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Geometric Design and Safety Assessment of Road

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ABSTRACT: India is one of the country having population will increase steadily causes site visitors extent extra. In addition to that sanctioning of budget from authorities for transportation infrastructure improvement isn't satisfactory. So that it's miles top-rated to plan and layout the geometric elements of the road all through the preliminary alignment stage itself through considering future site visitors increase. And it's far very difficult to improve geometric elements after creation and purpose to undesirable capital investment. This project affords assessment on beyond work carried out on geometric design of toll road and emphasizes making plans and designing of geometric functions. Despite the fact that there are wide variety of things influences on layout of motorway, but suitable geometric layout having goal of giving optimum performance in site visitors operation with contentment protection measures at affordable cost.

KEYWORDS: Geometric Design, Total Station, Civil 3D, Design criteria, Horizontal and Vertical alignment. Etc.

I.INTRODUCTION

In our modern-day age, transportation is vital almost for all the sports in our everyday lives. There are several specific modes, particularly dual carriageway, rail, air and water transportation labelled consistent with the vehicle and the motion type [4]. Nowadays, still the predominant part of the transportation worldwide is dealt with by highways. For efficient highway systems, land use planning and road community making plans are crucial ideas and they need to be treated collectively. Exceptional land makes use of generate wonderful requirements and awesome community design strategies are to be set up for awesome land makes use of a good way to have sustainable delivery via minimizing congestion and improving traffic protection [13]. Therefore, proper zoning plans and road network ought to be organized to distribute the land use styles, which includes residential areas, shopping facilities, trade regions, business centers and others.

Transportation infrastructure particularly concerning to highways facilities consists of the geometric components like horizontal alignment, vertical profile and go phase of the road. The importance of the motorway geometric layout can be analyzed with the accident facts of the special category roads [10].

The maximum full-size element of motorway engineering is the geometric layout of highways. It offers with the size and design of the street's seen characteristics. The significance of street geometric layout is to set the driving force and vehicle stipulations, which include effectiveness, protection, and so forth [5]. The features commonly seemed are the cross section, sight distance, intersection, vertical alignment and horizontal alignment. Proper geometric layout will assist to lessen injuries and their severity. The intention of geometric layout is consequently to offer ultimate effectiveness in visitors' operation and most safety at affordable price.

A function that requires "geometric shapes and road safety tests" involves the whole geometric structure of both pedestrian paths using a pc-assisted system, and also includes the same functions as building road alignment and arranging profile alignment using bearings or coordinates (easting and northing). channels and points for the proposed route; calculation of sight distances, radius of horizontal curves, and lengths of vertical curves; the formation of exchange and mathematical components aimed at obtaining the most efficient alignment while satisfying the needs and constraints of construction [12].



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Civil 3-D software developed by Autodesk. Civil 3-D is software used for engineering to perform its civil engineering tasks such as miles, layout, planning and road, road, water, land improvement and rail. This software is commonly used by civil engineers and various professionals. Civil 3-D is generally used to minimize the time of layout and also examine more than one situation. It is also enabling you to complete challenge in quick, exquisite and all of the extra genuinely. Its miles used to supply three-D fashions for initiatives on transportation, water or land tasks even as hold relationships to source statistics, as an instance, contours, corridors and grading. Civil 3-D is nicely-established inside the civil engineering society and normally utilized in numerous large and small creation tasks [13].

II.PROBLEM STATEMENT

- Geometric design for transportation facilities includes the design of geometric cross sections, horizontal alignment, vertical alignment, intersections, and various design details.
- These basic elements are common to all linear facilities, such as roadways, railways, and airport runways and taxiways.
- Although the details of design standards vary with the mode and the class of facility, most of the issues involved in geometric design are similar for all modes.
- In all cases, the goals of geometric design are to maximize the comfort, safety, and economy of facilities, while minimizing their environmental impacts.
- For the purpose of explanation, the order of presentation of material in this chapter is to consider geometric cross sections first, then vertical alignment, horizontal alignment, super elevation, intersections, and various design details.

III.OBJECTIVE

The main objective of the study is to examine the existing road geometry and its contribution in the road safety measures for reducing accidents and therefore reducing long term cost.

- To identify the safety issues in highway design to meet the needs of all types of road users and to minimize the conflict with one another.
- To analyze all accident black spots and convert them into non accidental prone areas and thus finding improvement scope in the road geometry with some measures.
- To increase awareness about safe design practices which involve in the planning, design, construction and maintenance of roads.

IV.LITERATURE SURVEY

In the past few many years, many researches have been performed to become aware of and to remedy complicated site visitors and transportation engineering problems. The have a look at has considered several reviews of posted and unpublished studies and related cloth for building the inspiration of the have a look at. The have a look at will assist the researchers to locate the deficiency within the roadway design and to set up the level of protection of the take a look at area, so as to allow government/corporations, keep away from the future taking place fee i.e., construction or coincidence price.

- Mannering et al. (2005) concluded that the layout of modern roadways is a complex process that presents the highway engineer with the most demanding conditions. Roadway attire should not simply forget the many layout controls and standards that extend beyond the basic software of regulatory requirements. Adjusting site visitors, construction prices, real estate fees, car differences and environmental and environmental concerns are all challenges facing civil engineers. A well-designed road takes into account economic impacts and environmental constraints, as well as mobility and safety issues.
- Ames et al. (1997) supplied an internet-based geometric layout software program bundle called roadway on line software for design (street) changed into advanced using the java programming language with the goal of helping students better understand the roadway planning and layout procedure. Avenue assists college students in accomplishing geometric design on a laptop display screen with an imported virtual contour map as the graphical design reference in the background. College students are capable of layout the geometry of a roadway more successfully and thereafter can cognizance extra on strategic choices, transportation making plans, and ability



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environmental and monetary affects. Moreover, the very last geometric design can be visualized in a 3D digital fact surroundings the use of digital fact version language (VRML) on an internet browser to look at the final roadway layout from exclusive views.

- Abdulla Galadari, et al., (1994) concluded that the elements affecting coincidence sever- its ranges based at the coincidence kind, driver-at-fault information and signal configurations through the usage of an ordered logistic model.
- Ali Abdi Kordani, et al., (1998) [studied to discover the correlation among facet friction aspect (call for) and longitudinal grade on horizontal curve by using 3-dimensional simulation model.
- Jaeyoung lee, et al., (2011) explained at the development of the relationship be- tween terrible pavement situations and crash severity levels the use of a series of Bayesian ordered logistic model for low, medium and excessive velocity roads and unmarried or multiple collision instances.
- Neeraj, et al., (2015) said formulas pavement extends to the horizontal curves. To avoid oversight, the widest part of the pavement is provided on horizontal curves called mechanical widening.
- Stergios mavromatis, et al., (2016) mentioned SSD adequacy research finishing on left-hand winding split roads is mainly based on the difference between available and on-demand SSDs.

V.DESIGN METHODOLOGY

The simplified methodology adopted for the project completion and elaborated as below,

- Engineering Survey and Investigation- The initial step includes the detailed survey of the project stretch including site assessment, reconnaissance survey, detailed topographical survey, traffic survey etc.
- Survey Analysis-The step includes the analysis of the survey data including the preparation of basic drawings.
- Design Base Preparation- The step includes the preparation of digital terrain model by AutoCAD Civil 3D using survey data.
- Conceptual Design- The step includes the design of various geometric components such as typical cross section, alignment.
- Detailed Design-The step includes the design of detailed geometric components such as, horizontal curves, vertical curves, super élévations, transition cuves, intersection etc.
- Safety Evaluation-The step includes the safety evaluation of designed intersections using the Auto TURN model.
- Validation with IRC provision- The step includes the verification of the designed parameters with respect to IRC provisions.

A. Design Procedure

- Create surface.
- Import factor documents (comprising northing, elevation and easting and stored in excel layout) into the AutoCAD civil 3-D environment.
- Create alignment with the alignment advent device.
- Calculate super elevation from the given alignment.
- Follow the IRC layout criteria in this assignment.
- Create surface profile.
- Create grade line and vertical curves the usage of the profile creation equipment.
- Create the assembly. The meeting is constructed by means of including person subassembly.
- Create a corridor, a 3D version illustration that consists of a mixture of vertical, horizontal and move-sectional elements. Corridors also used to calculate earthwork amount, perform sight distance evaluation and discover statistics for construction purposes.
- Generate quantity desk file.
- Generate perspective view.

B. Horizontal Alignment Design

The horizontal layout of the avenue describes its orientation and area in the planning process. It consists

of 3 geometric adders, tangents (straight segments), round curves and a transition spiral between tangents and curves. Right layout of alignment is will increase the dual carriageway capacities and also improves the layout pace performance.

In excel layout, Survey data containing Eastbound, Northing and Elevation were converted to imports in Civil 3-D. The alignment creation device changed into used to attract the street alignment after specifying the layout necessities to be implemented at the alignment. The use of the ' geometry editor ' device, the spiral and circular curves had been drawn and acquired alignment curve record.

The minimal curve radius changed into calculated in equation (1) primarily based at the super elevation, layout speed and coefficient of friction detailed within the layout criteria,

$$R = \frac{v^2}{127(e+f)} \quad (1)$$

Where R = minimum radius of horizontal curve in meters.

v = minimum design speed, Km/h.

e = super elevation.

f = coefficient of friction.



Fig.1: Horizontal Alignment generated by AutoCAD Civil 3D

C. Vertical Alignment Design

Vertical alignment is defined because the longitudinal section of the road. It consists of vertical curves and gradients, it additionally have an effect on the comfort in motors motion at high speeds, sight distance and preventing distance. While the horizontal alignment is constant, vertical alignment can then be created. To do this, first the horizontal alignment ground profile is evolved after which the vertical alignment is produced at the angle of the profile. Profile geometry turned into chosen with the aid of applying minimal ok design standards for vertical curves of sag and crest that meet the simple conditions for stopping sight distance, accessibility and look standards.

Vertical curve lengths were also calculated manually using the formula (2)

$$L = KA \quad (2)$$

Where,

K= length required for a 1% change of grade.

L = vertical curve length.

A = change of grade in %.

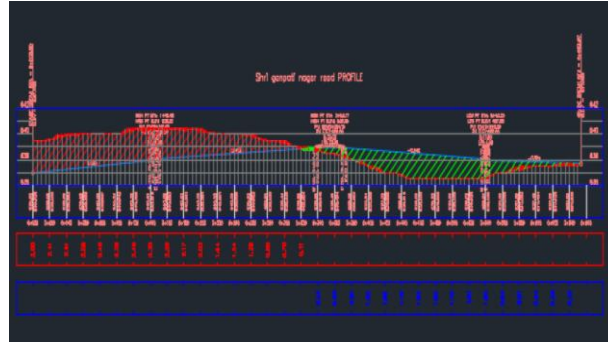


Fig. 2: Vertical alignment generated by AutoCAD Civil 3D

D. SSD modeling proposal

SSD efficiency check, which is an accurate process based on a realistic representation of road characteristics, as well as vehicle dynamics. Consequently, ground, travel surfaces and roadside factors are all taken into account along with actual friction and grade values in emergency braking conditions. Based on the process, when is the sufficient difference between an available and demanded SSD and an SSD:

$$SSD_{DEMANDED} \leq SSD_{AVAILABLE} \quad (3)$$

On the one hand, $SSD_{DEMANDED}$ is defined based on the point mass model (Equation 4) presented by many design guidelines worldwide, with true values of grade and longitudinal friction variation due to the effects of vertical curves and vehicle angles. In such an arrangement, it is noteworthy that these true grade and friction values are ignored in current practice.

$$SSD = V_o t + \frac{V_o^2}{2g(\frac{a}{g} + s)} \quad (4)$$

where:

V_o (m/sec) : vehicle initial speed

t (sec) : driver’s perception – reaction time [e.g. 2.5sec (AASHTO, 2011), 2.0sec (RAA, 2008)]

g (m/sec²) : gravitational constant

a (m/sec²) : vehicle deceleration rate [e.g. 3.4m/sec² (AASHTO, 2011), 3.7m/sec² (RAA, 2008)]

s (%/100) : road grade [(+) upgrades, (-) downgrades]

$SSD_{AVAILABLE}$, on the other hand, is known as the driver's focus on the height of the object, both of which are kept in a fixed offset in a 3D road environment. The available focus distance depends mainly on the alignment configuration. Therefore, in addition to the parameters from the horizontal and vertical alignment, the sectional elements (growth rate, a detailed description of the median resistance type), as well as the position of the driver and the object (in terms of their heights and the offset road from the median) are required. Parameters. Equations of analytic geometry are used to describe the visual line and to determine its intersection points with planes constructed by road geometry or to limit the driver's attention toward the object.

E. Decision of Super elevation

Super Elevation reduces the automobile inclination forward and backward by increasing the transverse slope provided by the centrifugal force effect and the outer edge of the pavement closer to the inner edge. Super elevation is defined after the horizontal curve radius is decided. Super elevation is applied to the alignment phase thru the command "edit super elevation".

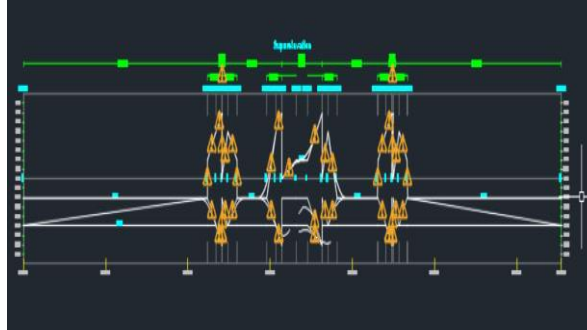


Fig.3: Super elevation View

F. Assemblies

Assembly is used for defining of platform in civil 3-d software program. “Subassembly “command is a part of platform, meeting that indicates together with shoulder, median, lane for developing traditional cross phase of avenue. Proper and left elements are introduced middle of platform with subassemblies. There are two probabilities for growing meeting as the use of existed subassemblies or growing subassemblies with the aid of oneself.

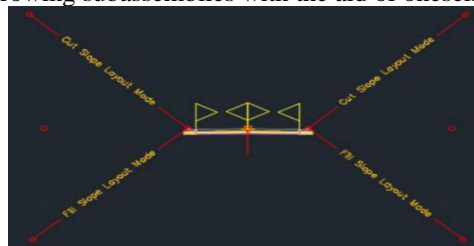


Fig. 4: Assembly

G. Cut and Fill Calculation

A function in AutoCAD Civil 3-D allows calculating the required earthwork within a few seconds after assignment. After constructing the surface and the recommended floor area, AutoCAD Civil 3-D makes it easy to produce a contrast surface that reveals the difference in height and calculates the volume between the two surfaces.

VI.CONCLUSION

After studied one-of-a-kind assets and past work it needs to be said some targets of geometric layout of dual carriageway given beneath

- A. The geometric design of roads with the help of AutoCAD Civil 3-D is also known as highly advantageous and person-friendly for 3-dimensional road layout.
- B. with IRC, the geometry of roads and AASHTO are additionally considered as all safety measures.
- C. It is equipped with a horizontal alignment, forms a vertical profile and can be installed cross-segment.
- D. Super reproduction implemented and fixed.
- E. The geometric design should provide maximum traffic weight capacity and safety justification at low fares.
- F. Extra care must be taken at the same time when planning the astonishing height and avenue expansion in horizontal geometry.
- G. About focus distance and vertical alignment brings very low propulsion as a result of low fuel consumption.

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