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Road Safety Audit on Selected Stretch of NH-27 (Greenland Chowkdi to Hirasar Diversion)

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Abstract: ***Today Road safety is a prime concern in field of Transportation Engineering. According to WHO (World Health Organization) road injury is 10th cause of death in 2016. Road Safety Audit is involves assessing safety performance and potentiality of accident on an existing road or a road under construction. This scenario especially in India needs to be dealt with this problem earliest because India is having highest number of Road Traffic Accident Fatalities in the world other than any country and second highest number in economic loss due to Road Traffic Accident. In this study, a stretch Rajkot-Ahmedabad National highway (NH-27) of 22 km (from CH 185+200 to CH 207+200) is selected for carrying out Road Safety Audit. Data collection includes Accident Data, Classified Traffic Volume, Speed Study and Road Inventory. Accident Data is collected from Police Station. The black spots (Hot spots) are identified for the selected Road stretch. Classified Traffic Volume and Spot Speed data are collected by survey. Road inventory survey will be carried out to collect data regarding Road condition, Geometry, Markings, Signs and Road-side Furniture etc. Road Safety Audit checklists will be utilized for the evaluation of the safety level of these particular road sections as per IRC: SP: 88-2010 (Manual on Road Safety Audit). This work mainly focuses on the causes of accidents and the preventive measures for the same. And from the results, the remedial measures have been recommend.***

Keywords: Road Safety Audit, Black spots, Causes of accidents, Road inventory, National Highway

I. INTRODUCTION

According to official statistics (National Crime Records Bureau), In India in 2015 1.46 people were killed in road accidents. The death rate per vehicle is 10 to 20 times higher in India as compared to other developed countries like USA, UK, Norway, and Japan. It is also much higher as compared to many other low income countries like Brazil, Mexico and Malaysia. In India, the share of National highways and state highways about 7% of total roadway network which constitutes for 52.8% of the total road accidents, 63% fatal accidents, 55.4% injury accidents in year 2015. It is believed partially that due to exponential growth of vehicles in last two decades has accounted for 5% of growth in accidents, fatalities and casualties. Estimated economic loss of about 3% in GDP is considered due to road accidents as per 10th Five Year Plan. Vulnerable Road Users (VRUs) constitute 60-80% of total road traffic fatalities in India. The proportions of VRU on highways are 32% and other motor vehicles are 68%. Road accidents are associated with number of problems like Road user behavior, environment, vehicle conditions and road conditions. For proper study of the accidents each problem has to study separately. Main problem is the rapid growth of vehicles due to urbanization, and due to that the roads are not able to serve properly as it is designed for less traffic. The most effective way of managing accident risk is through the development of 'safety culture'. A safety culture is the beliefs and ideas about accidents and their risk of happening and proper measures which are to be taken to decrease in the number of accidents. In India, the fast growth of Road Transportation contributes in the economic development of the country. But this growth in Transportation Sector leads to increase in Road Traffic Accidents. And if economic loss is calculated due to the accidents, than huge amount of economic loss occur every year in the form of accident. It was estimated in 1999-2000, that the economic loss due to accident is about 3% of GDP of India.

A. According to report of MORTH on Road Accidents in India-2015

1) The total number of road accidents increased by 2.5% from 4.8 lac in 2014 to 5.1 lac in 2015. (59 accidents / hour)
2) In India, about 1.46 lac people died in 2015 and increasing at a rate of 4.6% every year. (17 fatal accidents / hour)
3) Road accident injuries have also increased by 1.4% from 4.93 lac in 2014 to 5 lac in 2015
4) The severity of road accidents, measured in terms of number of persons Died per 100 accidents are increased from 28.5 in 2014 to 29.4 in 2015.
5) About 54.1 per cent of all persons Died in road accidents are in the 15 - 34 years age group during the year 2015.

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II. STUDY AREA

In this study, Road stretch of 22 km. is selected from NH-27. The stretch starts from Greenland Chowkdi (0 km) and ends at Hirasar diversion (22 km) on Rajkot-Ahmedabad National Highway. This highway is the one of the main road of Gujarat State. It connects two major cities of Gujarat which are Rajkot and Ahmedabad. The roadway stretch passes through Plain and rolling terrain. The land use pattern are residential, sub-urban, agricultural and industrial area. Road infrastructure details are as under.

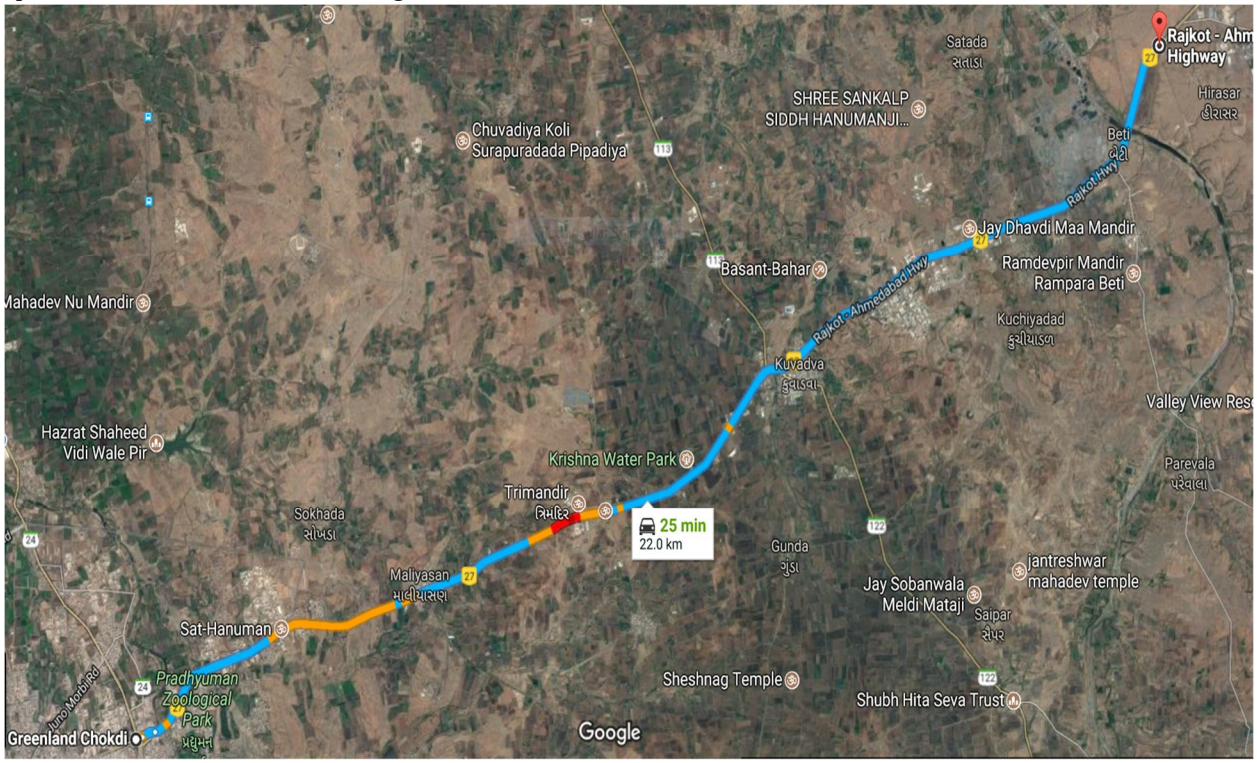

Figure 1. Satellite map of the selected stretch of NH-27

Table 1. Road infrastructure details of study highway

Particulars	Existing
Road Stretch	km 185.200 to km 207.200
Road length (km)	22 km
Start km	185.200 of NH 27
End km	207.200 of NH 27
Existing carriageway	4 lane divided
Design speed (kmph)	30-80
Road land width (m)	20.4 to 29.5
Major junction	2
Minor junction	14
Truck-Bus lay bye	8
Major Bridges	3
Minor Bridges	8
Culverts	19

III. SCOPE OF THE STUDY

The scope of the study is to perform road safety audit for a selected stretch from Rajkot-Ahmedabad National Highway (NH-27) from Greenland chowkdi CH 185+200 km to Hirasar Diversion CH 207+200 km and to suggest design measures and improvements to reduce accidents on stretch.

IV. OBJECTIVE OF STUDY

The objective of the Road Safety Audit is to ensure the movement of vehicles on new and all existing highway. The main objectives of this study are as follows:

A. To find out black spots from past accident data.
B. To evaluate road surface, geometry, road markings-signs and road side furniture for the present traffic condition.
C. To find the required improvements in present road condition.

V. DATA COLLECTION & ANALYSIS

A. Following Data of Study Area Corridor Were Collected

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

B. 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. The land Use pattern surrounding the study area corridor is sub-urban area, industrial area, and agricultural land.

Table 2. Road width measurements on study highway

Chainage (km)	Rajkot to Ahmedabad			Median width (m)	Ahmedabad to Rajkot		
	Carriage way width (m)	Shoulder width (m)	Earthen shoulder Widt0h (m)		Carriage way width (m)	Shoulder width (m)	Earthen shoulder Width (m)
186	7.50	1.20	2.00	1.20	7.70	1.20	2.50
187	7.60	1.30	2.20	1.20	7.60	1.50	2.50
188	7.50	1.00	0.00	1.20	7.70	1.20	1.80
189	7.70	1.30	2.20	4.10	7.60	1.50	2.50
190	7.50	1.30	2.80	4.30	7.70	1.10	2.20
191	7.50	1.30	2.50	1.20	7.70	1.10	2.20
192	7.60	1.20	2.40	4.30	7.70	1.10	2.10
193	7.70	1.20	2.20	4.10	7.70	1.20	2.40
194	8.00	1.00	2.00	4.25	7.70	1.00	2.70
195	7.60	1.20	4.30	4.30	7.50	1.20	1.80
196	7.40	1.40	2.40	4.30	7.70	1.10	2.20
197	7.40	1.50	2.10	4.20	7.70	1.00	2.10
198	7.80	1.50	2.00	4.10	7.80	1.50	2.20
199	7.70	1.30	1.00	4.30	7.60	1.50	1.30
200	7.50	1.50	2.50	4.20	8.00	0.80	1.70
201	7.40	1.40	2.20	4.20	7.70	1.10	1.60
202	7.30	1.50	2.20	4.40	7.80	1.00	1.90
203	7.60	1.20	3.10	4.30	7.80	1.00	3.00
204	7.50	1.20	1.30	4.30	7.80	1.00	2.00
205	7.90	1.10	2.60	3.90	7.50	1.00	2.70
206	7.50	1.20	2.80	4.50	7.50	1.00	2.50
207	7.70	1.00	2.80	4.50	7.70	0.80	2.60

Table 3. Road width measurements on the major bridges on study highway

Chainage (km)	Direction	Bridge length (m)	Carriageway width (m)	Median width (m)	Pedestrian walkway (m)	Safety Barrier height (m)
185+270	R-A	109.6	7.5	0	1.6+1.6	1.2
	A-R		7.5	0	-	1.2
186+350	R-A	147.2	6.9	0	-	1.2
	A-R		7	0	1.6+1.4	1.2
205+350	R-A	138.96	7	0	-	1.2
	A-R		7.2	0	1.8+1.8	1.2

Table 4. Road measurement at the diversions on study highway

Chainage (km)	Description	Median width (m)	Opening in median (m)
185+400	Navagam diverging	1.2	90
187+350	Navagam merging	1.5	107.2
187+900	Anandpar diverging	0.8	35.5
188+150	Sokhada	0.8	0
188+300	IOC station	0.8	28.3
189+750	Jamnagar merging	4.3	26
190+600	Maliyasan	5	15
190+700	Maliyasan	1.5	16
194+150	Targhadiya diversion	4.25	19.7
195+300	Gunda diversion	3.7	20.1
197+400	Kuvadva diversion	4.1	19.4
197+800	Vankaner Chowkdi	1.8	30.1
198+100	Kuvadva	2	80
198+400	Kuvadva	2.6	20.5
198+900	Kuvadva merging	2.4	16.4
200+150	Satada diverging	3.9	0
201+500	Satada merging	4.1	11.7
202+750	Kuchiyadad diversion	4.4	42.6
204+900	Rampar diversion	4.3	19
206+050	Jivapar diversion	4.3	19
206+550	Hirasar diversion	4.3	8
207+100	Bamanbor diversion	5	45

C. Accident Data from Police Stations

Accident data are collected from Kuvadva police station for the study area corridor, in the khatiyan register, accident data is recorded as FIR (First Information Report) as IPC 279, IPC 327/328/304a, MV Act 177/188. There were 308 accidents recorded during the period 2013 to 2017 on study area stretch. The collected data are analyzed accordingly.

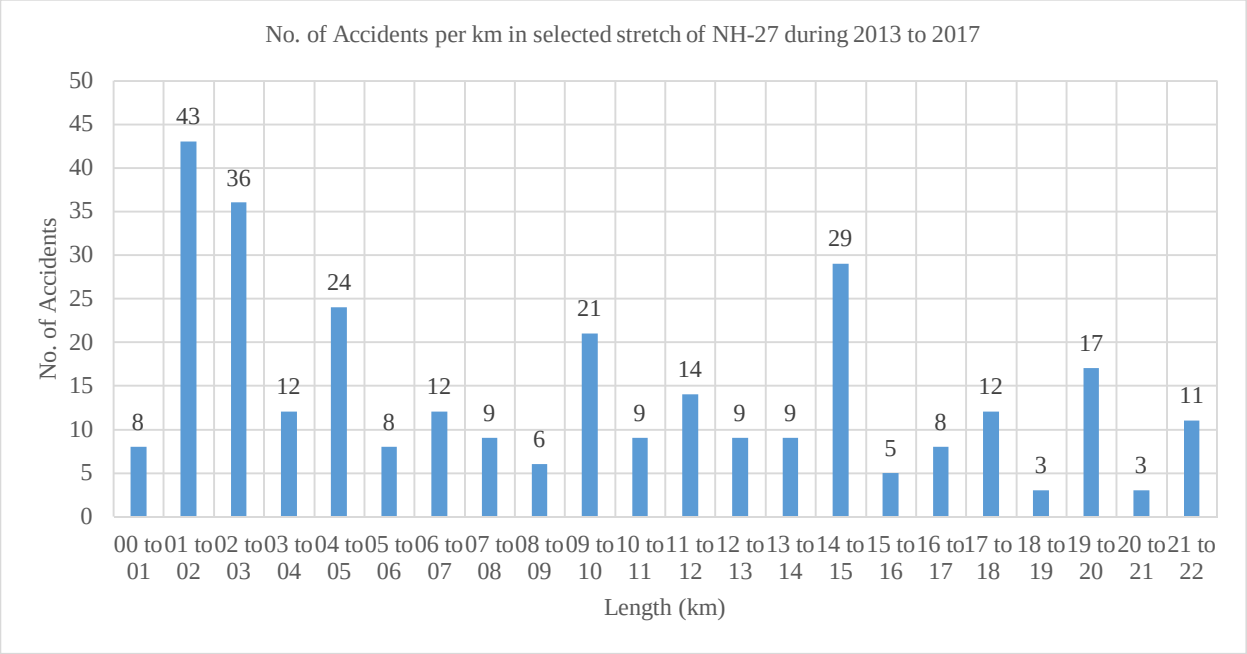

Figure 2. Number of accidents per km length in selected stretch of NH-27 during 2013 to 2017

From the figure number of accidents are more in 6 spots. The spot with high no. of accident is considered as the black spot. In this study stretch there are six black spots are seen, which are Navagam sub-urban area (01-02 km), Indian Oil Corporation Station (02-03 km), Near Maliyasan village (04-05 km), Rural area-Gunda diversion (09-10 km), Kuvadva GIDC (14-15 km), JK Hotel (19-20 km).

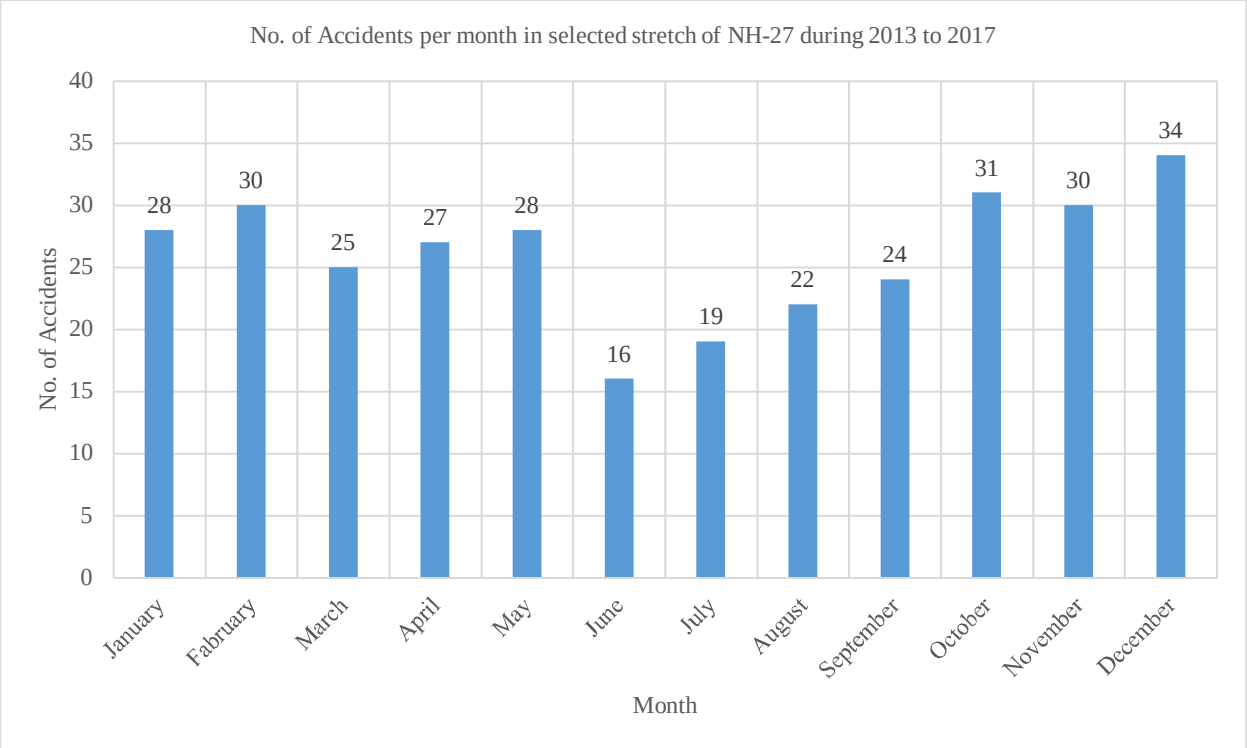

Figure 3. Number of accidents per month in selected stretch of NH-27 during 2013 to 2017

From the figure. the months in which number of accidents occurring more are: December, October, November and February. In other months also no more difference in number of accident except June, July and August.

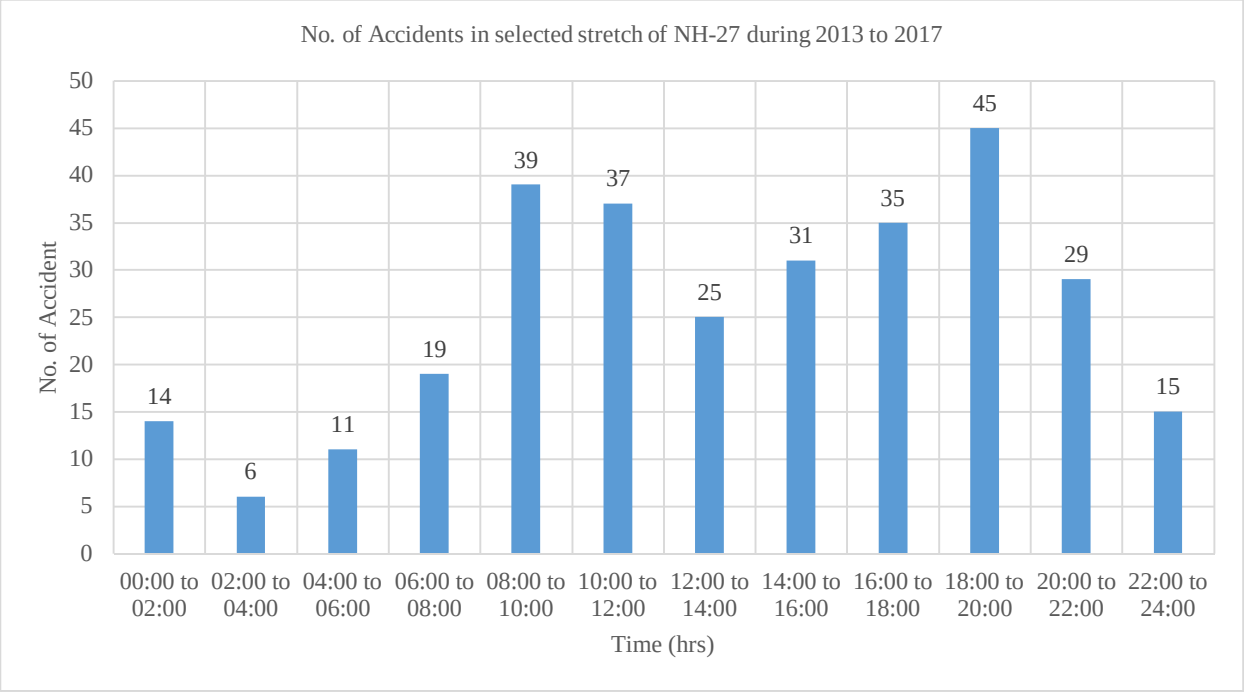

Figure 4. Number of accidents per 2-hour in a day in selected stretch of NH-27 during 2013 to 2017

From the figure, the accidents happened more during day time compare to night time. The reason for that is high traffic during day time. The accidents are more especially in morning peak hour and evening peak hour, when the worker and people living and working in Rajkot city and industrial area adjoining the study highway.

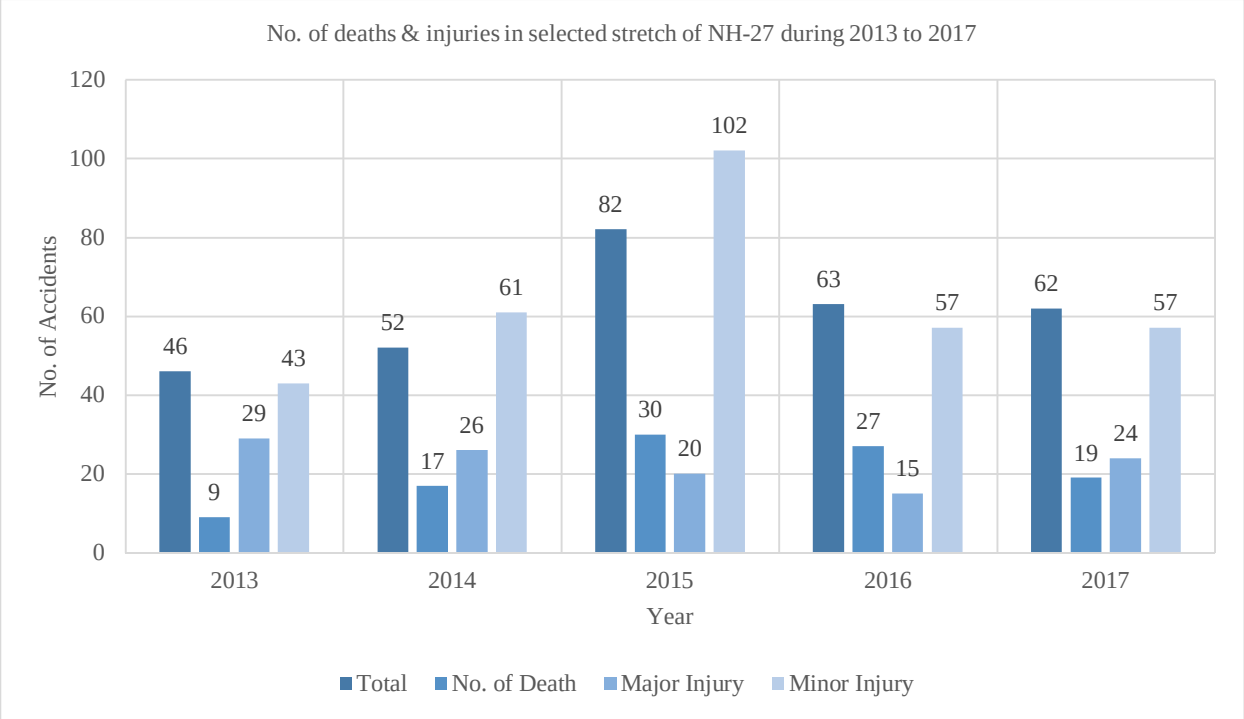

Figure 5. Number of accidents deaths & injuries in selected stretch of NH-27 during 2013 to 2017

From the figure, accidents were peak in year 2015, after that the number of accidents are decreasing. But deaths and major injuries are high. Which shows the requirements of the remedial measures to prevention of accidents.

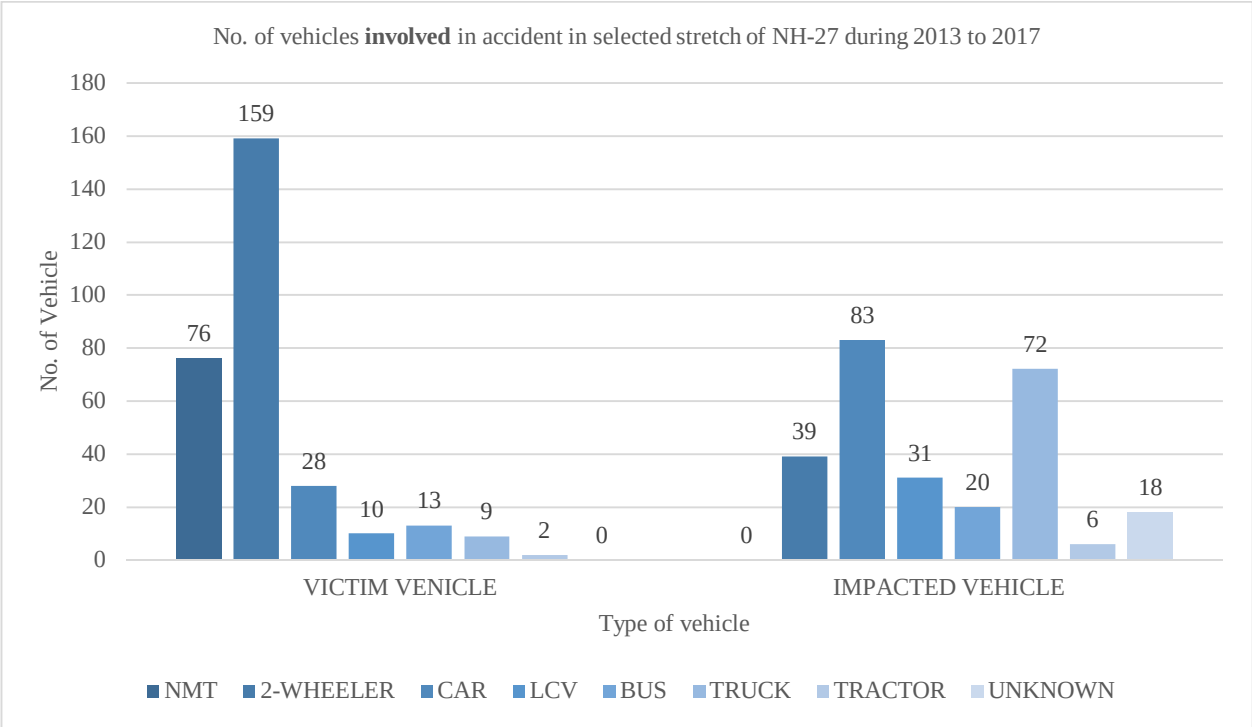

Figure 6. Number impacted vehicles & victim vehicle in selected stretch of NH-27 during 2013 to 2017

From the figure, it is seen that the victim vehicles are NMT (includes pedestrian) & Two Wheeler and impacted vehicles are Car, Truck & Two Wheeler. So the most vulnerable road user in study are NMT (includes pedestrian) & Two Wheeler.

D. Classified Volume Count

For determining traffic on selected corridor of NH-27, classified volume count is carried out. Classified volume counts were carried out for 24 hours-2 days basis by video-graphic method at Kuvadva (CH 197+700) the study stretch. The categories observed during the traffic survey are Multi-Axle Vehicle, Truck, Bus, Light Commercial Vehicle, Car, Three Wheeler, Two Wheeler, Non-Motorizes Traffic and Pedestrian. At the study stretch the amount of trucks and cars are more because this road is connects central Gujarat to Saurashtra and more number of goods are transport between this two segments. Also the Two-Wheeler traffic is high due to surrounding villages and industrial areas. It is clear that the study highway operates huge number of the vehicles. Due to this high traffic volume than the design capacity of the study highway, the level of service is also decreased to LOC D and in sub-urban area LOC F is observed. The highest category observed during the survey is Car and Two Wheeler. While converting in PCUs the highest category observed is Multi-Axle Vehicle and Car.

Table 5. Average daily traffic at kuvadva location (ch 197+700)

Type of Vehicle	ADT (veh/day)	PCU of Vehicle	ADT (PCU)
Multi-Axle Vehicle	4325	4.5	19462.5
Truck	3286	4	13144
Bus	2021	4	8084
Light Commercial Vehicle	4141	2.8	11594.8
Car	15241	1	15241
Three Wheeler	1918	1.6	3068.8
Two Wheeler	11237	0.5	5618.5
Non-Motorized Traffic	118	0.6	70.8
Pedestrian	775		0
Total	43062		76284.4

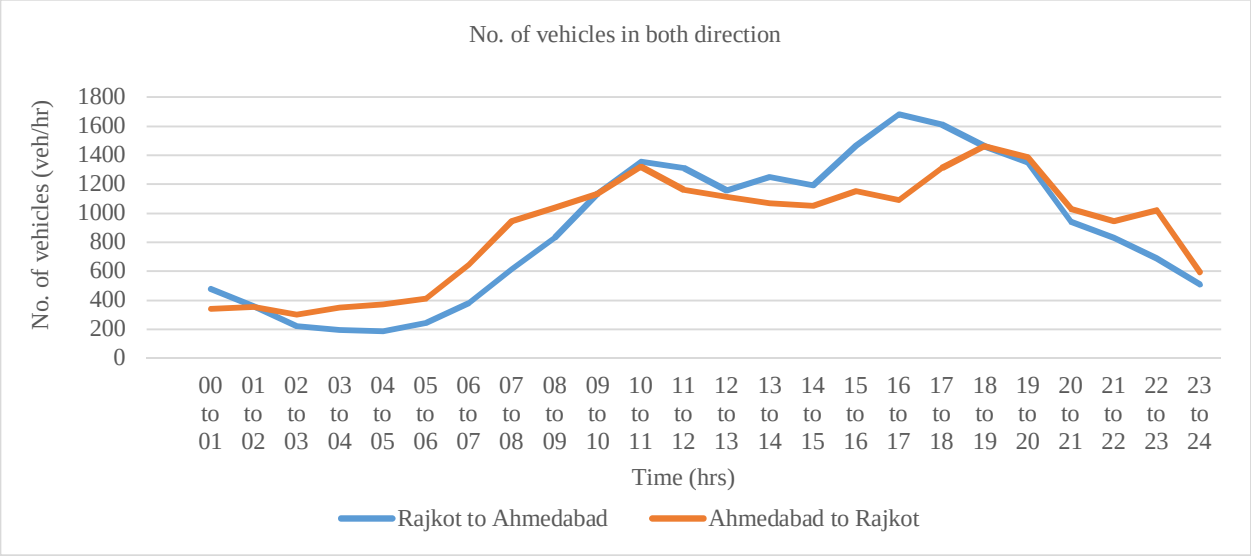

Figure 7. Number of vehicles per hour in both direction

E. Spot Speed Study

Spot Speed Study were carried out at five high accident prone locations on study stretch, Which are Navagam suburban area, near Maliyasan village, near Gunda village, near Kuvadva GIDC, near JK hotel. The survey was carried out by Radar gun. The objective of survey was to check speed of vehicle match geometric profile or not and found speed match with road profile. However, few vehicles were found over speeding. The details of spot speed study at different places are as shown in table

Table 6. Average speed of classified vehicles on different locations on the study highway

Location	Chainage (km+m)	Average Speed (kmph)						
		Multi-Axle Vehicle	Truck	Bus	Light Commercial Vehicle	Car	Three Wheeler	Two Wheeler
Navagam	186+500	49	51	54	51	56	38	52
Maliyasan	200+300	50	52	66	54	76	41	55
Gunda	195+000	50	52	66	55	78	41	55
Kuvadva GIDC	200+200	52	53	66	53	77	40	54
JK hotel	204+500	52	52	66	52	77	37	56

VI. CONCLUSION

A. The traffic is very high compare to the current design of the NH-27 and the level of service observed is LOC-D &LOC-F.

B. The Prevailing speed is matching with the design speed, but in the villages area along the study highway the speed is reduces. But it is still high than the speed limit into the villages which may cause the accident.

C. The safe overtaking opportunities are less during the peak hour of traffic, which results into the risky overtaking operations and may result into the accidents.

D. Road surface is in good condition due to recently overlay after last monsoon season. But due to overlay and high rain in monsoon season, the edge drop at the shoulder is high, some places it is about 25 to 30 cm. This may cause the unsafe road condition for the small vehicles like Two Wheeler, Auto etc.

E. The deficiency in road markings and signs are seen regularly on all the horizontal curves and diversions to the adjacent villages & industrial areas. At some curves the guide signs is provided on inner edge of the curve on median, where the signs are not visible due to plantation.

F. On the major bridges, minor bridges and culverts, the deficiency observed into the safety barriers. Gaps into the safety barrier, broken barrier and at some places safety barrier is not installed or it was theft. At some places where the height of embankment is high, safety barrier is not provided.

G. The poor pedestrian facilities observed on the roadway, guard rail is not provided on the bridges. In village areas the poor condition of the guard rail is observed. In sub-urban area and villages, the slow moving traffic have been observed. Which may cause into the accidents.

H. Many unauthorized median openings are observed on the fuel stations, hotels, industries. Where there is a chance of collision due to absence of markings and signs.

I. On all the junctions, poor signs and markings are observed. Unmaintained median opening and width, deficiency in signs & markings, Deficiency in channelizing islands, improper approach width etc.

J. At many places in sub-urban area, villages and other approaches, parking of the vehicles in observed. Which cause the visibility problems for the approaching vehicles and also reduced the effective lane width.

K. On bus & truck lay-bays, no signs and markings are observed. Some of them are on the horizontal curve, which may result into the blocking of the sight line of the driver.

VII. RECOMMENDATIONS

A. To serve the present traffic volume, the widening of the road is required.

B. On many curves, installation of delineators and guide signs is required. Where they installed, proper maintenance is required. The guide signs should be relocated to the outer edge of the curve from the median. The installation of guard rail is required.

C. On the bridges, the safety barrier should be maintained properly. The gap between rigid and flexible safety barrier should be closed. Where the height of embankment is more than 3m, safety barrier should be installed.

D. In sub-urban area and villages the separation of the slow moving traffic and fast moving traffic is needed. So provision of the service lane is required. The proper pedestrian facilities should be installed in sub-urban area and villages along the highway. Speed limit signs should be installed. Parking of vehicles on the roadway must be restricted and enough parking space should be provided.

E. Appropriate maintenance and installation of informatory signs on the all the median openings for the villages and industrial areas.

F. All the unauthorized medians must be closed.

G. On all the bus & truck lay-bays, installation of the proper signs and marking is required. Bus & truck bays on horizontal curve should be relocated on the straight road

H. Maintenance of the earthen shoulder is required. Places where the edge drop is more, it should be removed by filling of the earthen material.

I. On all the intersections & approaches; approach road width, stop markings, proper sight distance should be maintained. Parking of vehicles must be avoided and illegal constructed tea-stall should be removed.

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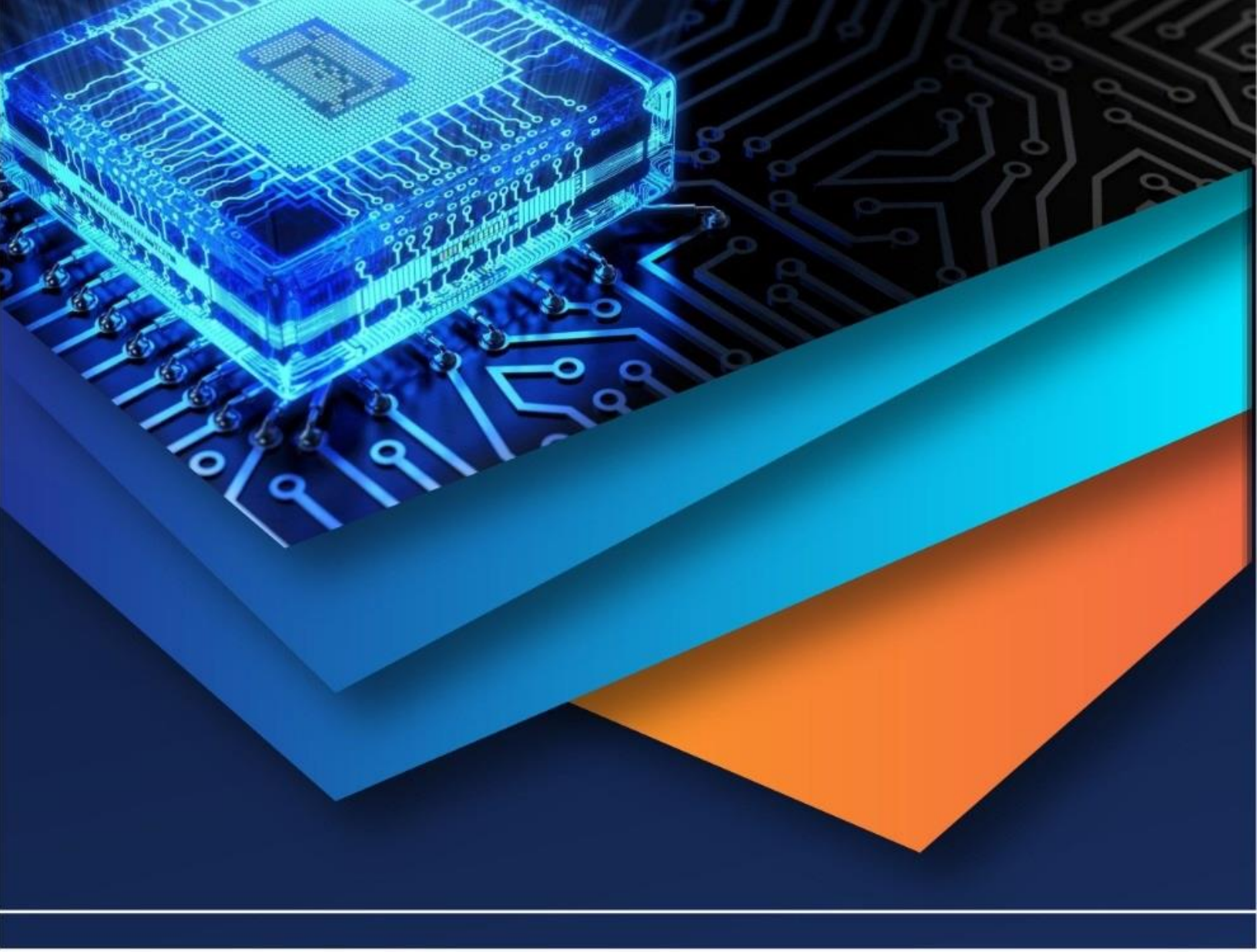

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