Study on Traffic Regulation at Highway Intersection

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Abstract— A sound understanding of the importance of intersections within a road network is a key factor forth efficient and effective management and control of transport networks when traffic operations are saturated. Conventional indices (e.g. level of service, degree of saturation, capacity or delay) reflect only the states of an intersection itself, but lack the ability to describe the influences among the intersections within a road network. To reduce traffic congestion at a grade intersection, one method is construction of flyover at intersection. The flyover facilitates the traffic flow in the direction of bridge, but the infrastructure cannot fully solve all of the problems especially on the secondary roads. Under the bridge, although it relieves the traffic congestion at the intersection, traffic signal at intersection also reduce congestion and accidental rate. Channelized intersection provides more safety and efficiency. It reduces the number of possible conflicts by reducing the area of conflicts available in the carriageway. If channelizing is not provided the driver will have less tendency to reduce the speed while entering the intersection from the carriageway. The presence of traffic islands, markings etc. indicates the driver to reduce the speed and becomes more cautious while passing through the intersection. A channelizing island also serves as a safety for pedestrians and makes pedestrian crossing safer. Traffic congestion on major roads depend upon existing bottlenecks at intersections is a major problem in India. To change this trend, this research was carried out in order to design effective traffic control mechanisms at the troubled spots in India. Traffic volume data was collected throughout the day. Furthermore, discharge headway and delay data were collected using stop watch. The geometric and traffic data collected were analysed using Microsoft Excel. An appraisal of Maui Intersection indicated that the major contributors to traffic are trucks, passenger cars, motorcycles and other modes of transportation traversing the intersection.

Key words: Traffic Regulation, Highway Intersection

I. Introduction

A. General

The history of man is tied to history of movement. Transportation is essential to social progress, transportation itself is a social progress because it has been used throughout history, the way in which not only goods and services are moved around but ideas are exchanged among people. However, the rise of transportation might grind to a halt as a result of bottlenecks occurring at intersections. An intersection is a general area where two or more roads cross at the same or different elevations. Interruption of traffic flow is a daily experience in urban centers of the world and it occurs primarily at intersections.

This study helps us to evaluate the importance of an intersection within a road network. Intersectionat Mauli is between the roads NH-907(Chandigarh-Dehradun) and NH-73 (Panchkula –Yamunagar) is at a distance of 26.9 kms from panchkula is identified as one of the critical intersections during a reconnaissance survey and as such selected for study

B. Traffic Signals at Intersection

Traffic signals are offering a maximum control to any road intersections. These relay messages of both what you must do and what not to do as a driver. The primary function of the traffic signals as we know is to assign the right of way to the contradicting movements of traffic in an intersection. This is actually done by allowing the conflicting traffic streams to share the same intersection by way of separating the time. Furthermore, the signals provide an orderly movement of the conflicting flows by means of assigning the right of way alternately to various movements of the traffic. However, it may interrupt extremely heavy flows to allow the crossing of some minor movements which otherwise, could not move safely into the intersection.

C. Channelized Intersection

Channelization is an integral part of at grade intersections and is used to separate turning movements from through movements where this is considered advisable and hence helps reduce the intensity and frequency of loss of life and property due to accidents to a large extent. Proper Channelization increases capacity, improves safety, provides maximum convenience, and instils driver confidence. Improper Channelization has the opposite effect and may be worse than none at all. Over Channelization should be avoided because it could create confusion and worsen operations.

D. Grade Separated Intersection

It is a bridge that eliminates crossing conflicts at intersections by vertical separation of roadways in space. Grade separated intersection are otherwise known as Interchanges. Grade separated intersection design is the highest form of intersection treatment. This type of intersection cause least delay & hazard the crossing traffic and is superior to intersections at grade from the point of view of traffic safety .Uninterrupted flow is possible for the crossing traffic. There is increased safety for turning traffic. There is overall increase in comfort & convenience. It is possible to adopt grade separation for all likely angles and layout of intersecting roads.

II. Methodology

The methodology involved for the study is as follows:
For the current study, Maul intersection is on Chandigarh-Dehradun highway (NH-907) and Panchkula-Yamunanagar highway (NH-73) as shown in Fig1.2 in the state of Haryana, India. It is the grade separated intersection with difference in level between the approaching roads. The complete channelizing of the intersection is necessary for proper installation of signs and signals as well as for the efficient movement of traffic.

A. *Data Collection*

Mauli intersection is identified as one of the critical intersections during a reconnaissance survey and as such, selected for study. Data on geometric features are collected at the intersection. Geometric details measured include: major road width, minor road width, number of lanes on major road, number of lanes on minor road and angles of inclination of the minor approaches relative to the major route. Data on traffic volume and delay are collected at approaches throughout the day. Transportation modes considered include bicycle, motorcycle, passenger car, bus, lorry, 2 axle truck, 3-axle truck, and 4-axle truck. The counts were broken down into four flow regimes of 15 minutes interval. Delay was measured using stop watch by successively taking note of waiting time of the first vehicle that reaches an intersection at an occurrence of stoppage before having the right of way

Parameters	Value
Major Road Width	18.00 m (Shoulder Inclusive)
Minor Road Width	7.5 m (Shoulder exclusive)
Number of Lanes on Major Road	4 Lanes (4-way)
Number of Lanes on Minor Road	2 Lanes (2-way)
Angle of Inclination of Minor Approaches Relative to Major Route ≈70˚	

Table 3.1: Geometric Features of Mauli Intersection

B. *Akcelik Models*

According to Akcelik, all capacity and performance calculations are carried out forindividual lanes of entry (minor) movements, but traffic in all lanes of the major (conflicting) movement is treated together as one stream. When there are several conflicting (higherpriority) streams at signalized intersections, all conflicting streams are combined as onestream. The resulting total opposing flow rate, qm may be expressed in passenger car units (pcu) allowing for the effect of heavy vehicles in the opposing streams. In the followingequations, qm is in veh/s or pcu/s

1) *AKCELIK – M3D Model*

For the Akcelik –M3D model, the bunched exponential distribution is used with the bunching model to determine φm using Δm and kd.

$$Qg = (3600\ tf\ )(1 - \Delta mqm + 0.5\varphi mqmtf)e{-}\lambda(tc{-}\Delta m)$$

1) AKCELIK – M3T Model

For the Akcelik - M3T model, the bunched exponential distribution is used with the Tanner bunching model to determine φm.

$$Qg = (3600\ tf\ )(1 - \Delta mqm)(1 + 0.5qmtf)e{-}qm(tc{-}\Delta m)$$

C. *Flyover Evaluation*

The project evaluation compares the cases with and without the flyover project in order to assess the benefits arising from the project. The benefits include savings in the value of time (VOT), vehicle operating cost (VOC) and cost of accidents. Details are as follows:

1) *Value of Time (VOT)*

Value of time means the cost (equivalent to money) that is lost due to delay during a trip, but when traffic flow through the intersection is improved after the flyover is operational, the increased intersection efficiency will save travel time and road users can use this time to do another activity. Value of time in the area (province) of case study can be calculated from the gross province product (GPP), number of people employed and average hours of work.

2) *Vehicle Operating Costs (VOC)*

Vehicle operating costs comprise the cost of fuel, lubricant cost, and operation cost, these correlated with number, type, and vehicle speed and traffic volume. When vehicles are waiting for green signal at the intersection stop line with the engine running, wasteful fuel consumption results which also vary with types of vehicles. The different traffic volume between case without and with project can be converted to equivalent monetary term.

III. DATA COLLECTION, ANALYSIS & DISCUSSION

A. *Traffic Characteristics of the Intersection under Study*

In Panchkula-Yamnanagar Road intersection being studied, it was observed that during peak periods, cars and tricycles contributed much to the worsening of the traffic situation of the city. Likewise, some of the buses and trucks that are bound to the north and even to the south are contributory to the said situation of the city. The unregulated stoppage of vehicles and loading and unloading near the intersection cause the unstable flow.

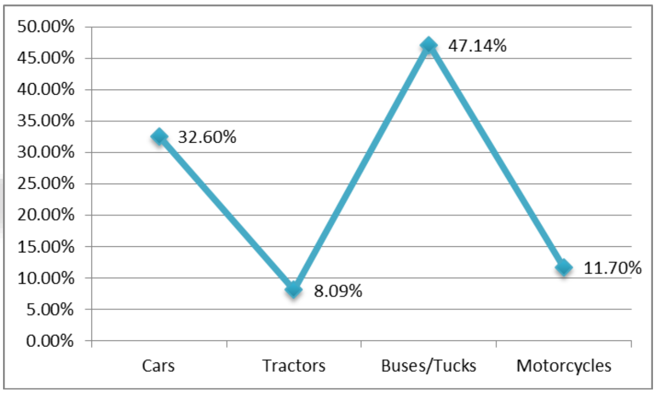

Fig. 4.2: Composition of Traffic throughout Day

B. *Design of Traffic Signal by Webster Method*

q_A = 400 PCU/hr
q_C = 334 PCU/ hr
Where q_A and q_C are thr no. of PCU vehicles per hour.
Saturation flow S_A = 1250 PCU/hr
S_C = 1000 PCU/hr
Assume all red time required for pedestrain crossing is 12 sec.

$$y_A = \frac{qA}{SA} = \frac{400}{1250} = 0.32$$

$$y_C = \frac{qc}{Sc} = \frac{334}{1000} = 0.33$$

$Y = y_A + y_C = 0.65$
$L = 2n + R$
$L = 2x\ 2 + 12$
$L = 16$ sec

$$Co = \frac{1.5L+5}{1-Y} = \frac{1.5\times16+5}{1-0.65} = 82.85 \text{ sec.}$$

$$\text{Green time } (G_A) = \frac{(Co-L)yA}{yA+yc} = \frac{(82.85-16)0.32}{0.65} = 32.9 \text{ sec.}$$

$$G_C = \frac{(Co-L)yc}{yA+yc} = 33.9 \text{ sec}$$

Adopt G_A = 33 sec

G_C = 34 sec

Providing amber time of 5 second for each phase for clearance

Co = 83 sec

$G_A + A_A + G_C + A_C$ = 83 sec

<table>
<tr><td>Phase A</td><td>Green Time = 33 sec</td><td>Amber Time = 5 sec</td><td colspan="2">Red Time = 39sec</td></tr>
<tr><td>Phase B</td><td colspan="2">Red Time = 38 sec</td><td>Green Time =34 sec</td><td>Amber Time = 5 sec</td></tr>
</table>

Table 4.12 Showing Cycle Time of Signals for Phase A & Phase B

C. Future Scope

There are some limitations in this research work and further study can be carried out some overcome limitation:

- The study is carried out at Mauli intersection and this research can be further executed in other cities to analyse capacity and performance analysis of roads due to heterogeneous traffic flow, road condition and driving characteristics.
- Traffic signal is the prime component for the operational analysis of intersection. More data collection is required for analysis of intersection with signalized and un-signalized intersections.
- By analysis of collected data, we have suggested that Flyover Bridge will also carry the future traffic safely 30 years. In future there is a scope of providing this flyover as a toll road for generating revenue and maintaining the speed of various vehicles.

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