Road Safety Audit of Selected Stretch from Umreth Junction to Vasad Junction

Devang G Patel, F. S. Umrigar, C. B. Mishra, Amit A Vankar

Abstract- Road Accidents are global phenomenon which is occurring all over the world but are very severe in mixed traffic conditions as prevailing in Indian road conditions. Many lives are lost and huge amount of property damage occurs due to accidents. In 2011 only, 121618 people lost their lives in road accident in India. From 2001 to 2011, the decade data shows the fatalities has been increased by 5.8% and the number of persons injured by 2.5%. As per Manual of Road Accidents in India 2011, 39,000 persons are killed and 1.3 lakh peoples are injured in road accidents occurred on all State Highways in 2011 on Indian Roads which consists of 27.4% and 26.1% respectively. This paper represents about Road Safety Audit on SH-83 and SH-188 which are one of the major state highways in the state of Gujarat which connects NH-8 having high traffic frequency of heavy vehicles. Analysis of major accident in the recent decades has concluded that driver's errors are the major concern for the occurrence of road accident.

Index Terms: Road Accident, Road Safety Audit, Black Spot, Socio-Economic Cost

I. INTRODUCTION

Road Accidents are increasing at a high rate all around the world day by day due to spectacular growth of the road transportation sector. Millions of people are injured and killed during years all over the world due to road accidents. Huge amount of socio-economic cost incurred due to accidents. Accidents rates is increasing despite of many preventive measures applied to improve road conditions and traffic laws. Ignoring the traffic rules is one of the major cause of accidents. 90% of road accidents are caused due to driver's errors.

Due to increase in vehicles and constant road width with changing environment scenario, the rates of accidents are increasing drastically. Road safety is the main concern to reduce accidents. For road user safety, the analysis of accident is primary requirement for road design.

In 2012, 1.2 million people were killed and 50 million people were injured in road accidents throughout the world out of which 90% of road traffic death and injuries occurred in low and middle income countries with most of the victims as pedestrians, cyclists and motor cyclists. Road accidents will be the fifth leading cause in the world up to 2030. (According to UN). Countries like Ghana, India, Mozambique and Pakistan are improving care to take for people who has suffered traffic injuries.

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Modernization and Urbanization has increased the number of registered motor vehicles result in increase of number of trips. India with 121618 fatalities per annum (in 2011) has accounted to about 10% of total world's road fatalities. State Highways and National Highways only contributes 6% of total Road Network of India but it accounts for 70-75% of daily traffic. The death rate per vehicle is 10-20 times higher than countries like Sweden, US, UK etc.

Table 1 Highway Accident Scenario in India

YEAR	Number of Road accident (in thousands)	Number of fatalities (in thousands)
1970	114.1	14.5
1980	153.2	24
1990	282.6	54.1
1996	371.2	74.7
1997	373.7	77
1998	385	79.9
1999	386.5	82
2000	391.4	78.9
2001	405.6	80.9
2002	407.5	84.7
2003	406.7	86
2004	429.91	79.35
2005	439.255	83.49
2006	460.92	93.91
2007	479.216	101.161
2008	484.704	106.591
2009	486.384	110.993
2010	499.628	119.558
2011	497.686	121.618

Source: Manual of Road Accidents in India 2012

II. HIGHWAY TRAFFIC AND SAFETY SCENARIO

Traffic conditions in India are heterogeneous. In India, all types of vehicles moves on same road result in increase in accidents. India's transportation system has number of drawbacks, which causes such as delays, safety issues, pollution and inadequate parking issues which can be resulted in to accidents.

India's road network is second largest road network in the world. Total length of road network in India is 4.24 million kilometers. The road network consists of 1000km Expressways, 70934 km National Highways, 1,54,522 kms of State Highways and 25,77,396 kms of Major District Roads.

Road Safety Scenario in India is in worst condition as regulations of traffic rules and policies are ineffective. Despite of having large road network, the conditions of road in India is worst which may accounts for safety issues of road users. Most of road users in India are of 2-wheelers and 4-wheelers.There is no different lanes for pedestrian and cyclists in India causing pedestrian fatalities on road.

Various Safety programs are organized by government of India to aware people about traffic rules and educate them about safety issues on road. Many organizations are working on road safety issues all over India such as Central and State Governments, Indian Road Congress, National Highway Authority of India etc.

III. ROAD SAFETY AUDIT

In proposed new transport projects, area-wide safety impact assessments are needed to ensure that the proposals do not have an adverse safety impact on the surrounding network. Road safety audits are required to check that the proposed design and implementation are consistent with safety principles.

Road safety audit can be defined as a systematic approach of evaluation of existing or new roads by an independent audit team at the stages of planning, design, construction, operation and maintenance to achieve accident free roads and to enhance overall safety performance

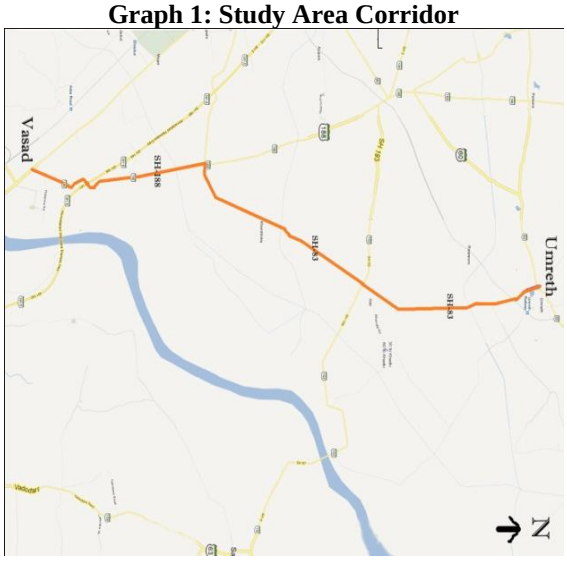
An essential element of the audit process is that it should be carried out separately by both an independent design team, as also an expert team with experience and expertise in road safety engineering and crash investigation.

Road Safety Audits are being used in our country by the National Highways Authority of India (NHAI) in the course of execution of National Highway Development Program (NHDP) in post construction phase. It is understood that the concept is being extended to the pre-construction phase also.

IV. STUDY AREA DELINEATION AND PROFILE

The study area corridor consist of two state highways SH-83 and SH-188 which are interconnected with each other located, starting from Umreth (22.7^{o}N, 73.12^{o}E) to Sarsa(22.54^{o}N, 73.06^{o}E)(SH-83) which is one of the major highway of Gujarat starting from Umreth to Tarapur(72 km) and Sarsa to Vasad(22.45^{o}N,73.066^{o}E)(SH-188) which is 10 km long. Road Safety under study is 29 km long. Study area is located in Anand district of Gujarat State. The whole stretch is located in Anand and Umreth talukas of Anand District (Gujarat State). Study Area consists of cities and villages such as Umreth, Ode, Khambolaj, Sarsa, Vehrakhadi and Vasad.

Graph 1: Study Area Corridor



V. OBJECTIVES OF STUDY

The main Objective is to identify Accident prone locations on the study area stretch and to give Road Safety measures at black spots. Following are the tasks to be carried out:

1) To study land use pattern along the study area corridor.

2) To identify causes of accidents

3) To identify black spots on study area..

VI. NEED OF THE STUDY

SH-83 is the major state highway of Gujarat. Road Safety Audit is to be done on the stretch from Umreth junction to Sarsa Junction (SH-83) and Sarsa junction to Vasad junction (SH-188) which connects NH-8. Many heavy vehicles are transporting the road construction materials from various quarries of Sevalia to the cities of Anand and Baroda. There is heavy goods transport due to various chemical factories and GIDC zones located near by the stretch.

VII. DATA COLLECTION AND ANALYSIS

Following data of study area corridor were collected:

1) Road Inventory and surrounding land use pattern.
2) Classified Volume Count.
3) Accident Data from Police Stations

1) Road Inventory and Surrounding Land use Pattern

Road inventory surveys are carried out identify the width of road, no of lanes, median facility, shoulder width, alignment of road, geometric details and Drainage facilities which are shown in Annexure 1. The land Use pattern surrounding the study area corridor is up most agricultural land.

2) Classified Volume Count

For determining traffic on selected corridor of SH-83 and SH-188, classified volume count is carried out. When the traffic is composed of a number of type of vehicles, the flow of different types of vehicles is carried out either hourly, daily or weekly basis. Classified Volume Counts are done by several methods such as manual methods, combination of manual and mechanical methods, Automatic counters, moving observer method and photographic methods.

Classified volume counts was carried out on weekly basis by photographic method on the study stretch. Locations where CVC was done are Umreth Junction and Vasad Junction. At the study stretch the amount of two wheelers and cars are more due to high annual income of farming for the people residing nearby area. People surrounding the study area corridor usually use their motor cycle for going to work nearby cities like Anand and Vadodara.

Table 2: ADT Classified Volume Count

Type of Vehicles	At Vasad Junction	At Umreth Junction
	Number of Vehicles	**Number of Vehicles**
2-Wheeler	5352	7268
Car,3-wheeler,jeep	4776	5688
Buses	420	404
Double Axle Trucks	3920	2556
Multi Axle Trucks	422	571
L.C.V	1425	1797
Cycle	1320	1756
Animal Drawn Vehicles	11	8
Tractor	290	362
Total	17936	20410

The number of vehicles on road shows that the dominance of two wheelers is clearly evident with the share of about 29.83%. Among the other vehicles, the cars, three wheelers, jeep are witnessed as26.62%. the significance of personalized transport on the stretch of the road calls for the demand of careful consideration of movements on roads.

3) Accident Data from Police Stations
Accident data are collected from various police stations near the study area corridor, the whole and sole custodians of the record. In the khatiyan register, accident data is recorded as FIR (First Information Report) as IPC 279, IPC 327/328/304a, M V Act 177/188. In the stretch, accident data from 3 police stations were recorded namely Umreth, Khambholaj and Vasad.

VIII. ANALYSIS AND INTERPRETATION OF ACCIDENT DATA

There were 250 accidents recorded during the period 2006-2012 on study area stretch. The collected data are analyzed according to the following groups (Shah K.K et al,-):
1) Yearly variation of accidents.
2) Road user type and fatalities
3) Accidents Classified According to Vehicle Type
4) Accidents Classified According to Time
5) Accidents Classified According to Month
6) Accident Classified According to Collision Type
7) Accident Classified According to Accident Spot
8) Accidents Classified According to Vehicle Manoeuvre
9) Accident Classified as per Driver's error

1. Yearly variations of Accidents (2006-2012).

Table 3: Yearly Distribution of accident data from year 2006-2012

Year	Fatal	Serious	Minor	Total
2006	12	11	22	45
2007	6	9	25	40
2008	5	3	28	36
2009	12	5	25	42
2010	7	7	16	30
2011	7	6	15	28
2012	8	7	14	29
Total	57	48	145	250

Table 3 shows that Accident is more during the year 2006 to 2009. There is a decrease in rate of accidents from year 2010 to 2012. There are total 250 accidents from 2006 to 2012 in which fatal, serious and minor are 57, 48 and 145 respectively. Accident occurred on road due to poor road conditions and no traffic signs on the road for alerting the driver. There was no speed limit restriction sign on the road. Due to installation of road signs and speed signs, improvement in road condition, there is decrease in accident after 2009.

2. Road user type and fatalities

Table 4: Road User type and fatalities

Road user	Fatal	Serious	Minor	Percentage	Total
Pedestrians	16	19	36	15	71
Two-wheeler	26	24	68	25	118
Cyclists	2	0	4	1.3	6
Bus	3	1	7	2.7	11
Others	60	50	154	56	264

Table 4 shows that 25% of total accidents are occurred due to motor-cyclists which is a personalized mode of transport and is highly vulnerable to accidents. Rash and negligent driving has proved to be cause of the serious and fatal accidents. Similarly, poor road geometry and inadequate street lighting also increases the incidents of accidents on roads. Pedestrian fatalities accounts for nearly 15% of total road fatalities. Fatalities due to rickshaw, cars and trucks nearly consist of 56% of total road fatalities. Cyclists and Bus fatalities are relatively low. Motor cycle consists of nearly 50% of traffic on study stretch as the people residing nearby prefer motor cycle for their daily use. Heavy vehicles pass through this stretch to transport goods as there are various GIDC Zones nearby the study area. Pedestrians and motor cyclists are vulnerable road user on the road. As the land use pattern nearby study stretch is agricultural land, the people working in farms uses motor cycles and scooters for moving from one place to other.

3. Accidents Classified By Vehicles Type

Table 5 shows that two wheelers, cars and three wheelers are responsible for 74% of total accidents. Light good vehicles and heavy good vehicles are responsible for 19% of total road accidents. Bus and Tractors are least responsible for road accidents. Two wheelers, cars and three wheelers consist of nearly 75% of traffic on study area corridor.

Table 5: Accidents classified as per vehicle type

vehtype1	Fatal	Serious	Minor	Total
Motor Cycle	14	9	29	52
Scooter	1	2	9	12

Three wheeler	5	14	47	66
Car/jeep/van	15	13	28	56
Light good vehicle	3	4	10	17
Heavy goods vehicle	11	4	14	29
Bus	3	1	5	9
Tractor	5	1	3	9
Total	57	48	145	250

4. Accidents Classified According to Time

Table 6 shows that 67% of accidents occurred during day time between 8:00 am to 6:00pm and 33% of accidents have been occurred between 6:00pm to 8:00am. Accidents are more during day time compared to night time. During day time visibility is more and numbers of trips are also more. Driver's have a tendency to take more risk during visibility hours. Also, it is seen that persons going for working place (morning 8:00 to 9:00, 10:00 am to 12:00 noon) and leaving working(17:00 pm to 20:00 pm hours) place shows the rise in accidents.

Table 6: Accidents classified as per time

Time	Fatal	Serious	Minor
0:00- 1:00	2	0	2
1:00-2:00	1	0	2
2:00-3:00	1	0	0
3:00-4:00	0	1	0
4:00-5:00	0	0	0
5:00-6:00	0	0	3
6:00-7:00	3	2	0
7:00-8:00	1	0	6
8:00-9:00	2	1	8
9:00-10:00	1	4	9
10:00-11:00	4	4	12
11:00-12:00	3	3	10
12:00-13:00	2	3	9
13:00-14:00	2	4	14
14:00-15:00	1	6	13
15:00-16:00	4	3	8
16:00-17:00	7	2	8
17:00-18:00	8	4	10
18:00-19:00	3	4	8
19:00-20:00	3	0	11
20:00-21:00	2	4	5
21:00-22:00	3	0	5
22:00-23:00	1	1	2
23:00-24:00	3	2	0
Total	57	48	145

5. Month wise Accidents Classifications:

Table 7: Monthly classification of accidents.

Month	Fatal	Serious	Minor
January	6	3	12
February	6	4	15
March	8	5	9
April	7	1	13
May	8	9	21
June	2	2	16
July	3	3	13
August	6	8	8
September	2	4	7
October	3	3	6
November	5	2	14
December	1	4	11
Total	57	48	145

Table7 shows that more number of accidents has been occurred during the month of May consisting of 15% of total road accidents which are the summer season and driver's do move at excessive speeds and are also inattentive.

6. Accident Classified According to Collision Type

Table 8: Accidents classified as per collision type

Collision type	Fatal	Serious	Minor
Over on Turn Collision	1	1	0
Head on	25	13	59
Rear end	3	4	17
Side impact	2	5	10
Side Swipe	7	5	23
Hit Parked Vehicles	2	0	1
Hit Fixed Objects	2	1	1
Hit Pedestrains	11	18	30
Hit Pedal Cyclists	1	1	4
Others	3	0	0
total	57	48	145

Table 8 shows that accidents 38.8% accidents are head on collision, 14% accidents are due to Side Swipe of vehicles and 23.4% of Accident is due to hitting to pedestrians. The dividers on the road are needed on the entire stretch to reduce the accidents.

7. Accident Classified According to Vehicle Manoeuvre

Table9 shows that 85.2% of accidents have been caused due to vehicles moving straight on road. The major contribution is due to poor road geometry resulting more of head on collisions and side swipe.

Table 9: Accident classified as per vehicle manoeuvre

Vehicle Manuoevere	Fatal	Serious	Minor
Going straight	48	37	128
Turning left	5	6	5
Turning right	1	2	2
U-turning	0	0	0
Overtaking(wrong side)	0	0	0
Overtaking (same side)	1	1	5
Reversing	0	0	0
sudden start	1	0	0
sudden stop	0	1	1
parked off road	0	0	1
stopped on road	0	0	1
Other	1	1	2
Total	57	48	145

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8. Accident Classified According to Accident Spot

Table10: Accidents classified as per location

Accident Spot	Fatal	Serious	Minor
Not at junction	24	21	51
T junction	13	8	38
Y junction	0	0	0
Cross Roads	9	12	35
Offset	6	5	12
Circle	0	0	0
Railway Crossing	0	0	0
Bridge	5	2	9
Others	0	0	0
Total	57	48	145

Table 10 shows that 38.4% of Accidents are occurred on straight road (not at junctions). 23.6% and 22.4% of total accidents are occurred at T-junction and cross roads respectively. Accidents on straight road occurred due to poor road conditions, geometry and also due to high speed of vehicles. On T sections and cross roads, occurrences of accidents are mostly due to improper sight distance.

9. Accident classified According to Driver's Error

Table 11: Accidents classified as per driver's error

Driver's Erro	Fatal	Serious	Minor
None	1	0	4
Fatigue/Slee	1	0	0
Inattention	54	42	132
Too Fast	53	47	137
Too Close	1	1	1
Disobeying T	0	0	0
Bad Overtaki	0	4	3
Bad Turning	1	2	3
Others	0	0	2

Table 11 shows that 93% of accidents are occurred due to driver's error in which driver's error is driving vehicle too fast and with improper attention which are 91.2% and 94.8% respectively.

IX. IDENTIFICATION OF BLACK- SPOTS

Black spots are are found at Vasad Junction, Umreth Junction, Sarsa Cross road, Ahima cross road, Navapura Cross road, ode cross road and Khanpur T-section on the study area corridor.

X. REMEDIAL MEASURES

Various Remedial Measures are to be taken at Black Spots:

1) At Umreth Junction and Vasad Junctions, there is need of island at the junction with proper signs and signals. Speed breaker should be provided to reduce speed on the junctions.

2) At Khanpur T-intersection, there is need to provide circle at middle of junction and median at the middle of road to separate traffic of both sides. Speed breakers are necessary to reduce speed. Installation of road signs at the junction is also necessary.

3) At Ahima Cross Road, Ode Cross Road and Navapura Cross Road, there is necessity to provide circle at the middle of cross roads and speed breakers to reduce speeds.

4) At Sarsa Cross Road, there is need to provide medians on all the four sides up to 50 m distance. Roundabout at the middle of cross road should also be constructed. Island should be installed at the curve of cross road on all four sides. Proper sight distance should be provided by removing unnecessary objects causing problems in visibility. Speed breakers should be installed to reduce speeds at junction. Proper road lighting is needed.

XI. CONCLUSIONS

From the accident analysis, it can be concluded that during day time the accidents are occurring more in number compared to night hours. This may be attributed due to poor road geometry and environment, lack of traffic sense and enforcement measures. Policies during rush hours need to be there. There should be new licensing system incorporating the points allotted for the penalties to driver's for violation and the limit of points should be there after which the license should be cancelled and the driver should again appeared for driver testing for new license. This will reduce the accidents on black spots considerably.

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ANNEXURE 1

From Chainage (kms)	To Chainage (kms)	Shoulder Width (m)	Lane Width (m)	Median Width (m)	Number of Culverts	No of Cross Roads	No of Bridges	No of T-Sections	No of Canals	Curves
0	0.68	0.7	3.15	0.78	1	1	0	2	0	1
0.68	1.83	1.5	3.58	-	0	0	1	0	0	1
1.83	4.49	1.2	3.7	-	0	1	0	0	0	1
4.49	4.847	0.8	3.78	-	0	1	0	0	0	0
4.487	8.227	1	3	-	0	0	0	2	1	4
8.227	8.427	0.8	3.2	-	0	0	0	0	0	0
8.427	10.427	0.6	3.1	0.7	2	2	0	1	0	0
10.427	14.827	0.8	3.39	-	1	0	0	1	1	2
14.827	19.502	1.1	3.5	-	0	4	0	3	0	2
19.502	28.392	1	3	-	3	0	1	7	1	5

AUTHORS PROFILE

Devang G. Patel was born on 20th November 1988 in Kheda, Gujarat. He has completed his Bachelor of Engineering (Civil) from SVIT Vasad, Gujarat University in 2011. Currently he is pursuing his M.Tech (Transportation System Engineering) from B.V.M Engineering College, V.V. Nagar, Gujarat Technological University.

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Amit A. Vankar was born in 2nd May, 1984 in Bhaner, Kheda District, Gujarat. He has completed his Bachelor of Engineering degeree in Civil Engineering, 2006 from B.V.M Engineering College, S.P. University. He achieved his Masters of Engineering in Transportation System Engineering 2008 from. He has a field experience of 2 years in L&T IDPL. He served his duty as consultant Engineer for 2 years in WAPCOS, Gandhinagar. Currently, he is guiding M.E. / M. Tech & Dissertation work in field of Civil/Transportation Engineering in B.V.M Engineering College.