Importance of Traffic Management during Execution of Metro Rail Project in India

Preyansh Gupta[1] M. R. Apte[2]
[1]M.E. Student [2]Assistant Professor
[1]Department of Construction and Management Engineering [2]Department of Civil Engineering
[1,2]Maharashtra Institute of Technology, Kothrud, Pune, India

Abstract— Most of the infrastructure projects in India run into trouble due to managerial factors rather than technical problems. The negligence in the overall management strategies not only affects the project time and cost but also to the community and the surrounding environment. Construction of large infrastructure project like Metro Rail Project is of prolonged duration of 10-15 years in an upcoming metro city. We all know that these projects are for social welfare through providing public transport facilities but for such a long tenure of actual execution work on roads, we totally neglect about systematic management strategies not to cause inconvenience to the commuters around. In this research paper we are going to analyze the freeway and arterial road congestion and the out turns of execution work to the surrounding society experiencing actual site conditions. Traffic characteristics and the standards designed will support this research work. Hence as a duty of civil engineer, suggesting some traffic diversion strategies as well as following some other useful norms can help to curtail the current trouble faced.

Key words: Capacity, Heterogeneous Traffic, Traffic Volume, LOS

I. INTRODUCTION

Pune district is well connected with the state capital and surrounding headquarters through road and rail linkages. The road network consists of Express Highways. National Highways, State Highways and Major District Roads. The district has total length of 13,642 km of roads. Pune where roads do not have adequate width and which cater to mixed traffic conditions comprising slow and fast moving vehicles, road transport can optimally carry 8,000 persons per hour per direction (phpdt). When traffic density increases beyond this level, average speed of vehicles comes down, journey time increases, air population goes up and commuters are put to increased level of inconvenience. The existing urban transport system of Pune City which is road-based has already come under stress leading to longer travel time, increased air pollution and rise in number of road accidents. With projected increase in the population of the city strengthening and augmenting of transport infrastructure has assumed urgency. Thus, many infrastructure projects are now forthcoming in the city.

Pune is turning into 'Smart City'. A Smart City is an urban environment where infrastructure and services are interlinked using technology to improve the quality of life by enhancing their operations. One of the great project under Smart city is execution of Metro Rail Project. The most evident problems experienced in Pune city is the design and maintenance of roads, inadequacy of public transport and congestion of streets. Also, day by day number of serious injuries, damage costs of injury collisions, total time spent travelling on roads, money spent on fuels and greenhouse gas emissions. Thus, there is lot of need to work for reducing traffic congestion problems prevailing in the city as well as traffic safety norms to be followed.

Before execution of any infrastructure project, the first and foremost activity is of selecting a work zone. Work zone management is of key importance for overall project management. The most important key activity involved after selecting work zone is of barricading. Comparing Indian scenarios, this key step of barricading is usually neglected while planning and execution of large scale projects. About 2 to 3% of total project cost of any infrastructure projects is involved in barricading. The project as a whole will not move ahead until this key step sets up on site. Thus, study of various impacts of barricading on the selected work zone and thus eventually on the total project is analyzed.

II. LITERATURE REVIEW

There are many researches going on and has been done throughout the world concerning traffic management and other related issues. For example, Yao-Jan Wu (2011) in his literature suggested that traffic congestion is a common phenomenon in our daily lives that greatly costs society. A better understanding of the interaction between freeways and arterial streets may help traffic engineers and researchers improve the operation of the existing facilities and deploy feasible traffic diversion plan to improve the usage of existing road capacity within a traffic network. Congestion results in many costs such as increased fuel consumption and time wasted when vehicles are idling in traffic. Because, construction of additional roads is not often a feasible solution, maximizing the utilization of existing roadway facilities is a relatively low cost option for reducing congestion. [12] There are many related type of researches for homogenous type of traffic congestion. In Indian scenario of heterogeneous traffic conditions these are of less relevance. But in India these type of researches are very rare, conveying how execution of construction project can disturb the commuters. Thus there is urgent need to give a thought towards this inconvenience caused. Below are some of the Indian researches that can help in some or the other way to support this research work.

Satish Chandra et. Al (2004) introduces a new concept for estimation of passenger car unit (PCU) of different class of vehicles under mix traffic conditions. It uses area of vehicles and speed of vehicles. for his research he collected traffic data at ten section on highway all over the India having carriageway width 5.5 to 8.8 m. Capacity estimation on highway is one of the toughest method.[9] Gabriel et. al,(2004) gave a procedure for calibration and construction of a model for freeway using vissim software.[4] Pruthvi Manjunatha and Peter Vortisch in the year 2012 said

that a methodology for calibrating a micro simulation model for mixed traffic is need to be proposed so that Driver behavior in mixed traffic can be observed . And they need to find the parameters required for Calibration such as sensitivity analysis, the optimum values for these parameters were obtained by minimizing the error between the simulated and field delay using a genetic algorithm. Characteristics from Mumbai are taken as case study to implement the methodology in VISSIM with Genetic Algorithm for solving the optimization formulation and was shown to produce reliable results and also defining the network elements .Beyond the flexibilities that present micro simulators offer, their ability to simulate the mixed traffic is still limited, additional parameters are required to accurately model some of the behavior in mixed traffic. [8] Siddharth S Mp et.al, (2013), gave a method for automatic calibration of vissim and sensitivity analysis of result by using traffic data from an intersection. Vissim is one of the extremely popular software for simulation. [10] Ketan Kumar Varmora (2015), studies mainly on adaptability of vissim for modeling of traffic under mix traffic condition. He concluded that vissim is able to simulate traffic under mix traffic condition and analysis of traffic better. [6] As stated by Dr. B.V Khode and Pratik Raj in the year 2016 that the continuous increase in vehicle on urban roads the congestion also increases and it became the major concern about how to maintain free flow speed of traffic. To avoid this congestion they have made microscopic model by using different computer program such as simulation as Simulation is the mirroring of the operation of a real world process or system. As a result they have suggested about the heterogeneous traffic condition, saturation flow rate, Lane changing strategies, volume capacity ratio and The traffic simulation tool vissim is can be used to simulate heavy populated road corridor and to identify the performances, Signalized and non-signalized intersection can also be optimize .[3]

III. CASE STUDY

A. Project Information

Pune Metro Rail project consist of two corridors, corridor I and corridor II. Corridor I start from Pimpri to Swargate. The total length of corridor 1 is of 16.589 km out of which a stretch of 11.5 km include elevated stations (9) and remaining 5.019 km included underground stations(6).[13] The execution work of this corridor on the pier alignment has already been started in great pace.

Corridor II starts from VANAZ and ends at RAMWADI. The total length of this corridor II is 14.665 km. For total stretch, includes 16 elevated stations. The execution work of this corridor has not been started yet in great pace, Soil testing at foot paths and various locations is in process with isolated barricading. Thus, to study the before and after effects of barricading, this corridor is taken as study area for research work.

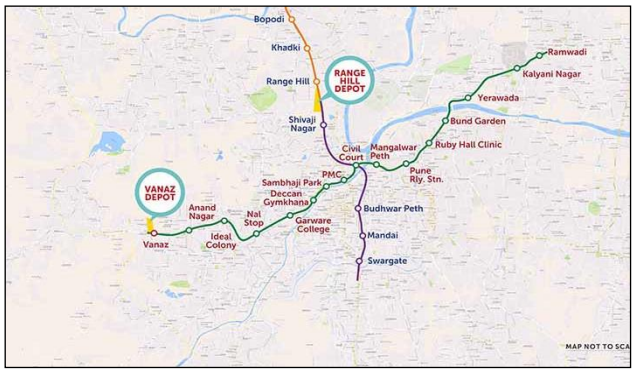


Fig. 1: Corridor II Route Map

B. Study Area

The study area from VANAZ to ANAND NAGAR is selected as study area due to three major reasons:

1) Residential area: challenging task
2) Congested line of alignment
3) Great experience to study and analyse such location of work zone management

Study Area	
Chainage Start	100 (Vanaz)
Chainage End	1220 (End Of Anand Nagar St.)
Total Length	1120 M
Total Pier	45

Table 1: Study Area

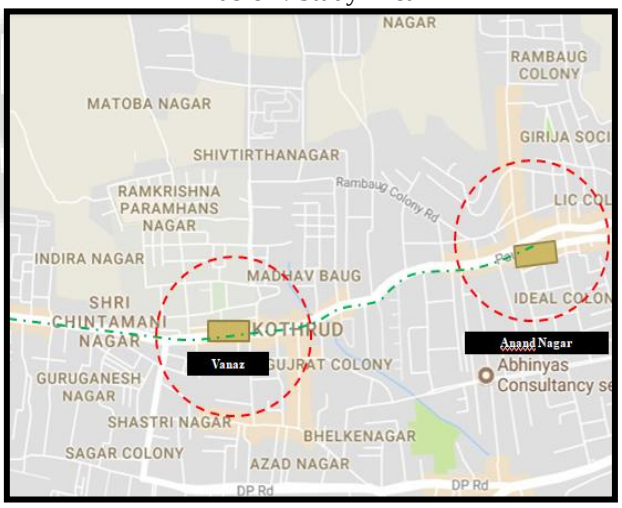


Fig. 2: Study Area (Vanaz to Anand Nagar)

After selection of study area of maximum influence, we need to finalize a management plan for work zone management. The objectives of preparing this management plan should clearly address the following crucial issues:-

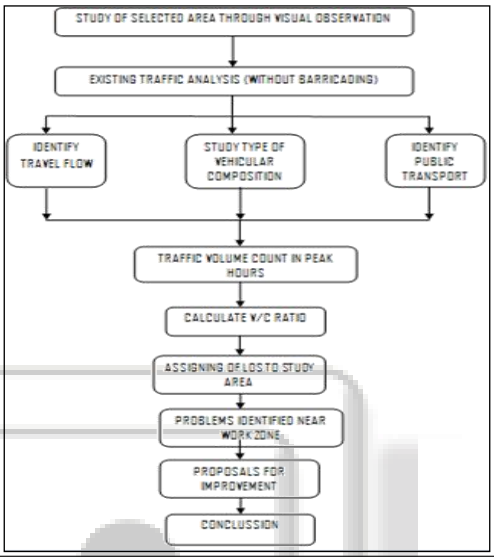
1) To curtail the trouble caused to commuters due to traffic congestion.
2) To reduce fuel consumption and time wasted when vehicles are idling in traffic.
3) To maximize the utilization of existing roadway facilities.
4) To provide safety to pedestrians traveling along the work zone.
5) To provide protection of working crew from hazards associated with moving traffic to reduce the delay in project that can be caused due to improper work zone management.

Keeping all the above issues in mind appropriate methodology is selected for carrying out research work.

IV. METHODOLOGY

Importance of traffic management and safety in and around work sites along public roads is our main motive to study.
The very first and important step of our methodology starts from having a keen visual observation of the selected study area.

The procedure followed to carry out the research work before and after commencement of construction works on main carriageway is as shown in the flow chart given below:



A. *Study of Influence Area*

The detail study of influence area starting from Vanaz Corner to Anand Nagar plays vital role. The first step is to perform a road inventory survey along the alignment of 1.12 kms. The purpose of road inventory survey will be further utilized for capacity and LOS (Level of Services) analysis. The road inventory survey is conducted in the morning at around 09:00- 11:30 AM, at eight intersections(Anna bhau sathe chowk, Anand Nagar chowk, Kinara Hotel chowk, Madhav Road intersection, Ramchandra mane road, Shripati sutar road , Nanasaheb sutar road) covering the study area.

The weather was sunny and suitable for data collection. Walking around links and locating objects and points by measuring tape. Basic information for planning purposes like location of traffic signs and distance of utility line from the roads are obtained. In addition, road conditions and road marking were also noted.

locations	link	name of road	ROW	Type of road	road material	one/two way	no of lane	median	shoulder	footpath			cycle track	parking	Bus stop
										yes/no	LHS	RHS	yes/no	yes/no	
Anna Bhau Sathe Chowk	3 to 4	A.B.S.chowk	10-12m	Sub-Arterial	Asphalt	2 way	4 lane	no	no	yes/no	yes	yes	no	no legal parking	no bus stop
Anand Nagar	10 to 17	miland society road	10-12m	Sub-Arterial	Asphalt	1 way	2 lane	no	yes	yes/no	2m	2m	no	legal parking	no bus stop
Kinar Hotel	5 to 15	poud road	25-30m	Arterial	Asphalt	2 way	6 lane	yes	yes	yes/no	2m	2m	no	legal parking	yes
Pratik Nagar	15 to 16	madhav road	25m	Sub-Arterial	Asphalt	2way	2 lane	no	yes	yes/no	2m	2m	no	legal parking	anand nagar bus stop
Kinara Hotel	5 to 6	ramchandra mane road	25m	Sub-Arterial	Asphalt	2way	4 lane	yes	yes	yes/no	1.5m	1.5m	no	no legal parking	no bus stop
Towards MIT	6 to 8	rambaugh road	20M	Sub-Arterial	Asphalt	2way	2 lane	no	no	yes/no	1.5m	1.5m	no	legal parking	Yes
Shivthirthi Nagar	7 to 13	shripati sutar road	15-20m	Sub-Arterial	Asphalt	2way	3 lane	no	no	yes/no	1.5m	1.5m	no	no legal parking	no bus stop
Idbi Bank	12 to 14	nanasaheb sutar road	10-15m	Sub-Arterial	Asphalt	2way	2 lane	no	no	no			no	no legal parking	no bus stop

Table 2: Road Inventory Survey

The above table shows the road inventory details of 8 selected intersections. The road inventory detail includes location, link, name of road, ROW, type of road, road material, traffic flow, number of lanes, presence of median and shoulders, presence of footpath and cycle track, presence of parking and bus stops for all the eight different roads of the study area.

B. *Existing Traffic Analysis*

Detail existing traffic analysis without barricading that is without actual execution work of metro has been started is carried out. Major activities under this existing traffic analysis can be headed as below:

- Identify traffic flow
- Study type of vehicular composition
- Traffic volume count in peak hours
- Check out public transport system and its share

Traffic volume studies are conducted to determine the volume, movement and classification of road way vehicles at a given location. This data can help identify traffic volume trends and critical periods. In our research study area of influence, In India traffic consists of different categories of vehicles with different flow characteristics and different speed and size. A heterogeneous type of flow is being absorbed in the field of Indian cities. Where it is required to convert the obtained values into a uniform value by converting it to a standard value that is Passenger car unit.

Thus by doing so it helps in better perspective of calculation of the same regarding the requirement. Different categories of vehicle where noted down in the field for an interval of 15 min duration and for three hours in the morning and evening during two weekdays and two weekends. Same data had to be converted to a uniform value.

A manual traffic count was conducted using tally sheet methods because we did not have access to mechanical or electronic counting board.

In above field work care must be taken to select to proper observer location where there can be a clear view of traffic. Hence through this intersection count we determine the capacity, analyzed intersections and evaluated congestions.

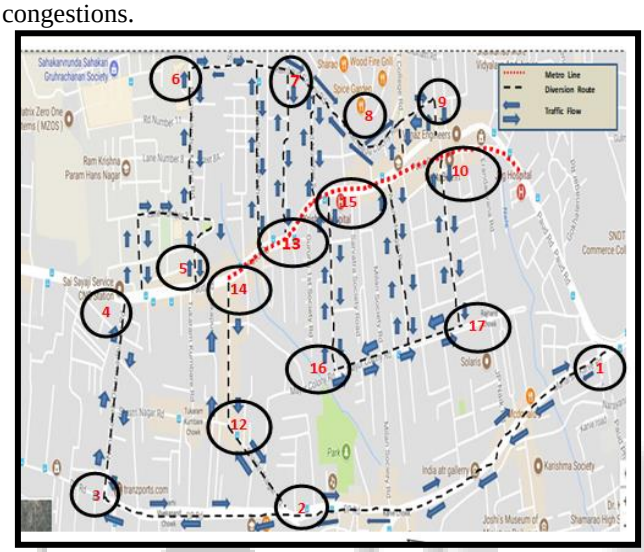


Fig. 3: Vehicular Travel Flow

Sr.No	Location	Link	Traffic Volume Count PCU(Passenger Car Unit) Morning	Evening
1	Ramchandra mane road	5 to 6	1450	1418
2	Rambaugh road	6 to 8	1512	1500
3	Shripati sutar road	7 to 13	1102	1358
4	Anna bhau sathe road	3 to 4	950	1315
5	Madhav road	15 to 16	980	1116
6	Anand nagar road	10 to 17	950	1000
7	Paud road	5 to 15	5400	5900
8	Nana saheb sutar road	12 to 14	1100	1150

Table 3: Traffic Volume Count

The above table shows the traffic volume count for all the eight different roads in the morning and evening peak hours.

C. Calculation of V/C Ratio

Vehicle to capacity ratio is also an important parameter to know the whether the condition is over saturated or under saturated for the same condition. Calculated as per [appendix]

Degree of saturation X=V/C

Where, V=volume (vehicles/hour)

C=capacity (vehicles/hour)

For Ex:-

1 - Ramchandra mane Road

Volume: 1359

Capacity: 2143

V/C ratio: 1359/2143

: 0.6

Hence the LOS (level of service) for this road is B,

Capacity and level of service: Capacity of any particular area or junction can be described as whether the present traffic is being accommodated by the present condition of the road without much difficulty. Certain conditions arise where the capacity of the selected stretch is very less thus leading to various problems like congestion and delay. This parameter mainly helps in identifying the where does a particular junction stands in case of handling of the traffic and its behavior for the same. This can be grouped under the SIX categories they are as follows:-

1) LOS (Level of Service) A

It indicates a free movement of vehicles without any obstruction or congestion.

2) LOS B, C, D, E

These all indicate the intermediate flow of vehicles for the same.

3) LOS F

Where the movement of vehicle is in worst-scenario, thus leading to more amounts of delay and conjunction this depicts the worst condition existing in the field.

Note: The standard theoretical capacity and the standard level of service threshold based on V/C ratio is given in appendix.

A	B	C	D	E	F	G
Sr.No	Location	link	Theoretical capacity	observed capacity	V/C ratio	LOS
1	Ramchandra mane road	5 to 6	2143	1450	0.67	B
2	Rambaugh road	6 to 8	2143	1512	0.7	B
3	Shripati sutar road	7 to 13	2143	1358	0.63	B
4	Anna bhau sathe road	3 to 4	2143	1315	0.61	B
5	Madhav road	15 to 16	2143	1116	0.52	A
6	Anand nagar road	10 to 17	2143	1000	0.46	A
7	Paud road	5 to 15	7714	5900	0.76	C
8	Nana saheb sutar road	12 to 14	1714	1250	0.67	B

Table 4: V/C Ratio

V. PROBLEMS IDENTIFIED AFTER BARRICADING

The following major problems are identified due to barricading are:

A. No Defined Lanes

The traffic is highly heterogeneous with different classes of vehicle and no lane discipline is followed.

B. Vehicles Are Randomly Spaced

With the continuous increase in congestion problem due to reduction of road width along the work zone, hence it's difficult to maintain the constant speed. Hence vehicles are randomly spaced.

C. Insubstantial Increase in Queue Length

The queue length invariably increases along the work zone during peak hours.

D. Increased In Fuel Consumption and Wastage of Time of the Commuters

Standing in queue for prolong duration during peak hours can leads to unreasonable wastage of commuter's time and fuel.

E. Speeding and weaving occurs as vehicles are more free to move about without discipline Traffic jams can occur

Due to traffic congestion leading to traffic jams near work zone, delay in construction project can also occur.

F. Safety Risks

Accident can occur which can threaten life of both commuters traveling and the workers working near the work zone.

G. Environmental Issues

Lot of noise pollution and CO2 emission leading to air pollution due to traffic congestion experienced.

VI. PROPOSAL FOR IMPROVEMENT

A. Alternate Route Findings

As per the V/C ratio and LOS analysis carried out in the research methodology the most critical of the selected influence area of 8 different roads is found out. The link 5-15 of paud road has LOS of C category. Due to this the commuters will experience high tension while driving in existing situation. People are already facing problem without barricading in the existing road alignment but after barricading, the scenario gets even more worsen. Thus there is a great need to divert the coming traffic on this road. Hence compulsion for alternate route finding and followings is a great need.

B. Capacity Analysis for Alternate Routes

Following the same procedure as per methodology, the capacity for alternate route can be found out after barricading work is executed, thus V/C ratio and suitable LOS can be found out.

C. Simulation through VISSIM Model

Whether comparing junction geometries, analyzing public transport priority schemes or considering the effects of certain signaling, Vissim allows you to simulate traffic patterns exactly. Motorized private transport, goods transport, rail and road related public transport, pedestrians and cyclists; Vissim displays all road users and their interactions in one model. Scientifically sound motion models provide a realistic modeling of all road users. The software offers flexibility in several respects, the concept of links and connectors allows users to model geometries with any level of complexity. Attributes for driver and vehicle characteristics enable individual parameterization. Furthermore, a large number of interfaces provide seamless integration with other systems for signal controllers, traffic management or emissions models. PTV Vissim is rounded off with comprehensive analysis options, creating a powerful tool for the evaluation and planning of urban and extra-urban transport infrastructure. For example, the simulation software may be used to create detailed computational results or impressive 3D animations for different scenarios. It is the perfect way to present convincing and comprehensible planned infrastructure measures to decision-makers and the public. Calibration of VISSIM is needed into the influence area of work zone. Accordingly the influence area under research work can be validated and simulated for further future scope of solving many issues throughout the complete stretch of metro rail.

D. Detailed Proposals and Drawings

As a solution to the existing problem, the detail drawing and the alternate route proposals can be further studied in the future scope.

VII. CONCLUSION

By following the best combination of above recommended solutions to the problem of congestion during execution of metro rail project, maintenance of traffic flow along work zone with minimum traffic disruption can be made possible. It is the duty of construction manager and the concern authorities to not only deal with the project issues but also to solve likely problems that can be caused during the project execution work.

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APPENDIX

In the present case study the below given tables have been used to calculate V/C ratio as well as LOS (Level of Service).

Type of roads	Design Volume			Maximum Capacity		
	Arterial	Sub-Arterial	Collector	Arterial	Sub-Arterial	Collector
2-lane(1way)	2400	1900	1400	3429	2714	2000
2-lane(2way)	1500	1200	900	2143	1714	1286
3-lane(1way)	3600	2900	2200	5413	4143	3143
4-lane undivided(2way)	3000	2400	1800	4286	3429	2571
4-lane divided(2 way)	3600	2900	----	5143	4143	----

6-lane undivided (2way)	4800	3800	----	6857	5429	----
6-lane divided(2 way)	5400	4300	----	7714	6143	----
8-lane divided(2 way)	7200	----	----	10286	----	----

Table 5: Road Capacity

Note:

1) Source IRC-106-1990 Guideline for Capacity of Urban Roads in Plain Area.
2) Maximum Capacity Of Roadway Is 1.43 Times The Value Of Design Volume.
3) Roads with No Frontage Access, No Standing Vehicle, Very Little Cross Traffic.
4) Roads with Frontage Area but No Standing Vehicles and High Capacity Intersection.
5) Roads with Free Frontage, Parked Vehicles and Heavy Cross Traffic.

LOS	DESCRIPTION	V/C
A	Free-flow condition with unimpeded maneuverability. Stopped delay at signalized intersection in minimal.	<0.6
B	Reasonably unimpeded operations with slightly restricted maneuverability. Stopped delay are not bothersome.	0.61-0.7
C	Stable operations with somewhat more restriction in making mid- block lane changing than los B. motorists will experience appreciable tension while driving	0.71-0.8
D	Approaching unstable operations where small increase in volume produce substantial increases in delay and decreases in speed.	0.81-0.9
E	operations with significant intersection approach delay and low average speed	0.91-1.00
F	Operations with extremely low speed caused by intersection congestion, high delay and adverse signal progression.	>1.0

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