TRAFFIC CONGESTION –A CASE STUDY OF VIDISHA CITY AFTER CONSTRUCTION OF NEW BYPASS ROAD

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Abstract : Cities and traffic have developed hand-in-hand since the earliest large human settlements. In today's world, many Indian cities are witnessing a spurt in urban growth. This increase in urban growth is accompanied by the growth in private vehicle ownership. With an explosive growth in the number of automobiles, the demand for parking escalates which result in footpaths and available open spaces being swallowed by informal and formal parking lots.
Vidisha as one of the most important city, located at the centre of the Madhya Pradesh state. With the rapid development of economy and infrastructure in the last few years, Vidisha, like many other Indian cities, has met some challenges. Traffic congestion in Vidisha is the one I want to talk in this Research work. Traffic congestion began to trouble people's lives in the past years, following with dramatic urbanization. People spent much more time on travelling, and their quality of life was threatened.
My thesis includes four parts: Introduction, theories and solution on reducing traffic congestion, present condition of the city's traffic and recommendations for Vidisha city transportation.
At the end of research it was concluded that congestion due to illegal and improper parking causes congestion at studied research points. Problem of congestion and jams at intersection must be solved by designing a signalized rotary and proper channelization.

Index Terms **– Traffic congestion, Parking escalates, Urban growth, Channelization, Signalized rotary.**

I. INTRODUCTION

1.1 General

Traffic congestion and parking are the growing problem in many of the Indian cities over the past few decades. Traffic congestion can hamper economic productivity in an area and increases the pollution caused due to vehicle emissions thus reducing the quality of life of the people. Whereas Parking is one of the major problem which was created by the increasing road traffic. The availability of less space in urban areas has increased the demand for parking space especially in areas like central business district. Vidisha is an important city of Madhya Pradesh which is suffering from the problem of traffic congestion over the last few years.
Due to traffic congestion and road side uneven parking, 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.
Congestion mitigation strategies can be broadly classified into three categories transportation system management (TSM), travel demand management (TDM), and land use management.
Another strategy which is widely used are regulatory management system in the strict law and rules should be made like no parking zone etc so that people should not park their vehicles besides the road so no congestion may occur on narrow roads.
Mainly traffic congestion happened at the intersection of roads. There are many solutions for reducing the congestion at intersection like construction of rotary or by signalization of the intersection. Now a days old rotary is replaced by new designs or by roundabouts. Roundabout is nothing but it just a small version of rotary as rotary needs more land for construction but roundabout needs very less land than rotary for their construction and operation. Design of channelized intersections requires the combined skills of the traffic engineer and the highway engineer. Of particular interest to the traffic engineer are capacity and delay, accident mitigation, vehicle operating characteristics, and appropriate traffic control. The overall layout of the intersection, including horizontal and vertical alignment, cross sectional arrangements, and drainage are specific elements of concern to the highway engineer. All of these features directly relate to design and operation of channelized intersections. The importance of good design practice for intersections cannot be underestimated. By their very nature, they represent locations of potential safety and/or operational problems. Channelized intersections are similar to other highway elements in that their design involves consideration of many factors. Physical dimensions and operational characteristics of vehicles, roadway approach geometrics, and human factors all contribute to the standards and guidelines that govern design of channelized intersections.

1.2 Location of Study

Vidisha is a city in the state of Madhya Pradesh, India. Vidisha district, is situated in the central part of the state and eastern part of the fertile Malwa region. It lies between latitude 23º20' and 24º22' North and longitude 77º15' and 78º18' East. The shape of this district is more or less elliptical and the longer axis lies from north-west to south-east with slight projections

on the north, north-west, south and south-west. Its greatest length from north-west to south-east is about 133.6 km. And the greatest width from north-east to south-west is about 96 km.

Here, the location of the research work is from Idgah square to Ahmedpur square, Vidisha (M.P.) At past, this road connects Bhopal to Sagar and named as a national highway NH 146. As this road was suffering from traffic jams problem, government had constructed a new Bypass road which goes from outside the city area, but still this road suffers from high congestion problems.

Figure : Selected area for study (Google map)

1.2 CAUSES OF TRAFFIC CONGESTION IN VIDISHA CITY

Vidisha is a rapid growing city of central India. With the rapid development of economy and infrastructure in the last few years, Vidisha, like many other Indian cities, has met some challenges, traffic congestion is one of them. Vidisha town is connected directly with pucca and national or state highways to all tehsils, important places of state, including Bhopal, the state capital. As per district statistical book-2012, In the district number of registered automobiles vehicles were 144,373 out of which 10,7462 were two wheelers, 784 were trucks, 210 were buses and 32660 were tractors. In the district 1,429.58 km. roads were metalled and 1,498.10 km. unmetalled (kuchacha) roads. 957 trucks/three wheelers, 218 buses/mini buses, 441 taxis/three wheelers, 92,687 two-wheelers including mopeds/scooter/motorcycle, 2,106 cars/jeeps and 20,601 tractors and trolleys, 5,701 Trailer and 80 other vehicle were registered in the district in the year 2009-10. Source : District Statistical Book-2012

Such a large number of vehicles were registered in the year 2009-2010. The current year is 2018 which shows that the number of vehicles should be more than that of the above old available data.

Here roads are characterized by mixed traffic, which include personal vehicles, trucks, buses, two wheelers, three-wheelers, including animal-driven carts and pedestrians. This creates problem for traffic congestion and leads to delays in movement of the traffic flow. Specially trucks and big vehicles create problems of congestion on the roads.
There has been inadequate public transport system in Vidisha. In spite of bus services, the transport system is not being able to keep pace with the growing population as a result of which, peoples have to use their private vehicles, leading to increased congestion on the roads. Due to increase in population and the attraction of human activities into urban region which in turn leads to the growth of vehicle ownership and use, there is demand for road space which has led to increase in the number of public transport operation. Consequently, the demand for road space is greater than the supply because the rate of provision of transport facilities is less than the rate of growth of vehicle ownership and use which result into traffic congestion.

Illegal parking is also a big reason behind the problem of traffic congestion and accidents. One of the serious ill-effects of parking is the loss of street space and the attendant traffic congestion. The capacity of the streets is reduced, the journey speed drops down and the journey time and delay increase. The operational cost of vehicle is there by increased, causing serious economic loss to the community. The manoeuvres associated with parking and unparking are known to cause road accidents. Careless opening of the doors of parked vehicles, moving out of a parked position and bringing a car to the parking location from the main stream of traffic are some of the common causes of parking accidents.

Increase in the growth rate of the population in Vidisha, which include the growing number of work force and utility of vehicular trips are another important cause. According to the census of the year 2011, the population of the only Vidisha city was 1,55,951 the population growth rate of the city is +2.2% per year. If population growth rate would be same as in the period 2001-2011, Vidisha's population in 2018 should be about 1,80,000.

Damaged roads, repairing roads and different types of road construction all contribute to traffic congestion in the Vidisha city.

II. LITERATURE REVIEW

Er Sumit Rana (2016) reviewed the increasing of traffic volume at intersection and he designed the signal based on Webster method. He also evaluate the PCU unit of Ghantaghar chowk, Karnal, a district of Haryana state. In his study he collected three type of data which are speed measurement, time headway measurement and width and lateral clearance of vehicles. His conclusion was based on the development of the PCU unit. The increasing of traffic volume at intersection has been arise a problems like road accidents, conflicts and congestions. These problems can solve by providing an efficient traffic signal control at the intersection for continuous and efficient movement of vehicles through the intersection.

Veethika Gomasta (2015) analysis the intersection for improving traffic flow at Bhopal city. In this research paper, signal are designed using Webster method. For future work they suggested the latest technology in traffic signal automation aids the traffic signal with GPS. The conclusion of that research was the afternoon peak hours at square is less than the required, so that the cycle time should be increased and in second case of congestion, paper suggested the widening of road network. They also suggested the construction of islands at different intersections.

Srikanth R (2017) analysis the traffic flow characteristics and its remedial measures to overcome congestion. He determine the vehicle composition in traffic stream and investigate the geometric elements to reduce congestion and conflicts of the vehicles. For his Research work he used piolet survey and traffic volume counts. After analysis the whole problem the paper concludes that number of lanes must be increased and signals are provided at the intersections. He also recommended to improving the existing footpath and providing a pedestrian crossover or skywalks.

Kanchal Dave (2017) determines the congestion cost in central business area of Indore city. Indore is the commercial capital of the central Indian state of Madhya Pradesh. Indore is the only city of India having 617 vehicles per 1000 people. In this paper an attempt has been made to determine the congestion cost on the basis of fuel consumption and value of time and also pollution emission. The thesis recommended that the method of electronic road pricing should suitable for collecting congestion charges.

Roshani Nasre (2017) designs a rotary intersection ay Bajaj square in Wardha city. The objective of this research is to evaluate the capacity of rotary intersection and suggest the modification for rotary intersection if required. Here the limitations are that, even when there is relatively low traffic, the vehicles are forced to reduce their speed. The research concluded that the present rotary of that area should be failed as traffic entering is higher than the rotary capacity so a signalized rotary must be designed.

Saurabh Sharma (2016) determines the total traffic entering and exit in an area Sitapura in Jaipur District of Rajasthan state. In his conclusion they describe that the percentage of two wheelers in the city is relatively high and percentage of Public transport is very less and need to be strengthened. This paper also concluded that the PCU value of a vehicle changes with change in traffic volume.

In past few years, due to rapid growth of city's population and modernization number of vehicles increases day by day. In olden days the city population was not that much and the roadways of that time was also not as much as busy today. One of the major reason behind the increasing rate of city is that, the city is located very near to the capital of the state Bhopal also buddist international tourism stupas are located at a distance of 12 km from Vidisha city.

According to the census of year 2001, the population of Vidisha district was 1,214,857 which were increased by 1,458,875 in the year 2011.

According to the census of the year 2011, the population of the only Vidisha city was 1,55,951 the population growth rate of the city is +2.2% per year. If population growth rate would be same as in the period 2001-2011, Vidisha's population in 2018 should be about 1,80,000.

The most deadly locations on our roads are the intersections. A study found that stop-controlled intersections were responsible for 72% of the deaths on Indian roadways that year. Due to the high level of risk that has been present on our roads for decades, design of intersection must be necessary not only for reducing the congestion but also for a safe journey. Although safety counter-measures can vary greatly depending on local issues and site issues.

III. METHODOLOGY

The methodology followed for this study could be divided into two phases :

- **Field Work :**

1) Identification of the problem of traffic congestion in different important points of the city.
2) Survey should be conduct to count the traffic by Manual methods. (In manual method traffic of one hour at its peak time should be taken)

3) Various surveys should be conduct like Traffic volume count and questionnaire type survey.

- **Secondary Work :**
  1) Some important data was reviewed by using a range of information sources such as research papers, internet search engines, news paper articles.
  2) The collected data was analyzed after all above works should be done.

3.1 Guidelines for the selection

Rotaries are not suitable for every location. There are few guidelines that help in deciding the suitability of a rotary. They are listed below.

1. Rotaries are suitable when the traffic entering from all the four approaches are relatively equal.

2. A total volume of about 3000 vehicles per hour can be considered as the upper limiting case and a volume of 500 vehicles per hour is the lower limit.

3. A rotary is very beneficial when the proportion of the right-turn traffic is very high; typically if it is more than 30 percent.

4. Rotaries are suitable when there are more than four approaches or if there is no separate lanes available for right-turn traffic. Rotaries are ideally suited if the intersection geometry is complex.

3.2 Width of the rotary

The entry width and exit width of the rotary is governed by the traffic entering and leaving the intersection and the width of the approaching road. The width of the carriageway at entry and exit will be lower than the width of the carriageway at the approaches to enable reduction of speed. IRC suggests that a two lane road of 7 m width should be kept as 7 m for urban roads and 6.5 m for rural roads. Further, a three lane road of 10.5 m is to be reduced to 7 m and 7.5 m respectively for urban and rural roads.The width of the weaving section should be higher than the width at entry and exit. Normally this will be one lane more than the average entry and exit width. Thus weaving width is given as,

$$\text{Weaving width} = [(e1 + e2)/2] + 3.5m$$

where, e1 is the width of the carriageway at the entry and e2 is the carriageway width at exit. Weaving length determines how smoothly the traffic can merge and diverge. It is decided based on many factors such as weaving width, proportion of weaving traffic to the non-weaving traffic etc. This can be best achieved by making the ratio of weaving length to the weaving width very high. A ratio of 4 is the minimum value suggested by IRC. Very large weaving length is also dangerous, as it may encourage over-speeding

3.3 Capacity

The capacity of rotary is determined by the capacity of each weaving section. Transportation road research lab (TRL) proposed the following empirical formula to find the capacity of the weaving section.

$$Qw = \frac{280w\left[1 + \frac{e}{w}\right]\left[1 - \frac{p}{3}\right]}{1 + \frac{w}{l}}$$

Where, e is the average entry and exit width, i.e, (e1+e2)/2 , w is the weaving width, l is the length of weaving, and p is the proportion of weaving traffic to the non-weaving traffic.

This capacity formula is valid only if the following conditions are satisfied.

1. Weaving width at the rotary is in between 6 and 18 meters.

2. The ratio of average width of the carriage way at entry and exit to the weaving width is in the range of 0.4 to 1.

3. The ratio of weaving width to weaving length of the roundabout is in between 0.12 and 0.4.

4. The proportion of weaving traffic to non-weaving traffic in rotary is in the range of 0.4 and 1.

5. The weaving length available at the intersection is in between 18 and 90 m.

3.4 Design Principles for Island

• The islands should be arranged so that the driving paths seem natural and easy to follow.

• There should be only one path for the same intersection movement.

• Points of crossing of the paths of vehicles should be separated as much as possible.

• Sudden and sharp reverse curves should be avoided.

• The intersection areas not used by vehicles should be marked as a reserve zone and thus areas of vehicle conflict should be reduced.

• Traffic streams should diverge or merge at small angles so that the process of vehicles leaving or entering through traffic stream is quick.

3.5 IRC:93-1985 Design Guidelines for Traffic Signal

It is the combination of approximate and Webster method. In IRC method signal timing is decided by approximate method and design is checked by Webster method.
Following steps are taken in the IRC method are:
(1) First calculate the cycle length with the help of approximate method.
(2) Check the calculated cycle length by IRC method. Minimum green time is obtained by assuming that first vehicle will take 6 seconds and subsequent will be clear at the rate of 2 seconds. Then green time for the road A and B are:

$$G_A = 1 \times 6sec + (X_A - 1) \times 2\,\text{sec} \nless 16\,sec$$

$$G_B = 1 \times 6sec + (X_B - 1) \times 2\,\text{sec} \nless 16\,sec$$

Where, Xa and Xb are number of vehicles in road A and road B in cycle length.

(3) Check by Webster method, green time calculated by Webster method should not be more than green time by approximate method.
(4) Green time from IRC method should not be more than green time from approximate method.

IV. DATA COLLECTION

The data was collected using manual count method for the week days in Month of February at Ahmedpur Square, Idgah square and New Bypass road of vidisha, counted the traffic volume approaching from the three or four approaches at both the intersections and their respective movement in different directions. The traffic movement of different class of vehicle is noted down in the table prepared for it.

Observer was stand on the four approaches of two Roads and counted manually the approaching vehicles from each direction and noted the number of different class of vehicles passing the intersection in the pre prepared table.
The traffic data collected is later converted into a common factor called Passenger Car Unit (PCU).
The maximum values of PCU from the traffic volume data is considered for the calculation of total traffic and the capacity of rotary or for channelization design purpose.

Questionnaire survey was also conducted for gathering more information about that particular area and for collecting general information about the drivers, so we can also find out the impact of driver in case of traffic congestion. The questionnaire type survey involves interviews with the drivers. Questionnaire survey was also based on the cordial talking with pedestrians, traffic police etc. Questionnaire surveys are very common for traffic congestion studies, parking studies and for accident studies. For questionnaire survey participation is ensured from each and every level of driver, traffic police. 100 drivers with different age groups were interviewed but the traffic police were 5 due to the fact that they are relatively small in number as compared to drivers and pedestrians.

Questions which should be asked by drivers, during our survey:-

1) About their age and categorize it in 4 different groups i.e. Below 20, 21 to 30 years, 31 to 40 years and 41 above.

2) About their training means that from whom they learn to drive.

3) Duration of driving of a driver per day. This we categorize in 3 groups i.e. Below 8 hours, 8 to 12 hours and above 12 hours.

V. ANALYSIS OF DATA

After computing the data of traffic volume count we found that the peak hour of traffic is mainly from 5 P.M. to 7 P.M. The peak hour vehicles are converted into PCU units for further calculations.

Vehicle type	Values of PCU
Two wheelers and cycles	0.5
Cars	1.0
Mini bus and large vans	1.5
Buses and trucks	3.0
Bullock cart	8.0

As we know that the congestion mainly occurs at intersection points so for reducing congestion at Idgah intersection, a well channelized Rotary should be design for easy and congestion free movement of traffic.

Figure: Idgah intersection

Design of rotary at Idgah intersection

Design Element:

1) Speed = 30 kmph

2) Shape: Circular

3) Radius of rotary road way
R1= V^2/127f
Where, f= 0.47 for 30kmph
For V=30kmph, R1= Radius of entry curve= 15 to 25m.

R1= V^2/127f
= 302/ (127×0.47)
= 15m.

R1= 15 to 25m. for 30kmph
So, R1= 20m.

4) For 4- lane road :

e1= 10m.
e2= 10m.

W= [(e1+e2/2) +3.5]
= (10+10/2) + 3.5
=13.5m.

5) Length of weaving section:
L= 4W
= 4×13.5
= 54m.

L= 30 to 60m. for 30kmph
So, L= 54m.

6) Radius at exit curve:
R2= 1.5 to 2 times of R1
= 2×20
= 40m.

7) Central diameter:
R= 1.33R1
= 1.33×20
= 26.6 say 27m.

CAPACITY OF ROTARY

$$e1 = entry\ width = 10m$$

$$e2 = exit\ width = 10m$$

$$weaving\ width = w = \left[\frac{e1 + e2}{2}\right] + 3.5 = 13.5m$$

$$weaving\ length = 4w = 4 \times 13.5 = 54m$$

$$P_{E-S} = \frac{(625 + 1236.5 + 200 + 275)}{625 + 1236.5 + 200 + 275 + 55 + 761} = \frac{2336.5}{3152.5} = 0.741$$

$$P_{W-N} = \frac{114 + 625 + 1199.5 + 275}{114 + 625 + 1199.5 + 275 + 660 + 98} = \frac{2213.5}{2971.5} = 0.744$$

$$P_{N-E} = \frac{1236.5 + 761 + 114 + 98}{1236.5 + 761 + 114 + 98 + 625 + 245} = \frac{2209.5}{3079.5} = 0.717$$

$$P_{S-W} = \frac{1199.5 + 98 + 200 + 761}{1199.5 + 98 + 200 + 761 + 612 + 275} = \frac{2258.5}{3145.5} = 0.718$$

So, proportion of weaving traffic to non-weaving traffic is highest in west-north direction.
Now capacity of rotary is given by the below equation.

$$Qw = \frac{280w\left[1 + \frac{e}{w}\right]\left[1 - \frac{p}{3}\right]}{1 + \frac{w}{l}}$$

$$Qw = \frac{280 \times 13.5\left[1 + \frac{10}{13.5}\right]\left[1 - \frac{0.744}{3}\right]}{1 + \frac{13.5}{54}}$$

$$\boldsymbol{Qw = 3998.93\ PCU.per\ hr.}$$

Now it is seen from the above result that the maximum capacity of the rotary is 3998.93 PCU/hour. And the total traffic entering the intersection is above 6000 PCU/hour. Hence in this case the **Signalized Rotary** should be provided.

TRAFFIC SIGNAL DESIGN (IRC METHOD)

First calculate the cycle length with the help of approximate method.

Critical lane volume of street 1= higher of two approach
=2242/2 = 1121 PCU/hour
Critical lane volume of street 2= higher of two approach
= 1399/2 = 699.5 say 700 PCU/hour
Total critical volume for the two signal phases = 1121+700 = 1821veh./hour
Saturation flow rate for intersection can be found out from the equation as = 3600/h
= 3600/2.4 = 1500 PCU/hour.
This means the intersection can handle only 1500 PCU/hour, however the critical volume is 1821 PCU/hour.
Hence the critical lane volume should be reduced and one simple option is to split the traffic into two lanes.
So, critical lane volume of street 1 after splitting the traffic is =1121/2 = 560.5 say 561 PCU/hour and the critical lane volume of street 2 after splitting the traffic is = 700/2 = 350 PCU/hour.
So, the total critical volume for two signal phases after splitting the traffic is = 561+350 = 911 PCU/hour which is lesser than saturation flow rate 1500 PCU/hour. Hence OK ..!

Pedestrian clearance time for street 1
= 14/1.2 = 11.66 say 12sec
Pedestrian green time for crossing street 1
= 12+7 = 19 sec

Pedestrian clearance time for street 2
= 13/1.2 =10.8 say 11sec
Pedestrian green time for crossing road 2
= 11+7 = 18 sec

Minimum green time for vehicle on street 2 = 19 sec

Minimum green time for vehicle on street 1 = 561/350*19= 30.45 say 31 sec

Add initial amber and clearance of 2 seconds each for minor as well as major street approaches.

The minimum cycle length works out to
= (2+19+2) + (2+31+2) = 58 say 60 sec. Two extra seconds should be distributed among both the streets. Hence G1 = 32sec and G2 = 20sec

Now check the calculated cycle length by IRC method.

Minimum green time is obtained by assuming that first vehicle will take 6 seconds and subsequent will be clear at the rate of 2 seconds. Then green time for street 1 and 2 are :-

Check for street 1
Number of vehicle per hour per lane = 561
Number of vehicle per lane per cycle of 60 sec
= 561/60 = 9.35 = 10 PCU
Therefore, Green time required for street 1 :

$$G_1 = 1 \times 6sec + (10 - 1) \times 2 \text{ sec} = 24\ sec$$

Since, 31 sec should be provided for street 1 which is more than the checked result. Hence OK..!

Check for street 2
Number of vehicle per hour per lane = 350
Number of vehicle per lane per cycle of 60 sec
= 350/60= 5.83 = 6 PCU
Therefore, Green time required for street 2 :

$$G_2 = 1 \times 6sec + (6-1) \times 2\,\text{sec} = 16\,sec$$

Since, 19 sec should be provided for street 1 which is more than the checked result. Hence OK..

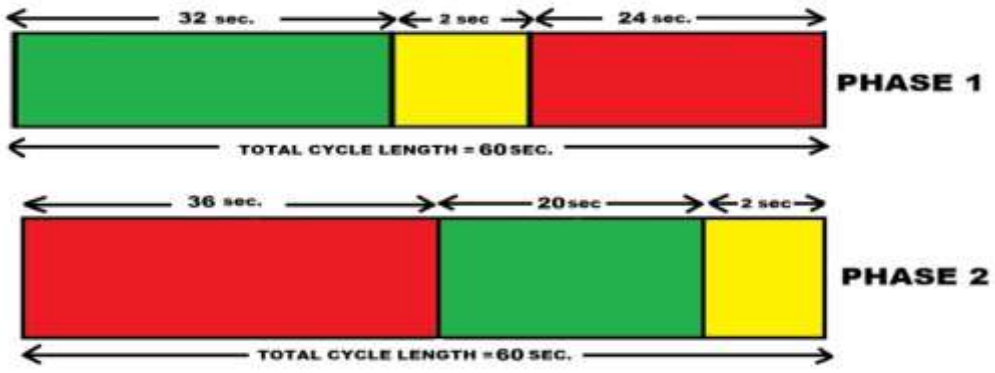
Optimization of signal timings

The optimum signal cycle is given by:
$Co = 1.5L + 5/1 - Y$
Where,
L = total lost time per cycle (sec)
Y= Volume/Saturation flow for critical approach in each phase.
Y=y1+y2+……yn
Then,
g1=y1/Y*Co
g2=y2/Y*Co
L= total amber time + reaction time of both phase
= 8+2*4
= 16 sec
Saturation flow for critical approach in phase 1
= 525*7 = 3675 PCU/hour
Saturation flow for critical approach in phase 2
= 525*6.5 = 3412 PCU/hour
y1=561/3675 = 0.15
y2=350/3412 = 0.10
Y=0.15+0.10 = 0.25

Optimum cycle time
$Co = 1.5L + 5/1 - Y$
Co = 1.5*16 + 5/1 – 0.25 = 38.66 say 39 sec
$g1 = (y1/Y) * 39$ = (0.15/0.25)*39 = 23.4 say 24 sec
$g2 = (y2/Y) * 39$ = (0.10/0.25)*39 = 15.6 say 16 sec

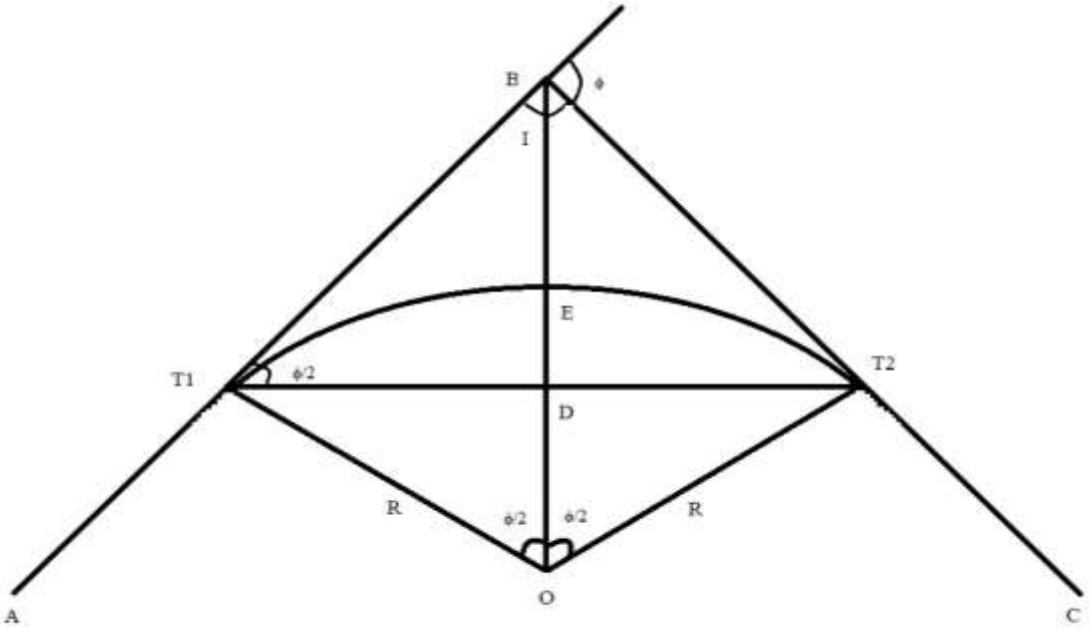
Effective green time after deducting initial and final amber time
g1=24-2-2 = 20 sec
But as per pedestrian requirements effective green time for street 1 to cross street 2 is = 32 sec
g2=16-2-2= 12 sec
But as per pedestrian requirements effective green time for street 2 to cross street 1 is = 20 sec
Therefore
The signal cycle time of 60 sec calculated by IRC method is accepted

Street	Initial amber	Green	Clearance amber	Red	Cycle length
1	2	32	2	24	60
2	2	20	2	36	60



Vidisha Bus stand is located at a few distance from Sehnai marriage garden. The bus drivers stopped there buses for passenger anywhere on the road also causes congestion. The turning lane radius was not properly designed which causes difficulty in turning the buses causes traffic jams and congestion during peak hours.

Design of horizontal alignment at 90 degree Intersection of Bus stand Road



As given in table of **IRC SP 041-1994**, the Radius of simple curve for 90 degree intersection is **18.29 m**. with **Taper 15:1**
Here, angle of intersection is 90 degree
Then, **ϕ = 180º - I** (I = angle of intersection)
ϕ = 180º - 90º = **90º**

Now, Degree of curve = **1719/R**
= 1719/18.29 = **93.99**

Tangent length (BT_1) or (BT_2) = **R tan (ϕ/2)**
= 18.29 tan (90º/2)
= **29.62 m**

Length of curve = Length of arc T_1ET_2
= **R × ϕ Radians**
= $\pi R\phi/180^o$
= **28.73 m**

Length of long chord = $2T_1D = 2OT_1 \sin\left(\frac{\phi}{2}\right) =$ **$2R \sin\left(\frac{\phi}{2}\right)$**
= 2×18.29×sin (90º/2)
= **31.13 m**

Apex distance = BE = OB – OE = R sec(ϕ/2) – R = **R {sec(ϕ/2) – 1}**
= 18.29 {sec(90º/2) – 1}
= 18.29 {1.414 – 1}
= **7.57 m**

Versed sine curve = DE = OE – OD = R – R cos(ϕ/2) = **R {1 – cos(ϕ/2)}**
= 18.29 {1 – cos(90º/2)}
= **8.69 m**

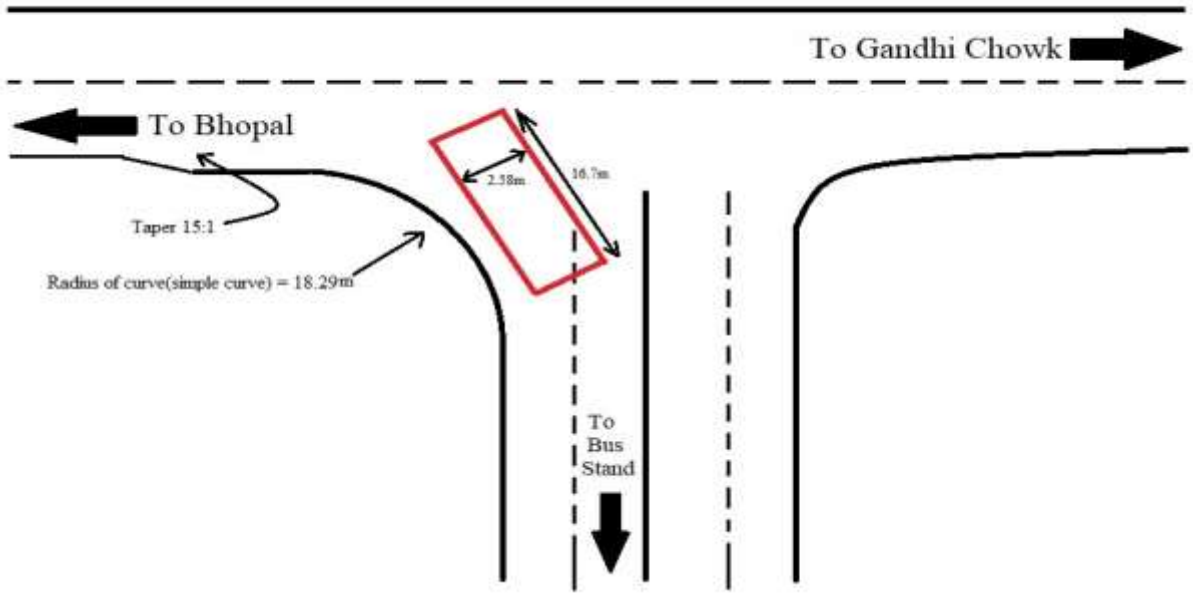
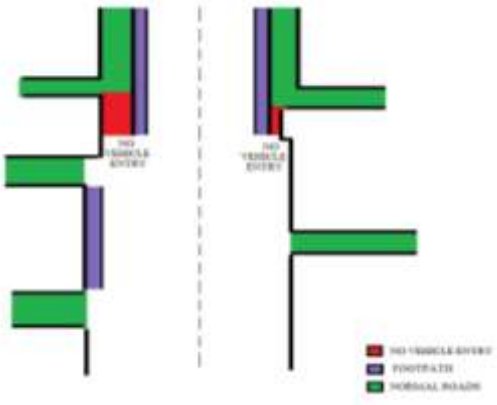


Figure: Bus stand 90 degree intersection after providing Curve (IRC SP 041-1994)

Now move on to our next intersection which is located at the end of the over bridge infront of SBI bank. Here two roads coming out from both the sides of the over bridge creates a improper intersection. The vehicles coming out from these roads cause congestion and traffic jams. This type of improper intersection also creates a atmosphere of several accidents. So for smooth and safe traffic flow, the roads of both sides of the over brigde should only be allowed for the pedestrians.

Figure: conditions of traffic jam at intersection in front of SBI bank at the end side of over bridge



Ahmedpur square, the end point intersection of this thesis, consists of a roundabout whichout any channelization causes difficulty for the drivers to understand the situation of the traffic flow. Channelization must be necessary to smooth flow at a roundabout intersection. It controls minor accidents as well as congestion problems.

ANALYSIS OF QUESTIONNAIRE SURVEY DATA

- **Age range of drivers:**

AGE RANGE	PERCENTAGE
Below 20 years	8%
21 to 30 years	45%
31 to 50 years	31%
Above 51 years	16%

From above collected data we found that drivers age range b/w 21 to 30 years are maximum. As new drivers (Below 20 years) have no experience of driving in different situations they creates congestion by making wrong decisions during their trip and very old drivers (Above 51 years) have to face the problem of taking late decisions due to their age factor. Only 16% drivers are found above the age of 51 years and 8% drivers are below 20 years which is small as compared to other age range.

- **Training of drivers:**

Trained at Driving School	5%
Trained by Old Driver/Another mode	95%

Training of driving is not only about how to drive? But also consists of knowledge about signals and signs, road markings e.t.c. Here 95% of the drivers have learned to drive a vehicle by another old driver or by their parents. This percentage increases the risk of less knowledge of driver about the traffic rules which may be responsible for the congestions and accidents.

- **Duration of driving of a driver (only for large vehicles and trucks):**

DURATION	PERCENTAGE
Below 8 hours	49%
8 to 12 hours	41%
Above 12 hours	10%

Duration of driving time affects the behavior and vision of driver. If the driver feels sleepy at the time of driving it causes major accidents.

VI. RESULTS

Research points	Recommendations
Idgah Intersection	Signalized rotary provided of radius 27m with two phase signal
Near Devi ka bagh	Illegal parking of marriage gardens should be prohibited strictly
Vidisha Bus stand	Turning radius must be designed 18.29m
Vegetable market (Sabji mandi)	Illegal parking and small vegetable and fruits vendors should be prohibited strictly

Infront of SBI bank	Both-side roads near over bridge should be No vehicle zone.(Only for pedestrian)
Infront of Dehat thana road at T-intersection	Illegal parking should be strictly prohibited
Ahmedpur intersection	Proper channelization should be done according to the guidelines provided in IRC SP 041-1994

VII. CONCLUSIONS

Traffic congestion is a global problem. Most of the Indian cities are suffer from this problem. There are many solutions available for reducing the congestion on the roads but some of these solutions need more space and area e.g. channelization, rotary construction e.t.c. The Idgah intersection has enough space to provide a rotary, but due to low capacity of rotary, signalized rotary should be designed. Radius of rotary is 27m and two phase signal should be provided at Idgah intersection.
Some of the areas like Devi ka bagh, vegetable market and T-intersection near Gopal complex suffer from illegal and irregular parking besides the roads. Small vegetables and fruits vendors also creates problem for traffic flow by making illegal possession besides the road at vegetable market (Sabji mandi) area. It needs to be check regularly by local traffic police to prohibited illegal parking strictly.
Infront of SBI bank there is a huge problem of congestion occurs due to turning of vehicles from the both sides roads beside the over bridge. For reducing congestion, here both roads were made to No vehicle zone.
Ahmedpur intersection is the last point of this thesis. Here a roundabout is already constructed by the government but it was failed to reduce the congestion as it was not properly channelized. So, channelization of Ahmedpur intersection must be done for smooth and safe flow of traffic and also for reducing congestion.
After analyzing the questionnaire survey data it was found that 8% of the drivers/riders are below 20 years of age and 16% of the drivers/riders are above 51 years of age. As the percentage of below 20 years age and above 51 years age persons are very less as compared to adults, so this factor is not mainly responsible for traffic congestion in researched area.
Another question is about training of drivers/riders in which it was concluded that only 5% of the persons are trained in driving schools. As the percentage of persons trained in driving schools are very less, this factor is responsible for creating the conditions of traffic congestion as the untrained person have less knowledge about the signs and signals of traffic.
And the last question is about duration of driving time of a driver in which it was found that the 41% of drivers drive their vehicles between the duration of 8 to 12 hours and 10% of the drivers drive their vehicle for more than 12 hours. Duration of driving time affects the behavior and vision of driver. If the driver feels sleepy at the time of driving it causes major accidents and creates major congestions on the road.

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REFERENCES

[1] IRC:65-1976, "Recommended Practice for Traffic rotaries", Indian Roads Congress, New Delhi.
[2] IRC 93-1985 Guidelines for Design of Signalized Road Intersections, Indian Roads Congress, New Delhi, India, 1985.
[3] Dr. Khanna, S.K. and Dr. Justo, C.E.G. Highway Engineering, Nem Chand & Bros., Roorkee, revised edition 2016.
[4] Dr. L.R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers.
[5] Mathew Tom V, Design Principles of Traffic signals (NPTEL), Indian Institute of Technology, Bombay.