COMPREHENSIVE TRAFFIC AND TRANSPORTATION STUDY FOR PORT BLAIR AND ENVIRONS

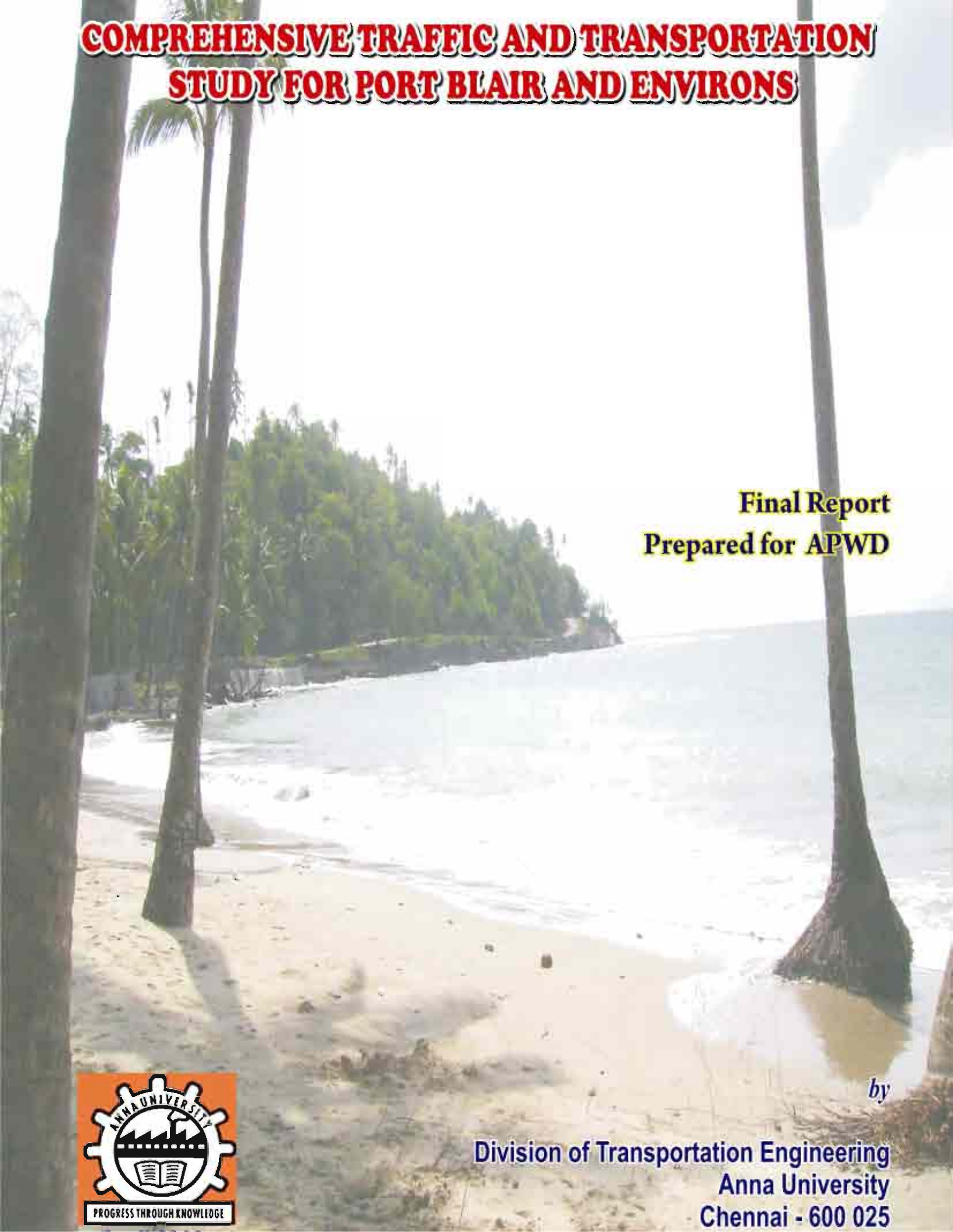

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Table of Contents

Chapter No	Contents		Page No
1	**Introduction**		
	1.1	Introduction	1
	1.2	Objective of the Study	2
	1.3	Scope of Services	2
	1.4	Output of the Study	3
	1.5	Need for the Study	5
2	**Port Blair and Its Environment**		
	2.1	Transport Scenario in Port Blair	8
	2.2	Modal Split	8
	2.3	Population in Port Blair and its Environs	10
3	**Household Characteristics**		
	3.1	Household Survey	13
	3.2	Vehicle Ownership	14
	3.3	Tele-Communication	14
	3.4	Household Distribution and Accessibility to Bus	15
	3.5	Income Wise Household distributions	16
	3.6	Income Vs Mode Choice	16
	3.7	Average Trip Length and the Mode Used	19
	3.8	Age Wise Trip Rate	20
	3.9	Mode Wise Trip Rate	21
	3.10	Household and Trip Rate	22
4	**Vehicle Population**		24
5	**Origin and Destination Study**		
	5.1	Zone Delineation	28
	5.2	Origin and Destination Study	28
6	**Speed Delay Studies**		
		6.1 Journey Speed	36
		6.2 Speed-Flow Relationship	38
7	**Intersection Studies**		
	7.0	Introduction	40
	7.1	Dairy farm Junction	40
	7.2	Hayat Singh Junction	41
	7.3	Bangla School Junction	42
	7.4	Secretariat Junction	43
	7.5	IP & T Junction	44
	7.6	Raj Nivas Junction	45
	7.7	Model School Junction	46
	7.8	Goalghar Junction	47

	7.9	Bengali Club Junction	48
	7.10	Light House Junction	49
	7.11	Delanipur Junction	50
	7.12	Haddo Junction	51
	7.13	Chattam Junction	52
	7.14	Clock Tower Junction	53
	7.15	Bathubasthi Junction	54
8	**Parking Studies**		58
9	**Intermediate Public Transport**		
	9.1	**Driver Characteristics**	62
	9.1.1	Age Distribution	62
	9.1.2	Educational Qualification	62
	9.1.3	Driving Experience	62
	9.1.4	Vehicle Ownership	62
	9.1.5	Average Monthly Income of Drivers	63
	9.2	**Operational Characteristics**	63
	9.2.1	Performance per Day	63
	9.2.2	Distance Operated in a Day	64
	9.2.3	Passenger Pickup Points	64
	9.2.4	Average Dead Kilometer	64
	9.2.5	Usage of IPT Mode	65
	9.2.6	Hire Charge	65
	9.2.7	Fuel Expenditure / Day	65
	9.2.8	Traffic Violation	66
10	**Bus Transport System in Port Blair & its Environs**		
	10.1	Introduction in Bus Transport System in Port Blair & its Environs	67
	10.2	Existing Bus Transport Scenario	67
11	**Accident Analysis**		
		11.0 Accident Scenario	71
12	**Freight Transport in Port Blair & Environs**		
	12.1	Introduction	73
	12.2	Vehicle Characteristics	73
	12.3	Operating Characteristics	74
	12.4	Findings and Conclusions	77
13	**Road Engineering**		
	13.1	**General**	78
	13.2	**Quality Evaluation of Materials and Specifications**	78
	13.2.1	Evaluation of Granular Materials	78
	13.2.2	Evaluation of Materials in Bituminous Layers	80
	13.2.3	Test Pits Evaluation	82
	13.2.4	Observations from Material Evaluation	82

	13.3	**Pavement Surface Quality Evaluation**	83
	13.4	**Design**	84
	13.4.1	General	84
	13.4.2	Soil Investigations	85
	13.4.3	Traffic Surveys	85
	13.4.4	Checking the thickness adequacy of existing pavements	86
	13.4.5	Observations from design checking of flexible pavements	87
	13.4.6	Typical design for cement concrete pavement	89
	13.4.7	Typical design for bituminous pavement	95
	13.5	**Maintenance Management System**	95
	13.5.1	General	95
	13.5.2	Present status of maintenance in Andaman	96
	13.5.3	Discussion on pavement condition	97
	13.6	Concluding remarks	101
	13.7	Recommendations	103
14	**Trip Generation And Trip Distribution**		
	14.1	Introduction	104
	14.2	Interactions between sectors	104
	14.3	Future Population Forecast	107
	14.3.1	Conventional Method of Population Projection	107
	14.3.2	System Dynamics Population Model	108
	14.4	Proposed Land Use Changes	113
	14.5	Trip Generation	115
	14.6	Trip Distribution	117
15		**Proposals**	
	15.1	Intersection Improvements	119
	15.2	LOS- Level of Service	119
	15.3	Accident At Intersections	120
	15.4	Improvement Measures Proposed	122
	15.5	Signal Design	123
	15.6	Grade Separator Design	128
	15.6.1	Bengali Club Junction	128
	15.6.2	Light House Intersection	136
	15.6.3	Goalghar Intersection	141
	15.6.4	Delanipur Intersection	147
	15.7	Conclusion	149
	15.8	Parking	149
	15.9	Installation of Traffic Signs	150
16		**Road Network Capacity and Traffic Assignment**	
	16.1	Introduction	157
	16.2	Existing Scenario	157
	16.3	Proposed Road Network Enhancements	160

	16.4	Conclusion	177
17		**Mass Transportation Planning**	
	17.1	Introduction	178
	17.2	Mass Transport Planning	178
	17.3	Mode Choice Model Building	179
	17.3.1	Utility Function Trip Purpose Wise	181
	17.4	Identification of Mass Transportation Route	183
	17.5	Route Evaluation	187
	17.6	Cost Benefit Analysis	191
	17.7	Environmental Benefits	192
	17.8	Planning of New Terminal	194
	17.9	Environmental Friendly Shuttle Service	195
18		**Findings and Recommendations**	
	18.1	Existing Transportation Scenario	197
	18.2	Proposals	199
	18.2.1	Intersection Improvements	199
	18.2.2	Parking Facility	199
	18.2.3	Road Engineering	200
	18.2.4	Safety Enhancements	200
	18.2.5	Proposed Road Network Enhancement	200
	18.2.6	Freight Planning	201
	18.2.7	Mass Transport Planning	201
	18.2.8	Cost and Phasing	202

List of Figures

Figure No	Titles	Page No
1.1	Port Blair and Settlements in its Environs	6
1.2	Study methodology	7
2.1	Model Share Buses in Port Blair	9
2.2	Model Share – Port Blair Environs	9
2.3	Decadal Growth Rate of Population in Port Blair and its Environs	10
3.1	HH Distribution By size (In Percentage)	13
3.2	HH Distribution by Accessibility to Bus Transport (Time)	15
3.3	HH Distribution by Accessibility to Bus Transport (Distance)	16
3.4	HH Distribution by Monthly Income (In Percentage)	16
3.5	Mode of Travel and Monthly Income (All Purposes)	17
3.6	Mode of Travel and Monthly Income (All Purposes)	17
3.7	Mode of Travel and Monthly Income (Work Purposes)	18
3.8	Mode of Travel and Monthly Income (Work Purposes)	18
3.9	Mode of Travel and Monthly Income (Other Purposes)	19
3.10	Mode of Travel and Monthly Income (Other Purposes)	19
3.11	House hold and Age Wise Trip Rate	21
3.12	House hold and Sex Wise Trip Rate	21
3.13	House hold and Mode Wise Trip Rate	22
3.14	House hold and Purpose Wise Trip Rate	23
3.15	House hold and Distance Wise Trip Rate	23
4.1	Growth of Vehicle Population in Port Blair	26
4.2	Composition Wise Vehicle Registration Trend	26
5.1	Delineation of Study Boundary	29
5.2	Inner Cordon, Outer Cordon and Screen line Location for OD Survey	31
5.3	Volume of Traffic entering and leaving the study area	32
5.4	Desire Line Diagram of trips from and to environs from Port Blair Municipal Area	33
5.5	Desire Line Diagram of trips in environs excluding Port Blair Municipal Area	35
5.6	Desire line diagram – Inner cordon	35
6.1	Journey Speeds at road in Port Blair and Its Environs	38
6.2	Speed-Flow relationship	38
6.3	Peak Hour Volume on all Major Road in Port Blair	39
6.4	Peak Hour Volume on all Major Road in Port Blair and Environs	39
7.1	Major Junction in Port Blair	40
7.2 (a)	Flow in each arm at peak Hour	41
7.2 (b)	Vehicle composition (Dairy farm Junction)	41
7.2 (c)	Hourly variation (Dairy farm Junction)	41

7.3 (a)	Flow in each arm at peak Hour	42
7.3 (b)	Vehicle composition (Hyat Singh Junction)	42
7.3 (c)	Hourly variation (Hyat Singh Junction)	42
7.4 (a)	Flow in each arm at peak Hour	43
7.4 (b)	Vehicle composition (Bangla School Junction	43
7.4 (c)	Hourly variation (Bangla School Junction)	43
7.5 (a)	Flow in each arm at peak Hour	44
7.5 (b)	Vehicle Composition (Secretariat Junction)	44
7.5 (c)	Hourly Variation (Secretariat Junction)	44
7.6 (a)	Flow in each arm at peak Hour	45
7.6 (b)	Vehicle Composition (IP & T Junction)	45
7.6 (c)	Hourly Variation (IP & T Junction)	45
7.7 (a)	Flow in each arm at peak Hour	46
7.7 (b)	Vehicle Composition (Raja Niwas Junction)	46
7.7 (c)	Hourly Variation (Raja Niwas Junction)	46
7.8 (a)	Flow in each arm at peak Hour	47
7.8 (b)	Vehicle Composition (Model School Junction)	47
7.8 (c)	Hourly Variation (Model School Junction)	47
7.9 (a)	Flow in each arm at peak Hour	48
7.9 (b)	Vehicle Composition (Goalghar Junction)	48
7.9 (c)	Hourly Variation (Goalghar Junction)	48
7.10 (a)	Flow in each arm at peak Hour	49
7.10 (b)	Vehicle Composition (Bengali Club Junction)	49
7.10 (c)	Hourly Variation (Bengali Club Junction)	49
7.11 (a)	Flow in each arm at peak Hour	50
7.11 (b)	Vehicle Composition (Light House Junction)	50
7.11 (c)	Hourly Variation (Light House Junction)	50
7.12 (a)	Flow in each arm at peak Hour	51
7.12 (b)	Vehicle Composition (Delanipur Junction)	51
7.12 (c)	Hourly Variation (Delanipur Junction)	51
7.13 (a)	Flow in each arm at peak Hour	52
7.13 (b)	Vehicle Composition (Haddo Junction)	52
7.13 (c)	Hourly Variation (Haddo Junction)	52
7.14 (a)	Flow in each arm at peak Hour	53
7.14 (b)	Vehicle Composition (Chattam Junction)	53
7.14 (c)	Hourly Variation (Chattam Junction)	53
7.15 (a)	Flow in each arm at peak Hour	54
7.15 (b)	Vehicle Composition (Clock Tower Junction)	54
7.15 (c)	Hourly Variation (Clock Tower Junction)	54
7.16 (a)	Flow in each arm at peak Hour	55
7.16 (b)	Vehicle Composition (Bathubasthi Junction)	55
7.16 (c)	Hourly Variation (Bathubasthi Junction)	55
8.1	On Street Parking on the Major Roads in CBD	59
8.2	Parking Study Stretches	59
8.3	Parking Accumulation – Bengali Club to Goalghar	60
8.4	Parking Duration – Bengali Club to Goalghar	60

11.1	Accident Analysis for Port Blair	71
11.2	Accident Victims during 2004-2006	72
11.3	Category of Vehicles Involvement in Accidents	72
13.1	Ravelling in Stretch S1	98
13.2	Ravelling in Stretch S2	98
13.3	Cracks in Stretch S3	99
13.4	Patch in Stretch S4	99
13.5	Cracks in Stretch S5	99
13.6	Pothole in Stretch S6	99
13.7	Ravelling in Stretch S7	99
13.8	Patches in Stretch S8	99
13.9	Patches in Stretch S9	100
13.10	Ravelling in Stretch S11	100
13.11	Pothole in Stretch S12	100
13.12	Pothole filled with water in Stretch S13	100
14.1	Delineation of Study Boundary	104
14.2	Concept of Interaction	106
14.3	Systems model for Population Projection	111
14.4	Population Growth Sector Wise	112
14.5	Typical Total Production and Total Attraction Output	117
15.1	Road Accidents at major Junctions – Port Blair	121
15.2	Accident Occurrence at Major Intersections	121
15.3	Proportion of Intersection Accidents in Port Blair (2003 – 2005)	122
15.4	Link – Wise Flow and Maximum queue Arm - Wise	124
15.5	Link Wise flow in the Network	124
15.6 (a)	Flow Profile in Hyat Singh to Bangla School Junction link	125
15.6 (b)	Flow Profile in Bangla Schools to Secretariat Link	125
15.6 (c)	Flow Profile in Secretariat to IP&T Link	125
15.6 (d)	Flow Profile in IP&T to Raja Nivas Link	126
15.7 (a)	Flow Profile in Goalghar to Bengali Club Link	126
15.7 (b)	Flow Profile in Bengali Club to model school Link	126
15.7 (c)	Flow Profile along Model School to Clock Tower	127
15.8 (a)	Flow Profile along Delanipur to Light House	127
15.8 (b)	Flow Profile along Light House to Clock Towers	127
15.9 (a)	Flow Profile along Hyat Singh to Goalghar	128
15.9 (b)	Flow Profile in Goalghar to Delanipur	128
15.10	Topography of the Road Network Surrounding Bengali Club Junction	129
15.11	Traffic flow at Bengali Club Junction during Morning Peak	129
15.12 (a)	Layout of the Proposed Grade Separator at Bengali Club Intersection (PROPOSAL 1)	131
15.12 (b)	Layout of the Proposed Grade separator at Bengali Club Intersection (PROPOSAL 2)	131

15.12 (c)	Layout of the Proposed Grade separator at Bengali Club Intersection (PROPOSAL 3)	132
15.12 (d)	Layout of the Proposed Grade separator at Bengali Club Intersection (PROPOSAL 4)	132
15.13 (a)	Conflicts in and around Bengali Club Junction for Existing Condition	133
15.13 (b)	Conflicts in and around Bengali Club Junction for the PROPOSAL 1	134
15.13 (c)	Conflicts in and around Bengali Club Junction for the PROPOSAL 2	134
15.13 (d)	Conflicts in and around Bengali Club Junction for the PROPOSAL 3	135
15.13 (e)	Conflicts in and around Bengali Club Junction for the PROPOSAL 4	135
15.14	Traffic flow at Light House Junction during Morning Peak	137
15.15 (a)	Layout of the Proposed Grade Separator at Light House Intersection (PROPOSAL 1)	138
15.15 (b)	Layout of the Proposed Grade Separator at Light House Intersection (PROPOSAL 2)	138
15.16 (a)	Conflicts at light House Intersection for the existing condition	139
15.16 (b)	Conflicts in and around Light House Junction for the PROPOSAL 1	139
15.16 (c)	Conflicts at Light House Junction for the PROPOSAL 2	140
15.17 (a)	Traffic flow at Goalghar Junction during Evening Peak	141
15.17 (b)	Topography of the Goalghar Junction	141
15.18(a)	Layout of the proposed Grade separator at Goalghar Intersection (PROPOSAL 1)	142
15.18 (b)	Layout of the proposed Grade separator at Goalghar Intersection (PROPOSAL 2)	142
15.18 (c)	Layout of the proposed Grade separator at Goalghar Intersection (PROPOSAL 3)	143
15.18 (d)	Layout of the proposed Grade separator at Goalghar Intersection (PROPOSAL 4)	143
15.19 (a)	Conflicts at Goalghar Junction for the Existing condition	144
15.19 (b)	Conflicts at Goalghar Junction for the PROPOSAL 1	144
15.19 (c)	Conflicts at Goalghar Junction for the PROPOSAL 2	145
15.19 (d)	Conflicts at Goalghar Junction for the PROPOSAL 3	145
15.19 (e)	Conflicts at Goalghar Junction for the PROPOSAL 4	146
15.20	Layout of the proposed Grade separator at Delanipur Intersection (PROPOSAL 1)	148
15.21	Proposed Parking Layout near Light House Junction	151
15.22	Proposed Parking Layout behind Clock Tower Junction	152
15.23	Proposed Parking Layout at Junglighat	153
15.24 (a)	Multi- storeyed Parking Lot near Stadium (Basement Floor Plan)	154

15.24 (b)	Multi- storeyed Parking Lot near Stadium (First Floor Plan)	155
15.24 (c)	Multi- storeyed Parking Lot near Stadium (Top Floor Plan)	156
16.1	Relationship between V/C ratio and Speed	157
16.2	V/C Ratio of the Major roads in study area for Morning Peak hour (2007)	158
16.3	V/C Ratio of the Major roads in Port Blair Town for Morning Peak hour (2007)	158
16.4	V/C Ratio of the Major roads in the study area for Evening Peak hour (2007)	159
16.5	V/C Ratio of the Major roads in Port Blair Town for Evening Peak hour (2007)	159
16.6	Proposed Developments as per Master Plan of Port Blair	161
16.7	Expected V/C ratio of the Major roads in the study area in 2027(Scenario I)	161
16.8	Expected V/C ratio of the Major roads in Port Blair in 2027 (Scenario I)	162
16.9	Cross Section of the Proposed Carriage way along Marine Drive	163
16.10	The Proposed Marine Drive Phase I and Phase II	164
16.11	V/C ratio of the Major roads in 2027 on Introduction of Marine Drive Phase – I	164
16.12	V/C ratio for major roads in 2027 on Introduction of Marine Drive Phase I & II	165
16.13	Proposed Marine Drive and New Links	166
16.14	Scenario 4- Introduction of Missing Links	166
16.15	Proposed Connectivity to Babu Lane and Traffic Movement in Adjoining Area	168
16.16	Expected V/C ratio in 2027 after Introduction of Missing Links	171
16.17	Scenario 5- Partial One-way System	171
16.18	Expected V/C ratio in 2027 after Introduction of Partial One-way	172
16.19	Scenario 6 - One-way System	172
16.20	Expected V/C Ratio in 2027 after Introduction of One way system	173
16.21	Scenario 7- Road Widening of Stretch to 4 Lanes	173
16.22	Expected V/C Ratio in 2027 after Widening of Stretch to 4 Lanes	174
16.23	Proposed Road Widening and New Roads	
16.24	Proposed Mass Transportation Alignments, Bus and Truck Terminals	175
17.1	Methodology for Route Evaluation	178
17.2	Logit Model Structure	179
17.3	Proposed Mass Transport Corridor – Route 1	184
17.4	Proposed Mass Transport Corridor – Route 2	185
17.5	Proposed Mass Transport Corridor – Route 3	185
17.6	Proposed Mass Transport Corridor – Route 4	186
17.6	Proposed Mass Transport Corridor – Route 5	186
17.8	Patronage Bar Chart for Each Stop Node for Route 5 (Chattam–Garacharma)	188

17.9	Load Profile for Route 5 (Chattam – Garacharma)	188
17.10	Passenger Load Chart for Route 5 (Garacharma - Chattam)	189
17.11	Load Profile for Route 5 (Garacharma - Chattam)	189
17.12	Proposed Mass Transport Corridor Route 5 – Phase II	190
17.13	Expected V/C ratio on Major Roads after Introduction of Mass Transport	191
17.14	Expected V/C ratio on Major Roads in Port Blair Town after Introduction of Mass Transport	191
17.15	Environmental Friendly Shuttle Service	195
	Annexure A	
A1	Peak Hour Traffic Flow - Chatham Junction	203
A2	Peak Hour Traffic Flow – Haddo Junction	203
A3	Peak Hour Traffic Flow - Delanipur Junction	204
A4	Peak Hour Traffic Flow - Goalghar Junction	204
A5	Peak Hour Traffic Flow – Bengali Club Junction	205
A6	Peak Hour Traffic Flow – Light House Junction	205
A7	Peak Hour Traffic Flow - Secretariat Junction	206
A8	Peak Hour Traffic Flow – Bangla School Junction	206
A9	Peak Hour Traffic Flow – Hyat Singh Junction	207
A10	Peak Hour Traffic Flow – Dairy Farm Junction	207
A11	Peak Hour Traffic Flow – IP & T Junction	208
A12	Peak Hour Traffic Flow – Raj Nivas Junction	208
A13	Peak Hour Traffic Flow – Model School Junction	209
A14	Peak Hour Traffic Flow – Clock Tower Junction	209
A15	Peak Hour Traffic Flow – Bathubasthi Junction	210
	Annexure C	
C1	Phasing Diagram for Chatham Junction	221
C2	Timing Diagram for Chatham Junction	221
C3	Phasing Diagram for Haddo Junction	221
C4	Timing Diagram for Haddo Junction	221
C5	Phasing Diagram for Delanipur Junction	222
C6	Timing Diagram for Delanipur Junction	222
C7	Phasing Diagram for Goalghar Junction	222
C8	Timing Diagram for Goalghar Junction	222
C9	Phasing Diagram for Bengali Club Junction	223
C10	Timing Diagram for Bengali Club Junction	223
C11	Phasing Diagram for Light House Junction	223
C12	Timing Diagram for Light House Junction	223
C13	Phasing Diagram for Secretariat Junction	224
C14	Timing Diagram for Secretariat Junction	224
C15	Phasing Diagram for Bangla School Junction	224
C16	Timing Diagram for Bangla School Junction	224
C17	Phasing Diagram for Hyat Singh Junction	225
C18	Timing Diagram for Hyat Singh Junction	225
C19	Phasing Diagram for Diary Form Junction	225

C20	Timing Diagram for Diary Form Junction	225
C21	Phasing Diagram for IP&T Junction	226
C22	Timing Diagram for IP&T Junction	226
C23	Phasing Diagram for Raj Nivas Junction	226
C24	Timing Diagram for Raj Nivas Junction	226
C25	Phasing Diagram for Model School Junction	227
C26	Timing Diagram for Model School Junction	227
C27	Phasing Diagram for Clock Tower Junction	227
C28	Timing Diagram for Clock Tower Junction	227
C29	Phasing Diagram for Bathubasthi Junction	228
C30	Timing Diagram for Bathubasthi Junction	228
	Annexure D	
D1	Traffic Signs for Movement Regulations	229
D2	Traffic Signs indicating suitable Driver Actions	230
D3	Traffic Signs indicating Curves	230
D4	Traffic Signs at School Zones and at Pedestrian Crossings	231
D5	Traffic Signs indicating Junction Type ahead	231
D6	Typical Information Signs	232

List of Tables

Table No	Titles	Page no
2.1	Modal Share of Trips in Port Blair	9
2.2	Modal Share of trips in Port Blair Environs	9
2.3	Port Blair – Population Growth	10
2.4	Population Growth in Port Blair and its Environs	11
2.5	Birth rate of population in A & N Islands	12
2.6	Death rate of population in A & N Islands	12
2.7	Migration pattern in A & N Islands	12
3.1	Total households Interviewed	13
3.2	Household Distribution By size	13
3.3	Vehicle Ownership (in Percentage)	14
3.4	Vehicle Ownership	14
3.5	Household Distribution by Telecommunication Facility	14
3.6	Household Accessibility to Bus Transport (Time)	15
3.7	Household Accessibility to Bus Transport (Distance)	15
3.8	Household Monthly Income	16
3.9	Trip Distribution With Respect To Mode and Monthly Income for All Purpose	17
3.10	Work Trip Distribution With Respect to Mode and Monthly Income	18
3.11	Other Purpose Trip Distribution Mode and Monthly Income Wise	19
3.12	Trip Length Mode Wise	19
3.13	Trip length Purpose Wise	20
3.14	Age wise trip Rate	20
3.15	Sex wise Trip Rate	21
3.16	House hold and Mode Wise Trip Rate	22
3.17	House hold and Purpose Wise Trip Rate	22
3.18	House hold and Distance wise Trip Rate	23
3.19	Monthly income Wise Trip Rate	23
4.1	Vehicular Population	27
5.1	Person Trip Matrix	30
5.2	Vehicle Trip in PCU's (Road Side Interview)	34
6.1	Journey Speed of Roads in Port Blair Municipal area	37
6.2	Journey Speeds of Roads in Environs (Outside Port Blair)	37
7.1	Traffic Flow Characteristics at Junctions	56
8.1	Parking Stretches in Port Blair	58
9.1	Age Wise Distribution of Auto rickshaw Drivers	62
9.2	Educational Qualification of Driver	62
9.3	Driving Experience	63
9.4	Ownership Details	63
9.5	Monthly Income	63
9.6	Trips Performed per day	63

9.7	Average Distance covered per day	64
9.8	Passenger Pickup points	64
9.9	Average dead km/day	65
9.10	Usage of IPT mode in peak hour	65
9.11	Hire charges/day	65
9.12	Fuel Expenditure per Day	66
9.13	Traffic Violation Record	66
9.14	Reasons for Traffic Violation	66
10.1	Bus transport Statistic for year 2002-2006	67
10.2	Passenger Travel Characteristics	68
10.3	Bus Operational Characteristics (2002 - 2006)	68
10.4	Existing Bus Service operation	69
10.5	Peak Hour & Off Peak Hour Crowding in Buses	70
11.1	Accident during the year 2003 to 2005 in Port Blair	71
11.2	Vehicles involved in Accidents Category wise (2003-2005)	72
12.1	Type of Parking	74
12.2	Type of commodities carried	74
12.3	No of days operated in a month	75
12.4	Fare Structure	75
12.5	Average Distance Covered per day	76
12.6	Operational Characteristics	76
12.7	Average maintenance cost per month	76
12.8	Trip Purpose of LCV	77
13.1	Test results of samples collected from granular base	79
13.2	Test results of samples collected from bituminous base	81
13.3	Test results of samples collected from surface course	81
13.4	Roughness values on study stretches	83
13.5	Test results of samples collected from subgrade	85
13.6	Traffic Loading Details	86
13.7	Composition of Existing Pavements	87
13.8	Present and Future Projected Traffic Loading	88
13.9	Pavement thickness required for present and future traffic	88
13.10	Design requirements of pavement composition	95
13.11	Intervention levels for primary roads	96
13.12	Intervention levels for secondary roads	97
13.13	Intervention levels for urban roads	97
13.13	Pavement condition details	98
14.1	Southern Sector	105
14.2	Southwestern Sector	105
14.3	North Western Sector	105
14.4	North Sector	105
14.5	Port Blair Sector	106
14.6	Population Projection by Arithmetic Increase Method	107
14.7	Population Projection by Geometric Increase Method	108
14.8	Population Projection by Incremental Increase Method	108
14.9	Migration Pattern in A & N Islands	110
14.10	2001 Population Sector wise	111

14.11	Total Population and Population Growth Sector-wise	112
14.12	Validation of Model	113
14.13	Existing Land Use Sector-wise	114
14.14	Proposed Land Use Sector-wise	114
14.15	Final Predicted Population	115
14.16	Current Person Trip Rate	116
14.17	Expected Sectoral Trip Rate in 2027	117
15.1	Peak Hour Traffic Flow on Major Intersections in Port Blair	119
15.2	LOS and Corresponding Range of Delay	120
15.3	Expected LOS and Delay for critical Junctions in Port Blair	121
15.4	Proposed improvement measures for the Major Intersections in Port Blair	124
15.5	Comparison of the proposals	136
15.6	Comparison of the proposals at Light House junction	140
15.7	Comparison of the proposals for Goalghar Junction	147
15.8	Comparison of the proposals	148
16.1	Existing V/C ratio on major road in Port Blair Town for Peak Hour	160
16.2	V/C Ratio on Major Roads in Port Blair Town for Scenarios 1, 2, 3 and 4	169
16.3	V/C Ratio on Major Roads in Port Blair Town for Scenarios 5, 6 & 7	170
16.4	Economical Comparison of Scenarios	177
16.5	Environmental Savings in each Scenario	177
17.1	Length and expected peak hour patronage	190
17.2	Data assumed in Discounted Cash flow Analysis	192
17.3	Emission load for various scenarios in CO, HC, NOX	194
18.1	Cost Estimate and Phasing of the Improvements	202
	Annexure B	
B1	Parking Accumulation - Aberdeen to Cellular Jail	211
B 2	Parking Duration - Aberdeen to Cellular Jail	211
B 3	Parking Accumulation - Bangla School To Hyat Singh	211
B 4	Parking Duration - Bangla School To Hyat Singh	212
B 5	Parking Accumulation - Bengali Club to Model School	212
B 6	Parking Duration - Bengali Club to Model School	212
B 7	Parking Accumulation - Bengali club To Goalghar	213
B 8	Parking Duration - Bengali Club to Goalghar	213
B 9	Parking Accumulation - Clock Tower to Aberbeen Jetty	213
B 10	Parking Duration - Clock Tower to Aberbeen Jetty	214
B 11	Parking Accumulation - Clock Tower to Cellular Jail	214
B 12	Parking Duration - Clock Tower to Cellular Jail	214
B 13	Parking Accumulation - Delanipur to Light House	214
B 14	Parking Duration - Delanipur to Light House	215
B 15	Parking Accumulation - Delanipur to Lilipur	215
B 16	Parking Duration - Delanipur to Lilipur	215
B 17	Parking Accumulation - Goalghar to Delanipur	216
B 18	Parking Duration - Goalghar to Delanipur	216

B 19	Parking Accumulation - Goalghar to Junglighat	216
B 20	Parking Duration - Goalghar to Junglighat	217
B 21	Parking Accumulation - Hyat Singh to Junglighat	217
B 22	Parking Duration - Hyat Singh to Junglighat	217
B 23	Parking Accumulation - Junglighat to Hyat Singh-	218
B 24	Parking Duration - Junglighat to Hyat Singh	218
B 25	Parking Accumulation - Light House to Clock tower	218
B 26	Parking Duration - Light House to Clock tower	219
B 27	Parking Accumulation - Lilipur to Haddo	219
B 28	Parking Duration - Lilipur to Haddo	219
B 29	Parking Accumulation - Model School to Nethaji Stadium	220
B 30	Parking Duration - Model School to Nethaji Stadium	220
B 31	Parking Accumulation - Annapoorna to Clock tower	220
B 32	Parking Duration - Annapoorna to Clock tower	220

List of Abbreviations

AIV	Aggregate Impact Value
AN	Andaman & Nicobar
APWD	Andaman Public Works Department
ATR	Andaman Trunk Road
BBD	Benkelman Beam Deflection
BM	Bituminous Macadam
BPM	Bituminous Penetration Macadam
CBD	Central Business District
CBR	California Bearing Ratio
CNG	Compressed Natural Gas
Co	Carbon Monoxide
CRMB	Crumb Rubber Modified Bitumen
CVPD	Commercial Vehicle Per Day
DBM	Dense Bituminous Macadam
DLC	Dry Lean Concrete
GPS	Global Positioning System
HC	Hydro Carbon
IPT	Intermediate Public Transport
IRC	Indian Roads Congress
IRR	Internal Rate of Return
IS	Indian Standards
LCV	Light Commercial Vehicle
LOS	Level of Service
LPG	Liquefied Petroleum Gas
LRT	Light Rail Transit
MoRTH	Ministry of Road Transport & Highways
MoSRT&H	Ministry of Shipping, Road Transport & Highways
msa	Million Standard Axle
MSS	Mix Seal Surfacing
NOx	Nitric Oxide
OD	Origin-Destination
PC	Premix Carpet
PCUs	Passenger Car Units
PM	Particulate Matter
PMB	Polymer Modified Bitumen
PWD	Public Works Department
ROW	Right Of Way
RTO	Regional Transport Office
SD	System Dynamics
SDBC	Semi Dense Bituminous Macadam
TOR	Terms Of Reference
TW	Two Wheeler
V/C	Ratio of Volume to Capacity
WBM	Wet Bituminous Macadam
WMM	Wet Mix Macadam

CHAPTER 1
INTRODUCTION

1.1 Introduction

The Andaman and Nicobar are a group of 572 Islands, islets, reefs and islet rocks in the Bay of Bengal extending from 6° North to 14° North Latitude and 92° East to 94° longitudes covering a geographical area of 8249 square kilometers. These islands are separated by a vast stretch of sea from the mainland and also separated by sea from each other and scattered over a length about 700 kms from Northern most point to the southern most point. The islands are divided into three districts i.e. South Andamans District, Middle and North Andamans District and Nicobars District separated by about 160 kms. Port Blair, the capital of the Union Territory, is the only town in the islands with an area of 17.74 sq. km. The population of Port Blair as per 1991 census was 74,955 and as per 2001 census it was 99,984. It is estimated that the present population will be in the order of about 1, 25,000. The topography is characterized by undulating terrain.

The Port Blair town is surrounded by sea on three sides i.e. North, East and West and therefore is growing linearly towards south only. The town is the administrative centre for both Civil and Defense functions and acts as the centre for receiving goods from the mainland for consumption for itself and for onward distribution to other parts of the territory. There are about 43, 000 vehicles operating in the town. The roads are narrow with poor geometrics and intersections, poor riding surface, lack of pavements & footpaths, inadequate signage system, improper connectivity etc. The road traffic in Port Blair is to be properly linked up and integrated with water transportation both inter-island and mainland-island which is also lacking, resulting in hardship to the commuters. The hierarchy of the network is also not clearly spelt out. In order to solve these problems, a comprehensive Traffic and Transportation study has been sponsored by APWD and the Division of Transportation Engineering is entrusted with the responsibility of conducting the study for the town of Port Blair and its environs.

1.2 Objective of the Study

The study area includes the Port Blair Municipal area and surrounding areas which are proposed to be declared as development area as per the Master Plan. The study will cover all intra-city passengers and goods movement as well as the inter-settlement movements to and from the study area. The study also includes the estimation of traffic and preparation of short, medium and long term perspectives. The main objective is to match the transport demand with the supply in terms of transport infrastructure, system control and management with optimal utilization of existing infrastructure.

I. The objectives of the study include

- Study of existing traffic and travel characteristics
- Projection of transport demand up to 2027
- Identification of short term improvement measures
- Preparation of medium and long term improvement plans
- Feasibility of integrated mass Transport System including economic and financial analysis
- Implementation mechanism and organizational structures

II. The objectives of the study may be grouped into the following major tasks

- Traffic and Transportation Studies
- Travel Demand Modeling
- Short Term management Measures
- Medium and Long term plans
- Feasibility study for Integrated Mass Transport System

1.3 Scope of Services

The scopes of services as per the Terms of Reference (TOR) are as given below:

- To study of existing land use pattern of Port Blair Town & its environs. Also to go through the available reports / plans on traffic and transport situation and related matters and collection of relevant data from various offices.

- ❖ To carry out primary surveys relating to traffic volume counts at mid-blocks & intersections, outer cordon survey, origin destination surveys, speed and delay study for selected important corridors, public transport surveys, intermediate Public Transport (IPT) survey, terminal studies and household travel survey. A sample size of minimum 3% shall be covered for the household survey. The results of household travel survey will be used to estimate the present intra-city transport demand, movement pattern, modal split, trip purpose etc. The survey will be carried out in all areas of Port Blair Town & its environs.
- ❖ Collection of primary road inventory data and identification of primary network. Consultants have to collect the data on Right of way (ROW) and parking and utilities
- ❖ Analysis and interpretation of above data to elicit the traffic and travel characteristics of the study area
- ❖ Develop the transport demand model, calibrate and validate the transport demand model for intra-city travels
- ❖ Project the transport demand up to the horizon year i.e. 2027 based on the calibrated models and proposed land use plans.
- ❖ Indicate the problems with priority areas and priority junctions and carry traffic estimates/projections on major travel corridors
- ❖ Identify the major transport corridors on the basis of transport demand
- ❖ Suggest alternative transport strategies-short, medium and long term, strengthening transport infrastructure, public transport system.

1.4 Output of the Study

I. Short Term Improvement Measures

- ❖ Prepare junction improvement plans for priority junctions
- ❖ The work will also include signal design, wherever necessary. The detailed design for junction improvement shall be submitted after approval of the draft report of short term measures and identification of junction to be improved by client

- ❖ Prepare traffic management schemes for priority areas
- ❖ Prepare the improvement plans for pedestrian facilities both for ‘along’ and ‘across’ movements
- ❖ Suggest the ‘on’ and ‘off’ street parking locations and to prepare plans for critical areas
- ❖ Suggest the locations and specifications for street furniture i.e., road markings and traffic signs
- ❖ Work out preliminary cost estimates of improvements measures and suggest phasing of implementation
- ❖ Development of terminal facilities

II. Medium and Long Term Improvement Plans

- ❖ Suggest improvement (widening and strengthening) of existing road network based on the forecast transport demand
- ❖ Indicate new road links for intra-city movement based on the transport demand and movement pattern
- ❖ Identify the need for urban bypasses for the through / intercity traffic.

III. Road Engineering

- ❖ Quality Evaluation
- ❖ Material Specification
- ❖ Road Maintenance Management System
- ❖ Design of Flexible / Rigid pavements for specific roads

IV. Mass Transport System Evaluation

- ❖ Development of alternative mass transport networks and assessment of traffic for forecasted demand on the alternatives: (Road based, Water based and Rail based)
- ❖ Evaluation of alternative integrated mass transport networks and selection of the best
- ❖ Preparation of alignment, locations of stations and interchange points

1.5 Need for the Study

The Population concentration and distribution pattern in Port Blair and its environs suggests that, Port Blair town has the higher concentration of population in few wards, out of 18 municipal wards and well distributed in its environs.

The ATR (Andaman Trunk road) is the only connection that ensures interaction among the regions on the south, south west, west and north. It is a long circuitous route typical to hilly regions. Bamboo flat region and the Tushnabad region do enjoy water transport connectivity with Port Blair. Except the southern region, for all other regions water transport connectivity could be less time consuming and more convenient. However the interiors of these regions may have to depend on road transport to reach the water transport terminals.

The Fig.1.1 shows the settlement pattern and the population distribution. Since, Port Blair has the highest concentration of population, it is considered as a separate entity and the four regions identified will be considered as four sectors for the purpose of developing a strategic development model to form transportation network. The level of interaction with Port Blair will essentially depend on the proposed development in each sector. While land use development can induce formation of appropriate transportation network, planning and development of transportation network can also induce development. In this context, if both land use and transport network development efforts are simultaneously undertaken it can foster speedy development of the entire Port Blair region.

In order to promote and foster development it becomes essential to make a thorough assessment of the existing level of transportation infrastructure in Port Blair as well as its environs. Therefore the exercise calls for delineation of zones and assessment of travel behavior of the people and the level of transportation infrastructure in all the four sectors individually.

The Study methodology is shown in Fig 1.2.

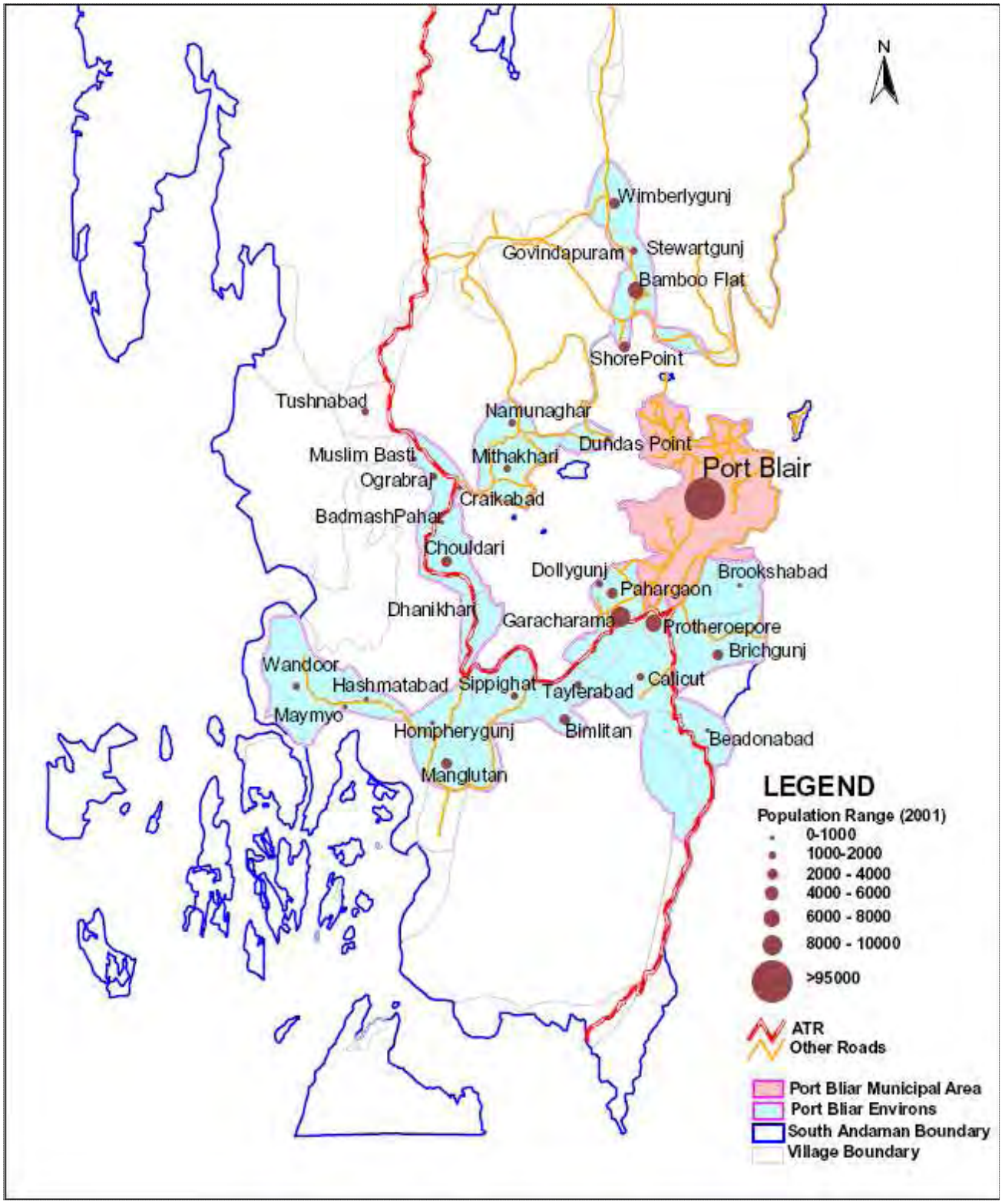

Fig 1.1 Port Blair and Settlements in its Environs

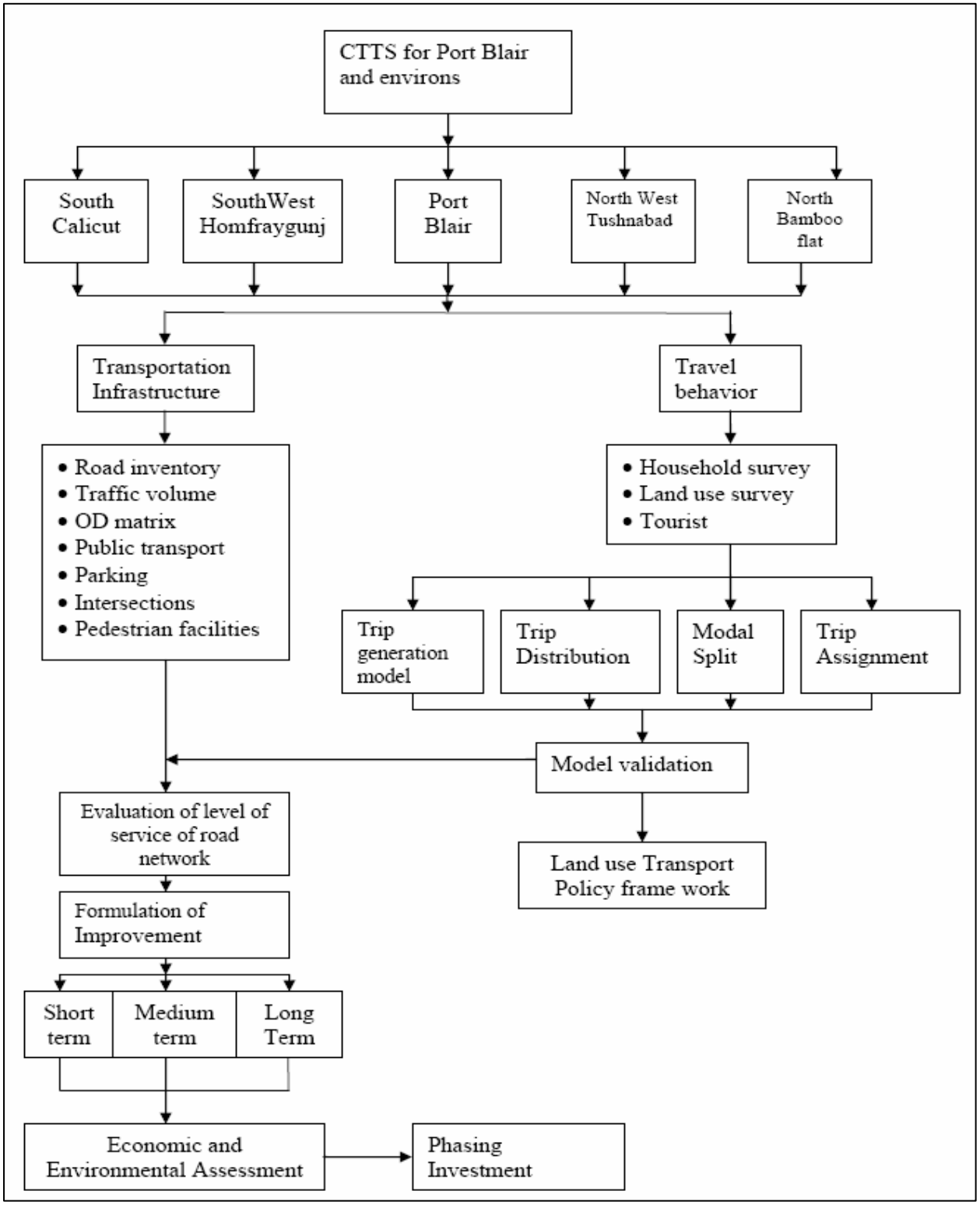

Fig 1.2 Study Methodology

CHAPTER 2
PORT BLAIR AND ITS ENVIRONS

2.1 Transport Scenario in Port Blair

Andaman Nicobar Islands in general and Port Blair in particular call for formulation of a Transport policy urgently. The current vehicle population is 43, 176 vehicles, which is likely to grow, particularly the two wheelers, auto rickshaws and car segments are going to face an upward trend. In view of the inherited road network which cannot be widened beyond certain limit and the vehicular pollution because of usage of fossil fuel, the congestion and pollution will be highly pronounced spoiling the natural form of the island. Non availability of extensive flat land for development is also a major constraint to dissipate congestion. Under such circumstances promotion of public transport is the best option in the long run. In the meanwhile to contain vehicular pollution usage of CNG, LPG and other non polluting fuels may have to be insisted upon along with slow reduction in the number of private vehicles.

It is possible to introduce a road based or rail based mass transport system in a place like Port Blair to reduce the environmental impact. The current level of modal shift in favor of private vehicles should be gradually reduced and the share of public transport increased.

2.2 Modal Split

Modal Split is a crucial indicator which shows the extent to which private vehicles have replaced public transport. The Table 2.1 and the Fig 2.1 show the share of Buses, the public transport mode, is 44.61% and a trips performed by walk is about 20 percent. The rest percentage is private vehicles excepting a small percentage 6.64 of ferry service. For a sustainable transport system the private modal share needs to be a minimum to protect the environment. The Table 2.2 and Fig. 2.2 show that the modal share of buses in environs is more when compared to Port Blair. As the role of two wheelers and cars is about 22 percent attempt need to be made to enhance the role of public transport to an extent of 80 percent by decreasing the role of two wheelers in the Port Blair environs.

Table 2.1 Modal Share of Trips in Port Blair	
Mode	**% share**
TW	15.15 %
Walk	19.917 %
Buses	44.61 %
Car/Van/Jeep	7.05 %
Pedal Cycle	1.24 %
Auto Rickshaw	1.87 %
Ferry	6.64 %
Others	3.53 %

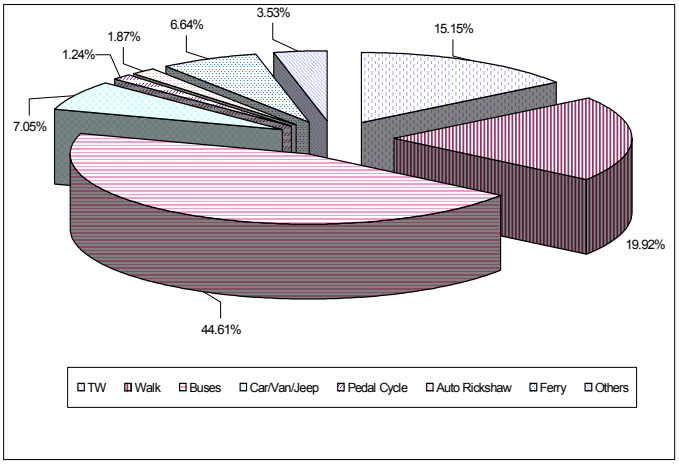

Fig 2.1 Modal Share of Trips in Port Blair

Table 2.2 Modal Share - Port Blair Environs	
Mode	**% Share**
Walk	2.11%
Cycle	20.25%
TW	16.46%
Car	3.59%
Auto	1.90%
Buses	45.36%
Ferry	6.75%
Others	3.59%

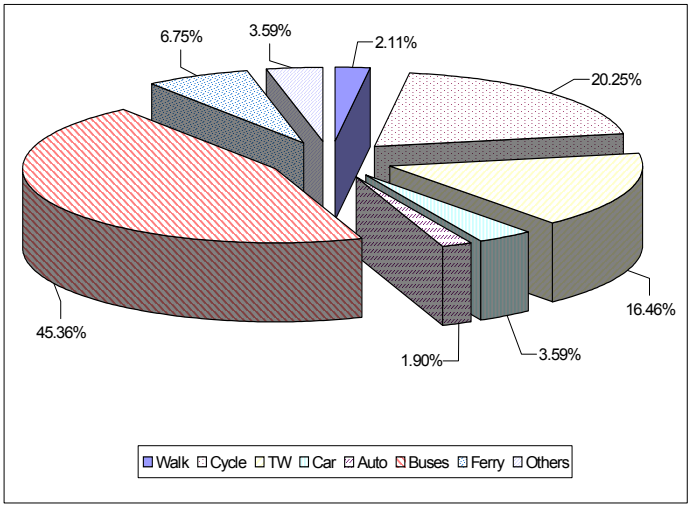

Fig 2.2 Modal Share - Port Blair Environs

2.3 Population in Port Blair and Its Environs

The population of Port Blair is mixture of several religions and migration from several parts of India. The Table 2.3 shows the growth of population in the Port Blair and its environs for the last few decades.

The Table 2.4 shows the population growth of Port Blair Municipal area and that of villages in its environs within the planning area. As per census 2001, over an area of 17.74 sq. km 99,984 persons were living in Port Blair and over an area of 139.38 sq. km in environs population was 61,636. Table 2.5 and Fig. 2.3 shows the decadal growth rate of population in Port Blair and its environs.

Table 2.3 Port Blair – Population Growth

Sl. No	Planning Area Details	Area In Sq. Km	Population 1961	Population 1971	Population 1981	Population 1991	Population 2001	Growth Rate (61-71)	Growth Rate (71-81)	Growth Rate (81-91)	Growth Rate (91-01)
1	**Port Blair (Municipal Area)**	17.74	14075	26218	49634	74995	99984	6.42	6.59	4.21	2.92
2	**Other Villages in Port Blair Planning Area**	139.38	7577	13874	23708	42177	61636	6.24	5.50	5.93	3.87
3	**Port Blair Planning Area**	157.12	21652	40092	73342	117172	161620	6.35	6.23	4.80	3.27

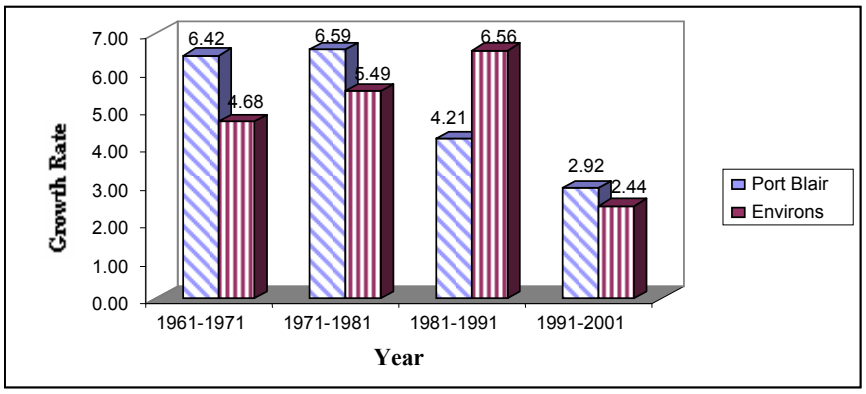

Fig 2.3 Decadal Growth Rate of Population in Port Blair and its Environs

Table 2.4 Population Growth in Port Blair and its environs

Sl. No	Name of Revenue Villages	Area in Hac	Population 1961	Population 1971	Population 1981	Population 1991	Population 2001	Growth Rate (61-71)	Growth Rate (71-81)	Growth Rate (81-91)	Growth Rate (91-01)	Average Growth Rate
1	Wimberlygunj	184.35	775	1550	2311	3092	3707	7.18	4.08	2.95	1.83	4.01
2	Stewartgunj	83.14	342	455	592	888	1070	2.90	2.67	4.14	1.88	2.90
3	Govindapuram	109.03	155	261	377	486	492	5.35	3.75	2.57	0.12	2.95
4	Shore Point	62.23		150	1139	1908	2962		22.47	5.29	4.50	10.75
5	Tushnabad	262.27	321	497	751	796	1190	4.47	4.21	0.58	4.10	3.34
6	Mittakhari	805.08	292	552	657	966	1109	6.58	1.76	3.93	1.39	3.41
7	Ograbraj	373.87	308	559	801	1078	1157	6.14	3.66	3.01	0.71	3.38
8	Muslim Basti	298.09	_	_	7	175	300			37.97	5.54	21.76
9	Namunnagar	1311.83	336	490	705	1174	1730	3.85	3.70	5.23	3.95	4.18
10	Dundas Point	167.26	115	267	368	511	566	8.79	3.26	3.34	1.03	4.10
11	Chouldari	1054.87	464	621	1177	1908	2146	2.96	6.60	4.95	1.18	3.92
12	BadmasPahar	98.46	61	108	144	295	326	5.88	2.92	7.44	1.00	4.31
13	Craikabad	39.49		140	141	196	220		0.07	3.35	1.16	1.53
14	Hompherygunj	183.38	202	188	243	335	396	-0.72	2.60	3.26	1.69	1.71
15	Maymyo	309.67	63	63	153	219	223	0.00	9.28	3.65	0.18	3.28
16	Wandoor	707.87	320	440	656	1008	1511	3.24	4.07	4.39	4.13	3.96
17	Asmathabad	248.25		95	203	389	463		7.89	6.72	1.76	5.46
18	Dhanikari	354.13	57	116	342	407	586	7.36	11.42	1.76	3.71	6.06
19	Manglutan	716.54	194	773	1097	1469	2151	14.83	3.56	2.96	3.89	6.31
20	School line	140.04		485	349	1337	331		-3.24	14.37	-13.03	-0.63
21	Prothrapur	463.36	325	552	996	3247	6509	5.44	6.08	12.54	7.20	7.82
22	Beadonabad	616.25	153	322	596	773	966	7.72	6.35	2.63	2.25	4.74
23	Brichgunj	431.34	177	271	329	1435	3540	4.35	1.96	15.87	9.45	7.91
24	Brooks Abad	414.66	5	45	197	651	241	24.57	15.91	12.70	-9.46	10.93
25	Calicut	421.50	182	321	679	1169	1890	5.84	7.78	5.58	4.92	6.03
26	Sippighat	381.37	240	360	472	729	1038	4.14	2.75	4.44	3.60	3.73
27	Teylerabad	413.05	159	194	520	794	1284	2.01	10.36	4.32	4.92	5.40
28	Dollygunj	172.87	197	276	352	812	1819	3.43	2.46	8.72	8.40	5.75
29	Pahargaon	172.90	283	369	1393	3184	3245	2.69	14.21	8.62	0.19	6.43
30	Bamboo Flat	357.27	1089	2191	3686	4726	6787	7.24	5.34	2.52	3.69	4.70
31	Bimblitan	1997.83	251	354	631	1027	2254	3.50	5.95	4.99	8.18	5.65
32	Garacharma	585.91	511	809	1644	4993	9427	4.70	7.35	11.75	6.56	7.59
	Port Blair (Municipal Area)	1774.00	14075	26218	49634	74995	99984	6.42	6.59	4.21	2.92	5.03
		15712.16	**21652**	**40092**	**73342**	**117172**	**161620**					

The Birth rate as given in the status paper on health services shows that there is a marginal decline in the birth rate when compared to 1991 and increase when compared to 1995. Similarly the death rate has been fairly low for urban area and little higher in rural area. Table 2.6 shows the birth rate and Table 2.7 shows the death Rate. Besides floating population, the migrant population into the island is significant. The Table 2.8 shows the decadal migration pattern in whole of A & N Islands.

The inter State migration is crucial to estimate, the immigrants into the islands over the decade. About 8438 persons have moved into the islands per annum in search of jobs/livelihood. The Port Blair planning area had a population of 1, 61,620 in 2001.

Table 2.5 Birth rate of population in A & N Islands*

Regions	Birth Rate per 1000 persons		
	1991	1995	2001
A & N Islands	**20**	**18.7**	**19.1**

Table 2.6 Death rate of population in A & N Islands*

Regions	Death Rate per 1000 persons		
	1981	**1991**	**2001**
Urban	2.4	3.9	3.6
Rural	9.2	6.4	5.6
Average	**5.8**	**5.15**	**4.6**

Table 2.7 Migration pattern in A & N Islands*

Place of last residence	Total Migrants		
	Persons	**Males**	**Females**
Inter district migration	7434	4361	3073
Inter State migration	84380	48008	36372
International migration	4258	2414	1844
Intra district migration	78094	39930	38164
Total Migration	**174166**	**94713**	**79453**

*Source: Census of India 2001

CHAPTER 3

HOUSEHOLD CHARACTERISTICS

3.1 Household Survey

Household survey is one of the basic surveys carried out to appreciate the travel characteristics of the city/town. Considering the size of the population in Port Blair Municipal area and its environs, a 3 percent sample was programmed. However since there has been significant increase in the population more number of households amounting to 3 to 4 percent sample was interviewed.

The Table 3.1 shows the number of Household's interviewed. The average household size is 4.3 Persons/HH in Port Blair Municipal area and 4.6 Persons/HH in fringe areas of Port Blair

Table 3.1 Total households Interviewed

Area	Population (2007)	Population Surveyed	% Sampled	Number of HH sampled
Port Blair	114982	4299	3.74	1000
Environs	72290	2380	3.29	517

The Table 3.2 indicates the distribution of Households by size. A major share of Household's has a size of 4 to 5 persons. Fig 3.1 shows the Household Distribution by size (in percentage).

Table 3.2 Household Distribution By size*

Area	1	2	3	4	5	6	>6
Port Blair	0.79	6.92	17.88	33.74	23.84	8.24	8.59
Environs	0.98	7.84	13.40	33.66	20.92	11.44	11.76

* Household size per 100 Households

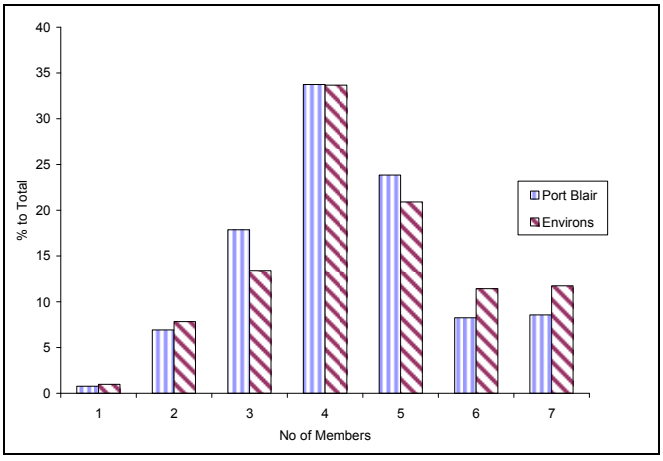

Fig 3.1 Household Distribution By size (in Percentage)

3.2 Vehicle Ownership

Many Households have more than one vehicle particularly two wheelers. The Table 3.3 shows the vehicle ownership details for both Port Blair Municipal area and fringe area. The Table 3.4 shows the distribution of vehicles in Households. The Port Blair Municipal area is observed to have more number of families having more than one vehicle.

Table 3.3 Vehicle Ownership (in Percentage)

Area	Vehicle Ownership for Every 100 Families			
	No vehicle	1 Vehicle	2 Vehicle	More than 3 Vehicle
Port Blair (No of Families)	37.02	51.11	9.99	1.88
Environs (No of Families)	61.11	33.33	3.92	1.63

Table 3.4 Vehicle Ownership

Vehicle Type	Vehicle Ownership per 100 Families	
	Port Blair	Environs
No Vehicle	32.13	57.01
Two Wheeler	42.15	28.96
Car/Van/Jeep/Taxi	14.43	7.93
Autorickshaw	7.89	4.27
LCV	1.99	0.00
Cycle rickshaw	0.92	0.91
Others	0.50	0.91

3.3 Tele-Communication facility

Compared to Port Blair Municipal area the outer area has more households having (51 percent) telephone connection (Table 3.5). There is predominance of cell phone connection in Port Blair Municipal area.

Table 3.5 Household Distribution by Telecommunication Facility

Area	Telecommunication facility per 100 households	
	With Telecom Facility	No Telecom Facility
Port Blair	43.08	56.92
Environs	50.98	49.02

3.4 Accessibility to Bus Transport

Almost 50 percent of the Households have accessibility to Bus Transport in less than 5 minutes by walk and another 35 to 40 percent household's fall within 6 to 15 minutes by walk. This shows that being small settlement having close network, the accessibility to bus transport is very good. Table 3.6 and Fig 3.2 show the household distribution by accessibility to bus transport in terms of time.

Similarly accessibility to Bus Transport in terms of distance shows (Table 3.7 & Fig 3.3) above 75 percent of the households are within 500 meters distance to the bus transport.

Table 3.6 Household Accessibility to Bus Transport (Time)

Region	Accessibility to Bus Transport Time Wise in %			
	< 5 Minutes	6 to 15 Minutes	16 to 30 Minutes	31 to 45 Minutes
Port Blair	46.98	41.97	9.21	1.84
Environs	45.10	35.29	6.21	13.40

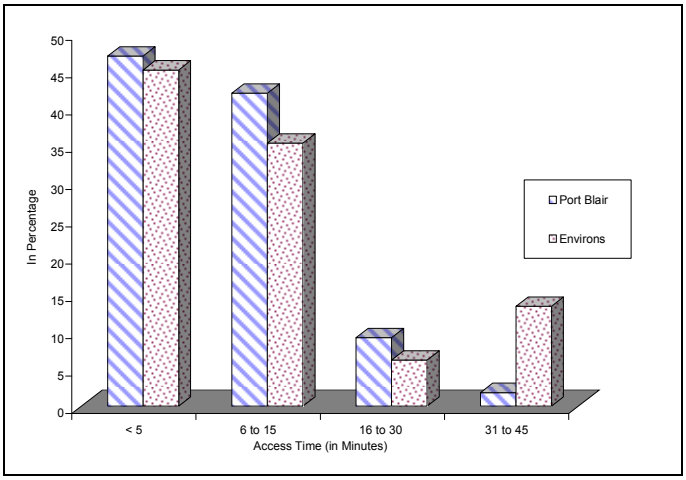

Fig 3.2 Household Distribution by Accessibility to Bus Transport (Time)

Table 3.7 Household Accessibility to Bus Transport (Distance)

Region	Accessibility to Bus Transport Distance Wise in %				
	< 250 m	251 to 500 m	501 to 750 m	751 to 1000 m	> 1000 m
Port Blair	34.71	43.56	15.34	3.68	2.72
Environs	37.91	48.69	10.46	1.31	1.31

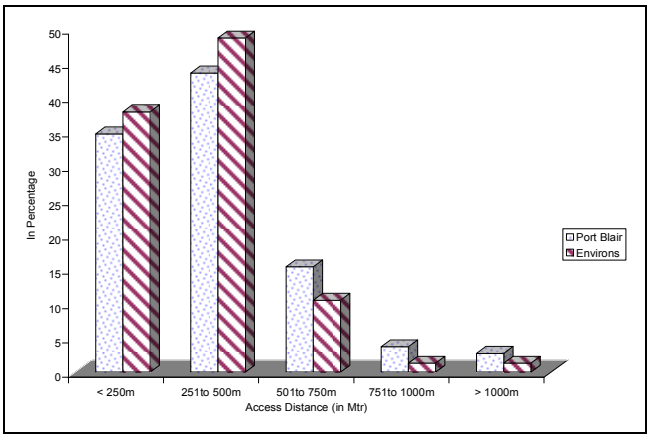

Fig 3.3 Household Distribution by Accessibility to Bus Transport (Distance)

3.5 Household Income

The monthly income distribution of Households is as shown in Table 3.8 and Fig 3.4. Port Blair and the fringe area have recorded a major percentage in the income range of Rs.5001 to 10000 and Rs.10000 and above. Poor Household having income less than Rs.3000 per month forms 10 percent in Port Blair and 20 percent in the fringe areas. Common income range seems to be between Rs.5001 and 10000 in both Port Blair and fringe areas. The higher the income, the higher would be the number of trips performed and vehicles owned.

Table 3.8 Household Monthly Income

Monthly income in Rs	% of Households	
	Port Blair	Environs
<3000	10.65	20.92
3000 - 5000	17.69	23.53
5000 - 10000	38.57	39.87
>10000	33.09	15.69

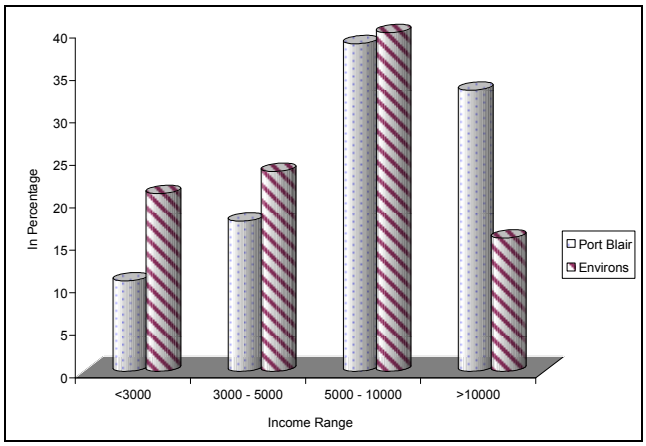

Fig 3.4 Household Distribution by Monthly Income (in Percentage)

3.6 Income Vs Mode Choice

The Table 3.9, Fig 3.5 and Fig 3.6 show the trip characteristics with respect to mode and income for both Port Blair Municipal area and the fringe areas.

Table 3.9 Trip Distribution With Respect To Mode and Monthly Income for All Purpose

Area	Income Range	Trip Distribution mode wise							
		Walk	Cycle	T.W	Car/Van/ Taxi	Bus	Auto Rickshaw	Ferry	Total
Port Blair	< 3000	50	0.00	0.00	0.00	16.67	0.00	33.33	100
	3000-5000	29.41	4.64	5.88	1.25	41.18	5.88	11.76	100
	5000-10000	15.79	2.63	13.16	2.63	47.37	2.63	15.79	100
	>10000	20.00	0.00	20.00	5.88	44.12	0.00	10.00	100
Environs	< 3000	50.00	0.00	0.00	0.00	16.67	0.00	33.33	100
	3000-5000	22.22	5.21	5.40	0.50	44.44	5.56	16.67	100
	5000-10000	15.15	3.03	12.12	7.88	43.64	3.03	15.15	100
	>10000	6.25	0.00	31.25	4.55	45.45	0.00	12.50	100

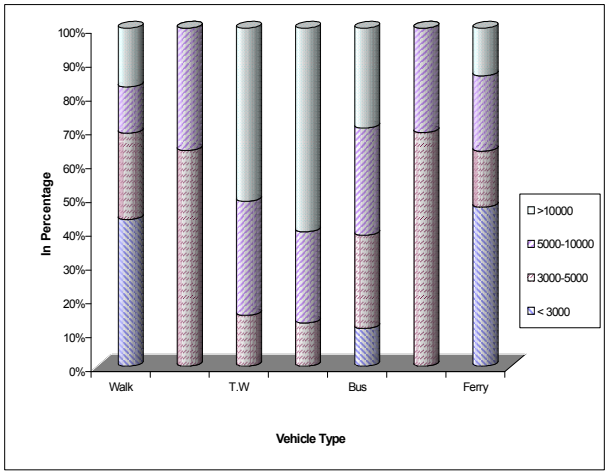

Fig 3.5 Mode of Travel & Monthly Income – all Trips in Environs

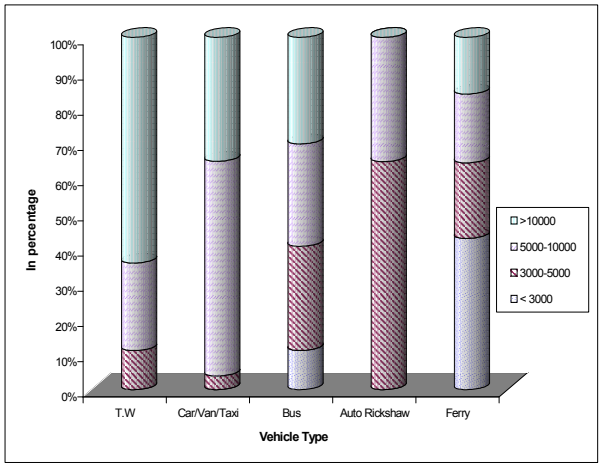

Fig 3.6 Mode of Travel and Monthly Income – all Trips in Port Blair

Walk Trips: In both the areas walk trips play a vital role. Walk trips are more prevalent among lower income group and as the income rises the share of walk trips reduces.

Bicycle Trips: Significantly bicycle trips are of predominance among the income group Rs.5000-Rs.10000 in both the regions. Cycle trips are not found in other income group at all.

Two Wheeler Trips: Two wheeler trips are found more in higher income group both in Port Blair and the fringe areas. The highest use is found in the income group of above Rs.10000 per month.

Cars: Usage of cars is found to be prevalent in the income group of 3000 to Rs.10, 000 in both Port Blair and fringe areas.

Buses: Buses are being predominantly used by all income groups in particular people having an house hold income of more than Rs.10,000 travel more in buses.

Auto: Usage of auto is also significant in the middle range of income.

Ferry: Households particularly living in Bamboo flat area, Dandas Point and those living in Port Blair but traveling to the islands use ferry service which is common and cheap.

3.6.2 Work Trips and the Mode Used

The predominant mode used for work purpose (Table 3.10, Fig 3.7, and Fig 3.8) is bus followed by two wheelers, cars and bicycles. Walk mode is found to be significant. Table 3.11 depicts almost similar characteristics in the case of mode used for all other purposes.

Table 3.10 Work Trip Distribution With Respect to Mode and Monthly Income

Area	Income Range	Work Trips Distribution mode wise in Percentage								
		Walk	Cycle	T.W	Car / Van / Taxi	Bus	Ferry	Others	Auto-rickshaw	Total
Port Blair	<3000	5.26	10.53	0.00	0.00	68.42	0.00	15.79	0.00	100
	3000-5000	29.11	1.27	8.86	11.39	37.97	5.06	1.27	5.06	100
	5000-10000	20.00	0.61	15.76	7.88	52.12	2.42	1.21	0.00	100
	>10000	9.09	1.52	25.76	4.55	39.39	9.09	8.33	2.27	100
Environs	<3000	39.47	2.63	5.26	10.53	34.21	0.00	7.89	0.00	100
	3000-5000	29.11	1.27	8.86	11.39	37.97	5.06	1.27	5.06	100
	5000-10000	20.00	0.61	15.76	7.88	52.12	2.42	1.21	0.00	100
	>10000	9.09	1.52	25.76	4.55	39.39	9.09	8.33	2.27	100

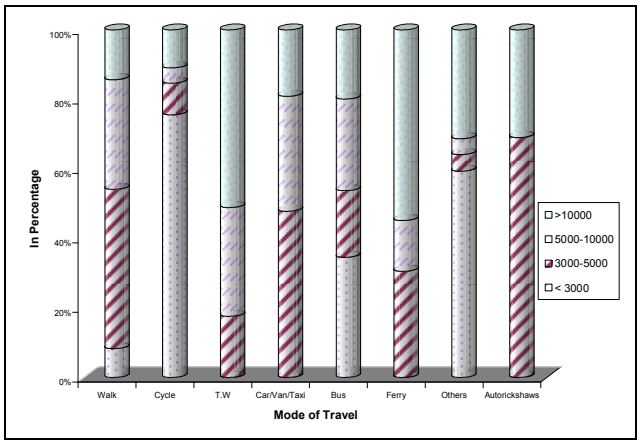

Fig 3.7 Mode of Travel & Monthly Income of Work Trips in Port Blair

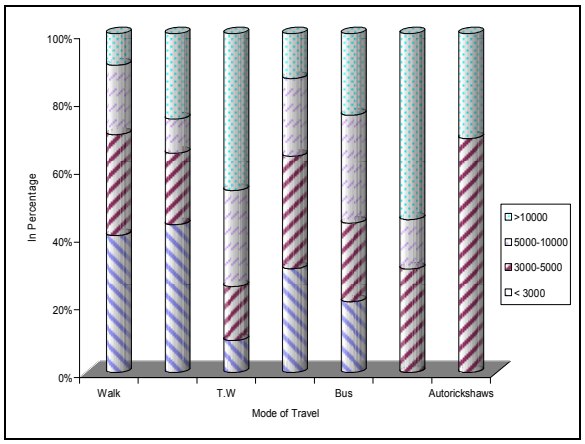

Fig 3.8 Mode of Travel & Monthly Income of Work Trips in Environs

Table 3.11 Other Purpose Trip Distribution Mode and Monthly Income Wise

Area	Income Range	Other Trips Distribution mode wise in Percentage							
		Walk	Cycle	T.W	Car/Van/ Taxi	Bus	Auto Rickshaw	Ferry	Total
Port Blair	<3000	50.00	0.00	0.00	0.00	16.67	0.00	33.33	100
	3000-5000	29.41	0.00	5.88	5.88	41.18	5.88	11.76	100
	5000-10000	15.79	2.63	13.16	2.63	47.37	2.63	15.79	100
	>10000	20.00	0.00	20.00	0.00	50.00	0.00	10.00	100
Environs	<3000	50.00	0.00	0.00	0.00	16.67	0.00	33.33	100
	3000-5000	22.22	0.00	0.00	11.11	44.44	5.56	16.67	100
	5000-10000	15.15	3.03	12.12	0.00	51.52	3.03	15.15	100
	>10000	6.25	0.00	31.25	0.00	50.00	0.00	12.50	100

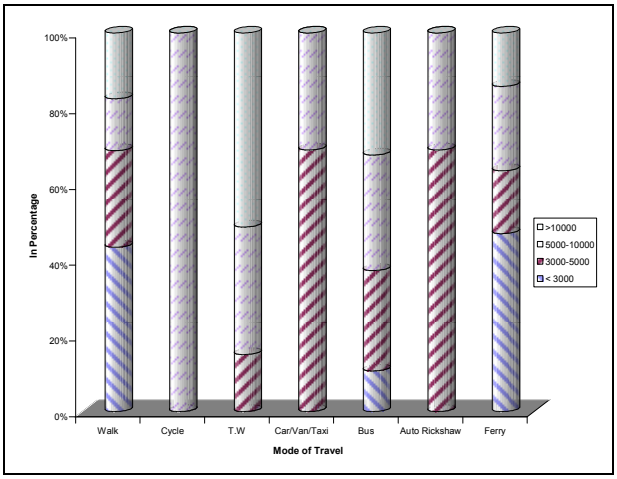

Fig 3.9 Mode of Travel & Monthly Income of Other Purpose Trips in Port Blair

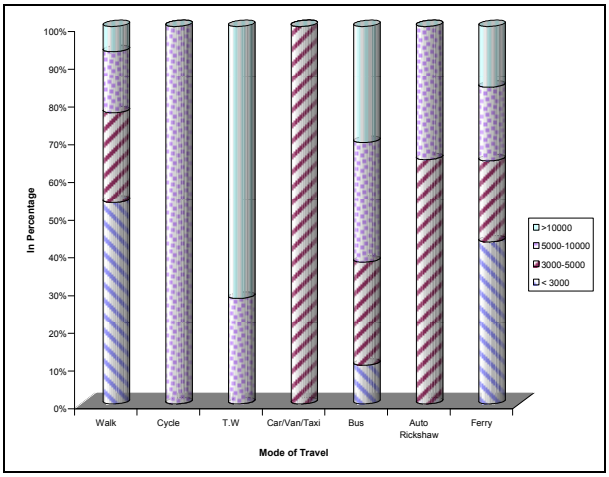

Fig 3.10 Mode of Travel & Monthly Income of Other Purposes Trips in Environs

3.7 Average Trip Length and the Mode Used

Walk trips are predominant both in Port Blair and its Environs. The average trip length of trips performed using different modes for all purposes is as shown in the Table 3.12.

Table 3.12 Trip Length Mode Wise

Mode	Average Trip Length
Walk	0.82
Two Wheeler	1.45
Car	3.82
Auto Rickshaw	2.61
Bus	5.46

The Table 3.13 shows the distance travelled using various modes for work and other purposes. Port Blair being a smaller settlement with a population of 1.2 Lakhs population has most of the activities spread over shorter distances. This is further helped by the hilly terrain where in walk trips for shorter distance are the most convenient mode of transport.

Table 3.13 Trip length Purpose Wise

Mode	Average Trip Length
Work	4.34
Social	1.56
Shopping	1.63
Business	3.62
Education	1.65

3.8 Age Wise Trip Rate

The predominant trips performed are always for work trips followed by education trips (Table 3.14 and Fig 3.11). The age group 5-17 is the age group of school going population which is 0.32 per Household. The age groups falling between 18 and 58 can be classified as working class population which has the higher trip rate. Male population in Household performs more number of trips than female population (Table 3.15 and Fig 3.12)

Table 3.14 Age wise trip Rate

Age Group (in years)	Trip rate in Port Blair		Trip rate in Environs	
	Per HH	Per Person	Per HH	Per Person
05 to 17	0.32	0.07	0.25	0.05
18 to 24	0.46	0.11	0.23	0.05
25 to 40	0.76	0.18	0.84	0.18
41 to 58	0.76	0.18	0.47	0.10
59 to 65	0.08	0.02	0.05	0.01
> 65	0.01	0.003	0.04	0.01

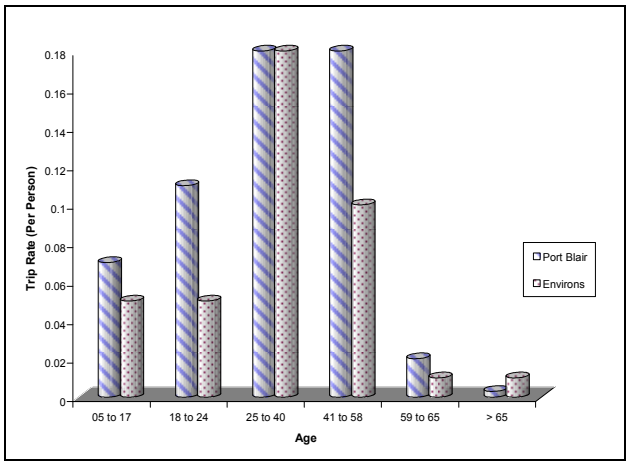

Fig 3.11 House hold and Age Wise Trip Rate

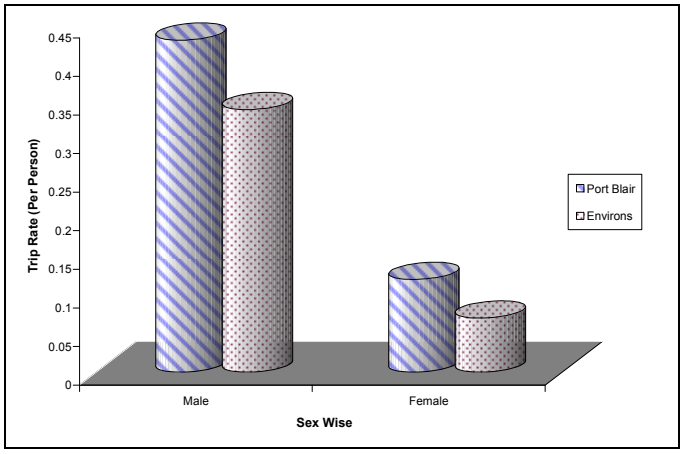

Fig 3.12 Household and Sex Wise Trip Rate

3.9 Mode Wise Trip Rate

Households have trips using walk mode followed by bus (Table 3.16 and Fig 3.13). Two wheeler forms the highest trip rate compared to all other modes.

Table 3.15 Sex Wise Trip Rate

Sex	Trip rate in Port Blair		Trip rate in Environs	
	Per HH	Per Person	Per HH	Per Person
Male	1.86	0.43	1.54	0.34
Female	0.53	0.12	0.33	0.07

Table 3.16 Household and Mode wise Trip Rate

Mode	Trip rate in Port Blair		Trip rate in Environs	
	Per HH	Per Person	Per HH	Per Person
Walk	0.71	0.16	0.44	0.10
Cycle	0.19	0.04	0.23	0.05
T.W	1.14	0.26	0.52	0.11
Car/Van/Taxi	0.47	0.11	0.23	0.05
Bus	0.67	0.15	1.00	0.22
Auto Rickshaw	0.16	0.04	0.03	0.01
Ferry	0.01	0.002	0.10	0.02
Others	0.01	0.002	0.06	0.01

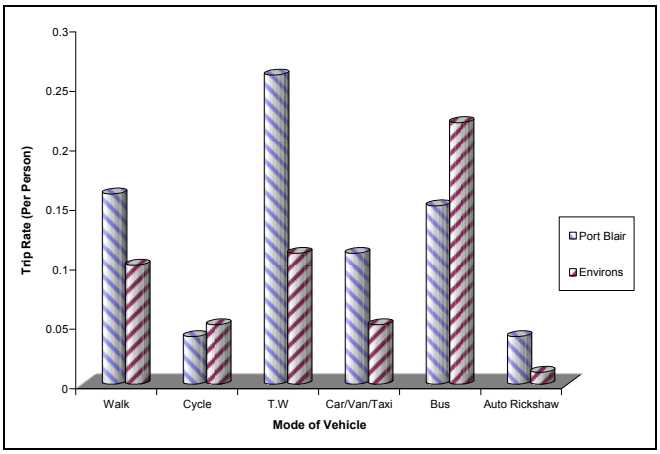

Fig 3.13 Mode Wise Trip Rate in Port Blair and Environs

3.10 Household and Trip Rate

Households perform more number of trips for work purpose (Table 3.17 and Fig 3.14). The distance of highest trip rate falls within 4 kms distance (Table 3.18 and Fig 3.15). Families having higher income above Rs.5000 per month perform more number of trips and the trip rate is the highest (Table 3.19).

Table 3.17 House hold and Purpose Wise Trip Rate

Purpose	Trip rate in Port Blair		Trip rate in Environs	
	Per HH	Per Person	Per HH	Per Person
Work	2.56	0.59	2.19	0.48
Education	0.15	0.03	0.18	0.04
Business	0.40	0.09	0.16	0.03
Shopping	0.10	0.02	0.00	0.00
Social & Recreational	0.03	0.01	0.03	0.01
Personal services	0.06	0.01	0.03	0.01
Change of Mode	0.04	0.01	0.05	0.01

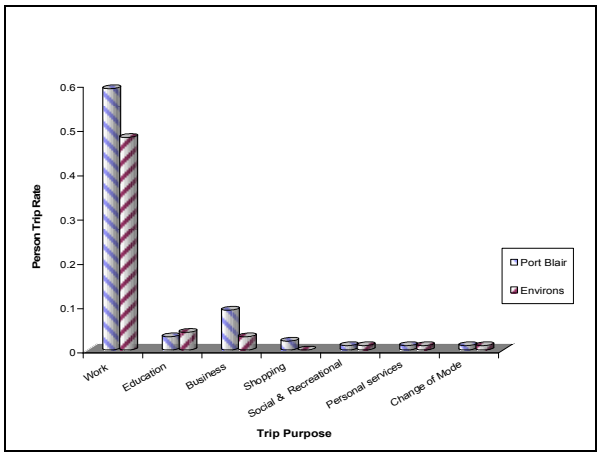

Fig 3.14 Purpose Wise Trip Rate

Table 3.18 House hold and Distance wise Trip Rate

Trip Distance in Km	Trip rate in Port Blair		Trip rate in Environs	
	Per HH	Per Person	Per HH	Per Person
1 to 2	2.50	0.58	1.20	0.26
2 to 4	0.40	0.09	0.32	0.07
4 to 6	0.24	0.05	0.27	0.06
6 to 8	0.05	0.01	0.27	0.06
>8	0.16	0.04	0.28	0.06

Table 3.19 Monthly income Wise Trip Rate

Monthly Family Income in Rs.	Trip Rate in Port Blair		Trip Rate in Environs	
	Per HH	Per Person	Per HH	Per Person
< 3000	0.24	0.05	0.26	0.06
3000 TO 5000	0.34	0.08	0.52	0.11
5000 TO 10000	1.21	0.28	1.11	0.24
>10000	1.56	0.36	0.71	0.15

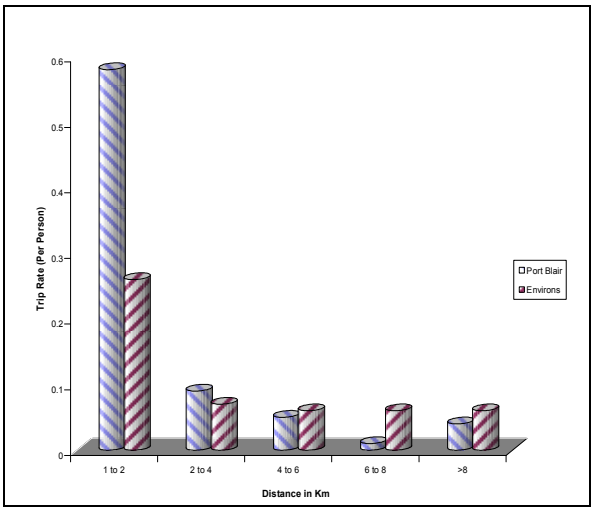

Fig 3.15 Distance Wise Trip Rate in Port Blair and Environs

Conclusion

- Walk trips are predominant in both Port Blair and its Environs
- Two wheeler trips are also increasing
- People own more number of two wheelers
- More number of Households has access to many activities within a walking distance of two Kms
- More than 50 percent of the population has access to bus within 5 minutes of walk
- Households having income of more than Rs.5000 is more (72%) which means the population has better affordability
- Per person trips are more for work followed by education

CHAPTER 4
VEHICLE POPULATION

Port Blair and its environs have a vehicular population of 43176 as on 2006 at a rate of 231 Vehicles per 1000 peoples

The Fig 4.1 and Table 4.1 indicate the steady growth of vehicular population from the year 1971. The vehicles have grown manifold since 1971. The Fig 4.2 shows the share of each vehicle in the overall vehicular population every year. It may be seen while the percentage share of trucks, buses and cars have shown decline, the share of two wheelers alone has shown tremendous increase. However, individually the vehicles have shown increase over the years. Interestingly, the two wheeler population has grown from 1985 and has shown tremendous increase from the year 1999, the vehicular growth pattern indicates increasing mobility of people for various purposes. Number of Autorickshaws (3 wheeler) has shown significant increase after the year 2000. From the registration trend 10.7% annual rate of increase in vehicle population is observed.

The sharp increase in vehicular population is not good from the environment point of view. Since all the vehicles are fossil fuel based, the environmental pollution would be significant to come and the natural fauna and flora is likely to be affected. Therefore in order to have a sustainable transport development there is an urgent need to control vehicular population and introduce pollution free fuels and implement mass transport systems.

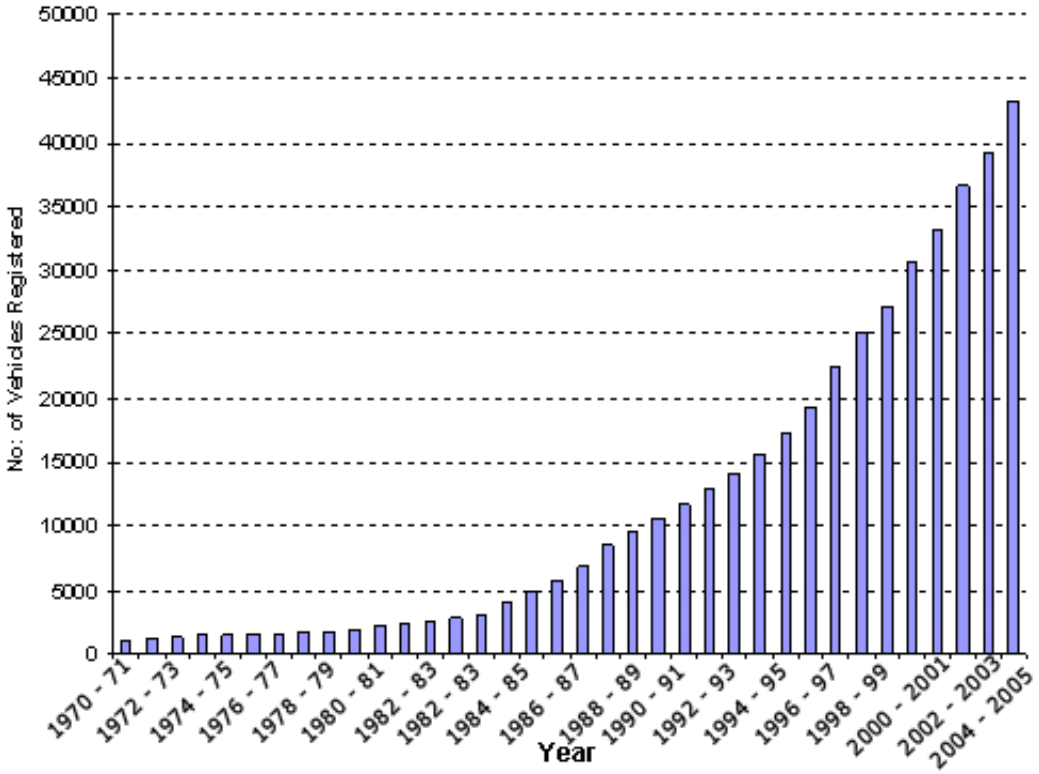

Fig 4.1 Growth of Vehicle Population in Port Blair

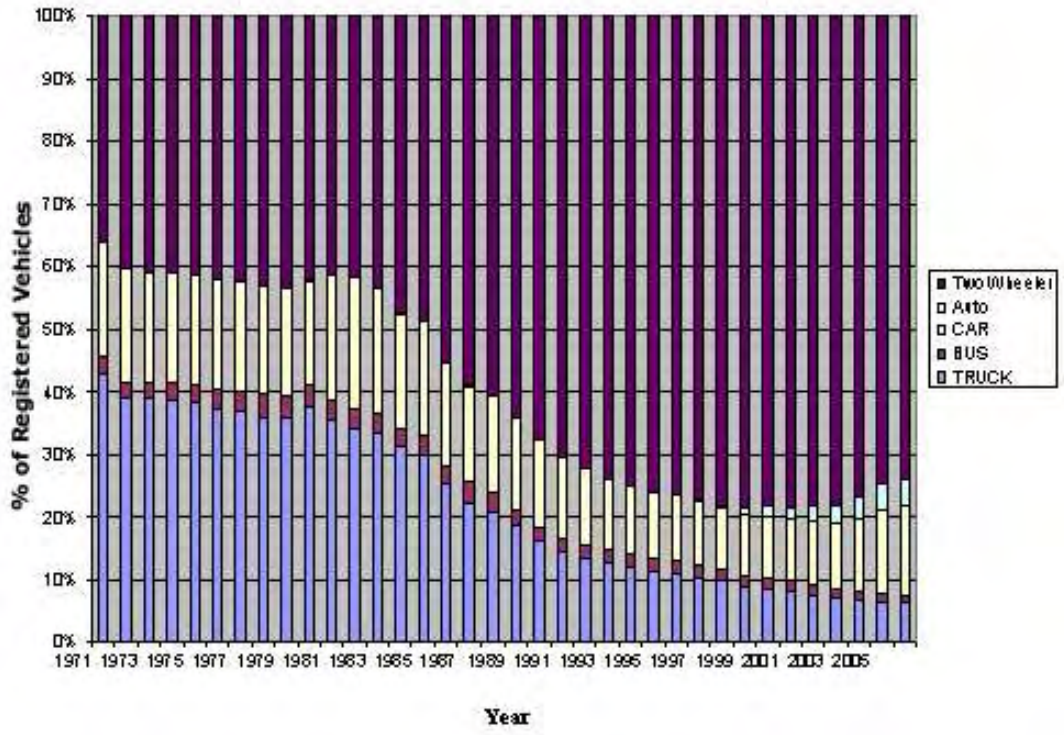

Fig. 4.2 Vehicle Registration Trend – Mode Wise

Table 4.1 Vehicular Population

YEAR	TRUCK	BUS	LMV	3 WHEELER	2 WHEELER	MOPED	TRACTOR	TRAILOR	OTHER	TOTAL
1970-71	321	30	201	1	395	0	28	8	111	1095
1971-72	329	32	224	1	498	0	30	10	116	1240
1972-73	335	35	243	1	568	0	62	20	123	1387
1973-74	345	40	256	1	599	0	77	20	125	1463
1974-75	356	46	270	1	632	0	82	22	128	1537
1975-76	366	51	283	1	674	0	84	22	128	1609
1976-77	376	56	294	1	710	0	94	22	128	1681
1977-78	386	62	301	1	758	0	96	22	129	1755
1978-79	402	67	309	1	790	0	98	22	130	1819
1979-80	462	70	323	1	823	0	118	24	130	1951
1980-81	501	74	437	1	894	10	122	25	130	2194
1981-82	539	78	498	1	972	20	122	25	131	2386
1982-83	570	80	508	1	1076	25	124	27	131	2542
1983-84	620	83	531	1	1341	35	126	29	131	2897
1984-85	645	93	578	1	1472	55	132	35	133	3144
1985-86	692	117	669	4	2159	75	133	36	162	4047
1986-87	739	164	760	5	2828	90	134	37	189	4946
1987-88	783	164	892	5	3382	105	154	44	224	5753
1988-89	829	164	1014	6	4230	145	159	45	250	6842
1989-90	867	190	1186	6	5540	205	177	45	271	8487
1990-91	887	207	1239	8	6338	437	182	47	276	9621
1991-92	913	225	1289	8	7067	567	182	47	290	10588
1992-93	933	237	1351	15	8009	629	195	47	300	11716
1992-94	968	256	1423	15	8919	703	205	54	314	12857
1994-95	1018	269	1504	15	9880	859	208	54	327	14134
1995-96	1106	296	1617	16	10935	976	212	54	347	15559
1996-97	1174	317	1767	20	12147	1185	227	54	356	17247
1997-98	1250	350	1885	32	13728	1397	236	60	373	19311
1998-99	1313	395	2190	243	16019	1685	237	60	405	22547
1999-2000	1416	424	2533	365	17856	1884	243	61	418	25200
2000-01	1460	448	2716	458	19338	2014	251	67	460	27212
2001-02	1519	459	3162	784	21743	2195	261	67	461	30651
2002-03	1580	476	3432	966	23563	2334	264	67	467	33149
2003-04	1635	508	4229	1287	25641	2562	280	67	469	36678
2004-05	1746	534	5164	1704	26250	2923	288	67	475	39151
2005-06	1931	540	6053	1840	28778	3198	292	67	477	43176

CHAPTER 5
ORIGIN AND DESTINATION STUDY

5.1 Zone Delineation

The Fig. 5.1 shows the zone delineation for Port Blair town and its environs (15450 Hac). Port Blair has 18 Municipal wards with a clear boundary. The Port Blair environs have 32 small and medium settlements. All the settlements are considered for the study and the villages are treated as traffic zones. The interaction between the external zones and the internal zones (Port Blair) can be assessed using OD Matrix.

Numbering of Zones

For the purpose of the study the Port Blair town is considered as a separate entity with Zone numbers starting 001 up to 018. The extended areas are considered as four sectors and each sector is designated as 1, 2, 3 & 4.

Southern sector – 1
South West sector – 2
North West sector - 3
North sector – 4

The zone numbers represent the village boundaries in each sector. The corresponding zonal number will be represented by the sector number followed by the village number. For example 108 will represent sector 1 and village number 8.

5.2 Origin and Destination Study

For the purpose of establishing the origin and destination of vehicles and passengers different studies were conducted. To identify the OD of vehicles, outer Cordon points were selected as shown in Fig 5.2. The outer Cordon points are located on all major entry points along the periphery of the study area. A twelve hour survey was conducted at these points with the help of police to stop the vehicles and enquire for the origin and destination. There are 2 points (Chattam and Phoenix Bay) which are jetty points from where vehicles and passengers enter into the study area. The Fig 5.3 shows the volume of traffic entering and leaving the study area. Maximum volume enters from the point located on north connecting Bamboo flat followed by south end (Garacharma).

Table 5.1 gives the origin and destination matrix (Person Trips) of the 47 zones in the study area. The Fig 5.4 shows the OD of person trips within Port Blair Municipal Area. The Desire line diagram is an indication of direction of travel by the people for their work and other purposes. Person trips emanating from Bamboo Flat towards Aberdeen Market and Bengali Club area seems to predominant majority, as the offices are located around Bengali Cub.

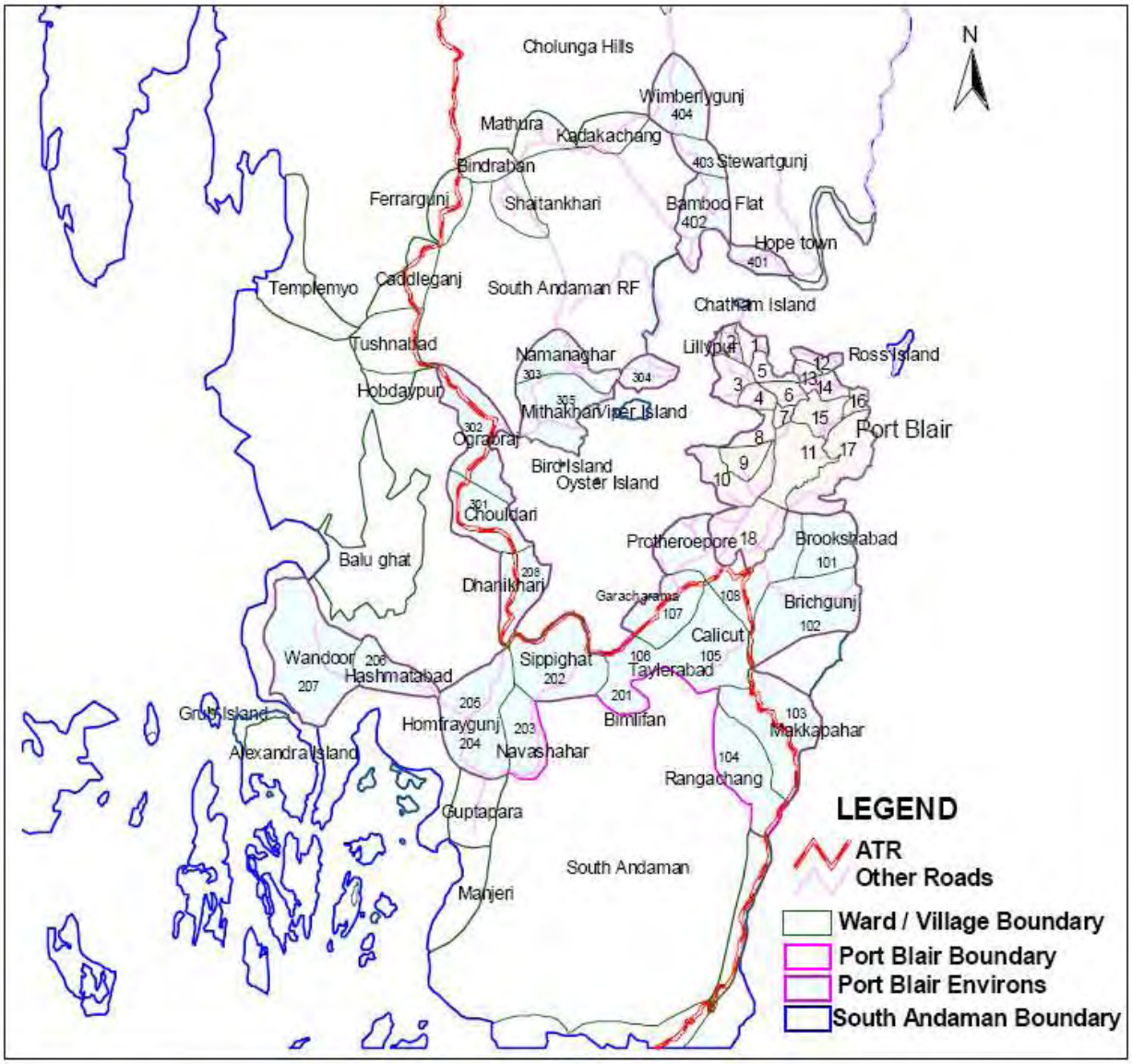

Fig. 5.1 Delineation of Study Boundary

Table 5.1 Person Trip Matrix

O/D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	101	102	103		105	106	107	108	202	203	204	205	206	207	208	301	302	303	304	305	401	402	403	404	150	250	350	450	201
1	526	842	0	35	175	175	0	175	0	0	0	526	35	0	35	140	0	175	0	0	0	0	0	0	140	35	0	0	0	0	0	0	0	0	0	0	35	0	70	0	0	70	0	35	35	0
2	570	2184	47	380	190	95	47	1282	0	285	332	760	95	142	142	142	0	95	0	95	0	0	95	0	285	142	0	0	0	0	0	0	0	0	0	0	47	0	190	0	47	95	47	0	0	0
3	23	139	534	46	0	23	139	46	46	23	23	0	348	0	325	23	0	46	0	0	0	0	0	0	93	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	46	0	0	0	0	0
4	54	288	90	1188	144	504	18	180	18	90	36	1188	234	54	324	180	0	18	0	0	0	0	72	0	36	36	0	0	0	0	0	0	0	18	0	0	0	0	0	72	0	36	36	0	0	18	0
5	42	21	0	125	156	52	21	21	10	21	21	343	31	10	62	10	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10	0	0	0	0	0
6	54	13	13	188	94	550	27	107	0	13	94	510	148	40	175	54	13	81	0	13	0	0	0	0	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	0	0	0	0	0	0	0
7	681	486	389	584	195	875	1653	2237	1556	3696	195	4085	1653	0	681	1556	0	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97	0	0	97	0	0	0	0
8	97	234	28	124	14	165	28	1710	152	372	41	552	69	0	138	276	14	41	0	0	0	0	0	0	138	110	0	0	0	0	0	0	0	0	14	28	0	0	0	14	0	14	14	0	0	14	0
9	0	7	13	39	7	26	0	92	20	20	0	26	13	0	13	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
10	116	699	233	466	349	582	0	1397	116	2212	582	4309	466	699	699	582	0	815	0	233	0	0	116	0	699	582	0	0	116	0	0	0	0	0	0	0	0	0	116	0	582	116	0	0	0	0
11	64	0	64	127	0	254	0	445	0	0	191	763	572	127	381	254	0	191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	191	0	0	0	0
12	67	61	6	134	164	116	0	207	0	213	49	803	213	55	213	49	0	49	12	49	24	0	61	0	225	43	0	0	0	0	6	0	0	6	0	0	0	0	0	103	0	37	12	0	18	0	0
13	73	0	171	122	317	122	73	147	0	49	317	415	342	244	24	24	0	49	0	0	0	0	0	0	562	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	16	127	0	0	16	32	652	0	0	16	16	95	143	414	191	111	0	16	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0
15	168	168	42	168	294	462	0	630	0	378	42	1344	210	462	546	168	0	504	0	0	0	0	84	0	294	42	0	0	0	0	0	0	0	84	0	0	0	0	0	420	0	294	0	0	0	0	0
16	0	54	0	217	272	217	272	272	0	217	109	2337	326	652	544	870	54	598	0	0	0	0	0	0	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	272	0	0	0	0	0	0	0
17	0	0	0	0	0	141	0	0	0	0	0	70	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	170	0	34	34	0	136	0	0	0	68	340	272	68	34	475	272	0	68	0	0	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
102	0	14	0	0	0	7	0	0	0	14	0	57	0	0	0	0	0	0	0	824	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0
103	12	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	31	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0
104	23	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	61	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0
105	0	5	0	10	0	0	0	0	0	8	5	26	0	0	0	0	0	0	0	0	0	0	26	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
106	0	0	0	0	0	19	0	0	0	0	0	57	0	0	0	0	0	0	19	19	0	0	0	57	57	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	19	0
107	40	79	40	0	26	53	26	119	13	40	13	514	316	13	92	13	13	40	0	26	53	0	26	0	356	132	13	0	26	0	0	0	0	13	0	0	0	0	0	26	0	0	13	0	0	26	0
108	30	60	0	30	0	0	0	135	0	30	0	150	15	30	30	0	0	45	0	0	0	0	60	30	165	105	0	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	0	8	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	0	0	0	0	0	16	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	4	0	0	0	0	29	0	7	0	0	0	4	0	11	0	0	0	0	0	0	4	0	4	0	18	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
202	0	0	15	0	0	0	0	0	0	7	0	75	0	0	15	15	0	0	0	22	0	0	0	0	0	0	0	0	0	22	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
203	0	0	0	0	0	0	0	0	0	6	0	4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
204	0	2	0	0	0	0	2	0	0	13	0	8	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	2	0	0	14	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0
205	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	3	0	0	0	6	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	3	0	0	0	0	0	0	0	0	3	3	0	0
207	0	0	15	0	0	0	0	15	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	45	15	0
208	23	0	0	0	0	23	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	160	23	0	0	0	0	23	0	0	0	0	0
250	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0
301	65	16	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	16	0	0	0	0	0	0	0	0	0
302	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
303	27	40	0	0	27	40	0	27	0	54	0	268	27	13	215	148	0	0	0	13	0	0	0	0	27	0	0	0	0	0	0	13	0	0	0	13	0	0	54	376	134	510	0	0	0	27	0
304	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0
305	0	6	11	0	6	0	0	11	11	34	6	45	0	0	17	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	146	22	202	0	0	0	6	0
350	0	0	0	0	0	0	0	13	26	13	0	0	0	0	0	0	0	0	0	0	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0
401	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
402	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	14	7	0	0	0	0	0	0	0	0	0	7	0
403	0	0	0	15	15	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0
404	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The Fig 5.4 shows the travel desire of the people within Port Blair emancipated area. The Northern half of Port Blair where there is a dense residential as well as work center including the market has the highest traffic movement. Predominant movements are between Nayagaon to Aberdeen Bazaar, Dudh Line to Aberdeen Bazaar and Chattam Islands to Aberdeen Bazaar. The desire lines indicate the major transport directions.

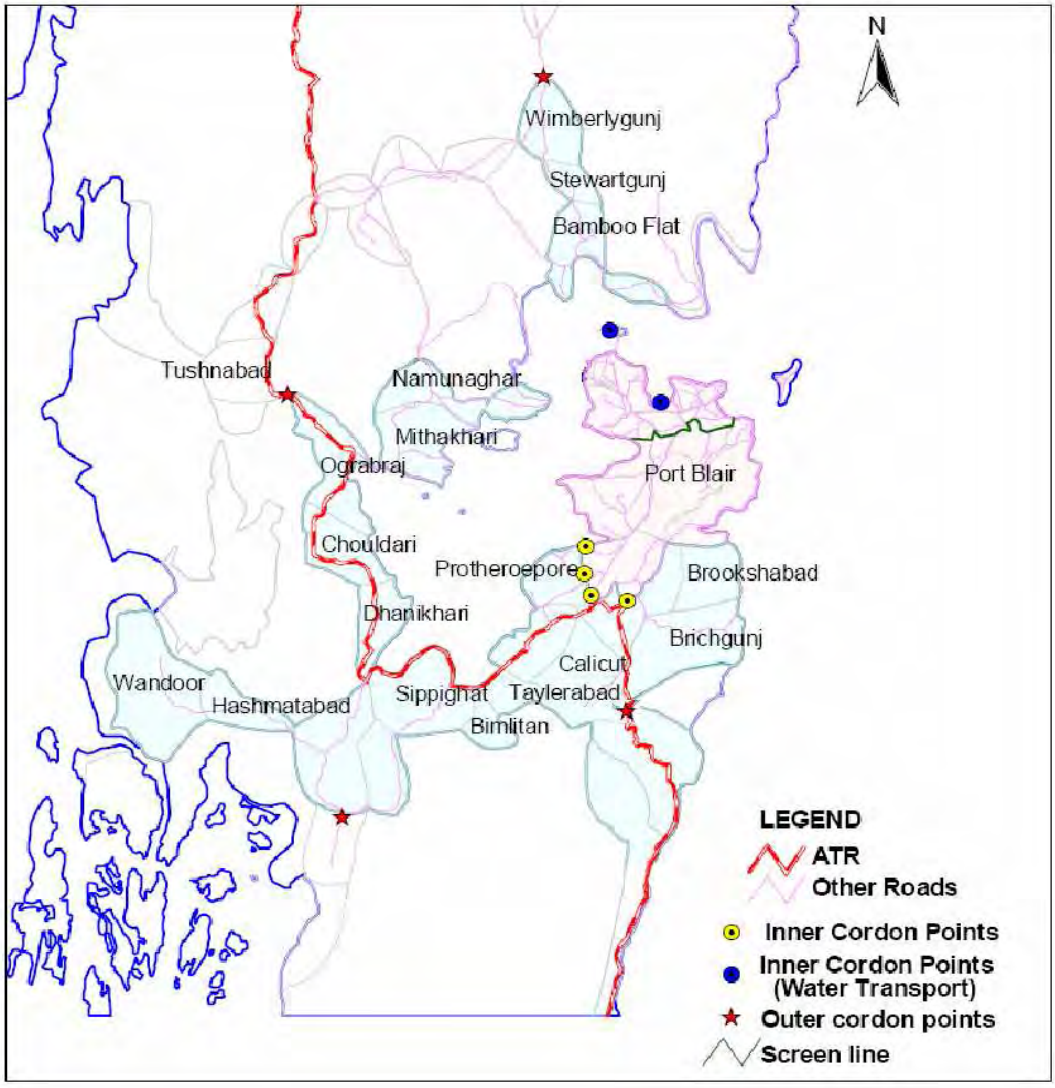

Fig. 5.2 Inner Cordon, Outer Cordon and Screen line Location for OD Survey

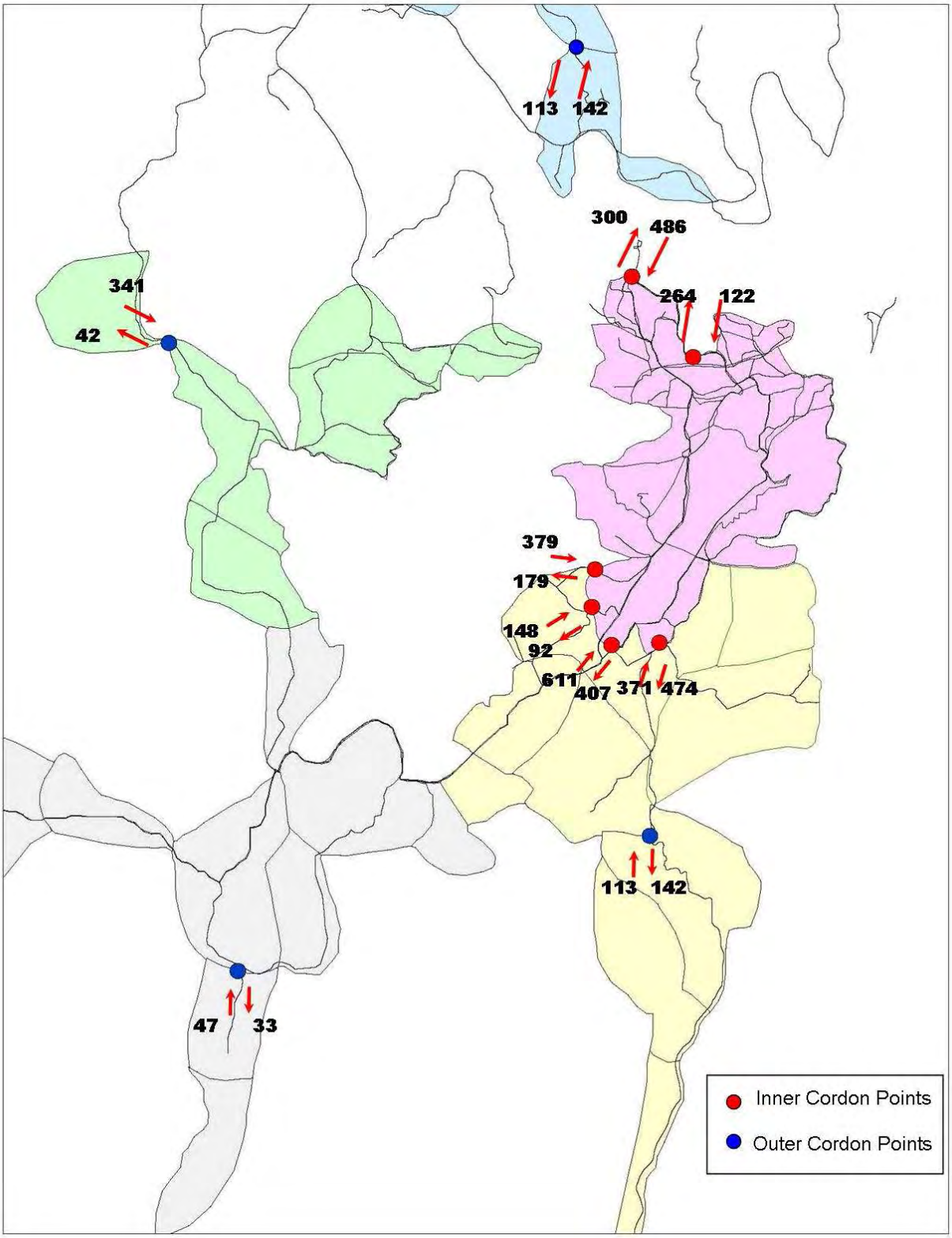

Fig. 5.3 Volume of Traffic Entering and Leaving the Study Area

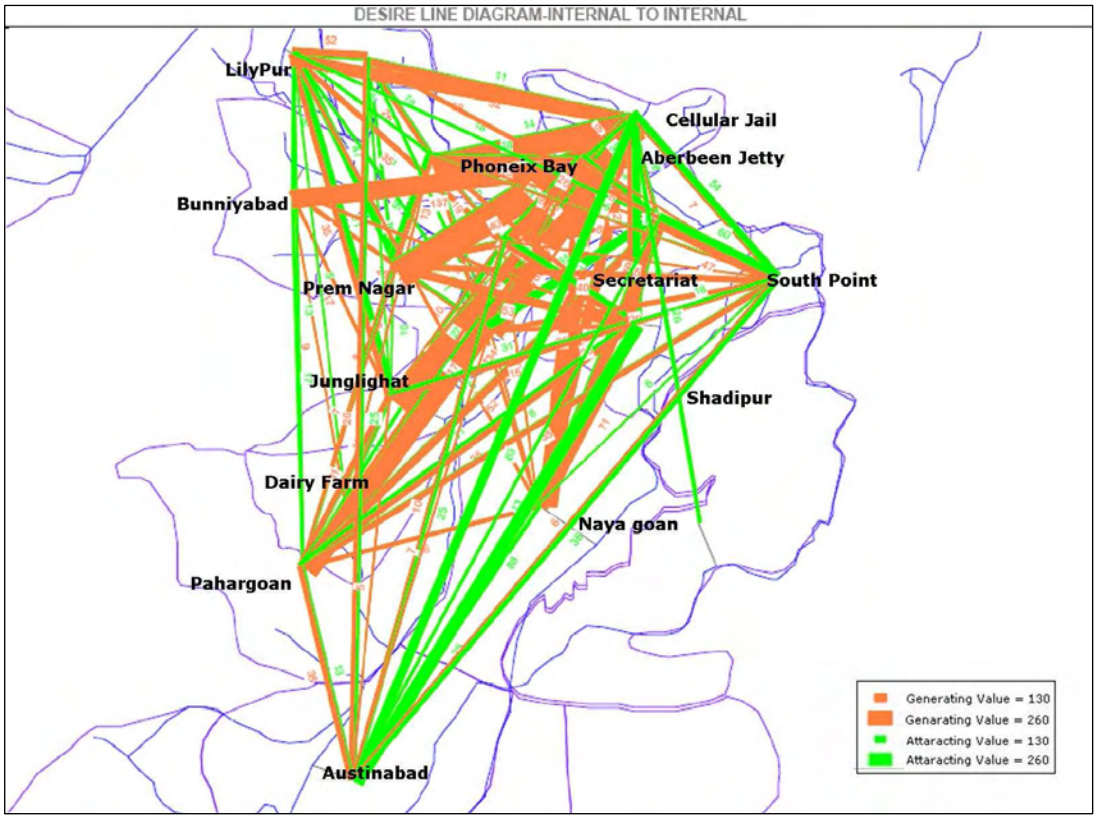

Fig. 5.4 Desire Line Diagram of Trips within Port Blair Municipal Area

Road side interview was conducted at all outer and inner Cordons with the help of police to ascertain the origin and destination of the vehicles. The Table 5.2 shows the OD matrix for all the 47 zones in the study area. It may be seen that vehicles originating from south and south west which forms a major share have destination at the surroundings of Aberdeen Bazaar. Similarly the vehicles originating from North, West also found the destination at the central area of Port Blair (Fig 5.5).

Similarly surveys conducted at the Inner Cordon points have exhibited a desire line diagram as shown in Fig 5.6. The North South movement is highly pronounced. Similarly Chatham Island to Aberdeen Bazaar has significant flow of vehicles.

There is a significant volume of person trips passing through Port Blair (Fig. 5.6). Notable are the movement from Makkaphar to Wimberlygunj; Bamboo flat in the North and Tusnabad in the West. While the North South movement takes place through Port Blair, the South West and South movement takes place through the study area.

Table 5.2 Vehicle Trip in PCU's (Road Side Interview)

O/D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
1	723	997	29	42	208	237	62	125	83	11	42	723	83	42	15	42	10	15	0	0	0	42	0	0	42	42	0	0	0	0	0	0	0	0	0	0	0	0	0	83	0	83	42	0	0	0	0
2	456	2828	46	639	137	162	46	365	776	116	91	1141	25	228	146	182	46	26	0	137	0	0	91	0	91	46	0	0	0	0	0	26	46	0	0	0	0	0	0	91	0	182	0	0	46	0	0
3	128	218	1115	54	28	116	136	154	54	10	27	363	408	56	82	39	26	54	0	54	0	0	0	0	27	82	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	54	0	0	0	0	0
4	156	372	23	386	256	177	87	15	116	9	29	256	93	93	23	170	17	23	0	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	62	25	25	137	647	234	9	25	12	12	50	473	274	162	75	50	112	99	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	12	0	0	12	0	0
6	43	79	26	79	157	773	71	16	94	18	63	519	220	36	31	29	16	16	0	16	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0
7	107	29	398	31	36	21	1443	133	398	22	0	265	0	133	265	129	27	18	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	1227	0	0	0	0	0
8	105	76	15	11	32	46	256	604	229	26	46	61	290	29	15	260	22	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	31	0	0	15	0	0
9	189	85	8	77	15	31	8	131	508	213	15	131	23	28	31	62	38	21	0	8	0	8	0	0	23	23	0	0	0	0	0	39	0	0	8	8	0	0	0	62	0	62	8	0	0	0	0
10	127	18	29	0	139	139	347	0	694	283	139	259	139	130	119	29	29	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	277	0	0	0	0	0	0	0
11	321	161	80	241	563	161	161	1286	321	80	2652	2732	482	643	25	402	161	33	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	559	0	161	0	0	80	0	0
12	46	107	0	99	274	168	91	61	122	23	175	1959	290	137	146	145	14	99	15	30	15	0	38	0	38	15	0	0	0	0	0	16	0	8	0	0	0	0	0	53	0	8	0	0	15	0	0
13	258	29	229	86	515	572	64	200	86	29	143	2661	1803	401	258	86	77	114	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	29	0	0	0	0	114	0	0	0	0	29	0	0
14	139	77	0	97	232	97	10	0	19	19	213	909	252	4102	197	271	29	19	0	0	0	0	0	0	19	19	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0
15	25	126	72	26	52	28	165	19	41	109	22	126	255	167	339	256	55	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
16	697	107	0	214	214	0	134	33	268	332	161	3324	375	590	33	1019	54	54	0	0	0	0	0	0	54	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	59	96	38	0	0	13	3	0	6	0	13	259	52	36	126	113	520	201	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	69	35	69	104	9	5	17	52	35	521	69	69	208	69	764	226	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	36	0	0	0	0	0	12	0	0	4	0	39	0	0	0	0	0	0	0	0	2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	15	122	0	0	0	122	3	5	122	49	0	488	0	0	0	0	0	0	460	3526	560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	22	0	0	0	0	0	1	1	0	6	0	56	0	0	0	0	9	0	0	0	223	256	359	0	311	0	0	0	0	0	0	189	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0
22	19	0	0	0	0	0	30	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	18	0	0	176	0	0	8	0	0	35	59	351	59	0	26	0	0	0	0	0	0	0	351	0	159	188	0	0	0	0	0	0	0	0	159	0	0	0	0	59	0	0	0	0	0	0	0
24	52	0	38	0	0	0	2	0	0	38	0	115	38	0	0	0	0	0	38	38	0	0	0	77	0	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	38	0
25	29	89	44	25	44	0	111	0	221	59	326	354	44	25	0	48	10	54	0	0	89	0	159	102	189	156	25	58	118	122	128	26	0	0	0	0	0	0	0	0	0	0	0	0	44	0	0
26	71	12	131	0	0	0	29	32	197	7	128	66	0	0	92	0	0	0	0	0	0	0	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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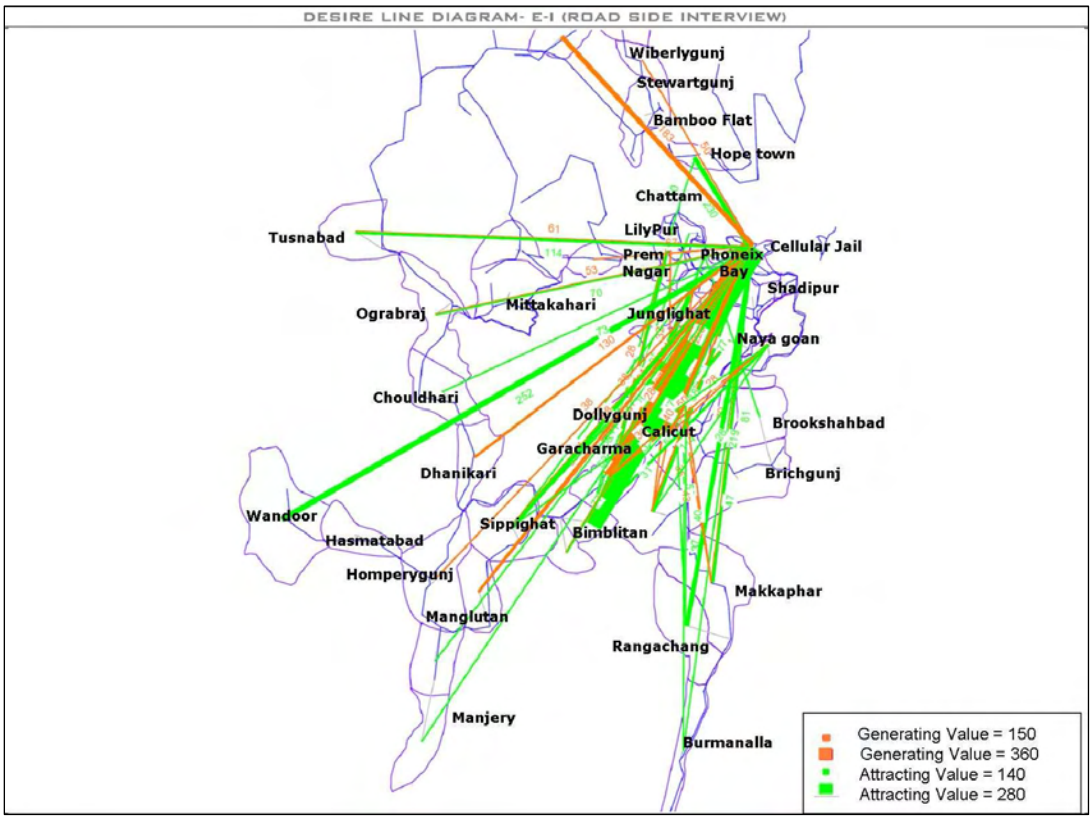

Fig. 5.5 Desire Line Diagram of Trips from Environs to Port Blair

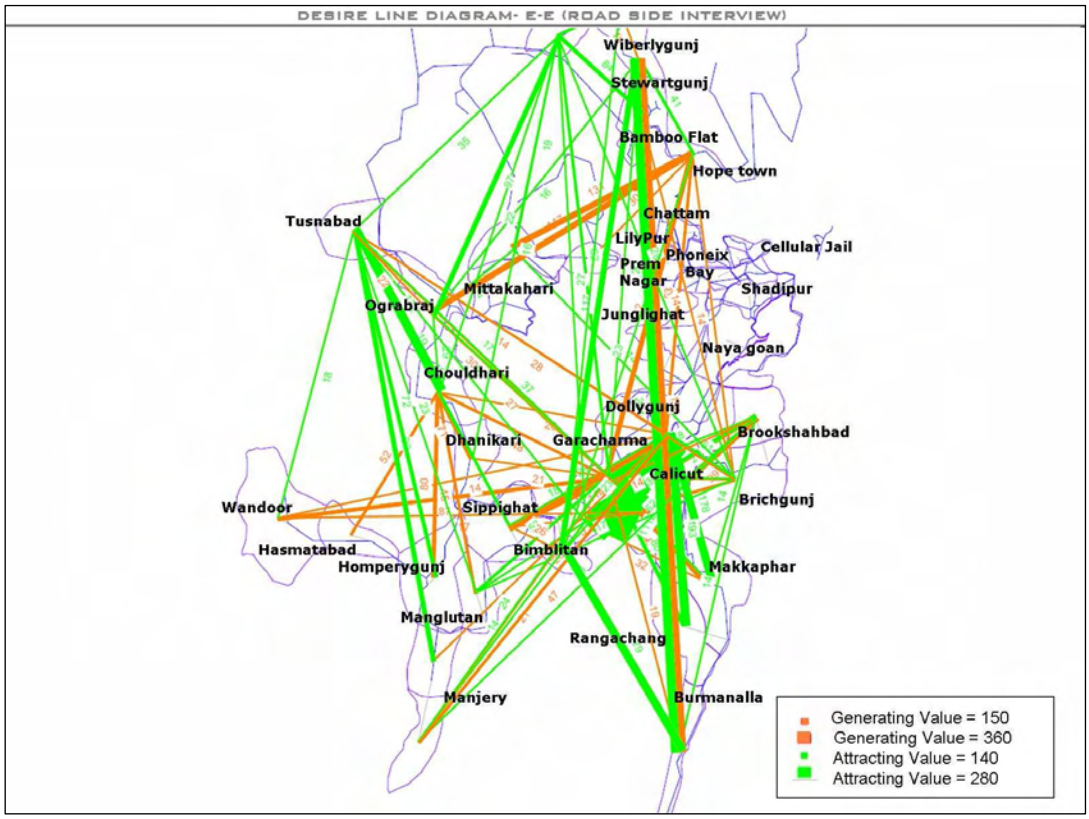

Fig. 5.6 Desire Line Diagram of Trips from Environs and to Environs

CHAPTER 6
SPEED AND DELAY STUDIES

6.1 Journey Speed

Speed and delay studies were conducted using moving car observer method on major roads in Port Blair and Environs. The journey speed in the morning peak hour for major roads is given in Table 6.1. Lower speed was observed in the stretch from Haddo to Bathubasthi and on the stretch from Bathubasthi to Dudh Line. As the traffic flow in these stretches was near and exceeding capacity the observed speeds were low. The speed level on the stretches is also shown in Fig 6.1.

Speed prevailing on the roads in Environs is given in Table 6.2 and in Fig 6.1. Higher speeds were observed on the roads in Environs. The roads are narrow single lane roads with a carriageway width of 4.5 meters. The speed was at low level when the road surface was in very bad condition due to poor road geometrics.

Table 6.1 Journey Speed of Roads in Port Blair Municipal area

Name of the Road	Distance in KM	JOURNEY SPEED (Km/hr)	
		Up	Down
Chatham to Power house	2.55	36.87	36.93
Power house to Light House	0.39	43.33	44.56
Light House to Bengali Club	0.44	46.38	45.52
Bengali Club to Model School	0.30	48.32	47.37
Model School to Raj Nivas	0.09	49.32	49.09
Raj Nivas to M.G.T	0.44	25.24	25.38
M.G.T to Nayagaon Junction	0.97	28.96	37.80
Nayagaon Junction to Dudhline	0.20	37.50	34.29
Dudhline to Chicagoan Junction	2.12	25.04	27.77
Chicagoan Junction to Chorbyncave	0.38	40.71	40.00
Chorbyncave to Austinabad	1.44	27.87	38.06
Austinabad to Prothropobre	0.42	18.00	18.13
Prothropobre to Pathargudde	1.19	35.35	49.58
Pathargudde to Bathubasthi	0.42	24.23	24.47

Table 6.1 Journey Speed of Roads in Port Blair Municipal area *(Contd..)*

Name of the Road	Distance in KM	JOURNEY SPEED (Km/hr)	
		Up	Down
Chatham Junction to Haddo	0.38	48.51	40.71
Haddo to Lillypur Junction	0.40	21.62	28.91
Lillypur Junction to Dhanwantri Junction	0.77	42.00	26.86
Dhanwantri Junction to Delanipur	0.53	15.82	26.72
Delanipur to Prem Nagar	0.27	32.40	41.54
Prem Nagar to Goalghar	0.49	25.57	24.92
Goalghar to Junglighat Junction	0.88	25.88	24.22
Junglighat Junction to Hyat Singh	0.30	41.86	42.86
Hyatt Singh to Diary farm	0.09	38.57	31.76
Diary farm to Airport Junction	0.43	57.33	25.54
Airport Junction to School line	0.98	23.52	25.02
School line to Minibay Junction	0.53	58.89	45.71
Minibay Junction to Dollygunj	0.59	32.78	21.51
Dollygunj to Bathubasthi	1.96	32.76	34.59

Table 6.2 Journey Speeds of Roads in Environs (Outside Port Blair)

Name of the Road	Distance in KM	JOURNEY SPEED	
		Up	Down
Bathubasthi to Pathargudde	0.42	22.91	22.50
Pathargudde to Prothrapur	1.19	46.06	44.91
Bathubasthi to Garacharma	1.86	25.66	27.02
Garacharma to Teylerabad Junction	0.26	48.75	42.16
Teylerabad Junction to Sippighat	2.22	37.31	37.95
Sippighat to Dhanikhari	3.52	32.15	33.42
Dhanikhari to Hompherygunj	0.62	25.66	25.83
Hompherygunj to Manglutan	1.73	40.08	42.72
Manglutan to Indira Nagar Junction	1.36	51.65	59.56
Indira Nagar Junction to Asmathabad	0.88	36.67	45.91
Asmathabad to Lalphar	1.22	24.32	32.97
Lalphar to North Wandoor	1.28	25.10	24.54
North Wandoor to Wandoor Jetty	1.75	41.34	42.68
Wandoor Jetty to Wandoor beach	1.19	27.78	27.78

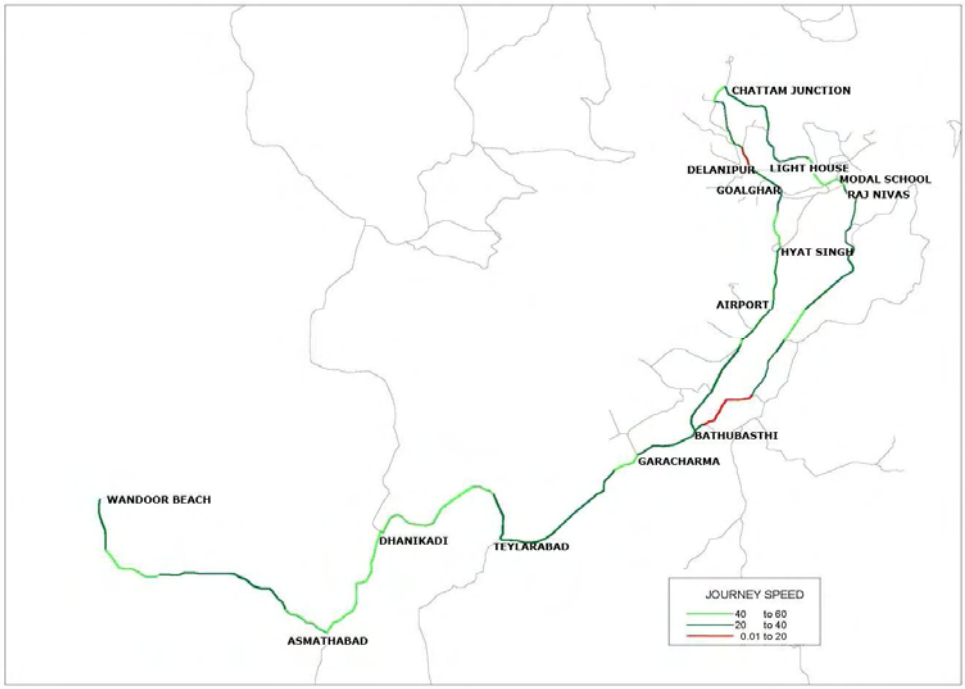

Fig. 6.1 Journey Speeds at road in Port Blair and its Environs

6.2 Speed-Flow Relationship

Speed flow relationship model is essential to evaluate various transport scenarios. The model pertaining to an area reflecting the road geometrics is a basic requirement for transport planning. From the volume data and speed data collected by primary survey Speed-Flow model is built for the Port Blair area. The speed flow model is shown in Fig.6.2. The volume of traffic observed on all the major roads in the study area during Morning Peak hour is shown in Fig.6.3 and Fig.6.4.

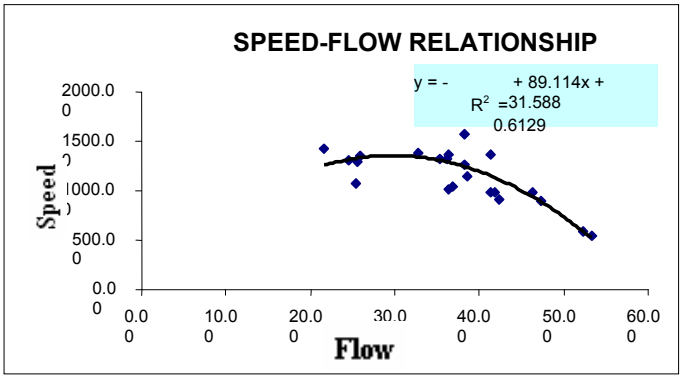

Fig. 6.2 Speed-Flow relationship

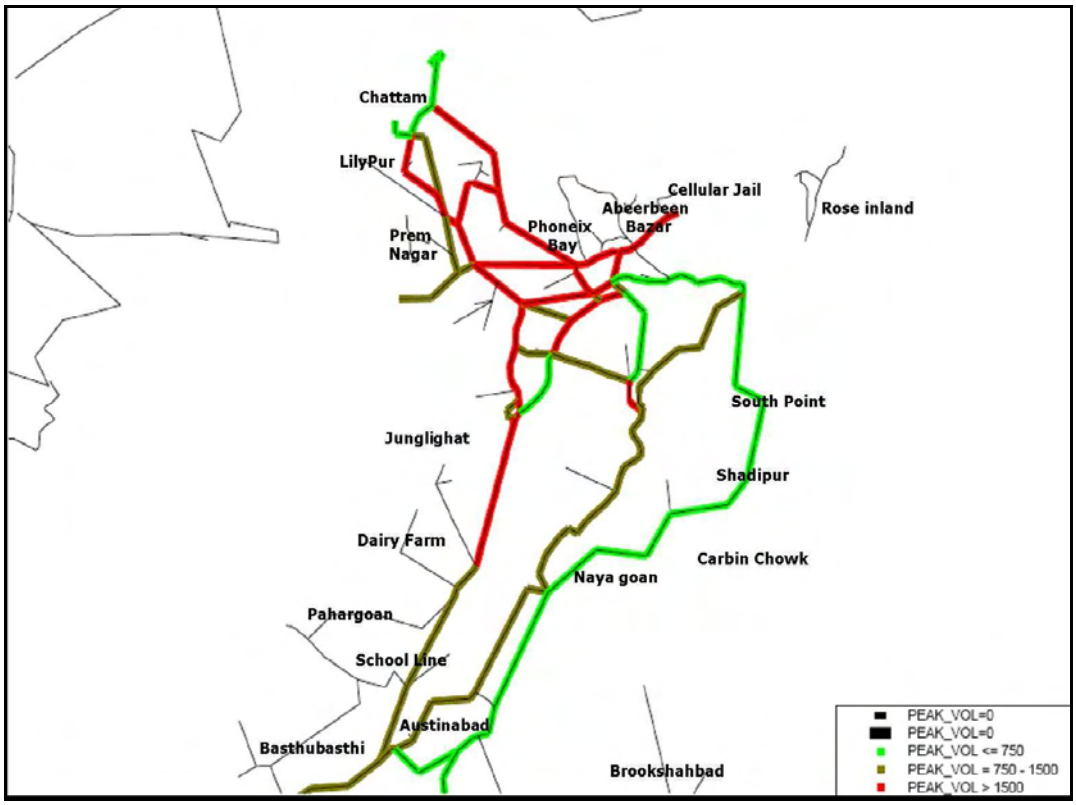

Fig.6.3 Peak Hour Volume on all Major Road in Port Blair

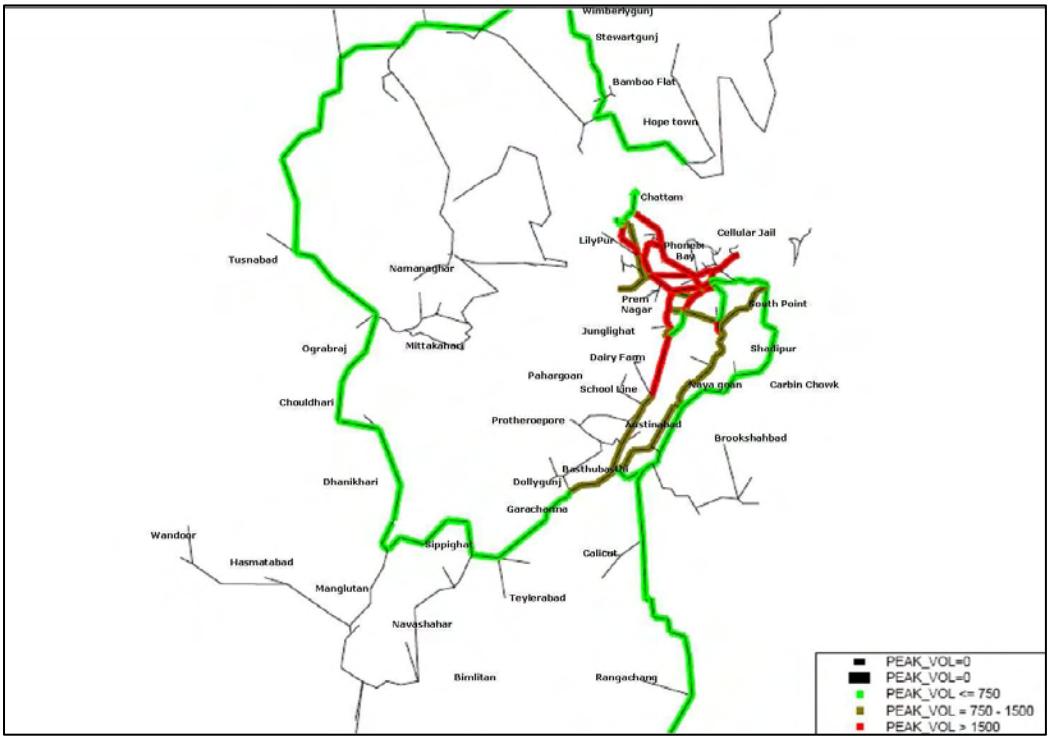

Fig. 6.4 Peak Hour Volume on all Major Road in Port Blair and Environs

CHAPTER 7
INTERSECTION STUDIES

7.0. Introduction

Intersections are crucial to traffic diversion for functional changes at several locations. Often intersections are either manually controlled or signal controlled in order to minimize delay and accidents. The efficiency of the functioning of the intersection depends on the geometrics and the type of control system. Higher the efficiency the lower the delay and therefore intersection improvement schemes are basic part of the Comprehensive Transportation Study. About 15 junctions have been identified to be major junctions as shown in Fig 7.1

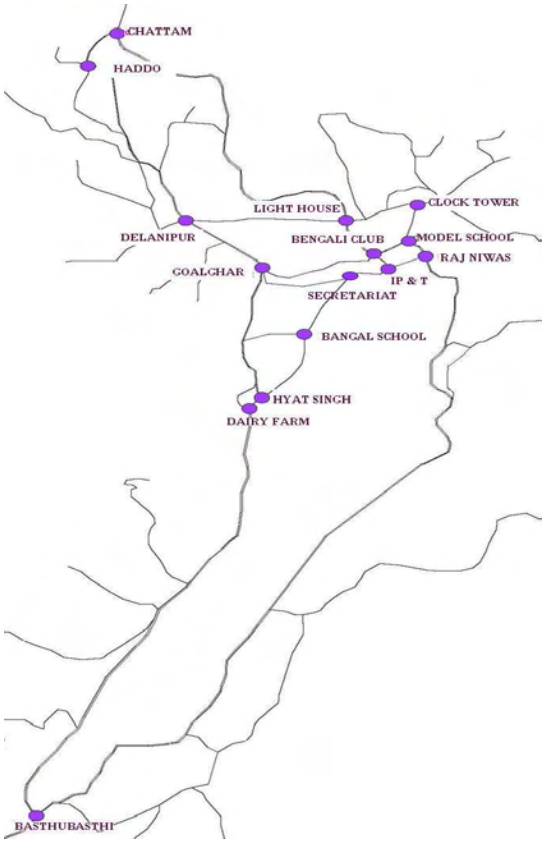

Fig 7.1 Major Intersections in Port Blair

7.1 Dairy farm Junction

It is a three armed ‘T’ junction. It handles a maximum of 1823 PCUS in the morning from 11:45 to12:45 hours and 2147 PCUS in the evening peak hour from 18:00 to 19:00 hours. The Fig 7.2 (a) shows the Traffic Flow pattern in the morning peak hour.

The Hyatt Singh arm and the Garacharma arm carry highest volume of traffic. It is an uncontrolled intersection having a traffic hourly variation as shown in Fig 7.2 (b). The higher volume of traffic handled is during the evening peak that is when the secretariat closes work for the day. Two wheelers occupy a predominant share of 39 percent while cars and auto rickshaws share 29 percent (Fig 7.2(c)). The share of bus is insignificant Fig 7.2(c). The junction qualifies for introduction of signal.

Fig 7.2 (a) Arm wise Flow at Dairy Farm Junction (Morning Peak)

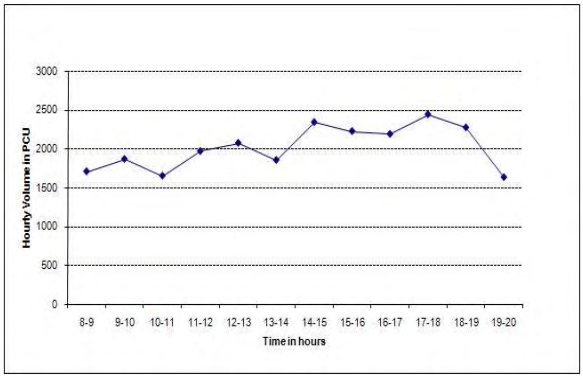

Fig 7.2 (b) Hourly Flow Variations at Dairy farm Junction

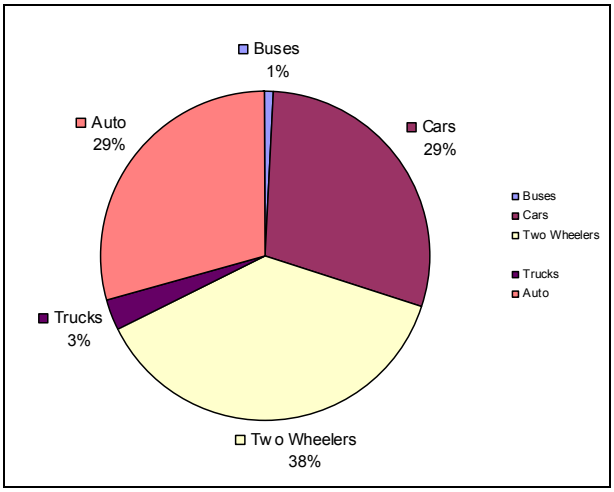

Fig 7.2 (c) Observed Vehicle Composition at Dairy farm Junction

7.2 Hyat Singh Junction

It is an uncontrolled three armed intersection handling a total volume of 2134 in the morning peak from 11:00 to 12:00 hours and 3477 during evening peak from 18:30 to 19:30 hours (Fig 7.3 (a)). Though it is a 'T' junction, the traffic flow observation shows that it is a straight road; connecting Garacharma and Secretariat. The higher volume required is during the evening peak (Fig. 7.3 (b))

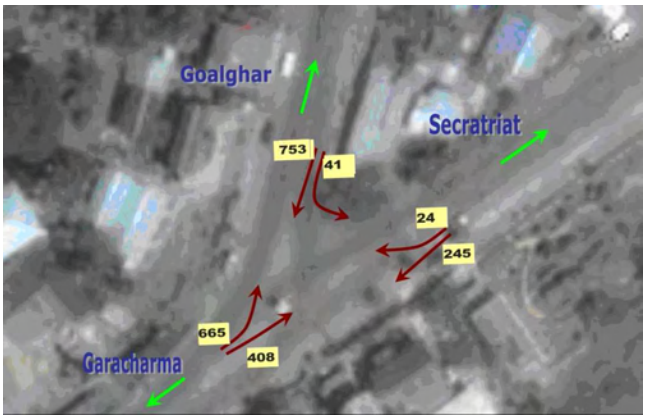

Fig 7.3(a) Arm wise Flow at Hyat Singh Junction (Morning Peak)

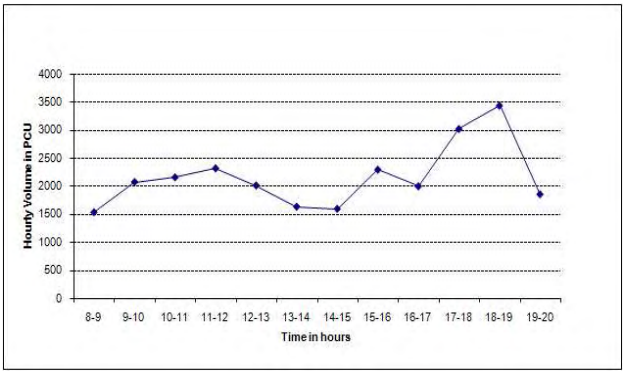

Fig 7.3 (b) Hourly Flow Variations at Hyat Singh Junction

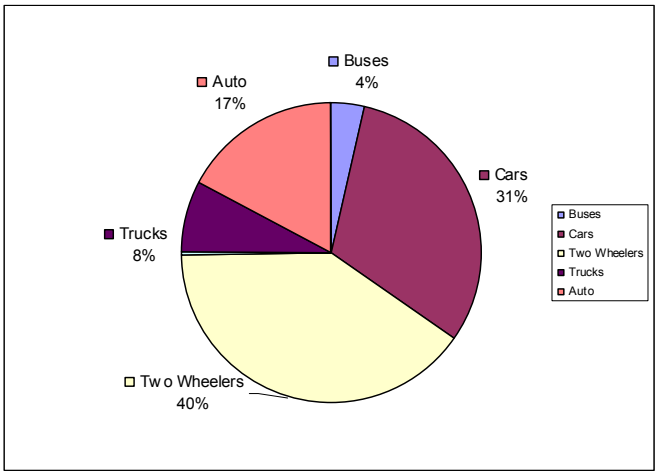

Fig 7.3(c) Observed Vehicle Composition at Hyatt Singh Junction

The predominant share in the composition of vehicles is observed to be two wheelers followed by cars and autos. Buses have 4% share (Fig. 7.3 (c))

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7.3 Bangla School Junction

It is a four armed intersection (Fig. 7.4 (a)) manually controlled, carries a volume of 1801 PCUS during the morning peak hour from 9.15 to 10.15 hours and 1485 PCU during the evening peak hour from 17.15 to 18.15 hours. The evening peak is generally spread out. The Fig. 7.4 (b) shows the hourly variation of traffic. It has registered higher volume during the morning peak 9 am to 10 am.

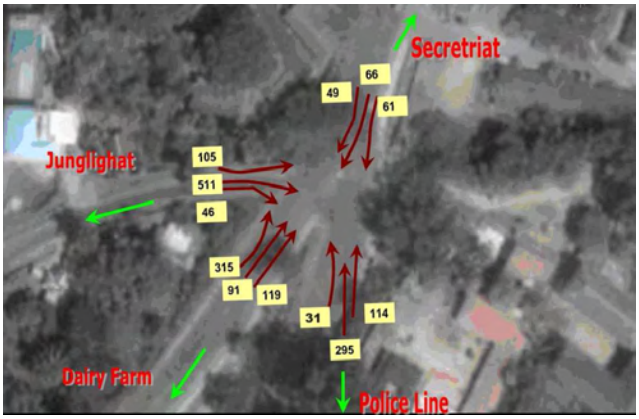


Fig 7.4 (a) Arm wise Flow at Bangla School Junction (Morning Peak)

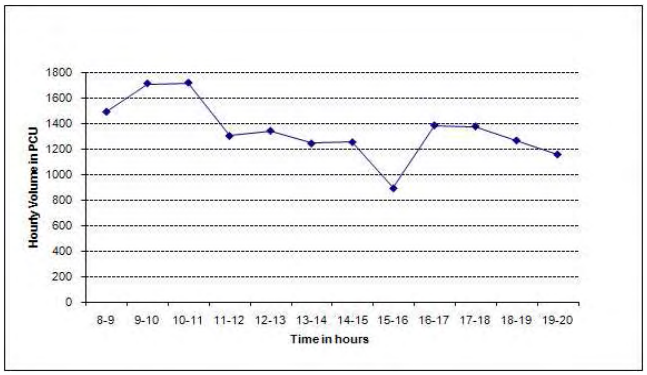


Fig 7.4 (b) Hourly Flow Variations at Bangla school Junction

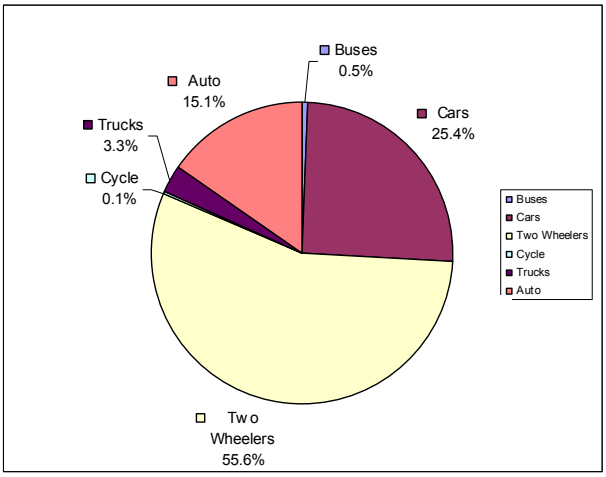


Fig 7.4 (c) Observed Vehicle Composition at Bangla School Junction

The vehicular composition indicates (Fig 7.4 (c)) that 57% of the vehicles are two wheelers and 25% cars. Auto rickshaws share 15% of the traffic. Heavy vehicles composition is found to be only to an extent of 3 percent. Buses share is practically nil.

7.4 Secretariat Junction

It is a four armed junction manually controlled. It handles a volume of 1457 - PCUS in the evening peak from 14.00 to 15.00 hours (Fig. 7.5 (a)). It is observed that this junction experiences two distinct peaks. One around 10 – 11 am and another at 2.00 – 3.00 hours (Fig 7.5 (b))

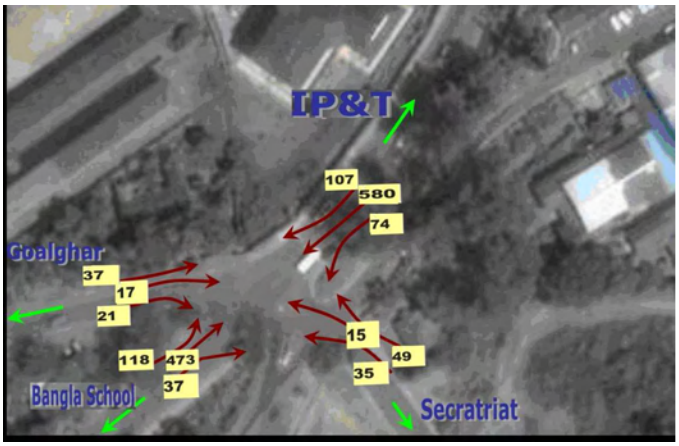


Fig 7.5 (a) Arm wise Flow at Secretariat Junction (Morning Peak)

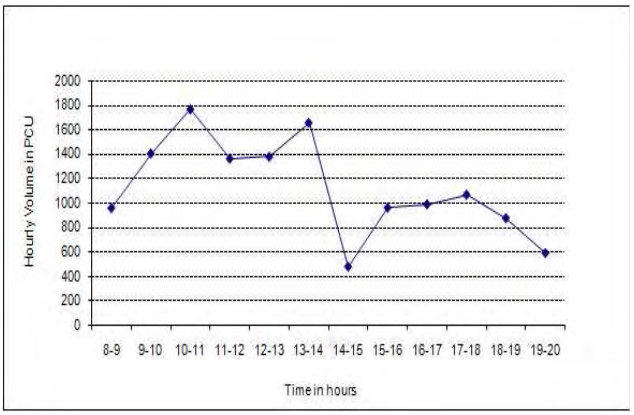


Fig 7.5 (b) Hourly Flow Variations at Secretariat Junction

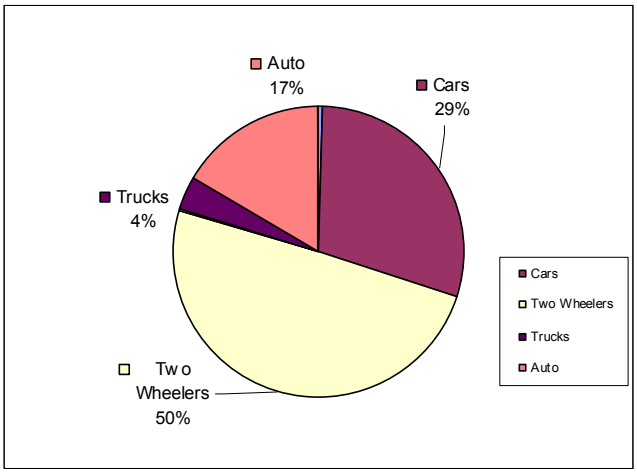


Fig 7.5 (c) Observed Vehicle Composition at Secretariat Junction

The vehicular composition in this case is 50% two wheelers and 29 percent cars followed by auto rickshaws (17%) (Fig 7.5 (c)).

7.5 IP & T Junction

It is four armed junction with a moderate flow of traffic (Fig 7.6 (a)). The traffic flow is more in the North South direction. It handles traffic of 2229 PCUS during morning peak from 8.30 to 9.30 hours and 1538 PCUS during evening peak hour from 12:00 to 13:00 hours. The traffic flow hourly variation is as shown in (Fig 7.6 (b)) having a pronounced peak spreads one or two hours 9 – 11 am.

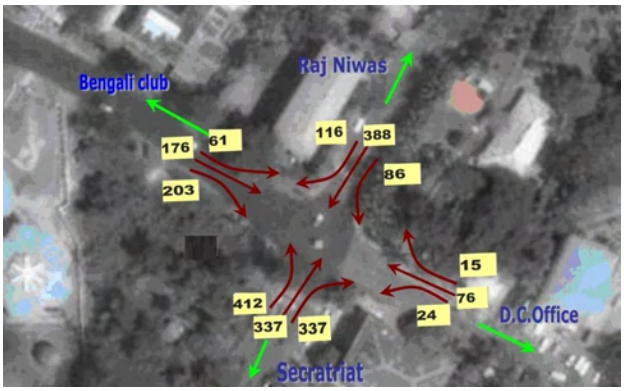


Fig 7.6 (a) Arm wise Flow at IP & T Junction (Morning Peak)

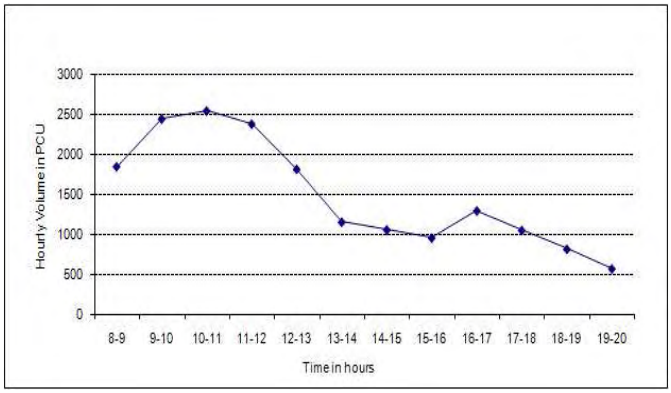


Fig 7.6 (b) Hourly Flow Variations at IP & T Junction

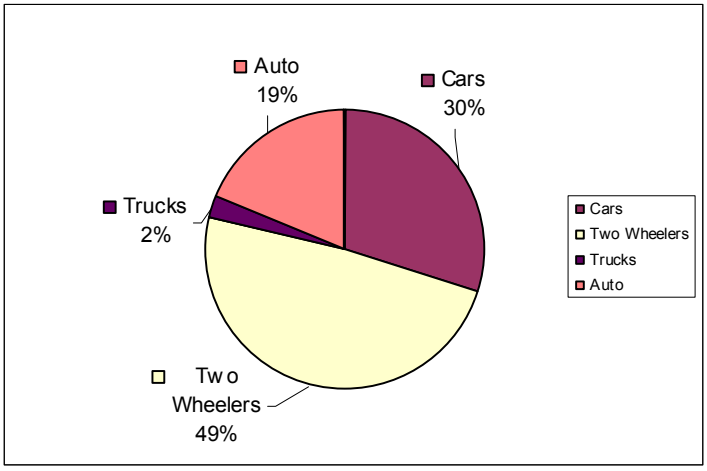


Fig 7.6 (c) Observed Vehicle Composition at IP & T Junction

The vehicular composition (Fig 7.6 (c)) shows that two wheelers share 49 percent is the highest, followed by cars 30 percent and Auto rickshaws form (19 percent).

7.6 Raj Nivas Junction

It is a four armed junction having 1554 PCUS during morning peak from 9:15 to 10:15 hours and 1259 PCUS during evening peak hour from 17:15 to 18:15 hours (Fig 7.7 (a)). Its flow is highly pronounced in the morning peak and reduces towards evening (Fig 7.7 (b). The evening peak is spread out compared to morning peak.

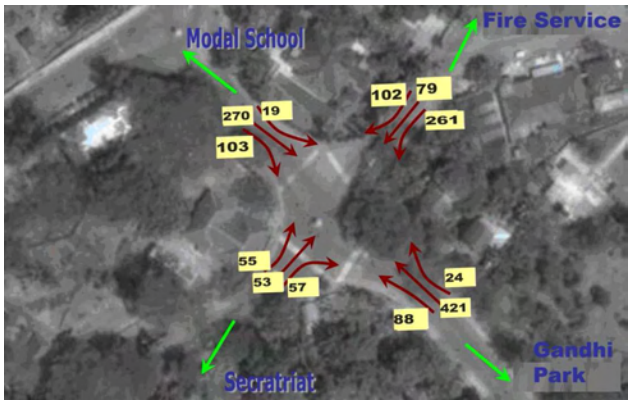


Fig 7.7 (a) Arm wise Flow at Raj Nivas Junction (Morning Peak)

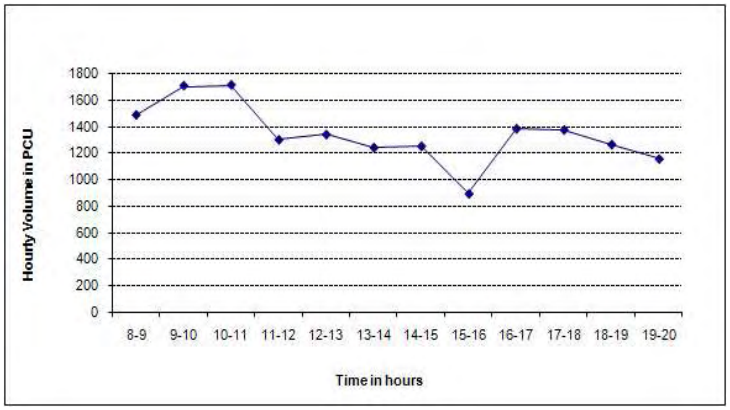


Fig 7.7 (b) Hourly Flow Variations at Raj Niwas Junction

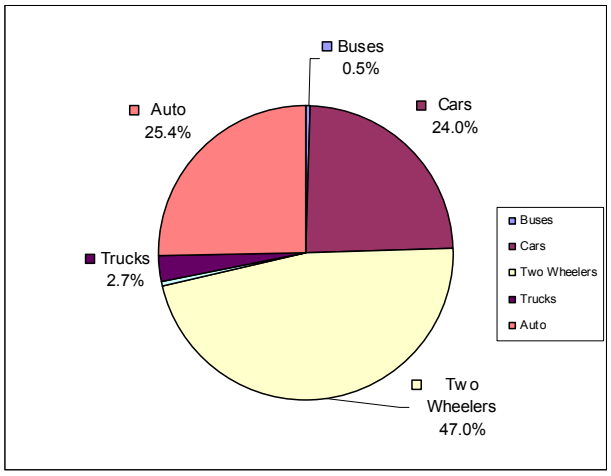


Fig 7.7 (c) Observed Vehicle Composition at Raj Niwas Junction

The vehicular composition (Fig 7.7 (c)) shows that the share of two wheelers is the highest (48%) followed by auto rickshaws (25%) and cars (24%).

7.7 Model School Junction

It is an important T section handling a volume of 3466 PCUS in the morning peak from 8.45 to 9.45 hours and 3174 PCUS in the evening peak from 16:00 to 17:00 hours (Fig 7.8 (a)). It handles huge volume when compared to many other junctions. The peak flows are highly pronounced both in the morning and evening (Fig 7.8 (b)).

Fig 7.8(a) Arm wise Flow at Model school Junction (Morning Peak)

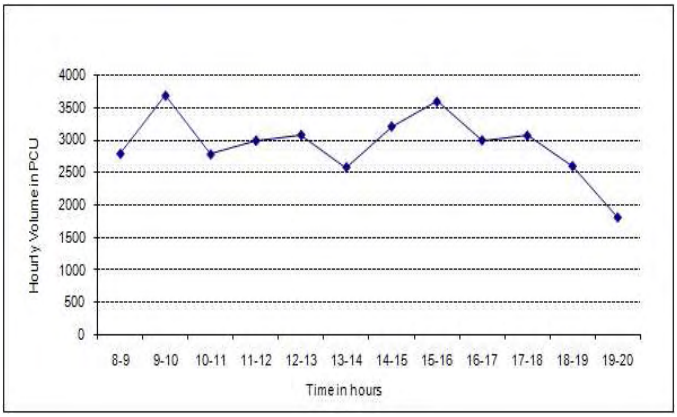


Fig 7.8 (b) Hourly Flow Variations at Model school Junction

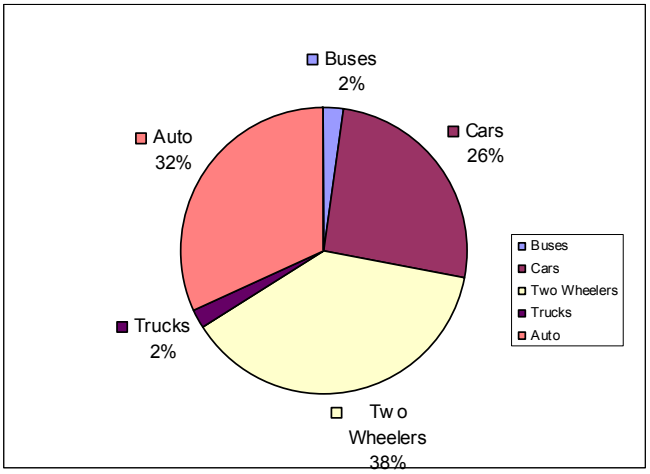


Fig 7.8 (c) Observed Vehicle Composition at Model school Junction

The vehicular composition (Fig 7.8 (c)) shows that 38% is of two wheelers followed by Auto rickshaws (32%) and cars (26%). Being at a commercial location, the share of Auto rickshaws is highly pronounced.

7.8 Goalghar Junction

It is one of the important four armed intersection manually controlled. Though the traffic handled is more during evening peak period compared to morning peak (Fig 7.9 (a)). The flow during morning and evening is well over 3,000 PCUS. The hourly variation of traffic (Fig 7.9 (b)) shows it remains to be at a higher level except during afternoon, with pronounced morning and evening peaks.

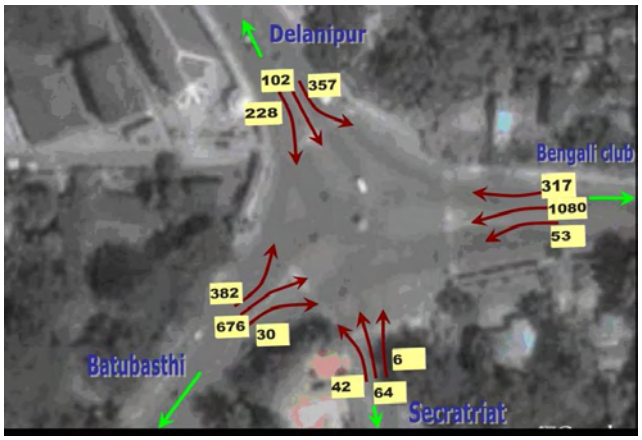


Fig 7.9 (a) Arm wise Flow at Goalghar Junction (Morning Peak)

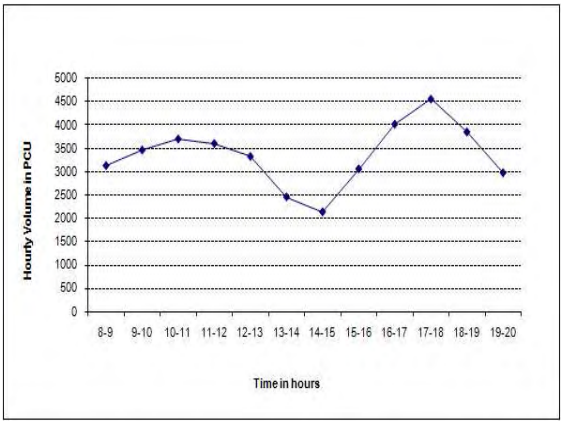


Fig 7.9 (b) Hourly Flow Variations at Goalghar Junction

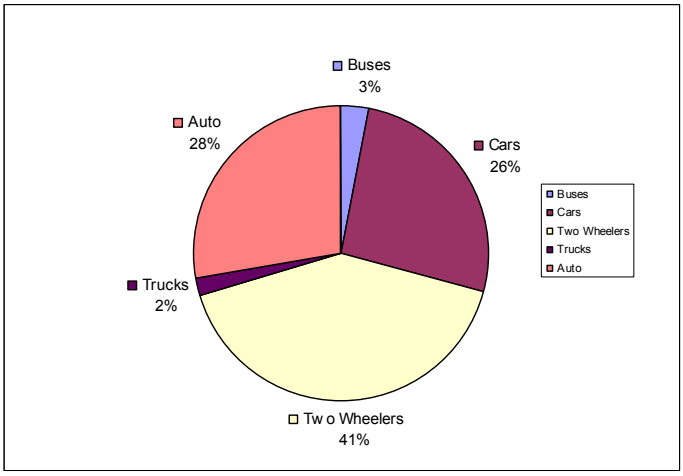


Fig 7.9 (c) Observed Vehicle Composition at Goalghar Junction

The vehicular composition shows (Fig 7.9 (c)) that 41% of the vehicles are two wheelers followed by Auto rickshaws (28%) and cars (26%). A share of 3% is certified by buses.

7.9 Bengali Club Junction

It is four armed junction complemented by rotaries to regulate traffic with police control. It is a very important junction handling a huge volume of 4902 PCUS in the morning peak from 9:00 to 10:00 and 3185 PCUS in the evening peak hour from 17:00 to 18:00 hours (Fig 7.10 (a)). The hourly variation of traffic shows that the peak which is highly pronounced gets drastically reduced towards evening (Fig 7.10(b)).

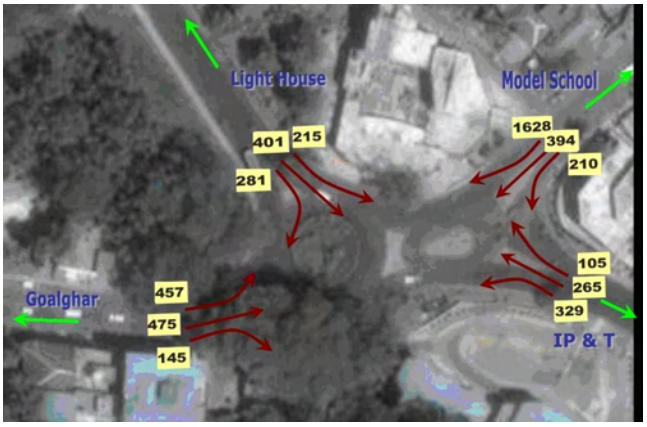


Fig 7.10 (a) Arm wise Flow at Bengali Club Junction (Morning Peak)

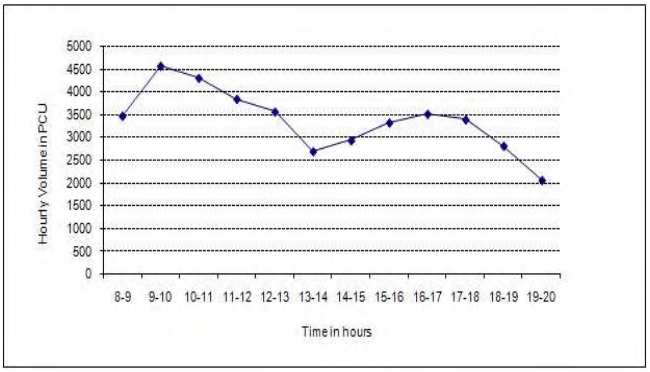


Fig 7.10 (b) Hourly Flow Variations at Bengali Club Junction

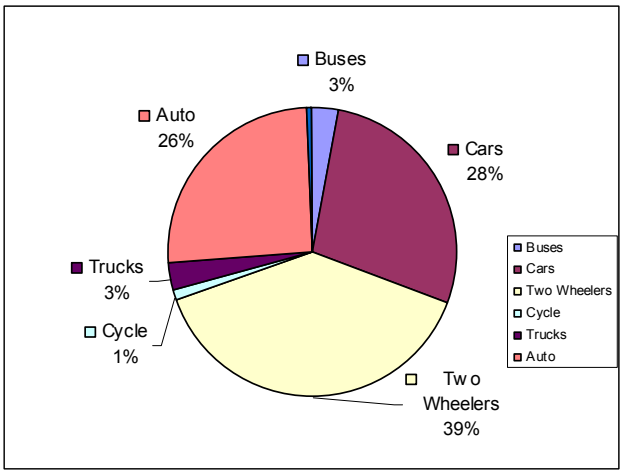


Fig 7.10 (c) Observed Vehicle Composition at Bengali Club Junction

The vehicular composition shows 39% of two wheelers followed by cars (28%) and 26% Auto rickshaws. This junction handles 3% of buses and trucks each (Fig 7.10 (c)).

7.10 Light House Junction

It is a four armed signalized junction handling a very high traffic. It is one of the busiest junctions (Fig 7.11 (a)). It handles a huge volume of 4055 PCUS in the morning from 11:15 to 12:15 hours and 3644 PCUS in the evening peak hours from 12:00 to 13:00 hours. The North South movement of traffic is highly pronounced.

The hourly variation of traffic (Fig 7.11 (b)) shows that after the morning peak, the traffic drastically reduces and the evening peak is spread over a long period.

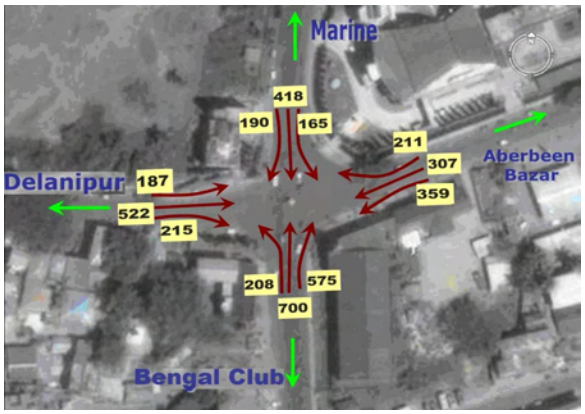


Fig 7.11 (a) Arm wise Flow at Light House Junction (Morning Peak)

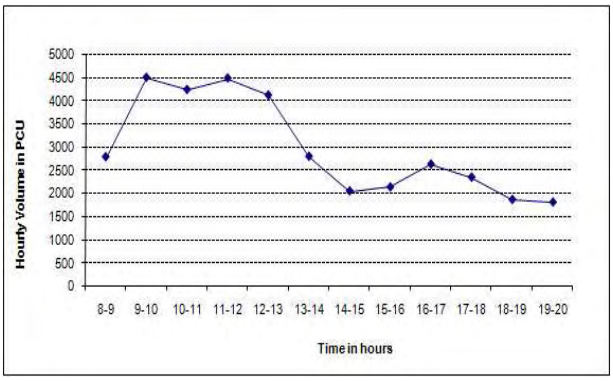


Fig 7.11 (b) Hourly Flow Variations at Light House Junction

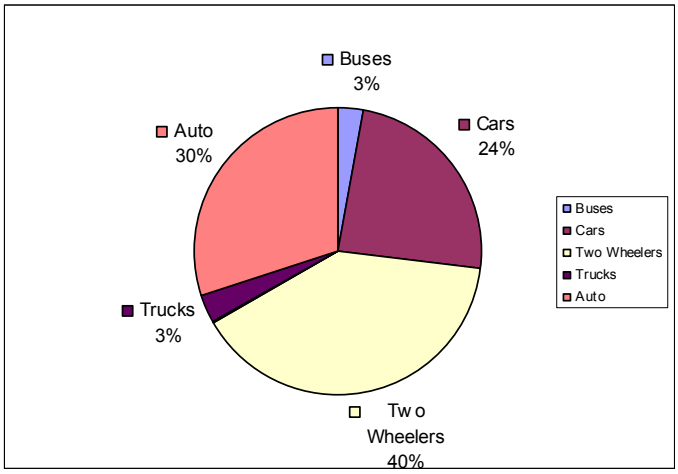


Fig 7.11 (c) Observed Vehicle Composition at Light House Junction

The vehicular composition of vehicle at the intersection indicates a major share of 40% is two wheelers followed by Auto rickshaws (30%), cars (24%) and buses (3%) (Fig.7.11(c))

7.11 Delanipur Junction

It is one of the major junctions handling heavy volume of traffic. It is a (Fig 7.12 (a)) four armed junction having highest flow in the North South direction. The morning peak volume 2978 PCUS marginally less compared to the noon peak. The morning and evening peak flows are almost equal (Fig 7.12 (b)).

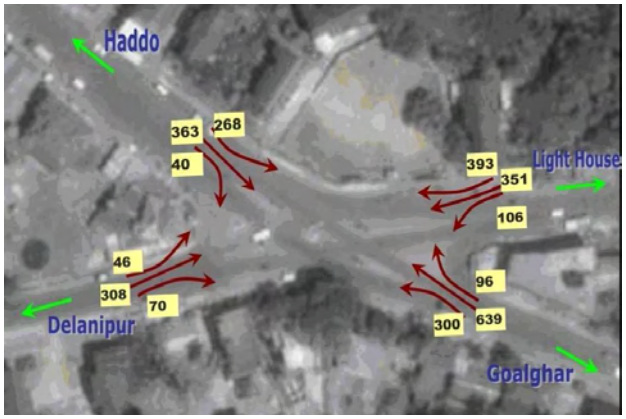


Fig 7.12 (a) Arm wise Flow at Delanipur Junction (Morning Peak)

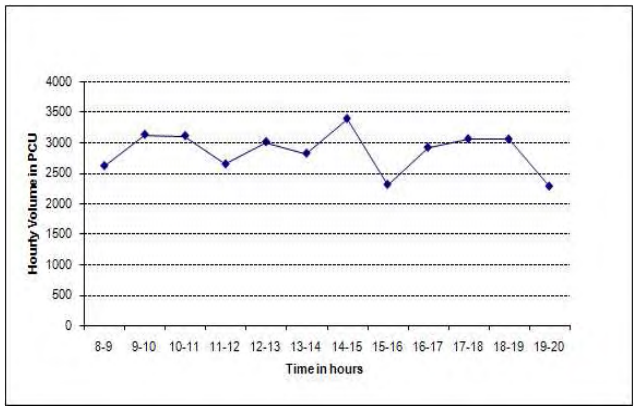


Fig 7.12 (b) Hourly Flow Variations at Delanipur Junction

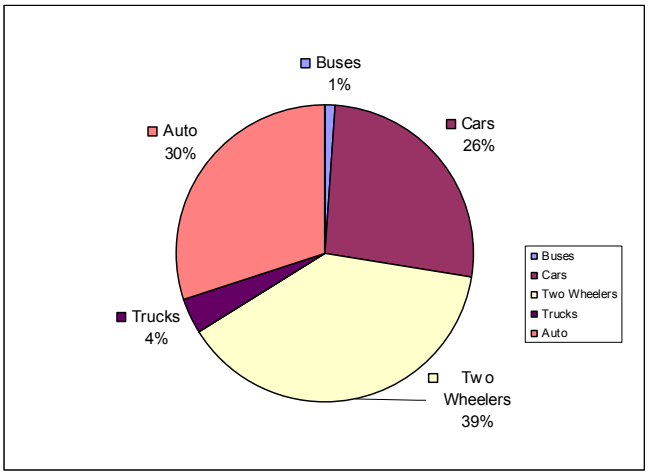


Fig 7.12 (c) Observed Vehicle Composition at Delanipur Junction

The vehicular composition shows that a major share is occupied by two wheelers (39%) followed by Auto rickshaws (30%) and cars (26%).

7.12 Haddo Junction

It is 'W' junction primarily catering to Chatham jetty and Haddo jetty. The volume of traffic handled by this intersection (Fig 7.13 (a)) during morning peak from 7.30 to 8.30 hours is in the order of 1042 PCUS and 798 PCUS in the evening peak hour from 19:00 to 20:00 hours. It is an uncontrolled intersection. The hourly variation of traffic shows two distinct peaks one in the morning and one in the evening. The traffic depends on the Ferry operations both in the morning and evening (Fig 7.13 (b)).

Fig 7.13 (a) Arm wise Flow at Haddo Junction (Morning Peak)

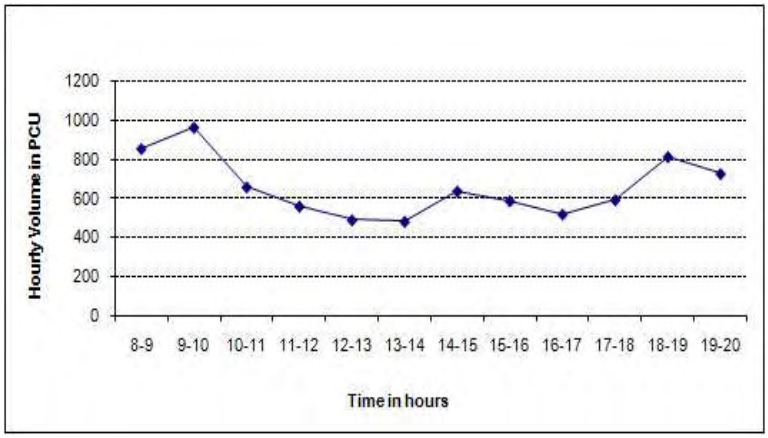


Fig 7.13 (b) Hourly Flow Variations at Haddo Junction

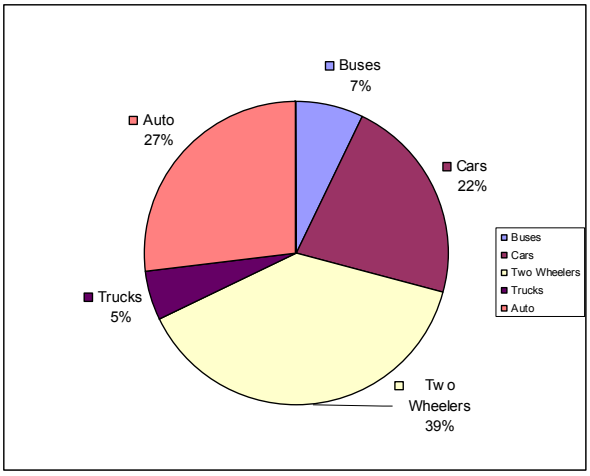


Fig 7.13 (c) Observed Vehicle Composition at Haddo Junction

The vehicular composition shows a 39% share of two wheelers followed by 27% Auto rickshaws and 22% cars (Fig 7.13 (c)). This junction also handles a share of 7% of buses which indicates the nearness of the junction to the Bus terminal and its importance.

7.13 Chatham Junction

It is one of the minor three armed junctions handling 604 PCUS in the morning peak from 8.00 to 9.00 hours and 523 PCUS during evening peak hour from 17:15 to 18:15 hours (Fig 7.14 (a)) day at a reduced rate compared to morning peak hour (Fig 7.14 (b)).

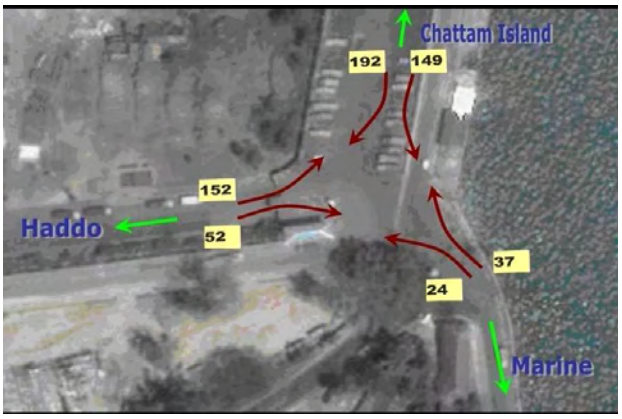


Fig 7.14 (a) Arm wise Flow at Chatham Junction (Morning Peak)

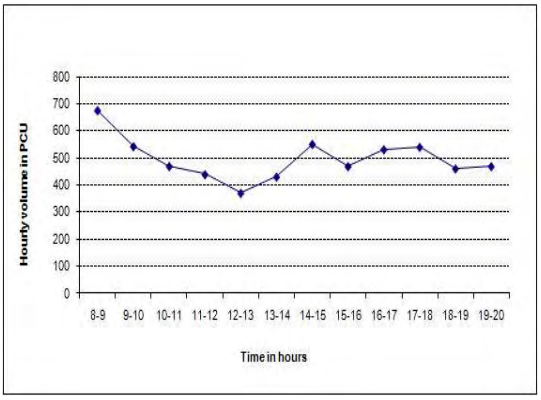


Fig 7.14 (b) Hourly Flow Variations at Chatham Junction

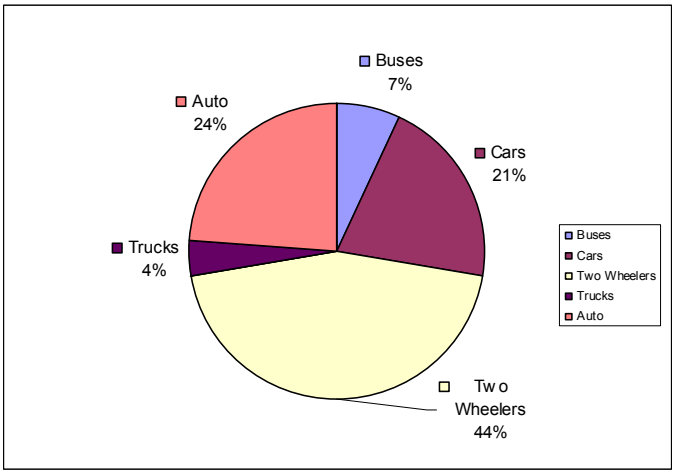


Fig 7.14 (c) Observed Vehicle Composition at Chatham Junction

The vehicular composition shows a very high share of 44% of two wheelers followed by Auto rickshaws (24%) and cars (21%). This junction also handles a share of 7% of buses (Fig 7.14 (c))

7.14 Clock Tower Junction

It is a three armed junction manually controlled handling a significant volume of traffic. It handles 2425 PCUS during the morning peak from 10.30 to 11.30 hours and 2528 PCUS in the evening peak from 19:00 to 20:00 hours (Fig 7.15 (a)). The traffic flow is significantly high towards the Light House side. The distribution of traffic (Fig 7.15 (b)) shows distinct peak both in the morning and evening peak with a marginal reduction during 14 to 15 hours.

Fig 7.15 (a) Arm wise Flow at Clock Tower Junction (Morning Peak)

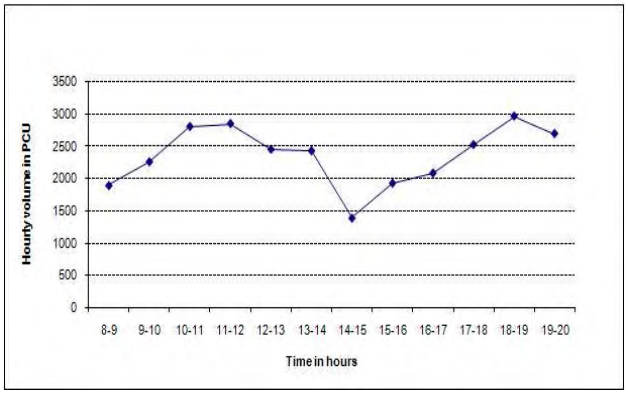


Fig 7.15 (b) Hourly Flow Variations at Clock Tower Junction

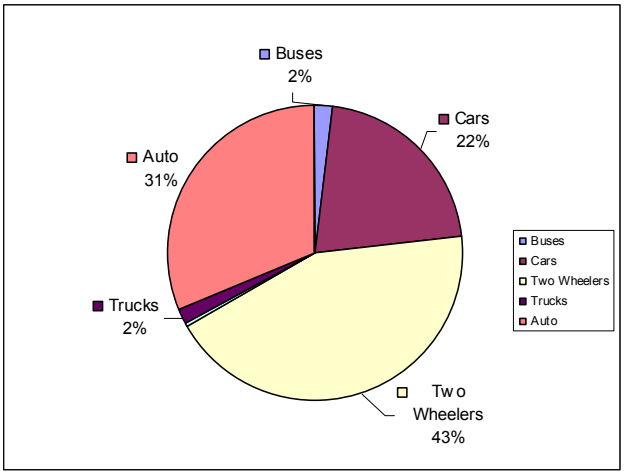


Fig 7.15 (c) Observed Vehicle Composition at Clock Tower Junction

The vehicular composition shows a vast share belongs to two wheelers (43%) followed by Auto rickshaws (31%) and cars (22%) (Fig 7.15 (c)).

7.15 Bathubasthi Junction

It is a 'T' junction handling a significant volume of traffic. It handles 1234 PCUS in the morning peak from 8:30 to 9:30 hours (Fig 7.16 (a)) and 1422 PCUS during the evening peak from 18:45 to 19:45 hours. The flow is more pronounced towards Dairy Farm. The flow gets reduced from morning peak and rises during the evening peak (Fig 7.16 (b)).

Fig 7.16 (a) Arm wise Flow at Bathubasthi Junction (Morning Peak)

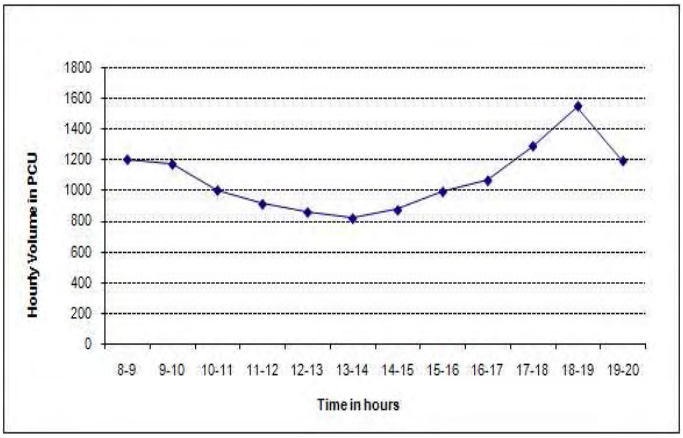


Fig 7.16 (b) Hourly Flow variations at Bathubasthi Junction

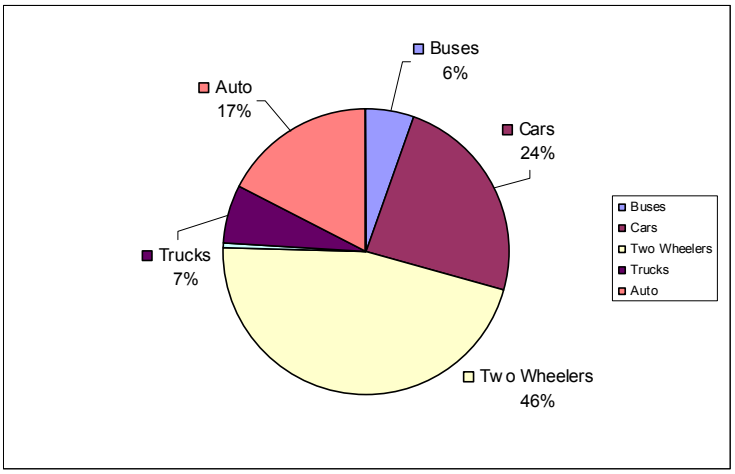


Fig 7.16 (c) Observed Vehicle Composition at Bathubasthi Junction

The vehicular composition indicates that a major share 46% is constituted by two wheelers followed by cars (24%) and Auto rickshaws (17%) (Fig 7.16 (c))

The peak hour traffic flow observed during the morning and evening peak hours and traffic composition for the major junctions are given in Table 7.1.Cycle traffic is almost absent due to the difficulty in riding on a undulating terrain. The Traffic flows in the Peak hour for the major junctions are given in Annexure A.

Table 7.1 Traffic Flow Characteristics at Junctions

Sl. No	Name of the Junction	Traffic flow		Vehicular Composition					
		Morning Peak in PCUS	Evening Peak in PCUS	Two wheeler	Cars	Auto Rickshaw	Truck	Bus	Cycle
1.	Dairy farm	1823	2147	38	29	29	3	1	-
2.	Hyat Singh Junction	2134	3774	40	31	17	8	4	-
3.	Bangla school Junction	1801	1485	57	25	15	3	-	-
4.	Secretariat Junction	1559	1451	50	29	17	4	-	-
5.	IP & T Junction	2229	1538	49	30	19	2	-	-
6.	Raj Nivas Junction	1554	1259	48	24	25	3	-	-
7.	Model school Junction	3466	3174	38	26	32	2	2	-
8.	Goal Ghar Junction	3336	3958	41	26	28	2	3	-
9.	Bengali Club Junction	4902	3185	39	28	26	3	3	1
10.	Light House Junction	4055	3644	40	24	30	3	3	-
11.	Delanipur Junction	2978	3090	39	26	30	4	1	-
12.	Chatham Junction	1042	798	39	22	27	5	7	-
13.	Haddo Junction	604	523	44	21	24	4	7	-
14.	Clock Tower	2425	2528	43	22	31	2	2	-
15.	Bathubasthi	1234	1422	46	24	17	7	6	-

Conclusion

1. Port Blair having 43, 000 vehicles are yet to classify itself as a major urban area.
2. The flow levels observed during morning and evening peak at all the 15 importance junctions varied from 522 PCUS to 4902 PCUS.
3. As per IRC none of the intersections qualify for a grade separator on traffic grounds. However on the topography and physical configuration aspect of the junctions, the following junctions viz Light House junction, Bengali club and Goalghar junction may be considered qualifying for a grade separator.
4. Almost 80% of the traffic is constituted by two wheelers (50%) and Auto rickshaws (30%). If these vehicles are replaced by way of shifting the passengers to an effective Mass Transport Facility and to certain extent cars, the roads and junction can function effectively for most years to come.
5. Very few junction handle Buses. The public transport plays a very minor role within overall traffic and transport scenario.
6. Trucks occupy a significant share with total traffic even during peak period.
7. All the junctions call for signal design eliminating manual control.

CHAPTER 8
PARKING STUDIES

Port Blair and its environs having above 43,176 vehicles face acute parking problem. Being a hilly terrain, the width of the roads is already narrow and invariably the road margins act as on street parking lots. The common scene is that on all major roads, on street parallel parking is prevalent (Fig. 8.1). Only at two locations small scale off street parking exists.

A 12 Hour survey was conducted along the following stretches (Fig. 8.2) to find out, parking accumulation, parking duration etc.

Table 8.1 Parking Stretches in Port Blair

Sl. no	Name of the Stretch	Distance in meters
1	Lillypur to Haddo	400
2	Delanipur to Lillypur	1300
3	Goalghar to Delanipur	760
4	Goalghar to Junglighat	880
5	Hyat Singh Junction to Junglighat	430
6	Delanipur to Light House	1400
7	Light House to Clock Tower	580
8	Clock Tower to Aberdeen	700
9	Aberdeen Bazaar to Cellular Jail	740
10	Modal School to Clock Tower	360
11	Bengali Club to Modal School	320
12	Bengali club to Goalghar	740
13	Bangla School to Hyat Singh Junction	1180
14	Annapurna to Clock Tower (Lane)	380

The parking accumulation and duration of parking of vehicles for the stretch Bengali Club to Goalghar is shown in Fig 8.3 and Fig 8.4. Similarly the parking accumulation and duration of parking for all the study stretches are shown as tables in Annexure B.

Fig. 8.1 On-street parking on the Major Roads in CBD

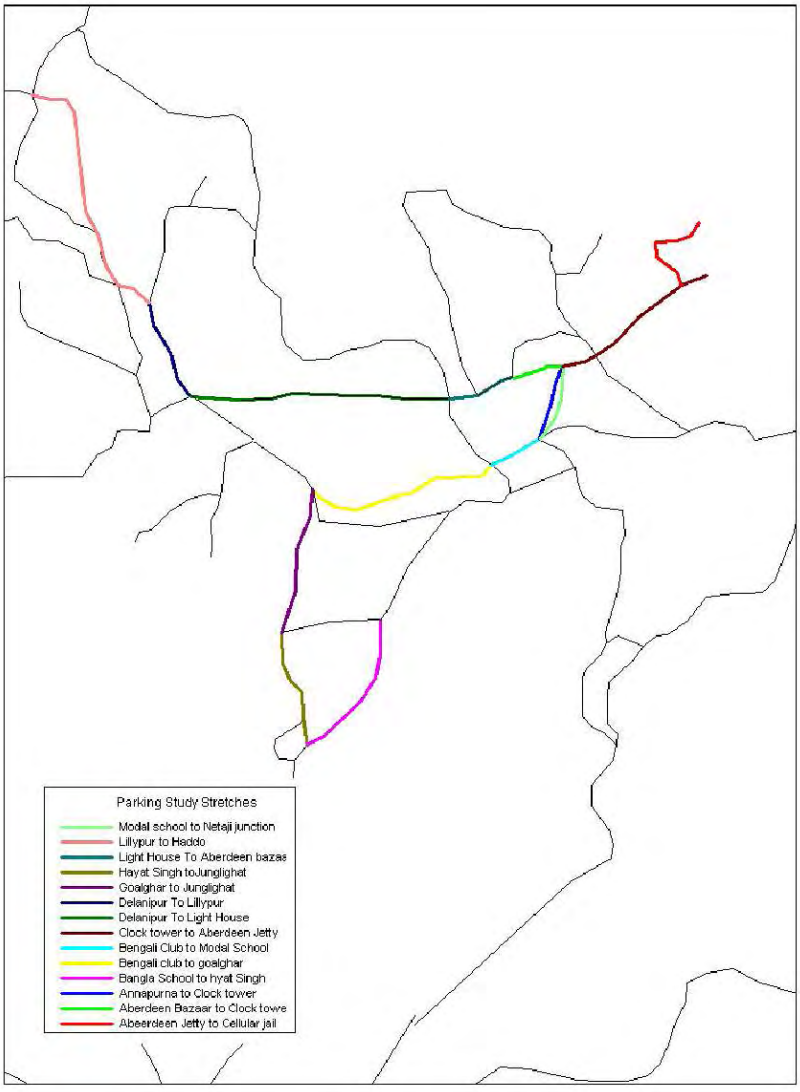


Fig 8.2 Parking Study Stretches

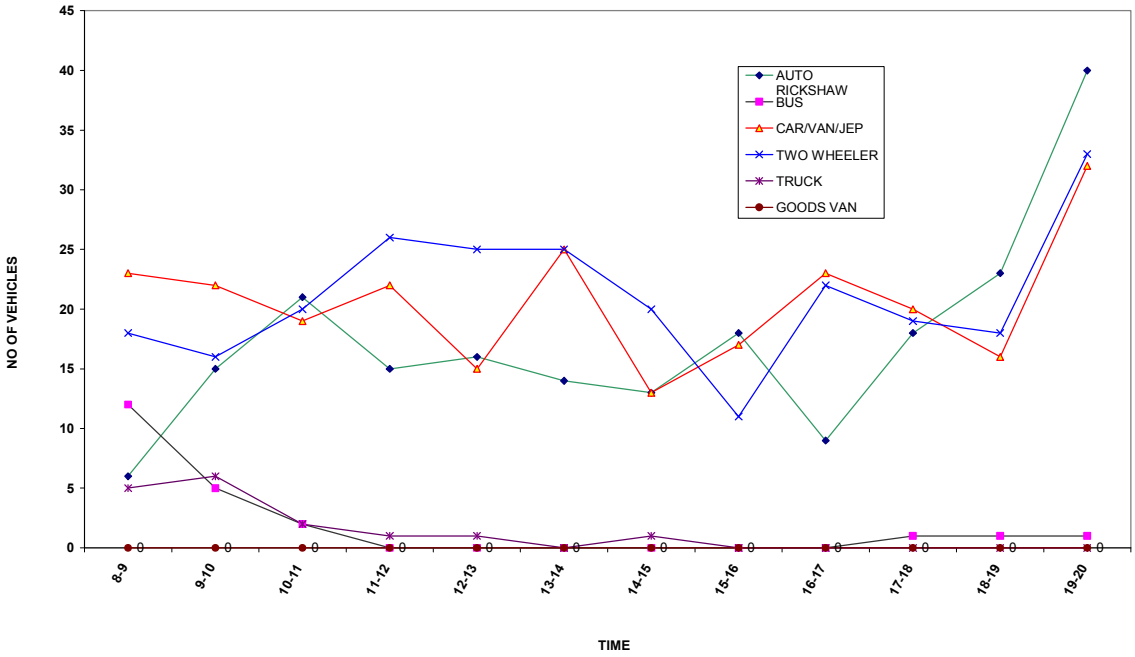


Fig.8.3 Parking Accumulation- Bengali club to Goalghar

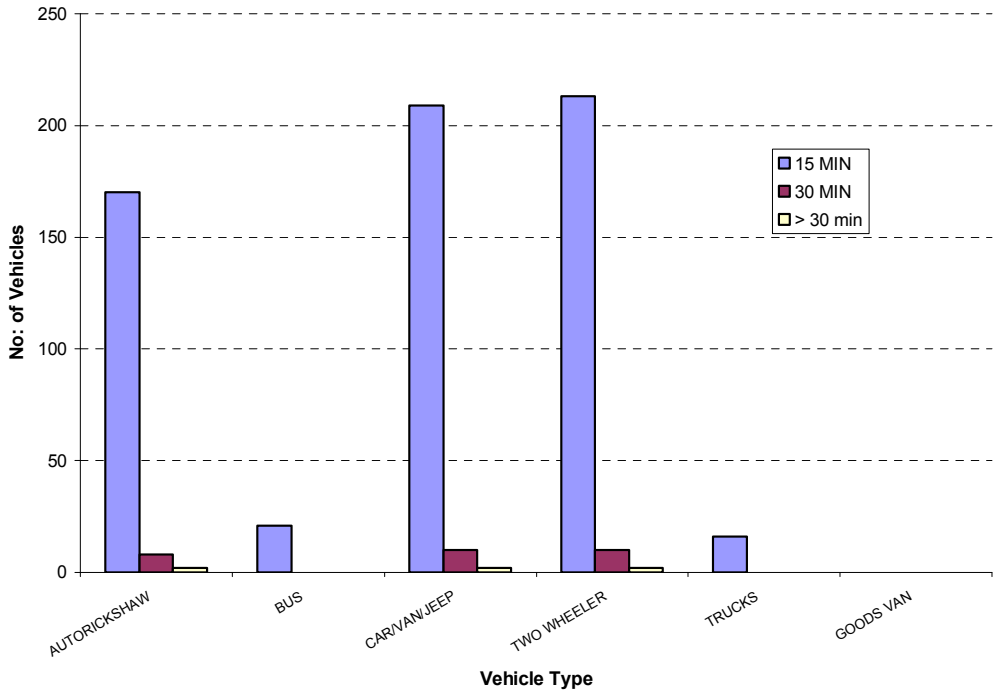


Fig. 8.4 Parking Duration– Bengali Club to Goalghar

Conclusion

- Parking is one of the major problems in spite of the fact that there are only 43000 vehicles. The intensity of the problem is more due to the narrow inherited road network in CBD.
- 'On Street' parking is practiced for all kind of vehicles.
- Port Blair being tourist-attracting town has large number of IPT vehicles parked on the roadside.
- Even the busy commercial area (Aberdeen market) does not have off street parking resulting in chaotic roadside parking.
- In majority of cases, the parking is of short duration less than 30 minutes. 90 to 95 % Parking is short duration (< 30 minutes)
- As on today parking fee is not collected at any of the locations.
- There is an urgent need for developing off street parking at least at a few locations to make the narrow road network free from interference.
- As Parking is practiced on both sides of road, it is the reason for delay and accidents
- Parking Problem is predominant at Aberdeen Bazaar, Junglighat, Cellular Jail & Delanipur areas.

CHAPTER 9
INTERMEDIATE PUBLIC TRANSPORT

The Autorickshaws have showed tremendous increase from the year 1998 and have become an integral part of urban transport in Port Blair. The Auto Rickshaws numbering 1840 in 2006 have a role to play in the passenger transport sector. In order to appreciate the characteristics of the Auto Rickshaws in terms of driver, vehicle, operation, and area of operation a detailed study has been undertaken.

9.1. Driver Characteristics

9.1.1 Age Distribution

The Table 9.1 shows the age wise distribution of auto drivers. About 86 percent of the drivers are below 36 years and above 18 years. They are mostly migrants from other states. This is one of the major occupation sector.

Table 9.1 Age Wise Distribution of Auto rickshaw Drivers

Age group	Percentage of drivers
<18-25	36.71
26-35	50.63
36-50	12.66

9.1.2 Educational Qualification

The predominant qualification of the drivers is up to high school (77 percent). About 18 percent of the drivers have reached up to higher secondary level (Table 9.2).

Table 9.2 Educational Qualification of Driver

Educational Qualification	Percentage of Drivers
Primary school level	1.23
High school level	77.78
Higher secondary level	18.52
College level	2.47

9.1.3 Driving Experience

Since the Auto Rickshaws have shown increase in number only after 1998, the experience of the drivers is predominantly in the range of 3 to 9 years, although drivers with less experience are also operating (Table 9.3).

Table 9.3 Driving Experience

Experience (years)	Percentage of Drivers
< 3	10.13
3-6	54.43
6-9	22.78
9-12	12.66

9.1.4 Vehicle Ownership

About 40 percent of the Auto Rickshaw drivers are found to be owners of the vehicles and the rest use hired vehicles (Table 9.4).

Table 9.4 Ownership Details

Ownership Category	Percentage of Drivers
Owner	40.74
Hire	59.26

9.1.5 Average Monthly Income of Drivers

About 74% of the drivers earn a monthly income less than 5000 (Table 9.5). In a small town like Port Blair, the number of trips performed and the length of trips performed matter a lot for a meaningful income.

Table 9.5 Monthly Income

Monthly Income Range (Rs)	Percentage of Drivers
1500-2500	26.58
2500-5000	56.96
5000-10000	16.46

9.2. Operational Characteristics

9.2.1 Performance Per Day

Majority of the Auto Rickshaws perform significant number of trips 10 to 25 trips.

Table 9.6 Trips Performed per day

Trips Performed per day	Percentage of trips
5-10	2.47
10-15	19.75
15-25	37.04
>25	40.74

9.2.2 Distance Operated in a Day

Almost all of the Auto Rickshaws are operated for a maximum distance of 200 Km per day (Table.9.7) and the income is accordingly derived.

Table 9.7 Average Distance covered per day

Distance covered per day (km)	Percentage
25-50	1.25
50-100	25
100-150	40
150-200	31.25
200-250	1.25
>250	1.25

9.2.3 Passenger Pickup Points

Auto Rickshaws do not have a regulated parking place; they may have to pick up passengers at points where there is demand. Generally bus stop is a major location for picking up passenger besides doing so on the way (Table 9.8).

Table 9.8 Passenger Pickup points

Locations of Passenger Pickup	Percentage
Bus Stop	50.62
On the way	49.38

9.2.4 Average Dead Kilometerage

Dead kilometerage is an unproductive running of Auto rickshaws where there is no revenue generated. Auto drivers tend to maintain a very low dead kilometerage. The Table 9.9 shows the average dead Km/day. Wherein the dead kilometerage does not exceed 50 Km which is very higher. Compared to the earnings, the kilometerage run every day (200 Km) the competition seems to be more to result in higher dead kilometerage.

Table 9.9 Average dead km/day

Dead kilometreage per day	Percentage
<5	6.17
5-10	32.10
10-15	16.05
15-25	18.52
25-50	23.46
>50	3.70

9.2.5 Usage of IPT Mode

Auto Rickshaws seemed to be in higher demand between 11 to 14 hours (Table 9.10) a three-hour peak.

Table 9.10 Usage of IPT mode in peak hour

Time period of Demand (hours)	Percentage
6-8	16.67
8-11	6.25
11-14	56.25
14-24	20.83

9.2.6 Hire Charge

Drivers using the hired Auto Rickshaws need to pay around Rs.160 per day. This means unless the drivers earn at least double the amount they will not be in a position to pay for the hiring charges and earn Rs 5000 and more per month (Table 9.11).

Table 9.11 Hire charges/day

Hire charges per day (Rs)	Percentage
<160	97.92
>200	2.08

9.2.7 Fuel Expenditure / Day

For majority of Auto Rickshaws, the fuel expenditure seems to be in the order of Rs 250 to 350 per day (Table 9.12). This means an average daily income of Rs.700 per day alone can keep the drivers in a position to pay for hire charges, fuel charges and to have a monthly income of Rs.5,000 and more per month.

Table 9.12 Fuel Expenditure per Day

Expense (Rs)	Percentage
<200	5.88
200-250	11.76
250-350	76.47
>350	11.76

9.2.8 Traffic violation

More than half of auto rickshaw drivers (56.8%) have violated the traffic rules and are caught for that (Table 9.13). Over loading of passengers is the major violation reported (Table 9.14), whereas not in uniform while driving and exceeding the speed limits are the other violations reported.

Table 9.13 Traffic Violation Record

Violation of Traffic Rules	Percentage
Yes	56.79
No	43.21

Table 9.14 Reasons for Traffic Violation

Reasons For Traffic Violation	Percentage
Signal violation	8.82
Over loading	47.06
No parking	8.82
Non uniform	20.59
Over speed	14.71

CHAPTER 10

BUS TRANSPORT SYSTEM IN PORT BLAIR & ITS ENVIRONS

10.1 Introduction

State Transport Service operates buses from Aberdeen Bazaar terminus to various places within Port Blair Municipal area and to towns within Environs and beyond. Private buses are also operated from Aberdeen Bazaar to various locations in Port Blair and from Chatham Island to Cellular Jail to cater the needs of people coming by ferry from Bamboo Flat and Dandas Point. Terminus is located near the Aberdeen Bazaar for the exclusive use of State Transport Service Buses. The existing terminal can serve only the present fleet strength. The area will not be sufficient to handle additional fleet strength and that of private operators. Private buses park their buses haphazardly outside the terminal for boarding and alighting of passengers.

10.2 Existing Bus Transport Scenario

Though the new road proposals and road improvements will definitely facilitate better movements there is an urgent need to promote mass transportation. Increasing the mass transportation rider ship will reduce the private vehicles on road in turn reducing the vehicular emission let into the atmosphere.

The existing Bus Transport Scenario is given in Table 10.1, Table 10.2 and Table 10.3.

Table 10.1 Bus transport Statistic for year 2002-2006

Sl. No.	Items	2002-2003	2003-2004	2004-2005	2005-2006
1.	Buses Owned by Transport Dept. (in Nos.)	165	132	138	142
2.	Buses on Road (in Nos.)	70	78	72	98
3.	Average Seating/ Capacity per Vehicle (in Nos.)	52	50	48	48
4.	Percentage Fleet Utilization (in %)	42	59	52	69
5.	Average Vehicle Utilization (in Km)	156	162	164	148

Table 10.2 Passenger Travel Characteristics

Year	Number of Passenger Carried (in Lakhs)	Average distance covered per passenger (in Kms)	Average earning per passenger (in Rs)	Earning per passenger per KM (in Rs)
2002 -2003	33.50	1.01	7.21	7.13
2003-2004	39.73	0.96	8.58	NA
2004-2005	45.6	0.96	6.36	6.63
2005-2006	60.08	9.75	6.86	9.15

Table 10.3 Bus Operational Characteristics (2002 - 2006)

Year	Number of Routes Operated	Route kilometer (in Kms)	Average Route distance (in Kms)	Number of Scheduled Trips (Yearly)	Gross Kilometer (in Lakhs)
2002 -2003	65	2081	21	118731	31.8
2003-2004	70	2106	NA	123138	38.02
2004-2005	70	2100	26	113940	35.53
2005-2006	67	2078	24	125250	45.54

Though there has been a decline in the number of buses owned, number of buses operated and fleet utilization has gradually increased over the years and but Percentage fleet utilization is only 69 % in the year 2005-2006. The demand for public transport has increased from 33.50 Lakhs to 60.08 Lakhs passengers (Table 10.2) which indicates the willingness of people to shift to Public Transport. The number of routes of bus operation is 67 and is found to be same from 2002 to 2006. Average route distance of bus operation is 25 km only. Most of the bus routes are operated within Port Blair and from Port Blair to nearby settlements.

Due to the undulating topography it is uneconomical to operate more number of buses, and there is a need to develop a suitable public transport system like LRT or Monorail as places like Port Blair has to reduce the environmental impact. The current level of modal shift in favor of private vehicles should be gradually reduced and the share of public transport increased.

Nearly 42 buses are operated by the State Transport Service as ordinary and express services. 145 ordinary services and 16 Express Long Distance services are operated per day.

Ordinary services are operated to 29 destinations within the municipal area and in the environs. The detail of the destination and number of services operated per day is given in Table 10.4. It was observed 45.36 % of trips in the environs are by bus transport and 44.61% of trips in Port Blair are by bus transport. The peak hour crowding along various bus routes (Table 10.5) is a testimony to the fact. Bus transport meets 45 % of travel demand and its role has to enhance further. Port Blair being an environmentally sensitive area bus transport operation has to be upgraded to meet the travel demand of all categories of users.

Table 10.4 Existing Bus Service operation

Sl. No.	Name of the Destination	Number of Services operated / day
1	Attam Pahar	7
2	Carbin Junction	3
3	Chatham	16
4	Dolly Gunj	8
5	Ferargunj	3
6	Hadipur	2
7	Jawahar Colony	3
8	Minnie bay	8
9	Namunnagar	4
10	Naya Pahar Goan	10
11	Bamboo flat	3
12	Bamboo Nalla	2
13	Bimblitan	6
14	Birch Gunj	9
15	Brookshabad	7
16	Calicut	8
17	Chidiyatapu	4
18	Garacharma	1
19	Jirkatang	2
20	Kodiaghat	7
21	Macca Pahar / Burma Nallah	3
22	Manglutan	1
23	Manjeri	5
24	New Bimblitan	1
25	Ranchi Basti	1
26	Saitan Khari	2
27	Tirur	10
28	Tusna Bad	1
29	Wandoor	8

Table 10.5 Peak Hour & Off Peak Hour Crowding in Buses

Origin and Destination	Off Peak Hour Crowding	Peak Hour Crowding
Aberdeen Bazaar to Attam Pahar	41	55
Aberdeen Bazaar to Carbin Junction	30	46
Aberdeen Bazaar to Chattam	30	85
Aberdeen Bazaar to Dolly Gunj	42	62
Aberdeen Bazaar to Ferargunj	46	65
Aberdeen Bazaar to Hadipur	36	54
Aberdeen Bazaar to Jawahar Colony	39	58
Aberdeen Bazaar to Minnie Bay	30	58
Aberdeen Bazaar to Namunnagar	33	58
Aberdeen Bazaar to Naya Pahar Goan	38	52
Aberdeen Bazaar to Bamboo flat	40	42
Aberdeen Bazaar to Bamboo Nalla	41	48
Aberdeen Bazaar to Bimblitan	42	44
Aberdeen Bazaar to Birch Gunj	45	52
Aberdeen Bazaar to Brookshabad	34	50
Aberdeen Bazaar to Calicut	35	55
Aberdeen Bazaar to Chidiyatapu	30	65
Aberdeen Bazaar to Garacharma	42	48
Aberdeen Bazaar to Jirkatang	42	52
Aberdeen Bazaar to Kodiaghat	44	44
Aberdeen Bazaar to Macca Pahar/Burma Nalla	35	48
Aberdeen Bazaar to Manglutan	30	49
Aberdeen Bazaar to Manjeri	31	48
Aberdeen Bazaar to New Bimblitan	35	52
Aberdeen Bazaar to Ranchi Basti	38	54
Aberdeen Bazaar to Saitan Khari	34	52
Aberdeen Bazaar to Tirur	43	55
Aberdeen Bazaar to Tusnabad	60	75
Aberdeen Bazaar to Wandoor	42	50

CHAPTER 11
ACCIDENT ANALYSIS

11.1 Accident scenario

With the increasing vehicular population, there has been a pronounced increase in the number of accidents, particularly the fatal accidents. The Table 11.1 and Fig 11.1 show the accident data for the period 2003 to 2005. Increase in fatal accident is a sign of increasing number of vehicles, speeding, non observance of traffic rules and regulations.

Table 11.1 Accident during the year 2003 to 2005 in Port Blair

Year	Accidents Severity wise				
	Simple	Grievous	Fatal	Non Injury	Total
2003	109	22	6	1	138
2004	103	50	2	0	155
2005	109	36	15	1	161
Total	321	108	23	2	454

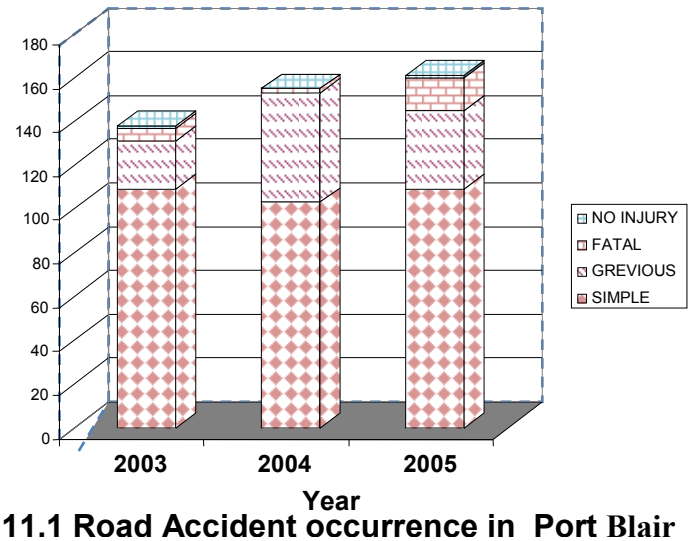


Fig 11.1 Road Accident occurrence in Port Blair

Pedestrians (32%) and Two Wheeler riders (31%) are the most vulnerable category (Fig 11.2). Safe Pedestrian crossing facilities are required near the junctions and Schools. Two Wheelers and Cars are involved in more number of accidents when compared to other

vehicles. The vehicle wise involvement in accidents during 2003-2005 is shown in Table 11.2 and Fig 11.3.

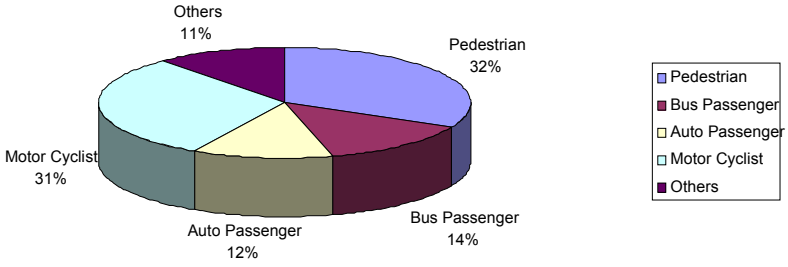


Fig. 11.2 Accident Victims during 2003-2005

Table 11.2 Vehicles involved in Accidents Category wise (2003-2005)

Year	Bus	Car/Van/Jeep	Two wheeler	Auto	Truck	Others
2003	22	44	31	21	20	0
2004	18	32	39	28	13	1
2005	37	38	72	29	28	1

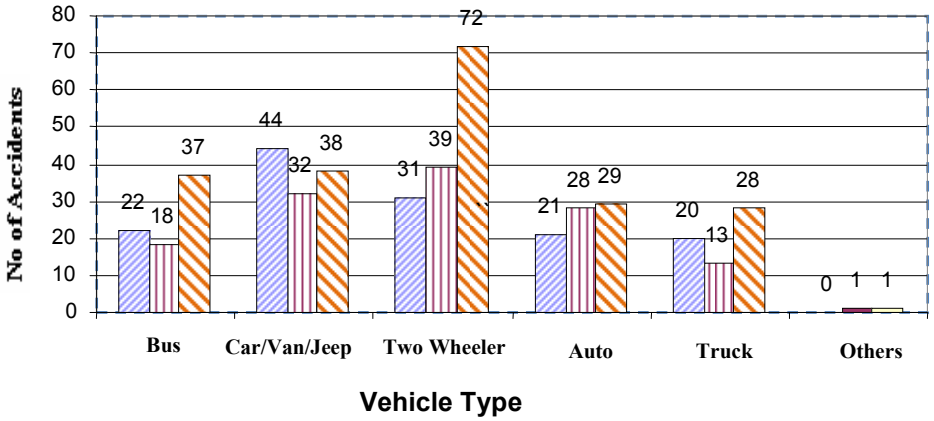


Fig.11.3 Category of Vehicles Involved in Accidents

CHAPTER 12
FREIGHT TRANSPORT IN PORT BLAIR AND ENVIRONS

12.1 INTRODUCTION

Goods transport plays a major role in transferring the essential commodities transported by water transport from the main land to the Port Blair region. The goods are carried from the Port Blair harbor to the wholesale depots and warehouses, and then to the retail market in the adjoining areas.

Light Commercial Vehicles are used for goods transport predominantly to distribute goods for retailers. The greatest advantage the Light Commercial Vehicles (LCVs) have is the inherited narrow road network pattern particularly in the CBD and the predominance of wholesale activity within CBD, for its demand. The record at the RTO office indicate 2300 trucks and tractors were registered and are operated in AN Islands. However it is assessed around 1500 registered goods trucks are operated in Port Blair and Environs. In order to assess the existing characteristics, problems faced by LCV and the exact role it plays in the goods transport sector a sample survey was conducted with 70 such vehicles. The objective of conducting such a study is to appreciate the vehicle characteristics, operational characteristics, economy and its present role.

12.2 VEHICLE CHARACTERISTICS

i) Type of vehicles

A host of LCVs are available in the market to suit to the requirement and demand. The study indicates the majority of the LCV are of Tata make and have a carrying capacity of 1 to 3 tons although vehicles with higher capacities up to 4.5 tons are also found operating. Vehicles of less carrying capacity are observed to be more in demand obviously because of the retailers and users requirement.

ii) Period of Operation

The LCVs are observed to be operated mostly during day time with only 37% being in idling condition. The Table 12.1 shows that LCVs are preferred in the day time.

iii) Type of Parking

A major percentage of LCVs is observed to be parked in on-street sites (Table 12.1). The off-street parking facility has to be established as on-street parking facility is likely to hamper smooth flow of traffic.

Table 12.1 Type of Parking

Place of Parking	Percentage
On Street	73%
Off Street	8%
Unknown	19%

12.3 OPERATING CHARACTERISTICS

i) Type of Commodities carried

The Table 12.2 clearly indicates that the LCVs are essentially preferred for transport of iron & steel (21 %), vegetables, fruits & flowers (16%), building materials (15 %) and Household articles & furniture goods (15 %). This is very well corroborated by the fact that the wholesale activities are predominantly located in the CBD. The road network being narrow the quantum to be carried per trip is less than its carrying capacity, the LCVs are in great demand.

Table 12.2 Type of commodities carried

Commodities	Percentage
Food Grains	13%
Fruits, Flowers	16%
Textiles	5%
Small Parcels	1%
Fast Foods	0%
Drugs	1%
Building Materials	15%
Iron and Steel	21%
Industrial Raw Materials	8%
Manufactured Goods	1%
Household Articles	15%
Chemicals	5%

ii) Trip performed

Every day a vast majority of the LCVs (54% - 96%) perform three trips per day. Number of trips is strongly related to the demand for movement of goods of lesser quantity. Vehicles performing less than two trips are only 4%. Thus the demand is for a maximum of three or four trips per day.

iii) Number of days operated in a month

A vast majority (62%) of the vehicles are operated for 6 to 15 days in a month (Table 12.3) and about 5% of the vehicles are operated for 16 to 20 days in a month. This indicates that while there is demand for LCV for goods transport not all vehicles are always in demand, may be due to excess number of vehicles than actually required.

Table 12.3 No of days operated in a month

Days Operated	Percentage
<5	23%
6-10	40%
11-15	22%
16-20	5%

iv) Fare structure

The operation of LCVs is not in the organized sector. Therefore it is unregulated. Depending upon the demand, the distance and type of goods handled and the regularity with which an operator is offered business, the flat fare changes. There are basically three types of fares charged (Table 12.4), one on hourly basis, which does not seem to find favour among users as the environment in which it is operated is not conducive in providing economic service. The second type is based on kilometers operated. Here irrespective of the time taken for every trip, the charges are based on kilometers covered. The practice seemed to be acceptable to the users as well as operators. But the third one is the most preferred by the operators, wherein neither the time nor the kilometer run is taken into account, a flat rate is charged depending upon the area, type of commodity handled etc. 38% of the operators seem to opt for this type of fare.

Table 12.4 Fare Structure

Fare Structure	Percentage
Hour Basis	27%
Km Basis	35%

More than 8 percent of the operators cover a distance of 100 to 200 Km every day (Table 12.5) which means approximately Rs. 10/Km is charged if the trip length is about 100 Km. in this context a cursory look at the Table 12.6 will

reveal that about 77% of the operators operate within the Port Blair Planning area. About 23% operate outside. Since the CBD is at the centre of the city the LCV trips emanating from CBD necessarily end up predominantly in the environs.

Table 12.5 Average Distance Covered per day

Average Distance (Kms)	Percentage
<50	0%
51-100	8%
101-200	81%
>200	12%

Table 12.6 Operational Characteristics

Area of Operation	Percentage
Within city	15%
Outside city	62%
Outside PA	23%

v) Maintenance cost and dead kilometerage

About 86 percent of the operators (Table 12.7) are observed to be spending less than Rs. 1000 on maintenance of the vehicle per month. The age of the vehicle, the poor road conditions and high order congestion in the CBD, is stated to be the reasons for highest maintenance cost.

Table 12.7 Average maintenance cost per month

Expenditure (Rs)	Percentage
<=1000	86%
1001-1500	-
1501-2000	14%
2001-2500	-
>2500	-

The absence of authorized parking place in the Port Blair Muncipal area and the spread of wholesale/ retail area the dead kilometerage in the case of 50 percent of the operators is observed to be between 20 and 30 Km.

vi) Trip purpose of LCV

It is seen in the Table 12.8 about 12% of the LCVs are used to transport goods from wholesaler to retailer. The predominant uses are other use (i.e. retailer to customer – 69%) godown to shop (12%) and shop to house (8%).

Table 12.8 Trip Purpose of LCV

Purpose	Percentage
Godown to shop	12%
Wholesaler to Retailer	12%
Shop to House	8%
Others (please specify)	69%

12.4 FINDINGS AND CONCLUSIONS

- The LCVs play a vital role in the goods transport sector of Port Blair Environs. The predominance of wholesale activity and the highly congested road network warrant the usage of LCV to move goods from wholesaler to retailer in small quantities.

- Predominance of wholesale activity in the CBD attracts larger number of LCVs for distribution of goods particularly Iron & Steel, fruits, vegetables, flowers and hardware in all directions. The LCVs add to the already stressed road network not only while moving but also when stationary as parking place is scarce resulting in creating bottlenecks for movement of traffic. An exclusive off street parking facility for LCV and Trucks is required.

- While an operator makes clearly a profit of Rs. 8000 to Rs. 10000 per month, it provides enormous scope of employment and it is a small industry by itself. However, since it is not in the organized sector its operation, fares etc. are not subject to scrutiny through laws.

- LCVs will continue to play a vital role particularly when the demand for movement of goods are in small quantity irrespective of whether the wholesale activities are located in CBD or elsewhere in Port Blair and Environs.

- A significant percentage of LCVs 12% are already engaged in carrying goods from godowns to shops in the CBD indicating the situation that there is shortage in godown facilities in the CBD. This fact itself should create the awareness that shifting of wholesale activity from the central part of Port Blair is of paramount importance.

CHAPTER 13
ROAD ENGINEERING

13.1 General

This chapter addresses the following aspects related to pavement construction, maintenance and design.

1. Quality evaluation of materials and specifications
2. Riding surface quality evaluation
3. Design of pavements
4. Maintenance management

13.2 Quality Evaluation of Materials and Specifications

Test pits were made on selected road stretches and samples were collected from bituminous and granular layers. Thickness and qualitative assessment of the level of compaction in bituminous and granular layers were observed.

13.2.1 Evaluation of Granular Materials

The following laboratory tests were conducted on granular (Water Bound Macadam) samples and the results are furnished in Table 13.1.

1. Aggregate impact value (AIV) test (as per IS 2386 Part IV)
2. Combined flakiness and elongation indices (Total) test (as per IS 2386 Part I)
3. Water absorption test (as per IS 2386 Part III)
4. Soundness test (as per IS 2386 Part V)

Aggregate impact test was conducted to assess the impact strength of aggregates. According to Ministry of Shipping, Road Transport and Highways (MoSRT & H) Specifications for Roads and Bridge works, 2001, the aggregate impact value shall not be more than 30% for water bound macadam. It is observed that AIV exceeds 30% for 2 out of 13 samples.

Table 13.1 Test results of samples collected from granular base

Sl. No	Name of the stretch	Code	AIV %	Water absorption %	Combined Flakiness & Elongation Indices %	Soundness with $MgSO_4$ %
1.	Clock tower to Delanipur	S1	28	0.72	**31.14**	7.26
2.	Delanipur to Goalghar	S2	26	0.87	26.18	5.80
3.	Goalghar to Bengali Club	S3	24	0.77	28.05	1.56
4.	Clock Tower to Y Narayana Junction	S4	28	0.76	38.23	6.72
5.	Y Narayana to Cellular Jail	S5	27	1.02	33.21	6.90
6.	Swapna Hall to Pathergudda Jn	S6	19	0.90	26.20	1.13
7.	Austinabad to Prothrapur	S7	23	0.84	28.17	1.60
8.	Pahargaon diggi to Swapna Theatre	S8	25	0.67	29.81	1.89
9.	Burmanallah to Rangachaung	S9	28	1.45	43.68	6.35
10.	Wandoor to Chidiyatapu @ 24/0 Km	S10	41	2.90	42.89	12.42
11.	Tushnabad to Ferrargunj	S11	34	1.63	37.79	9.79
12.	Namunnagar to Saithangadi	S12	24	1.24	28.19	1.61
13.	Whimberlygunj to Stewartgunj	S13	17	0.66	26.40	1.06
Requirements as per MoSRT&H, 2001			**Max 30%**	**Max 2%**	**Max 30%**	**Max 18%**

Combined flakiness and elongation indices were determined to assess the shape of aggregates. According to MoSRT & H (India) 2001 specifications, combined flakiness and elongation indices shall not be more than 30% to provide sufficient strength for the WBM layer. This value exceeds 30% for 6 out of 13 samples. The reasons for exceeding the limit may be due to the poor condition of stone crusher units or geological nature of rock. The detailed investigations are to be carried out to identify the exact reason and suitable measures are to be taken.

Water absorption property of aggregates is an indirect measure of density of aggregates. The water absorption value shall not be more than 2% for WBM (MoSRT & H 2001). This value exceeds 2% for one out of 13 samples in the present study.

The Soundness test was carried out to assess the resistance of aggregates against disintegration due to the action of weather, physical and chemical action of rain and ground water etc. The soundness test can be carried out with sodium sulphate or magnesium sulphate solution. The soundness value shall not be more than 12% when tested with sodium sulphate solution and shall not more than 18% when tested with magnesium sulphate solution (MoSRT & H, 2001). In this study, tests were carried out with magnesium sulphate and the results are found to be within the permissible limit for all the samples.

13.2.2 Evaluation of Materials in Bituminous Layers

The Centrifuge extraction tests were carried out to determine the binder content in the bituminous base and surface courses. The test results of samples collected from bituminous base and surface courses are given in Table 13.2 and Table 13.3 respectively. The minimum bitumen content percentage in base course and surface course are 3.10 and 5.01 respectively by the weight of mix, which are found to be reasonable.

The following tests were carried out in the laboratory on aggregates separated in centrifuge extraction test to assess the quality of aggregates used in base and surface courses and the results are furnished in Table 13.2 and Table 13.3 respectively.

1. Aggregate impact value test (as per IS 2386 Part IV)
2. Combined flakiness and elongation indices (Total)
   (as per IS 2386 Part I)
3. Water absorption test (as per IS 2386 Part III)
4. Soundness test (as per IS 2386 Part V)

Table 13.2 Test results of samples collected from bituminous base

Sl. No.	Code	AIV %	Water absorption %	Combined Flakiness & Elongation Indices %	Soundness with $MgSO_4$ %	Bitumen Content %
1.	S1	24	0.62	29.83	1.60	3.49
2.	S2	24	0.68	31.03	1.64	5.12
3.	S3	29	0.93	34.82	8.20	4.56
4.	S4	26	0.58	28.96	3.24	4.92
5.	S5	25	0.59	24.01	1.82	4.96
6.	S6	20	1.30	26.98	1.31	5.14
7.	S7	22	1.11	25.61	1.28	4.97
8.	S8	17	1.54	28.99	0.81	5.00
9.	S9	38	1.33	36.23	11.40	3.16
10.	S10	39	1.67	37.38	11.56	4.27
11.	S11	18	1.90	24.73	0.96	3.10
12.	S12	25	2.04	26.71	1.78	5.70
13.	S13	11	0.70	29.30	1.76	4.38
Requirements as per MoSRT&H,2001		**Max 30%**	**Max 2%**	**Max 30%**	**Max 18%**	**-**

Table 13.3 Test results of samples collected from surface course

Sl. No.	Code	AIV %	Water absorption %	Combined Flakiness & Elongation Indices %	Soundness with $MgSO_4$ %	Bitumen Content %
1.	S1	22	0.69	28.76	1.42	5.01
2.	S2	24	0.67	31.47	1.59	6.24
3.	S3	20	0.81	34.91	1.26	5.92
4.	S4	41	1.93	26.97	12.80	5.36
5.	S5	28	0.86	32.85	6.82	5.84
6.	S6	22	0.85	26.87	1.48	5.76
7.	S7	18	2.58	28.92	1.02	5.80
8.	S8	22	2.10	25.25	1.12	5.77
9.	S9	32	0.83	34.55	8.16	5.20
10.	S10	38	0.69	26.58	12.10	5.66
11.	S11	26	2.30	34.78	5.20	5.20
12.	S12	24	1.32	29.63	1.62	5.33
13.	S13	16	0.76	31.60	0.96	5.40
Requirements as per MoSRT&H,2001		**Max 30%**	**Max 2%**	**Max 30%**	**Max 18%**	**-**

The aggregate impact value shall not be more than 30% for ordinary mixes such as Premix Carpet (PC), Bituminous Macadam (BM), Bituminous Penetration Macadam (BPM), Surface Dressing (SD) and Mix Seal Surfacing (MSS). The value shall not be more than 27% for Dense Graded Bituminous Macadam (DBM) and Semi Dense Bituminous Concrete (SDBC). For high type mix (i.e., Bituminous Concrete) the value shall not be more than 24% (MoSRT&H, 2001). The AIV exceeds 30% for 2 samples collected from bituminous base and 3 samples collected from surface course.

The maximum permissible combined flakiness and elongation indices percentage is 30% for bituminous base and surface courses. This value exceeds 30% for 4 samples collected from bituminous base and 6 samples collected from surface course.

The water absorption value exceeds the permissible limit of 2% for one sample collected from bituminous base and 3 samples collected from the surface course.

The soundness values are found to be within the requirement of 18% for all the samples in base and surface courses.

13.2.3 Test Pits Evaluation

The test pits of 60cm x 60cm size were made and evaluation was carried out during May 2007. In general, lack of bond was observed between granular construction and bituminous layer. Compaction of WBM was found to be generally not satisfactory.

13.2.4 Observations from Material Evaluation

The following observations are made from the laboratory evaluation and test pits examination:

1. Except combined flakiness and elongation indices, the properties of aggregates are satisfactory for most of the samples. By exercising strict quality control on aggregates before or during construction, inferior quality materials can be avoided.

2. Excessive flaky and elongated aggregates are used in pavement layers. With proper maintenance of stone crushers and identifying right type of rocks through geological investigations, this problem can be solved.
3. Insufficient compaction of WBM was noticed generally in all the study roads. This may be due to insufficient rolling during construction without sprinkling adequate quantity of water for forming slurry or due to excessive flaky and elongated aggregates
4. In general, adequate bonding is not available between WBM and bituminous layer. This may be due to inadequate application of binder for tack coat and prime coat.

13.3 Pavement Surface Quality Evaluation

Roughness of a road is an important parameter which not only indicates the comfort level of ride over a pavement surface, but it is related to vehicle's vibration, operating speed, wear and tear of the wheel, vehicle operating cost etc. Roughness refers the deviations of a pavement surface from a true planar surface. Roughness is used as an indicator to represent to the overall condition of the pavement also.

The roughness values were measured on all the study stretches (S1 to S13) using precise equipment called 'MERLIN' (as per IRC: SP16 – 2004). The roughness values obtained from the field measurements are furnished in Table 13.4.

Table 13.4 Roughness values on study stretches

Stretch	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Roughness in mm/km	2305	2981	1857	4771	4095	5448	6790	3648	3647	3647	2981	6343	6343

According to 'Guidelines for Maintenance Management of Primary, Secondary and Urban Roads, 2004, Ministry of Road Transport and Highways, Government of India', pavement condition is classified in to three levels based on roughness values. Immediately after the construction of new pavements or

renewal of surface courses, the roughness value expected is less than 2000mm/km. This is considered as Level 1 (Good). Level 1 is the desired level that provides for highest level of comfort, convenience and safety. Level 2 represents the average pavement condition. It is the level to which the road deteriorates from level 1 after two – three years of use before fresh maintenance is implemented. The maximum permissible limit for level 2 is 3000mm/km. Level 3 represents the minimum level necessary to protect the investment and provide reasonable levels of safety. The maximum permissible limit for level 3 is 4000mm/km.

Out of 13 stretches considered in this study, one stretch is in good condition (level 1), 3 in average conditions (level 2), 3 in acceptable conditions (level 3) and the remaining 6 are not in acceptable level.

The following observations can be made from roughness results.

1. Out of 13 study stretches, 6 stretches are found to be in unsafe and not acceptable condition.
2. To increase the riding comfort and safety of the user, either surface treatment (PC / MSS / SDBC / BC) or strengthening (BM / DBM) with surface treatment can be done.

13.4 Design

13.4.1 General

The design of pavement involves the determination of the total thickness required and deciding suitable composition for it. The total thickness requirement mainly depends on the sub grade strength (generally expressed in terms of CBR%) and traffic loading. In this study, the thickness adequacy of existing pavements is checked and typical designs are made for the construction of new pavements after conducting soil investigations and traffic surveys. As almost all the existing roads in the study area are constructed with flexible (bituminous) pavements, the adequacy of bituminous pavements are checked in this report. However type designs for a cement concrete pavement and bituminous pavement for typical sub grade strength and traffic loadings prevailing in Port Blair and its environs are also furnished in this chapter.

13.4.2 Soil Investigations

From the test pits, soil samples were collected at sub grade level and laboratory experiments were carried out. The characteristics of soil samples including CBR values are furnished in Table 13.5. The maximum dry density greater than 1.75 for all the samples indicates that the sub grade soil is fit for pavement construction without any carted earth. The CBR value varies between 4% and 28%, which indicates the vast variability in sub grade strength. Due to this vast variation, a single type design cannot be adopted for all the roads in the study area.

Table 13.5 Test results of samples collected from subgrade

Sl. No.	Code	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	I.S - Soil Classification	MDD g/cc	OMC (%)	Soaked CBR (%)
1	S1	42	22	20	CL	1.752	18	4
2	S2	39	20	19	CL	1.995	11	4
3	S3	41	21	20	CL	1.983	11	4
4	S4	40	20	20	CL	1.990	10	5
5	S5	NON PLASTIC			SM	2.011	11	26
6	S6	29	21	8	CL	1.930	11	5
7	S7	32	21	11	CL	1.784	13	6
8	S8	36	20	16	CL	2.012	13	6
9	S9	NON PLASTIC			SM	2.039	13	28
10	S10	36	20	16	CL	1.861	14	5
11	S11	31	22	9	CL	1.930	15	6
12	S12	34	22	12	CL	2.010	10	8
13	S13	NON PLASTIC			SM	2.127	12	15

13.4.3 Traffic Surveys

The traffic surveys (7 days, 24 hours) were carried out during May 2007 in all the study stretches to arrive the number of commercial vehicles per day (CVPD). The CVPD values arrived are shown in Table 13.6.

Table 13.6 Traffic Loading Details

Stretch	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
CVPD	271	75	108	98	102	220	969	78	60	112	96	68	46

13.4.4 Checking the thickness adequacy of existing pavements

The following methodology is adopted for checking the adequacy of thickness of existing bituminous pavements.

1. CVPD value is converted into equivalent number of standard axles and represented in millions standard axles (*msa*) using the following equation.

$$N = \frac{365 \times [(1 + r)^{n} - 1]}{r} \times A \times D \times F$$

where N = cumulative number of standard axles to be catered for in the design in terms of msa;

A = Initial traffic in terms of CVPD;

D = Lane Distribution factor (1 for single lane, 0.75 for two lanes);

F = Vehicle damage factor for hilly terrain (0.5 for 0 150CVPD, 1.5 for 150 – 1500 CVPD, 25 for > 1500 CVPD);

R = Annual growth rate of commercial vehicles (assumed as 7.5% as per IRC 37: 2001)

2. The soaked CBR value of sub grade is taken as sub grade strength.
3. Corresponding to soaked CBR value and traffic loading in *msa*, total thickness required for the pavements are arrived from Fig 1 and Fig 2 of IRC: 37 - 2001
4. The total thickness requirement is compared against the existing thickness observed from test pits.

The thickness of existing pavement layers in the study stretches are given in Table 13.7. The present traffic loading and future projected cumulative traffic loading for the next 20 years (assuming 7.5% annual growth) are calculated for the study stretches and given in Table 13.8. The thickness of pavement required for the present and future cumulative traffic loading corresponding to the soil CBR value is arrived for all the study stretches and given in Table 13.9.

It is observed that for the stretches S1, S2, S3, S8, S10, S11 and S12, the thickness available is sufficient not only for the present traffic, but also for the next 20 years future traffic. In the remaining stretches, the thickness available is insufficient to meet out even the present traffic loading.

Table 13.7 Composition of Existing Pavements

Stretch	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Thickness of granular layer (mm)	830	850	840	170	170	150	150	200	150	350	350	350	200
Thickness of bituminous layer (mm)	150	150	150	100	100	50	100	200	100	100	350	100	100
Total Thickness (mm)	980	1000	990	270	270	200	250	400	250	450	700	450	300

13.4.5 Observations from design checking of flexible pavements

It is inferred from design checking of study stretches that the pavement thickness available is insufficient even for the present traffic in 6 stretches, where as it is more than sufficient in 7 stretches not only for the present traffic, but for the next 20 years future traffic also. Hence, it can be concluded that scientific approach is not practiced in the study area for the design of roads.

Table 13.8 Present and Future Projected Traffic Loading

Stretch code	Traffic Loading in *msa*																				
	Present traffic May 2007	Future Traffic after the years																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
S1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	1.3	1.4	1.6	1.9	2.1	2.3	2.6	2.9	3.2	3.5	3.9
S2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	1.3	1.5	1.7	2.0	2.2	2.5	2.8	3.2	3.5	3.9	4.3	4.7	5.2
S7	<1.0	<1.0	1.1	1.7	2.4	3.1	3.8	4.7	5.5	6.5	7.5	8.6	9.8	11.0	12.4	13.9	15.4	17.1	18.9	20.9	23.0
S8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S11	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S12	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
S13	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 13.9 Pavement thickness required for present and future traffic

Stretch	Thickness required in mm																				Existing thickness in mm
	For present traffic (May 2007)	For future traffic after the years																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
S1	480	480	480	480	480	480	480	480	480	485	490	500	510	520	535	545	560	570	580	595	605	980
S2	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	1000
S3	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	990
S4	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	270
S5	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	270
S6	430	430	430	430	430	430	430	435	445	460	470	485	500	510	520	535	540	550	560	575	585	200
S7	390	390	400	435	460	490	510	535	545	550	575	590	605	615	620	625	630	635	640	645	650	250
S8	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	400
S9	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	250
S10	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	450
S11	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	700
S12	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	450
S13	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	300

13.4.6 Typical design for cement concrete pavement

Generally in hilly terrains, cement concrete pavements are not preferred due to lesser frictional resistance (grip between vehicle tyre and pavement surface) offered by the surface. The condition becomes worst when the pavement is wet during rainy days. Since the study area is a hilly terrain receiving rainfall for more than 6 months in a year with annual rainfall exceeding 3000 mm, adoption of cement concrete pavement is not a better choice.

However, wherever pucca drainage of surface or subsurface water is not possible and the bituminous pavements are likely to be damaged by moisture, cement concrete pavements will be the better choice. Hence cement concrete pavements can be preferred in identified stretches of the study area where the terrain is reasonably plain and drainage is a great problem.

In the study area, since the type of soil is sandy clay in most of the stretches (10 out of 13 stretches) with CBR value around 5%, a typical cement concrete pavement design is made with CBR 5% which is given below:

i) Design Parameters

Design wheel load	= 5.1 tones
Concrete grade	= M 40
CBR of sub-grade soil	= 5% (found from laboratory test)

ii) Sub-base

Provide Dry Lean Concrete (DLC) of 10 cm thickness using 1:4:8 mix as sub -base over the compacted graded gravel layer/ coarse sand / coarse quarry dust of 15cm thickness.

iii) Pavement Slab Thickness

Trial thickness	= 20 cm
Modulus of sub-grade reaction of soil	= 4.2 kg/cm^2/cm

Effective k over 10 cm DLC corresponding to 5% CBR = 16.6 kg/cm^2/cm

$$\text{Radius of relative stiffness (l)} = \left(\frac{3 \times 10^5 \times 20^3}{12\,(1-0.15^2) \times 16.6} \right)^{1/4}$$

= 59.25 cm

Radius of contact area = 15.02 cm

Ratio a/h = $\frac{15.02}{20}$ = 0.751 < 1.724

Providing slabs of 3.5 m x 3.5 m

L/l = 350 / 59.25 = 5.91

Corresponding C value = 0.902

For 20 cm thick slab, temperature differential for Andaman region

= 15.8°C

Temperature stress at critical edge = $E\alpha tc / 2$

= ($3 \times 10^5 \times 10 \times 10^{-6} \times 15.8 \times 0.902$) / 2

= 21.38 kg/cm^2

Flexural Strength of concrete = $0.7\sqrt{40}$ = 4.427 N / mm^2

= 44.27 kg/cm^2

Residual strength = 44.27 – 21.38 = 22.89 kg/cm^2

Edge wheel load stress from IRC chart = 18 kg/cm^2

Factor of safety = Residual Strength = 22.89 = 1.27 > 1 **Safe**

Edge Load Stress = 18

iv) Design of Dowel bar

Let the diameter be 25 mm

Design wheel load = 5100 kg

Percentage load transfer = 40

Joint width, z = 2.0 cm

Permissible bearing stress in concrete (F_b) = $\frac{(10.16-2.5) \times 400}{9.525}$

= 321.7 kg/cm^2

Assumed spacing between dowel bars = 25cm

First dowel bar is placed at a distance = 15 cm from the pavement edge

Assumed length of dowel bar = 50 cm

Dowel bars up to a distance of 1.0 x radius of relative stiffness from the point of load application are effective in load transfer.

Number of dowel bars participating in load transfer when wheel load is just over the dowel bar close to the edge of the slab

= 1+(l/spacing) = 1 + 59.25/25 = 3 bars

Assuming that the load transferred by the first dowel is P_t and assuming that the load on dowel bar at a distance of 'l' from the first dowel to be zero, the total load transferred by dowel bar system.

$$= \left[1 + \frac{(59.25 - 25)}{59.25} + \frac{(59.25 - 50)}{59.25}\right] \times P_t$$

$$= (1 + 0.578 + 0.156) \times P_t = 1.734\ P_t$$

Load carried by the outer dowel bar (P_t) = (5100 x 0.4) / 1.734
= 1176.47 kg

Moment of inertia of dowel bar = $\frac{\pi (2.5)^4}{64}$ = $1.917 cm^4$

Relative Stiffness of dowel bar embedded in concrete (β)

$$= \left(\frac{41500 \times 2.5}{4 \times 2x10^6 x 1.917} \right)^{1/4}$$

= 0.287

Bearing stress in dowel bar = $(P_t \times k)(2 + \beta z) / (4 \beta^3 EI)$

= $(1176.47 \times 41500)(2+0.287x2) / (4x0.287^3 x2x10^6 x1.917)$

= 346.64 which is greater than $321.7 kg/cm^2$

Unsafe

Revise the slab thickness as 25 cm.

Radius of relative stiffness (l) = $\left(\frac{3 \times 10^5 \times 25^3}{12 (1-0.15^2) \times 16.6} \right)^{1/4}$

= 70.04 cm

L/l = $\frac{350}{70.04}$ = 4.997

Corresponding C value = 0.719

For 25 cm thick slab, temperature differential for Andaman = 16.2^oC

Temperature stress at critical edge = $E\alpha tc / 2$

$= (3 \times 10^5 \times 10 \times 10^{-6} \times 16.2 \times 0.719) / 2$

$= 17.47 \text{ kg/cm}^2$

Residual strength = $44.27 - 17.47 = 26.8 \text{ kg/cm}^2$

Edge wheel load stress from IRC chart = 15 kg/cm^2

Factor of safety = Residential Strength = $26.8 = 1.79 > 1$

Edge Load Stress 15 **Safe**

$(1+ 0.643+0.286) \times P_t = 1.929 P_t$

$P_t = (0.4 \times 5100 / 1.929) = 1057.541 \text{ kg}$

$F_b = \frac{(10.16 - 2.5) \times 400}{9.525} = 321.7 \text{ kg/cm}^2$

Assumed spacing = 25 cm

Moment of inertia = $\frac{\pi (2.5)^4}{64} = 1.917 \text{cm}^4$

$$\beta = \left(\frac{41500 \times 2.5}{4 \times 2 \times 10^6 \times 3.02} \right)^{1/4}$$

$= 0.287$

Bearing stress in dowel bar = $\frac{(1057.541 \times 41500)(2 + 0.287 \times 2)}{4 \times 0.287^3 \times 2 \times 10^6 \times 1.917}$

$= 311.60 \text{ kg/cm}^2$ which is lesser than 321.7kg/cm^2

Safe

V) Design of Tie Bars

Diameter of tie bar corresponding to 25cm thick slab = 12mm
Allowable tensile stress in deformed bar (as per IRC 21 - 2000)

$= 200 \text{kg/cm}^2$

Allowable bond stress for deformed tie bars = 24.6kg/cm^2

Area of steel bar per m width of joint to resist the frictional force at

Slab bottom (A_s) = bfw / s

= (3.5x1.5x0.25x2400) / 2000

= 1.575 cm^2/m

Spacing of tie bars = 100A / A_S

= (100x1.13) / 1.575

= 71.7 cm

Provide at a spacing of 70cm c/c

Length of tie bar, L = (2 x Sx A) / B x P

= (2x 2000 x 1.13) / 24.6 x 3.77

= 48.74 cm

Increase length by 10 cm for loss of bond due to painting and another 5 cm for tolerance in placement. Therefore the length is

= 48.74 + 10+ 5

= 63.74 say 64 cm

Recommendations

1. For DLC and pavement slab, 43-grade cement is recommended.
2. The concrete grade M 40 for pavement slab is to be designed from any approved laboratory and the design mix proportion is to be adopted. For estimation purpose, 1:1 ½:3 mixes may be used approximately.
3. A separation membrane (plastic sheet) of minimum thickness of 125 micron (0.125 mm) is recommended to reduce the friction between concrete slab and DLC sub-base.
4. Aggregates for pavement concrete shall be natural material with Los-Angles Abrasion value not more than 35%.
5. Dowel bars shall be covered by a thin plastic sheath for at least 60 percent of the length from one end. The sheath shall be tough, durable and of an average thickness not greater than 0.5 mm and shall have closed end.
6. The joint should be filled with rubberized bitumen (CRMB 55) or bitumen pad.

7. The coarse-grained quarry dust layer is be compacted by roller at optimum moisture content. The optimum moisture content should be obtained from the laboratory.

ABSTRACT

CBR of soil : 5%

Pavement Design Details

i) Filling with coarse sand or coarse grained quarry dust : 15 cm thick

ii) Dry Lean Concrete (DLC) 1:4:8 nominal mix : 10 cm thick

iii) Separation membrane (plastic sheet) in between DLC and pavement slab : at least 125 micron (0.125 mm)thick

iv) Pavement slab with plain cement concrete (M 40 grade – design mix) : 25 cm thick

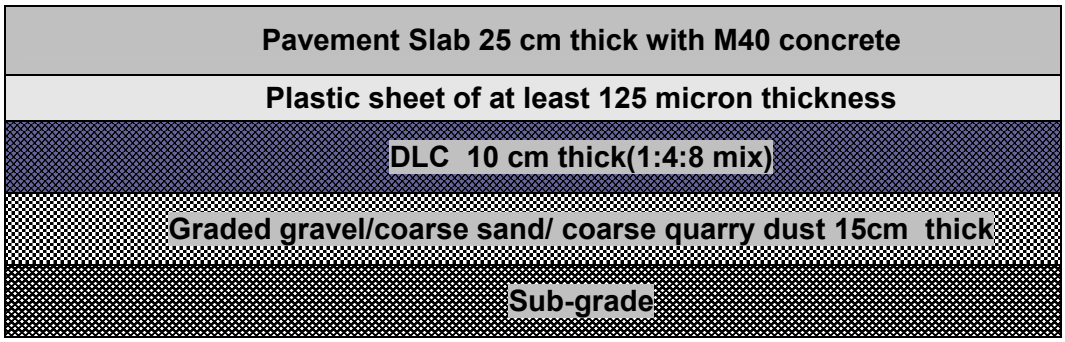
v) Pavement slab size : 3.5 m x 3.5 m

vi) Spacing of joints in longitudinal and transverse directions : 3.5 m

vii) Joint width : 2 cm

viii) Dowel bars (for transverse and longitudinal joints)

- diameter : 2.5 cm
- length : 50 cm
- spacing : 25 cm c/c
- steel grade : deformed bar



RECOMMENDED CROSS SECTION OF PAVEMENT

13.4.7 Typical design for bituminous pavement

For CBR value 5% and different traffic levels, design calculations were made as per IRC 37-2001 and the design requirements are given in Table 13.10.

Table 13.10 Design requirements of pavement composition

Traffic in CVPD	No. of lanes	Total thickness required (mm)	Granular sub-base (mm)	Granular base (mm)	Bituminous base (mm)	Wearing course (mm)
<150	1	435	210	225	-	20 PC
<150	2	430	205	225	-	20 PC
150-450	1	655	300	250	65 DBM	40 BC
150-450	2	630	275	250	65 DBM	40 BC
450-1500	1	710	300	250	120 DBM	40 BC
450-1500	2	695	300	250	110 DBM	40 BC

Note: 1) For granular base, water bound macadam (WBM) or wet mix macadam WMM) is recommended.

2) For granular sub-base, the materials such as sand, gravel or mixture of sand and gravel may be used.

13.5 Maintenance Management System

13.5.1 General

The main objective of a pavement maintenance management system is to provide a scientific tool to maintain roads at desired serviceability levels. It is also well-accepted fact that due to paucity of funds it is not possible to provide the highest level of serviceability. Also, in some areas the low volume of traffic does

not justify high levels of serviceability. Since the pavements deteriorate with time, it is necessary to maintain them to provide minimum desired service to its user and save the valuable assets.

13.5.2 Present status of maintenance in Andaman

The present policy of maintenance of roads in Andaman PWD is based on providing routine maintenance wherever required and renewal after every 3 years in Port Blair Town and 4 years in outside town limits without analyzing its economic implications. The main drawback of this policy is that some roads, though good are resurfaced as per time specific renewal cycle while some other roads deteriorate quickly, even though needing renewal but not covered by the maintenance cycle.

For Andaman conditions (annual rainfall >3000mm), it is suggested that condition responsive maintenance intervention criteria may be adopted instead of time bound maintenance. To formulate condition responsive maintenance criteria, some basic minimum desired serviceability level need to be fixed. The criteria furnished in “Guidelines for Maintenance Management of Primary, Secondary and Urban Roads MORT&H (2004)” for the maintenance of roads as given in Table 13.10, Table 13.11 and Table 13.12 can be practiced in the study area for better results.

Table 13.10 Intervention levels for primary roads

Sl. No.	Serviceability Indicator	Level 1 (good)	Level 2 (average)	Level 3 (acceptable)
1.	Roughness (max permissible)	2000 mm/km	3000 mm/km	4000 m/km
2.	Potholes per km (max numbers)	Nil	2-3	4-8
3.	Cracking and patching area (max permissible)	5%	10%	10-15%
4.	Rutting (max permissible)	5mm	5-10mm	10-20mm

Table 13.11 Intervention levels for secondary roads

Sl. No.	Serviceability Indicator	Level 1 (good)	Level 2 (average)	Level 3 (acceptable)
1.	Roughness (max permissible)	3000 mm/km	4000 mm/km	5000 mm/km
2.	Potholes per km (max numbers)	2-3	4-8	9-12
3.	Cracking and patching area (max permissible)	10%	10-15%	up to 25%
4.	Rutting (max permissible)	5-10mm	10-20mm	up to 20mm

Table 13.12 Intervention levels for urban roads

Sl. No.	Serviceability Indicator	Level 1 (good)	Level 2 (average)	Level 3 (acceptable)
1.	Roughness (max permissible)	2000 mm/km	3000 mm/km	4000 mm/km
2.	Potholes per km (max numbers)	Nil	2-3	4-8
3.	Cracking and patching area (max permissible)	5%	10%	10-15%
4.	Rutting (max permissible)	5 mm	5-10 mm	10-20 mm
5.	Deflection	1.0 mm	1.0 - 1.5 mm	1.5 – 2.0 mm

The pavement condition surveys (by making physical measurements) were conducted on stretches S1 to S13 during May 2007 and the results of the surveys are given in Table 13.13. Some of the distresses observed during condition surveys are shown in Fig 13.1 to Fig 13.12.

13.5.3 Discussion on pavement condition

The pavement condition data observed during May 2007 on 13 stretches (shown in Table 13.13) are discussed below with respect to each serviceability indicator.

(i) Roughness

The roughness in urban roads varies between 1857 mm/km and 4771 mm/km. The value exceeds the maximum permissible limit of 4000 mm/km in stretches S4 and S5 whose age since last renewal is 3 years.

The roughness in rural roads varies between 2981 mm/km and 6790 mm/km. The value exceeds the maximum permissible limit of 5000 mm/km in 4 out of 8 stretches. Within two years of renewal, the stretches S6, S10, S12 and S13 have reached more than 5000 mm/km which is considered to be high, unsafe and undesirable.

Table 13.13 Pavement condition details

Sl. No	Stretch	Type of road	Age since last renewal in years	Roughness (mm/km)	No. of potholes	Cracking (% of area)	Patches (% of area)	Ravelling (% of area)	Rutting (mm)
1.	S1	Urban	1	2305	12	NIL	NIL	38	18
2.	S2	Urban	1	2981	3	0.75	NIL	8	14
3.	S3	Urban	2	1857	NIL	NIL	NIL	NIL	12
4.	S4	Urban	3	4771	2	35	5	58	2.2
5.	S5	Urban	3	4095	NIL	25	5	50	26
6.	S6	Rural	2	5448	9	1	5	2	17
7.	S7	Rural	3	6790	11	5	3	40	17
8.	S8	Rural	2	3748	6	NIL	NIL	NIL	40
9.	S9	Rural	2	3647	NIL	15	5	50	27
10.	S10	Rural	1	3647	4	52	NIL	3	7
11.	S11	Rural	1	2981	NIL	NIL	NIL	1.5	10
12.	S12	Rural	2	6343	8	5	10	13	67
13.	S13	Rural	2	6343	16	NIL	2	40	30

* A selected stretch of 1 km length is considered for the study where the length exceeds 1km

Fig 13.1 Ravelling in Stretch S1

Fig 13.2 Ravelling in Stretch S2

Fig 13.3 Cracks in Stretch S3

Fig 13.4 Patch in Stretch S4

Fig 13.5 Cracks in Stretch S5

Fig 13.6 Pothole in Stretch S6

Fig 13.7 Ravelling in Stretch S7

Fig 13.8 Patches in Stretch S8

Fig 13.9 Patches in Stretch S9

Fig 13.10 Ravelling in Stretch S11

Fig 13.11 Pothole in Stretch S12

Fig 13.12 Pothole filled with water in Stretch S13

(ii) Potholes

The number of potholes in urban roads varies between 0 and 12. The number exceeds the maximum permissible limit of 8 in the stretch S1 whose age since last renewal is one year only.

The number of potholes in rural roads varies between 0 and 16. The number exceeds the maximum permissible limit of 12 in the stretch S13 whose age is 2 years.

(iii) Cracking and patching area

The cracking and patching area put together varies from 0 to 40% in urban roads and 0 to 52% in rural roads. The permissible range is 10 to 15% for urban roads and upto 25% for rural roads. The urban stretches S4 and S5 are witnessing 40% and 30% respectively whose age since last renewal is 3 years. The rural

stretch S10 with renewal age of just one year is witnessing 52% which indicates the premature occurrence of excessive failures.

(iv) Rutting

The maximum permissible rutting in urban and rural roads is 20mm. Excessive rutting is observed in the stretches S8, S9, S12 and S13 whose age since last renewal is 2 years.

(v) Ravelling

Ravelling is not included as serviceability factor in the maintenance manual. However, since ravelling is one of the important causes of other failures, the percentage of area affected by ravelling is measured and reported. It is found from Table 13.13 that the percentage of ravelling area exceeds the reasonable limit of 20% in 3 out of 5 urban roads and 3 out of 8 rural roads. Almost the stretches S2 and S9 are witnessing excessive ravelling in 2 years whereas the stretch S1 is witnessing excessive ravelling in just one year.

13.6 Concluding Remarks

From the field studies conducted in Port Blair and its environs and laboratory investigations made, the following conclusions are arrived:

1. Since the CBR and maximum dry density of subgrade soil are greater than 2% and 1.75 g/cc respectively in all the study stretches, it may be concluded that the subgrade soil in the study area is almost good enough to construct the pavement layers without any carted earth.
2. Excessive uses of flaky and elongated aggregates are observed in all the pavement layers which are likely to affect the strength and cause premature failures. With proper maintenance of stone crusher units and identifying right type of rocks through geological investigations, this problem can be solved. The employment of a qualified geologist with atleast M. Sc (geology) qualification is recommended for identifying the source of right type of rocks.

3. Except excessive flakiness and elongation, other properties of aggregates are almost satisfactory. However it is observed that quality is lacking in some of the samples. Hence it is recommended to adopt strict quality control measures during construction for ensuring uniform quality throughout the region.

4. Inadequate compaction of WBM and poor bonding between WBM and bituminous layers are noticed generally in all the study stretches. By exercising strict quality control measures during construction, these defects can be rectified.

5. The riding quality of pavement surface is found to be beyond acceptable and unsafe level in 6 out of 13 study stretches. Three stretches have attained this condition within two years of age since last renewal. The existing pavement thickness in these stretches is also found to be insufficient and this could be the main reason for getting unacceptable condition at an early period of 2 years.

6. The distress such as potholes, cracking & patching area, rutting and ravelling are found to be exceeding the maximum permissible limit in some of the stretches in just one year or two years. Hence the present policy of APWD to renew the pavements after 3 or 4 years has no relevance with the actual performance. The main reason for getting excessive surface defects may be due to heavy annual rainfall in the study area. By adopting condition responsive maintenance intervention criteria instead of time bound maintenance may solve this problem. Development of pavement performance prediction models for various distresses and for the overall pavement condition exclusively for Andaman conditions by conducting detailed performance studies for a period of atleast 3 years in the specially built in service pavements under different soil and traffic conditions and use of these models for deciding the maintenance intervention criteria would be the scientific approach for the maintenance strategies.

13.7 Recommendations

1. Strict quality control on materials and construction procedures are to be exercised
2. Crumb Rubber Modified Bitumen Grade-55 (CRMB-55) or Polymer Modified Bitumen Grade-70 (PMB-70) is recommended for the bituminous layers to overcome excessive ravelling which is the root cause for many other failures.
3. To identify the source for the right type of aggregates, a qualified geologist may be employed.
4. Adequate laboratory facilities are to be created for strict quality control. Similar to the procedure adopted for National Highway works, exclusive quality control team may be formed under the direct control of Superintending Engineer for surprise quality checkings.
5. The thickness adequacy of existing pavements are to be checked by comparing the available thickness with design requirements and the pavements are to be strengthened if found necessary. The Benkelman Beam Deflection (BBD) tests may also be carried out to decide the thickness of overlay required.
6. Original works shall not be carried out without proper pavement design.
7. Development of Pavement performance prediction models exclusively for Andaman conditions is strongly recommended for effective maintenance programs.
8. Latest developments in pavement materials, design, construction and maintenance aspects are to be exposed to the field engineers at all levels by conducting periodical training programs.

CHAPTER 14

TRIP GENERATION AND TRIP DISTRIBUTION

14.1 Introduction

Port Blair being the hub of activity, it interacts with the hinterland for various purposes of employment and commercial activity. For the purpose of identifying the level of interaction taking place, the hinterland has been divided into four sectors namely, South, South West, North West and North, and Port Blair has been taken as the Core Sector.

14.2 Interactions between sectors

The environs around Port Blair has been divided into four sectors based on Population distribution and the level of developments as shown in Fig.14.1. Tables 14.1, 14.2, 14.3, 14.4 and 14.5 shows the sectoral characteristics of Southern, South Western, North western, Northern and Port Blair sectors, the traffic zones, name of the traffic zone and the population in each zone. The Fig. 14.2 shows the concept of interaction.

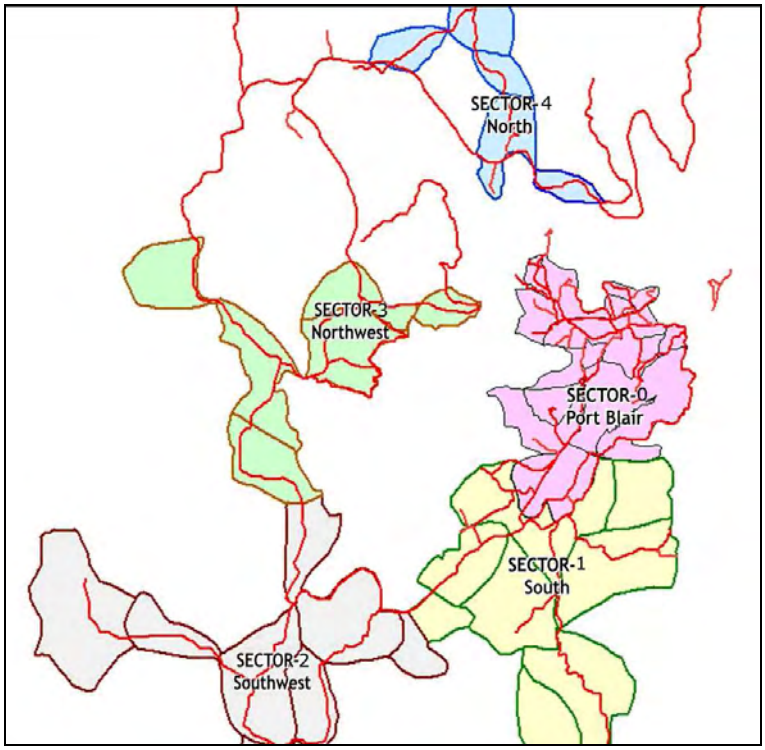


Fig.14.1 Delineation of Study Boundary

Table 14.1 Southern Sector

Sl. No.	Zone No	Name	Population
1.	101	Brookshabad	3486
2.	102	Brichgunj	3540
3.	103	Makkaphar	966
4.	104	Rangachaung	424
5.	105	Calicut	1890
6.	106	Tylerabad	1284
7.	107	Garacharma	9427
8.	108	Prothrapur	8328
Total population			**29345**

Table 14.2 Southwestern Sector

Sl. No.	Zone No	Name	Population
1.	202	Sippighat	1038
2.	203	Nayasahar	331
3.	204	Manglutan	2151
4.	205	Hompherygunj	619
5.	206	Asmathabad	463
6.	207	Wandoor	1511
7.	208	Dhanikari	806
Total population			**6919**

Table 14.3 North Western Sector

Sl No.	Zone No	Name	Population
1.	301	Chouldari	2446
2.	302	Ograbraj	2347
3.	303	Namanagar	1730
4.	304	Dandes Point	566
5.	305	Mithalkari	1109
6.	350	Tushnabad	1190
Total population			**9388**

Table 14.4 North Sector

Sl No.	Block No	Name of the zone	Population
1	401	Hope town	2962
2	402	Bamboo flat	6787
3	403	Stewart gunj	1462
4	404	Wimberg gunj	3707
Total population			**14918**

Table 14.5 Port Blair Sector

Sl No.	Zone No	Population
1	1	5371
2	2	8257
3	3	6415
4	4	7135
5	5	4662
6	6	4471
7	7	6005
8	8	9941
9	9	5548
10	10	9417
11	11	5195
12	12	4730
13	13	4162
14	14	4690
15	15	3653
16	16	4159
17	17	6124
18	18	5049
Total population		**104984**

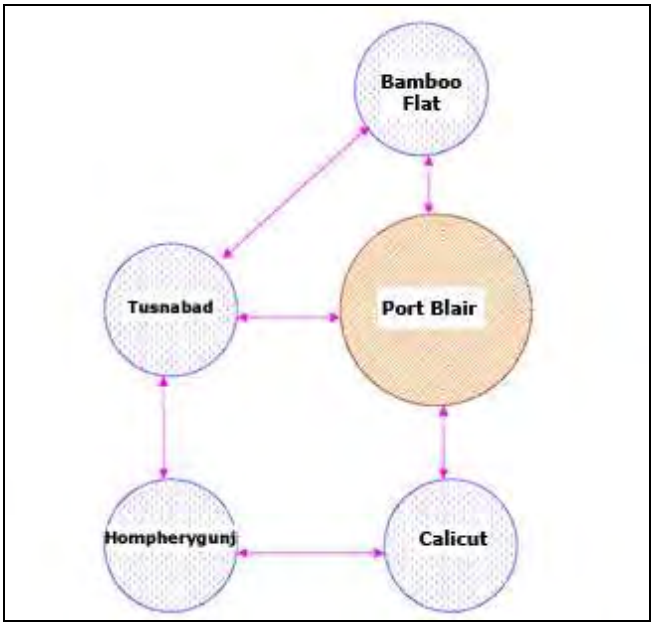


Fig. 14.2 Concept of Interaction

14.3 Future Population Forecast

For the purpose of planning, assessment of future population becomes essential. The future population is projected for the 20 years upto 2027. Population projection has been carried out using the conventional methods as well as System Dynamics method.

14.3.1 Conventional Method of Population Projection

The three convention methods used for the population projection are: Arithmetic method, Geometric method and Incremental method.

Arithmetic Increase Method

The formula used for the projection of the population using arithmetic increase method is P = P + nr. Table 14.6 shows the population figures obtained by this projection

Table 14.6 Population Projection by Arithmetic Increase Method

Area	Population reported as per census 2001	Projected Population		
		2011	2021	2027
Port Blair (Municipal Area)	99984	129979	159974	180971
Other Villages in Port Blair Planning Area	61636	86290	110944	128202
Total	161620	216269	270919	309173

Geometric Increase Method

The formula used for the projection of the population using geometric increase method is ($P_n = P (1 + i_p / 100) ^ n$). The Table 14.7 shows the population figures obtained by this projection.

Table 14.7 Population Projection by Geometric Increase Method

Area	Population reported as per census 2001	Projected Population		
		2011	2021	2027
Port Blair (Municipal Area)	99984	134370	180582	222093
Other Villages in Port Blair Planning Area	61636	91236	135052	177719
Total	161620	225606	315634	399812

Incremental Increase Method

The formula used for the projection of the population using arithmetic increase method is (Pn=P*e^rn). The Table 14.8 shows the population figures obtained by this projection

Table 14.8 Population Projection by Incremental Increase Method

Area	Population reported as per census 2001	Projected Population		
		2011	2021	2027
Port Blair (Municipal Area)	99984	134307	163898	190234
Other Villages in Port Blair Planning Area	61636	79538	96832	108784
Total	161620	213845	260730	299018

14.3.1 System Dynamics Population Model

The System Dynamic (SD) tool used in this study has four basic building blocks stock, flow, connector and converter. Stocks (levels) are used to represent anything that accumulates an example would be Population. Flows (rates) represent activities that increase and decrease stocks. STELLA is a system dynamic package, which is used to project population data for the consequent year. STELLA mainly uses feedback loop structure, which acts as a fundamental building level. STELLA is dynamic and user friendly it has been used in this study.

The increase in population is due to in-migration and birth rate hence the positive sign (+) which indicates the increase in population. Similarly the decrease in population is by out-migration and death rate which is indicated by negative sign (-). Population is taken as slack (level). The change in Birth rate, death rate, in-migration rate and out-migration rate changes automatically the population over the years dynamically. Population model were formulated for each sector considered in the study.

Identification of Key Variables

The increase in population may be due to both social increase and natural increase. The social increase is by in-migration and natural increase is due to higher birth rate. Similarly the decrease in population is by out migration and death rate. The variables that affect population are birth rate, death rate, in-migration and out-migration. The parameters considered for the model are: Population, Birth rate, Birth Normal, Death rate, Death Normal, In-migration rate, In-Migration Normal, Out-Migration rate, Out-Migration Normal.

Population

Population is taken as stock level. The change in Birth rate, death rate, in-migration rate and out-Migration rate will automatically change the population value dynamically. The population data of the base year 2001 was collected from Census of India 2001. The base year population for the port Blair is 99984.

Birth rate

The birth normal is defined as the number of births per thousand of population. The birth rate is the product of Birth normal and Population. The Birth rate is taken as 19.1 for the study area.

Death rate

The death rate is also defined as graphical function with current death rate as initial value and targeted death normal as upper limit. The Death Rate as per census is for urban area is 5.6 and rural area is 3.6.

In-Migration rate

In-migration rate is determined from number of migrants within 10 years and converted to migration/ year. The inter State migration is crucial to estimate

the in-migrants into the islands over the decade. About 8438 persons have moved into the islands per annum in search of jobs / livelihood. The Migration Pattern is given in the Table 14.9.

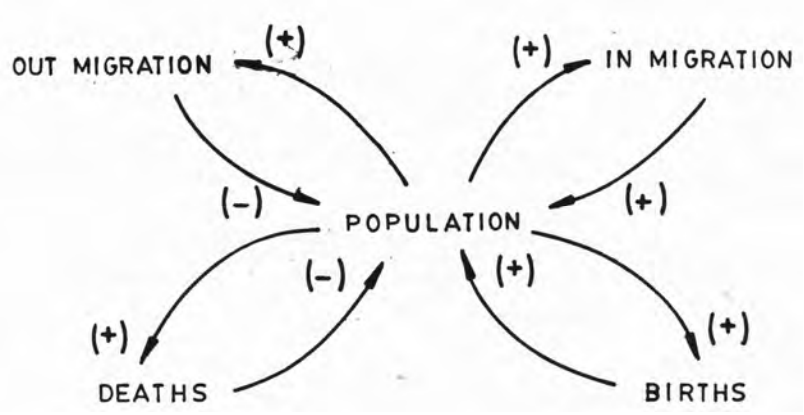
Table 14.9 Migration Pattern in A & N Islands*

A & N Islands	Total Migrants per Decade		
	Persons	Male	Female
Place of last residence	174167	94713	79434
Inter District migration	7434	4361	3073
Inter State migration	84380	48008	36372
International migration	4258	2414	1844
Intra Distinct migration	78094	39930	38164

*Source: Census of India 2001.

Causal Loop Diagram

The next step is to draw the causal loop diagram, which shows the cause and effect of each variable with other in the loop. The causal loop diagram is shown in the Fig 14.2.



Population Model

Each sector considered has different characteristics. Except Port Blair all other zones are rural and it has different birth rate and death rate than urban area. Five different models are developed for each sector considering the corresponding values for each zone. The population of each sector is shown in the Table 14.10.

Table 14.10 2001 Population Sector wise

S. No	Sector Name	Population (2001)
1.	Port Blair	99084
2.	Southern sector	29345
3.	Southwestern sector	7919
4.	Northwestern sector	9388
5.	Northern sector	14918
	Total	161554

The change in Birth rate, death rate, in-migration rate and out-migration dynamically changes the population over the years. Base year of population has been taken as 2001, the last known census data. The Population model for Port Blair sector is shown in Fig.14.3. Similarly Population model were formulated for each sector.

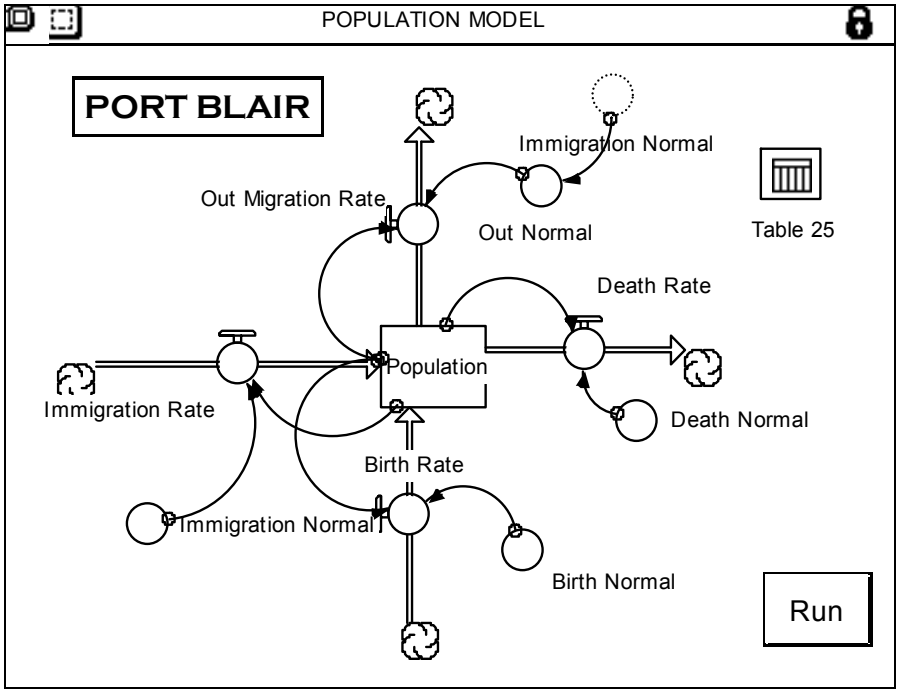


Fig 14.3 Systems model for Population Projection

Population model was formulated separately for each sector. The growth of population over a period of 20 years in each sector is shown in Fig.14.4. The Population of Port Blair sector expected on 2011, 2020, 2027 are 129045, 167298 and 204732 respectively. The total population growth for each sector over the period of years is given in Table 14.11.

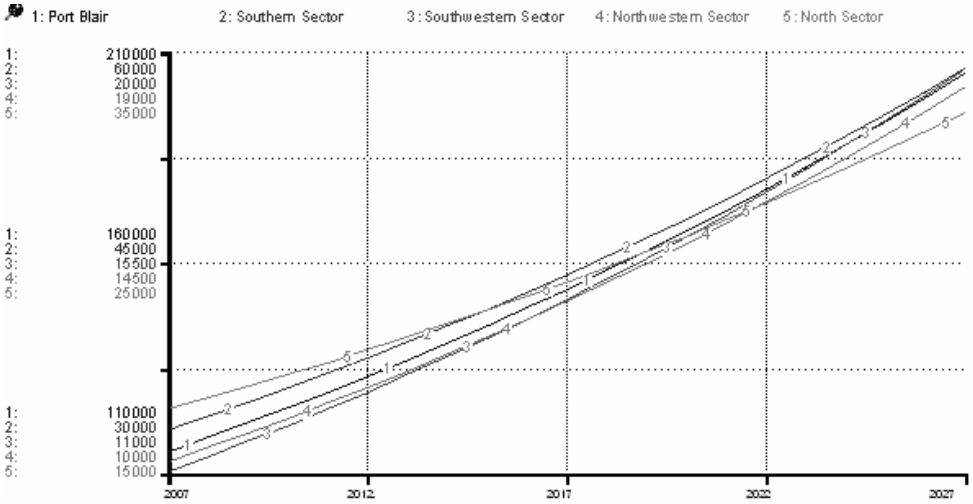


Fig.14.4 Population Growth Sector Wise

Table 14.11 Total Population and Population Growth Sector-wise

Year	Total	Port Blair	Southern Sector	South-western Sector	North-western Sector	Northern Sector
2007	200031	124099	35289	12124	11683	17106
2008	206163	127731	36321	12479	12025	17606
2009	212197	131469	37384	12845	12378	18121
2010	218408	135317	38478	13221	12740	18652
2011	224800	139277	39603	13609	13114	19197
2012	231379	143353	40762	14007	13498	19759
2013	238151	147549	41955	14418	13893	20337
2014	245121	151867	43182	14840	14301	20932
2015	252295	156311	44445	15275	14720	21544
2016	259679	160896	45746	15722	15151	22174
2017	267279	165595	47084	16183	15595	22823
2018	275102	170441	48461	16657	16052	23490
2019	283153	175429	49879	17145	16522	24178
2020	291440	180563	51338	17648	17006	24885
2021	299970	185848	52840	18165	17504	25813
2022	308749	191287	54386	18697	18017	26362
2023	317785	196895	55977	19245	18545	27133
2024	327086	202647	57615	19808	19089	27927
2025	336659	208578	59301	20389	19648	28744
2026	346512	214692	61035	20986	20225	29585
2027	356654	220965	62821	21601	20816	30450

Validation of Model

The validation is an important step in model development that determines the realistic feature of model. The model is also validated to know the percentage error from the real data. Hence the built model was validated using the population of 1991 and projected for 2001. Results of the validation are shown in Table 14.12

from the validation it was analyzed that the percentage of deviation from the real data was within ± 5%.

Table 14.12 Validation of Model

Sl. No.	Settlement	1991 Population	2001 Population	Model Output	Error (%)
1.	Port Blair	74995	99084	97658	1.438
2.	South Sector	22680	29345	27968	1.257
3.	South Western Sector	4876	7919	6596	4.445
4.	North Western Sector	4567	9388	8572	3.365
5.	North Sector	10054	14918	13045	4.578

14.4 Proposed Land use Changes

Port Blair and Environs are proposed to have major changes in land use as per the proposed master plan. The major proposals are to decongest the Port Blair sector by shifting the administrative center to Hompherygunj. The Calicut is to be developed as transit node with new airport and bus terminal is proposed near Garacharma. The other sectors like Bamboo flat, Tusnabad are proposed to be developed as residential center. The proposed development is shown in Fig.14.5. The different category of land use for each sector in 2007 is given in Table 14.13 and Table 14.14 gives the future proposed land use for each sector.

The system dynamic model developed suits well in estimating the future population for a sector where there is steady and natural growth of population. Since in this study there is major change in land use the change in population as per proposed land use is to be accounted. Correction factor is to be applied to sectors where there is major change in land use to calculate the population of that area. The in-migration rate is modified as per the increase in households in the sector. The corrected population after the considering the land use is given in Table 14.15.

Table 14.13 Existing Land Use Sector-wise

Area	Agriculture (%)	Mixed Residential (%)	Transport and Communication (%)	Submerged Land (%)	Others (%)	Water Body (%)	Forest (%)	Public (%)	Commercial (%)	Defense Land (%)	Industrial (%)	Recreational (%)
Port Blair	4.34	31.47	3.78	3.02	14.63	2.92	1.67	10.08	17.47	1.87	6.56	2.19
South Sector	0.93	85.86	4.61	0.29	0.54	1.24	3.98	0.65	0.55	1.13	0.19	0.03
South Western sector	32.85	19.94	9.14	12.44	6.24	9.24	7.43	1.18	1.23	0.00	0.10	0.20
North Western Sector	53.34	16.69	8.27	11.75	3.54	1.62	2.73	1.00	0.75	0.00	0.31	0.00
North sector	33.56	41.32	16.68	0.16	1.41	1.28	2.49	1.61	1.15	0.00	0.35	0.00

Table 14.14 Proposed Land Use Sector-wise

Area	Agriculture (%)	Mixed Residential (%)	Transport and Communication (%)	Submerged Land (%)	Others (%)	Water Body (%)	Forest (%)	Public (%)	Commercial (%)	Defense Land (%)	Industrial (%)	Recreational (%)
Port Blair	1.05	52.62	3.25	0.01	0.37	1.07	1.08	33.96	2.97	1.97	0.45	1.20
South Sector	11.40	34.16	38.51	4.54	0.18	1.42	4.37	2.07	0.28	2.17	0.44	0.45
South Western sector	5.49	86.59	1.00	1.43	0.00	1.49	1.01	1.55	0.70	0.00	0.00	0.74
North Western Sector	7.02	57.99	4.65	7.38	0.22	1.64	0.78	6.36	6.95	0.00	0.56	6.45
North sector	27.63	6.47	54.47	1.64	0.00	2.79	3.08	2.50	1.00	0.00	0.00	0.42

Table 14.15 Final Predicted Population

Sector Name	Residential Area	Expected Number of Household in 2027	Final Predicted Population
Port Blair	11667	53853	242340
South Sector	3200	22688	102094
South Western Sector	647886	10119	45536
North Western Sector	10490	3289	14802
North Sector	540	7907	35581

14.5 Trip Generation

The factors influencing trip production from each zone and trip attraction to each zone was estimated from the household data. For calculating trip production and trip attraction among the 47 zones in the study area, regression analysis was carried out considering the factors influencing trip production and trip attraction

Regression analysis was carried out by considering various influencing factors like total number of vehicles owned per family, total number of employed persons per family and total number of household for arriving trip productions per zone. Land use factors like total area per zone, residential area per zone, commercial area per zone, industrial area per zone, public and semi-public area per zone and other areas including roads, open spaces per zone were considered for modelling trip attractions to each zone. Trip production and attraction models are as follows:

The trip production and Trip attraction models per zone was developed with the data of existing scenario. The model was used for predicting the trip attraction and trip production for the future period. Total number of trips produced and total number of trips attracted towards the zones for 2027 was estimated. Total production and total attraction must be equal. So Adjust phase was used for balancing total production with that of the total attraction.

From the Trip generation stage it was found that totally nearly 379099 trips are to originate and destine within study area during peak hour in 2027.

Regression Model for Trip production per zone

P = -311.3863 + 0.628 x Veh + 1.9965 x Emp + 0.6638 x HH

where P is the number of trips produced or generated from the zone

Veh - No of vehicles owned per family,

Emp - No of persons employed per family,

HH - No of households per zone.

Regression Model for Trip Attraction per zone

A = 2145.96 – 0.13857 x Tot-A + 04519 x Z Res-A + 0.19663 x Com-A + 11.6043 x Ind-A + 0.16757 + Pub-A + 0.31488 * other-A

Where, A is the total number of trips attracted to the zone,

Tot-A - the total area in the zone in hectares,

Res-A - the total residential area in the zone,

Com-A - the total commercial area in the zone,

Ind-A - the total industrial area in the zone,

Pub-A - the total public area in the zone,

Other-A - the total other land area in the zone.

Fig.14.8 shows the typical output of total production and total attraction for 26 zones. The Table 14.16 shows the current person trip rate for various sectors.

Table 14.16 Current Person Trip Rate

Sl. No.	Name of the Sector	Person Trip Rate
1.	Port Blair	0.45
2.	South Sector	0.44
3.	South Western Sector	0.23
4.	North Western Sector	0.22
5.	North Sector	0.17

TAZ	TOTALP	TOTALA
1	5970	6759
2	10545	3011
3	8234	5415
4	8937	3114
5	16388	3540
6	9405	3026
7	13267	2776
8	16126	2740
9	17135	4557
10	10146	49185
11	5910	7573
12	14089	2886
13	5547	2533
14	6307	3251
15	10549	3737
16	9557	4016
17	8205	5663
18	12772	8978
19	8404	42189
20	13708	6914
21	14201	15635
22	6731	8037
23	10869	11176
24	4598	3360
25	19786	7504
26	13460	6967

Fig.14.8 Typical Total production and Total attraction output

The Trip rate for 2027 was estimated with the projected vehicle ownership, employment and number of households per zone. The expected trip rate in 2027 is given in Table 14.17.

Table 14.17 Expected Sectoral Trip Rate in 2027

Sl. No.	Name of the Sector	Existing Scenario
1.	Port Blair	1.2
2.	South Sector	1.2
3.	South Western Sector	0.8
4.	North Western Sector	0.6
5.	North Sector	0.6

14.6 Trip Distribution

The generated trips from each zone get distributed to many zones. The trip distribution is carried out from each zone to other zones, thus making it possible to identify major transport corridor. A very high percentage share of trips generated within the Port Blair sector itself indicate the fact that, the study area is not

economically vibrant to attract trips from other sectors. Nevertheless there is a significant interaction seen from each sector and the south sector stand out to have highest interaction with Port Blair sector.

Trip distribution has been carried out by Gravity model which is given by the equation below

$$T_{i-j} = \frac{P_i A_j F_{i-j}}{\sum_{i=1}^{n} A_j F_{i-j}}$$

Where,

	T_{i-j}	–	Number of trips from zone i to j
	P_i	–	Total number of trips produced in zone i
	A_j	–	Total number of trips attracted to zone j
	F_{i-j}	–	Emprically derived Travel time factor
	K_{i-j}	-	Specific zone to zone adjustment factor

The factors F_{i-j} and K_{i-j} between the zones are obtained by calibration process for the present trip distribution. The arrived factors are used distributing the future trips with the forecasted zonal trip attraction and trip production.

CHAPTER 15

PROPOSALS

15.1 Intersection Improvements

Peak hour traffic observed during the morning and evening periods at the 15 major intersections in Port Blair is given in Table15.1.

The maximum peak hour traffic was observed at Light House, Bengali Club, Model School, Goalghar, Delanipur and Hyat Singh Junctions. The traffic is expected to increase by 3% to 5% annually. The expected flow in the immediate future was computed for all the intersections with a annual growth of 5%. The quality of flow in terms of LOS (Present & Future), the past accident history of the intersection and the physical features of intersections were studied in detail to identify the junctions needing improvement.

Table 15.1 Peak Hour Traffic Flow on Major Intersections in Port Blair

SL.NO.	NAME OF THE INTERSECTION	MORNING PEAK HOUR FLOW in PCUs	EVENING PEAK HOUR FLOW in PCUs
1	CHATTAM	604	523
2	HADDO	1042	798
3	DELANIPUR	2978	3090
4	GOALGHAR	3336	3958
5	BENGALI CLUB	4902	3185
6	LIGHT HOUSE	4055	3644
7	SECRATRIAT	1559	1451
8	BANGLA SCHOOL	1801	1485
9	HYAT SINGH	2134	3777
10	DIARY FORM	1823	2147
11	IP & T	2229	1538
12	RAJ NIVAS	1554	1259
13	MODEL SCHOOL	3466	3174
14	CLOCK TOWER	2425	2528
15	BATHUBASTHI	1234	1422

15.2 LOS- Level of Service

The Level of Service (LOS) is an important parameter indicating the quality of flow at a junction. LOS is computed from the expected delay a vehicle is likely to experience. Delay was calculated for the intersections using Webster's formula. Range of delay for various LOS is given in Table 15.2.

Table 15.2 LOS and Corresponding Range of Delay

Delay in Vehicle/sec	LOS
<10	A
10-20	B
20-35	C
35-55	D
55-85	E
>85	F

The Volume Capacity Ratio and LOS from the year 2007 was computed for junctions carrying maximum traffic and given in Table15.3. Intersections with LOS E need grade separation for movement of vehicles without undesirable delay. The V/C ratio of Light house is 1.39 in 2008 and expected delay is 58 sec/PCU. The V/C ratio of Bengali club is 1.64 in 2008 and delay per PCU is 56 sec. For Model school junction V/C ratio is 1.31 and expected delay is 64sec/PCU. Goalghar junction is expected to reach the LOS E in 2014. Delanipur Junction is expected to have LOS E in 2011, Hyat Singh Junction in 2013.

Nearly half of the major junctions are likely to experience inordinate delay in the near future and require measures to avoid the delay.

15.3 Accident at Intersections

On analyzing location of road accidents during the period 2004 to 2006 in Port Blair nearly 19% of accidents in Port Blair has occurred at the fifteen major intersections. Measures have to be taken at the major intersections to improve safety.

Though the total numbers of accidents at the major intersections are on the decline, the numbers of fatal accidents are found to be on rise (Fig 15.1). The number of accidents at each major intersection (Fig 15.2) and the proportion of intersection accidents for the duration 2003 to 2005 (Fig 15.3) shows that Goalghar (20 accidents) Diary farm (17 accidents) and Bathubasti (10 accidents) junctions have maximum accident occurrence.

Table 15.3 Expected LOS and Delay for critical Junctions in Port Blair

YEAR	DELANIPUR			BENGALI CLUB			GOALGHAR			LIGHT HOUSE			MODEL SCHOOL			HYAT SINGH		
	V/C	DELAY In Secs/PCU	LOS	V/C	DELAY In Secs/PCU	LOS	V/C	DELAY In Secs/PCU	LOS	V/C	DELAY In Secs/PCU	LOS	V/C	DELAY In Secs/PCU	LOS	V/C	DELAY In Secs/PCU	LOS
2007	1.31	50	D	1.56	54	D	1.14	47	D	1.32	58	E	1.24	59	D	0.79	23	D
2008	1.37	50	D	1.64	56	E	1.20	49	D	1.39	60	E	1.31	64	E	0.83	25	D
2009	1.44	52	D	1.72	58	E	1.26	50	D	1.46	62	E	1.37	67	E	0.87	27	D
2010	1.51	54	D	1.81	61	E	1.32	51	D	1.53	65	E	1.44	70	E	0.92	29	D
2011	1.59	55	E	1.94	64	E	1.39	53	D	1.61	68	E	1.51	75	E	0.96	32	D
2012	1.67	57	E	1.99	68	E	1.41	55	D	1.69	71	E	1.59	80	E	1.01	34	D
2013	1.75	59	E	2.09	72	E	1.46	57	D	1.78	75	E	1.67	86	F	1.06	37	E
2014	1.84	61	E	2.19	79	E	1.53	58	E	1.86	79	E	1.75	95	F	1.11	40	E

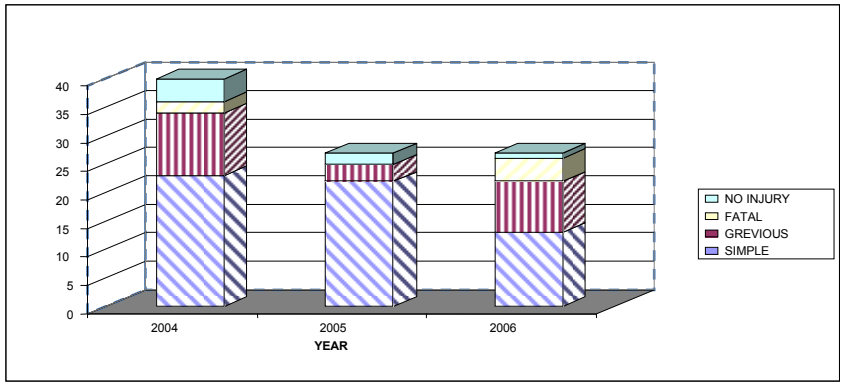


Fig 15.1 Road accidents at Major Junctions – Port Blair

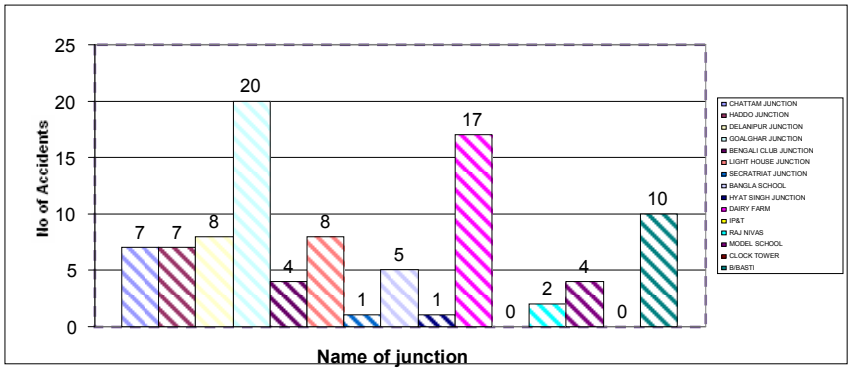


Fig 15.2 Accident Occurrence at Major Junctions (2003 – 2005)

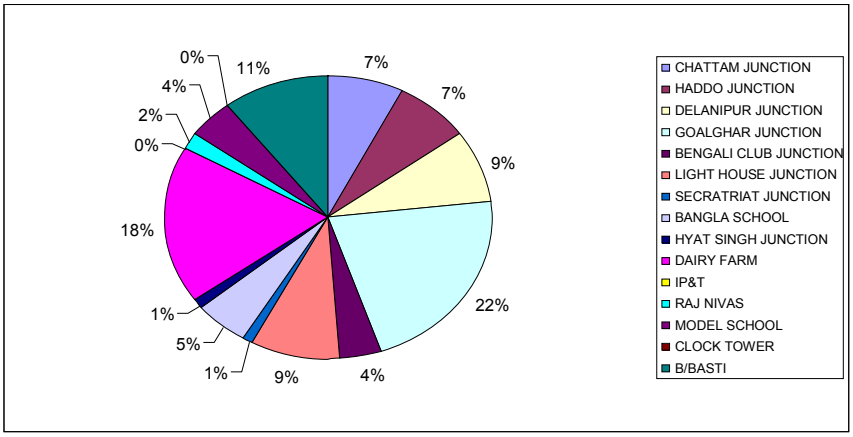


Fig 15.3 Preparation of Intersection Accidents in Port Blair (2003 – 2005)

15.4 Improvement Measures Proposed

Based on the performance analysis of junctions in terms of traffic carrying capacity in peak hours and accident rate the suggested improvement measure at each intersection is given in Table15.4

Table 15.4 Proposed improvement measures for the major intersections in Port Blair.

Sl. No	Name of the Intersections	Short Term Measure	Medium Term Measure
1	Chatham	Signal	—
2	Haddo	Signal	—
3	Delanipur	Signal	—
4	Goalghar	Signal	Grade Separation (2011)
5	Bengali Club	Signal	Grade Separation
6	Light House	Signal	Grade Separation
7	Secretariat	Signal	—
8	Bangla School	Signal	—
9	Hyat Singh	Signal	Grade Separation(2013)
10	Dairy Farm	Signal	—
11	IP & T	Signal	—
12	Raj Nivas	Signal	—
13	Model School	Signal	Grade Separation
14	Clock Tower	Signal	—
15	Bathubasthi	Signal	—

15.5 Signal Design

Eleven intersections are in close proximity i.e. within a distance 1.5 km to each other in the CBD of Port Blair. Traffic movements at the intersections are regulated by manual control at present. At these intersections during peak hours traffic signal control is advised for smooth and safe flow.

Traffic signal is designed for the morning peak hour flow at the eleven intersections. The movements permitted, green timings for the intersections are given as figures (Fig C1 to Fig C15) in Annexure C

Traffic signals if not coordinated will create a stop and go scenario to avoid it, the signals are to be coordinated along routes and in the area. Signal coordination was carried out using TRANSYT Software. The flow in the network comprising of the eleven junctions as link wise flow is given in Fig 15.4. Fig 15.5 shows maximum queue in each arm of the intersections.

Corridors having maximum flow were identified in the Port Blair town and they are,

1. Hyat Singh junction to Raj Nivas via Secretariat & IP&T.
2. Hyat Singh to Delanipur via Goalghar.
3. Goalghar to Clock Tower via Bengali club and Model school.
4. Delanipur to Clock Tower via Light House.

The traffic signals in the network were optimized for a common cycle time of 120 seconds and link speed of 30kmph. The flow profiles after coordination in the four corridors with offset time is given in Fig 15.6 to Fig 15.9.

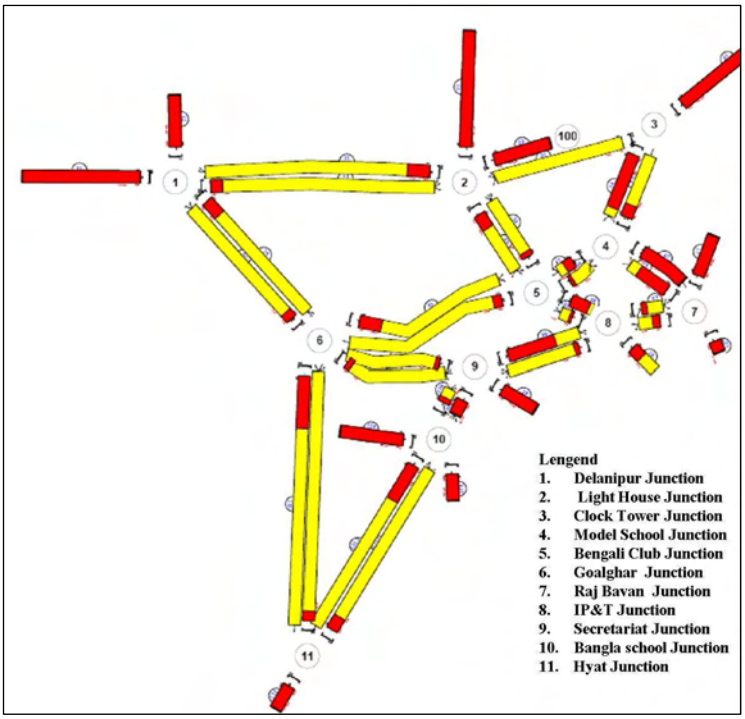


Fig 15.4 Link-wise Flow and Maximum Queue Arm-wise

Fig 15.5 Link wise flow in the Network

The cycle time for a junction is divided into number of time intervals know as steps. For each link the cyclic flow profile which is a histogram showing the flow along the link for each step of cycle is shown for the four corridors

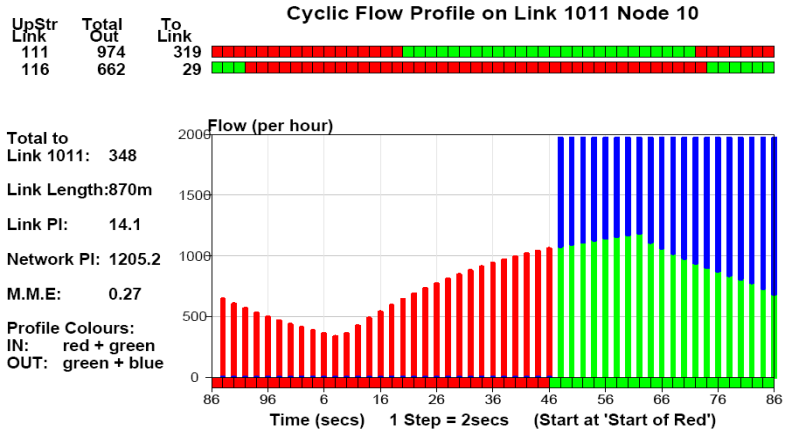


Fig 15.6 (a) Flow Profile in Hyat Singh to Bangla School Junction Link

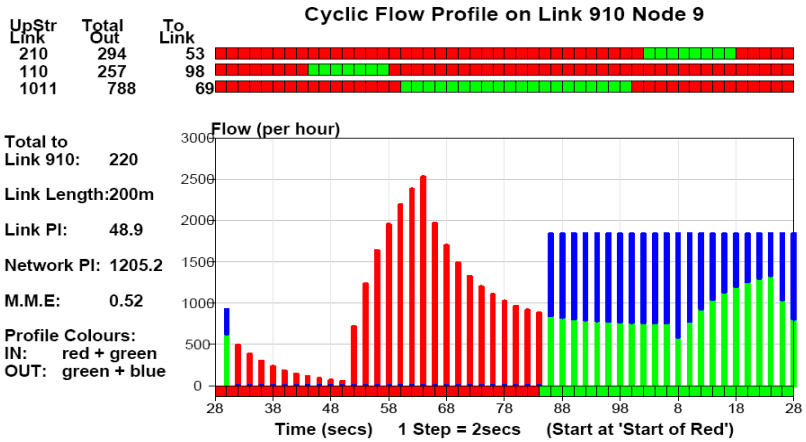


Fig 15.6 (b) Flow Profile in Bangla School to Secretariat Link

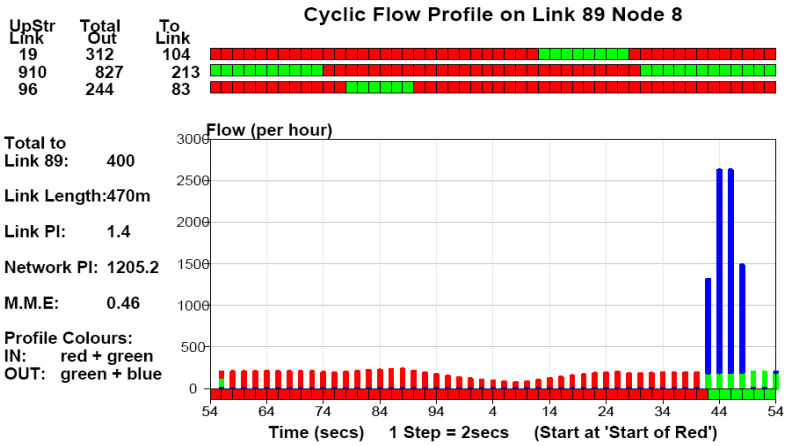


Fig 15.6 (c) Flow Profile in Secretariat to IP&T Link

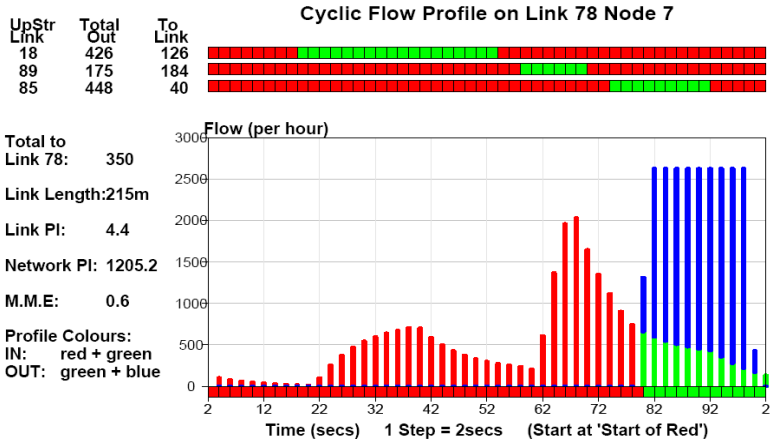


Fig 15.6 (d) Flow Profile in IP&T to Raj Nivas Link

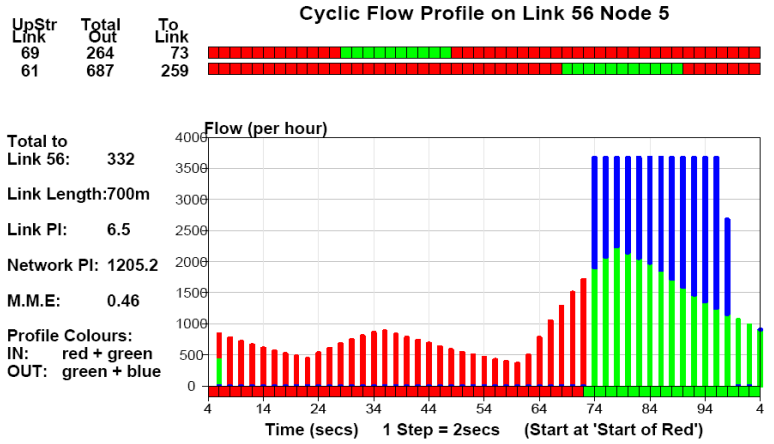


Fig 15.7 (a) Flow Profile in Goalghar to Bengali Club Link

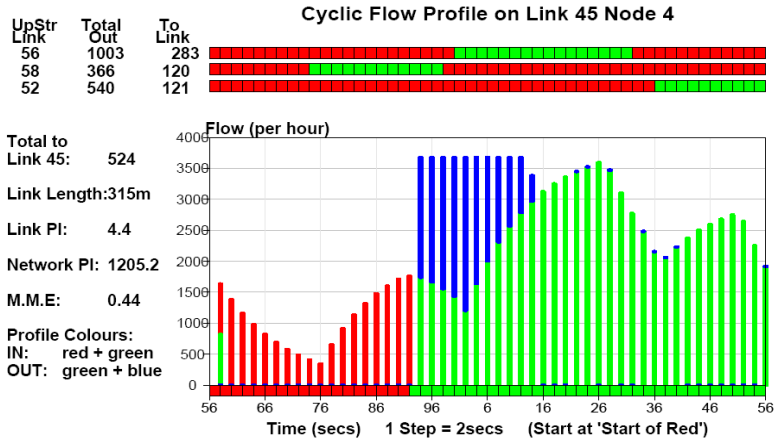


Fig 15.7 (b) Flow Profile in Bengali Club to Model School Link

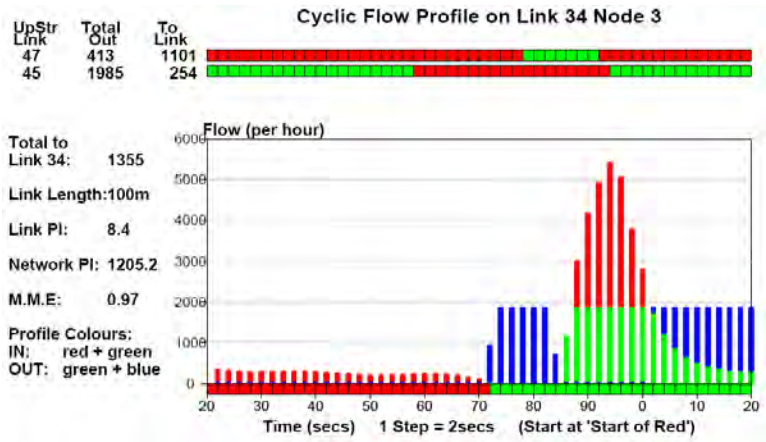


Fig 15.7 (c) Flow Profile in Model School to Clock Tower Link

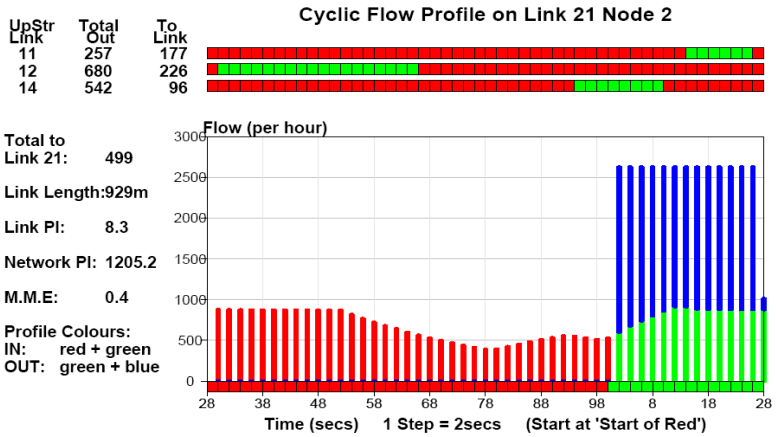


Fig 15.8 (a) Flow Profile in Delanipur to Light House Link

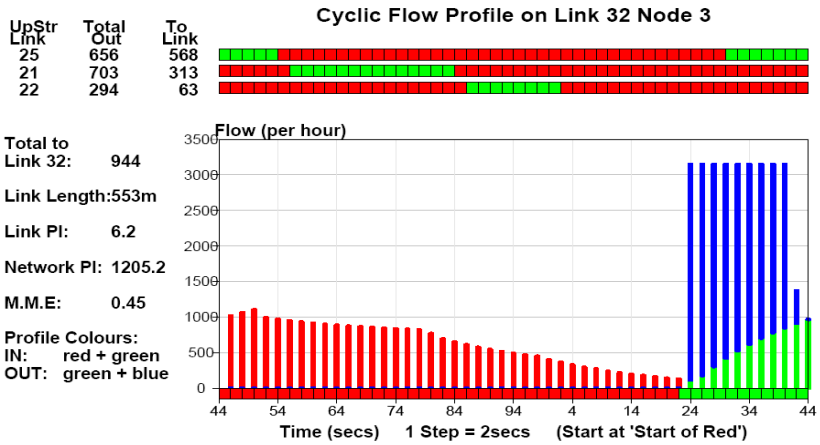


Fig 15.8 (b) Flow Profile in Light House to Clock Towers Link

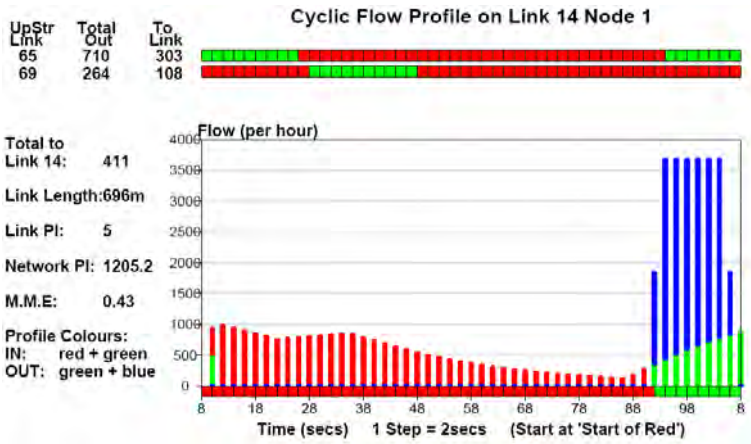


Fig 15.9 (a) Flow Profile in Hyat Singh to Goalghar Link

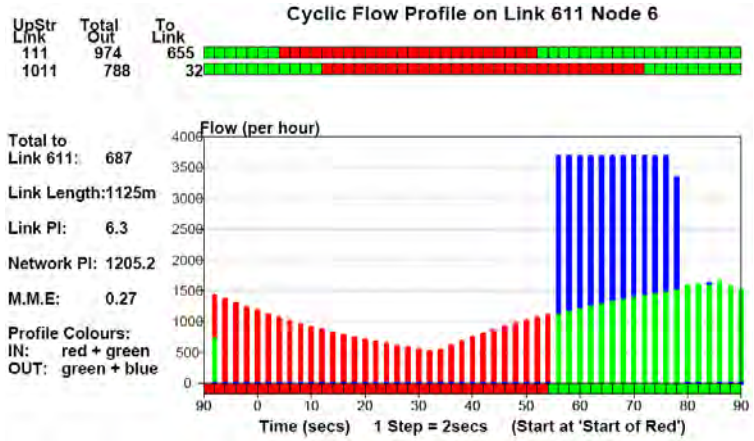


Fig 15.9 (b) Flow Profile in Goalghar to Delanipur Link

15.6 Grade Separator Design

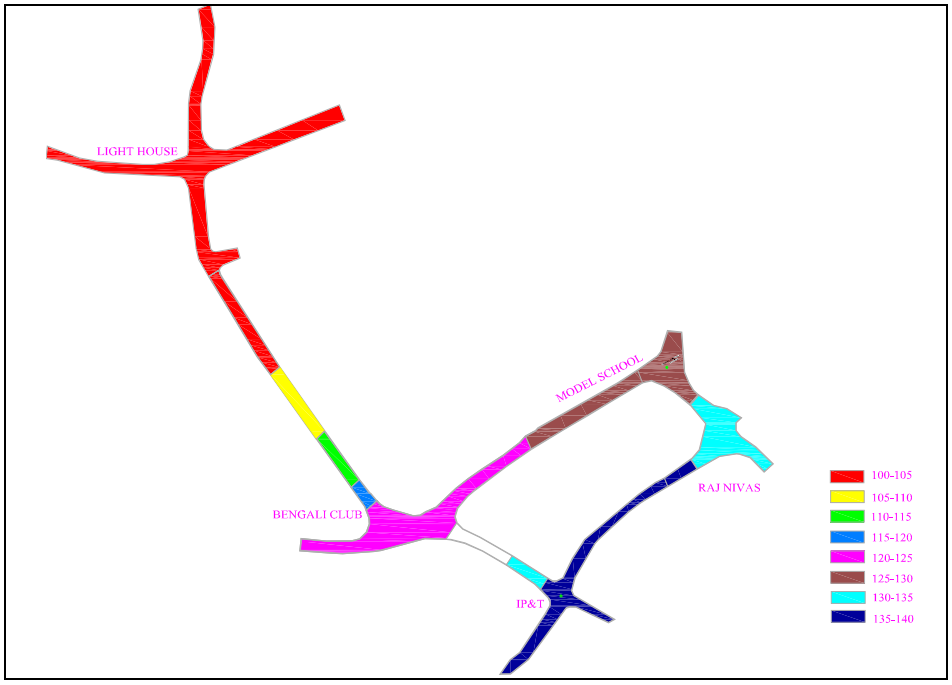
It was suggested that grade separation is required in the near future for Bengali Club Junction, Goalghar and Light House Junction. Delanipur Junction and Hyat Singh Junctions require grade separation after 5 years. The optimal layout of the grade separation facility has been worked considering all the options. Ramp slope of 1 in 30 and geometric considerations as per IRC codes were followed, in working out the layouts.

15.6.1 Bengali Club Junction

Bengali Club Junction is located close to IP & T Junction (150 m), Model School (300 m) and Light House Junctions (420 m). Grade separator has to be planned

considering the topography (Fig. 15.10) flow pattern and its proximity to the other intersections.

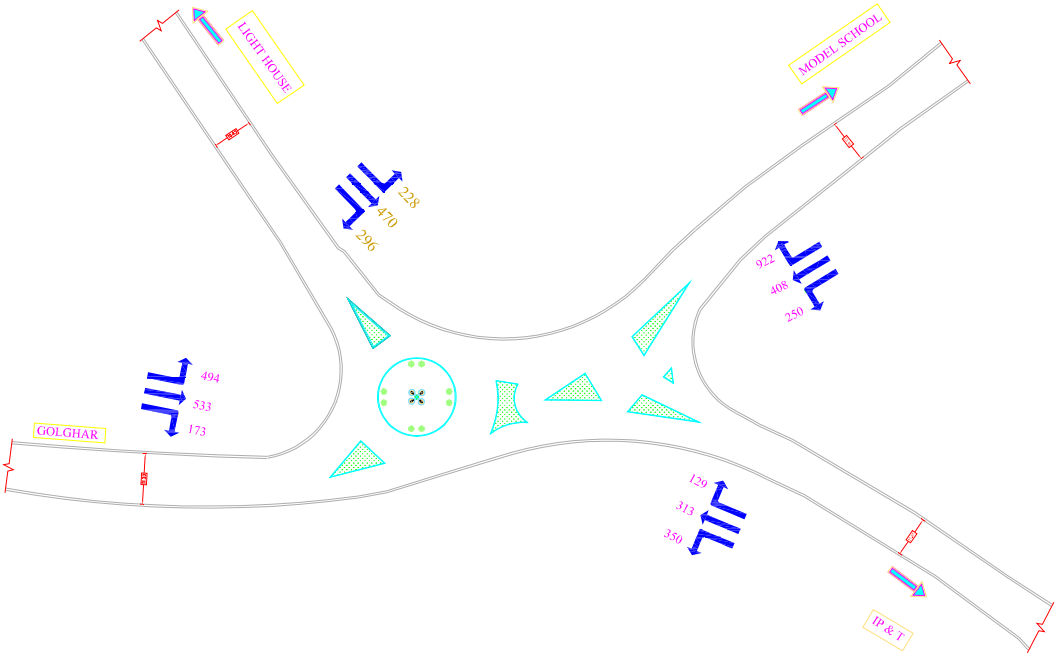
Illustration of the traffic flow pattern at the Bengali club intersection is as shown in Fig.15.11. The peak hour flow in the intersection is 4902 PCUs. Of the total traffic 35 percent is from Model School, 26 percent from Goalghar. 22 percent from Light House and the rest 17 percent is from IP&T. It may also be seen that 63% of the traffic from Model School direction is right turning traffic towards Light House and the rest 27 percent is through and left turning traffic.



Note: 100m is considered as datum of Light House Junction

Fig 15.10 Topography of the Road Network Surrounding Bengali Club Junction

Thus the right turning traffic from Model School at the Bengali Club Junction is the highest compared to through and turning traffic. Proportion of straight traffic on Goalghar – Model School section is higher than the straight traffic of Light House–IP&T section.



NOTE: Flow in PCUs

Fig 15.11 Traffic flow at Bengali Club Junction during Morning Peak

Four proposals were formulated for grade separator arrangement at Bengali Club Junction. The proposals are

1. A 5m wide unidirectional fly-over along West-East direction along the road from Goalghar to Model School for straight traffic, with right turn arm, towards IP&T to enable easy uninterrupted right turning flow from Goalghar. (Fig 15.12 (a)).
2. A 5m wide unidirectional flyover along West-East direction for easy flow of straight traffic from Goalghar to Model School (Fig 15.12 (b) the traffic movement has been made as one way in clockwise direction.
3. A 5m wide flyover along East-West direction for straight traffic from Model School to Goalghar and with right turn arm towards Light House to enable right turning from Model School towards Light House. (Fig 15.12 (c)).
4. An 8m wide two way flyover along East-West direction to enable straight movements between Model School and Goalghar. (Fig (15.12d)).

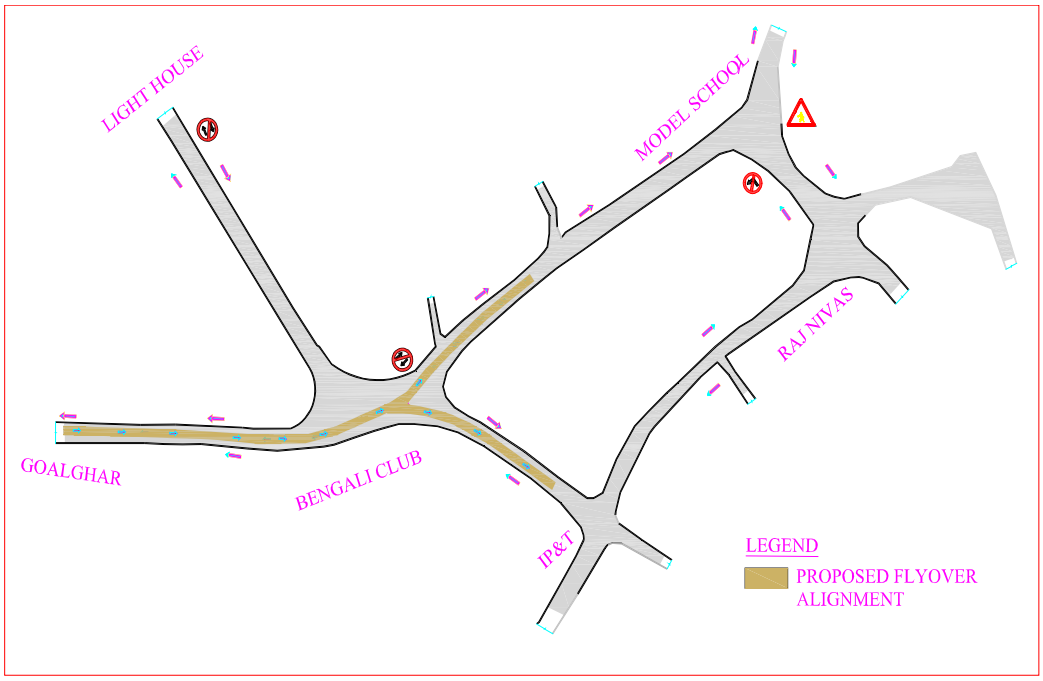


Fig.15.12 (a) Layout of the Proposed Grade Separator at Bengali Club Intersection (PROPOSAL 1)

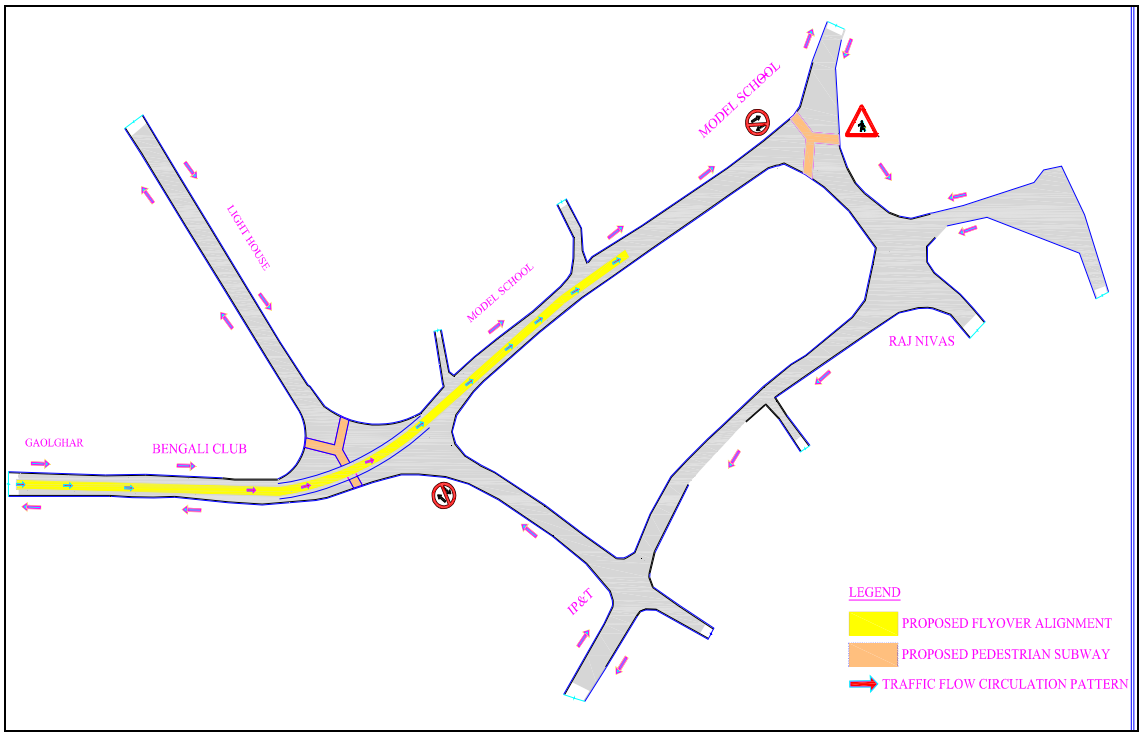


Fig. 15.12 (b) Layout of the Proposed Grade separator at Bengali Club Intersection (PROPOSAL 2)

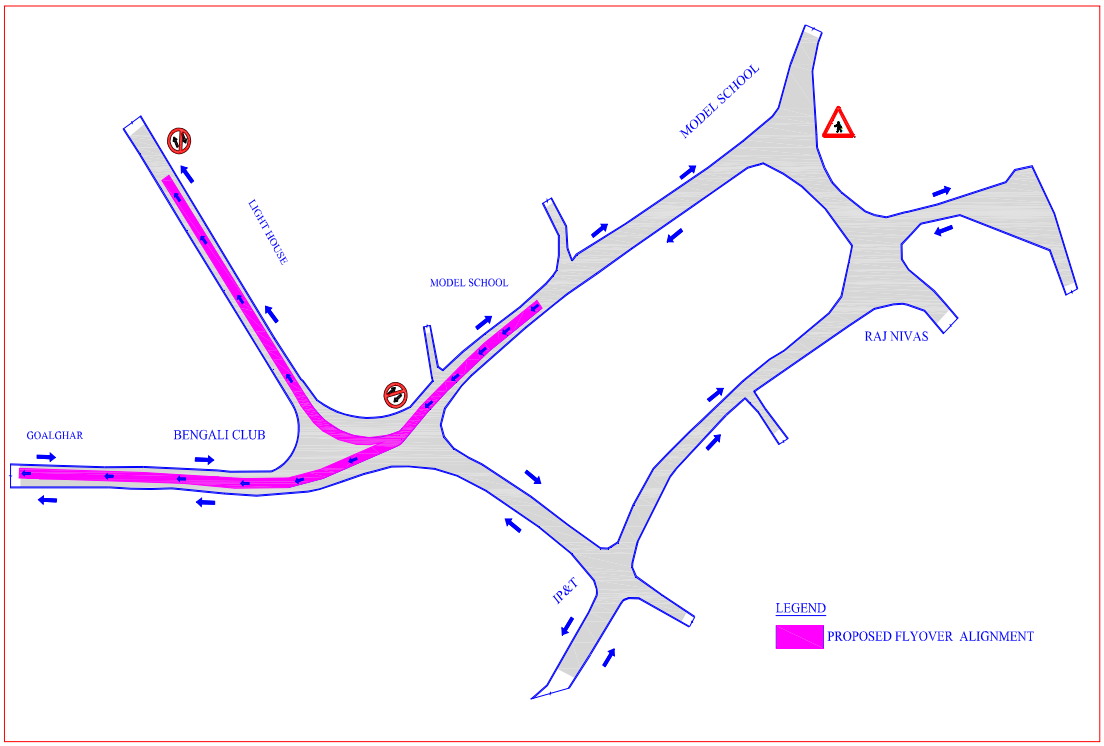


Fig. 15.12 (c) Layout of the Proposed Grade separator at Bengali Club Intersection (PROPOSAL 3)

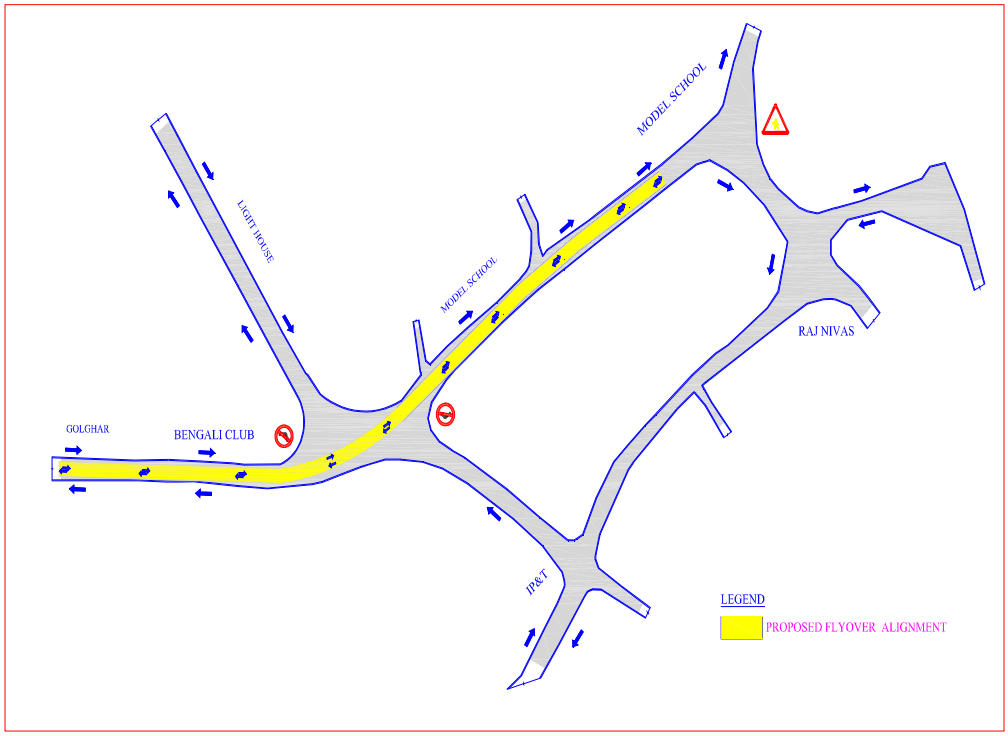


Fig. 15.12 (d) Layout of the Proposed Grade separator at Bengali Club Intersection (PROPOSAL 4)

The four proposals were compared with the existing situation for delay at each junction, potential conflict, estimated cost and savings in terms of fuel and travel time. Conflicts for the existing condition and proposals are given in Fig 15.13(a) to 15.13(e)

The proposals were evaluated in term of delay as Seconds/Vehicle, additional land required, number of collision points and implementation hurdles. The summary of the results are given in Table15.5. On detailed analysis proposal 2 is found to be the optimal one. The vehicles are likely to be subjected to minimum delay in proposal 2 and the number of conflicts is also minimum for the proposal 2. So proposal 2 is recommended for implementation at Bengali Club.

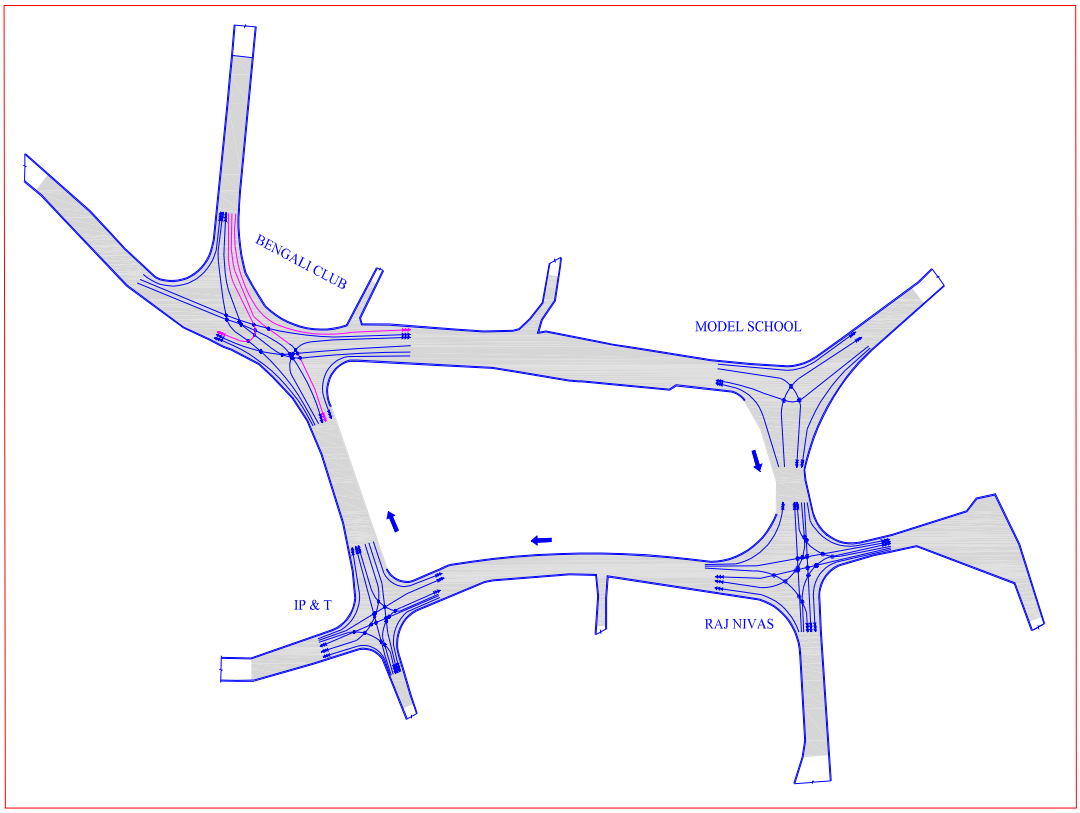


Fig 15.13(a) Conflicts in and around Bengali Club Junction for Existing Condition

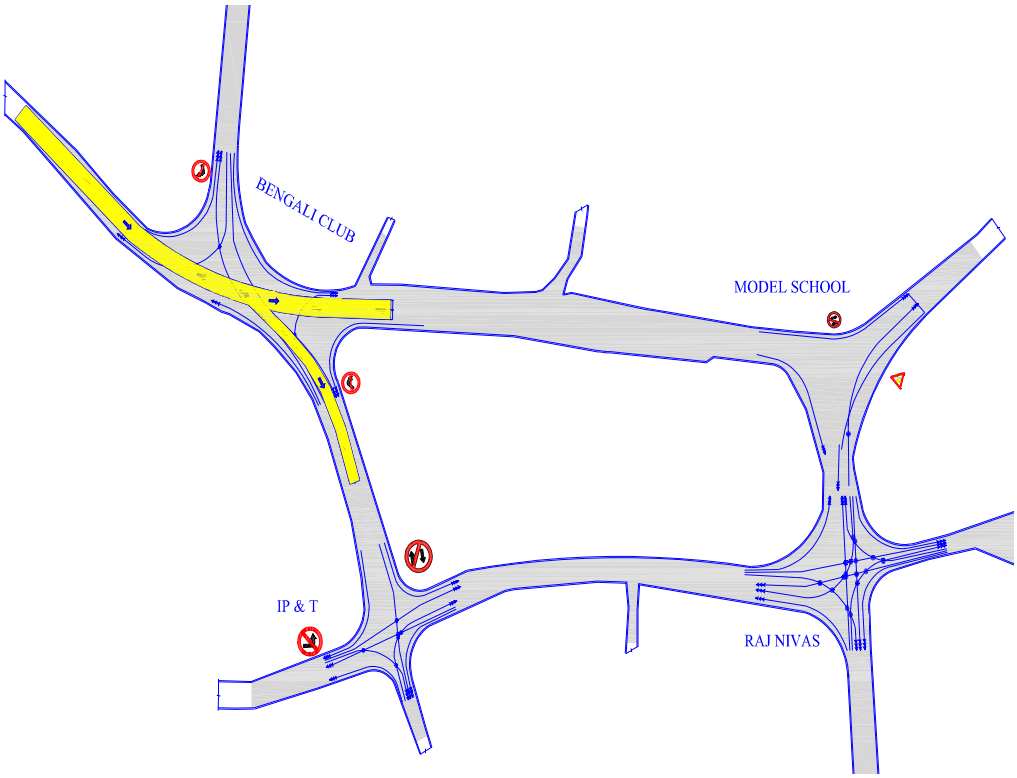


Fig 15.13(b) Conflicts in and around Bengali Club Junction for the PROPOSAL 1

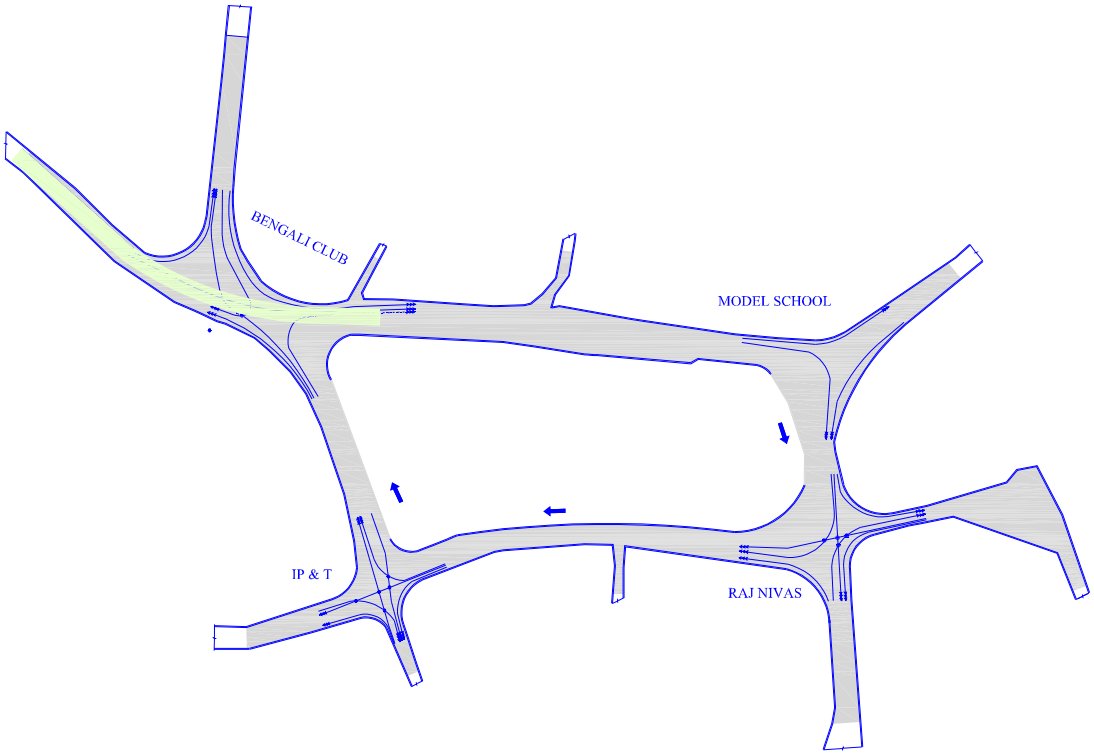
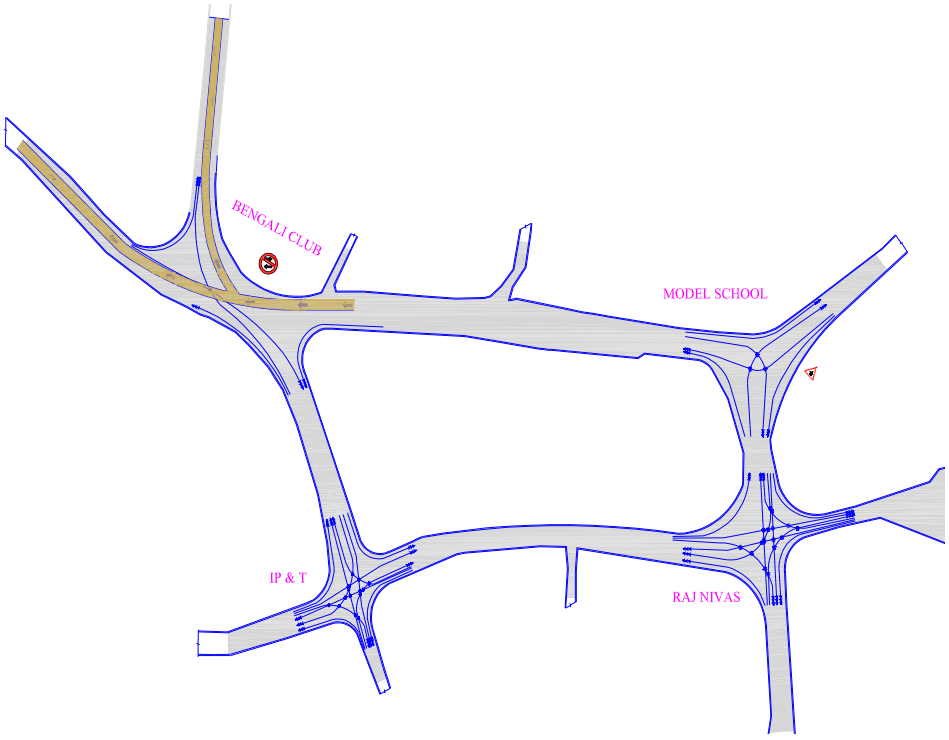


Fig 15.13(c) Conflicts in and around Bengali Club Junction for the PROPOSAL 2



15.13(d) Conflicts in and around Bengali Club Junction for the PROPOSAL 3

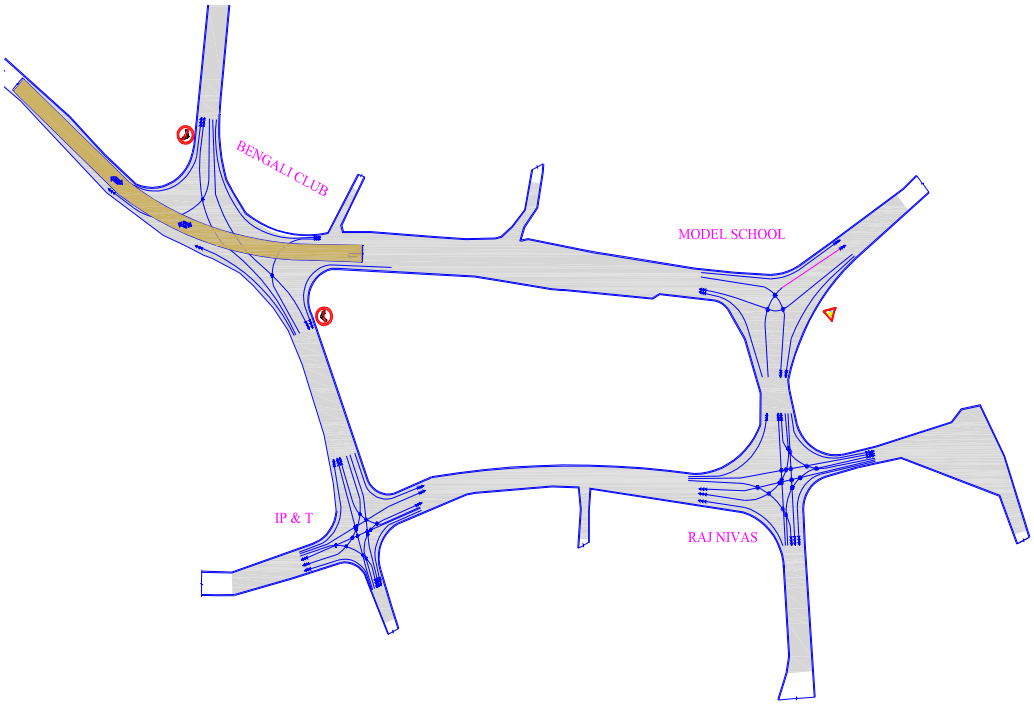


Fig
15.13(e) Conflicts in and around Bengali Club Junction for the PROPOSAL 4

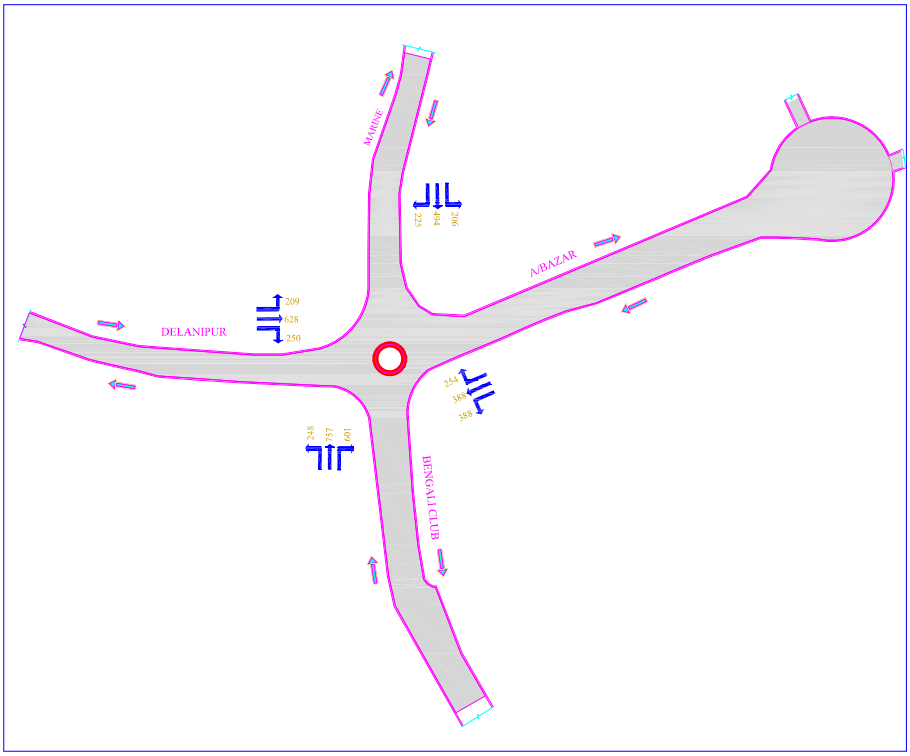
Table 15.5 Comparison of the proposals at Bengali Club Junction

Options	Extent of land to be acquired	Delay in peak hour		Saving cost (Fuel + Travel time) Lakhs/ Year	Cost of construction in Crores	Number of collision points					Hurdles in implementation if any
		PCU-Hr	Sec/ PCU			B.C	IP&T	M.S	R.N	TOTAL	
Existing	---	61.30	56.49			16	16	3	16	51	---
Proposal 1	≈ 1950 sq.m	1.59	2.43	40.60	12.00	0	8	1	16	25	Existing width of road is 11m leaving 5m for fly-over, 2m on either side have to be acquired. This proposal consists of Pedestrian subway in Bengali club junction and model school junction
Proposal 2	≈ 1500 sq.m	9.63	18.51	70.50	10.00	3	4	0	3	10	Existing width of road is 11m leaving 5m for fly-over 2m on either side have to be acquired
Proposal 3	≈ 2500 sq.m	4.58	13.18	35.98	14.00	1	16	3	16	36	Terrain is steep from IP&T towards light house. Hence, to meet the IRC standards the ramp has to be extended till the next junction
Proposal 4	≈ 2500 sq.m	9.24	16.63	38.16	14.00	2	16	3	16	37	Leaving 8m space for fly over 4m has to be acquired on either side of the road

15.6.2 LIGHT HOUSE INTERSECTION

Light house intersection is one of the most critical and important intersection that requires improvement for the immediate future traffic. The traffic flow at Light house Intersection is 4055 PCUs in the morning Peak hour (Fig.15.14). At present manual control is provided to control the flow at the Intersection. The intersection is one among the five intersections in Port Blair that have high accident occurrence.

Considering the traffic expected and accident rate prevailing, the intersection calls for grade separation in the near future.



Flow in PCUs

Fig 15.14 Traffic flow at Light House Junction during Morning Peak

On extensive analysis the proposal for solving the problems at Light House Junction is shown in Fig 15.15(a) -15.15(b). The proposal consists of

1. An 8m wide fly-over along Aberdeen Bazar and Delanipur.
2. An 8m wide fly-over along Marine and Bengali club.

The conflict points for existing condition 15.16(a) and for proposals 15.16(b) & 15.16(c) show that grade separation will lead to reduction in accident occurrence. Proposal 1 will hamper the flow at Gandhi Statue junction whereas on implementation of proposal 2, separation of straight flow in that direction will enable minimum delays.

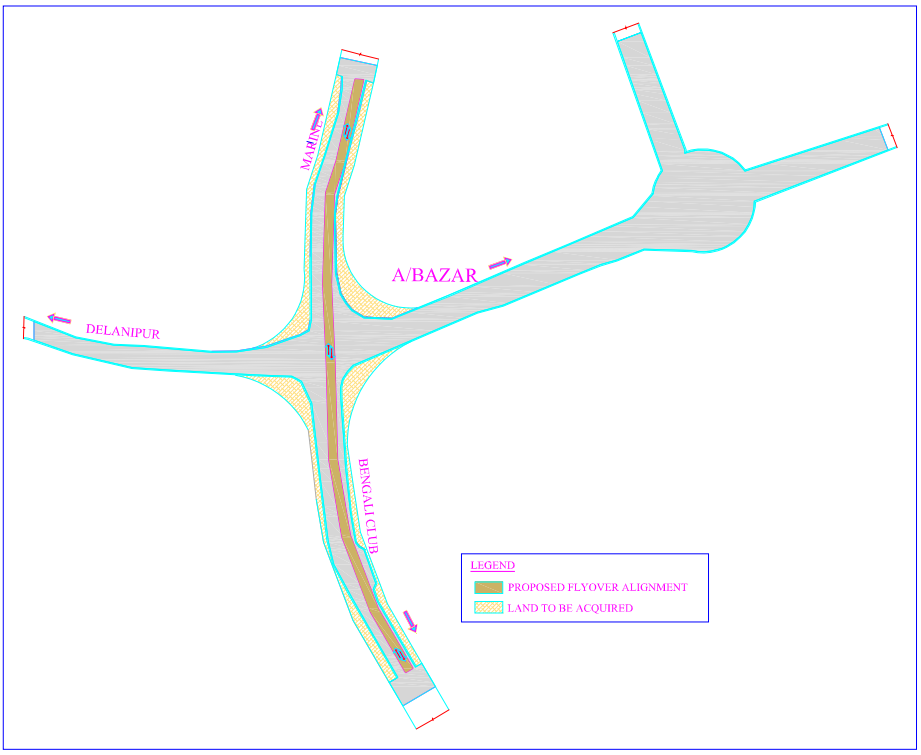


Fig15.15 (a) Layout of the Proposed Grade Separator at Light House Intersection (PROPOSAL 1)

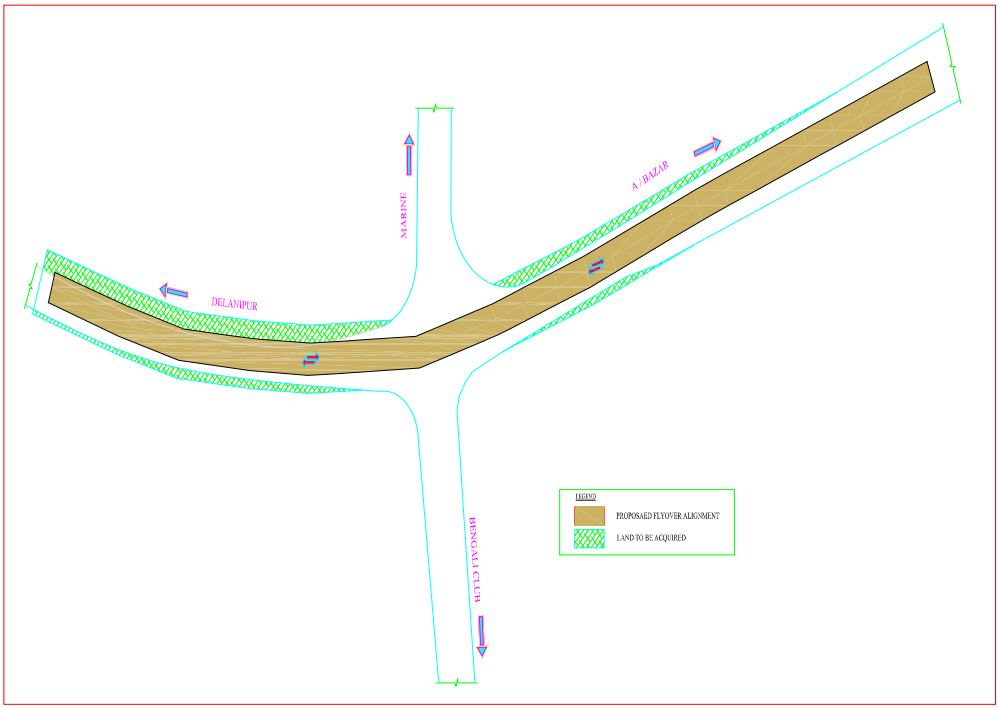


Fig.15.15 (b) Layout of the Proposed Grade Separator at Light House Intersection (PROPOSAL 2)

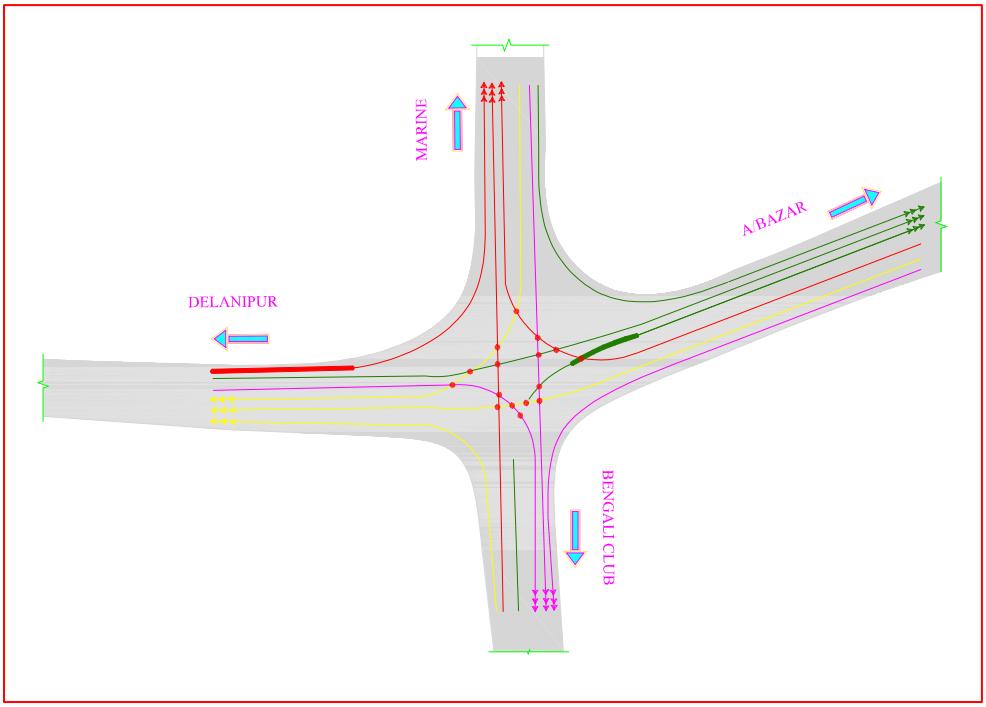


Fig 15.16(a) Conflicts at Light House Intersection for the existing condition

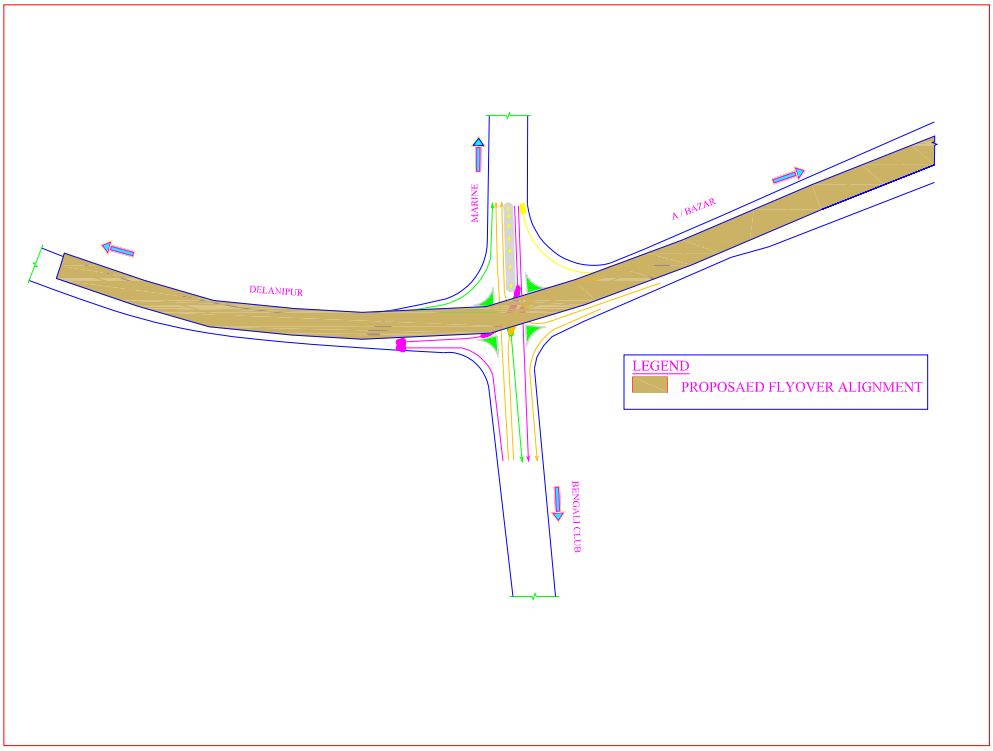


Fig 15.16(b) Conflicts in and around Light House junction for the PROPOSAL 1

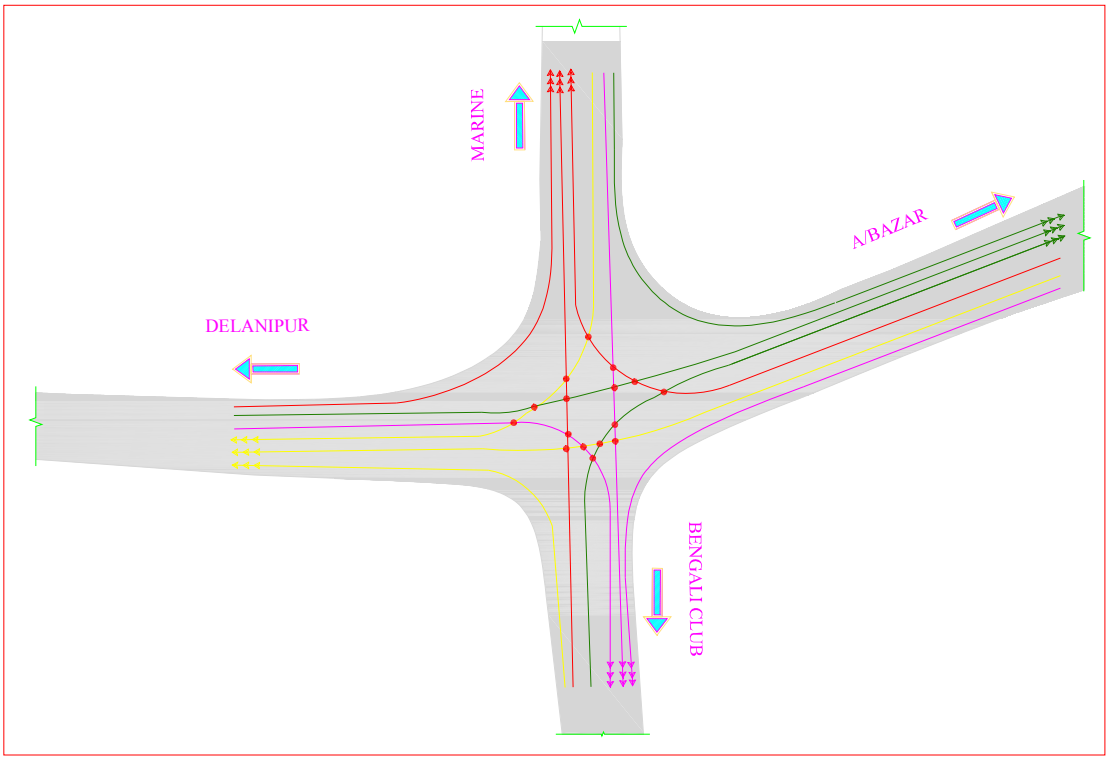


Fig 15.16(c) Conflicts at Light House Junction for the PROPOSAL 2

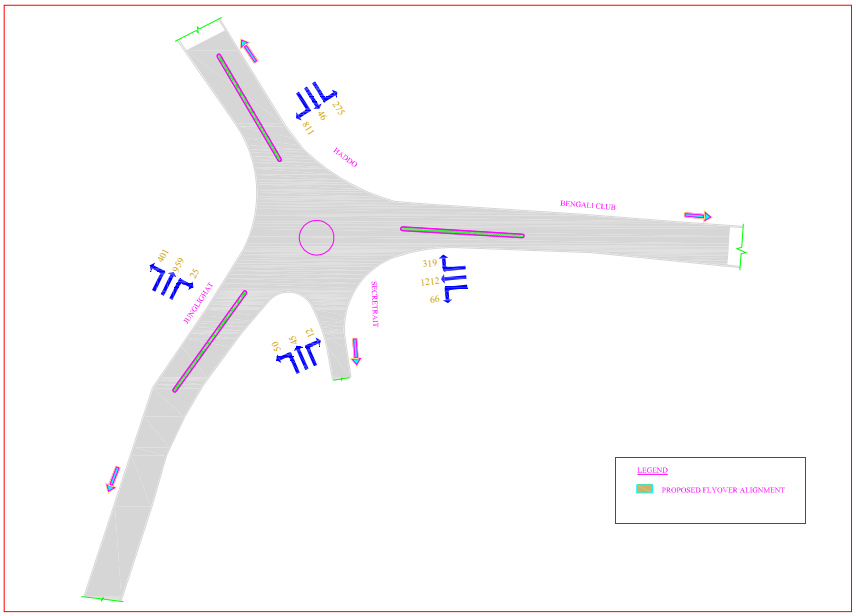
Table 15.6 Comparison of the proposals at Light House junction

Options	Extent of land to be acquired	Delay in peak hour		Saving cost (Fuel + Travel time) Lakhs/Year	Cost of construction in Crores	Number of collision points	Hurdles in implementation if any
		PCU-Hr	Sec/PCU				
Existing	---	76	60			16	---
Proposal1	≈1200sq.m	55	52	15.29	14	8	Existing width of road is 11m leaving 8m for fly-over, 4.5m on either side have to be acquired
Proposal2	≈1400sq.m	49	50	20.95	14	8	Existing width of road is 11m leaving 8m for fly-over 4.5m on either side have to be acquired

Proposal 2 is recommended for implementation

15.6.3 Goalghar Intersection

Goalghar intersection is one of the most critical and important intersection that requires improvement for the immediate future traffic. The maximum traffic flow at Goalghar Intersection in Junglighat is 3958 PCUs during the Evening Peak hour. At present manual control is provided to control the flow at the Intersection. But the traffic volume has already reached to the extent which requires traffic signal for the intersection (Fig15. 17(a)). The junction has maximum accident occurrence considering the high rate of accident occurrence and grade separation is required soon. The Topography of Goalghar Junction is given in Fig 15.17(b)



Flow in PCUs

Figure 15.17(a) Traffic flow at Goalghar Junction during Evening Peak

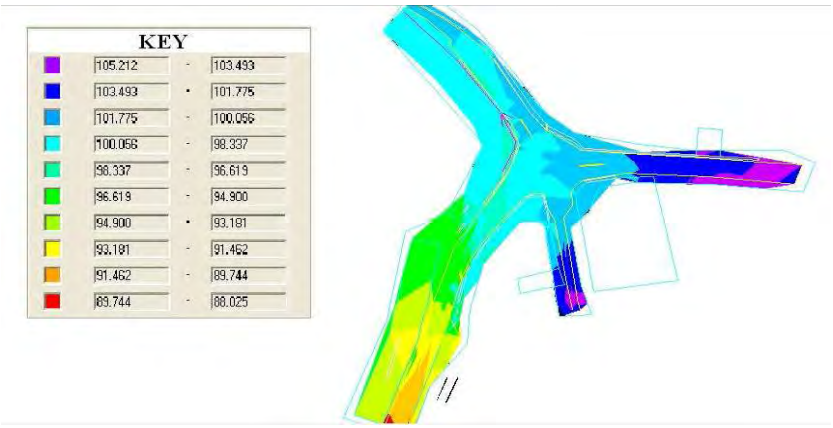


Fig 15.17(b) Topography of the Goalghar Junction

Proposal for Improvement

The proposals formulated for solving the problems at Goalghar Junction and their details are:

a) Proposal 1: An 8m wide fly-over along stretches connecting Bengali club and Junglighat.
b) Proposal 2: A 5m wide unidirectional flyover from Delanipur to Junglighat
c) Proposal 3: Proposal 1+Road leading to secretariat – one way
d) Proposal 4: Proposal 2+Road leading to secretariat – one way

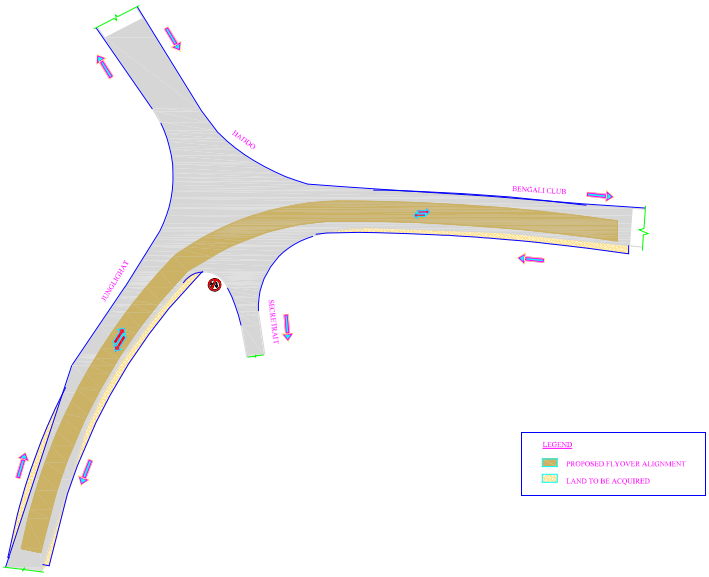


Fig.15.18 (a) Layout of the proposed Grade separator at Goalghar Intersection (PROPOSAL 1)

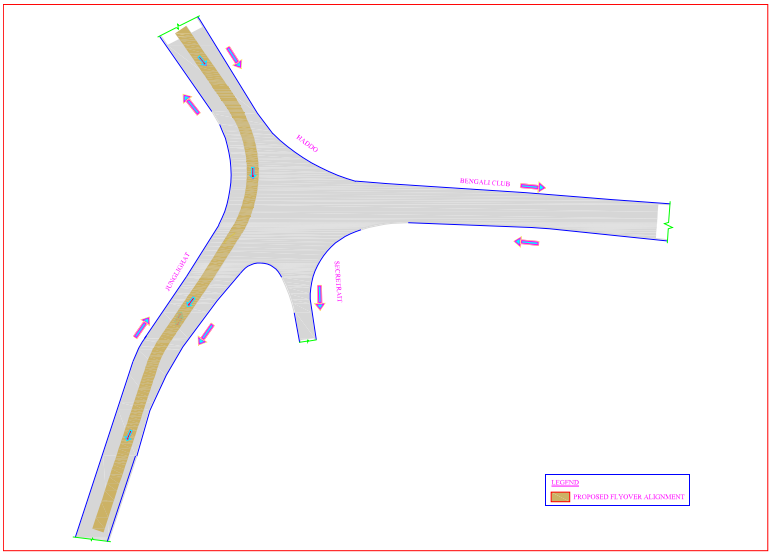


Fig15.18 (b) Layout of the proposed Grade separator at Goalghar Intersection (PROPOSAL 2)

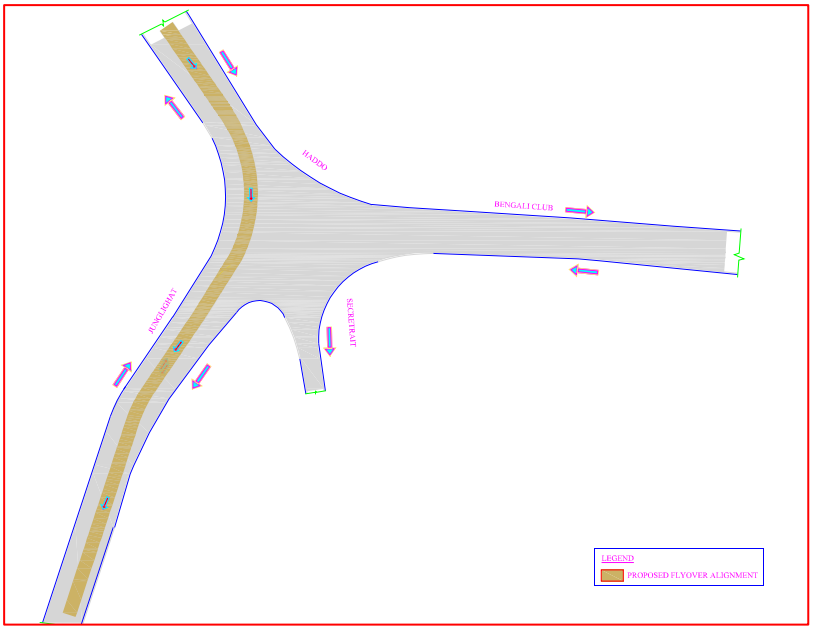


Fig15.18 (c) Layout of the proposed Grade separator at Goalghar Intersection (PROPOSAL 3)

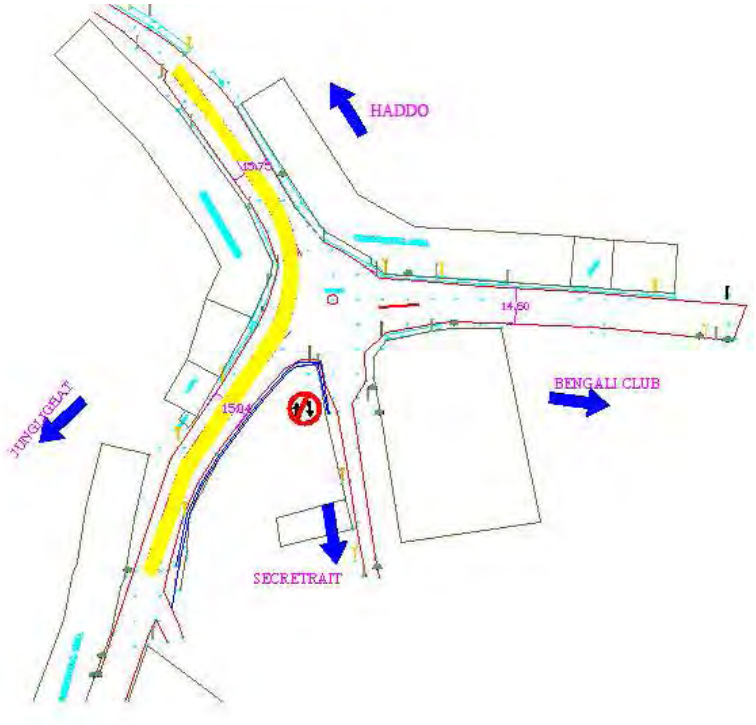


Fig15.18 (d) Layout of the proposed Grade separator at Goalghar Intersection (PROPOSAL 4)

Number of conflicts in each proposal, the expected fuel and time saving were computed for the present condition. The conflict for the existing condition and the proposals are given in Fig 15.19(a) to Fig 15.19 (e)

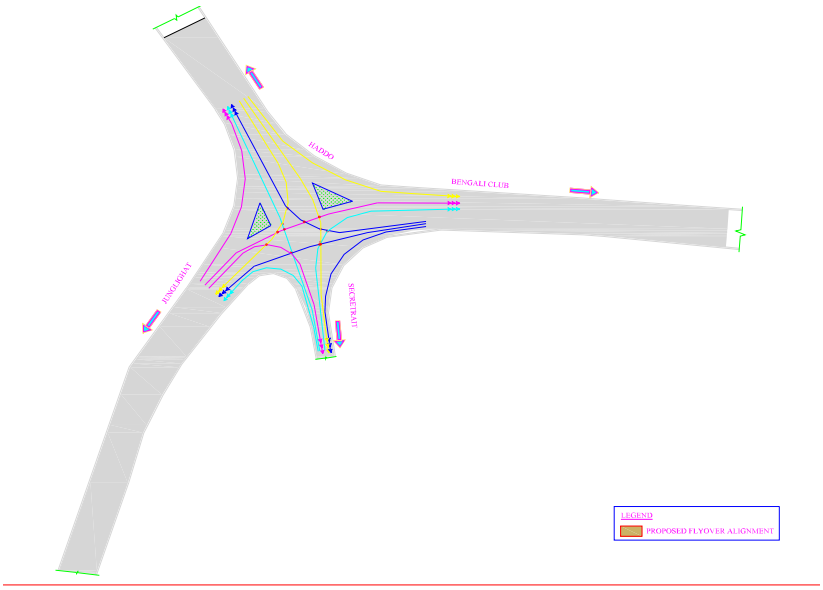


Fig 15.19 (a) Conflicts at Goalghar Junction for the Existing condition

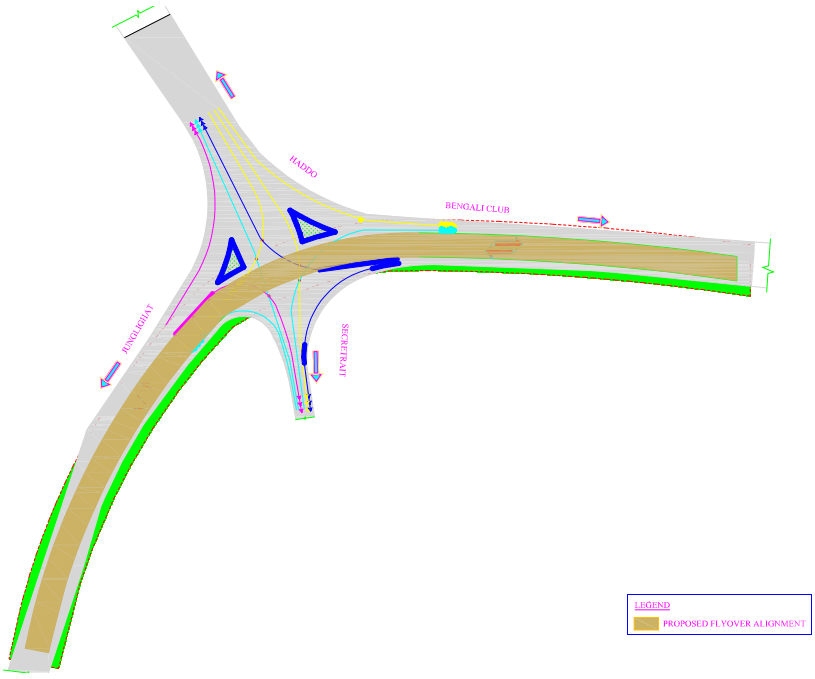


Fig 15.19 (b) Conflicts at Goalghar junction for the PROPOSAL 1

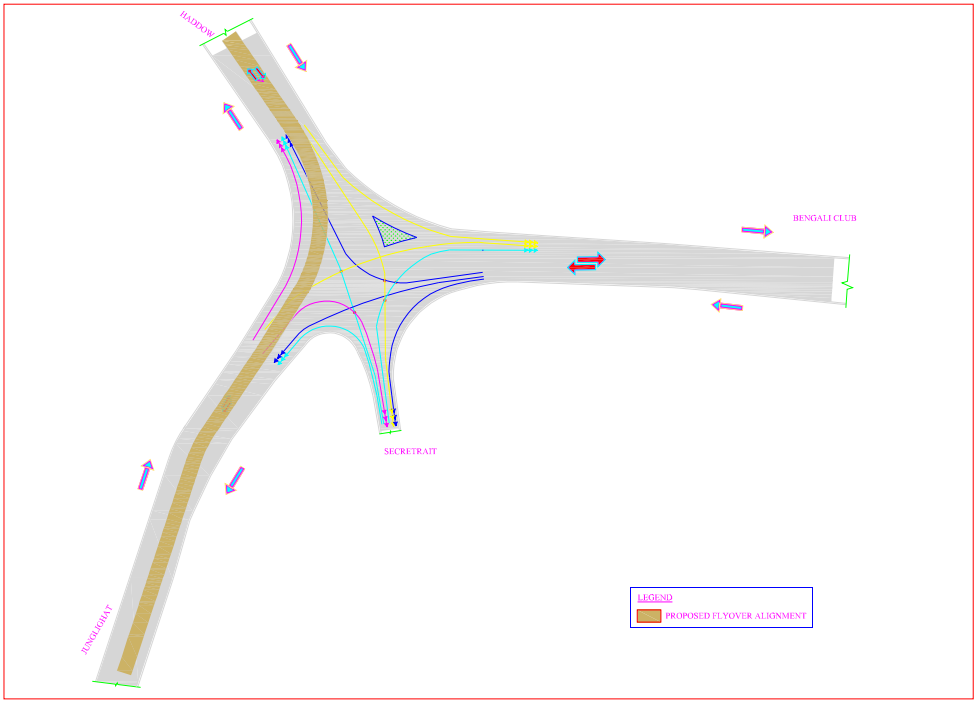


Fig 15.19 (c) Conflicts at Goalghar Junction for the PROPOSAL 2

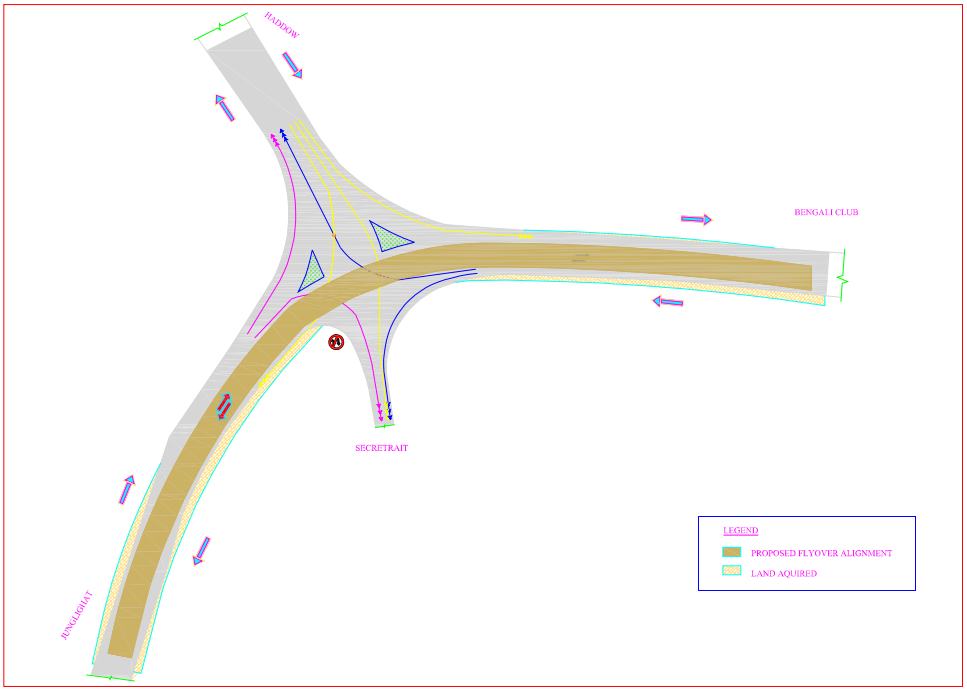


Fig 15.19 (d) Conflicts at Goalghar Junction for the PROPOSAL 3

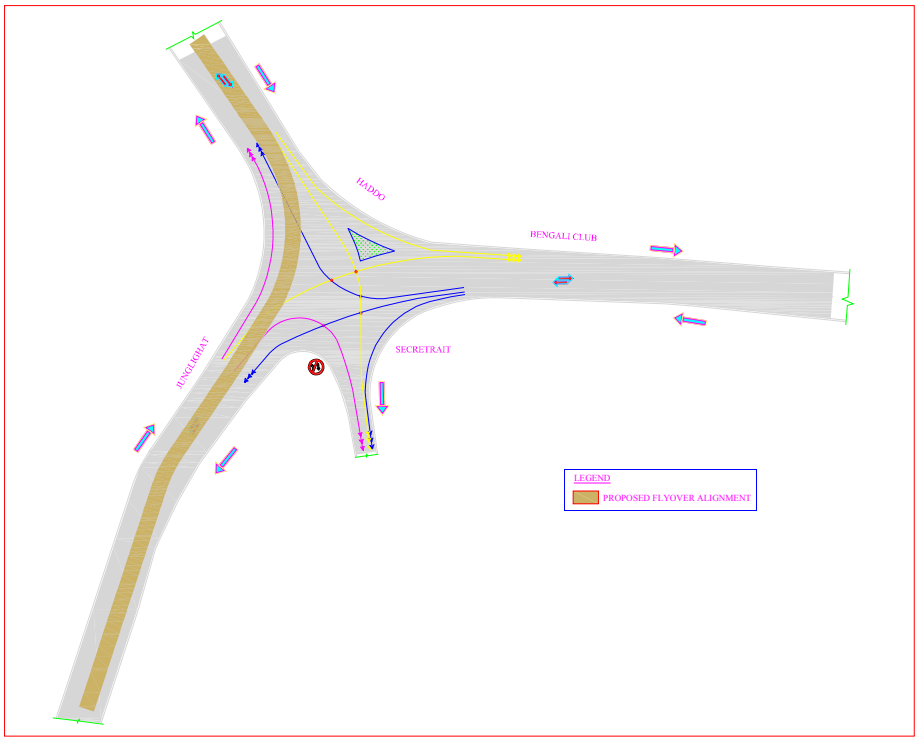


Fig 15.19 (e) Conflicts at Goalghar junction for the PROPOSAL 4

The summary of the findings is tabulated and given in Table 15.7 Proposal 3 has the maximum fuel and time saving and the number of conflicts is also minimum. As there is a slope in the road stretch from Goalgharlhar Junction to Junglight, to maintain a slope of 1 in 30 the length of the ramp needs to be extended for a length of 400metres.

Table 15.7 Comparison of the proposals for Goalghar Junction

Options	Extent of land to be acquired	Delay in peak hour		Saving cost (Fuel + Travel time) Lakhs/Year	Cost of construction in Crores	Number of collision points	Hurdles in implementation if any
		PCU-Hr	Sec/PCU				
Existing	---	47	46			16	---
Proposal 1	1500sq.m	11	14	17.20	20.00	8	Existing width of road is 11m leaving 8m for fly-over, 4.5m on either side have to be acquired
Proposal 2	1500sq.m	28	36	4.62	20.00	12	Existing width of road is 11m leaving 5m for fly-over, 4.5m on either side have to be acquired
Proposal 3	1500sq.m	3	8	20.11	20.00	3	Existing width of road is 11m leaving 8m for fly-over, 4.5m on either side have to be acquired
Proposal 4	1500sq.m	22	32	8.45	20.00	5	Existing width of road is 11m leaving 5m for fly-over, 4.5m on either side have to be acquired

15.6.4 Delanipur Intersection

The traffic at Delanipur Junction is also on the rise as in the entire area and it will require grade separation facility in the medium term (after 5 years). 8m wide fly over to carry the straight traffic between Goalghar and Haddo is recommended for implementation.

On extensive analysis the proposal for solving the problems at Delanipur Junction is shown in Fig 15.20. The proposal consists of

a. An 8m wide fly-over along stretches connecting Goalghar and Haddo.

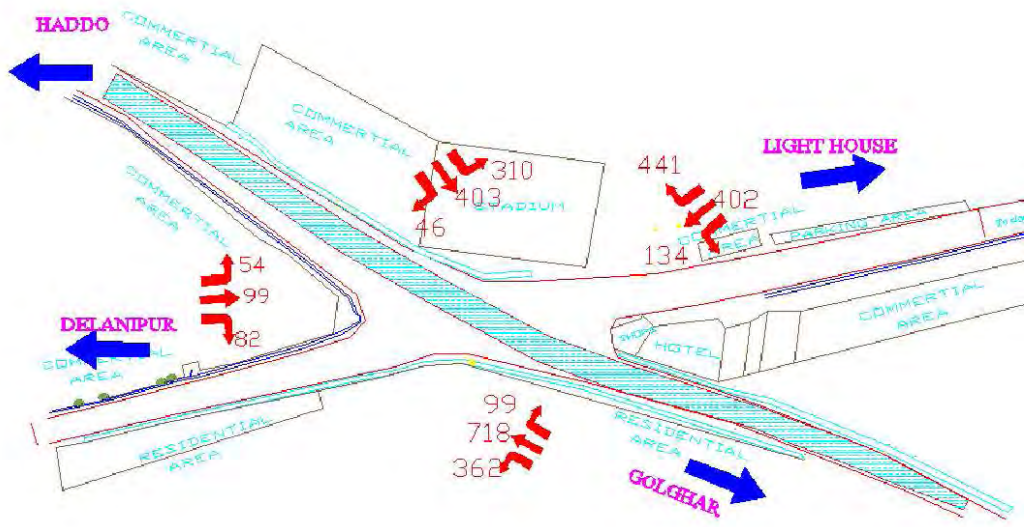


Fig.15.20 Layout of the proposed Grade separator at Delanipur Intersection (PROPOSAL 1)

Reduction in conflicts, delay and savings due to the proposal is considerable. The proposal is recommended for implementation in the medium term.

Table 15.8 Comparison of the proposals

Options	Extent of land to be acquired	Delay in peak hour		Saving cost (Fuel + Travel time) Lakhs/Year	Cost of construction in Crores	Number of collision points	Hurdles in implementation if any
		PCU-Hr	Sec/ PCU				
Existing	---	41.6	50.2	--	--	16	---
2011		56.6	55.7	---	--	16	---
Proposal 1	3000sq.m.	29	46	13.84	14	8	Existing width of road is 12m & 8m in Haddo and Goalghar stretches respectively. leaving 8m for fly-over, 4.5m on either side have to be acquired

15.7 CONCLUSION

The proposals formulated for each intersection were compared with the existing situation for delay at junction, potential conflict, estimated cost and savings in terms of fuel and travel time. The optimal solution is suggested for implementation.

There is also a possibility of the traffic (Haddo to Junglighat) to get shifted to marine drive, once the marine drive is constructed. It is suggested that the grade separation facility at Goalghar and Delanipur junctions may be taken up after observing the shift in traffic to marine drive.

The following benefits are expected on implementation of the proposed improvements at intersections:

1. There will be free flow of traffic at intersection.
2. The safe movement of pedestrian and vehicles will be ensured.
3. The traffic on heavily loaded stretch is dispersed. Smooth flow of traffic at permissible speeds will be ensured.

15.8 Parking

Parking is one of the major traffic problem in Port Blair. Detailed Parking study has been carried out and it was found locations identified by Traffic police & APWD for on -street/off-street surface Parking lots development are justifiable. But as the suggested locations have limited capacity Multi Level Parking facility is suggested at Netaji Club area, and Netaji Stadium (near Y Narayan junction) and surface level off-street parking is proposed behind Ratna Market (PBMC Land) and near Junglighat School

The open space behind ratna market owned by PBMC is proposed for development as an off-street parking lot (Fig 15.21). The drain on the Souhtern side is to be covered with an RC slab and to be used as approach road to the parking lot. 38 car and nearly 200 two wheelers could be parked in the space available.

Similarly the land owned by Netaji Club could be used for parking (Fig 15.22). Either surface parking could be allowed or underground parking facility could be developed on public private partnership concept.

The open land available near Junglighat School could be developed as an off-street parking lot (Fig 15.23). It would ease the parking demand in the Junglighat area.

There is great demand for parking near Cellular Jail and Stadium. A multilevel parking is proposed near the Y-Narayan Junction (Fig 15.24).

It is also suggested

1. To collect nominal Parking fee.
2. To permit vehicle Parking on only one side of road stretch.
3. To penalise for Parking on No-Parking Zones to adopt and banning Parking activities on No Parking zones.
4. To reserve space for 50 to 100 cars and 300 two wheelers at tourist places like Wandoor, Chidayatop.

15.9 Installation of Traffic Signs

Traffic signs and information signs are essential to assist the drivers to reach the destination easily and safely. Indications for speed regulations in school zones, pedestrian crossings, road curves etc are very much required in a road network. But the installation of traffic signs was not found to be practiced vigorously in the Port Blair town and in the Environs. It is urgently required to install signs near Schools, Hospitals, Parking zones, Major intersections, horizontal curves, vertical gradients etc. Information signs indicating the route to reach prominent stations are to be installed. Traffic signs are to installed as per IRC Code of practice for road signs IRC 67-2001, road delineators to enable visibility and guidance during night time are to be installed as per IRC recommended practice for road delineators IRC 79-1981 and road markings are to be carried out as per IRC code of practice for road markings IRC-35-1997. The important Traffic signs suggested for installation are indicated in Annexure D.

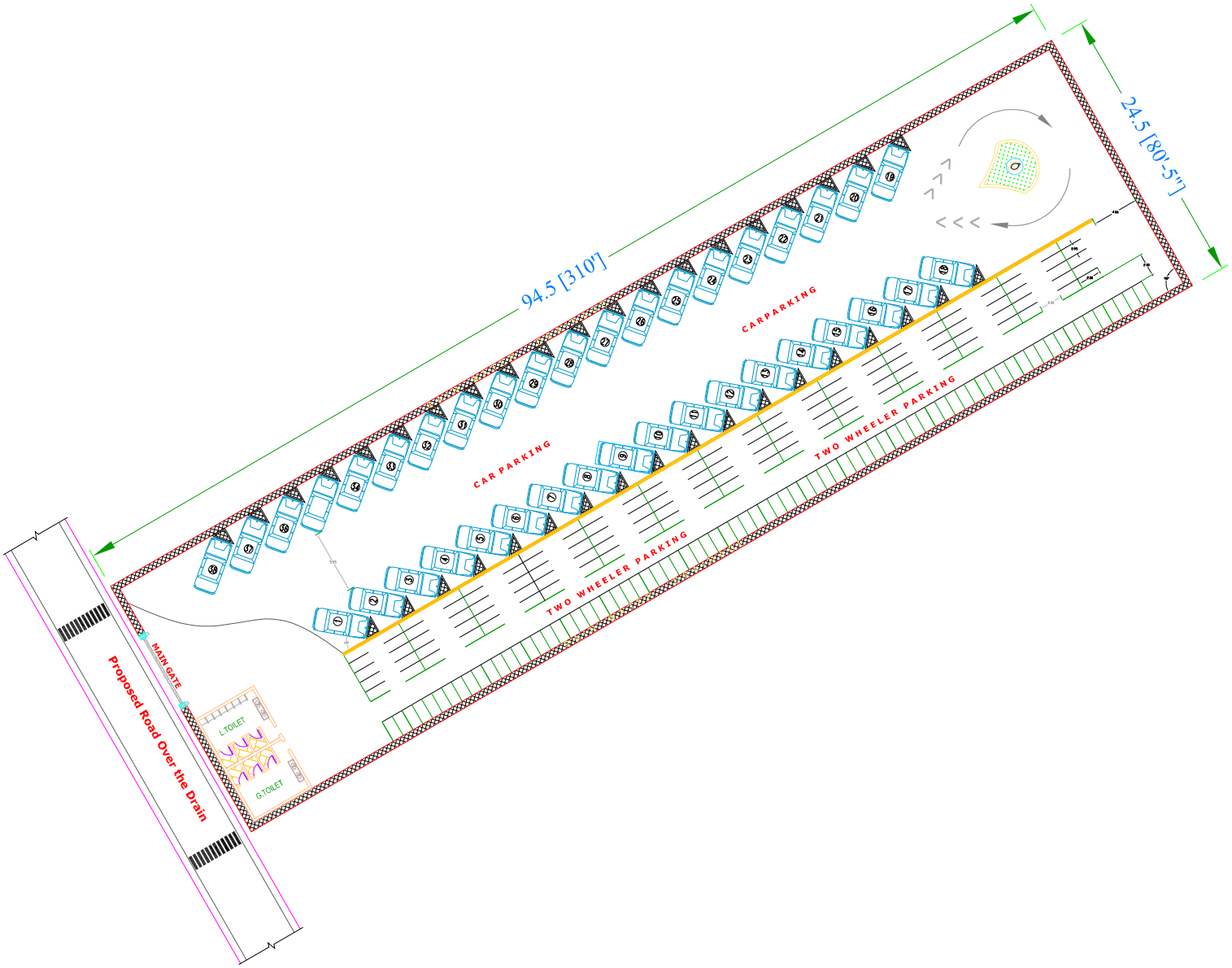


Fig 15.21 Proposed Parking Layout behind Ratna Market

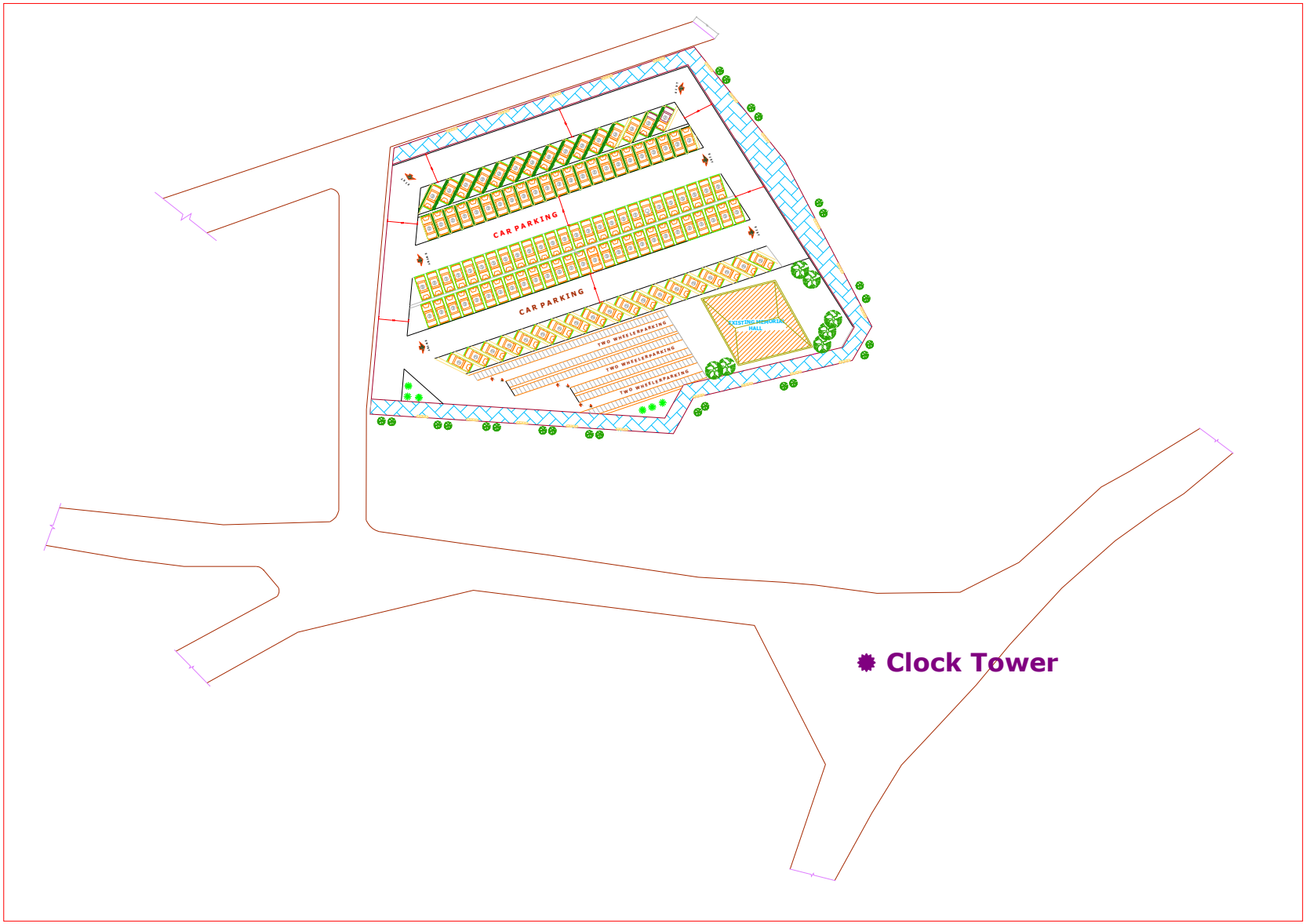


Fig 15.22 Proposed Parking Layout behind Clock Tower Junction

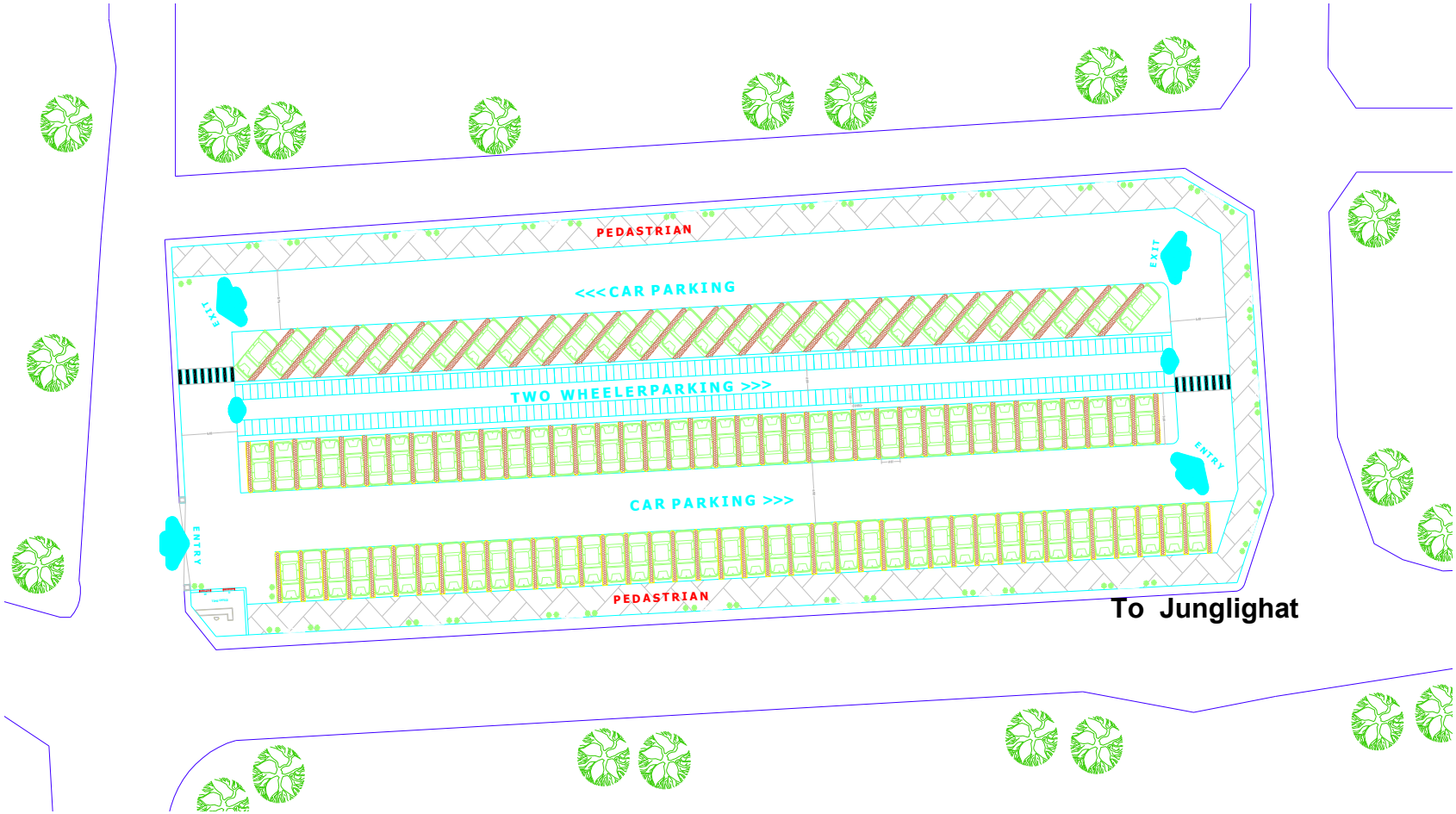


Fig 15.23 Proposed Parking Layout near Junglighat School

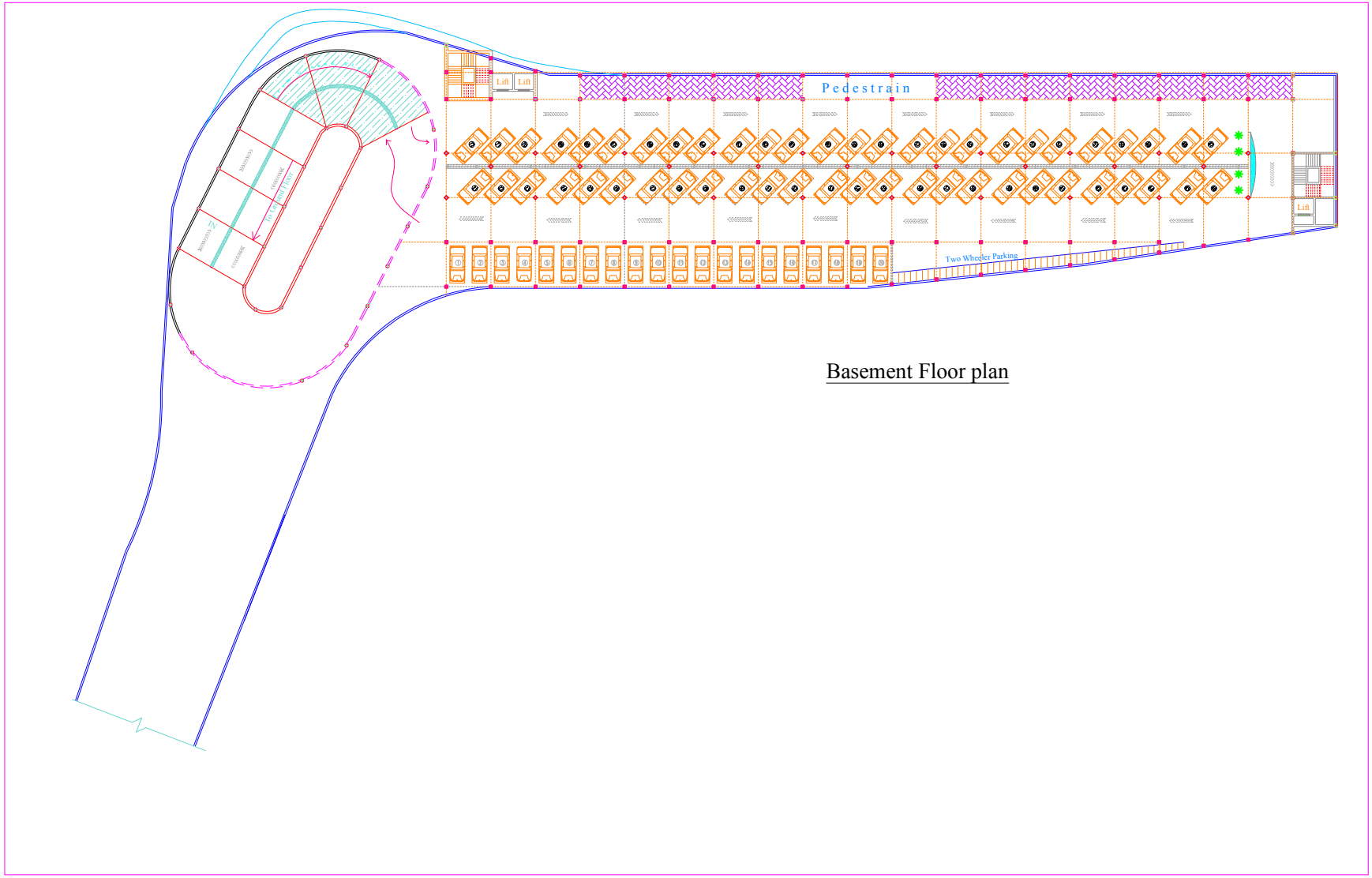


Fig 15.24 (a) Multi- storeyed Parking Lot near Stadium (Basement Floor Plan)

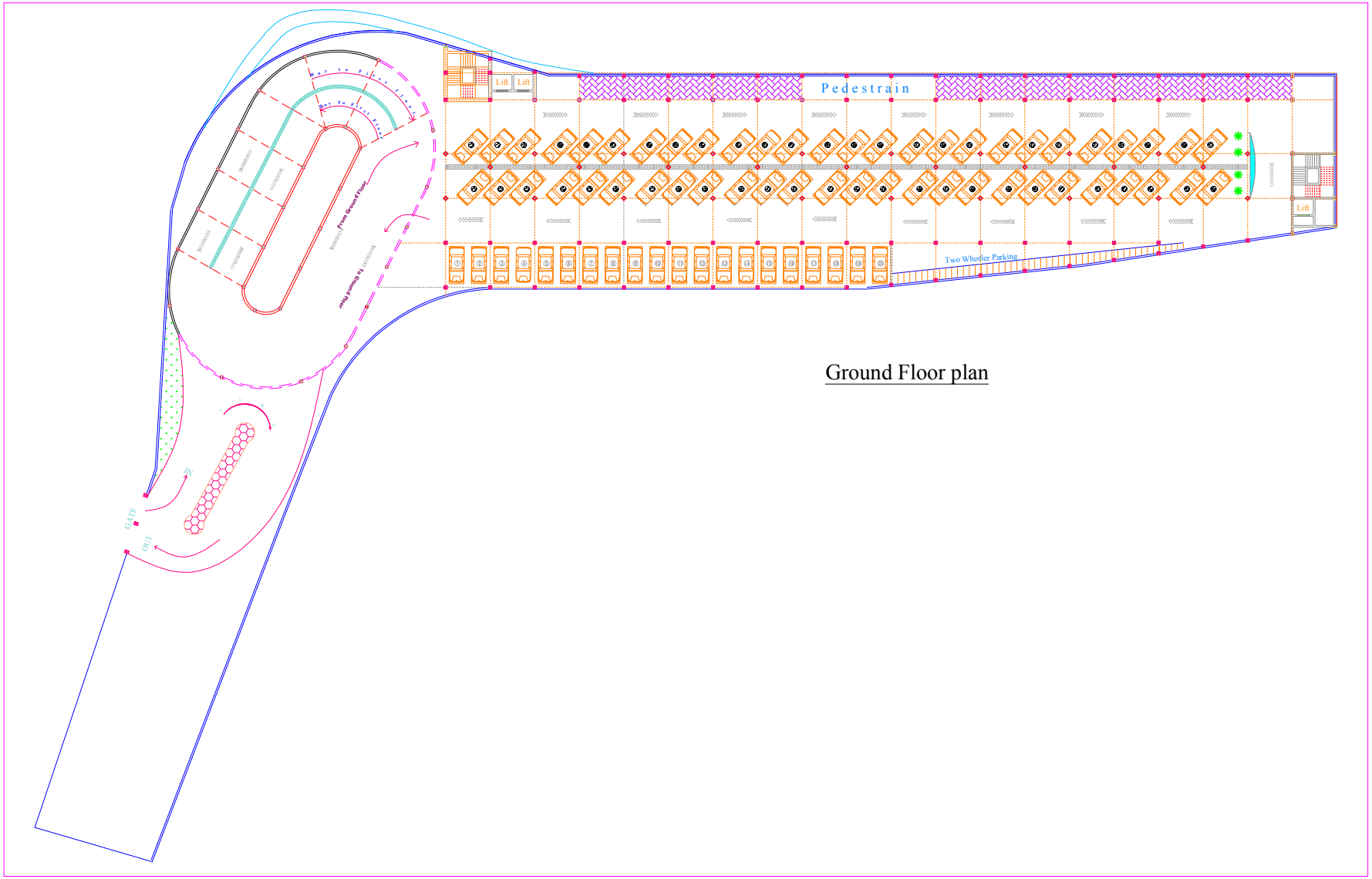
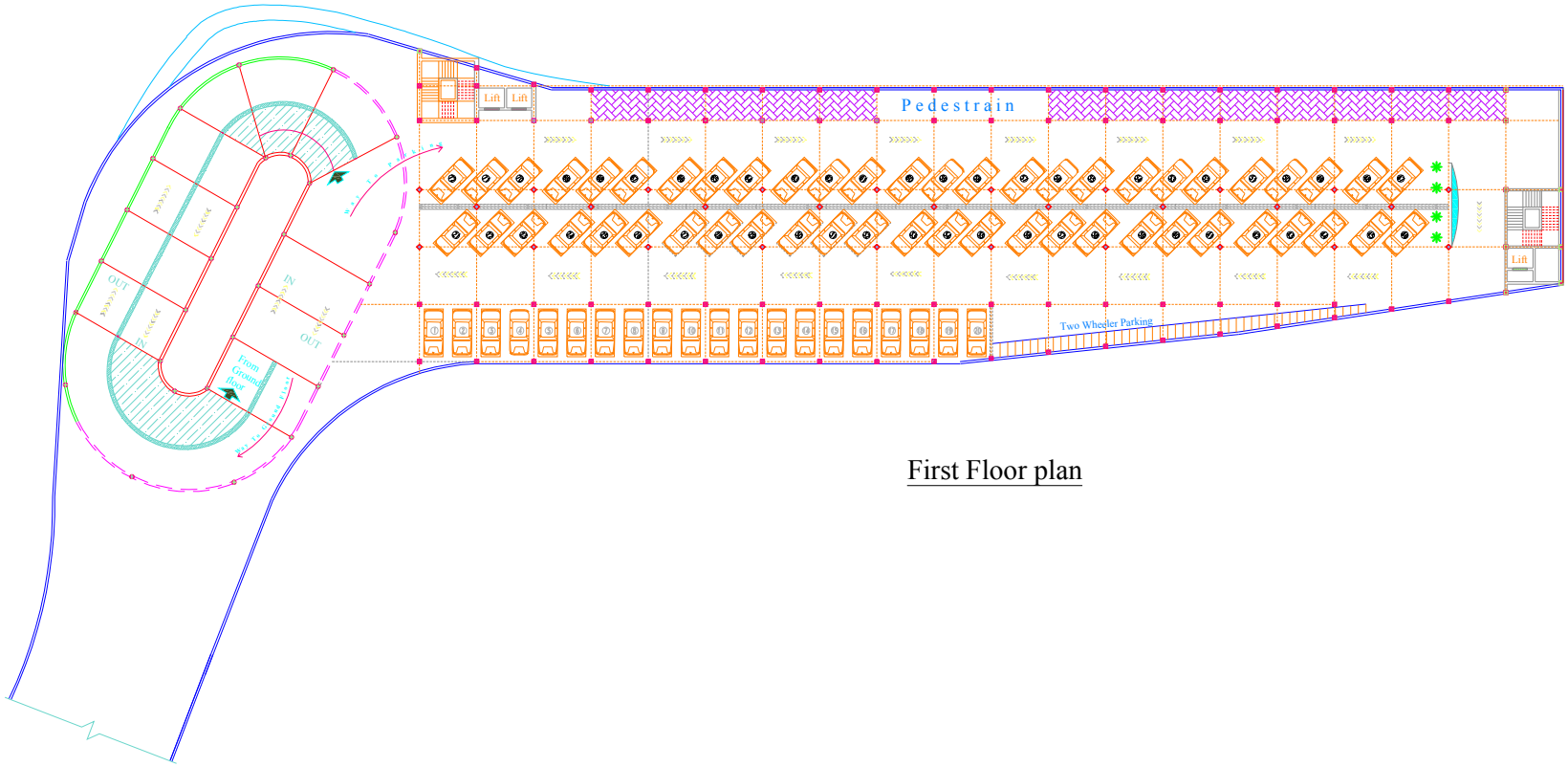


Fig 15.24 (b) Multi- storeyed Parking Lot near Stadium (Ground Floor Plan)



First Floor plan

Fig 15.24 (c) Multi- storeyed Parking Lot near Stadium (First Floor Plan)

CHAPTER 16
ROAD NETWORK CAPACITY AND TRAFFIC ASSIGNMENT

16.1 Introduction

Traffic assignment is an important stage in transport planning process intended to evaluate the road network capacity for the existing and future traffic flows. The assignment technique followed is capacity restraint method reflecting the flow level and capacity of each section as Volume Capacity ratio. Volume capacity ratio attains a maximum value of unity indicating the traffic is moving at reasonable speed. When volume capacity ratio is greater than one it indicates that LOS has reached F, extremely congested condition. Fig.16.1 shows the relation between V/C ratio and speed. The desirable level of service is C.

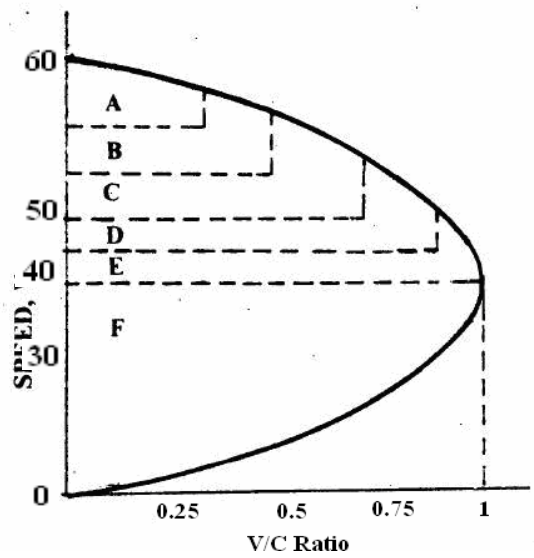


Fig. 16.1 Relationship between V/C ratio and Speed

16.2 Existing Scenario

Andaman Trunk road (single lane with 4.5 m wide carriageway) connects Port Blair with the settlements in environs and that in the North and South of the environs. At present it has a V/C ratio of maximum 0.46 on the interior of environs and 0.7 on the stretches close to Port Blair.

The major roads in Port Blair municipal area are two lane roads. Volume capacity ratios for the existing roads, in Port Blair vary from 0.36 to 1.98. The road connecting Chatham Island and Bathubasthi via Haddo, Delanipur, Junglighat, Dairy Farm Junction has V/C ratio between 0.57 and 1.43. The other alternate road connecting Cellular Jail and Bathubasthi via Murugan Temple, Dudh line, Nayagaon, Austinabad etc has V/C ratio between 0.36 and 1.98. As both roads connect many residential areas to the CBD the volume of traffic observed during peak hours is exceeding the carrying capacity of the roads.

The road stretch from Goalghar to Cellular Jail via Bengali club and Model School in the CBD is heavily congested. The V/C ratio of the entire road network in the study area and that in Port Blair during morning and evening peak hours is shown in Fig.16.2, Fig.16.3, Fig.16.4 and Fig.16.5. The existing road width, Speed and V/C Ratio on major roads in Port Blair town for morning peak hour is given in Table 16.1. In the morning peak hour the flow is towards CBD and in the evening it is from CBD. Many stretches of the existing road network have a V/C ratio exceeding one, which call immediate attention.

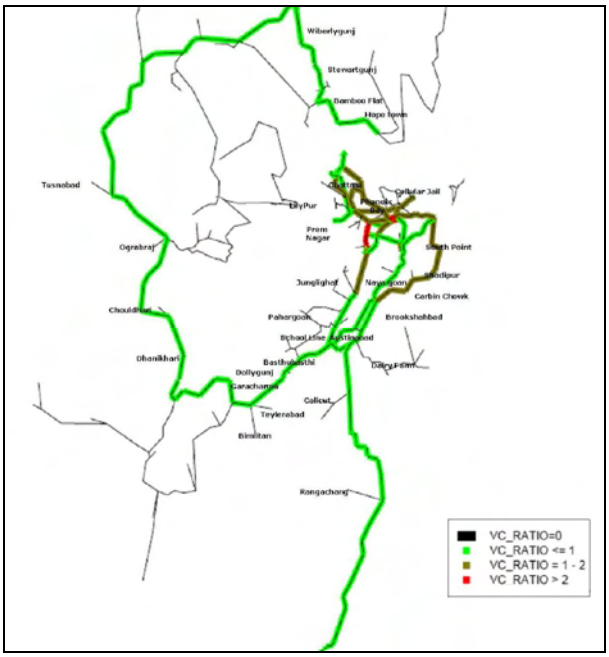


Fig.16.2 V/C Ratio of the Major roads in study area for Morning Peak hour (2007)

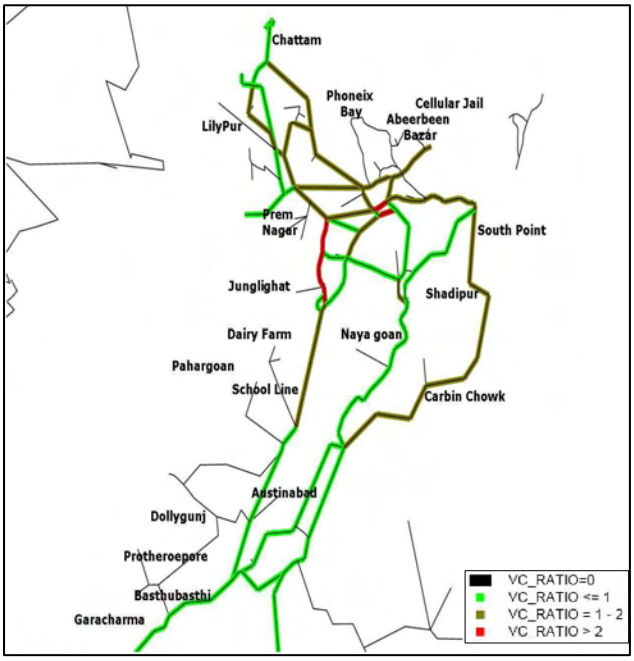


Fig 16.3 V/C Ratio of the Major roads in Port Blair Town for Morning Peak hour (2007)

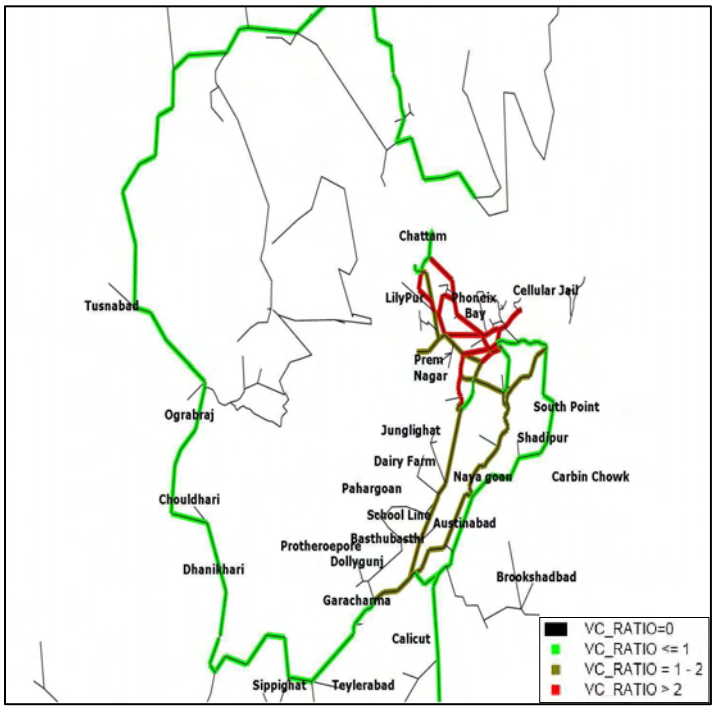


Fig 16.4 V/C Ratio of the Major roads in the study area for Evening Peak hour (2007)

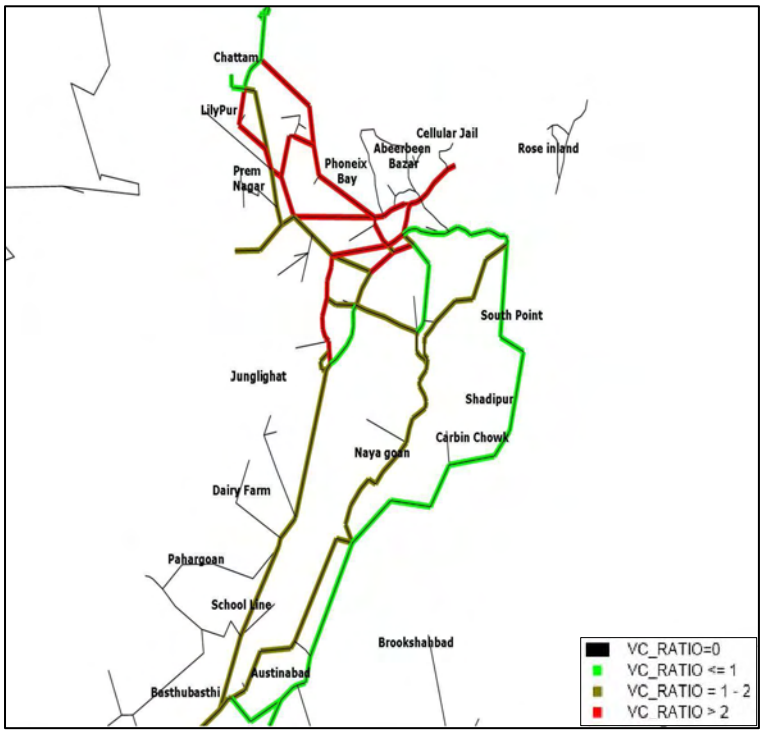


Fig 16.5 V/C Ratio of the Major roads in Port Blair Town for Evening Peak hour (2007)

Table 16.1 Existing V/C ratio on major road in Port Blair Town for Peak Hour

Name of the Stretch	Road width	Speed	Existing V/C Ratio
Chatham - Lillypur	3.5	48.51	0.570
Lillypur - Chatham	3.5	40.71	0.432
Lillypur - Delanipur	3.5	42.00	1.310
Delanipur - Lillypur	3.5	26.86	1.280
Delanipur - Light House	3.5	43.33	1.200
LightHouse - Delanipur	3.5	41.28	0.820
Delanipur - Goalghar	3.5	32.40	1.450
Goalghar - Delanipur	3.5	41.54	1.230
Goalghar - Bengali club	3.5	47.37	1.120
Bengali club - Goalghar	3.5	46.32	1.110
Bengali club - LightHouse	3.5	46.38	1.900
LightHouse - Bengali Club	3.5	45.52	1.780
LightHouse - Clock Tower	3.5	36.87	1.640
Clock Tower - LightHouse	3.5	38.56	1.340
Clock Tower - Model School	3.5	46.37	1.380
Model School - Clock Tower	3.5	46.13	1.240
Model School - Bengali Club	3.5	45.32	2.180
Bengali club - Model School	3.5	42.15	1.830
Model School - Raj Nivas	3.5	38.02	0.880
Raj Nivas - Model School	3.5	49.09	0.740
Bengali club - IPNT	3.5	36.87	0.850
IPNT - Bengali club	3.5	35.61	0.670
Raj Nivas - IPNT	3.5	43.33	2.180
IPNT - Raj Nivas	3.5	41.39	1.340
IPNT - Secretariat	3.5	25.38	1.330
Secretariat - IPNT	3.5	32.57	1.180
Secretariat - Bangala School	3.5	41.86	1.030
Bangla School - Secretariat	3.5	42.86	0.820
Bangla School - Hyat Singh	3.5	25.88	0.440
Hyat Singh - Bangla School	3.5	24.12	0.680
Goalghar - Hyat Singh	3.5	41.86	2.390
Hyat Singh - Goalghar	3.5	42.86	1.290
Hyat Sign - School Line	3.5	23.52	1.120
School Line - Hyat Singh	3.5	25.03	0.730
School Line - Bathubasthi	3.5	32.76	0.770
Bathubasthi - School Line	3.5	34.59	0.890

16.3 Proposed Road Network Enhancements

Port Blair and the settlements in environs are poised for rapid developments in the near future, as authorities have proposed major developments for the environs and Port Blair (Fig.16.6). The population growth due to natural rise and immigration, and the tourists flocking to Port Blair are to further congest existing road network. The trips likely to be generated and distributed between various zones in 2027 considering the developments were dealt in detail in earlier sections.

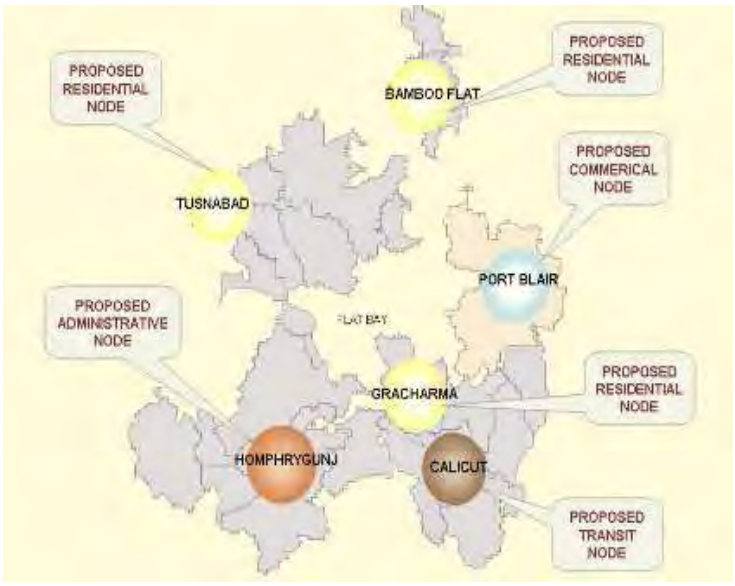


Fig.16.6 Proposed Developments as per Master Plan of Port Blair

Assigning the future expected trips between zones it was observed the existing road network will not be able to handle the traffic. The expected V/C ratio of the road stretches on assigning the 2027 traffic is shown in Fig.16.7 and Fig.16.8. The V/C ratio is to be in the range of 1.2 to 5.6 for the major roads in Port Blair and 5 to 6 in the roads of environs.

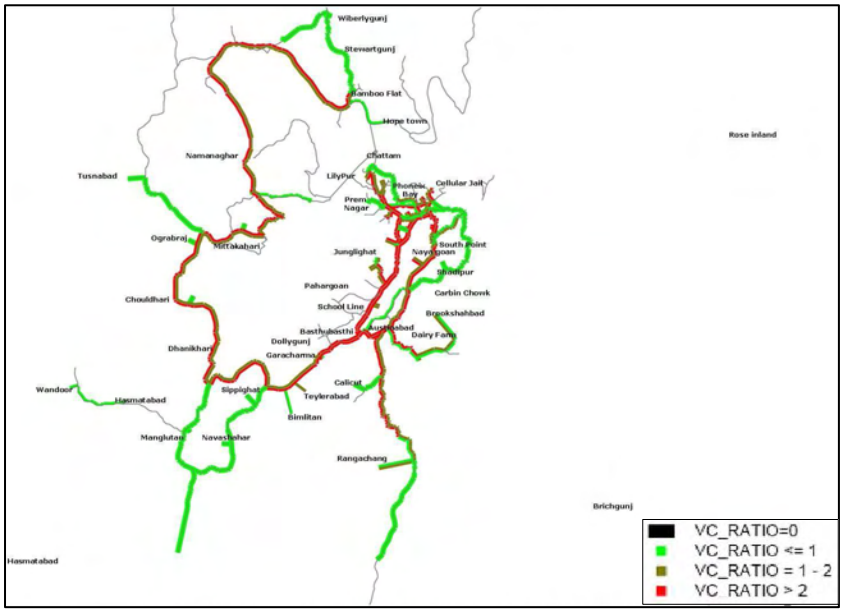


Fig.16.7 Expected V/C ratio of the Major roads in the study area in 2027 (Scenario I)

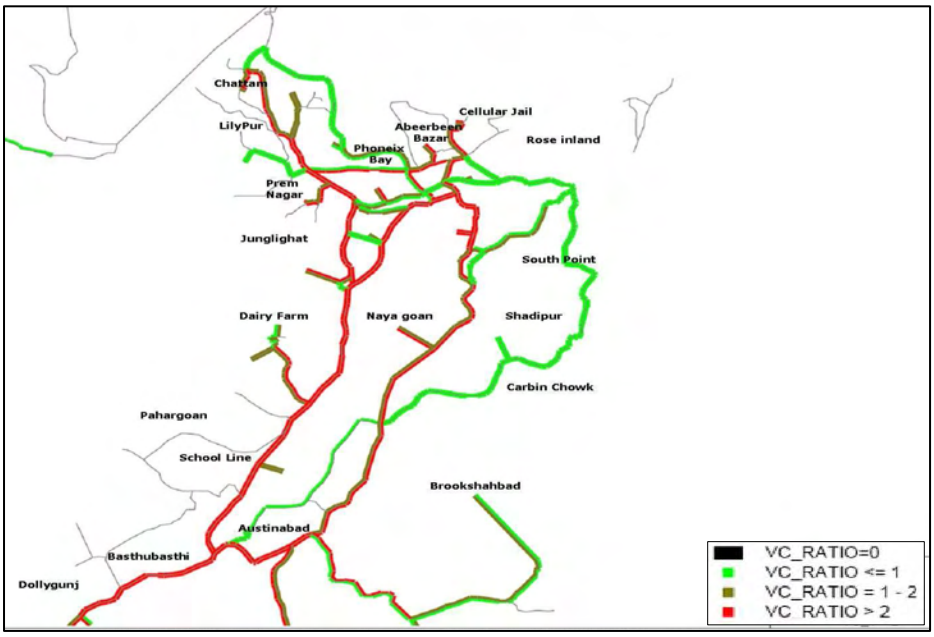


Fig.16.8 Expected V/C ratio of the Major roads in Port Blair in 2027 (Scenario I)

Tourism and related commercial activities when on the rise is going to have its impact on the existing road network. The scenarios were formulated with prime importance to have all weather road connectivity between settlements and Port Blair. Provision of missing links and widening of existing roads are essential to ensure smooth and fast travel.

Formulation of scenarios in tandem with the proposed developments in the area made and extensive analysis of the road network was carried out to evaluate the scenarios. The lists of the scenarios formulated and evaluated for their effectiveness in easing traffic congestion are:

1. Scenario I – Existing network – DO Nothing Scenario
2. Scenario II – Existing Network + Introduction of Marine drive phase I
3. Scenario III – Scenario II + Introduction of Marine drive phase II
4. Scenario IV – Scenario III + Introduction of Missing Links
5. Scenario V – Scenario IV + Introduction of Partial one way system
6. Scenario VI – Scenario IV + Introduction of One way system
7. Scenario VII – Scenario VI + Road widening

In the proposed master plan Hompherygunj is to be developed as administrative node, Tushnabad & Bamboo flat as residential zones and Calicut as Transport node.

As connectivity among the nodes and Port Blair is to be scaled up a marine drive with 4 lane roads and on exclusive cycle track (Fig 16.9) for a length of 30 Kilometers is proposed. The proposed route of the new road is shown in Fig 16.10.

On Introduction of the marine drive the road stretch between Chatham Island and Bathubasthi via Junglighat is to get relieved from congestion to a great extent. Similarly travellers to North Andaman via Tushnabad and to residents in Western zone would be highly benefited. Long distance traffic from Port Blair CBD can easily reach to the proposed marine drive through the links provided and proceed towards their destination. V/C of the road stretch between Junglighat and Bathubasthi is expected to reduce from 3.6 to nearly one on introduction of marine drive phase I. V/C for the entire road network for scenario 2 (Introduction of marine drive phase I) is shown in Fig 16.11.

Extension of the marine drive from Dandas points to Bamboo flat (Scenario 3) will provide good connectivity to residents in Bamboo flat to the proposed administrative node near Hompherygunj and to Port Blair. The V/C ratio for scenario 3 is shown in Fig.16.12. The two bridges over seawater for a length 1 to 1.5 Kilometers is required in Phase I and Phase II.

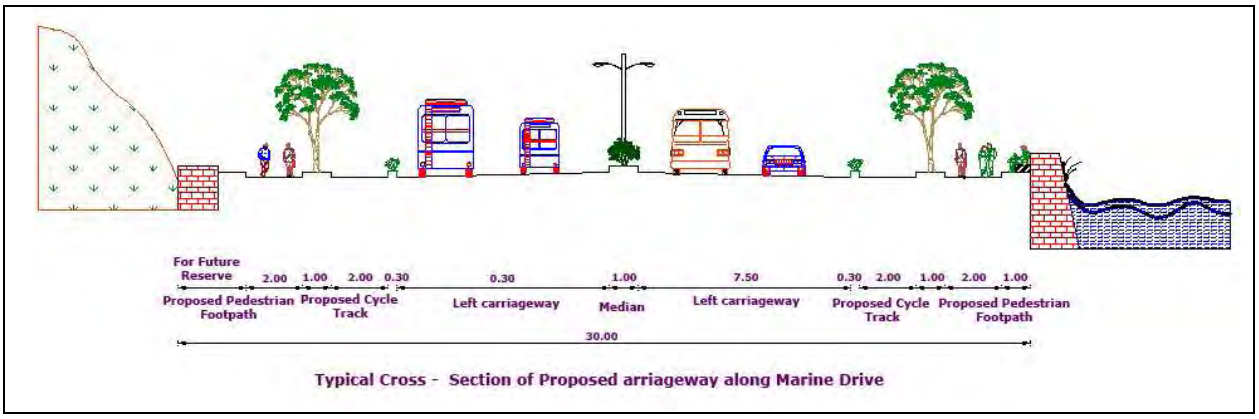


Fig 16.9 Cross Section of the Proposed Carriage way along Marine Drive

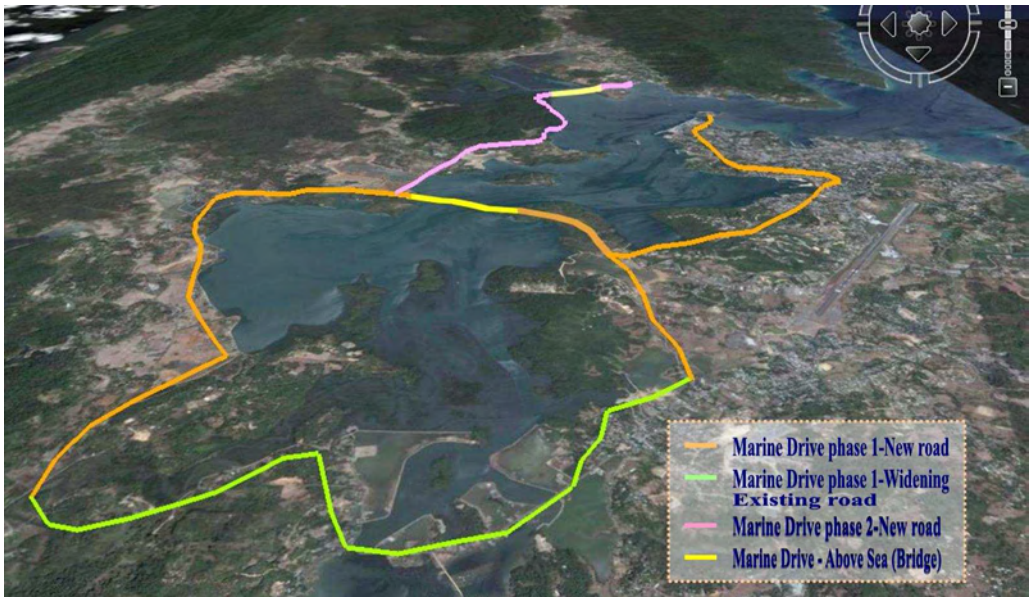


Fig 16.10. The Proposed Marine Drive Phase I and Phase II

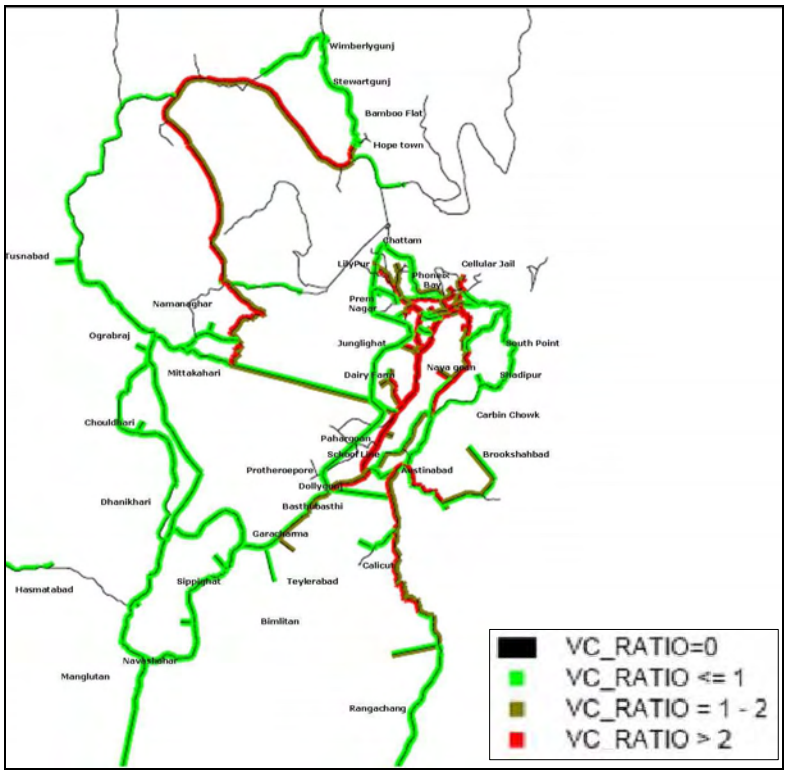


Fig 16.11 V/C ratio of the Major roads in 2027 on Introduction of Marine Drive Phase – I

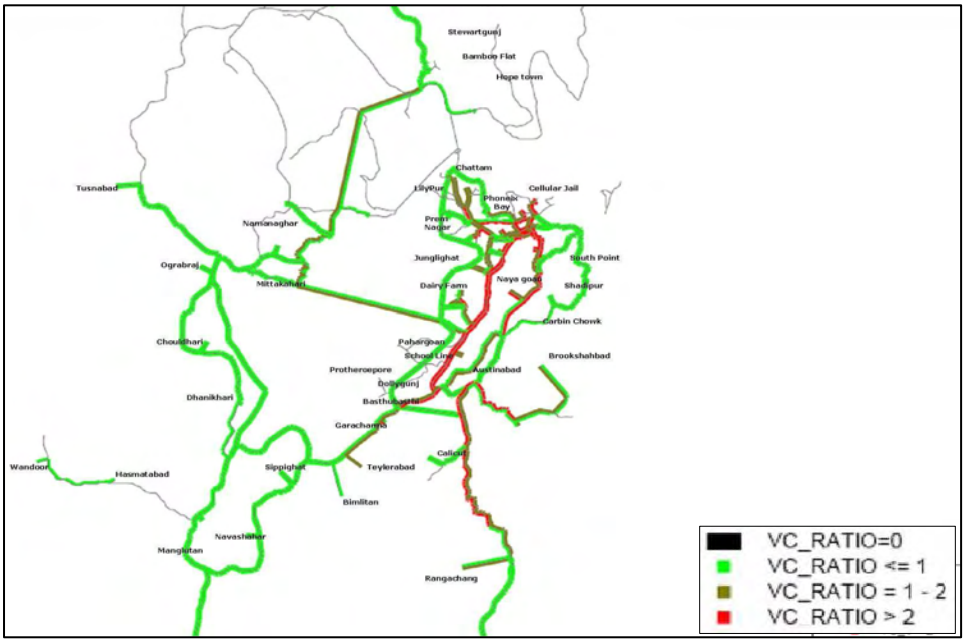


Fig.16.12 V/C ratio for major roads in 2027 on Introduction of Marine Drive Phase I & II

Construction of the marine drive is to cost nearly Rs. 490 crores (Construction cost assumed Rs.20000/sq.m) and it is expected to result in a fuel saving of Rs.16.1 crores annually. The marine drive being proposed along the shoreline will promote tourism related activities and water sports activities. Residents from Western sector and Northern sector at present rely on ferry service (available from 6.00 AM to 10.00 PM) to reach Port Blair for work, daily needs and medical facilities. The travel by road takes 2 to 3 hours at present whereas the proposed road will reduce the travel time to ½ hour to 1 hour, moreover connectivity will be assured throughout the day and even during adverse weather conditions.

As Bamboo flat area is designated as residential area in proposed master plan and due to its dependence on Port Blair as like other settlements a direct link between the two is justifiable. People use the ferry to cover the distance of nearly 2 kilometere. To facilitate easy movement a cable stayed bridge of span 1 kilometere can be considered for connecting Chatham Island with the Bamboo flat region (Fig 16.13). The proposed bridge needs to be aligned and designed ensuring smooth flow of ship to Haddo Jetty. Under water tunnel can be considered as an alternative if cable stayed bridge is not feasible.

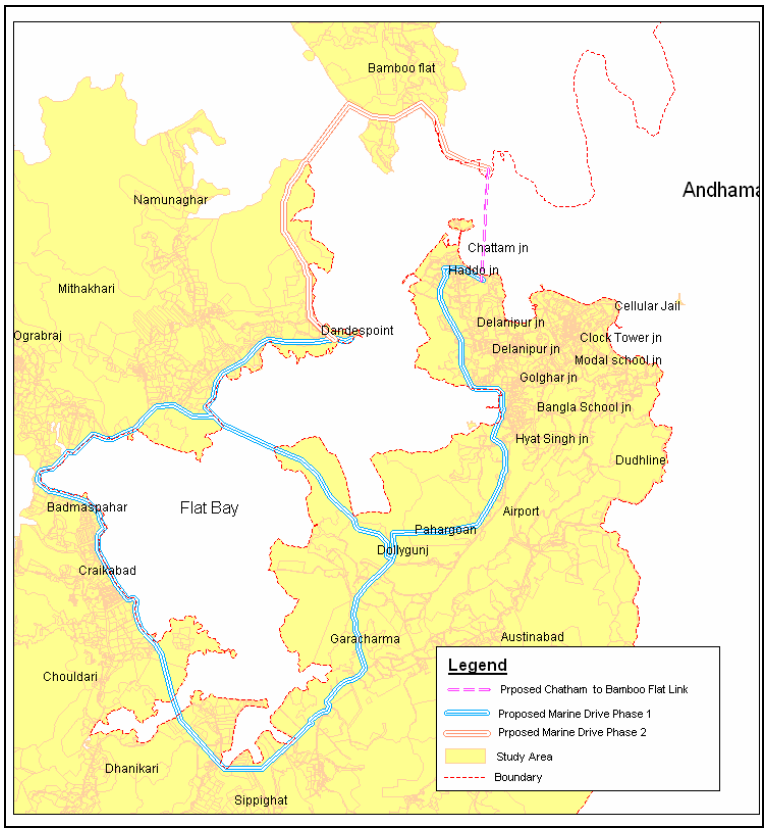


Fig 16.13 Proposed Marine Drive and New Links

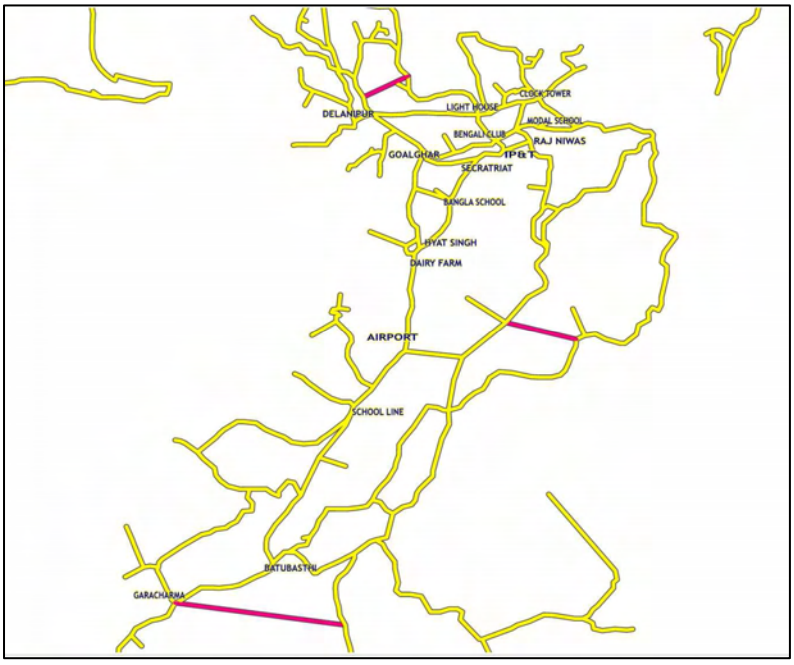


Fig.16.14 Scenario 4- Introduction of Missing Links

It is found the introduction of marine drive eliminates the bye passable traffic from city roads but still the relief to city road network is not at desirable levels. The existing road network needs enhancement by adding missing links (Scenario-4, Fig. 16.14 & Fig.16.15), introduction of one-way system (Scenario 5 and Scenario 6, Fig.16.17 and Fig.16.19) and road widening (Scenario 7, Fig.16.21).

The extent of relief on introduction of the improvement measures is shown as V/C ratios in Fig.16.16, Fig.16.18, Fig.16.20, and Fig.16.22. The expected V/C ratio for all scenarios is tabulated in Table 16.2 and Table 16.3.

Aberdeen Bazaar is the popular commercial center in Port Blair town. It's proximity to the Bus Terminal, Ratna Market, Commercial establishments, Cellular Jail and Stadium has enabled it to be a preferable shopping place and visiting site for the residents in Port Blair and Environs, and also the tourists. The Babu lane road stretch lacks connectivity and as it is a dead end where unauthorized parking is practiced currently. Lack of connectivity in the commercial area poses a threat to life and property in case of fire or emergencies as access is restricted. Connectivity to the Babu lane is proposed with a 8 m wide elevated roadway to the road leading to Phoenix Bay. The elevated roadway is to have a gradient of 1 in 30 and the possible circulation pattern is also indicated in Fig 16.15. The proposed connectivity would enable vehicles from Aberdeen Bazaar to Delanipur, Chattam Island, Prem Nagar, Lillypur etc to prefer this route and avoid the circuitous Clock Tower, Bengali Club and Goalghar route. As a result there is a possibility of relief in congestion and delay at Model School, Bengali Club and Goalghar junctions. The elevated road can be supported on single column ensuring least disturbance to the existing movements to and from Mohanpara bus terminal and the road adjacent to it. The elevated road connectivity to Babu lane is to cost nearly Rs. 14 crores.

To enable free flow in the round Basti area the road stretch needs to be widened atleast as a 2 Lane. The missing links that are likely to provide better connectivity and reduce travel distance is given in Fig16.14. The cost of construction of missing links with 2-lane wide carriageway is Rs.64 Crores. But the extent of benefit is only marginal. Major roads in Port Blair are two lane roads with intense developments on the sides limiting the scope for further widening. To accommodate the growing traffic one-way

arrangements were analyzed. Scenario 5 with partial one-way arrangement (Fig.16.17) does not provide the relief in congestion as expected (Fig.16.18).

One-way arrangement as shown in Fig.16.19 is effective in reducing the congestion level. The V/C ratio for the scenario 6 is shown in Fig.16.20. The proposal is likely to increase the travel distance by 20% to 40%. But reduction in delay at junctions, increase in speed will result in substantial fuel and time saving. Safe pedestrian crossings arrangements have to be provided when one-way arrangement is implemented, at locations where pedestrian movements are observed in sufficient numbers.

It was observed the maximum vehicle movements are along Bathubasthi to Chatham Island route via Junglighat and Delanipur. The road stretch is a major corridor that has to be widened to enable smooth movement along the stretch (Fig.16.21). The construction cost expected is Rs.102.24 Crores and it will be beneficial with considerable fuel and time savings.

Fig 16.15 Proposed Connectivity to Babu Lane and Traffic Movement In Adjoining Area

Table 16.2 V/C Ratio on Major Roads in Port Blair Town for Scenarios 1, 2, 3 and 4

Name of The Stretch	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Do-Nothing Scenario	Marine Drive Phase I	Marine Drive Phase II	Missing Links
	V/C Ratio	V/C Ratio	V/C Ratio	V/C Ratio
Chatham - Lillypur	3.81	3.6	2.00	0.20
Lillypur - Chatham	1.80	1.8	1.00	0.20
Lillypur - Delanipur	4.73	4.5	2.90	0.50
Delanipur - Lillypur	2.81	2.0	1.60	0.40
Delanipur - Light House	2.52	2.5	2.50	2.70
LightHouse - Delanipur	0.92	0.9	0.90	0.80
Delanipur - Goalghar	5.03	4.5	2.90	0.60
Goalghar - Delanipur	2.67	2.2	1.60	1.50
Goalghar - Bengali club	1.79	2.3	2.30	2.10
Bengali club - Goalghar	2.26	1.0	1.00	3.50
Bengali club - LightHouse	2.83	1.6	1.60	0.00
LightHouse - Bengali Club	1.57	2.8	2.80	2.30
LightHouse - Clock Tower	3.40	3.4	3.20	0.00
Clock Tower - LightHouse	1.17	1.2	3.40	1.70
Clock Tower - Model School	1.89	1.9	1.20	0.00
Model School - Clock Tower	6.21	6.2	6.20	4.90
Model School - Bengali Club	3.85	3.8	1.90	0.00
Bengali club - Model School	5.03	5.0	5.00	4.80
Model School - Raj Nivas	1.55	1.6	3.80	1.60
Raj Nivas - Model School	4.57	4.6	4.60	0.00
Bengali club - IPNT	1.80	1.8	1.60	0.00
IPNT - Bengali club	3.51	3.5	3.50	3.30
Raj Nivas - IPNT	1.71	2.3	1.60	1.60
IPNT - Raj Nivas	1.40	1.5	1.50	0.00
IPNT - Secretariat	3.51	4.1	4.10	2.70
Secretariat - IPNT	4.91	5.0	5.00	3.80
Secretariat - Bangala School	3.31	3.9	3.90	2.80
Bangla School - Secretariat	4.66	4.8	4.80	3.80
Bangla School - Hyat Singh	3.30	3.9	3.90	2.67
Hyat Singh - Bangla School	4.49	4.6	4.60	3.60
Goalghar - Hyat Singh	3.48	3.0	1.40	0.20
Hyat Singh - Goalghar	2.87	2.4	1.80	0.60
Hyat Sign - School Line	4.81	4.9	3.80	1.20
School Line - Hyat Singh	6.32	5.9	5.20	1.40
School Line – Bathubasthi	3.49	3.6	3.10	4.40
Bathubasthi – School Line	5.45	4.0	5.30	5.70

Table 16.3 V/C Ratio on Major Roads in Port Blair Town for Scenarios 5, 6 & 7

Name of The Stretch	Scenario 5	Scenario 6	Scenario 7
	Partial One way	All One way	Widening of Major Roads
	V/C Ratio	V/C Ratio	V/C Ratio
Chatham - Lillypur	3.6	3.57	0.20
Lillypur - Chatham	1.6	1.60	0.20
Lillypur - Delanipur	4.4	4.37	0.50
Delanipur - Lillypur	2.0	1.95	0.40
Delanipur - Light House	2.4	2.25	2.70
LightHouse - Delanipur	0.9	0.63	0.80
Delanipur - Goalghar	4.7	4.89	0.60
Goalghar - Delanipur	2.5	2.79	1.50
Goalghar - Bengali club	2.5	2.67	2.10
Bengali club - Goalghar	1.6	2.72	3.50
Bengali club - LightHouse	2.8	0.00	0.00
LightHouse - Bengali Club	1.1	2.23	2.30
LightHouse - Clock Tower	3.4	0.00	0.00
Clock Tower - LightHouse	0.7	1.80	1.70
Clock Tower - Model School	2.4	0.00	0.00
Model School - Clock Tower	6.2	5.10	4.90
Model School - Bengali Club	1.0	0.00	0.00
Bengali club - Model School	8.1	6.90	6.80
Model School - Raj Nivas	1.4	1.29	1.60
Raj Nivas - Model School	0.0	0.00	0.00
Bengali club – IP&T	0.0	0.00	0.00
IP&T - Bengali club	3.5	4.03	4.30
Raj Nivas – IP&T	8.3	3.70	3.70
IP&T - Raj Nivas	1.3	0.00	0.00
IP&T - Secretariat	3.6	2.68	2.70
Secretariat – IP&T	5.0	4.93	3.80
Secretariat - Bangala School	3.6	2.84	2.80
Bangla School - Secretariat	5.0	4.93	3.80
Bangla School - Hyat Singh	3.6	2.67	2.67
Hyat Singh - Bangla School	4.8	4.76	3.60
Goalghar - Hyat Singh	3.5	4.24	0.20
Hyat Singh - Goalghar	2.7	2.52	0.60
Hyat Sign - School Line	5.1	5.10	1.20
School Line - Hyat Singh	6.5	6.45	1.40
School Line - Bathubasthi	3.5	3.51	0.90
Bathubasthi - School Line	4.3	4.31	1.20

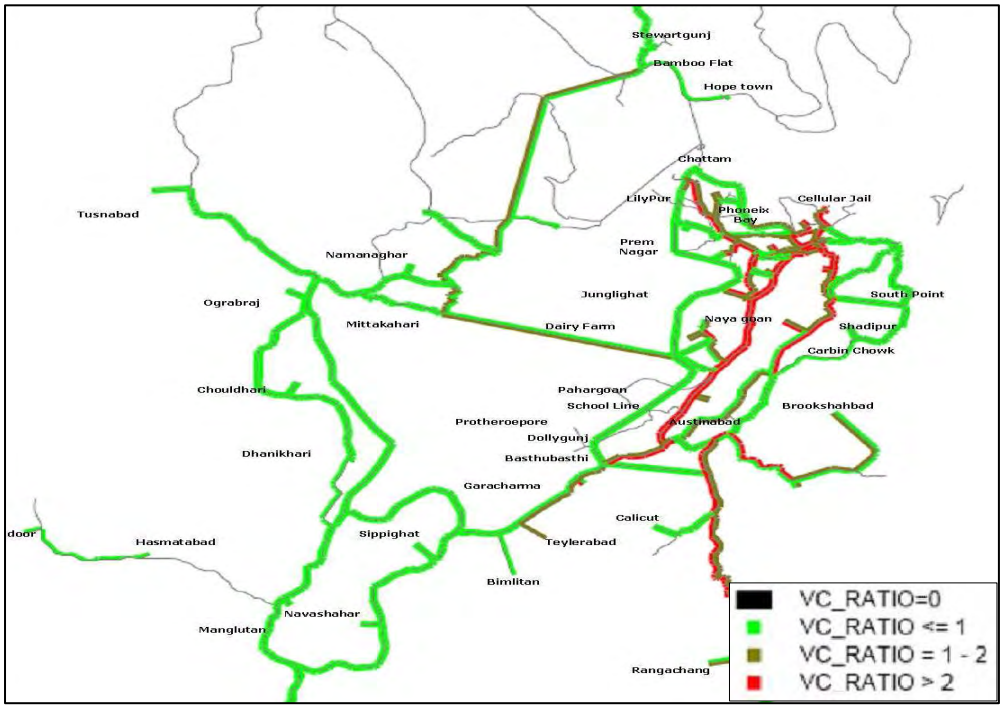


Fig 16.16 Expected V/C ratio in 2027 after Introduction of Missing Links

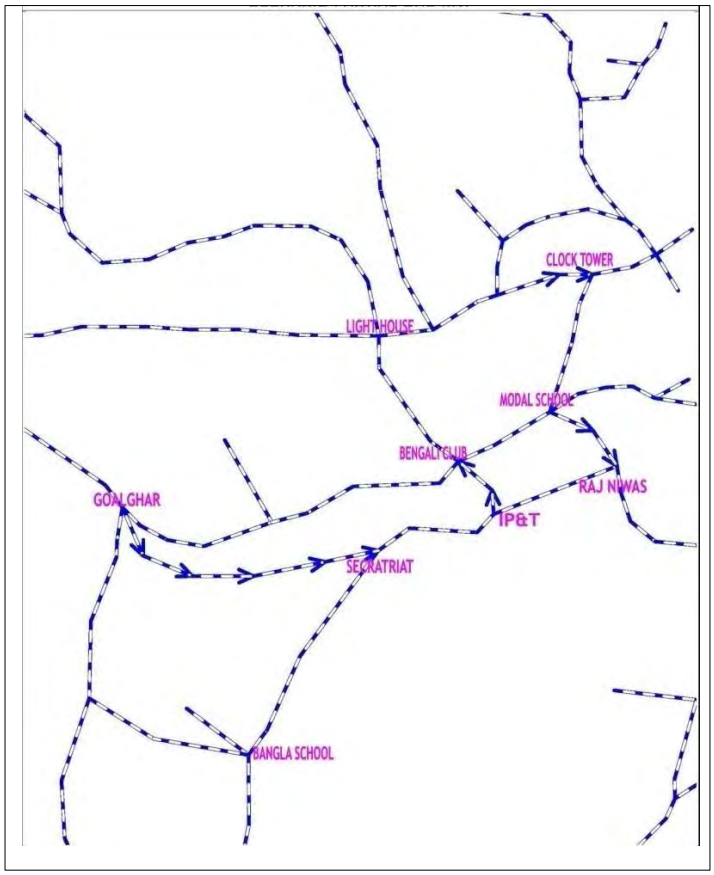


Fig 16.17 Scenario 5- Partial One-way System

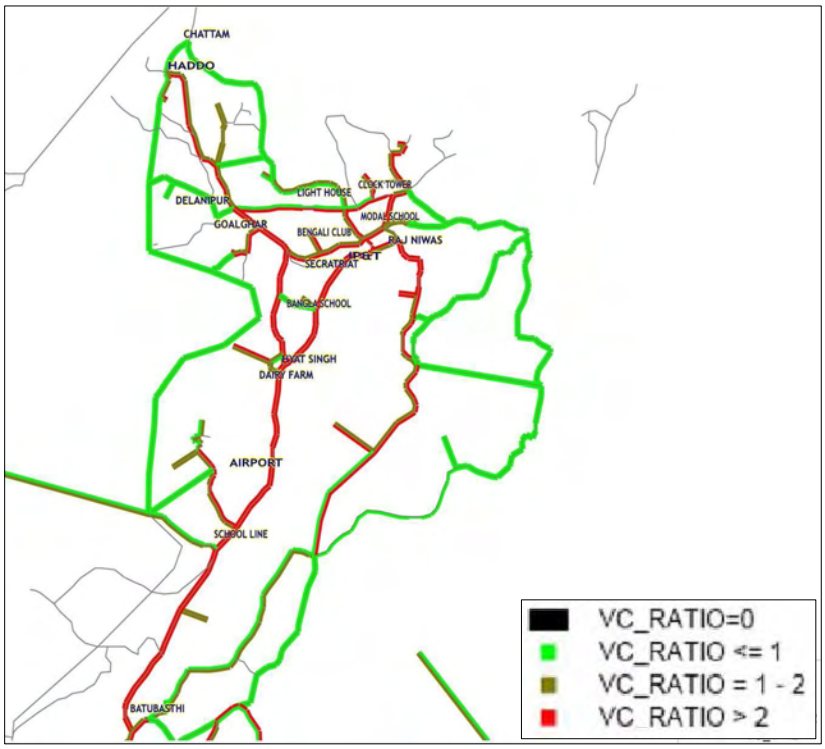


Fig 16.18 Expected V/C ratio in 2027 after Introduction of Partial One-way

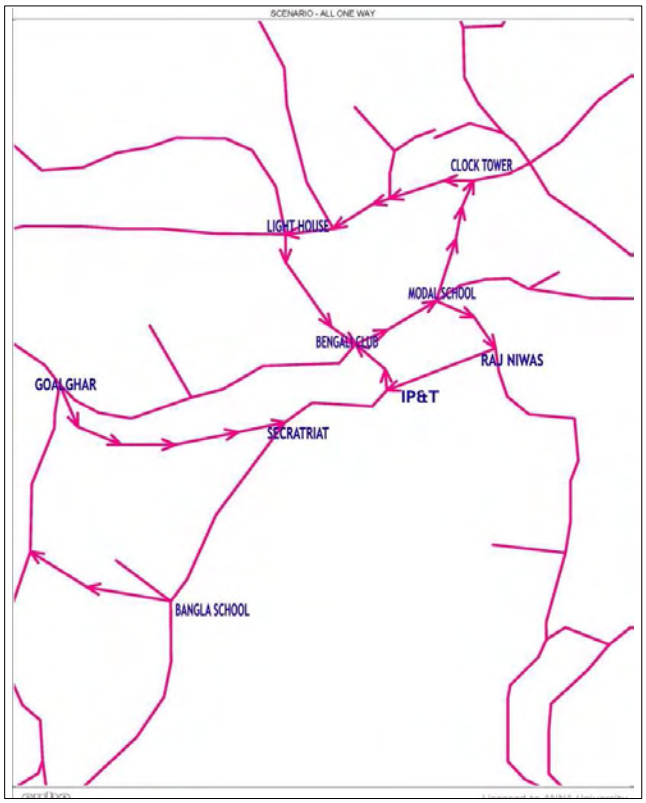


Fig.16.19 Scenario 6 - One-way System

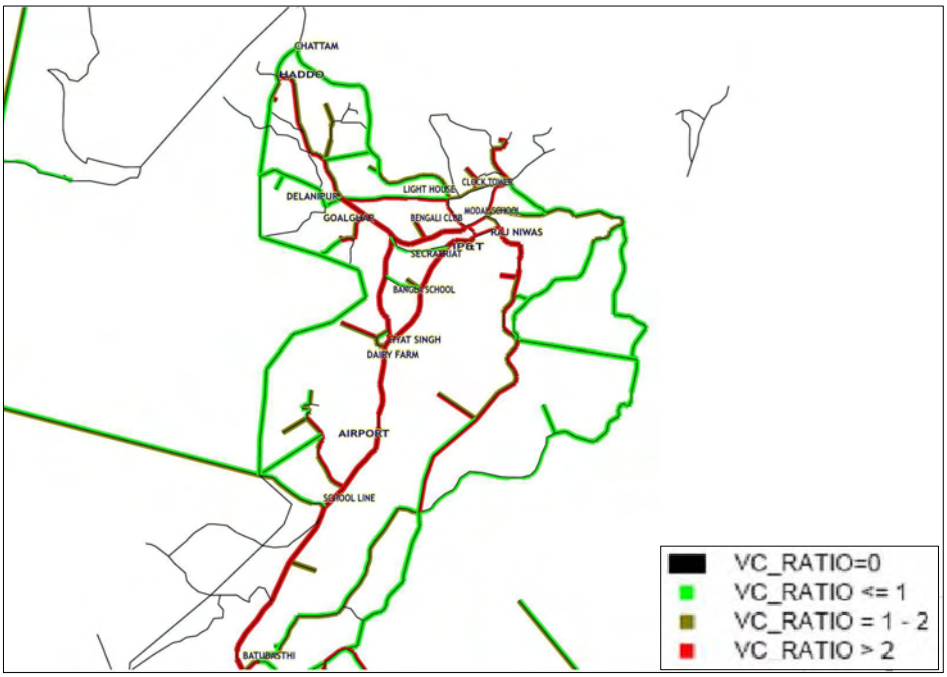


Fig.16.20 Expected V/C Ratio in 2027 after Introduction of One way system

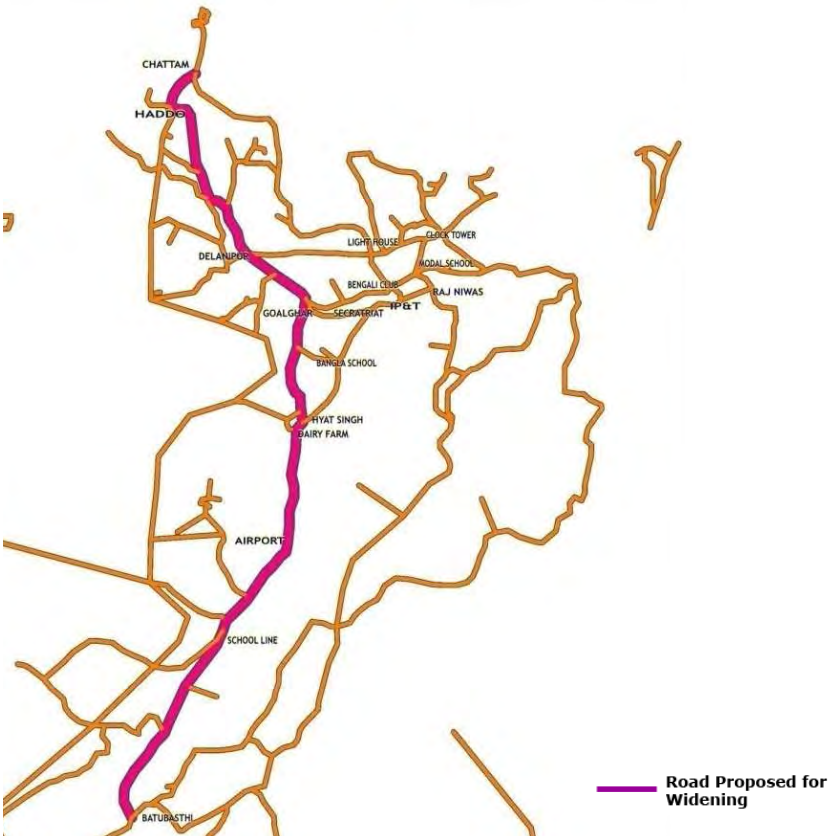


Fig 16.21 Scenario 7- Road Widening of Stretch to 4 Lanes

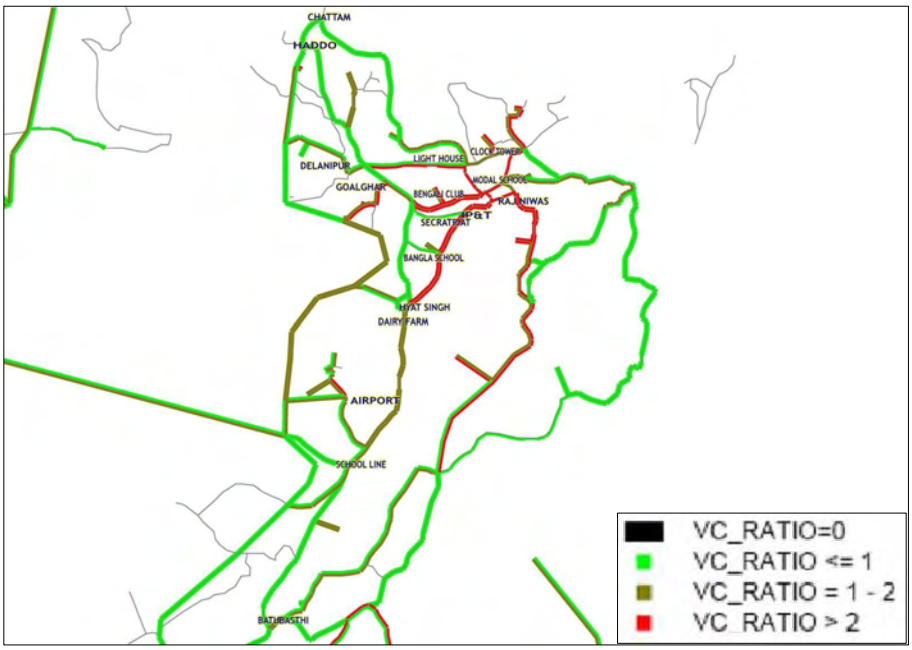


Fig 16.22 Expected V/C Ratio in 2027 after Widening of Stretch to 4 Lanes

As Hompherygunj is proposed as an administrative zone and Calicut areas as transit zone 4 Lane road connectivity is required from marine drive (Fig 16.23). Currently the existing Jetty facility for freight movements between islands is utilized to the maximum extent and new Jetty facility is required to handle the additional cargo movements expected in the near future. The location proposed in the draft master plan for enhanced cargo movements is Phongibalu Jetty (Fig 16.23). Further Wandoor is the preferred tourist, visited by large of national and international tourists Phongibalu Jetty and Wandoor needs better connectivity from Hompherygunj. 2 Lane roads are to be provided upto Phongibalu Jetty and Wandoor from Hompherygunj to facilitate easy movement of freight and tourists respectively.

FREIGHT PLANNING

The following suggestions are made for efficient and safe freight movements in Port Blair & Environs

- Freight movements are essential for daily needs and developmental works
- 100 to 900 trucks per day has been observed on many stretches
- Freight movement can be restricted in CBD during morning (8 to 11 AM) and evening (4 to 7.00 PM) peak hours to reduce the risk due to truck movements and to avoid congestion due to pulling out of trucks from on-street parking lots.

- An exclusive freight jetty at Phongibalu with 2 lane link from Hompherygunj is suggested.
- Truck Terminal is to be provided near the proposed Bus Terminal near Garacharma (Fig 16. 24).

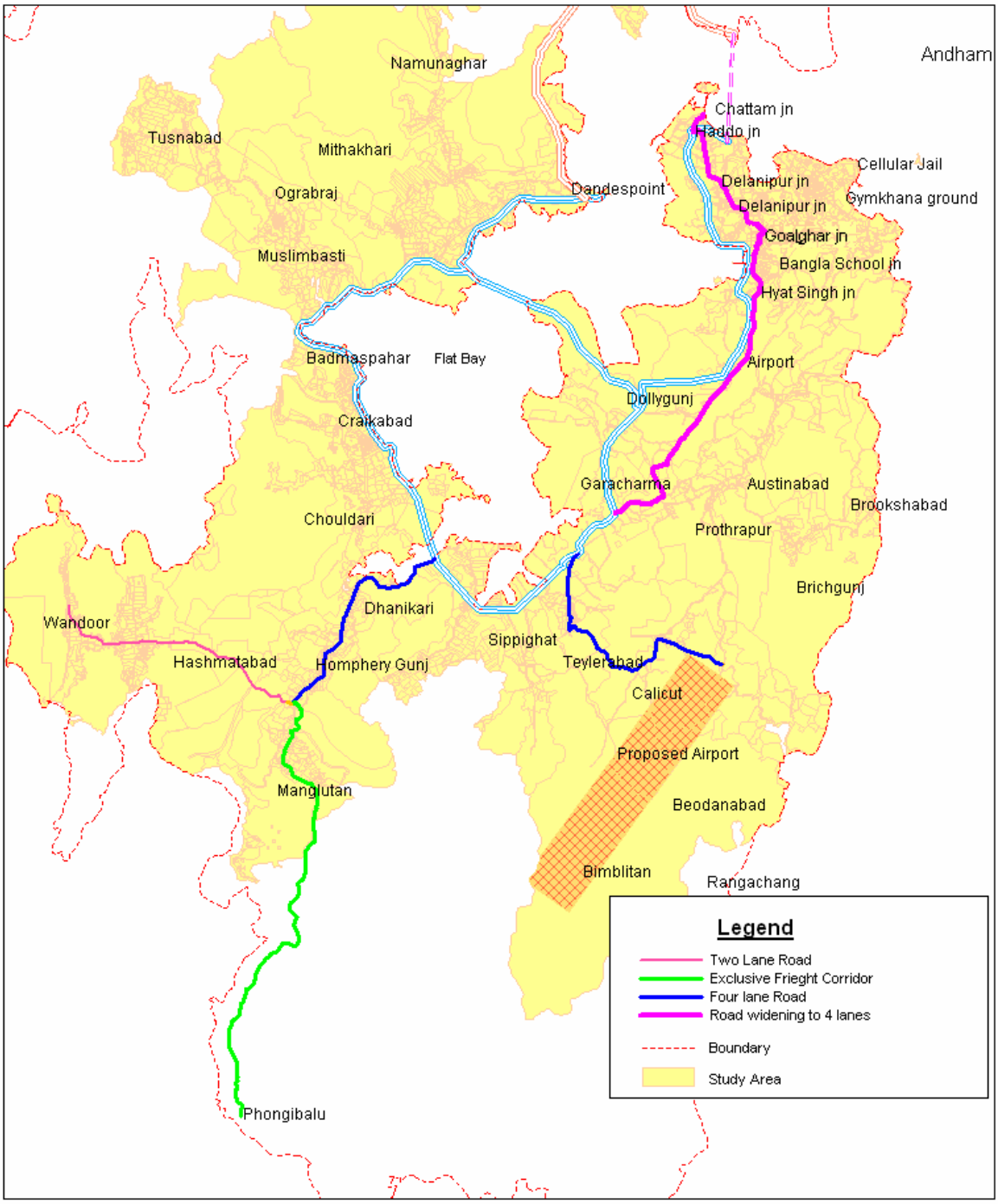


Fig 16.23 Proposed Road Widening and New Roads

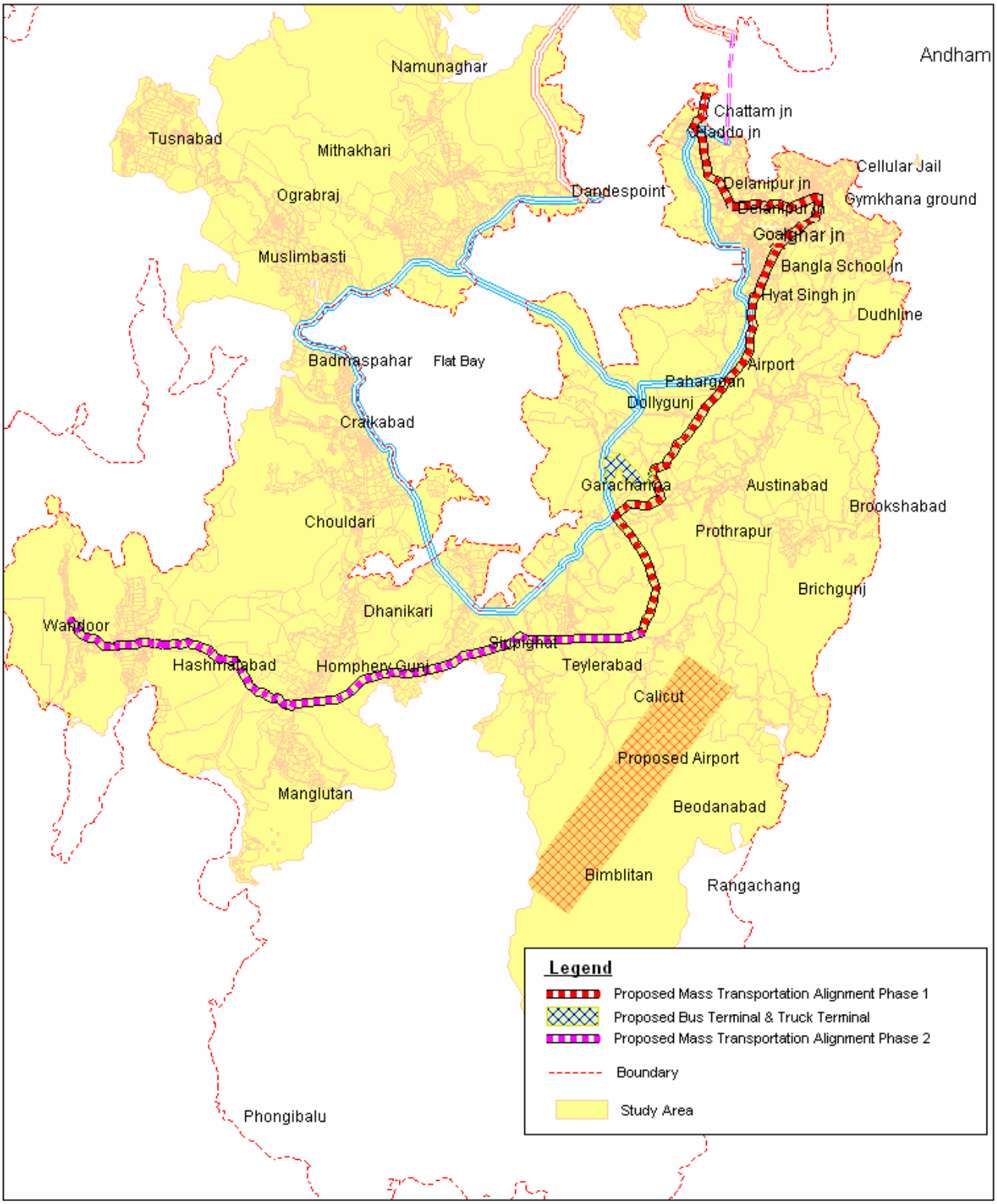


Fig 16.24 Proposed Mass Transportation Alignments, Bus and Truck Terminals

16.4 Conclusion

The Scenarios were evaluated for the fuel savings, time saving and the benefits expected are given in Table 16.4 with the budget requirements. The set of improvements required for enhancing the road network to meet the demand in 2027 has been identified and is recommended for implementation in phased manner.

Table 16.4 Economical Comparison of Scenarios

Sl .No	Scenario	Cost of Construction in Crores of Rs.	Fuel savings/year in Crores of Rs	Man hour savings/year in Crores of Rs	Total Savings/Year In Crores of Rs
1	Marine Drive phase_1	401	12.47	2.53	1.5
2	Marine Drive phase_2	90	4.2	2.40	6.7
3	Missing Links	78	0.05	-	0.05
4	Partial one-way	0.75	0.039	0.364	0.39
5	All one way	1.0	0.54	0.088	0.628
6	Widening of Major Roads	102	6.15	1.04	7.19

The Scenarios were environmentally evaluated for the Carbon monoxide reduction, Hydro carbon reduction and Nitrogen oxides reduction. The Environmental benefits expected for in all the considered scenarios are given in Table 16.5.

Table 16.5 Environmental Savings in each Scenario

Scenario	Savings CO	Savings HC	Savings NO_X
Marine Drive Phase_1	19.57%	25.92%	26.61%
Marine Drive Phase_2	8.1%	14.37%	15.40%
Missing Links	0.21%	0.19%	0.14%
Partial One way	0.29%	0.35%	0.13%
All One Way	10.34%	0.40%	1.47%
Widening Of Major Roads	16.94%	29.36%	28.26%

CHAPTER 17

MASS TRANPORTATION PLANNING

17.1 Introduction

Nearly 50,000 vehicles including 43,176 vehicles registered in Andaman and those registered in other Indian States are plying in Port Blair and Environs. An annual vehicle growth rate of 9.4% is observed during 2000 – 2007. If the same trend is to continue upto 2027 nearly 2, 50, 000 vehicles are expected to ply in the area. The five-fold rise in vehicle population will bring chaos and pollute the environmentally sensitive area.

17.2 Mass Transport Planning

To improve the quality of travel and to safeguard the environment it is required to promote mass transportation and discourage the private transport rider ship. The route with maximum demand for Mass Transport facility has to be identified for planning the facility. The steps involved in mass transportation route evaluation are shown in Fig.17.1.

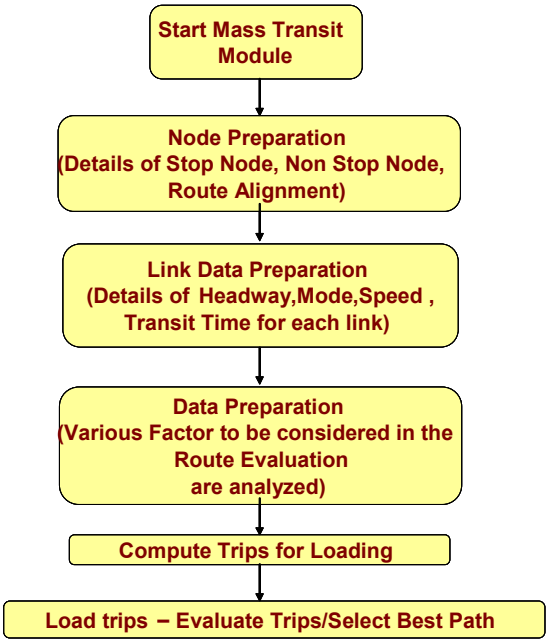


Fig 17.1 Methodology for Route Evaluation

A mode choice or mode split model is concerned with the trip-maker's behavior regarding the selection of travel mode. The reasons underlying this choice vary among individuals, trip type, and the relative level of service and cost associated with the

available modes. When significant changes occur in a situation, trip-makers respond to varying degrees by shifting from one mode to another. For example, a significant increase in the parking fees charges at a destination may induce some people to shift from driving a car to riding a bus.

The characteristics of the trip also have an effect on the choice of mode. It seems more likely, for example, that a person would choose to travel to work or school by a mass transit system but prefer the private automobile, if available, for social trips.

The mode choice behavior of trip-makers can be explained by three categories of factors: the characteristics of the available modes; the socioeconomic status of the trip-maker, and the characteristics of the trip. These are the categories of independent variables that would be included in the mathematical models of mode choice. The dependent variable would be the market share or the percent of travelers that are expected to use each of the available modes.

17.3 Mode Choice Model Building

Logit choice models have a number of distinct possible outcomes and the model estimates the probability of choosing each particular outcome. The alternatives are evaluated using either their costs or their utility values. Costs and utilities are related. As the utility of an alternative increases the alternative becomes more attractive, but an increase in cost makes the alternative less attractive. The simplest choice model splits total travel demand between two alternatives (or modes); it is known as the binary choice model. This may be extended by adding further alternatives, so forming a multinomial model.

The Fig.17.2 shows the structure of the mode split of different vehicles considered for the study.

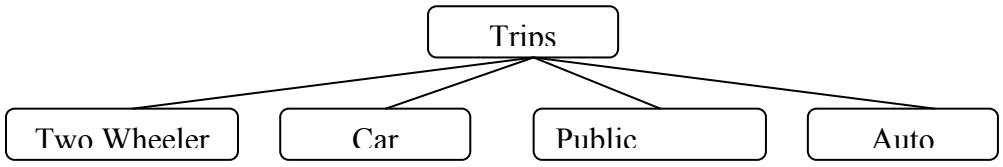


Fig.17.2 Logit Model Structure

Mode Choice Modeling

The various input required for the mode choice modelling model are

1. Travel Time Matrix for each O-D pair in the study area
2. Cost of travel Matrix for each O-D pair for all Vehicle type.
3. Out of Travel Time Matrix for each O-D pair for all Vehicle type.

The above inputs are calculated separately for work and other purposes.

Utility matrix for each type of Vehicle considered is the linear weighted sums of the independent variables like Average House hold Income, Number of Vehicle Owned, Travel Time, Out of Vehicle Travel Time, Cost of Travel and weighted by the regression coefficients obtained above from the regression analysis. User's socioeconomic characteristics are believed to be important factors in mode choice process. In this study the socioeconomic factors like household income and the vehicle owned were taken into account.

Average Household Income

The average house hold income of people differs from one zone to other zone. The detail of the aggregate average household income of people for each zone was calculated. For the future, the average income is assumed to increase by 25% per annum.

Number of Vehicle Owned

The vehicle ownership decides the mode choice of the people and it is the important factor in the choice. The average number of vehicles owned per household for each zone and the type of vehicle owned is obtained from the household survey results.

For the future projection the existing trend in the vehicle ownership in relation to income of the family has been used.

Cost of Travel

Cost of travel has greater influence on the choice of mode. The unit cost of travel was calculated for each mode of travel considering the 2007 fuel cost. The operating cost per Km for two wheelers was estimated as Rs.2.64 per Km, for Car as Rs.6.345 per Km and for Bus as Rs.3 per Km as minimum amount and 0.50 for additional kilometer traveled.

17.3.1 Utility function Trip Purpose wise

The utility function, *U,* has the property that an alternative is chosen if its utility is greater than the utility of all other alternatives in the individual's choice set. Alternatively, this can be stated as alternative, '*i*', is chosen among a set of alternatives, if and only if the utility of alternative, '*i*', is greater than or equal to the utility of all alternatives, '*j*', in the choice set, *C*. This can be expressed mathematically as:

If $U(X_i, S_t) \geq$ If $U(X_j, S_t)$

U - Is the mathematical utility function

X_i, X_j - are vectors of attributes describing alternatives i and j, respectively (e.g., travel time, travel cost, and other relevant attributes of the available modes),

S_t - is a vector of characteristics describing individual *t* that influence his /her preferences among alternatives (*e.g.*, household income and number of automobiles owned for travel mode choice),

The utility function is typically expressed as the linear weighted sum of the independent variables of their transformation that is

$$U = a + a_1 X_1 + a_2 X_2 + \ldots\ldots + a_n X_n$$

where U is the derived from a choice defined by the magnitudes of the attributes X that are present in the choice and weighted by the model parameters a_n

The multiple linear regression analysis is concerned with the establishment of relationship between variables which is known to respond to changes for two or more variables. The factors which affect the modal choice have been selected and the relationship between the modal choice and the variables has been found out by using regression analysis. The various factors considered for the analysis are Average Household Income, Number of Vehicle Owned, Travel Time, Out Vehicle Time and Cost.

The utility equation for work trips is

$U = 1.1703 + 1.05\ E\text{-}06\ X_1 - 0.27085\ X_2 + 0.001055\ X_3 + 0.23865\ X_4 + 0.002252\ X_5$

The R^2 value of the model is 0.608.

The utility equation for other trips is

$U = 0.7674 + 2.56\ E\text{-}06\ X_1 - 0.0161\ X_2 - 0.00442\ X_3 + 0.299\ X_4 - 0.00084\ X5$

The R^2 value is 0.622.

where X_1 = Average House hold Income; X_2 = Number of Vehicle Owned

X_3 = Travel Time; X_4 = Out of Vehicle Travel Time; X_5 = Cost of Travel

The relationship between dependent and independent variables for the utility equations developed by regression analysis is good as R^2 value > 0.60. The Utility matrix is calculated mode-wise for work and other purpose.

Logit Model states that the probabilities of choosing a mode are given by the equations below:

$$P_{TW} = \frac{\exp(U_{Tw})}{\exp(U_{TW}) + \exp(U_{CAR}) + \exp(U_{PT}) + \exp(U_{AUTO})}$$

$$P_{CAR} = \frac{\exp(U_{CAR})}{\exp(U_{TW}) + \exp(U_{CAR}) + \exp(U_{PT}) + \exp(U_{AUTO})}$$

$$P_{PT} = \frac{\exp(U_{PT})}{\exp(U_{TW}) + \exp(U_{CAR}) + \exp(U_{PT}) + \exp(U_{AUTO})}$$

$$P_{AUTO} = \frac{\exp(U_{AUTO})}{\exp(U_{TW}) + \exp(U_{CAR}) + \exp(U_{PT}) + \exp(U_{AUTO})}$$

The Mode Choice results for the base year 2007 are given below

- Probability of choosing Two Wheeler = 0.4408
- Probability of choosing Car = 0.1364
- Probability of choosing Public Transport = 0.3192
- Probability of choosing Auto = 0.1036
- The travel cost of private vehicles would increase by 2.5 times for the horizon year 2027 and the travel cost of public transport by 1.5 times the existing cost.
- The Modal Split expected for the year 2027 are given below
- Probability of choosing Two Wheeler = 0.2146
- Probability of choosing Car = 0.1011
- Probability of choosing Public Transport = 0.5146
- Probability of choosing Auto = 0.1696

The forecast demands for vehicles are given as follows:

Demand for Two Wheeler, D_{TW} = Total demand, D x Probability of choosing T_W, P_{TW}

$D_{TW} = D \times P_{TW,}$

Whereas demand for car, Public Transport and Autorickshaws has been assessed as:

$D_{CAR} = D \times P_{CAR}$

$D_{PT} = D \times P_{PT}$

$D_{AUTO} = D \times P_{AUTO.}$

Demand mode-wise was assessed and O-D table mode-wise was prepared for Mass Transport Planning.

17.4 Identification of Mass Transportation Route

To improve the quality of travel and to safe guard the environment it is required to promote Mass Transportation and discourage the private transport ridership.

High concentrated travel corridor is identified for proposing a suitable Mass transport system. Higher concentration of travel was noticed from Chatham Island to Garacharma.

Planning Mass Transportation facility involves

1. To identify the optimal routing which attract maximum demand.
2. Estimate the quantum of ridership patronage in peak hours and non-peak hours.

All the routes connect Garacharma and Chatham Island, where ferry trips from Bamboo Flat and Dandas point are fed. The salient features of each route are given below.

Route 1: It passes along the residential areas in Lillypur and Delanipur, commercial zone Junglighat, Airport and Educational Institutions near Lamba Line and Dolly Gunj. The Route and the catchments area is shown in Fig.17.3. The route length is 10.02 Km

Route 2: The route alignment and the catchments area is shown in Fig.17.4. The route passes along the shore line between Chatham Island and Light House Junction. The route is proposed along Light House, Bengali Club, Hyat Singh Junction, Airport and Garacharma. The secretariat is connected by the route and the route length is 10.14 Km.

Route 3: The route is proposed to connect the residential areas on the right hand side of the Airport viz., Nayagoan, Dudhline etc. Aberdeen Bazaar is also connected. The ropute length is 13.26 Km CBD is well connected with the residential areas on the middle east of Port Blair. The route alignment and the catchment area is shown in Fig.17.5.

Route 4: The route is proposed to connect the Aberdeen Bazaar, Secretariat, Airport and Garacharma. The route and catchments area is shown in Fig.17.6. The route length is 10.96 Km.

Route 5: The route is modification of route 1 with connection to Aberdeen Bazaar and Secretariat. The route length is 11.45 Km. The route alignment and the catchments area is shown in Fig.17.7.

Fig.17.3 Proposed Mass Transport Corridor - Route 1

Fig.17.4 Proposed Mass Transport Corridor - Route 2

Fig.17.5 Proposed Mass Transport Corridor - Route 3

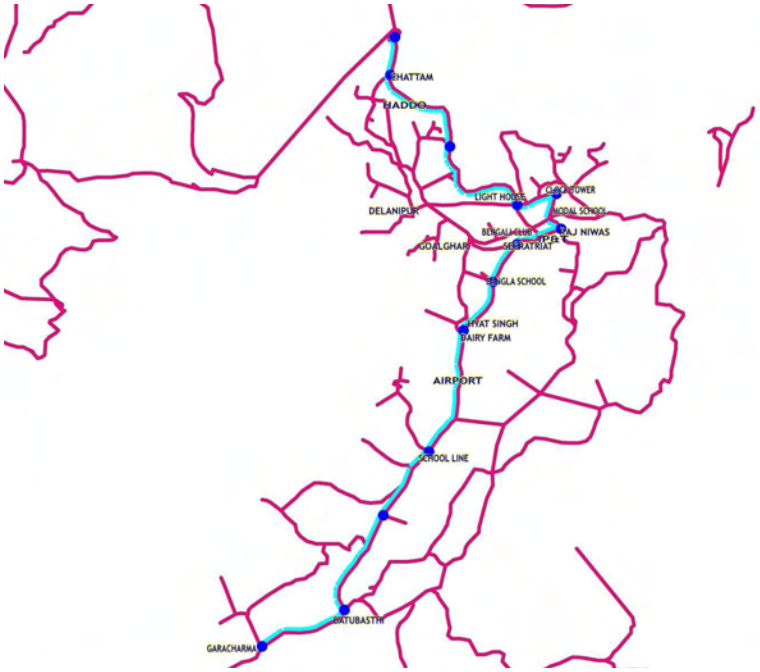


Fig.17.6 Proposed Mass Transport Corridor - Route 4

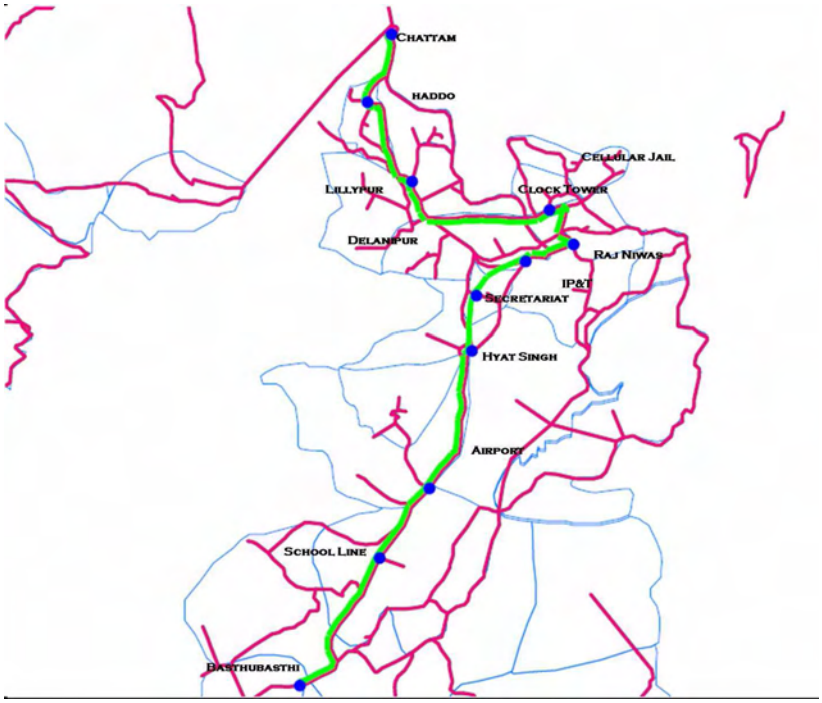


Fig.17.7 Proposed Mass Transport Corridor - Route 5 Phase I

17.5 Route Evaluation

The following assumptions were made for selection of the route with maximum patronage

Frequency of service	=	10 minutes in peak hour.
Average waiting at station	=	5 minutes during peak hour.
Average walking speed	=	1.2 m/sec.
Average spacing between stations	=	0.5 km in CBD 1.00 km at other locations.
Average speed of journey	=	40 kmph.
Dwell time at stations	=	30 seconds.

Identification of “reasonable” or “attractive” multiple discrete routes between zones has been done taking into account:

- Number of transfers
- Spread — the margin of cost over the minimum cost route
- Nontransit and in-vehicle costs
- Boarding and transfer penalties by mode
- Waiting time, derived from the combined frequency of services at stop nodes
- Fares

The different route selected for the study are developed in network and system data like different mode, capacity for each mode frequency are given as inputs.

From the model analysis Route 5 has the optimal patronage and it is given in Fig.17.8 and Fig.17.10 for both directions. The load profile for route 5 for each direction is given in the Fig.17.9 and Fig.17.11.

The Route 5 facilitates comfortable and economic travel from Chattam to Garacharma and has 11 stops in between. The Fig.17.11 and Fig.17.13 show the expected number of persons boarding and alighting at each stop during peak hour. The Green bar shows the number of persons Boarding the transit and the blue bar shows the number of persons alighting at each stop. The dark red line shows the total number of persons in vehicle at each stop. In the morning peak hour along Chattam to Garacharma the persons boarding is expected to gradually increase, maximum boarding is expected at clock tower, Model School and Bangla School stops. The maximum number of persons alighting is at last three stations School Line, Bathubasthi and Garacharma. The reason for higher alighting at school line is presence of schools and colleges and public places near School Line.

In the reverse direction, Garacharma to Chattam during morning peak hour, maximum number of persons are expected to board at stops near Garacharma and in gradually after Hyat Singh junction. The load profile for the direction is shown in Fig.17.13.

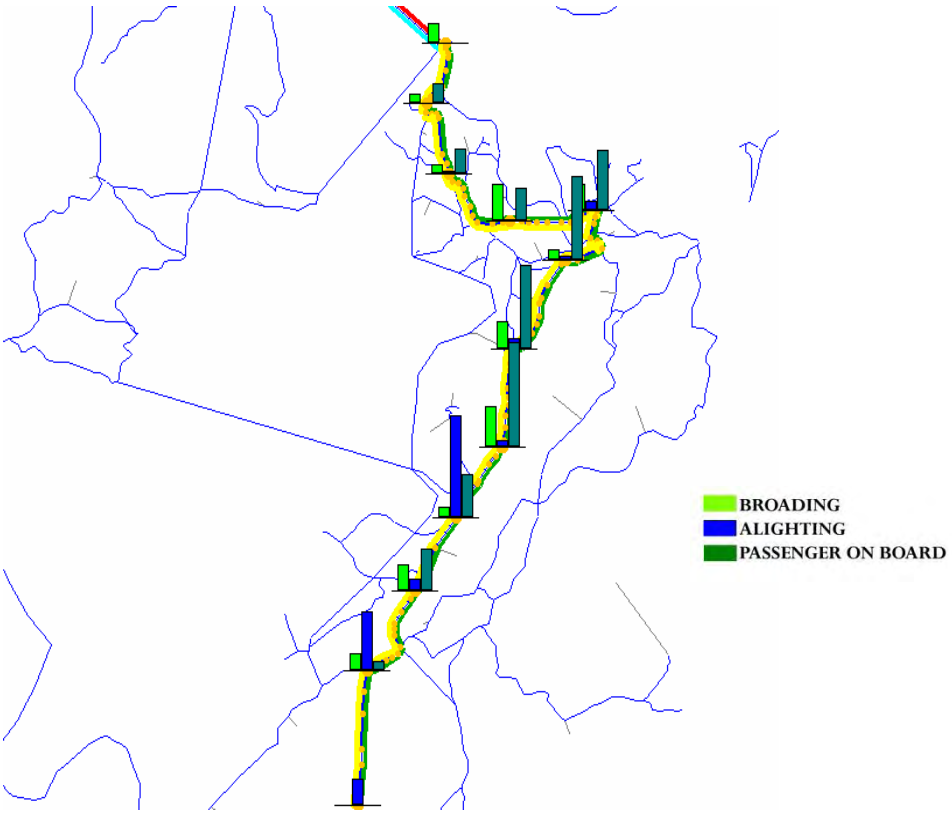


Fig.17.8 Patronage Bar Chart for Each Stop Node for Route 5 (Chattam – Garacharma)

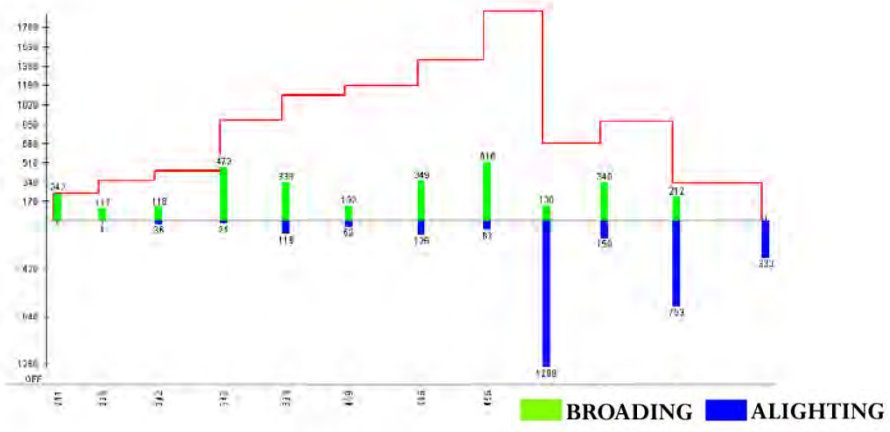


Fig.17.9 Load Profile for Route 5 (Chattam – Garacharma)

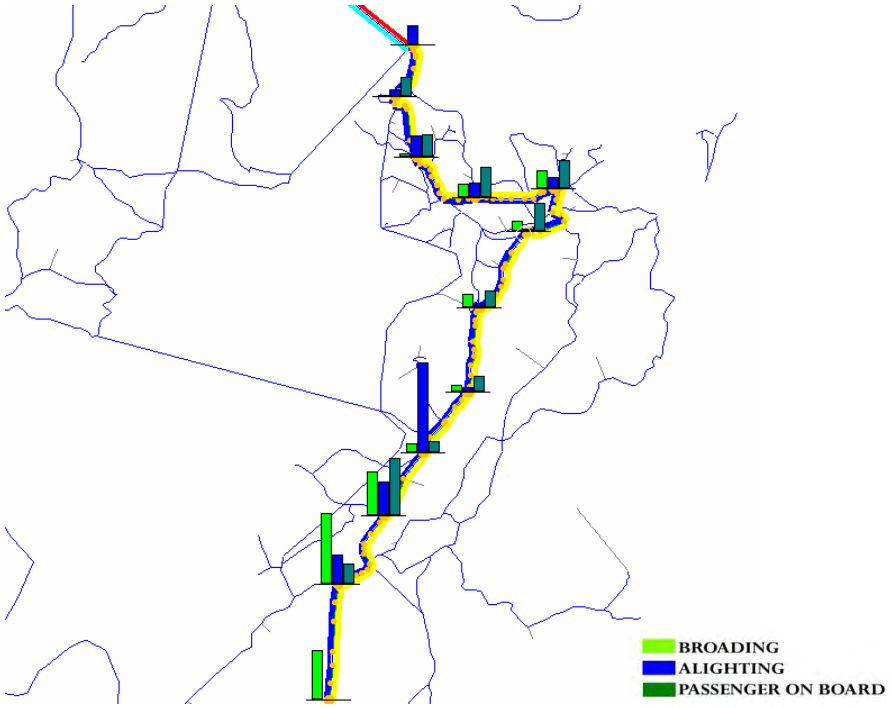


Fig.17.10 Passenger Load Chart for Route 5 (Garacharma - Chattam)

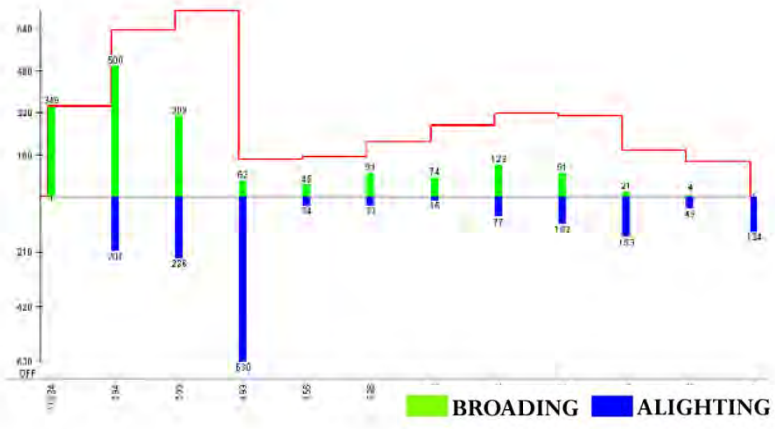


Fig.17.11 Load Profile for Route 5 (Garacharma - Chattam)

The optimal route was suggested based on the length of the route and patronage expected in peak hour. The Length of Routes and expected Peak Hour Patronage are given in Table 17.1.

Table 17.1 Length and expected peak hour patronage

Route Number	Length of the Route in Kms	Total Peak Hour Patronage
1	10.02	12672
2	10.14	9810
3	13.26	11856
4	10.96	11502
5	11.45	15336

On analysis of the routes based on traffic grounds, route 5 is the optimal route. It is estimated to carry 15,336 passengers in peak hours. The shift of travel to Mass Transport will have positive impact on the road network with reduction in the congestion level and environmental pollution.

As Hompherygunj is to be developed as administrative node, the route can be further extended to Hompherygunj via the transit node, Calicut, Fig.17.12. The expected V/C ratio of the road stretches on assigning the 2027 traffic after introduction of Mass transport corridor (Route 5) is shown in Fig.17.13 and Fig.17.14. The route after Phase II extension is expected to carry 23500 passengers during peak hours.

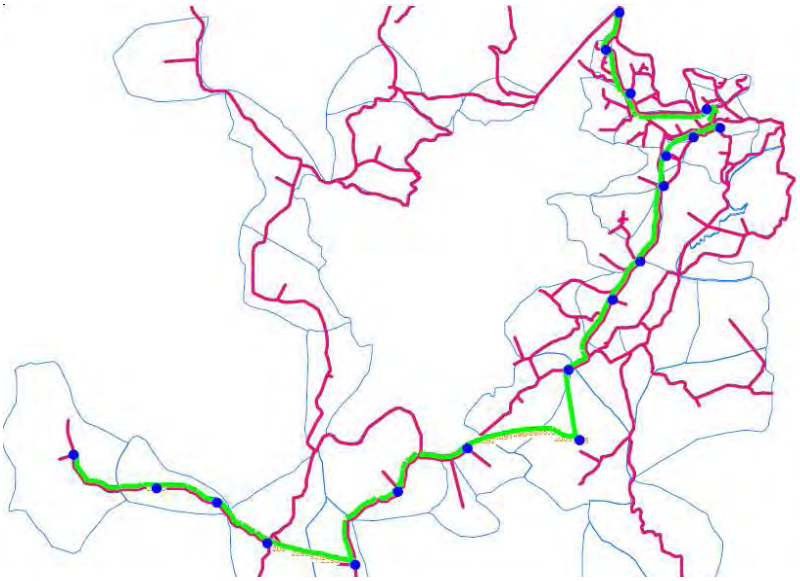


Fig.17.12 Proposed Mass Transport Corridor Route 5 – Phase II

Fig.17.13 Expected V/C ratio on Major Roads after Introduction of Mass Transport

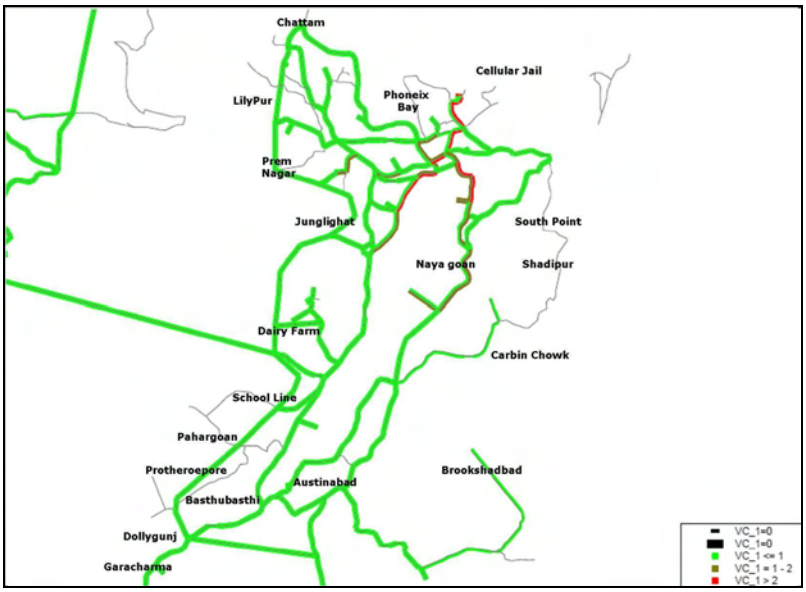


Fig.17.14 Expected V/C ratio on Major Roads in Port Blair Town after Introduction of Mass Transport

17. 5 Costs Benefit Analysis

The basic principle behind any method of economic evaluation is to measure the cost of the projects, determine the benefits that are likely to accrue and compare the two. Cost and Benefits involved in the projects are to be established to judge the financial viability of the Project.

The basic data assumed in the discounted cash flow analysis is given below in Table 17.2.

Costs

The costs involved are Capital cost needed for initial construction, operating cost and maintenance cost. The cost of construction of Public transport facility of LRT or Monorail is 100Crores/Km and for Route 5 it comes to around 1200 Crores.

The maintenance cost and operating cost are recurrent in nature and is required to keep the assets in good condition in the future years. The running cost is assumed to be 2 % of the construction cost and to have 5% increase every year.

Table 17.2 Data assumed in Discounted Cash flow Analysis

Sl. No	Description	Assumption
1.	Cost of Construction	1200 crores
2.	Maintenance and Running Cost	2 % of total cost
3.	Interest rate	8.50 %
4.	Tenor	30 years
5.	Principal Moratorium	1 year
6.	Repayment	30 years
7.	Average Revenue Per person	Rs.12
8.	Increase in Running Cost	5 % per Year

Revenue Expected

The demand calculated form the route evaluation gives the peak hour demand and it is assumed that number of service in Peak Hour is 6 and in non peak hour is 4. Assuming that the LRT is to run for 10 hours a day and the demand in Non-Peak hour is assumed to be 25 % of the Peak hour and revenue expected per day is calculated.

The minimum cost of travel is assumed to be Rs.7 up to 5 Km distance and for every additional Kilometer traveled extra cost is assumed to be Rs.0.75/km. The revenue expected is calculated based on the demand and for Phase I, IRR is calculated. The IRR value is 4% for a conservative forecast of passenger demand.

17.6 Environmental Benefits

Transport, especially the road transport is one of most air polluting activities in the economy. Burning of fossil fuels by vehicles contribute air pollution loads in the form of Carbon Monoxide (CO), Hydrocarbons (H), Nitric Oxide (NOx) and Particulate Matter

(PM). For example a passenger car manufactured without an emission reduction technology (pre Euro technology) emits 0.0002 kilograms (kgs) of PM and 0.0009 kgs of NOx per every kilometer (km) distance traveled.

The increasing vehicular traffic increases the V/c ratio. The higher the value of V/C ratio, the higher is the reduction in speed. The reduction in the traffic speed will results in higher vehicular emission. High order air pollution under normal circumstances should deter the traffic from using the stretch of road when the pollution level is more. In the absence of alternative route and mode choice the traffic continues to surge on the same road stretch. In order to reduce the pollution level, the V/c ratio should be less than 0.6 and the optimum speed range should be between 35 kmph to 45 kmph. This can be achieved either through introduction of new proposals to accommodate the increasing traffic or introduction of mass transport.

Pollution Load before introduction of Public Transport

The average speed on each stretch is calculated based on the established speed flow relationship. The traffic flow in each link is obtained from the capacity restraint assignment before the introduction of public transport facility. The emission model of TRL is used to calculate the CO emission, HC Emission, NO_x Emission for each type of vehicle. The composition of traffic from the modal split is used to separate the flow in link into different composition. Emission load is calculated for different stretches of roads for peak hour in 2027 and it is given in Table 17.8. In peak Hour CO Emission is expected to be 276.568 tonnes, HC Emission is 94.921 tonnes, NO_x Emissions 83.925 tonnes.

Pollution Load after introduction of Public Transport:

Pollution load calculated by TRL method for different stretches of roads for peak hour after introduction of Public Transport is given in Table 17.3. In peak Hour in 2027, expected CO emission is 150.32 tonnes, HC emission is 41.9 tonnes, NO_x emissions 35.5 tonnes.

Table 17.3 Emission load for various scenarios in CO, HC, NOX

Scenario	Vehicular Emission during peak hour in Kg			Reduction in CO	Reduction in HC	Reduction in NOX
	Total CO	Total HC	Total Nox			
Before Introduction of Public Transportation	276567.806	94920.751	83925.352			
After Public Transport Introduction	150321.394	41948.272	35468.586	126246.412	52972.480	48456.766
Percentage Reduction				**46%**	**56%**	**58%**

Nearly 50,000 vehicles including 43,000 vehicles registered in Andaman and those registered in other Indian States are plying currently in Port Blair and Environs. An annual vehicle growth rate of 9.4% is observed during 2000 – 2007. If the same trend is to continue upto 2027 nearly 2, 50, 000 vehicles are expected to ply in the area. The five fold rise in vehicle population will bring chaos and pollute the environmentally sensitive area.

Though the new road proposals and road improvements will definitely facilitate better movements there is an urgent need to promote Mass Transportation. Increasing the Mass Transportation rider ship will reduce the private vehicles on road in turn reducing the vehicular emission let into the atmosphere. As a short term measure to preserve the fragile environment use of CNG is recommended. As use of CNG will reduce the quantum of pollutants from vehicle exhaust

17.7 Planning of New Terminal

At present there is a Bus Terminus near Aberdeen Bazaar for the Andaman State Transport Service Buses. All buses start and end their trips here. The bus terminus will not be able to accommodate further increase in fleet strength therefore it is proposed to shift the bus terminus to near Garacharma (as proposed in draft Master Plan) on a spacious location. An area of nearly 5-8 acres land in Transport Nagar, which is closer to the Chattam – Garacharma road, and proposed Marine drive is suggested for Bus terminal. A state of art modern bus terminus has to be planned to house existing buses and the future fleet strength increase. People have to be provided with environmentally friendly mass transport ride to Port Blair from Transport Nagar. By shifting the Bus terminus to Transport Nagar entry of long distance buses to the city centre could be avoided. The existing terminal could be used for local buses plying

within Port Blair and once the mass transport system starts functioning the location could be used for parking facility.

17.8 Environmental Friendly Shuttle Service

Provision of the mass transportation facility is found to decongest the major roads in Port Blair. The V/C ratio expected on the road network on assigning the future traffic shows the roads in city center have to carry traffic beyond capacity. It indicates additional measure is required to decongest roads in CBD area. It is suggested to have battery operated minibus operation on circular route to reduce the use of private vehicles. It is expected that nearly 50 % auto rickshaw riders in CBD would switch over to this facility. The service is to be with definite frequency in peak and off peak hours and to charge less than auto rickshaw ride. The route for shuttle service is shown in Fig.17.15. On introduction of shuttle service curb on autorickshaw operation or prevention of further addition of auto rickshaw to the existing autorickshaw population in Port Blair is suggested.

Fig 17.15 Environmental Friendly Shuttle Service

Conclusion

A. Bus operation in port Blair to be improved by:

- Design of Bus Bays/ Bus stops with staggering
- Introduction of CNG operated buses
- Introduction of modern Low floor buses
- Introduction of modern system like GPS for Fleet management for effective real time monitoring
- Planning and construction of a modern bus Terminal – at Transport Nagar
- Optimisation of operations by route rationalization

B. By introducing the appropriate mass transport facility (Monorail or LRT) along the route suggested would reduce the number of private vehicles on road and reduce vehicular pollution to a great extent.

C. Introduction of Environmental friendly shuttle service in the City Center.

CHAPTER 18

FINDINGS AND RECOMMENDATIONS

Port Blair is the gateway to Andaman and Nicobar Islands. The town is the administrative center for both civil and defense functions in Andaman and Nicobar group of Islands. Port Blair town is spread over an area of 17.74 sq km and its population as per 2001 census was 99,984. 32 villages are in the planning area (139.38 Sq km) with a population of 61636 in 2001.

Port Blair is connected by air and water transport to the mainland. It is connected to the settlements in the planning area and the other parts of Andaman Island by Andaman Trunk Road popularly called as ATR. The roads in the municipal area are two lane roads. As the terrain is undulating the roads are circuitous and narrow. 43,176 vehicles are operating in the planning area in 2006 and ferry services are also used for local travel in the Port Blair and environs.

The population in the Port Blair town and environs is projected to be nearly 3.5 lakhs in 2027. The area is poised for higher order growth. Lot of tourists spots are located in and around Port Blair town and also in various parts of Andaman Islands. The inflow of tourists to the islands is on the rise. Major Land use developments (new administrative center in Hompherygunj, airport at Calicut, Bus Terminal at Garacharma and residential developments at Bamboo Flat and Tusnabad) has been proposed in the draft Master Plan. The increase in population, increased inflow of tourists and the proposed developments are expected to generate lot of travel. This increased traffic movements would bring higher stress on the narrow inherited road network. Hence the comprehensive traffic and transportation study has been entrusted and carried out. The findings and proposals of the study are as follows.

18.1 Existing Transportation Scenario

As on 2006 43176 vehicles were registered and plying on the road network of Port Blair and environs. 10.7% annual rate of increase in vehicle population has been observed. Nearly 70% of registered vehicles were two wheelers, 14% cars, 6% trucks, 6% autorickshaws and the other vehicles formed the balance share. If the same trend is to continue nearly 2, 50,000 vehicles are expected in 2027.

In the Port Blair town 44.61% of the trips were performed by bus, 7.05% of trips by car, 15.15% of trips by two wheelers, 1.24% of trips by car, 19.92% of trips

by walk, 6.64% of trips by ferry and 3.53% of trips by other modes. It was observed that use of private modes is on the rise and patronage for public transport is declining. Majority of trips performed are work purpose trips followed by education and other purpose trips.

Travel pattern of the trips performed were studied in details (by household interview and road side interview). Port Blair town was considered as one sector with 18 zones, where as southern part, south western part, north western part and northern part of planning areas were considered separate sectors. The trips performed within each sector and from one sector to the other were studied in detail. Highest traffic movements were observed in the northern part of Port Blair town, the predominant movements were Nayagaon to Aberdeen Bazaar, Dudh line to Aberdeen Bazaar and Chattam Island to Aberdeen Bazaar. Significient trips from Northern sector to Southern sector and North Western sector to Southern sector was observed.

The speed and delay study was conducted using GPS fitted in moving car. The speed stretchwise, delay and reason for delay were recorded. The speed recorded stretchwise of road network was in the range of 15kmph to 30kmph in the Port Blair town and 25kmph to 40 Kmph in the environs. The delay was mainly at the intersections.

Major 15 intersections were identified and hour wise volume count, turning movements and composition was observed for 12 hours and recorded. The peak hour traffic flow at the intersections varies from 522 PCUs to 4902pcus per hour. The traffic flow at the intersections was currently manually controlled.

There is acute parking problem prevailing in the Port Blair town. On street parking is prevalent on both sides of all major roads. Parking maneuvers cause delay and are likely to cause accidents. Parking of vehicles was for short duration (i.e. less than 30 minutes duration). Parking problem is predominant at Aberdeen Bazaar, Junglighat, Cellular Jail and Delanipur.

State Transport Service operates 142 buses in Port Blair town and in the environs. Private buses are also operated in Port Blair. Nearly 60 lakhs passengers' trips were performed by bus transport in the year 2005-06.

161 accidents were reported in Port Blair town in the year 2005, 15 accidents were fatal, 36 accidents grievous, 109 accidents were of simple injury and 1

accidents non injury category. Pedestrians (32%) and two wheelers (31%) were found to be most vulnerable category.

On study of the materials used for road construction and the pavement surface riding quality it was observed that flaky and elongated aggregates were used leading to premature failure. The riding quality of pavement surface needs attention. The surface roughness in Urban roads varied from 1857mm/km to 4771mm/km whereas in environs the range was from 2981mm/km to 6790mm/km. For a comfortable travel, surface roughness needs to be maintained within 4000mm/km. Due to excessive rainfall, pavement distress in the form of pot holes, cracking, rutting and raveling was noticed on many road stretches.

18.2 Proposals

The year 2027 was taken as the planning horizon. Four stage transport planning exercise was carried out. Number of scenarios was formulated and the proposals expected to yield benefits in terms of maximum fuel and time saving, and the one causing least environmental degradation were identified. The proposals recommended for consideration and implementations are listed as follows.

18.2.1 Intersection Improvements

The volume capacity ratio and level of service of the major intersections was computed year wise for a traffic growth of 3% per year. It is proposed to install traffic signal at all the 15 major intersections in Port Blair town. Eleven intersections in Port Blair CBD are in close proximity (i.e. within a distance of 1.5km) to each other and traffic signal coordination is required to avoid stopping at every intersections.

Grade separator facility is required at Bengali Club and Light House junctions. At Bengali Club an 5m wide flyover along east – west direction with one way traffic movement (Fig 15.12(b)) is found to cause least delay and is recommended for implementation. At Light House intersection 8m wide grade separator from north to south i.e. from Marine Drive to Bengali Club is proposed (Fig 15.15(a)).

18.2.2 Parking Facility

The following measures are required to solve the parking problem in Port Blair. On street parking has to be permitted on only side and after development of sufficient off – street parking facilities on – street parking is to be discouraged to the extent possible. Parking fee can be collected to discourage indiscriminate long term

parking. Off – street parking is suggested in open space behind Ratna Market (Fig15.2) and near school area in Junlighat (Fig 15.25) whereas multi level parking is proposed near stadium (Fig 15.24) to ease the parking problem at Cellular Jail and near the stadium. To satisfy the parking demand in Aberdeen Bazaar the vacant land of Netaji Club (Fig 15.22) could be utilized on Public Private Participation Concept as surface parking or underground parking facility can be built with mutual consent.

18.2.3 Road Engineering

Pavements may be constructed with appropriate design practices and strict quality control; crumb modified Bitumen Grade–55 or polymer modified Bitumen Grade–70 is recommended for the Bitumous layers to overcome the excessive ravelling which is the root cause for other pavement failures. It is strongly recommended to develop Pavement Management system exclusively for the roads in Andaman.

18.2.4 Safety Enhancements

Road accidents occurrence is on the rise. Pedestrians and two wheelers are most affected category of road users. Protected footpaths abd safe pedestrian crossings are essential on all major roads in Port Blair Town. Installation of road signs, adequate information boards for guidance to prominent locations as per IRC code is required. Monitoring cameras to identify traffic rule and speed are to be installed at major intersections and on mid blocks of major roads.

18.2.5 Proposed Road Network Enhancement

Currently volume capacity for the roads in the study varies from 0.36 to 1.98, if the existing road network is not enhanced the V/C ratio in 2027 is likely to be range of 1.2 to 5.6

In the proposed master plan Hompherygunj is to be developed as administration node, Calicut as airport and residential areas in Bamboo Flat and Tusnabad. To cater the need of the existing travel and that needed due to proposed development a new road along the coast is proposed for a length of 30 kilometers from Chattam Island to Bamboo Flat via Dandas point. The proposed marine drive (Fig 16.13) is to be a four lane road with cycle tracks on both sides. The proposal can be taken up in two phases. The marine drive would provide good, all weather road connectivity to all settlements in the Port Blair environs. Further connectivity

between Bamboo Flat and Chattam Island as suspension bridge or as on under water tunnel without affecting the ship movements to Hadoo harbour would enhance quick travel from Bamboo Flat area to Port Blair and Calicut (Fig 16.13).

Babu lane in Aberdeen Bazaar lacks connectivity and the connectivity as proposed (Fig 16.15) is required to facilitate movements.

One way arrangement in Aberdeen Bazaar, Bengali Club and Light House area (Fig 16.19) is proposed to reduce congestion prevailing due to heavy traffic movements in the area. Heavy traffic movements are observed along the Bathubasti to Chattam Island road. So Road widening is required to reduce congestion on this stretch.

18.2.6 Freight Planning

Freight movements are essential for transport of daily needs of the people in the Island and for infrastructure development works. An exclusive freight jetty at Phonghibalu and a two lane road connectivity from Hompherygunj to Phonghibalu is required to segregate the freight movements from the busy roads of Port Blair town. A terminal for parking of trucks is proposed, adjacent to the Bus terminal near Garacharma.

18.2.7 Mass Transport Planning

Promotion of mass transport ridership in port Blair and environs is to be given prime importance. At present bus transport is the only mass transport facility in operation. Model for mode choice was built to estimate the probable users of mass transportation. The optimal routing and expected patronage was estimated for the proposed LRT or Monorail system.

The optimal route (Fig 17.7) for the transit system identified was the one that connects Chatham Island to Garacharma via Lillypur, Delanipur, Secretariat, Junlighat, Airport, Lamba line and Dollygunj. The route length is 11.45 kilometer. On introduction of mass transport facility, it would enable shift from private modes which in turn would help in easing congestion level on roads and reduce vehicular emission load.

Long distance buses also originate from the bus terminal at Mohanpara. It is proposed to have an exclusive bus terminal for the long distance buses near Garacharma (Fig 16.23). The existing bus terminal could be further improved for use of city buses operating in Port Blair.

It was observed short distance travel was very common in the Aberdeen Bazaar, Cellular Jail and Nayagaon area. A environmental friendly battery operated mini bus operation at regular intervals is proposed. The route for shuttle bus operation is shown in Fig 17.15. Further curb on registration of autorickshaws is to implemented.

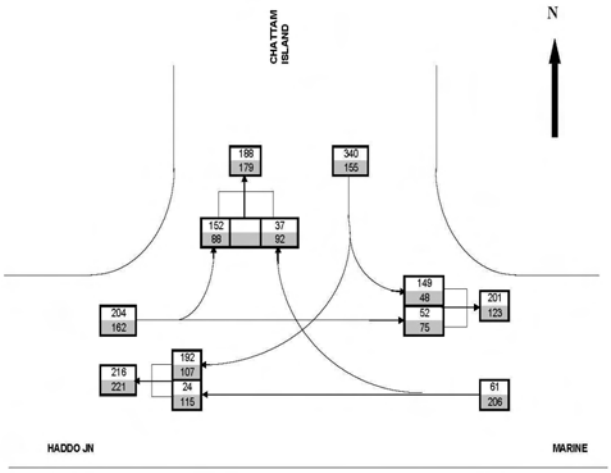
18.2.8 Cost and Phasing

The appropriate cost involved and suggested phasing for implementation is given in Table 18.1.

Table 18.1 Cost Estimate and Phasing of the Improvements

Sl No	Description of proposal	Estimated Cost in Crores of Rs.	Phasing			Remarks
			i 2008-2012	ii 2012-2016	iii 2016-2020	
1.	One-way System	1.00	☑	-	-	
2.	i. Signal design	0.75	☑	-	-	
	ii. Signal co-ordination	0.50	-	-	-	
3.	Grade Separators		-	-	-	
	i. Light house	14.00	☑	-	-	
	ii. Bengali club	10.00	☑	-	-	
	iii. Goalghar	20.00	-	☑	-	
	iv. Delanipur	14.00	-	☑	-	
4.	Widening of Road Stretch from Chatham to Bathu Basthi	102.00	-	☑	-	
5.	i. Marine Drive Phase-1	401.00	☑	-	-	
	ii. Marine Drive phase-2	90.00	-	☑	-	
6.	Mass Transportation System		-	-	-	
	i. Phase 1	400.00	-	☑	-	
	ii. Phase 2	450.00	-	-	☑	
7.	Environmental Friendly Shuttle Service	5.00	☑	-	-	
8.	Shifting of Bus Terminus	20.00	☑	-	-	
9.	Missing Links	78.00	☑	-	-	
10.	Parking Lot Design	20.00	☑	-	-	
11.	Pavement Management system	1.00	☑	-	-	
Total (in Crores) =		**1626.25**	**550.25**	**626**	**450**	

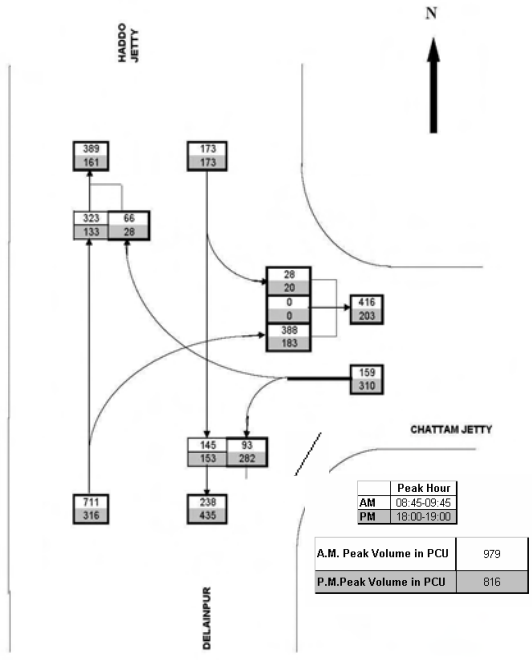
Annexure A
Peak Hour Traffic Flow at Major Intersections



	Peak Hour
AM	08:00-09:00
PM	14:00-15:00

A.M. Peak Volume in PCU	675
P.M.Peak Volume in PCU	551

Fig A1 Peak Hour Traffic Flow - Chatham Junction



	Peak Hour
AM	08:45-09:45
PM	18:00-19:00

A.M. Peak Volume in PCU	979
P.M.Peak Volume in PCU	816

Fig A2 Peak Hour Traffic Flow – Haddo Junction

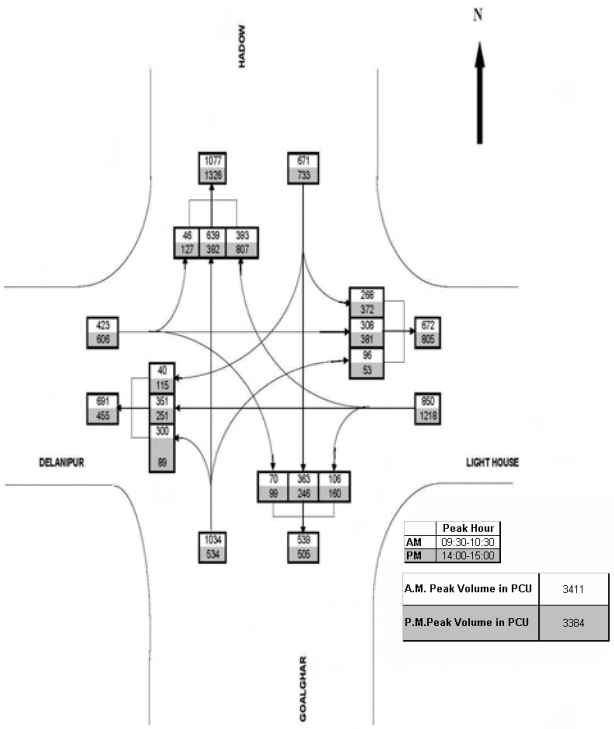


Fig A3 Peak Hour Traffic Flow - Delanipur Junction

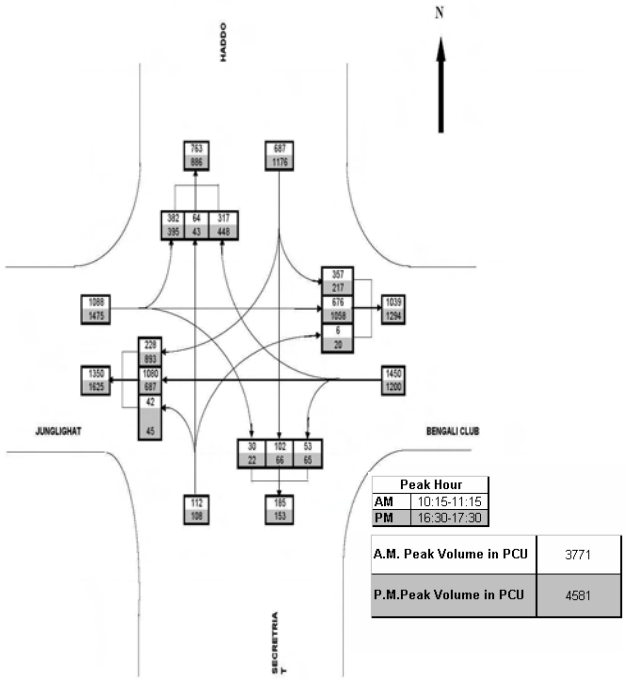


Fig A4 Peak Hour Traffic Flow - Goalghar Junction

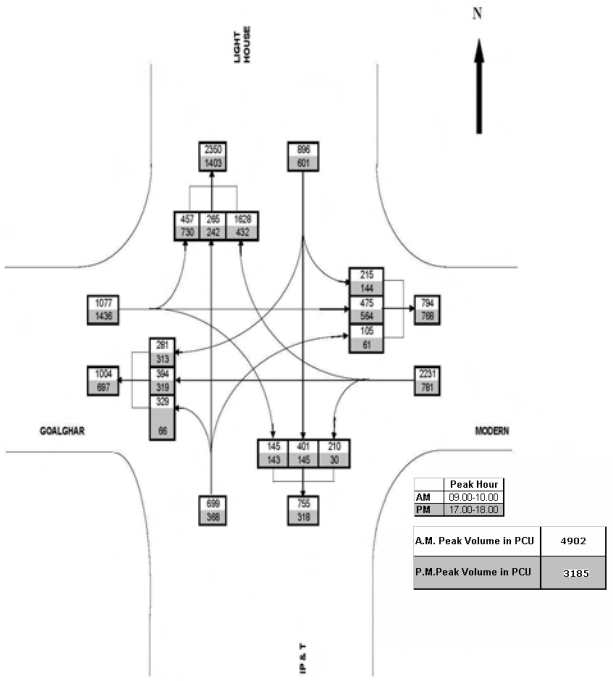


Fig A5 Peak Hour Traffic Flow – Bengali Club Junction

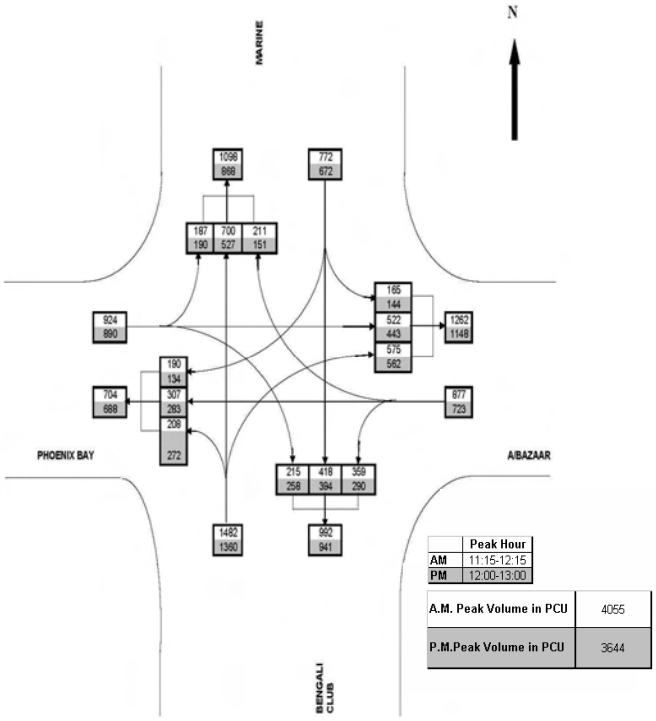


Fig A6 Peak Hour Traffic Flow – Light House Junction

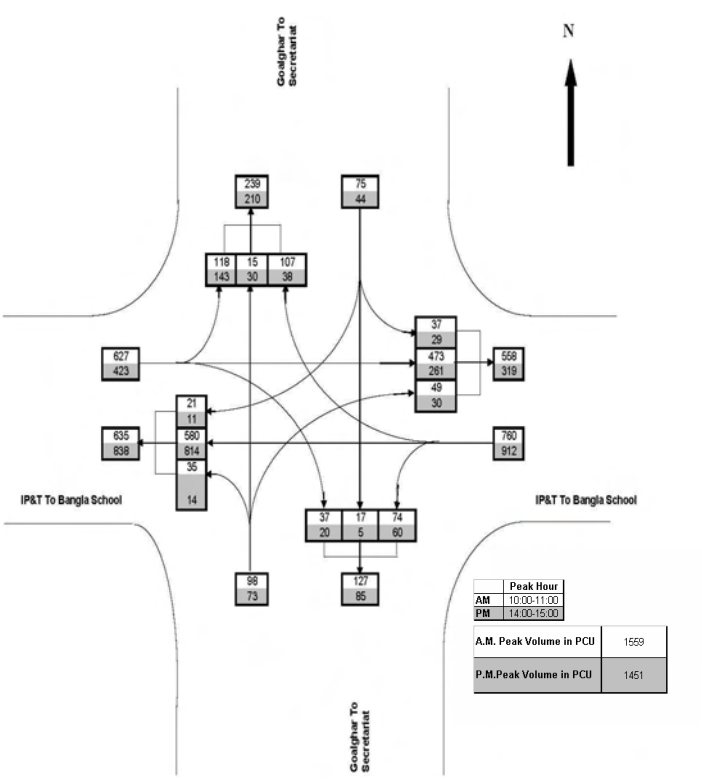


Fig A7 Peak Hour Traffic Flow - Secretariat Junction

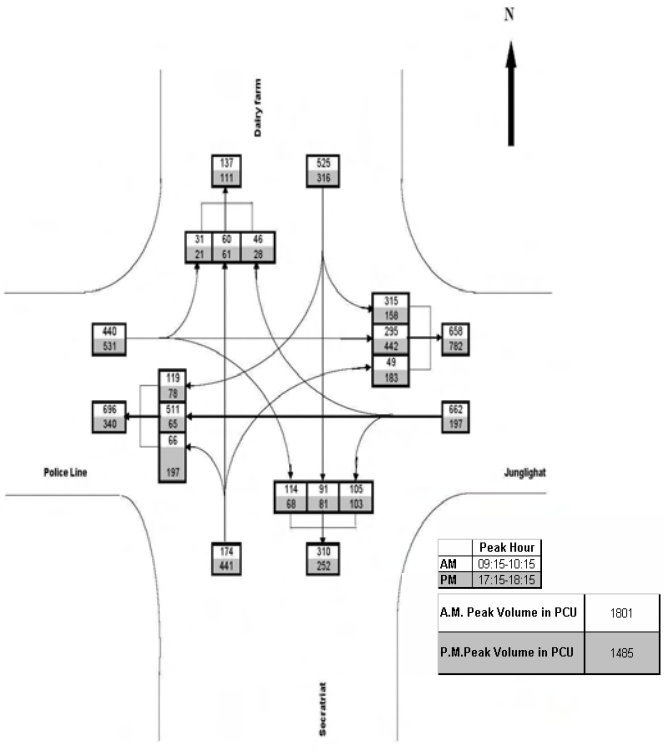


Fig A8 Peak Hour Traffic Flow – Bangla School Junction

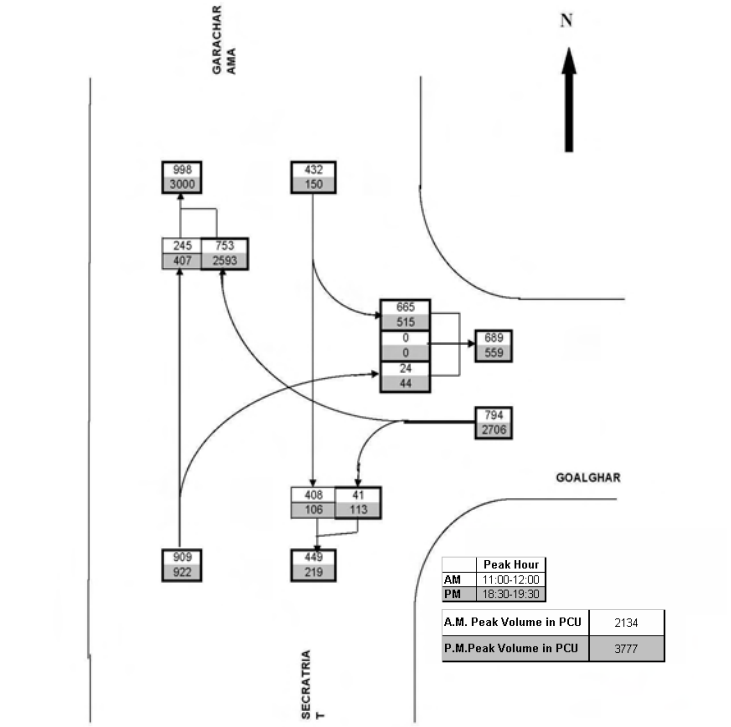


Fig A9 Peak Hour Traffic Flow – Hyat Singh Junction

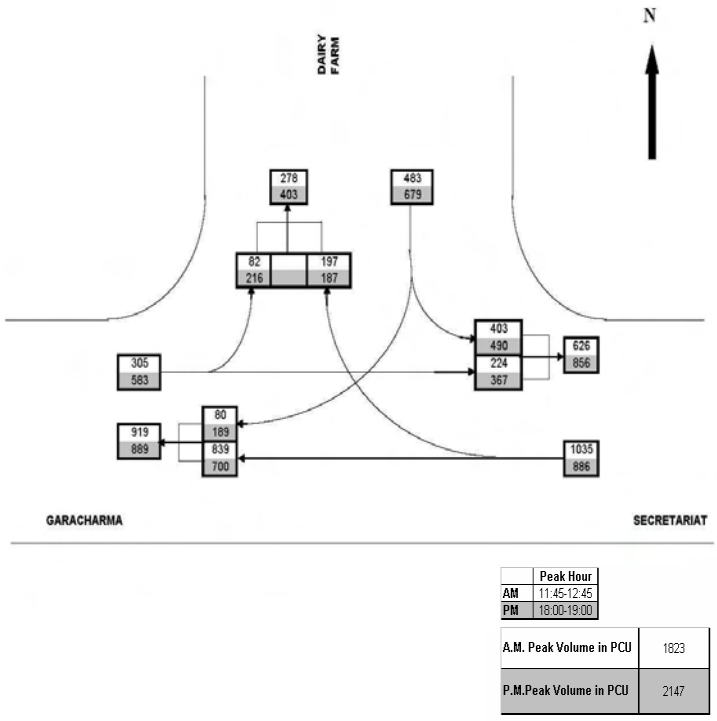


Fig A10 Peak Hour Traffic Flow – Dairy Farm Junction

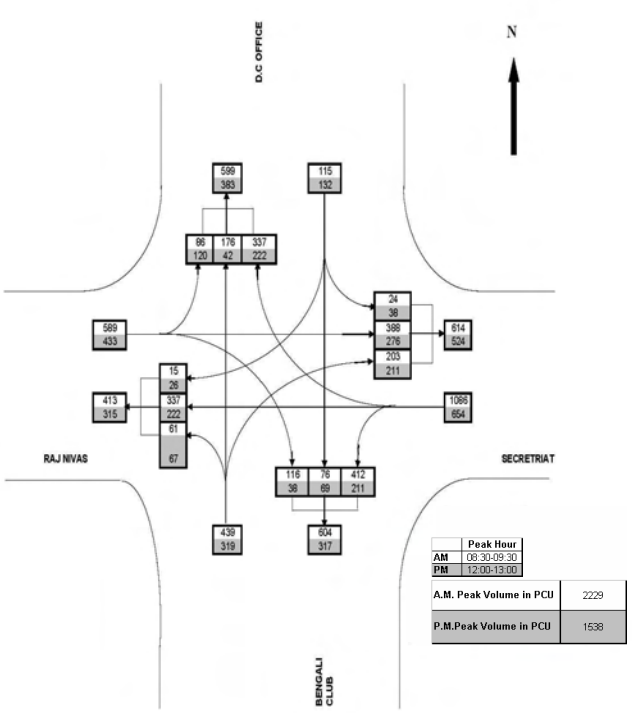


Fig A11 Peak Hour Traffic Flow – IP & T Junction

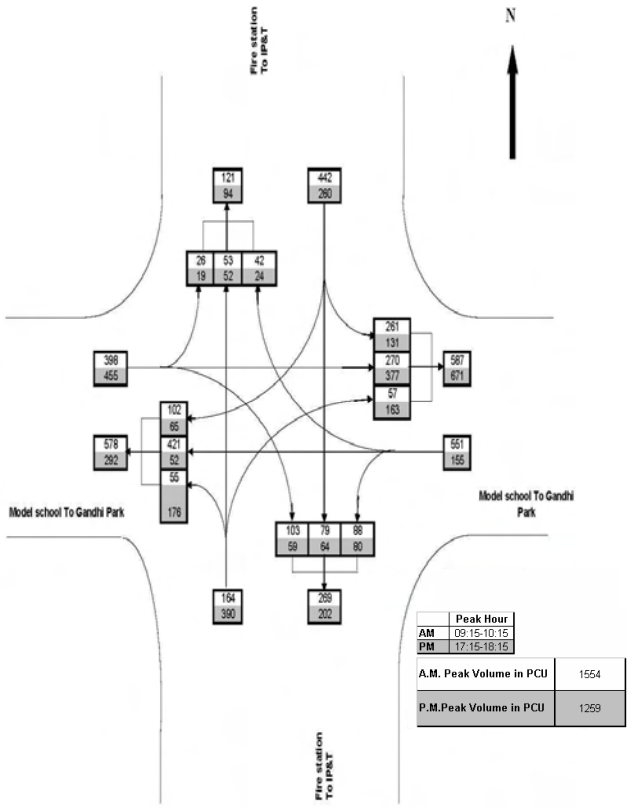


Fig A12 Peak Hour Traffic Flow – Raj Nivas Junction

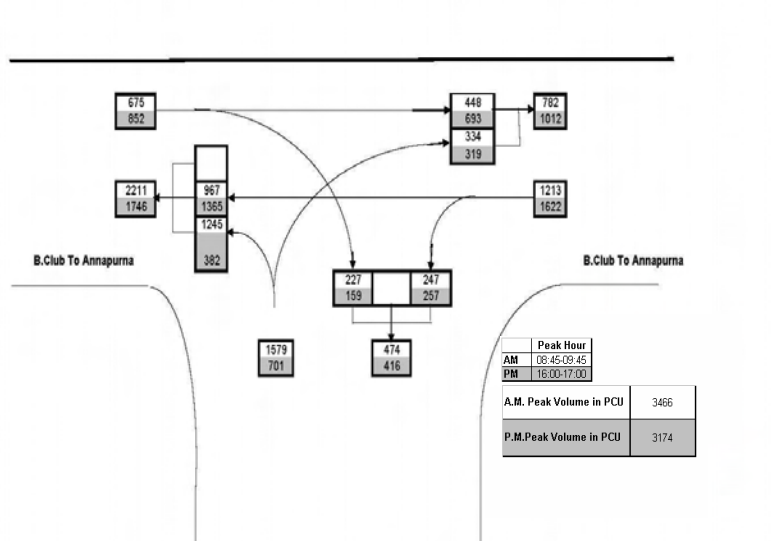


Fig A13 Peak Hour Traffic Flow – Model School Junction

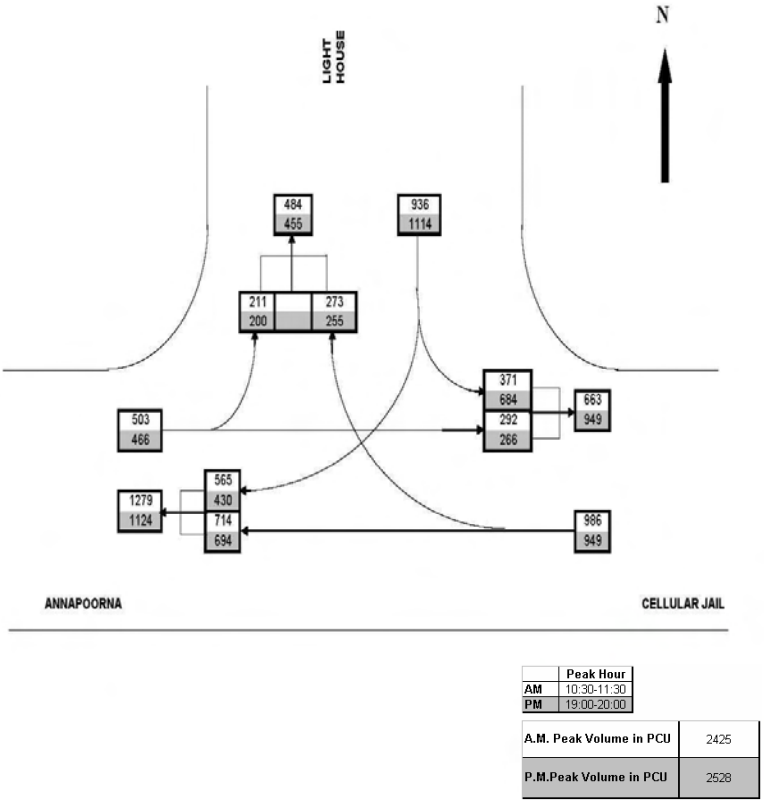


Fig A14 Peak Hour Traffic Flow – Clock Tower Junction

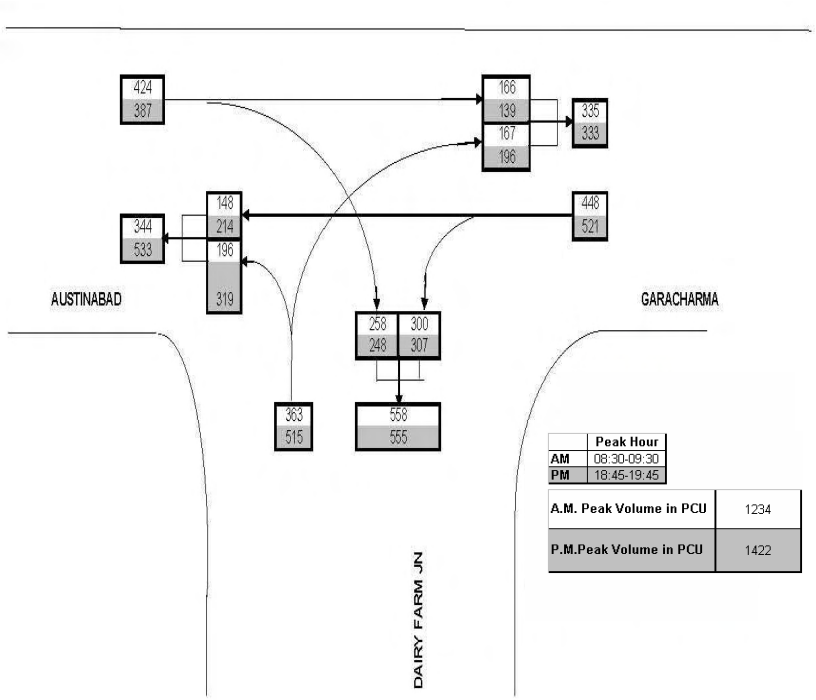


Fig A15 Peak Hour Traffic Flow – Bathubasthi Junction

Annexure B
Parking Studies

Aberbeen to Cellular Jail

Table B1 Parking Accumulation – Aberdeen to Cellular Jail

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Truck	Total
8-9	12	1	9	17	7	46
9-10	3	3	19	22	5	52
10-11	5	2	15	7	11	40
11-12	3	7	14	26	9	59
12-13	4	7	13	27	6	57
13-14	5	6	12	21	8	53
TOTAL	**32**	**26**	**82**	**120**	**46**	**307**

Table B 2 Parking Duration Aberdeen to Cellular Jail

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Trucks
15 Min	22	12	62	83	17
30 Min	5	5	10	15	4
45 min	0	0	0	3	1
1 Hour	0	1	0	0	3
1h 15 min	0	0	0	0	0
1h 30 min	0	0	0	0	2
Total	**27**	**18**	**72**	**101**	**27**

Bangla School to Hyat Singh

Table B 3 Parking Accumulation- Bangla School To Hyat Singh

Time	Auto Rickshaw	Bus	Car/Van/JEEP	Two Wheeler	Truck	Total
8-9	0	0	6	25	2	33
9-10	2	1	26	40	0	69
10-11	3	3	25	36	2	69
11-12	3	1	15	25	1	45
12-13	4	1	19	30	5	59
13-14	2	0	16	26	4	48
14-15	1	1	16	25	1	44
15-16	2	0	10	29	1	42
16-17	2	1	12	20	1	36
17-18	3	0	7	23	1	34
18-19	1	0	5	18	0	25
19-20	2	0	7	14	0	23
Total	**25**	**8**	**164**	**311**	**18**	**527**

Table B 4 Parking Duration Bangla School To Hyat Singh

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Trucks
15 Min	20	8	112	233	14
30 Min	1	0	7	23	3
45 min	1	0	1	6	0
1 Hour	0	0	0	1	0
1h 15 min	0	0	0	3	0
1h 30 min	0	0	0	0	0
Total	22	8	123	266	17

Bengali Club to Model School

Table B 5 Parking Accumulation Bengali Club to Model School

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Truck	Total
8-9	12	4	10	37	1	**64**
9-10	18	1	21	24	0	**64**
10-11	9	0	8	31	0	**48**
11-12	3	0	8	15	0	**26**
12-13	9	0	16	17	0	**42**
13-14	3	0	9	14	0	**26**
14-15	6	0	15	20	1	**43**
15-16	1	0	9	19	0	**29**
16-17	4	0	14	22	0	**40**
17-18	8	0	15	14	0	**37**
18-19	6	0	8	14	1	**29**
19-20	5	0	4	8	0	**17**
Total	**84**	**5**	**137**	**235**	**3**	**465**

Table B 6 Parking Duration Bengali Club to Model School

Time	Autorickshaw	Bus	Car/Van/Jeep	Two Wheeler	Trucks
15 MIN	68	4	119	205	3
30 MIN	8	0	9	13	0
45MIN	0	0	0	2	0
1 HOUR	0	0	0	0	0
1H15MIN	0	0	0	0	0
1H30MIN	**0**	**0**	**0**	**0**	**0**
TOTAL	**76**	**4**	**128**	**221**	**3**

Bengali Club to Goalghar

Table B 7 Parking Accumulation- Bengali club To Goalghar

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	TRUCK	Total
8-9	6	12	23	18	5	64
9-10	15	5	22	16	6	64
10-11	21	2	19	20	2	64
11-12	15	0	22	26	1	64
12-13	16	0	15	25	1	57
13-14	14	0	25	25	0	64
14-15	13	0	13	20	1	47
15-16	18	0	17	11	0	46
16-17	9	0	23	22	0	54
17-18	18	1	20	19	0	58
18-19	23	1	16	18	0	58
19-20	40	1	32	33	0	106
Total	**208**	**5**	**137**	**235**	**3**	**465**

Table B 8 Parking Duration– Bengali Club to Goalghar

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	TRUCKS
15 MIN	170	21	209	213	16
30 MIN	8	0	8	8	0
45MIN	1	0	2	2	0
1 HOUR	0	0	0	0	0
1H15MIN	1	0	0	0	0
1H30MIN	0	0	0	0	0
TOTAL	**171**	**21**	**219**	**223**	**16**

Clock Tower to Aberdeen Jetty

Table B 9 Parking Accumulation – Clock Tower to Aberbeen Jetty

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	TRUCK	GOODS VAN	Total
8-9	10	0	14	16	2	0	**42**
9-10	10	4	18	25	0	0	**57**
10-11	10	5	21	23	4	1	**64**
11-12	10	5	21	21	7	0	**64**
12-13	16	0	30	14	3	1	**64**
13-14	5	2	23	18	3	0	**51**
Total	**61**	**16**	**127**	**117**	**19**	**2**	**342**

Table B 10 Parking Duration – Clock Tower to Aberbeen Jetty

Time	AUTORICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	TRUCKS
15 MIN	50	10	111	93	19
30 MIN	5	4	8	12	0
45MIN	1	0	0	0	0
1 HOUR	0	0	0	0	0
1H15MIN	0	0	0	0	0
1H30MIN	0	0	0	0	0
TOTAL	**54**	**14**	**119**	**106**	**19**

Clock Tower to Cellular Jail

Table B 11 Parking Accumulation – Clock Tower to Cellular Jail

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	Total
8-9	0	0	0	0	**0**
9-10	14	0	8	19	**41**
10-11	1	0	16	34	**51**
11-12	1	0	20	38	**59**
12-13	1	0	4	53	**58**
13-14	1	0	12	52	**66**
Total	**18**	**0**	**60**	**196**	**275**

Table B 12 Parking Duration – Clock Tower to Cellular Jail

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER
15 MIN	18	0	54	170
30 MIN	0	0	3	13
45MIN	0	0	0	0
1 HOUR	0	0	0	0
1H15MIN	0	0	0	0
1H30MIN	0	0	0	0
TOTAL	**18**	**0**	**57**	**183**

Delanipur to Light House

Table B 13 Parking Accumulation – Delanipur to Light House

Time	Auto Rickshaw	Bus	Car/Van/JEEP	Two Wheeler	Truck	Goods Van	Total
8-9	18	1	0	7	15	7	**48**
9-10	16	2	20	11	14	1	**64**
10-11	16	0	30	15	3	0	**64**
11-12	7	1	28	28	0	0	**64**
12-13	12	0	26	19	7	0	**64**
13-14	24	1	24	11	4	0	**64**
Total	**93**	**5**	**128**	**91**	**43**	**8**	**368**

Table B 14 Parking Duration– Delanipur to Light House

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	TRUCKS
15 MIN	88	5	108	83	8
30 MIN	3	0	7	4	0
45MIN	1	0	2	0	0
1 HOUR	0	0	0	0	0
1H15MIN	0	0	0	0	0
1H30MIN	0	0	0	0	0
TOTAL	**88**	**5**	**117**	**87**	**8**

Delanipur to Lilipur

Table B 15 Parking Accumulation –Delanipur to Lillipur

TIME	Auto Rickshaw	Bus	Car/Van/JEEP	Two Wheeler	Truck	Total
8-9	16	0	19	22	3	**60**
9-10	0	1	8	13	2	**24**
10-11	21	0	11	4	1	**37**
11-12	5	2	8	10	4	**29**
12-13	8	9	11	12	1	**41**
13-14	12	14	9	11	2	**48**
14-15	16	8	14	15	4	**57**
15-16	9	8	15	7	5	**44**
16-17	6	5	17	7	1	**36**
17-18	5	7	11	12	4	**39**
18-19	12	5	8	7	3	**35**
19-20	6	3	9	7	2	**27**
Total	**116**	**62**	**140**	**127**	**32**	**477**

Table B 16 Parking Duration – Delanipur to Lilipur

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Trucks
15 MIN	103	18	111	111	17
30 MIN	8	7	11	8	2
45MIN	1	1	1	0	0
1 HOUR	0	5	1	0	0
1H15MIN	0	0	0	0	0
1H30MIN	0	0	0	0	0
TOTAL	**108**	**32**	**124**	**119**	**27**

Goalghar to Delanipur

Table B 17 Parking Accumulation – Goalghar to Delanipur

Time	Auto Rickshaw	Bus	Car/Van/JEEP	Two Wheeler	Truck	Total
8-9	2	6	15	16	9	48
9-10	16	8	16	16	7	63
10-11	15	0	0	0	0	15
11-12	15	5	16	16	2	54
12-13	16	3	7	16	12	54
13-14	16	6	17	16	5	60
14-15	10	3	15	16	2	46
15-16	16	2	13	16	3	50
16-17	9	3	6	16	1	35
17-18	13	3	8	16	2	42
18-19	17	4	16	14	4	55
19-20	10	3	14	14	3	44
Total	**155**	**46**	**143**	**172**	**50**	**566**

Table B 18 Parking Duration – Goalghar to Delanipur

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Trucks
15 MIN	124	41	109	134	48
30 MIN	8	1	12	6	1
45MIN	1	1	2	5	0
1 HOUR	2	0	1	0	0
1H15MIN	1	0	0	1	0
1H30MIN	0	0	0	1	0
TOTAL	**135**	**43**	**124**	**147**	**49**

Goalghar to Junglighat

Table B 19 Parking Accumulation – Goalghar to Junglighat

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Truck	Total
8-9	13	0	18	33	0	**64**
9-10	12	2	11	39	1	**65**
10-11	20	0	11	32	1	**64**
11-12	20	2	11	27	0	**60**
12-13	23	0	14	26	1	**64**
13-14	18	0	12	32	1	**63**
14-15	17	1	13	30	3	**64**
15-16	19	1	19	25	0	**64**
16-17	22	0	10	32	0	**64**
17-18	13	0	23	28	0	**64**
18-19	22	0	19	22	1	**64**
19-20	23	2	22	17	0	**64**
Total	**222**	**8**	**183**	**343**	**8**	**764**

Table B 20 Parking Duration – Goalghar to Junglighat

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	TRUCKS
15 MIN	177	8	165	305	8
30 MIN	21	0	9	19	0
45MIN	2	0	0	0	0
1 HOUR	2	0	0	0	0
1H15MIN	0	0	0	0	0
1H30MIN	0	0	0	0	0
TOTAL	**193**	**8**	**174**	**324**	**8**

Hyat Singh to Junglighat

Table B 21 Parking Accumulation – Hayat Singh to Junglighat

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Truck	Goods Van	Total
8-9	3	0	7	13	9	0	**32**
9-10	4	1	3	13	9	2	**32**
10-11	2	1	8	21	0	0	**32**
11-12	14	2	8	7	1	0	**32**
12-13	4	0	6	49	3	2	**64**
13-14	3	4	17	35	5	0	**64**
14-15	12	4	16	14	2	0	**48**
15-16	15	2	11	24	12	0	**64**
16-17	4	0	27	32	0	1	**64**
17-18	6	0	7	49	0	2	**64**
18-19	0	0	11	35	17	1	**64**
19-20	2	0	12	34	3	1	**52**
Total	**69**	**14**	**133**	**326**	**61**	**9**	**612**

Table B 22 Parking Duration – Hyat Singh to Junglighat

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Trucks	Goods Van
15 MIN	58	6	101	215	11	3
30 MIN	7	1	11	41	11	3
45MIN	1	3	2	7	5	
1 HOUR	0	0	1	2	2	
1H15MIN	0	0	0	0	1	
1H30MIN	0	0	0	0	0	
TOTAL	**60**	**10**	**115**	**265**	**30**	**6**

Junglighat to Hyat Singh

Table B 23 Parking Accumulation –Junglighat to Hyat Singh-

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Truck	Goods Van	Total
8-9	3	1	5	18	8	0	**35**
9-10	0	0	0	8	9	1	**18**
10-11	21	3	22	107	12	2	**167**
11-12	31	4	28	69	13	1	**146**
12-13	9	1	27	34	1	1	**73**
13-14	8	2	19	70	1	9	**109**
14-15	17	1	7	29	9	1	**64**
15-16	3	0	12	49	0	0	**64**
16-17	4	0	19	39	0	2	**64**
17-18	6	2	7	35	11	3	**64**
18-19	2	0	16	46	0	0	**64**
19-20	4	0	11	23	4	2	**44**
Total	**108**	**14**	**173**	**527**	**68**	**22**	**912**

Table B 24 Parking Duration –Junglighat to Hyat Singh

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Trucks	Goods Van
15 MIN	86	10	120	335	19	15
30 MIN	12	0	14	65	7	15
45MIN	1	0	8	20	8	1
1 HOUR	3	2	1	7	0	0
1H15MIN	0	0	0	0	1	0
1H30MIN	0	0	0	1	1	0
TOTAL	**91**	**12**	**143**	**428**	**36**	**18**

Light house to Clock Tower

Table B 25 Parking Accumulation –Light House to Clock tower

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	TRUCK	GOODS VAN	Total
8-9	14	0	10	15	0	0	**39**
9-10	10	0	3	9	0	0	**22**
10-11	11	0	48	96	6	6	**167**
11-12	5	0	27	68	2	3	**105**
12-13	4	0	14	24	3	0	**45**
13-14	7	0	0	0	0	0	**7**
Total	**51**	**0**	**102**	**212**	**11**	**9**	**385**

Table B 26 Parking Duration – Light House to Clock tower

Time	Auto Rickshaw	Car/Van/Jeep	Two Wheeler	Trucks	Goods Van
15 MIN	35	66	128	8	6
30 MIN	6	11	21	0	6
45MIN	2	1	5	1	1
1 HOUR	0	0	4	0	0
1H15MIN	0	1	0	0	0
1H30MIN	0	0	1	0	0
TOTAL	**43**	**80**	**160**	**9**	**7**

Lilipur to Haddo

Table B 27 Parking Accumulation –Lilipur to Haddo

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Truck	Goods Van	Total
8-9	3	3	13	40	1	0	**60**
9-10	2	2	3	20	0	0	**27**
10-11	2	0	14	35	1	0	**52**
11-12	9	1	8	34	1	0	**53**
12-13	12	13	11	2	6	0	**44**
13-14	19	4	8	10	2	0	**43**
14-15	12	13	11	2	6	0	**44**
15-16	10	10	14	8	2	1	**45**
16-17	13	8	5	7	9	0	**42**
17-18	7	2	5	21	2	0	**37**
18-19	9	2	5	19	0	0	**35**
19-20	6	1	7	10	0	1	**25**
Total	**104**	**59**	**104**	**208**	**30**	**2**	**507**

Table B 28 Parking Duration – Lilipur to Haddo

Time	AUTO RICKSHAW	BUS	CAR/VAN/JEEP	TWO WHEELER	TRUCKS	GOODS VAN
15 MIN	91	20	85	149	25	3
30 MIN	7	8	7	24	2	3
45MIN	3	4	1	4	0	0
1 HOUR	0	1	1	1	0	0
1H15MIN	0	0	0	0	0	0
1H30MIN	0	0	0	0	0	0
TOTAL	**94**	**34**	**94**	**178**	**27**	**3**

Model school to Netaji Stadium

Table B 29 Parking Accumulation –Model School to Nethaji Stadium

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Truck	Total
8-9	3	0	30	28	3	**64**
9-10	2	0	11	40	0	**53**
10-11	0	0	5	53	4	**62**
11-12	11	3	10	16	3	**43**
12-13	8	0	29	11	7	**55**
13-14	13	0	23	21	6	**63**
Total	**37**	**3**	**108**	**169**	**23**	**340**

Table B 30 Parking Duration –Model School to Nethaji Stadium

Time	Auto Rickshaw	Bus	Car/Van/Jeep	Two Wheeler	Trucks
15 MIN	35	3	84	143	23
30 MIN	2	0	13	14	1
45MIN	0	0	0	0	0
1 HOUR	0	0	0	0	0
1H15MIN	0	0	0	0	0
1H30MIN	0	0	0	0	0
TOTAL	**37**	**3**	**97**	**157**	**24**

Annapoorna to Clock Tower

Table B 31 Parking Accumulation –Annapoorna to Clock tower

Time	Auto Rickshaw	Car/Van/Jeep	Two Wheeler	Truck	Goods Van	Total
8-00-9.00	0	0	0	0	0	0
9.00-10.00	10	23	26	3	2	64
10.00-11.00	2	26	36	0	0	64
11.00-12.00	0	23	41	0	0	64
12.00-13.00	0	9	55	0	0	64
13.00-14.00	1	15	44	4	0	64
Total	**13**	**96**	**202**	**7**	**2**	**320**

Table B 32 Parking Duration – Annapoorna To Clock Tower

Time	Auto Rickshaw	Car/Van/Jeep	Two Wheeler	Trucks	Goods Van
15 MIN	9	26	107	5	2
30 MIN	2	9	17	2	0
45MIN	0	6	13	0	0
1 HOUR	0	1	4	0	0
1H15MIN	0	2	0	0	0
1H30MIN	0	0	1	0	0
TOTAL	**11**	**49**	**142**	**7**	**2**

ANNEXURE C
SIGNAL DESIGN

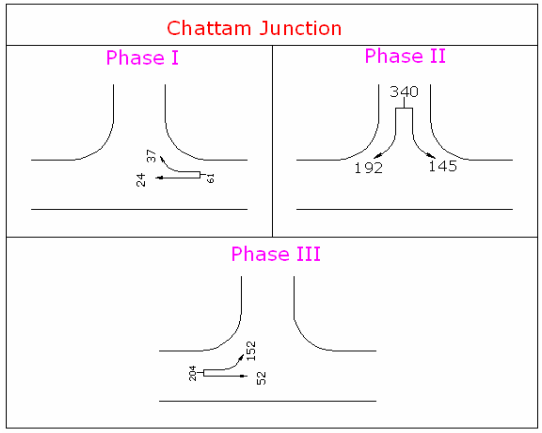


Fig C1: Phasing Diagram for Chattam Junction

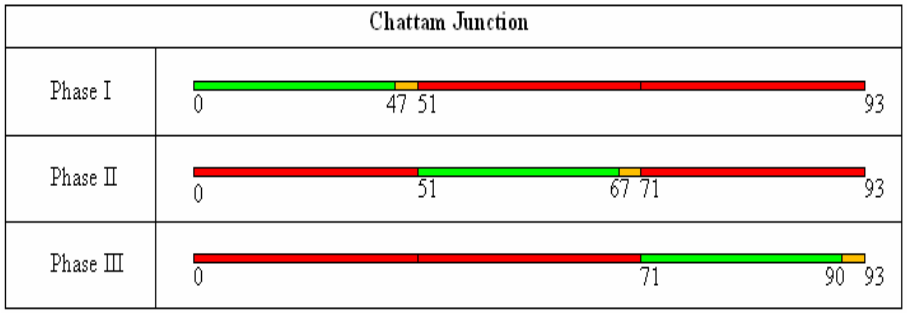


Fig C2: Timing Diagram for Chatham Junction

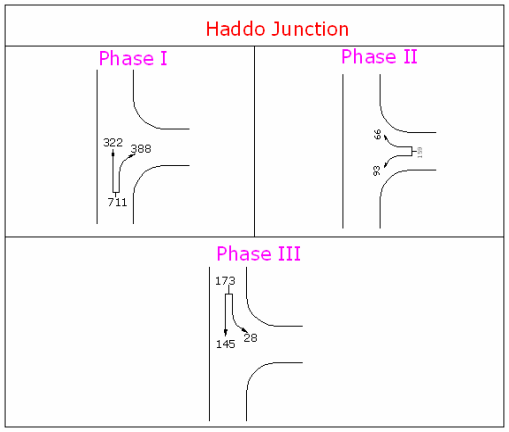


Fig C3: Phasing Diagram for Haddo Junction

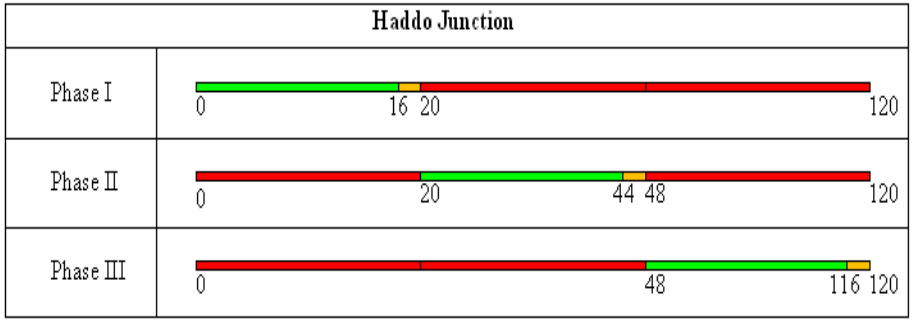


Fig C4: Timing Diagram for Haddo Junction

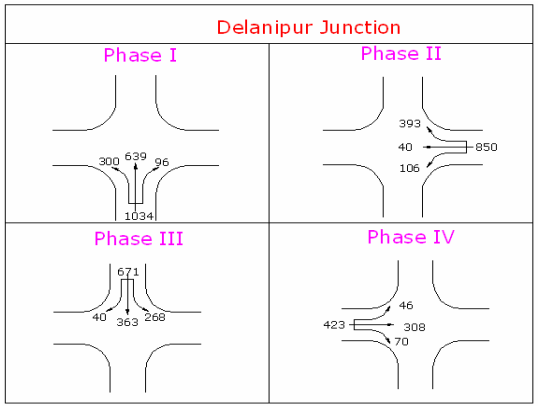


Fig C5: Phasing Diagram for Delanipur Junction

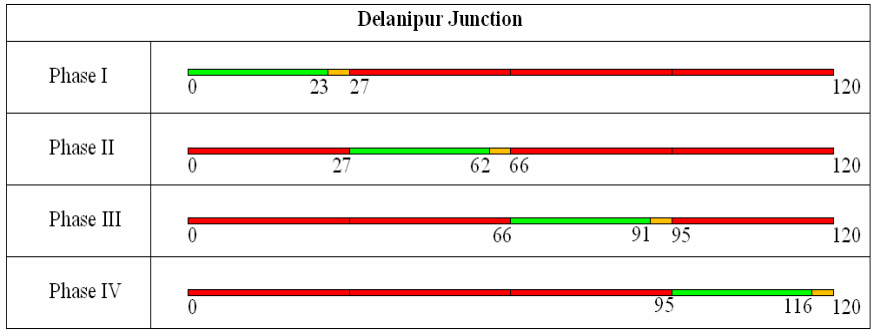


Fig C6: Timing Diagram for Delanipur Junction

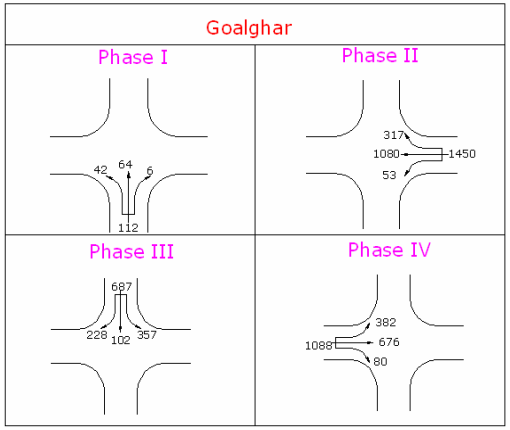


Fig C7: Phasing Diagram for Goalghar Junction

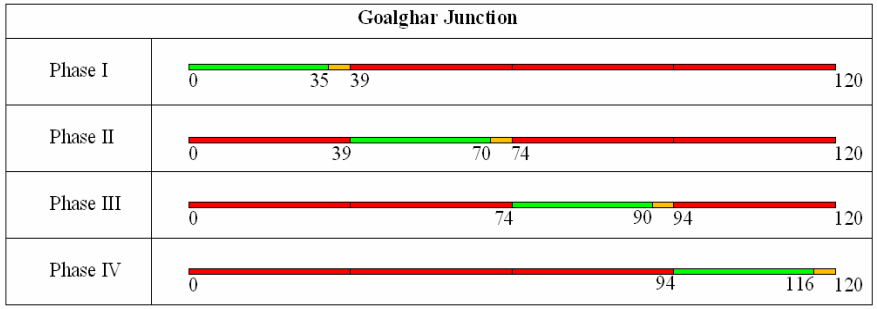


Fig C8: Timing Diagram for Goalghar Junction

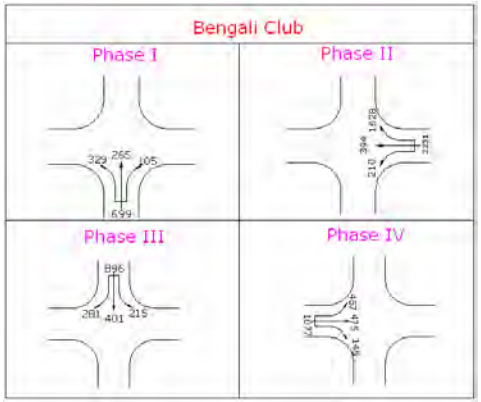


Fig C9: Phasing Diagram for Bengali Club Junction

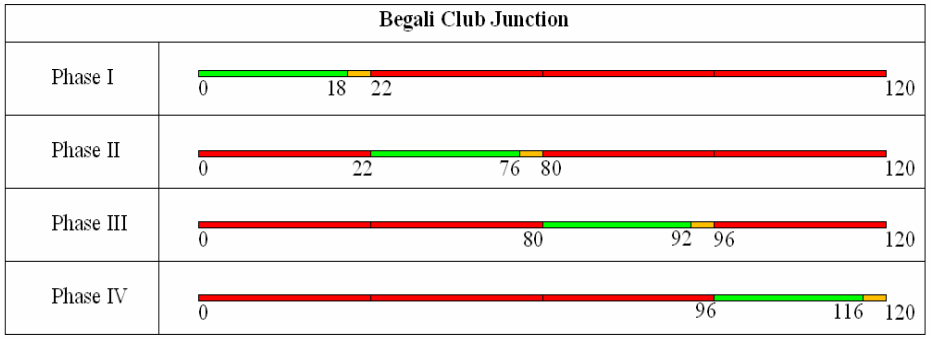


Fig C10: Timing Diagram for Bengali Club Junction

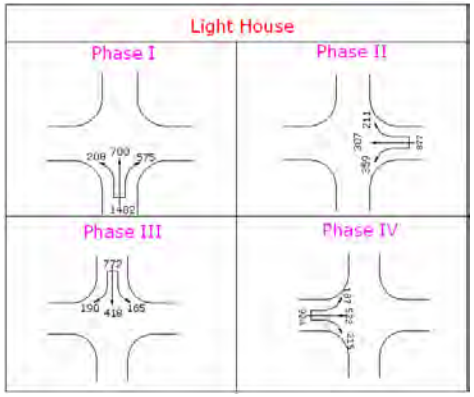


Fig C11: Phasing Diagram for Light House Junction

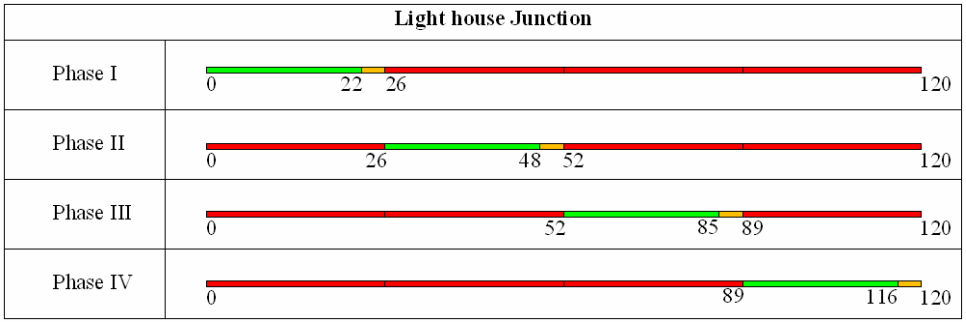


Fig C12: Timing Diagram for Light House Junction

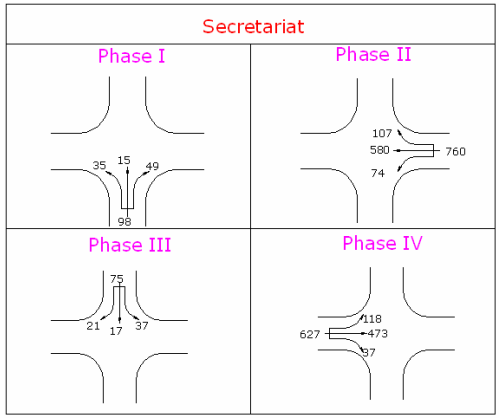


Fig C13: Phasing Diagram for Secretariat Junction

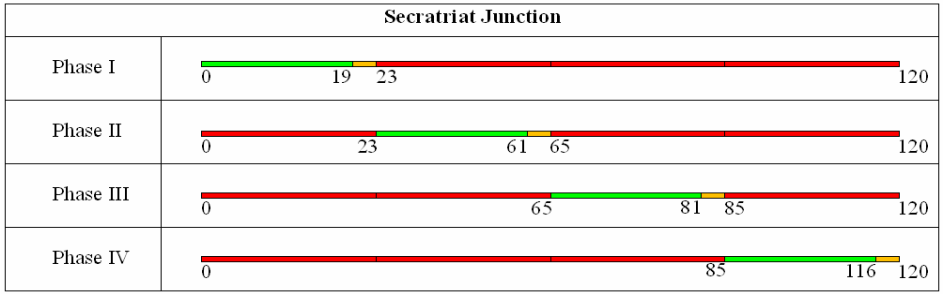


Fig C14: Timing Diagram for Secretariat Junction

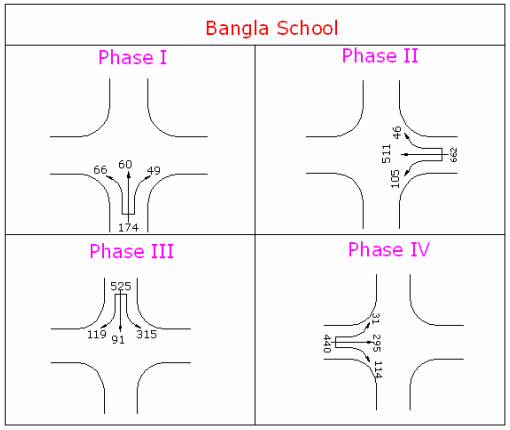


Fig C15: Phasing Diagram for Bangla School Junction

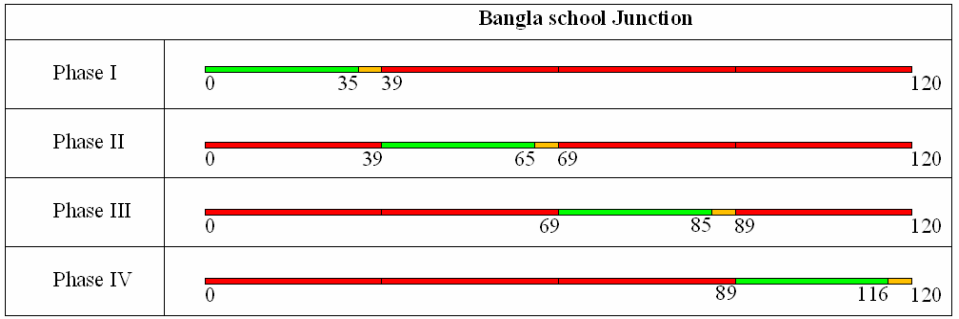


Fig C16: Timing Diagram for Bangla School Junction

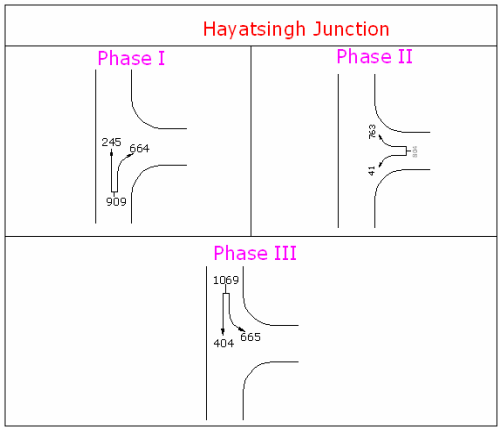


Fig C17: Phasing Diagram for Hyat Singh Junction

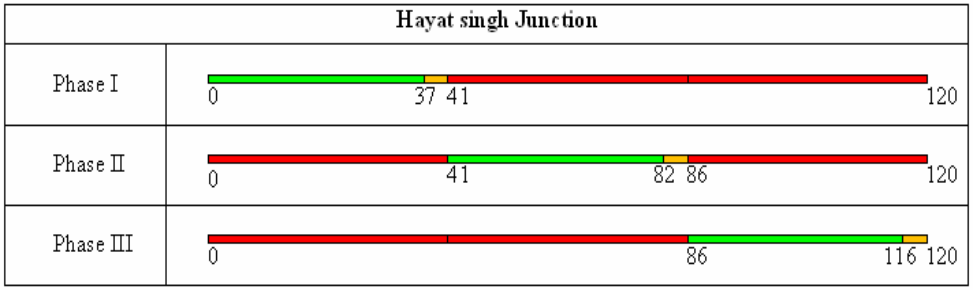


Fig C18: Timing Diagram for Hyat Singh Junction

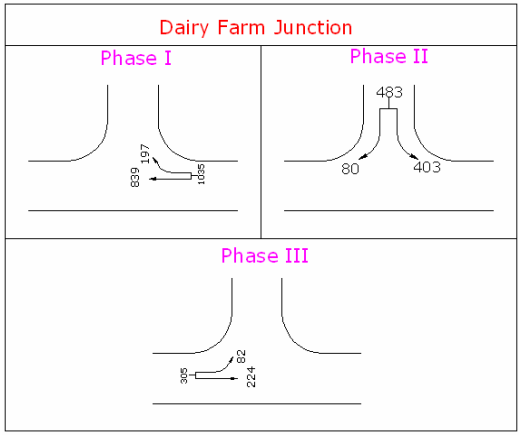


Fig C19: Phasing Diagram for Diary Farm Junction

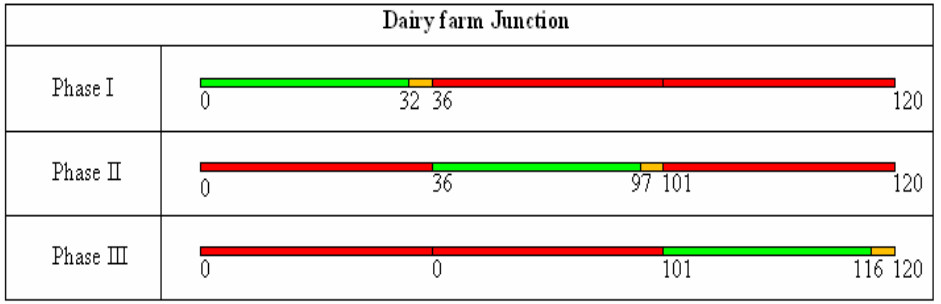


Fig C20: Timing Diagram for Diary Farm Junction

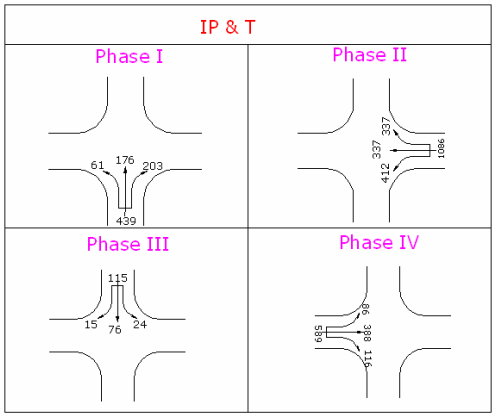


Fig C21: Phasing Diagram for IP&T Junction

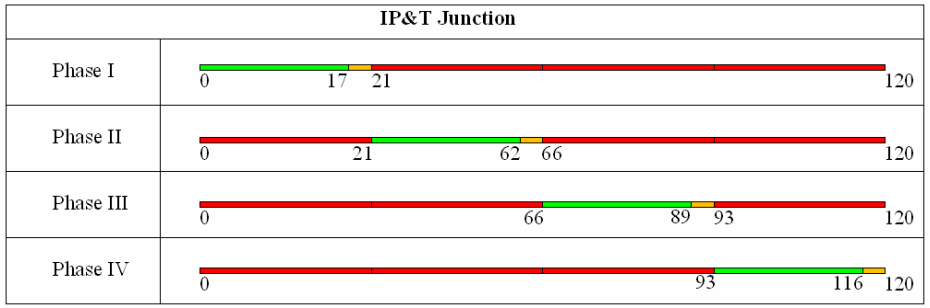


Fig C22: Timing Diagram for IP&T Junction

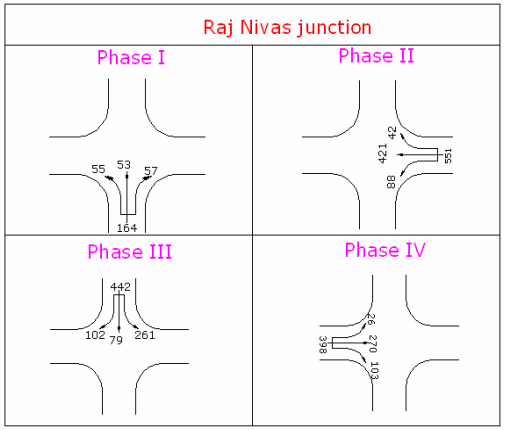


Fig C23: Phasing Diagram for Raja Nivas Junction

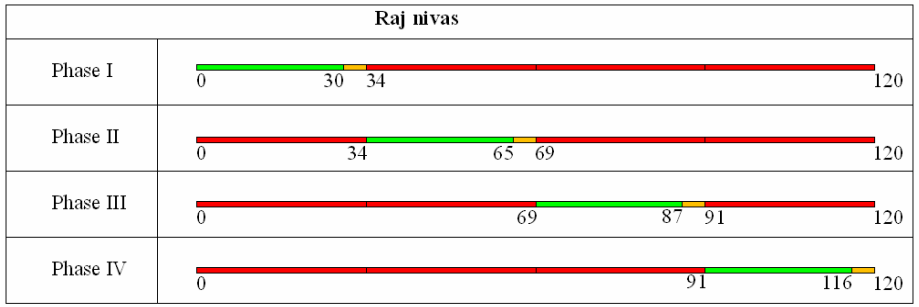


Fig C24: Timing Diagram for Raja Nivas Junction

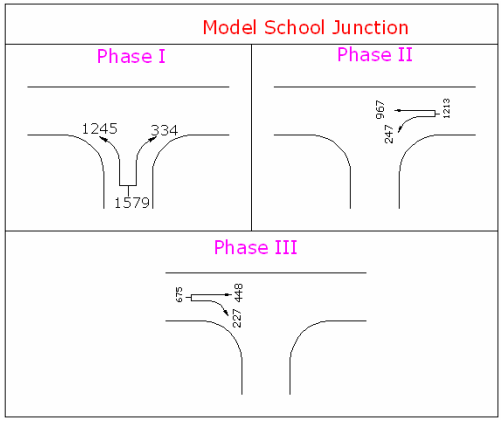


Fig C25: Phasing Diagram for Model School Junction

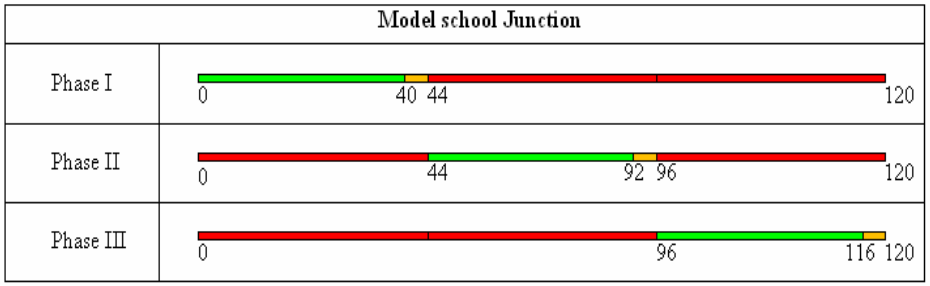


Fig C26: Timing Diagram for Model School Junction

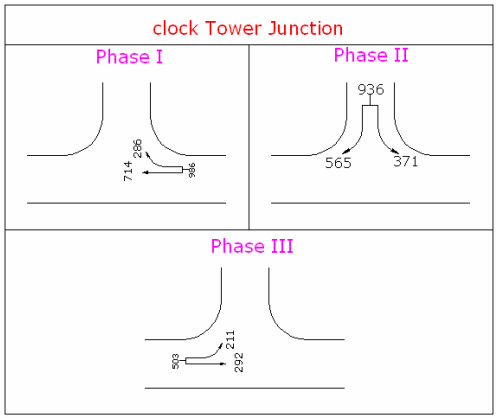


Fig C27: Phasing Diagram for Clock Tower Junction

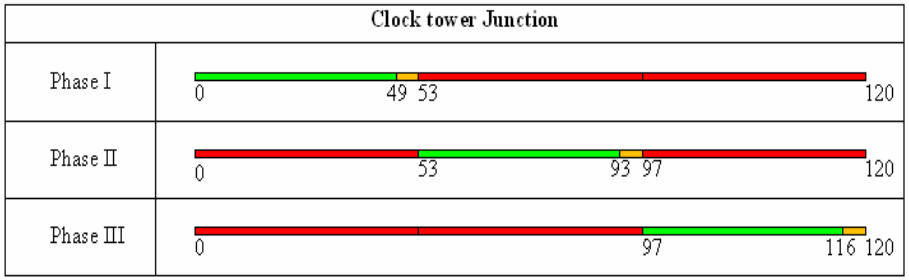


Fig C28: Timing Diagram for Clock Tower Junction

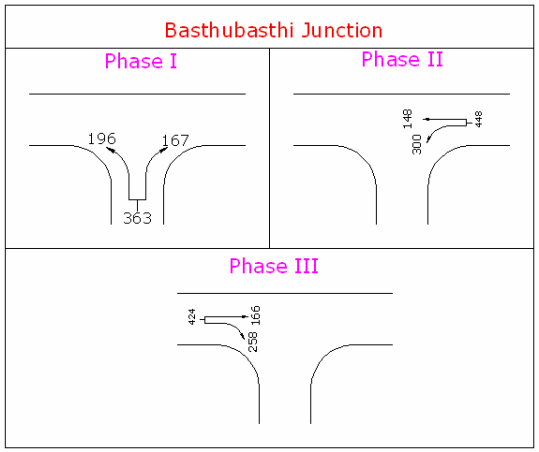


Fig C29: Phasing Diagram for Bathubasthi Junction

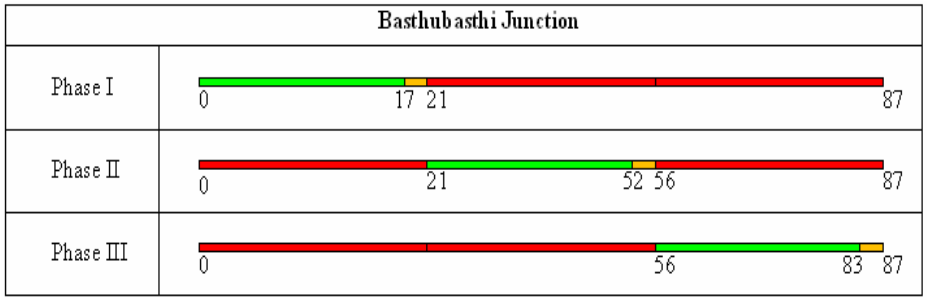
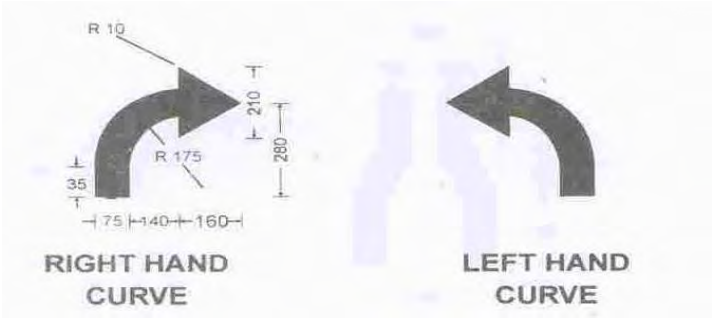


Fig C30: Timing Diagram for Bathubasthi Junction

Annexure D
Traffic Signs Suggested for Installation

Fig D 1 Traffic Signs for Movement Regulations

Fig D 2 Traffic Signs indicating suitable Driver Actions



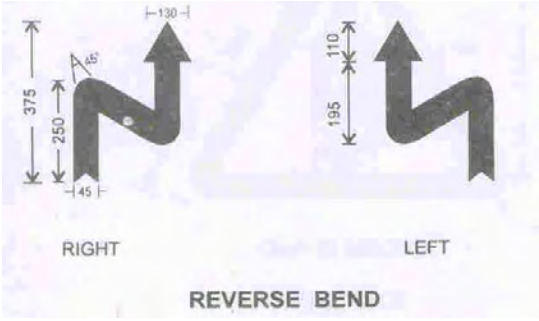


Fig D 3 Traffic Signs indicating Curves

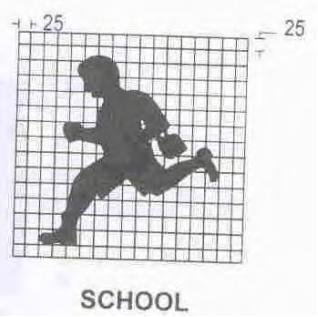
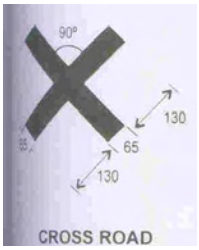
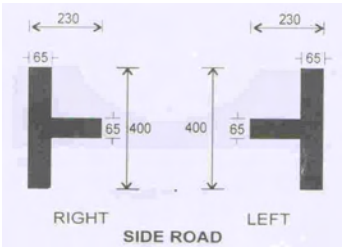
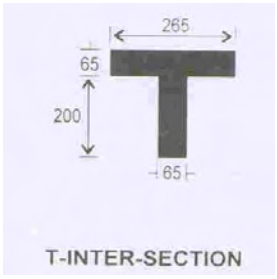
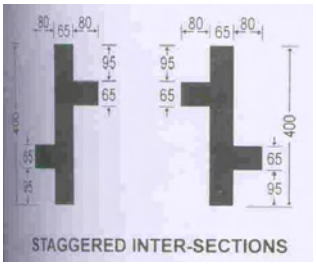


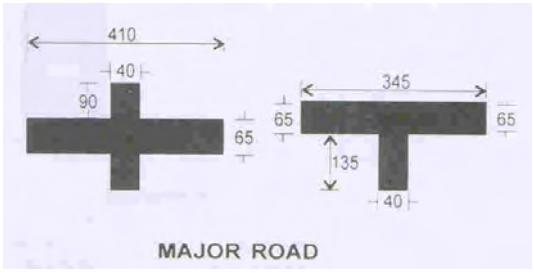
Fig D 4 Traffic Signs at School Zones and at Pedestrian Crossings











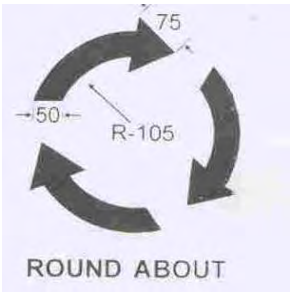


Fig D 5 Traffic Signs indicating Junction Type ahead

Fig D6 Typical Information Sign

PREFACE

Port Blair is the capital of Andaman and Nicobar, having an area of 17.74sq.km. The population of Port Blair was 99,984 in 2001 and it said to be 1, 25,000 as on today. The topography of Port Blair is characterized by undulating terrain. Port Blair Town, being a centre of activity is surrounded by sea on three sides and experiences a linear development towards south. The Port Blair Port receives goods from mainland for consumption for itself and for onward distribution to other parts of the territory. Being administrative centre for both civil and defence functions, it is found that 60% of the employment is in the Government sector. There is an estimated 40,000 vehicles operating in the town. Though the number of vehicles perse is small, lack of adequate road network, geometrics, good riding surface, footpaths, signage, and several missing links, the town faces traffic congestion particularly during peak hours. The main public transport is buses supplemented by intermediate public transport and the rest are private vehicles. There are number of Goods Vehicles plying in the town to distribute the goods. Before the Port Town faces serious increase in number vehicles, APWD found it fit to institute the Comprehensive Traffic and Transportation Study for Port Blair to cover a future period of 20 years so that adequate transportation infrastructural facilities are created in time. The APWD has entrusted the responsibility of preparing the Comprehensive Traffic and Transportation Plan to the Division of Transportation Engineering, Anna University. Detailed study on the travel characteristics of the local population, land use disposition, road network configuration and transport systems was carried out and traffic control measures, network augmentation and regulatory measures are suggested. This final report contains the study details and the proposals.

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