



# Effect on Various Traffic Flow Parameters before and After Widening of Sardar Bridge Passing Over the Tapi River – A Case Study of Surat City

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## ABSTRACT

Traffic continues to grow with population growth. The increase in vehicle rates directly impacts the new route. There are three main characteristics of the traffic flow: volume, speed and density. In this study shown if the bridges are not built, from what route the vehicle travels. After a construction of new rout what impact on the traffic flow characteristics are mainly measures. In this the past traffic data are collected from the SMC and present traffic data are collected by the manual method. Traffic volume is count by the manual method as well as speed is also count by the manual method. This paper investigated present passenger car unit for the given bridges and give the real scenario of the vehicle volume. The result of the paper reflects the real traffic situation of Sardar bridge on the Tapi River. At the end of paper data and analysis data show that the bridges can satisfy the present vehicle traffic condition or not.

**Key Words:** *Bridge, traffic, vehicle speed, vehicle volume, vehicle density*

## 1 INTRODUCTION

A bridge is a structure constructed to overcome physical obstacles such as a body of water, a valley or a road, in order to allow passage over the obstacle. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed, the material used for construction and the funds available to build it. There are three major components to a bridge. First, the sub-structure (foundation) transfers the load from the bridge to the ground; it consists of components like columns (also called piers) and abutments. An abutment is the connection between the end of the bridge and the ground road that provides support for the end sections of the bridge. Secondly, the bridge superstructure is the horizontal platform that spans the space between the pillars.

The bridges are built to provide easy and practical movement of traffic for a place in an uninterrupted place. The bridges also contribute greatly to the aesthetic of the town. People travelling on the bridge can enjoy the panoramic view of the town. The bridges have reduced travel and travel expenses. It diverts the traffic in the various directions. Bridges influence traffic patterns, such as vehicle speed, traffic, and traffic volume and road capacity.

Traffic impact analysis should be used as a virtual part of several types of data to judge a different traffic flow parameter. Traffic flow is the study of the movement of drivers and vehicles between two points and how they interact with each other.

### 1.1 STUDY AREA

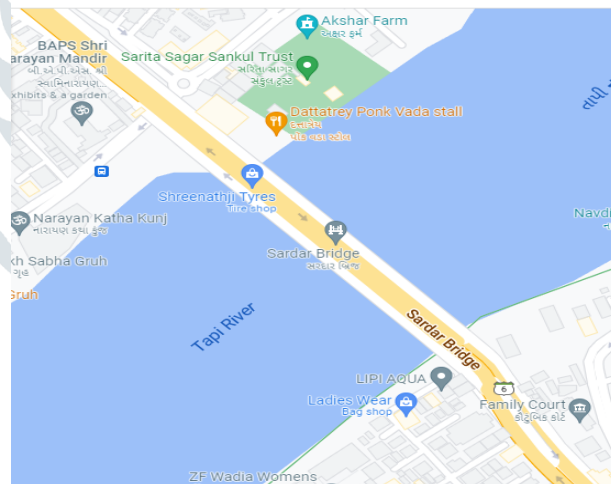
In India, the geographical viewpoint of the city of Surat is 260 km north of the city of Mumbai and 224 km south of the city of Ahmadabad. On the map it is  $21^{\circ} 12'$  north latitude,  $72^{\circ} 52'$  east longitude near the shoreline of the Tapi River. Surat is a city located on the western part of India in the state of Gujarat.

Surat is also known as a city of bridges, In Surat presently 124 bridges in Surat. In this instance, there are 60 bridges at Creek, 28 bridges over bridges, 18 railway bridges and 18 river bridges.



### 1.2 Sardar Bridge

As the development took place in the Rander and Adajan of western part of Surat city, traffic was increased on Nehru Bridge and in the year 1991, Sardar Bridge near Athwagate was constructed in the year 1996.



**Figure 1.Sardar bridge Google image**

Considering the future development of Adajan, Pal& Hazira industrial area to match the requirement of traffic volume. It was decided to construct new bridge between Sardar Bridge & Nehru Bridge which is also helpful to reduce the traffic burden at Chowk junction. It was insisted by merry time board for navigation purposed below the bridge to provide safe Clearances Even during high tide

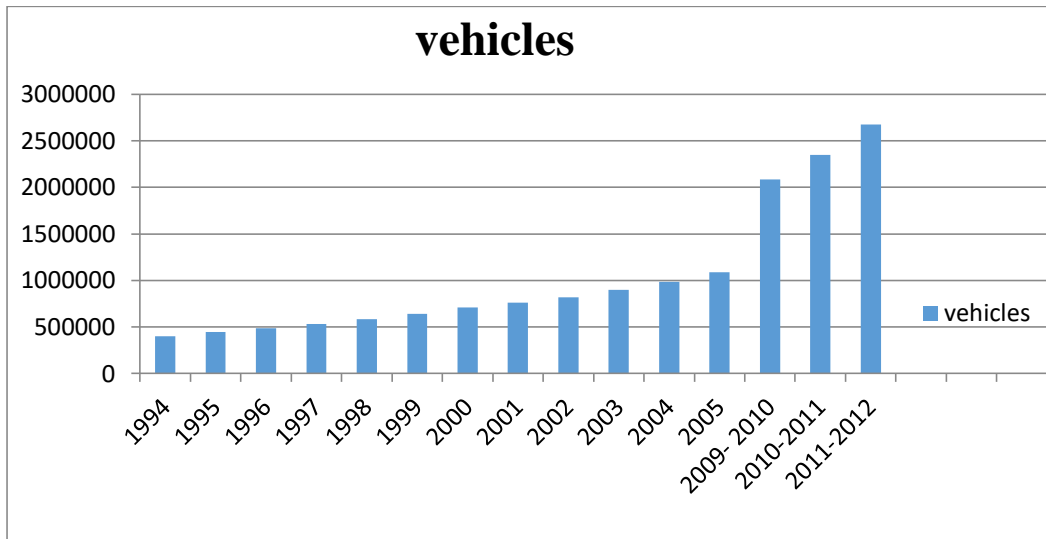
### 1.3 DATA COLLECTION

For the purpose of study traffic data are collected on Sardar Bridge, which were taken on the starting and ending point of bridge. Traffic data was collected for 16 hours from morning 7 to 11 in night on stretch of Sardar bridge. Vehicle passage on bridge counted by manual method.

**1.4 Traffic scenario of Surat:**

Surat city has good road connection network. All roads are carried a various type of vehicle like car, buses, trucks, motorcycles, bicycles, auto rickshaws, LCV, HCV, animal cart, etc. All vehicles has different characteristic related to traffic.

The table below shows the growth of vehicles in % compared with the previous year. The value of the vehicle recorded in RTO increases over time.

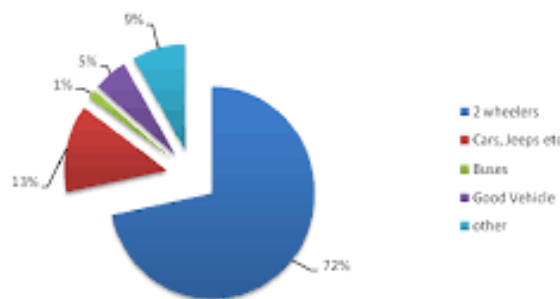


**Figure 2 Vehicle Growths in %**

The above table 1.4 shows the number of vehicle increment by the last decade. The data are collected from the RTO Surat. Increment in vehicle rate it's directly affect on the traffic flow parameter.

**1.5 Vehicle composition:**

The vehicle are registered in RTO are various categories like 2W, 3W, 4W, autoeickshaw, bus and other commercial vehicles. The rate of growth has remained high at 9-10%. In the absence of public transport system the rate of increase in auto rickshaws has been approximately 4.5% whereas rapid increment in the rate of motorcars has been observed in the last year is approximately 12.21 % - 14.1%.



**Fig. 3 Composition of registered vehicle chart**

The number of vehicle are registered in RTO in the year of 1995 is 4 lakh and the present the this is reached the 36 lakh in year of 2012, of this 40% are 2-w and close to 18% are cars. In January 2017 the vehicle growth rate is estimated was 34.84%. With high per capita income, it's a trend to own private vehicles for the fastest journey.

## 2. DATA COLLECTION

The traffic data that has been used in this study for the traffic flow characteristics analysis is primarily collected from SMC bridge cell. The past traffic flow data have been collected from the SMC bridge cell with official permission from civil Department of Modasa. The present traffic data such as a speed, volume, will be measured with the help of manual count method.

### 2.1 Inventory data of bridges

From these data it is known that the primary information about the bridges. The data like construction year, length of bridge and connecting area etc.

**Table 1 inventory data of bridge**

No	Name of bridge	Year of construction	Length of bridge (m)	No of span	Span length (m)	No of lane	Total width (m)	Carriage way width (m)	Footpath width (m)	Divider width (m)
5	Sardar bridge	1991	700.00	14	50	4	22.40	7.5 +7.5	3.25 (both side)	0.9
	After widening	2010	700	14	50	8	36.8	15.5 + 15.5	2.05 (both side)	0.9 between lane

The above table shows the information related to the bridge. This data are collected manual from measuring some component. Other information of bridges is collected from the official website of SMC bridge cell.

### 2.2 Sardar Bridge data

The bridge connects the athwah and adajan area for the movement of vehicle. When the bridge capacity is reduce and need to expand a bridge for the future traffic volume the data are collected by the SMC by the manual count method. The old bridge is not capable to take present vehicle movement so it's decided to expand a bridge. When the traffic increases on Nehru Bridge the Sardar Bridge is constructed to divert the some traffic on it.

The data shown in below table4.2 is taken on the date10/09/2007. On this date the vehicle volume counts data s taken for design of bridge.

### 2.3 Traffic volume

The table 4.2 show the total number of vehicle movement between the athwah and adajan area.

**Table 2 traffic volume data of Sardar bridge from SMC**

Movement	Adajan to athwah	Athwah to adajan
Traffic volume Of 16hr (PCU)	29548	31758
Morning peak hour	10.00 am TO 11.00am	12.00 Noon TO 1.00pm

<b>Peak hour PCU</b>	3571	2824
<b>Evening peak hour</b>	3.00pm To 4.00pm	7.00pm To 8.00pm
<b>Peak hour PCU</b>	2580	3946

(Source: SMC Bridge cell)

The above table 4.2 shows total vehicle volume movement from adajan to athwah and athwah to adajan. From the table it shows that adajan to athwah in morning more trip are took place to athwah side. In evening athwah to adajan more trips generate to reach destination.

#### 2.4 Vehicle speed

For the collection of speed data manual method used. The vehicle speed data are collected by the SMC on the date 10/9/2007. The below table 4.3 show the vehicle speed data collected from the SMC bridge cell.

**Table 3 Vehicle speed data of Sardar bridge from SMC**

TIME : 10.00am TO 10.30am		SARDAR BRIDGE VEHICLE SPEED DATA										
ADAJAN TO ATWAH												
DATE: 10.09.2007 7	2 wheeler			3 wheeler			4 wheeler			HCV		
	TIM E Distance (M)	SPEED		TIM E (Sec)	SPEED		TIM E (Sec)	SPEED		TIM E (Sec)	SPEED	
		M/ S	KM/ H		M/S	KM/ H		M/ S	KM/ H		M/ S	KM/ H
50	10.25	4.8 8	17.6	15.26	3.28	11.80	16.15	3.1 0	11.15	18	2.7 7	10
50	11.25	4.4 4	16.0	16.25	3.08	11.08	15.45	3.2 4	11.65			
50	12.65	3.9 5	14.2	15.48	3.23	11.63	14.2	3.5 2	12.68			
50	12.48	4.0 1	14.4	13	3.85	13.85	15.26	3.2 8	11.80			
50	13.45	3.7 2	13.4	14.56	3.43	12.36	15.6	3.2 1	11.54			
50	15.26	3.2 8	11.8	14.58	3.43	12.35	12	4.1 7	15.00			
50	14.26	3.5 1	12.6	15.26	3.28	11.80	13.36	3.7 4	13.47			
50	15.36	3.2 6	11.7	18.15	2.75	9.92	15.26	3.2 8	11.80			
AVG.			13.97			11.85			12.38			10

The data are representing various categories like 2W, 3W, 4W and HCV vehicle speed. Table shows the every vehicle speed in KM/H for the various vehicles.

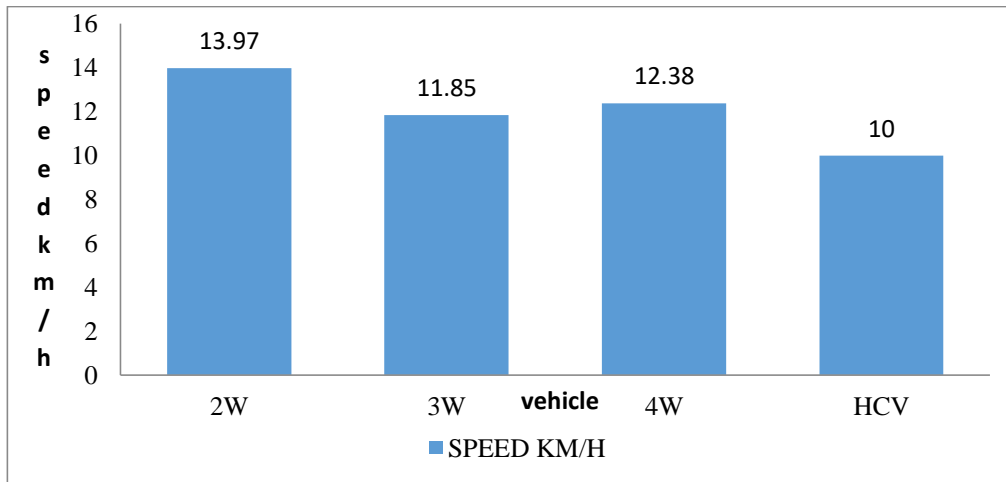


Fig. 4 Vehicle speed data of Sardar bridge from SMC

The above fig 4.2 shows the average speed of 2W, 3W, 4W, and HCV. The shows the average speed of vehicle in peak hour. When the vehicle volume are counted on that day vehicle speed are measured.

2.5 Vehicle Density

The density of vehicle is measure vehicle/km. Vehicle density data collected by SMC using photographic method. The data are shown below in fig 4.3.

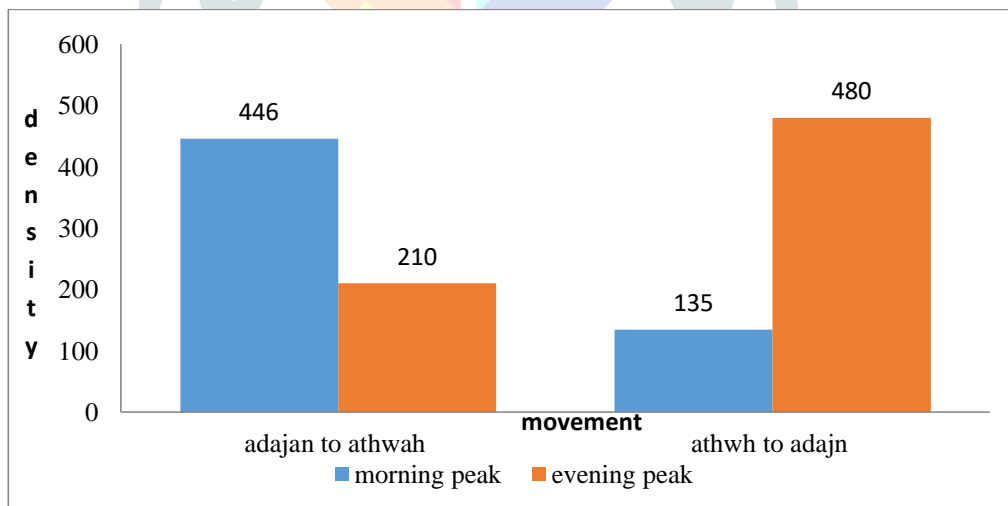


Fig. 5 Vehicle speed data of Sardar bridge from SMC

The fig. 4.3 data shows that in morning hour vehicle density is more from adajan to athwah. For athwah to adajan the density is increase in evening peak hour. Density is calculated using eq.1.3B

The table4.5 show the total number of vehicle movement between the chowk and adajan area. The given below table shows total volume, morning peak hour and evening peak hour of 16 hrs. This data are collected by the manual method

### 3. Present Traffic Data Collection

Present traffic data such as traffic volume, speed of the vehicle and density of vehicle is measured with the manual count method. Present data are collected at the various points of bridges.

#### 3.1 Sardar Bridge

On Sardar bridge traffic data are counted for 2 days. Total 16hr volume of vehicle is counted. The data are collected on date 4/2/21 and 6/2/21. In morning group of member are divided with the different categories of vehicles on various point of bridge. The survey sheet is making before it. The all data are collecting in survey sheet and after that it's summarize

#### 3.2 Graphical representation of volume for athwah to adajan

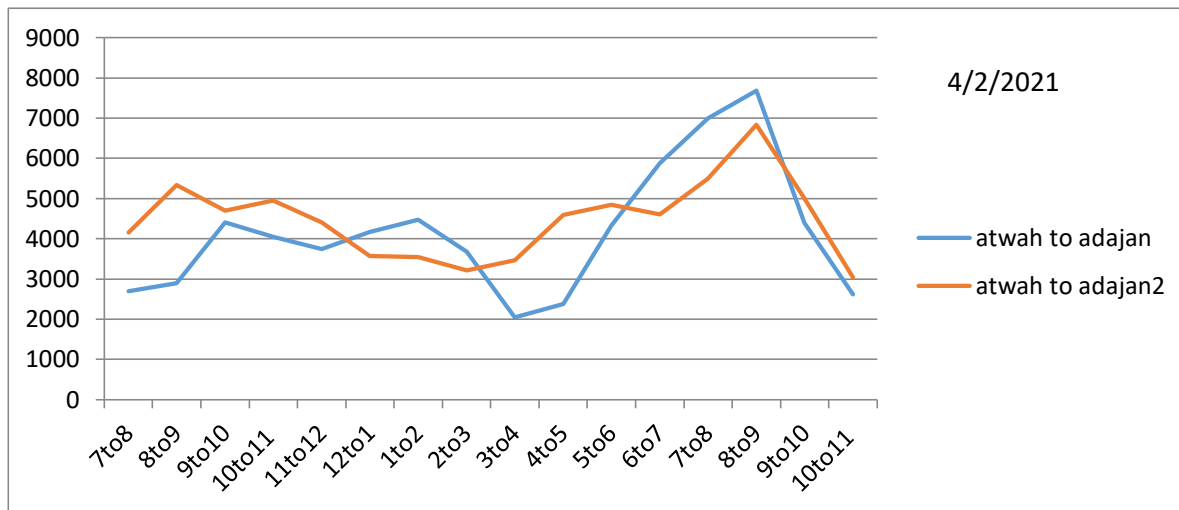


Fig. 6 graphical representation of volume data adajan to athwah

The above two fig 6 shows the graphical representation of the traffic volume data for athwah and adajan area. The data are collected by the manual method with help of survey team. The volumes are increase in morning and after the vehicle are reducing and the volume increase after an evening.

#### 3.3 Vehicle Speed

Vehicle speed is measure manually. Taking a length of 50m and selecting a two point for taking a measurement. Vehicle entre in the area and leaving the both time are recorded. After calculation vehicle speed is calculated.

Table 4 Vehicle Speed Data for adajan to athwah

TIME : 12.00 am TO 12.30Noon			ADAJAN TO ATWAH									
DATE:	2 wheeler			3 wheeler			4 wheeler			HCV		
04.02.21	TIME	SPEED		TIME	SPEED		TIME	SPEED		TIME	SPEED	
Distance (M)	(sec)	M/S	KM/H	(sec)	M/S	KM/H	(sec)	M/S	KM/H	(sec)	M/S	KM/H
50	5.69	8.79	31.63	6.34	7.89	28.39	4.26	11.74	42.25	7.12	7.02	25.28
50	4.36	11.47	41.28	5.78	8.65	31.14	5.26	9.51	34.22			
50	5.36	9.33	33.58	7.23	6.92	24.90	5.67	8.82	31.75			
50	4.69	10.66	38.38	5.26	9.51	34.22	5.1	9.80	35.29			
50	4.87	10.27	36.96	7.15	6.99	25.17	5.23	9.56	34.42			
50	4.85	10.31	37.11	6.89	7.26	26.12	6.12	8.17	29.41			
50	5.45	9.17	33.03	5.58	8.96	32.26	5.48	9.12	32.85			

50	4.25	11.76	42.35	7.23	6.92	24.90	5.26	9.51	34.22			
50	3.48	14.37	51.72	5.69	8.79	31.63	6.12	8.17	29.41			
50	4.18	11.96	43.06	7.25	6.90	24.83	4.87	10.27	36.96			
50	5.56	8.99	32.37	6.48	7.72	27.78	4.69	10.66	38.38			
50	5.26	9.51	34.22	7.26	6.89	24.79	5.87	8.52	30.66			
50	4.56	10.96	39.47	6.69	7.47	26.91	5.67	8.82	31.75			
50	5.48	9.12	32.85	7.26	6.89	24.79	4.14	12.08	43.48			
50	5.48	9.12	32.85	4.69	10.66	38.38	5.69	8.79	31.63			
50	5.4	9.26	33.33	5.87	8.52	30.66	6.71	7.45	26.83			
50	4.9	10.20	36.73	6.75	7.41	26.67	4.63	10.80	38.88			
50	5.23	9.56	34.42	6.96	7.18	25.86	5.87	8.52	30.66			
50	4.58	10.92	39.30	5.48	9.12	32.85	6.48	7.72	27.78			
50	4.69	10.66	38.38	5.63	8.88	31.97	5.69	8.79	31.63			
Average	4.8432		37.7		8.01	28.84	5.5872		32.79	7.12		25.28

The above table 4.7 shows the speed of vehicle for adajan to athwah. The speed of vehicle is counting using eq. 1.3A. The avg. speed of 2W is 37.7km/h, 3w is 28.84km/h, 4w is 32.79km/h and HCV is 25.28 km/h in morning time.

**Table 5 vehicle speed adajan to athwah**

<b>ADAJAN TO ATWAH</b>										
<b>TIME :</b> 4.00pm TO 4.30pm	<b>2 wheeler</b>				<b>3 wheeler</b>			<b>4 wheeler</b>		
<b>DATE:</b> 04.02.21	<b>TIME</b> (Sec)	<b>SPEED</b>		<b>TIME</b> (Sec)	<b>SPEED</b>		<b>TIME</b> (Sec)	<b>SPEED</b>		
<b>Distance</b> (M)		<b>M/S</b>	<b>KM/H</b>		<b>M/S</b>	<b>KM/H</b>		<b>M/S</b>	<b>KM/H</b>	
50	3.69	13.55	48.8	3.98	12.56	45.23	4.58	10.92	39.30	
50	3.5	14.29	51.4	5.65	8.85	31.86	6.2	8.06	29.03	
50	3.14	15.92	57.3	6.5	7.69	27.69	4.25	11.76	42.35	
50	4.19	11.93	43.0	5.45	9.17	33.03	4.26	11.74	42.25	
50	4.17	11.99	43.2	6.45	7.75	27.91	5.26	9.51	34.22	
50	3.5	14.29	51.4	3.58	13.97	50.28	4.15	12.05	43.37	
50	3.4	14.71	52.9	4.58	10.92	39.30	4.26	11.74	42.25	
50	6.2	8.06	29.0	5.69	8.79	31.63	5.26	9.51	34.22	
50	4.26	11.74	42.3	5.26	9.51	34.22	4.69	10.66	38.38	
50	3.56	14.04	50.6	4.25	11.76	42.35	5.32	9.40	33.83	
50	4.67	10.71	38.5	3.89	12.85	46.27	4.25	11.76	42.35	
50	3.48	14.37	51.7	3.58	13.97	50.28	4.36	11.47	41.28	
50	4.99	10.02	36.1	4.25	11.76	42.35	3.15	15.87	57.14	
50	3.98	12.56	45.2	3.26	15.34	55.21	4.78	10.46	37.66	
50	3.98	12.56	45.2	5.26	9.51	34.22	4.12	12.14	43.69	
50	4.98	10.04	36.1	4.28	11.68	42.06	5.26	9.51	34.22	
50	3.58	13.97	50.3	5.29	9.45	34.03	3.26	15.34	55.21	
50	3.25	15.38	55.4	6.45	7.75	27.91	4.26	11.74	42.25	



50	3.54	14.12	50.8	4.15	12.05	43.37	4.23	11.82	42.55
50	4.9	10.20	36.7	5.26	9.51	34.22	3.69	13.55	48.78
Avg.Speed &Time	4.048		45.8	4.853		38.67	4.4795		41.22

The above table4.8 shows the speed of vehicle for adajan to athwah in 4pm to 4.30pm. The avg. speed of 2W is 45.8 km/h, 3w is 36.67 km/h, and 4w is 41.22 km/h in evening hour. The speed of vehicle is counting using eq. 1.3A.

**Table 6 vehicle speed adajan to athwah**

TIME : 10.00am TO 10.30am		ADAJAN TO ATWAH							
DATE:	2 wheeler			3 wheeler			4 wheeler		
04.02.21	TIME (Sec)	SPEED		TIME (Sec)	SPEED		TIME (Sec)	SPEED	
Distance (M)		M/S	KM/H		M/S	KM/H		M/S	KM/H
50	5.23	9.56	34.4	6.48	7.72	27.78	6.98	7.16	25.79
50	5.12	9.77	35.2	5.71	8.76	31.52	5.96	8.39	30.20
50	4.26	11.74	42.3	6.15	8.13	29.27	6.23	8.03	28.89
50	4.67	10.71	38.5	5.18	9.65	34.75	5.87	8.52	30.66
50	3.45	14.49	52.2	6.78	7.37	26.55	6.12	8.17	29.41
50	5.48	9.12	32.8	5.87	8.52	30.66	5.64	8.87	31.91
50	4.58	10.92	39.3	5.67	8.82	31.75	6.78	7.37	26.55
50	4.15	12.05	43.4	4.78	10.46	37.66	6.98	7.16	25.79
50	3.48	14.37	51.7	5.87	8.52	30.66	6.69	7.47	26.91
50	3.24	15.43	55.6	7.63	6.55	23.59	7.23	6.92	24.90
Avg.	4.366		42.5	6.012		30.42	6.448		28.10

The table4.9 shows the movement between adajan to athwah. The average speed of vehicles are registered is for 2W is 42.5km/h, for3W is 30.42km/h and for 4W IS 28.10 km/h. No HCV is registered during peak hour.

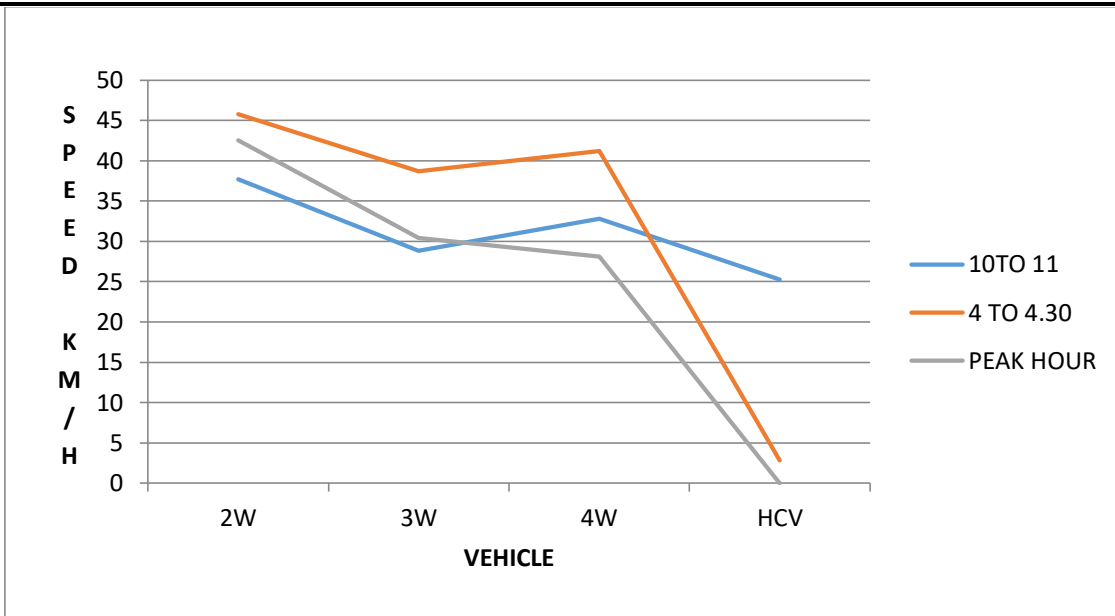


Fig. 7 Vehicle speed for adajan to athwah

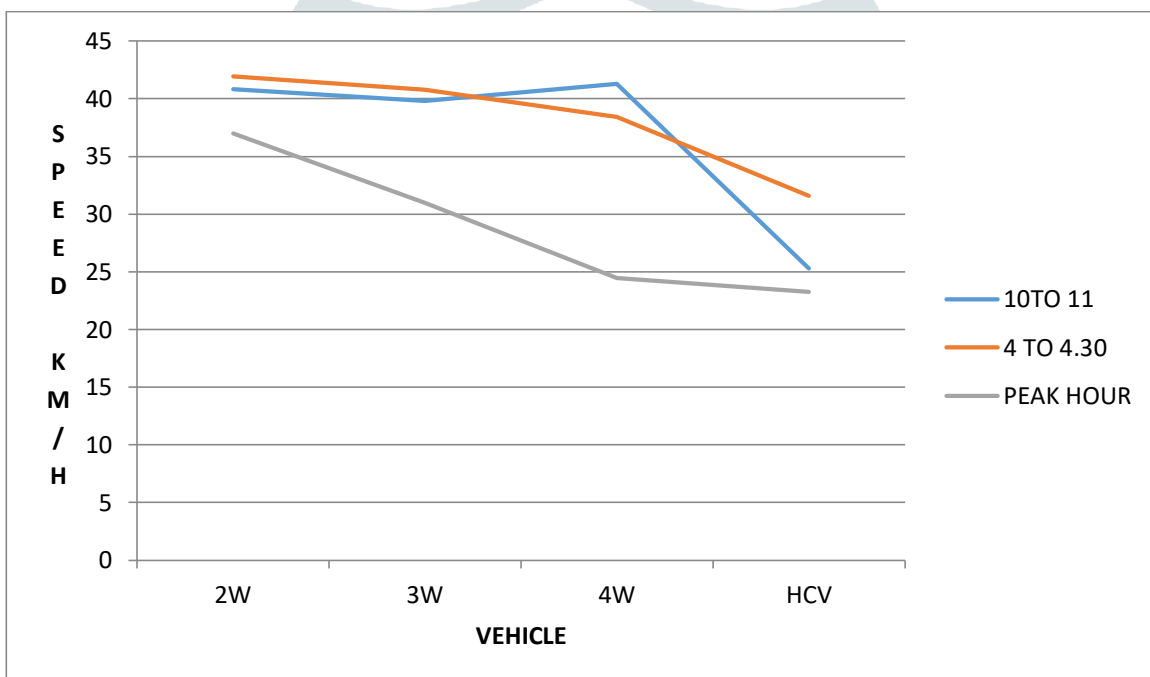


Fig. 8 Vehicle speed Athwah to adajan

The above fig 7 and 8 shows the vehicle speed for the both lane. From the graph its shows that in morning hour vehicle speed are reduced as compared to the normal hour.

For adajan to athwah in morning vehicle speed reduces due to heavy vehicle flow in that direction. For athwah to adajan the vehicle speed is reduced in evening due to the heavy vehicle flow in that direction. All speed are measure manually

For adajan to athwah in morning vehicle speed is 49 km/h is reduced by 40km/h in peak hour.

For adajan to athwah in morning vehicle speed is 43km/h is reduced by the 38 km/h in peak hour.

### 3.5 Vehicle density

Vehicle density are measure with the clicking the picture of x length and counting the number of vehicle occupy the length of bridge. On ether method is counting density is analytical method by mathematical equation 1.3B

Table 7 vehicle density of Sardar Bridge

Movement	Adajan to athwah	Density of vehicle (vehicle/km)	Athwah to adajan	Density of vehicle (vehicle/km)
Peak hour volume (PCU)	5479	161	4757	150
Speed of vehicle (km/h)	34		33	
12 to 12.30 noon vehicle volume	4735	140	2962	68
Speed of vehicle (km/h)	33		42	
4 to 4.30pm vehicle volume	2457	60	3936.50	97
Speed of vehicle (km/h)	41		38	

The above table7 shows the density of vehicle in 1 km length. It's clearly show that in morning, if speed of vehicle is more the vehicle density is less and the speed is decrease the vehicle density in increase.

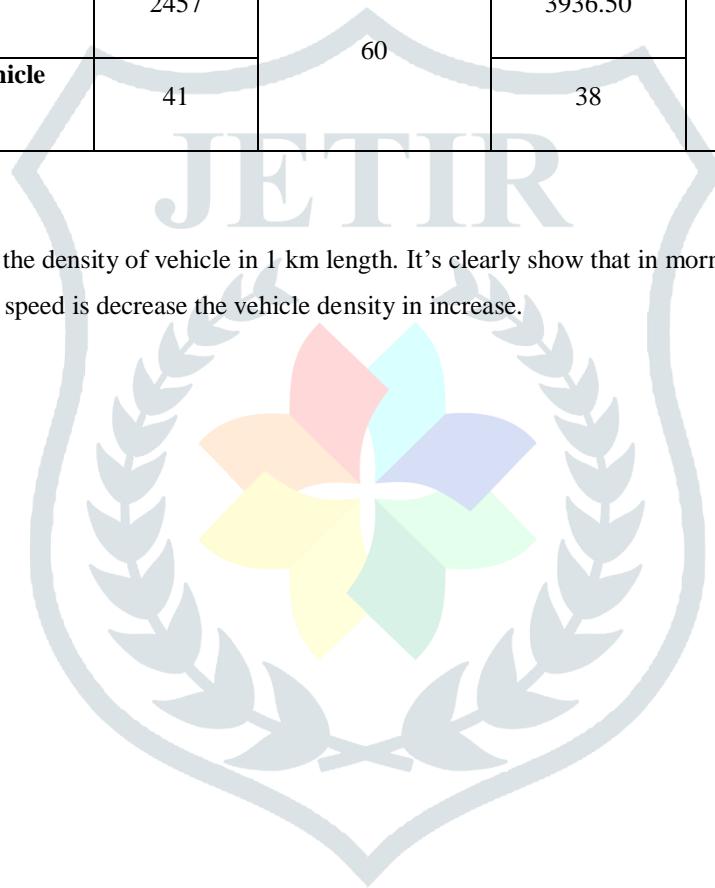


Table 8 Detailed vehicle volume comparison

Bridge Name	Movement		Date		Traffic Volume (number)		Peak hour of bridge				Peak hour volume (PCU)				Capacity Of Bridge in PCU		V/C Ratio		Traffic Volume Increase %
							Past		Present		Past		Present		Past	Present	Past	Present	
	From	To	Past	Present	past	Present	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening					
Sardar	Adajan	Atwah	10/9/7	4/2/21	29548	60822.5	10-11 (am)	3-4 (pm)	10-11 (am)	8-9 (pm)	3541	2580	5479	4924	3600	7200	0.98	0.76	99
	Atwah	Adajan			31758	59181	12.0noon-1 (pm)	7-8 (pm)	10-11 (am)	8-9 (pm)	2824	3946	3727.5	4757			0.78	0.66	87

The table 4.12 gives the detail comparison of traffic parameter of volume in past and present. when the one route is available all vehicle are moving n that section so the Nehru bridge not satisfy the v/c ratio and not give the better level of service. With time increasing in population it's also increasing the traffic congestion problem. Before the widening of bridge vehicular flow is affect by the various parameters but after widening new route vehicle passing over the bridge with better level of service.

#### 4 Comparison of traffic Speed of Bridges

The vehicle speed comparison between present and past data. Vehicular volume affect on the speed parameter. Increasing in volume it's reduced the speed of vehicle and increase the travel time.

**Table 9 % increase in speed**

Sr. No	Bridge name	Avg. Speed km/h		% increase speed
		Past	Present	
1	Nehru bridge	25	32	28
2	Sardar bridge	12.8	34	99.9

- n the past, when the bridge is not enlarged, the vehicle takes 182s (3in) to cross the bridge.
- Following the widening of the bridge, the vehicle takes 56s (0.93min) to cross a Sardar bridge in rush hour volume.
- It makes it clear that the post-widening of the bridge reduces the time spent by vehicles crossing the bridge.
- If the time to cross the bridge reduce its average stopping time of the vehicle and thus the emission of pollution of the vehicle is thus reduce its aid to the environment.

#### 4.1 Comparison of traffic density of Bridges

The vehicle density comparison between present and past data. Vehicular speed and volume affect on the density parameter. Increasing in speed it's reduced the density of vehicle and decrease the travel time.

**Table 10 % increase or decrease in density**

Sr. No	Bridge name	Movement	Density vehicle/km		% increase density	% decrease density
			Past	Present		
2	Sardar bridge	Adajan to athwah	446	161	-	- 63.90
		Athwah to adajan	480	150	-	-68.75

## CONCLUSION

### 5.1 General

The main aim of this study is to compare the actual traffic flow parameter like speed, flow and density of vehicle with past data on the selected river bridges on Tapi River Surat. This chapter includes the final result and the recommendation of the collected data.

## 5.2 Conclusion

- The metro area population of Surat in 2020 was 7,185,000 lakh and a current population is 7,490,000 lakh its shows the 4.24% growth rate of population from last decade.
- As know Surat is fastest growing city with increase in population the vehicle population is also increase by an 8.9% from the last year vehicle population.
- The volume of existing conditions was performed for 16 hours, so it is concluding that around six to seven lakh of vehicle travel across Tapi River Bridges.
- Construction and widening of Sardar Bridge in adajan seems useful because the data shoes more than 90% increase in volume and mannerly reduction in vehicular density is -65.5% from last data and increase in speed by 90% from last data.
- As same way after expansion of Sardar bridge the vehicular speed increase and due to that travel time reduce and the purposed of expansion is fulfilled.

## 5.3 Recommendation

- The collected all traffic data for the various bridges is use for a cordon line survey and making a model for the future scope. From the collected data the new transportation facilities can be design for the selected area or route.

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