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Research Paper

Signal timing optimization: A case study of Loni Intersection, New Delhi

Engineering

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Hariom Maheshwari

Urban Planner, Master of City Planning from IIT Kharagpur and KIT, Germany, B.Arch from RTM Nagpur University

ABSTRACT

The rapid pace of urbanization has led to proliferation of automobiles in urban areas. Exponential growth of automobile has caused phenomenal increase in traffic congestion at most of the intersections. In this paper attempt has been made to consider Loni square formed by intersection of Mangal Pandey Marg and Loni road, in the North Eastern part of Delhi. Loni intersection lies in Zone E of Delhi Master Plan - 2021. Presently the intersection suffers major setback in terms of its efficient and safe traffic operation, resulting in traffic congestion, substantial long queue, vehicular delay and increase in pollution. In order to ensure smooth movement of traffic and pedestrian safety, various alternatives were worked out in order to optimize signal timing and prevent delay.

Introduction

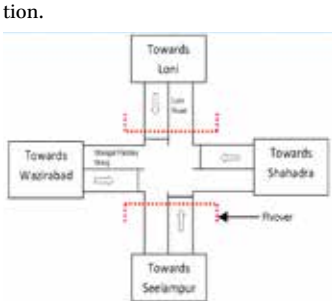
Rapid growth of automobiles has significantly stressed existing transport infrastructure in the urban areas. Transportation sector plays an important role in economic development. If transport infrastructure is not taken care of in a rational manner then it will exert adverse pressure on the society resulting in traffic congestion, pollution emission and high rate of road accidents.

Sharing of limited road space at Loni intersection by increasing volume of traffic, flowing from multiple directions has reduced the efficiency of the intersection leading to frequent traffic congestion. Loni intersection has LOS F. The present study aims at proposing pragmatic solutions in order reduce cycle time, ensure smooth movement of traffic and pedestrian safety at Loni intersection. Multiple alternative solutions like redesigned traffic signal, construction of underpasses etc were worked out and the best feasible solution has been identified and recommended in order to enhance mobility and arrive at acceptable optimize cycle time.

Area profile

Mangal Pandey Marg has been identified in the Master Plan of Delhi (MPD) – 2021 as a major arterial road, having 60 m Right of Way (ROW). The road has commercial activities on either sides and is encroached by informal activities and on-street parking reducing the effective ROW to 53 - 55 m. Mangal pandey Marg and Loni road has 8 lane and 4 lane divided carriageway respectively. Table 1 Shows Modal split at Loni Intersection. Due to presence of various commercial activities at Loni intersection the share of Non Motorized Vehicles (NMV) is 21%.

The service lanes and NMV track, meant to cater to local traffic and NMV are absent or in sub-optimal condition resulting in intermixing of fast and slow moving vehicles reducing the effective capacity of the road from 1800 PCUs/hr per lane to 1300 PCUs/hr per lane. A flyover is already constructed on Mangal Pandey Marg between Wazirabad to Shahadra to allow smooth flow of traffic but despite of such capital intensive project, Loni intersection faces the problems of congestion, accidents and pollution.



Map 1: Schematic plan of Loni Intersection

Table 1: Modal split at Loni Intersection

Mode	Percentage
Bicycle	4
Cycle-Rickshaw	14
Hand Carts	3
Car/Jeeps	24
Two Wheelers	15
Bus	7
Auto Rickshaw	15
Trucks	14
LCV	3
Tractor	1

Table 2: Turning Movement Count of vehicles

From To Vehicles	(PCU/hr)
Seelampur Wazirabad	913
Loni	1537
Shahadra	1161
Wazirabad Loni	2642
Shahadra	2843
Seelampur	2971
Loni Shahadra	769
Seelampur	1473
Wazirabad	1125
Shahadra Seelampur	2235
Wazirabad	2561
Loni	2486

Case 1- Traffic Signal

Since a flyover already exist at Loni intersection on Mangal Pandey Marg between Wazirabad to Shahadra, therefore this traffic virtually do not enter into the intersection and hence this traffic flow can be ignored for the purpose of calculating optimum signal time. Therefore three phase signal is designed in following way:

Phase1: Loni to Seelampur - straight flow

Phase2: Loni to Wazirabad & Seelampur to Shahadra

Phase3: Wazirabad to Seelampur & Shahadra to Loni

Optimum cycle time

$$Co = \frac{5L + 5}{1 - \sum Y}$$

Where:

Co = Optimum cycle time (sec)

L = Time lost time (sec)

Y=Sum of Volume/Capacity ratios (Saturation flow of 1300PCUs/hr is considered, because intermixing of fast and slow moving vehicles has reduced the capacity of the road from 1800 PCUs/hr per lane to 1300 PCUs/hr per lane)

Time Lost (L)

$$L = 2 \times N + R$$

Where,
N = number of phase

R = all red time= 3 sec for each leg

Maximum flow (PCU/hour) in each phase (q) is:

Flow in Phase 1 – 1537 PCU/hour

Flow in Phase 2 – 1161 PCU/hour

Flow in Phase 3 – 2971 PCU/hour

From the above equation Co = -83 sec, since Co<0, therefore this option is not possible.

Case 2- Construction of integrated multi-modal transit corridor
In this case proposal for road widening is considered in order to develop integrated multi-modal transit corridor on Mangal Pandey Marg and Loni Road. Integrated multi-modal transit corridor will accommodate dedicated NMV track, pedestrian pathway and Service road in order to segregate slow and fast moving modes. Segregation of slow and fast moving modes will reduce conflicts, ensure traffic safety, prevent traffic congestion and will enhance the capacity of road from 1300 PCUs/hr per lane to 1800 PCUs/hr per lane.

In this case three phase signal is considered which are divided as follows:
Phase1: Loni to Seelampur - straight flow

Phase2: Loni to Wazirabad & Seelampur to Shahadra

Phase3: Wazirabad to Seelampur & Shahadra to Loni

Maximum flow (PCU/hour) in each phase (q) is:
Flow in Phase 1 – 1537 PCU/hour

Flow in Phase 2 – 1161 PCU/hour

Flow in Phase 3 – 2971 PCU/hour

From the calculation, ΣY > 1 and Co<0, therefore this option is not possible.

Case 3- Construction of underpass on Loni road
There is significant traffic flow between Loni and Seelampur therefore a 7 m wide two ways divided underpass is proposed on Loni road at Loni intersection. After proposing an underpass on Loni road, the straight traffic destined to Seelampur and Loni on Loni road will not virtually enter into the intersection and hence this traffic flow can be ignored for the purpose of calculating optimum signal time. In this case proposal for integrated multi-modal transit corridor is also considered.

In this case two phase signal is considered which are divided as follows:
Flow in Phase 1 – 1161 PCU/hour

Flow in Phase 2 – 2971 PCU/hours

From the above equation Co = 68 sec to 70 sec , this option is acceptable.

Here capacity of road considered is 1800 PCUs/hr per lane.

Total Green time (G)

$$G = Co - A1 - A2 - L$$

Where, A1,A2 = Amber time for phase 1 & 2

L = Total Time lost in all phases

Therefore

G= 70-3-3-16

G=48 sec

Therefore Green time for phase 1 (GP1)

GP1 = 13 sec

GP1 = Error! Not a valid link. sec

$$GP2 = \frac{2971}{(1161 + 2971)} \times 48$$

GP2 = Error! Not a valid link. sec

Phase	Green time	Amber time	Time lost	Total length
Phase 1	13	3	6	22
Phase 1	35	3	6	44

CONCLUSION
Above discussion shows that because of heavy traffic flow, intermixing of modes travelling with different speed Loni intersection suffers from significant traffic delay and congestion therefore planned interventions were required to allow smooth flow of traffic. The planned intervention includes construction of underpass on Loni road and development of integrated multi-modal transit corridor. These interventions if implemented will significantly reduce signal timing, traffic congestion, environmental pollution, accidents, and ensure pedestrian safety. In addition Intelligent Transportation System (ITS) should also be deployed for efficient enforcement of traffic regulations.

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