CHAPTER 1
INTRODUCTION

Background

Bangalore, the Capital of Karnataka is the Fifth Largest City in the Country and is growing at a rate, which is significantly higher than that of others. Due to the Growth in Economic Activities, the City is attracting migrants. To serve this Influx of Population, Residential Layouts are being developed. But adequate Transport Infrastructure Facilities such as Roads, Grade Separators, Subways, Mass Transit System, etc. to match this demand are conspicuously absent. The additional demand is to be catered by the already Saturated Road Network. Due to the Inherent Road Network in Bangalore, there are on the average 2 Major and 2 Minor Junctions per kilometer of Road Length. This has resulted in increase in Travel Time due to frequent Bottlenecks and Breakdowns.

1.1.2 The Urban Form of Bangalore is characterized by a Radio – Concentric System structured by Ring Roads, Five Major Radial Roads and Five Secondary Radial Roads. The Five Major Radial Roads are Mysore Road (SH – 17) in the South / South West, Old Madras Road (NH – 4) in the North / North East, Bellary Road in the North, Hosur Road (NH – 7) in the South – East and Tumkur Road in the North – West. Similarly, the Five Secondary Radial Roads include Magadi Road (SH – 17E) in the West, Kanakapura Road (NH – 209) in the South, Bannerghatta Road (SH – 48) in the South, Varthur Road and Whitefield Road (SH – 37) in the East. The differentiated development of the City based on Geographical Sectors and the Star like Growth Array along the Major Roads, mark the change from a Concentric Spatial Growth to a Sectorial and Linear Radial Development.

1.1.3 The City had a population of 24.75 Lakh in 1981 and 65.00 Lakh in 2001. The extent of Developed Area has also increased considerably, in 1971 the Area was 174.7 Sq. km. and today it is about 800 Sq. km. In absence of Adequate Mass Transportation System, the use of personal motor vehicles for intra – city travel has increased substantially. This has resulted in growth of motor vehicles, which is four times the rate of population growth in the last two decades (1.91 Lakh vehicles in 1981 and 23 Lakh vehicles in 2005). The Public Transport System (Bus) is overstressed carrying about 50 Lakh Commuters in a daily basis. Congested Streets and Longer Route Length due to Urban Sprawl have only served to reduce Bus Frequencies further. In a recent study done by CRRI, it has been reported that annual traffic growth rates vary in the range of 2 – 4% in the central zone, 5 – 7% in the intermediate zone and 8 – 9% on the regional roads in Bangalore City. CRRI study also reported delays of 26.8 sec per km of travel and 9.9 seconds per minute of travel.

1.1.4 The combined effect of all these on the Road Network of Bangalore is Delay and Congestion beyond Tolerable Limits. Vehicular Conflicts at the Intersections are being eliminated by Traffic Signals but at the Expense of Delays and Long Queues. The Peak Hour has spread over a longer period of time, since there are no Perceptible Capacity Augmentation / Conflict Reduction Measures. Traffic related Problems have become Regular Phenomena on Bangalore Roads, due to the Vast Developments. This fact is substantiated by the Traffic Study Results at various Road Networks and Intersections of the City. Most of the Major Junctions of the Core City have crossed the mark of 10000

PCUs in the Peak Hour. Though number of Grade Separators have been constructed and are being constructed, most of them are located in the Developed Part of the City and causing a Trigger of Congestion at adjacent Junctions. Traffic Management Measures such as One Way Systems, Parking Restrictions, Junctions Improvements, etc. are being implemented to ease the Congested Street Network. But the ever increasing Traffic is fast deteriorating the Limited Improvement in Level of Service these Traffic Management Measures can offer.

1.1.5 As a Comprehensive Development Programme for Improvement of Road Network, the Bruhat Bangalore Mahanagara Palike (BBMP) has planned Grade Separated Junction, Widening of Roads, Strengthening of Pavement Base and Sub – Base, Improvement to Pedestrian Facilities, Provision for Car Parking, etc. BBMP has constituted a separate cell to coordinate the Widening of Major Roads in Bangalore City in the face of Land Acquisition Challenges. This Response is the Answer to the severe strain on the Urban Infrastructure, which is inevitable due to the very rapid rate of growth in traffic. Travel Demands of Passengers have increased many folds in the last two decades. Unfortunately, Growth in the Infrastructure is not commensurate with the growing demands of traffic. There is an exigent need to effectively manage the Traffic and Transportation Systems to optimize the Solutions with Short Term and Long Term Measures.

1.1.6 One of the Practical Steps towards Optimal Solutions that will also give an Immediate Relief to Traffic Scenario is Capacity Augmentation. Capacity Augmentation is not possible without widening the high – density corridors. Increasing the capacity of important corridors is inescapable in the long run even if it entails Land Acquisition at high cost. The Land Acquisition is proposed through a Process of Conferring Development Rights (Transfer of Development Rights), by which the owner of the land who has surrendered the part of the land towards infrastructure projects would be allowed to carry out construction based on enhanced Floor Space Index (FSI) conferred by the TDRs.

1.1.7 The existing Road Network System of Bangalore is a major concern, both in terms of Conditions of Roads and the Structure of the Network. The Basic Structure is Radio – Concentric with about Ten Major Roads converging on the Centre. The Roads themselves are crowded and their Convergence creates Heavy Congestion. In order to ease the Traffic related Problems, the Bangalore Development Authority (BDA) constructed the Outer Ring Roads (ORR) connecting all Major Roads and Highways in and around Bangalore. The newly developed areas on the outer side of the Ring Road have caused much increase in Traffic across the Ring Road, which in turn is obstructing Flow of Traffic along the Ring Road and the ORR is currently heading towards a Saturated State of Flow, leading to Planning of New Road Infrastructure Development. With the introduction of Bruhat Bangalore Mahanagara Palike in January 2007, the City Development Area has increased considerably in the Outer Part of this Stretch of Ring Road and this in turn is increasing the Traffic Load in the Junctions.

1.1.8 The Project Corridor acts as a Radial Road in Western Part of Bangalore City and provides connectivity between Bangalore City and Magadi Town. The Corridor interfaces with Chord Road near Toll Gate, Outer Ring Road near Malegalu Main Road, NICE

Corridor near Hirohalli and beyond this it is SH – 17E and joins NH – 48 near Kunigal. The Study Area caters to considerable local and outside traffic heading towards Hassan, Chikmagalur, Mangalore throughout the day. This Corridor acts as an Alternative Stretch to NH – 4 to reach NH – 48. These being the Background, the Bruhat Bangalore Mahanagara Palike has proposed to construct Grade Separator at Major Junctions and to close Median at Minor Junctions with Appurtenant Link Improvements from Chord Road to Outer Ring Road (ORR) Junction along Magadi Road covering a total of 6 Junctions (out of which, 2 Junctions have been taken for improvement) for a total length of 3.5km in order to provide Uninterrupted, Seamless Traffic Flow and to increase Level of Service along the Corridor.

1.2 Existing Junctions along the Project Corridor

The following Junctions are present along the Project Corridor.
The following Junctions are present along the Project Corridor.

- Chord Road – Magadi Road Junction – Four Arm Junction.
- Veeresh Theatre Junction – Three Arm Junction.
- Jaimunirao Circle – Four Arm Junction.
- Raheja Park Apartment Junction – Three Arm Junction.
- Basaveshwara Nagar Road Junction – Three Arm Junction.
- Outer Ring Road Junction – Four Arm Junction.

1.3 Junctions proposed for Improvements

The following Junctions have been taken for the proposed Improvements.

- Jaimunirao Circle.
- Basaveshwara Nagar Road Junction.

Key Map of the Project Corridor proposed for Improvements is enclosed in **Annexure A.1.1**.

1.4 Contents of the Report

The Methodology, as detailed in the Project Proposal, has been followed for carrying out the necessary Investigations and Preparation of this Detailed Project Report.
This Report includes the following.

- Chapter 2: Objectives and Scope of Study
- Chapter 3: Study Corridor
- Chapter 4: Field Studies and Analysis
- Chapter 5: Planning and Design Considerations
- Chapter 6: Corridor Improvement Scheme
- Chapter 7: Design of Grade Separator
- Chapter 8: Traffic Management / Diversion and Traffic Engineering Schemes
- Chapter 9: Project Cost
- Chapter 10: Implementation Plan
- Chapter 11 Conclusion
- Chapter 12: Photographs
- Chapter 13: Drawings

CHAPTER 2
OBJECTIVES AND SCOPE OF STUDY

2.1 Objectives

The Project has been taken up to address the Traffic related Problems on the Project Corridor. The Study Area spans from Chord Road – Magadi Road Junction to Outer Ring Road Junction along Magadi Road. This Stretch has been selected primarily keeping in mind that this Corridor acts as a Radial Road in Western Part of Bangalore City and caters to considerable local and outside traffic heading towards Hassan, Chikmagalur, Mangalore throughout the day. This Corridor acts as an alternative stretch to NH – 4 to reach NH – 48.

The Primary Objectives of the Study are

- To effectively and optimally manage Traffic on the Corridor.
- To conduct necessary Surveys and Investigations to arrive at Alignment Alternatives for Traffic Improvement along the Corridor.
- To suggest Optimal and Feasible Grade Separation Schemes and Appurtenant Link Improvement Measures to reduce travel time.
- To improve the existing Junctions to streamline Traffic Flow at Grade Level.
- To improve the Environmental Conditions of the Corridor by reducing Idle Time.
- To reduce the Vehicle Operation Cost of the Road Users.
- To reduce Traffic Accidents.

To summarise, the Main Objective of the Study of this Corridor is to offer to the Road Users commuting through this Corridor Comprehensive Connectivity, Convenience, Comfort, Affordability, Safety and Aesthetics.

2.2 Project Scope

The Scope of the Study to be carried out by the Consultant involves the following.

- Review of Available Data and Reports.
- Topographical Survey of the Corridor.
- Necessary Traffic Survey to obtain Data and its Analysis for the Concept Proposal.
- Geotechnical Investigation.
- Work out Traffic Management / Diversion and Traffic Engineering Schemes during Project Execution.
- Work out Land Acquisition Details.
- Engineering Designs along with Detailed Estimate of the approved Concept.
- Project Scheduling.
- Preparation of Bid Documents to finalise Execution Agency.

2.3 Approach Methodology

The Activities that are involved in the Preparation of Detailed Project Report for Signal Free Corridor from Chord Road to Outer Ring Road Junction along Magadi Road are briefed below.

2.3.1 Stage 1

- To define the Objective and Scope of Work.
- To plan Approach and Methodology, Data Collection.
- Carry out Field Reconnaissance Survey that includes Site Appreciation, Identification of Survey Locations and Site Constraints.

2.3.2 Stage 2

- Data Collection
  - Engineering Surveys and Investigations
    1. Classified Turning Traffic Volume Survey.
    2. Vehicular Delay and Accumulation Survey.
    3. Occupancy Survey.
    4. Topographic Survey.
    5. Geotechnical Investigation.
  - Secondary Data
    1. Details of on going Road Improvements, Junction Improvements, Grade Separator Schemes, Footpath Improvement Schemes and Metro Rail Alignment along the Project Stretch.

- Analysis of Traffic Volume Count in deciding the Alignment of Grade Separation Scheme and other Corridor Improvement Schemes.
- Analysis of Surface Level Improvements based on the Traffic Data and Proposed Grade Separation Scheme.
- Analysis of Traffic Circulation at Surface Level on Proposed Scheme.
- Design suitable Traffic Improvement Measures to reduce Conflicting Traffic Stream.
- Preparation of Layout Drawings and Longitudinal Sections of all the Proposals conceptualized.
- Work out Land Acquisition Details, if any, for the Proposed Alternatives.
- Costing based on Block / Line Estimate.

2.3.3 Stage 3

- Engineering Designs, Drawings and Longitudinal Sections of the Approved Concept.
- Land Acquisition Details for the Approved Concept.
- Detailed Cost Estimate.
- Traffic Diversion and Management Scheme during project execution.

2.3.4 Stage 4

- Preparation of Tender and Contract Documents.

2.4 Design Philosophy

The Design Standards that will be adopted in the Design of Corridor Improvement Schemes shall be in accordance with the Codal Provisions of India as stipulated by the Indian Road Congress (IRC), Indian Standard Specifications (IS) and the Ministry of Road Transport & Highways (MoRT&H). Deviations may be considered in Planning Parameters, if absolutely necessary, considering the Dense Urban Conditions from the

present Codal Provisions. These Modifications in the Design shall be adopted based on Sound Engineering Practices.

The Detailed Designs and Drawings of the Approved Concept that will be presented as part of the Detailed Project Report shall be based on the Studies and Investigations carried out at Site, i.e. Traffic Data, Geotechnical Data, Soil Profile, etc.

CHAPTER 3
STUDY CORRIDOR

3.1 Study Corridor

The Study Corridor is located in the West Quadrant of Bangalore and connects Outer Ring Road in the West with Chord Road in the East. It runs from Chord Road – Magadi Road junction to Outer Ring Road Junction.

3.2 Salient Features of the Corridor

1. Total Length of the Corridor – 3.5 km.
2. Important Junctions along the Corridor
   - Chord Road – Magadi Road Junction – Four Arm Junction.
   - Veeresh Theatre Junction – Three Arm Junction ('Y' Shaped).
   - Jaimunirao Circle – Four Arm Junction.
   - Raheja Park Apartment Junction – Three Arm Junction ('Y' Shaped).
   - Basaveshwara Nagar Road Junction – Three Arm Junction ('T' Shaped).
   - Outer Ring Road Junction – Four Arm Junction.

   Key Map of the Study Corridor is enclosed in **Annexure A.1.1** and the Existing Views of the Junctions are enclosed in **Chapter 12 – Photographs**.

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3. Two Way Movements with at least four lane are seen throughout the Corridor. Some Stretches are wider with Road Divider. Footpath is present on either side throughout the Corridor.
4. The Study Area caters to considerable local and through amount of traffic destined towards Magadi, Hassan, Chikmagalur and Mangalore. Further, with the spurt in the economy, the Residential Areas in and around this Corridor, such as Vijay Nagar, K. H. B. Colony, Govindaraja Nagar, Kamakshipalya, Prashant Nagar Colony, Basaveshwara Nagar, have been encouraging conversion of Residential Area into partial Commercial Area at a very fast pace since 10 years. With this change in the Land Use Pattern, Traffic along this Corridor has been increased considerably in last 10 years time.
5. The Study Area is located in Thickly Developed Residential and Commercial Area Rajaji Nagar Industrial Town, Kamakshipalya Industrial Estate and is surrounded by some of the well know establishments like Veeresh Theatre, Raheja Park Apartment, Government Homeopathic College, Educational Institutes, Public Service Facilities like Telephone Exchange, Karnataka Electricity Board Office, Hospitals, etc.
6. This Corridor interfaces with Chord Road near Toll Gate, Outer Ring Road near Malegalu Main Road and NICE Corridor near Hirohalli.
7. The Local Public Transportation is primarily being met by the Bangalore Metropolitan Transport Corporation (BMTC), originating at Majestic Bus Stand and destined towards Kamakshipalya, Peenya, Laggere, Sunkadakatte, Gorugunte Palya.

3.3 Junction Details

3.3.1 Chord Road – Magadi Road Junction

3.3.1.1 Physical Details

This Junction is located about 3km away from the City Railway Station. This is a four – legged Intersection in which Chord Road (Road towards Yeshwanthapura – Road towards Mysore Road) forms North – South Axis and Magadi Road forms East – West Axis. The Junction is located in Thickly Developed Residential and Commercial Area.

Four lane divided bi directional Underpass is present along Chord Road. Bi directional Turning Traffic Movements are permitted over the Underpass.

3.3.2 Veeresh Theatre Junction

3.3.2.1 Physical Details

This Junction is located about 380m away from the Chord Road – Magadi Road Junction. This is a three – legged ('Y' Shaped) Intersection. The Details of the Arms forming this Intersection are as follows.

Magadi Road towards Jaimunirao Circle Side of the Intersection

This Part of the Road is divided bi directional with 1m wide Central Median. The Width of Carriageway varies between 16m and 18m near the Junction whereas the ROW of this Road varies between 25m and 30m. The Gradient is slopping towards the Junction. Well Developed Commercial and Residential Establishments; Rajaji Nagar Industrial Town on northern side are present along this stretch of Road.

Magadi Road towards Chord Road – Magadi Road Junction

This part of the Road is divided bi directional with 0.89m wide Central Median. The Width of Carriageway varies between 16m and 17m near the Junction whereas the ROW of this Road varies between 25m and 28m. The Gradient is slopping away from the Junction. This Stretch passes through Well Developed Residential and Commercial Establishments. The well known Veeresh Theatre is present on southern side, very near to Junction along this stretch of Road.

Road towards Manuvana (Vijay Nagar) Side of the Intersection

This part of the Road is undivided uni directional. The Carriageway Width is 12m near the Junction whereas the ROW of this Road varies between 12m and 19m. The Gradient is slopping away from the Junction. Either side of this Stretch is populated with thick Residential and Commercial Establishments.

3.3.3 Jaimunirao Circle

3.3.3.1 Physical Details

This Junction is located about 340m away from the Veeresh Theatre Junction. This is a typical four – legged Intersection. The Details of the Arms forming this Intersection are as follows.

Magadi Road towards Raheja Park Apartment Junction Side of the Intersection

This part of the Road is divided bi directional with 0.88m wide Central Median. The width of Carriageway varies between 18m and 19m near the Junction whereas the ROW

of this Road varies between 26m and 27m. The Gradient is slopping towards the Junction. Well Developed Commercial and Residential Establishments are present along this stretch of Road.

Magadi Road towards Veeresh Theatre Junction Side of the Intersection

This part of the Road is divided uni directional with 0.88m wide Central Median. The Carriageway Width is 17m near the Junction whereas ROW of this Road varies between 24m and 26m. The Gradient is slopping away from the Junction. Well Developed Commercial and Residential Establishments are present along this stretch of Road.

Road towards Agrahara Dasarahalli Side of the Intersection

This part of the Road is undivided uni directional. The Carriageway Width is 5.5m near the Junction whereas ROW of this Road varies between 8m and 9m. The Gradient is slopping away from the Junction. Either side of this Stretch is populated with Well Developed Residential and Commercial Establishments.

Road towards Vijay Nagar Side of the Intersection

This part of the Road is undivided uni directional. The Carriageway Width is 12m near the Junction whereas ROW of this Road is 19m. Either side of this Stretch is populated with Well Developed Residential and Commercial Establishments.

3.3.3.2 Site Constraints

Bus Stops near the Junction are creating Bottlenecks.

3.3.4 Raheja Park Apartment Junction

3.3.4.1 Physical Details

This Junction is located about 900m away from the Jaimunirao Circle. This is a three – legged ('Y' Shaped) Intersection. The Details of the Arms forming this Intersection are as follows.

Magadi Road towards Basaveshwara Nagar Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1m wide Central Median. The Width of Carriageway varies between 24m and 25m near the Junction whereas the ROW of this Road varies between 32m and 33m. The Gradient is slopping towards the Junction. Well Developed Commercial and Residential establishments are present along this stretch of Road.

Magadi Road towards Jaimunirao Circle Side of the Intersection

This part of the Road is divided bi directional with 0.8m wide Central Median. The Width of Carriageway varies between 21m and 25m near the Junction whereas the ROW of this Road varies between 27m and 30m. The Gradient is slopping away from the Junction. Well Developed Commercial and Residential Establishments are present along this stretch of Road.

Road towards Vijay Nagar Side of the Intersection

This part of the Road is undivided uni directional. The Width of Carriageway varies between 9m and 10m near the Junction whereas the ROW of this Road varies between 13m and 14m. The Gradient is slopping towards the Junction. Either side of this Stretch is populated with thick Residential and Commercial Establishments.

3.3.4.2 Site Constraints

Culvert is present very near to the Junction on the Arm towards Jaimunirao Circle.

3.3.5 Basaveshwara Nagar Road Junction

3.3.5.1 Physical Details

This Junction is located about 300m away from the Raheja Park Apartment Junction. This is a typical three – legged ('T' Shaped) Intersection. The Details of the Arms forming this Intersection are as follows.

Magadi Road towards Kamakshipalya Side of the Intersection

This part of the Road is divided bi directional with 1m wide Central Median. The Width of Carriageway varies between 30m and 31m near the Junction whereas the ROW of this Road varies between 38m and 39m. The Gradient is slopping towards the Junction. Well Developed Commercial and residential Establishments are present along this stretch of Road.

Magadi Road towards Raheja Park Apartment Junction Side of the Intersection

This part of the Road is divided bi directional with 1m wide Central Median. The Carriageway Width of this Stretch varies between 30m and 31m near the Junction whereas the ROW of this Road varies between 40m and 41m. The Gradient is slopping towards the Junction. Well Developed Commercial and Residential Establishments, Public Service Buildings are present along this stretch of Road.

Road towards Havanoor Circle Side of the Intersection

This part of the Road is divided bi directional with 0.4m wide Central Median. The Width of Carriageway varies between 14m and 15m near the Junction whereas the ROW of this Road is 24m. The Gradient is slopping towards the Junction. Either side of this Stretch is populated with thick Residential and Commercial Establishments.

3.3.5.2 Site Constraints

Transformers are present along Magadi Road very near to the Junction.

3.3.6 Outer Ring Road Junction

3.3.6.1 Physical Details

This Junction is located about 2.18km away from the Basaveshwara Nagar Road Junction. This is a four – legged Intersection in which Outer Ring Road forms North – South Axis and Magadi Road forms East – West Axis.

The Construction of six lane divided bi directional Flyover along Ring Road Axis is under Progress.

Topographical Maps of all the Six (6) Junctions are enclosed in Chapter 13 – Drawings.

Existing Vehicle Turning Movements at the Junctions are enclosed in Annexure A.3.1.

Existing Views of the Junctions are enclosed in Chapter 12 – Photographs.

3.4 Street Lighting Pattern

Road Side Street Lighting Arrangement along the Project Stretch is not adequate. Provision for the same will be incorporated in the Corridor Improvement Scheme.

3.5 Bus Stops

The presence of Bus Stops in the Carriageway on the Intersecting Arms of the Junctions hinders the smooth Traffic Movement along the Intersecting Arms of the Junctions.

3.6 Pedestrian Movement

The presence of Bus Stops, Well Developed Commercial Areas, Institutional Buildings, Recreational Facilities and their related activities in the vicinity of the Junctions leads to hazardous movement pattern of the Pedestrians across the Road, thus reducing the Safety Aspects. Further, presence of Trees and other Utilities, Commercial Activities on the Footpath reduces the Effective Width of the Footpath and in turn obstructs the Pedestrian Movement.

3.7 Scope for Improvement

This Corridor is one of the oldest Arterial Roads in Western Part of Bangalore City and connects the City with Magadi Town. The initial development carried out along this Road is of ribbon type. It has been observed that many Cross Roads are feeding into this Arterial Road and creating junctions at very close interval of 20 – 25m. Treating all the junctions is not practically viable solution. Hence, the Improvement of this Corridor has been limited to closing the Medians at Minor Junctions and creating Grade Separator at Jaimunirao Circle, Basaveshwara Nagar Road Junction along with U Turn for the Turning Movements at Grade, Dedicated U Turn with Physical Separator near Patalamma Street and between Patalamma Street and Outer ring Road Junction.

CHAPTER 4
FIELD STUDIES AND ANALYSIS

4.1 General

This Chapter presents the various Studies (Reconnaissance Survey, Traffic Survey, Topographical Survey, Geotechnical Investigation, etc.) and thereafter the Data, obtained as a Result of these Studies, Analysis carried out by the Consultant. The Results of Analysis form Inputs for Planning and Design of Proposed Corridor Improvement Scheme, Traffic Forecast and Economic Analysis.

4.2 Reconnaissance Survey

Reconnaissance Survey has been carried out along the Corridor and at the Junctions and the Physical Characteristics of the Corridor and Junctions such as Road Geometrics, Pavement Structure, Traffic Controls (Signs, Signals, Road Markings and Parking Restrictions), Side Walks, Shoulders, Adjacent Land Use, Service Lines (For Example Water, Electricity, Telephone), Storm Water Drains and the Intensity of Non – Traffic Activities, which encroach upon Road Space (such as Hawkers, Builder's Materials, Market Stalls, etc.) have been studied. The Data recorded have been detailed out in **Chapter 3 – Study Corridor**.

4.3 Traffic Surveys

To establish the Vehicular Traffic Flow Characteristics such as Hourly variation, Composition, Peak Hour Flows along the Corridor and at the Junctions, Turning Movement Survey of Vehicles at Junctions has been conducted.

4.3.1 Methodology for Traffic Surveys

4.3.1.1 Turning Movement Survey of Vehicles at Junctions

24 hours Manual Traffic Counts have been conducted to cover all the Vehicular Movements at the Junction. The Vehicle Classification System adopted for the Study is given in **Table 4.1**.

Table 4.1
Vehicle Classification System

<table>
<tr><th colspan="2">Motorised Traffic</th><th>Non – Motorised Traffic</th></tr>
<tr><td colspan="2">2 – Wheelers, Auto Rickshaw, Passenger Car: Car, Taxi and Jeep</td><td rowspan="7">Bicycle, Cycle Rickshaw, Animal Drawn Vehicle, Hand Drawn Cart</td></tr>
<tr><td colspan="2">Utility Vehicle: Van and Tempo</td></tr>
<tr><td>Bus</td><td>Mini Bus
Standard Bus</td></tr>
<tr><td rowspan="2">Truck</td><td>Light Commercial Vehicle (LCV)</td></tr>
<tr><td>Heavy Commercial Vehicle (HCV)</td></tr>
<tr><td rowspan="2">Farm Vehicle</td><td>Agricultural Tractor (AgT)</td></tr>
<tr><td>Agricultural Tractor & Trailer (AgTT)</td></tr>
</table>

The Turning Movement Survey has been conducted to obtain Information on Mode wise and Direction wise Turning Movement of Traffic at the Intersection. The Survey has been conducted for 24 hours (0600 hrs. to 0600 hrs.) covering morning and evening peak hours.

Traffic Counting has been carried out manually in two twelve – hour shifts by trained enumerators, using hand tally. The Count Data have been recorded at 15 minute intervals using hand tallies and total per hour for each vehicle category has been computed. The Traffic Volume Count Data has been processed using the commonly used Spreadsheet Package. The processed Hourly Traffic Volume Data has been compiled Direction wise.

The Peak Hourly Directional Vehicular Movement Data has been used to plan and design the Improvement Scheme such as Grade Separation and At Grade Intersections with Traffic Signals.

4.4 Analysis of Traffic Study Data

The Data and Pertinent Information collected from the Traffic Surveys have been analysed using the Utility Software Packages (MS – EXCEL) to obtain the required Information concerning Traffic Characteristics at the Intersections in the Corridor. Findings and the brief Discussions thereon are presented in this Section.

4.4.1 Analysis of Turning Movement Count Data

Data have been processed on quarter hourly basis to establish the most appropriate Peak Hours. Data collected from Surveys have been computerised and analysed to study Hourly Variation of Traffic, Peak Hour Flows, Traffic Composition, etc. and are presented Junction wise below. The Counts have been classified by Category of Vehicles and by Direction of Movement. The various Vehicle Types having different Sizes and Characteristics have been converted into Equivalent Passenger Car Units. The Passenger Car Unit (PCU) Factors recommended by Indian Road Congress in "Guidelines for Capacity of Urban Roads in Plain Areas" (IRC: 106 – 1990) have been used. The same are detailed in **Table 4.2**.

Table 4.2
Recommended PCU Factors for Various Types of Vehicles in Urban Roads

Sl. No.	Vehicle Type	Equivalent PCU Factors	
		% Composition of Vehicle Type	
		Up to 10%	10% and above
A	Fast Vehicles		
1	Two wheelers, Motorcycle or Scooter, etc.	0.5	0.75
2	Passenger car, Pick – up Van	1.0	1.0
3	Auto Rickshaw	1.2	2.0
4	Light Commercial Vehicle	1.4	2.0
5	Truck or Bus	2.2	3.7
6	Agricultural Tractor Trailer	4.0	5.0
B	Slow Vehicles		
1	Cycle	0.4	0.5
2	Cycle Rickshaw	1.5	2.0
3	Tonga (Horse drawn vehicle)	1.5	2.0
4	Hand Cart	2.0	3.0

(Source: IRC: 106 – 1990)

4.5 Veeresh Theatre Junction

4.5.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.1**. The Hourly Traffic Volume observed at the Junction varied in the range of 323 – 5144 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (4235 PCU) and 1800 – 1900 hrs. in the evening (5144 PCU). This Junction handles more than 3000 PCU / hr. for most part of the day (0800 – 2000 hrs.) This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Veeresh Theatre Junction is given in **Annexure A.4.1**.

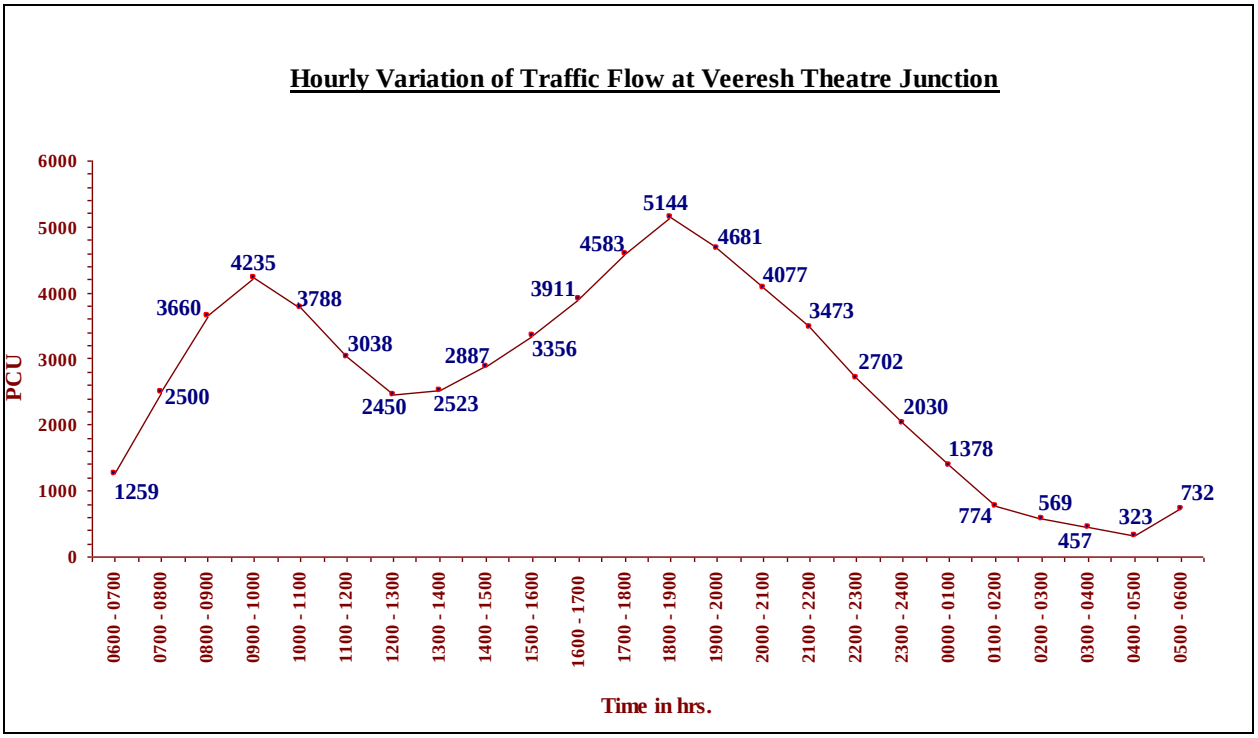

Fig. 4.1

4.5.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.2** for Veeresh Theatre Junction. The major flow is along Magadi Road Axis in which current Peak Hour Flow is 2985 PCU, which amounts to 57.93% of Junction Volume.

4.5.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Veeresh Theatre Junction and is shown in **Fig. 4.3**. Share of Two Wheelers is high (38.92%). The Analysis of Composition of Vehicles in the Traffic Stream at the Junction brings out the following.

- **Passenger Vehicle Category**: Two Wheelers along with Cars / Taxi / Jeep constitute 57.76% while Buses account for 5.2%.
- **Freight Vehicle Category:** LCV constitutes 1.39%.

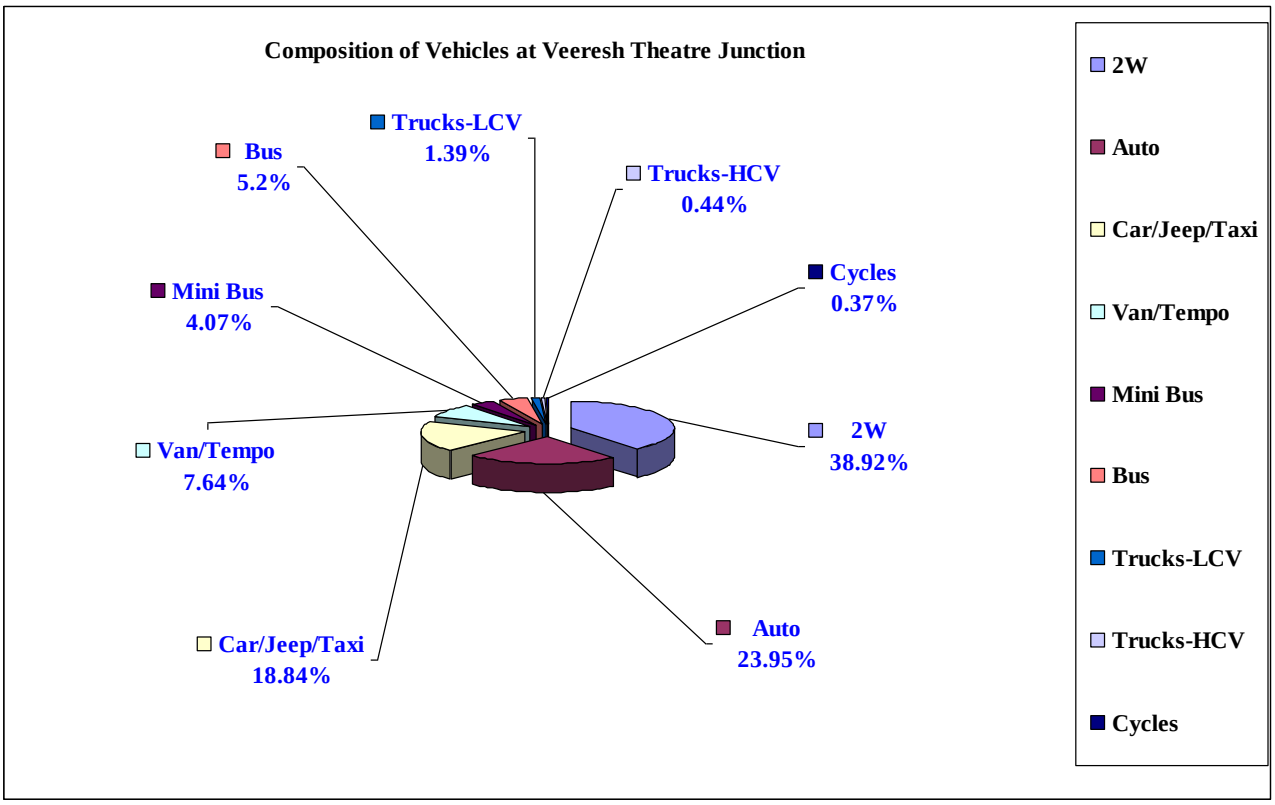

Fig. 4.3

Details of Vehicle Composition are given in **Annexure A.4.1**.

4.6 Jaimunirao Circle

4.6.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.4**. The Hourly Traffic Volume observed at the Junction varied in the range of 343 – 5336 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (4358 PCU) and 1800 – 1900 hrs. in the evening (5336 PCU). This Junction handles more than 3500PCU / hr. for most part of the day (0800 – 2000 hrs.) This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Jaimunirao Circle is given in **Annexure A.4.2**.

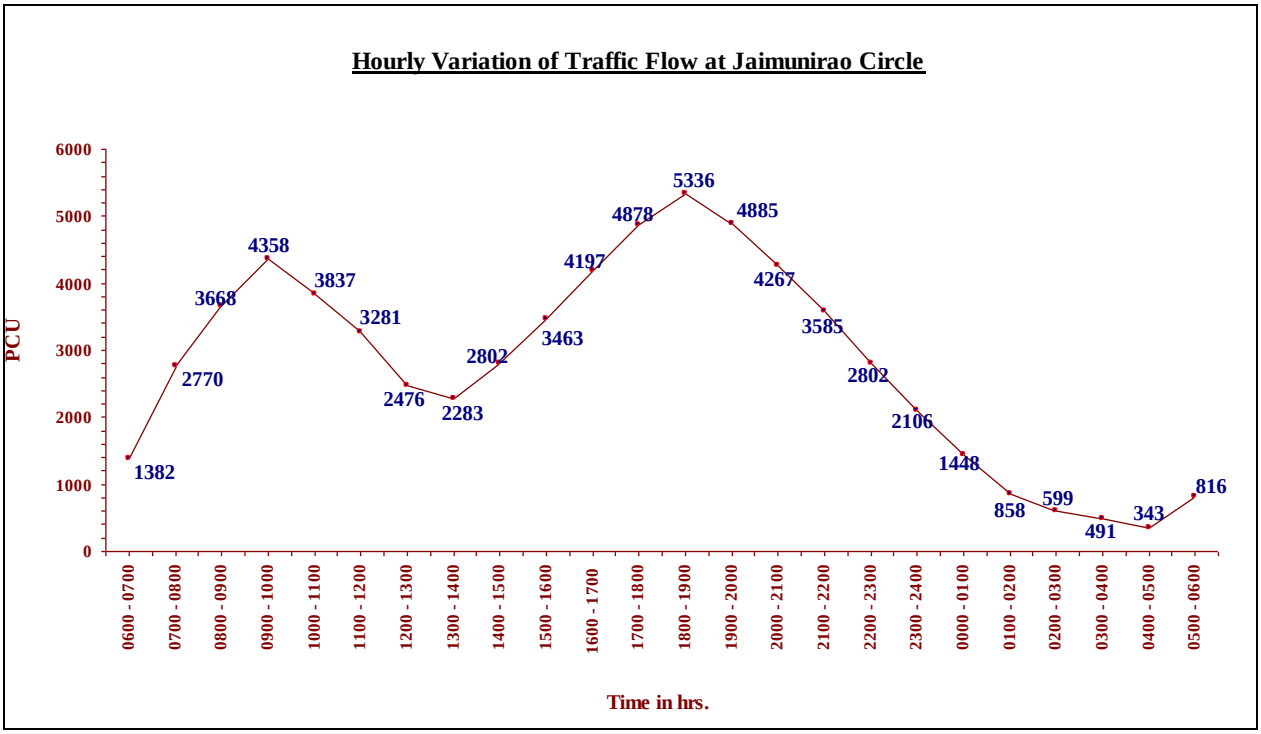

Fig. 4.4

4.6.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.5** for Jaimunirao Circle. The major flow is along Magadi Road in which current Peak Hour Flow is 3126 PCU, which amounts to 58.58% of Junction Volume.

4.6.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Jaimunirao Circle and is shown in **Fig. 4.6**. Share of Two Wheelers is high (38.02%). The Analysis of Composition of Vehicles in the Traffic Stream at the Junction brings out the following.

- **Passenger Vehicle Category**: Two Wheelers along with Cars / Taxi / Jeep constitute 54.79% while Buses account for 5.2%.
- **Freight Vehicle Category**: LCV constitutes 1.7%.

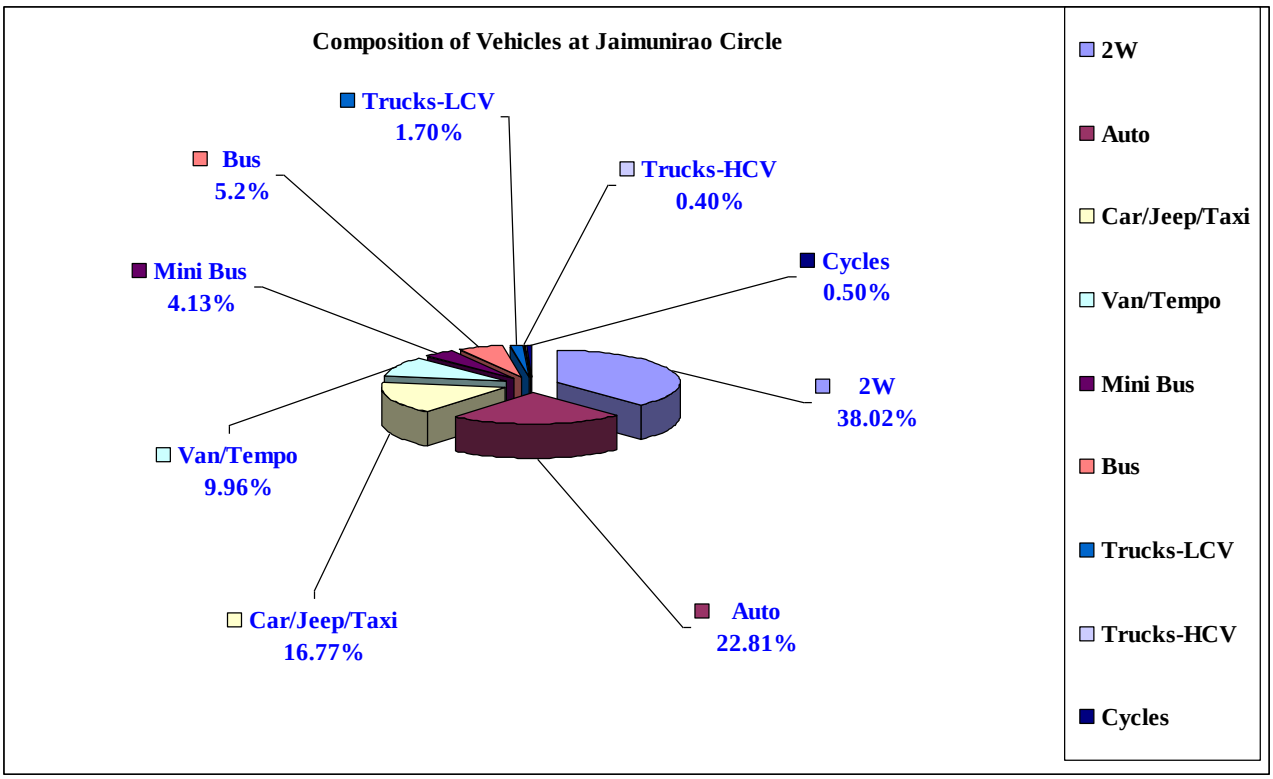

Fig. 4.6

Details of Vehicle Composition are given in **Annexure A.4.2**.

4.7 Raheja Park Apartment Junction

4.7.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.7**. The Hourly Traffic Volume observed at the Junction varied in the range of 367 – 5131 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (4425 PCU) and 1800 – 1900 hrs. in the evening (5131 PCU). This Junction handles more than 3500 PCU / hr. for most part of the day (0800 – 2000 hrs.) This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Raheja Park Apartment Junction is given in **Annexure A.4.3**.

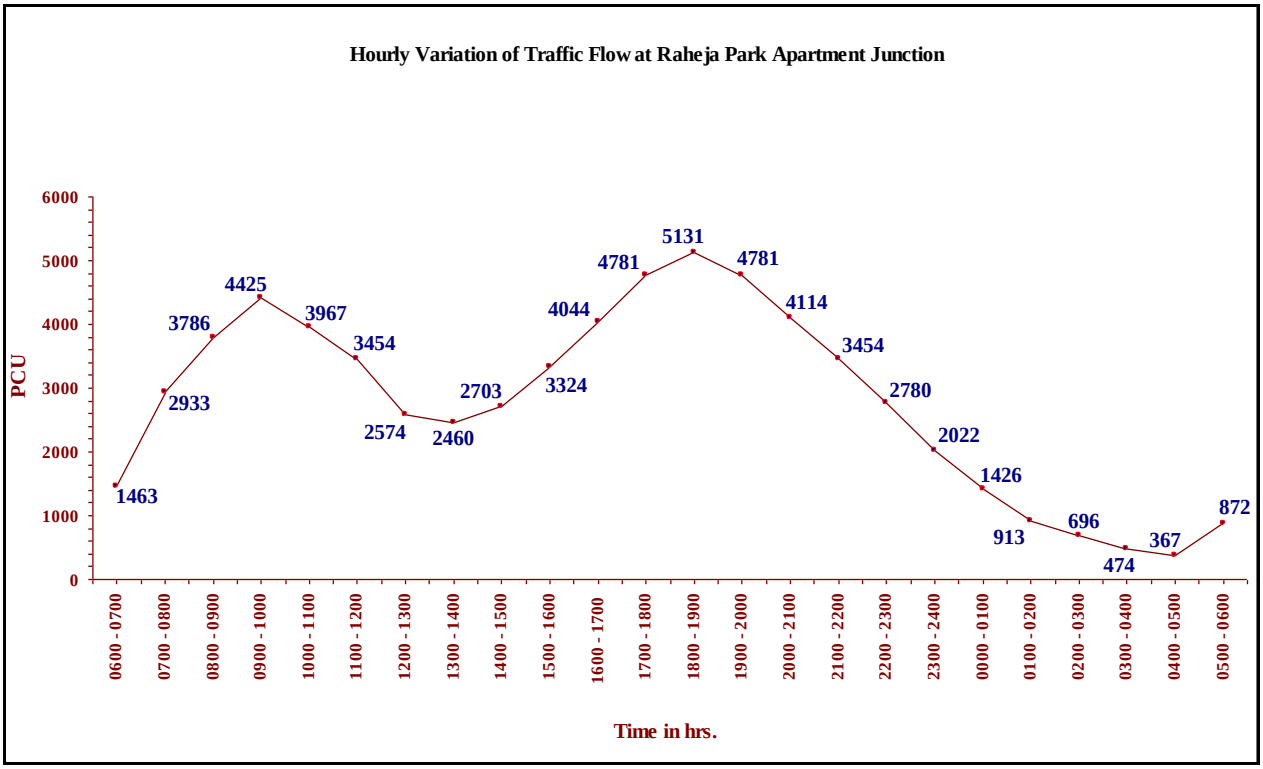

Fig. 4.7

4.7.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.8** for Raheja Park Apartment Junction. The major flow is along Road towards Magadi Road in which current Peak Hour Flow is 4003 PCU, which amounts to 78.01% of Junction Volume.

4.7.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Raheja Park Apartment Junction and is shown in **Fig. 4.9**. Share of Two Wheelers is high (39.27%). The Analysis of Composition of Vehicles in the Traffic Stream at the Junction brings out the following.

- **Passenger Vehicle Category**: Two Wheelers along with Cars / Taxi / Jeep constitute 56.44% while Buses account for 5.2%.
- **Freight Vehicle Category**: LCV constitutes 1.57%.

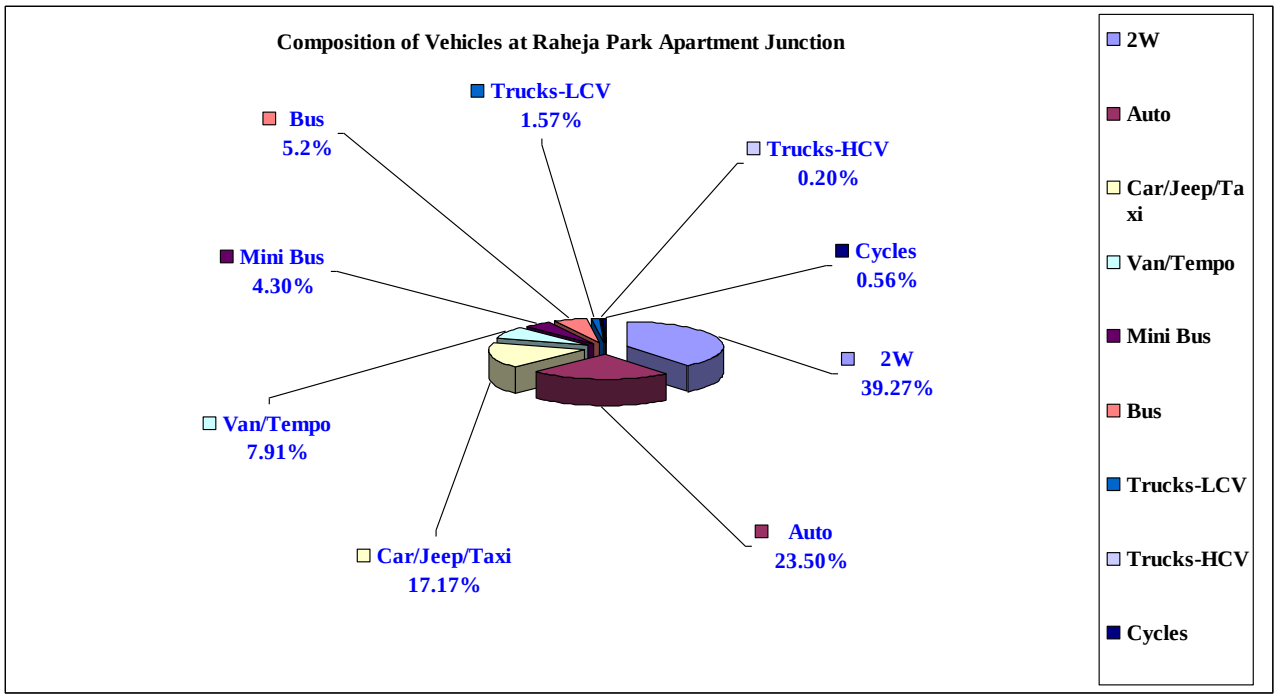

Fig. 4.9

Details of Vehicle Composition are given in **Annexure A.4.3**.

4.8 Basveshwara Nagar Road Junction

4.8.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.10**. The Hourly Traffic Volume observed at the Junction varied in the range of 352 – 6189 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (6189 PCU) and 1800 – 1900 hrs. in the evening (5638 PCU). This Junction handles more than 4500 PCU / hr. for most part of the day (0800 – 2000 hrs.) This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Basaveshwara Nagar Road Junction is given in **Annexure A.4.4**.

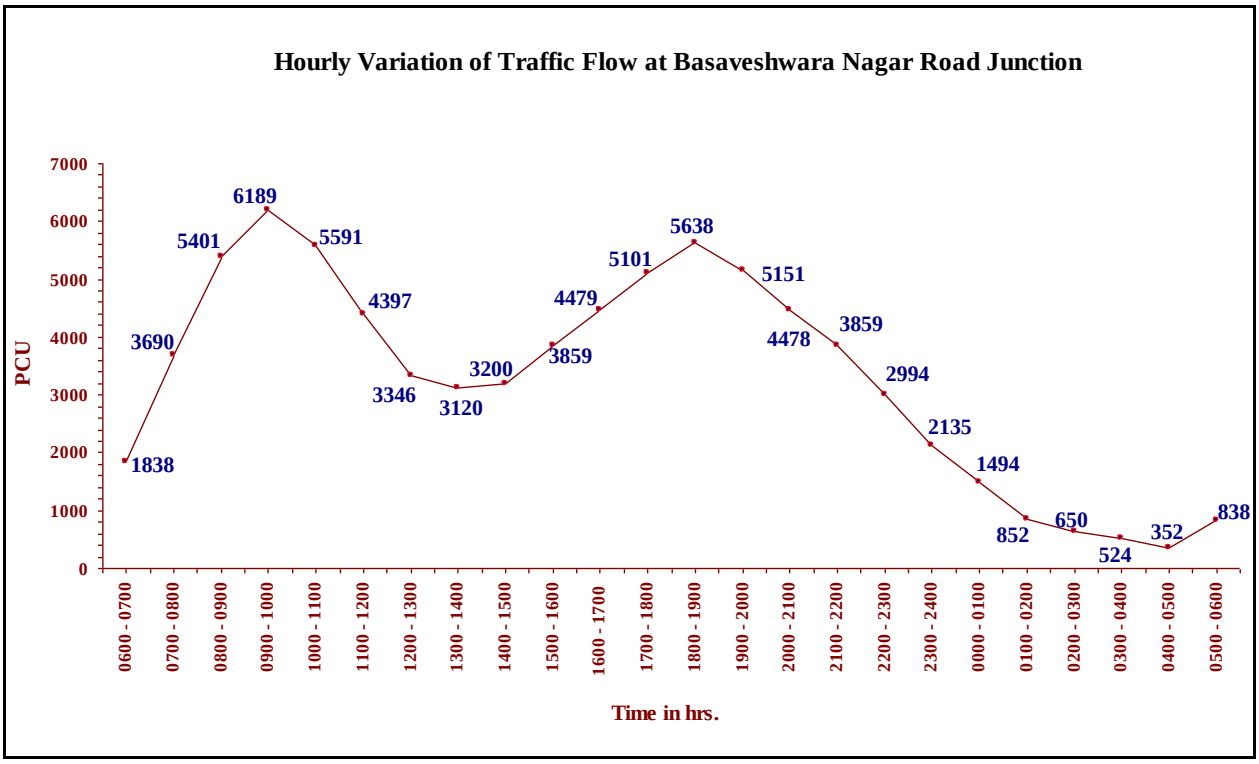

Fig. 4.10

4.8.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.11** for Basaveshwara Nagar Road Junction. The major flow is along Magadi Road in which current Peak Hour Flow is 4710 PCU, which amounts to 76.1% of Junction Volume.

4.8.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Basaveshwara Nagar Road Junction and is shown in **Fig. 4.12**. Share of Two Wheelers is high (38.77%). The Analysis of Composition of Vehicles in the Traffic Stream at the Junction brings out the following.

- **Passenger Vehicle Category:** Two Wheelers along with Cars / Taxi / Jeep constitute 55.93% while Buses account for 5.97%.
- **Freight Vehicle Category:** LCV constitutes 1.45%.

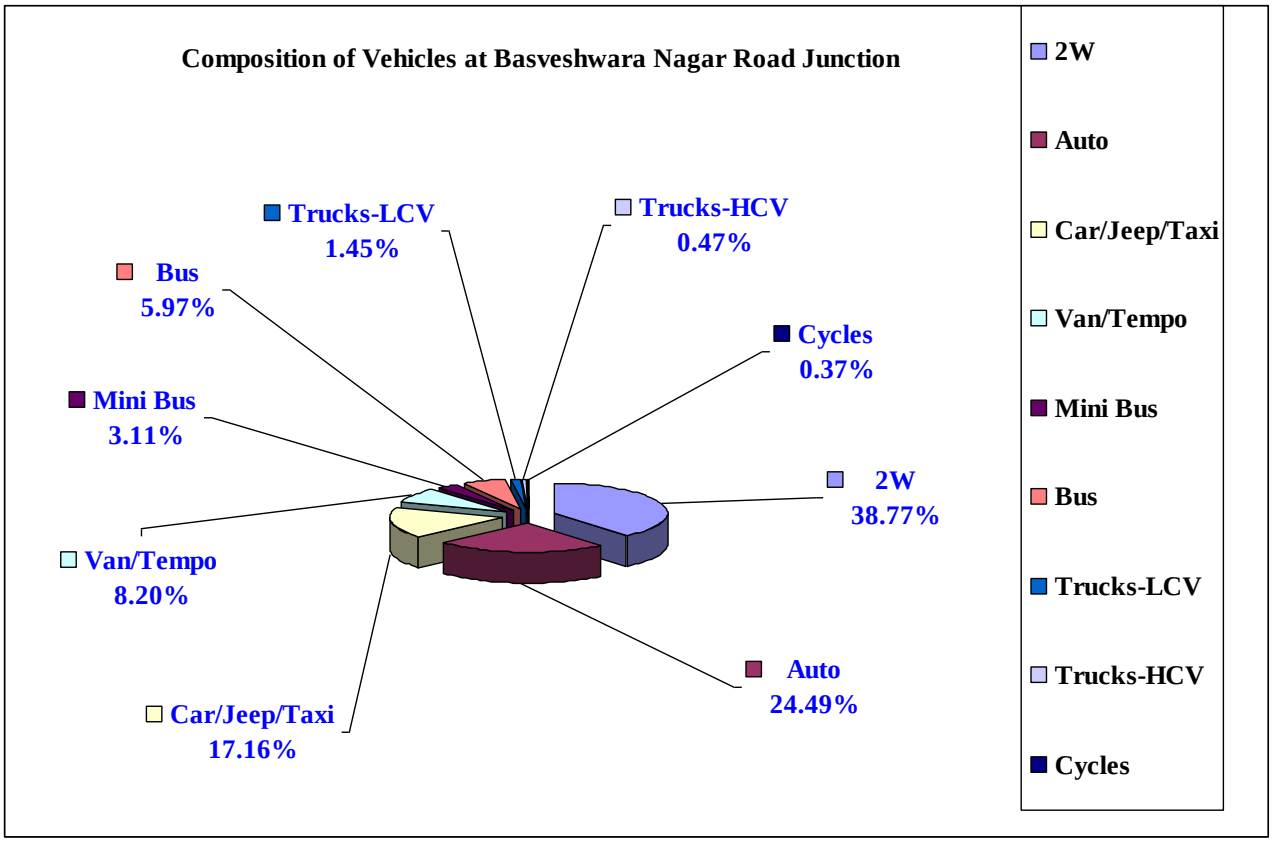

Fig. 4.12

Details of Vehicle Composition are given in **Annexure A.4.4**.

4.9 Topographic Survey

A Comprehensive Topographic Survey has been conducted all along the Corridor using Total Station Equipment to accurately map the Area and obtain the Present Information on Road Width, Adjoining Land Use, Building Offsets and Levelling Data using Auto Level. The GTS Bench Mark has been transferred to the Site by carrying out Fly Leveling and the Bench Marks have been established at Site. The entire Levelling has been carried out using GTS Bench Mark. The Profiles and Levels of the Road Network within the Study Area have been also captured by taking Longitudinal and Cross Section Levels. The Extent of Survey has been limited to 100m beyond the Battery Limit on both the sides of the Corridor and to 200m on all the Cross Roads joining with the Corridor. The Details have been captured adequately for Planning and Designing of proposed Corridor Improvement Scheme. The Data captured is in 3 – D Format, which have been directly downloaded to Computers and is compatible for Modern Design Softwares. Topographical Map is given in **Chapter 10 – Drawings**.

The Existing Site Features collected during Topographical Survey are enumerated in **Chapter 3 – Study Corridor.**

4.10 Geotechnical Investigation

Geotechnical Investigation has been carried out with the Primary Objective of establishing the Ground Condition at the Site for Major Junctions coming along the Corridor and evaluating the Bearing Pressure and other Engineering Design Parameters through the Field and Laboratory Tests.

Geotechnical Investigation Reports for each of the following Junctions are enclosed in **Annexure A.4.13**.

- Jaimunirao Circle.
- Basaveshwara Nagar Road Junction.

CHAPTER 5
PLANNING AND DESIGN CONSIDERATIONS

5.1 General

Planning and design of Grade Separated Facility comprising of Grade separator, Surface Level Roads, at – grade Junction, Pedestrian Facilities, etc. are essentially based on the Design Standards as stipulated in relevant IRC Standards and MoRT&H Specifications. Whenever, the Codes / Standards are silent on some of the Aspects, the same will be planned / designed based on Sound Engineering Practices. Design Standards relevant to the Project Corridor along with the Broad List of Design Parameters and the relevant IRC Codes / Specifications have been detailed in **Table 5.1**. Estimation of Design Traffic in the Base Year and the Horizon Year has also been summarized in the following sections.

Design Standards (as appropriate) have been further elaborated under the following heads:

- Geometric Design
- Drainage
- Road Furniture and Appurtenances
- Grade Separated Structure

5.2 Factors Considered in Planning

The Important Factors considered in the Planning of Grade Separated Facility are detailed below.

- Grade Separated Facility has been planned in such a way that it blends well with the existing Transport Infrastructure Facilities in the City.
- Grade Separated Facility has been planned in such a way that it not only provides Traffic Relief but also enhances the Capacity of the Junctions.
- Grade Separated Structure should have no / minimum Impact on the existing environment and its surroundings. It should not mask the Buildings of Historical Importance.
- Layout of Grade Separated Facility and the Shape / Size of its Components will be harmonized so that to result in Aesthetically Pleasing Structure.
- Drainage and Illumination of the Grade Separated Facility and the Surface Level Roads have been properly planned as per Relevant Provisions of IRC / IS Codes and
- Distance between Expansion Joints would be kept at about 60 – 75m to provide Better Riding Comfort.

5.3 Design Standards Related to Geometric Design

Design Standards related to Road Geometric along with the suggested Design Values / Standards and Recommended Values based on Site Conditions and Data Analysis are detailed in **Table 5.1**.

Table 5.1
Geometric Design Standards

Sl. No.	Design Parameters	Reference Code / Design Values
1.	Design Speed	IRC: 69 – 1977 – "Space Standards for Roads in Urban Areas". IRC: 86 – 1983 – "Geometric Design Standards for Urban Roads in Plains". IRC: 92 – 1985 – "Guidelines for the Design of Interchanges in Urban Areas".
2.	Geometric Design Standards	
	• Carriageway Width	Four lane divided bi directional Carriageway with raised kerb – 7.5m X 2.
	• Median	1m
	• Footpath at grade level	2.5m
	• Camber (Bi – directional)	2.5% for Paved Carriageway
	• Super elevation	Limited to 5% (1 in 20).
	• Horizontal Curves	IRC: 38 – 1988 – "Guidelines for Design of Horizontal Curves for Highways and Design Tables" (First Revision).
	• Vertical Curves	IRC: SP: 23 – 1983 – "Vertical Curves for Highways"
	• Gradient	Entry and Exit Ramps – 5% (1 in 20) Minimum Permissible Gradient for Drainage – 0.5% (lined) and 1% (unlined)
	• Vertical Clearance	4.5m.
	• At – grade junction	IRC: SP: 41 – 1994 – "Guidelines on Design of At Grade Intersections in Rural & Urban Areas".
3.	Road Traffic Signal	IRC: 93 – 1985 "Guidelines on Design and Installation of Road Traffic Signals".

5.4 Design Standards Related to Drainage

Drainage of Storm Water collected in Underpass and on Surface Level Roads are essentially based on the Guidelines given in IRC: SP: 42 – 1994 – "Guidelines on Road Drainage" and in IRC: SP: 50 – 1999 – "Guidelines on Urban Drainage". The Suggested Design Values / Standards and Recommended Values based on Site Conditions are detailed in **Table 5.2.**

Table 5.2
Design Standards Related to Drainage

Design Parameters	Reference Code / Design Values
• Camber	2.5% (bi – directional) for carriageway
• Longitudinal Gradient	Minimum 0.3% for satisfactory drainage
• Drain Type	RCC Box Drain covered with Precast RCC Slab

5.5 Design Standards Related to Road Furniture and Appurtenances

Utility and Importance of the Grade Separated Facility (Grade Separator, Surface Level Roads and Junction) is greatly enhanced by installing Road Furniture and Appurtenances at appropriate locations, which ensures Improved Safety. Planning and Design of Road Furniture and Appurtenances are as per the Guidelines stipulated in IRC. Detailing of each of these Components has been done so that to integrate the same with the Grade Separator Scheme. The Suggested Design Values / Standards are detailed in **Table 5.3**.

Table 5.3
Design Standards Related to Road Furniture and Appurtenances

Sl. No.	Design Parameters	Reference Code / Design Values
1	Road Markings	IRC: 35 – 1997 – "Code of Practice for Road Markings (with Paints)".
2	Road Signs	IRC: 67 – 2001 – "Code of Practice for Road Signs".
3	Road Delineators	IRC: 79 – 1981 –"Recommended Practice for Road Delineators"
4	Pedestrian Facilities *	IRC: 103 – 1988 – "Guidelines for Pedestrian Facilities".

(*– Footpath, Pedestrian Crossing, Zebra Crossing, etc.)

5.6 Design Standards Related to Grade Separated Structure

The Design Standards and Loading considered for Grade Separated Structure have been as stipulated in latest IRC Codes / Special Publications supplemented by appropriate MoRT&H Circulars and / or IS Codes.

5.7 Lighting

The Preparation of Lighting Scheme, Installation and Maintenance of Street Lights in the Underpass and at Surface Level are essentially based on IS: 1994 (Part I and II) – 1970.

CHAPTER 6
CORRIDOR IMPROVEMENT SCHEME

6.1 General

The Proposal for Corridor Improvement includes Junction Improvements by proposing Grade Separator at Major Junctions and closing of Median at Minor Other Improvements such as Improvements to Footpath, Median, Drainage System; Provision of Effective Illumination, etc. have been accommodated in the Project Proposal.

The Concepts proposed for each Project Junction are briefly explained below.

6.2 From Veeresh Theatre Junction to Raheja Park Apartment Junction

A four lane divided bi directional Flyover has been proposed along Magadi Road from Veeresh Theatre Junction to Raheja Park Apartment Circle with 5.5m wide Slip Road and 1.5m wide Footpath on either side at grade level.

Following are the Salient Features of the Flyover.

• Total Length of Flyover	1014.51m
• Number of Lane	4 lane divided bi directional
• Carriageway Width	7.5m X 2
• Length of Obligatory Span at Veeresh Theatre Junction	30m
• Length of Obligatory Span at Jaimunirao Circle	30m
• Length of Obligatory Span at Raheja Park Apartment Junction	30m
• Vertical Clearance	4.5m
• Gradient	5% (1 in 20)
• RCC Viaduct between Veeresh Theatre Junction and Jaimunirao Circle	330m
• RCC Viaduct between Jaimunirao Circle and Raheja Park Apartment Circle	359.74m
• Length of Approach Ramp towards Basaveshwara Nagar Road Junction	82.54m
• Length of Approach Ramp towards Chord Road – Magadi Road Junction	141.20m
• Width of Slip Road	5.5m
• Width of Footpath	1.5m

6.3 Basaveshwara Nagar Road Junction

At this Junction, a four lane divided bi – directional Underpass has been proposed along Magadi Road with 5.5m wide Slip Road and 1.5m wide Footpath on either side at grade level.

Following are the Salient Features of the Underpass at Basaveshwara Nagar Road Junction.

- Total Length of Underpass 267.5m
- Number of Lane 4 lane divided bi directional
- Carriageway Width 7.5m X 2
- Length of Covered Portion 33m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Kamakshipalya 179.97m
- Length of Approach Ramp towards Raheja Park Apartment Junction 54.6m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 558.69Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / 2319 / BNRJ / GAD / 602** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / 2319 / BNRJ / LAD / 604**.

6.4 Near Patalamma Street

Dedicated U Turn of Turning Radius 11.5m with Physical Separator has been proposed near Patalamma Street, 980m away from the Basaveshwara Nagar Road Junction. 1.5m wide Footpath has also been proposed on either side of the Road. To accommodate all the Provisions, 1502.24 Sqm of Land needs to be acquired.

Concept Plan is presented in **Drawing No. MC / BBMP / 2319 / PS / CP / 702** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / 2319 / PS / LAD / 703**.

6.5 Between Patalamma Street and Outer Ring Road Junction

Dedicated U Turn of Turning Radius 11.5m with Physical Separator has been proposed between Patalamma Street and Outer Ring Road Junction, 250m away from the Outer Ring Road Junction. Provision for 1.5m wide Footpath on either side of the Road has also been proposed. To accommodate all the Provisions, 1597.04 Sqm of Land needs to be acquired.

Concept Plan is presented in **Drawing No. MC / BBMP / 2319 / PS – ORR / CP / 802** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / 2319 / PS – ORR / LAD / 803**.

6.6 Preferred Option

The above Options were presented to TAC and it has been finalised to adopt 4 lane divided bi directional Underpass along Magadi Road with 5.5m wide Slip Road and 1.5m wide Footpath on either side at grade level at Jaimunirao Circle with the Option for Basaveshwara Nagar Road Junction, Dedicated U Turns with Physical Separator near Patalamma Street and between Patalamma street and Outer Ring Road Junction unaltered.

Following are the Salient Features of the Underpass at Jaimunirao Circle.

• Total Length of Underpass	239.04m
• Number of Lane	4 lane divided bi directional
• Carriageway Width	7.5m X 2
• Length of Covered Portion	30m
• Vertical Clearance	4.5m
• Gradient	5% (1 in 20)
• Length of Approach Ramp towards Veeresh Theatre	85.82m
• Length of Approach Ramp towards Raheja Park Apartment Junction	123.22m
• Width of Slip Road	5.5m
• Width of Footpath	2.5m
• Land Acquisition	2726.67 Sqm

Layout Plan and Longitudinal Section for the Preferred Option at Jaimunirao Circle are presented in **Drawing No. MC / BBMP / 2319 / JC / GAD / 402** and Land Acquisition Details are given in **Drawing No. MC / BBMP / 2319 / JC / LAD / 404**.

CHAPTER 7
DESIGN OF GRADE SEPARATOR

7.1 Planning and Investigations

The Corridor Improvement Scheme has been discussed in detail in Chapter 6. The Length of the Underpass has been determined based on the Depth of Deck Slab, where a minimum Vertical Clearance of 4.5m has to be provided. By considering the Economy of the Project, Open Cut System has been considered both for Ramp and Covered Portion of the Underpass. Diversion of the Underground Services like Water, Sewer, Electricity, etc., which will affect the Construction Activities will be programmed prior to the Excavation Work.

7.2 General Arrangement

Care has been taken while designing so that the structure generally fulfills the following requirements.

- The Soundness of the Structure and its Durability are of the highest standards.
- Aesthetics is in harmony with the surroundings.
- Speedy and Practicable Construction.
- Economy in Construction.

7.3 Design of Underpass

Based on the Economy of the Project and Site Condition, the Covered Portion of the proposed Underpass has been designed as Precast RCC Closed Box Section. For Approaches, Open Box and Conventional RCC Retaining Structure have been adopted. The Drawings for Covered and Open Portions of the Underpass at respective Junctions are enclosed in **Chapter 13 – Drawings**.

Design loads

1. **Live Load**

   Class 70R Loading has been considered.

2. **Seismic Force**

   The Underpass has been designed for the Seismic Force as per the provisions of IS: 1893 (Latest Edition).

3. **Earth pressure**

   - The Soil Properties for Embankment like Dry Density of Soil 1.85 t / cum.; Saturated Density 2.00 t / cum.; $\Phi = 30^0$ and c = 0 have been considered for Estimation Purpose.
   - Saturated Density of the Backfill (minimum 2 t / cum) has been considered for calculating Active Earth Pressure for Estimation Purpose.

4. **Temperature Range**

   - For Design of Structure, to account for temperature, the following Formula has been considered.

(DL) = αLt,

The value of "t" shall be ±17^{0}C.
Where α = Coefficient of expansion or contraction
L = Length of the member
(DL) = Expansion / Contraction due to Temperature Variation in appropriate units.

The Superstructure has been designed for Effects of Distribution of Temperature across the Deck Depth as per the relevant Codal Provisions. For Calculation, Thermal Force Effect (E) of 50% of the Insulation Value has been considered so that to account for Effect of Creep on Thermal Strain.

7.4 Foundation

a) Retaining Walls
The Retaining Walls for the Approaches have been proposed to be of RCC appropriate with the Site Conditions. The Depth of the Foundation has been determined based on the Soil Investigation Report. Maximum Settlement allowed is 10mm. Adequate Protection has been given to Reinforcement against Corrosion.

b) Underpass
Closed and Open Portions of the Underpass including Retaining Walls shall be of minimum M35 grade Ready Mix Concrete.

7.5 Crash barriers

Concrete Crash Barriers shall conform to Clause 809 of MoRT&H Specifications. The Height of the Concrete Crash Barrier is 1000mm above the Finished Road Level. It has been designed to resist an Impact of 30t Axle Loads.

7.6 Wearing Coat

Wearing Coat conforming to Clause 2702.1 of MoRT&H Specifications for Road and Bridge Works (latest edition) has been provided for smooth riding surface.

7.7 Approach Slab

The Approach Slab conforming to Clause 2704 of MoRT&H Specifications for Road and Bridge Works (Latest Edition) has been provided.

7.8 Durability

From the Durability Consideration, the following minimum Grades of Concrete are to be considered for Plain Cement Concrete (PCC) and Reinforced Cement Concrete (RCC).

a) Minimum Grade of Concrete shall be as below.

PCC for Levelling Course	M15
RCC for Open Foundation, Substructure and Superstructure	M35

b) Minimum Cement Content, Diameter of Bar and Cover Requirements

For PCC and RCC, the value given below regarding minimum Cement Content and maximum Water Cement Ratio shall be followed.

PCC		RCC	
Minimum cement Content Kg / cum.	Maximum Water Cement Ratio	Minimum cement Content Kg / cum.	Maximum Water Cement Ratio
360	0.45	400 / 400	0.45 / 0.40

The minimum Nominal Diameter of Reinforcement is 10 mm.

7.9 Drainage

Drainage of Storm Water collected in the Underpass and at Surface Level Roads are essentially based on
IRC: SP: 42 – 1994 – "Guidelines on Road Drainage".
IRC: SP: 50 – 1999 – "Guidelines on Urban Drainage".

The Drainage Spouts conform to Clause 2705 of MoRT&H Specifications.

7.10 Traffic Signs, Markings and other Road Appurtenances

Traffic Signs, Markings and other Road Appurtenances shall conform to Clause 800 of the MoRT&H Specifications for Road and Bridges (latest edition). Road Markings shall conform to IRC: 35 – 1997 and Road Signs shall confirm to IRC: 67 – 2001.

7.11 Medians, Kerbs and Footpaths

Medians, Kerbs and Footpaths shall conform to Clause 407, 408 and 409 of the MoRT&H Specifications for Road and Bridges (latest edition).

7.12 Lighting

The Lighting within the Covered and Open Portion of Underpass, Service Roads, Junction at Surface Level above the Underpass, etc. has been provided as per relevant Codal Provisions. The Illumination proposed is an average 125 lux through out.

7.13 Specification and Design Codes

The Designs of Structural Components have been in conformation to the Criteria laid down in the Latest Editions of the following Codes of Practice and Standard Specifications.

a) IRC Standard Specifications and Code of Practice for Road Bridges with amendments issued upto the Date of Issue of Tender Notice.

IRC: 6	Loads and Stresses
IRC: 21	Cement Concrete (Plain and Reinforced)
IRC: 35	Code of Practice for Road Markings
IRC: 78	Foundation and Substructure
IRC: 83	Standard Specifications and Code of Practice for Road Bridges
IRC: 92	Guidelines for the Design of Interchanges in Urban Areas

b) IRC – SP: 33 Guidelines on Supplemental Measures for Design, Detailing and Durability of Important Bridge Structures (if applicable).
c) Specification for Roads and Bridge Works (Latest Edition), published by IRC, New Delhi on behalf of Govt. of India, Ministry of Shipping, Road Transport and Highways.

7.14 Boring Data and Soil Investigation at Site

The Details of Boring Data and Soil Investigation Report have been enclosed in **Chapter 4**.

CHAPTER 8
TRAFFIC MANAGEMENT / DIVERSION DURING CONSTRUCTION AND TRAFFIC ENGINEERING SCHEMES

8.1 General

Traffic Management / Diversion during construction of Grade Separation Scheme is essential for smooth flow of traffic. Traffic Diversion / Management during Construction has been planned so that not to cause inconvenience for Traffic Movement and the Width of Carriageway available for Traffic Movement during Construction is adequate.

8.2 Traffic Management during Construction

Work on the entire length of the Grade Separator for each Junction has been planned continuously for six months and the Construction of Grade Separator at each Junction has been planned to tackle separately, phase wise. Wherever land is available for the proposed Slip Road, the available land will be strengthened to allow the traffic. Otherwise alternative routes have been worked out for the diversion of traffic and the Details are enclosed in **Chapter 13 – Drawings**. The proposed scheme shall ensure the smooth flow of traffic during the entire Construction Period. During the entire Construction Period, Street Parking on all the approach arms of the junction shall be strictly prohibited.

Traffic Management and Diversion Scheme during Execution are given in **Chapter 13 – Drawings**.

8.3 Necessary Improvements

For Effective Implementation of Traffic Diversion Scheme, Diversion Routes shall be kept in Traffic Worthy Condition (Free from Pot Holes, Ruts, Undulation, etc.) during the entire Construction Period.

Necessary Signboards for guiding the Road Users shall be located as per IRC Norms. The Traffic Management Scheme and Traffic Diversion Plans proposed shall be discussed with Police Authorities before Implementation. All the Necessary Improvements and Location of Signboards shall be finalized during Implementation in discussion with Police Authorities.

8.4 Traffic Engineering Schemes Components

Design of At Grade Junction is essential for proper dispersion of traffic retained at Surface Level in the Post Grade Separator Scenario. The Various Components of At Grade Junction and in the Grade Separator that need to be Planned, Designed and Built Integrally in the Grade Separation Scheme are detailed in Table 8.1. Planning and Design of these Components are as per the Guidelines stipulated in IRC.

Table 8.1
Components of At Grade Junction and Grade Separation Scheme

Sl. No.	Components	Description	Standards
1.	Traffic Signals	Fully Automatic Traffic Signal with Timer (Solar)	IRC: 93 – 1985
2.	Road Markings	On Grade Separator and at Surface Level Roads	IRC: 35 – 1997
3.	Road Signs	On Grade Separator and at Surface Level Roads	IRC: 67 – 1977 & IRC: SP – 31 – 1992
4.	Road Delineators	On Grade Separator and at Surface Level Roads	IRC: 79 – 1981
5.	Geometrics	Surface Level Roads	IRC: 86 – 1983
6.	Geometrics	Junction	IRC: SP – 41 – 1994
7.	Pedestrian Facilities	At Surface Level Roads and near the Junction (Footpaths, Railing & Zebra Crossing)	IRC: 103 – 1988

The Drawings for the proposed Traffic Signage and Road Marking for the Post Grade Separator Scenario are enclosed in **Chapter 13 – Drawings**.

CHAPTER 9
PROJECT COST AND ECONOMIC EVALUATION

9.1 Rate Analysis

As part of the Detailed Project Report (DPR), Rate Analysis of each of the item has been prepared by adopting PW, P & IWTD SR 2009 – 10, Bangalore Circle and NHSR 2009 – 10, National Highways Circle, Bangalore. The Rates as given in PW, P & IWTD SR are to be enhanced by 6% for additional weightages for the Works to be executed under Extra Ordinary Conditions for Bangalore Metropolitan Limits. Items not covered in NHSR / PW, P & IWTD SR have been based on Market Rates.

9.2 Detailed Cost Estimate

As part of DPR, Detailed Cost Estimate has been prepared for the Grade Separated Structure and Surface Level Roads based on Detailed Engineering Design.

9.3 Project Cost

The Rates of the various Items of Works have been analysed keeping in view of the basic rates as per SR and their respective lead.

To accommodate the proposed Corridor Improvement Scheme, 4850 Sqm. (at Jaimunirao Circle 2123.81 Sqm, at Basaveshwara Nagar Road Junction 325.32 Sqm, near Patalamma Street 1130.49 Sqm, between Patalamma Street and Outer ring Road Junction 1270.38 Sqm) of Land needs to be acquired. The Process of Land Acquisition has been initiated by BBMP and this will be carried out by Transfer of Development Rights (TDR) Scheme.

The Abstract of the Project Cost is detailed in **Table 9.1**. For the proposed Corridor Improvement Scheme, total Cost of the Project has been worked out as **Rs. 29.737 Crore**. Further, the Abstract of the Junction wise Project Cost is detailed in **Table 9.2, and 9.3** respectively.

The Detailed Cost Estimate is presented in **Annexure A.9.1**.

Table 9.1

Abstract of Project Cost

Sl. No.	Particulars	Cost in Rs.
1.	Proposed Construction of Vehicular Underpass at Jaimunirao Circle	116580000.00
2.	Proposed Construction of Vehicular Underpass at Basaveshwara Nagar Road Junction	139780000.00
3.	Proposed U Turn with Physical Separator near Patalamma Street	20510000.00
4.	Proposed U Turn with Physical Separator between Patalamma Street and Outer Ring Road Junction	20500000.00
	Total	297370000.00

Table 9.2
Abstract of Project Cost for Jaimunirao Circle

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 3.5m X 1.0m	19310000.00
2.	Lowering the Segments and other Allied Works	7870000.00
3.	Construction of Retaining Wall	24140000.00
4.	Formation of Service Road and Concreting of Ramps	24260000.00
5.	Providing Drainage Facility to Underpass	7700000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	10950000.00
	Sub Total	94230000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @1.5%	1413450.00
8.	Add for Utility Shifting Charges @ 20%	18846000.00
9.	Add Cost for Topographical Survey	40000.00
10.	Add Cost for Soil Investigation	120000.00
11.	Add Cost for Electrical Works	1900000.00
		116549450.00
11.	Miscellaneous and Rounding off	30550.00
	Total	116580000.00

Table 9.3

Abstract of Project Cost for Basaveshwara Nagar Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 3.5m X 1.0m	21240000.00
2.	Lowering the Segments and other Allied Works	8540000.00
3.	Construction of Retaining Wall	30830000.00
4.	Formation of Service Road and Concreting of Ramps	29710000.00
5.	Providing Drainage Facility to Underpass	9240000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	13510000.00
	Sub Total	113070000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1696050.00
8.	Add for Utility Shifting Charges @ 20%	22614000.00
9.	Add Cost for Topographical Survey	40000.00
10.	Add Cost for Soil Investigation	120000.00
11.	Add Cost for Electrical Works	2210000.00
		139750050.00
11.	Miscellaneous and Rounding off	29950.00
	Total	139780000.00

CHAPTER 10
IMPLEMENTATION PLAN

The entire Project Period for each Junction has been divided into two parts viz.

1. **Tendering Stage and Finalisation of Contract.**
2. **Execution of the Project including Utility Shifting.**

The 1st Part will entail a period of **45 Days** whereas the 2nd Part will entail a period of **180 Days** in case of Underpass.

Further, each Junction will be tackled in Phase wise so that not to cause inconvenience to the Flow of Traffic throughout the Corridor.

The Total Time to handover the Project for each Junction to the BBMP will thus be **225 Days** in case of Underpass from the Date of Notice Inviting Tender.

The Detailed Implementation Plans for all the Project Junctions are attached in **Annexure A.10.1**.

CHAPTER 11
CONCLUSION

8.1 The Project Corridor acts as a Radial Road in Western Part of Bangalore City and provides connectivity between Bangalore City and Magadi Town. The Corridor interfaces with Chord Road near Toll Gate, Outer Ring Road near Malegalu Main Road, NICE Corridor near Hirohalli and beyond this it is SH – 17E and joins NH – 48 near Kunigal. The Study Area caters to considerable local and outside traffic heading towards Hassan, Chikmagalur, Mangalore throughout the day. This Corridor acts as an Alternative Stretch to NH – 4 to reach NH – 48. These being the Background, the Bruhat Bangalore Mahanagara Palike has proposed to construct Grade Separator at Major Junctions and to close Median at Minor Junctions with Appurtenant Link Improvements from Chord Road to Outer Ring Road (ORR) Junction along Magadi Road covering a total of 6 Junctions (out of which, 2 Junctions have been taken for improvement) for a total length of 3.5km in order to provide Uninterrupted, Seamless Traffic Flow and to increase Level of Service along the Corridor.

8.2 Existing Junctions along the Project Corridor

The following Junctions are present along the Project Corridor.

- Chord Road – Magadi Road Junction – Four Arm Junction.
- Veeresh Theatre Junction – Three Arm Junction.
- Jaimunirao Circle – Four Arm Junction.
- Raheja Park Apartment Junction – Three Arm Junction.
- Basaveshwara Nagar Road Junction – Three Arm Junction.
- Outer Ring Road Junction – Four Arm Junction.

8.3 Junctions proposed for Improvements

The following Junctions have been taken for the proposed Improvements.

- Jaimunirao Circle.
- Basaveshwara Nagar Road Junction.

8.4 For the proposed Corridor Improvement Scheme, total Cost of the Project has been worked out as **Rs. 29.737Crore** with Implementation Period as **225 Days**.

8.5 To keep pace with the High Density of Traffic, it is Techno Economically Feasible to take up this Project along the mentioned stretches of Magadi Road.