# A STUDY OF GEOMETRIC DESIGN OF ROADWAY USING CIVIL 3D 2020

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## ABSTRACT

India is a country whose population is growing rapidly, indicating that traffic is also increases. The development of rural areas also increases its means furthering of transportation facilities are also developed. The geometric design manages the dimensions and layout of visible features of the road such as alignment, sight distance, cross-section, and intersections. The basic object is optimizing efficient traffic and safety of highway and minimizing cost and environmental damages. Design the road knows about the fundamental of road geometric and next step to upgrade their value is by learning software for use of the essential information. Geometric Design of road involves such tasks as creating the road alignment and plotting the alignment profile using bearings or coordinates (easting and northing), stations and elevations of points along the proposed route, lengths of vertical curves, computation of earthwork quantities, and numerous other analyses and calculations aimed at finding the optimum alignment while satisfying design standards and constraints. When geometric design performed manually, it is time-consuming and highly susceptible to very costly errors. In the present time, various software is available in market such as Bentley MX Road, AutoCAD Civil 3D, etc. are used to design the geometry of road. Current patterns are adapted to the utilization of computer programs for roadway geometry design. This dissertation presents a complete geometric design of road project using AutoCAD Civil 3D software. The main aim of the project is to display how geometric design can be performed in a very short time with accuracy. The road design procedure using AutoCAD Civil 3D has been presented. This software provides clarity, save times and effort to a user. Civil 3D is software for engineering it is used for the design, plan and manage the civil engineering works. This software is generally used by experts and civil engineers.

***Keywords: - Civil 3D, Alignment, Profile, Corridor, Geometric design.***

## INTRODUCTION

AutoCAD Civil 3D is a software application used by civil engineers and professionals to plan and design the projects for building constructions, road engineering projects, water include construction of dams, ports, canals, embankments etc. AutoCAD civil 3D associate design and production drafting, greatly reducing the time it takes to implement design changes and evaluate multiple situations. A change made in one place immediately updates an entire project, helping you complete projects faster, smarter, and more accurately. Civil 3D provides to create 3D models of the project and helps to adopt for both small- and large-scale projects. It helps to imagine the things in 3D visualization, reduces the time and budget. It also inherits many benefits of using civil 3D.

## OBJECTIVE OF GEOMETRIC DESIGN

The basic objectives in geometric design are to optimize efficiency and safety while minimizing cost and environmental damage. Geometric design also affects community goals, including providing access to employment, schools, businesses, and residences, accommodate a range of travel modes such as walking, bicycling, transit, and automobiles, and minimizing fuel use, emissions, and environmental damage.

## LITERATURE REVIEW

Geometric design of a typical highway using AutoCAD Civil 3D software. The aim of the project was to demonstrate how roadway geometric design can be performed in a very short time with much ease and precision. 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 favorably with that of AutoCAD Civil 3D.

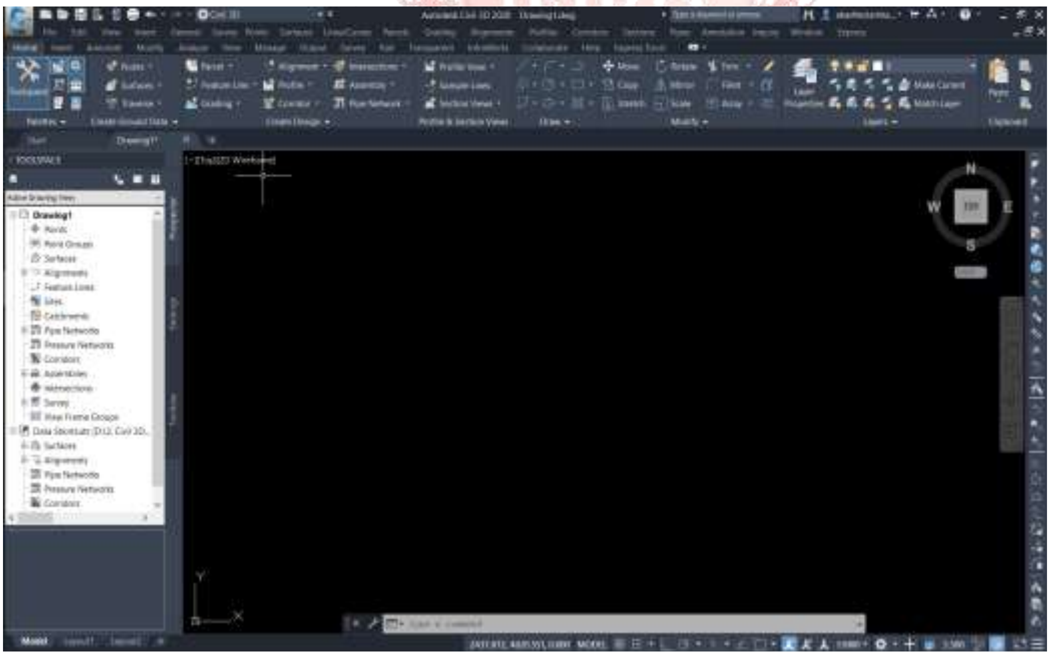
## RESEARCH METHODOLOGY

*Steps to be perform in design office.*

- **Clean up the Survey data**
- **Import the Data to Civil 3D**
- **Setup data Shortcuts for Project**
- **Preparation of Surface.**
- **Horizontal Alignment Design.**
- **Vertical Alignment Design.**
- **Generation of Drawings.**
- **Assemblies and Corridor**
- **Generation of Quantities.**

## INTRODUCTION TO CIVIL 3D

AutoCAD Civil 3D is a civil engineering design and documentation tool developed by Autodesk. Civil 3D is an engineering software application used by civil engineers and other professionals to plan, design, and manage civil engineering projects. Civil 3D allows is used to create three dimensional (3D) models of land, water, or transportation features while maintaining dynamic relationships to source data such as grading objects, breaklines, contours, and corridors.



**Civil 3D Interface**

**Google Earth Preview.**

## DATA SHORTCUTS

*Introduction to Data Shortcuts.*

Data shortcuts is use to create a new file with use of previous data. Fig. 10, we create an alignment and profile in one file (file A), then next we create a data shortcut of alignment and profile from original file (File A), Now we create a new C3D file and import the data shortcuts in new drawing (File B). after this if you make any changes in File A then it automatically shown in File B.

| File A | File B | File C |
|---|---|---|
| Alignment Profile | Corridor | C/S Sections |

## DATA PROCESSING BEFORE INITIATE DESIGN

**Geometric design of highway deals with following elements:**

- Cross sectional elements
- Sight distance considerations
- Horizontal alignment details
- Vertical alignment details
- Intersection elements

Under cross sectional elements, the considerations for width of pavement, the surface characteristics and cross slope of pavement are included. The sight distance or clear distance visible ahead of the driver at horizontal and vertical curves and at intersections govern the safe movements of vehicles.

*Design Controls and Criteria*

The geometric design of highways depends on several design factors. The important of these factors which control the geometric elements are:

1) Design speed
2) Topography
3) Traffic factors
4) Design hourly volume and capacity
5) Environmental and other factors.
6) Cross Section Elements

## SURFACE

As we discussed earlier, Surface is nothing but the terrain model, basically there have two types of models, first one

- **Existing Ground Surface model**: - The Existing Surface model help us to get the existing geometry of roadway, like road width, existing superelevation etc.
- **Proposed Road Surface model**: - after finishing our horizontal and vertical design we can go to the model developing of our proposed roadway

Surface is not required when we go for horizontal design but when are start working on Vertical profile, existing surface is must be required to start the design in vertical design.

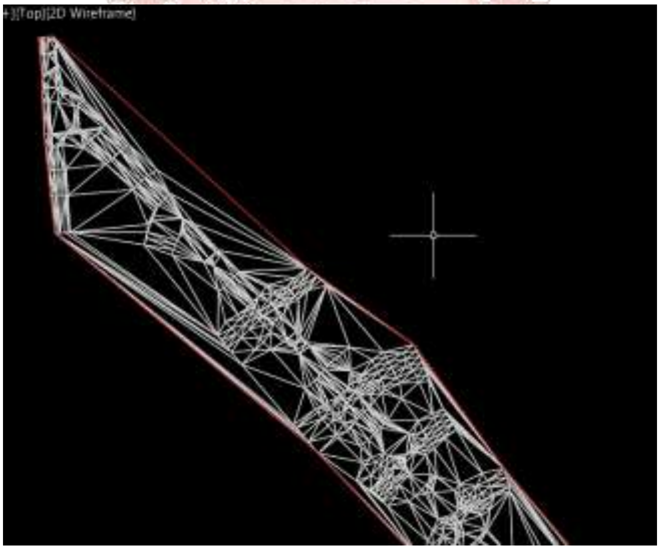
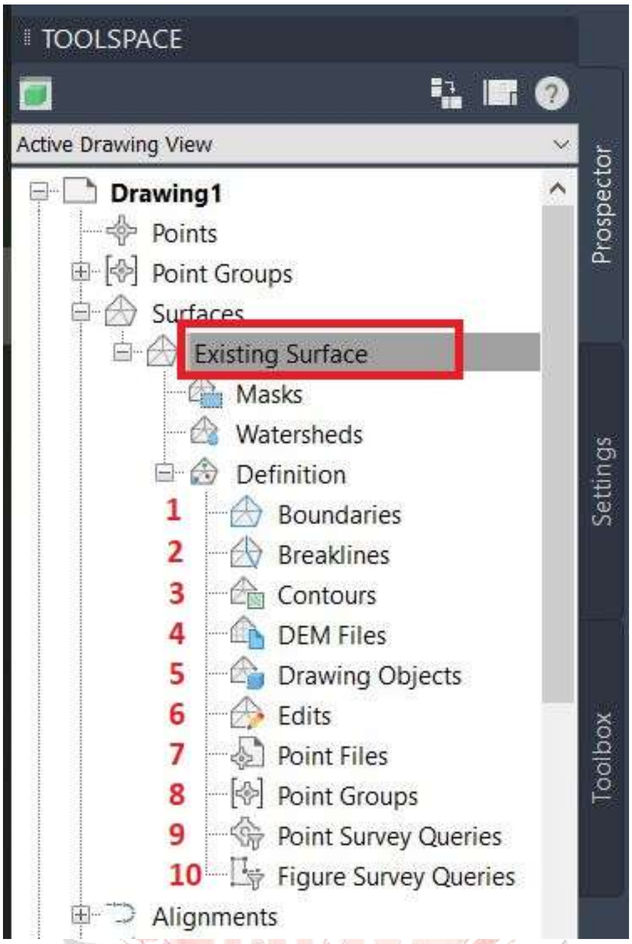


**Figure 1:- Created Surface**

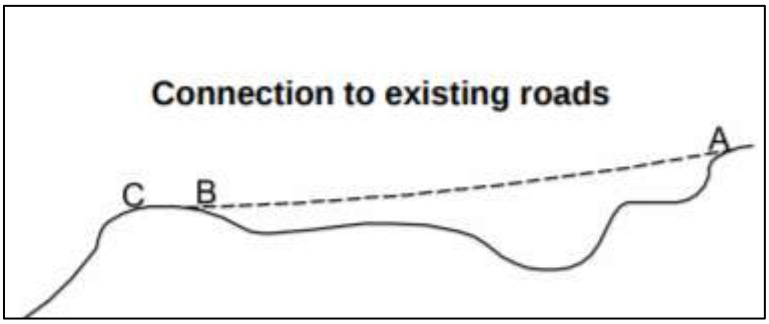



Options available in CIVIL 3D Surface

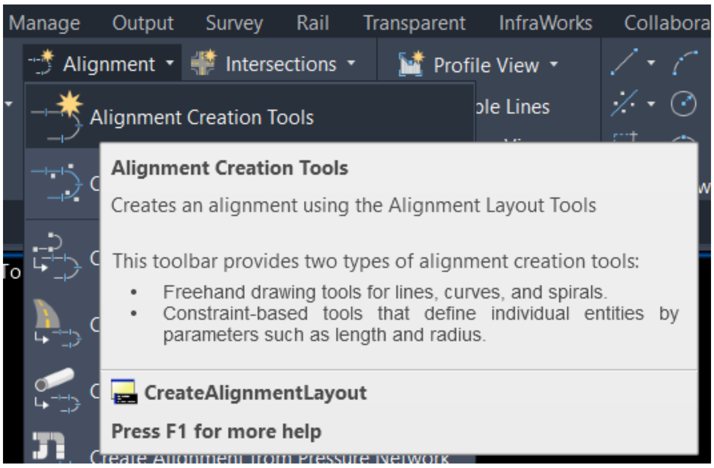
## HIGHWAY GEOMETRIC DESIGN

**Alignment.**

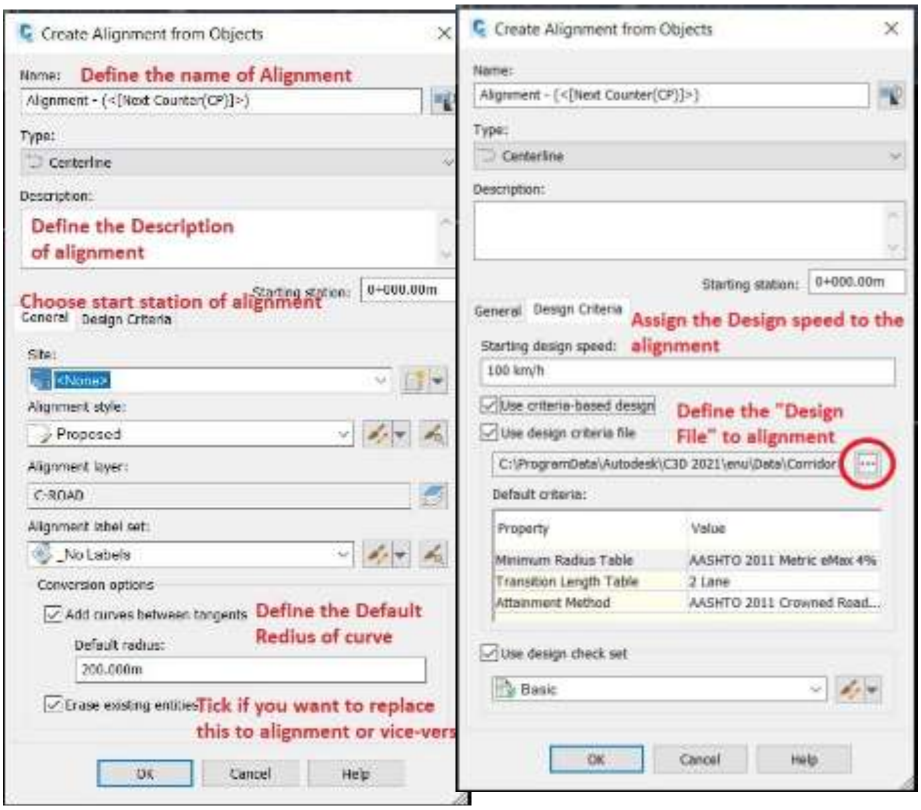
Alignment is a Center line of the roadway, we have two center line existing CL and proposed CL, Existing alignment means, Center line of existing roadway, this line helps us a lot while we design our proposed alignment.



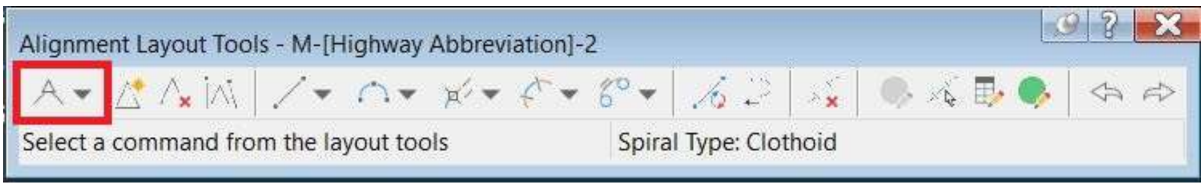

**Basic Logic of Alignment**



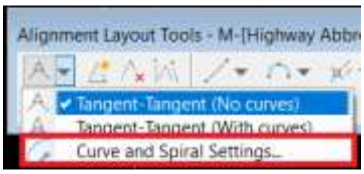

Alignment Creation Tool




Values to define about alignment.




**Geometry Editor**




- **Tangent-Tangent (No Curves)**

As its self-explanatory name, we can draw the alignment by just assigning PI locations, or in simple words, when we draw the alignment and assigning the curve locations, then C3D generate only PI Point, later it need to assign the curve.

- Tangent-Tangent (With Curves)

With this command, C3D directly generate "Curve" for PI locations as per default radius. Before you use this command, you have to make some setting as mention below.

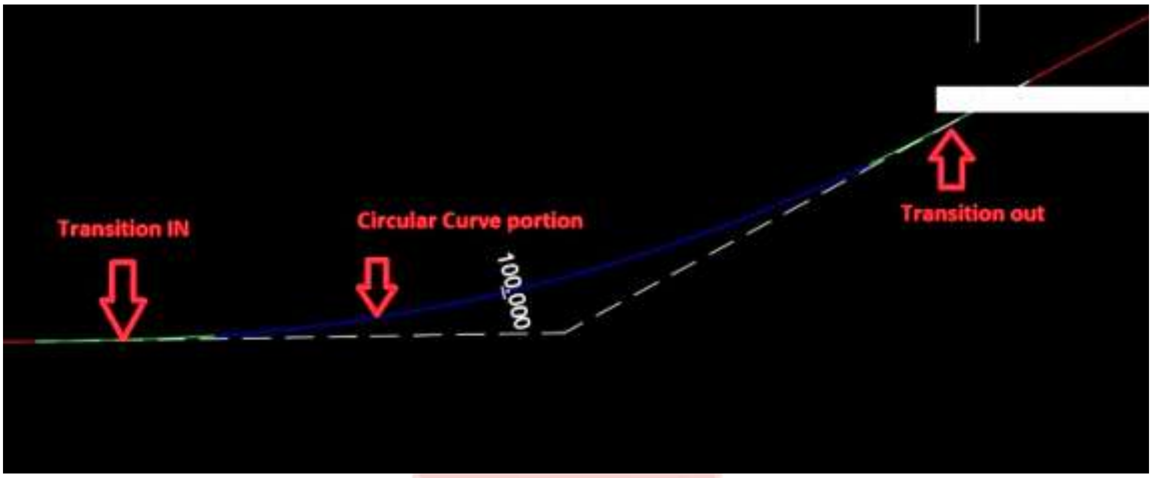



**Figure 2:- Contains in Transition Curves**

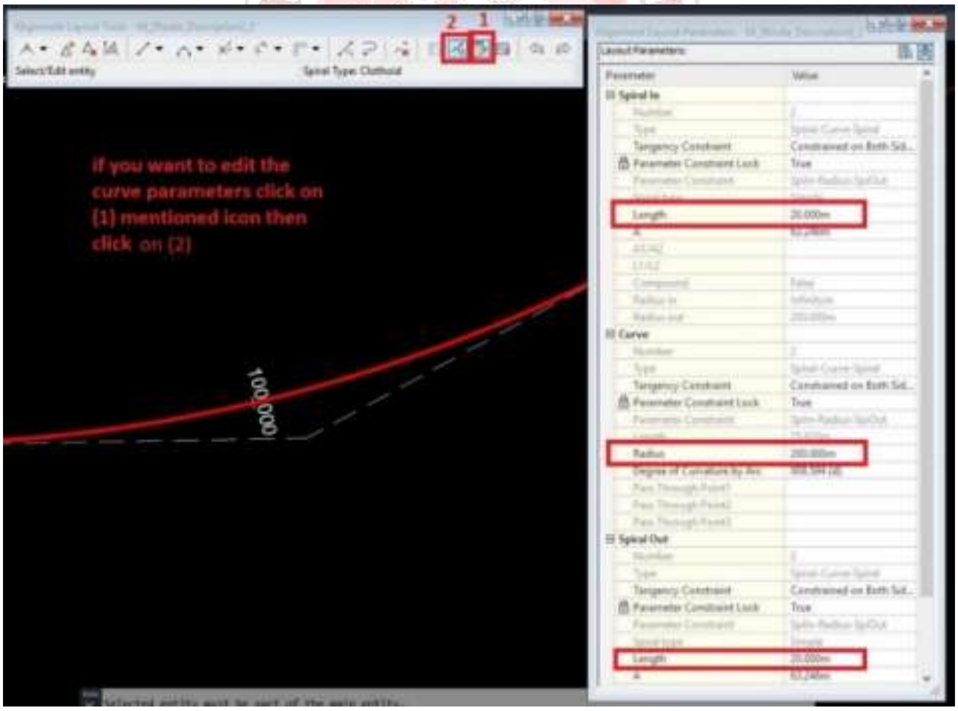



**Figure 3:- Modify the Curve Parameters.**

## SUPERELEVATION

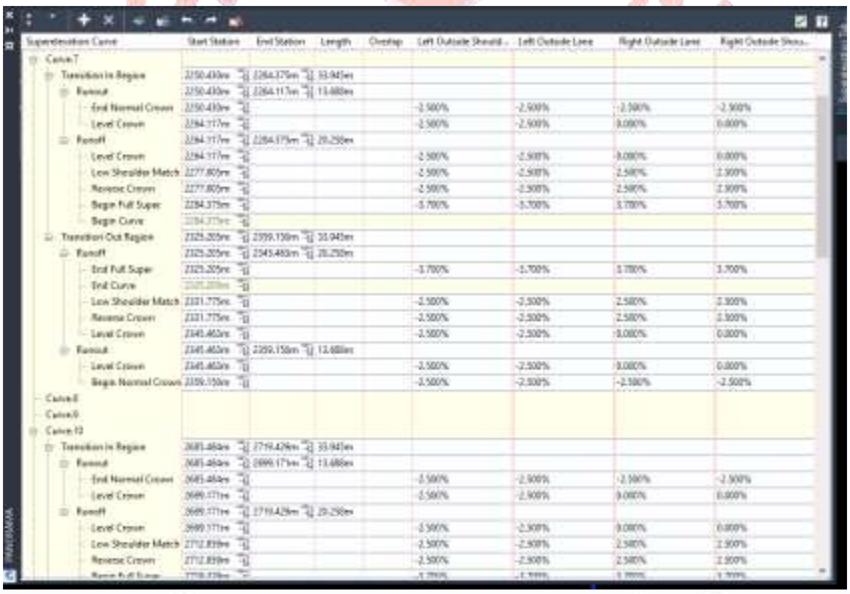
*Introduction to Superelevation*

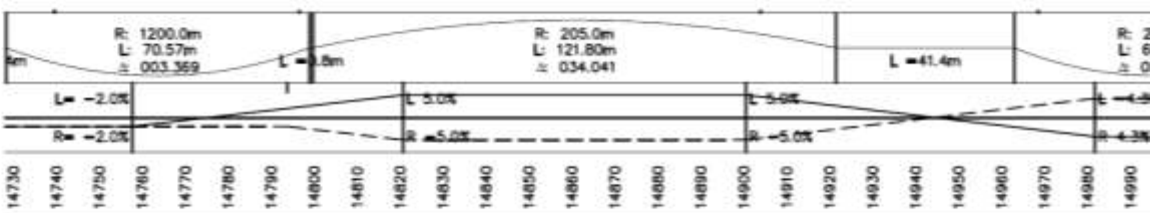
Superelevation is the transverse slope provided to counteract the effect of centrifugal force and reduce the tendency of the vehicle to overturn and to skid laterally outwards by raising the pavement outer edge with respect to the inner edge. Superelevation is represented by "e"

**Superelevation Station in Curves,**

- For with Transition Curves
  - End Normal Crown
  - Level Crown
  - Reverse Crown
  - Begin Full Super
  - End Full Super
  - Reverse Crown
  - Level Crown
  - Begin Normal Crown

- For without Transition Curve.
  - End Normal Crown
  - Reverse Crown
  - Begin Full Super
  - End Full Super
  - Reverse Crown
  - Begin Normal Crown



## VERTICAL ALIGNMENT

*Vertical Alignment in Civil 3D*

**Overview**

The second important thing in design engineering is design of Profiles. This is the elevation of the central line of the horizontal alignment. The vertical alignment of a road consists of gradients (straight lines in a vertical plane) and vertical curves. The vertical alignment is usually drawn as a profile, which is a graph with elevation as vertical axis and the horizontal distance along the center line of the road as the horizontal axis.

Specification of gradients.

| Terrain | Ruling | Limiting | Exceptional |
|---|---|---|---|
| Plain/Rolling | 3.3 | 5.0 | 6.7 |
| Hilly | 5.0 | 6.0 | 7.0 |
| Steep | 6.0 | 7.0 | 8.0 |

**K Values: -**

- This value represents the horizontal distance along which a 1% change in grade occurs on the vertical curve. It expresses the abruptness of the grade change in a single value. Speed tables or other design tools often provide a target minimum K value.
- The K Values can be calculating by formula of **Curve Length/Grade Change (A Value).** The Indian Standard are specifying some K values according to design speeds. **IRC 23 table no. 06 and DMRB CD109 Table 2.10**

| Design speed (km/h) | Length of summit curve (metre) for | | | Length of valley curve (metre) for headlight distance |
|---|---|---|---|---|
| | Stopping sight distance | Intermediate sight distance | Overtaking sight distance | |
| 20 | 0.9A | 1.7A | | 1.8A |
| 25 | 1.4A | 2.6A | | 2.6A |
| 30 | 2.0A | 3.8A | | 3.5A |
| 35 | 3.6A | 6.7A | | 5.5A |
| 40 | 4.6A | 8.4A | 28.4A | 6.6A |
| 50 | 8.2A | 15.0A | 57.5A | 10.0A |
| 60 | 14.5A | 26.7A | 93.7A | 15.0A |
| 65 | 18.4A | 33.8A | 120.4A | 17.4A |
| 80 | 32.6A | 60.0A | 230.1A | 25.3A |
| 100 | 73.6A | 135.0A | 426.7A | 41.5A |

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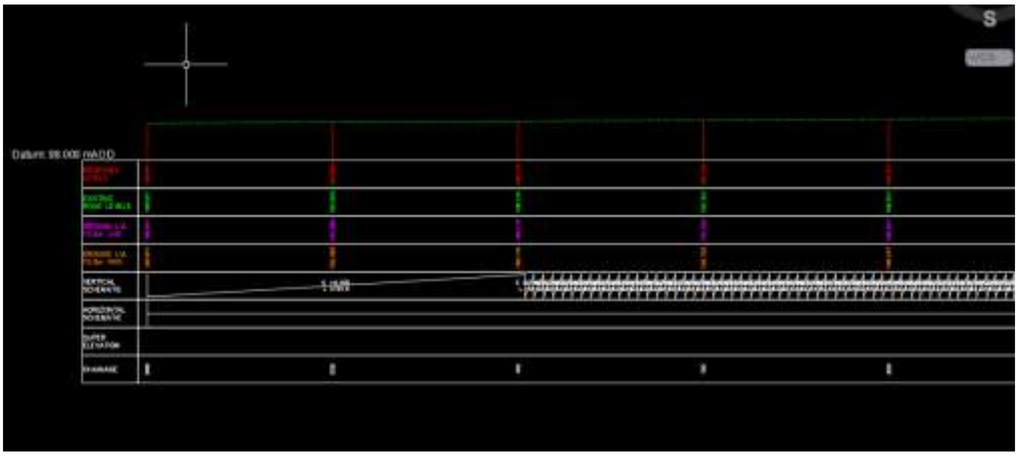


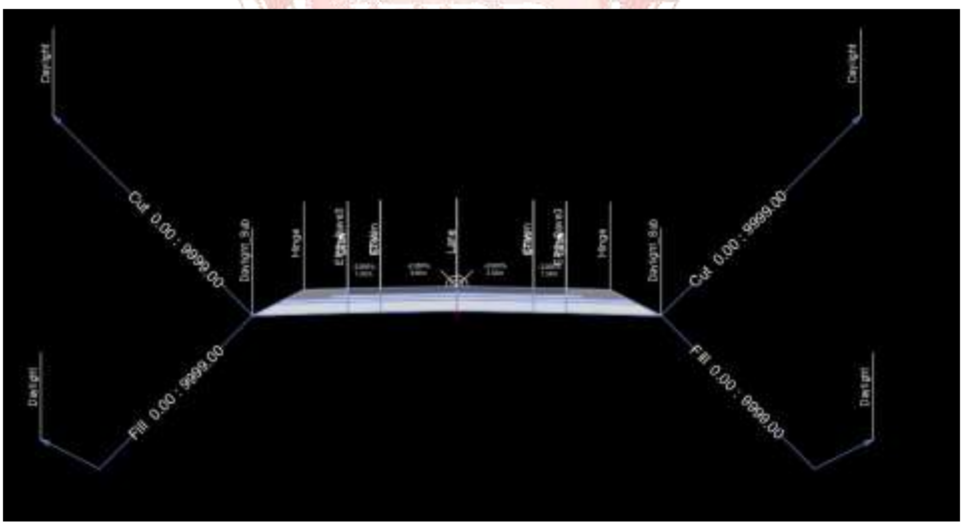
Figure 4:- Generated Profile View in Civil 3D

## ASSEMBLIES AND CORRIDOR MODELLING

*Modelling*

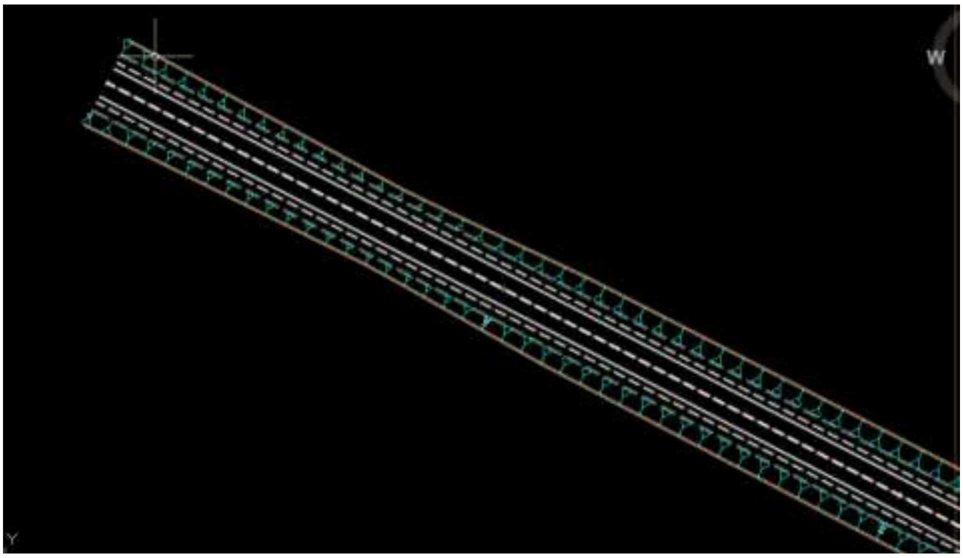
**Assemblies**

- An assembly is an AutoCAD Civil 3D drawing object that manages a collection of subassembly objects. Together, assemblies and subassemblies function as the basic building blocks of a roadway or other alignment-based design.
- We have some preinstalled subassemblies, those we can use to make a assembly,
  But this assemblies have some limitations, so we can create this subassemblies in Assembly composer.




**Corridors**

- A corridor model builds on and uses various AutoCAD Civil 3D objects and data, including subassemblies, assemblies, alignments, surfaces, and profiles. The corridor manages the data, tying various assemblies (applied for different ranges of stations) to the baselines and their finished grade profiles.




**Updated Corridor Section is Seems like above**

**Generation of Quantities**

**By Average end area method**

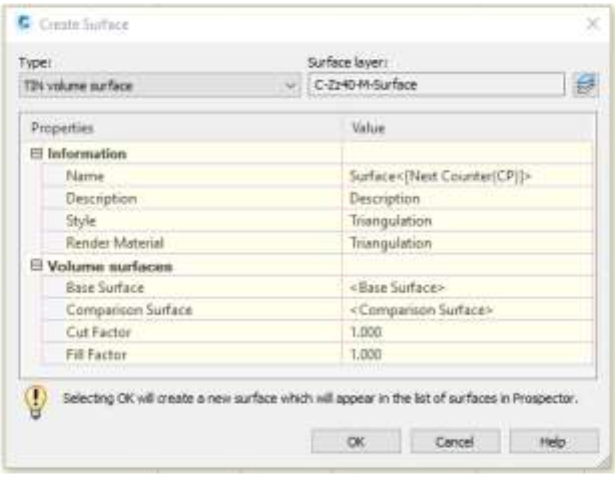
- Generally, we need the Earthwork Quantities, but sometimes material quantities also.
- In Civil 3D We have some different methods to calculate quantities.
- At the time of generation of Quantities, we need to define a design file.

**By Volume Dashboard Method.**

This method can be more accurate than Average End area Method.


**Figure 5 :- Panorama of Quantity**

- Add the Surface with this, in this pop up you have to define Base Surface and bottom Subgrade surface to Civil 3D and hit ok.



## CONCLUSION

*Conclusion*

- The use of AutoCAD Civil 3D for roadway geometric design makes the design process to be completed within a very short time and with much ease and amazing precision. These capabilities of AutoCAD Civil 3D eliminate the major disadvantages of the manual design approach that is cumbersome, time consuming and highly prone to costly errors.
- The solutions for road design in AutoCAD Civil 3D software make defining, annotating, and analyzing your road design more efficient and help your design comply with sound engineering standards.
- Using criteria-based design, road modelling with real-time analysis and designer feedback helps expedite the design process and minimizes problematic issues.
- Additionally, a good understanding of subassemblies and their functions enables the efficient construction of more accurate, construction-ready corridor models. Utilizing points, links, shapes, codes, target parameters, and road models, which can be tailored to your designs needs, will automate many repetitive and/or difficult road design tasks, such as labelling and updating cross section sheets.

*Scope for Future Study*

- Only one formats of survey data are analyzed in the study i.e., topo Survey. Other formats like total station, auto level and GPS data may be considered for the future study.
- More complex problems like interchange design, and rotary intersection etc. may be studied to check the capabilities of software in handling complex situations.

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