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Construction horizontal road alignment between two location

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Abstract

Two-lane, two-way highway facilities represent the majority of the total length of highway network in many countries. The geometric design of such facilities is considered as one of the most important factors affecting the traffic performance and safety issues, especially the horizontal alignment. However, the interaction between the horizontal curve design elements and the traffic performance still unclear and needs more investigations. This paper aims to explore the relationship between the characteristics of horizontal alignment and the traffic performance. The follower density, a new and promising performance measure, is herein used as a measure of effectiveness (MOE), since the currently used MOE (in HCM-2000), percent-time-spent-following (PTSF), is hardly observed in the field. In this study, the traffic data are collected from mid-tangent and mid-curve points at nine different sites with various horizontal alignment characteristics. Then, several relationships between the follower density, flow rate, horizontal alignment characteristics (curve radius, tangent length), and average speed are investigated. The results shows that the horizontal alignment characteristics have a significant effect on the follower density, especially curve radius value, by decreasing radius, the follower density increases (i.e., traffic performance decreases). It is also noticed that a value of horizontal curve radius falling between 400 and 450m seems to be a threshold of the significant impact of curve radius on traffic performance. It is worth to mention that the results and relationships presented in this paper is a step towards understanding the interaction between horizontal alignment and traffic performance at two-lane highway facilities and more investigation at other locations and under different traffic conditions are recommended.

Key words: T.C, SSD, OSD, C.V, HCM, TRB etc.

1. INTRODUCTION

Four-lane, two-way highways present a particular challenge to highway engineers as they constitute the majority of any network in terms of distance (kilometers), .Measuring traffic performance at these facilities is a complex issue due to their unique characteristics, since a single lane is provided for travel in each direction resulting in higher level of interaction between vehicles traveling not only in the same but also in opposing directions. Thus, attaining a desired speed movement in the Four-lane highways traffic stream is dependent on the ability to pass slower vehicles ahead, which in turn is a function of oncoming traffic level and geometry characteristics. The interaction between the geometric design and traffic performance at four-lane highway facilities are still unclear and needs more investigations.

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Understanding how the horizontal alignment parameters affect the operational characteristics of traffic on two-lane highways could be very useful for highway practitioners. This paper aims to investigate the interaction between the traffic performance and horizontal alignment at rural fourlane highways. The follower density (number of follower vehicles per a kilometer) is used as a measure of performance in this study. Recently, the follower density is proved to be a useful measure of performance at four-lane highways in several studies. On the other hand, the horizontal alignment is investigated in terms of tangent length and curve radius. The relationships between the follower density and the horizontal curve parameters, as well as between the follower density and average speeds at the mid-tangent and mid-curve points over 9 different sites are carried out. 2. LITERATURE SURVEY Varieties of research studies were reviewed to help identify issues which are related to the vehicle speed at horizontal curves, through available methods and by considering some factors in such a manner that should be analyzed in horizontal curves, literature review was not limited to, but did include on emphasis on vehicle speed models associated with horizontal curves, vehicle speed data collection & linear mixed model. A traffic study is conducted to evaluate the transportation system serving an area and to identify any improvements necessary to accommodate existing or projected traffic volumes. The study consist of data collection, including existing traffic volumes and turning movements counts, projected traffic volumes, and the identification of required movements such as traffic calming volumes. Any identified may include a feasibility analysis, include identification of impacted properties, impacted structures, alternate alignments, physical constrains and roadway design criteria to be used. Highway Capacity Manual Concept for Evaluating Traffic Performance of fourLane Highways:- The Highway Capacity Manual (HCM) published by the Transportation Research Board (TRB) presents the widely accepted standards for analysis of two-lane highway capacity and quality of service. The first edition of the HCM was published in 1950 and included an analytical procedure for capacity analysis on two-lane highways (4). Practical capacity was used to account for operating conditions or “quality of service” on two-lane highways. It is defined as maximum traffic volume under prevailing conditions without traffic conditions becoming “unreasonable”. Operating speed was used as a performance measure for practical capacity. 3.

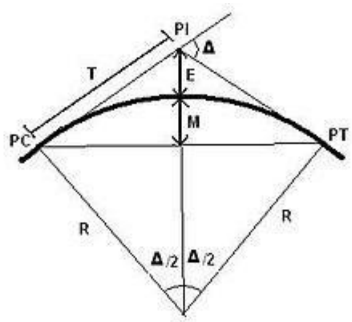
2. Objectives

This project is to determine the effect of horizontal alignment component like radius of the curvature, deflection angle, length of transition curve, width of the roads & other characteristics on traffic flow like speed of the vehicles (especially C.V.) (Spot speed, space mean speed). The scope of the project is determining the road characteristics & to develop the relationship between speed of vehicle & radius, deflection angles. To develop the relationship between length of transition curve & the space mean speed (L/T). To determine the inadequacy in the design & setting up of T.C. & circular curves To determine & analyze the impact on the safety of the vehicles by considering parameters like SSD, OSD. To develop the criteria to give suggestions to overcome the problems at the specified locations.

HORIZONTAL ALIGNMENT

Horizontal of road, known as tangents, connected by circular horizontal curves Circular curves are defined by radius (tightness) and deflection angle (extent). The design of a horizontal curve Alignment is a one of the component of highway design. Horizontal alignment in road design consists of straight sections entails the determination of a minimum radius (based on speed limit), curve length, and objects obstructing the view of the driver.

Terminology



(Layout of a simple horizontal curve)
R = Radius
PC = Point of Curvature (point at which the curve begins)
PT = Point of Tangent (point at which the curve ends)
PI = Point of Intersection (point at which the two tangents intersect)
T = Tangent Length
C = Long Chord Length (straight line between PC and PT)
L = Curve Length
M = Middle Ordinate, now known as HSO - Horizontal Sightline Offset (distance from sight-obstructing object to the middle of the outside lane)
E = External Distance
= Coefficient of Side Friction
u = Vehicle Speed
d = Deflection Angle

Geometry

Geometry

$$T = R\tan(\frac{\Delta}{2})$$

$$C = 2R\sin(\frac{\Delta}{2})$$

$$L = R\pi\frac{\Delta}{180}$$

$$M = R(1 - \cos(\frac{\Delta}{2}))$$

$$E = R(\frac{1}{\cos(\frac{\Delta}{2})} - 1)$$

Sight Distance

$$M = R(1 - \cos(\frac{28.65S}{R}))$$

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$$R = \frac{u^2}{15(e + f_s)}$$

Safety effects of alignment

A safety performance function to model curve perform
on two-lane roads is:

$$AMF = \frac{1.55L_c + \frac{80.2}{R} - .012S}{1.55L_c}$$

Where
AMF = Accident modification factor, a multiplier that describes how many more crashes are likely to occur on the curve compared to a straight road
Lace = Length of the horizontal curve in miles.
R = Radius of the curve in feet.
S = 1 if spiral transition curves are present
S = 0 if spiral transition curves are absent

Overtaking sight distance/Passing sight distance

Passing/Overtaking Sight Distance (PSD) or (OSD) is the minimum sight distance that is required on a highway, generally a two-lane, and two-directional one that will allow a driver to pass another vehicle without colliding with a vehicle in the opposing lane.
The first distance component d1 is defined as:

$$d_1 = 1000t_1\left(u - m + \frac{at_1}{2}\right)$$

- t_1 = time for initial maneuver,
- a = ;acceleration (km/h/sec),
- u = ;average speed of passing vehicle (km/hr.),
- m == difference in speeds of passing and impeder

The second distance component d_2 is defined as:

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$$d_2 = (1000ut_2)$$

- t_2 = time passing vehicle is traveling in opposing lane,
- u= average speed of passing vehicle (km/hr.).

The third distance component is more of a rule of thumb than a calculation. Lengths to complete this maneuver vary between 30 and 90 meters.

With these values, the total passing sight distance (PSD) can be calculated by simply taking the summation of all three distances.

$$d_p = (d_1+d_2+d_3)$$

Speed studies

Spot speed- a speed of a vehicle at a spot (instantaneous speed)

Space mean speed- an average speed of vehicles that occupy a highway segment

$$v_s = \frac{L}{\sum_{i=1}^{n} \frac{t_i}{n}} = \frac{nL}{\sum_{i=1}^{n} t_i}$$

Where

vs = average travel speed or space mean speed (kph)

L = length of the highway segment (km)

ti = travel time of the ith vehicle to cross the section (hours)

- n = number of travel times observed

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Udaipur-Bhatewar (NH-76.location 37kms)

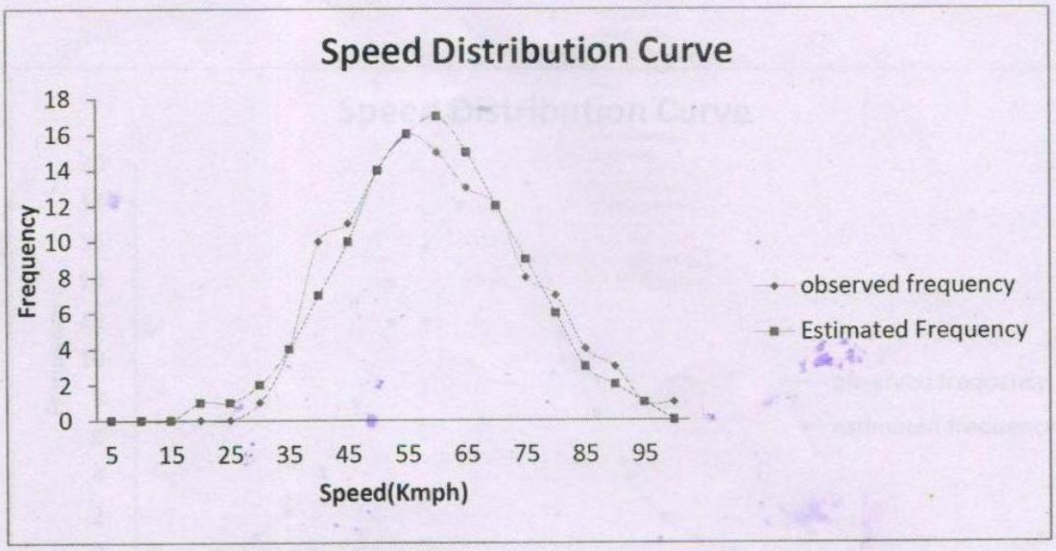

Fig: 4.4 (Speed distribution curve)

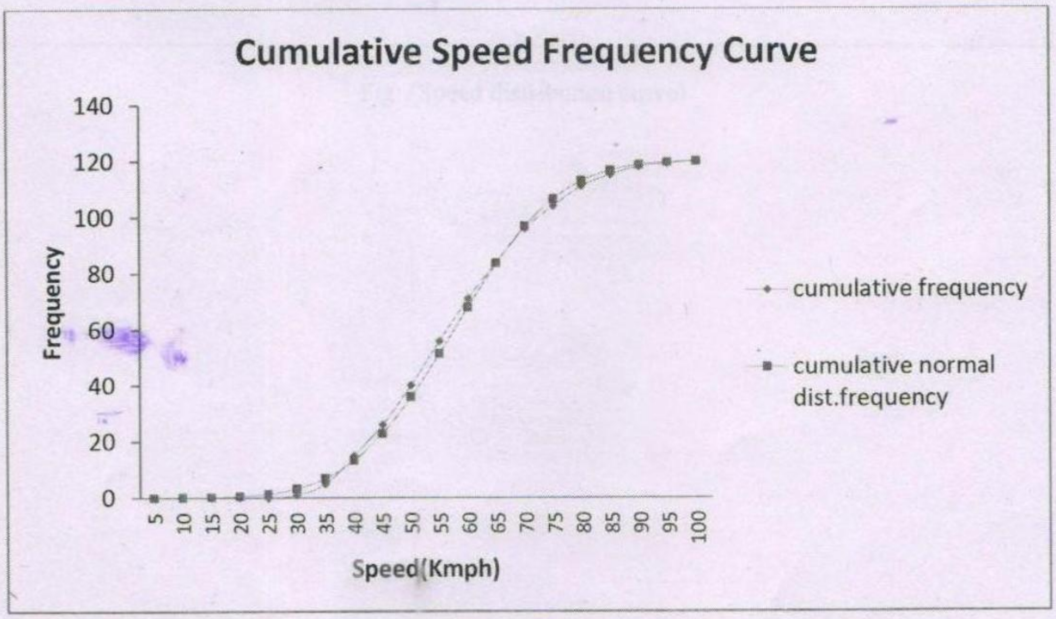

Fig: 4.5 (Cumulative speed frequency curve)

Observed and expected frequency curves for CAR

40

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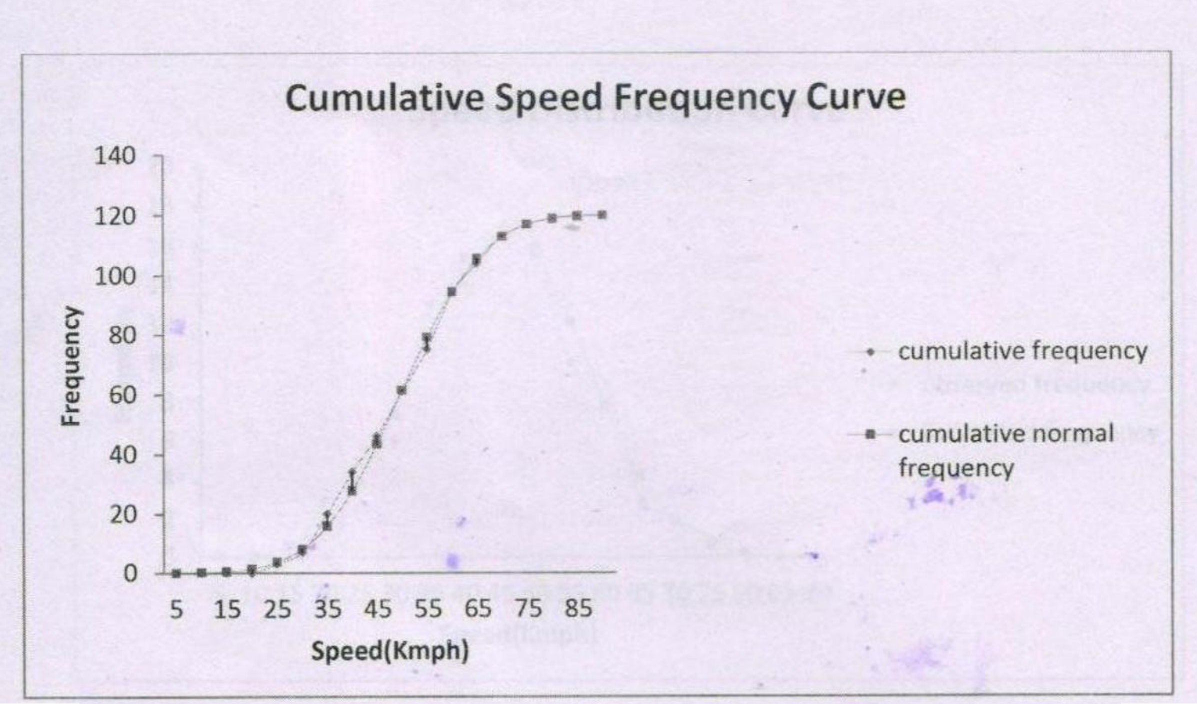

Fig: 4.6 (Cumulative speed frequency curve for two wheeler)

Observed and expected frequency curves for Two Wheeler

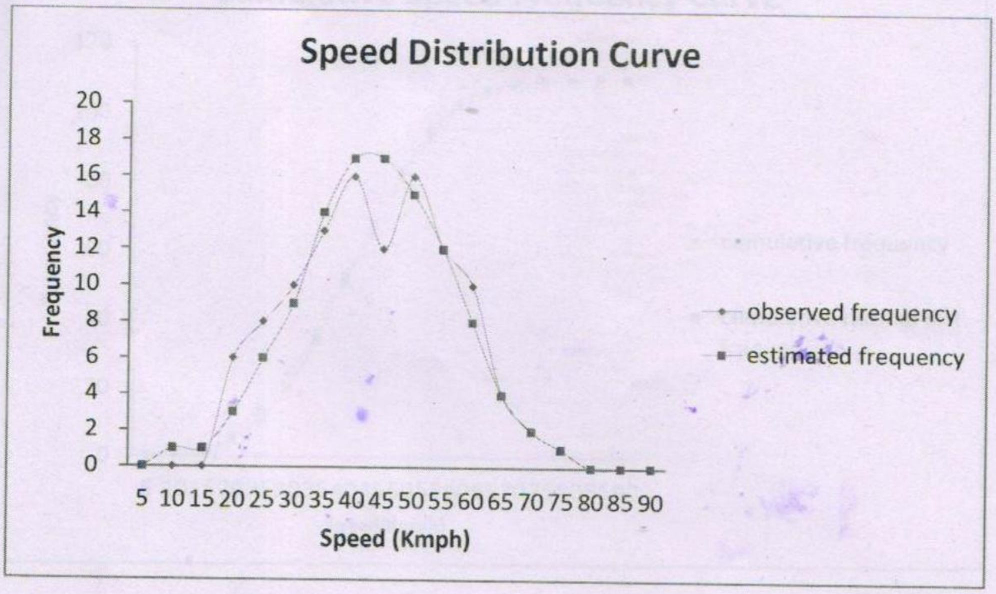

Fig: (Speed distribution curve)

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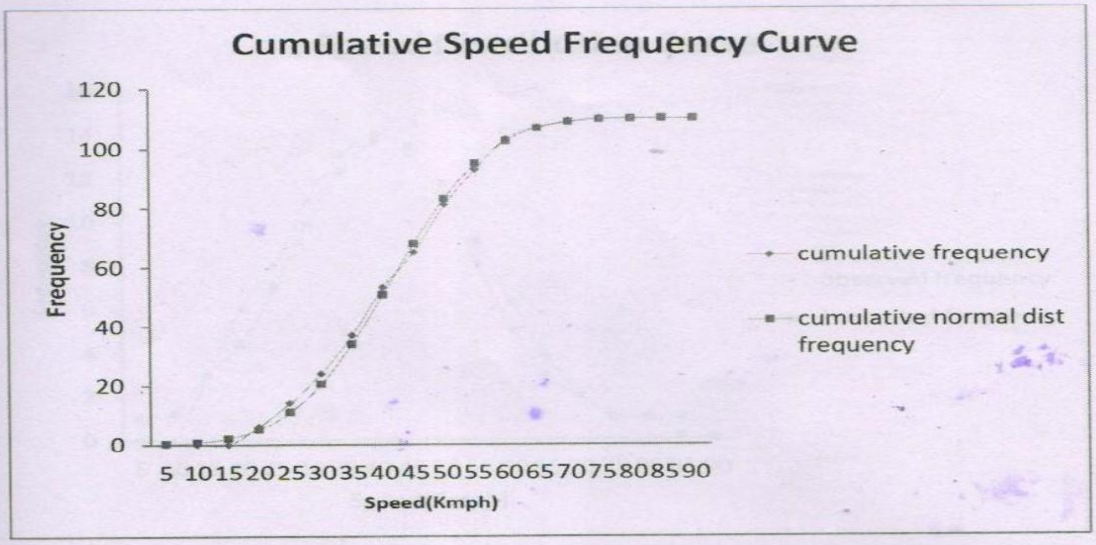

Fig: 4.8 (Cumulative speed frequency curve for bus)

Observed and expected frequency curves for Bus

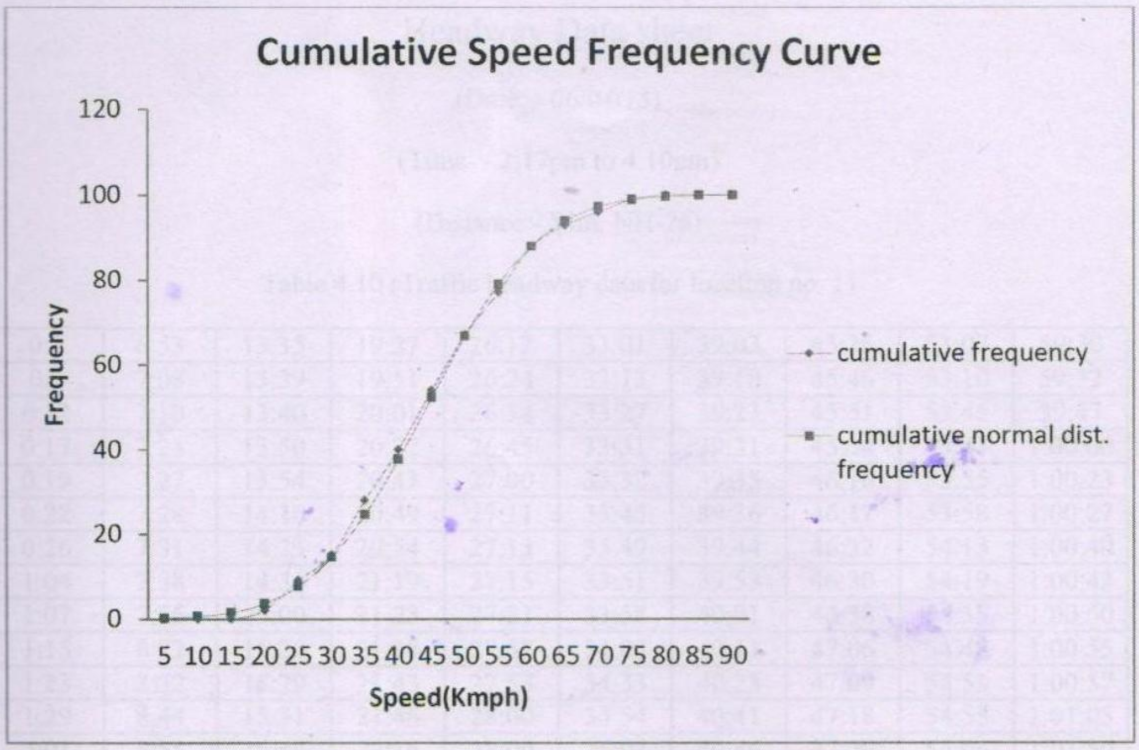

Fig: 4.10 (Cumulative speed frequency curve for LCV)

Observed and expected frequency curves for LCV

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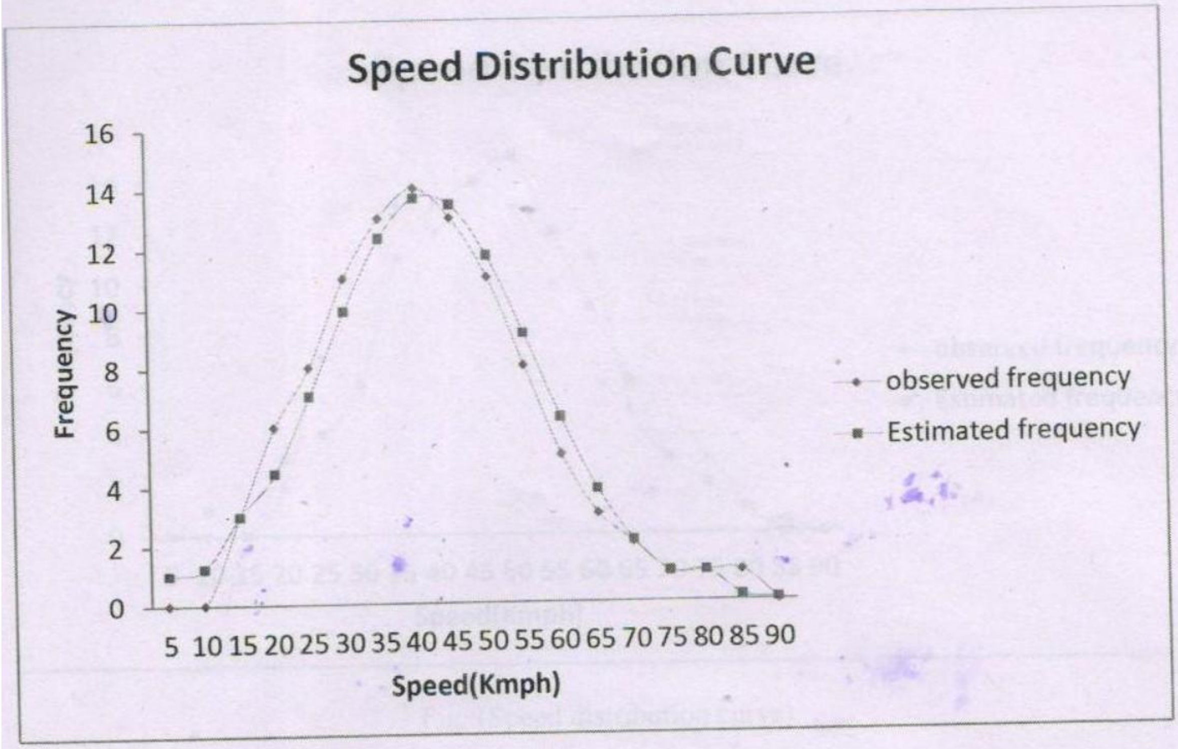

Fig: (Speed distribution curve)

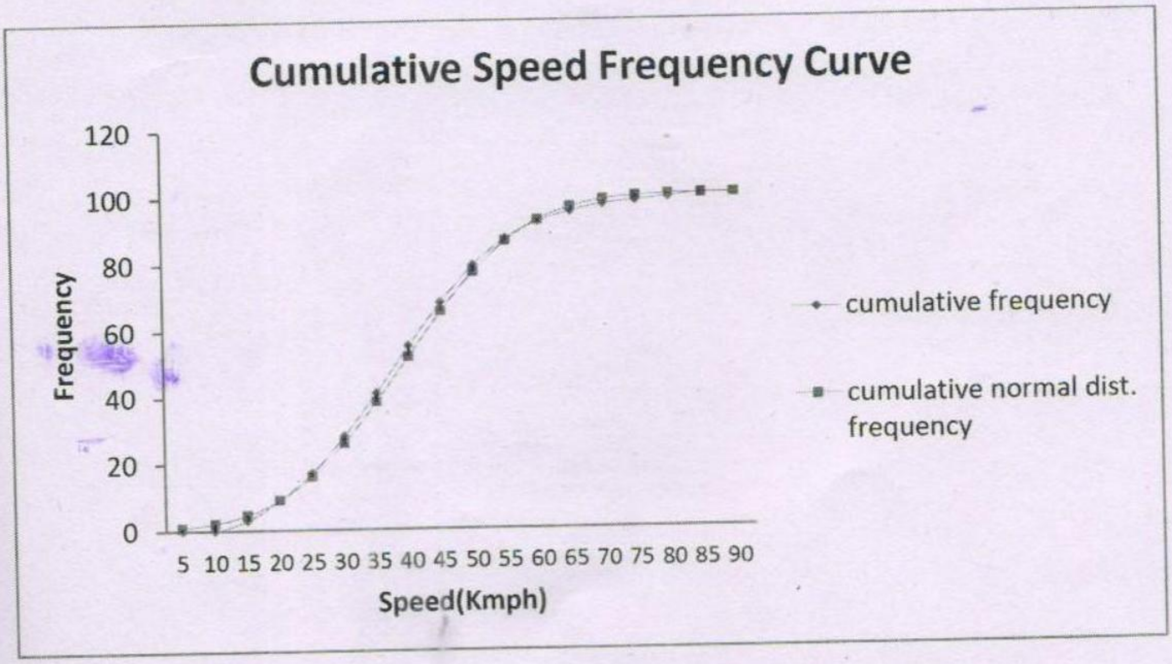

Fig: 4.9 (cumulative speed frequency curve for trucks)

Observed and expected frequency curves for Trucks

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CONCLUSIONS

The main objective of this research could be of massive significance to highway planner and designer as they can use these results to make effective operational improvement on NH-76. And the following conclusions are derived thus from the analysis;

In this research, the values gotten on deflection angle, radius of curvature and transition length is most preferable and satisfies for further design considerations and to overcome the problems at the specified locations of NH -76. Analysis indicated the differences in safety conditions are principally experienced by various vehicle configurations while travelling in a curved road by measuring spot speed of the vehicle, headway data and traffic volume per day.

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