JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

NEW TRAFFIC CONTROL APPROACH TO REDUCE TRAFFIC PROBLEMS IN SHIRDI

[1]Mr. Sarthak R. Bodakhe, [2]Ms. Madhuri Nikam,

[1]P.G. Students, [2]Assistant Professor

[1]Civil Engineering Department SOET, Sandip University Nashik, Maharashtra, India

[2]Assistant Professor Civil Engineering Department SOET, Sandip University Nashik, Maharashtra India

Abstract : The increasing number of vehicles on our road intersections has given rise to the problems like road accidents, congestions, conflicts and bottlenecks. These problems can now only be solved by providing an efficient and advanced traffic control at intersections and that can be achieved by provision of a traffic signal system at intersections with various traffic sensors for continuous and efficient movement of vehicles through the intersections at Shirdi, the city of Shri. Saint Sai Baba, is also facing the same traffic problems due to pilgrims and National Highway 752G. Here, the sensors are proposed to be installed which will automatically guide and optimize traffic at various crowded junctions. At the present no any efficient traffic management system is installed on the roads. So, this paper is showing traffic analysis and installation of various sensors for optimizing smooth traffic flow within the city.

Index Terms – Traffic Sensors, Traffic management, Signal Design

I. INTRODUCTION

Amongst the places of deep belief and faith in India, falls Shirdi – the place of Saint Sai Baba. The devotees and followers of Sai Baba are spread all over the world and hence the place has attained importance. A small village in Ahmedanagar district Shirdi has acquired a lot of fame & followers for Saint Shree Sai Baba. Sai Baba attained Samadhi on Dassera day in 1918.Sai Baba preached at Shirdi all his life & renowned people's faith in God. Devotees from every faith throng here all year round to pay their respects to his memory. Khandoba Mandir Samadhi of Shree Sai Baba Dwarkamai mosque, Mhasoba temple all these places are within a periphery of 1km & can be covered on foot. There are many traffic problems in Shirdi town as there is congested area near vicinity of Temple complex. Traffic on roads are in huge amount and there are many devotees come from all over India need a safe transport facility and good marked pedestrian cross. So here giving an extra advanced approach to traffic controlling system which are fully automated with sensors and will work automatically according to need.

Traffic control supervises the movement of people, goods, or vehicles to ensure efficiency and safety. Traffic is the movement of people and goods from one location to another. The movement typically occurs along a specific facility or pathway that can be called a guideway. It may be a physical guideway, as in the case of a railroad, or it may be an agreed-upon or designated route, marked either electronically (as in aviation) or geographically (as in the maritime industry). Movement excepting pedestrian movement, which only requires human power, involves a vehicle of some type that can serve for people, goods, or both. Vehicle types often referred to as modes of transportation, can be broadly characterized as road, rail, air and maritime (*i.e.*, water-based). In road traffic, intersections with traffic lights (*i.e.*, green, amber, and red indications) will often add a separate lane with a lighted green arrow to allow left turns with no opposing traffic. This frequently results in longer non green periods at the intersection, causing an increased delay and a reduction in efficiency and mobility. Traffic control will always be burdened with seeking to satisfy the frequently conflicting goals of safety and mobility.

There really a need to signalise traffic junctions in town there were need to interview local residents, taxi drivers, stake holders, auto rickshaw drivers and MSRTC bus drivers. The result of interview showed there is strict action plan needed to guide traffic in proper way. MSRTC bus drivers also claimed that pedestrian crosses street very carelessly and in unmatched interval which leads to application of emergency brakes which is not good for passengers and other vehicles on street. They are still hoping good signalised traffic operation. There is hazardous flow of traffic through national highway and town junctions at which passenger car unit survey shows congestion happens very frequently plus the pedestrian crossing carelessly adds very unhealthy situations in transportation through national highway. As a result of survey carried in local residents and pilgrims as well as interviewing local stake holders and user demanded signalized junctions and proper pedestrian crossing. Signalising town highway will lead to smooth traffic flow along national highway and Shirdi like holy town where devotees gather from all India needs safe moving in town and Sai Baba Temple Complex.

1.1 Introduction to study area

Shirdi pronunciation also known as Sainagar is a city in the Indian state of Maharashtra. It is located in the Rahata taluka of Ahmednagar District. It is accessible via the Ahmednagar–Malegaon State Highway No.10, approximately 83 km (52 mi) from Ahmednagar and 15 km (9.3 mi) from Kopargaon. It is located 185 km (115 mi) east of the Western Seashore line (the Ahmednagar–Manmad road which is National Highway No. 752 G), a very busy route. Shirdi is famously known as the home of the late 19th century saint Shri Sai Baba. The Shri Saibaba Sansthan Trust located in Shirdi is one of the richest temple organizations.

1.2 Introduction to study area

Shirdi pronunciation also known as Sainagar is a city in the Indian state of Maharashtra. It is located in the Rahata taluka of Ahmednagar District. It is accessible via the Ahmednagar–Malegaon State Highway No.10, approximately 83 km (52 mi) from Ahmednagar and 15 km (9.3 mi) from Kopargaon. It is located 185 km (115 mi) east of the Western Seashore line (the Ahmednagar–Manmad road which is National Highway No. 752 G), a very busy route. Shirdi is famously known as the home of the late 19th century saint Shri Sai Baba. The Shri Saibaba Sansthan Trust located in Shirdi is one of the richest temple organizations.

1.3 Demographics

As of the 2011 India census, the population of Shirdi stood at 36,004. Males constitute 53% of the population and females 47%. Shirdi has an average literacy rate of 70%, higher than the national average of 59.5%: male literacy is 76%, and female literacy is 62%. In Shirdi, 15% of the population is under six years of age.

1.4 Roads & Internal Communication

The Ahmednagar Manmad road is one of the important roads of Shirdi running in the North South direction. Near the Sai Baba temple another road branches off to Pimpalwadi, which runs in the East West direction perpendicular to the Ahmednagar Manmad road. The Kankuri Road on the west of Ahmednagar Manmad Road is the third important road. It serves as an access to three marriage halls and a big hotel. Large area to the north of this road has developed recently. The fourth major road is the Nadurkhi road running in the South West direction from Ahmednagar Manamad Road. The Sai Sansthan Hospital is situated on this road. The Ahmednagar Manmad Road is widened to 30m width and has been concretised. Similarly the Pimpalwadi Road is being concretised and the width of the road is 15m. The roads in gaothan area are narrow, especially those near the Chavadi and the Dwarkamai Masjid. The Palkhi route of Shri Saibaba has been recently widened and strengthened in most areas. The total length of roads in Shirdi is around 60km. There are 3 main junctions in the city which are, 1) The Pimpalwadi Road Junction, 2) The Kankuri Road Junction, 3) The Nandurkhi Road Junction, at present there no signals at any of the junctions. The Pimpalwadi Road Junction is a threeway junction but a DP road is proposed near the Jain Mandir. It would then become a 4-way junction. Being close to the Samadhi Temple and the Dining hall signals need to be installed for better traffic management. The Kankuri Road junction is a three-way junction. It is junction between a 12 m wide road and a 15 m wide road. The work for junction improvement is under progress. The Nandurkhi Road is an awkward junction as it is a 4-way junction with tow arms staggered. The Ahmednagar Manmad Road forms one part the Nadurkhi Road joins on the east side and the New Pimpalwadi Road joins at about 50 m distance from the junction.

II. RESEARCH METHODOLOGY

2.1 Nandurkhi Road Junction (4 Leg Junction)

This is the main junction within Shirdi and contains heavy traffic flow. North to South road is National Highway No. 752G which is Nagar Manmad Highway. East to West road is DP road in Shirdi Growth Centre. This junction is proposed to be installed with sensors and signals to reduce traffic congestions and guide smooth flow of traffic.

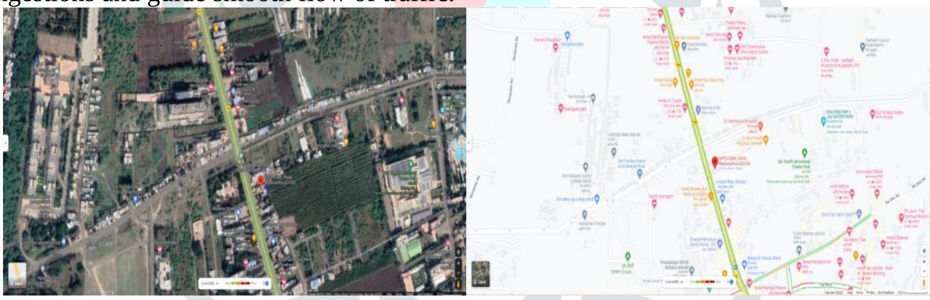
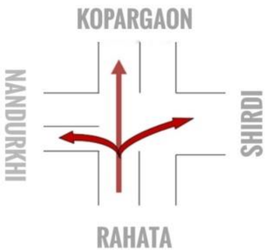


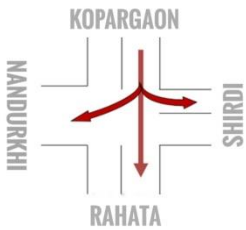
Figure No. 2.1 Satellite image of study area

2.1.1 Data at intersection for traffic volume count

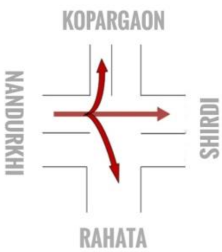
Following are the four phases of traffic movement at the Nandurkhi Junction for study of traffic flow and optimising traffic lights according to data received by traffic sensors which is based on actual traffic volume available at the junction:



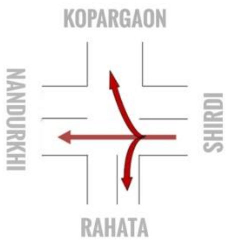
Phase 1



Phase 2



Phase 3



Phase 4

Figure No. 2.2 Different phases of traffic

Table No. 2.1 Equivalency factor for use in signal design (IRC SP 041)

Types of Vehicles	PCU Passenger
Car	1.0
Auto-rickshaw	1.0
Bus Truck	3.0
Tractor-Trailer unit	3.0
Motor cycle, Scooter, Bicycle	0.5

The traffic volume count is done by video graphic survey at 11 a.m. on 5th March, 2021

Table No. 2.2 Data count for vehicles at intersection

Phase	Direction	2-wheeler	Light vehicle	4-wheeler	Bus	Cycle
Phase 1	Rahata to Nandurkhi	130	04	22	02	00
	Rahata to Kopargaon	368	04	62	06	00
	Rahata to Shirdi	150	18	12	00	10
Phase 2	Kopargaon to Shirdi	160	04	34	00	08
	Kopargaon to Rahata	212	06	16	00	14
	Kopargaon to Nandurkhi	538	06	42	10	10
Phase 3	Nandurkhi to Kopargaon	88	00	20	00	06
	Nandurkhi to Shirdi	162	08	28	06	02
	Nandurkhi to Rahata	164	08	20	00	06
Phase 4	Shirdi to Rahata	70	10	20	00	00
	Shirdi to Nandurkhi	76	02	08	00	02
	Shirdi to Kopargaon	170	08	18	04	00

The objective of phase design is to separate the conflicting movements in an intersection into various phases, so that the movements in a phase should have no conflicts. For this type of junction, the four-phase system is best ideally suited.

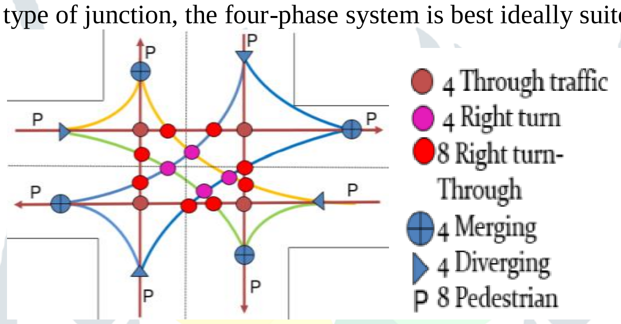


Figure No. 2.3 Conflict Points at Intersection

2.1.2 Estimation of signal timings by Webster's method

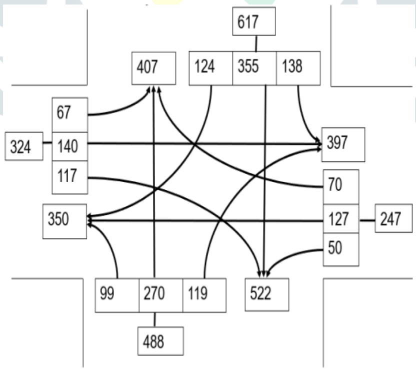


Figure No. 2.4 Traffic volume count in PCU/hr. from different directions

The above figure gives us the sum total value of the vehicles coming from different directions and through this, we can design the traffic signal properly using Webster's method.

$$\textbf{Amber time for phases} = \tau_{min.} = tr + \frac{V}{2xd} + \frac{W+L}{V}$$

Where, tr = Perception Reaction Time = 1s

V = Design Speed = 30 KPH = 8.33 m/s

d = Comfortable deceleration rate = 4 m/s2

W = Width of intersection = 15 m

L = Length of vehicle

$$\tau_{min.} = \text{Minimum amber time} = 1 + \frac{8.33}{2x4} + \frac{15+4}{8.33} = 4.44s = 5.0\text{ Sec.}$$

Table No. 2.3 Saturation Flow Rate

APPROACH	WIDTH (m)	SATURATION FLOW RATE
NORTHBOUND APPROACHES (ROAD 1)	7	525 x Width = 525 x 7= 3675
SOUTHBOUND APPROACHES (ROAD 2)	7	525 x Width = 525 x 7= 3675
WESTBOUND APPROACHES (ROAD 3)	7	525 x Width = 525 x 7= 3675
EASTBOUND APPROACHES (ROAD 4)	3.75	525 x Width = 525 x 3.75= 1969

Table No. 2.4 Critical flow ratio

PHASE	CRITICAL FLOW RATIO
1	488/3675 = 0.133
2	617/3675= 0.168
3	324/3675= 0.0882
4	247/1969= 0.0672

Total Lost Time (per phase) = Startup Time + Movement Time
Where, Movement Time = 0.5 x Amber Time = 0.5 x 5 = 2.5s
Therefore, Total Lost Time (per phase) = 2+2.5 = 4.5s Total Lost Time = 4 x 4.5 = 18s
Optimum Cycle Time = Co = $\frac{1.5 \text{ x } L+5}{1-Y} = \frac{1.5 \text{ x } 18+5}{1-0.456}$ = 58.82s = 60 Sec
Total Green Time = 60 – (5x4) = 40s

Table No. 2.5 Calculation of green time and red time for different phases

PHASE	GREEN TIME (sec)	AMBER TIME (sec)	RED TIME (sec)
1	(0.133/0.456) x 40= 11.67 ~12	5	60 – (12+5) = 43
2	(0.168/0.456) x 40= 14.73 ~15	5	60 – (15+5) = 40
3	(0.0882/0.456) x 40= 7.136 ~7	5	60 – (7+5) = 48
4	(0.0672/0.456) * 40= 5.890 ~6	5	60 – (6+5) = 49

2.1.3 Final signal timings

Table No. 2.6 Final signal timings

PHASE	GREEN TIME (sec)	AMBER TIME (sec)	RED TIME (sec)
1	12	5	43
2	15	5	40
3	7	5	48
4	6	5	49

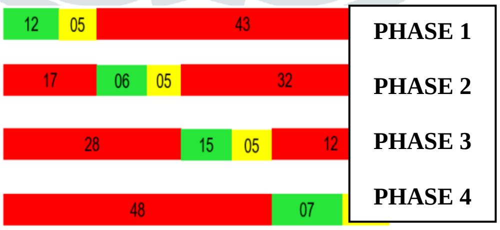


Figure No. 2.5 Final signal timing diagram

We are developing a simulation by using Pygame to simulate the movement of vehicles which are moving right, left and straight ahead across a traffic intersection having traffic lights with a timer. It has a four-way traffic intersection with traffic signals that control traffic flow in both directions. On top of each signal is a timer that displays the amount of time before the signal changes from red to green, green to yellow, or yellow to red. Here are some images which ae used for simulation such as images of 4-way intersection, traffic signal i.e., red, yellow and green, car, truck and buses etc. and the images should be resized according to our needs. Vehicles such as cars, bikes, buses, and trucks are generated, and the images we have only facing towards right. Therefore the images of vehicles should be rotated in all direction and save each of them to get images facing all directions and their movement is controlled according to the signals and the vehicles around them.

This data will be automatically counted based on Webster method to improve timings at appropriate situation according to traffic volume available at the junctions and supplied to computer connected to sensor system. The sensor system will work according to Webster method for signalization and programmer will be generated in software and timings will be adjusted automatically.

2.2 SL Road system

Figure No. 2.6 SL Road Controller

The new SL Road System is the first step on Sensor Lines way to become a system supplier in the wide field of traffic management. Sensor Line's SL Road System comes with the new SL Road Controller, including the SL Road Manager Software. The SL Road Manager Software gives you the possibility to teach-in every data information to all kinds of vehicles and to install and update new software versions. Everything handled from one Computer. Also available, new SL Road Cockpit, which gives you the access to many different traffic management applications and also to many statistics and reports. The complete SL Road System allows every customer to manage and control every traffic issue and every part of roads.

2.2.1 Installation

Since 24th of August 2017, Sensor Line has a new test track in Schrobenhausen. At Königslachener Weg, two systems have been installed: two 1-Slot Frames plus a loop wire and four PUR Sensors with the configuration for double wheel detection, also in combination with a loop wire. They are installed with three different filler materials for comparison. The purpose of this test track is on the one hand to further develop and refine the System SL Road System and on the other hand to have an exhibition site to meet with customers. Sensor Line is committed to constantly improving the outstanding fibre optic sensor technology and products and offering the best services possible to their customers.

CERTIFICATE

ISO 9001:2015
IT Zert hereby certifies that

SENSORLine
Sensor Line GmbH

Carl-Poellath-Straße 19
86529 Schrobenhausen
Germany

scope of application:

has successfully implemented and applies a quality management system according to ISO 9001:2015.

Figure No. 2.7 Certificate of product

2.3 SL PUR Sensor

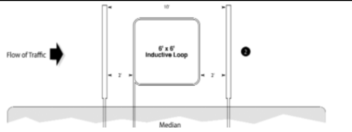
The SL PUR sensor detects vehicles in road traffic for applications like axle counting, speed measurement, headway measurement, vehicle classification and cyclist counting. The SL PUR sensor is designed for permanent installation in concrete or asphalt roads. Its special T-shape ensures a fast and long-term installation. The pressure of a wheel deforms the SL PUR sensor. This deformation decreases the optical transmittance inside the sensor. This transmittance change is detected by our opto-electronic interfaces like the dynamic or static optical transmittance analyzer and is transformed into signals for traffic data processing. Easy installation in a 3/4" wide by 1.5" deep(19 x 38 mm) slot. The sensor to be installed 3/4"(19mm) below the surface. This balances the disturbance of the road and the depth of the cut while maintaining the integrity of the pavement over time. A shallow installation is fill an option, depending on local conditions.

Figure No. 2.8 SL PUR Sensor

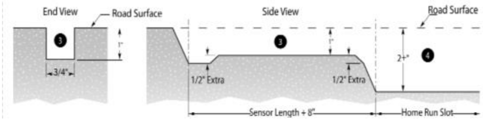
2.3.1 Installation of Sensors

These installation instructions for the Measurement Specialties Roadtrax® BL traffic sensor are intended to guide you in the correct installation procedures and should be followed closely. Please note there may occasionally be local conditions and regulations that require modification, and that additional equipment may be needed for the installation of the inductive loops and any necessary off-road work.

1) Ensure that the road is safely closed, as per local regulations.
2) Using pavement crayons, paint, tape measure and cord, carefully mark the layout of the sensor installation. Ensure sensors are emplaced exactly perpendicular to the flow of traffic and that all lines are straight. Verify that the passive cable length is enough to reach the cabinet. Do not splice cable if it is too short. Typical WIM/Classification site layout with 11' (3.5 m) sensors is shown below.

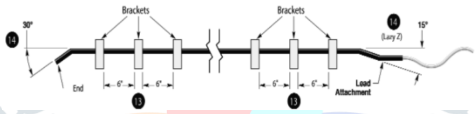


3) Using a 3/4" (20 mm) Diamond Blade, wet cut slot for sensor. Slot must be 3/4"(20 mm) wide (±1/16" or ±2 mm) by 1" (25 mm) minimum deep. Cut slot 8" (200 mm) longer than sensor length (including lead attachment). Drop blade an extra 1/2" (12 mm) down on both ends. Repeat for all sensors.

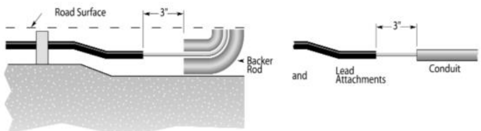


4) Cut home run slots for BL sensors centre the home run slot on the sensor slot. Home run slots are typically cut the depth of the loop home run slots. The minimum width of the slot needs to be 1/4" (6 mm). Cut it wider if you are using conduit or tubing.
5) Cut all inductive loops sets (if applicable) Note: If inductive loops and home run slots are being dry cut, dry cut these slots and clean the area before wet cutting the BL sensor slots.
6) Power wash and sweep all slots. All slots must be very clean.
7) Dry all slots with compressed air. All slots and the pavement 1' (300 mm) on either side must be completely dry.
8) Place duct tape along length of both sides of the sensor slot. Tape must be 1/8"(3 mm) away from the slot. Repeat for all sensors.

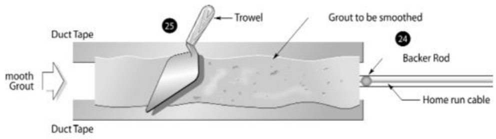
9) Remove BL sensor from box. Visually inspect sensor to ensure it is straight without any twists or curls. Check passive cable for bare wire. Check lead attachment for cracks or gaps. Look at data sheet to ensure the correct sensor is being installed, Class I versus Class II. Again, verify that there is sufficient passive cable to reach the cabinet.
10) Connect sensor up to LCR Meter. Test capacitance and dissipation factor. Test the resistance on the 20m S setting. Capacitance should be within ±20% of the enclosed data sheet. Resistance should be >20m S. Dissipation factor should be
11) Place sensor on tape next to the slot. From this point forward, handle the sensor with latex (or equivalent) gloves.
12) Clean sensor with steel wool or emery pad (Scotch BriteTM). Wipe down with alcohol and clean lint-free cloth.
13) Place installation brackets on sensor every 6" (150 mm) for the length of the sensor, use the 3/4" (20 mm) (small) brackets.



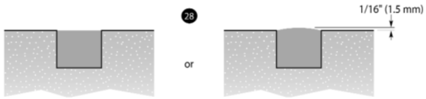
14) Bend the end of the sensor downward at a 30º angle. Bend the lead attachment end down at a 15º angle and then 15º back up until level (forming a lazy Z).
15) Emplace sensor in the slot in the road. The end of the sensor should be at least 2" (50 mm) from the end of the slot, and the tip should not touch the bottom of the slot. The lead attachment should also not touch the bottom or the sides of the slot.
16) If any of the 3/4" (20 mm) (small) brackets do not fit snugly against the sides of the slot or are loose, replace with a 1" (25 mm) (large) bracket and repeat step 15.
17) Starting at the lead attachment end, position the sensor so that it is 3/8" (9 mm) below the surface of the road using the depth gage enclosed in the box. At this point, the installation bracket is 1/8" (3 mm) below the surface of the road.
18) Visually inspect the length of the sensor to ensure it is at uniform depth along its length and it is level (not twisted, canted or bent).



19) Run the passive wire the length of the home run slot. 3" (75 mm) from the lead attachment place foam backer rod under and over passive cable (inside the slot). This will keep the grout from running out into the deeper home run slot. If the passive cable is put in a conduit, also allow 3" (75 mm) between the lead attachment and the beginning of the conduit.
20) Repeat steps 9-18 for all BL sensors to be installed.
21) Emplace all inductive loops to site specifications (if applicable).
22) Using low speed mixing drill (450 rpm) and a mixing paddle, premix the grout for 2 minutes or until smooth.
23) Add hardener to grout and mix according to manufacturer's instructions.
24) Immediately pour grout into slot using a small bead. Using a small bead allows the installer to watch the grout flow under the sensor, eliminating air pockets. Start at the end and pour towards the lead attachment. Repeat until slot is completely full of grout. DO NOT FILL SLOT IN ONE PASS.



25) Using putty knife or trowel, lightly spread (feather) the grout smooth along the length of the slot. Resin should be slightly higher than tape as it will shrink while curing.
26) Remove tape as soon as grout begins to set (2-5 minutes, depending on grout type and ambient temperature).
27) Remove backer rod from the slot. Fill in home run cable and inductive loops with loop sealant.
28) Once grout is cured, use an angle grinder or a belt sander to grind/sand the top of the grout flush with the surface.



29) Wait allotted period to allow loop sealant and grout to fully cure (45 - 60 minutes) and then open the lane to traffic.
30) Hook up oscilloscopes to sensors and view wave forms as vehicles pass. Ensure signal is clear without noise.

2.4 Data and Sources of Data

For this study secondary data has been collected. From the website of Shri. Sai Baba Sansthan, Shirdi Nagar Panchayat, Traffic analysis report from RTO Office of Shirdi. Demographical data is collected from Census of India 2011. For other maps and satellite images are taken from Google Maps. Shri. Sai Baba Santhan keeps yearly records of pilgrims visiting temples and residing in Bhakt Niwas and hotels from nearby vicinity. Also, traffic data is kept by RTO office of Shirdi which also stores the data of annual accidents occur in the city. KSE the monthly stock prices for the sample firms are obtained from Jan 2010 to Dec 2014. And from the website of SBP the data for the macroeconomic variables are collected for the period of five years. The time series monthly data is collected on stock prices for sample firmsand relative macroeconomic variables for the period of 5 years. The data collection period is ranging from January 2010 to Dec 2014. Monthly prices of KSE -100 Index is taken from yahoo finance.

III. RESULTS AND DISCUSSION

The smart traffic management systems help to detect the congestion area and according to it, it helps to reduce congestion. For this action, it uses sensors data to analyse and synchronize in a real-time basis. Traffic light blinks on the basis of congestion on given input data. As application of this need to apply in Shirdi town where traffic problems are more due to various junctions on National Highway. It will also helpful for safe Highway crossing of pedestrians like pilgrims and local residents where no any lawful zebra crossing is marked.
As compare to traditional system STM system will provides more benefits. Some of the benefits are:

- By enhancing the flow of traffic will reduce regular congestion. That means less waiting time at intersections and lower emissions, increasing the air quality.
- Prioritize traffic based on changes in traffic conditions in real time.
- Smart Traffic Management system will improve traffic safety, because uncertain speeds, heavy traffic can all result in accidents and death.
- This system also helpful to reduce infrastructure damage. It is possible to identify overloaded vehicles and provide them appropriate way or road, which will reduced road damage.
- Reduce everyday congestion markedly, by smoothing traffic flows and prioritising traffic in response to demand in real time.
- Reduce pollution throughout the city: stop-start driving is inefficient and polluting. So that the holy place of Baba will be less pollute and conserve its old heritage as it was before.
- Give priority to buses approaching junctions, phasing lights to give traffic flowing with buses a ‘green wave’ through the city.
- Enable a much more effective response to traffic incidents. The system can be pre-programmed to handle a sudden increase in traffic on any of the road length and junctions along it.

This system is detecting congestion also synchronizing activity between traffic lights. This new technology will automatically updating traffic light timing in real time and updating and informing drivers of ideal speeds. It regulates healthy transportation flow according to traffic volume available in any lane. Helpful to reduce congestion and time spent on the road and by reducing congestion it will decrease pollution. Thus, this study on solving traffic issue and giving new controlled approach will be helpful with a view of Town Planning as it achieves all the objectives of Town Planning like Beauty, Environment, Convenience and Health.

IV. ACKNOWLEDGMENT

I am grateful to the project co-ordinator Ms. Madhuri Nikam, HOD Dr. P.L. Naktode and staff of Civil Engineering Department, Sandip University, Nashik for giving me the opportunity to work on this project and for guiding me throughout our research work. I am also thankful to RTO – Shirdi and Shri. Sai Baba Santhan Trust, Shirdi for providing the permissions and facilities necessary for completion of my research work. Special thanks to my family and friends for supporting me throughout my work.

REFERENCES

[1] P. Typaldos, V. Volakakis, M. Papageorgiou, “Vehicle-Based Trajectory Specification in Presence of Traffic Lights with Stochastic Switching Times”, IFAC PapersOnLine 54-2 (2021) 298–305.

[2] Siti Komsiyah, Evelyn Desvaniaa, “Traffic Lights Analysis and Simulation Using Fuzzy Inference System of Mamdani on Three-Signaled Intersections”, 5th International Conference on Computer Science and Computational Intelligence 2020, Procedia Computer Science 179 (2021) 268–28.

[3] Luis Ramirez-Polo, Miguel A. Jimenez-Barros, Vladimir Varela Narváez, Carlos Parodi Daza, “Simulation and Optimization of Traffic Lights For Vehicles Flow in High Traffic Areas”, International Workshop of Innovation and Technologies (IWIT 2021) November 1-4, 2021, Leuven, Belgium, Procedia Computer Science 198 (2022) 548–553.

[4] Action plan for environmental improvement at – Shirdi**.**

[5] ICOMS DETECTIONS SA, Avenue Albert Einstein 11/B | B-1348 Louvain-la-Neuve (Belgium).

[6] https://en.wikipedia.org