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A Brief Study on Road Geometry Design by SuperCivilCD Software (ROAD)

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Abstract - *Road safety is an issue of prime importance in all motorized countries. The road accident results in serious social and economic problems. India is one of the country having population increases progressively causes traffic volume more. The effects of road design elements such as horizontal and vertical curves, lane width, shoulder width, superelevation, median width, curve radius, sight distance, etc. on safety have been studied. The relationship between geometric design elements and accident rates is complex and not fully understood. In addition to that sanctioning of funds from government for infrastructure development, is also not satisfactory. In this study a reiterative procedure to design road geometry elements by using "Supercivilcd" software (ROAD) is done.*

Key Words: **Road Geometry, Design, Software, SupercivilCD**.

1. INTRODUCTION

1.1. Road Geometrics Elements

Geometric design of a highway deals with the dimensions and layout of visible features of the road such as horizontal and vertical alignments, sight distance, etc. The geometrics of highway should be designed to provide efficiency in traffic operations with maximum safety at reasonable cost. It is possible to design and construct the pavement of a road in stages, but it is very expensive and rather difficult to improve the geometrics elements of a road in stages at a later date. The road can serve the purpose in the best possible manner for which they are meant with proper geometric design. Here is a brief definition of some geometric elements.

Alignment: The alignment is the route of the road, defined as a series of horizontal tangents and curves.

Profile: The profile is the vertical aspect of the road, including crest and sag curves, and the straight grade lines connecting them.

Cross - Sections: Under cross sections elements, the considerations for the width of pavement, formation and land, surface characteristics and cross slope of the pavement are included.

Sight Distances: Road geometry affects the sight distance available to the driver. The sight distance or clear distance visible ahead of a driver at horizontal and vertical curves and at intersections govern the safe movements of vehicles. Types of sight distances are:-

(a) Stopping Sight Distance (SSD)
(b) Safe Overtaking Sight Distance (OSD)
(c) Safe sight distance for entering into uncontrolled intersections.

Cross slope: Cross slope or camber is the slope provided to the road surface in the transverse direction to drain off the rain water from the road surface**.**

Superelevation: To counteract the effect of centrifugal force and to reduce the tendency of the vehicle to overturn or skid, the outer edge of the pavement is raised with respect to the inner edge, thus providing a transverse slope i.e. superelevation throughout the length of the horizontal curve.

Horizontal Curves: Horizontal curves are provided to change the direction of centre line of the road. When a vehicle negotiates a horizontal curve, centrifugal force acts outwards through centre of gravity of the vehicle which depends upon the radius of curve and speed of vehicle.

Transition Curves: A transition curve is a curve introduced between a straight and circular curve whose radius decreases from infinity at the tangent point to a designed radius of the circular curve.

1.2 Software

Software's are actual accessible for our day to day work. They accomplish our activity easier and comfortable. Also, the plan becomes added efficient. They advance our productivity; makes designing, planning, and assay of huge projects easier with the use of minimum time and resources. Here "SuperCivil CD" (ROAD) SOFTWARE IS USED FOR THE DESIGN PURPOSE. SUPERCIVILCD IS A WEST AUSTRALIAN ANCIENT ACCESSION COMMITTED TO ACCESS ALL ASPECTS OF OUR NONCOMBATANT WORKS OPERATION. SUPERCIVILCD IS A DIFFERENT CIVIL, structural and architectural engineering handbook-cum-architecture software on CD-ROM is absolutely like a mini album of civilian engineering. It is acutely and advantageous to professionals including Architects, Builders, Contractors, Structural Engineers, Consultants, Designers / Draughtsmen, Project Managers, Estimators / Tenders, civilian engineers, and students.

SuperCivilCD software consists of various kind of software are:-RC DESIGN PACKAGE, STEEL DESIGN PACKAGE, CONSTRUCTION PACKAGE, BILLING PACKAGE, ROAD PACKAGE, VALUATION, HVAC & ELECTRIC PACKAGE. The advantages are the software is self learning product, easy to use and learn, simple and user friendly.

2. SOFTWARE ANALYSIS

2.1 Design of Stopping Sight Distances (SSD)

(a) SSD between a vehicle and stationary object:-

Inputs:
VELOCITY OF VEHICLE IN KMPH = 80

REACTION TIME OF VEHICLE IN SECONDS = 2.5

ROAD GRADIENT IN % = 2.5

COEFFICIENT OF FRICTION = 0.7

BRAKE EFFICIENCY OF VEHICLE IN % = 50

Outputs:
TOTAL STOPPING SIGHT DISTANCE IN METRE = 123

HEAD LIGHT SIGHT DISTANCE IN METRE = 123

INTERMEDIATE SIGHT DISTANCE IN METRE = 246

(b) SSD between vehicles moving in opposite direction:-

Inputs:
VELOCITY OF VEHICLE #1 IN KMPH = 80

VELOCITY OF VEHICLE #2 IN KMPH = 60

REACTION TIME OF VEHICLE # 1 IN SECONDS = 2.5

REACTION TIME OF VEHICLE # 2 IN SECONDS = 2.5

ROAD GRADIENT IN % = -2.5

COEFFICIENT OF FRICTION = 0.7

BRAKE EFFICIENCY OF VEHICLE (1) IN % = 50

BRAKE EFFICIENCY OF VEHICLE (2) IN % = 20

Outputs:
STOPPING SIGHT DISTANCE OF VEHICLE (1) IN METRE = 133.12

STOPPING SIGHT DISTANCE OF VEHICLE (2) IN METRE = 127.59

TOTAL STOPPING SIGHT DISTANCE IN METRE = 261

2.2 Design of Horizontal Curves

Inputs:
VELOCITY OF VEHICLE IN KMPH= 80

COEFFICIENT OF LATERAL FRICTION = 0.15

RADIUS OF HORIZONTAL CURVE IN M = 150

Outputs:
REQUIRED SUPERELEVATION IN % = 18.59

MINIMUM REQUIRED LATERAL COEFFICIENT OF FRICTION = 0.28

REQUIRED RADIUS OF HORIZONTAL CURVE IN METRE = 251.96

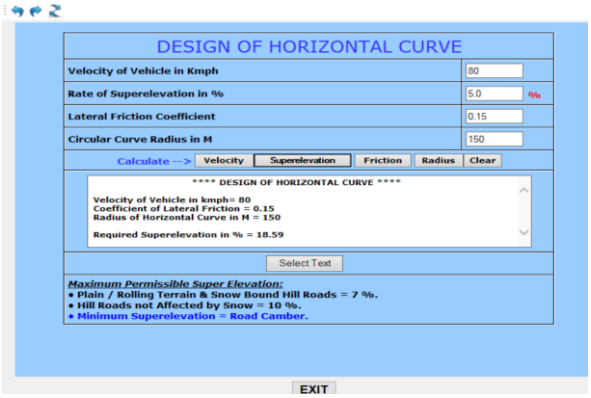

Fig -1: Horizontal Curve Design Option in Software

2.3 Length of Transition Curves

Inputs:
VELOCITY OF VEHICLE IN KMPH = 65

RADIUS OF CIRCULAR CURVE IN METRE = 220

ROTATION FOR SUPERELEVATION: PAVEMENT ROTATED ABOUT CENTER LINE

TERRAIN: PLAIN / ROLLING

RATE OF CHANGE OF SUPERELEVATION = 1 IN 150

SUPERELEVATION IN % = 7

PAVEMENT WIDTH INCLUDING WIDENING IN METRE = 7.5

Outputs:
RATE OF CENTRIFUGAL ACCELERATION (C) IN M/SEC3 = 0.57

TRANSITION CURVE LENGTH AS PER (C) IN METRE = 47.08

TRANSITION CURVE LENGTH AS PER SUPERELEVATION RATE IN METRE = 39.37

TRANSITION CURVE LENGTH AS PER EMPIRICAL FORMULA IN METRE = 51.85

DESIGN (MAXIMUM) TRANSITION CURVE LENGTH IN METRE = 51.85

OFFSETS BETWEEN CIRCULAR & TRANSITION CURVE IN METRE = 0.5

3. RESULT

It is well observed while doing with the software the output results are knowingly calculated of different road geometrics as follow:

DESIGN OF STOPPING SIGHT DISTANCES (SSD)

(a) SSD between a vehicle and stationary object:-
VELOCITY OF VEHICLE IN KMPH = 80

REACTION TIME OF VEHICLE IN SECONDS = 2.5

ROAD GRADIENT IN % = 2.5

COEFFICIENT OF FRICTION = 0.7

BRAKE EFFICIENCY OF VEHICLE IN % = 50

And the result of this input is:- TOTAL STOPPING SIGHT DISTANCE IN METRE = 123; HEAD LIGHT SIGHT DISTANCE IN METRE = 123; INTERMEDIATE SIGHT DISTANCE IN METRE = 246

(b) SSD between vehicles moving in opposite direction:-
VELOCITY OF VEHICLE #1 IN KMPH = 80

VELOCITY OF VEHICLE #2 IN KMPH = 60

REACTION TIME OF VEHICLE # 1 IN SECONDS = 2.5

REACTION TIME OF VEHICLE # 2 IN SECONDS = 2.5

ROAD GRADIENT IN % = -2.5

COEFFICIENT OF FRICTION = 0.7

BRAKE EFFICIENCY OF VEHICLE (1) IN % = 50

BRAKE EFFICIENCY OF VEHICLE (2) IN % = 20

And the results of this input is:- STOPPING SIGHT DISTANCE OF VEHICLE (1) IN METRE = 133.12; STOPPING SIGHT DISTANCE OF VEHICLE (2) IN METRE = 127.59; TOTAL STOPPING SIGHT DISTANCE IN METRE = 261

DESIGN OF HORIZONTAL CURVES

VELOCITY OF VEHICLE IN KMPH= 80

COEFFICIENT OF LATERAL FRICTION = 0.15

RADIUS OF HORIZONTAL CURVE IN M = 150

And the result of this input is:- REQUIRED SUPERELEVATION IN % = 18.59**;** MINIMUM REQUIRED LATERAL COEFFICIENT OF FRICTION = 0.28**;** REQUIRED RADIUS OF HORIZONTAL CURVE IN METRE = 251.96

LENGTH OF TRANSITION CURVES

VELOCITY OF VEHICLE IN KMPH = 65

RADIUS OF CIRCULAR CURVE IN METRE = 220

ROTATION FOR SUPERELEVATION: PAVEMENT ROTATED ABOUT CENTER LINE

TERRAIN: PLAIN / ROLLING

RATE OF CHANGE OF SUPERELEVATION = 1 IN 150

SUPERELEVATION IN % = 7

PAVEMENT WIDTH INCLUDING WIDENING IN METRE = 7.5

And the results of this input is:- RATE OF CENTRIFUGAL ACCELERATION (C) IN M/SEC3 = 0.57**;** TRANSITION CURVE LENGTH AS PER (C) IN METRE = 47.08**;** TRANSITION CURVE LENGTH AS PER SUPERELEVATION RATE IN METRE = 39.37**;** TRANSITION CURVE LENGTH AS PER EMPIRICAL FORMULA IN METRE = 51.85**;** DESIGN (MAXIMUM) TRANSITION CURVE LENGTH IN METRE = 51.85; OFFSETS BETWEEN CIRCULAR & TRANSITION CURVE IN METRE = 0.5

4. CONCLUSIONS

It is well concluded after using software for analysis and design of road geometrics elements. The software is very versatile and very convenient to use for designing road geometrics elements. As various input parameter can be change number of time and within very short interval of time we can get the desire output. On the other side by hand calculation we can use any of the method, here number of methods are there we have to shift to the method and according to the method we can get the design like AASTHO , IRC, etc. so we can also compare the design output by various method. This software not only gives us design but also optimise our design which can be very much useful in the industry.

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