

## HEALTH OF URBAN ROADS OPTIMIZATION OF CAPACITY

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### ABSTRACT

The problem of traffic congestion in developing countries at alarming stage. The congestion in urban areas is in general at fixed locations and regular nature. Due to congestion we are losing man-hours, fuel, temper causing road rages and increasing health hazards due to air and noise pollution, VOC, wear and tear of roads and grading of Nation. The most of time problem is diverted by the all stockholders as “more number of vehicles, shortage of road facilities and user behavior”. The user behavior is developed with mobility atmosphere in years. The optimization of road capacity by reorientation and re-organizing of the existing facilities are an economical, environmentally beneficial, instantly effective, and to be implemented in very short time. For explanation and salutation of the problem, a very congested urban road “VIKAS MARG –Delhi-India” has been considered which is most representative of congested urban roads. The road is 44.00 m wide, divided 6 lane with footpath and service lanes. The capacity of the road is 2900 - 4500 PCU and volume on the road is 4213 and 3400 PCU with minimum speed 10.63Km/H and 5.15Km/H in morning and evening pecks respectively. The un-optimized design of traffic signals, without any data is operated without synchronization also increasing congestion. The space for pick and drop for passengers and materials are not specified in roads and therefore the drivers of these vehicles unknowingly deciding themselves, waiting and parking within the lane. The road capacity can be increase up to 4500 to 5000 PCU by optimization.

**KEYWORDS:** Traffic congestion- Pollution and Solution.

### INTRODUCTION

Performance of the same person is varying in healthy and unhealthy situation. The similarly the actual capacity of roads are also depend on operational health of road. The well designed with consideration of actual requirements, operated as designed with proper and synchronized signaling, road marking, street furniture and enforcement. The traffic congestion is one of the two main problems, road accident and traffic congestion. The maximum negative effects of accidents are visible and almost accountable but the negative effects of congestion are large in numbers, long in time span and very complicated such as Economic, Environmental, Health, Social and driving stress become one cause of road rages and accidents. The road accidents are being observed in full length of any road at any spot and at any time ie. very difficult to predict but the problem of congestion appeared at only countable stretches or points due to existing bottle necks in the roads are permanent or created during operation, most likely in urban areas. The International grading of a nation for developed and developing countries are also influenced by statues of traffic and pollution. The problem of congestion in urban areas is more towards traffic management instead of lack of infrastructure. In increasing number of vehicles and scarcity of space, optimization of road capacity is an economical and sustainable solution.

The most congested road “VIKAS MARG,- New Delhi” suitably representing any congested urban road is taken as example for describe the problem and solutions. The road is 44.00 m wide, 6 lane divided, raised footpath and service lane. The area is converted from unplanned residential to dense residential, commercial and institutional without adding any facilities. The

maximum available road width being utilized by users unaware about effect in traffic operation in haphazard manner for pick and drop to passengers by busses, autos and taxis, parking, loading & unloading of material by commercial units, extended shops, cordoned electrical transformers, telephone poles and unplanned trees in lanes etc. The enforceable road marking for dedicated lane for different categories of vehicles. Well marked space outside of lanes for pick and drop or waiting for buses, taxi, three wheelers and commercial goods carrier. The other elements of road required to be re-treated as intersections, zebra crossing, free left turn traffic segregation, entry and exit from and into the road from Metro - Stations, opening in central verge M.S. Grill for pedestrian and occasional crowd management in Mandir.

The Delhi traffic police is a separate unit of Delhi police headed by joint CP Traffic with approximate annual budget of Rs. 5910.28 crores and with performance of 1582 fatal accidents out of 8085 accidents reported and number of stretches with minimum speed less than 5.15 Km/H, average speed 20 Km/H is responsible for design, maintained and operate the signaling and enforcement. The basic and necessary classified traffic volume data are not available with traffic police for design, synchronized, optimize and operate the traffic signals. The most of traffic signal cycles and phase settings are based on hit and trail basis and switched/operated manually in congested areas resulting more congestion through overriding sophisticated electronic systems by human captancy. The actual traffic in morning and evening peaks has been counted by analyzing 16 hours video recording and it has been found that the peak hour's traffic is less than the theoretical capacity of the road. The speed on the road calculated by moving car in traffic flow at different time and days and minimum speed 5.15 Km/H during evening peak when volume is 3400 PCU.

The average speed can be improved and negative effects of traffic congestions are reduced for a long time with accommodating incremental traffic growth by addressing very small- small points pointed out above.

**METHODOLOGY:** The theory of the paper “health of the road affecting the capacity of Road and therefore congestion without saturation condition occurs” is verified by calculating actual traffic in peak hours, theoretical capacity of road, speed on road, and elements of road other than traffic, increasing congestion.

The Method adopted for determination of peak hours actual classified traffic volume by counting of classified traffic volume for 16 hours from 06.00 AM to 10.00 PM as per IRC Recommendation. The classified actual traffic volume is computed by 16 hours video recording of traffic with the help of video camera installed on DMRC FOB Laxmi Nagar Metro Station intersection. The classified traffic data has been determined by manual analysis of Video Recording, tabulated and compared with theoretical capacity with National and Inter National standards. The journey speed determined by moving car method at different days and time. The volume and average speed plotted on the graph and compared. The effect of un-synchronized traffic signal observed and proposed to synchronized all signals in section under consideration with permissible Speed. The timing of green phase in each intersection in a straight road to be fixed as “ A Vehicle started in green phase cross the all intersections in green phase without waiting at any inter section in straight stretch”. The actual position and proposed time of journey between two intersections based on permissible speed limit has been plotted. The width of the road proposed to be initially cleared and then utilized for accommodating different operational elements of road. The positive and negative, individual and mass effects of re-orientation of road elements are to be elaborated and openly discussed with in all stakeholders ie. Delhi traffic

police, Delhi PWD, East Delhi Municipal Corporation, Delhi Police, Electrical and MTNL, Resident Welfare Association, Laxminagar Vyapar Mandal and other if any. The priorities to be establish by explaining the short and long term, negative effects of traffic congestion. The capacity of road to be restored/ enhanced and higher level of service can be achieved by re-arranging the activities on the road other than traffic movement and regulate the traffic flow.

## DATA COLLECTION AND ANALYSIS

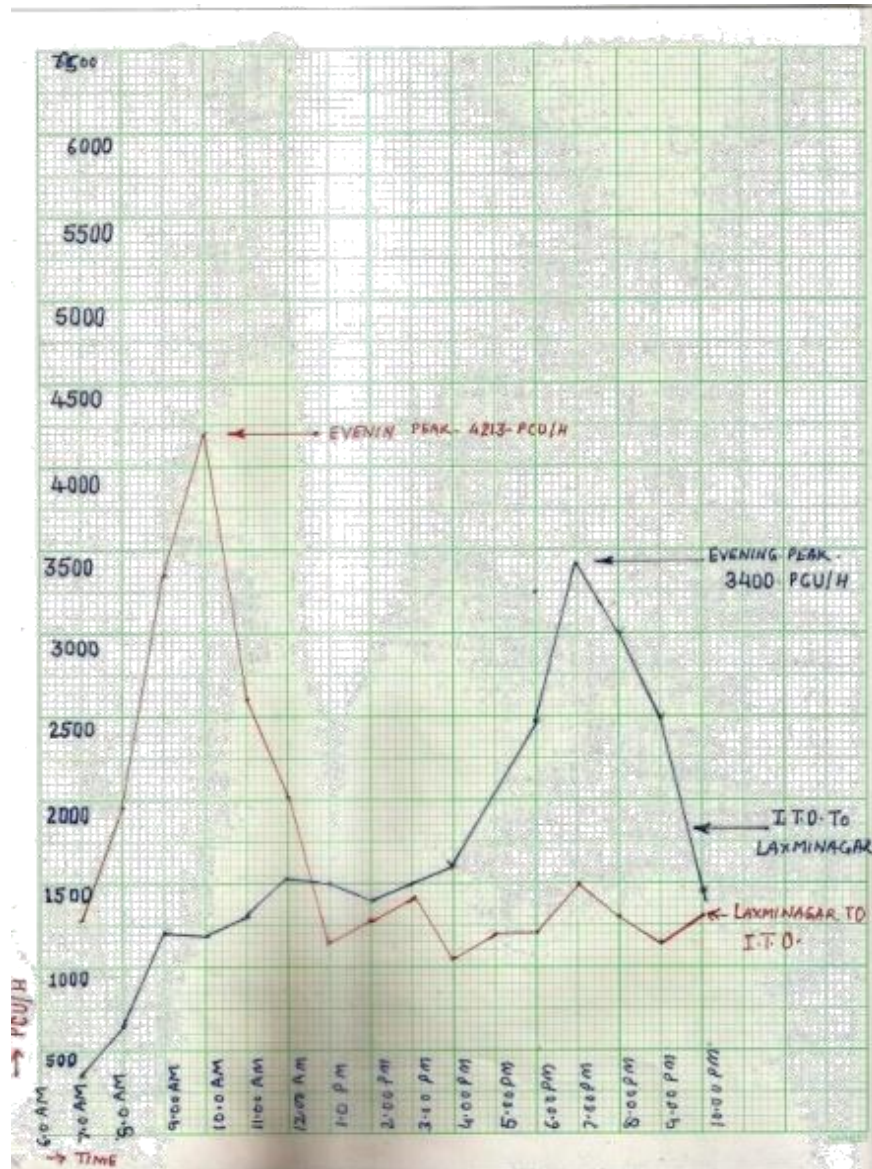
The four different observation have been have been taken for data collection and analyze simultaneously.

1- Classified Traffic Volume. 2- Space Mean Speed 3-Space Utilization 4- Signaling and phasing.

**Classified Traffic Volume:** When we approached the traffic police for traffic count, they have no any data. To determine the peak hour volume the Video Camera stalled on the DMRC - FOB Laxminagar Metro Station at a suitable location to record the total entry and exit traffic of Vikas Marg from 06-00AM to 10-00PM as per IRC recommendation, on 30-04-2013. The classified traffic counted for 16.00 Hours by analyzing videos on each entry and exit in 15 minute intervals. The classified traffic data are further converted in PCU with consideration of equivalent factor based on percentage participation of type of vehicles. The classified volume converted in PCU and tabulated for comparison with Indian and UK theoretical capacity of Urban Road.

### Comparison of Actual traffic Volume with theoretical

S.No.	Observation traffic of Time	IRCper-86-1983	Design capacity	Recommended	IRCpercapacity design Recommended-106-1990	capacity Road in U.K.	ITOtoKarkardomaon Traffic Actual	Exceeded traffic %Morning	Karkardomat to ITO Actual Traffic	Exceeded traffic %Evening
1	06-00--07-00		2500		2900	4800	1275	-	349	
2	07-00--08-00		2500		2900	4800	1951	-	651	
3	08-00--09-00		2500		2900	4800	3355	15.69	1222	
4	09-00--10-00		2500		2900	4800	4213	45.28	1195	
5	10-00--11-00		2500		2900	4800	2635	-	1291	
6	11-00--12-00		2500		2900	4800	2015	-	1531	
7	12-00--13-00		2500		2900	4800	1191	--	1476	
8	13-00--14-00		2500		2900	4800	1264	-	1386	
9	14-00--15-00		2500		2900	4800	1409	-	1490	
10	15-00--16-00		2500		2900	4800	1066	-	1595	
11	16-00--17-00		2500		2900	4800	1219	-	2485	
12	17-00--18-00		2500		2900	4800	1220	-	3289	13.41
13	18-00--19-00		2500		2900	4800	1526	-	3400	17.24
14	19-00--20-00		2500		2900	4800	1338	-	2982	2.83
15	20-00--21-00		2500		2900	4800	1156	--	2502	
16	21-00--22-00		2500		2900	4800	1334	--	1467	



**Graphical presentation of 16 hour traffic volume**

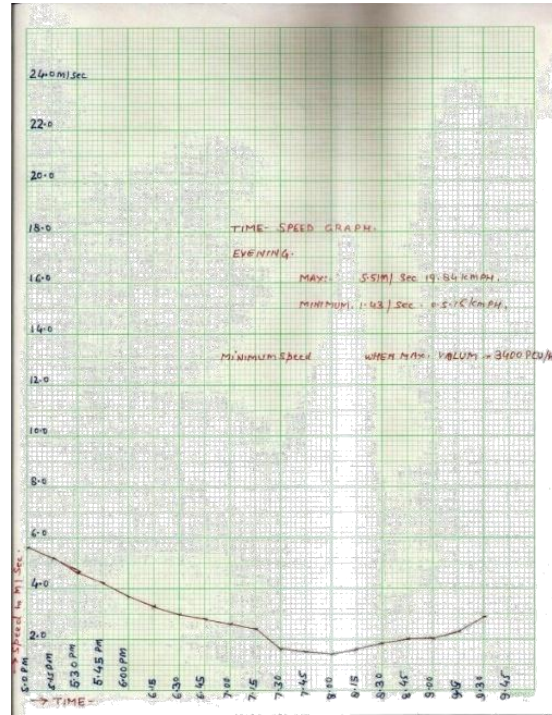
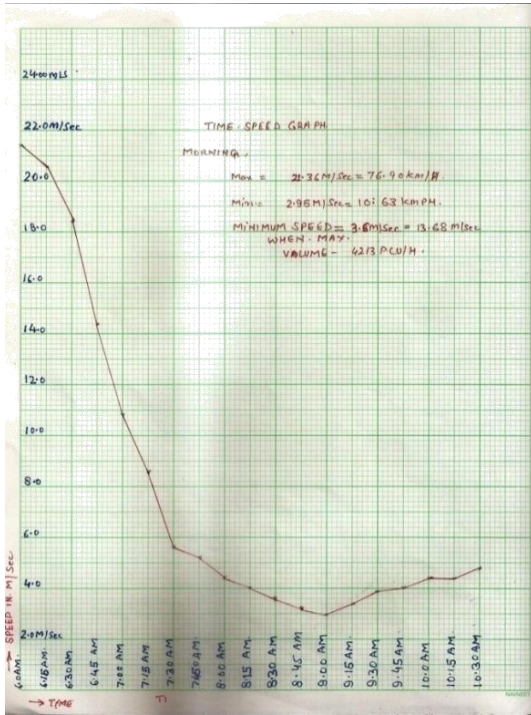
**The Space Mean Speed:** To determine the space mean speed of road moving car method is adopted. The Journey time on the section “The time in the total journey from Karkardooma to Laxminagar and Laxminagar to Karkardooma in morning and evening peak are calculated with moving car and stop watch. The Entry and exit time recorded for two times in a day for nine days to reduce the localized effect of specific activity at particular time and day. The total length of stretch (2670 m) is divided by journey time for calculation of journey speed in m/s. There after the journey speed converted in Km/Hour and tabulated below for morning and evening peaks in reverse directions.

### Morning Space Means Speed

S.No.	Date	Entry Time	Exit Time	Journey Time	Speed M/Sec	Speed Km/H
1	29-04-13	06:00 AM	06:02:05	02:05	21.36	76.90
2	29-04-13	06:15 AM	06:17:10	02:10	20.54	73.94
3	30-04-13	06:30 AM	06:32:25	02:25	18.41	66.29
4	30-04-13	06:45 AM	06:48:05	03:05	14.43	51.95
5	01-05-13	07:00 AM	07:04:06	04:06	10.85	39.07
6	01-05-13	07:15 AM	07:20:12	05:12	08.56	30.82
7	02-05-13	07:30 AM	07:37:44	07:44	05.75	20.72
8	02-05-13	07:45 AM	07:53:30	08:30	05.24	18.86
9	03-05-13	08:00 AM	08:10:02	10:02	04.44	15.97
10	03-05-13	08:15 AM	08:26:12	11:12	03.97	14.29
11	06-05-13	08:30 AM	08:42:05	12:06	03.68	13.24
12	06-05-13	08:45 AM	08:58:38	13:38	03.26	47.66
13	07-05-13	09:00 AM	09:15:04	15:04	02.95	10.63
14	07-05-13	09:15 AM	09:28:28	13:28	03.30	11.88
15	08-05-13	09:30 AM	09:41:32	11:32	03.86	13.89
16	08-05-13	09:45 AM	09:56:01	11:01	04.04	14.54
17	09-05-13	10:00 AM	10:10:08	10:08	04.39	15.81
18	09-05-13	10:15 AM	10:24:15	09:45	04.56	16.42
19	10-05-13	10:30 AM	10:39:16	09:16	04.80	17.29

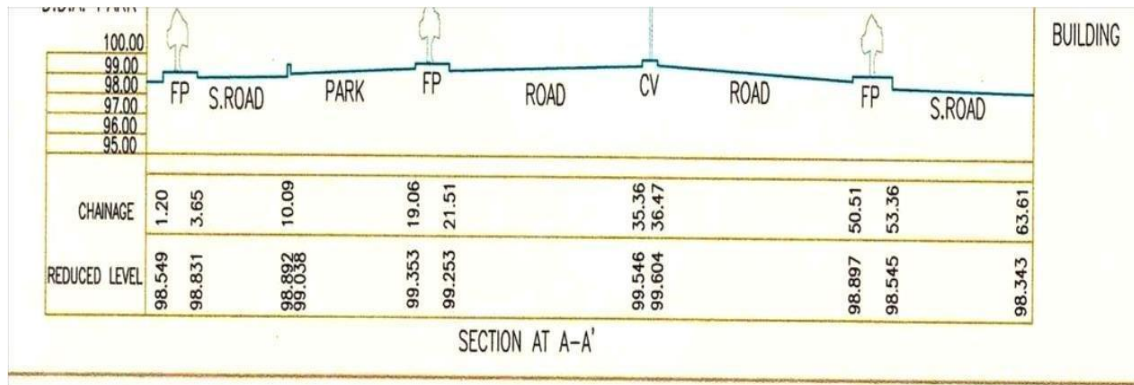
### Evening Space Means Speed

S.No.	Date	Entry Time	Exit Time	Journey Time	Speed M/Sec	Speed Km/H
1	29-04-13	05:00 PM	05:08:05	08:05	5.51	19.84
2	29-04-13	05:15 PM	05:23:35	08:35	5.18	18.65
3	30-04-13	05:30 PM	05:39:26	09:26	4.72	16.98
4	30-04-13	05:45 PM	05:55:35	10:35	4.20	17.00
5	01-05-13	06:00 PM	06:12:08	12:08	3.67	13.21
6	01-05-13	06:15 PM	06:28:25	13:25	3.32	11.95
7	02-05-13	06:30 PM	06:44:45	14:45	3.02	10.86
8	02-05-13	06:45 PM	07:00:55	15:55	2.80	10.10
9	03-05-13	07:00 PM	07:17:02	17:02	2.61	09.40
10	03-05-13	07:15 PM	07:33:25	18:25	2.42	08.71
11	06-05-13	07:30 PM	07:56:09	26:09	1.70	06.13
12	06-05-13	07:45 PM	08:13:10	28:10	1.58	05.69
13	07-05-13	08:00 PM	08:31:05	31:05	1.43	05.15
14	07-05-13	08:15 PM	08:42:15	27:15	1.63	05.87
15	08-05-13	08:30 PM	08:55:33	25:33	1.74	06.26
16	08-05-13	08:45 PM	09:08:18	23:18	1.91	06.88
17	09-05-13	09:00 PM	09:22:01	22:01	2.02	07.28
18	09-05-13	09:15 PM	09:34:13	19:13	2.32	08.35
19	10-05-13	09:30 PM	09:45:17	15:17	2.91	10.48



**Graphical Presentation of Space Means Speed on Vikas Marg**

**Space availability and Utilization:** The road width is taken from pre metro drawing provided by PWD Delhi Govt. and physically available. The width of different element of roads tabulated and percentage of encroachment evaluated through visual observations and photographed. And percentage of space encroached are calculated accordingly. The total space utilized for the purposes other than the traffic movements is calculated by the multiplying length of the stretch by encroached width. The rental value of the spaced calculated on the basis of market rates are in practice in Laxminagar and taken from the local shop owners.



SOURCE – PWD (DELHI GOVT.)

Five sections are considered for calculation of encroached space and valuation

### Calculation and Valuation of encroached space

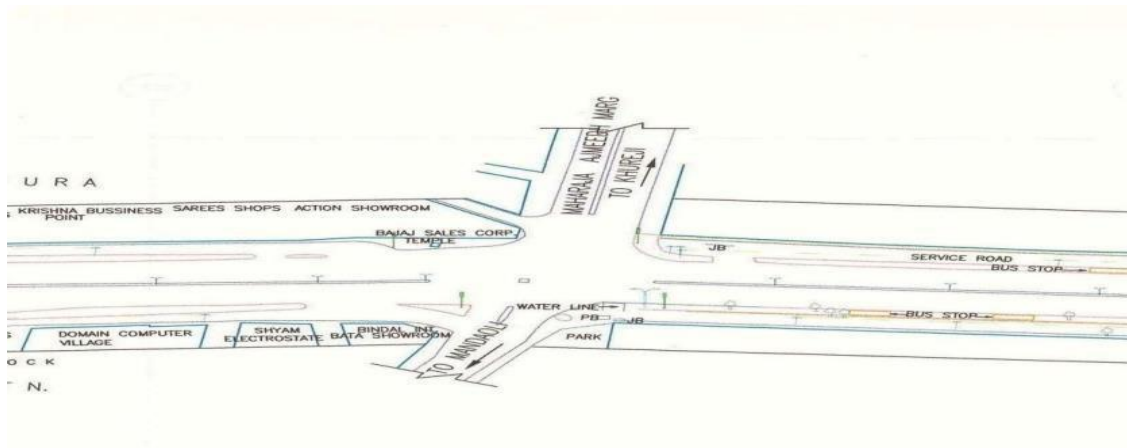
S.No.	Section of Width-AA	Section of Width-BB	Section of Width-CC	Section of Width-DD	Section of Width-EE	Min Width Average	% Area Encroached	Min Width Average	Segment of Road
1	1.20	1.8	1.5	1.44	1.50	1.488	100	1.49	Between Building and Service Lane
2	8.97	---	--	0.41	---	4.69	---	---	Drain
3	2.4	---	--	0.45	----	1.425	--	---	Drain
4	6.44	5.44	5.58	5.98	6.12	5.912	50	2.96	Service Lain
5	2.45	3.32	3.15	2.97	2.87	2.952	100	2.95	Footpath
6	13.85	10.83	10.91	11.03	10.97	11.52	20	2.30	Three Lain
7	1.11	1.03	1.27	1.01	1.20	1.124	---	---	Center Verge
8	14.04	11.56	11.74	11.00	11.08	11.884	20	2.38	Three Lain
9	2.85	3.42	3.42	3.00	4.23	3.384	100	3.38	Footpath
10	10.25	5.30	5.44	7.27	6.05	6.862	50	3.43	Service Lain
11	---	-----	-----	0.96	----	0.96	---	----	Drain
12	---	1.60	1.21	0.88	1.7	1.347	100	1.35	Between Building Line and Service Lain
Total Average Encroached Width in Full Length of Road -2670m						= 20.24m			
Total Area						20.24X2670m=54041 Sqm. =54041sqmx10.76 =581481Sqft			
The Rental Value of the land on Vikas Marg (As per President Traders Association) 25X10ft =250Sqft=Rs70000.00/Month =Rs280/Sqft/Month						Marg Based on Market Rate 581481X280=Rs162814680./Month =Rs- 8,14,07,340.00./ Month			

**4-Traffic management with Synchronized Signals:** During the observation of site it has been noted that the following factors related to traffic management also damping the speed of vehicles with the permissible speed limit. The lane markings are not proper and enforceable for Lane Driving, intersections are not properly marked and physically channelized for free left turn, Zebra Crossings, distance from intersection for pick and drop space, blind cuts in center verge for pedestrian without any signals, enforcement of restrictions for NMV and synchronization of signals. The Delhi Traffic Police and Delhi PWD using applying provisions of traffic management listed as above in isolation of each other, pick and choose basis on different time and location. Here we are considering only Synchronization of Traffic Signals in details for explanation of road condition and scope.

**4-a-Traffic signal phasing and synchronization:** The Delhi is claiming to be a world class city. Delhi Traffic police have no classified traffic volume data for the any intersection, basic data for the designee of signal phasing and synchronization of all signals in a straight section. Therefore most of traffic signal cycles and phasing are operated by hit and trail basis or electronic signals switched / operated manually. No classified traffic data collected from the field that is basic for design and operation of electronic signals. Therefore the signals are not related with the traffic count (Traffic Police have no traffic count) entering in the intersection from the individual sides and also not interconnected with the time spends by the vehicles from one intersection to next intersection by synchronization of traffic signal cycles. It means a vehicle approaching an intersection, facing and waiting at red phase of Traffic signal is moving to next intersection at green signal while reaching at next intersection facing red signal. To reduce the delay at intersection a vehicle moving with permissible speed in straight stretch of the road, clearing red traffic signal at one intersection should be found Green signal by synchronization method at all other intersections of the Straight stretch. The phasing and cycle of the all intersection in the stretch are collected from Delhi Traffic Police (Onnyx Electronics Delhi) and data generated by reverse calculation only for demonstration of synchronization system for the section.

**4-b-The green time for the each intersection calculated from the Phasing time:** The green time for each approach of all five intersections are being calculated with help of drawing of intersection provided by PDW Delhi Government and Green- Read Time with the help of Phasing and Signal Cycle obtained by Delhi Traffic Police. The all Inter sections in the stretch are considered but only one intersection is being displayed due to space constant.

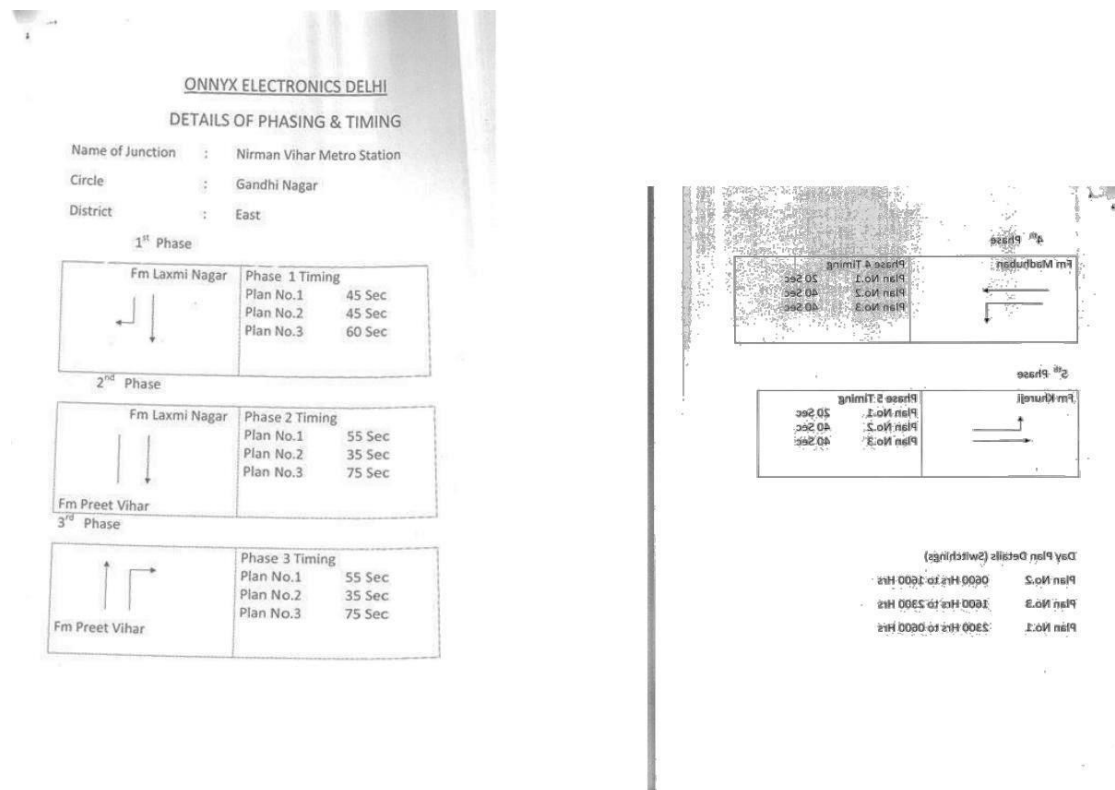
#### Drawing of Intersections: V3S- Mall



Source – Pwd (Delhi Govt.)



## Phasing time and signal of Intersections: V3S- Mall



Source – Delhi Traffic Police

### Summary of Signal Design Details of all Intersections for Synchronization

S. No	Name of Intersection Distance in	Distance in (m)	Cycle Time	Laxmi Nagar T-Point to Karakaduma		Karkaduma to Laxmi Nagar	
				Green Phase	Red Phase	Green Phase	Red Phase
1	Laxmi Nagar T Point	0-00	160	140	20	85	75
2	Vijay Chowk Laxmi Nagar	450=450	190	130	55	135	55
3	Nirman Vihar	700=1150	250	100	140	110	140
4	Preet Vihar	970=2120	165	45	120	110	55
5	Karkardooma	550=2670	290	80	210	80	210

**Table No. 3.11- Summarized Timing for Synchronization analysis of traffic signal phasing, cycle and its co-relation.**

### CONCLUSION

The road under consideration is six lanes, divided three lane one way urban road. The road is also provided with footpath and service lanes. The operating condition of the road in peak hours is approximately jamming. The agencies are always making issue “the road is congested due to volume exceeded to its capacity”. The traffic congestion is become news mater one or two times

every year and authorities passing orders for removal of encroachment on the level of Minister concern, Green Tribunal, Honorable L. G. of Delhi and Supreme Court of India time to time. The agencies are utilizing these opportunities for expenditure of funds repeatedly changing footpaths and kerb stones, purchasing of street furniture's celebrating zero tolerance weeks and amount of expenditure as a measure of effort for removal of traffic congestion. The actual reasons of traffic congestion such as enforceable lane markings, operational ability of marked bus lanes, usability of service lanes, designated space for every vehicle for all expected activities by them layout of intersections data collection and synchronized signals etc. are newer recorded and there for no effective steps has been taken to remove the reasons for traffic congestion with evaluation of effects. During the study, it has been found that the optimum capacity of the road has not been utilized till now. The jamming condition in the section occurred due to design road width is not available for traffic movement. There are huge encroachment and commercial activities on the road being carried out. No enforcement and regulations for operation of traffic as per design of road is appeared on the road. . The minimum speed in the section is 10.63Km/H when volume is 4213 PCU in morning peak is approximate double the minimum speed is 5.15Km/ H in evening peak with 3400 PCU. This is the effect of commercial activities in evening. The peak hour's traffic volume on the road is exceeding by very less for the small period from recommended traffic volume by IRC-86-1998 and IRC-106-1990.(Required to be revised with technological of Modern Vehicles .) The road capacity for three lanes one way with footpath and service lanes are not provided in IRC-106-1990 (Capacity of Urban Roads) .The road capacity obtained by strict enforcement and regulation is much higher in other countries. The design capacity prescribed by the IRC revised and increased from 2500 PCU IRC-86-1983 to 2900 PCU in IRC-96-1990 still appears less realistic and taken more Liberally which are based on 35-40 years old vehicle properties related to speed and control. New urban road capacity check conducted and published in FERGUSON McILVEEN August 2005. U.K. Standards is 4800 PCU for similar roads.

The Maximum traffic from Karkardooma to Laxmi Nagar T- Point side in morning peak hours is approximately 4200 PCU/ H and road operated with level of service between "C" and "D" with lesser encroachment of parking on outer lane and in service lane minimum encroachment of activities of shops. The Maximum traffic from ITO to Karkardooma is approximately 3400PCU/H and road operated approximately Jamming condition due to outer lane fully covered with parked vehicles and service lane encroached with Maximum activities of shops. Driving behavior of bus drivers and other commuters are treated at par in morning and evening Peak Hours. The journey speed on the section is decreased with the increase in volume up to peak hours. The journey speed decreases less in morning peak than in evening peak even then, peak hours volume in morning is more than evening. The reason behind that intensity of encroachment in morning is less than evening.

The space provided in design of road is not available for the traffic operation. The area is converted from un-authorized residential to dense residential, institutional and commercial area. The more space is required for the services and in absence of free space for the essential services; all activities are utilizing the road space as desired and decided by individuals.

The approximate rental value of the road space utilized for personal purposes is

Rs-8,14,07,340.00/ Month and sharing the amount between agencies and encroachers are the main reason for implementing *tools and rules* for removal of traffic congestion in regular and effective manner. The traffic data is not collected for efficient design of road facility, monitoring and regulating system. The traffic signal phasing and cycle in all intersection of the stretch based

on hit and trail basis. The optimum operational traffic volume cannot be achieved without design of signal phasing and time cycle based on actual traffic volume in each approach of all intersections and all intersections synchronized. The road can be operated up to 50 K m/ h speed for a number of years with inclusion of normal vehicular growth with minor re-orientations of road elements and proper enforcement.

**Proposal for capacity optimization:** The optimization of capacity the main points to be considered for fulfilling the following requirements.

- 1- Boundaries of road space marked and controlled by the road owning authorities.
- 2- Pedestrian paths are marked /constructed along the building line and keep operational in full length, checked by “wheel Chair method” in regular interval.
- 3- Service lanes between footpaths and main lanes of 2.5 m width with on interval overtaking space also provide space for vehicles loading unloading commercial goods with time restriction.
- 4- The space between service lane utilize for pick and drop space and wafting of drivers out of operational with essay entry and exit for all size regular nature vehicles on road.
- 5- The 3.00m width outer bus lane keep free from parked vehicles tree in lane transformer in lane ramps of connecting streets in road in operational condition.
- 6- Bell mouths are to be keeping in functional condition to keep road free from water logging and provide full width in all weather.
- 7- The time for execution of work and space of road to be used for material, machinery and activities other than under treatment included in financial bids as monetary benefits.
- 8- The shop owners are included in coordinating comity
- 9- The vehicles can be parked in nearer by rented parking’s and ferry system for pick and drop from parking to shops and shops to parking to be managed by vyapar mandals enhancing sales.
- 10- The government agencies to acquire vacant plots in vicinity and create small modern parking lots may be with PPP mode.
- 11- Road marking of intersection layouts with consideration of usable zebra crossings, isolation of left turning vehicles, no stoppage of vehicles with in the 70 to 100 m from intersection.
- 12- Classified data collection and updating at regular intervals which is not very expensive now days.
- 13- Synchronization of signals.
- 14- The traffic police is drawn from civil police trained for crime detection instead of prevention and also un aware traffic theories such as queuing theory, classified traffic and PCU et. The work of traffic operating is fully based on prevention, to overpower this operational behavioral problem “the traffic morsels to be recruited initially trained for the purpose.
- 15- Every day checking by driving before peak hours by authorized and responsible persons.
- 16- The any material stacked with in the space to be removed and keep in Government Accounts without any intimation.
- 17- Road cleaning staff is keep responsible and appreciating for same day reporting for any encroachment.

- 18- Star rating for the performance of road to be granted as energy consuming equipments.
- 19- Effect on pollution with change of traffic congestion.
- 20- A comedy may be formed headed by and associable officials to whom report all concerns.

**List of concern authorities required to be taking action with each other.**

(At Present they are working against each other)

- 1- Delhi PWD
- 2- Delhi Traffic Police
- 3- East Delhi Municipal corporation
- 4- Delhi – Civil Police
- 5- Delhi Electrical Department
- 6- Delhi Metro
- 7- MTNL
- 8- Vyapar Mandal
- 9- Resident Welfare Association.
- 10- Delhi Pollution Control Board