International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

L Capacity Evaluation of AT-Grade Intersection

Alpana Jha

Lecturer (Civil Engineering), Government Polytechnic Vadnagar, Gujarat, India

Abstract: ***The urban traffic congestion has become a global phenomenon. Rapid urbanization and industrialization have caused an unprecedented revolution in growth of vehicles all over the world. Environmental pollution is one of the problems faced by humanity these days. Due to fast growing vehicular traffic, cities become congested and road links, intersection become saturated, busy and supply service is above its capacity. Therefore, it requires effective controls to regulate the traffic and optimize delay and congestion of the traffic at the intersection. Space sharing intersection e.g rotaries and pretimed signals are widely used to control the intersections. Space sharing intersection are intended to give equal priority and permit continuous movement of all intersecting vehicle flows. For higher traffic volumes, space sharing intersections such as rotary is not preferable due to increase in congestion and overall intersection delay and conflicts. In pretimed signal, green times for the phases remain constant for the particular period of the day, although demand fluctuates during that period. This problem can be eliminated by providing over bridge at rotary intersection. This study presents literature review on At-grade Intersection and Grade separated Intersection and literature on case study. Shivranjani signalized intersection on 132ft ring road is selected as a case study intersection. The flow rate, saturation flow rate and its adjustment factors, capacity, volume to capacity ratio, delay for lane group, approaches and intersection as whole and delay comparison with level of service were calculated as described in highway Capacity Manual 2000. Past study proves that shivranjani at-grade intersection was required to be converted to grade separated intersection to reduce congestion and delay.***

Keywords: Intersection, At-grade intersection, Grade separated intersection.

1. Introduction

The urban traffic congestion has become a global phenomenon. Due to fast growing vehicular traffic, cities become congested and road links, intersection become busy and saturated. Therefore, it requires effective controls to regulate the traffic and optimize delay and reduce congestion of the traffic at the intersection.

There are many ways to control the traffic congestion at intersection such as converting the unsignalised intersection in to signalized intersection, by changing the cycle length of signalized intersection, by changing the type of phases, by providing flyover or underpass at intersection etc.

2. Objective

1) To carry out literature review on Intersection.
2) To understand various terminologies related to intersection.
3) To carry out the literature review on case study.

3. Intersection

In the field of road transport, an intersection is a road junction where two or more roads either meet or cross at grade (they are at the same level). Such a road junction may also be called a crossroads. Or meet at different level

3.1 Types of intersections

At Grade Intersection- Where roads join or cross at same level, then intersection is known as "At-Grade intersection".

Grade Separated Intersection Where roads join or cross at different levels, then intersection is known as "Grade Separated Intersection".

3.1.1 At-Grade Intersection

At-Grade Intersection can be divided into four major categories:

1) Uncontrolled Intersections-These types of intersections occur where the intersecting roads are of relatively equal importance and when traffic volumes are so light that no form of control or road sign appears necessary.
2) Priority Intersections – These types of intersections occur where one of the intersecting roads is given definite priority over others. Some form of sign will usually control the minor road or marking, such as a stop to yield sign, thus main road do not get delay.
3) Space Sharing Intersections – These types of intersections are intended to permit fully equal priority and to permit continuous movement for all intersecting vehicle flows, e.g., rotaries and other weaving areas.
4) Time Sharing Intersections- These types of intersections are those at which alternate flows are given the right of way at different points in time. Typically these intersections are controlled by traffic signals or by police officers .For higher traffic volumes, time sharing intersections i.e., signalized intersection is preferable to reduce overall intersection delay and conflicts, in comparison to rotary and priority intersections.

3.1.2 Grade Separated intersection

There are basically two type of grade separated structure. One is overpass or over bridge and second is underpass or under bridge. When the major highway or urban road is taken above by raising its profile above the general ground level by means of over bridge, it is called over pass. When the major highway or urban road is taken by depressing its profile below the general ground level by means of under bridge, it is called under pass. The choice of over pass or under pass depends upon topography, vertical alignment, drainage, economy, aesthetic features, etc.

4. Criteria for Provision of Grade Separated Intersection

1) On high type facilities such as expressways, freeways and motorways.
2) Certain at-grade intersections which have reached the maximum capacity and where it is not possible to improve the capacity further by retaining the at- grade crossing .
3) At certain locations which have a proven record of bad accident history when functioning as at grade junctions.
4) At junctions where the traffic volume is heavy and the delays and loss caused justify economically the provision of grade- separation.
5) At certain specific topographical situation where it is logical to provide a grade-separated intersection, which may involve considerable earthwork or acquisition of separated structure rather than an at-grade
6) Grade separation to be provided in urban street if the estimated traffic volumes within the next 5 years are in excess of the capacity of at-grade intersection.
7) 7. Grade separation to be provided in urban street when traffic projections show that '•ohnnes within the next 20 years will exceed the capacity of at-grade intersection.
8) Grade separation to be provided at intersections of divided rural highways if the ADT *c me cross road within the next 5 years exceeds 5000.
9) Where this figure will be reached within the next 20 years, the need for such facilities should be kept in view.
10) Grade separation is of great importance across railway lines. Current Indian practice **3br** rural highways requires grade separation to be provided across existing railway iocs if the product of ADT and the number of trains per day exceeds 50,000 within next 5 years.
11) For new constructions such as bye passes, grade separations should provided when this figure is greater than 25,000.

5. Advantages of Grade-Separation

1) Maximum facility is given to the crossing traffic. As the roads are separate, this avoids necessity of stopping and avoids accidents while crossing.
2) There is increased safety for turning traffic and by indirect interchange ramp even right turn movement is made quite easy and safe by converting into diverging to left and merging from left.
3) There is overall increase in comfort and convenience to the motorists and saving in travel time and vehicle operation cost.
4) The capacity of the grade operated intersection can practically approach that of the two cross roads.
5) Grade separation is a part of controlled access highway like expressway and freeway.
6) It is possible to adopt grade separation for all likely angles and layout of intersecting roads.
7) Stage construction of additional ramps is possible after the grade separation structure between main roads are constructed.

6. isadvantages of Grade Separation

Following are the disadvantages of grade-separation:
1) It is very costly to provide complete grade separation and interchange facilities.
2) Where there is limited right of way like built up or urban area or where the topography is not favourable, construction of grade separation is costly, difficult and undesirable.
3) In flat or plain terrain, grade separation may introduce undesirable crests and sags in the vertical alignment.

7. Capacity and Level-of-Service Concepts

The HCM 2000 presents methods for analyzing capacity and level of service for a broad transportation facilities. It provides procedures for analyzing streets and highways, bus and on-street light rail transit, and pedestrians and bicycle paths. Facilities are classified into two categories of flow: uninterrupted and interrupted. Uninterrupted-flow-facilities have no fixed elements, such as traffic signals. Traffic flow conditions result from the interactions among vehicles in the traffic stream and between vehicles and geometric and environmental characteristics of the roadway. Interrupted-flow facilities have controlled and uncontrolled access points that can interrupted the traffic flow. These access points including traffic signals, stop signs, yield signs, and of control that stop traffic periodically (or slow it significantly), irrespective of amount of traffic.

Uninterrupted and interrupted flows describe the type of facilities, not the quality the traffic flow at any given time. A freeway experiencing extreme congestion, for example, is still an uninterrupted flow facility because the causes of congestion are internal.

The analysis of interrupted-flow facilities must account for the impact of fixed interruptions. A traffic signal, for example, limits the time available to various movements in an intersection. Capacity is limited not only by the physical space but by the time available for movements. Transit, pedestrian, and bicycle flows generally are considered to be interrupted, Uninterrupted flow might be possible under certain circumstances, such as in a long bus way without stops or along a pedestrian corridor. However, in most situations, capacity is limited by stops along the facility.

8. Case Study-Shivranjani Intersection

Shivranjani Intersection is a signalized intersection with following geometric details:

Table 8: Geometric details for Case study Intersection

Name of intersection: Shivranjani Intersection					
Approach	Lane Group	No. of lanes Per lane Group	Width per lane (m)	Approach Width (m)	Approach Grade (%)
North	Left turn	1	3	40.23	0
	Through	4	3		
	Right turn	1	4		
South	Left turn	1	3	40.23	0
	Through	4	3		
	Right turn	1	4		

East	Left turn	1	3	28	0
	Through	3	2.6		
	Right turn	1	2.5		
West	Left turn	1	3	28	0
	Through	3	2.6		
	Right turn	1	2.5		

8.1 Comparison between Capacity and Present Traffic Volume

Table 8.1 shows the comparison between capacity and present traffic volume of shivaranjani intersection. It indicates that shivaranjani intersection capacity is 10,320veh/h while the present traffic volume at shivaranjani intersection is 13,421veh/h. It means the present traffic is 30% more than capacity of shivaranjani intersection.

Table 8.1: Comparison Between Capacity and Present Traffic Volume

Approach	Capacity veh/h	Present Traffic Volume veh/h
North	2653	3230
South	2648	3292
East	2538	3432
West	2481	3467
Intersection Total	10320	13421

(Source: Traffic Survey)

8.2 Comparison Between Volume to Capacity Ratio and Flow Condition for Lane Groups

There are three different conditions for measuring flow condition These are:
1) When v/c ratio less than one, flow condition is under saturated
2) When v/c ratio equal to one, flow condition is saturated
3) When v/c ratio more than one, flow condition is over saturated

Table 8.2 shows the comparison between v/c ratio and flow condition for lane groups. It indicates that in all approach left turn lane group flow condition is under saturated, because it carried
Continuous traffic movement. Remaining lane group for all approach flow condition is over saturated.

Table 8.2: Comparison Between v/c Ratio And Flow Condition for Lane Groups

Sr. No.	Approach	Lane Group	v/c Ratio	Flow condition
1	North	Left turn	0.574	Under saturated flow
2		Through	1.788	Over saturated flow
3		Right turn	1.723	Over saturated flow
4	South	Left turn	0.545	Under saturated flow
5		Through	1.814	Over saturated flow
6		Right turn	1.785	Over saturated flow
7	East	Left turn	0.817	Under saturated flow
8		Through	1.838	Over saturated flow
9		Right turn	1.762	Over saturated flow
10	West	Left turn	0.922	Under saturated flow
11		Through	1.861	Over saturated flow
12		Right turn	1.833	Over saturated flow

8.3 Comparison between Critical Volume to Capacity Ratio For Intersection And Flow Condition

There are three different conditions for measuring critical flow condition. These are
1) When critical v/c ratio for intersection less than one, flow condition is under saturated
2) When critical v/c ratio for intersection equal to one, flow condition is saturated
3) When critical v/c ratio for intersection more than one, flow condition is over saturated

There are four lane groups which behave as a critical lane group. They are:
a) South approach through lane group
b) South approach right turn lane group
c) West approach through lane group
d) West approach right turn lane group

Table 8.3 shows the comparison between critical v/c ratio for intersection and flow condition. It indicates critical v/c ratio for shivaranjani intersection is 1.827 which is more than one • So, flow condition for shivaranjani intersection is over saturated.

Table 8.3: Comparision Between critical v/c Ratio for Intersection and Flow Condition

Sr. No.	Approach	Lane Group	Critical v/c Ratio for Intersection	Intersection Flow Condition
1	South	Through	1.827	Over saturated Flow
2		Right Turn		
3	North	Through		
4		Right Turn		

8.4 Comparison Between Delay and Level of Service

Table 8.4: Comparison between Delay And Level Of Service

Sr.No.	Approach	Lane Group	Lane Group Delay s/veh	Lane Group Level of Service
1	North	Left turn	2.25	A
2		Through	414.72	F
3		Right turn	403.16	F
4	South	Left turn	2.03	A
5		Through	426.39	F
6		Right turn	430.37	F
7	East	Left turn	6.75	A
8		Through	455.42	F
9		Right turn	432.37	F
10	West	Left turn	14.4	A
11		Through	465.72	F
12		Right turn	447.64	F

8.5: Comparison between Delay and LOS for Approach and Intersection

Approach	Approach Delay	Approach LOS	Intersection Delay	Intersection LOS
North	340.37	F	342.14	F
South	352,69	F		
East	338.79	F		
West	337.34	F		

9. Discussion

The capacity of shivaranjani intersection is less than present traffic demand as described in section 8.2. So it may be needed to improve present signalized condition or present geometric condition. Here v/c ratio for through and right turn traffic movements for all approach of shivaranjani intersection are over saturated . It indicates of actual or potential breakdown. Critical v/c ratio at shivranjani intersection is greater than one. This indicates that the signal and geometric design cannot accommodate the combination of critical flows at the intersection. This condition may be ameliorated by increased cycle length, changes in the phasing plan, and basic changes in geometrics. Further, here all left turns and right turns are protected phases and v/c ratios are unacceptable, it is probable that geometric changes will be required to ameliorate the condition. Also there are comparison between delay and level of service. It indicates that shivaranjani intersection approach delay and intersection delay is very high and it place in LOS F.

10. Conclusion

Results of different parameters related to signalized intersection such as capacity, volume to capacity ratio, critical volume to capacity ratio for intersection as whole and delay with level of service criteria are analysed and discussed. With this analysis and discussion following conclusions are carried out:

1) The present traffic volume of shivaranjani intersection is more than present capacity of intersection. So grade separation to be provided.
2) The v/c ratios for lane groups are unacceptable and all turning movements are protective phasing. So geometric changes will be required.
3) The critical v/c ratio for intersection as whole is greater than one. So intersection geometry changes will require.
4) The delay for lane groups, approaches and intersection as whole are unacceptable and delay level of service is F.

Conclusion of this work is "Convert the shivaranjani at grade intersection in to grade separated intersection".

11. Future Scope of Work

In this report, it is the conclusion that shivaranjani intersection is converted from at grade intersection to grade separated intersection. The future work may be carried out on this report are:

- Geometric design of grade separator
- Economic evaluation of providing a grade separation at shivaranjani intersection, etc.

References

[1] Saxena C, *A Course in Traffic Planning and Design Second Edition* , Dhanpat Rai Publication.
[2] Kadiyali L.R., *Traffic Engineering and Transport Planning sixth reprint 2004*, Khanna Publishers.
[3] Khanna S. K., Justo C.E.G., *Highway engineering Eighth edition*, New Chand and Bros, Roorkee.
[4] *Highway Capacity Manual 2000* by Transportation Research Board, National Research council, Washington D.C
[5] Dissertation on " *Capacity analysis of signalized Intersection in Devloping Countries*" 2002 by Gopal R. Patil.