

Full Length Research Paper

Traffic Analysis of Grade Intersections and Measures of Congestion Mitigation at Indore

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Abstract

The study of grade intersection requires understanding of the principles of both traffic and highway engineering. The operation of an intersection is influenced by its capacity, queue length and delay, accident potential, vehicle operating characteristics and traffic control. The physical layout of an intersection is defined by its horizontal and vertical alignment, roadway cross-section, surface texture and drainage. The successful integration of these entire factors is required for good design, which must overcome the potential safety and operation conflicts that are inherent when traffic streams interact at intersection. To achieve the said objective for removing congestion and for the smooth flow of traffic, the methodology followed is the traffic survey at the specific intersection grades, previous traffic data's, accident studies, vehicle growth factors, etc. will be analyzed to come out on a result or conclusion from which we can develop the techniques to improve the traffic flow and congestions at the different grade intersections.

Keywords: Traffic Survey, Accident study, Vehicle growth, Congestion.

INTRODUCTION

The design of an at-grade T - intersection & Y-intersection requires understanding of the principles of traffic safety and highway and transportation engineering. The operation of an intersection is influenced by its capacity, queue length and delay, accident potential, vehicle operating characteristics and traffic control.

It has long been recognized that intersections are the element of the roadway system that experiences the greatest number and severity of crashes, at least one-third and as much as one-half of all crashes occur at intersection. This is expected because different traffic

stream meets and conflicts with each other at intersection. Intersection involving high-speed multilane divided highway and minor street with two-way stop control are no exception. Although expressway is considered to be safer than two-lane roadway any collision that occurs at an intersection on those types of roadway could potentially be very severe due to high speeds. It is helpful to know the intersection characteristics on these divided highways that contribute to more crashes in order to identify safety countermeasures.

Follow-up headway is the minimum headway between two entering 2 vehicles, which can be calculating by the average difference between route times of the two coming vehicles accepting the same mainstream headway under a queued condition. In

other word the follow-up headway is equal to the inter-vehicle headway on an approach at capacity. Increasing the follow-up time and critical gap decreases capacity. Several T – Intersections capacity models exist and can be classified into two broad categories - theoretical and empirical. The Tanner model is based on gap- acceptance theory with gap-acceptance parameters.

The Highway Capacity Manual (HCM 2010) Intersections capacity model has been analyzed through exponential regression model with gap-accepting theory. The NCHRP Report 572 model is based on empirical exponential regression) capacity model with no explicitly. Now a day it has traffic congestion at intersections of in Indore city at peak hours in the morning and in evening. Hence the traffic police need to manage the situation to regulate the traffic flow. Otherwise it would be practically difficult to provide normal traffic flows, particularly at intersections, which is dependent on driver behavior and balanced traffic flow.

This problem will continue and it may more difficult in the future condition due to the rapid growth of population, congestion and numbers of vehicles in Indore. Road planning and sub-standard geometric conditions have a significant effect on intersection capacity and traffic congestion. Therefore, it is necessary to evaluate the capacity of T- intersections mean Guitar Chowk for proper traffic operation and planning for future.

The current procedure to evaluate the operational performance of an un-signalized intersection is adopted directly from the United States Highway Capacity Manual. Such procedure would lead to inaccuracy interpretations of the results of the analysis as all as parameters on local traffic characteristics. As a result, planning for improvements would not be reliable. Therefore, it is very important to re-design to remove congestion which occurs in future.

Two factors of the input parameters are that required the motorist's critical gap and follow-up time. These two parameters will influence the results of the performance analysis as well as the flow of traffic.

The objectives of this research are to develop capacity formulation for un-signalized intersection with respect to Indian road condition& analyze the effect of

variation in parameters to the performance of un-signalized intersection. Making road safety a smooth flow of traffic in intersection planning and operation. Understanding the needs of cyclists and pedestrians at intersections and crossings. Improving the behavior and traffic flow on road for users at intersections. To design the traffic island for better traffic flow. Design of traffic lights, etc.

METHODOLOGY

The design of intersection has very efficiency of operation, safety, speed, cost of operation and capacity which are directly governed. The proper design controls accidents rates, delay, fuel consumption, better visibility and orderly movement of traffic. With the help of this designing an intersection has been control all the factors which are affects the road users. The flowchart represented in the Fig.1. shows the brief methodology of this research.

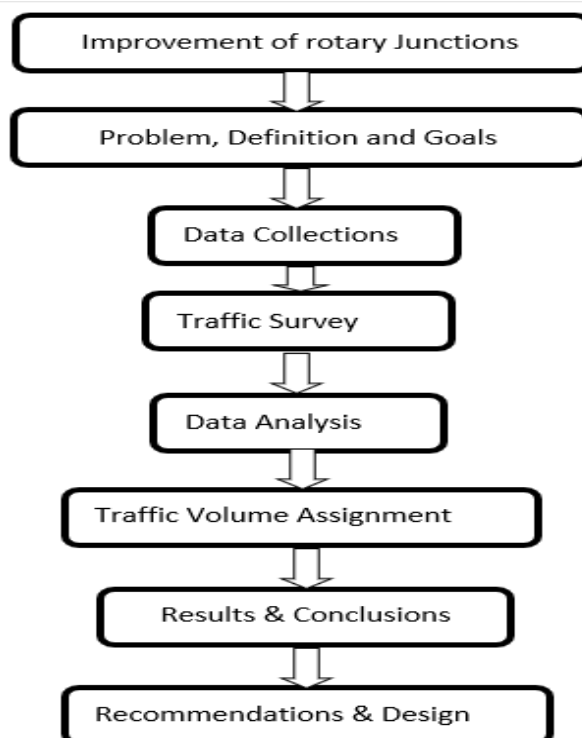


Fig.1. Flowchart Representing Methodology

DATA COLLECTION

For the improvement of intersection data collection may be like traffic volume, capacity of intersection, vehicle passing in peak hour, congested time of intersection, flow of traffic, peak hour capacity etc. At study site some surveys are conducted for collecting data. Counting the vehicle, there route, types, direction are calculated between some interval like morning to noon, noon to evening and it is distributed in hourly bases. This is the surveying site which has high capacity of traffic volume, intersection capacity, and more vehicles passing un-signalized intersection in Indore (M.P) India. It is T - type of junction carrying large number of flow of traffic during peak hour.



Figure 2. Co-ordinate-22°43'31.11"N 75°53'13.02"

In this junction survey and data collection can be taken from the different routes. These are:

A-F, A-D, A-B, E-B, E-D, E-F, C-F, C-B, C-D

Where

Route towards Palasiya - (R) = A
Route towards Palasiya - (L) = B

Route towards Vijay Nagar - (R) = F
Route towards Vijay Naga - (L) = E
Route towards By Pass - (R) = L
Route towards By Pass - (L) = R

In this paper, data collections have been shown for Route A – F. By the same method, data were collected for A-D, A-B, E-B, E-D, E-F, C-F, C-B, C-D.

Data Analysis

Data analysis deals with the analysis of the data collected in the previous chapter with using different methodologies to come with a result. To study about the improvement features and design of T-intersection and Y-intersection, it is necessary to analyze the very first traffic volume. The mathematical calculations have to be carried out to analyze the data and the analysis must be presented on the graph to study it is more good manner.

Route Assignment

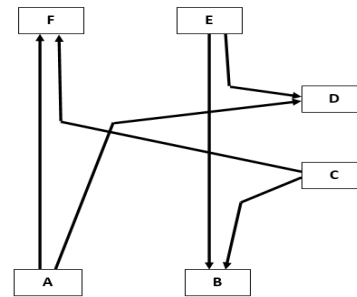
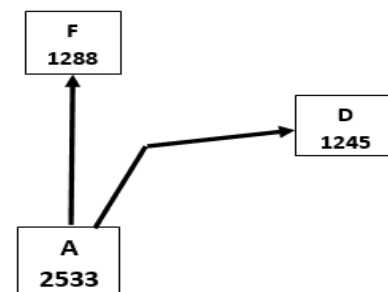


Figure 4. Route assignment in each leg of intersection



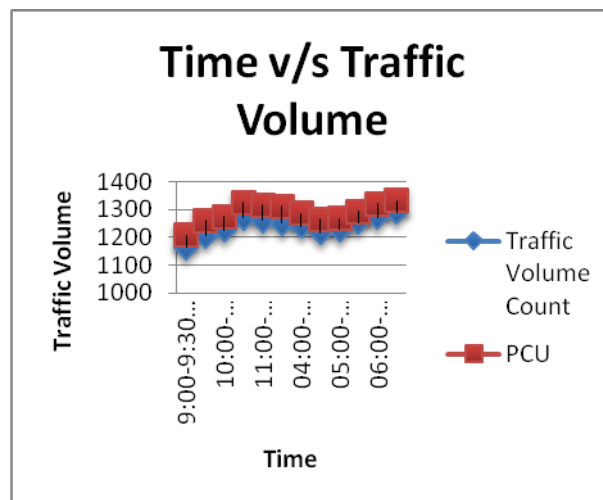
(a)

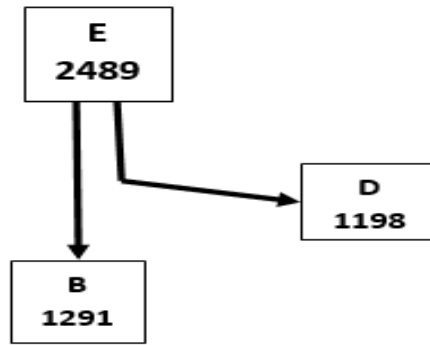
Table 1. Traffic Survey for Route A - F

Time	2Wheeler	3Wheeler	Car	Van	Bus	LCM	Bicycle	Rickshaw
09:00-09:30 am	210	140	280	160	30	153	80	110
09:30-10:00 am	217	148	286	163	36	158	83	114
10:00-10:30 am	226	136	294	169	35	163	89	113
10:30-11:00 am	228	154	300	172	38	166	94	118
11:00-11:30 am	233	143	296	166	36	171	90	125
11:30-12:00 pm	232	152	299	178	41	156	81	112
04:00-04:30 pm	230	149	313	186	34	147	74	106
04:30-05:00 pm	227	142	316	175	36	136	71	113
05:00-05:30 pm	237	135	321	178	32	131	69	124
05:30-06:00 pm	251	141	328	183	33	123	63	131
06:00-06:30 pm	245	138	330	187	37	134	73	128
06:30-07:00 pm	255	144	324	194	36	139	78	121

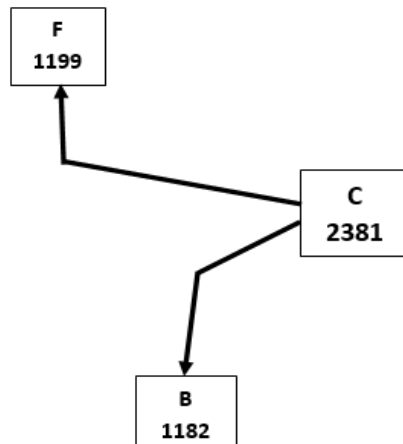
Table 2. Traffic Volume for Route A - F

Time	Total Vehicle Count	PCU
9:00-9:30 am	1163	1207.7
9:30-10:00 am	1205	1260.05
10:00-10:30 am	1225	1274.8
10:30-11:00 am	1270	1324.4
11:00-11:30 am	1260	1314.95
11:30-12:00 pm	1251	1311.1
04:00-04:30 pm	1239	1285.7
04:30-05:00 pm	1216	1265.55
05:00-05:30 pm	1227	1268.05
05:30-06:00 pm	1253	1293.55
06:00-06:30 pm	1272	1320.05
06:30-07:00 pm	1291	1332.85
Total	14872	15458.75

**Figure 3.** Time v/s Traffic Volume for Route A - F



(b)



(c)

Fig 5. a, b and c shows separate route assignment for each leg with their PCU/hr

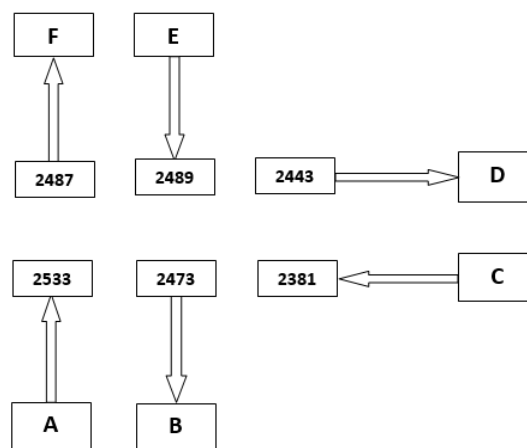


Fig 6. Traffic in terms of PCUs in each leg of intersection

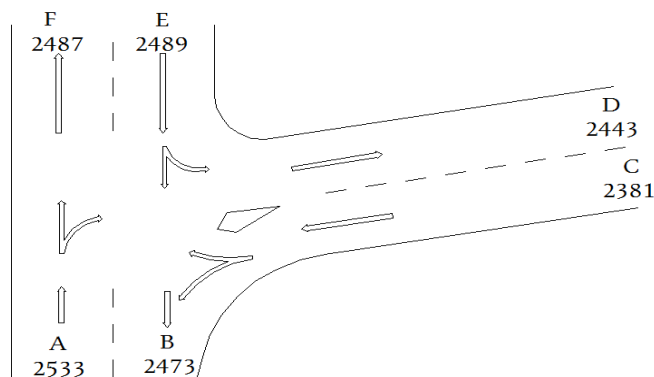


Fig 7. Plan and route direction of intersection

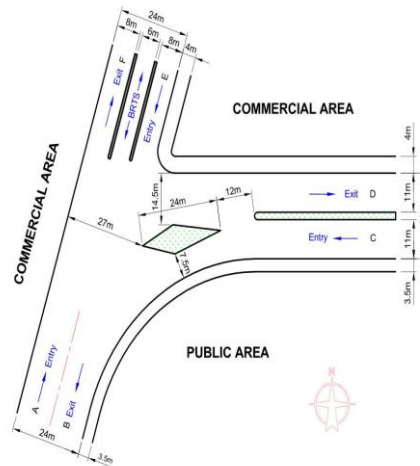


Fig 8. Plan & Dimension of Y-intersection

The following two – way traffic flow has been observed:

- a). A-B Leg: 3824 PCUs/hr.
- b). C- D Leg: 3626 PCUs/hr.
- c). E-F Leg: 3777 PCUs/hr.

As per Highway Capacity Manual (1965), Highway Research Special Report 87, Washington, 1965, the maximum capacity of an intersection of 4- lane in terms of PCUs are 1400-1800 PCUs/hr, in one direction and for 2-lane with moderate interface from cross traffic has capacity of 700-800 PCUs/hr. in one direction.

According to this study:

Analysis of leg A-B:

Leg A has traffic 2533 PCUs/hr. > 1400-1800 PCUs/hr.
 Leg B has traffic 2473 PCUs/hr. > 1400-1800 PCUs/hr.

Analysis of leg C-D:

Leg C has traffic 2381 PCUs/hr. > 1400-1800 PCUs/hr.

Leg D has traffic 2443 PCUs/hr. > 1400-1800 PCUs/hr.

Analysis of leg E-F:

Leg E has traffic 2489 PCUs/hr. > 1400-1800 PCUs/hr.

Leg F has traffic 2487 PCUs/hr. > 1400-1800 PCUs/hr.

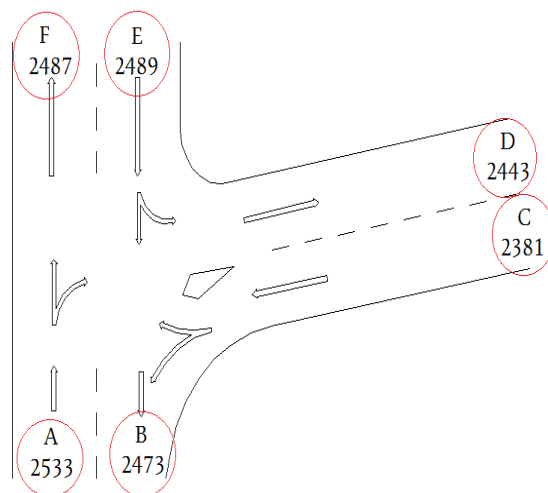


Fig 9. Show the exceeding of traffic in each leg

Intersection Traffic Volume Capacity

The capacity of the intersection is directly determined by the capacity of each weaving section. This capacity is determined by the geometric layout, including entrance and exit, and the percentage of weaving traffic. The transportation and road research laboratory (U.K.) which has recommended the following formula for finding capacity:

$$Qp = \frac{2800W \left(1 + \frac{e}{W}\right) \left(1 - \frac{P}{3}\right)}{1 + \frac{W}{l}}$$

Where,

Qp = Practical capacity of weaving section of an intersection in PCUs/hr.

W = width of the weaving section in metres (6 – 18 metre)

e = average entry width of intersection in metres, which is determined by the given formula:

$$e = \frac{e1 + e2}{2}$$

l = length of weaving section between the ends of channelizing island in metres.

P = Proportion of weaving traffic means ratio of sum of crossing streams to the total traffic on the weaving section. Formula:

$$P = \frac{b + c}{d + b + c}$$

The width of entry & exit carriageway is 8.0m & 12.0m respectively.

The width of non-weaving section is 11.0m.

Therefore

The width of weaving section will be:

e= 13.5 m

The minimum length of weaving section should be 30m.
Then

$$P = \frac{1182 + 1198}{1291 + 1182 + 1198}$$

Now, Capacity of intersection will be

$$Qp = \frac{280 * 13.5 \left(1 + \frac{12}{13.5}\right) \left(1 - \frac{0.64}{3}\right)}{1 + \frac{13.5}{55}}$$

This is very much higher traffic than the standard flow of 2746PCUs/hr.

RESULT

While the study of at-grade Y- intersection of Guitar Chowk, Indore it had been observed that the traffic is increasing day by day which results traffic congestion at that particular intersection and also delay to the road users specially during peak hours and normal hours too.

There are lots of parameters which had been adopted to analyze the study result. In this research, traffic flow is analyzed for each route to understand in which route the highest traffic volume occurs. These data collected in terms of PCUs/hr at the interval of 30 minutes at the peak hours of the traffic flow. There are no signals and proper road marking provided to control the traffic. After the study of traffic volume and capacity of intersection at Guitar Chowk, Indore, and the following results were observed:

- 1). Intersection entrance leg was identified as A, C & E.
- 2). Intersection exit leg was identified as B, D & F.
- 3). In entrance leg, the route exceeding traffic volume were identified as B (2473 PCUs/hr.), D (2443 PCUs/hr.) and F (2487 PCUs/hr.).
- 4). In exit leg, the route exceeding traffic volumes were identified as A (2533 PCUs/hr.), C (2381 PCUs/hr.) & E (2489 PCUs/hr.).
- 5). The weaving section was identified with the maximum weaving among all the weaving routes as

E – B route.

6). The traffic volume study analysis gives the result need to improve the intersection in all routs because of exceeding traffic volumes.

7). To manage in improving the intersection, there should be improvement in design features or geometry of junction.

8). There should be improvement in entry radius, width of carriageway at entry and exit, traffic islands, proper channelization, entry & exit angles, camber or slopes, medians signals etc.

9). The design speed should be regulating to reduce congestions and accidents until the design features are not improved.

The extra lane should be provided for public transport stoppage.

CONCLUSION

Intersections are the critical component of roadway system and frequently act as a choke point on the transport system. The current data shows the increment in traffic as well as site constraints. The engineer needs to design methods and criteria based on fundamental relationship between capacity, flow of traffic, geometry design, safety that will enable users to get directly from proposed geometry to the realistic estimates of operating conditions. The result of this study gives the idea that what measures are suggested to remove such kind of problems and the precautions to be used to remove congestion at intersection.

RECOMMENDATIONS

After the analysis of the data collected and on the basics of result obtained, following are the recommendations made to remove congestion and improve traffic flow at at-grade intersection:

- 1). Provision of traffic islands in Leg C - D with increase in length of median and provide space of 7.5m for U-turn. Also remove the island which is on the Leg C-D due to improper position as shown in Fig.10.
- 2). Increase the entry width of 15 m in leg E as shown in Fig.10.

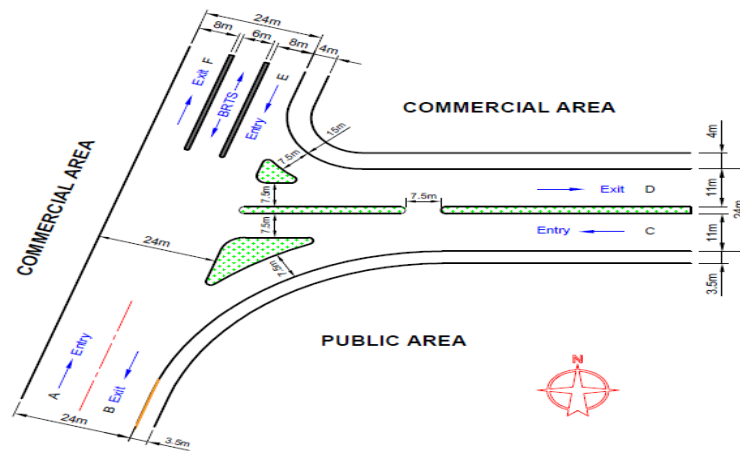


Fig 10. Intersection with recommended islands

- 3). Three-phase signals are provided at the intersection for mix traffic and Two-phase signals for BRTS. That helps to reducing conflict points and chances of accidents.
- 4). Proper markings on the road should be there like zebra crossing, edge markings, stop lines for signals, pedestrian crossing. And some signs boards for example, speed limit sign, intersection sign etc.
- 5). A high standard of lighting is needed at junction and many accidents can be prevented with adequate illumination, for example, staggered arrangement, central, opposite and combination of all.

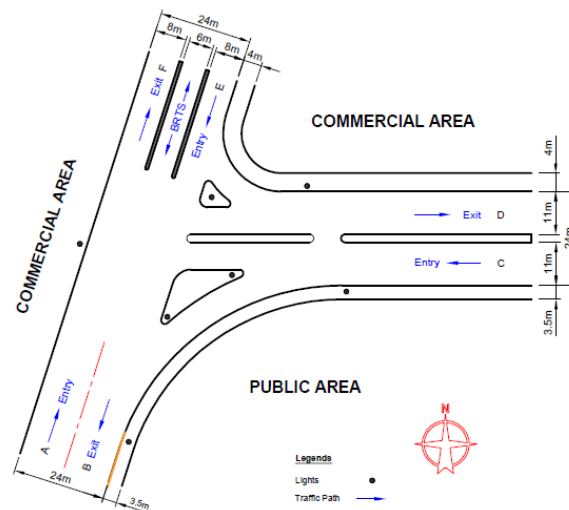


Fig 11. Light arrangement in intersection

- 6). Increase the width of road in Leg F for tackle maximum traffic.
- 7). No entry for Heavy Commercial Vehicles. They should be restricted at peak hours.
- 8). Overhead pass should be providing for the pedestrians for safe crossing the road.
- 9). There should be proper stop for BRTS or for public transport vehicle with sign and markings and provide

extra lane with separate median especially in Route A-E and E- B.

10). Provided of piped drain with grating in the intersection area should be choked. Therefore, in intersection provide drainage through channels in the traffic island. Road side ditches also provided for surface drainage.

11). Restricts the speed limit of vehicles while they cross the intersection.

12). There should be no parking at nearby areas of intersection especially on street parking.

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