Design of Traffic Control System

Komal Vasant Tilekar[1]* Prof. A. P. Khatri[2]

[1] ME Civil (Construction Management) 2nd Year Student Civil Engg. Dept. TSSMs BSCOER Narhe, Pune

[2] Assistant Professor, TSSM'S B.S.C.O.E.R., Narhe-41, Pune

Abstract* – Traffic control has been a serious issue since human civilization. The modern world demands mobility. Cars represent the main method of mobility, but today's congested highways and city streets don't move fast, and sometimes they don't move at all. The India has 70% mobility on the road mode, hence the major problems created in large cities are the traffic congestion, wastage of valuable time in developed countries. For this need to solve the major problem of traffic, to achieve the strategic goal of reducing the congestion and improving the safety of the road users, main aim is to design the best traffic system that will be flexible and adoptive. Intelligent traffic systems (ITS), sometimes called intelligent transportation systems, apply communications and information technology to provide solutions to this congestion as well as other traffic control issues.

The intelligent transport system (ITS) takes the first step towards meeting this challenge by providing effective, reliable and meaningful knowledge to motorists in time through signals. Problems like high traffic congestion, low transportation efficiency, low safety and endangered environment can be solved through innovative and sophisticated ways of handling latest techniques. In this paper various factors required to reduce traffic problem at various intersections are studied in details and implemented them for reducing the traffic problem form the data collected through traffic surveys at one congested points of Pune city & Design of signals for one junction is carried out.

***Keywords* — Intelligent Transport System, Traffic Signal Design, Traffic Congestion.**

---------------------------------x---------------------------------

I. INTRODUCTION

Urbanization can be defined as a concentration of people in a geographic area who can support themselves from the city's economic activities on a fairly permanent basis. The city can be centre of industry, exchange, education, government, religious activity, tourism, or involve all these activities. These diverse areas of opportunity attract people from rural area/smaller towns/other cities to the cities where the opportunities' and life style quality match their aspirations.

Urban areas have many obvious faults insofar as their services to people are concerned. They can be overcrowded, contain large amounts of substandard housing, be polluted (air, noise, environmental), be centers of unemployment, and have vested interest groups. Taxation tends to be high and services less than adequate. However, with all of these faults, urban areas are here to stay. The charge to planners, at all levels, public and private, is to find ways of making these essential elements in our social system work better, more efficiently and thus make our cities better places to live in.

1.1 Transportation Engineering:

In the society of today the road network is of great importance. As cities grows so does the needs of transportation and this puts an increased pressure on the infrastructure. Thus it is of great importance to have a reliable and redundant infrastructure for the traffic, to make sure that it works even during bad conditions. There are several different hazards which may have an impact on the road infrastructure such as for example natural catastrophes, accidents or failure of parts of the road network. Since the different infrastructure systems get more and intertwined in the society of today and the society becomes more vulnerable for catastrophes, these hazards might have effects on other infrastructure systems as well. Thus more and more researchers start to look at the risk of possible cascaded consequences in interconnected networks Transport planning has been historically concerned with travel behavior and the transportation system in some nominally 'typical' conditions under which the networks were designed for certain demand and certain capacity. In the past insufficient consideration has been given to the r robustness and associated reliability of road networks. It is only during the last decade that considerable research interest has started to emerge for this important aspect of the transportation system.

1.2 Traffic Engineering:

Traffic engineering is a branch of transportation engineering that uses engineering techniques to achieve the safe and efficient movement of people and goods. It focuses mainly on research and construction of the immobile infrastructure necessary for this movement, such as roads, railway tracks, bridges, traffic signs and traffic lights.

Traffic engineering is also defined as phase of engineering which deals with planning & geometric design of streets, highways, abutting lands & with traffic operation thereon, as there use is related to the safe, convenient & economic transportation of persons & goods.

1.3 Traffic Congestion

A system is said to be congested when the demand exceeds the capacity of the section. Traffic congestion can be defined in the following two ways:

1. Congestion is the travel time or delay in excess of that normally incurred under light or free flow traffic condition.

2. Unacceptable congestion is travel time or delay in excess of agreed upon norm which may vary by type of transport facility, travel mode, geographical location, and time of the day. Congestion pricing - sometimes called value pricing - is a way of harnessing the power of the market to reduce the waste associated with traffic congestion. Congestion pricing works by shifting purely discretionary rush hour highway travel to other transportation modes or to off-peak periods, taking advantage of the fact that the majority of rush hour drivers on a typical urban highway are not commuters. By removing a fraction (even as small as 5%) of the vehicles from a congested roadway, pricing enables the system to flow much more efficiently, allowing more cars to move through the same physical space. Similar variable charges have been successfully utilized in other industries - for example, airline tickets, cell phone rates, and electricity rates. There is a consensus among economists that congestion pricing represents the single most viable and sustainable approach to reducing traffic congestion.

1.4 Effects of Congestion

Congestion has a large number of ill effects which include:

- Loss of productive time
- Loss of fuel
- Increase in pollutants (because of both the additional fuel burned and more toxic gases produced while internal combustion engines are in idle or in stop-and-go traffic)
- Increase in wear and tear of automobile engines
- High potential for traffic accidents
- Negative impact on people’s psychological state, which may affect productivity at work and personal relationships
- Slow and inefficient emergency response and delivery services.
- The summation of all these effects yields a considerable loss for the society and the economy of an urban area.

1.5 Traffic Signals:

Traffic Signals are one of the more familiar types of intersection control. Using either a fixed or adaptive schedule, traffic signals allow certain parts of the intersection to move while forcing other parts to wait, delivering instructions to drivers through a set of colorful lights (generally, of the standard red-yellow (amber)-green format). Some purposes of traffic signals are to (1) improve overall safety, (2) decrease average travel time through an intersection, and (3) equalize the quality of services for all or most traffic streams. Traffic signals provide orderly movement of intersection traffic, have the ability to be flexible for changes in traffic flow, and can assign priority treatment to certain movements or vehicles, such as emergency services. However, they may increase delay during the off-peak period and increase the probability of certain accidents, such as rear-end collisions. Additionally, when improperly configured, driver irritation can become an issue.

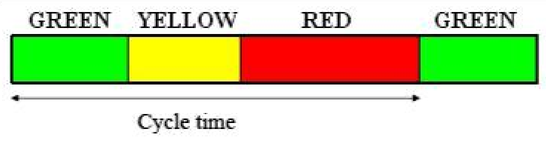


Figure 1: signal timing at a traffic signal

Figure 2: Traffic Signals

1.6 Intelligent Transportation System

Intelligent Transportation Systems (ITS) is the application of computer, electronics, and communication technologies and management strategies in an integrated manner to provide traveller information to increase the safety and efficiency of the surface transportation systems. These systems involve vehicles, drivers, passengers, road operators, and managers all interacting with each other and the environment, and linking with the complex infrastructure systems to improve the safety and capacity of road systems.

- Application of ITS in traffic control system-ITS is a comprehensive system which can prepare safe smooth and pleasant environment for road traffic.
- The fundamental element for ITS is communication technology between road infrastructure and vehicle.
- ITS comp rises of broad range wireless and wireline communication based information.
- ITS utilize existing roadways more efficiently to reduce congestion, delay, minimize accidents and improve air quality.
- ITS provide tools for skilled transportation professionals to collect and analyze the data about the performance of the system during peak hours.
- Thus ITS is an international program intended to improve surface transportation system through advanced technologies.

II. OBJECTIVE AND AIM

Followings are the objectives of the present paper:

1. To design traffic signals of Intersection at Navale Bridge Chowk, Wadgaon, Pune for efficient vehicle movement.

III. LITERATURE REVIEW

A literature review surveys scholarly articles, book, dissertation, conference proceedings and other resources which are relevant to particular issue, are of research, or theory and provide context for dissertation by identifying past research. Research tells a story and the existing literature helps us identify where we are in the story currently. It is up to those writing a dissertation to continue that story with new perspectives but they must first be familiar with the story before they can move forward.

3.1 Signals, signal conditions & the direction of evolution

John. A. Endler : This paper is published by the American Naturalist, in March 1992. In vol. 139. Supplement. According to this paper, study of physical properties of road users and environmental conditions, signals & signaling behavior, properties of sensory systems.

3.2 Modeling and Simulation of Urban Traffic Signals

Khodakaram Salimifard and Mehdi Ansari : Traffic signals play a vital role in effective traffic management. In this paper we apply Arena simulation tool box for modeling and simulation of urban traffic signal system. It has been shown that Arena could be used in simulation of traffic signals system, despite the fact that Arena is not designed for modeling urban traffic signal control. We presented a non-trivial case study to illustrate how Arena is capable of modeling traffic systems.Urban traffic control is one of the important problems inall countries. There have been lots of efforts and academic research to resolve the problem. Simulation is an approach which could be utilized in order to scientifically tackle the problem. Arena is a simulation tool widely being used for modeling and simulation of discrete event systems. However, it is not designed to be used for modeling urban traffic systems. In this paper, we presented a simulation modeling and analysis of an urban traffic signal control. A traffic signal system is described as a set of Arena modules. It has been shown that Arena could be used to model urban traffic if it is carefully utilized. The result of this research is used to improve the traffic flow of the intersection. The results show that the proposed modeling approach could be used as a basis for the analysis of different control policies such as the timing of green or red periods of traffic lights.

3.3 Traffic Congestion

Causes and Solutions: A Study of Talegaon Dabhade City

Shekhar K. Rahane, 2 Prof. U. R. Saharkar: Traffic congestion is a major urban transport problem .Due to traffic congestion, there is possibility of accidents because of poor traffic management. To eliminate road accidents and to save precious human life it is essential to find proper solution for traffic congestion. In this paper traffic congestion problem in Talegaon Dabhade,Tal-Maval. Dist-Pune is identified and studied for finding out the causes and proposed solution of it. In the recent years there has been a considerable loss due to the accidents to the precious human life and to the vehicles to some extend in Talegaon Dabhade. Traffic congestion is a global as well as localproblem. All over the world, the prime cause of traffic congestion is on street parking. In Talegaon, traffic congestion is a common issue like Mumbai. different infrastructural and managerial projects are granted for reducing traffic jam. However in Talegaon this type of policy is not addressed yet. Traffic congestion constraints can be ameliorated by embarking on various strategies such as road capacity expansion, improved road infrastructures, restricting routes for Rickshaw, financial penalty to the traffic law breakers and application of Fly over. Most importantly, proper traffic management system along with appropriate implementation of traffic rules is necessary to mitigate the problems of traffic congestion in Talegaon Dabhade.

3.4 Real-Time Traffic Signal Timing for Urban Road Multi-Intersection

Lin Dong, Wushan Chen : This paper develops a real-time traffic signal timing model which is to be integrated into a single intersection for urban road, thereby solving the problem of traffic congestion. We analyze the current situation of the traffic flow with release matrix firstly, and then put forward the basic models to minimize total delay time of vehicles at the intersection. The optimal real-time signal timing model (non-fixed cycle andnon-fixed split) is built with the Webster split optimal model. At last, the simulated results, which are compared with conventional model, manifest the promising properties of proposed model.

IV. METHODOLOGY

4.1 Design Step for Traffic Signal at Location

Normal flow, $Y1 = q1 / s1$ and $Y2 = q2 / s2$

Optimum signal cycle time, $Co = (1.5L + 5) / (1-Y)$

Co = the optimal delay cycle length

L = total lost time in sec.

$L = 2n$

n = number of phase

R = all red time.

$Y = Y1+Y2$

Applying green time= $G1=(Y1/Y) \times (Co-L)$

$G2=(Y1/Y) \times (Co-L)$

4.2 Methods of Designing Intersections

F.V. Websters method - In the 1950's Webster conducted a series of experiments on pretimed isolated intersection operation (1) Two traffic signal timing strategies came from his study One is signal phase splits. Webster demonstrated, both theoretically and experimentally ,that prettied signals should have their critical phases timed for the equal degree of saturation for given cycle length equation in developing the equation for the optimal minimum delay cycle length , it was assumed that the effective green time of the phases were in the ratio of their respective y values.

$Co = [(1.5L + 5)/(1-Y)$

Where Co = The optimal minimum delay cycle length

L= Total lost time with in the cycle sec Y= The sum of critical phase flow ratio

The above two strategies are very useful for traffic design and planning when the two rules are applied together one can practically minimizes the resulting delay at an isolated pretimed signalized intersection

4.3 Design of Intersection of Traffic Signal:

The design hour traffic volumes in PCU/hr collected can be tabulated

As per the roadway width time taken for pedestrian to cross the street is calculated. If there is a large width of streets it is desirable to have a central pedestrian refuge of at least 1m width. Time that will be needed by pedestrian to reach the pedestrian refuge from the kerb will then be:

Time = Distance/velocity

= X seconds

This will be the pedestrian clearance interval during which no signal is displayed to the pedestrian and those who have just left the kerb or the central refuge before the termination of the pedestrian green signal can reach safely the central refuge of the kerb as the case may be. The pedestrian clearance interval is followed by amber of the next vehicular phase and by the red signal in pedestrian phase.

For the "average" and level sites with the parking prohibited, no correction are needed for the Saturation flow obtain from the below formula.

S = 525W

Where,

W= width of approach road in Meters

We have to consider straight moving vehicles for that purpose following corrections are applied to the left and right turning vehicles. The effect of left turning traffic will be accounted for it constitute more than 10% of the traffic by counting each left turner as equivalent to 1.25 straight ahead vehicles. Since no exclusive right turning lanes are provided, the effect of right turning traffic will be accounted for by counting each right turner as equivalent to 1.75 straight ahead vehicle

Maximum Y (Y max) for two different phases is calculated by the following formula:

Y= (q/s)

Where,

q = flow in arm after applying corrections s = saturation flow

Calculate Intergreen time as follows:

Intergreen period= Amber period (a) + All red period

Calculate lost time as follows:

Lost time (L) = Lost time per vehicular phase x Number of phases.

Calculate optimum cycle time:

Optimum cycle time,

C0 =[(1.5L+5)÷(1-y)]

Apportioned Green time for each phase by using following formula

GNS phase = -------------------------For N-S

GEW phase = -------------------------For E-W

Where,

GNS= green time for N-S phase

GEW= green time for E-W phase

V. FIELD STUDY & DATA ANALYSIS

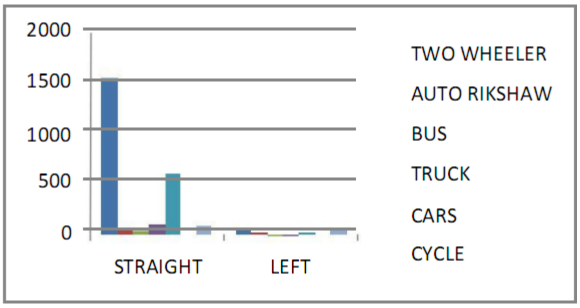
5.1 Volume Count Data at Navale Bridge from East

Table 5.1.1: Vehicular movement in VEH/HR

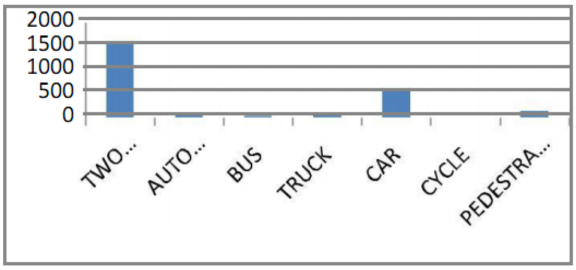
From	To	Two Wheeler	Auto Riksha	Bus	Truck	Car	Pedestrain	Total
	Straight (W)	1551	57	39	98	608	78	2431
E	Left (S)	53	20	3	3	15	68	162
	Total	**1604**	**77**	**42**	**101**	**623**	**146**	**2593**

Table 5.1.2: Vehicular movement in pcu/hr

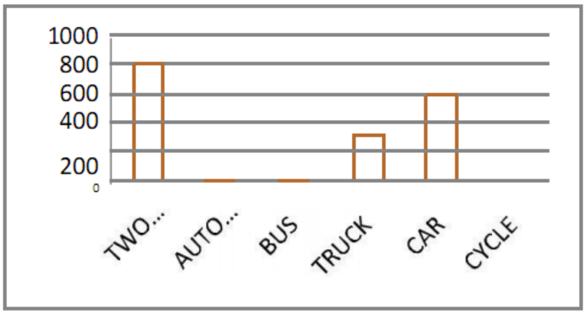
From	To	Two Wheeler	Auto Riksha	Bus	Truck	Car	Total
	Straight (West)	775.5	57	117	294	608	1890.5
E	Left (South)	26.5	20	9	9	15	113.5
	Pucfactor	0.5	1	3	3	1	
	Total	**802**	**77**	**126**	**303**	**623**	**2004**



Graph 5.1.1 Vehicular wise Turning movement



Graph 5.1.1 Vehicular Movement in veh/hr



Graph 4.4.3 Vehicular Movement in pcu/hr

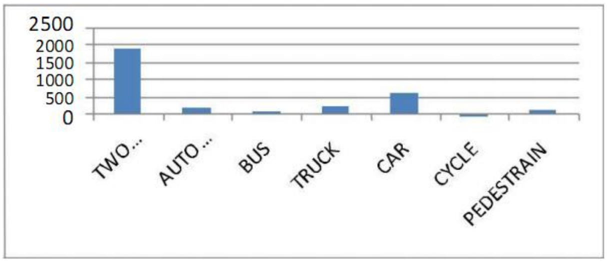
From North

Table 5.1.3 Vehicular movement in veh/hr

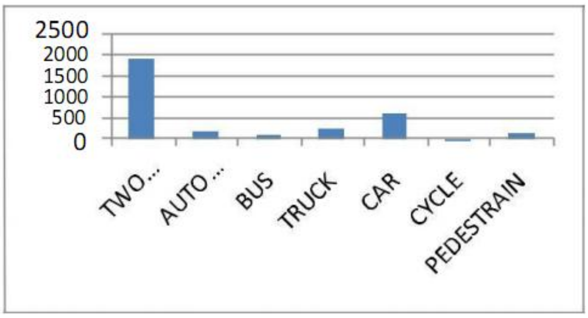
From	To	Two Wheeler	Auto Riksha	Bus	Truck	Car	Cycle	Pedestrain	Total
	Straight (S)	490	63	11	05	139	01	51	760
N	Left (E)	1419	110	82	215	472	-	75	2373
	Total	1909	173	93	220	611	1	126	3133

Table 5.1.4 Vehicular movement in pcu/hr

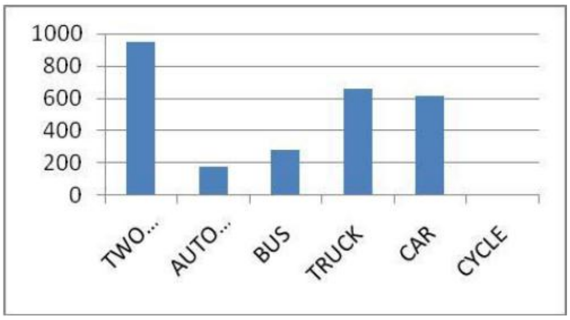
From	To	Two Wheeler	Auto Riksha	Bus	Truck	Car	Cycle	Total
	Straight (S)	245	63	33	15	139	01	520.5
N	Left (E)	709.5	110	246	645	472	-	2220
	Pucfactor	0.5	1	3	3	1	0.5	
	Total	954.5	173	279	660	611	0.5	2740.5



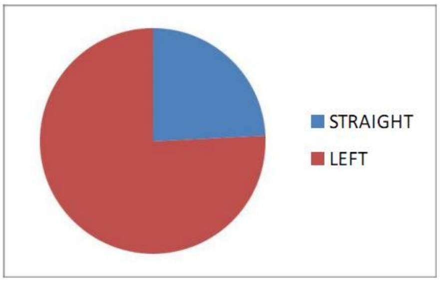
Graph 4.4.4. Vehicular wise Turning Movement in veh/hr



Graph 4.4.5. Vehicular wise Turning movement in veh/hr



Graph 4.4.6 Vehicular movement in pcu/hr



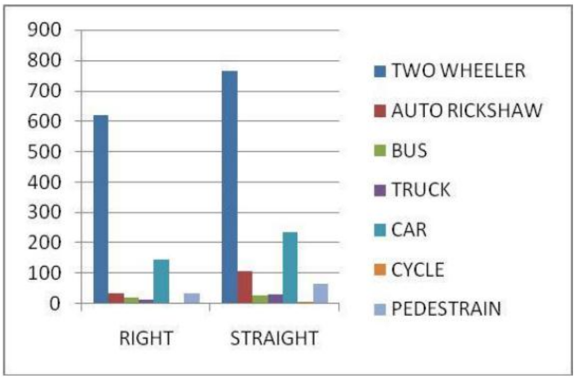
From South

Table 5.1.5Vehicular wise movement in veh/hr

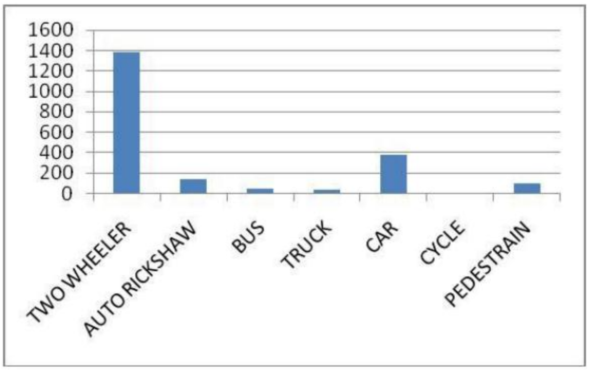
From	To	Two Wheeler	Auto Riksha	Bus	Truck	Car	Cycle	Pedestrain	Total
	Straight (N)	764	107	27	30	237	6	67	1238
S	Left (E)	621	33	20	15	144	3	36	872
	Total	1385	140	47	45	381	9	103	2110

Table 5.1.6 Vehicular Wise Movement in veh/hr

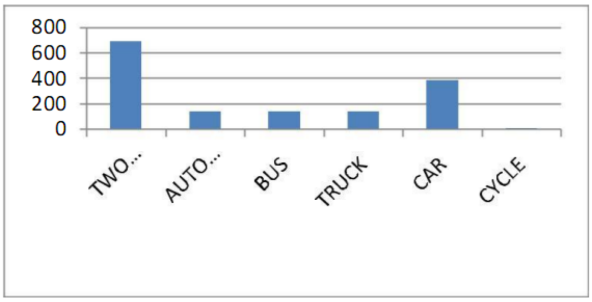
From	To	Two Wheeler	Auto Riksha	Bus	Truck	Car	Cycle	Total
	Straight (N)	382	107	81	90	237	3	936.5
S	Left (E)	310.5	33	60	45	144	0.9	611.4
	Pucfactor	0.5	1	3	3	1	0.5	
	Total	692.5	140	141	135	381	3.9	1547.9



Graph 4.4.7 vehicular wise Turning movement



Graph 4.4.8 Vehicular wise Turning movement veh/hr



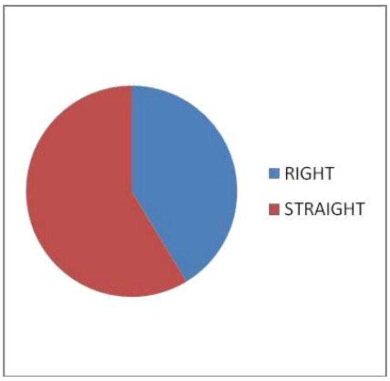


Figure 4.4.9 percentage wise turning movement

5.2. Design of Intersection of Traffic Signal at Navale Bridge (Pune)

The design hour volumes in PCU/hr collected are as follows

From	N			E			S			W		
To	W(L)	E(S)	S(R)	S(L)	W(S)	N(R)	W(L)	N(S)	E(R)	N(L)	E(S)	S(R)
Pcu/hr	-	2220	520.5	113.5	1890.5	-	-	936.5	611.5	-	-	-

Time = Distance /Velocity

Distance (width of road)= (36-7.4)=14.3m

The width of the approach road from each direction is 14.3m Since the site is 'average' and is level with the parking prohibited ,no corections are neded for the saturation flow obtained from the above formula.

S=525 W

=525 X 14.3 = 525 x 14.3= 7507.5

FROM	E		N		S	
TO	S(W)	L(S)	S(S)	L(E)	S(N)	R(E)
PCU/hr	1890.5	113.5	520.5	2220	936.5	611.4
Correction for left turn		28.375		555		
Correction for right turn						458.55
Total	1890.5	141.875	520.5	2775	936.5	1069.95
q	2032.375		3295.5		2006.645	
S	7507.5		7507.5		7507.5	
Y = q/S	0.27		0.43		0.26	

Provide amber time= 5 sec.

Calculation of Intergreen period,

Amber time = 5 x 3=15 sec.

Total= 15sec

Starting delay per vehicular phase= 10 sec.

Lost time = lost time per phase x no. of phases

L = 10 x 3

L= 30 sec.

Optimum cycle time= Co= (1.5L+ 5)/(1-Y)

(1.5X30 + 5)/1-(0.27+0.43)

166.66 .

Say = 150 sec

Effective green time per cycle available to the vehicular

phase= Co-L= 150-30 = 120sec.

This will be apportioned between N-S and

E-W phase as follows-

$$G_{E\text{-}W} = \frac{Y_{E\text{-}w}}{Y} \times (C_0 - L)$$

=(0.43 X 120) / (0.43 + 0.27)

73.71 sec

Say = 74 sec.

$$G_{s\text{-}n} = \frac{Y_{S\text{-}N}}{Y} (C_0 - L)$$

=(0.26 X 120) / (0.26 + 0.43 + 0.27)

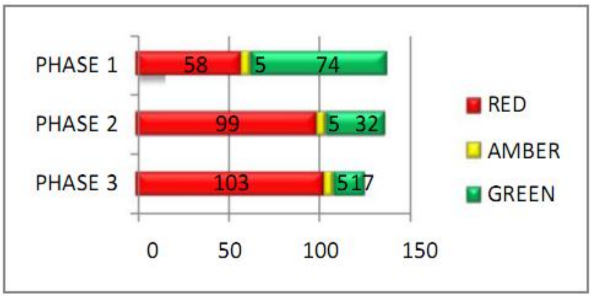
= 32 sec.

$$G_{N\text{-}S} = \frac{Y_{N\text{-}S}}{Y} (C_0 - L)$$

= (0.06 X 120) / (0.43)

= 16.74 Sec

= Say 17 Sec.



VI. CONCLUSION

In this paper following parameters of traffic control system are studied

1. Traffic signal

2. Intelligent traffic system

And also decide location at point such as Navale Bridge Chowk, for that I am going to study the traffic congestion in Pune city making a smart city

3. We have planned for the efficient flow of traffic and making smart city.

Location	Phases	Current Green Time	New Green Time
Navale Bridge	Phase 1	-	74 Second
	Phase 2	-	32 Second
	Phase 3	-	17 Second

VII. REFERENCES

D. R. Pathak & H. K. Gite, Transportation Engineering-ii S C Rangwala, Highway Engineering (Volume-I)

Dr. L.R. Kadiyali, Traffic Engineering & Transport Plannig (Khanna Publication)

Dr. Tom V. Mathew (2013). IIT Bombay, design principle of traffic signal.International Journal of Modelling and Optimization, Vol. 3, No. 2, April 2013

John. A. Endler (1992). Signals, signal conditions & the direction of evolution vol. 139 march 1992

Modelling and Simulation of Urban Traffic Signals.International Journal of Advances in Engineering & Technology, Nov 2011 ©IJAET ISSN: 2231-1963. DESIGN AND SIMULATION OF ANINTELLIGENT TRAFFIC CONTROL SYSTEM,Traffic Signs Manual 2013 London: TSO, Fourth edition 2013

Corresponding Author

Komal Tilekar*

ME Civil (Construction Management) 2nd Year Student Civil Engg. Dept. TSSMs BSCOER Narhe, Pune

E-Mail – komaltilekar07@gmail.com