

Impacts of Roadway Condition, Traffic and Manmade Features on Road Safety

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Abstract — Accident leads to disablement, death, damage to human health and property, social suffering and general degradation of environment. The road accident situation in India is alarming. Records show that there is one death at every 2.75 minutes because of road accidents. Road accidents inflict heavy economic loss to the country. Road Safety is necessary to reduce accident involving both human and vehicles there by making the road more safe and user friendly to traffic. NH-5 is one of the major connectivity from Chennai to Calcutta which caters to the need of transportation of light goods to heavy goods and passengers. Study area was undertaken on road NH-5 from Chilakaluripeta to Ongole with stretch of 183 Km in Andhra Pradesh state. The coal based power plants and steel industries have been set up in this place since 2006. The study Stretch is a major connectivity to number of heavy industries like Nalco, Bhushan steel, Jindal steel, GMR, ESSAR steel, Adani power, Monnet and many more small scale industries based on Talcher coal mines. The location in a roadway where the traffic accident often occurs is called a black spot. The safety deficiencies were detected to minimize accidents and save the road users. The deficiencies along with the measures for further improvement have been presented in this paper.

Index Terms— Average Daily Traffic, Black spots, Blood Alcohol Concentration, Cross junction, Level of Service, Passenger Car Unit, MORTH.

1 INTRODUCTION

ROAD crashes take away the life of 3,000 people every day. This is a global humanitarian disaster, and it is man-made. (Global Road Safety, Partnership Annual Report 2011). Road safety is one of the most important problems in our society. Every year 1.2 million of people are killed and between 20 and 50 million people are injured in road accidents. If current trends continue road traffic accidents are predicted to be third leading contributor to the global burden of Disease and injury by 2020 (Torregrosa et al., 2012).

India had earned the dubious distinction of having more number of fatalities due to road accidents in the world. Road safety is emerging as a major social concern around the world especially in India.

To minimize the no of crashes by any kind and severity expected to occur on the entity during a specific period is known as road safety. Road users in India are heterogeneous in nature, ranging from pedestrians, animal-driven carts, bi-cycles, rickshaws, hand carts and tractor trolleys, to various categories of two/three wheelers, motor cars, buses, trucks, and multi-axle commercial vehicles etc., Road accidents are a human tragedy, which involve high human suffering. They impose a huge socio-economic cost in terms of untimely deaths, injuries and loss of potential income. The ramifications of road accidents can be colossal and its negative impact is felt not only on individuals, their health and welfare, but also on the economy.

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TABLE 1
ROAD ACCIDENT IN INDIA (2006-2015)

Year	No of Accidents		Number of Persons		Accident Severity
	Total	Fatal	Killed	Injured	
2006	4,07,497	73,650	84,674	408,711	20.8
2007	4,06,726	73,589	85,998	435,122	21.1
2008	4,29,910	79,357	92,618	464,521	21.5
2009	4,39,255	83,491	94,968	465,282	21.6
2010	4,60,920	93,917	105,749	496,481	22.9
2011	4,79,216	1,01,161	114,444	513,340	23.9
2012	4,84,704	1,06,591	119,860	523,193	24.7
2013	4,86,384	1,10,993	125,660	515,458	25.8
2014	4,99,628	1,19,558	134,513	527,512	26.9
2015	4,97,686	1,21,618	1,42,485	5,11,394	28.6

Road safety in India is the poorest in the world. According to MORTH 2013 India has the highest no of accidents in the world. Awareness among road users and safe design of road components is necessary to reduce accident involving both human and vehicles.

TABLE 2
VARIOUS FACTORS RELATED TO ACCIDENT

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Driver - Related
Alcohol and drugs, Sickness, Unsafe speed, Cell Phone Use, Drowsing or Fatigue, Distraction, Fatigue, Improper Passing or Turning, Disregard traffic controls, Non Use of Restraint
Vehicle - Related
Over Loading, Steering defect, Brake defect, Tire failure, Light defect, Improper wheel alignment.
Environmental - Related
Road side hazard, Vision obstruction, Ruts, Improper traffic control, Debris or Garbage on the road, Road Side Hazard, smoke or fog, Fixed Objects, Glare, Water ponding, Improper/nonworking traffic controls, Shoulders defective

TABLE 3
TYPES OF ACCIDENT, POSITION OF VEHICLES AND CONSEQUENCES

Type of Accident	Position of Vehicles
Head on	Vehicle from opposite direction
Rear end	Vehicle in same direction
Angle and tuning	Vehicle from adjacent direction (Intersection)
Parking or Backing	Overtaking
Roll over	On path
Run-off-road	Off path
Moped bike	On curve tuning
Fixed Objects (Trees and Poles)	Off path curve
Pedestrian	
Animal	
Consequences	
Property Loss, Contusion (Head injury without skin unbroken), Spot Death, Fracture, Loss of consciousness, Freezing, Amputation (Loss of one or more limb), Trauma, Head/Neck injury, Laceration (Injury involving cut), Abrasion, Vision/Speech/Hearing Impairment, Sprain (Ankle/Joint twist), Chest pain/Respiratory impairment	

2 DATA COLLECTION

The only information available for accident studies is the FIR (First Information Report) lodged in the police stations. The data from these records of last ten years (2006-2015), were extracted from the FIR record filed under IPC No.279/337/338/304(A). Vehicles those involved in accidents and reported in the F.I.R. The categories of vehicles include tempo, auto, mini-truck, minibus, Tata indica, Tata-407, trecker, motorcycle, tanker, tailor (articulated vehicle), truck and bus.

2.1 Road Selected For Study

Four-lane roads from Chilakaluripeta to Nellore on NH-5 were chosen for this study. The following stretches were selected for data collection.

- i. Chilakaluripeta to Martur
- ii. Martur to Mederametla
- iii. Mederametla to Maddipadu
- iv. Maddipadu to Ongole

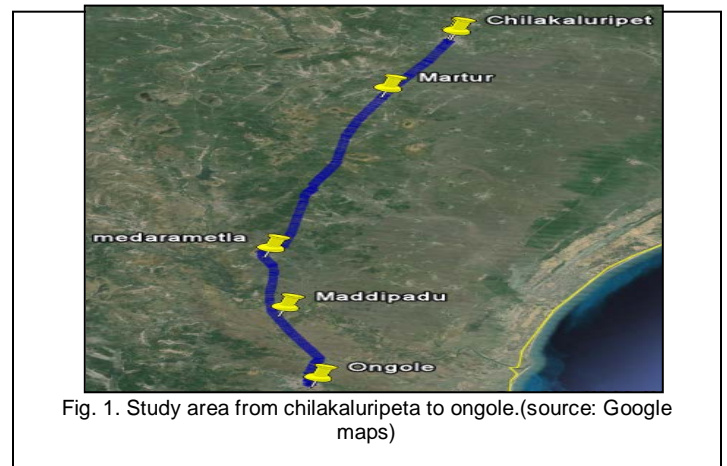


Fig. 1. Study area from chilakaluripeta to ongole. (source: Google maps)

2.2 Data collected from Police Records

With the prior permission of the concerned S.P, the accident data were collected on four-lane highways from three police stations.

TABLE 4
POLICE STATIONS AND ROAD SECTIONS COVERED

Police Station	Road section covered under the police station
Chilakaluripeta	Km 0 on NH-5
Martur	Km 15 on NH-5
Mederametla	Km 30 on NH-5
Maddipadu	Km 45 on NH-5
Ongole	Km 60 on NH-5

TABLE 5
DETAILS OF ACCIDENTS

Year	Fatal	Major injury	Minor injury
2006	15	16	37
2007	11	35	50
2008	16	25	45
2009	20	32	39
2010	21	34	40
2011	18	41	84
2012	4	24	61
2013	13	32	81
2014	18	34	84
2015	11	30	58
Total	147	303	579

2.3 Data collected from P.W.D Records

P.W.D (Public Works Department) records are the main source of details of road.

TABLE 6
DETAILS OF ROAD SECTION

Width of Carriage way in Mt	7
Width of Formation in Mt	12
Width of Land in Mt	45

In addition to the above, traffic volume data were also obtained from PWD records.

TABLE 7
TRAFFIC VOLUME DATA

YEAR	ADT	Average PCU PER DAY	PCU/HR
2006	14533	24656.11	1027.33
2008	12584	21501.46	895.89
2010	12679	21655.23	902.30
2012	10484	18102.4	754.26
2014	12700	21689.22	903.71

3 ANALYSES OF DATA AND DISCUSSION

TABLE 8

ACCIDENT RATE

Number of stretch	Name of stretch	Length	No of accidents in a year	
			Sum of 10 year	Accident rate
1	Chilakaluripeta-Martur	15km	228	45.6
2	Martur -Mederametla	25km	208	41.6
3	Mederametla-Maddipadu	10km	26	5.2
4	Maddipadu-Ongole	10km	239	47.8

TABLE 9
FREQUENCY OF ACCIDENT

Distance of origin	No of accidents (2002-2011)	Frequency	Total frequency
0-15	228	32.5	32.5
15-40	208	29.6	62.1
40-50	26	3.7	65.8
50-60	239	34.1	100
Total	701	100	

It is observed that frequency and rate of accident is more for stretch Maddipadu - Ongole, followed by stretch Chilakaluripeta - Martur, Martur - Mederametla, Mederametla - Maddipadu, respectively.

3.1 Variation in Accidents

The annual variation in accidents of total stretches during year 2006-2015. In the year 2011 accident rate was high and low in the year 2006. It may be due to increase in number of vehicles, bad traffic environment and increase in population.

It is observed that number of accidents are more for stretch 1 and 4 are more higher than stretch 2 and 3. This is because of high traffic volume on stretch 4.

Traffic volume decreases on stretch-3 as stretch -4 is connected to NH-23 which goes towards coal mines. Stretch 1 has high population density as this is the main town of the Angul district. Accident rate is more due to more number of commercial and noncommercial vehicles on the road, bad traffic environment.

3.2 Monthly Variation in Accidents

Peak accident occurs in summer season i.e. In the month of March, April and May. This is due to distraction related to environment. Problem in these months are glare, fatigue, inconvenient heat.

3.3 Hourly Variation in Accidents.

One can observe more accidents occurs in between 8PM to 9PM. In this hour line truck(Truck Series) start their long journey. Most of the driver do not use speedometer as they drive by approximation. Speed crosses limiting speed as a result accident occur. Also they drink and drive in the evening hour. In the late night they use marijuana as a result reaction time increases and loss of control occurs. Some drivers make the vehicle over load. In India load capacity is 10 ton or 16.2 ton for goods carriage but they carry more than those results uncontrolled and lead to accidents.

3.4 Vehicles Involved in Fatalities

The results indicate that 59 percent of fatalities are due to truck drivers followed by 26 percent by unknown driver, 7 percent by motor cycles, 5 percent by car and jeep, 3 percent by bus. They consume alcohol and drugs in long driving. As a result reaction time increases and loss of control occurs during speed driving leads to fatalities.

4 ACCIDENT INVESTIGATION AND BLACK SPOT ANALYSIS

4.1 Accident Investigation

4.1.1 Accident No: 1

Accident type : Head-on collision
Location : Captive power plant gate, Rajupalem
Near Martur
Date and Time : March 30, 2015; 4.30PM
Vehicle 1 : Tata Truck No AP-16/RB-6545
Vehicle 2 : Bajaj CT - 100
motor cycle no AP-27/U-3323

Fatalities/Injuries: One person dead and one person severe Injured.

Description : On 30th march 2015 one Bajaj motor cycle with two person collided with a aluminum loaded truck in Rajupalem around 4.30 PM. The motor cycle was coming from chilakaluripeta to martur and truck was moving on highway. The motor cycle rushed to the right side of truck front. The truck applied brake and turned towards left side. The bike fell down under the rear right wheels. The victims were severely injured. The rider lost his right leg completely and left leg scratched while other was under truck with severe knee and head injuries. The rider had used helmet and saved from head injury. The ambulance came after 30 minutes and took victims to the hospital. The victims were two brothers from Martur town and rider lost his life after two hour of incident.

Cause of accident was due to presence of old banyan tree on the corner of T-junction and ditches of shoulder was filled with water. The motor cycle could not notice the truck due to that big tree and collided with truck on the highway. The tyre skid mark length was 11mt. The accident images were shown below:



Fig. 2 & 3. Accident image of bike and a lorry

4.1.2 Accident No : 2

Accident type : collision with tree
Location : In front of police station Mederametla
Date and Time : JUN 13, 2015; 12.30PM
Vehicle 1 : Ashok Leyland trailer
Vehicle 2 : Bajaj Auto

Fatalities/Injuries: Two person minor Injured

Description : The trailer was on the highway with normal speed. At a T-junction one auto with nine passengers was changing direction (left turn) from bus stop road to highway. Both vehicles became front to front. The trailer driver applied sudden brake and struck the vehicle with an old tree present at corner of junction. The auto was escaped from collision. Driver and helper were injured. The accident photo is shown here,



Fig. 4. Accident photo of a lorry

4.1.3 Accident No: 3

Accident type : Collision with tree and compound wall
 Location : Smelter traffic post ongole
 Date and Time : MAR 12, 2015; 9.10AM
 Vehicle 1 : Tata truck
 Fatalities/Injuries : One person severe Injured and one minor injured

Description : The truck was moving on NH-5. Near traffic post the truck driver could not notice traffic median due to absence of sign post and signal. The truck ran over median and hit with a tree and finally struck with compound wall. The driver became severe injured and helper became minor injured. The vehicle, tree and the compound wall were completely smashed. The accident photo is shown below.



Fig. 5. Accident Photo of a Tree which was damaged in collision

5 BLACK SPOT ANALYSIS

The point where accident occurs frequently is known as black spot or accident point. Analysis is required for improving traffic environment.

5.1 Stretch - 1



Fig. 6. Black Spot Points Stretch-1

**TABLE 10
BLACK SPOT ANALYSIS STRETCH-1**

Accident Point	Numbers	Problems	Safety Enhancement
Divyavoti Talkies	13	X-Unsignalised, 10w Garages, Sight distance obstruction by Shops	Junction Improvement, Sight distance visibility
Bazar Chowk	6	O-Unsignalised, Transformer, 2w Show Rooms	Junction improvement, Clearance Of obstruction on the Shoulder,
Budhi Thakurani	8	O-Unsignalised, Taxi stand, Stalls on the Shoulder	Clearance of obstruction on Shoulder, Sight distance visibility
SBI martur	6	T, Taxi stand, Vegetable Market	Clearance of obstruction on Shoulder, Sight distance visibility
Tatapudi	15	X-Signalized, Cinema Hall, 2w garages, Trees and Poles on Shoulder	Clearance of obstruction on Shoulder, Sight distance visibility
Kanchan Talkies	10	T, Cinema Hall, Trees on Blind Corner, Trees and Poles on Shoulder, Main Bus Stop	Clearance of obstruction on Shoulder, Sight Distance Visibility
Yalla varthi cold storage	16	X-Signalized, Paved Shoulder withno Marking, Transformer on blind corner, On Street Parking of Vehicles	Clearance of obstruction on Shoulder, Sight Distance visibility
Police Training Center	20	Paved Shoulder withno Marking, On Street Parking	Installation of Speed Breakers, Marking
Martur	11	T, Petrol Pump, Transformer on blind corner, Sight Distance obstruction	Junction Improvement, Clearance of Obstruction on Shoulder

5.2 Stretch - 2

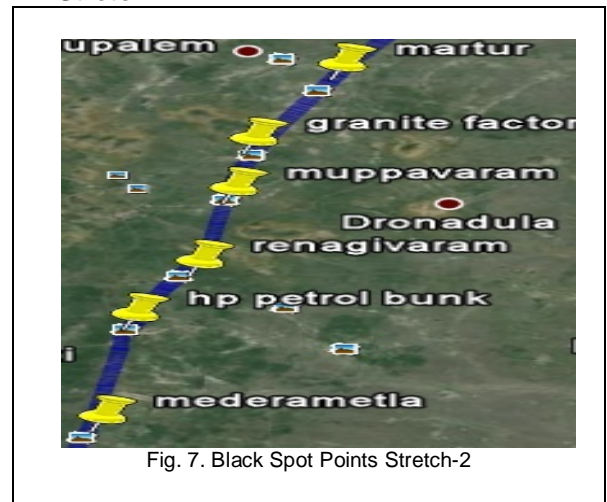


Fig. 7. Black Spot Points Stretch-2

**TABLE 11
BLACK SPOT ANALYSIS STRETCH-2**

Accident Point	Nos	Problems	Safety Enhancement
Market yard	14	Vehicle Parking on Shoulder, Trees and Poles on Shoulder.	Clearance of Road Side
Tulsi Dhaba	8	Meat and Fish Shop on The Shoulder, Old Trees on The Shoulder	Discouragement of Fish and Meat Shop on The Shoulder, Trees on Shoulder should be removed
Muppavaram	15	Median without Sign on the Road, Temple on the Shoulder, Trees on the Shoulder.	Medians to be Painted, obstacle on The Road Should Be Removed
Renangi varam	10	T, Wine Outlet, Unpainted Median, Trees on Shoulder	Median to be Painted, Junction Improvement
Hp petrol bunk	6	T, Unpainted Median,	Junction Improvement,
Mederametla	14	Village Area on Both Side, Godown, Plants on Shoulder	Speed Restriction, Shoulder Improvement

Accident Point	Nos	Problems	Safety Enhancement
Hp petrol bunk	08	T, On Road Bus Stop, Auto and Taxi Stand, Trees on Edge, Shop Verandah on Shoulder, Shoulder Ponding	Separate Bus Stop, Shoulder obstruction Clearance and Maintenance, Junction Improvement
Cold storage	11	Petrol Pump, Betei and Tea shop on shoulder, Shoulder Ponding by Drain Water, Heavy Machinery Garages	Road Side Clearance, maintenance of Shoulder
Rice mills	5	Cinema Hall, Shoulder Drop Off, Old Grift Tree Branches	Visibility by Cutting old Tree Branches, Shoulder Maintenance
Auto nagar	21	Motor Show Room, Dhabas, Shoulder Ponding By Drain	Off Street Parking Facility, Shoulder maintenance

5.3 Stretch - 3

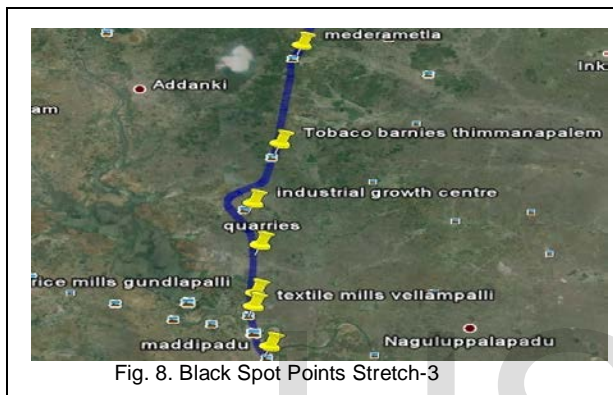


Fig. 8. Black Spot Points Stretch-3

TABLE 12
BLACK SPOT ANALYSIS STRETCH-3

Accident Point	No	Problems	Safety Enhancement
Industrial growth centre	10	Steep Gradient	Speed restriction, Junction Improvement
Textile mills	15	Trees on Shoulder,	Road maintenance, Shoulder maintenances
Maddipadu Junction	16	Bad Shoulder	Shoulder maintenance

5.4 Stretch - 4

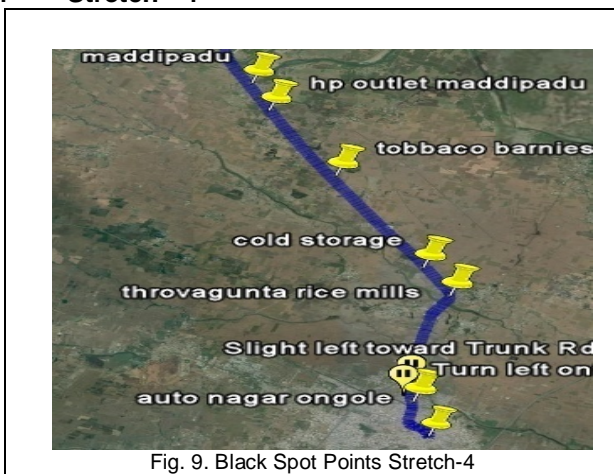


Fig. 9. Black Spot Points Stretch-4

TABLE 13
BLACK SPOT ANALYSIS STRETCH-4

6 CONCLUSIONS AND RECOMMENDATIONS

1. The available literatures on accident analysis indicate that 77.5 percent of road accidents in India are caused due to driver's error.
2. Heavy vehicles like truck are involved in maximum no of accident on two-lane roads. It is estimated that fatalities caused by truck is 59 % followed by other (26%) and bike (7%) and jeep (5%) and bus (3%). Road safety awareness should be raised among road user.
3. Stretch IV has the highest no of accidents which accounts for 34.1% of total accidents. The accident rate can be decreased by Providing a vehicle underpass, road side clearance, proper maintenance of shoulders, lighting, and junction improvement.
4. Stretch I have the second highest no of accidents accounts for 32.5% of total accident. The Accident rate can be reduced by providing signalized junction, junction improvement, and shoulder Clearance, installation of humps, shifting of poles, removal of trees near the edge of pavement etc.
5. No of accidents in stretch II accounts for 29.6% of total accidents. The accident rate can be minimized by clearing-off shoulders, reducing speed limit, junction improvement, providing Signals on the median, shifting structures on the shoulder.
6. Stretch III has minimum no of accidents accounts for 3.7% of total accidents. Speed limit reduction near junction should be reduced to prevent accidents.
7. In stretch IV at MADDIPADU, providing of VEHICULAR UNDERPASS should be done, so that all NH-5 vehicles will move on NH-5 and village vehicles will go through the underpass so that the accident rate will decrease.

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