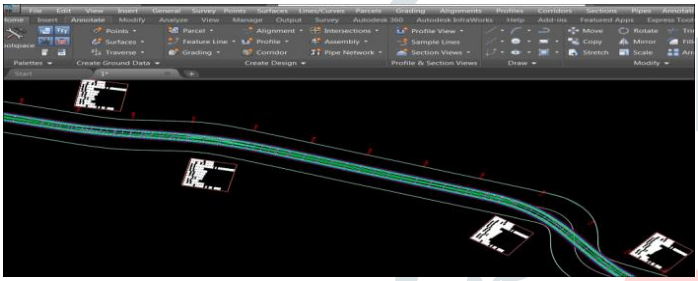


Fig.7. Horizontal Alignment

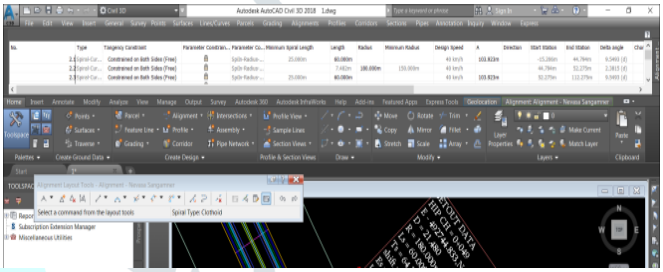


Fig.8. Horizontal Geometry Editor

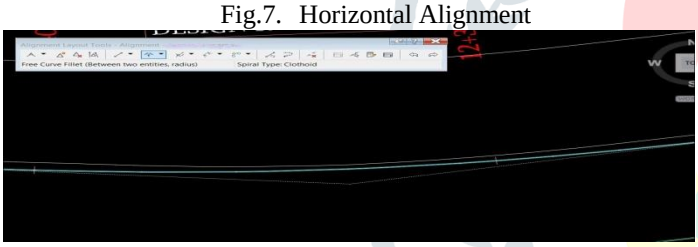


Fig.9. Curve fitting operation

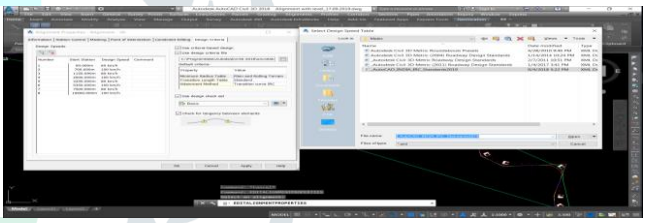


Fig.10. Criteria Based Design Check

This Criteria Based Design option allows design reviews of the existing alignment to be used. A design check is a term specified by the developer that verifies that the entity complies with the minimum design standards for the model alignment and profile. For various types of entities, such as lines, curves and spirals, design checks can be identified.

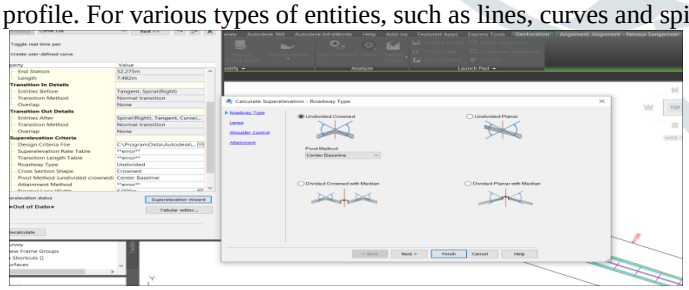


Fig.11. Calculate Superelevation

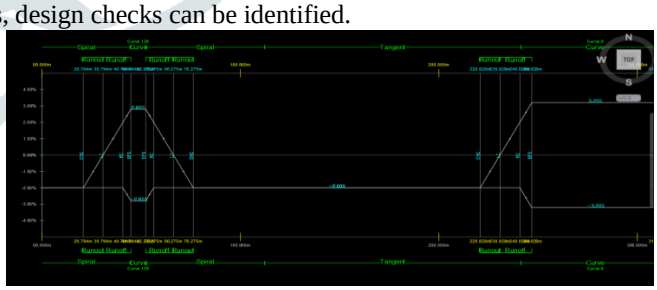


Fig.12. Draw Superelevation View

6.52 Vertical Alignment Design

After horizontal alignment design, vertical alignment will be created. For that existing surface profile created, and then designed profile demarks on profile view. After finishing profile section there will be created one surface profile and one layout profile referring vertical alignment of the road on the drawing.

Vertical curve lengths were also manually determined using Formula (6.2)

$$L = KA \qquad (6.2)$$

Where K= length required to change grade by 1 percent.

L = The length of the vertical curve.

A = change in percentage of grade.

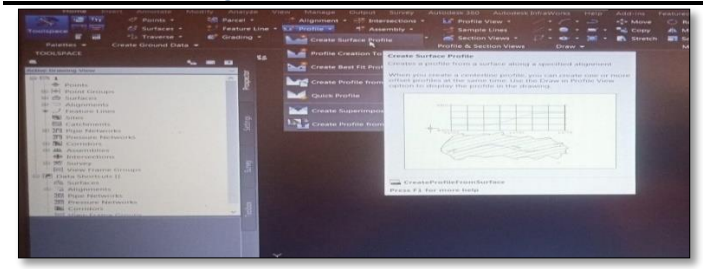


Fig.13. Create Surface Profile

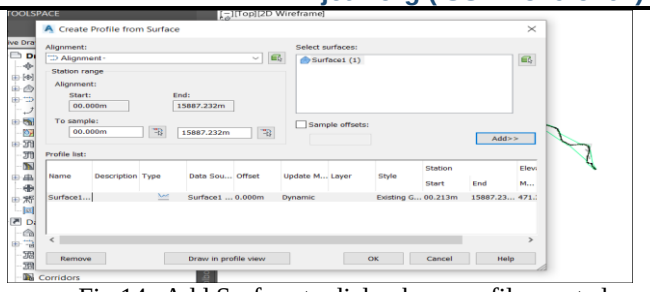


Fig.14. Add Surface to dialog box, profile created

Creating tangents and then applying vertical parabolic curves is clarified by the technique that best represents the standard procedure.

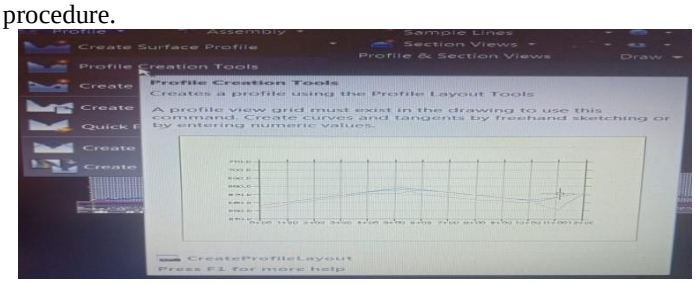


Fig.15. Profile Layout Toolbar

Fig.16. Vertical Geometry Editor Command

6.53Assembly (Cross Section)

Assembly refers to a cross-section of the road design used by 3D road alignment at incremental positions to construct a road layout. There is an assembly and subassembly object library in AutoCAD Civil 3D, which allows choosing cross-section structures. A primary road complete section assembly is used for this analysis in the development of a road corridor.

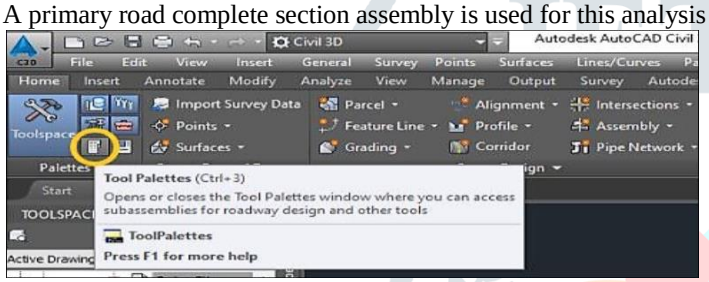


Fig.17. Access to Tool Pallet

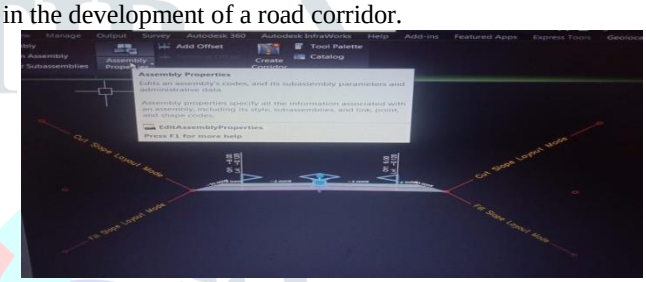
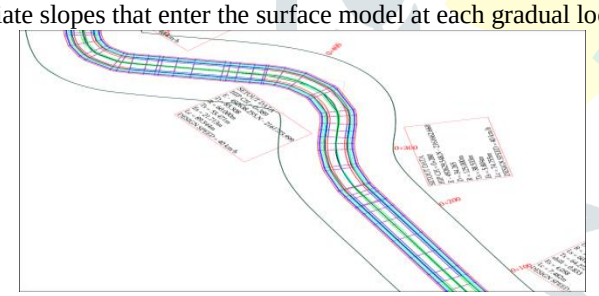


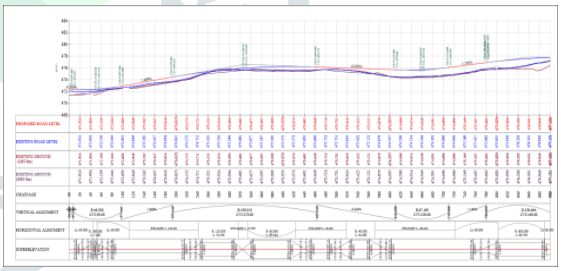
Fig.18. Access to Assembly Properties Command

6.54 Corridor

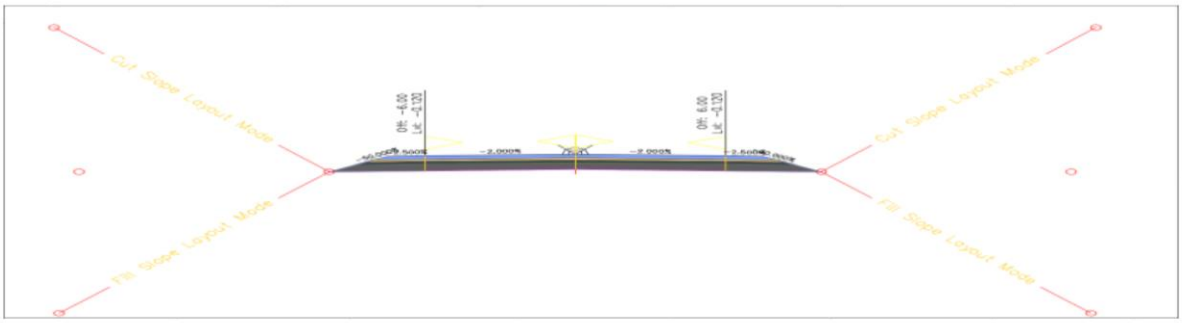
The corridor model creates & uses multiple AutoCAD Civil 3D elements including data, along with assemblies, alignments, surfaces or even profiles. Same being created from the baseline by placing 2D parts at gradual locations, and that by creating appropriate slopes that enter the surface model at each gradual location



Corridor



Profile



Assembly

Fig.19. Elements of a Corridor Design

Table II: Sample Calculation

Chainage	End Area Cut (m2)	End Area Fill (m2)	Volume Cut (m3)	Volume Fill (m3)
0	51.307	0	0	0
10	55.633	0	534.697	0
20	54.452	0	550.425	0
30	47.344	3.907	508.979	19.535
40	42.978	0.272	451.609	20.895
50	44.915	2.807	439.466	15.397
51.684	49.772	0.711	79.715	2.962
51.687	49.782	0.707	0.161	0.002
60	58.481	0	449.997	2.94
70	58.747	0	586.144	0
80	57.053	0	579.001	0
81.732	57.339	0	99.053	0
90	46.381	0	428.659	0
91.687	35.871	0.101	69.347	0.087
91.69	35.881	0.1	0.116	0
100	38.204	1.219	306.818	5.717
110	46.305	0	421.187	6.365
115	36.461	0.013	207.275	0.03
120	45.425	0.006	204.821	0.048
126.732	41.029	0.456	289.464	1.605
130	34.185	1.998	121.69	4.365
136.723	23.817	4.777	192.049	25.182
140	25.232	5.309	79.042	18.121
141.097	26.066	4.839	27.738	6.036
145	27.91	3.34	104.182	17.151
150	19.227	4.283	116.297	20.101
160	15.597	2.738	171.5	36.075
Cumulative Volume			**7020**	**202.5**

6.55Volume Surface

A volume surface gives an exact difference between certain base or the reference surfaces to AutoCAD Civil 3D. In this analysis, following the steps outlined in the previous chapters, the TIN volume surface is developed for measurement of cutting and filling volumes.

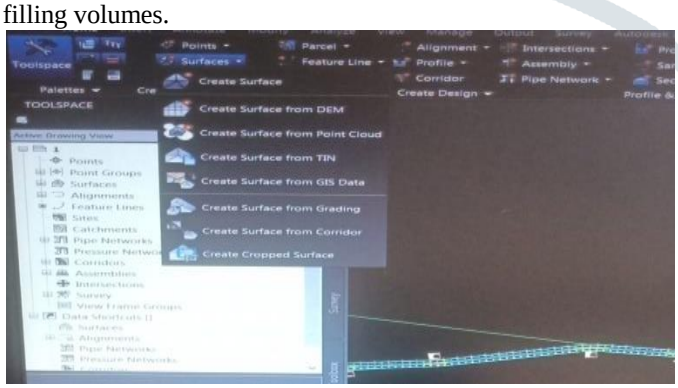


Fig.20. Surface Command

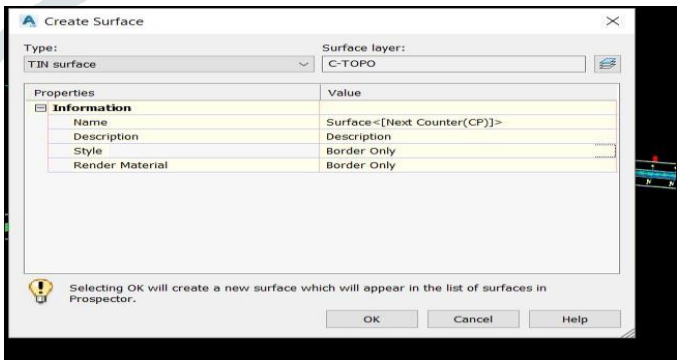


Fig.21. Selection TIN volume surface

6.56Masshaul diagram

In order to create cross-sections and mass-haul diagrams, the software needs sample lines from the corridor. Sample lines are linear items used to generate imaginary sections across corridor.

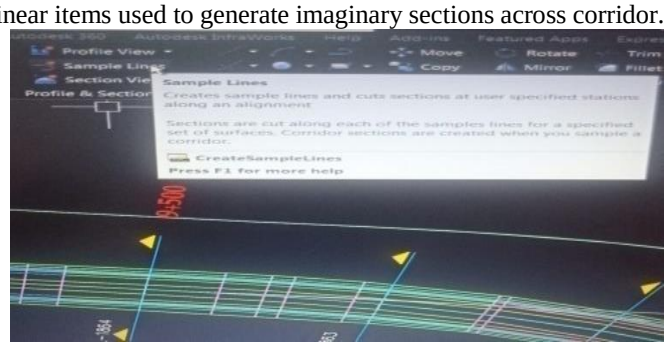


Fig.22. Sample Lines Command

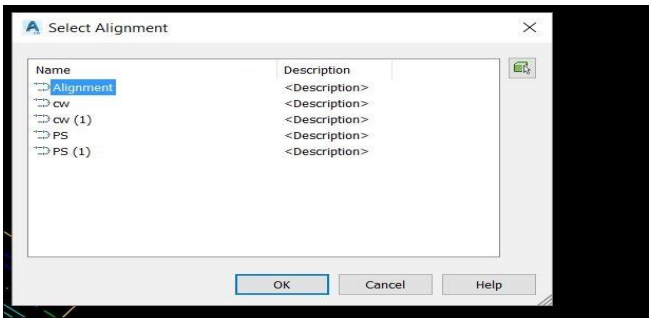


Fig.23. Selection of Alignment

The sample lines are formed by accepting the settings and pressing an extra Spacebar or Enter. The lines of the sample can be seen from the design viewpoint at this point Sample Lines from Plan. A cross-section collection is drawn from the sample lines.

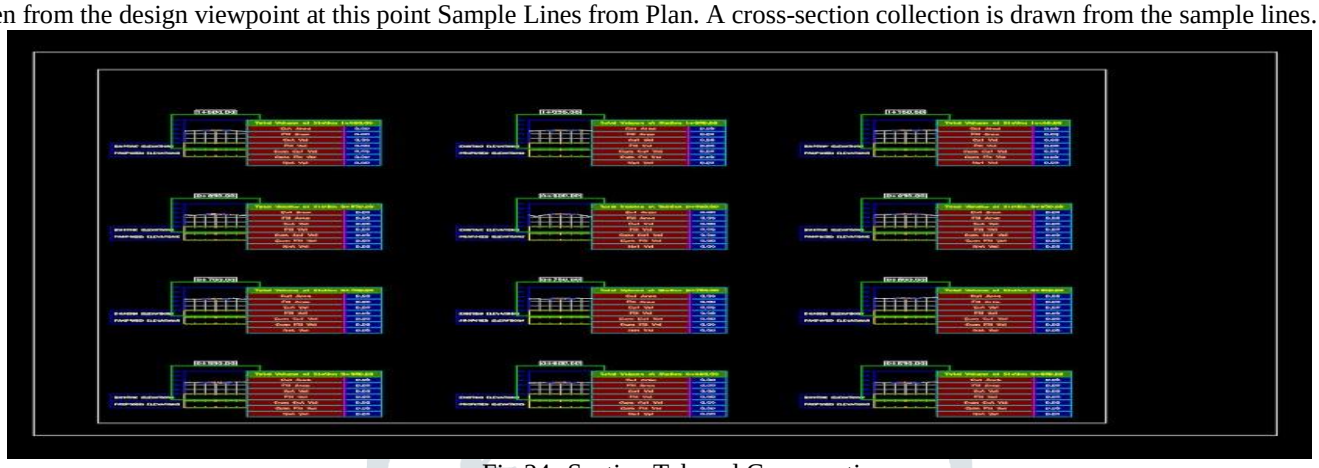


Fig.24. Section Tab and Cross sections

The Compute Materials command is selected from the section tab, and alignment and groups sample line are defined and the ground surface and the corridor surface are specified.

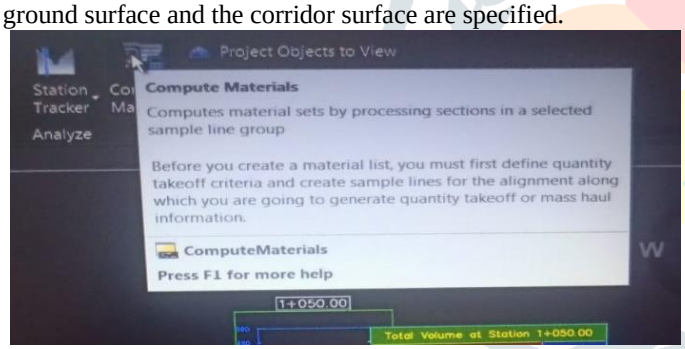


Fig.25. Compute Materials Command

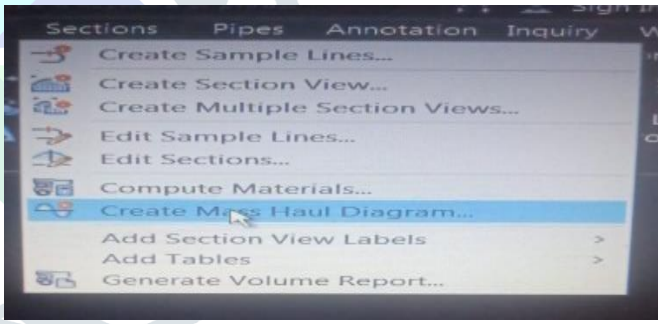


Fig.26. Mass Haul Diagram Command

VII. Conclusion

- Highways Geometric design with the help of AutoCAD civil 3D can be said to be extremely useful and also user-friendly for a three-dimensional roadway design.
- AutoCAD Civil 3D supports design checks for different codes and thus provides global platform for design and analysis.
- Horizontal and Vertical Geometry improved with the desired standards in minimum time.
- AutoCAD Civil 3D is a convenient tool to design assembly and corridor for design highway.
- Quantity of earthwork can be preciously calculated.
- Super elevation calculated and implemented according to standards.

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