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# Better Street Designing for Mobility Problem: A Case Study on Arterial Road of Rajkot City

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**Abstract:** *Streets occupy approximately 20% of the total land area in a typical city. It plays a vital role in the development of the towns and cities since the beginning and it is important form of public space. Recently, streets have been reduced to more restricted role of serving as conduits for the mobility of heterogeneous traffic. The situation is getting worse every day as the number of private vehicles grows exponentially.*

*There is an urgent need to look after the streets where people walk, talk, cycle, shop, and perform multitude of social functions that are critical to the health of the cities. Cities identity mainly depends upon the design of streets.*

*Modern streets also carry a number of infrastructure services such as water, sewer, storm water, electrical, and telephone lines. In this study, a stretch of Kalawad road of Rajkot city of 2 km i.e. from KKV chowk to Jaddu's Food Field is selected for carrying out Road Safety Audit as per IRC: SP-88 (2010).*

*Data collection includes road inventory survey, photographic survey, classified volume count, spot speed study survey, accident data from police station, and checklist as per IRC. This work focuses on evaluating existing road condition, prioritizing the movement of slow moving modes like cycle and pedestrian, reducing barriers affecting the mobility, and providing recommendations and suggestive design as per Indian Road Congress.*

**Keywords:** *Livable Street, Mobility, Street Design, Road Safety Audit, Walkable Street*

## I. INTRODUCTION

As per UN (United Nations) statistics, urbanization trend in India is 31.16%, in Gujarat is 42.59% and in Rajkot District is 58.12%. Times of India states about urbanization problems that road accidents claims five times more lives than murders in 2018. Average speed of ridership in Bengaluru is 18 kmph and is highest in between 3am to 6am i.e. 33 kmph. This is due to rapid increase in the growth of vehicle number.

1000 new vehicles are registered daily in Hyderabad causing traffic congestion where commuters thrown off balance in traffic. UNESCO (United Nations Educational, Scientific and Cultural Organization) identified that increase in number of vehicles day by day causes congestion on streets.

Mobility of pedestrians get affected on footpath by encroachment of other modes of vehicle. Rising numbers of 2-wheelers and 4-wheelers in city increases passenger's ridership day by day, which has reached to 1.3 to 1.5 lakh passenger's ridership in Ahmedabad in 2018.

High Court giving notice to Ahmedabad Municipal Corporation for not removing parked vehicles and auto-rickshaws on road. This unauthorized parking causes hindrance to mobility of other vehicles and causes traffic jams. In Rajkot, most city roads (97%) has a right of way of upto 30m.

The average speed of all modes in the city is 16 kmph, and is much lower in the old city area due to delays from the narrow streets and people walking on the streets. Most arterial roads have average speeds higher than 20 kmph. Footpaths are on all major roads in the city, but in most areas the width is less than 1.5m and is encroached upon by street furniture, telephone boxes, tree, and make-shift shops. The average trip length for the city is approximately 3.8 km, inclusive of walk trips. The motor vehicle growth is 9.5% annually and the highest growth is of 2-wheelers, is 9.8%.

## II. STUDY AREA

A 2.1 km stretch of Kalawad road of Rajkot city is selected for the study. The stretch starts from KKV chowk and ends at Jaddu Food Field (JFF). It is the busiest road in terms of traffic. It connects various public parks, temples, malls, hotels, theatre and schools. It is an arterial road connecting Central Business District (CBD) to Gujarat Industrial Development Corporation (GIDC) Metoda. It connects Educational zone, Commercial zone and Industrial zone along its length.

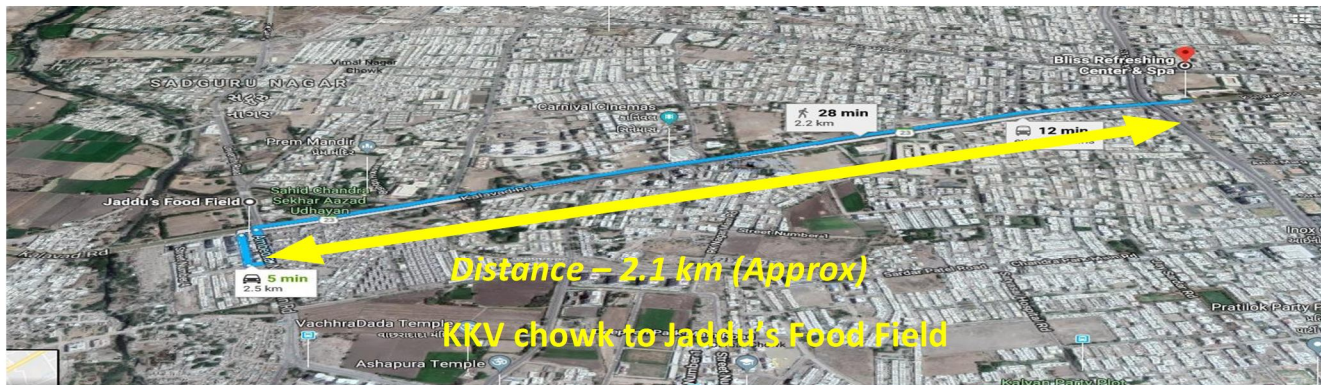


Fig. 1 - Satellite map of selected stretch of Kalawad road

Table 1 – Road infrastructure details of selected stretch of kalawad road

Road infrastructure detail of selected stretch of kalawad road	
Particulars	Existing
Roads	Regional road
Length of selected stretch	2.1 km
Minimum Effective carriageway width	7.4 m
Maximum Effective carriageway width	15.7 m
Minimum Right of way	24.7 m
Maximum Right of way	37.1 m
Divided/Undivided	Partly Divided

### III.SCOPE OF THE STUDY

The scope of study is to perform Road Safety Audit for the selected 2.1 kilometre stretch of Kalawad road i.e. from KKV chowk to Jaddus Food Field chowk and suggest recommended measures for necessary improvement and propose a better street design.

### IV.OBJECTIVE OF STUDY

The objective of the study is as follows:

- A. To evaluate the existing road geometry, road condition, road markings-signs, road-side furniture for the present traffic conditions.
- B. To reduce the barriers like obstruction by trees, obstruction by wrong side parking, and provide respective recommendations.
- C. To propose the better street design

### V. DATA COLLECTION AND ANALYSIS

A. The following data for the study area were collected

- 1) Road Inventory Survey
- 2) Photography Survey
- 3) Classified Volume Count and Percentage Vehicular Composition
- 4) Spot Speed Study
- 5) Accident Data from Police Station

B. Road Inventory Survey

The width of selected stretch of Kalawad road i.e. from KKV to Jaddus Food Field is measured. Chainage is taken at all junctions from reference point (KKV hall chowk). The width of road is measured at those junctions. The average width of the kalawad road from KKV chowk to Jaddu's Food Field is 27.08 meters. This dimensions falls under the criteria of minimum right of way 24.7 meters to maximum right of way 37.1 meters.

Table 2 – Dimension of Kalawad Road (width of road and number of junction)

Sr. No.	Junction Landmark	Chainage from previous Location (m)	Width of Road (m)	Chainage (m)
1	KKV Hall Chowk	0.0 m	30.20 m	0.0 m
2	Krishna Medicine	304.30 m	25.01 m	304.30 m
3	Satyasai Hospital Road	222.40 m	22.42 m	526.70 m
4	RMC Swimming Pool Road	238.40 m	25.53 m	765.10 m
5	Jyoti Nagar Main Road (crystall mall)	340.30 m	28.64 m	1105.40 m
6	B.I.S. Office Corner	258.50 m	25.70 m	1363.90 m
7	Pushkar Dham Main Road	310.26 m	27.98 m	1674.16 m
8	Sankalp the taste of south restaurant	65.60 m	27.98 m	1739.76 m
9	Jaddu's Food Field Chowk	300.20 m	30.26 m	2039.96 m

### C. Photography Survey

The 2.1 kilometre stretch of Kalawad Road is divided into 50 metre sections each showing real conditions of road. It marks the obstruction caused in mobility of vehicles, land use pattern of road, use of road side furniture and improvement needed for the use of road by road users.

Table 3 – 50 m sections of selected stretch of kalawad road i.e. KKV chowk to JFF chowk

Section No.	Landmark 1	Landmark 2 (Opposite of Landmark 1)	Chainage (m)
1	KKV Chowk (divider starting point)	KKV Chowk	00 - 25 m
2	Gate-B of GT Sheth School	Gate-2 Utsav Party Plot	25 - 50 m
3	Bank of India	IDBI Bank	50 - 100 m
4	I shree Khodiyar pan corner	Jokal Cards	100 - 150 m
5	Ravi Prakashan	KKK pan corner & cold drinks	150 - 200 m
6	Mile Stone Apartment Gate	Om Fast Food	200 - 250 m
7	Krishna Medical	Ram Dham 2,4,5,6 Street	250 - 300 m
8	Pride Corporate Building	Ram Dham Street No.-3	300 - 350 m
9	Khetla Aapa Tea Stall	Aavaas Wall Class B-84	350 - 400 m
10	Corporation Bank	Aavaas Wall Class B-84 Gate	400 - 450 m
11	K7 International	RMTS Pick Up- Atmiya College	450 - 500 m
12	Corporation Plot Wall	Atmiya Gate (Electric Sub Station)	500 - 550 m
13	Corporation Plot Wall	Atmiya Gate	550 - 600 m
14	Indian Oil Fuel Station	Atmiya College Wall	600 - 650 m
15	RMC Swimming Pool	Atmiya College Wall	650 - 700 m
16	RMC Swimming Pool Gate - 2	Atmiya College Wall	700 - 750 m
17	Kendriya Vidhyalaya School Wall	Atmiya College Wall	750 - 800 m
18	Kendriya Vidhyalaya School Gate	RMC Bus Stop	800 - 850 m
19	Kendriya Vidhyalaya School Wall	Pradhan Mantri Jan Aushadhi Kendra	850 - 900 m
20	Kendriya Vidhyalaya School Wall	Pradhan Mantri Jan Aushadhi Kendra	900 - 950 m
21	Kendriya Vidhyalaya School Wall	ESR- Eleated Service Reservoir	950 - 1000 m
22	Samaj Suraksha Khatu - Gujarat Rajya	City Bus Pick Up- Crystall Mall	1000 - 1050 m
23	Mansik Kshati vada badko nu gruh	One Center corner	1050 - 1100 m
24	Crystall Mall	Shell Petrol Pump	1100 - 1150 m
25	Just in Time- Crystall Mall	Rani Tower	1150 - 1200 m
26	Government Boys Hostel	IBP Auto Service	1200 - 1250 m

27	Government Boys Hostel	Gov. Water Treatment Plant	1250 - 1300 m
28	Government Boys Hostel	Bharat Petroleum	1300 - 1350 m
29	RMC Nyari Filter Plant	Open Land Area	1350 - 1400 m
30	RMC Nyari Filter Plant	Open Land Area	1400 - 1450 m
31	RMC Nyari Filter Plant	Open Land Area	1450 - 1500 m
32	BSNL Office	Mitsubishi Motors Showroom	1500 - 1550 m
33	Om Sai nath Roses Nursery	Sales India Showroom	1550 - 1600 m
34	Jalaram Restaurant	Sadguru Colony Gate	1600 - 1650 m
35	Pushkardham Road	Neel ka Dhaba	1650 - 1700 m
36	Jail na Bhajiya	Om Ruda-1 Plot Ho. Association	1700 - 1750 m
37	Sankalp The Taste of South Restaurant	Open Land Area	1750 - 1800 m
38	RMC Public Bath & Toilet	Culvert	1800 - 1850 m
39	Love Temple Garden (drainage line)	Slum Area	1850 - 1900 m
40	Love Temple Garden (drainage line)	Balaji Pan & Cold drinks	1900 - 1950 m
41	Temple	Daya Bapa Tanduri Matka Chaa	1950 - 2000 m
42	Jaddu's Food Field Chowk	Jaddu's Food Field Chowk	2000 - 2050 m

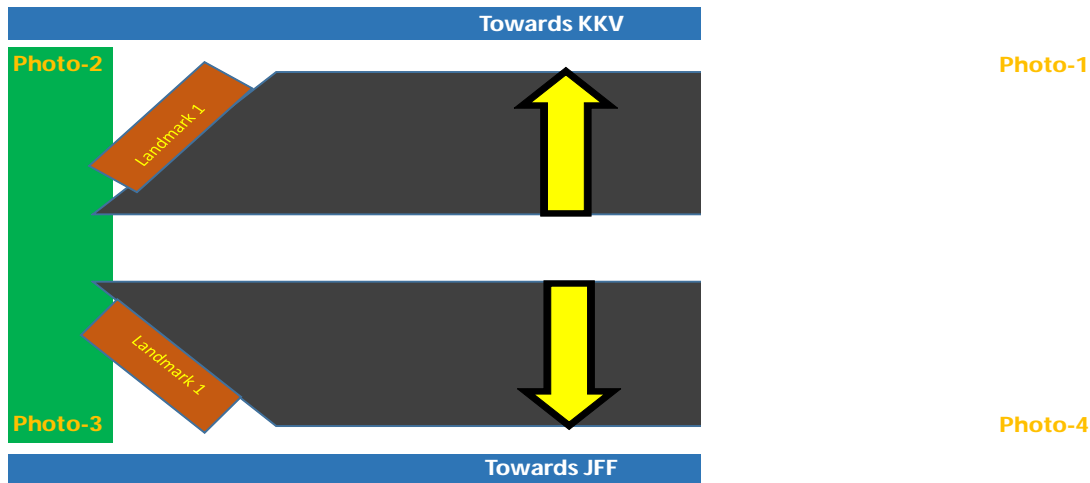


Fig. 2 – Template of Photography Survey

**D. Classified Volume Count and Percentage Vehicular Composition**

Classified volume count is carried out for determining traffic on selected stretch of Kalawad road. It is conducted for 24 hours-2 days by video-graphic method. The categories of vehicle observed are Heavy Commercial Vehicle, Bus, Light Commercial Vehicle, Car, Auto, Two-wheelers, Non-motorised Vehicle and Pedestrian. In the survey, the two-wheeler vehicles movement is more compared to others. This is because there are 4 schools, various hotels, malls, commercial business buildings and GIDC Metoda Industrial zone in the route.

Table 4 – Passenger Car Unit (PCU) calculation

Type of vehicle	ADT (veh/day)	PCU of vehicle	ADT (PCU)
HCV	419	4.5	1885.5
Bus	367	4	1468
Light Commercial Vehicle	1752	2.8	4905.6
Car	7947	1	7947
Auto	5640	1.6	9024
2-wheeler	30906	0.5	15453
Non-motorised Vehicle	1481	0.6	888.6
Pedestrian	3664		0
Total	52176		41571.7

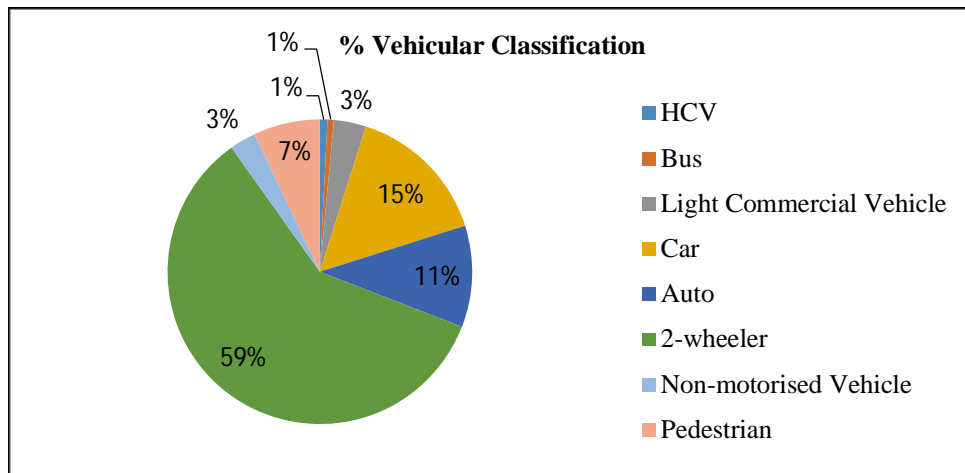


Fig. 3 – Percentage Vehicular Classification

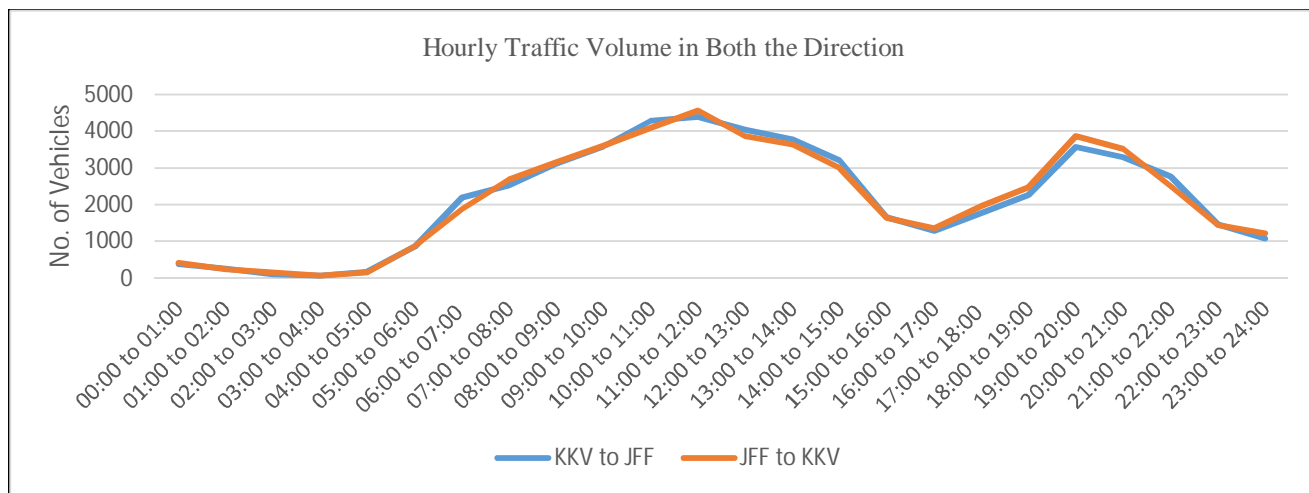


Fig. 4 – Hourly Traffic Volume in both the Direction

**E. Spot Speed Study**

The Bushnell Radar gun is used to measure the spot speed study. The average number of samples taken for the survey is 5-10% of the total classified volume count survey. The spot speed study is conducted at four locations on the road stretch. Locations are at ravi prakashan, KKK pan-cold drink (opposite of ravi prakashan), open slum area and love temple garden (opposite of open slum area). It is observed that the speeds of vehicles are as per design speed limit except some vehicles. During high traffic hours, desired speed limit cannot be achieved for free movement of vehicles.

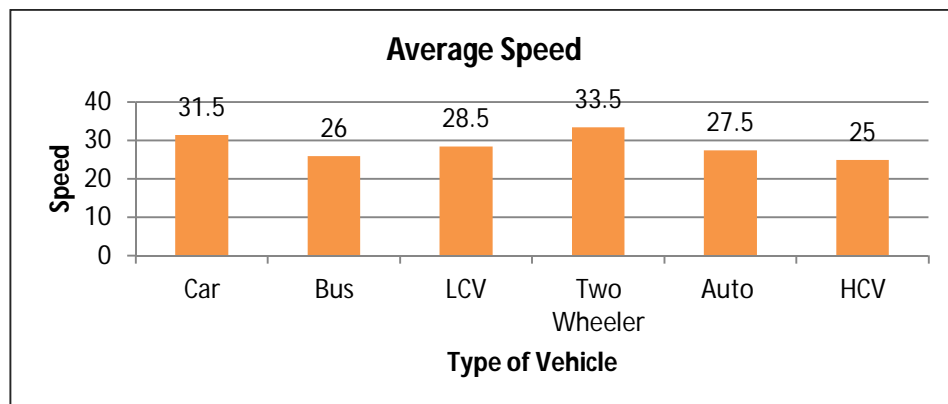


Fig. 5 – Average Speed of Vehicles

**F. Accident Data from Police Station**

The accident data are collected from Gandhigram Police Station, as the study area falls under this station. The data of last 5 years are collected i.e. from 2013 to 2017. The data are classified as type of accident, number of accidents per month and number of accidents per time interval.

The average number of accidents from 2013 to 2017 year is 45 accidents per year out of which 69% are minor accidents, 22% are major accidents and 9% are fatal accidents. Most of the accidents occurred in the time period of 12:00 to 14:00 and 20:00 to 22:00

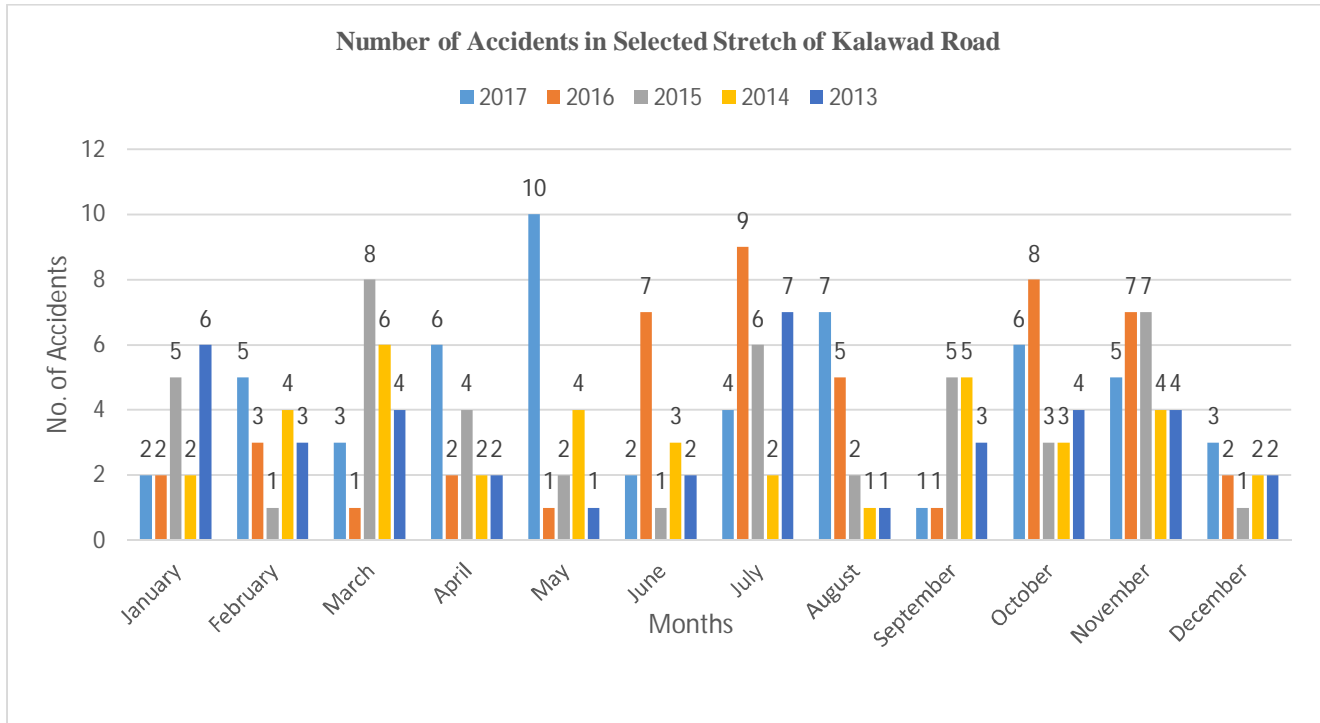


Fig. 6 –Number of accidents per month for the year 2013 to 2017

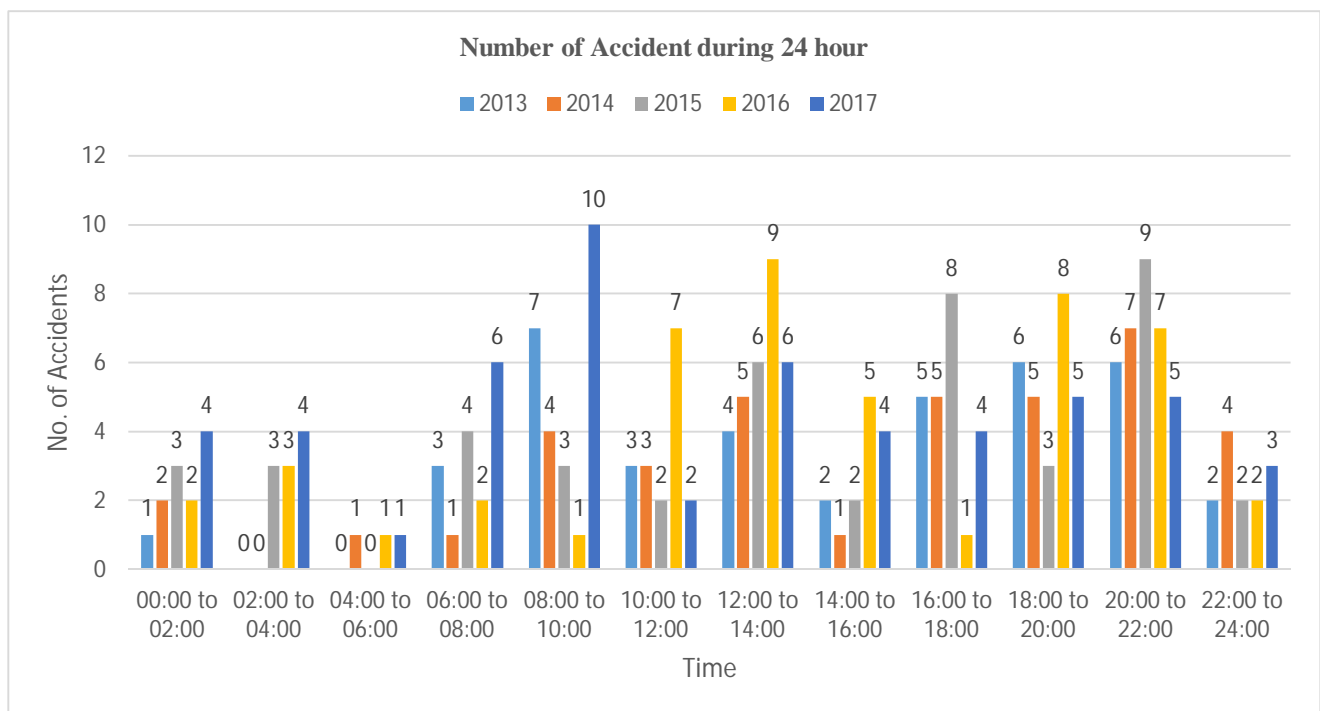


Fig. 7 –Number of accidents in 2 hours duration for 24 hours for the year 2013 to 2017

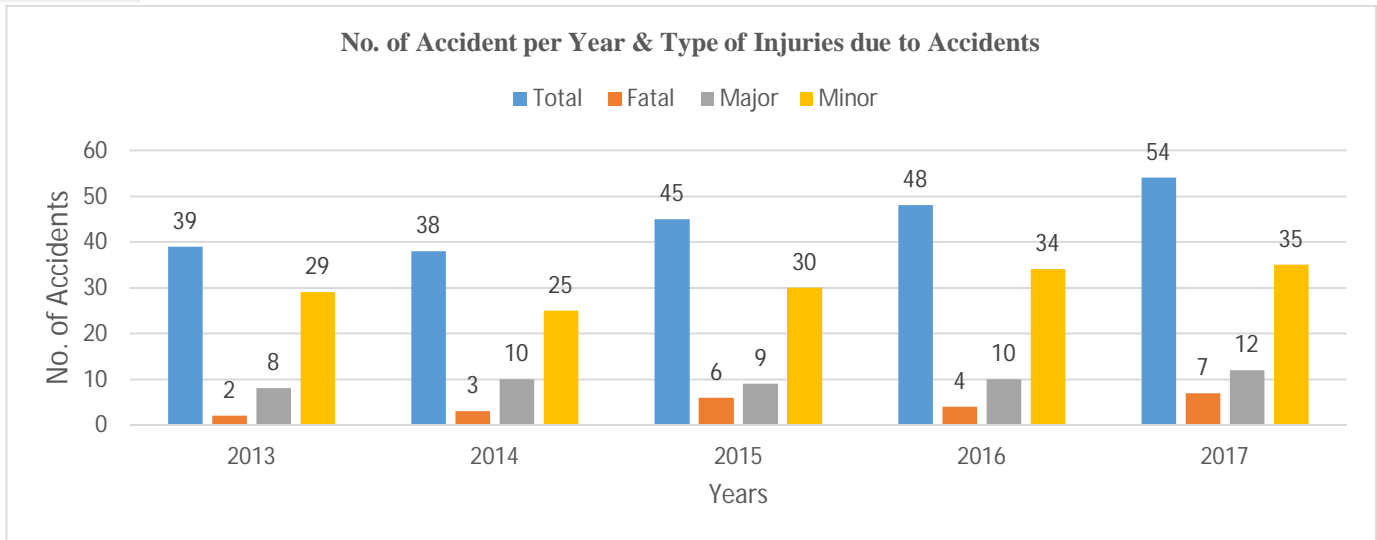


Fig. 8 –Number of accidents in 2 hours duration for 24 hours for the year 2013 to 2017

### VI. CONCLUSION

- A. Traffic volume is high compared to present design of existing stretch of kalawad road.
- B. The speed is not as high as the design speed during the peak hour function nearby schools and colleges; this reduces the required space for the free flow of traffic mobility.
- C. During peak hour of traffic operation, overtaking opportunities are low.
- D. The road markings, reflectors and signs are missing throughout the road at various locations.
- E. Excessive provision of hoardings and landmarks at same place confuses the driver.
- F. On the culvert, provision of sign board of bottle neck approach is required.
- G. The poor pedestrian facilities are observed throughout the road, proper crossing facilities for pedestrians are required on the roadway.
- H. The separation of slow moving traffic is required as the percentage share for pedestrian is 10% and cycle is 4%
- I. Sign boards for parking lots and reflectors for shoulder trees are required to improve the mobility.
- J. Provision of underground water drainage lines are required to reduce the coagulation of water on road stretch.
- K. An obstruction by trees causes the accidents, accumulation of vendors nearby trees and parking of vehicles nearby trees reduces carriageway width which hinders the mobility of other vehicles.
- L. Sign boards for auto rickshaw should be placed nearby schools for smooth movement of vehicles on road during peak hours and reduce congestions.

### VII. RECOMMENDATIONS

- A. Width of road is adequate but it need to be furnished for proper usage.
- B. Provision of parking of vehicles needed in business zones and where there are provisions, they need to be maintained and furnished with sign boards.
- C. Adequate width of footpath needed i.e. approximately 1.8 m to 2.0 m.
- D. Obstruction on footpath like electric poles, substations, trees, etc should be removed for proper movement of pedestrians.
- E. Excessive hoardings and landmarks should be reduced for making undistracted driving for road users.
- F. Reflectors should be placed on shoulder trees for making effective mobility of vehicles during night hours.
- G. Traffic calming instruments should be placed nearby schools and colleges.
- H. No Horn and No Parking sign boards should be placed nearby schools and colleges.
- I. Sign boards for Narrow Road Ahead, Speed Limit signs, School Ahead signs, etc. should be installed for effective operation of road.
- J. Separate parking areas should be provided and restricted parking zones should be maintained.
- K. Appropriate maintenance and installation of informatory signs should be placed.
- L. Illegal parking and encroachment of street vendors should be removed for making effective use of carriageway.

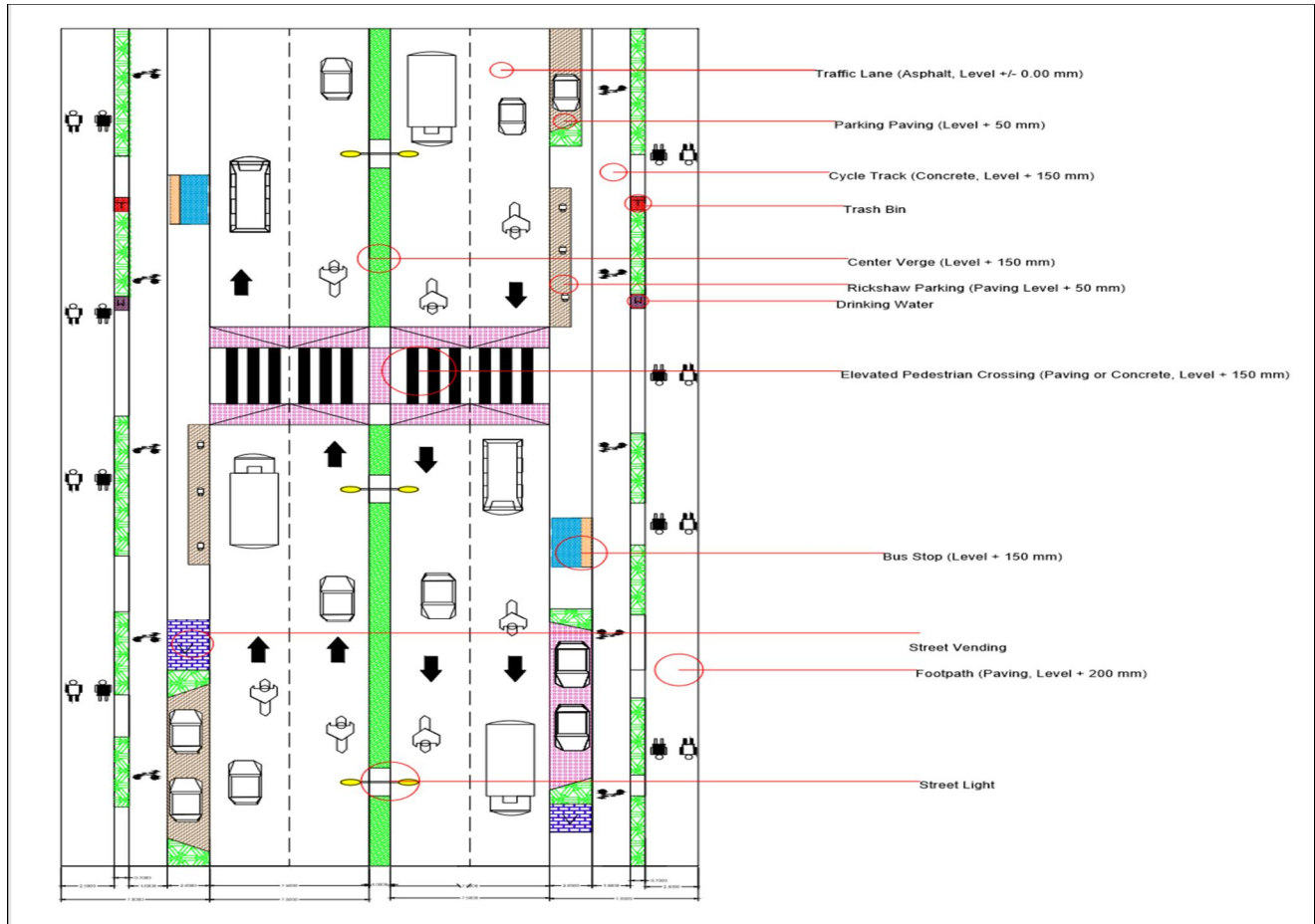


Fig. 9 –Plan view of proposed design for selected stretch of road

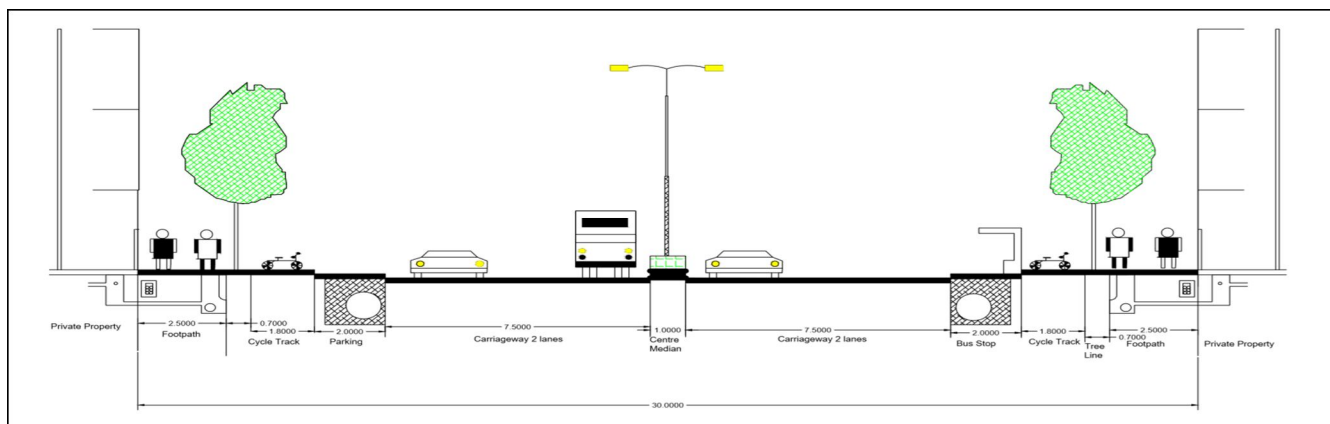


Fig. 10 –Cross section view of proposed design for selected stretch of road

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