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Investigation of Geometrical Elements & Traffic Safety Performance on Existing Highways

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***Abstract*—Improving the safety of highway traffic is vital to the efficiency of the traffic system. The study looks in to the geometric aspects and offers ways to reduce the traffic congestion at the selected highway. The effects of design elements camber, lane width, shoulder width, superelevation, radius of curve, sight distance and others have been investigated. In this study, the characteristics of road geometric design elements are analysed. Their effects on highway safety are explained, geometric elements are investigated, and IRC-recommended measures for enhancing road safety at T intersection are presented.**

Keywords—Automated traffic light system, Geometric design elements, IRC, Intersection, Investigation, Traffic safety

I. INTRODUCTION

In order to ensure the welfare of all living things, including humans and other animals, road safety is crucial. The goal of traffic engineering is to facilitate the flow of people, products, and services along roads in a manner that is environmentally friendly, quick, comfortable, efficient, and convenient. In order to promote traffic calming in residential areas, highway construction and the installation of road signs and lights are also installed. This covers designs for road pavement marking and signage, neighbourhood traffic control, traffic reduction, and neighbourhood traffic safety. When operating a vehicle or using public roads in general, one must abide by a number of fundamental principles. However, there are more accidents on the road every day. The results of road accidents are very serious social and economic problems.

The geometric design elements is vital for traffic safety measures. Traffic safety and geometric design components must to be connected. Alignment consistency is the main problem in contemporary highway geometric design. Because this will allow most drivers to operate the vehicle at their desired speed along the entire alignment.

Alignment: The alignment is the path taken by the road, which is represented by a series of horizontal curves and tangents.

Profile: The profile of the road is its vertical aspect, which includes the grade lines that connect its crest and sag curves.

Sight distance: It is the length of the road surface where a driver can see objects, either stationary or moving, that are at a certain height above the carriageway.

Superelevation: A portion of the centrifugal force is supposed to be countered by super-elevating on curves, with the other portion being resisted by lateral friction.

Horizontal curves: Curves that are horizontal are available to alter the direction of the road's centerline.

Vertical curves: These are the curves that separate two sections of a straight road with varying gradients.

II. METHODOLOGY

We have selected the study area for the investigation of geometrical elements on existing road. By using EDM instrument – Total station the survey taken in the study area. Shoulder width, width of carriageway, superelevation, camber, gradient, radius of curvature, design speed, stopping sight distance are checked based on the traffic survey. PCU and lane capacity determined for suggesting safety enhancement measures for the selected road.

Kuppam is a municipality in the Chittoor district of Andhra Pradesh, India. It is approximately 115.8 kilometers south-west of Bangalore, Karnataka's capital, and 243 kilometers east of Chennai, Tamil Nadu's capital. Kuppam Mandal's Mandal Headquarters is located at Kuppam Revenue Division. The intersection of the Krishnagiri –

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Palamaner state highway and the Natrampalli – Thirupattur - Kuppam road is located at 12°43'47.2" N, 78°20'56.2" E, north of the Tamil Nadu – Andhra Pradesh state boundary.

III. INVESTIGATIONS

Certain physical and visual features are addressed in the design of a highway system to satisfy the scientific and practical needs of the road user and the vehicle. This is done to provide safe and smooth vehicle and pedestrian circulation at a fair cost. Apart from maintaining road safety, skilled management of the various elements of geometric design will make the highway blend in with the landscape it passes through and provide driving enjoyment. The geometric design characteristics should be built with future traffic needs in mind and should be upgradeable in the future. As a result, it is critical that the geometric aspects are designed from the starting. In the design of various elements, appropriate IRC specifications and standards are applied in the study area.

A. Width of Carriageway

The width of the carriageway or width of pavement depends on the width of the traffic lane and the number of lanes. The width of a traffic lane is determined by the vehicle's width and clearance. Side clearance boosts efficiency and safety of vehicles. A vehicle's maximum width is 2.44 meters while the ideal side clearance for single-lane traffic is 0.68 meters. A single lane road must have a minimum lane width of 3.75 meters. However, the required side clearance is 0.53 meters on both sides and 1.06 meters in the middle. As a result, a two-lane road requires a minimum of 3.5 meter lanes. As per IRC: 73-1980, for state highways width of carriageway should be 7m.

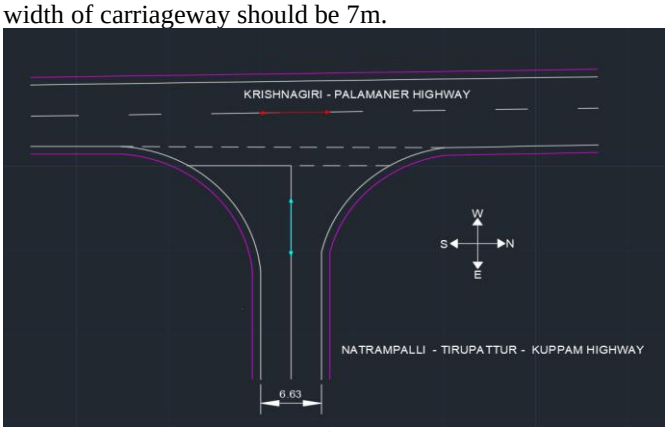

Fig.1: Width of the carriageway

B. Width of Shoulder

It serves as an emergency lane for cars and as a service lane for vehicles that have broken down along the road's side. A minimum shoulder width of 4.6 meters is required such that a truck parked on the shoulder has a clearance of 1.85 metres from the pavement edge. 2.5 meter is the IRC recommended shoulder width. The recommeded shoulder width on selected highways is 0.9m on both sides as per IRC.

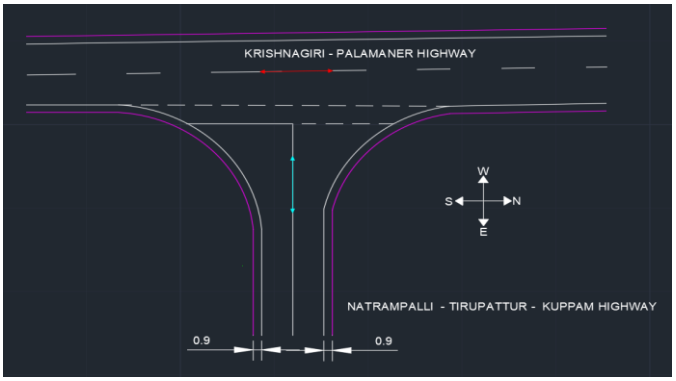

Fig.2: Width of shoulder

C. Camber

The cross slope supplied to raise the center of the road surface in the transverse direction to drain rain water from the road surface is known as camber or cants. Camber provided in the study area is 1 in 22.1. But as per IRC, the required camber should be 1 in 50 or 2%.

D. Superelevation

Superelevation is the transverse slope provided to counteract the effect of centrifugal force and reduce the tendency of vehicle to overturn and to skid laterally outwards by raising the pavement outer edge with respect to inner edge. superelevation is represented by “e”. According to IRC: 73-1980, the recommended superelevation for the areas which are not bounded by snowfall is 10%.

E. Friction

When a vehicle is turning on a horizonal curve, this friction provides resistance to lateral sliding. This friction is employed in the superelevation and horizonal curve design. The recommended value of the lateral friction coefficient by the Indian Road Congress is 0.15.

F. Gradient

The term "gradient of road" refers to the rate of rising or falling over the length of the road respect to the horizontal. In other words, the longitudinal slope provided to the road's formation level along its alignment. I t is expressed in 1 in n. It can be represented in percentage also. As per IRC, this is a mountainous terrain with ruling gradient should be 1 in 20 or 5%.

G. Design Speed

Design speed is defined as the maximum speed at which vehicles can travel safely under favorable conditions. It is approximately the maximum speed adopted by most drivers on the highway. This is dependent on the topography and the highway's classification. It is the single most important factor which controls a number of geometric design features gradient, horizontal and vertical curves, height distances, and superelevation. As a result, the design speed must be carefully chosen. 50kmph is the design speed should be taken as per IRC: 73-1980.

H. Radius of Curvature

The radius of the circular arc that best approximates the curve at that point is equal to the radius of the curve. The radius of curvature of a surface is the radius of a circle that best

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matches a normal section or combinations of normal sections. The radius of curvature needed in the intersection is 78.74m.

IV. SUGGESTIONS AND REMEDIAL MEASURES

A. *Shoulder width*

The main reason for the accidents in the intersection is due to the absence of shoulder width. Hence provide 0.9m shoulder width on both sides of the road. Specific road side parking place should be provided for parking the vehicles.

B. *Drainage*

- Proper camber should be provided as per IRC recommendations. The camber suggested for the selected highway is sloped camber.
- Longitudinal RCC drains should be built to drain surface water by keeping a proper shoulder at intersection.

As per IRC: SP:42-2014, the rectangular section is commonly utilized in both urban and rural areas, and is usually lined with RCC. The drainage system having a rectangular section with depth 0.9m and width 0.3m and wall thickness 0.15m is suggesting for the selected roads. The footpath should be constructed above the drainage.

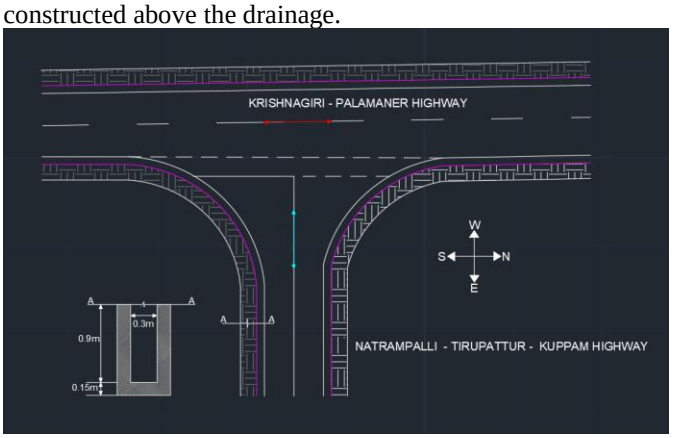

Fig. 3: Drainage

C. *Footpath*

Any area usually used by 'all' pedestrians is characterized as a pedestrian pathway. They can be close to highways or far distant from them. Footpaths, like motorways and railways, should be viewed as a connected and continuous transportation system. Sidewalks must be provided on each sides of the road and above the level of the carriageway, separated by kerbs, in order to be functional. The required width of footpath should be a minimum of 1.8 m as per IRC:103-2012. The height of the step riser should be 150 mm.

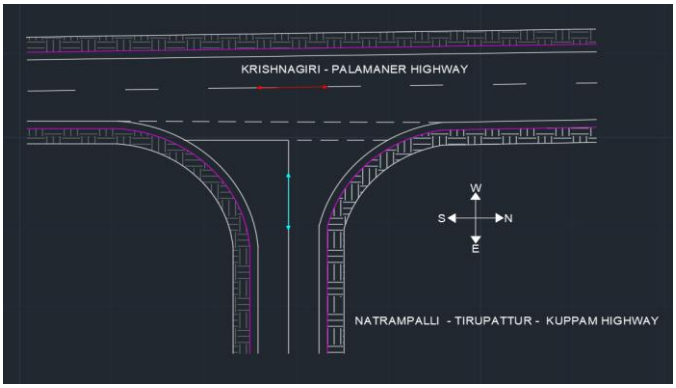

Fig.4: Footpath

D. *Traffic Signs*

Discontinuous signs, lack of warning signs, mistakes in the location and content of signs, occlusion problems, and other issues trouble the traffic sign system. Hence, new traffic signs should be created and installed in a systematic manner based on existing problems and characteristics of highway curvatures and gradients to avoid redundant information.

E. *Intersection Channelization*

In intersection, vehicles are operated without rules. The intersection has poor visibility and so the frequency of collision of vehicles are higher in the location. Hence, channelization pavement markings are painted to split different direction flows and standardize traffic order by implementing automated traffic light signal.

F. *Sight Distance Improvement*

Poor visibility problems are one of the reasons for the collision of vehicles in this intersection. Hence, buildings, trees or wire poles should be removed at the intersection. Convex mirror will placed at curves. This will helps the drivers to see the vehicle come from the opposite direction and move their vehicle safely.

G. *Pavement Markings*

The markings should be repainted. At the intersection, crosswalks, channelizing lines, and symbol markings should be introduced.

V. AUTOMATED TRAFFIC LIGHT SYSTEM

By Trial cycle method, 120 seconds is the required cycle length for the traffic signal.

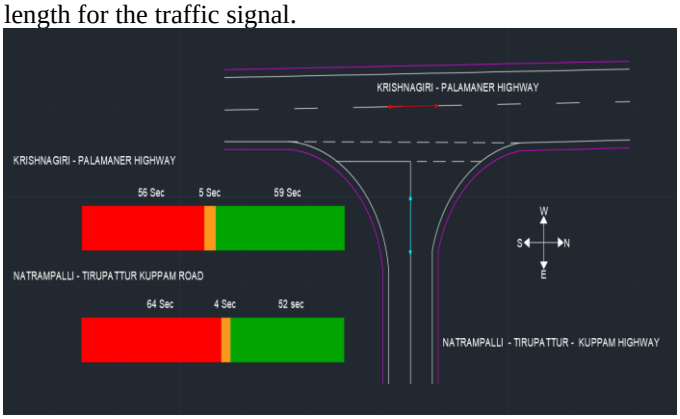

Fig. 5: Trial cycle method

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By using this we have proposed an idea for controlling traffic in the intersections. In this project we are using RTC module to get the accurate time for the night time light changes to work. With the help of RTC module as per the program code, when the specified time (8.00PM to 6.00AM) reaches the yellow light will be continuously powered on for until the time specified to turn off and back to its default lightning time. The switching was defined on the program code when the lighting function of yellow light need to be changed.

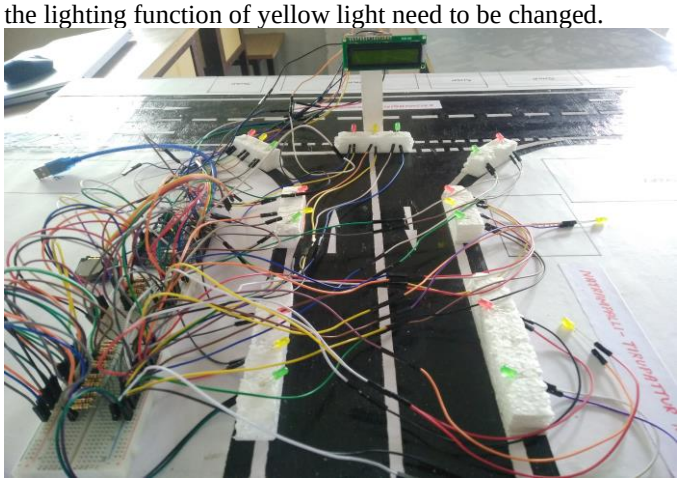

Fig.6: Automated Traffic Light System

In day time, first the red light will light up in the positions where the red light was fixed for the specified time we are provided in the code. After 64 seconds, the yellow light will light up for just 4 seconds to give an indication to the vehicles that the green light is going to light up. So, after 4 seconds, green light will light up for 52 seconds that allows the vehicles to pass the junction. Similarly, the traffic light controller will work the system will keep looping.

VI. CONCLUSION

A transportation infrastructure will lead to the growth of fasters. As a result, the country's overall development will be more balanced. Hence, a well-developed and sound road network is needed. In this view, the investigation of geometric elements are done at T intersection in Kuppam, and various issues related to the saftey performance of road has been found. Hence remedial measures are suggested for the enhancement of traffic safety of road.

- Provide 0.9m shoulder width on both sides of the road.
- Specific road side parking place should be provided for parking the vehicles.
- Raise the road level by constructing embankment.
- Sloped camber should be provided.
- Longitudinal RCC drains should be built to drain surface water by keeping a proper shoulder at intersection. The drainage system having a rectangular section with depth 0.9m, width 0.3m and wall thickness 0.15m is suggesting for the selected roads.
- The footpath should be constructed above the drainage. The required width of footpath should be a minimum of 1.8 m as per IRC 103 2012.
- New traffic signs should be created and installed in a systematic manner.
- Channelization pavement markings are painted to split different direction flows and standardize traffic order by implementing automated traffic light system.
- Buildings, trees or wire poles should be removed at the intersection and placing of convex mirror will increase the visibility of drivers at curves.
- The markings should be repainted as per IRC 35 2015.

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