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ACCIDENT STUDY ON NATIONAL HIGHWAY - 5 BETWEEN ANAKAPALLI TO VISAKHAPATNAM

B. SRINIVAS RAO
Scientist
RDP Area
CRRI, New Delhi, India - 110 0020
E-mail: raobs@crridom.org

E. MADHU
Scientist
TTP Area
CRRI, New Delhi, India –110 020

SANTOSH JALIHAL
Scientist
TTP Area
CRRI, New Delhi, India – 110 020
E-mail: sjalihal@crridom.org
Fax: 91 011 26312268

T.S. REDDY
Director Grade Scientist
TTP Area
CRRI, New Delhi, India – 110 020
E-mail: reddy@crridom.org
Fax: 91 011 26312268

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Abstract

'Accidents are not natural but they are caused' is a common cliché in the area of traffic safety. Thus, if accidents are caused by some, surely the ones responsible for could be identified and appropriate remedial measures developed and implemented to the extent feasible. Analysis of previous data indicates that 66% of the accidents occur due to human error and 33% due to road parameters such as road and vehicle interaction, other road user and environmental factors. India has a road network of 3.3 million km consisting of National Highway (NH), State Highway (SH), Major District Roads (MDR) and Other District roads (ODR). National Highways constitute 2% of the total road length and carries more than 40% of passenger traffic and 85% of goods traffic has registered more accidents accounting for 20%, as compared to other roads. This paper lays emphasis on accident studies on the 40 km long National Highway - 5 section between Anakapalli and Visakhapatnam, in the State of Andhra Pradesh, India.

The Institute has undertaken a study on NH-5 between Anakapalli to Visakhapatnam during the year 2003 and it runs through urban, semi urban and rural areas. The accident data for the last five years was collected form the concerned police station and analyzed there after.

The data revealed that 64 deaths and 373 injuries were recorded between January to December, 2002 and 20 deaths, 82 injuries were recorded between January to June, 2003. The analysis of the data from safety point of view indicated that the vehicle drivers are the single major factor responsible for the accidents as they fail to perceive the situation ahead because of poor reflexes, fatigue, inexperience or being under the influence of intoxicants. The accident data for the section indicated that two wheelers are the ones who mainly suffer the fatalities and major injuries, which is around 35% followed by trucks 23% involved in accidents. The reasons for the accidents can be attributed to the

lack of signage, raised median cover with trees/bushes, making pedestrians not visible to driver, improper design of pedestrian crossing, frequent median openings, and lack of enforcement to control wrong side movements. There are however, other factors, which contribute directly or indirectly to the accidents include road, vehicle, road user and environmental factors.

From the results of the analysis, it can be concluded that this National Highway section needs improvement from safety point of view. A large number of accidents have been occurring over such a small section of 40 km length. Proper traffic guidance and control system to guide road users ensuring safe movement of vehicles has been recommended and some of the facilities such as pedestrian crossings and median openings, acceleration and deceleration lanes were re-designed in order to improve the safety of the road and minimize the accidents.

1. INTRODUCTION

Accidents, tragically, are not often due to ignorance, but are due to carelessness, thoughtlessness and over confidence. William Haddon[1] has pointed out that road accidents were associated with numerous problems each of which needed to be addressed separately. Human, vehicle and environmental factors play roles before, during and after a trauma event. Accidents, therefore, can be studied in terms of agent, host and environmental factors and epidemiologically classified into time, place and person distribution. This paper lays emphasis on accident studies on the 40 km long National Highway - 5 section between Anakapalli and Visakhapatnam.

This study stretch of National Highway-5 starts from Koppaka Village (near ROB), Anakapalli to New NHAI office, Visakhapatnam (i.e. from Km 359.2 to Km 395.875 and from Km 0.0 to Km 2.837), with a total length of 39.512kms. It is a four lane divided highway with shoulder and side drains. The open side drains exist for some part of the study stretch. The service road exist for short length and are discontinuous.

For the purpose of the study, a Road Traffic Accident (RTA) was defined as accident, which took place on the road between two or more objects, one of which must be any kind of a moving vehicle.

2. ROAD SAFETY PROBLEM IN DEVELOPING COUNTRIES

Growth in urbanization and in the number of vehicles in many developing countries has led to increased traffic congestion in urban centres and increase in traffic accidents on road networks, which were never designed for the volumes and types of traffic, which they are now required to carry. In addition, unplanned urban growth has led to incompatible land uses, with high levels of pedestrian-vehicle conflicts. The drift from rural areas to urban centres often results in large number of new urban residents unused to such high traffic levels. As a result, there has often been a severe deterioration in driving conditions and a significant increase in the hazards and competition between different classes of road users. In addition, the inherent dangers have often been made worse by poor road maintenance badly designed intersections and inadequate provision for pedestrians. All of these have contributed to the serious road safety problems in developing countries like India. It has been estimated that over 300,000 persons die and 10 to 15 million persons are injured every single year in road accidents throughout the world (TRL and ODA, 1991). Road accidents in developing countries are a cause for growing concern and road accidents cost around one percent of Annual Gross National Product (GNP) resources of developing Countries, which they can ill afford to lose. The deaths per 1000 vehicles registered in developing countries are as shown in Figure 1.

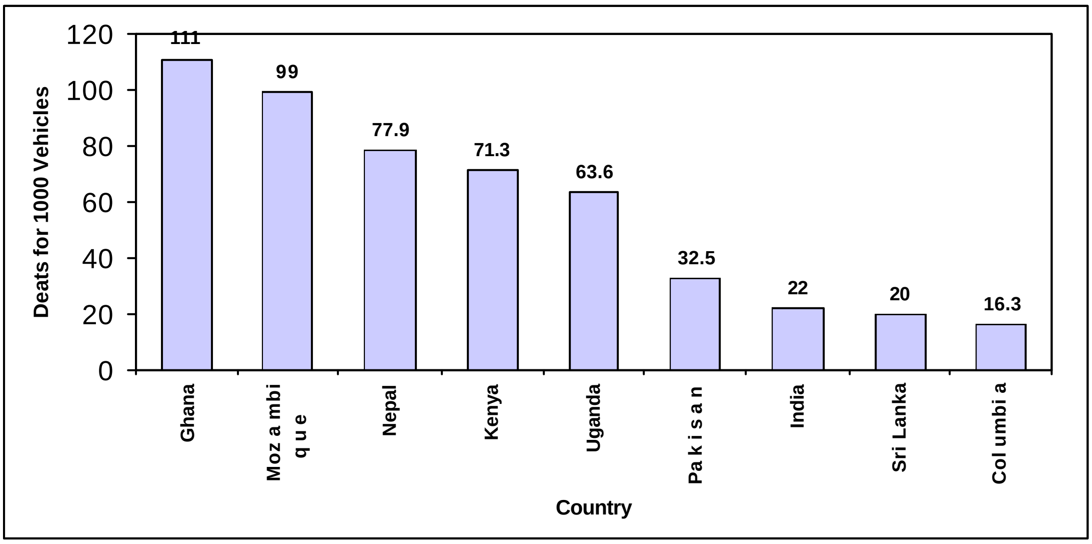

Figure 1: Fatality Rates in Selected Developing Countries

2.1 Accident Scenario In India

The spectacular growth in the Road Transportation Sector in India has been a key element in the economic development. In the country, more than 70,000 people die and nearly 4lakhs persons are injured in about 3 lakhs and more road accidents every year. The trend inroad accidents and number of vehicles registered during the period from 1970 – 1995 are shown in Figure 2. India's motor vehicle population is just 1% of the world's, but her share of world road traffic accidents is 6%. Even though it can be observed from Figure 2 that the accident rate has been steadily decreasing over the past 25 years, the accident rate is still very high compared to the developed nations.

2.2 Road Condition And Traffic Safety

The effect of road conditions in road safety to date is still underestimated. On the basis of widespread scientific research involving analysis of road accidents and a study of how vehicles are driven under different road conditions, it will be probable for the highway engineer to establish the effect of road conditions on accidents. The main road conditions that contribute to accidents are:

1. Road Width
2. Width and state of shoulders
3. Width of the median
4. Grades
5. Deficiency in sight distance
6. Radius of the horizontal curve and deficiency in super elevation at curves

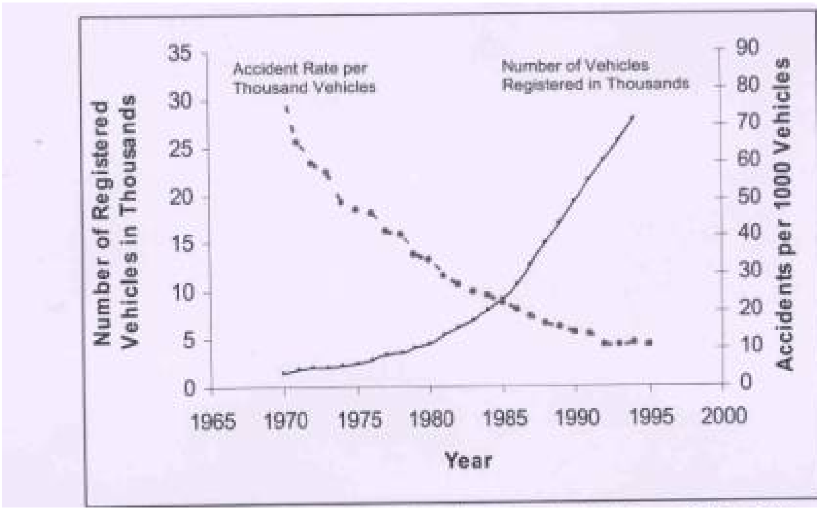

Figure 2: Trends in Vehicle Registration and Accidents rates in India From 1970 - 1995

The traffic parameters, which affect safety, are traffic volume and speed. The engineering solutions to the safety problem consist in suggesting suitable improvements to the road conditions or to suggest suitable changes in the management of traffic.

3. DATA COLLECTION

The main data requirements for the evaluation of the accident reduction measures no National Highway – 5 were:

- Details of road Inventory
- Signage inventory
- Traffic volume
- Pedestrian volume count
- Spot speed
- Speed and Delay
- Accident Study

A detailed inventory survey was carried out on the entire section to measure the roadway geometric parameters like the roadway width and footpath width and signage inventory. Classified traffic volume counts was carried out on normal working day for 24 hours to assess the total daily traffic, hourly variation, composition, peak hour volumes and directional flows at three representative locations. Pedestrian volume count was carried out for 12 hours near NAD ‘X’ road junction (km 385.5) and Maddilapalem bus depot (km 0.0) due to heavy pedestrian movement at these locations. Spot speed studies were carried out at nine locations. Further, these locations were selected in such a way that the impact of local traffic on the operating speed could also be ascertained along with the geometrics of the road such as horizontal curves. Speed and delay study was also conducted for the entire section (from km 359.2 to km 395.875 and from km 0.0 to km 2.837) covering different hours of day by moving car method. Accident data was collected for the year 2002 from the concerned police station (Visakhapatnam City Traffic Police, VCTP, and Anakapalli Rural Police), who are responsible for recording and maintaining of accident data.

4. ANALYSIS OF DATA

4.1 Traffic Studies

The section of National Highway caters to various types of traffic such as urban, sub-urban and regional traffic. The development alongside the highway indicates that land use on both sides of the highway is mixed with urban and rural and mainly consists of commercial, residential and industrial establishments (such as Visakha Steel, BHPV, Visakha Dairy, Airport etc.). Based on the land use and other activities, the stretches from Km 0.0 to Km 2.837 and Km 386.0 to Km 395.875 can be classified under urban area (equal to a length of 12.712 kms), from Km 384.0 to Km 386.0 and Km 376.0 to Km 378.0 under semi-urban area (about a length of 4.0 kms) and remaining road stretch can be classified under rural area (about a length of 22.8 kms), In order to appreciate and assess the traffic characteristics, as envisaged in the previous section, the following traffic surveys were carried out.

- Classified Traffic Volume Counts
- Speed and Delay Studies
- Spot Speed Studies
- Network Inventory
- Inventory of Road Sign

4.1.1 Classified Traffic Volume Counts

From the surveys it was observed that the road stretch under consideration carries highly mixed traffic of both fast moving vehicles (such as cars, jeeps, vans, scooters, motor cycles, tempos, trucks, LCVs and buses) and slow moving vehicles (cycles, tractors, animal drawn carts etc.). The average daily traffic (ADT) varied from 11130 vehicles (at Km371.4km) to 64400 vehicles (at Km 0.0). The higher ADT was observed within the urban area and as expected the ADT decreased on the semi urban / rural stretch of highway as shown in Table 1. It is interesting to note that SMVs are considerably small in proportion. Light fast vehicles are predominant in the entire study stretch. But in the rural section the goods vehicles increase in proportion.

Table 1 Details of Average Daily Traffic on National Highway - 5

S. No.	Chainage (Km)	Type of Development	Average Daily Traffic										
			Car	Two Wheeler	Auto	Bus	LCV	HCV	Bicycle	Other	FMV	SMV	Total
1	0.0	Urban	7432 (11.5%)	36650 (56.9%)	12931 (20.1%)	1996 (3.1%)	942 (1.5%)	1661 (2.6%)	2764 (4.3%)	25 (0%)	61612 (95.7%)	2789 (4.3%)	64401 (100%)
2	385.5	Semi-Urban	6054 (18.4%)	17402 (53%)	4466 (13.6%)	1781 (5.4%)	882 (2.7%)	1669 (5.1%)	562 (1.7%)	20 (0.1%)	32254 (98.2%)	582 (1.8%)	32836 (100%)
3	371.4	Rural	1232 (11.1%)	4047 (36.4%)	1402 (12.6%)	712 (6.4%)	376 (3.4%)	2751 (24.7%	592 (5.3%)	18 (0.2%)	10520 (94.5%)	610 (5.5%)	11130 (100%)

4.1.2 Speed and Delay Studies

The journey speed in the study stretch varied from a minimum of 33.7 kmph to a maximum of 65.4 kmph. The average journey speed and the average delay for entire study stretch is about 45.0 kmph and 8 min. respectively in the directions. The delay per kilometer is about is about 11 sec in both the directions for the entire stretch.

As expected, the lower speeds were observed from Chainage Km 0.0 to Km 2.837, Km 386.0 to Km 395.875 and near Km 377.0 due to heavy roadside development, higher proportion of local traffic, intersection delays and side friction.

4.1.3 Spot Speed Studies

The spot speed surveys were carried out using Ultralyte LR100 radar gun and also based on trap length method. The spots speeds of different vehicles in each direction were obtained on sampling basis. The speeds obtained were obtained in off-peak period i.e. from 06:00h to 08:00 and 11:00 to 15:00 since the higher speeds of operation are expected during this period. The summary of spot speeds on critical sections is presented in Table 2. From the analysis of spot speed distribution the following observations are made.

- The operating speeds were observed to be higher than the posted speed limits in all the sections.
- 85th percentile speed of cars is ranging from 52 to 89 kmph, for two wheelers it is ranging from 50 to 80 kmph and in case of autos it is ranging from 44 to 69 kmph.
- 85th percentile speed of buses is ranging from 45 to 75 kmph; for LCVs it is observed to be varying from 50 to 76 kmph and the same in case of HCVs is 53 to 71 kmph.

4.1.4 Inventory of Road Signs

The road stretch was examined for the adequacy of road signs and these are identified under three groups namely prohibitory / mandatory, cautionary / warning, and information signs and are summarized in Table 3.

Table 2: Summary of Spot Speeds on NH-5 (Anakapalli – Visakhapatnam)

S. No.	Location (km)	Direction	Vehicle Type								
			Car			Auto			2W		
			Mean	85th Percentile	N	Mean	85th Percentile	N	Mean	85th Percentile	N
1	361.6	UP	53.55	61.90	85	45.35	56.4	62	48.21	58.63	129
		DOWN	60.36	74.50	111	48.31	55.32	87	52.42	61.85	236
2	363.4	UP	59.75	72.87	129	47.52	55.4	105	51.54	62.42	128
		DOWN	59.86	79.00	74	49.56	56.12	72	52.08	59.8	129
3	381.2	UP	73.96	88.41	127	57.43	68.89	102	65.11	80.83	128
		DOWN	73.48	88.98	121	60.51	67.67	106	66.18	76.92	101
4	394.5	UP	47.38	56.54	108	36.95	44.6	75	45.68	55.89	108
		DOWN	49.78	59.31	129	40.23	46.03	86	47.58	56.87	129
5	392.5	UP	62.70	71.64	84	42.96	50.64	60	52.39	64.23	84
		DOWN	56.15	65.28	91	41.14	46.69	49	51.29	61.59	110
6	386.8	UP	64.24	75.12	123	51.74	58.95	85	57.34	64.92	104
		DOWN	64.58	77.59	117	52.16	62.03	56	89.2	71.4	93
7	1.3	UP	45.55	53.25	128	38.34	45.63	129	43.58	50.56	129
		DOWN	45.85	52.63	129	36.86	45.23	129	43.25	52.28	129
8	393.4	UP	50.81	60.08	75	38.48	43.9	51	48.98	62.68	67
		DOWN	46.38	54.43	78	37.62	43.69	49	45.05	54.88	79
9	391.3	UP	56.53	64.69	84	41.8	50.56	59	47.95	56.68	75
		DOWN	51.25	61.18	90	37.44	46.36	54	47.76	60.8	92

Table 2: Summary of Spot Speeds on NH-5(Anakapalli – Visakhapatnam Section)

S. No.	Location (km)	Direction	Vehicle Type								
			Bus			LCV			HCV		
			Mean	85th Percentile	N	Mean	85th Percentile	N	Mean	85th Percentile	N
1	361.6	UP	43.74	51.8	43	46.84	55.46	11	48.61	60	88
		DOWN	52.72	60.38	53	*	*	*	54.93	66.72	211
2	363.4	UP	48.65	56.77	88	*	*	*	54.39	64.52	125
		DOWN	49.65	57.32	65	*	*	*	53.53	61.21	128
3	381.2	UP	57.64	71.37	87	63.28	76.08	37	59.51	71.43	132
		DOWN	62.35	76.51	74	58.43	68.23	32	63.65	76.92	104
4	394.5	UP	36.9	44.72	49	*	*	*	38.69	48.65	64
		DOWN	44.15	50.78	65	*	*	*	44.87	53.02	69
5	392.5	UP	46.43	54.4	38	*	*	*	42.61	51.72	59
		DOWN	42.65	49.79	44	*	*	*	45.33	54.28	47
6	386.8	UP	53.4	62.5	39	*	*	*	48.62	57.41	36
		DOWN	54.28	62.33	42	*	*	*	50.76	60	36
7	1.3	UP	41.29	47.81	129	42.74	50.65	36	38.19	45.01	93
		DOWN	39.31	46.87	129	*	*	*	41.25	49.05	129
8	393.4	UP	44.01	54.21	42	*	*	*	42.93	49.79	48
		DOWN	40.5	48.77	52	*	*	*	40.43	46.32	46
9	391.3	UP	48.23	55.47	69	*	*	*	47.14	54.71	49
		DOWN	44.26	49	37	*	*	*	42.29	53.35	35

Note: UP - Towards Bhubaneshwar; Down – Toward Anakapalli; N – Sample Size
All Mean and 85th percentile values in kmph; * In adequate sample size

4.2 Accident Scenario

To assess the accident scenario, it is very much necessary to collect the accident data. In this regard, accident data was collected for the year 2002 from the concerned police station (Visakhapatnam City Traffic Police, (VCTP) and Anakapalli Rural Police), who are responsible for recording and maintaining of accident data. Out of the total study stretch of NH-5, the VCTP are responsible for recording of accident data in the stretch from Km 361.0 to Km 395.878 and from Km 0.0 to Km 2.837, whereas the remaining study i.e from Km 359.2 to Km 361.0 comes under the jurisdiction of Anakapalli Rural Police. A cursory review of accidents within the study area showed that about 376 accidents occurred on the study stretch of NH-5 in the year 2002. A further analysis of this data also revealed that about 66 persons were killed and about 389 persons were injured on the study stretch in the same year. A close look on the total accidents on all types of the roads in the Visakhapatnam city has revealed that the accidents on NH-5 (study stretch) alone are around 34%, which is a significant part and a major reason for authorities concern (Refer Figure 3). The analysis also showed that the accidents occurred during day time (56%) is slightly more than night time, where as fatal accidents were slightly more during night hours i.e. about 58% as shown in Figure 4. The fatality rate on NH-5 is about 19% as shown in Figure 5.

The most frequent accident configurations (Figure 6) involved two wheelers (35%) followed by goods vehicles (23%), cars (17%), autos (15%), Buses (9%) and unknown vehicles (1%).

The accidents distribution during different hours in a day is presented in Figure 7. From the Figure it is evident that the number of accidents are slightly more in the day because of heavy traffic conditions. The severity index (ratio of number of people killed to the total number of accidents) is presented in Figure 8 and it can be seen that the severity index is high in night hours when compared to the day hours.

From the accident analysis, it indicates that the accidents are occurring almost uniformly during day as well as night hours but severity index is very high in the night hours. This may also be attributed to poor illumanisation and absence of warning measures such as delineation and retro-reflective material. It can also be seen from the analysis that two wheelers and trucks contribute to majority of accidents. This is mainly because of the discontinuous of service roads leading to wrong side movement of traffic in order to avoid long detours. Poorly designed access roads from the adjacent areas of the highway are also leading to frequent conflicts between local traffic (mostly two wheelers) and through traffic (goods vehicles).

Table 3: Summary of Design Features of NH-5 (Anakapalli – Visakhapatnam Section)

Chainage (kms)	Number of Culverts	Side Drain		Median Openings	Number of Access		Curves		Service Road		Road Signs		
		L	R		L	R	L	R	L	R	M	W	I
359.2-360	1			1	1			1			2	1	4
360-361	2			1	1								3
361-362	5											2	1
362-363	2			1	3	1		1			2	4	
363-364	3					1	1				1	3	
364-365	4			1	1	1	1	1			1	4	1
365-366		Y_c	Y_c	1	2	1		1			1	2	6
366-367	4			1	1	3							2
367-368	2			1	1						1	1	1
368-369	1	Y_c	Y_c	2	6	1						2	1
369-370	1			2	6	2		1					3
370-371	2					2	1	1					4
371-372	2				1		1	1			1		5
372-373	1	Y_c	Y_c	3	5		1				2		1
373-374	1			3	4	1							
374-375	1				1			1					1
375-376	1			1	1	4	1						
376-377		Y_c	Y_c	2	4	6	1				1		6
377-378	2	Y_o	Y_o	3	9	4	1		Y_p	Y_p	1		2
378-379		Y_o	Y_o	2	5	2		1	Y_p	Y_f		2	9
379-380	1	Y_o	Y_o	3	4	3	1		Y_p	Y_p			6
380-381	1			1	2						1		5
381-382	2				1		1						
382-383	2						1	1			1		4
383-384	2			1	1						1		2
384-385	2			1	2		1	2			3		5
385-386		Y_o	Y_o	1	1	4		1			2	1	6
386-387	1	Y_o	Y_o	2	2	5		1			1	7	5
387-388	1			3	2	2		1	Y_f	Y_f		6	2
388-389	2	Y_o	Y_o	1	2	2		1	Y_f	Y_f	4	6	5
389-390	2	Y_o	Y_o	2	2	2			Y_f	Y_f		2	
390-391	1	Y_o	Y_o		2	1	1	1	Y_f	Y_f	4		2
391-392		Y_o	Y_o	2	3	2	1		Y_f	Y_f		1	1
392-393	2	Y_o	Y_o	1	2	4	1				1		1
393-394	4	Y_o	Y_o	2	8	9	1	1			3	1	5
394-395	1	Y_o	Y_o	2	9	6	1	1			2	1	10
395-395.875		Y_o	Y_o	1	9	5	1				3	2	6
0-1	2	Y_o	Y_o	3	4	8	1	1			3	2	6
1-2	2	Y_o	Y_o	1	4	4	1	1				1	6
2-2.837	1	Y_o	Y_o	1	1	1		1				2	8

Note: L – Left; R – Right; Y_p – Partly Exists; Y_o – Open Drains Exists; Y_c – Covered Drains Exists; Y_f – Fully Exists; M – Mandatory/Prohibitory Signs; W – Warning / Cautionary Signs; I – Informatory Signs

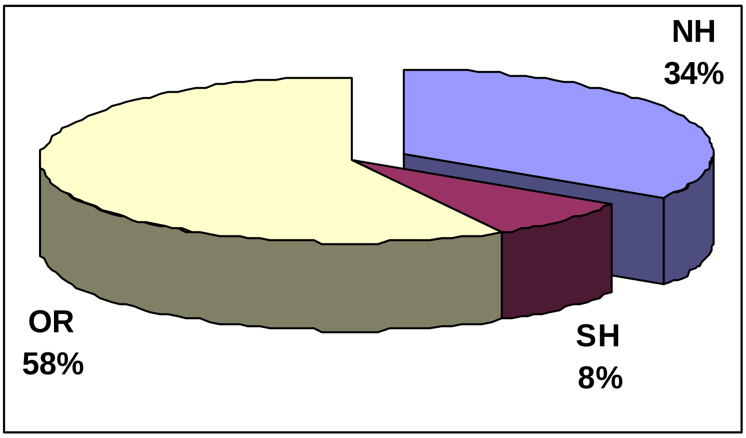

Figure 3: Accidents Distribution based on road type in 2002 on NH-5

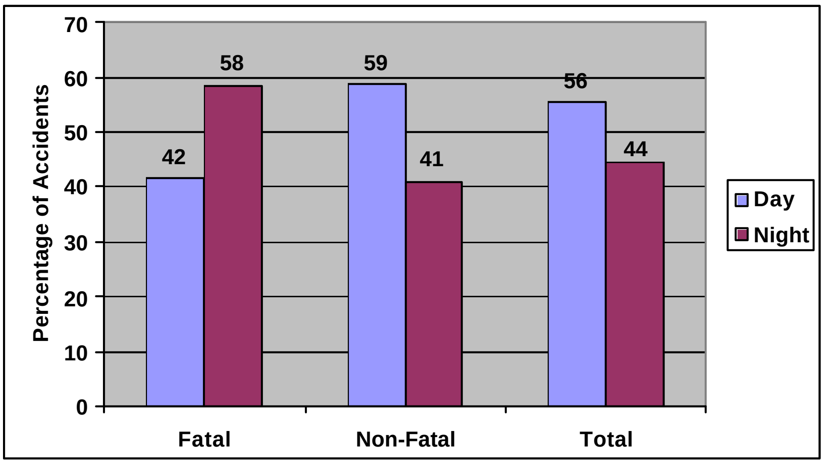

Figure 4: Time Wise Accidents Distribution based on type of Accidents on NH-5

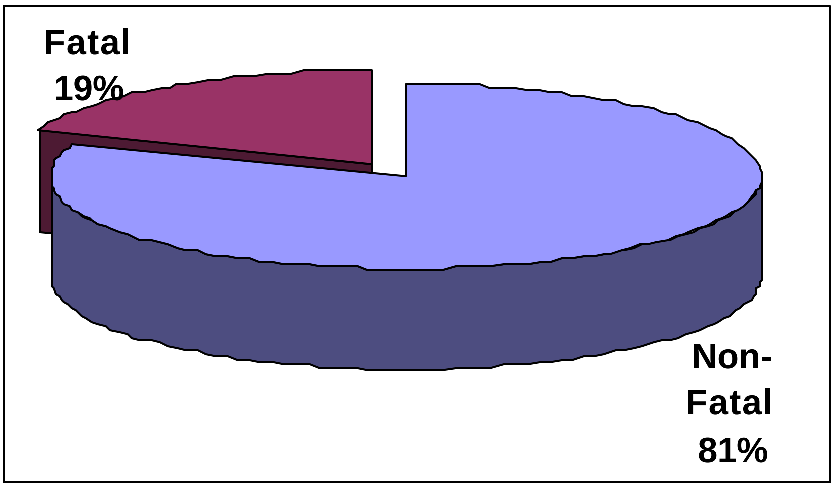

Figure 5: Fatality Rate on NH in 2002

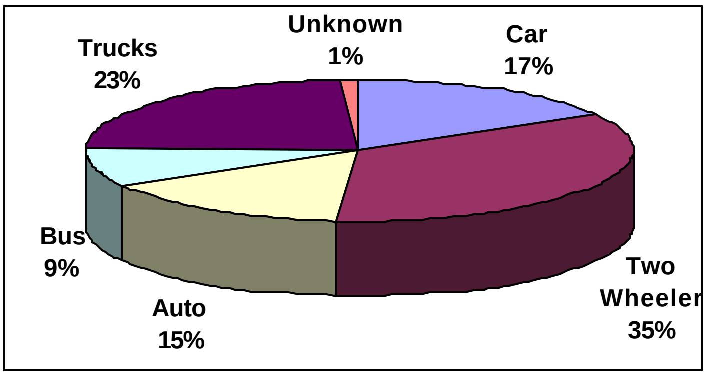

Figure 6: Accidents Distribution based on types of Vehicles involved on NH-5

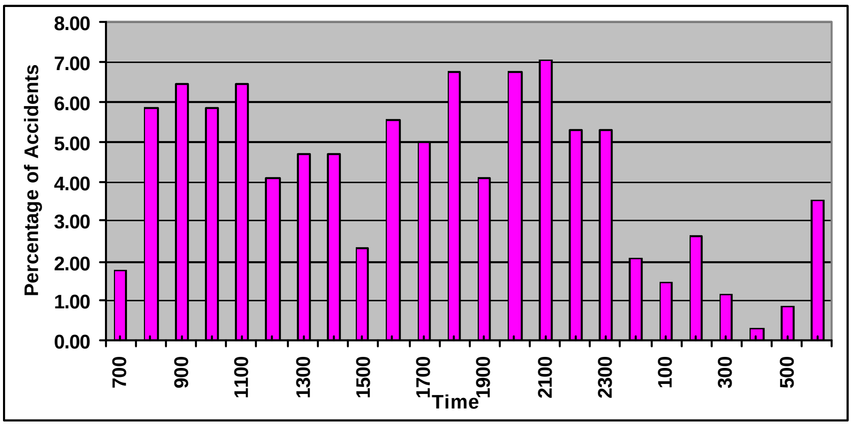

Figure 7: Hourly Distribution of Accidents in the Study Stretch of NH-5

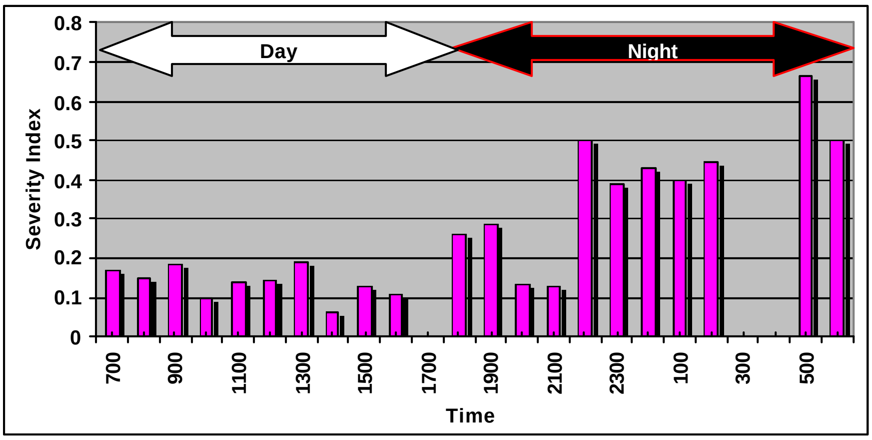

Figure 8: Severity Index Distribution based on Time on NH-5

4.3 Identification of Black Spots

The entire section of NH-5 between Anakapalli to Visakhapatnam is unsafe from safety point of view. The main reason is local traffic has direct access to the National Highway, which results in congestion and accidents. Analysis of accident data within the study area showed that about 376 accidents occurred on the study stretch of NH-5 in the year 2002. A further analysis of this data also revealed that about 66 persons were killed and about 389 persons were injured on the study stretch in the same year. A close look on the total accidents on all types of the roads in the Visakhapatnam city has revealed that the accidents on NH-5 (study stretch) alone are around 34%, which is a significant part and a major reason for authorities concern. Maximum accidents were occurred at km 370.4 (near Toll Booth), km 373.4 (near Ravi Filling Station), km 1.178(near Temple) and km 1.651(near Hill top road). The identified black spots were investigated in detail to assess the cause of accidents and suggest the remedial measures to minimize the accidents.

1) km 370.4 (near Toll Booth)

The section at km 370.4 is two lane divided carriageway with 0.5 m median width and surrounded by residential / commercial activities and is shown schematically in Figure 9. Access road is joining the NH-5 at this point at the higher grade and sharp curve, which result in minimum sight distance and accidents prone zone. Most of the accidents in the year 2002 occurred at this point were due to inadequate sign boards to guide the road user to perceive the situation and act upon it.

Remedial Measures

Proper sign boards such as Informatory, warning and caution sign should be placed as per IRC specifications to guide the road user to perceive the situation. These include curve ahead, access road signs along with delineators and retro-reflective markers along the curve. Further it is suggested to provide acceleration and deceleration lanes.

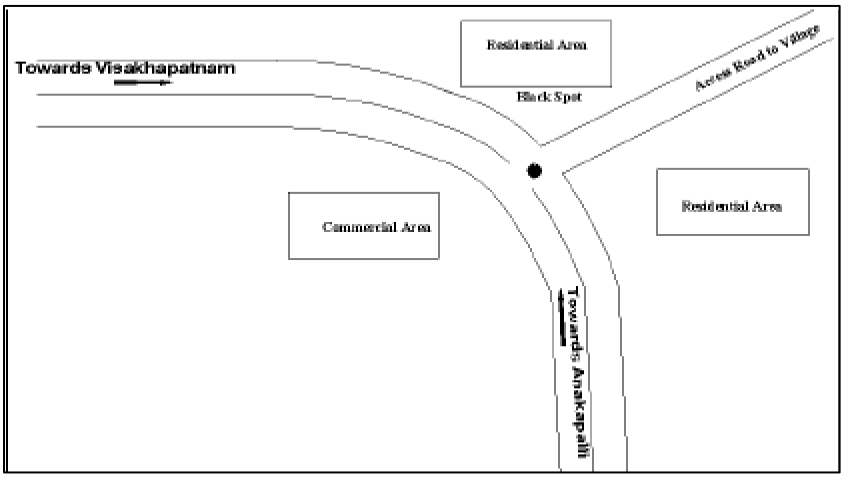

Figure 9: Typical layout of Accident prone location at km 370.4 towards Visakhapatnam

2) km 373.4 (near Ravi Filling Station)

This is another black spot at km 374.4 near Ravi filling station. Two median openings were provided for the convenience of filling fuel at an interval of 20 m as shown in Figure 10. Hence, the road user moves in wrong direction to fill the fuel and has resulted in increased accident rate.

Remedial Measures

It was suggested to the National Highway Authority of India (NHAI) to close both the median openings to minimize the accident, as the fuel filling facility is available on both sides.

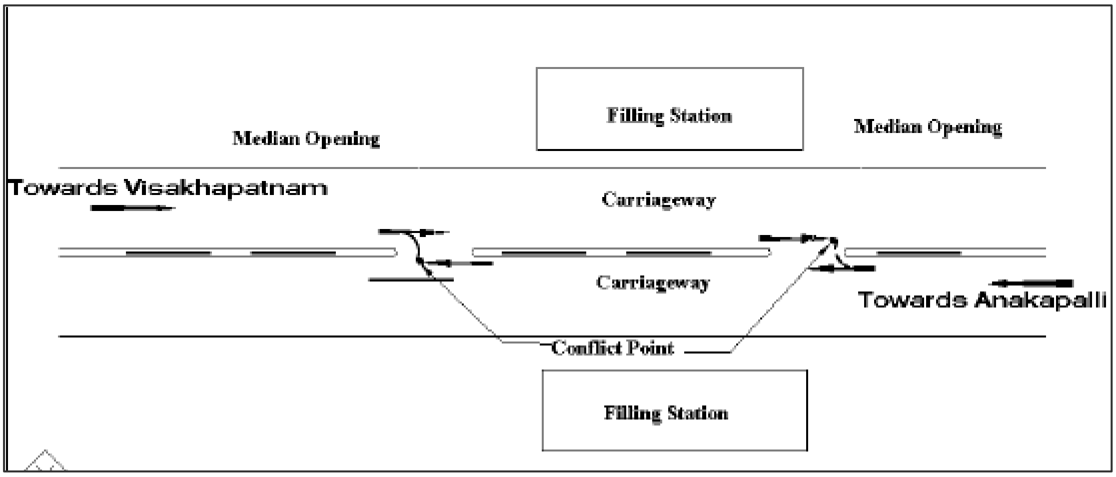

Figure 10: Typical layout of Accident prone location at km 373.4

3) Km 1.178 (near Temple)

The identified black spot is in the city area of Visakhapatnam at km 1.178 and traffic movement towards Bhubaneshwar is shown in Figure 11. The accidents occur at this point mainly due to the access road joining the National Highway, encroachment and provision of narrow right of way (ROW) 20 m. further the city traffic and through traffic are not segregated which results in reduced safety.

Remedial Measures

In order to improve the safety and ensure smooth flow of traffic, it has been suggested to construct service road on both sides of the National Highway, which will also segregate local traffic. Further, it is suggested to remove encroachment on National Highway and provide improved junction geometrics and high mast to improve illumination during night.

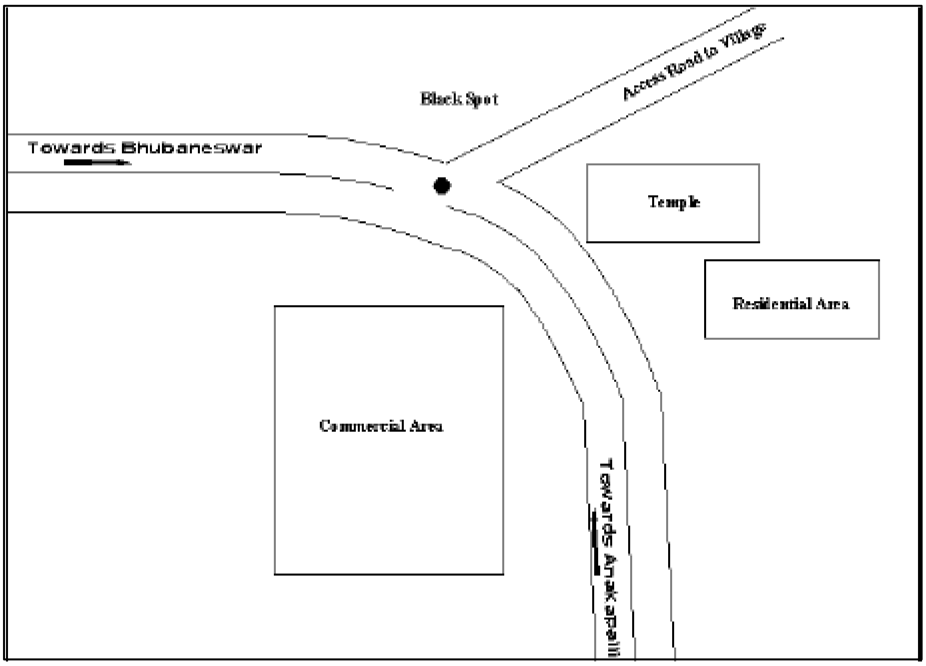

Figure 11: Typical layout of Accident prone location at km 1.173

4) Km 1.651 (near Hill top Road)

The identified black spot is at km 1.651 and schematic diagram is shown in Figure 12. The accidents at this point occur mainly due to the access road joining the National Highway, encroachment and narrow right of way (ROW).

Remedial Measures

In order to improve the safety and ensure smooth flow of traffic, it has been suggested to construct service road on both sides of the National Highway, which will also segregate local traffic. Further, it is suggested to remove encroachment on National Highway and provide improved junction geometrics and high mast to improve illumination during night.

5.0 CONCLUSIONS

From the accident analysis, it can be concluded that the accidents are occurring almost uniformly during day as well as night hours but severity index is very high in the night hours. This may also be attributed to poor illumination and absence of warning measures such as delineation and retro-reflective material. It can also be seen from the analysis that two wheelers and trucks contribute to majority of accidents. This is mainly because of the discontinuous service roads leading to wrong side movement of traffic in order to avoid long detours. Poorly designed access roads from the adjacent areas of the highway are also leading to frequent conflicts between local traffic (mostly two wheelers) and through traffic (goods vehicles).

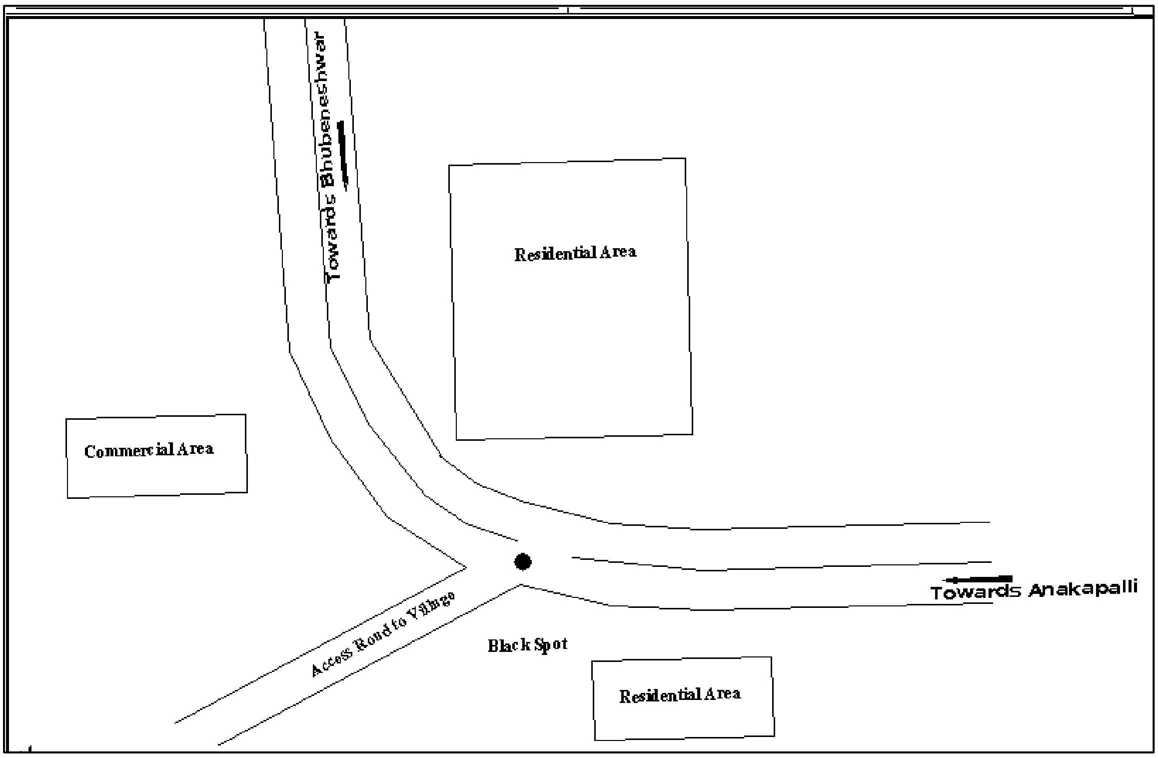

Figure 12: Typical layout of Accident prone location at km 1.651

Four black spots were identified on the section at km 370.4 (near Toll Booth), km 373.4 (near Ravi Filling Station), km 1.178(near Temple) and km 1.651(near Hill top road). The identified black spots were investigated in detail to assess the causes of accidents and appropriate the remedial measures were suggested to NHAI to implement the same so that the accidents and severity of accidents are reduced at these locations. Once the proposed measures are implemented, the after studies will be carried out to assess the impact of improvement measures on number and type of accidents and their severity.

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