

# iRAP Baseline Data Collection in India

Final Report – Karnataka Phase

Submitted by:

**JP Research India Pvt. Ltd.**

583/1, 1st Floor, Sri Kumaran Salai,  
Civil Aerodrome Post, Avinashi Road,  
Coimbatore – 641014 Tamil Nadu, INDIA

Submitted to:

**International Road Assessment Programme (iRAP)**  
Worting House, Basingstoke Hampshire, RG23 8PX UK

30 March 2012

# iRAP Baseline Data Collection in India

## Final Report – Karnataka Phase

### *Table of contents*

ACKNOWLEDGEMENTS .....	2
INTRODUCTION .....	3
PROJECT OBJECTIVES .....	3
ROAD CORRIDORS .....	3
DATA REQUIRED .....	3
PROJECT TIMELINE .....	3
OBJECTIVE OF THIS REPORT.....	3
ABOUT JP RESEARCH INDIA .....	4
SH17: BASELINE DATA COLLECTION .....	5
THE STUDY AREA.....	6
TRAFFIC VOLUME AND SPEED DATA .....	6
POLICE DATA .....	13
ACCIDENT INVESTIGATION DATA .....	20
CONCLUSIONS .....	27
SH20: BASELINE DATA COLLECTION .....	32
THE STUDY AREA.....	33
TRAFFIC VOLUME AND SPEED DATA .....	33
POLICE DATA .....	43
ACCIDENT INVESTIGATION DATA .....	43
CONCLUSIONS .....	49
APPENDIX A: VEHICLE TYPE DEFINITIONS .....	52
APPENDIX B: POLICE DATA CODING FORMAT .....	54
APPENDIX C: CRASH CONFIGURATION TYPES .....	55

## Acknowledgements

We express our sincere thanks to Mr. B H Anil Kumar, IAS, Chief Project Officer; Mr. H. S. Prakash Kumar, KES, Project Director; Mrs K R Devika, Assistant Engineer; and all staff of the Karnataka State Highway Improvement Project-II (KSHIP-II) for all the valuable assistance during the project.

We also express our sincere thanks to Mr. N Achutha Rao, IPS, Director General and Inspector General of Police; Mr. Praveen Sood, IPS, Additional General of Police and Commissioner of Traffic and Road Safety; Mr. Kaushalendra Kumar, IPS, Superintendent of Police, Mandya District; Mr. Sandeep Patil, IPS, Superintendent of Police, Belgaum District; Mr. Abhishek Goyal, IPS, Superintendent of Police, Bagalkot District; Deputy Superintendents of Police of Mandya and Srirangapattana; and all officers of Karnataka State Police who offered their support.

And finally, we are grateful to Mr. Greg Smith, Regional Director; Mr. Luke Rogers, Senior Road Safety Engineer, International Road Assessment Programme (iRAP) – Asia Pacific; the World Bank for providing us this opportunity to conduct safety research and to provide greater insight into traffic safety issues on Indian roads. We also thank the Global Road Safety Facility (GRSF) and Bloomberg Philanthropies for supporting and funding this initiative to make India's roads safer.

## Introduction

The India Four States Project is an initiative of the Global Road Safety Facility (GRSF) funded with support from Bloomberg Philanthropies. The project includes iRAP road infrastructure risk assessments and preparation of investment plans for the 'Four States Network', as follows:

- Andhra Pradesh : 440km
- Assam : 970km
- Gujarat : 570km
- Karnataka : 1,800km

The Four States Project is being delivered in two phases. The first phase has been managed by the GRSF, which procured road inspections and coding (including coder training and supervision) according to iRAP specifications. The contract for these services was awarded to ARRB Group and their Indian partner company, Indian Road Survey and Management (IRSM).

The second phase of the project includes collection of supporting data and generation of iRAP Star Ratings and Safer Roads Investment Plan. This phase has been contracted to JP Research India Pvt. Ltd. (JPRI) for the states of Karnataka and Gujarat. The details of this project are as below:

## Project Objectives

The objective of this project is to collect data for selected road corridors that can be used by:

1. The World Bank to establish a baseline for monitoring of road safety performance.
2. iRAP in the generation of Star Ratings and Safer Roads Investment Plans.

## Road Corridors

This project focuses on the following four state highways:

- |         |                                 |          |
|---------|---------------------------------|----------|
| 1. SH17 | : Maddur to Mysore, Karnataka   | : 53 km  |
| 2. SH20 | : Belgaum to Hungund, Karnataka | : 171 km |
| 3. SH6  | : Dahej to Bharuch, Gujarat     | : 45 km  |
| 4. SH13 | : Ankleshwar to Valia, Gujarat  | : 30 km  |

## Data Required

1. The data required for each of the road corridors is:
  - a. Accident data and fatalities
  - b. Traffic speeds
  - c. Traffic volumes
2. The data is to be collected through primary research (in the field) and secondary research (liaison with local authorities).

## Project Timeline

The project duration including reporting is to be completed by 31 March 2012.

## Objective of this report

This report documents the Karnataka Phase of the project and includes the data collected, analysis, findings and conclusions of the following state highways

SH17 – Maddur to Mysore

SH20 – Belgaum to Hungund

## About JP Research India

JP Research India Pvt Ltd (JPRI) is a research firm involved in the business of automotive accident data collection and analysis since 2006. The company, a fully owned subsidiary of JP Research, Inc., is a forerunner in road safety research and has undertaken pioneering on-scene accident and in depth data collection projects aimed at scientifically understanding and mitigating road accident fatalities in India.

Accident research has proven to be the best way to understand the characteristics of real-world road traffic accidents. Countries such as the USA, UK, Germany and Japan have been able to use the results of such research to significantly reduce the number of road traffic fatalities in their countries. The fact that India has been losing more than 100,000 lives on road every year makes it imperative that we, too, conduct this kind of research to identify and then take swift steps to address the key factors influencing the high traffic injury and mortality rate in our country.

JPRI is experienced in using accident research methodologies developed in other nations and customizing these to suit India's unique traffic conditions. After conducting numerous studies and on-site accident research projects on Indian roads, JP Research India has developed its own India-specific accident data collection forms, a methodology for conducting site and vehicle accident investigations in the inimitable Indian traffic environment, and a searchable database of in-depth accident data. In addition, the company's experts offer training in all of these areas, for those who would prefer to perform their own data collection and analyses.

In other words, JPRI's overriding objective is to understand Indian roads, traffic and road users in ways that can be used to save lives - ours and yours.

### Contact:

JP RESEARCH INDIA PVT LTD  
583/1,1st Floor, Sri Kumaran Salai,  
Civil Aerodrome Post, Avinashi Road,  
Coimbatore 641 014 Tamil Nadu, INDIA  
Phone : +91-422-6065001  
E-Mail : reachus@jpresearchindia.com  
Website : www.jpresearchindia.com

## SH17: Baseline Data Collection



*Shown above is a picture of a section of the State Highway 17 (SH17) between Maddur and Srirangapattana. A typical gap-in-median is shown having a speed breaker (which looks like a pedestrian crossing). In addition, the picture also shows the presence of farm tractors on the road. A barricade being used to slow down traffic before the gap-in-median is also seen on the left. It tries to reduce speeds of vehicles by blocking the left lane.*

The following sections describe the area of study, data collected, findings and conclusions for the State Highway 17 (SH17) corridor from Maddur to Mysore.

### The Study Area

The study area, a 53 km stretch of SH17 connecting Maddur to Mysore, was selected based on instructions provided by iRAP for performing traffic volume, speed and accident data collection.

SH17 is a four lane divided road with a raised curb median (width 1.8 m) and no paved shoulders. It includes truck lay-by in both directions at some places. Study area selected is from Nidaghatta Dargah in Maddur to the Ring road-BM road junction of Mysore. Along the stretch, there are 3 towns (Maddur, Mandya and Srirangapattana) and many villages on either side of the road. This highway links Bangalore to Mysore and has many tourist attraction spots close to Mysore. Many tourists travel to these places from Bangalore and other cities. Hence the traffic on this road is mostly cars. There are motorized two wheelers which are mostly used by local people to ply short distances between or within the towns. Government buses (public transport) also ply on this highway carrying passengers to Mysore and many other tourist places.

### Traffic Volume and Speed Data

The following sections give details of the traffic volume and speed data collection for SH17.

### Spot Selection

The stretch was carefully studied to determine places where significant traffic was being added to the highway or being subtracted from it. These places usually include major towns or villages that draw frequent on/off traffic, either as destinations in themselves or as connections to some other place. Spots around these locations offer a good idea of the traffic volume for the whole stretch selected. It was found that most of the traffic is added or subtracted around towns and cities such as Maddur, Mandya and Srirangapattana. The study sites on SH17 have been identified by the Global Positioning System (GPS) coordinates and area type provided in Table 1, and they are shown graphically in Figures 1 and 2.

Sites	GPS Coordinates		Area Type	Posted Speed Limit (kmph)
A	12° 34' 43.88" N	77° 01' 36.48" E	Rural	30
B	12° 32' 12.85" N	76° 54' 56.40" E	Urban	30
C	12° 30' 32.31" N	76° 50' 25.00" E	Rural	30
D	12° 28' 43.31" N	76° 46' 04.62" E	Rural	30
E	12° 21' 57.56" N	76° 39' 42.38" E	Urban	30

Table 1: GPS Coordinates, area type and posted speed limit of the five study sites on SH17



Figure 1: Screen shot from Google Earth, showing the study sites (Sites A, B, C, D and E)



Site A  
(Maddur)



Site B  
(Near Mandya Entrance)



Site C  
(Sundahalli)



Site D  
(Kodishettypura)



Site E  
(Siddalingapura)

Figure 2: Photos of the study sites on SH17 (Sites A, B, C, D and E)

## Data Sample Collected

Data collection for traffic volume count and speeds was as per the guidelines laid down by iRAP. Please refer to the “iRAP Baseline Data Collection in India – Inception Report” published by JPRI on November 1, 2011.

The data sample collected for traffic volume count and speed on all sites of SH17 at 4 time durations (06:01 to 12:00, 12:01 to 18:00, 18:01 to 24:00 and 00:01 to 06:00) is shown below:

- 5 locations were monitored (Sites A, B, C, D and E).
- 11983 vehicles were counted during four time durations.
- 7461 speeding incidents were recorded.
- 1424 minutes of data was collected.

The status of data collection (speed and traffic volume) at all study sites at different time durations are shown in Table 2.

Study Sites	06:01 to 12:00 hrs	12:01 to 18:00 hrs	18:00 to 24:00 hrs	00:01 to 06:00 hrs
Site A	Data collected	Data collected	Speed Data not collected	Speed Data not collected
Site B	Data collected	Data collected	Speed Data not collected	Speed Data not collected
Site C	Data collected	Data collected	Speed Data not collected	Speed Data not collected
Site D	Data collected	Data collected	Speed Data not collected	Speed Data not collected
Site E	Data collected	Data collected	Speed Data not collected	Speed Data not collected

Table 2: Status of speed and traffic volume data collected at different study sites on SH17

Traffic volume data was collected for all time durations. Speed data could not be collected during the night time durations (18:01 - 24:00 hrs) and (00:01 - 06:00 hrs) due to safety concerns and due to practical problems faced in data collection. Glaring headlamps of vehicles during night hours often blinded researchers, making it difficult to record speeds of oncoming vehicles and to identify vehicle type. These issues were communicated to iRAP and researchers were advised not to collect speed data for these time durations due to safety concerns. *Based on the lower traffic volume, and the low number/type of accidents examined during night hours [see next section], speed data at night time durations is considered to be of less significance than during the daylight duration.*

## Traffic Volume Count

To standardize the observed time for comparison, JPRI normalized the count in a given site for a given 6 hours' time duration to a one hour sample. This was done by using the following formula.

$$\text{Number of vehicles passing in one hour at one site} = \frac{\text{Number of vehicles counted in time } (t, \text{ in minutes}) * 60 \text{ minutes}}{(t, \text{ in minutes})}$$

This one hour sample was then extrapolated to the specific 6 hours' time duration. The end results were then added to get an estimation of the number of vehicles passing through a given site in 24 hours. Based on the above calculation, the new total vehicle count obtained for SH17 is **120,276** and the total vehicle count at each site is as show below in Figure 3.

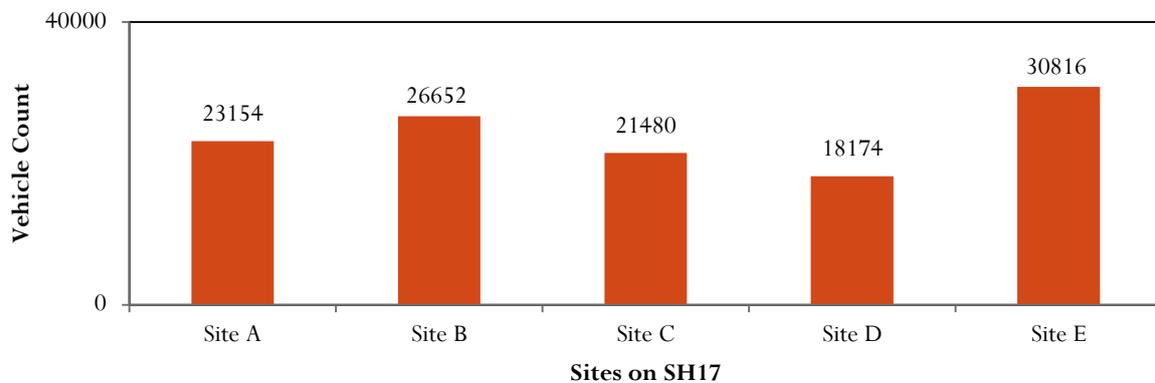


Figure 3: Traffic volume count at each site on SH17 estimated for 24 hours

The 24 hour data sample for traffic volume count was distributed by vehicle type and the result is as shown in Figure 4. *The definition for each vehicle type is provided in Appendix A.*

Figure 4 indicates that cars (35%) constituted the highest road user type counted on the SH17. This was followed by motorized two wheelers (32%) and trucks (18%). Buses, other motor vehicles, pedestrians, bicyclists and non-motorized vehicles together accounted for 15% of the total traffic volume.

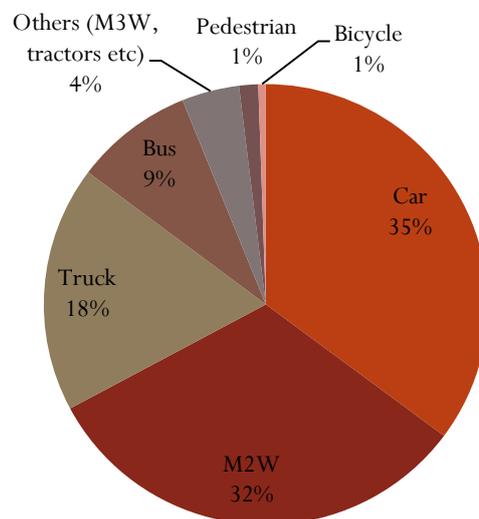


Figure 4: Percentage composition of road users counted on SH17  
(Sample Size: 120,276 vehicles counted at all sites during the four time durations)

It is important to note that:

1. Cars, motorized two-wheelers and trucks, form 85% of the vehicles on SH17.
2. Although trucks form the third highest vehicle type, they account only for 18% of the vehicles on SH17.

### Traffic volume percentage counts for each time duration

Traffic volume counts were taken at different durations of the day (the four time durations) at each of the five study sites (A, B, C, D and E). The traffic volume composition, for each time duration is as shown in Figure 5.

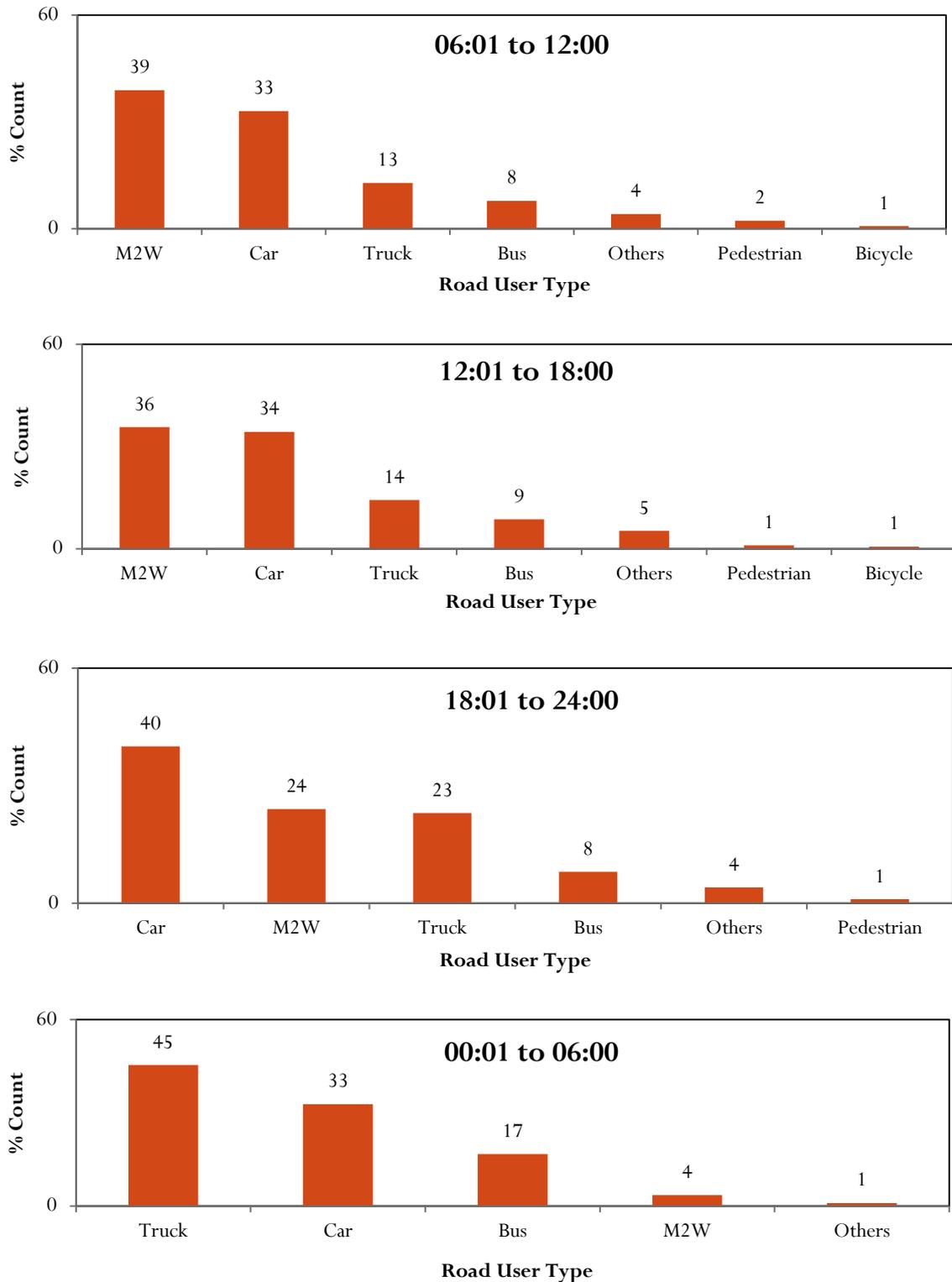


Figure 5: Traffic volume percentage distribution by vehicle type for the four time durations on SH17

The resulting data provides an estimate of the volume and types of vehicles seen on weekdays on the study stretch for each of the time durations. During daylight hours (06:01 to 18:00 hrs), motorized two wheelers were the most common vehicles seen on the road, followed by cars, trucks and buses. However, during the evening hours (18:01 to 24:00 hrs), cars formed the highest road user type an increase was seen in the number of cars, followed by motorized two wheelers and trucks. Traffic volume was lowest during the night hours (00:01 to 06:00 hrs), when trucks were the principal road users, followed by cars and buses.

### 85<sup>th</sup> Percentile Speeds

The “85<sup>th</sup> percentile speed” is the speed at or below which 85% of the vehicles were found to travel. This measure is different from the “average” speed. By omitting speed variations possibly caused by very few vehicles that travelled at high speeds (variations that would necessarily be included if a simple average was calculated), the 85<sup>th</sup> percentile reflects the speed at which most vehicles travel on a given stretch of road. The overall 85<sup>th</sup> percentile speed for each vehicle type (averaged across all five sites) is shown in Figure 6.

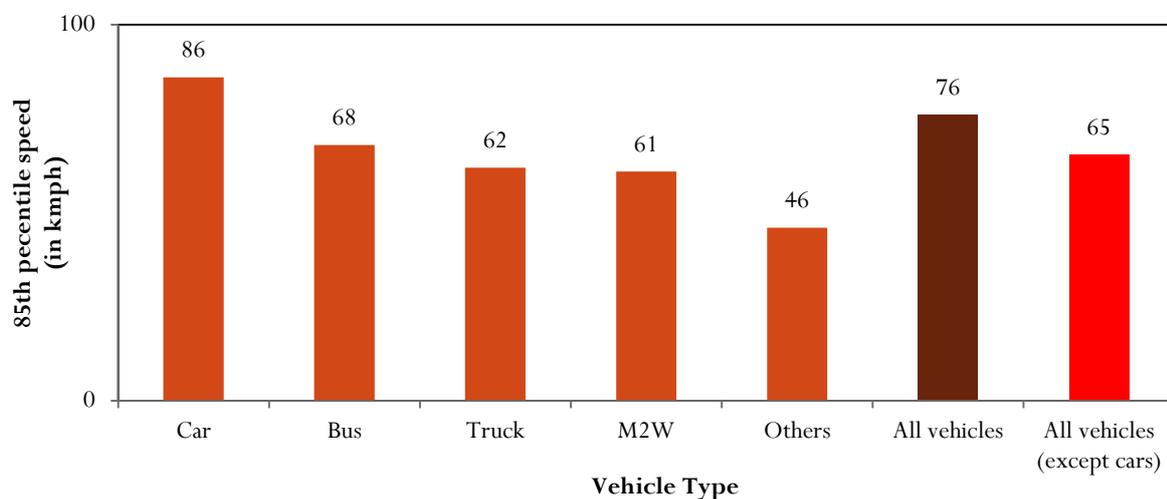


Figure 6: Average “85<sup>th</sup> Percentile Speed” of each road user type in all study sites on SH17

It can be seen from Figure 6 that cars were found to be travelling the fastest with 85<sup>th</sup> percentile speed of 86 kmph. Cars were followed by buses and trucks at 68 kmph and 62 kmph respectively. The 85<sup>th</sup> percentile speed of all vehicles was calculated as 76 kmph. But when cars were excluded in the calculation, 85<sup>th</sup> percentile speed of all vehicles was 65 kmph. Speed limit posts are mostly absent on these highways and the available posted speed limits of 30 kmph were far lesser than the actual speed measured.

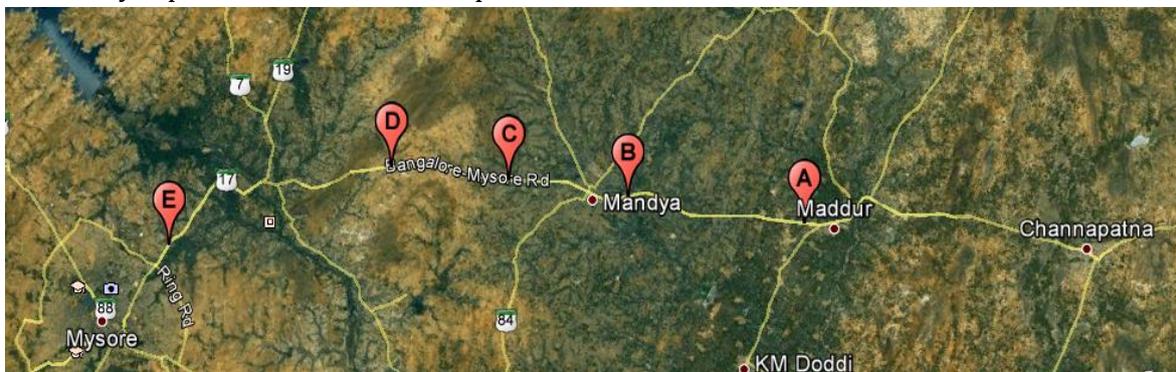
### Findings and Observations

The following are the findings and observations of the speed and traffic volume count study on SH17:

- Cars and motorized two wheelers constitute the highest volume of road users on the stretch.
- Motorized two wheelers and cars together constitute the highest number of road users in three out of the four time durations studied at all five sites.

- Trucks constitute the third highest road user on SH17 but account for only 18% of the road users.
- During the time duration (00:01 to 06:00 hrs), when traffic volume is very less, trucks were the highest road users.
- It was observed that farm tractors constituted 4% of the traffic volume.
- Cars had the highest 85<sup>th</sup> percentile speed of 86 kmph, which is 10 kmph higher than the 85<sup>th</sup> percentile speed of all vehicles (76 kmph).
- The 85<sup>th</sup> percentile speed for “all vehicles excluding cars” was calculated as 65kmph indicating a major influence of car speeds on SH17.

A summary is provided below for the speed and traffic volume data for each site.



### Traffic Speed

SITE E	SITE D	SITE C	SITE B	SITE A
M2W – 55 kmph	M2W – 67 kmph	M2W – 62 kmph	M2W – 60 kmph	M2W – 61kmph
Car – 72 kmph	Car – 99 kmph	Car – 92 kmph	Car – 80 kmph	Car – 87 kmph
Bus – 59 kmph	Bus – 68 kmph	Bus – 69 kmph	Bus – 68 kmph	Bus – 69 kmph
Truck – 57 kmph	Truck – 74 kmph	Truck – 61 kmph	Truck – 61 kmph	Truck – 62 kmph
Others – 43 kmph	Others – 48 kmph	Others – 46 kmph	Others – 46 kmph	Others – 46 kmph
All vehicles – 65 kmph	All vehicles – 87 kmph	All vehicles – 81 kmph	All vehicles – 71 kmph	All vehicles – 77 kmph

### Traffic Volume Count

SITE E	SITE D	SITE C	SITE B	SITE A
M2W - 35%	M2W - 24%	M2W - 28%	M2W - 39%	M2W - 31%
Car - 32%	Car - 40%	Car - 37%	Car - 34%	Car - 34%
Truck - 16%	Truck - 24%	Truck - 20%	Truck - 14%	Truck - 21%
Bus - 7%	Bus - 9%	Bus - 12%	Bus - 7%	Bus - 9%
Others - 5%	Others - 3%	Others - 3%	Others - 4%	Others - 5%
Pedestrian - 4%			Pedestrian - 1%	
Bicycle - 1%			Bicycle - 1%	
Total count – 30816	Total count – 18174	Total count – 21480	Total count – 26652	Total count – 23154

## Police Data

Police reported accident data was collected from the four police stations whose jurisdiction includes the study area. The status of police data collection for each of the four police stations for SH17 is as shown below in Table 3.

Police Station	2009	2010	2011
Maddur Traffic Police Station	Data Not Collected	Data Collected (from Sep '10)	Data Collected
Mandya Rural Police Station	Data Not Collected	Data Collected	Data Collected
Mandya Traffic Police Station	Data Not Collected	Data Not Collected	Data Collected
Srirangapattana Police Station	Data Collected	Data Collected	Data Not Collected

Table 3: Status of police reported accident data from all police stations on SH17

JPRI has managed to collect data on 1090 police reported accidents in two (2) years from three police stations, namely, Maddur Traffic, Mandya Rural, and Srirangapattana. In case of Maddur Traffic data was available only from September 2010. In case of Mandya Traffic only 2011 data was obtained for 74 accidents. This was also included for analysis, and hence a total of 1164 accidents were finalized. The data was obtained in a format prepared by the respective police stations. JPRI researchers prefer to collect and code data in a standard format which is easier to analyze, but in case of SH17 accidents, JPRI researchers had to compile all the accident data from the police stations, understand and clean up the formats and interpretations and finally prepare the dataset which can allow for some preliminary analysis. *The variables used for compiling the dataset and analysis have been provided in Appendix B.*

## General Overview of Police Data

A total of 1164 police reported accidents on SH17 were obtained and the analysis is presented below.

## Injury Severity

Highest injury severity of an accident in the police record was confirmed by researchers by looking at the Section of Indian Penal Code (IPC) under which the case was booked. The IPC sections for road traffic accidents and their interpretations for highest injury severity of the road traffic accidents are explained in Table 4.

INDIAN PENAL CODE SECTION	DEFINITION	HIGHEST INJURY SEVERITY OF THE ACCIDENT
IPC 304(A)	Causing death by negligence	Fatal/Killed
IPC 338	Causing grievous hurt by act endangering life or personal safety of others	Hospitalized/Grievous
IPC 337	Causing hurt by act endangering life or personal safety of others	Minor Injury
IPC 279	Rash driving or riding on a public way	No Injury

Table 4: Sections of Indian Penal Code (IPC) relating to road traffic accidents and their interpretation for injury severity

A total of 1164 accidents resulted in 249 fatal victims and 1273 injured victims. The accidents were divided based on the highest injury severity for each road accident. The result can be seen as shown in Figure 7. Out of the 1164 crashes 14% had at least one fatality. There were 249 road users who were fatal (202 male and 47 female), and 1273 road users were injured (986 male and 287 female). The results show very less cases involving hospitalization (4%), while the number of minor injury cases (61%) is very high and questionable.

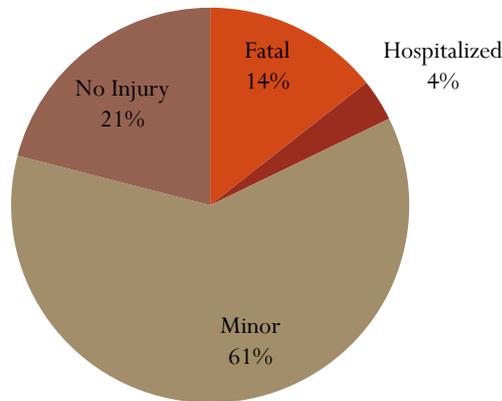


Figure 7: Road accidents on SH17 distributed by highest injury severity (Number of accidents - 1164)

### Road Users Involved

As shown in Figure 8, cars (33%) constitute the highest number of road users involved in accidents on SH17. They were followed by motorized two wheelers (23%) and trucks (15%). Pedestrians were involved in 13% of the accidents on SH17. Road user type was unknown for 3% of the vehicles.

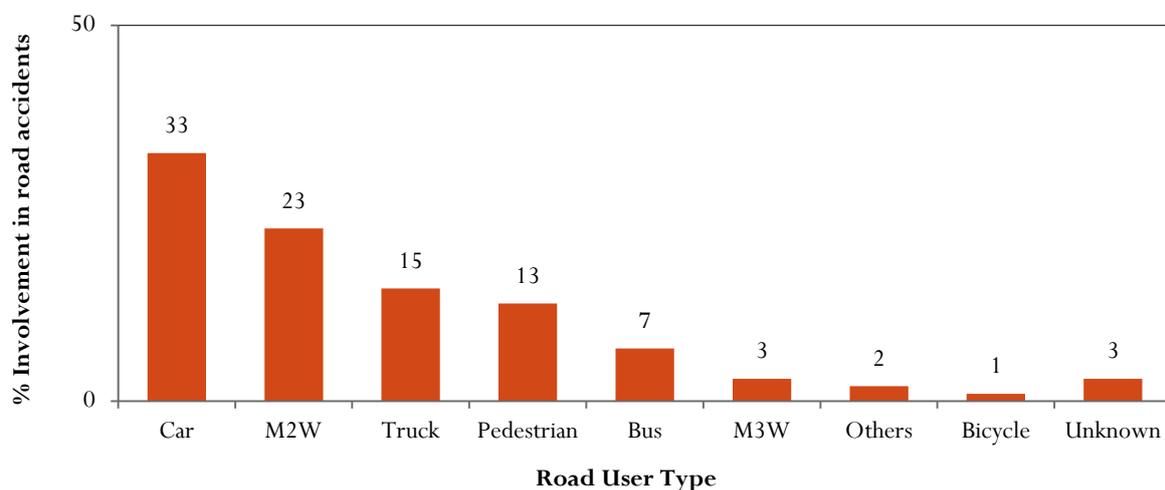


Figure 8: Percentage distribution of road user types involved in road accidents on SH17

### Killed/Seriously Injured Road Users

As shown in Figure 9, pedestrians (43%) were the most vulnerable road users involved in fatal or grievous accidents, followed by motorized two wheelers (39%). Although cars are the third highest road user types, they account for only 8% of the road users killed or seriously injured.

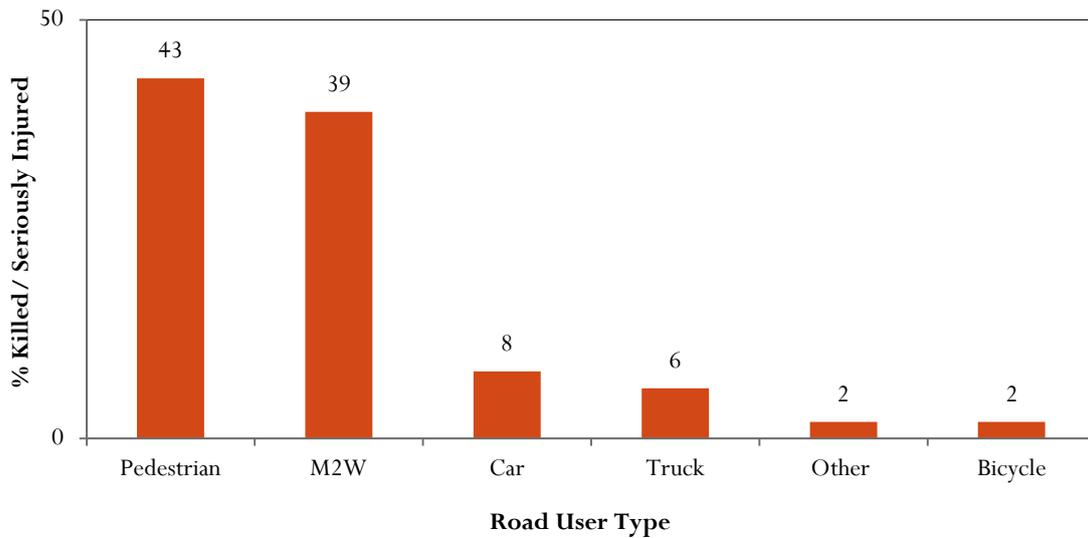


Figure 9: Percentage distribution of road user type killed or seriously injured on SH17

Motorised two wheelers and pedestrians account for only 36% of the road users involved in a road accident, but constitute 82% of the killed or seriously injured road users. Hence they can be considered as the most vulnerable road users on SH17. Cars are involved in 32% of road accidents but they constitute only 8% of the killed or seriously injured road users.

### Crash Configuration

The 1164 accidents were distributed as per the crash configurations and results were plotted as shown below in Figure 10. *The definitions for the various types of crash configurations are provided in Appendix C.*

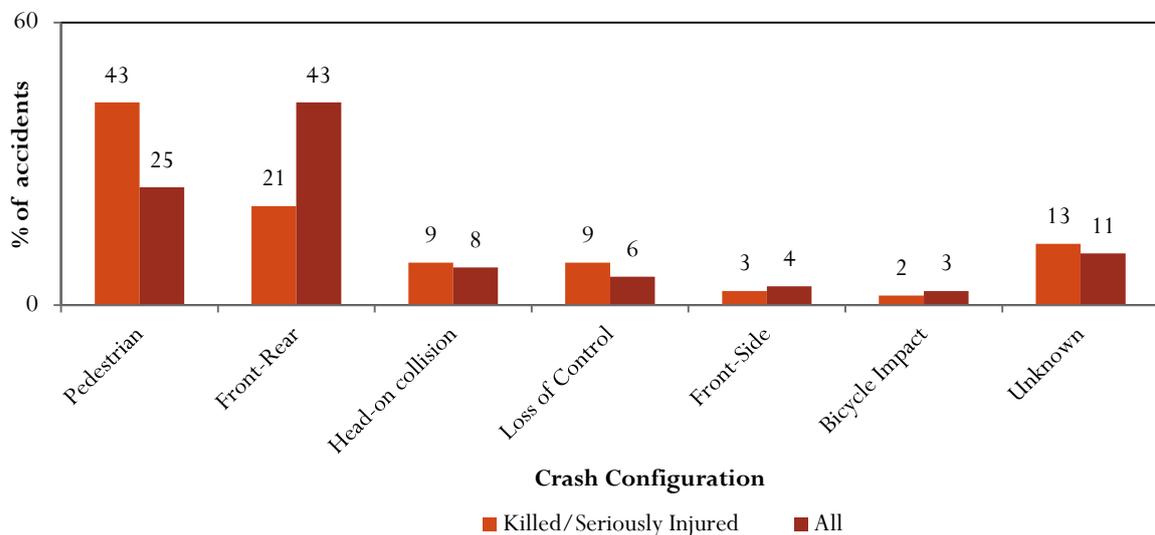


Figure 10: Percentage of accidents by crash configuration and injury severity

Pedestrian impacts (43%) constitute highest number of accidents involving killed or seriously injured victims followed by front-rear collision (21%), head-on collisions (9%) and loss-of-control (9%) on SH17. These four accident configurations also constitute 82% of the total accidents. Unknown crash configurations could not be clearly identified by researchers as most of these cases were coded as “type of collision – other” by police.

Based on the above details the following are the important points:

1. There is a high involvement of cars in road accidents followed by motorized two wheelers and trucks on SH17.
2. Motorized two wheelers and pedestrians are the major affected road user types followed by cars.
3. Pedestrian impacts, front-rear collisions, head-on collisions and loss of control are the major types of road accidents occurring on the SH17.

### In-Depth Analysis of Police Data

The four major crash configurations are analyzed in detail below. Although the pre-crash event could not be identified from the police reports, due to limited data on the accidents, the below sections try to understand the type of vehicles involved in each crash type.

#### Front-Rear Collisions (503 Out Of 1164, 43%)

The 503 front-rear collisions were distributed as per the vehicle type affected in the accident and their respective injury severity. The results were plotted as shown below in Figure 11.

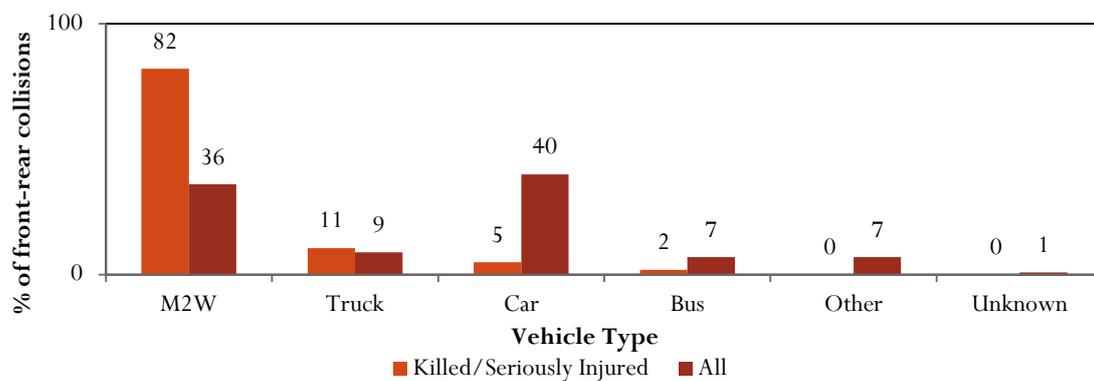


Figure 11: Percentage distribution of road user types sustaining injuries in front-rear collisions by injury severity on SH17

As can be seen in Figure 11, motorized two wheelers (82%) are the most affected road user types in front-rear collisions followed by trucks (11%). Cars have a very high involvement in front-rear collisions but have very low representation in killed or seriously injured front-rear collisions. Next, the collision partners who were not as severely affected were distributed based on the injury severity of the accident. Below is the result as shown in Figure 12.

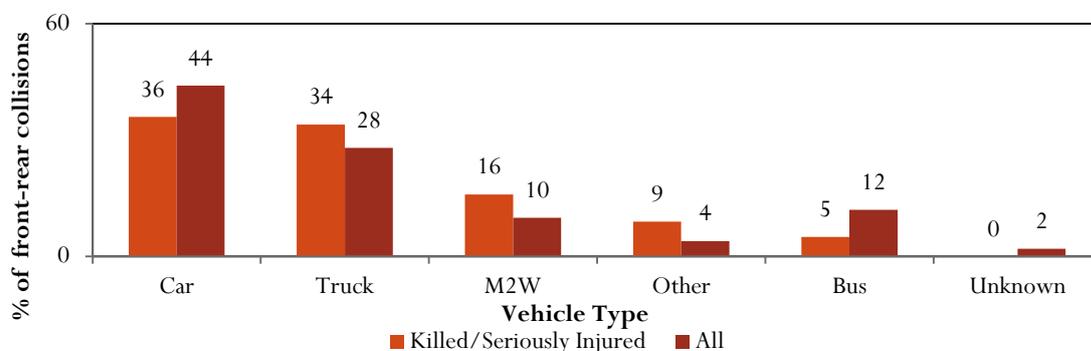


Figure 12: Distribution of road user types involved in front-rear collisions by injury severity of the collision partner

Figure 12 indicates that cars (44%) again have a high involvement in front-rear collisions, followed by trucks (28%) and motorized two wheelers (10%). It is also noted that 70% of the killed or seriously injured front-rear collisions are caused by cars and trucks.

**Road User Analysis:**

Road user type mostly involved in front-rear collisions: Cars, trucks and motorized two wheelers

Road user type mostly affected in front-rear collisions: Motorized two wheelers

This indicates that front-rear collisions on SH17 need to be examined in detail as they involve all the major vehicle types on this road but seriously affect motorized two wheelers the most.

**Pedestrian Impacts (296 Out Of 1164, 25%)**

The 296 pedestrian accidents were distributed as per the struck vehicle type and the resulting injury severity of the pedestrian. The results were plotted as shown below in Figure 13.

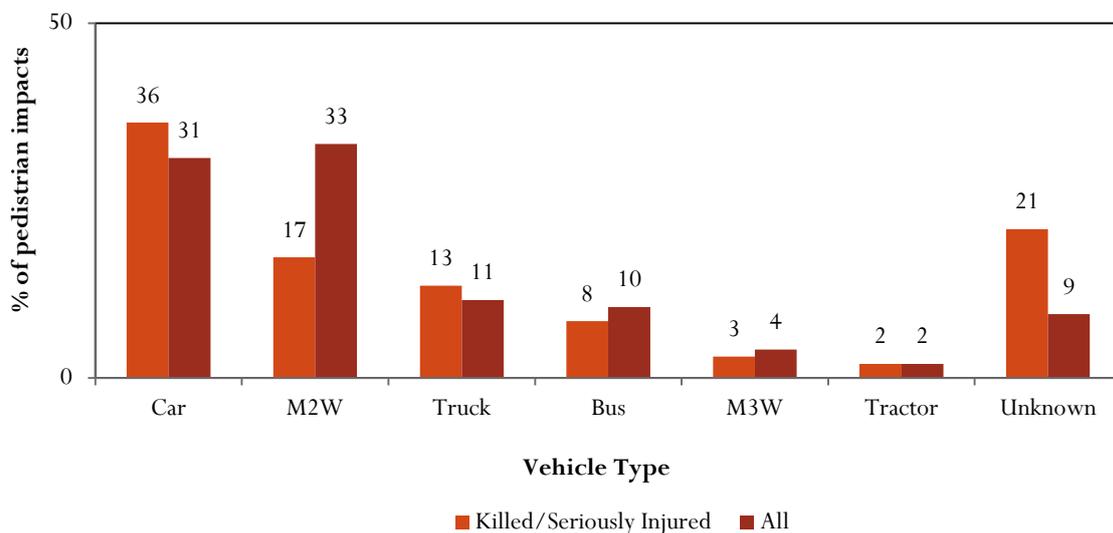


Figure 13: Percentage distribution of vehicles involved in pedestrian impacts by struck vehicle type and the resulting injury severity of the pedestrian on SH17

As shown in the Figure 13, highest percentages of involvement in pedestrian impacts leading to death or serious injuries are caused due to cars (36%) followed by motorized two wheelers (17%), and trucks (11%). It is interesting to note that cars and motorized two wheelers together constitute 64% vehicles involved in all pedestrian impacts. Vehicle type was not available for 27 accidents in police records, which are probably hit and run cases.

**Road User Analysis**

Road user type mostly involved in pedestrian impacts: Cars and motorized two wheelers

Road user type mostly affected in pedestrian impacts: Pedestrians

Pedestrian accidents involving cars are seen to be more serious and this indicates the problem with speeds of cars on SH17. Motorized two wheelers are the highest vehicle types involved in all pedestrian accidents. This needs to be examined in detail.

### Head-On Collisions (96 out of 1164, 8%)

The 96 head-on collisions were distributed as per the vehicle type and their respective injury severity where the occupants were killed or were seriously injured. The results were plotted as shown below in Figure 14.

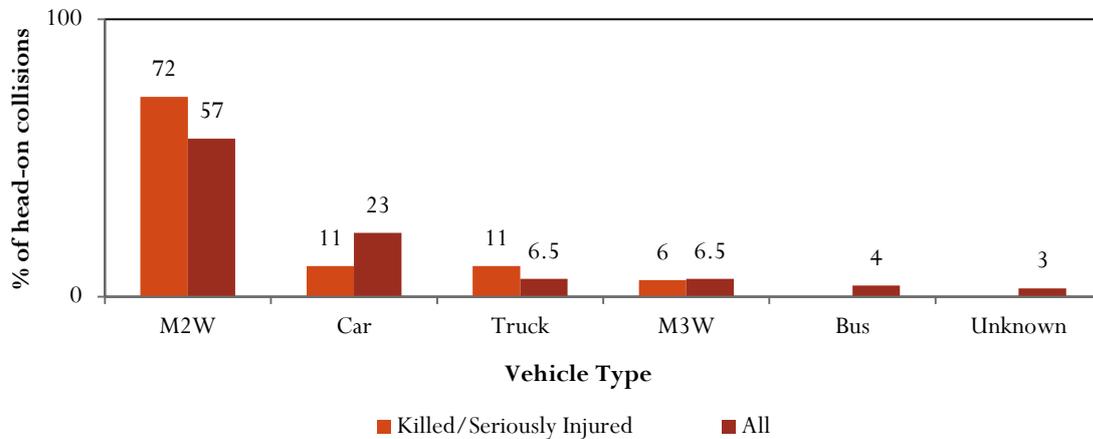


Figure14: Percentage distribution of vehicle types affected in head-on collisions by injury severity on SH17

As shown in the Figure 14, highest percentages of killed or seriously injured head-on collisions involved motorized two wheelers (72%). Cars and trucks constitute the second highest vehicle types, but each account only for 11% of killed or seriously injured head-on collisions.

Next, the collision partners who were not as severely affected were distributed based on the injury severity of the accident. Below is the result as shown in Figure 15.

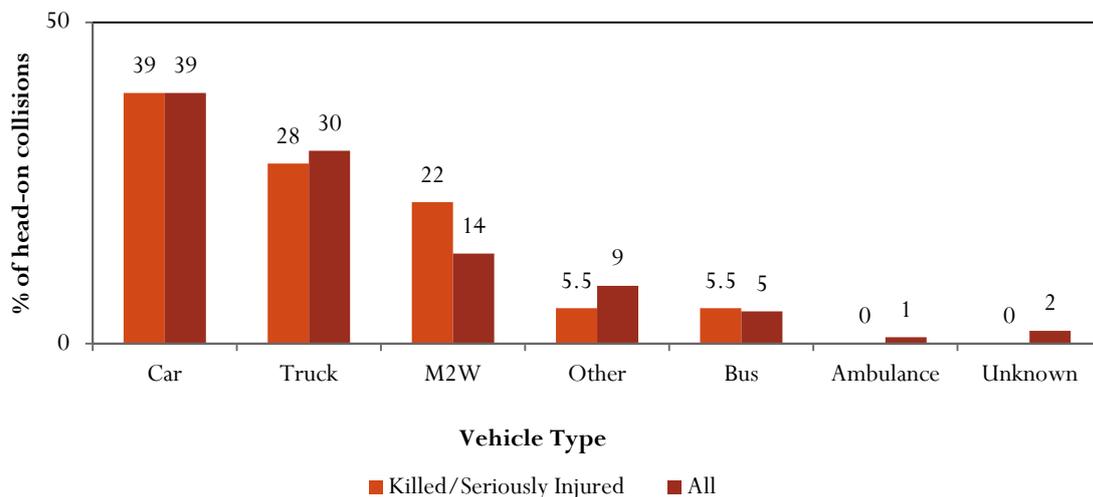


Figure 15: Percentage distribution of vehicle types involved in head-on collisions that caused injuries to the collision partner, by injury severity on SH17

Figure 15 indicates that cars (39%) have a high involvement in head-on collisions, followed by trucks (30%) and motorized two wheelers (14%). It is also noted that 89% of the killed or seriously injured head-on collisions are caused by cars, trucks and motorized two wheelers.

### Road User Analysis

Road user type mostly involved in head-on collisions: Cars, trucks and motorized two wheelers  
Road user type mostly affected in head-on collisions: Motorized two wheelers

This is similar to front-rear collisions, although it is far less in number. But considering that SH17 is a divided 4-lane highway, the reasons for head-on collisions on this divided highway need to be examined.

### Loss of Control (64 out of 1164, 6%)

JPRI researchers found that all single-vehicle accidents are coded as loss of control accidents by the police. It could not be ascertained if the vehicle involved in a rollover, departed from the roadway, etc. The 64 accidents involving loss of control were distributed based on vehicle type. The results obtained are as shown below in Figure 16.

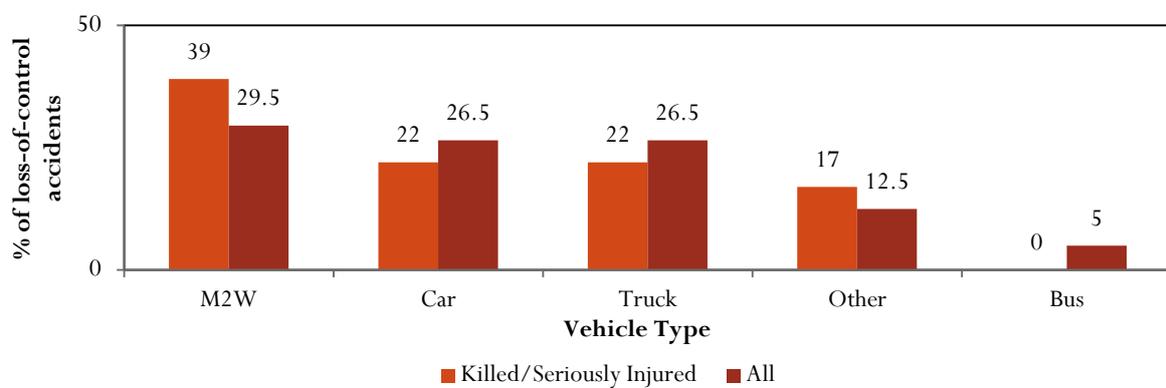


Figure 16: Distribution of road user types involved in loss of control accidents by injury severity

It can be seen that motorized two wheelers, cars and trucks are the highest involved vehicles in loss of control accidents. Motorized two wheelers (39%) constitute the highest road user type involved in loss of control accidents resulting in killed/seriously injured victims.

### Road User Analysis

Road user type mostly involved in loss of control accidents: Motorized two wheelers, cars and trucks.

Road user type mostly affected in loss of control accidents: Motorized two wheelers, cars and trucks.

### Summary of Police Data Analysis

Based on the above data analysis, the important findings are listed below:

1. Front-rear collisions are the highest in occurrence on SH17.
2. Pedestrian impacts are the second highest in occurrence but highest when compared to other crash types in terms of injury severity.
3. Head-on collisions are the third highest followed by loss of control accidents.
4. It is noted that in all the crash types, cars, motorized two wheelers and trucks are highly involved while motorized two wheelers and pedestrians are the most affected road user types with high injury severity.

*JPRI then analyzed the on-site accident investigation data to get a better understanding of the infrastructure problems causing the above.*

### Accident Investigation Data

With the support of iRAP, the Karnataka State Highways Improvement Project - II (KSHIP-II), and the Karnataka State Police, the JPR India team performed detailed investigations of accidents that occurred along the stretch of SH17 defined as the study area. In-depth data was collected for all accidents occurring in the study area from 17 October 2011 to 30 November 2011. During this period, 23 accidents were examined.

### General Overview of Accident Investigation Data

#### Injury Severity

A total of 23 traffic accidents were examined on the study area of SH17 over a period of 45 days. These crashes involved a total of 9 fatalities and 17 grievously injured victims. As shown in Figure 17, 57% of the crashes examined resulted in fatality or hospitalization.

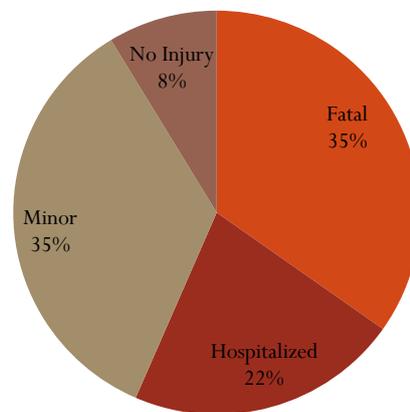


Figure 17: Percentage distribution of accidents examined by highest injury severity

#### Road Users Involved

The percentages of the road users involved road accidents examined on SH17 are shown in Figure 18 below. Cars (35%) formed the majority of the accident-involved vehicles, followed by motorized two wheelers (23%) and trucks (16%). These findings complement those of the volume count, which showed cars, motorized two-wheelers and trucks to be the top three road users on the SH17.

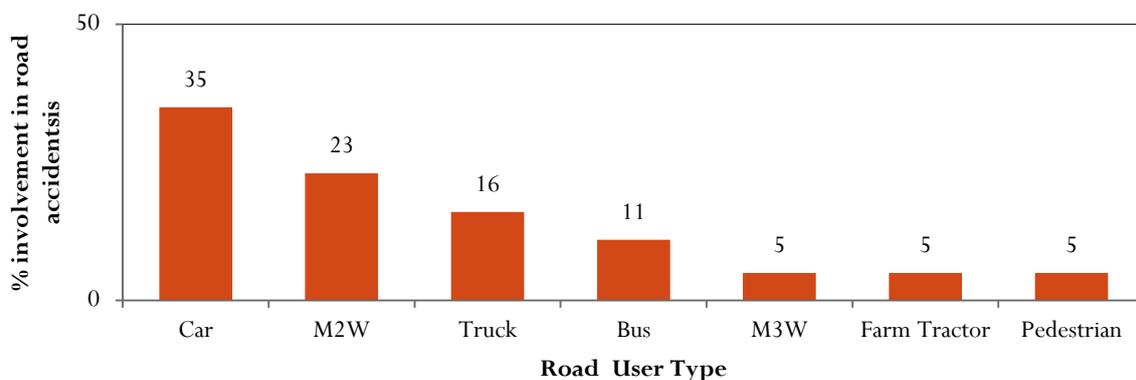


Figure 18: Percentage involvement of road user types in the accidents examined on SH17

## Killed/Seriously Injured Road Users

The distribution of road user types killed or seriously injured is shown in Figure 19.

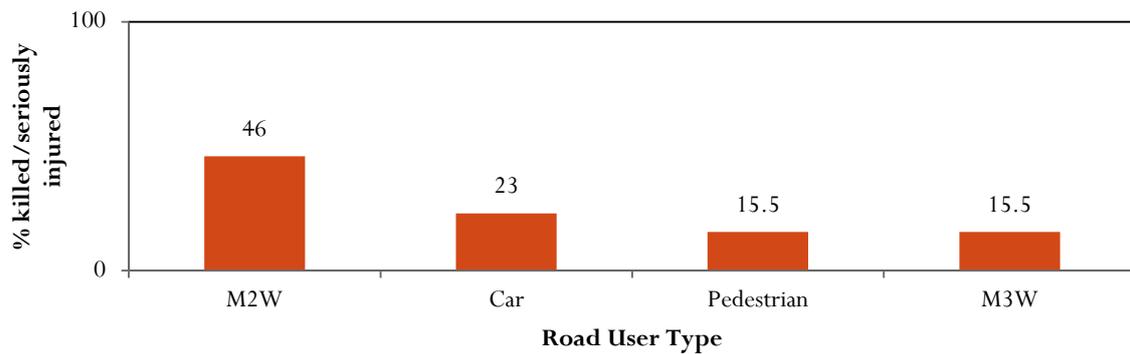


Figure 19: Percentage distribution of road user types killed or seriously injured in accidents examined on SH17

Analysis shows that motorized two wheelers (46%) are the highest affected road user in accidents examined on SH17. Cars (23%) form the second highest road user type followed by pedestrians (15.5%) and motorized three wheelers (15.5%).

## Crash Configuration

Analysing the first crash configuration of all 23 crashes examined (Figure 20), most of the crashes seen were front-rear collisions (35%) followed by front-side collisions (22%) and rollovers/loss of control (17%). Figure 20 also shows that most killed/serious injury cases were caused as a result of front-rear collisions (38%), followed by rollovers/loss of control (23%) and pedestrian impacts (15%).

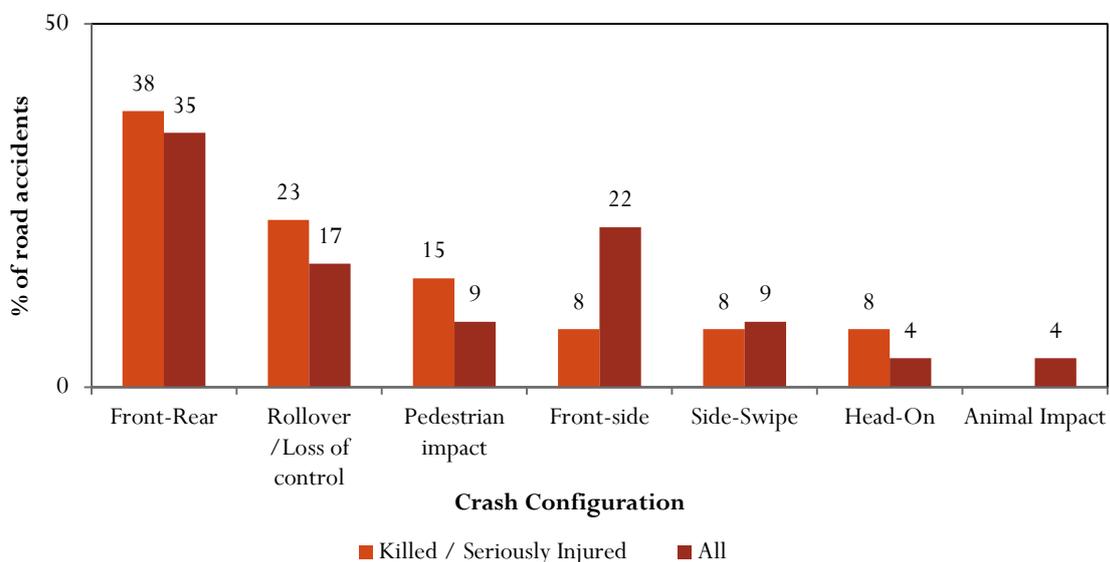


Figure 20: Percentage distribution of accidents by crash configuration and injury severity (Number of accidents = 23)

## Comparison of Police Data and Accident Investigation Data

The data obtained from police for approximately 2 years and the data obtained from crash investigations by JPRI have been compared in Table 5 below:

	Police Data	JPRI Accident Investigation Data
<b>Duration</b>	Approximately 2 years	45 days
<b>Number of accidents</b>	1164	23
<b>Killed/Seriously Injured Road Users</b>	Pedestrians (43%) M2W (39%) Car (8%) Truck (6%) Others (2%)	M2W (46%) Car (23%) Pedestrians (15.5%) M3W (15.5%)
<b>Crash Configuration</b>	Front-Rear (43%) Pedestrian (25%) Head-on (8%) Loss of Control (6%) Front-Side (4%)	Front-Rear (35%) Front-Side (22%) Rollover/Loss of Control (17%) Pedestrian (9%) Sideswipe (9%) Head-on (4%)

Table 5: Comparison of police data and accidents examined on SH17

Based on the above comparison, the following observations have been made:

1. As informed earlier in this report, the police reported accident data was not analysed using the coding format developed by JPRI. JPRI was given data tables as per individual police station format. This has been compiled and put together for police data analysis.
2. Pedestrians, motorized two wheelers and cars form the top three road users killed/seriously injured in accidents.
3. Front-rear collisions are represented as the most frequent crash types occurring on SH17 by both data sources.
4. The top five crash configurations match in both. Although it must be made clear at this point that a lot of discrepancies were observed in police coded crash configurations and these errors were cleaned up to the greatest extent possible by JPRI researchers. Questions can be raised about police coded type of collision as researchers found that there is no clear definition for them. For e.g. it was observed that pedestrian impacts were coded as “front-rear collisions”. Bicyclist impact was coded as “head-on collision” and a lot of single vehicle accidents were coded as “Other” or “Loss of Control” without any details.

***Based on the above notes, the report uses the JPRI accident investigation data as the main source for analysis of pre-crash events and contributing infrastructure factors.***

### Front-Rear Collisions (8 out of 23, 35%)

As per police data and accident investigation data, front-rear collisions account for the highest type of accidents on SH17 and are also the most severe accidents. The 8 front-rear collisions examined by JPRI are listed in Table 6 below.

S. No.	Leading Vehicle	Following Vehicle	Pre-crash Event	Contributing Infrastructure Factor
1	M2W	Car	Slowed Down	Gap-in-median
2	Truck	M2W	Slowed Down	Speed breaker
3	M2W	Car	Stopped	Gap-in-median
4	M2W	Bus	Slowed Down	Barricade
5	Truck	Car	Slowed Down	Speed breaker
6	M2W	Car	Slowed Down	Gap-in-median
7	M3W	Bus	Slowed Down	Following too closely
8	Bus	Truck	Slowed Down	Speed breaker

(Red indicates that the road user met with fatal/grievous injuries)

Table 6: Front-rear collisions examined by JPRI on SH17

### Pre-crash Event

The pre-crash event for each of the front-rear collisions was identified and the results are as shown in Figure 21.

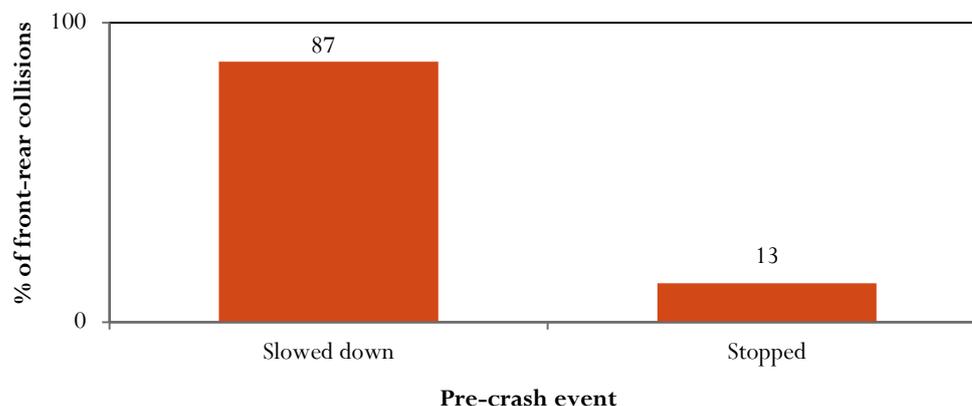


Figure 21: Pre-crash event for front-rear collisions

It can be seen from Figure 21 that 87% of the front-rear crashes occurred due to slowing down of the vehicle in front, while in only one cases, the vehicle in front was stopped.

### Contributing Infrastructure Factor

Since slowing down of vehicles caused 87% of the front-rear collisions, the influencing infrastructure factors for these conditions were examined, and the results are as shown in Figure 22.

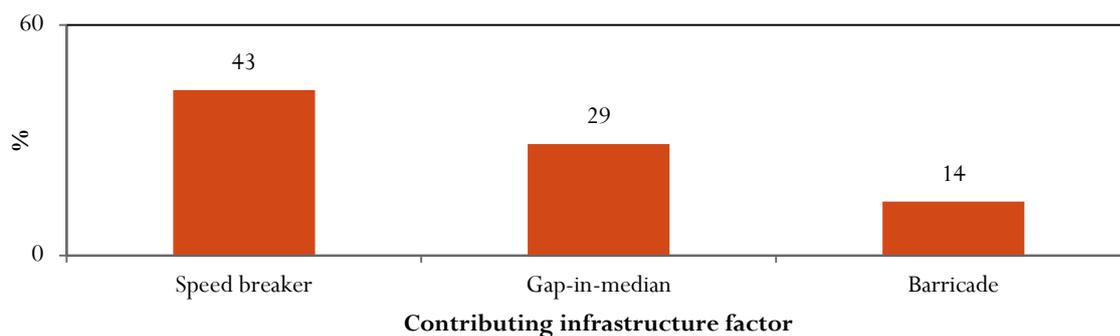


Figure 22: Contributing infrastructure factors leading to pre-crash event “slowed down” and causing front-rear collisions

As can be seen from Figure 22, gaps-in-median and speed breakers together *influenced 72% of the front-rear collisions for which pre-crash event was slowing down*. Barricades describe the devices used by traffic police to regulate traffic.

### Front-Side Collisions (8 out of 23, 35%)

The 5 front-side collisions examined by JPRI are listed in Table 6 below.

S. No.	Turning Vehicle	Vehicle Going Straight	Pre-crash Event	Contributing Infrastructure Factor
1	Truck	Car	Turning off	Intersection
2	Truck	Car	U-turn	Gap-in-median
3	M2W	Car	Crossing	Intersection
4	Car	Car	U-turn	Gap-in-median
5	Tractor	Car	Turning in	Intersection

(Red indicates that the road user met with fatal/grievous injuries)

Table 7: Front-side collisions examined by JPRI on SH17

### Pre-crash Event

The pre-crash event for each of the front-side collisions was identified and the results are as shown in Figure 23. As can be seen, in all the cases, once of the vehicles was turning off/in the highway, taking a U-turn or crossing over an intersection.

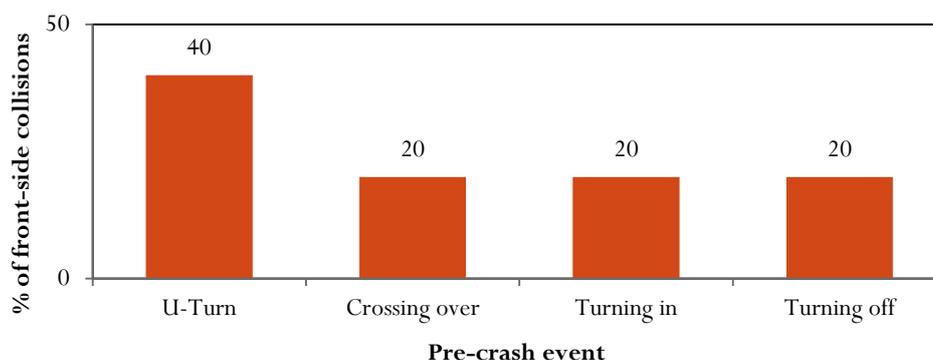


Figure 23: Pre-crash event for front-side collisions

### Contributing Infrastructure Factor

All front-side collisions occurred at junctions/intersections where vehicles were trying to join/exit/cross the highway or at gaps-in-medians where vehicles were taking a U-turn to change direction of travel.

### Rollovers or Loss-of-Control (4 out of 23, 17%)

The 4 rollover/loss of control accidents examined by JPRI are listed in Table 8 below.

S. No.	Vehicle Type	Pre-crash Event	Contributing Infrastructure Factor
1	M2W	Did not see speed breaker	Speed breaker
2	M3W	Driver distracted by passenger	Not Applicable
3	M2W	Unknown	Unknown
4	Car	Avoidance maneuver	Gap-in-median

(Red indicates that the road user met with fatal/grievous injuries)

Table 8: Rollover or loss of control accidents examined by JPRI on SH17

### Pre-crash Event

The pre-crash event for each of the rollover or loss of control accidents was identified and the results are as shown in Figure 24.

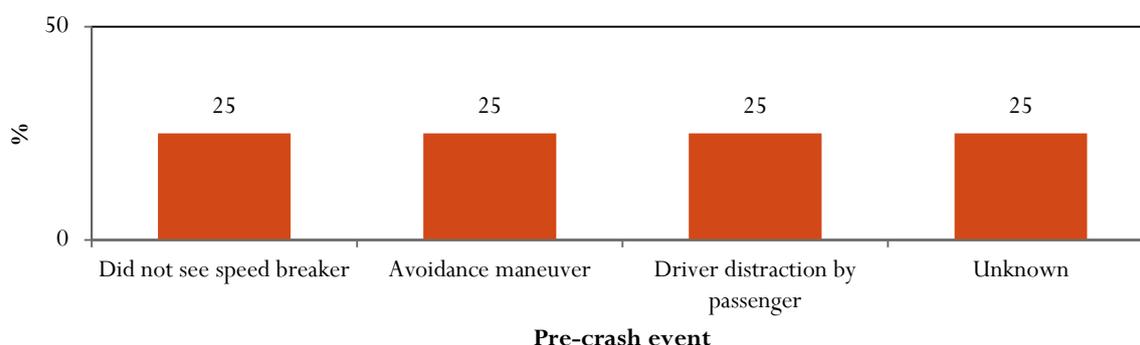


Figure 24: Pre-crash event for rollover / loss of control accidents

There were two rollovers, out of which one was caused due to driver distraction. In this case (driver distraction by passenger) the driver of an overloaded auto rickshaw tried to hold an occupant who was about to fall off from the vehicle. During the process he turned the handle of the vehicle and the vehicle rolled.

In the second case (avoidance maneuver), a car travelling on the highway saw an unknown vehicle entering the road through a gap-in-median. The driver of the car steered left to avoid that vehicle and eventually lost control. The car went off the road and rolled over.

Two (2) loss-of-control cases were examined, where in one - a scooter rider did not notice a speed breaker and lost balance when the vehicle went over it. Both the riders fell on the road and sustained grievous injuries. The cause for another loss of control accident was not known where a motorcycle lost balance and fell down on the highway sustaining fatal injuries.

### Contributing Infrastructure Factor

From the above it is seen that speed breakers and gaps-in-median influence 50% of the rollover/loss of control accidents.

### Pedestrian Impacts (2 out of 23, 9%)

The 2 pedestrian accidents examined by JPRI are listed in Table 9 below.

S. No.	Vehicle Type	Pre-crash Event	Contributing Infrastructure Factor
1	Bus	Pedestrian crossing	Poor pedestrian infrastructure at gap-in-median
2	Farm Tractor	Pedestrian standing/ Vehicle turning off the highway	Poor pedestrian infrastructure at junction

(Red indicates that the pedestrian met with fatal injuries)

Table 9: Pedestrian accidents examined by JPRI on SH17

### Pre-crash Event

In the first case, the pedestrian was crossing the road at night near a gap-in median. A bus hit the pedestrian. The road did have zebra crossings, but no pedestrian crossing warning signs or lighting.

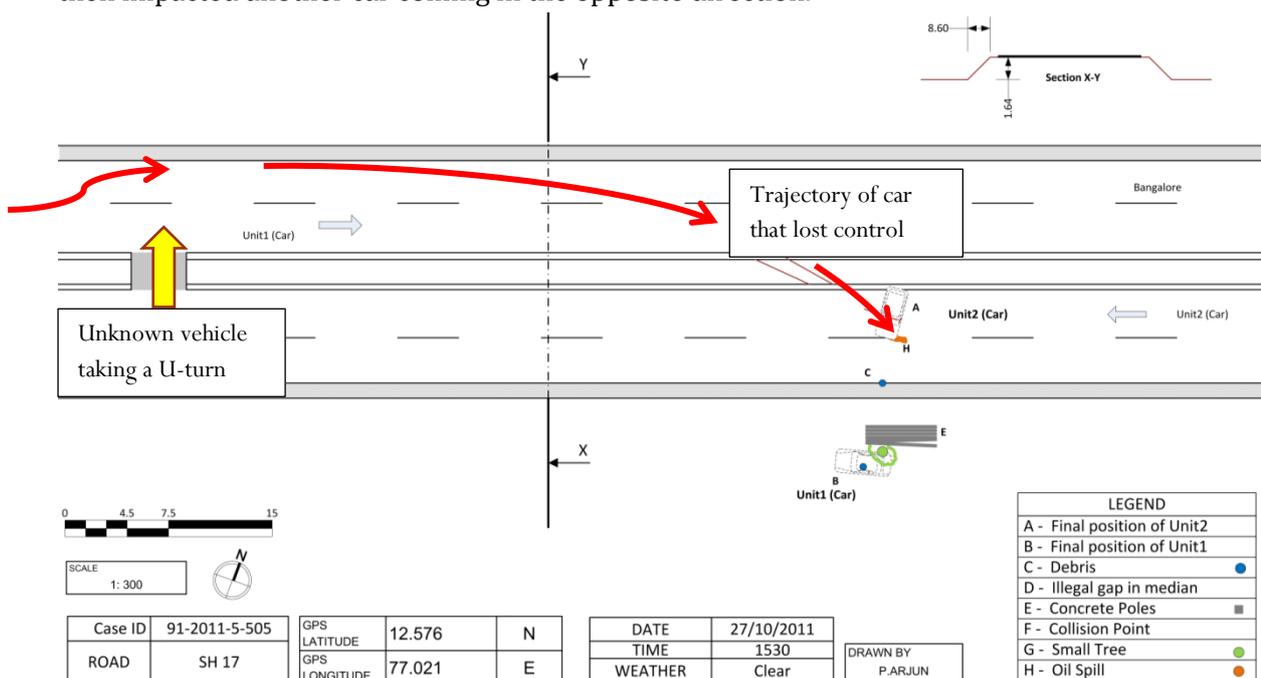
In the second case, the pedestrian (a child) was standing alongside the road when a farm tractor trying to turn off the highway ran over the child.

### Contributing Infrastructure Factor

From the above it is seen that poor pedestrian infrastructure influence these accidents.

### Head-On Collisions (1 out of 23, 5%)

This accident has been discussed to show how head-on collisions can take place on divided 4-lane roads. It is well known that head-on collisions can occur when vehicles are travelling in the wrong direction on a divided highway, but in this case a car lost control, crossed the median and then impacted another car coming in the opposite direction.





The car that lost control



The gap-in-median



The car travelling in the opposite lane

Figure 25: Scene diagram & images for the head-on collision examined on the SH17 showing how a gap-in-median influenced this accident.

### Conclusions

Based on the above analysis of accidents on SH17, the results of the road safety issues and the contributing infrastructure factors have been tabulated below:

Crash Configurations	Pre-crash Event	Contributing Infrastructure Factor	Percentage contribution (out of 23 accidents examined)
Front-Rear Collisions	Slowed down vehicles	Speed Breaker	12%
		Gap-in-Median	8%
		Barricades	4%
Front-Side Collisions	Taking U-turn	Gap-in-Median	8%
	Turning in/off/crossing over	Intersection	12%
Rollovers/Loss of Control	Loss of Control	Speed Breaker	4%
		Gap-in-Median	4%
Pedestrian Impacts	Walking alongside Or Standing on road side	Poor pedestrian infrastructure	8%
Head-On collision	Loss of Control during avoidance maneuver	Gap-in-Median	4%

Table 10: Determination of contributing infrastructure factors and their influence on accidents

## Areas of improvement in infrastructure

1. Gaps-in-median are the contributing infrastructure factors for 28% of the accidents examined on SH17.
2. Speed breakers are the contributing infrastructure factors for 16% of the accidents examined on SH17.
3. 12% of the crashes occurred near intersections.
4. 8% of crashes were caused due to poor pedestrian infrastructure.

Each of the contributing infrastructure factors are explained below:

### Gaps-in-median

There were many gaps in medians which were found to be made just by breaking the median, and were without any proper finishing as can be seen in Figure 25. They even lack information signs about a U-turn present in such location. Police informed that it is the general public which used to cut open the median which could be used as a shortcut to access cross roads nearby.



Figure 26: Crude gap-in-median. Roadway also lacks information signs

Plants on the median are usually grown to cut off headlight glares from vehicle travelling in opposite direction. But such plants were also found near the gaps in medians which totally/partially obstructed the vision of road users accessing the U-turns.



Figure 27: Driver's ability to see upcoming U-turn is obstructed by plants (left); the same U-turn is visible suddenly when the driver comes closer. (right)

Absence of deceleration lanes/exit lanes near gaps in medians and intersections also influenced crashes. When a vehicle has an intention to take a U-turn or exit the highway, the vehicle would slow down or stop on the highway. The vehicle behind would not be aware of this and would collide with this vehicle in front.



Figure 28: Absence of deceleration lanes near U-turns

### Speed breakers

The speed breakers found on SH17 were painted with white vertical stripes (parallel to the vehicle direction). This pattern created an optical illusion such that the elevation of the hump disappeared and it looks like a pedestrian crossing (Figure 29). Also the conspicuity of these speed breakers was poor during the night (Figure 30). Due to these problems, riders and drivers often don't realize there is a speed breaker until they are upon it, which can cause loss of control of their vehicles, as was seen in this study.

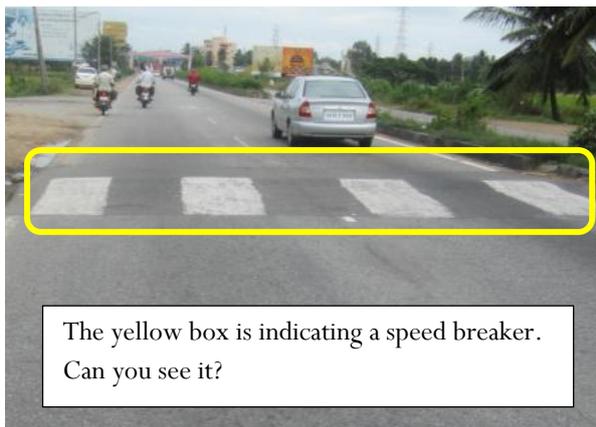


Figure 29: Longitudinal pattern of white lines on speed breakers make it look like a pedestrian crossing (left); Actual pedestrian crossing (right)

Front-rear and front-side collisions also took place near speed breakers. These occurred when the leading vehicle slowed down for the speed breaker, and the following vehicle (due to driver inattention, too close following, etc.) collided into the leading vehicle in some manner. However, if speed breakers are not evident, the driver of leading vehicle is more likely to apply brakes all of sudden on realizing there is a speed breaker ahead, and that increases the chances for collision.



Figure 30: Speed breakers lacked conspicuity at night

### **Barricades**

Barricades were placed on roadway near busy areas in order to cut speeds of passing vehicles. But these barricades were placed in wrong locations (very close to a U-turn, etc.) which confused the path of vehicles travelling through them. Also the barricades were seen to be very old and in extremely bad condition (Figure 30). They also lacked reflectors or warning signs on them making their presence less visible on the road.



Figure 31: Barricades on roadway were found in very bad condition and lacked conspicuity

### **Poor pedestrian infrastructure**

Lack of proper pedestrian facilities on the study stretch of SH17 forces pedestrians to walk on the carriageway, and that action likely makes them more prone to being hit by vehicle traffic. At least one pedestrian impact seen during the study was determined to be influenced by this factor. Absence of pedestrian crossings and improper maintenance of those that do exist not only put pedestrians in harm's way, but may indirectly lead to other accidents as vehicles attempt to avoid collisions with pedestrians and bicyclists.



Figure 32: Poor pedestrian infrastructure on SH17.

### Road users to be considered

1. Pedestrians and motorized two wheelers: Most vulnerable road users on the SH17.
2. Trucks: High volume and high involvement in road accidents.
3. Cars: High speed, high volume and high involvement in road accidents.

### Other important issues to be considered

1. Road markings, zebra crossings and warning signs are not maintained in some areas of the stretch.
2. Plants on the median should be trimmed near U-turns, which would improve driver visibility when approaching a junction/intersection or gap-in-median.
3. Speed limit signs should be installed at more frequent intervals (as reminders), particularly where new traffic is joining the highway. Since most of the cars are seen going at high speeds on this stretch, interceptors can be deployed.

## SH20: Baseline Data Collection



*Shown above is a picture of a section of the State Highway 20 (SH20) between Belgaum and Bagalkot. Tractors carrying sugarcane and farm goods (note the double trailers) are a common sight. In addition, the picture also shows an overloaded truck trying to overtake a tractor. Also seen are a mother and daughter waiting on the road side for a lift. Also observed were the narrow paved shoulders of width 1.5m.*

The following sections describe the area of study, data collected, findings and conclusions for the State Highway 20 (SH20) corridor from Belgaum to Hungund.

### The Study Area

The study area, a 171 km stretch of SH20 connecting Belgaum to Gaddanakeri (129 km), and Bagalkot to Hungund (42 km), was selected based on instructions provided by iRAP for performing traffic volume, speed and accident data collection.

SH20 is a two-lane undivided road with paved shoulder of 1.5m width on both sides, divided by white broken line (road marking) all along the stretch. This highway connects Belgaum, Bagalkot and Hungund, of which the section of the highway near Belgaum is urban, Bagalkot is semi-urban, and that near Hungund is rural. Most parts of the stretch, except for the above said places, are rural with agricultural farms on both sides. There were intersections which led to small villages and hamlets.

### Traffic Volume and Speed Data

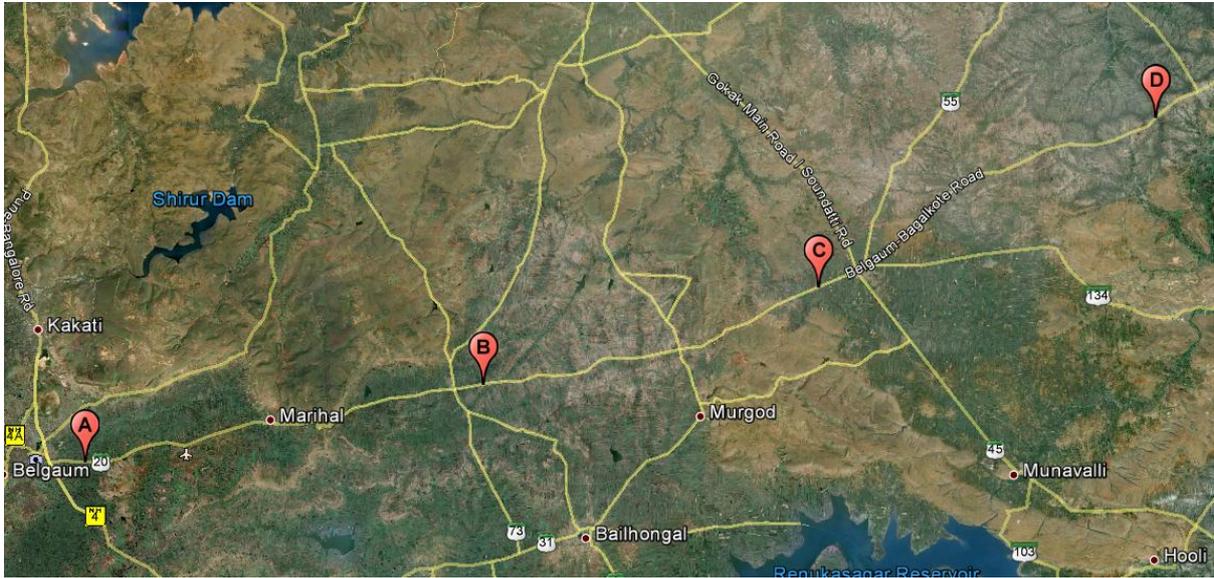
The following section gives details of the traffic volume and speed data collection for SH20.

### Spot Selection

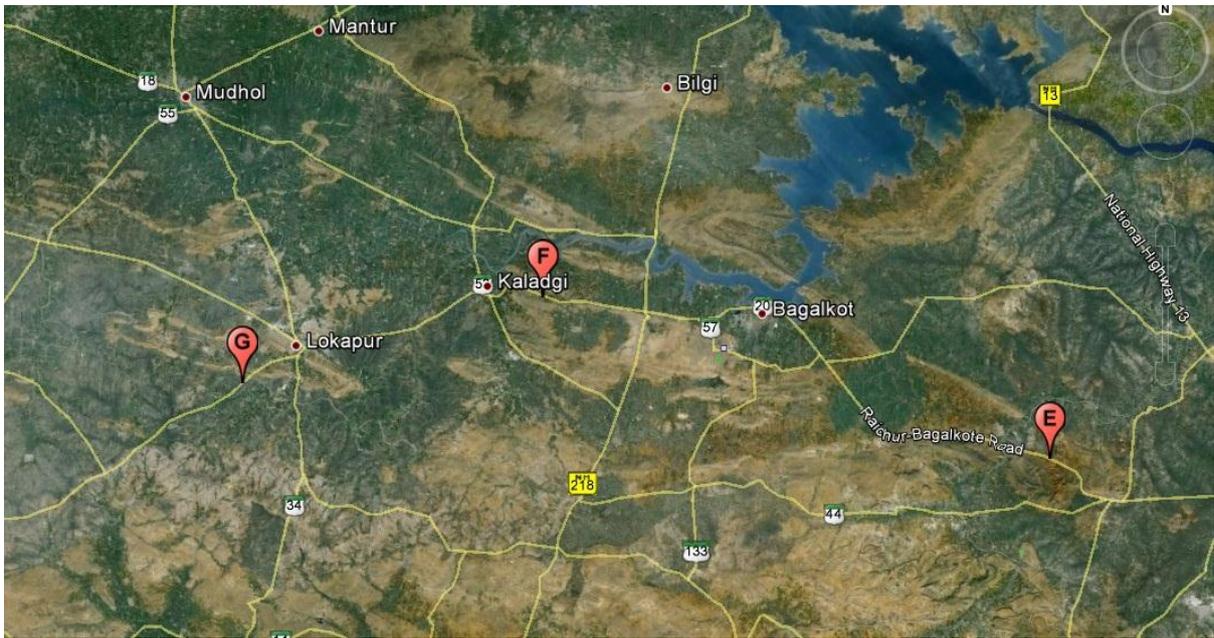
The stretch was carefully studied to determine places where significant traffic was being added to the highway or being subtracted from it. These places usually include major towns or villages that draw frequent on/off traffic, either as destinations in themselves or as connections to some other place. Such locations offer a good idea of the traffic volume for the whole stretch selected. The study locations on SH20 have been identified as per the Global Positioning System (GPS) coordinates provided in Table 1, and they are shown graphically in Figures 1 and 2.

Sites	GPS Coordinates		Area Type	Posted Speed Limit (kmph)
<b>A</b>	15° 51' 28.52" N	74° 33' 15.29" E	Urban	50
<b>B</b>	15° 54' 12.89" N	74° 47' 41.11" E	Rural	60
<b>C</b>	15° 57' 36.61" N	74° 59' 49.70" E	Rural	60
<b>D</b>	16° 03' 35.06" N	75° 12' 05.56" E	Rural	60
<b>E</b>	16° 05' 06.82" N	75° 54' 05.14" E	Rural	60
<b>F</b>	16° 11' 50.12" N	75° 32' 22.06" E	Rural	60
<b>G</b>	16° 08' 14.00" N	75° 19' 30.00" E	Rural	60

Table 1: GPS Coordinates, area type and posted speed limit of the seven study sites on SH20



Sites A, B, C and D – Belgaum District



Sites E, F and G – Bagalkot District

Figure 1: Screen shot from Google Earth, showing the study sites (Sites A, B, C, D, E, F and G)



Site A  
(Basavannakudachi)



Site B  
(Somanahatti)



Site C  
(Yaragatti)



Site D  
(Chandaragi)



Site E  
(Doddannavara Mines)



Site F  
(Tulasigere)



Site G  
(Mallapura)

Figure 2: Photos of the study sites on SH20 (Sites A, B, C, D, E, F and G)

## Data Sample Collected

Data collection for traffic volume count and speeds was as per the guidelines laid down by iRAP. Please refer to the “iRAP Baseline Data Collection in India – Inception Report” published by JPRI on November 1, 2011.

The data sample collected for traffic volume count and speed on all sites of SH20 at 4 time durations (06:01 to 12:01, 12:01 to 18:00, 18:01 to 24:00 and 00:01 to 06:00) is shown below:

- 7 locations were monitored (Sites A to G).
- 8519 vehicles were counted during four time durations.
- 7477 speeding incidents were recorded.
- 4937 minutes of data was collected.

The status of data collection (speed and traffic volume) at all study sites at different time durations are shown in Table 2.

Study Sites	00:01 to 06:00 hrs	06:01 to 12:00 hrs	12:01 to 18:00 hrs	18:01 to 24:00 hrs
Site A	Data collected	Data collected	Data collected	Data collected
Site B	Data collected	Data collected	Data collected	Data collected
Site C	Data collected	Data collected	Data collected	Data collected
Site D	Data collected	Data collected	Data collected	Data collected
Site E	Data collected	Data collected	Data collected	Data collected
Site F	Data collected	Data collected	Data collected	Data collected
Site G	Data collected	Data collected	Data collected	Data collected

Table 2: Status of traffic speed and volume data collected at different study sites

## Traffic Volume Count

To standardize the observed time for comparison, JPRI normalized the count in a given site for a given 6 hours time duration to an 1 hour sample. This was done by using the following formula.

$$\text{Number of vehicles passing in one hour at one site} = \frac{\text{Number of vehicles counted in time } (t, \text{ in minutes}) * 60 \text{ minutes}}{(t, \text{ in minutes})}$$

This one hour sample was then extrapolated to the specific 6 hours time duration. The end results were added to get an estimation of the number of vehicles passing through a given site in 24 hours. Based on the above calculation, the new total vehicle count obtained for SH20 is **49326** and the total vehicle count at each site is as show below in Figure 3.

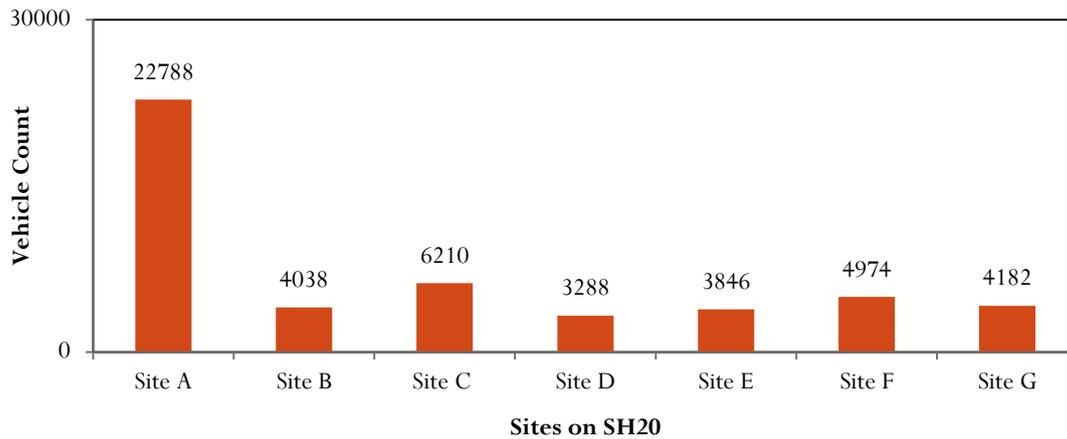


Figure 3: Traffic volume count at each site on SH20 estimated for 24 hours

The 24 hour data sample for traffic volume count was distributed by vehicle type and the result is as shown in Figure 4. *The definition for each vehicle type is provided in Appendix A.*

Figure 4, indicates that motorised two wheelers (33%) constituted the highest road user type on SH20. This was followed by trucks (26%) and cars (25%). Other motor vehicles, buses, bicyclists, pedestrians and non-motorized vehicles together accounted for 16% of the total traffic volume.

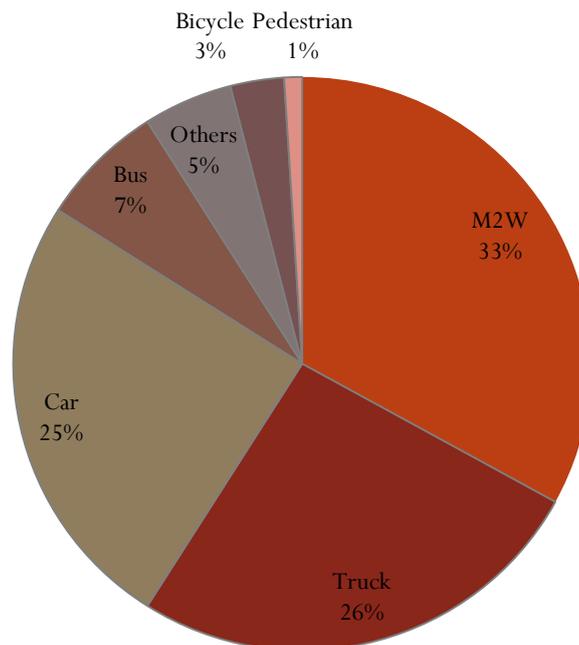


Figure 4: Percentage Composition of Road Users counted on SH20  
(Sample Size: 49326 vehicles counted at all sites during the four time durations)

It is important to note that:

1. Motorized two-wheelers are the highest road user types on the SH20 followed by trucks and cars. Together these three road user types account for 84% of the vehicles on SH20.
2. Other vehicle types mainly include tractors and account for 5% of the road users on SH20.

### Traffic volume percentage counts for each time duration

Traffic volume counts were taken at different time durations of the day (the four time durations) at each of the seven study sites (A, B, C, D, E, F and G). The data, for each time duration, is as shown in Figure 5.

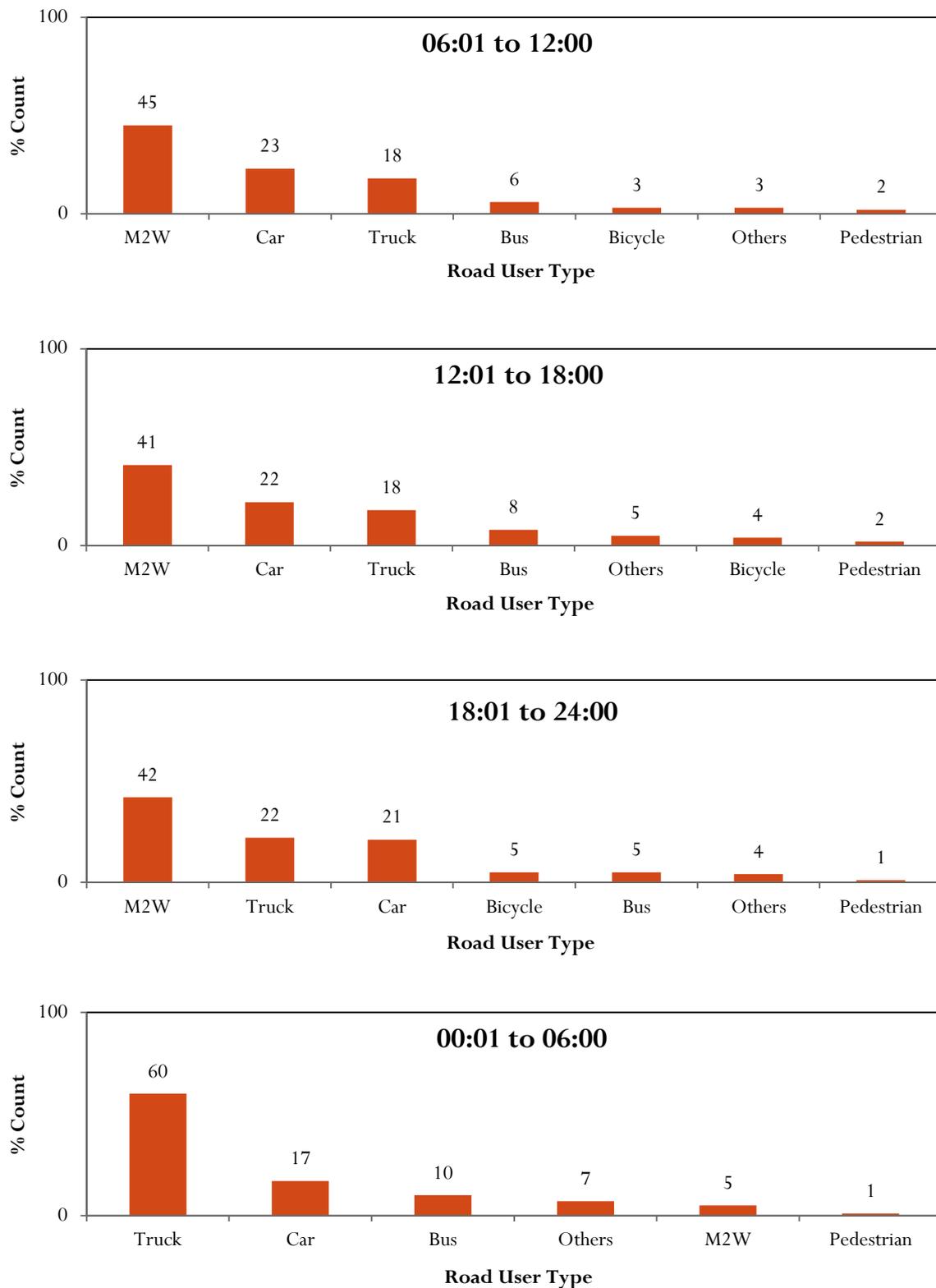


Figure 5: Traffic volume percentage distribution by vehicle type for the four time durations on SH20

The resulting data provides an estimate of the volume and types of vehicles seen on weekdays on the study stretch for each of the time durations. Traffic volume was lowest during the night hours (00:01 to 06:00 hrs) and trucks were the main road users plying at this time. Trucks constitute the highest road users during the time durations of 00:01 to 06:00 hrs, while motorized two wheelers are the highest road users for the remaining three time durations. Cars were the second highest road users in three time durations (except in 18:01 to 24:00 hrs).

### 85th Percentile Speeds

The “85<sup>th</sup> percentile speed” is the speed at or below which 85% of the vehicles were found to travel. This measure is different from the “average” speed. By omitting speed variations possibly caused by very few vehicles that travelled at high speeds (variations that would necessarily be included if a simple average was calculated), the 85<sup>th</sup> percentile reflects the speed at which most vehicles travel on a given stretch of road. The overall 85<sup>th</sup> percentile speed for each vehicle type (averaged across all four sites) is shown in Figure 6.

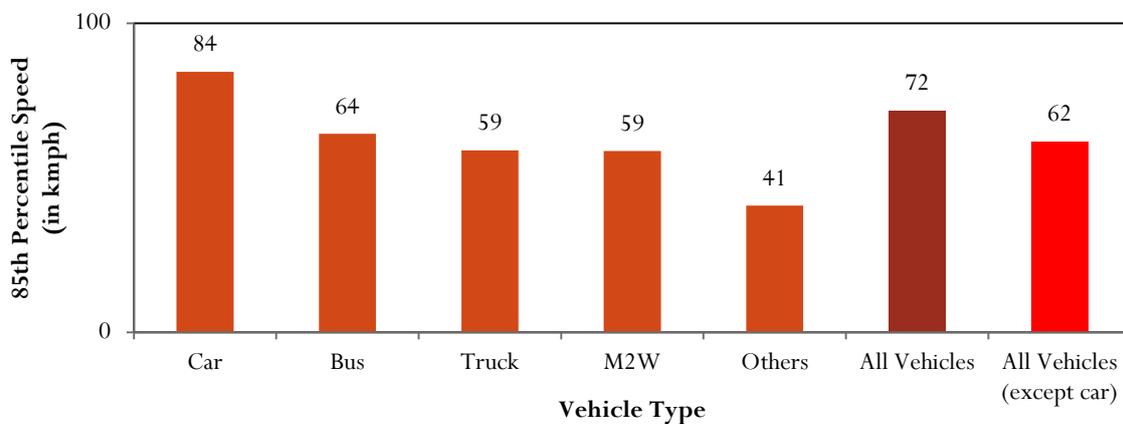


Figure 6: Average “85<sup>th</sup> Percentile Speed” of each road user type in study sites (A, B, C and D) on SH20 in Belgaum district

Figure 6 clearly denotes that in study sites of Belgaum district cars travel the fastest, with an average 85<sup>th</sup> percentile speed of 84 kmph. This is then followed by buses, trucks and motorized two wheelers with average 85<sup>th</sup> percentile speeds of 64 kmph, 59 kmph, and 59 kmph respectively. The 85<sup>th</sup> percentile speed for all the vehicles was found to be 72 kmph, and it was 62 kmph when cars were excluded from the calculation.

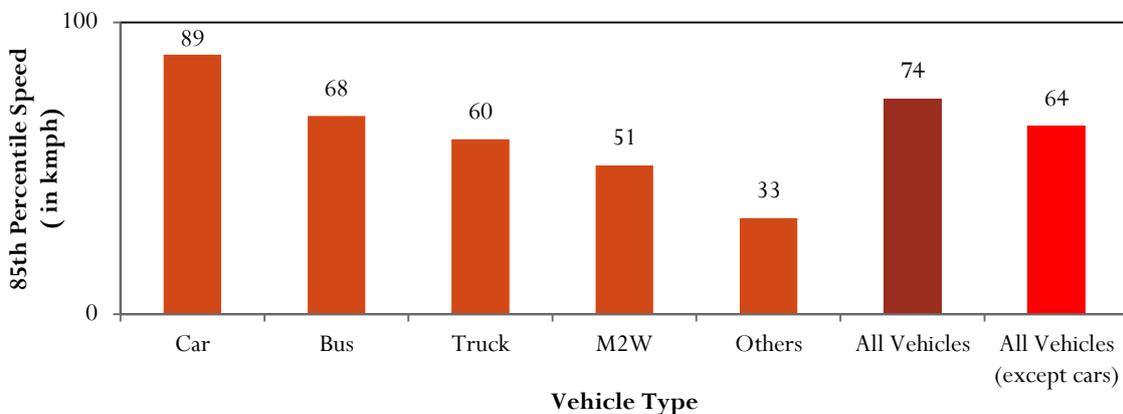


Figure 7: Average “85<sup>th</sup> Percentile Speed” of each road user type in study sites (E, F, and G) on SH20 in Bagalkot district

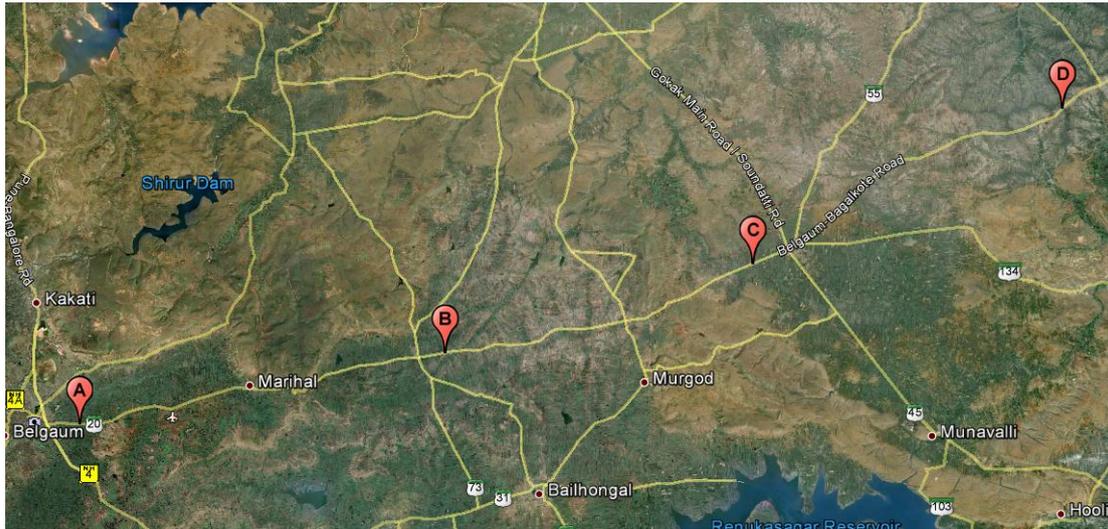
Figure 7 clearly denotes that in study sites of Bagalkot district cars travel the fastest, with an 85<sup>th</sup> percentile speed of 89 kmph. This is then followed by buses, trucks and motorized two wheelers with 85<sup>th</sup> percentile speeds of 68 kmph, 60 kmph, and 51 kmph respectively. The 85<sup>th</sup> percentile speed for all the vehicles was found to be 74 kmph, and it was 64 kmph when cars were excluded from the calculation.

### Findings and Observations

The following are the findings and observations of the speed and traffic volume count study on SH20:

- Motorized two wheelers are the highest number of road users, followed by trucks and cars.
- Traffic volume was found to be comparatively high in site A because of its proximity to Belgaum city.
- Motorized two wheelers were the highest road users from 06:01 to 24:00 hrs during a day. Trucks took the leading position during the time duration 00:01 to 06:00 hrs.
- Traffic volume was the lowest during the time duration 00:01 to 06:00 hrs.
- The 85<sup>th</sup> percentile speeds for cars were the highest in Belgaum and Bagalkot districts, and was well above the posted speed limit by 24 kmph and 29 kmph respectively.
- Other vehicles (farm tractors, motorised three wheelers) constituted 5% of the total traffic volume.

A summary is provided below for the speed and traffic volume data for each site.



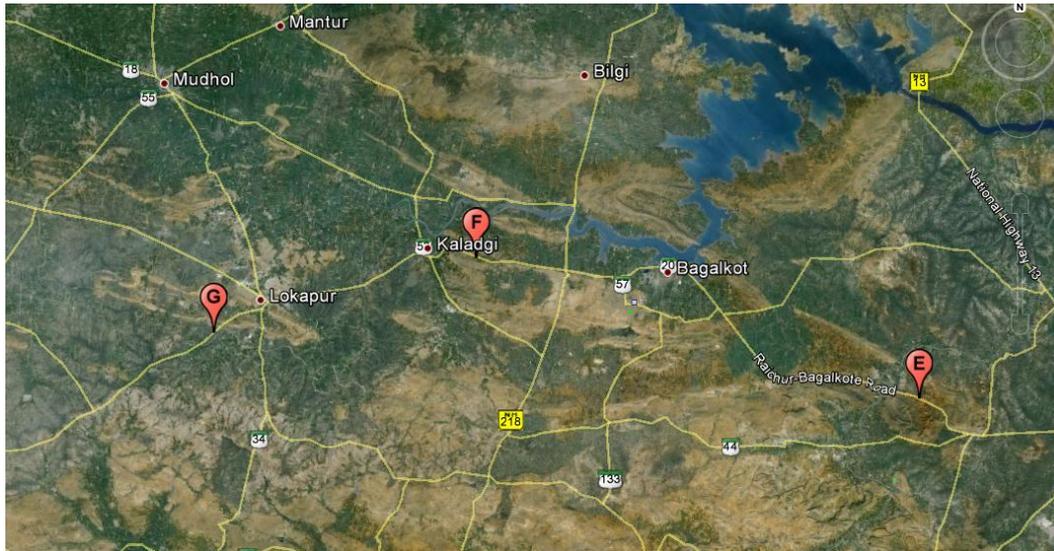
Sites A, B, C and D – Belgaum District

**Traffic Speed**

SITE A	SITE B	SITE C	SITE D
Car – 76 kmph	Car – 83 kmph	Car – 87 kmph	Car – 91 kmph
Bus – 62 kmph	Bus – 60 kmph	Bus – 70 kmph	Bus – 65 kmph
Truck – 56 kmph	Truck – 58 kmph	Truck – 60 kmph	Truck – 60 kmph
M2W – 53 kmph	M2W – 57 kmph	M2W – 63 kmph	M2W – 61 kmph
Others – 46 kmph	Others – 45 kmph	Others – 38 kmph	Others – 35 kmph
All vehicles – 61 kmph	All vehicles – 72 kmph	All vehicles – 75 kmph	All vehicles – 79 kmph

**Traffic Volume Count**

SITE A	SITE B	SITE C	SITE D
Car – 13 %	Car – 34%	Car – 27%	Car – 33%
Bus – 5%	Bus – 8%	Bus – 7%	Bus – 6%
Truck – 11%	Truck – 33%	Truck – 33%	Truck – 39%
M2W – 58%	M2W – 20%	M2W – 27%	M2W – 15%
Bicycle – 7%	Others – 2%	Others – 4%	Others – 6%
Others – 5%	Bicycle – 2%	Pedestrian – 1%	Pedestrian – 1%
Pedestrian – 1%	Pedestrian – 1%	Non-motorized – 1%	Total Count – 3288
Total Count – 22788	Total Count – 4038	Total Count – 6210	



Sites E, F and G – Bagalkot District

*Traffic Speed*

SITE G
Car – 92 kmph
Bus – 67 kmph
Truck – 62 kmph
M2W – 53 kmph
Others – 31 kmph
All vehicles – 76 kmph

SITE F
Car – 90 kmph
Bus – 69 kmph
Truck – 61 kmph
M2W – 55 kmph
Others – 31 kmph
All vehicles – 76 kmph

SITE E
Car – 85 kmph
Bus – 68 kmph
Truck – 56 kmph
M2W – 44 kmph
Others – 38 kmph
All vehicles – 69 kmph

*Traffic Volume Count*

SITE G
Car – 27%
Bus – 5%
Truck – 30%
M2W – 30%
Others – 5%
Pedestrian – 2%
Bicycle – 1%
Total Count – 4182

SITE F
Car – 26%
Bus – 7%
Truck – 26%
M2W – 30%
Others – 6%
Bicycle – 2%
Pedestrian – 3%
Total Count – 4974

SITE E
Car – 26%
Bus – 12%
Truck – 26%
M2W – 29%
Others – 5%
Bicycle – 1%
Pedestrian – 1%
Total Count – 3846

## Police Data

JPRI researchers tried to obtain accident data from the police, but unfortunately it was in the form of statistical figures for the entire district without any descriptions, and the data available with them was insufficient for analysis. This problem was raised with KSHIP-II and after request letters were sent out to the police department, JPRI researchers followed up with the police stations a number of times (by phone and personal visit) to obtain accident data in a format useful for analysis, but as on 15 March 2012, data has not been collected. **Hence the entire analysis is based on accident investigation data of JPRI.**

## Accident Investigation Data

With the support of iRAP, the Karnataka State Highway Improvement Project-II (KSHIP-II) and the Karnataka State Police, the JPRI team performed detailed investigations of accidents that occurred along the stretch of SH20 defined as the study area. In-depth data was collected for all the accidents occurring in the study area from 15 November 2011 to 30 December 2011. During this period, 14 accidents were examined in Belgaum district and 5 in Bagalkot district, making a total of 19 crashes, over the 171km stretch. The analysis and results are provided for Bagalkot and Belgaum districts together.

## General Overview of Accident Investigation Data

### Injury Severity

A total of 19 traffic accidents were examined on the study area of SH20 over a period of 45 days by two teams in Belgaum and Bagalkot districts. These crashes involved a total of 10 fatalities (5 fatalities occurred in a single crash) and 22 hospitalized victims. 9 victims sustained minor injuries. As shown in Figure 8, about two-third (63%) of the crashes examined resulted in fatality or grievous injury.

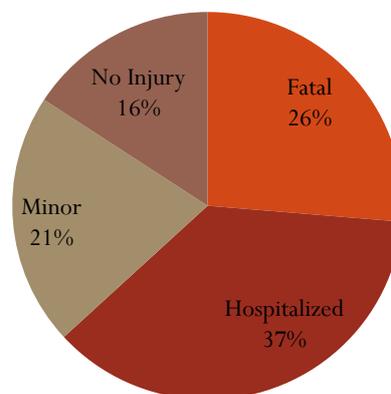


Figure 8: Percentage distribution of accidents examined, by highest injury severity

### Road Users Involved

The percentages of the road users involved in road accidents examined on SH20 are shown in Figure 9. Trucks (30%) formed the majority of the accident-involved vehicles, followed by cars (27%) and farm tractors (16%). Although the stretch had M2W volume of 30%, only 13% were involved in accidents.

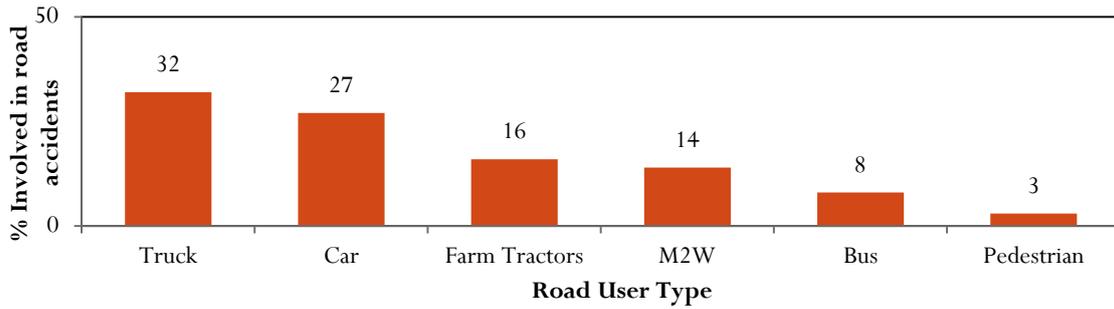


Figure 9: Percentage involvement of road user types in accidents examined on SH20

### Killed/Seriously Injured Road Users

Analysis also showed that out of the 19 accidents, 12 accidents involved killed or seriously injured victims. The distribution of the road user type killed or seriously injured is shown in Figure 10 below.

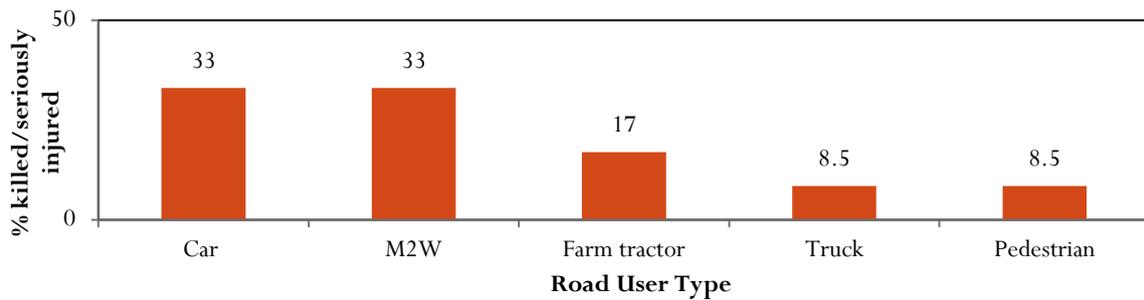


Figure 10: Percentage distribution of road user types killed or seriously injured in accidents examined on SH20

### Crash Configuration

The first crash configuration of all the 19 accidents examined was analysed. The distribution of these accidents based on crash configuration and the resulting injury severity is shown below in Figure 11. Most of the accidents seen were front-rear collisions (42%) and head-on collisions (21%). In addition, sideswipes, rollovers (11% each) and pedestrian impacts, loss-of-control, object impact (5% each) were also examined.

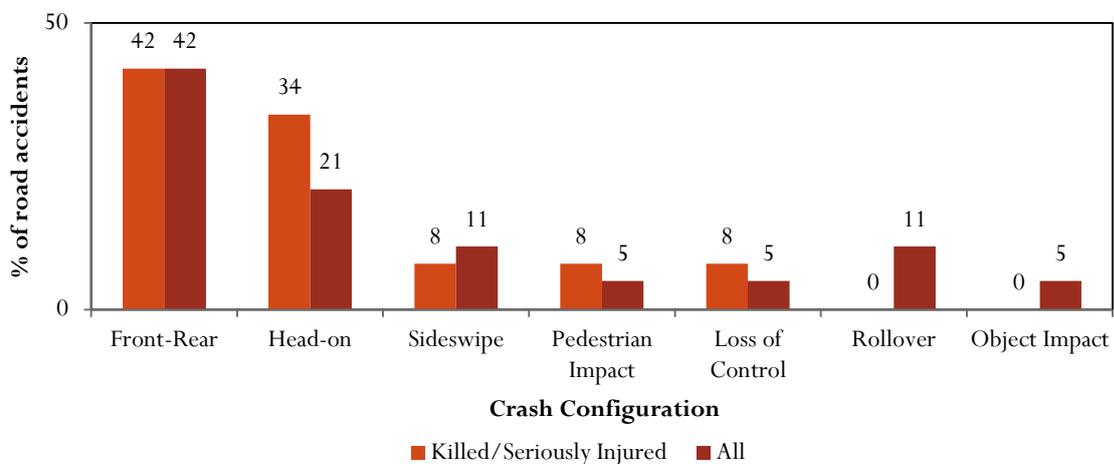


Figure 11: Percentage distribution of accidents by crash configuration and injury severity (Number of accidents = 19)

The two rollover accidents examined involved a car whose driver was under the influence of alcohol, and an overloaded truck whose driver was unable to negotiate a turn on the road. The loss-of-control accident involved a motorized two wheeler rider under the influence of alcohol. The rider lost control when he rode over sugarcane leaves lying on the road. The object impact involved a car and a tree. The car went off the road (due to a tyre burst, as per eye-witnesses) and hit a tree which was located at quite a distance from the road edge. These four accidents being caused mainly due to human/vehicle factors have not been included in the main crash configurations discussed in the following sections.

Based on the above details the following are the important points observed during the accident investigations:

1. There is a high involvement of trucks and cars in road accidents on SH20.
2. Cars, motorized two wheelers and farm tractors were the main road users on SH20 with fatal/serious injuries.
3. The major crash configurations observed on SH20 are front-rear collisions, head-on collisions, sideswipes and pedestrian impacts.

In the following sections, each of these crash types are examined in detail to determine the pre-crash event (critical event leading to the crash) and the contributing infrastructure factors influencing these events.

### Front-Rear Collisions (8 out of 19, 42%)

The 8 front-rear collisions examined by JPRI have been listed below:

S. No.	Vehicle in Front	Vehicle at Rear	Pre-crash Event	Contributing Infrastructure Factor
1	Tractor	Car	Tractor parked on road side	Narrow paved shoulder
2	Car	Truck	Car stopping due to an accident in front	Not Applicable
3	Tractor	Car	Tractor parked on road side	Narrow paved shoulder
4	M2W	Unknown	Unknown	Unknown
5	Truck	Truck	Bus (another vehicle) parked on road side	Narrow paved shoulder
6	M2W	Car	M2W turning into the highway	Intersection
7	Tractor	Truck	Tractor parked on road side	Narrow paved shoulder
8	Truck	Truck	Truck parked on road side	Narrow paved shoulder

(Red indicates that the road user suffered fatal/grievous injuries)

Table 3: Front-rear collisions examined by JPRI on SH20

## Pre-crash Event

The pre-crash events identified for the 8 front-rear collisions have been presented below in Figure 12.

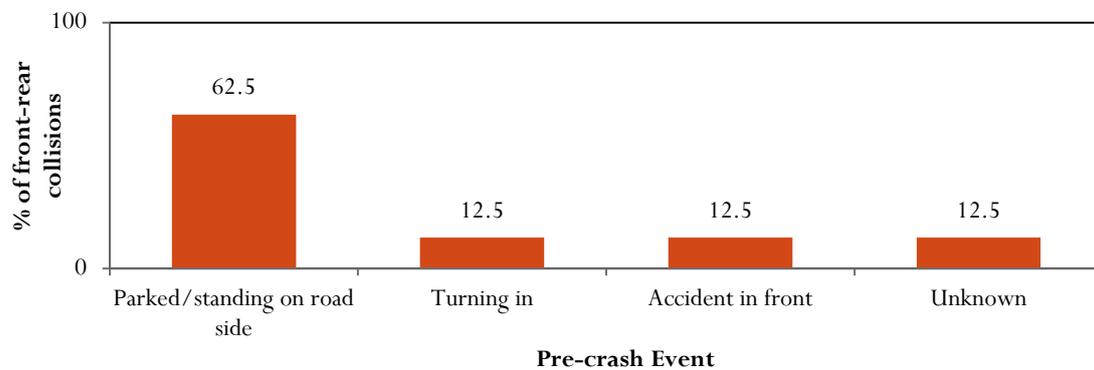


Figure 12: Pre-crash events for the 8 front-rear collisions on SH20

As can be seen 62.5% of the front-rear collisions involved a vehicle parked/standing on the road side. The other pre-crash events involved turning into the highway, an accident in front and unknown reasons. Of these three only turning into the highway has a clear infrastructure influence (intersection) while for the other two, no infrastructure influence could be determined.

## Contributing Infrastructure Factors

For the front-rear collisions involving a “parked vehicle in front” as pre-crash event, it was noted that all these vehicles were standing on the road side shoulder. As the road side shoulder is narrow (1.5 m width), part of the vehicles is on the road way. Hence, narrow paved shoulders were identified as the contributing infrastructure factors for these cases which account for 50% of the front-rear collisions.

It is also interesting to note that farm tractors were the main vehicles which were parked/standing on the road side. Parked tractors and trailers on the road side are quite common on SH20 as farmers load/unload farm goods onto these vehicles.



Figure 13: A car rear ended an unattended trailer parked on the shoulder

## Head-On Collisions (4 out of 19, 21%)

The 4 head-on collisions examined by JPRI have been listed below:

S. No.	Vehicle on opposite lane	Vehicle on right lane	Pre-crash Event	Contributing Infrastructure Factor
1	Car	Car	Overtaking	Undivided Road
2	Truck	Tractor	Overtaking	Undivided Road
3	M2W	Bus	M2W exiting a gas station	Entry/exit of gas station
4	Car	Truck	Overtaking	Undivided Road

(Red indicates that the road user suffered fatal/grievous injuries)

Table 4: Head-on collisions examined by JPRI

### Pre-crash Event

In 3 of the 4 cases, pre-crash event was overtaking while in one case a head-on collision was caused due to a motorcyclist exiting a gas station and a minibus travelling in the opposite direction of the motorcyclist.



Figure 14: Entry/Exit to a gas station on SH20

### Contributing Infrastructure Factors

These types of accidents occur when a vehicle moves into the oncoming lane on an undivided road for overtaking. Hence undivided road influences these kinds of accidents a lot. In one of the cases, an overtaking Maruti Omni (van) collided head-on with a truck travelling in opposite direction. This accident resulted in 5 fatalities in the van.



Figure 15: Van and the truck inspected on SH20

### Sideswipe (2 out of 19, %)

The 2 sideswipe collisions examined by JPRI have been listed below:

S. No.	Vehicle	Vehicle	Pre-crash Event	Contributing Infrastructure Factor
1	Bus	Car	Car stopped on the road side	Narrow paved shoulder
2	Truck	Truck	Vehicle encroaching into oncoming lane	Undivided Road

(Red indicates that the road user suffered fatal/grievous injuries)

Table 5: Sideswipe collisions examined by JPRI on SH20

The first sideswipe involved a car and a bus travelling in the same direction. The car wanted to reach a hospital on the right side. The driver stopped the car on the left side of the road for the following traffic to pass. A bus coming from behind sideswiped the car.

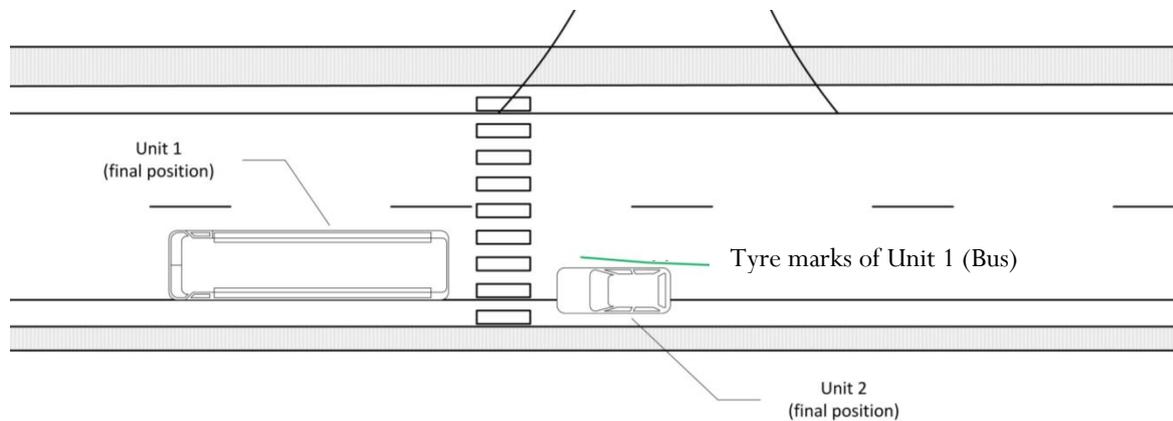


Figure 16: Scene diagram showing the sideswipe collision between the car and the bus

In the second case, two trucks travelling in opposite directions sideswiped each other. One of the trucks had encroached into the lane (reasons unknown) of the other resulting in this collision.

#### Pre-crash Event

The pre-crash events are stopping on the road side and encroaching into oncoming lane.

#### Contributing Infrastructure Factors

It was determined that the narrow shoulder was not sufficient to park the car as can be seen in the scene diagram. In case of the sideswipe involving the trucks, undivided road is the main influence for encroaching into the oncoming lane.

### Pedestrian Impact (1 out of 19, %)

In this single pedestrian impact case, a pedestrian had got down from a bus at a bus stop and then crossed the road from behind the bus. Another bus was travelling in the opposite direction towards this bus stop. The driver of this bus did not see the pedestrian crossing the road from behind the bus and when the pedestrian came in front of the bus, the driver did not have sufficient time to react and avoid the pedestrian.



Figure 17: Scene of pedestrian accident with a bus. The location is a junction and also has a bus stop. But there are no warning signs or pedestrian infrastructure.

### Pre-crash Event

As described above, pedestrian was crossing the road before the bus impacted the pedestrian.

### Contributing Infrastructure Factors

It is clear that driver vision obstruction (caused due to the pedestrian crossing the road from behind the bus) was the reason that the pedestrian accident could not be avoided, but from the infrastructure point of view it is also visible from photos that adequate pedestrian infrastructure has not been provided to inform drivers in advance to drive carefully through this junction.

### Conclusions

Based on the above analysis of accidents on SH20, the results of the road safety issues and the contributing infrastructure factors have been tabulated below:

Crash Configurations	Pre-crash Event	Contributing Infrastructure Factor	Percentage contribution (out of 19 crashes examined)
Front-rear Collisions	Vehicle parked/standing on road side	Narrow paved shoulder	26%
	Turning in	Intersection	5%
	Accident in front	Not Applicable	5%
	Unknown	Unknown	5%
Head-on Collisions	Overtaking	Undivided road	16%
	Turning in	Entry/exit of gas station	5%
Sideswipe	Car stopped on the road side	Narrow paved shoulder	5%
	Vehicle encroaching into oncoming lane	Undivided Road	5%
Pedestrian Impacts	Walking alongside/crossing	Poor Pedestrian Infrastructure	5%

Table 6: Determination of contributing infrastructure factors and their influence on accidents

### Areas of improvement in infrastructure

1. Narrow paved shoulder accounted for 31% of the accidents.
2. Undivided road accounted for 21% of the accidents.
3. 5% of the crashes were caused due to poor pedestrian infrastructure.
4. 5% of the crashes occurred near an intersection.

### Road users to be considered

1. Farm tractors: Low volume but high involvement in road accidents.
2. Trucks and cars: High volume and high involvement in road accidents.
3. Motorized two wheelers: High volume and most vulnerable.

### Other important issues to be considered

#### Agricultural produce on road

There are farms on both sides all along the stretch. The agricultural produce from these farms is often seen to be laid out on the roads for drying or loading onto trailers towed by farm tractors. This produce on the road creates conditions for vehicles to skid and lose control, thus, causing injury not only to the road users but also to the farmers.



Figure 18: Agricultural produce on the road causes vehicles to skid

#### Rumbler strips

Rumbler strip found on this stretch were unscientific and were very high for small as well as medium sized vehicles. They also might cause loss of balance for two wheelers. Although no crashes caused due to rumbler strips were seen in this study, police and people around these places also suggested redesigning these strips as they have seen many accidents occurring due to them. They also lacked any kind of paint or reflectors on them which would make them completely invisible in the night.



Figure 19: Rumbler strips as seen on SH20

### Multiple warning signs

Multiple warning/road side signs at a single place should be avoided as they cause confusion to drivers. Or they may simply be ignored.



Figure 20: A series of road signage on SH20 near Chandargi

### Driving under influence (DUI)

Driving under influence (DUI) of alcohol increases the reaction time of drivers resulting in poor driver control. Many accidents involve drivers under the influence of alcohol and hence strict enforcement and checking of this condition can also decrease the number of accidents by a great number.

## Appendix A: Vehicle Type Definitions

### M2W - Motorized two wheelers

Any vehicle that is motorized and operates on two wheels. This includes bikes, mopeds, scooters and scooterettes.



Bike



Moped



Scooter



Scooterette

### M3W - Motorized three wheelers

Any vehicle that is motorized and operates on three wheels. This includes three wheeled auto rickshaws that are exploited either as a goods carrier or passenger carrier.



Goods carrier



Passenger carrier

### Car

Any vehicle that is motorized and operates on four wheels and essentially conceived as a passenger carrier. This includes all types of passenger cars like sedan, jeep, van and hatchback.



Sedan



Jeep



Van



Hatchback

### Truck

Any vehicle that is motorized and operates on four or more wheels and is essentially conceived to carry goods. This includes pickup trucks, two axle trucks, three axle trucks, multi axle trucks, tipper trucks, tanker trucks and tractor trailers.



Light commercial truck



Light commercial truck (pick-up)



Tractor



Tipper truck



Tractor with trailer



Multi axle truck



Two axle truck



Tanker

## Bus

Any vehicle that is motorized and operates on four or more wheels and is essentially conceived as passenger carrier. This includes four wheeled mini bus, six wheeled city bus, six wheeled intercity liner, ten wheeled (three axle) intercity liner.



Mini bus



Two axle bus



Multi axle bus

## Others

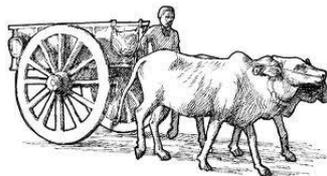
Any vehicle that is motorized and that does not come under the above said categories. This includes heavy earth movers, farm tractors, and specialized custom made vehicles.



Farm tractor

## Non-motorized

Any vehicle that is not motorized and is either used as a passenger carrier or a goods carrier. This includes animal driven carts and carriages and cycle rickshaws.



Bullock cart

## Bicycle

Any vehicle that operates essentially on two wheels and is not motorized.



Bicycle

## Appendix B: Police Data Coding Format

Following variables are collected from police reported accidents:

1. Serial No
2. Year
3. Police Station
4. Crime No.
5. Injury Severity
6. Section of Law
7. Date of Accident (DOA)
8. Time of Accident (TOA)
9. Location
10. Road Type
11. Fatal Male
12. Fatal Female
13. Injured Male
14. Injured Female
15. Property Damage
16. Type of Collision
17. Type of Vehicle involved
18. Highest Injury Severity Road User Type
19. Number of vehicles involved

## Appendix C: Crash Configuration Types

Crash configuration can be roughly defined as the type of accident based on the direction of travel and the general area of damage to vehicles during the collision. For this study, crash configuration was generally divided into one of seven categories:

1. Front-Rear Collision
2. Front-Side Collision
3. Head-On Collision
4. Sideswipe
5. Rollover or Loss of Control
6. Pedestrian/Bicycle Impact
7. Animal or Object Impact

These categories are described, with examples, in the following paragraphs.

### Front-Rear Collision

This type of collision occurs between two vehicles, where one vehicle (leading) is travelling/stopped ahead of the other vehicle (following), both travelling in the same direction. Usually such collisions occur due to the slowing down of the leading vehicle, or with a stationary (parked/stopped) vehicle, as shown in figure. Note that this example also shows a trailer under-ride, which can be particularly dangerous to occupants of the following vehicle since that vehicle may have virtually no protective/bumper contact with the leading vehicle until its bumper reaches that vehicle's tires (or until the windshield/cab of the passenger compartment contacts the rear of the truck/trailer).



### Front-Side Collision

This type of collision occurs between two vehicles, where the front plane of one vehicle's contacts the side plane of another vehicle during collision. Most commonly, this sort of collision takes place in intersections and during U-turns.



### Head-On Collision

When two vehicles approaching each other in opposite directions collide with each other, such a collision is called a head-on collision. It is most common on undivided roads, when one vehicle is trying to overtake and is in the oncoming lane. Speed and relative size of the colliding vehicles can greatly affect how serious this type of collision is in terms of occupant injury and vehicle damage. The



head-on collision shown in figure, for example, reveals very little crumple; the same scenario with a compact car in the place of one of the trucks would likely show a very different outcome.

### **Sideswipe**

Side-swipe is when two vehicles, travelling in the same direction or in opposite direction to each other, collide in such a way that their side planes (as shown in figure) just rub each other with a very little overlap between the two.



### **Rollover or Loss of Control**

Rollover describes the overturning of a vehicle along its longitudinal or lateral axis. The usual case is when a vehicle loses control, goes off-road, and rolls. However, a rollover can also take place on-road. In case of two wheelers losing control and falling down, such an event would only be called a “Loss of Control”. As shown in figure, a rollover means that multiple sides of the vehicle will come into contact with ground or other objects, presenting multiple opportunities for occupant contact with the vehicle’s interior and for the vehicle to come into contact with objects that could lead to intrusion into the passenger compartment. Rollovers can also be initiated by any another type of collision (a sideswipe, for example), but often they are single-vehicle crashes.



### **Pedestrian/Bicycle Impact**

When a vehicle hits a pedestrian or a bicycle, such an impact is coded as a pedestrian/bicyclist impact.

### **Animal or Object Impact**

When a vehicle hits an animal, it is coded as an animal impact. When the impact is with an inanimate object that is not a vehicle, it is coded as an object impact.