GEOMETRIC DESIGN OF RURAL ROAD USING AUTOCAD CIVIL 3D

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Abstract - *Rural roads are also known as low volume roads the preponderance of the population of India is living in rural areas. It is essential to plan and design the road with safe, efficient, economic and easy for the movement of traffic and collect the details of different studies. Survey is carried out to give best possible alignment. In the furtherance of transportation facilities in the rural areas will faster the development of these areas and overall country. Geometric design plays a major role in every road and it is weighty in the road alignment. AutoCAD Civil 3D is a software application used by civil engineers and professionals to plan and design the projects. This paper lavishes on a total geometric design of rural road using AutoCAD civil 3D software. AutoCAD civil 3D associate design and production drafting, greatly reducing the time it takes to implement design changes and assess multiple set of circumstances. The main aim of this project is to exemplify the proposed road alignment in a comfortable way using AutoCAD civil 3D. Tabular columns for curves, profile section will generate automatically. Gradually Volume Report sheet is generated. By using total station survey can be carried out rapidly and can truncate the time. Total station is a nifty for importing the points in AutoCAD civil 3D which is in the form of x, y, z co-ordinates that is latitude, longitude and elevation. These co-ordinates of the ground will generate and helps to design the alignment in the AutoCAD.*

Key Words: **Geometric design, Total Station, AutoCAD civil 3D.**

1. INTRODUCTION

In the present trend, geometric design is an important component and having a great effect while aligning a new road. Geometric design is a backbone of any alignment of road. It deals with cross sectional elements, sight distance considerations, horizontal alignment and vertical alignment details, intersection elements and it is relaying on the important factors such as design speed, topography or terrain, traffic factors, design hourly volume and capacity, environmental and other factors. While aligning a new road, it should be short, easy, safe and economic and it is expected to be comfort and safe for the movement.

Rural road is a road network with a low volume traffic and low design speed which provides market access to farms, employment and connects different communities. Rural roads are classified into other district road (ODR) and village road (VR). These roads are able to reach the group of villages in rural area of the country and to provide connectivity. It is owned by local authorities.

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.

Total station is a combination of electronic distance measurement (EDM), an electronic digital theodolite, and a computer in one unit used to measure horizontal angles, vertical angles and sloping distances of the objects. It takes a part by providing all the three co-ordinates of the observed points that is northing, easting, and elevation. These points are further transferred into AutoCAD civil 3D.

2. STUDY AREA LOCATION

The study area is located in Mysore district of Mysore taluk from Doddamara gowdanahalli to Handanahalli – Hunsuru. Length of stretch is 5.3km. Project area passes through plain terrain and rolling terrain. Existing study area consists of asphalt road and Soil road. The alignment comprises of significant horizontal curves which would require geometric corrections.

Figure 1 – Satellite image of selected area of the project

3. DATA COLLECTION

Collecting the data and quantifying the information from a survey in the field or the study area in a systematic path in order to get proper and scrupulous picture of an area of interest, also to analyze and evaluate the outcomes and retort to the research problems.

3.1 Surveying

Surveys are carried out before starting the project such as Map study, Reconnaissance survey, Preliminary survey, Final location. Map study is to have a rough idea of the field. Reconnaissance survey is to visit the site and scrutinize the main features of the area but not in detail. The data derived from the reconnaissance surveys are normally utilized for planning and programming the detailed surveys and investigations and few possible alignments can be chosen for any alteration or changes. In Preliminary surveys, survey specialists and party performs field surveying duties using total station and collects all data which are necessary like latitude, longitude, elevation and other required measurements and data in the alternate alignments proposed. At last, final locating the centre line of the ground.

3.2 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 10 years @ 6% growth rate,

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

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,

$$= \frac{317.39 \times 365 \times (1+0.06)^{10} - 1 \times 1}{r}$$

= 1526960

Therefore,   ESAL = 152696

ESAL	152696
Category	T9

For Cumulative ESAL applications >1,500,000 – 2,000,000 Traffic comes under category T9 as per IRC: SP- 72 -2015 "Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads".

4. DESIGN OF FLEXIBLE PAVEMENT FOR 10 YEARS AS PER IRC: SP: 72-2015

Data,
1. Single lane two carriageway = 1
2. PCU = 4514
3. No. of commercial vehicles as per last count (P) = 153 CVPD
4. Traffic growth rate per annum (r) = 5%
5. Design life (n) = 10 years
6. Vehicle damage factor (F) = 3.50
7. CBR of subgrade soil = 8%
8. Lane distribution factor (D) = 1
9. Initial Traffic in the year of completion of construction in terms of the number of commercial vehicles per day (A)
   $A = P (1+r)^x$

   = 161

Calculation of MSA is given by formula,

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

N = 2.59 msa (Say 3 msa)

For traffic category "T9" obtained from traffic analysis, Design crust for 3 msa based on pavement design catalogues for gravel/ gravel bases and sub-bases as per code is tabulated as below.

Table 1 - Design Crust for 3.00 MSA

PAVEMENT LAYERS	DESIGNED CRUST
BC	20
DBM	50
Granular Base	225
Granular Sub base	150
Total	**445**

5. TOTAL STATION

Total Station is a combination of Electromagnetic Distance Measuring (EDM), Theodolite and Micro processor 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 were 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.

Figure 2 - Co-ordinates of the points

6. 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.
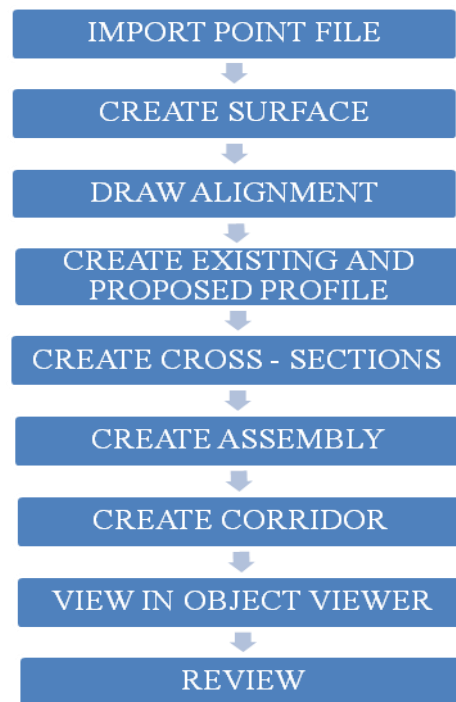

Figure 3 - Flow Chart of AutoCAD Civil 3D

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.

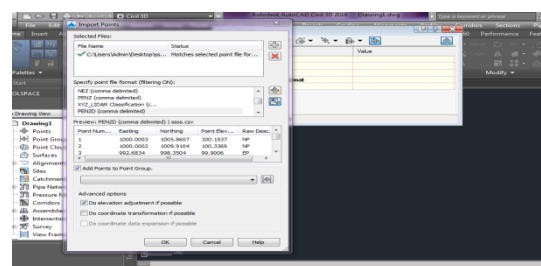The below figures shows the design procedure;
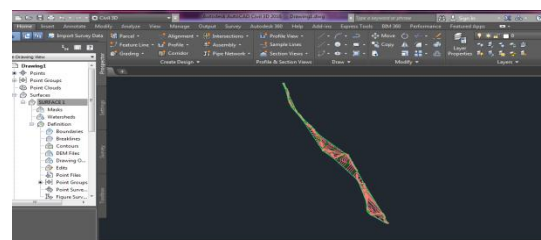

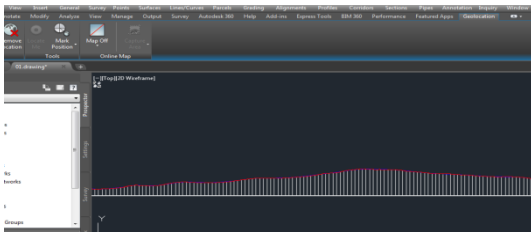**Figure 4 - Import Point File**

Figure 5 - Surface Creation

Figure 6 - Profile creation

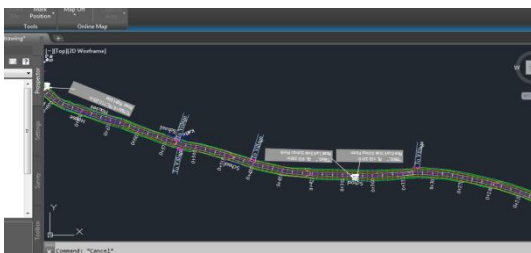**Figure 7 - Cross sections of the road alignment**
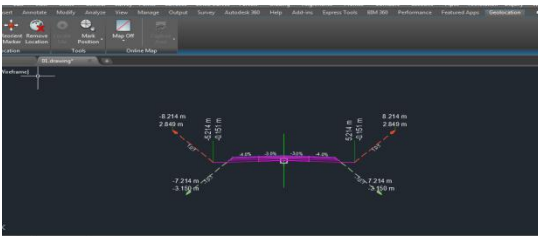

Figure 8 - Corridor creation
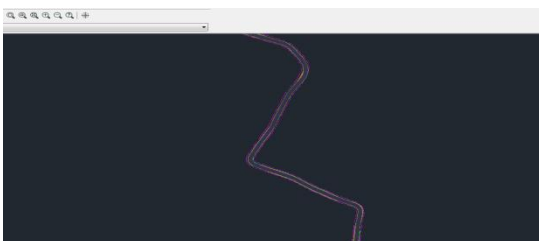

Figure 9 - Assembly creation

Figure 10 - Object viewer

Design criteria

Design standards adopted for rural roads –is adopted from IRC: SP: 20 – 2002 "Rural Roads Manual"

a) Design Speed – 50kmph

b) Road Way Width – 7.5m

c) Carriageway width – 3.75m

d) Shoulder width – 1.875m

e) Super elevation – 8%

f) Camber in shoulders – 4%

g) Camber in carriageway width – 3%

7. OUTPUT OF THE DESIGN

Drawings are the results obtained for the proposed road and simultaneously tabular column are generated automatically with details.

We will get the formation level, cross sections, curve details along with the information of depth of cut and fill (Earthwork quantity) for the entire project stretch.

8. CONCLUSION

Consequence of this observations made, investigations done, collection of traffic data, examination of the existing study area helps us to align the road which is feasible and sound in an effective way. By using total station makes survey easier and possible to truncate the time for the field survey. It eradicates manual errors like reading and recording co-ordinates. These co-ordinates enroll for map making and plotting contour and cross section in AutoCAD civil 3D. AutoCAD civil 3D helps to complete the design process in a relaxed and comfortable way within time and also it preserves lot of time and effort. This project introduces a complete geometric design of the village road using AutoCAD civil 3D.

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