Traffic Intersection in Urban Area

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Traffic Intersections

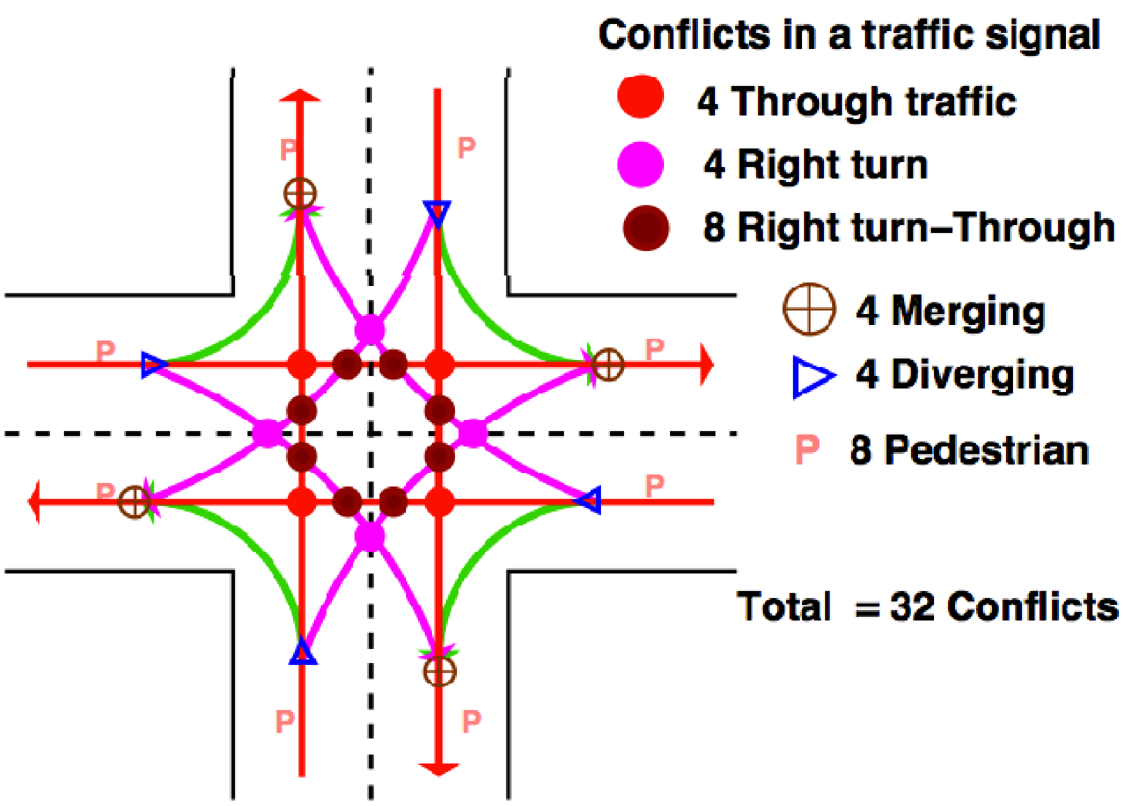
- Intersection is an area shared by two or more roads. This area is designated for the vehicles to turn to different directions to reach their desired destinations.

Issues

The pedestrians also seek same space for crossing. Drivers have to make split second decision at an intersection by considering his route, intersection geometry, speed and direction of other vehicles etc. A small error in judgment can cause severe accidents.

Conflicts at an intersection

- Conflicts at an intersection are different for different types of intersection. Consider a typical four-legged intersection as shown in figure.

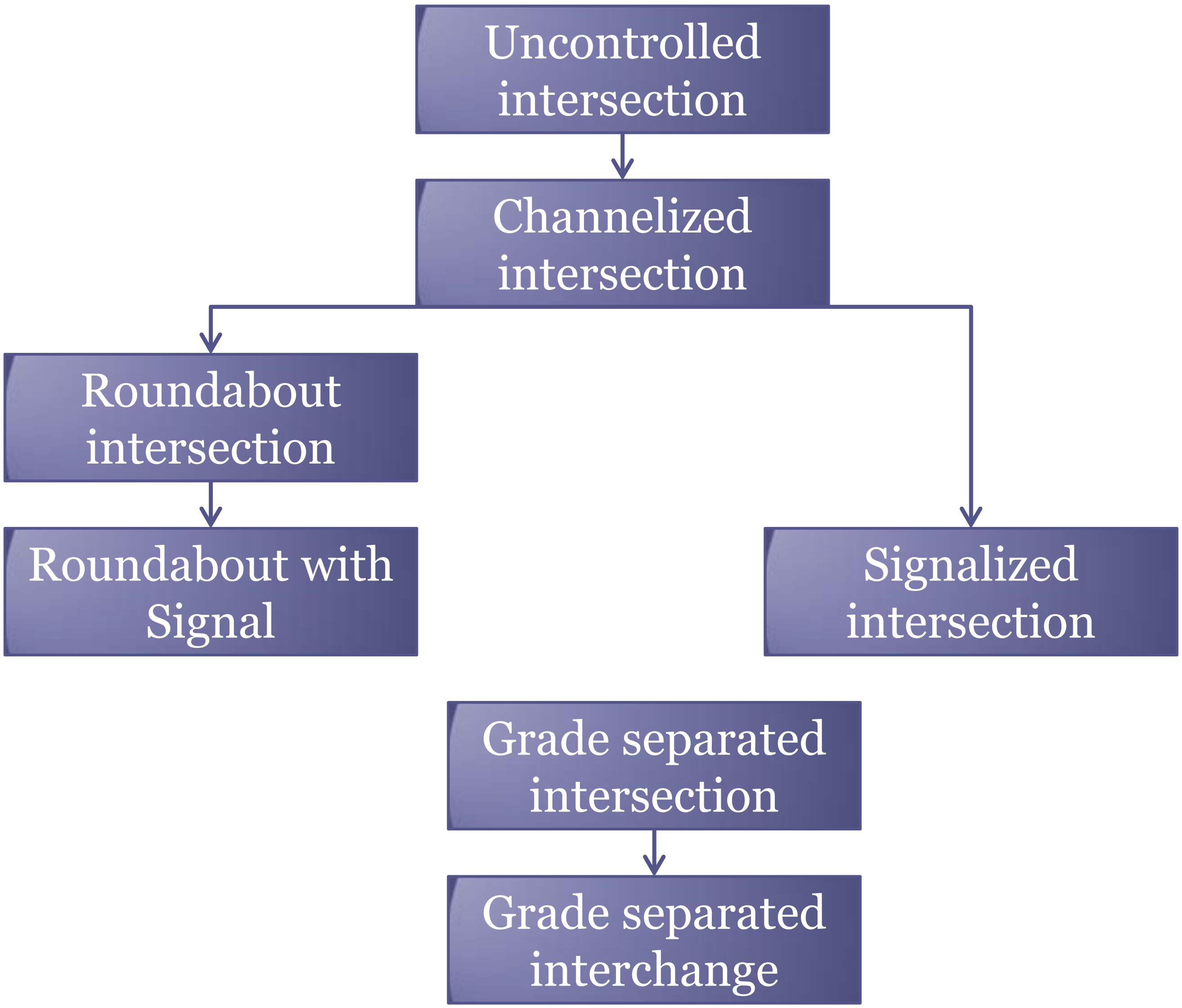


Levels of intersection control

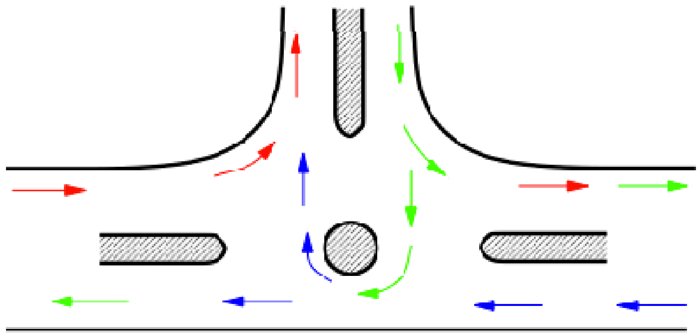
Another Form of Hierarchy

- Passive Control
  1. No control
  2. Traffic Signs
  3. Traffic signs plus road marking
- Semi Control
  1. Channelization
  2. Roundabouts
- Active Control
  1. Traffic Signals
  2. Grade Separated Intersection
  3. Grade Separated Interchange
     - i. Trumpet interchange
     - ii. Diamond interchange
     - iii. Clover leaf interchange

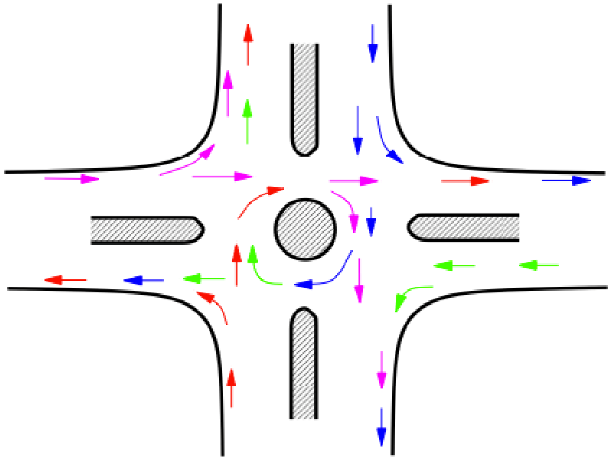
Life cycle of Intersections



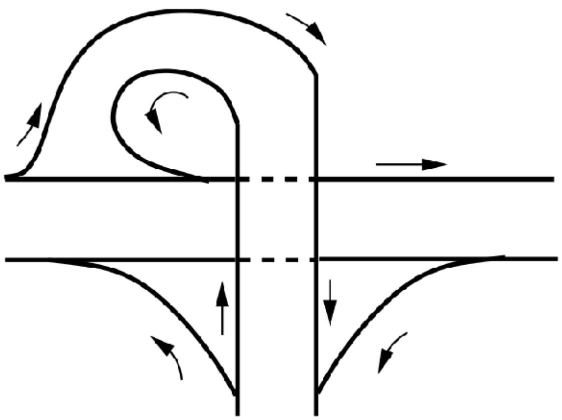
Intersection



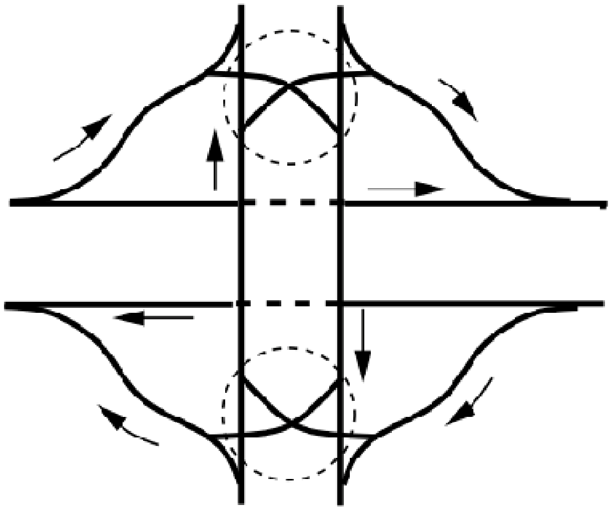
Channelization of traffic through a three legged intersection



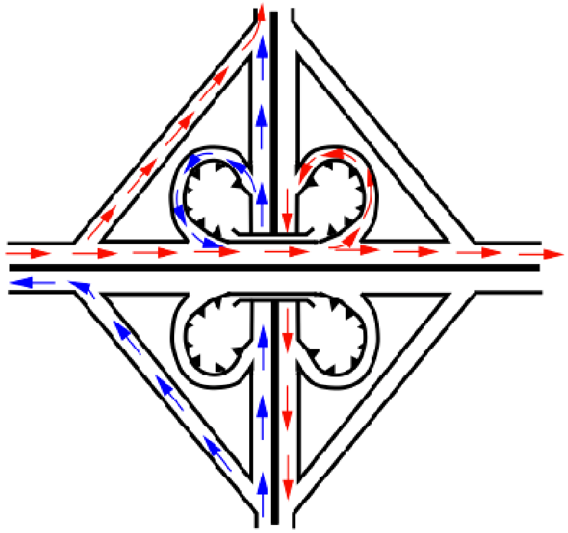
Channelization of traffic through a four legged intersection



Trumpet interchange



Diamond interchange



Cloverleaf Interchange

FOUR-LEG INTERSECTIONS (International Studies)

Common issues associated with signalized intersections include:

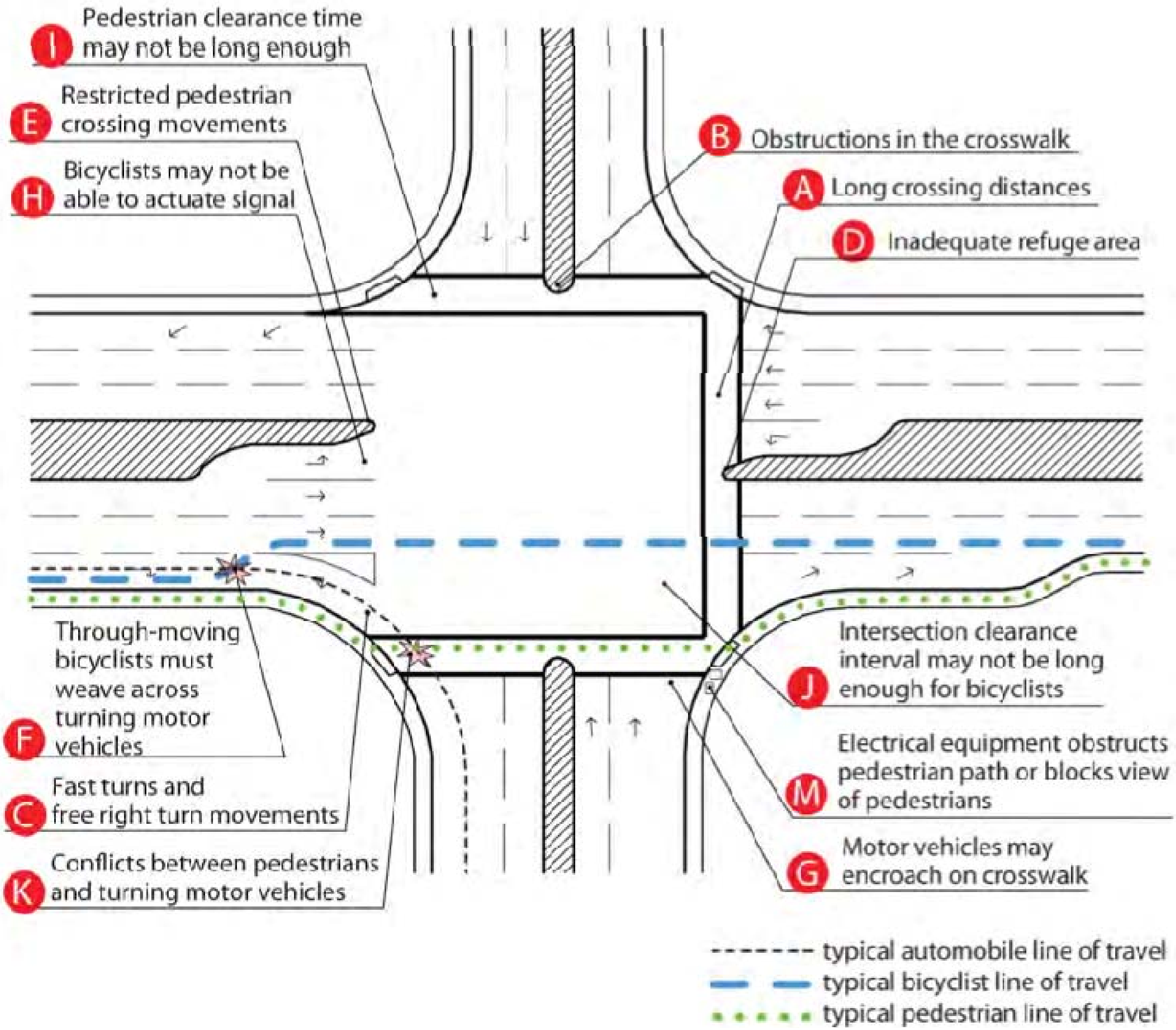
- Long crossing distances
- Obstructions in the crosswalk
- Wide turning radii encourage fast turns
- Inadequate refuge area
- Restricted pedestrian crossing

FOUR-LEG INTERSECTIONS (International Studies)

- Through-moving bicyclists to weave across multiple lanes
- Crosswalk, limiting visibility.
- Bicyclists may not be able to actuate
- Pedestrian clearance time may not be long enough
- Conflicts between pedestrians and turning motor vehicles

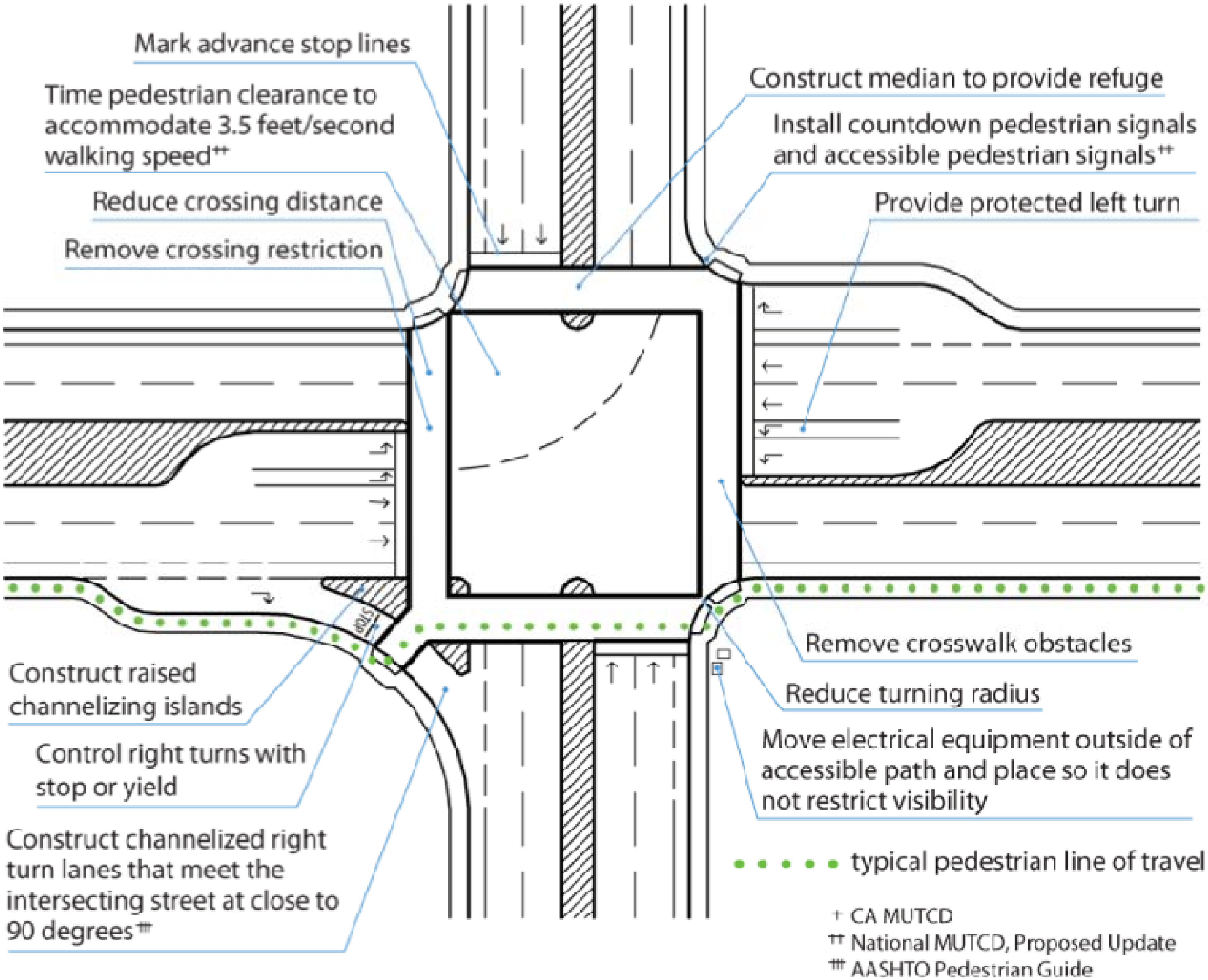
Issues Associated with Signalized Intersections

(International Studies)



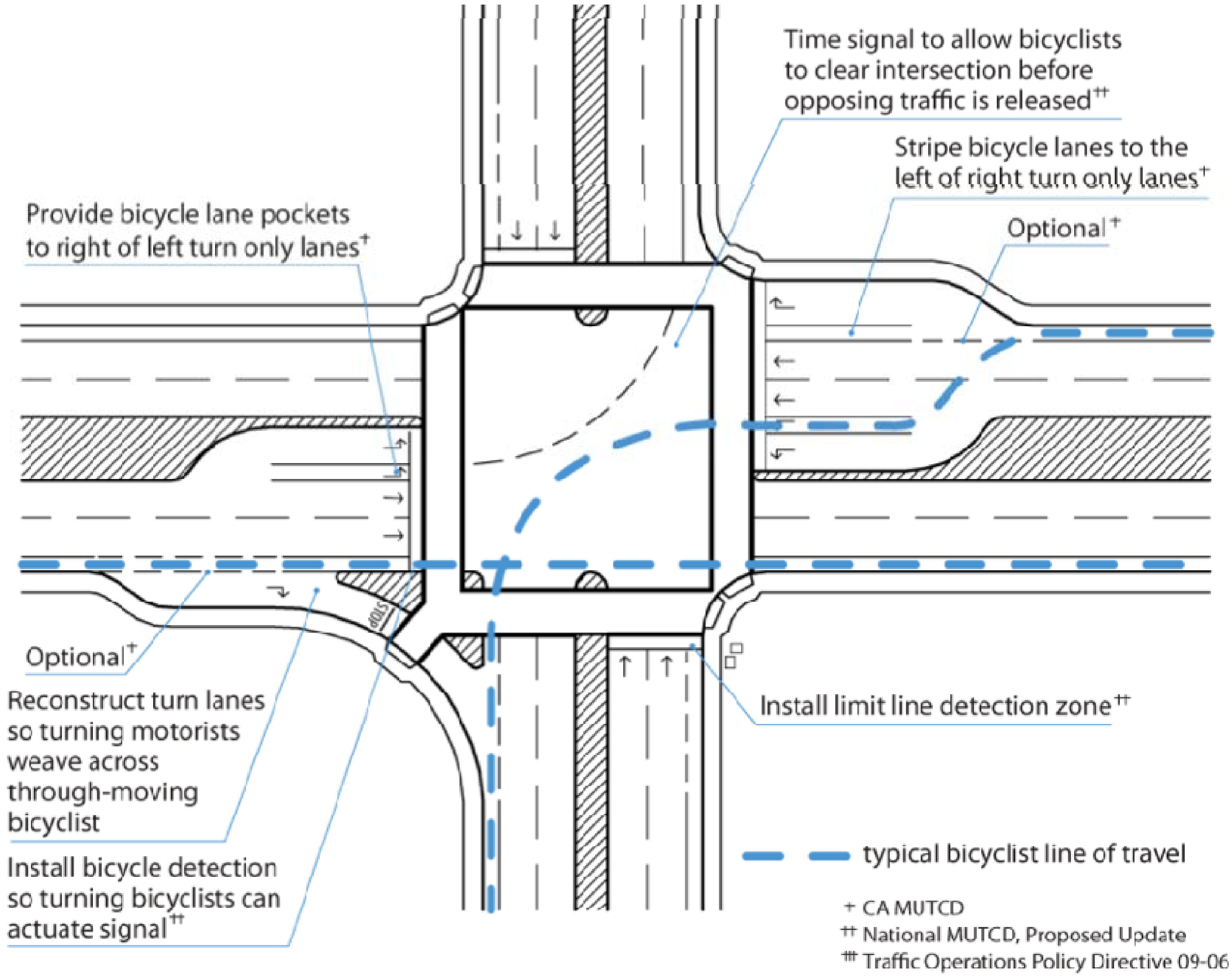
Common Intersection Treatments for Pedestrians

(International Studies)



Common Intersection Treatments for Bicyclists

(International Studies)



Speed Management Treatments

(International Studies)

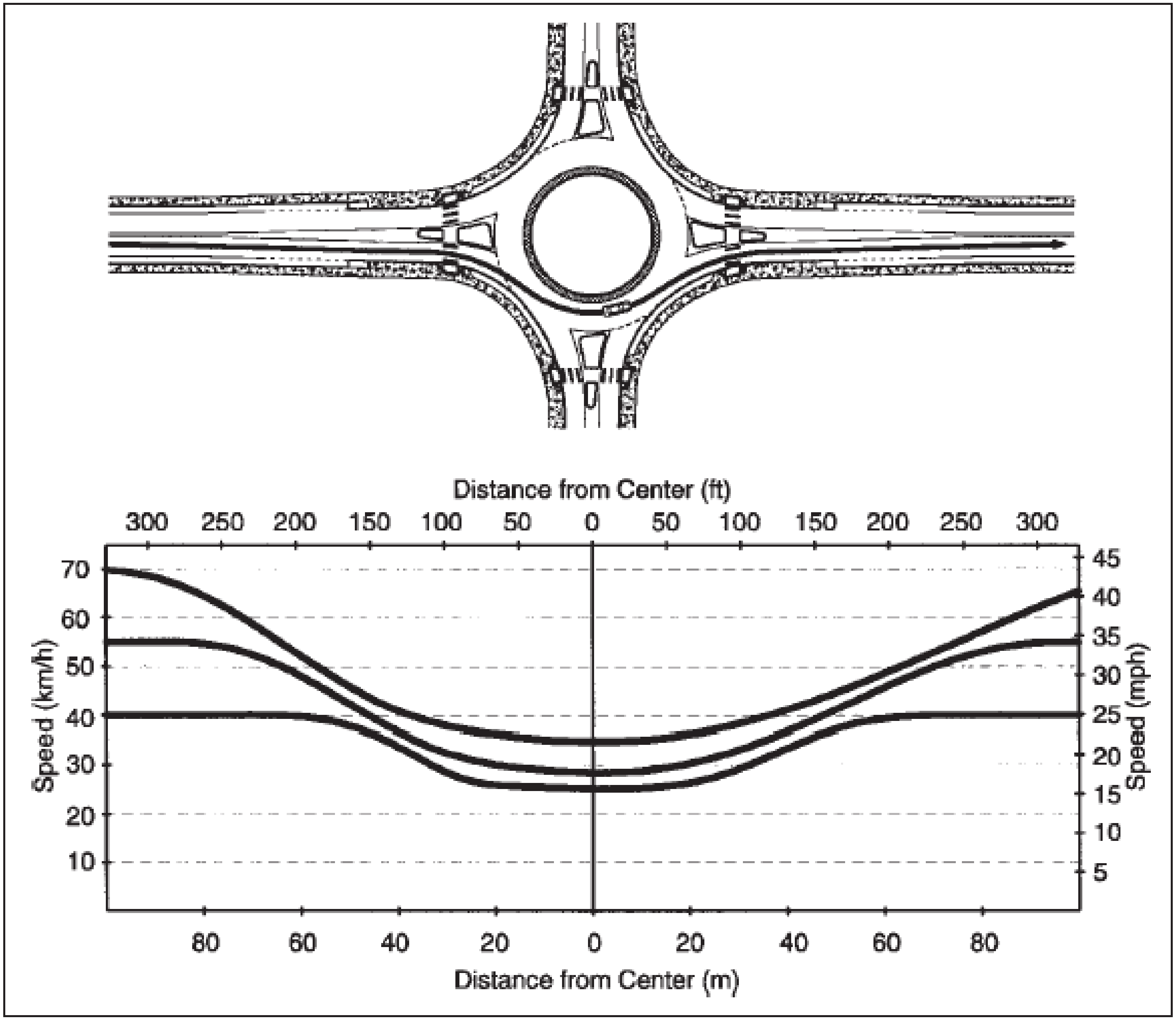
Engineering Countermeasures for Speed Management	
Countermeasure	Reduction in 85th percentile speed
Roundabout *In urban and suburban environments where posted speed is 45 mph or less*	**25% to 42%**
Lateral Shift *Travel Lane shift*	**8% to 25%**
Center Island *Narrows travel lanes*	**12%**
Converging Chevron Marking Pattern[a] *Transverse pavement marking*	**11% to 24%**
In-Roadway Warning Lights *At pedestrian crossings*	**5% to 7%**
Speed Activated Feedback Signs *Dynamic display speed warnings*	**7% to 19%**
Gateway Treatment *Combined use of signs, landscaping, etc.*	**5% to 7%**

[a] Experimental treatment.

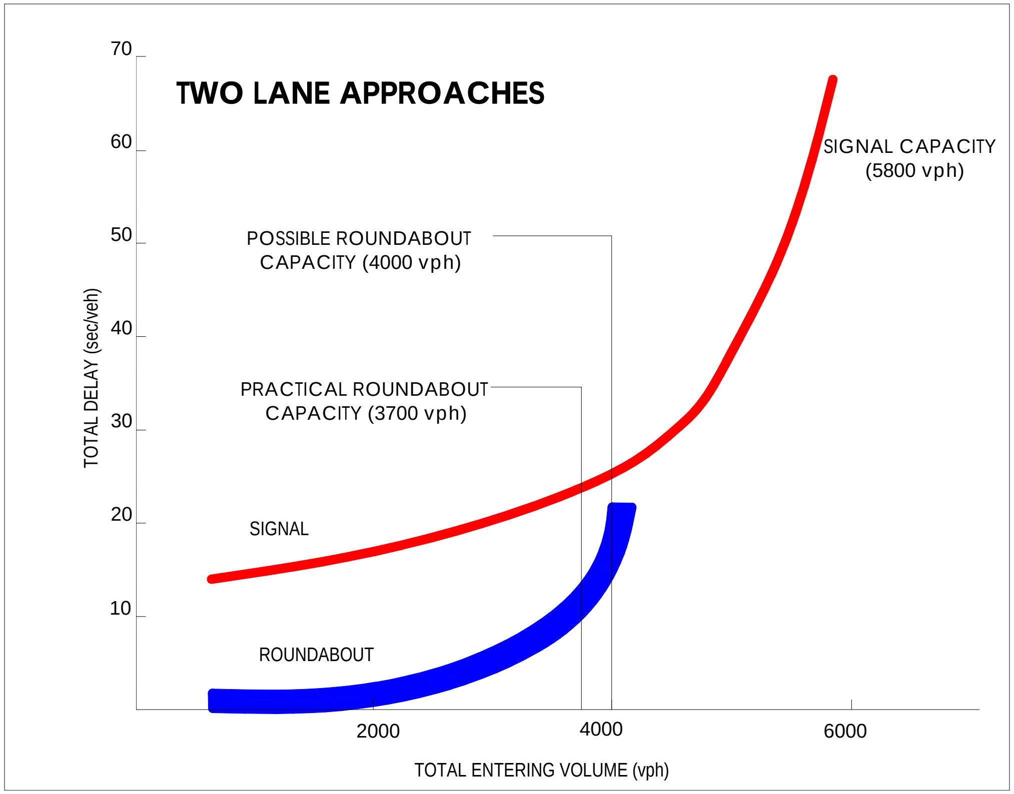
Source: FHWA, *Engineering Countermeasures for Reducing Speeds: A Desktop Reference of Potential Effectiveness*, May 2009. A full list along with studies cited can be found at http://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/.

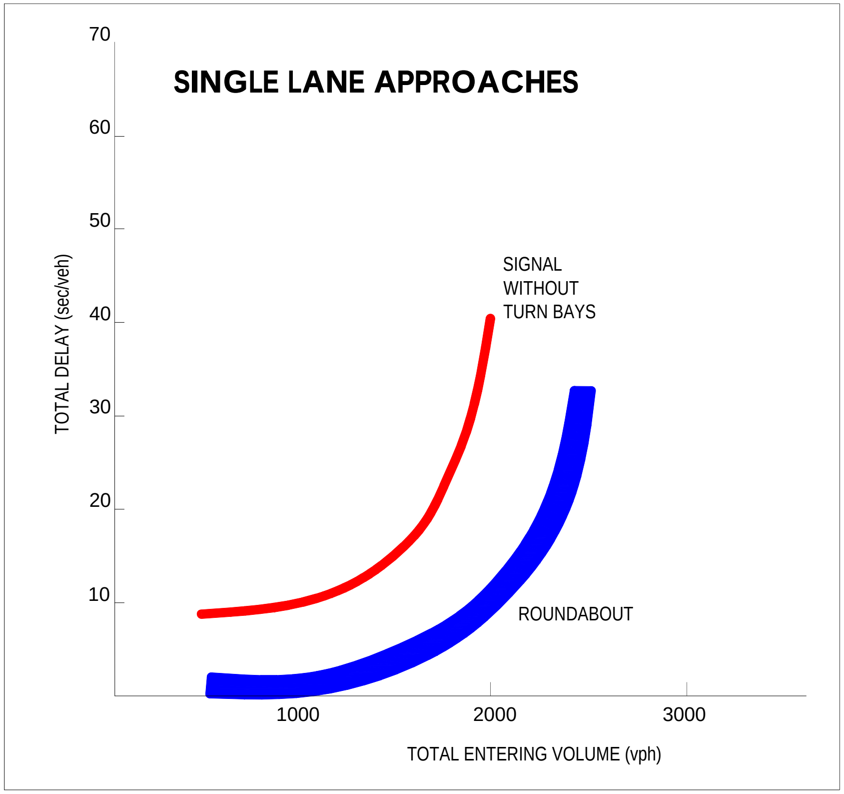
Reducing motor vehicle speeds can improve safety for pedestrians and bicyclists.

SAMPLE THEORETICAL SPEED PROFILE
(URBAN COMPACT ROUNDABOUT)



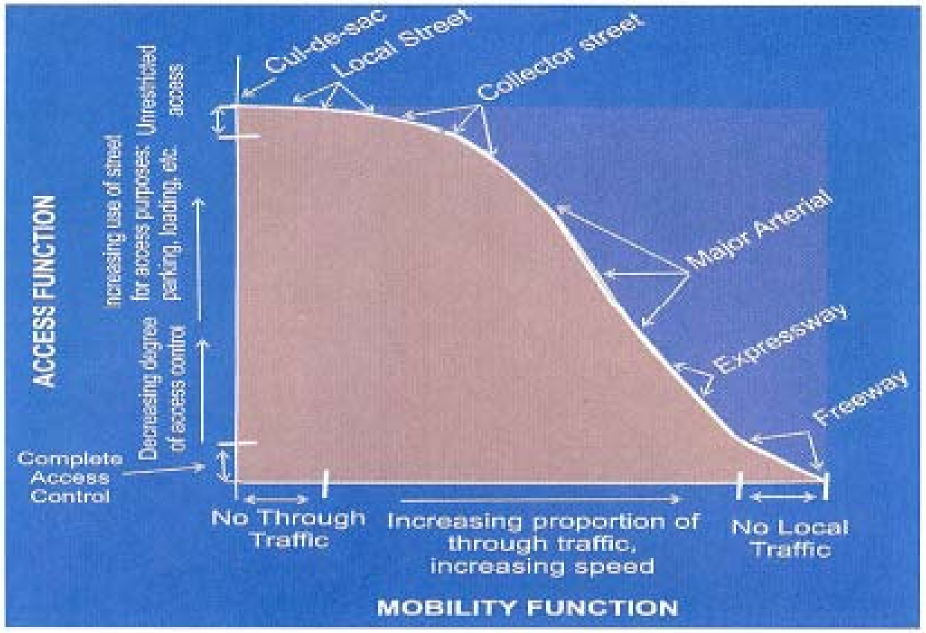
PERFORMANCE COMPARISONS OF CONTROL ALTERNATIVES





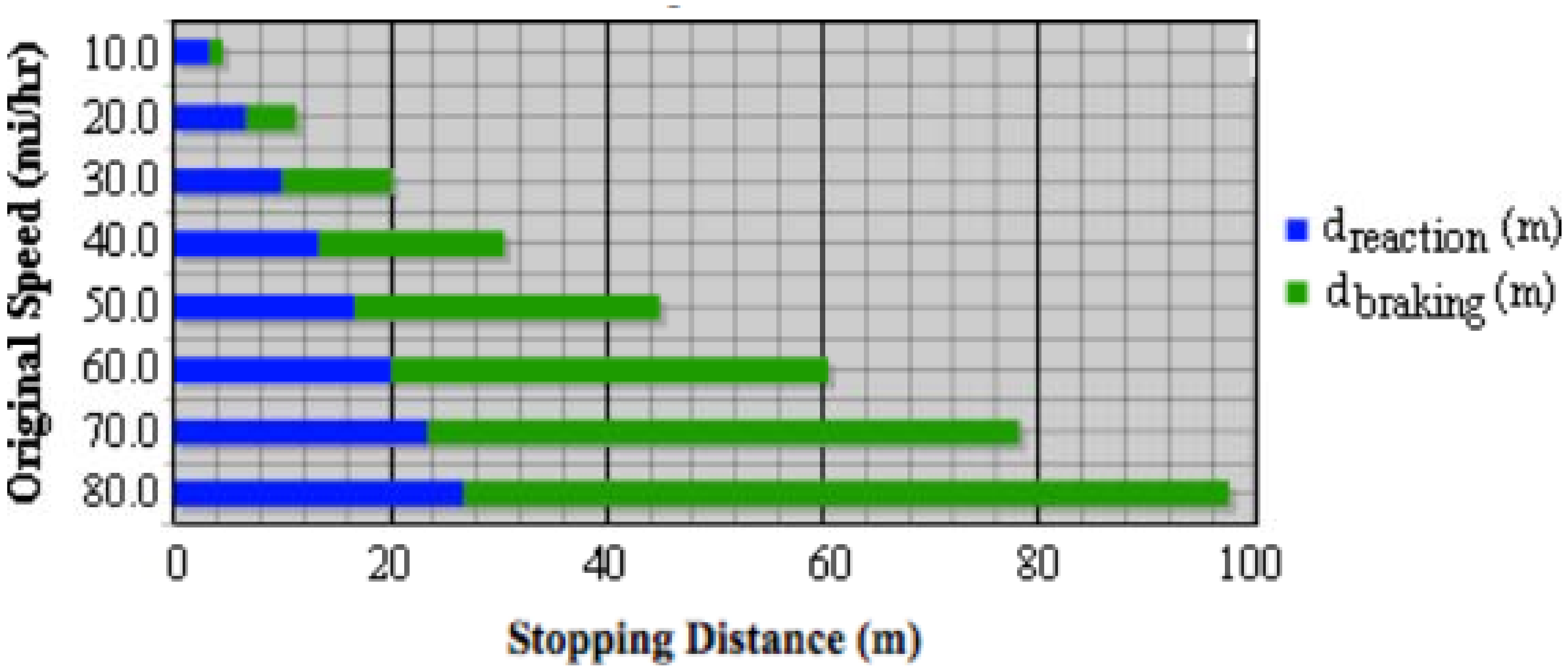
Safety Balance Between Accessibility & Mobility Needs

- Safe designs are different for major and minor roads.
- Narrow sections or slow points may be suitable on minor roads to slow down traffic and improve safety.
- However, on major roads such squeeze points may well cause frustration and become accident black spot.
- The function of a road should be clear to its users and treatments should not give conflicting messages.
- Functional grouping of roads is necessary pre-requisite for a safe road network.

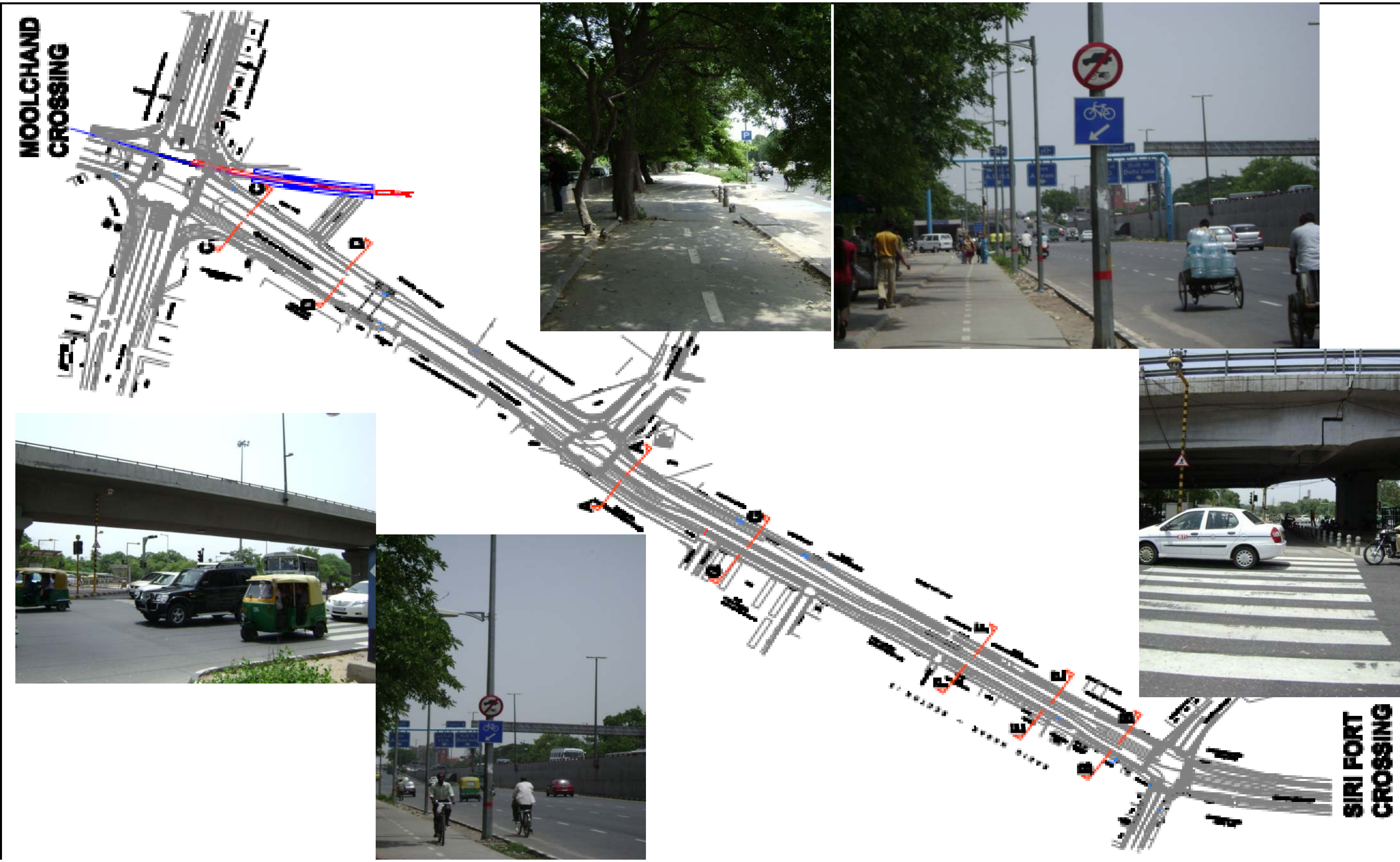


Schematic Relationship between Access and Movement Functions of Roads

REACTION STOPPING DISTANCE

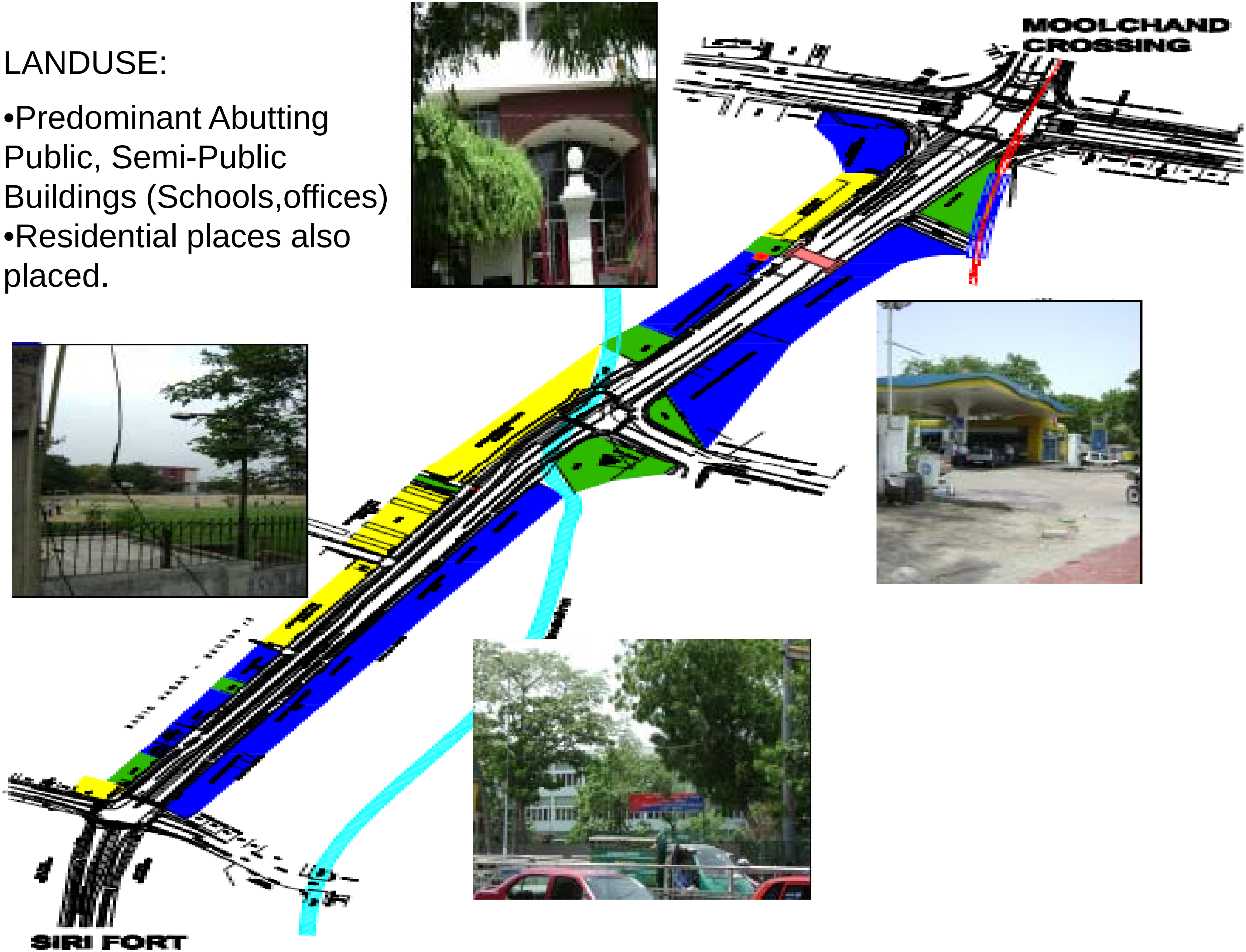


CASE STUDY 1 - Josip Broz Tito Marg

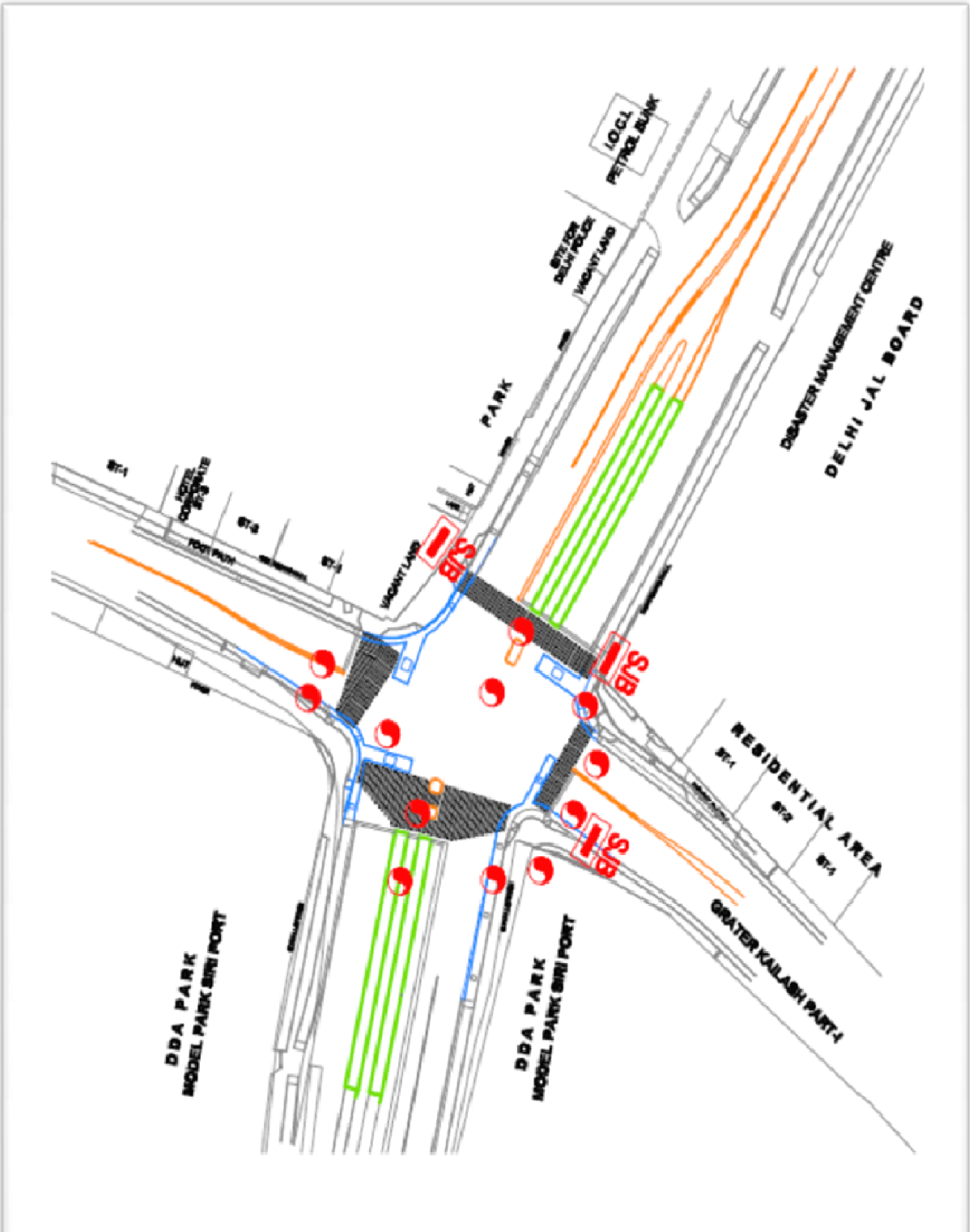


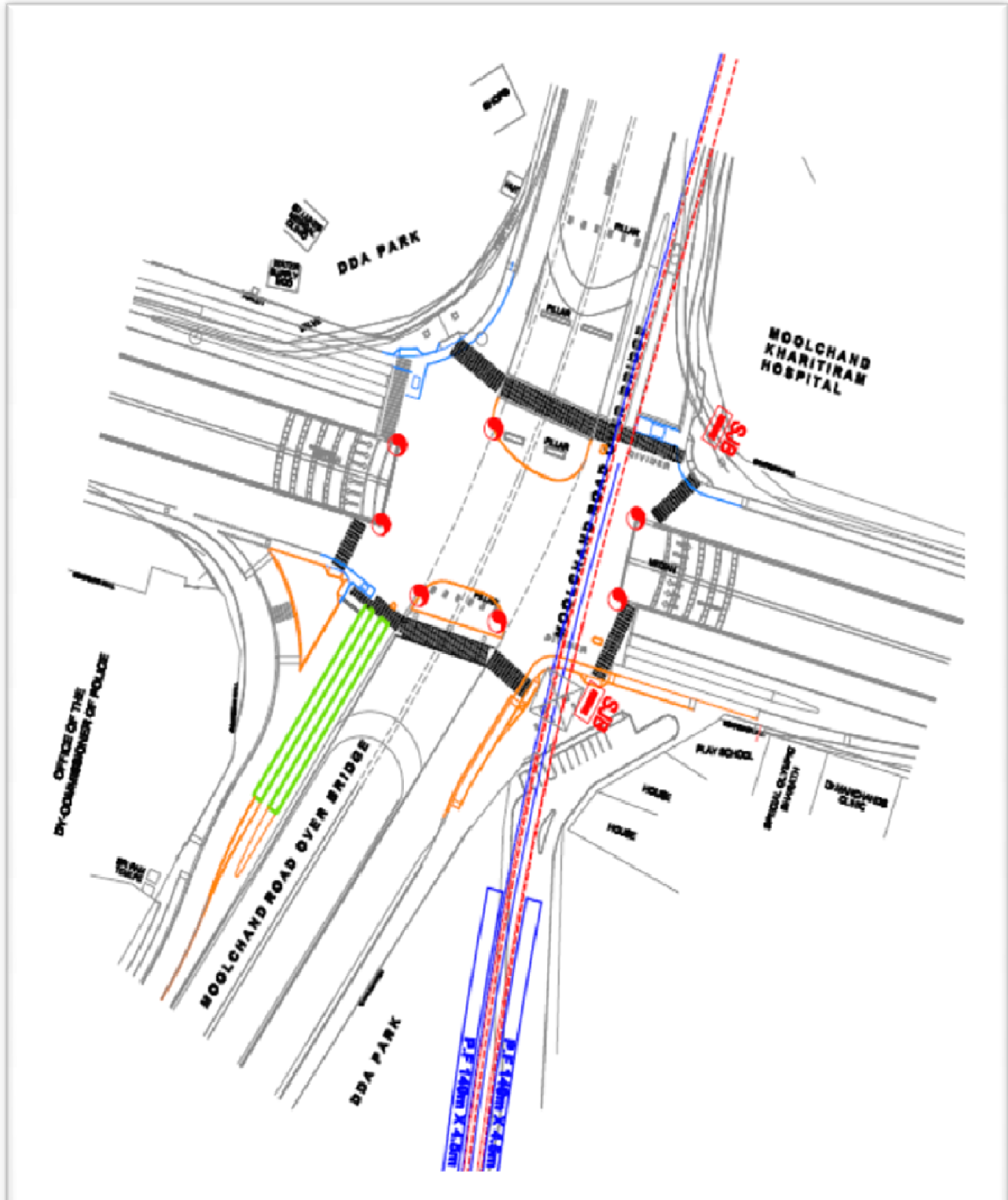
LANDUSE:

•Predominant Abutting Public, Semi-Public Buildings (Schools,offices)
•Residential places also placed.

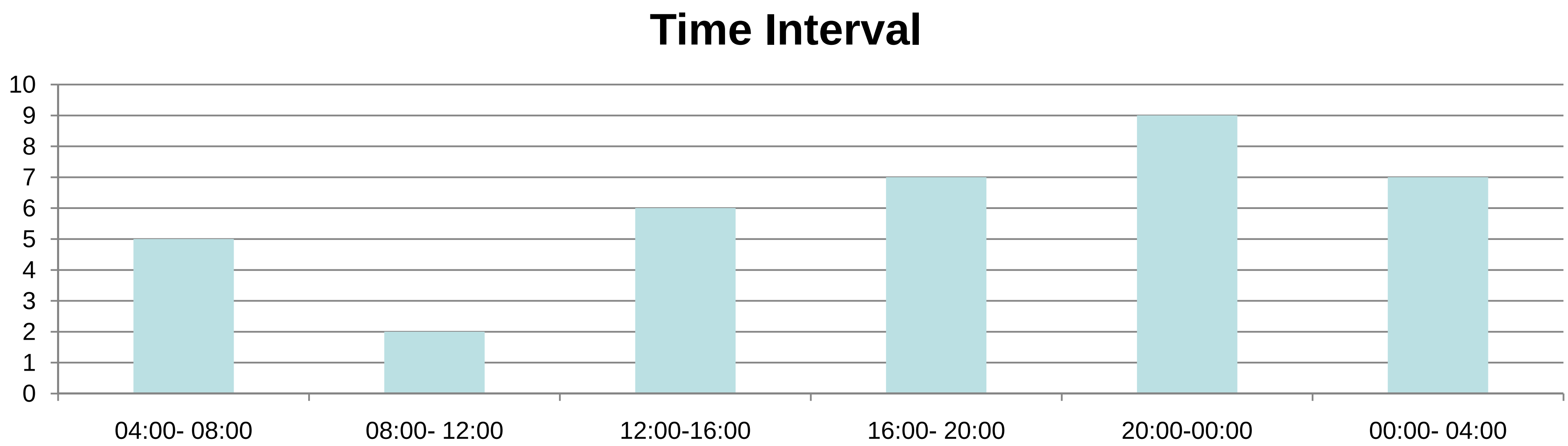


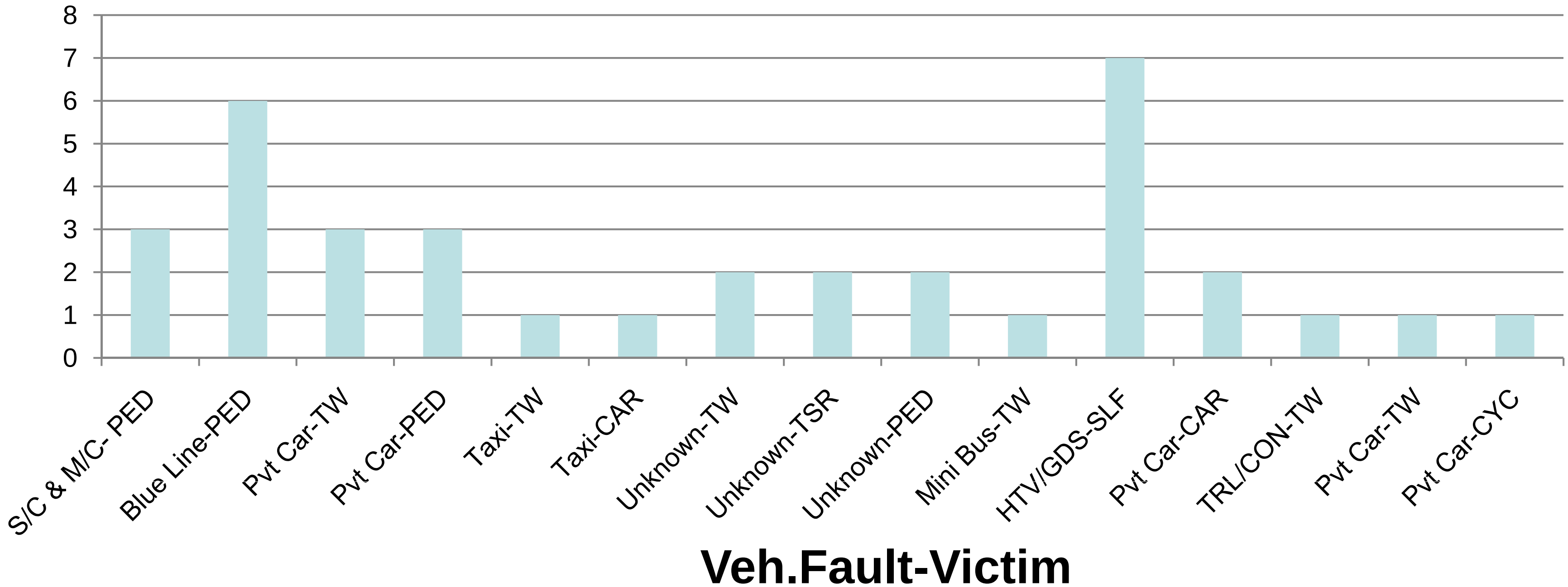
JUNCTION DETAILS



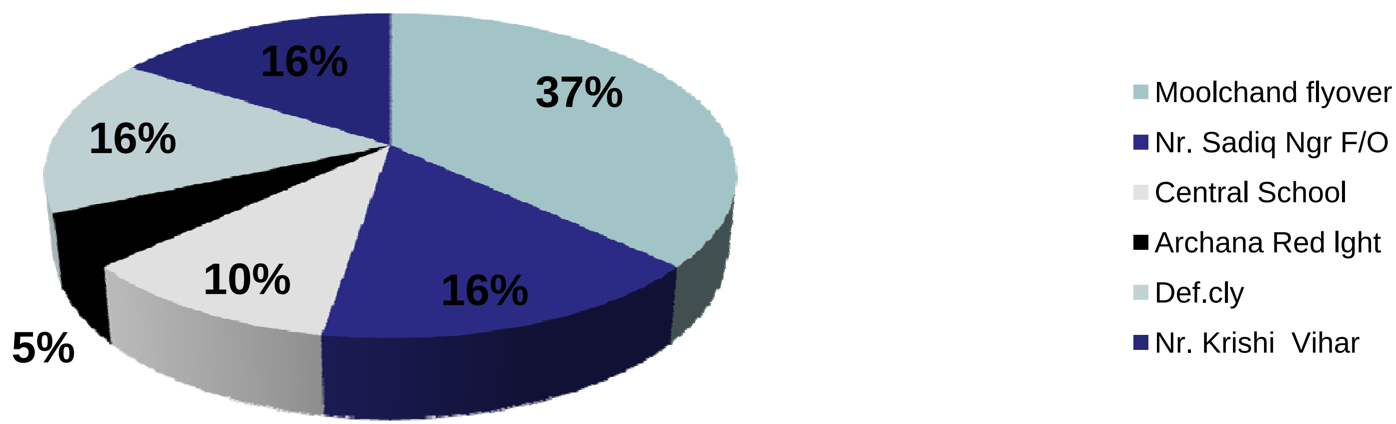


ACCIDENT DATA ANALYSIS

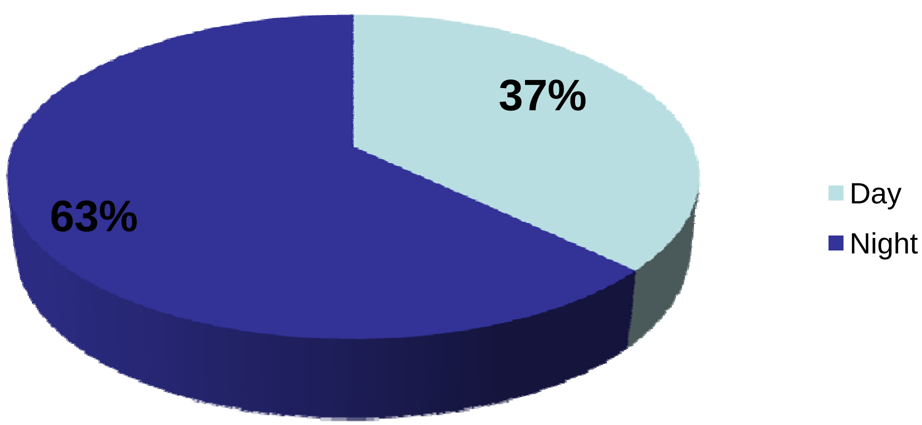




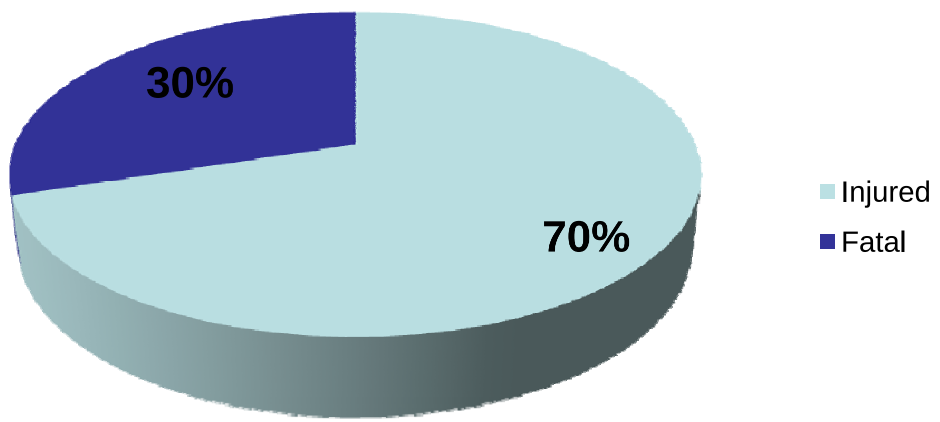
Accident Spot



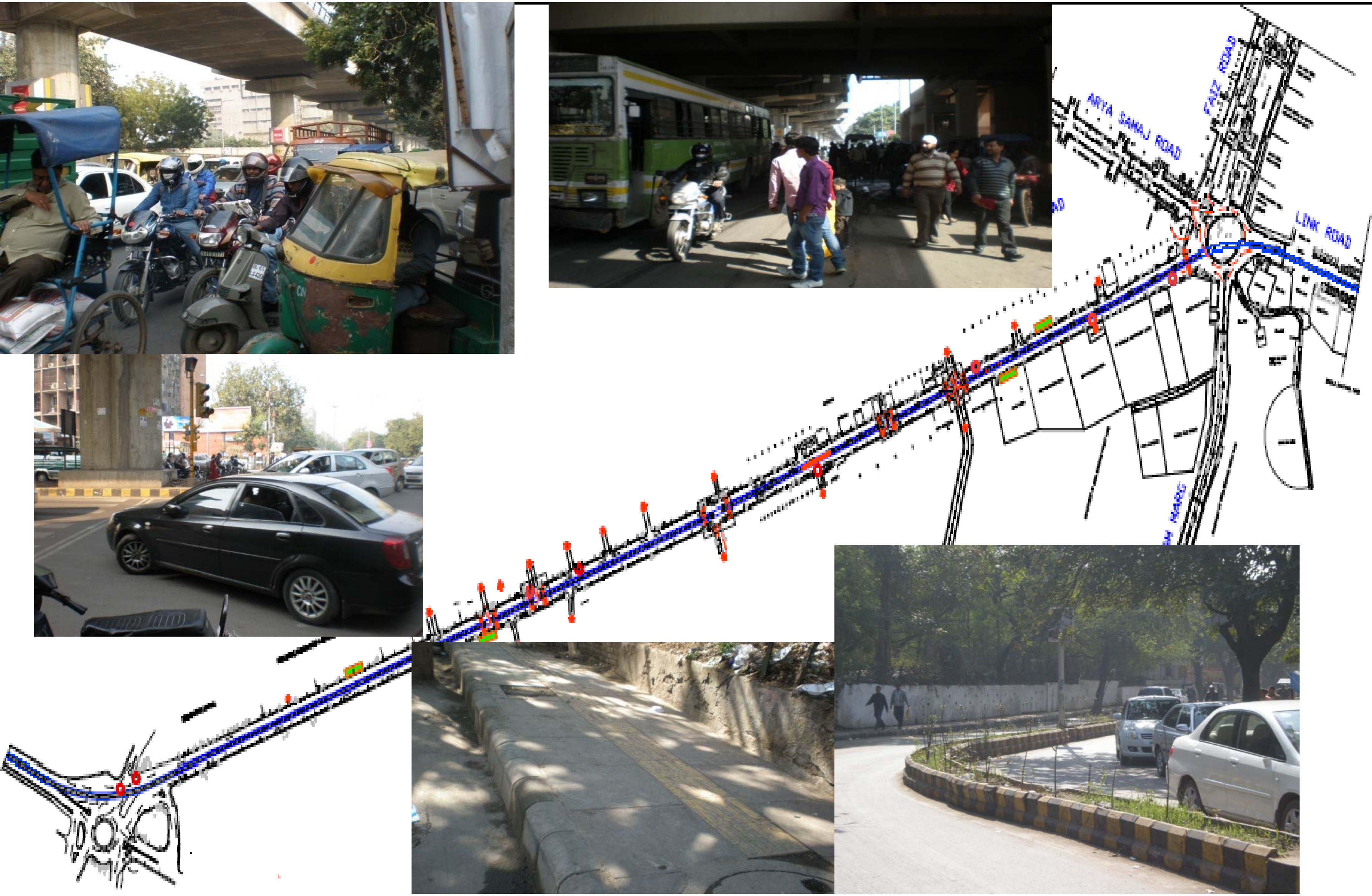
Day/Night



Type of Accident



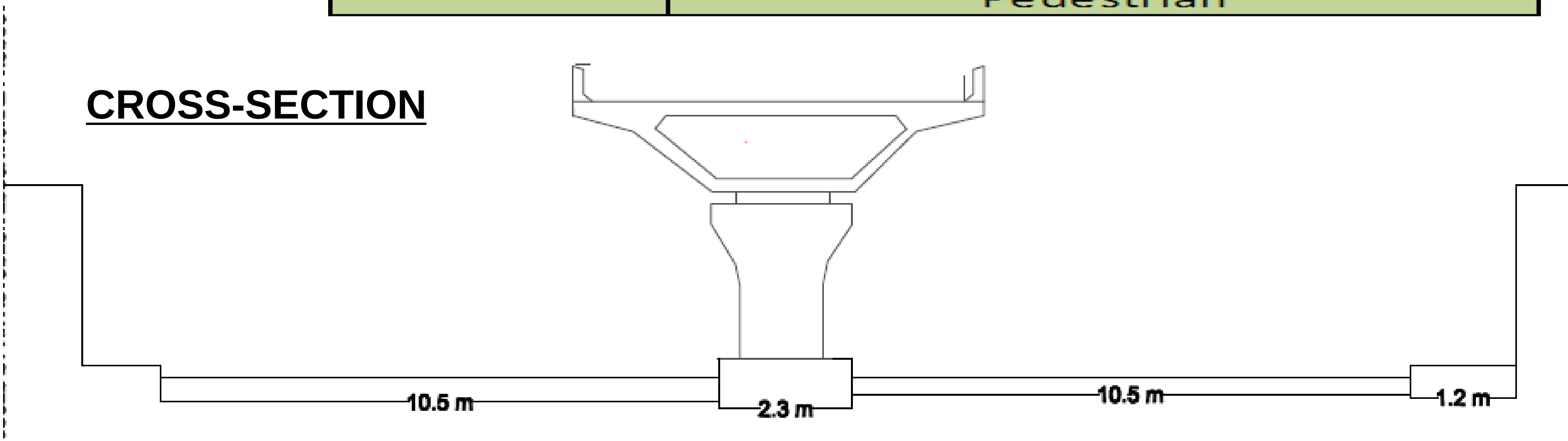
CASE STUDY II – PUSA ROAD



INTRODUCTION

Distance	2200m
Number of Bus stops	4
Number of Petrol Pump	3
Number of Local Roads Meeting	8 on Both sides
Speed Limit	40
Footpath	1.25 m
Median	3m
Service Road	no
Pedestrian Facilities	Zebra Crossing& footpath
Signages	Clear Signages for Speed Limit & Pedestrian

CROSS-SECTION



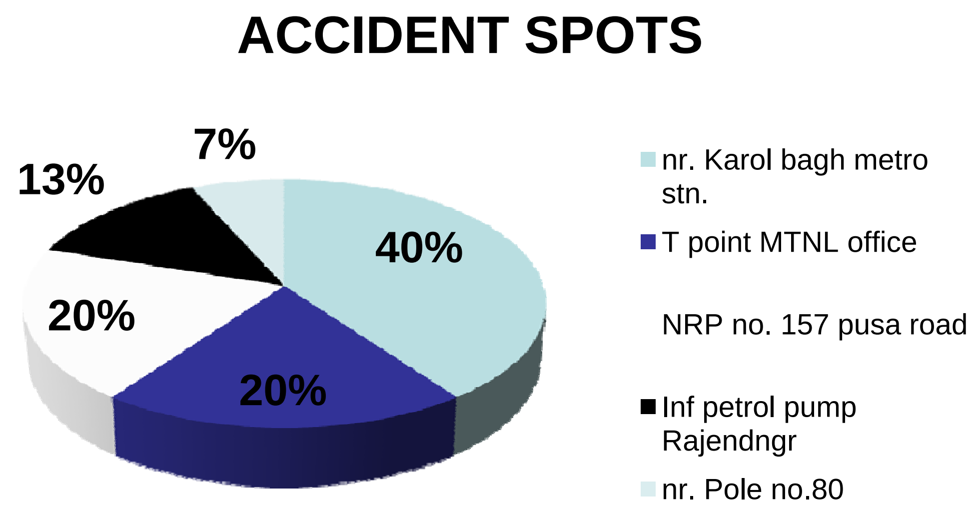

721
HOTEL
Le Suite
SALE
SBI Credit Cards

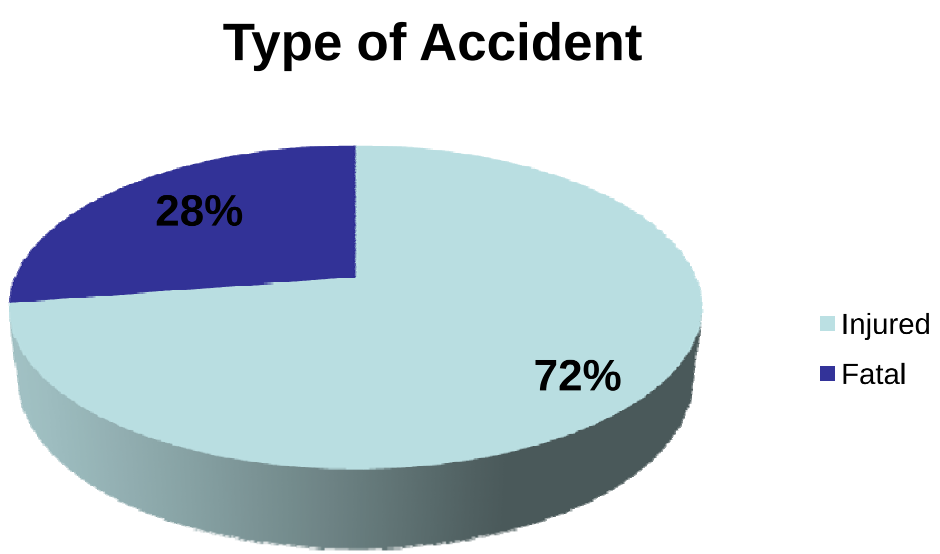

HOTEL
Le Suite
SBI Credit

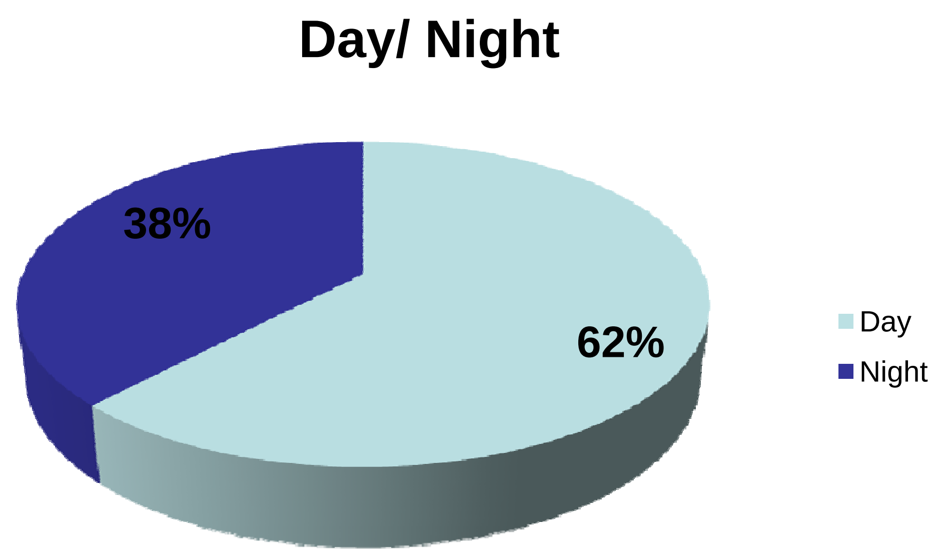

ORBIT
i20

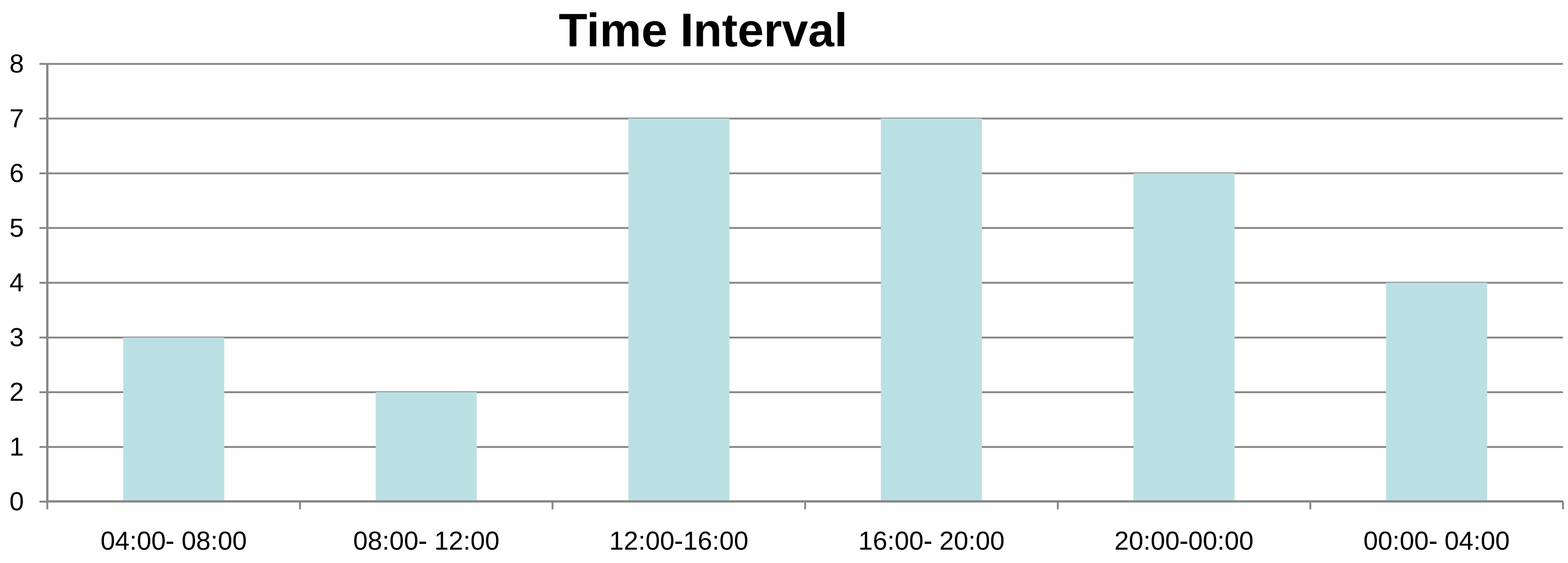

BUS
DL1LK9986

ACCIDENT DATA ANALYSIS

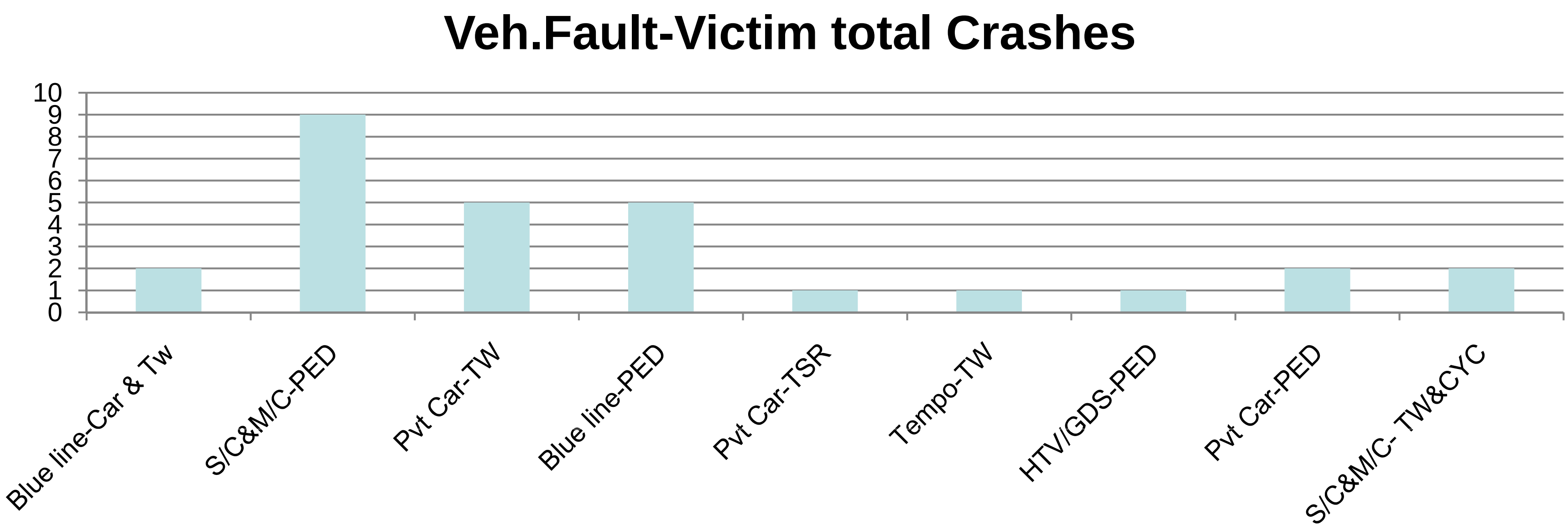








Time Interval
8
7
6
5
4
3
2
1
0
04:00- 08:00
08:00- 12:00
12:00-16:00
16:00- 20:00
20:00-00:00
00:00- 04:00



Veh.Fault-Victim total Crashes
10
9
8
7
6
5
4
3
2
1
0
Blue line-Car & Tw
S/C&M/C-PED
Pvt Car-TW
Blue line-PED
Pvt Car-TSR
Tempo-TW
HTV/GDS-PED
Pvt Car-PED
S/C&M/C- TW&CYC

TRAFFIC FLOW THEORY (LOS)

- LOS definition generally describes thee conditions in terms of factors such as speed, travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience and safety

LOS A:-

Free Flow Operation

LOS B:-

Reasonably free flow,Ability to maneuver is only slightly restricted, Effects of minor incidents still easily absorbed

LOS C:-

Speeds at or near FFS, Freedom to maneuver is noticeably restricted, Queu may form behind any significant blockag

LOS D:-

Speeds decline slightly with increasing flows, Density increases more quickly, Freedom to maneuver is more noticeably limited, Minor incidents create queuing

LOS E:-

Operation near or at capacity, No usable gaps in the traffic stream, Operations extremely volatile, Any disruption causes queuing

LOS F:-

Breakdown in flow, Queues form behind breakdown points, Demand > capacity

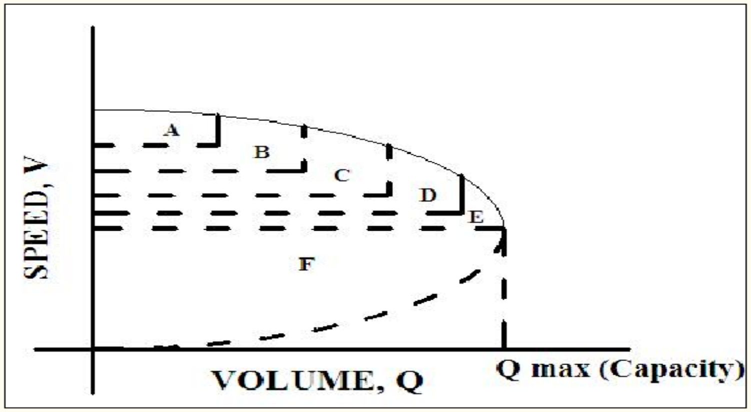
Values of LOS parameters

k → Maximum density; u → Minimum speed; q → Maximum service flow rate

Free flow speed (FFS)

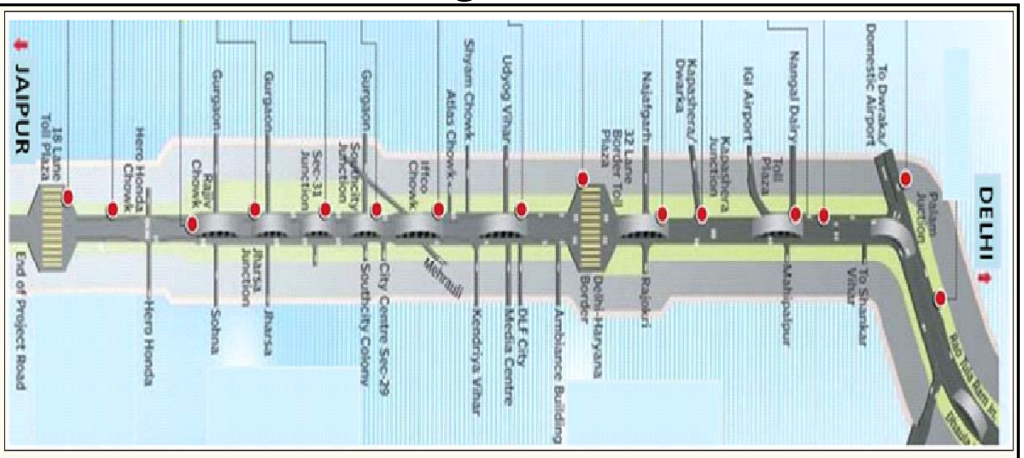
Criteria	LOS A	LOS B	LOS C	LOS D	LOS E
FFS = 75 mi/h					
Maximum density (pc/mi/ln)	11	18	26	35	45
Minimum speed (mi/h)	75.0	74.8	70.6	62.2	53.3
Maximum v/c	0.34	0.56	0.76	0.90	1.00
Maximum service flow rate (pc/h/ln)	820	1350	1830	2170	2400
FFS = 70 mi/h					
Maximum density (pc/mi/ln)	11	18	26	35	45
Minimum speed (mi/h)	70.0	70.0	68.2	61.5	53.3
Maximum v/c	0.32	0.53	0.74	0.90	1.00
Maximum service flow rate (pc/h/ln)	770	1260	1770	2150	2400
FFS = 65 mi/h					
Maximum density (pc/mi/ln)	11	18	26	35	45
Minimum speed (mi/h)	65.0	65.0	64.6	59.7	52.2
Maximum v/c	0.30	0.50	0.71	0.89	1.00
Maximum service flow rate (pc/h/ln)	710	1170	1680	2090	2350
FFS = 60 mi/h					
Maximum density (pc/mi/ln)	11	18	26	35	45
Minimum speed (mi/h)	60.0	60.0	60.0	57.6	51.1
Maximum v/c	0.29	0.47	0.68	0.88	1.00
Maximum service flow rate (pc/h/ln)	660	1080	1560	2020	2300

Relation between Speed Volume

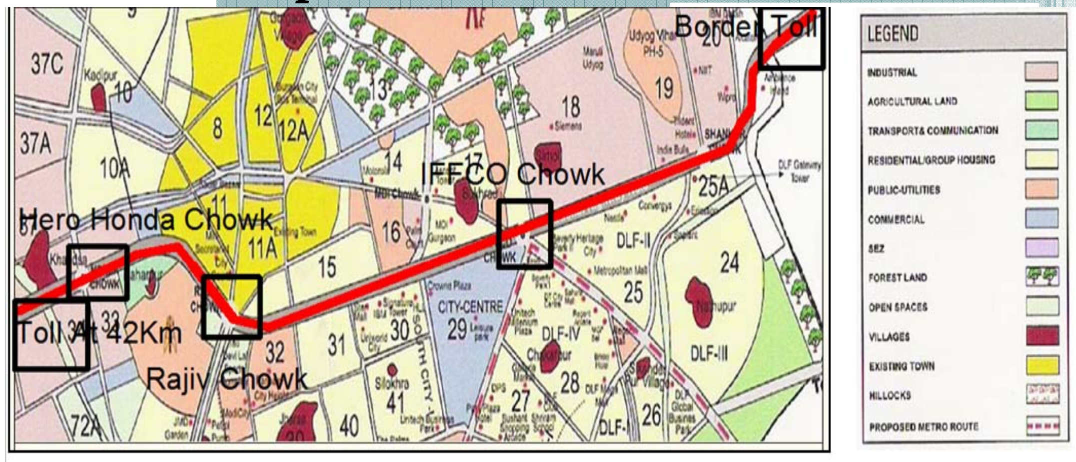


VIEWS OF STUDY AREA STRETCH

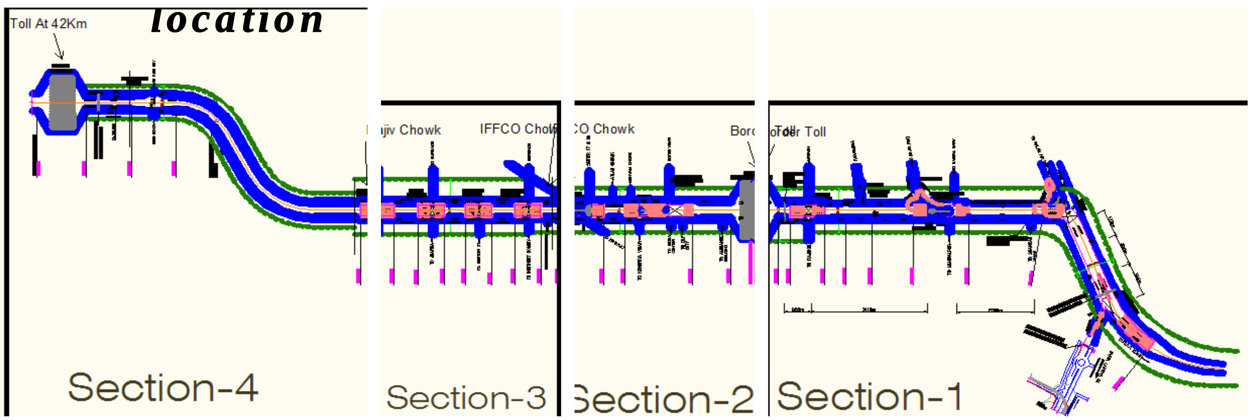
Schematic Alignment Plan



Land use plan



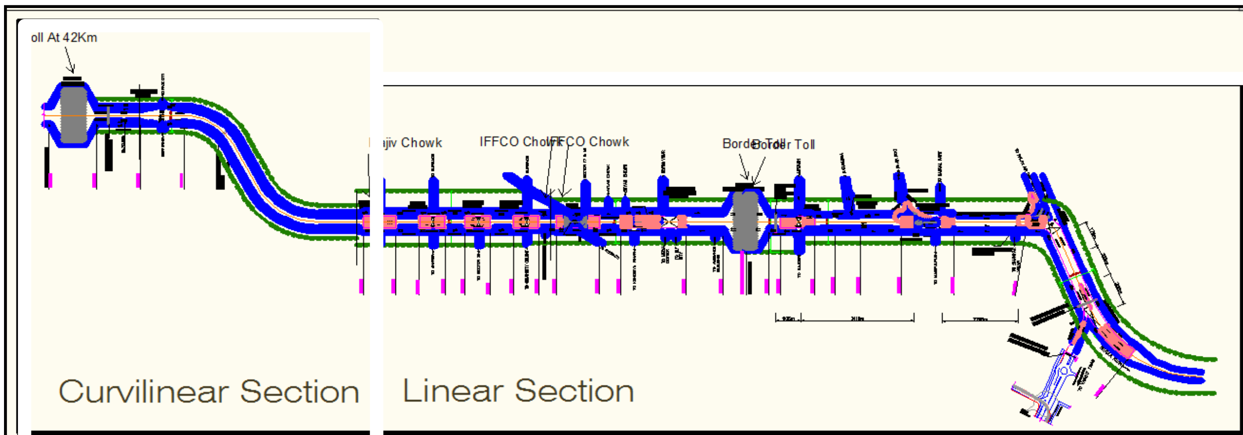
Identification of survey location



➢Depending upon the reconnaissance survey & secondary survey data, the survey locations were identified and studied.

➢For detailed analysis of survey, the entire 28 km stretch was divided into <u>*4 sections*</u> considering its analogous profile and accident spots.

➢Since the corridor has linear as well as curvilinear profile, for identification of <u>***speed character***</u> the entire study corridor is divided in 2 sections <u>***the linear segment & curvilinear segment.***</u>



JOURNEY SPEED ANALYSIS ON LINEAR SECTION OF STRETCH

Speed analysis of Car:

Speed (KMPH)	Observed Frequency	Theoretical Frequency	Cumulative Frequency	Theoretical Cumulative frequency
30	0%	1.16%	0%	1.20%
40	2%	3.21%	2%	4.40%
50	5%	8.17%	7%	12.50%
60	35%	15.29%	42%	27.80%
70	8%	21.10%	50%	48.90%
80	10%	21.80%	60%	70.70%
90	31%	15.93%	91%	86.70%
100	5%	8.74%	95%	95.40%
110	3%	3.53%	99%	98.90%
120	1%	1.05%	100%	100%

Speed analysis of Truck

Speed (KMPH)	Observed Frequency	Theoretical Frequency	Cumulative Frequency	Theoretical Cumulative frequency
20	0%	2%	0%	2%
30	15%	10%	15%	13%
40	40%	26%	55%	39%
50	21%	33%	77%	72%
60	7%	20%	94%	93%
70	7%	6%	91%	99%
80	4%	1%	95%	100%
90	5%	0%	100%	100%

Speed analysis of Bus:

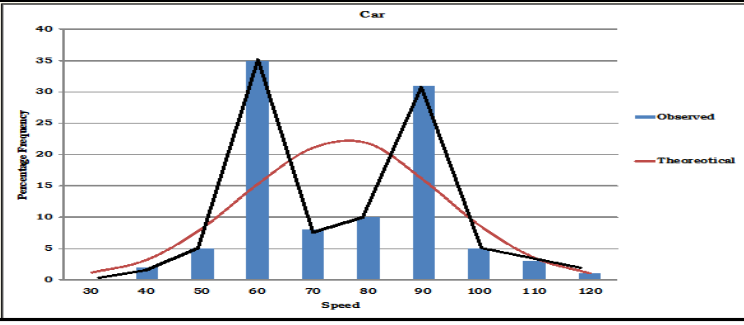
Speed (KMPH)	Observed Frequency	Theoretical Frequency	Cumulative Frequency	Theoretical Cumulative frequency
20	0%	0%	0%	0%
30	1%	2%	1%	2%
40	25%	10%	26%	12%
50	27%	27%	53%	39%
60	13%	34%	66%	73%
70	19%	20%	85%	94%
80	3%	6%	88%	99%
90	12%	1%	100%	100%

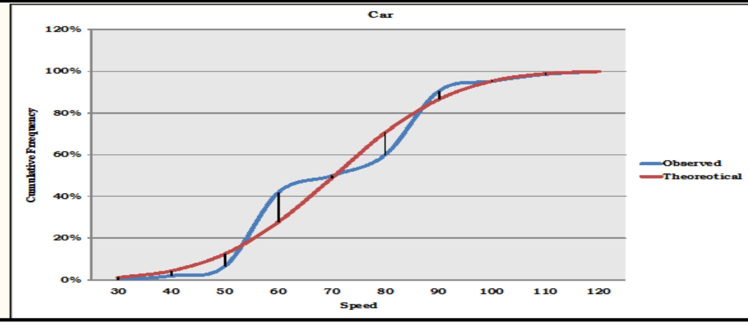
Speed analysis of All Vehicles:

Speed (KMPH)	Observed Frequency	Theoretical Frequency	Cumulative Frequency	Theoretical Cumulative frequency
10	0%	0%	0%	0%
20	0%	0%	0%	0%
30	8%	0%	8%	0%
40	20%	1%	29%	1%
50	16%	12%	45%	13%
60	12%	63%	58%	56%
70	15%	36%	73%	92%
80	6%	7%	79%	100%
90	3%	0%	82%	100%
100	11%	0%	93%	100%
110	1%	0%	94%	100%
120	6%	0%	100%	100%

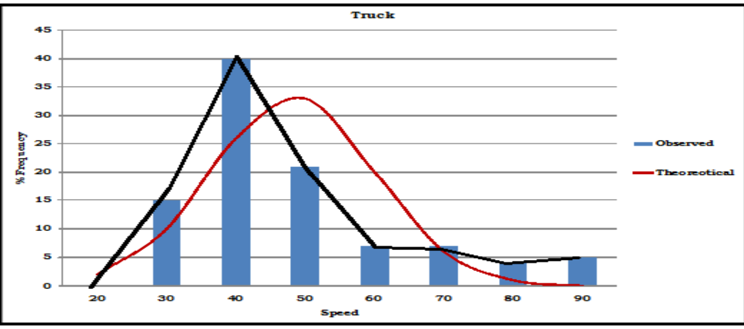
As observed from analysis the 85th & 95th percentile Speed was evaluated to be around 60 to 70 kmph respectively on the corridor, where the minimum speed limit is 40 kmph.

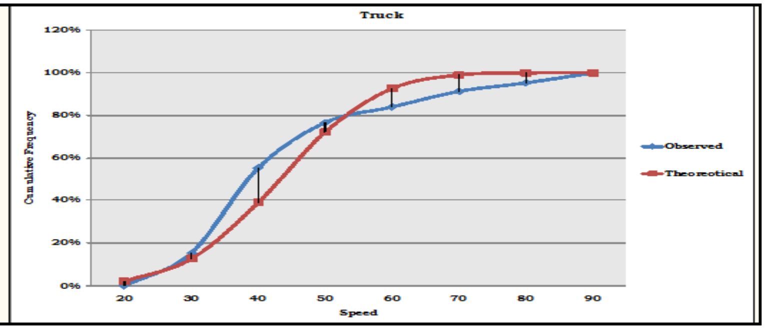
JOURNEY SPEED ANALYSIS ON LINEAR SECTION OF STRETCH (cont.)



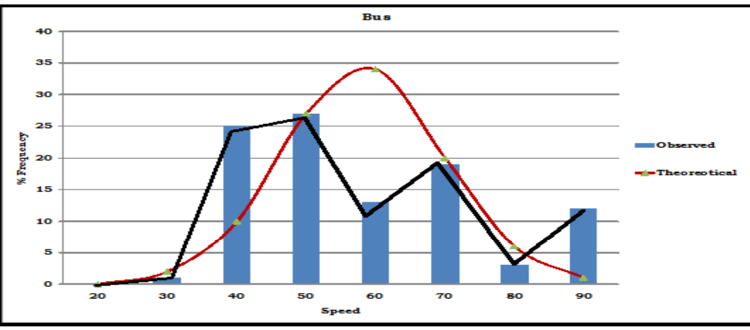


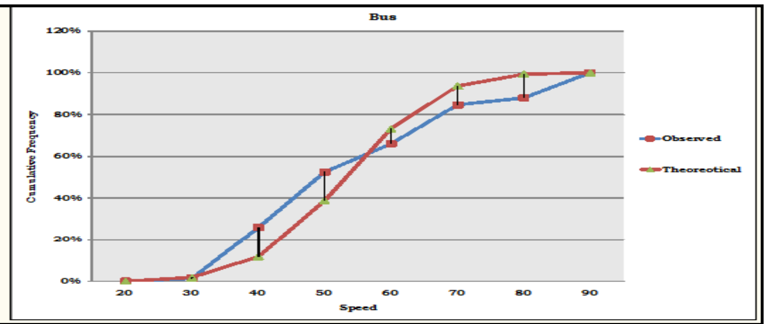
Normal distribution Curve & Cumulative frequency curve (CAR)



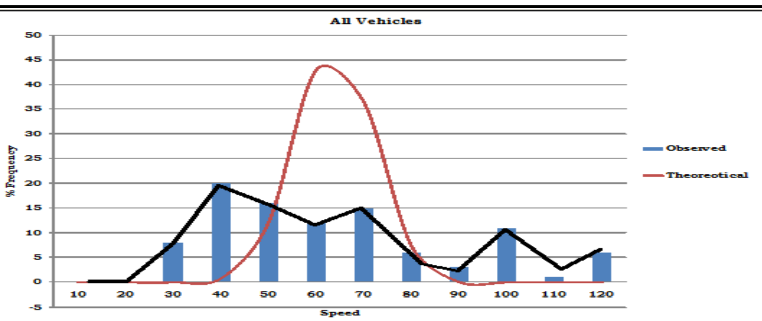


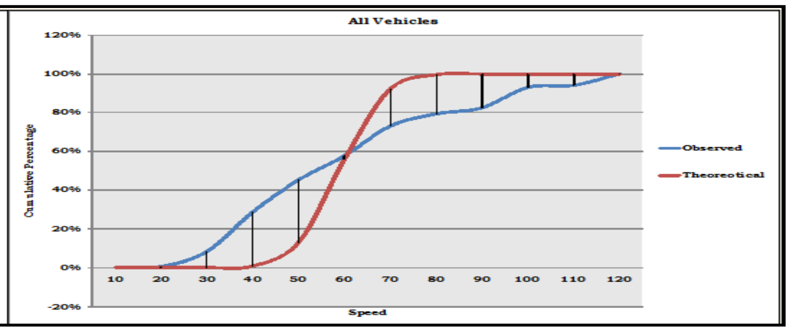
Normal distribution Curve & Cumulative frequency curve (TRUCK)





Normal distribution Curve & Cumulative frequency curve (BUS)





Normal distribution Curve & Cumulative frequency curve (All Vehicles)

Huge variation is observed for normal distribution between observed data and theoretical data.
Thus above analysis justifies the occurrence of collision characterized accidents due to involvement of cars and their reason being over speeding.

JOURNEY SPEED ANALYSIS ON CURVI LINEAR SECTION OF STRETCH

Speed analysis of Car:

Speed (KMPH)	Observed Frequency	Theoretical Frequency	Cumulative Frequency	Theoretical Cumulative frequency
40	0%	2%	0%	2%
50	9%	8%	9%	10%
60	24%	21%	33%	31%
70	24%	31%	57%	62%
80	37%	25%	93%	87%
90	3%	11%	96%	97%
100	4%	3%	100%	100%

Speed analysis of Truck

Speed (KMPH)	Observed Frequency	Theoretical Frequency	Cumulative Frequency	Theoretical Cumulative frequency
30	0%	4%	0%	4%
40	32%	21%	32%	25%
50	33%	68%	65%	92%
60	26%	2%	91%	94%
70	7%	6%	99%	100%
80	1%	0%	100%	100%

Speed analysis of Bus:

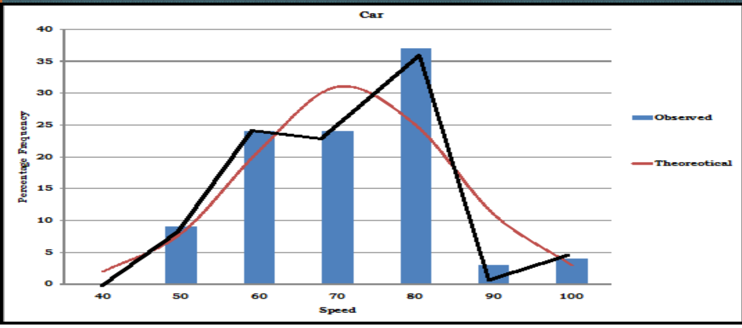
Speed (KMPH)	Observed Frequency	Theoretical Frequency	Cumulative Frequency	Theoretical Cumulative frequency
30	0%	0%	0%	0%
40	13%	6%	13%	6%
50	29%	29%	42%	34%
60	29%	44%	71%	78%
70	20%	20%	91%	98%
80	9%	2%	100%	100%

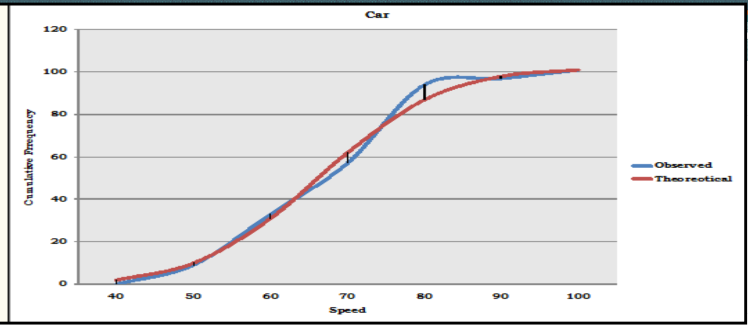
Speed analysis of All Vehicles:

Speed (KMPH)	Observed Frequency	Theoretical Frequency	Cumulative Frequency	Theoretical Cumulative frequency
10	0%	0%	0%	0%
20	0%	0%	0%	0%
30	8%	0%	8%	0%
40	22%	2%	30%	2%
50	12%	14%	42%	16%
60	14%	38%	56%	54%
70	14%	37%	70%	91%
80	1%	7%	80%	98%
90	11%	2%	91%	100%
100	9%	0%	100%	100%

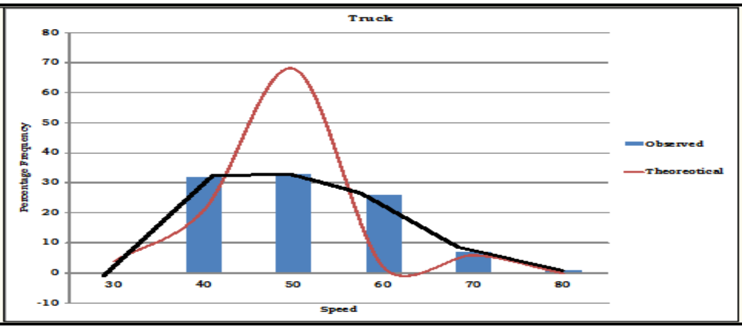
As observed from analysis the 85th & 95th percentile Speed was evaluated to be around 60 to 70 kmph respectively, where as the minimum speed limited posted is 40 kmph.

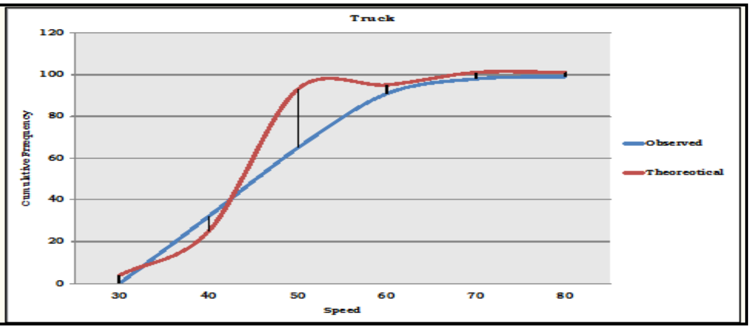
JOURNEY SPEED ANALYSIS ON CURVI LINEAR SECTION OF STRETCH (cont.)



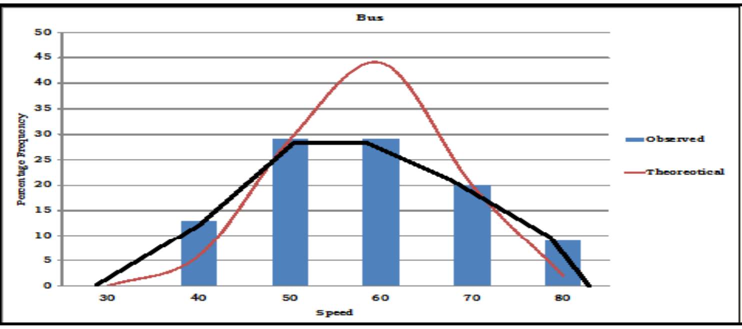


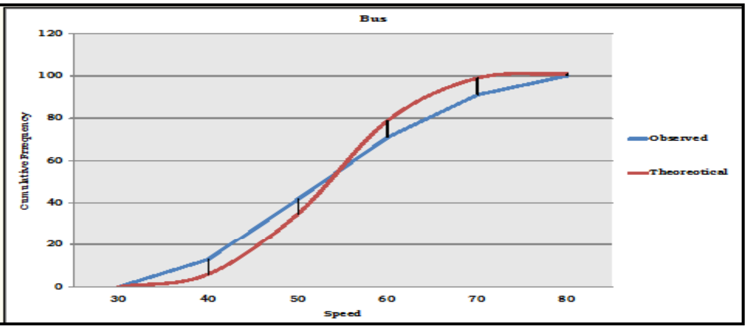
Normal distribution Curve & Cumulative frequency curve (CAR)



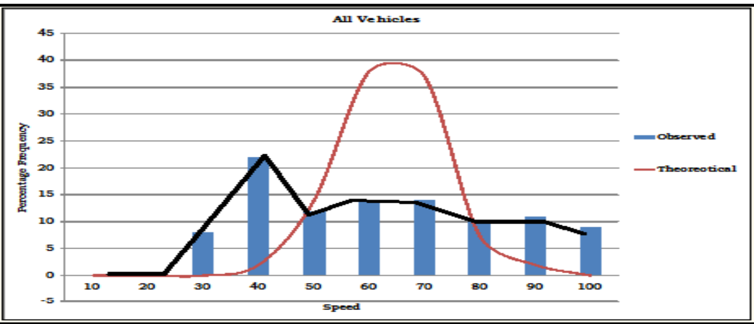


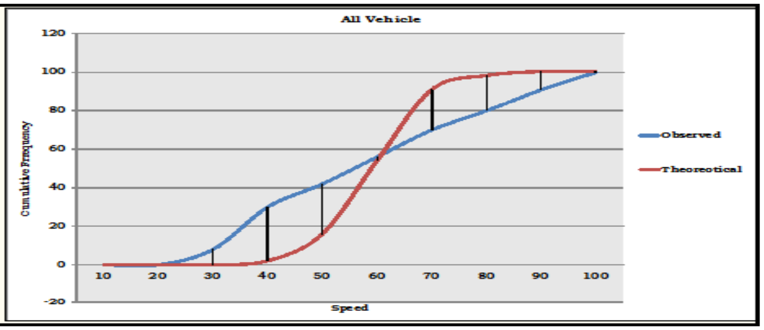
Normal distribution Curve & Cumulative frequency curve (TRUCK)





Normal distribution Curve & Cumulative frequency curve (BUS)



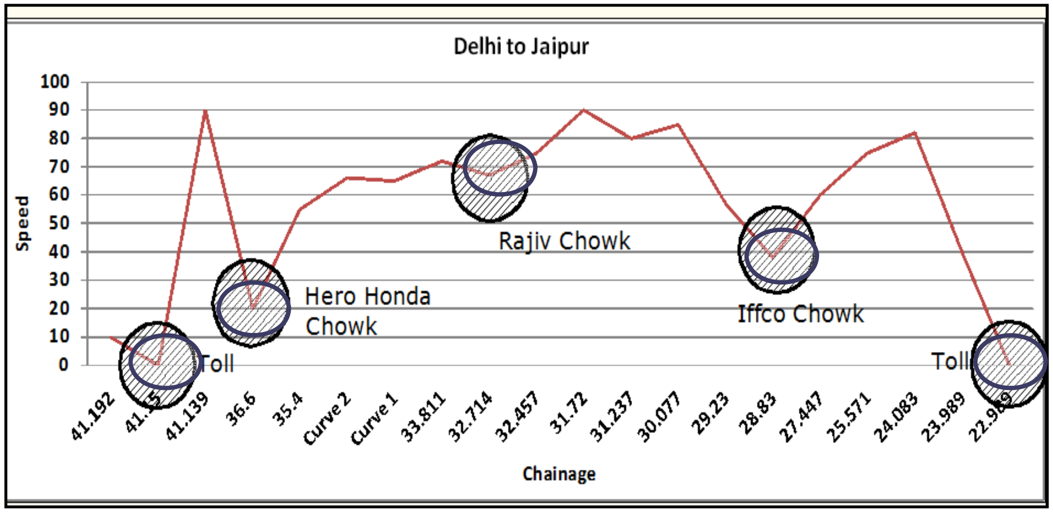


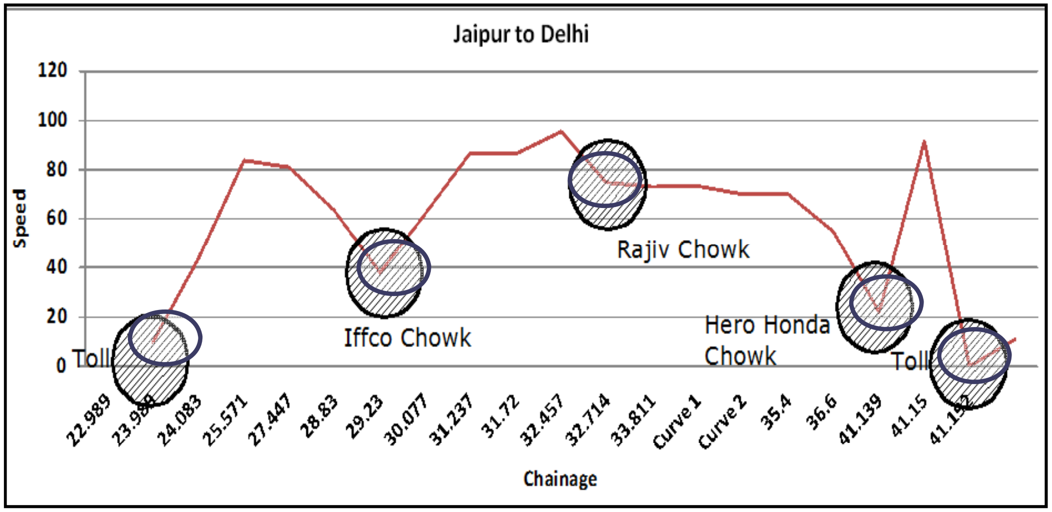
Normal distribution Curve & Cumulative frequency curve (All Vehicles)

The analysis justifies the occurrence of rear end accidents by over speeding. Also this curve section ends near Hero Honda Chowk which is a pedestrian influence area and hence for such high speed collision between pedestrian and vehicle is bound to occur.

SPEED ANALYSIS BY MOVING CAR METHOD

➤Speed survey was also conducted by "Moving Car method" during morning peak hour to identify the chainage wise speed profile of the entire stretch.
➤To identify the speed profile on the stretch the speed survey data was compared with intersection location and accident location

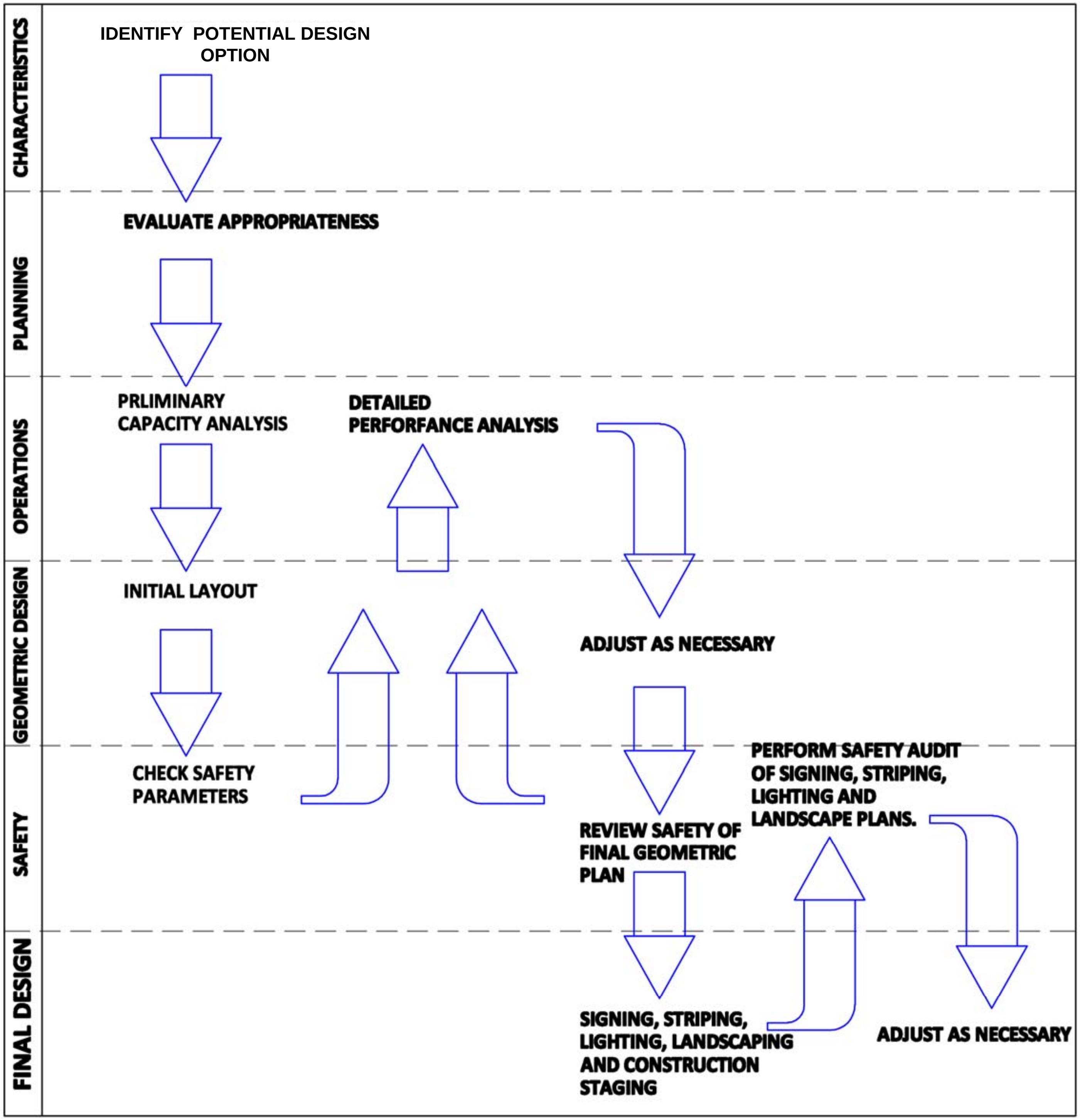




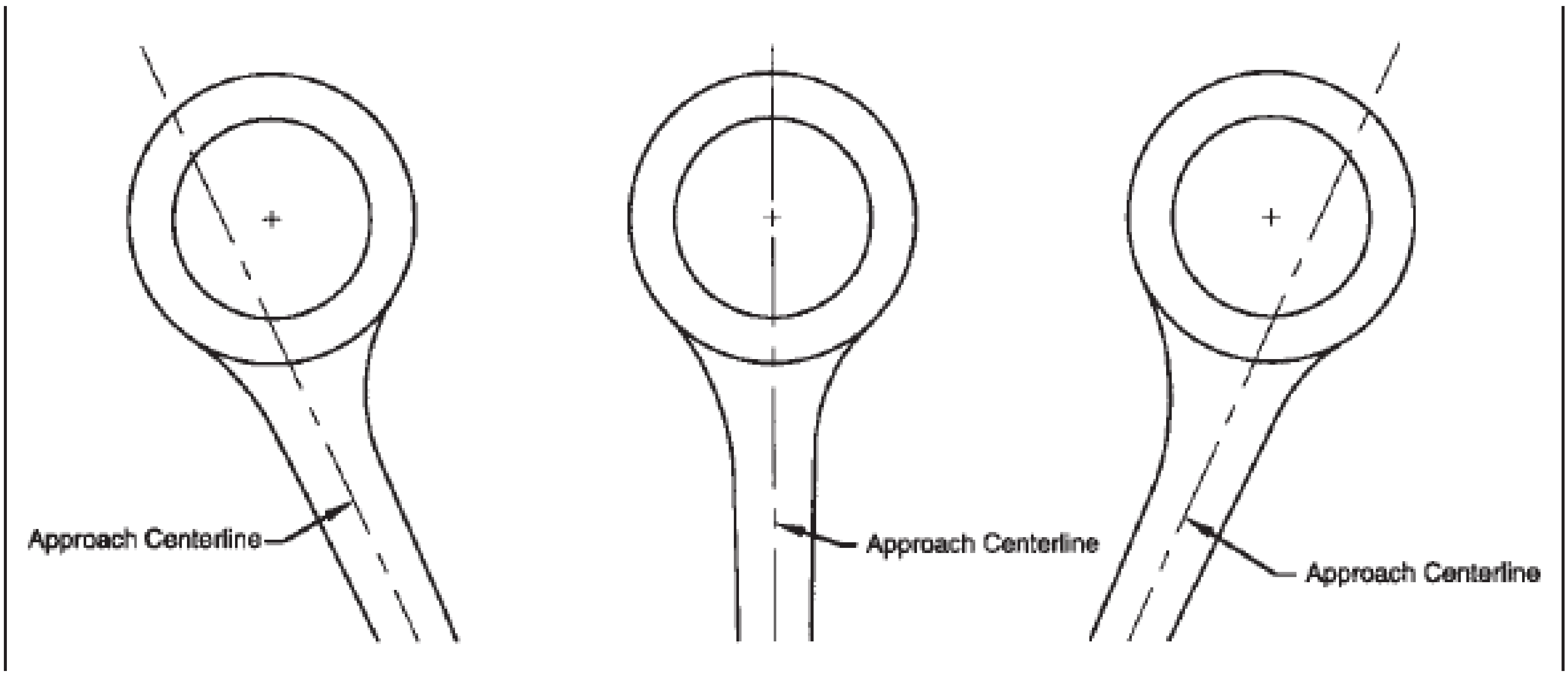
➤From the chart it is observed that speed decrease noticeably wherever intersections are present & where accidents are happening.
➤Speed was observed to be of constant nature over a distance of 2 kms.

During rainy season it was observed that the drains gets clogged and all the water lingers on the road surface causing problems of skidding for fast moving vehicles.

METHODOLOGY OF DESIGN

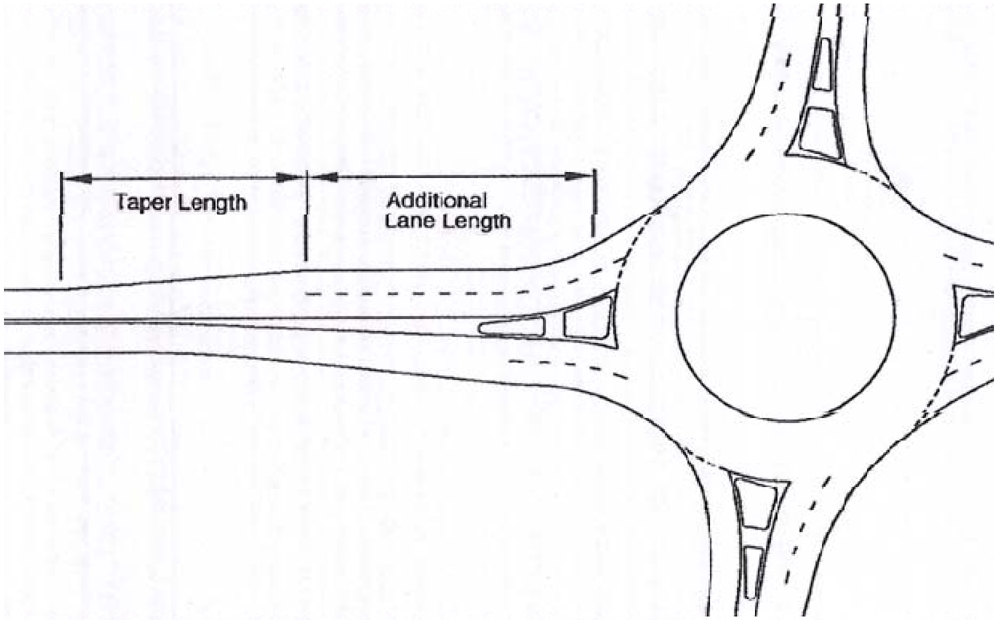


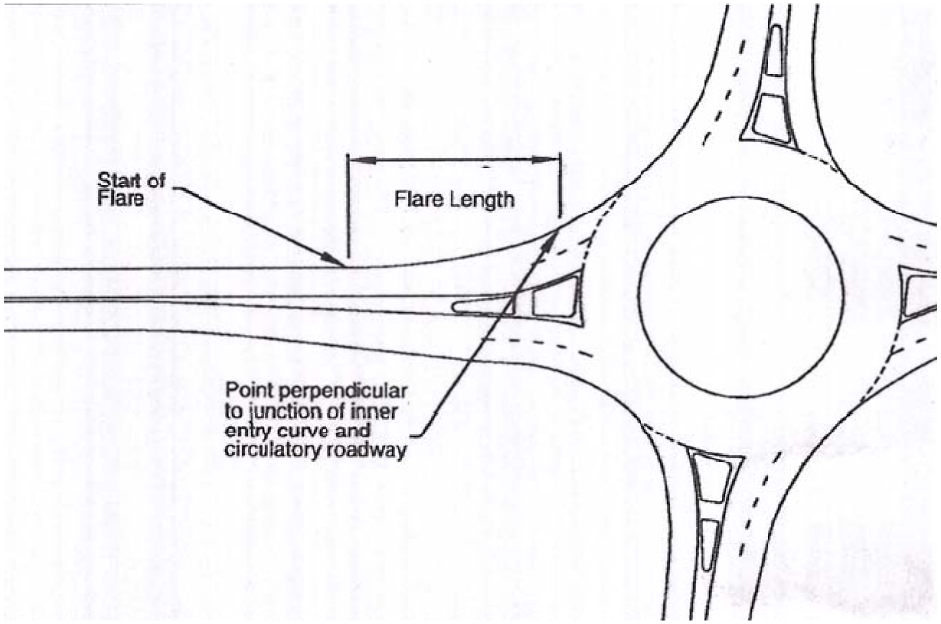
RADIAL ALIGNMENT OF ENTRIES.



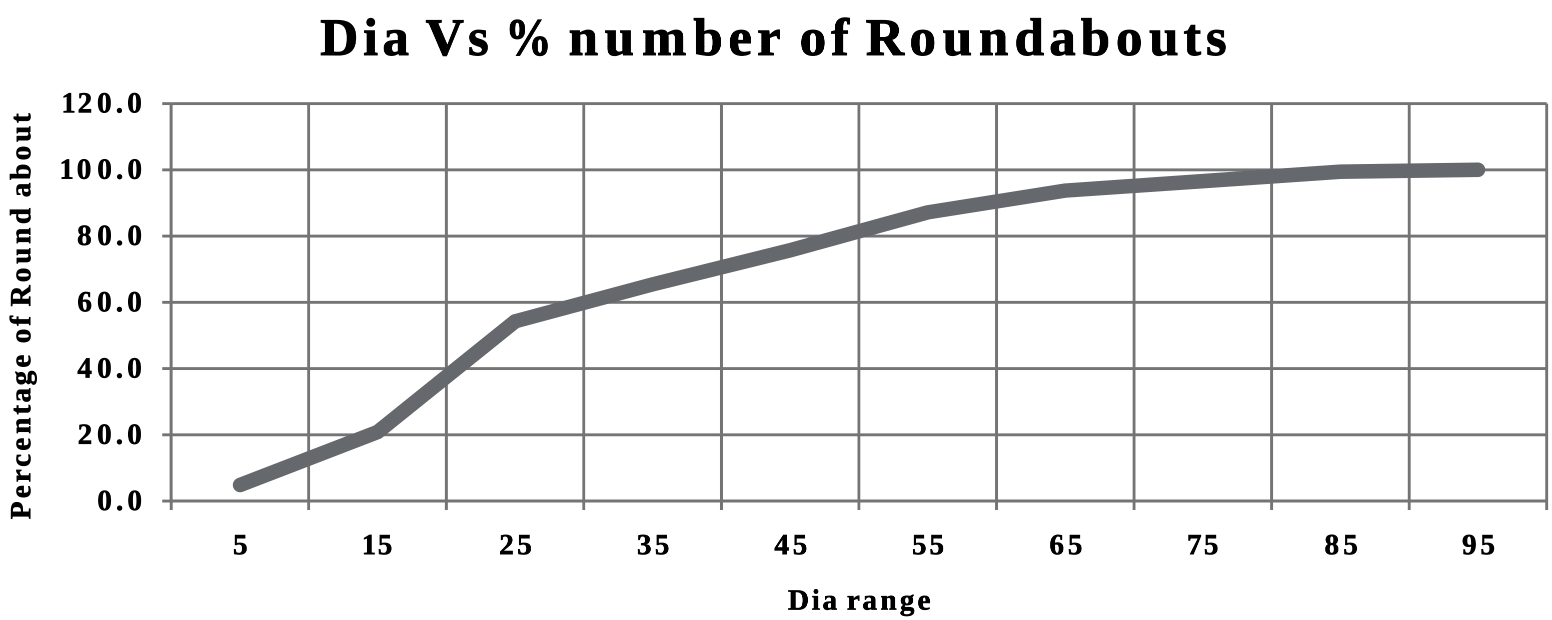
Unacceptable Normal Acceptable

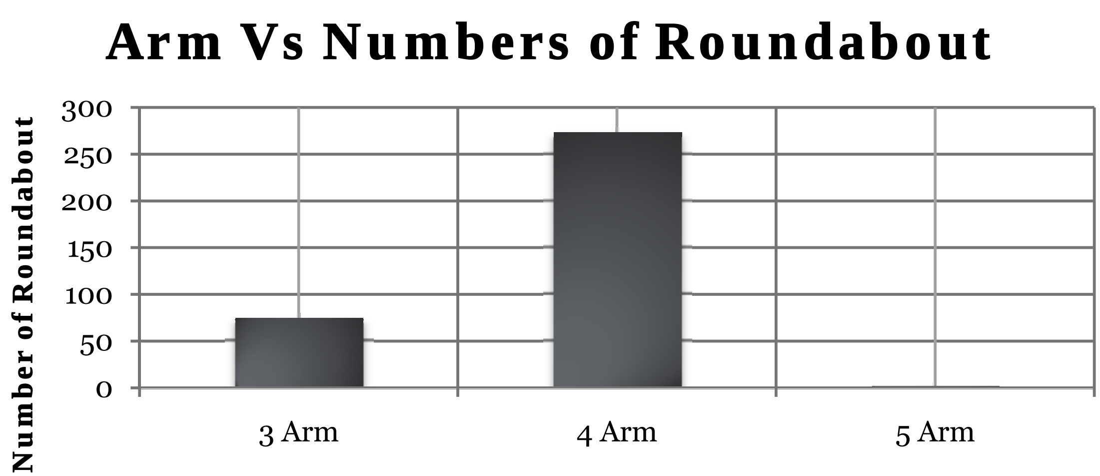
APPROACH WIDENING BY ENTRY FLARING



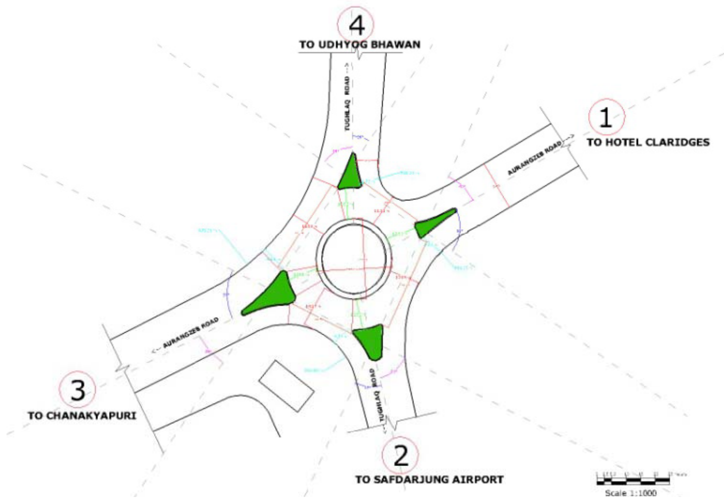


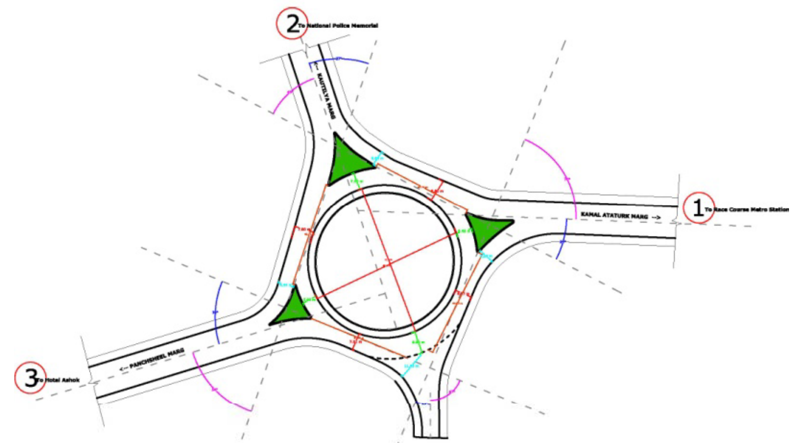
EXISTING ROUNDABOUT TYPOLOGY IN INDIAN SCENARIO



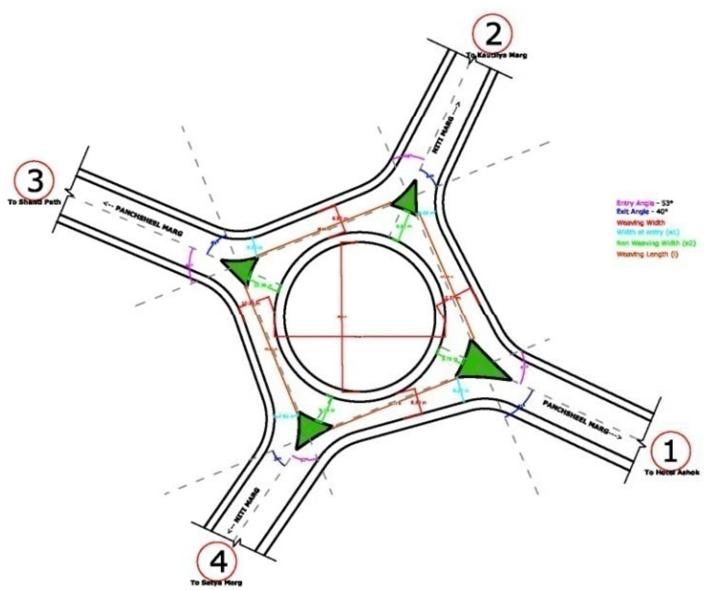


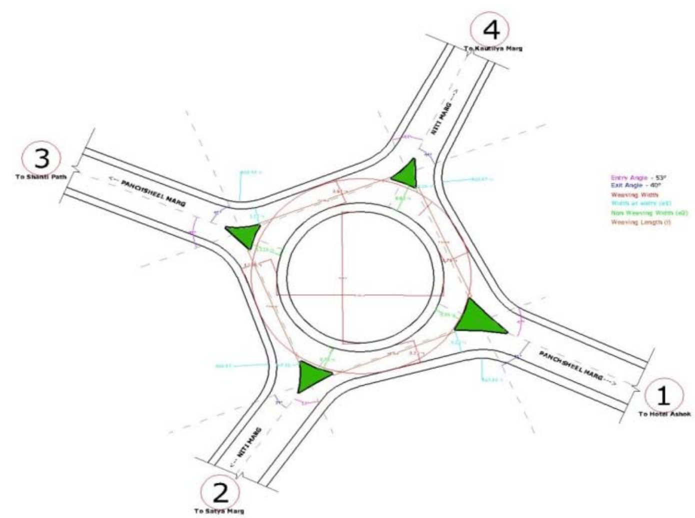
Roundabout Details



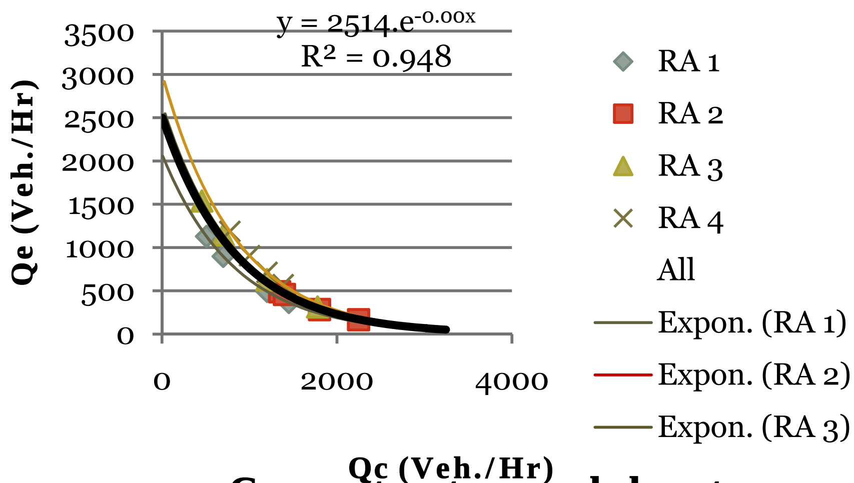


ROUND ABOUT - Hotel Samrat





Comparison of generic model with other research models



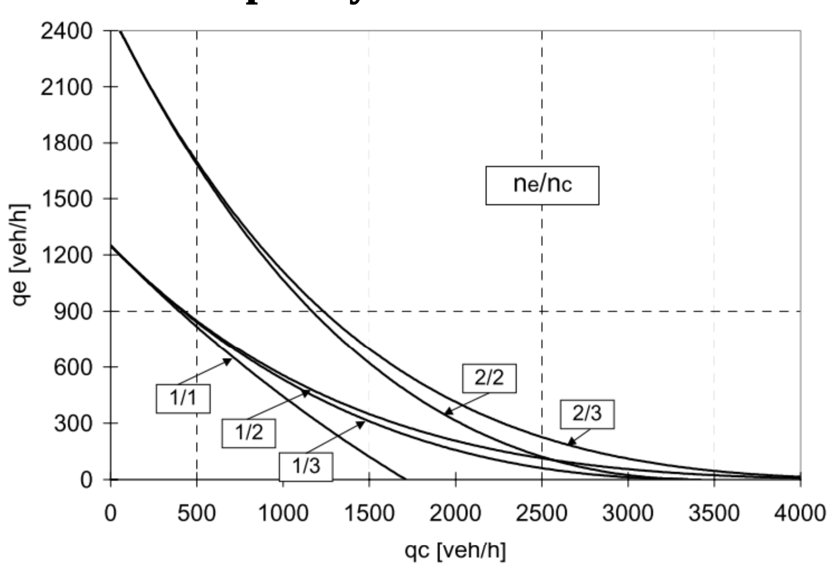
Capacity of urban double- lane roundabouts-

The Kimber equations presented earlier form the basis for the capacity equation derived for the double-lane roundabout. The following geometric parameters were assumed: D = 55 m, re = 20 m, φ = 30°, v = 8 m, e = 8 m, and l′ = 40 m.

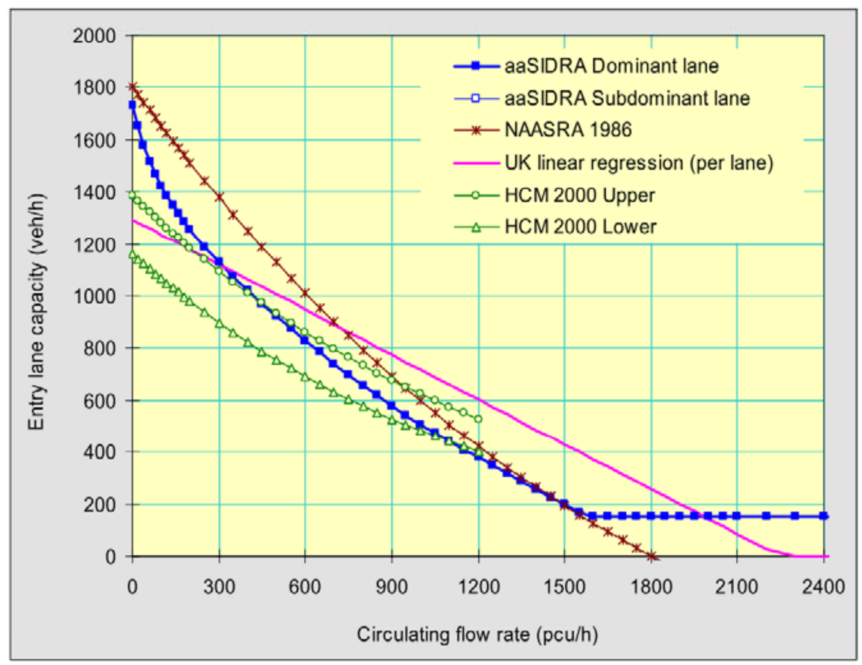
Kimber Equation- $Qe = 2424 - 0.7159Qc$

Robinson, B. W. & Rodegerdts, L.A. (2012)

Capacity at roundabouts

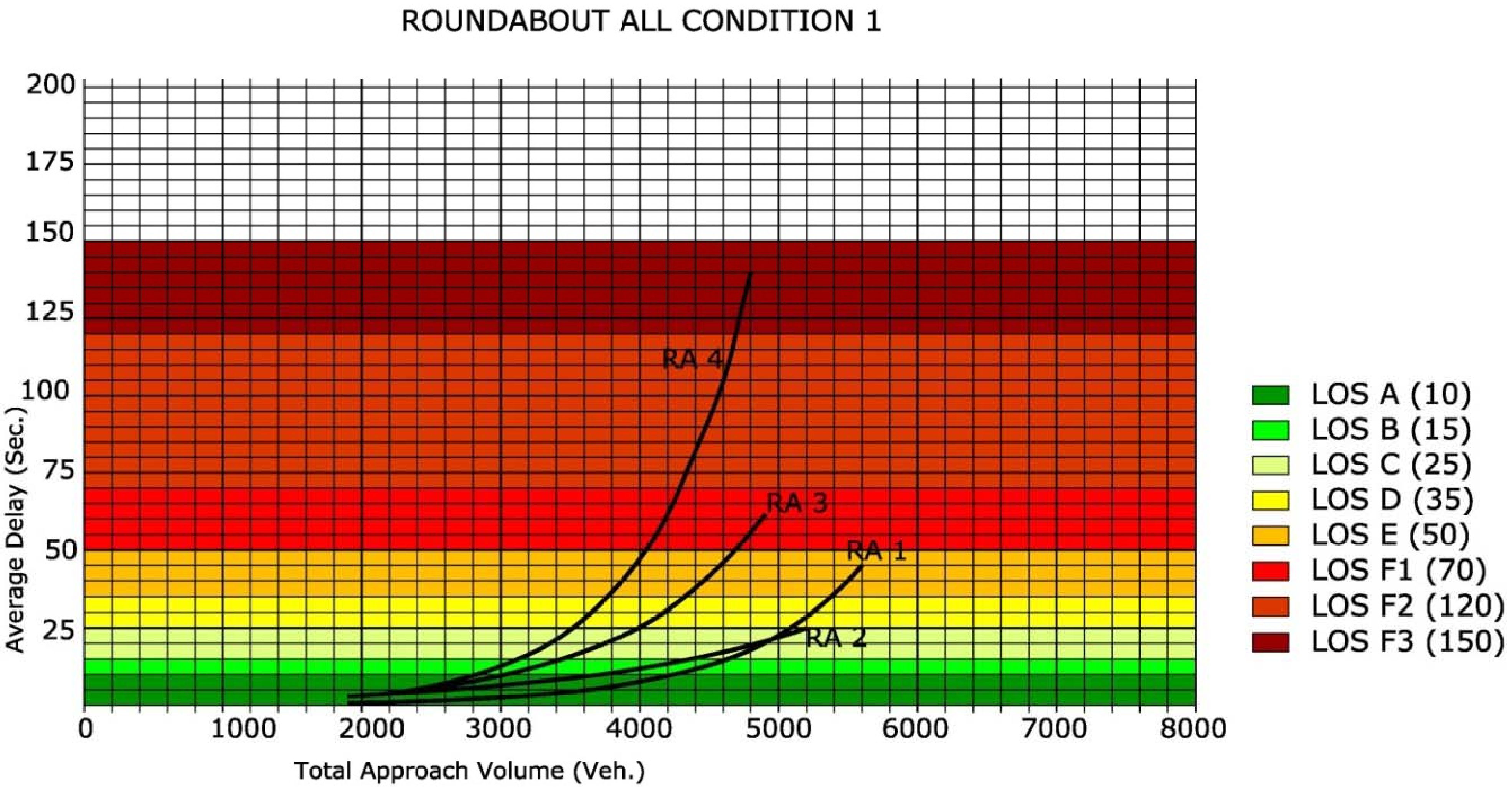


German Highway Capacity Manual, (FGSV, 2001)

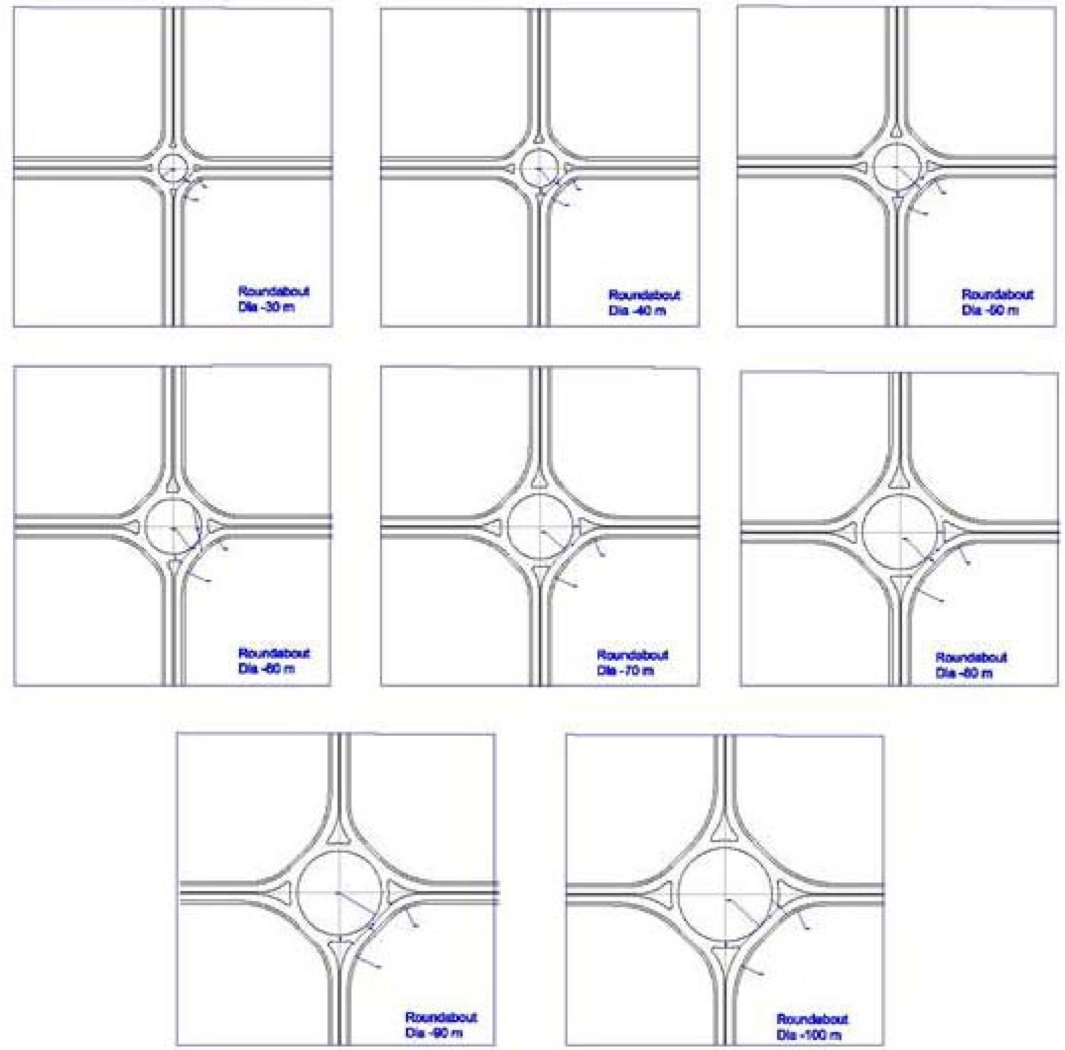


Akçelik, R. (2003)

Benchmarking Delay Model

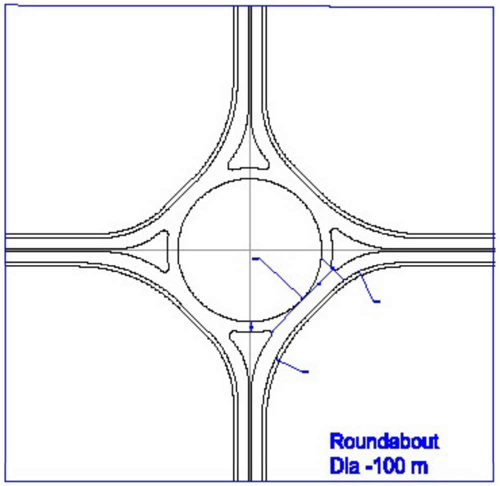


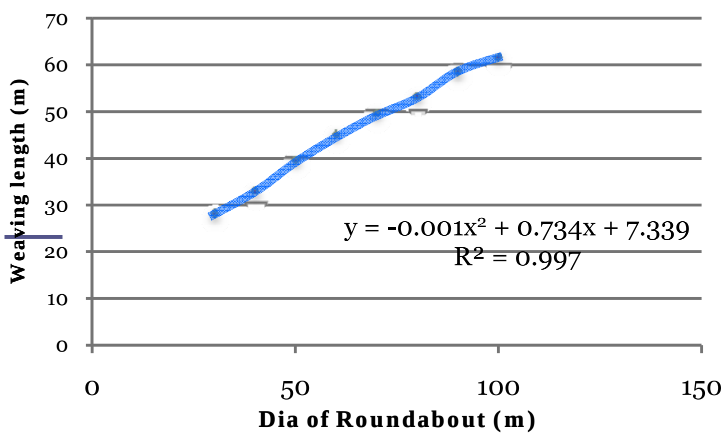
- weaving width = 3 lanes,
- non-weaving width = 2 lanes
- For particular diameter of roundabout, weaving length was found from the layout drawings of the roundabout.

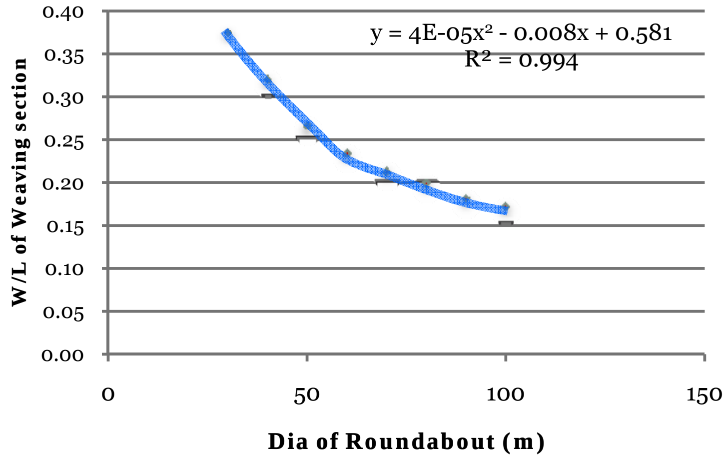


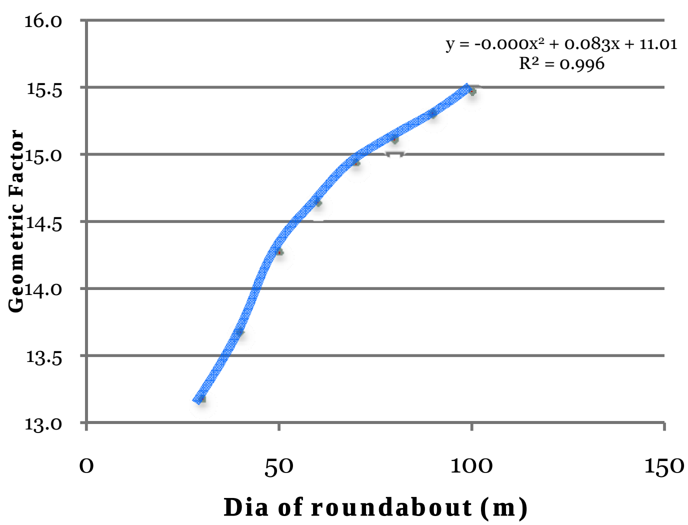
TYPE 1: ROUNDABOUT DIA RANGE 30 -100 M

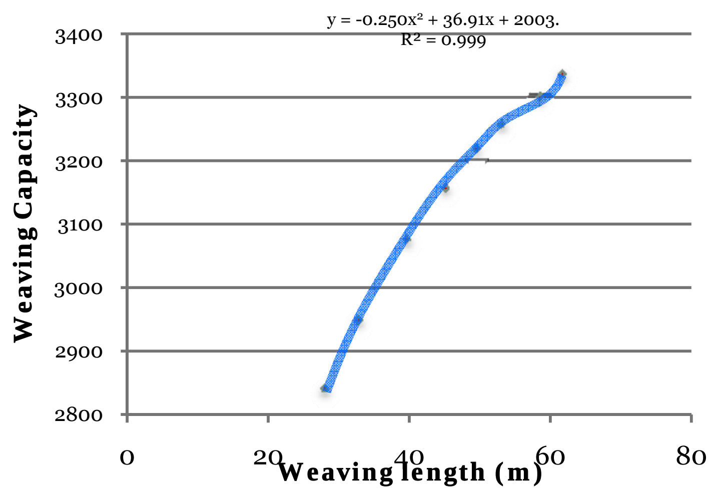
Relationship developed

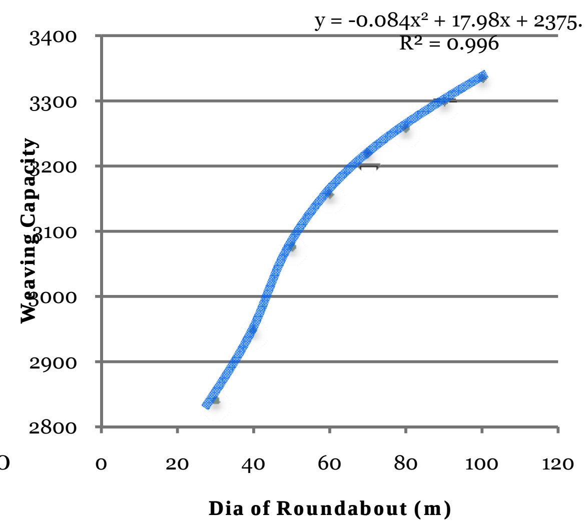








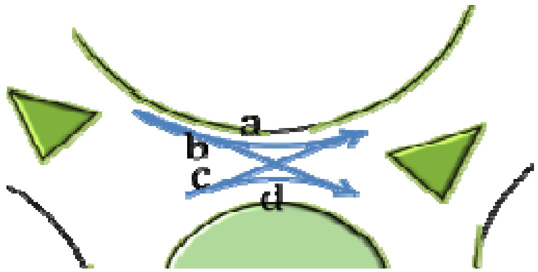




CVR (Conflicting Vehicle Ratio)

- It is the ratio of vehicles that weaves through the weaving section. It may be defined as the ratio of weaving traffic from the approach arm to the traffic exiting from weaving section. Mathematically it is defined as the ratio of ‘b’ and ‘c’.

$$CVR = \frac{b}{c}$$



b - weaving traffic from entry arm (straight + right + u)

c - Traffic coming from circulating section moving towards exit arm of weaving section.

If ‘b/c’ is less or large, weaving traffic may find the gap. However it may be true for certain range of ‘b’ and ‘c’.

WFI (Weaving Flux Intensity)…1

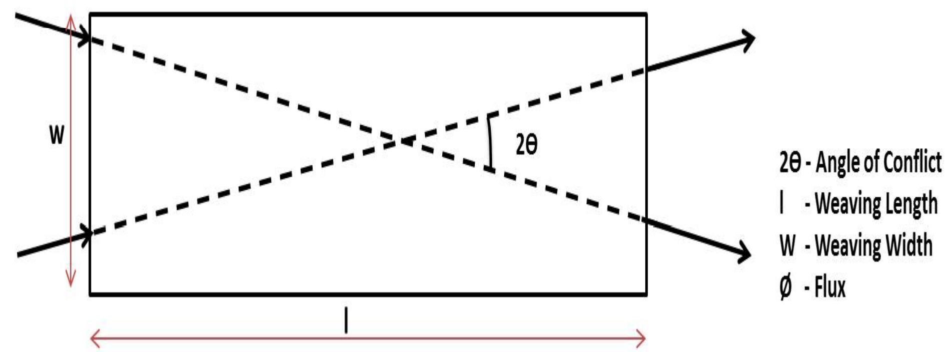
$$Weaving\ Flux\ Intensity = \frac{Vehicle\ flow\ at\ weaving\ section\ per\ hour}{Area\ of\ Weaving\ Section}$$

This concept of Weaving Flux Intensity is derived from the Electric Flux.

$$\emptyset = \sum E ds\ Cos\ \Theta\ = EA\ Cos\Theta$$

$$(for\ uniform\ area\ of\ cross\ section)$$

E – Electric field intensity
A – Area of Cross section
Θ – Angle between electric field intensity and area vector (perpendicular to cross sectional area)



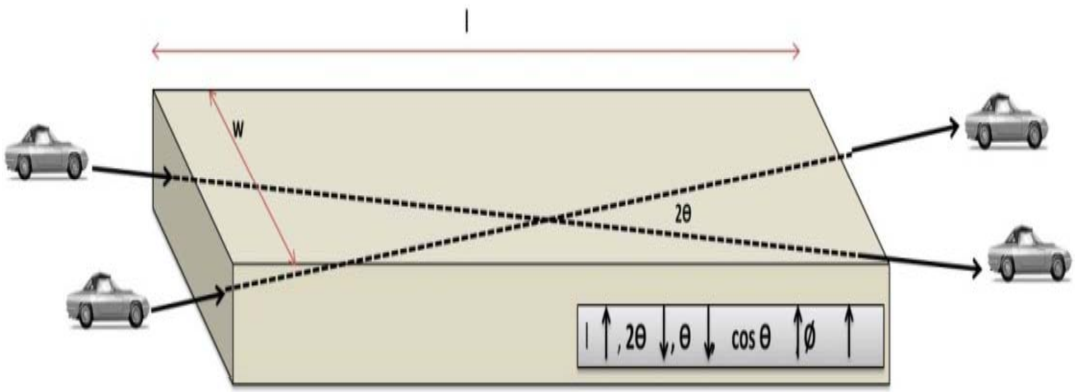
$$\emptyset = E\ A\ \cos\Theta\ ; \quad \text{where, } [A = w \times h,\ \cos\Theta = \frac{l}{l'}]$$

$$= \frac{E\ w\ l\ h}{l'}$$

$$= \frac{E\ A_w\ h}{l'} \quad ; \text{where, } [A_w = l \times w]$$

$$\text{Thus, } \emptyset\ \alpha\ \frac{A_w}{l'}$$

WFI (Weaving Flux Intensity)…1



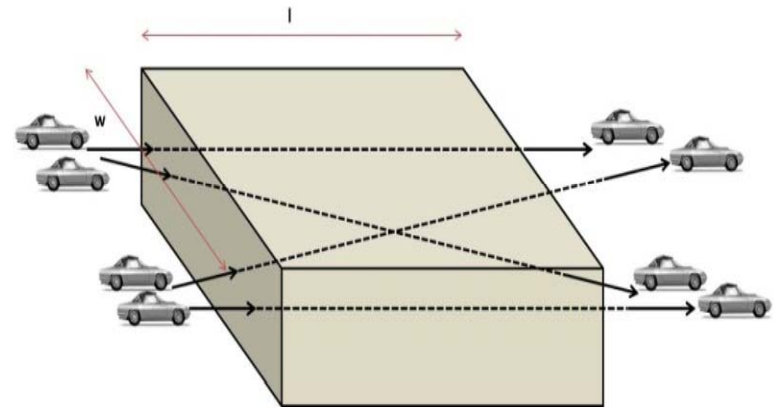


Illustration of Concept 1

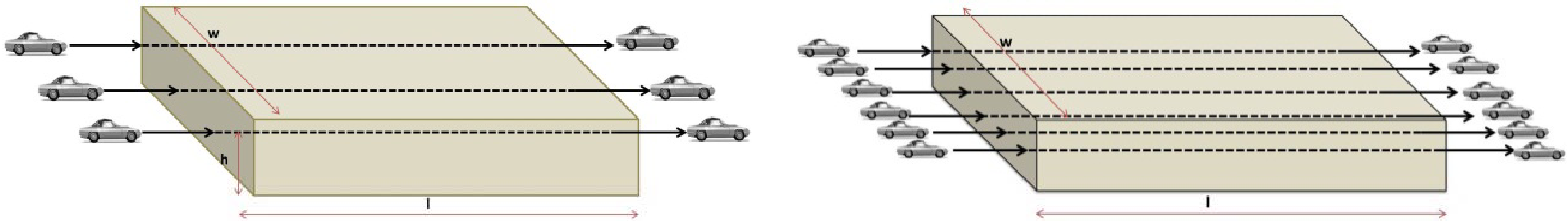
$l = 40$ m	$l = 60$ m
$w = 10$ m	$w = 10$ m
$l' = \sqrt{(w^2 + l^2)}$	$l' = \sqrt{(w^2 + l^2)}$
$l' = \sqrt{(1600 + 100)}$	$l' = \sqrt{(3600 + 100)}$
$l' = 41.231$ m	$l' = 60.082$ m
$A_w = l \times w = 400\ m^2$	$A_w = l \times w = 600\ m^2$
$A_w/l' = 400/41.231 = 9.70$	$A_w/l' = 600/60.082 = 9.986$

Illustration of Concept 2:

$l = 40$ m	$l = 40$ m
$w = 10$ m	$w = 15$ m
$l' = \sqrt{(w^2 + e^2)}$	$l' = \sqrt{(w^2 + e^2)}$
$l' = \sqrt{(1600 + 100)}$	$l' = \sqrt{(1600 + 225)}$
$l' = 41.231$ m	$l' = 42.72$ m
$A_w = l \times w = 400\ m^2$	$A_w = l \times w = 40 \times 15 = 600\ m^2$
$A_w/l' = 400/41.231 = 9.70$	$A_w/l' = 600/42.72 = 14.05$

within certain range, increase in 'w' results in more increase in A_w /l and thus relatively more increase in vehicular flux

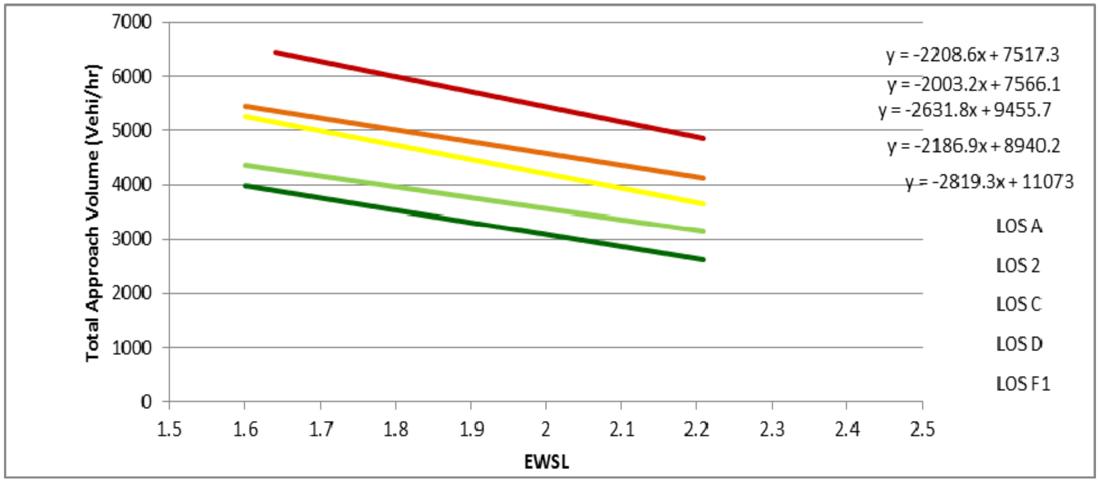
WFI (Weaving Flux Intensity)…2

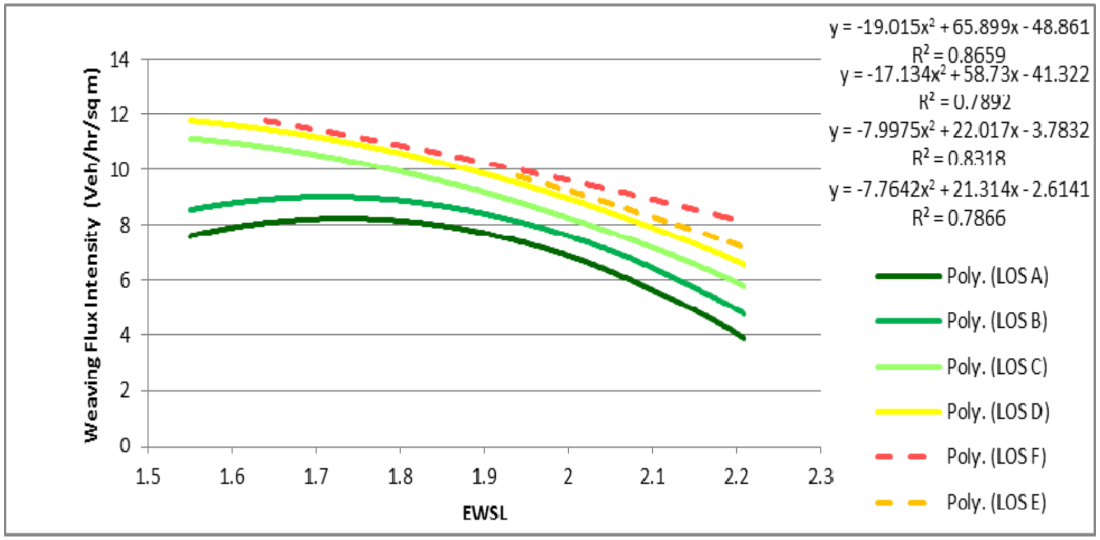


•Increase of vehicular intensity also results in increase of vehicular flux.

• Vehicular flux is maximum when vehicles do not weave but it is only theoretical and not practical because basic role of weaving section is to provide merging and diverging .

DEVELOPEMENT OF INTER RELATIONSHIP ..1

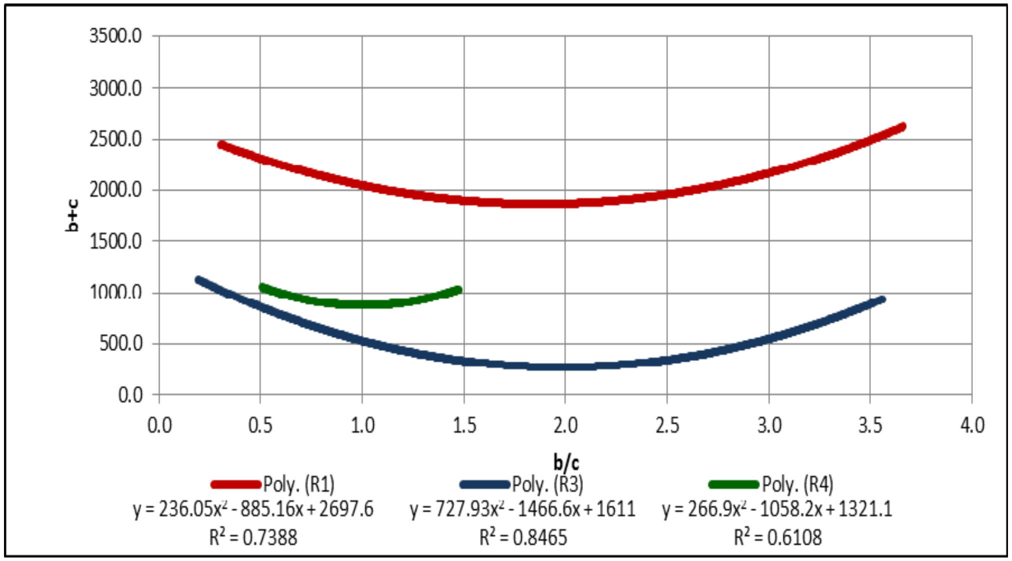


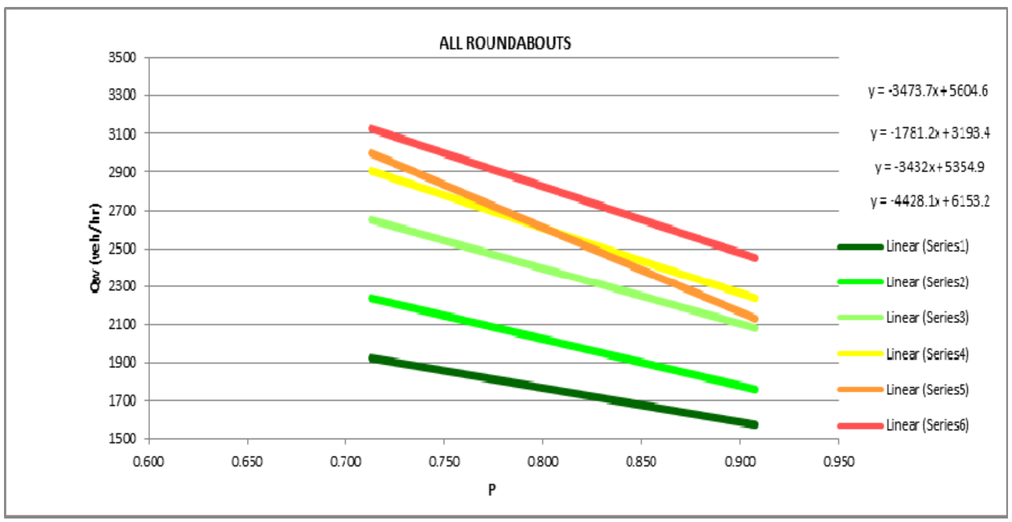


As EWSL increases, total approach volume handled by roundabout decreases at all level of service. However this decrease has more gradient at LOS E and F1.

As EWSL increases, WFI decreases. WFI is more at lower value of EWSL.

DEVELOPEMENT OF INTER RELATIONSHIP ..2





(b+c) is minimum for a particular value of b/c. The relationship is quadratic for all the roundabouts. However the minima of the function is different for different roundabout.

As proportion of weaving traffic increases, flow at weaving section decreases at all level of service but the slope of the graph keeps increasing from level of service A to level of service F.

THANK YOU