Road safety audit: Development of an accidental model for Urban area

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***Abstract* - In today's world, road and transport has become an integral part of every human being. Everybody is a road user in one shape or the other. The present transport system has minimized the distances but it has on the other hand increased the life risk. The rate of accident in developing countries like India increases year by year. To reduce this adverse effect of transportation the work towards road safety is become necessary now a day. The paper is having two main goals: To carry out road safety audit for reducing vulnerability of accident in the main corridor of urban area and To develop the accidental model taking time of accident as main parameter. To achieve these goals the black spots are identified based on accident detail of stretch selected. For this research paper the study area selected is corridor of Narol to Naroda national highway-Ahmedabad city of Gujarat state.**

***Index Terms*—Transportation, Road Accident, Black Spots, Road safety, and Road Safety audit.**

I.INTRODUCTION

In an era of continuous growth in mobility and demand for transportation, safety is an issue of major social concern and an area of extensive research and work. The rate of accident in developing countries like India increases year by year. To reduce this adverse effect of transportation the work towards road safety is become necessary now a day. Study of the road network and geometric feature are essentially to tackle problems of accident in a city. The occurrence of accident not only causes immediate loss in term of property and life but may also cause a long term pain or grief.

II.OVERVIEW OF COMMONLY USED TERM

- **Road accidents:** A road is a thoroughfare, route, or way on land between two places, which has been paved or otherwise improved to allow travel by some conveyance, including a horse, cart, or motor vehicle.
- An accident is an unplanned and uncontrolled event, which occurred on a road open to a public traffic resulting in personal injury, damages to the property and loss of life in which at least one moving vehicle was involved.
- **Black spot:** The location in a road where the traffic accidents often occur is called a Black Spot.An accident black spot is a term used in road safety management to denote a place where road traffic accidents have historically been concentrated.
- **Road safety:** Road traffic safety refers to methods and measures for reducing the risk of a person using the road network. The users of a road include pedestrians, cyclists, motorists, their passengers, and passengers of on-road public transport, mainly buses and trams. Best-practice road safety strategies focus upon the prevention of serious injury and death crashes in spite of human fallibility.
- **Road safety audit:** A Road Safety Audit (RSA) is defined as "the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users."

Road safety audits differ from conventional traffic safety studies in two key ways: road safety audits are often pro-active investigations, rather than reactive investigations of sites with histories of complaints or poor safety performance, and the investigation team is independent from the staff that is designing the project or maintains the road.

III.OBJECTIVE

The specific objectives of this paper are:

1. To carry out Road safety audit at selected study area.
2. To give remedial measures for reduction in accidents on stretch.
3. To develop the accidental model for the urban area.

IV. SURVEY WORK CARRIED OUT FOR ROAD SAFETY AUDIT

1) Collection of accidental data

The section of national highway no.8 with provision of BRTS corridor is selected as study area for accidental study. The data of accidents occurred in this corridor from past 5years are collected from zonal police stations. Accident data collected are from

the zonal police stations of last five year from the 2009 to 2013, There are 58 number of fatal accident, 310 number of major accident and 90 number of minor accident as shown in Table 1.

Table-1: Accident statistics of Study area from the year 2009 to 2013

Year	Fatal	Major injury	Minor injury	Total
2009	6	66	19	91
2010	15	71	16	102
2011	5	70	17	92
2012	12	58	14	84
2013	20	45	24	89
Total	58	310	90	458

(Source: zonal police stations of Ahmedabad)

2) Classified Volume Count Survey

The study area selected is having 3-lane 2-carriageway road with facilities of 2-way BRTS corridor, service lane at both side and parking lane. For the traffic volume count survey the video graphic and manual count methods are used. Because of the less traffic movement at the mid blocks, the volume count survey was carried out by the application of manual counting method. Other than that, at every intersection (Isanpur, Ghodasar, Expressway, CTM) the video graphic method is applied for volume count. Narol circle is covering very vast area so the videography is giving effective results for traffic volume count on all the sides of circle. So, the manual counting method is used over there too. The summarization of that data is shown in table below:

Table 2: Classified Volume Count PCU/hour at different location in peak hours

Sr. no.	Location	Time	Direction	Two Wheeler PCU/hr	Three Wheeler PCU/hr	Four Wheeler PCU/hr	Bus/ Truck PCU/hr	LCV PCU/hr	Cycle PCU/hr	Total PCU/hr
1	Narol circle	Morning	Narol to Isanpur	783	648	494	347	552	87	**2909**
			Isanpur to Narol	1085	651	427	567	465	70	**3265**
		Evening	Narol to Isanpur	787	709	435	515	425	48	**2917**
			Isanpur to Narol	1177	581	441	641	546	43	**3428**
2	Isanpur cross road	Morning	Isanpur to Ghodasar	553	543	567	502	222	15	**2400**
			Ghodasar to Isanpur	1122	424	544	560	246	12	**2906**
		Evening	Isanpur to Ghodasar	1422	366	502	616	341	28	**3273**
			Ghodasar to Isanpur	1130	323	535	497	275	30	**2788**
3	Ghodasar cross road	Morning	Ghodasar to Jasodanagar	1071	268	404	348	444	22	**2557**
			Jasodanagar to Ghodasar	1143	416	648	528	471	19	**3225**
		Evening	Ghodasar to Jasodanagar	1130	288	501	306	455	30	**2710**
			Jasodanagar to Ghodasar	1305	452	535	487	551	25	**3353**
4	Expressway Tran Rasta	Morning	Expressway to Jasodanagar	1656	830	772	1501	368	86	**5211**
			Jasodanagar to Expressway	1468	451	494	767	302	142	**3623**
		Evening	Expressway to Jasodanagar	1500	1196	1267	1733	471	100	**6267**
			Jasodanagar to Expressway	1659	505	511	676	297	191	**3838**

5	CTM cross road	Morning	CTM to Expressway	1663	878	695	875	384	85	**4579**
			Expressway to CTM	1496	395	516	932	485	175	**3998**
		Evening	CTM to Expressway	1501	1057	1216	1759	443	130	**6104**
			Expressway to CTM	1753	447	488	749	384	170	**3990**
6	Isanpur to Ghodasar midblock	Morning	Isanpur to Ghodasar	1050	457	514	410	197	15	**2642**
			Ghodasar to Isanpur	1747	712	201	342	210	12	**3224**
		Evening	Isanpur to Ghodasar	1259	460	343	563	303	25	**2951**
			Ghodasar to Isanpur	1310	667	259	323	234	25	**2816**
7	CTM to Expressway midblock	Morning	CTM to Expressway	1633	825	705	895	332	84	**4473**
			Expressway to CTM	1542	423	501	767	471	188	**3891**
		Evening	CTM to Expressway	1467	1073	1267	1575	453	123	**5957**
			Expressway to CTM	1641	464	496	669	302	210	**3782**

3) Spot speed survey

Spot speed Study is used to determine the speed of vehicle at a spot of the road section. It is done in Road Safety Audit when the black spots are determined. It is useful in comparing design speed with actual speed of vehicle. Spot speeds are needed to control traffic operations and regulations. To enable safe speed limit on road so that accidents can be reduced, speed survey is carried out on different segments of study area. Among some different methods of spot speed survey the radar gun method is used.

Table- 3: Average Spot Speed of Vehicles at study locations

Location	Direction	Time	Category of Vehicle					
			2/W	3/W	4/W	LCV	Bus	Truck
Narol circle	Narol to Isanpur	Morning	51	38	47	41	35	49
	Isanpur to Narol		49	41	52	38	42	44
	Narol to Isanpur	Evening	53	40	51	38	41	43
	Isanpur to Narol		53	41	55	39	47	45
Isanpur cross road	Isanpur to Ghodasar	Morning	44	30	47	38	43	45
	Ghodasar to Isanpur		46	36	53	41	39	41
	Isanpur to Ghodasar	Evening	50	38	54	43	41	39
	Ghodasar to Isanpur		42	35	51	44	45	47
Ghodasar cross road	Ghodasar to Jasodanagar	Morning	44	39	46	43	48	36
	Jasodanagar to Ghodasar		49	40	50	37	42	41
	Ghodasar to Jasodanagar	Evening	49	43	51	45	38	44
	Jasodanagar to Ghodasar		46	34	45	39	43	44
Expressway Tran Rasta	Jasodanagar to Expressway	Morning	52	38	54	49	50	42
	Expressway to Jasodanagar		42	37	53	44	39	40
	Jasodanagar to Expressway	Evening	55	43	52	45	41	45
	Expressway to Jasodanagar		45	40	56	39	37	43
CTM cross road	Expressway to CTM	Morning	49	37	53	40	39	42
	CTM to Expressway		52	41	50	45	36	40
	Expressway to CTM	Evening	51	40	50	38	42	46
	CTM to Expressway		47	38	48	40	42	41

4) Road inventory measurement

Road inventory survey was carried out from Narol circle to CTM cross road. There are five different locations selected as black spots based on accident data recorded in police stations. The inventory survey

was carried out at those black spots. The locations are Narol circle, Isanpur cross road, Ghodasar, Expressway Tran Rasta and CTM cross road. The inventory details of the spots are as follows:

Table-4: Road Inventory Details (all dimensions are in meter)

Sr. no.	Location	Direction	Carriageway width in m	Footpath in m	Service lane width in m	BRTS Corridor width in m	Parking lane width in m
1.	Narol circle	Narol circle to Isanpur	14.75	3.05	4.60	6.10	3.57
		Isanpur to Narol circle	13.29	3.05	3.20	6.10	3.57
2.	Isanpur cross road	Isanpur to Ghodasar	13.60	2.57	5.70	5.50	3.57
		Ghodasar to Isanpur	12.75	2.57	4.97	5.50	3.57
3.	Ghodasar	Ghodasar to Jasodanagar	7.28	2.15	N.A.	5.01	N.A.
		Jasodanagar to Ghodasar	7.17	2.10	N.A.	5.01	N.A.
4.	Expressway Tran Rasta	Expressway to Jasodanagar	14.38	2.03	5.66	4.67	4.38
		Jasodanagar to Expressway	12.57	2.03	6.40	4.67	3.54
5.	CTM cross road	CTM to Expressway	12.59	2.00	6.68	5.01	4.61
		Expressway to CTM	14.36	2.00	6.59	5.01	4.49

V. OBSERVATIONS

From the surveys conducted some important notes are observed, which are as follows:

1. There are no of traffic signals provided at any of those five intersections.
2. There is no provision of service lane and parking lane from Ghodasar to Jasodanagar road.
3. The heavy volume of auto is parked at Narol circle, Isanpur intersection and Expressway Tran Rasta, this reduction in the available road space for the through traffic leads to traffic congestion and ultimately leads to accidents at various critical locations.
4. Pedestrians are most vulnerable victim due to insufficient pedestrian facilities and poor knowledge about traffic rules.
5. 50% accidents are occurred during night time. Most Accidents are recorded during peak hours between 7:00 pm to 6:00 am and 12:00 pm to 6:00 pm.
6. From spot speed study, we can conclude that maximum speed is of two wheelers and car i.e. nearly 50 kmph.
7. Most of accidents are caused during summer season indicating driver driving very inattentive during the clear weather and as in winter season because of the foggy weather.
8. Maximum accidents are occurred during the summer season at night time, due to the clear weather and the less traffic which leads to high speed.
9. The maximum traffic is due to two wheelers at every intersections as well as mid blocks i.e. around 50% of all traffic.
10. The unauthorized vendors are observed at Isanpur and CTM cross road.

VI. REMEDIAL MEASURES

The problem of accident is more active due to mix traffic and complex flow. For full realization of the problems and the factors contributing to road accidents the effective systematic studies was carried out. To arrive at suitable measures to effectively decrease the accident rates, the statistical analysis of accidents at road stretches has been carried out. Based on the accident analysis, road geometry, environment and some other factors, the following measures are recommended:

1) Because of the presence of vendors on road side the capacity of roads are reduced so those vendors should be removed as soon as possible.
2) Because of traffic signals are not provided on this route the drivers are not well aware of the vehicle movements on cross roads. So the signals should be provided at some junctions where it required.
3) There are no proper pedestrian crossing facilities all over the route, which forces the pedestrians to cross the road in an uneven pattern. This increases the conflict points and in turn giving rise to accident. So proper zebra crossing or foot over bridges should be constructed according to the need of the region.
4) The auto rickshaws and Trucks are involved in an unauthorized parking which reduces the capacity of road due to which accidents occur. So proper facilities for their parking should be provided alongside the road.
5) At Ghodasar Junction, there is need of island at the junction with proper signs and signals. Speed breaker should be provided to reduce speed on the junctions.
6) At Isanpur intersection sight distance not clearly visible due to the big hoardings are there. So proper control is required to make safe road.
7) Drivers training are most important requirement for safe driving.
8) The police patrolling at night time are requiring because of the drivers are having drugs of any other alcoholics drink that may causes an accidents.
9) There is grate width of service lane at the stretch, due to this the heavy vehicles like truck or LCV run through it, so tapering at entrance of service lane is required.

10) The work hours of trips of driver are reduced or extra driver for driving for long trip is must.
11) Parking lane should be provided at Ghodasar to Jasodanagar stretch.

VII. DEVELOPMENT OF ACCIDENTAL MODEL

The linear regression model is developed, for that total accidents, fatal accidents, major accidents and minor accidents are considered as dependent variable and accidents per month respected to time is considered as independent variable.

From the above table we have concluded:

- Total accident (fatal, major and minor) is more affected during day and night due to high traffic during day while race driving due to free speed, poor visibility, drugged driver etc. during night time.
- Fatal accident takes place during day time as it is affected due to high and uncontrolled traffic condition.
- Fatal accident during night time is affected due to free speed as well as physical and psychological condition of driver.
- Major accident which harms individual/property is having more co-relation during day time due to heavy traffic on this corridor.
- Major accident has very high co-relation for the night movement due to above mentioned reasons (high speed, physical and psychological condition of driver etc.).
- During day time minor accident takes place in high numbers due to the movement of traffic (weaving, merging, diverging etc.).
- The minor accident during night time is due to less attentiveness of driver.
- The goodness of models is examined on the basis of statistical value i.e. coefficient of correlation (r), which is restricted from 0 to 1.
- The value of coefficient calculated from the regression nearer to 1 is indicating goodness of model.
- The model for the total accidents with the combination of both day and night time accidents having best value r (0.982), which shows the goodness of model.

VIII. CONCLUSION

Following are the conclusions drawn from the study:

- The black spots are identified based on police record, deficiencies of geometric like Non availability of footpath, service lane, parking lane etc. Non Availability of speed breaker, Advertisement board at intersection, improper zebra crossing, other parameter like absence of traffic police, not working traffic signal, unauthorized parking at intersection etc.
- Based on the accident data majority of accidents occurred at the Narol circle, Isanpur, Ghodasar, C.T.M and Expressway cross road.
- There are no traffic signals provided at any of those five intersections.
- There is no provision of service lane and parking lane from Ghodasar to Jasodanagar road.

Table-5: Model development for the Accident

Sr. no.	Type of accident	During Day time only	During night time only	Combination of Day and Night time
1.	Total accidents	y = 3.1265 + 1.074x	y1 = 2.899 + 1.099x	y3 = -0.013 + 0.986x1 + 1.015x2
		r = 0.723	r =0.743	r =0.982
2.	Fatal accidents	y4 = -0.077 + 0.136x	y5 = -0.043 + 0.096x	y6 = 0.031 + 0.099x1 + 0.088x2
		r =0.568	r =0.382	r =0.184
3.	Major accidents	y7 = 0.017 + 0.538x	y8 = 0.290 + 0.569x	y9 = -0.039+ 0.0631x1 +| 0.537x2
		r =0.871	r =0.855	r =0.847
4.	Minor accidents	y10= 0.183 + 0.231x	y11=-0.247 + 0.334x	y12=-0.0023 + 0.258x1 + 0.344x2
		r =0.503	r =0.719	r =0.484

- The heavy volume of auto is parked at Narol circle, Isanpur intersection and Expressway Tran Rasta, this reduction in the available road space for the through traffic leads to traffic congestion and ultimately leads to accidents at various critical locations.
- There is grate width of service lane at the stretch, due to this the heavy vehicles like truck or LCV run through it, so tapering at entrance of service lane is required.

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