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ANALYSIS OF ROAD ACCIDENTS AND SUGGESTED SAFETY MEASURES

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ABSTRACT

Road safety becomes a complex and multifaceted problem for the simple reason that transportation and development is becoming more intense and complicated than ever before as the population and economic activities grow in their size. Independent studies by both World Health Organization and World Bank have estimated that about 5, 00,000 people lost their lives and over 15million suffer injuries each year as a result of road accidents. In India the number of accidents and the fatalities has been increasing over the years and accidents per 1000 vehicles are high in India compared to other developed countries in the world. The tendency of accidents to cluster or concentrate at few spots is known as 'black spots' or 'accident spots'. These spots are considered as prime candidates for improvement/remedial works to enhance road safety. Identification of such locations helps to achieve quick and better cost effective solutions to traffic safety problems. Three such accident prone locations on highways radiating from Pulivendula town are selected and traffic surveys are collected at these accidents prone locations .The accident analysis is carried out for the traffic data collected .The analysis revealed that excess speed, absence of caution boards and not proper maintenance of shoulders at the highway sections are prime causative factors for accidents and these accident prone locations need immediate attention of installation of traffic sign boards and speed limit is to be warranted.

Key words: black spots, traffic data, location features, causative factors, road safety.

INTRODUCTION

In India, the number of accidents and the fatalities has been increasing over the years and the total accidents in the country were 2,24,000 and the fatalities were 56,500 in the year 1991. Accidents per 1000 vehicles are high in India compared to other developed countries in the world. The fatality rate per 1000 motor vehicles is 2.82 in India whereas it is less than 0.5 in most of the developed countries. In most of the cities in India, the collection and compilation of accident data is mostly dependent on manual reporting and recording systems and hence the analysis are based on few broad trends considering only few parameters like the road user category, accident prone roads and locations, time and day of accident etc. quick retrieval and eliciting of complicated cross comparisons are not possible which are so essential to understand the causation of accidents at any given black spot. The tendency of the accidents to cluster or concentrate at few spots known as "black spots" or "accident spots" is well known. These Spots are considered as prime candidates for improvement/remedial works to enhance road safety. Identification of such locations helps to achieve quick and better cost effective solutions to traffic safety problems. Therefore the development of appropriate methods for identification of black spots should become the subject of immediate attention.

LITERATURE REVIEW

Silcock and Smith [(1)] reviewed the various methods of identifying accident prone location in U.K. The U.S. Federal highway administration [(1)] vides its report no. FHWA-RD-77-81 compiled Taylor and Thomson gives details of methods of identification of hazardous locations.

The simplest and most commonly used method of identifying high accident location is by means of black spot maps. The location of each accident is shown by means of colored pins or flags. A similar method is used by the police authorities in the federal republic of Germany [(1)] pinned accident maps only give a visual indication and does not take traffic density into account. As a result, this is not an entirely satisfactory method, at least from comparison point of view. The method used in Hertfordshire (great Brittan) is very similar to the map system, but certain criteria for defining accident prone sites are used and they are given below [(2)].

Black spot: 4 accidents in one year in area of 0.1 sq.km.

Black site: 12 accidents in three years on a 0.3 km road length

Black mile: A 1 mile length of road included in a list of twenty one-mile length of road having the highest accident record in one year

Accident prone area: an area with an accident number well above the average.

Skid spot: 3 dry or wet skids in one year in an area of 0.1sq.km.

Dark site: a site with a high number or high proportion of night accidents

In Belgium [(2)] any location with at least 10 accidents (including damage accidents only) reported to the authorities during one year is usually considered a black spot. Any one km. road section where at least 10 accidents have been reported is considered a dangerous section.

OBJECTIVES

I. To identify accident prone locations on highway radiating from Pulivendula town.
II. To conduct traffic surveys to collect traffic data and location features on three selected accident prone zones.
III. To analyze the causative factors for accidents on these highway black spots and suggest accident counter measures.
IV. To analyze the relationship between highway safety and road geometric design elements.

METHODOLOGY

Accident data is collected from the nearby police station of the pulivendula town and three accident prone locations on selected based on number of accidents occurred during past three or four years. Traffic surveys are conducted for two days on each selected accident prone location during peak hours and also spot speeds are collected manually by stopwatch method. Location features of the selected accident prone locations are also noted. Obtained traffic volume is converted into equivalent passenger car unit by multiplying with PCU values. Relationship between road safety and highway geometric design elements is also studied. The traffic volume is collected by conducting two directional traffic surveys on selected accident prone locations. Traffic is classified as 1) Car/jeep 2) Bus 3) Truck 4) Auto 5) Motor-cycles 6) Cycles 7) Bullock-carts. The traffic volume is collected for two days on each accident prone location during peak hours i.e., 8:30am-10:30am and 4:30pm-6:30pm. Spot speeds are collected on the three selected accident prone location by using stop watch method. A section is considered on road and certain distance is measured by using chain or tape for study. The observers are stationed at one side and start the stop watch and when it cross the study length the observer stops the stopwatch and time is noted and is converted into speed.(Speed= Distance / Time).From the spot speed data of the selected accident prone locations, frequency distribution table of spot speed data is prepared by arranging the speed groups covering desired speed ranges and the number of vehicles in each speed range. The arithmetic mean of the measured speeds is taken as the average spot speed of all the vehicles in the stream. The table gives the general information of the speeds maintained on the section and also regarding the speed distribution pattern. The design speed on the three accident prone locations is obtained from cumulative speed distribution curves. This design speeds are used to calculate stopping sight distance and overtaking sight distance on the road sections of three accident prone locations. A graph is plotted with the average values of each speed group on the X-axis and cumulative percent of vehicles travelled at or below the different speeds on the Y-axis. This graph is called 'cumulative speed distribution diagram'. From this diagram, the 85^{th} percentile speed is determined i.e., the speed at or below which 85 percent of the vehicles are passing the point on the highway can be assessed; in other words, only 15 percent of the vehicles exceed this speed at that spot and this speed is adopted for the 'safe speed limit' at this zone. The 15^{th} percentile speed is considered to represent the lower speed limit, to prohibit slow moving vehicles to decrease delay and congestion, as 85 percent of the vehicles in the stream travel at speeds higher than this value and therefore need overtaking opportunities. For the purpose of checking the requirements of highway geometric design elements, the 98^{th} percentile speed is generally taken as the 'design speed' of the existing roadway facility.

Stopping Sight Distance (SSD)

SSD=0.278 V. t + (V^2 /254f)

V=Design speed of vehicle in 'kmph', t=Driver's reaction time=2.5 sec, f=Design coefficient of longitudinal friction and is taken from the table below.

Speed(kmph)	20-30	40	50	60	65	80	100
Longitudinal co-efficient friction ,f	0.40	0.38	0.37	0.36	0.36	0.35	0.35

Overtaking Sight distance (OSD)

OSD=0.28 V_b. t +0.28 V_b. T+ (2s+0.28 V.T)

V= Speed of overtaking vehicle or Design speed in kmph,t = Reaction time of driver =2sec,V_b = Speed of overtaken vehicle kmph= (V-16) Kmph,T=Time taken for Overtaking operation in seconds and is given by, T= √(14.4s/A) s=Spacing of vehicle = (0.2 V_b+6),A=Acceleration, characteristics and overtaking vehicle in kmph/sec

V	25	30	40	50	65	80	100
A(kmph/sec)	5	4.80	4.45	4	3.28	2.56	1.92

RESULTS

Traffic Volume Details at Accident Prone Locations

Accident Location	**Traffic volume per hour**					
	Bus	**Car/Jeep**	**Truck**	**Motor cycles**	**Auto's**	**Cycles**
Near TTD kalyanamandapam (Muddanur Road)	31	67	17	480	96	38
Near kothisamadhi (Parnapalli Road)	16	27	25	215	48	15
Near kanumpalli gattu (Kadiri Road)	9	36	33	68	13	13

Equivalent PCU values for Rural Intersections and Midblock [(4)]

Vehicle Type	Mid-Block	Intersections
Car	1.0	1.0
Bus/Truck	2.2	1.3
Two wheeler	0.4	0.6
Auto	0.5	0.8
Cycle	0.7	0.4

Traffic Volume in equivalent passenger car unit at Accident prone Locations

Accident Location	**Traffic volume per hour**						
	Bus	**Car/Jeep**	**Truck**	**Motor cycles**	**Auto's**	**Cycles**	**Total**
Near TTD kalyanamandapam (Muddanur Road)	69	76	38	192	48	27	450
Near kothisamadhi (Parnapalli Road)	36	27	55	86	24	11	239
Near kanumpalli gattu (Kadiri Road)	20	36	73	28	7	10	174

Frequency Distribution table at TTD Kalyanamandapam

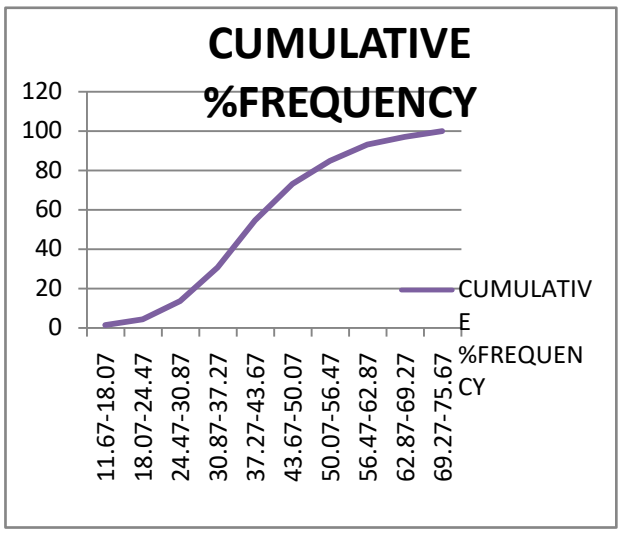
SPEED	MEAN SPEED	FREQUENCY	%FREQUENCY	*CUMULATIVE %FREQUENCY*
11.67-18.07	14.87	4	1.230769231	1.230769231
18.07-24.47	21.27	10	3.076923077	4.307692308
24.47-30.87	27.67	30	9.230769231	13.53846154
30.87-37.27	34.07	55	16.92307692	30.46153846
37.27-43.67	40.47	78	24	54.46153846
43.67-50.07	46.87	60	18.46153846	72.92307692
50.07-56.47	53.27	39	12	84.92307692
56.47-62.87	59.67	27	8.307692308	93.23076923
62.87-69.27	66.07	12	3.692307692	96.92307692
69.27-75.67	72.47	10	3.076923077	100

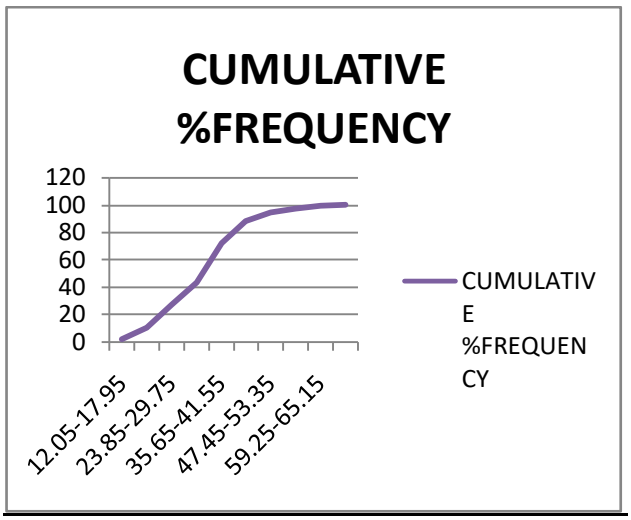
Frequency Distribution table at Kothisamadhi

SPEED	MEAN SPEED	FREQUENCY	%FREQUENCY	*CUMULATIVE %FREQUENCY*
12.05-17.95	15	29	8.055555556	2.237654321
17.95-23.85	20.9	10	2.777777778	10.83333333
23.85-29.75	26.8	60	16.66666667	27.5
29.75-35.65	32.7	57	15.83333333	43.33333333
35.65-41.55	38.6	103	28.61111111	71.94444444
41.55-47.45	44.5	59	16.38888889	88.33333333
47.45-53.35	50.4	23	6.388888889	94.72222222
53.35-59.25	56.3	8	2.222222222	96.94444444
59.25-65.15	62.2	8	2.222222222	99.16666667
65.15-71.05	68.1	3	0.833333333	100

Frequency Distribution table at kanumpalli gattu

SPEED	MEAN SPEED	FREQUENCY	%FREQUENCY	CUMULATIVE %FREQUENCY
13.84-23.04	18.44	6	1.617250674	1.617250674
23.04-32.24	27.64	18	4.851752022	6.469002696
32.24-41.44	36.84	75	20.21563342	26.68463612
41.44-50.64	46.04	79	21.29380054	47.97843666
50.64-59.84	55.24	69	18.59838275	66.57681941
59.84-69.04	64.44	59	15.90296496	82.47978437
69.04-78.24	73.64	29	7.81671159	90.29649596
78.24-87.44	82.84	26	7.008086253	97.30458221
87.44-96.64	92.04	9	2.425876011	99.73045822
96.64-105.84	101.24	1	0.269541779	100





X-axis = Speed (kmph)

Y-axis = Cumulative percent of vehicles

Cumulative Speed Distribution Curve at TTD Kalyanamandapam

98thpercentile Speed= 70

85thpercentile Speed=63

15th percentile Speed=36

X-axis = Speed (kmph)

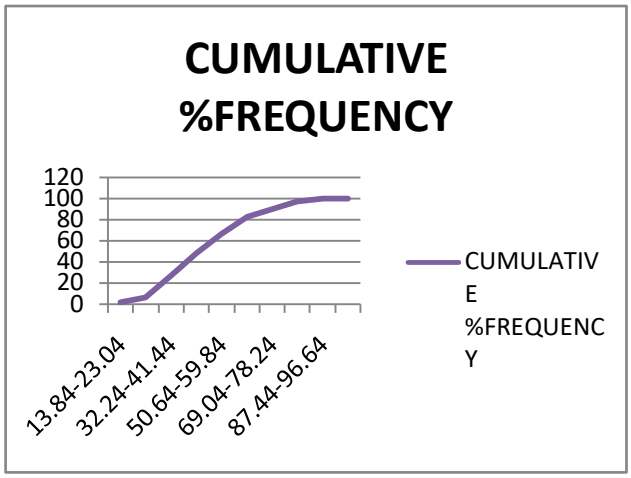
Y-axis = Cumulative Percent of Vehicles

Cumulative Speed Distribution Curve at Kothisamadhi

98thpercentile speed =64

85th percentile speed =50

15thpercentile speed =30



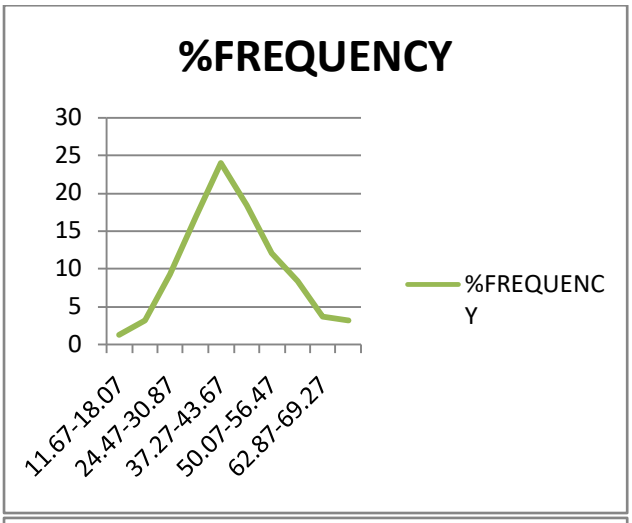
X-axis = Speed (kmph)

Y-axis = Cumulative percent of vehicles

Cumulative Speed Distribution Curve at Kanumpalli gattu

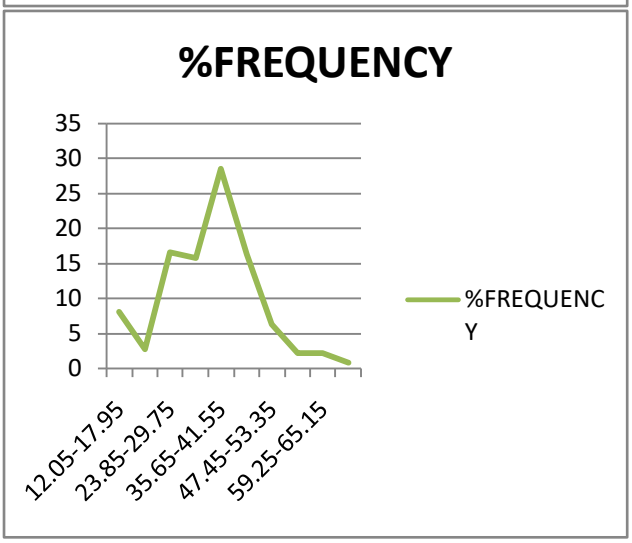
98thpercentile Speed =85

85thpercentile Speed =79



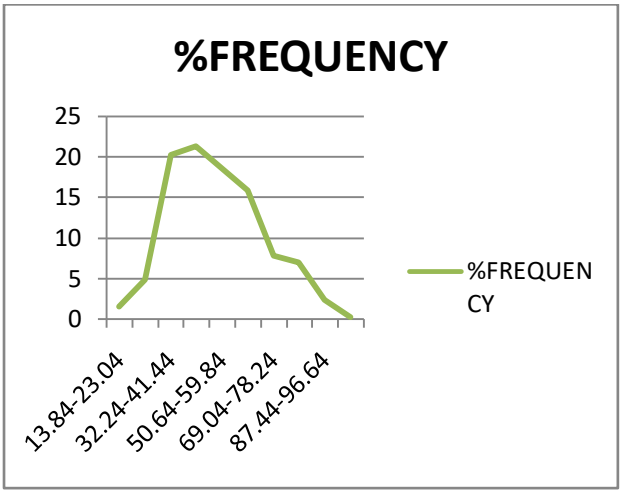
Frequency Distribution Curve at TTD Kalyanamndapam

Modal average speed = 47 kmph



Frequency Distribution Curve at kothisamadi

Modal average speed = 44 kmph



Frequency Distribution Curve at kanumpalli gattu

Modal average speed = 57 kmph

Calculated Traffic Data

S.NO.	Accident prone location	Design speed (kmph)	Average speed (kmph)	Speed limit (kmph)	SSD (m)	OSD (m)
1.	At TTD kalyanamandapam	70	47	63	102.23	361.73
2.	At Kothisamadi	64	44	50	89.27	292.96
3.	At kanampalli gattu	85	40	79	140.34	533.15

CONCLUSIONS

The important conclusions and recommendations drawn from the analysis of accidents at selected accident pone locations are

1) The Design Speed of vehicles at these selected accident prone locations (TTD kalyanamandapam , Kothisamadhi, Kanumpalli gattu) are 70,64,85 kmph respectively and speed limit limits at these locations are 63,50,79 kmph. The average speed of traffic at these locations is 47, 44, 40 kmph respectively.
2) Few accidents at these locations happened due to the high speed which crossed the speed limit.
3) No sign board or caution boards installed at these selected locations.
4) The shoulders at these three accident prone zones are not properly maintained.
5) Among three accident locations selected, muddanur road is experiencing more traffic volume so immediate attention of installation of sign boards, speed limit and caution boards is to be done.
6) The accident prone location need immediate attention of:
    - ✓ Installation of traffic sign boards
    - ✓ Shoulders should be properly maintained
    - ✓ Speed limit is to be warranted
    - ✓ Edge line delineation system

SUGGESTED SAFETY MEASURES

- 90% of accidents can be avoided by strict enforcement of speed limits.
- Heavy penalty should be imposed on those who cross the speed limits if this happens no one dares to go with high speed.
- Tamper proof speed controllers should be made mandatory for all heavy vehicles. New heavy vehicles should have built in tamper proof speed controllers.
- Two wheelers manufacturers should be asked to design two wheelers with designed maximum speed limit (suitable speed limit may be selected for each country.
- New gadgets are to be developed for collision prevention and fitted to the vehicles. Research organizations should be asked to develop such gadgets.
- The geometric design features are to be checked and corrected if necessary.
- The braking system, steering, indicators, lighting system and condition of tyres of a vehicle are to be checked at suitable intervals and heavy penalty should be levied on defective vehicles.
- Lighting is particularly desirable at intersections, bridge sites and at places where there are restrictions to traffic movements.
- Taking legal actions on drivers who violate speed limits.
- Installation of tachometers in all public transport vehicles to give record of running speeds and respective timings; this will help the drivers of these vehicles to develop correct speed habit.

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