

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.
- 1.1.8 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 Present Study Area spans from Mysore Road Junction to Central Silk Board Junction along Outer Ring Road covering a distance of 13.4km. in the Southern part of Bangalore City. The Study Corridor interfaces with Mysore Road (SH – 17) at Mysore Road Junction, NICE Road near Veerabhadreshwara Nagar Junction, National Highway – 209 at Kanakapura Road Junction, State Highway – 48 at Bannerghatta Road Junction and National Highway – 7 at Central Silk Board Junction. Hence, the Project Corridor acts as a major link between National Highways. Most of the heavy commercial traffic moving via Bangalore to other part of National Highways is being diverted through this Corridor. 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. Further, 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 along the Corridor. The Study Area caters to considerable local and outside traffic destined towards different parts of National Highways. With the setting up of Electronics City on Hosur Road, the growth of the techno polis has led to increase in traffic. The traffic originating from the various quarters of the City passes through this Corridor to reach Kumaraswamy Layout, J. P. Nagar, Bannerghatta Road, BTM Layout and Hosur Road to reach Electronic City. Further, many large Residential Sites have been converted into Apartments / Flats along this Corridor and a site that would house either a family or two now will be able to house multiple number of families and with this the number of Vehicle / Traffic also has increased manifold in last 10 years. These being the Background, the Bruhath Bangalore Mahanagara Palike has proposed to construct Grade Separator using Pre Cast Element Technology at Major Junctions and to close Median at Minor Junctions with Appurtenant Link Improvements from Mysore Road Junction to Central Silk Board Junction along Outer Ring Road covering a total of 16 Junctions (out of which, 9 Junctions have been taken for improvement) for a total length of 13.4km 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.

- Mysore Road Junction – Four Arm Junction.
- Veerabhadreshwara Nagar Junction – Four Arm Junction.
- KEB Junction near PESIT College – Three Arm Junction (“T” Shaped).
- Dr. Muthuraj Road Junction – Four Arm Junction.
- Janata Bazar Junction – Three Arm Junction (“T” Shaped).
- Food World Junction – Four Arm Junction.
- Kamakhya Theatre Junction – Four Arm Junction.
- Kittur Rani Chennamma Circle – Four Arm Junction.
- Kadirenahalli Road Junction – Four Arm Junction.
- Kanakapura Road Junction – Four Arm Junction.
- Puttenahalli Road Junction – Four Arm Junction.
- Dollar’s Colony Junction – Four Arm Junction.
- Bannerghatta Road Junction – Three Arm Junction.
- Jayadeva Hospital Junction – Four Arm Junction.
- Udupi Garden Junction – Four Arm Junction.
- Central Silk Board Junction – Four Arm Junction.

1.3 Junctions proposed for Improvements

The following Junctions have been taken for the proposed Improvements.

- KEB Junction near PESIT College.
- Dr. Muthuraj Road Junction.
- Janata Bazar Junction.

- Food World Junction.
- Kamakhya Theatre Junction.
- Between Kadirenahalli Road Junction and Kanakapura Road Junction.
- Kanakapura Road Junction.
- Dollar's Colony Junction.
- Udupi Garden 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 Mysore Road Junction to Central Silk Board Junction along Outer Ring Road covering a distance of 13.4km. in the Southern part of Bangalore City. The Study Corridor interfaces with Mysore Road (SH – 17) at Mysore Road Junction, NICE Road near Veerabhadreshwara Nagar Junction, National Highway – 209 at Kanakapura Road Junction, State Highway – 48 at Bannerghatta Road Junction and National Highway – 7 at Central Silk Board Junction. This Stretch has been selected primarily keeping in mind that this is the important Link providing connectivity between the National Highways.

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 and Scheme to shift Existing Utilities that will obstruct the Execution.
- Detailed Investigations for all Existing Surface and Underground Utilities and Realignment of Existing Utilities interfering in the Execution of the Project.
- Detailed Engineering Designs along with Detailed Estimate of the approved Concept.
- To study the Environmental and Social Impacts that can be caused due to the Construction.
- 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 Mekhri Circle to Hope Farm Junction via Old Madras 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. Origin Destination Survey.
 3. Vehicular Delay and Accumulation Survey.
 4. Occupancy Survey.
 5. Topographic Survey.
 6. Geotechnical Investigation.
 - Secondary Data
 1. Economic Indicators affecting Traffic Growth.
 2. Past Accident Data.
 3. 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.
- Analysis of Traffic Diversion and Management Scheme during Project Execution.

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 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, Existing Utilities, Geotechnical Data, Soil Profile, etc.

CHAPTER 3

STUDY CORRIDOR

3.1 Study Corridor

The Study Corridor is located in the South Quadrant of Bangalore City and connects Mysore Road on the Western Side with the Hosur Road on the Eastern Side. It starts from Mysore Road Junction and ends at Central Silk Board Junction near Hosur Road along Outer Ring Road. This Corridor acts as a major link between National Highways.

3.2 Salient Features of the Corridor

1. Total Length of the Corridor – 13.4 km.
2. Important Junctions along the Corridor
 - Mysore Road Junction – Four Arm Junction.
 - Veerabhadreshwara Nagar Junction – Four Arm Junction.
 - KEB Junction near PESIT – Three Arm Junction ('T' Shaped).
 - Dr. Muthuraj Road Junction – Four Arm Junction.
 - Janata Bazar Junction – Three Arm Junction ('T' Shaped).
 - Food World Junction – Four Arm Junction.
 - Kamakhya Theatre Junction – Four Arm Junction.
 - Kittur Rani Chennamma Circle – Four Arm Junction.
 - Kadirenahalli Junction – Four Arm Junction.
 - Kanakapura Road Junction – Four Arm Junction.
 - Puttenahalli Road Junction – Four Arm Junction.
 - Dollar's Colony Junction – Four Arm Junction.
 - Bannerghatta Road Junction – Three Arm Junction.
 - Jayadeva Hospital Junction – Four Arm Junction.
 - Udipi Garden Junction – Four Arm Junction.
 - Central Silk Board 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 9 – Photographs**.

3. Two Way Movements with at least four lane are seen along this 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 outside traffic destined towards different parts of National Highways. With the setting up of Electronics City on Hosur Road, the growth of the techno polis has led to increase in traffic. The traffic originating from the various quarters of the City passes through this Corridor to reach Kumaraswamy Layout, J. P. Nagar, Bannerghatta Road, BTM Layout and Hosur Road to reach Electronic City. Further, many large Residential Sites have been converted into Apartments / Flats along this Corridor and a site that would house either a family or two now will be able to house multiple number of families and with this the number of Vehicle / Traffic also has increased manifold in last 10 years.
5. The Study Area is located in Thickly Developed Residential and Commercial Area and is surrounded by some of the well known establishments like PES Institute of

Technology, National Council of Educational Research and Training, Kamakhya Theatre, Infosys Technology, Jayadeva Institute of Cardiology, Wipro Systems, Central Silk Board, etc.

6. The Local Public Transportation is primarily being met by the Bangalore Metropolitan Transport Corporation (BMTC), originating at Banashankari Bus Stand, Central Silk Board Bus Stand and Domlur Bus Stand and destined to Banashankari, JP Nagar, BTM Layout, Kathriguppe, Hosakerehalli, Nayandahalli.
7. This Corridor caters to the movement of heavy commercial traffic moving via Bangalore to other part of National Highways.
8. The Study Corridor interfaces with Mysore Road (SH – 17) at Mysore Road Junction, National Highway – 209 at Kanakapura Road Junction, State Highway – 48 at Bannerghatta Road Junction and National Highway – 7 at Central Silk Board Junction.

3.3 Project Junctions

3.3.1 Mysore Road Junction

3.3.1.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road. This is a typical four legged intersection in which Ring Road forms one axis and Road towards Kengeri – Road towards Deepanjali Nagar forms another axis.

The Details of the Arms forming this intersection are as follows.

Ring Road towards KEB Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 2.7m wide Central Median. ROW of this Road varies between 21m and 27m near the Junction. The gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road. Storm Water Drain of 29m wide towards Deepanjali Nagar Side and 27m wide towards Kengeri Side is present across this Road near the Junction.

Road towards Kengeri Side of the Intersection

This part of the Road is four lane divided bi directional with 1.14m wide Central Median. ROW of this Road varies between 33m and 39m. The gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Road towards Deepanjali Nagar Side of the Intersection

This part of the Road is four lane divided bi directional with 0.3m wide Central Median. ROW of this Road varies between 16m and 17m near the Junction. The gradient is slopping towards the Junction. Either side of this Stretch is populated with thick Residential and Commercial Establishments.

3.3.1.2 Existing Traffic Regulations

- Two directional movements are permitted in all the four arms of the Junction. It is permitted to move from each arm towards all other three arms in the Junction.
- Free Left Turn is allowed from KEB Junction Side to Kengeri Side of the Intersection.

3.3.1.3 Site Constraints

- Storm Water Drain of 29m wide towards Deepanjali Nagar Side and 27m wide towards Kengeri Side is present across Outer Ring Road towards KEB Junction near the Junction.

3.3.2 Veerabhadreshwara Nagar Road Junction

3.3.2.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road and is 960m away from the Mysore Road Junction. This is a typical four legged intersection in which Ring Road forms one axis and Road towards Kuvempu Nagar – Munishwar Nagar forms another axis.

The Details of the Arms forming this intersection are as follows.

Ring Road towards Mysore Road Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 45m and 56m near the Junction. The gradient is gently slopping towards the Junction. Well developed Commercial and Residential Establishments, Institutional Buildings are present along this stretch of Road.

Ring Road towards KEB Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 45m and 46m near the Junction. The gradient is slopping away from the Junction. This Stretch passes through developed Commercial and Residential Establishments on both the sides. Well known PES Institute of Technology is located at about 435m away from the Junction along this stretch of Road.

Road towards Kuvempu Nagar Side of the Intersection

This part of the Road is two lane undivided bi directional. ROW of this Road varies between 13m and 16m near the Junction. The gradient is slopping towards the Junction. Either side of this Stretch is populated with thinly developed Residential and Commercial Establishments.

Road towards Munishwar Nagar Side of the Intersection

This part of the Road is two lane undivided bi directional. ROW of this Road varies between 13m and 16m near the Junction. The gradient is slopping away from the Junction. Either side of this Stretch is thinly developed.

3.3.2.2 Existing Traffic Regulations

Two directional movements are permitted in all the three arms of the Junction. It is permitted to move from each arm towards all other two arms in the Junction.

3.3.3 KEB Junction near PESIT College

3.3.3.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road and is 800m away from the Veerabhadreshwara Nagar Junction. This is a typical three legged ('T' Shaped) intersection in which Ring Road forms one axis and Road towards Girinagar forms another axis.

The Details of the Arms forming this intersection are as follows.

Ring Road towards Mysore Road Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 43m and 59m near the Junction. The gradient is gently slopping towards the Junction. Well developed Commercial and Residential Establishments, Institutional Buildings are present along this stretch of Road. Public Service Stations such as Karnataka Power Transmission Corporation Limited (KPTCL) is present on the northern side of this stretch near the Junction.

Ring Road towards Dr. Muthuraj Road Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 31m and 40m near the Junction. The gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Road towards Girinagar Side of the Intersection

This part of the Road is two lane undivided bi directional. ROW of this Road varies between 13m and 16m near the Junction. The gradient is slopping towards the Junction. Either side of this Stretch is Vacant Land.

3.3.3.2 Existing Traffic Regulations

Two directional movements are permitted in all the three arms of the Junction. It is permitted to move from each arm towards all other two arms in the Junction.

3.3.3.3 Site Constraints

Public Service Facility such as KPTCL is present along Road towards Mysore Road Junction near the Junction and close to ROW.

3.3.4 Dr. Muthuraj Road Junction

3.3.4.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road and is 625m away from the KEB Junction. This is a typical four legged intersection in which Ring Road forms one axis and Road towards Hosakerehalli – Road towards Seetha Circle forms another axis.

The Details of the Arms forming this intersection are as follows.

Ring Road towards KEB Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 30m and 32m near the Junction. The gradient is

slopping away from the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Ring Road towards Kathriguppe Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 30m and 32m near the Junction. The gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments, Institutional Building are present along this stretch of Road.

Road towards Hosakerehalli Side of the Intersection

This part of the Road is undivided bi directional. ROW of this Road varies between 16m and 17m near the Junction. The gradient is slopping towards the Junction. Either side of this Stretch is populated with thick Residential Establishments.

Road towards Seetha Circle Side of the Intersection

This part of the Road is undivided bi directional. ROW of this Road varies between 23m and 25m near the Junction. This Stretch of Road passes through Well Developed Residential and Commercial Area.

3.3.4.2 Existing Traffic Regulations

Two directional movements are permitted in all the four arms of the Junction. It is permitted to move from each arm towards all other three arms in the Junction.

3.3.4.3 Site Constraints

Along Road towards Hosakerehalli and Road towards Seetha Circle Side Residential and Commercial Establishments are located close to ROW on either direction.

3.3.5 Janata Bazar Junction

3.3.5.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road and is 400m away from the Dr. Muthuraj Road Junction. This is a typical three legged ("T" Shaped) intersection in which Ring Road forms one axis and Ittamadu Main Road forms another axis.

The Details of the Arms forming this intersection are as follows.

Ring Road towards Dr. Muthuraj Road Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 30m and 32m near the Junction. The Ground Profile is undulated towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Ring Road towards Food World Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide central median. ROW of this Road varies between 30m and 32m. The Ground Profile is undulated towards

the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Ittamadu Main Road Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch is 9m near the Junction.

3.3.5.2 Existing Traffic Regulations

Two directional movements are permitted in all the three arms of the Junction. It is permitted to move from each arm towards other two arms in the Junction.

3.3.6 Food World Junction

3.3.6.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road and is 900m away from the Hosakerehalli Junction. This is a typical four legged intersection in which Ring Road forms one axis and Road towards Bhuvaneshwari Nagar – Road towards Vidyapeetha Circle forms another axis.

The Details of the Arms forming this intersection are as follows.

Ring Road towards Janata Bazar Junction Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 25m and 31m near the Junction. The gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Ring Road towards Kamakhya Theatre Side of the Intersection

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 30m and 32m near the Junction. The gradient is slopping away from the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Road towards Bhuvaneshwari Nagar Side of the Intersection

This part of the Road is undivided bi directional. ROW of this Road varies between 11m and 13m near the Junction. Either side of this Stretch is populated with thick Residential and Commercial Establishments.

Road towards Vidyapeetha Circle Side of the Intersection

This part of the Road is undivided bi directional. ROW of this Road varies between 24m and 25m near the Junction. This Stretch of Road passes through Well Developed Residential and Commercial Area.

3.3.6.2 Existing Traffic Regulations

Two directional movements are permitted in all the four arms of the Junction. It is permitted to move from each arm towards all other three arms in the Junction.

3.3.6.3 Site Constraints

Along Road towards Bhuvaneshwari Nagar and Road towards Vidyapeetha Circle Residential and Commercial Establishments are located very close to ROW on either direction.

3.3.7 Kamakhya Theatre Junction

3.3.7.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road and is 400m away from the Food World Junction. This is a typical four legged intersection in which Ring Road forms one axis (East – West Axis) and Road towards Chennammakere Achukattu – Road towards Uttarahalli forms another axis (North – South Axis).

The Details of the Arms forming this intersection are as follows.

Ring Road towards Food World Junction Side of the Intersection (arm on west side)

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 30m and 32m near the Junction. The gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments, Government Office Building are present along this stretch of Road.

Ring Road towards Kittur Rani Chennamma Circle Side of the Intersection (arm on east side)

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 30m and 34m near the Junction. The gradient is slopping away from the Junction. Thickly developed Commercial and Residential Establishments, years old Sree Kamakhya Cine Complex are present along this stretch of Road. Storm Water Drain of average width 15m is crossing this Road at 100m away from the Junction.

Road towards Chennammakere Achukattu Side of the Intersection (arm on north side)

This part of the Road is two lane undivided uni directional. ROW of this Road varies between 12m and 16m near the Junction. This Stretch of Road passes through Well Developed Residential and Commercial Area.

Road towards Uttarahalli Side of the Intersection (arm on south side)

This part of the Road is two lane undivided bi directional. ROW of this Road varies between 9m and 10m near the Junction. Either side of this Stretch is populated with thick Residential and Commercial Establishments.

3.3.7.2 Existing Traffic Regulations

Two directional movements are permitted in all the arms of the Junction except the Arm towards Chennammakere Achukattu. It is permitted to move from each arm towards all other arms in the Junction except the Arm towards Chennammakere Achukattu.

3.3.7.3 Site Constraints

- Storm Water Drain of average width 15m is present across Ring Road towards Kittur Rani Chennamma Circle at about 100m away from the Junction.
- Along Road towards Uttarahalli and Road towards Chennammakere Achukattu Residential and Commercial Establishments are located close to ROW on either direction.

3.3.8 Kittur Rani Chennamma Circle

3.3.8.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road and is 800m away from the Kamakhya Theatre Junction. This is a typical four legged intersection in which Ring Road forms one axis (East – West Axis) and Road towards Thyagaraj Nagar – Road towards Padmanabhanagar forms another axis (North – South Axis).

The Details of the Arms forming this intersection are as follows.

Ring Road towards Kamakhya Theatre Side of the Intersection (arm on west side)

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 27.6m and 33.8m near the Junction. The gradient is slopping towards the Junction. Thinly developed Commercial Establishments, Institutional Buildings are present along this stretch of Road.

Ring Road towards Kadirenahalli Junction Side of the Intersection (arm on east side)

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 25.8m and 27.7m near the Junction. The gradient is slopping towards the Junction. Major Public Service Stations such as Fire Station, Karnataka Power Transmission Corporation Limited (KPTCL), Bangalore Electric Supply Company (BESCOM) is present on the northern side of this stretch near the Junction. Storm Water Drain of 5m wide is present across this Road near the Junction. This stretch of Ring Road passes through major Residential Establishments on both the sides with a Vacant Land on southern side.

Road towards Thyagaraj Nagar Side of the Intersection (arm on north side)

This part of the Road is four lane divided bi directional with 0.2m wide Central Median. The ROW of this Road varies between 22.3m and 23.1m near the Junction. The gradient is slopping towards the Junction. Well Developed Residential and Commercial Establishments are present on either side of this Road.

Road towards Padmanabhanagar Side of the Intersection (arm on south side)

This part of the Road is four lane divided bi directional with 0.3m wide Central Median. ROW of this Road varies between 26m and 28.8m near the Junction. The gradient is slopping towards the Junction. Public Service Facilities such as Hospitals, Medical Clinics and Pathological Laboratory; School Buildings and thinly developed Commercial Establishments are present all along this Road. Either side of this stretch is populated

with Thick Residential Establishments. Storm Water Drain of 9m wide is present across this Road near the Junction.

3.3.8.2 Existing Traffic Regulations

Two directional movements are permitted in all the four arms of the Junction. It is permitted to move from each arm towards all other three arms in the Junction.

3.3.8.3 Site Constraints

- Storm Water Drains of 9m wide and 5m wide are respectively present across Road towards Padmanabhanagar and Kanakapura Road near the Junction.
- Public Service Facilities such as KPTCL, BESCOM, Fire Station are present along Kanakapura Road near the Junction and close to ROW.
- Along Road towards Padmanabhanagar and Road towards Thyagaraj Nagar Commercial Establishments are located close to ROW on either direction.

Tender has been finalised for the Construction of Four Lane Divided Bi Directional Flyover along Ring Road Axis.

3.3.9 Kadirenahalli Road Junction

3.3.9.1 Physical Details

Kadirenahalli Junction is one of the most important and busiest Junctions on the Outer Ring Road in South Western part of Bangalore City and is 1.1km away from the Kittur Rani Chennamma Circle. The Uttarahalli Road a radial road, which connects well known Banashankari Residential Extension and Uttarahalli via Kadirenahalli with many old and newly developed Peripheral Residential Areas. This is a four legged intersection in which Ring Road forms one axis and Uttarahalli Road forms another axis.

The Construction of Four Lane Divided Bi Directional Underpass along Ring Road Axis is under Progress.

3.3.10 Kanakapura Road Junction

3.3.10.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of South Western Part of Bangalore City on the Outer Ring Road and is 1.2km away from the Kadirenahalli Junction. This is a typical four legged intersection in which Ring Road forms one axis (East – West Axis) and Road towards Banashankari Temple – Road towards Kanakapura forms another axis (North – South Axis).

The Details of the Arms forming this intersection are as follows.

Ring Road towards Kadirenahalli Junction Side of the Intersection (arm on west side)

This part of the Road is four lane divided bi directional with 1.5m wide Central Median. ROW of this Road varies between 31m and 36m near the Junction. The gradient is slopping away from the Junction. Well Developed Residential and Commercial Establishments, Burial Ground are present on this stretch of Road.

Ring Road towards Puttenahalli Junction Side of the Intersection (arm on east side)

This part of the Road is four lane divided bi directional with 1.7m wide Central Median. ROW of this Road varies between 30m and 34m near the Junction. The gradient is slopping towards the Junction. This stretch of Ring Road passes through major Commercial Establishments on both the sides with two Vacant Lands on Northern Side.

Road towards Banashankari Temple Side of the intersection (arm on north side)

This part of the Road is four lane divided bi directional with 1.5m wide Central Median. The ROW of this Road varies between 27m and 30m near the Junction. This stretch of Road passes through Well Developed Commercial Establishments on both the sides with two Vacant Lands on Western Side and one Vacant Land on Eastern Side.

Road towards Kanakapura Side of the Intersection (arm on south side)

This part of the Road is four lane divided bi directional with 1.5m wide Central Median. ROW of this Road varies between 29m and 34m near the Junction. Either side of this Stretch is populated with Thick Residential and Commercial Establishments.

3.3.10.2 Existing Traffic Regulations

Two directional movements are permitted in all the four arms of the Junction. It is permitted to move from each arm towards all other three arms in the Junction.

3.3.11 Puttenahalli Road Junction

3.3.11.1 Physical Details

Puttenahalli Junction is one of the most important and busiest Junctions on the Outer Ring Road in Southern Part of Bangalore City and is 1.35km away from the Kanakapura Road Junction. This is a typical four legged intersection in which Ring Road forms one axis (East – West Axis) and Road towards Jayanagar – Road towards Puttenahalli forms another axis (North – South Axis).

The Construction of Four Lane Divided Bi Directional Underpass along Ring Road Axis is under Progress.

3.3.12 Dollar's Colony Junction

3.3.12.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of Southern Part of Bangalore City on the Outer Ring Road and is 1km away from the Puttenahalli Road Junction. This is a typical four legged intersection in which Ring Road forms one axis (East – West Axis) and Road towards J. P. Nagar 2nd Phase – Road towards Dollar's Colony forms another axis (North – South Axis).

The Details of the Arms forming this intersection are as follows.

Ring Road towards Puttenahalli Junction Side of the Intersection (arm on west side)

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 28m and 31m near the Junction. The gradient is slopping towards the Junction. Thickly developed Residential and Commercial Establishments are present on this stretch of Road.

Ring Road towards Bannerghatta Road Side of the Intersection (arm on east side)

This part of the road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 30m and 35m near the Junction. The gradient is slopping towards the Junction. This stretch of Ring Road passes through Thickly developed Residential and Commercial Establishments on both the sides.

Road towards J. P. Nagar 2nd Phase Side of the Intersection (arm on north side)

This part of the Road is two lane undivided bi directional. The ROW of this Road varies between 17m and 19m near the Junction. Well Developed Residential and Commercial Establishments are present on either side of this Road.

Road towards Dollar's Colony (arm on south side)

This part of the Road is two lane undivided bi directional. ROW of this Road varies between 15m and 20m near the Junction. This stretch of Road passes through thickly developed Residential and Commercial Establishments on both the sides with two Vacant Lands on Eastern Side near the Junction.

3.3.12.2 Existing Traffic Regulations

Two directional movements are permitted in all the four arms of the Junction. It is permitted to move from each arm towards all other three arms in the Junction.

3.3.13 Bannerghatta Road Junction

3.3.13.1 Physical Details

Bannerghatta Road Junction is one of the most important and busiest Junctions on the Outer Ring Road in Southern Part of Bangalore City and is 615m away from the Dollar's Colony Junction. The Bannerghatta Road is a radial road, which connects Bangalore City Centre and many newly developed Peripheral Residential and Industrial Areas. This is a three legged ('Y' Shaped) intersection in which Jayadeva Hospital Road – Bannerghatta Road forms one axis (North – South axis) and Road towards Dollar's Colony Junction forms one axis of Ring Road towards west.

The Details of the Arms forming this intersection are as follows.

Ring Road towards J. P. Nagar Side of the Intersection (arm on west side)

This part of the Road is four lane divided bi directional with 1m wide Central Median. ROW of this Road varies between 30.3m and 30.6m near the Junction. The gradient is slopping away from the Junction. Well Developed Commercial and Residential Establishments, a Temple are present on this stretch of Road.

Jayadeva Hospital Road Side of the Intersection (arm on north side)

This part of the Road is four lane divided bi directional with 0.3m wide Central Median. ROW of this Road varies between 36.35m and 44.5m near the Junction. The gradient is slopping towards the Junction. This stretch of Ring Road passes through Major Residential and Commercial Establishment on both the sides with Well Established Temples on both sides and a Slum spread over a large area on the Eastern Side.

Bannerghatta Road Side of the Intersection (arm on south side)

This part of the Road is four lane divided bi directional with 1.5m wide Central Median. ROW of this Road varies between 20.6m and 24.5m near the Junction. The gradient is slopping away from the Junction. Either side of this stretch is populated with Thick Residential and Commercial Establishments.

3.3.13.2 Existing Traffic Regulations

Two directional movements are permitted in all the three arms of the Junction. It is permitted to move from each arm towards all other two arms in the Junction.

3.3.13.3 Site Constraints

- BESCOM Lines are present along all the three arms near the Junction and close to ROW.
- Transformer is present near the Junction on Ring Road Axis towards Dollar's Colony Junction.
- Well Established Temples are present along all the three arms near the Junction.
- A Well Established Slum spread over a large area on the Eastern Side of Arm towards Jayadeva Hospital Road very close to the Junction is present.

3.3.14 Jayadeva Hospital Junction

3.3.14.1 Physical Details

Jayadeva Hospital Junction is one of the most important and busiest Junctions on the Outer Ring Road in Southern Part of Bangalore City and is 1.05km away from the Bannerghatta Road Junction. This is a typical four legged intersection in which Road towards Udupi Garden Junction – Road towards Jayanagar forms one axis (East – West Axis) and Road towards Dairy Circle – Bannerghatta Road forms another axis (North – South Axis). The Junction is located in Thickly Developed Residential and Commercial Area. The well known Jayadeva Institute of Cardiology and Jayadeva Cardiac Hospital are located on the Northern Side of this Junction.

Road towards Udupi Garden Junction – Road towards Jayanagar

Four lane undivided uni directional Flyover is present along this Stretch. Uni directional Traffic Flow is permitted over the Flyover from Jayanagar Side to Udupi Junction Side.

Road towards Dairy Circle – Bannerghatta Road

Four lane divided bi directional Underpass is present along this Stretch. Service Road of 7.5m wide is present on either side of Road towards Dairy Circle Side. Towards

Bannerghatta Road Side, Service Roads of respective width of 10.5m and 6m are present on the Eastern and Western Sides.

3.3.15 Udupi Garden Junction

3.3.15.1 Physical Details

This Junction is located in Well Developed Residential and Commercial Area of Southern Part of Bangalore City on the Outer Ring Road and is 1.1km away from the Jayadeva Hospital Junction. This is a typical four legged intersection in which Ring Road forms one axis (East – West Axis) and Road towards Madiwala – Road towards BTM Layout forms another axis (North – South Axis).

The Details of the Arms forming this intersection are as follows.

Ring Road towards Jayadeva Hospital Junction Side of the Intersection (arm on west side)

This part of the Road is divided bi directional with 0.7m wide Central Median. The Carriageway of this stretch of the Road is not uniform. The width of Carriageway from the Junction towards Jayadeva Hospital Side is 8.7m and from Jayadeva Hospital Side towards Junction is 22.01m. The additional width is the Carriageway is due to coverage of drain along the Road. ROW of this Road varies between 30m and 44m near the Junction. The gradient is slopping towards the Junction. Thickly developed Residential and Commercial Establishments are present on this stretch of Road.

Ring Road towards Central Silk Board Junction Side of the Intersection (arm on east side)

This part of the road is divided bi directional with 1m wide Central Median. The Carriageway of this stretch of the Road is also not uniform. The width of Carriageway from the Junction towards Central Silk Board Junction Side is 10.7m and from Central Silk Board Junction Side towards Junction is 8.9m. ROW of this Road varies between 30m and 39m near the Junction. The gradient is slopping away from the Junction. This stretch of Ring Road passes through Well Developed Residential and Commercial Establishments on both the sides.

Road towards Madiwala Side of the intersection (arm on north side)

This part of the Road is undivided bi directional. The Carriageway width along this Stretch is 21m near the Junction. The ROW of this Road varies between 18m and 26m near the Junction. Well Developed Residential Establishments are present on either side of this Road.

Road towards BTM Layout (arm on south side)

This part of the Road is two lane divided bi directional with 0.5m wide Central Median. ROW of this Road varies between 18m and 20m near the Junction. This stretch of Road passes through Thickly developed Residential and Commercial Establishments on both the sides.

3.3.15.2 Existing Traffic Regulations

Two directional movements are permitted in all the fours of the Junction. It is permitted to move from each arm towards all other three arms in the Junction.

3.3.15.3 Constraints

- Drain along Road towards Jayadeva Hospital Junction is present near the Junction.
- Along Road towards BTM Layout Commercial Establishments are located close to ROW on either direction.

3.3.16 Central Silk Board Junction

3.3.16.1 Physical Details

Central Silk Board Junction is one of the most important and busiest Junctions on the Outer Ring Road in Southern Part of Bangalore City and is 1.4km away from the Udupi Garden Junction. This is a typical four legged intersection in which Ring Road (Road towards Udupi Garden Junction – Sarjapura Road) forms one axis (East – West Axis) and Road towards Madiwala – Hosur Road forms another axis (North – South Axis). The Junction is located in Thickly Developed Residential and Commercial Area. Six lane divided bi directional Flyover is present along Madiwala – Hosur Road.

Road towards Udupi Garden Junction is six lane divided bi directional with 0.5m wide Central Median. ROW of this Road varies between 30m and 35m near the Junction.

The Flow of Vehicles at all the Junctions is controlled by Automated Traffic Signal manned with Traffic Police Personnel.

Topographical Maps of all the sixteen (16) 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 adequate. Though there are sufficient number of Street Lighting provided along the Project Corridor, the presence of Road Side Trees in close proximity to the Light Poles obstruct the effective illumination.

3.5 Bus Stops

The presence of Bus Stops on the Intersecting Arms of the Junctions inside the Carriageway hinders the smooth traffic movement along the Intersecting Arms of the Project Junctions.

3.6 Pedestrian Movement

The presence of Bus Stops, Educational Institutions, Government Offices, Well Developed Commercial Areas 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 on the Footpath reduces the Effective Width of the Footpath and in turn obstructs the Pedestrian Movement.

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**

Motorised Traffic		Non – Motorised Traffic
2 – Wheelers, Auto Rickshaw, Passenger Car: Car, Taxi and Jeep		Bicycle, Cycle Rickshaw, Animal Drawn Vehicle, Hand Drawn Cart
Utility Vehicle: Van and Tempo		
Bus	Mini Bus Standard Bus	
Truck	Light Commercial Vehicle (LCV)	
	Heavy Commercial Vehicle (HCV)	
Farm Vehicle	Agricultural Tractor (AgT)	
	Agricultural Tractor & Trailer (AgTT)	

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	
		Upto 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 K.E.B Junction near PESIT College

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 457 – 8799 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1100 hrs. in the morning (8799 PCU) and 1800 – 1900 hrs. in the evening (7798 PCU). This Junction handles more than 5000 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 K.E.B Junction is given in **Annexure A.4.1**.

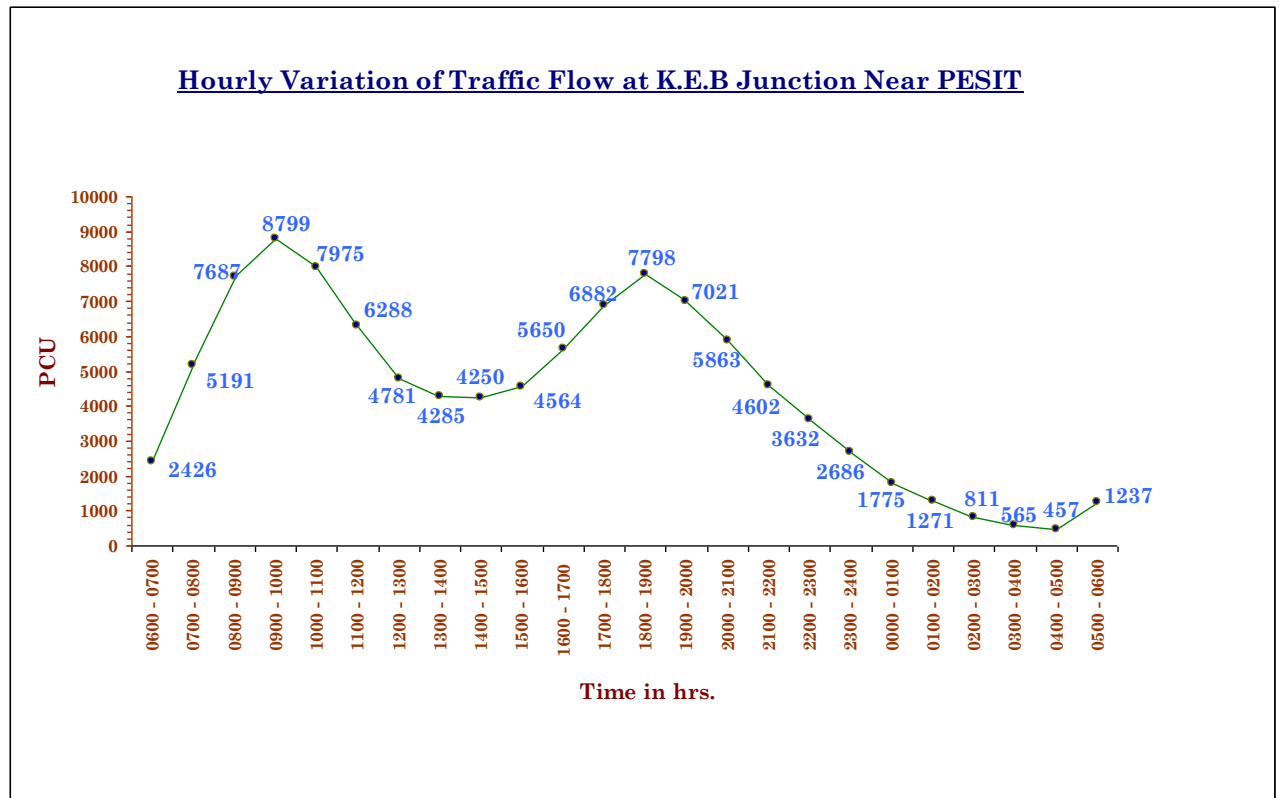


Fig. 4.1

4.5.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.2** for K.E.B Junction. The major flow is along Outer Ring Road in which current Peak Hour Flow is 4538 PCU, which amounts to 51.57% of Junction Volume.

4.5.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at K.E.B Junction and is shown in **Fig. 4.3**. Share of Two Wheelers is high (37.08%). 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 54.89% while Buses account for 5.63%.
- **Freight Vehicle Category:** LCV constitutes 1.62%.
- **Non Motorised Vehicle Category:** Cycle constitutes 0.58%.

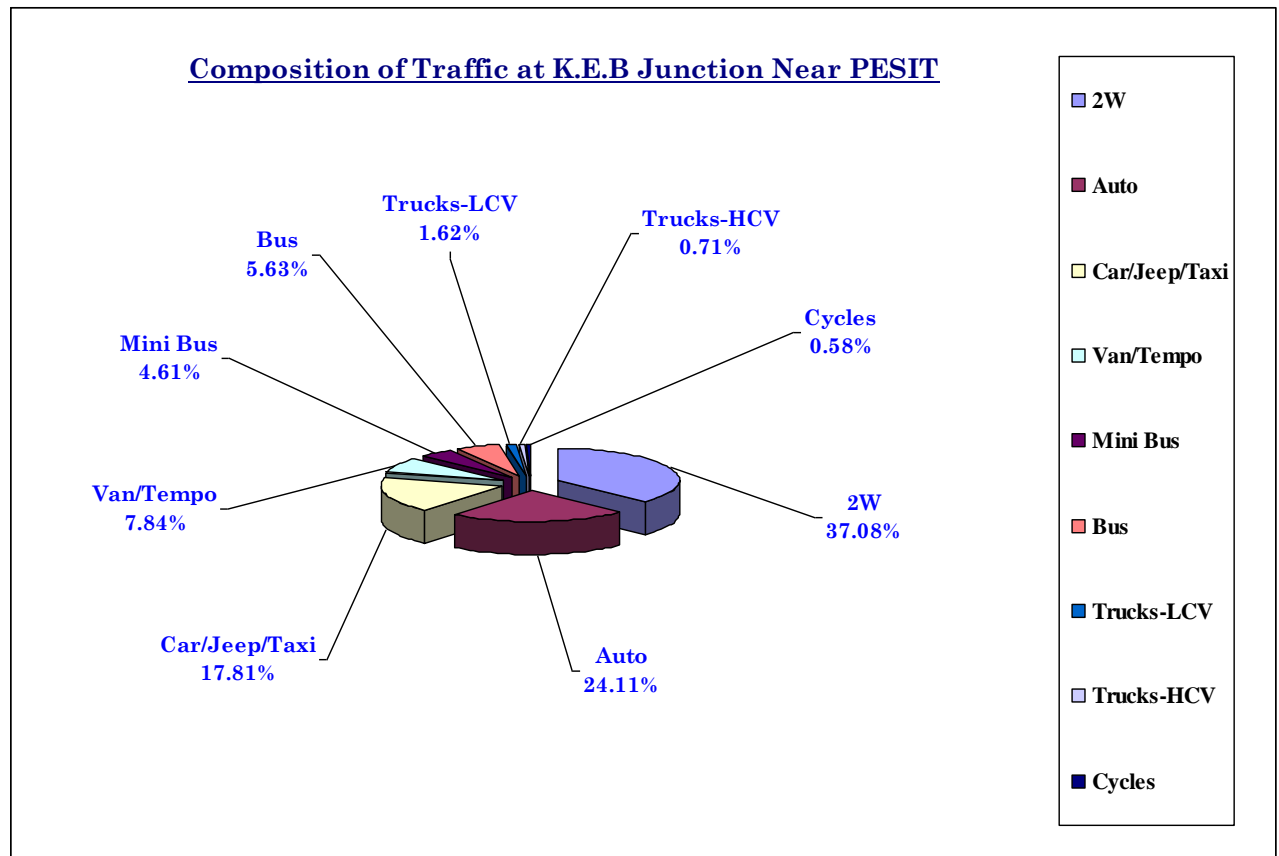


Fig. 4.3

4.6 Dr. Muthuraj Road Junction

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 511 – 9680 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1100 hrs. in the morning (9680 PCU) and 1800 – 1900 hrs. in the evening (8517 PCU). This Junction handles more than 5500 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 Dr. Muthuraj Road Junction is given in **Annexure A.4.2**.

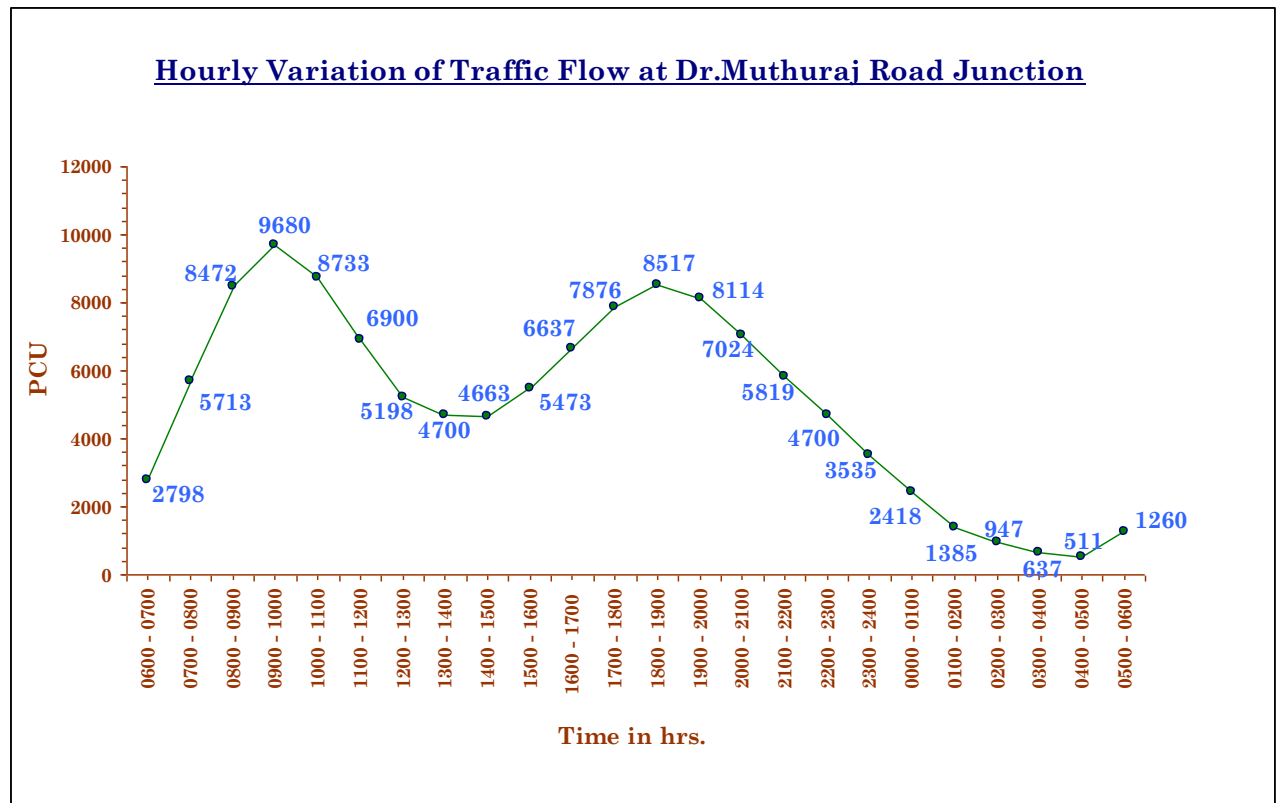


Fig. 4.4

4.6.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.5** for Dr. Muthuraj Road Junction. The major flow is along Outer Ring Road in which current Peak Hour Flow is 3897 PCU, which amounts to 40.25% of Junction Volume.

4.6.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Dr. Muthuraj Road Junction and is shown in **Fig. 4.6**. Share of Two Wheelers is high (40.21%). 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 57.2% while Buses account for 5.49%.
- **Freight Vehicle Category:** LCV constitutes 1.54%.
- **Non Motorised Vehicle Category:** Cycle constitutes 0.55%.

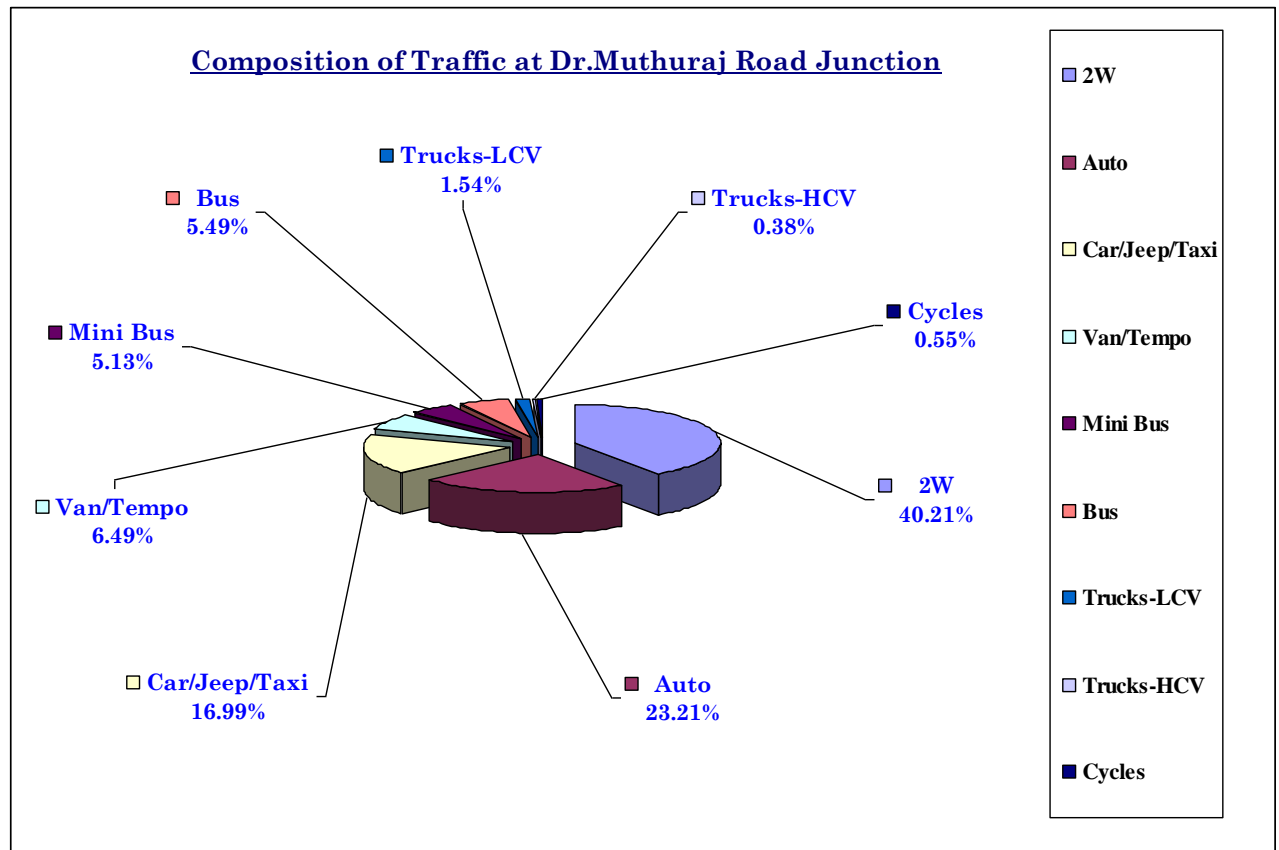


Fig. 4.6

4.7 Food World 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 553 – 10191 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1100 hrs. in the morning (10191 PCU) and 1800 – 1900 hrs. in the evening (9396 PCU). This Junction handles more than 6500 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 Food World Junction is given in **Annexure A.4.3**.

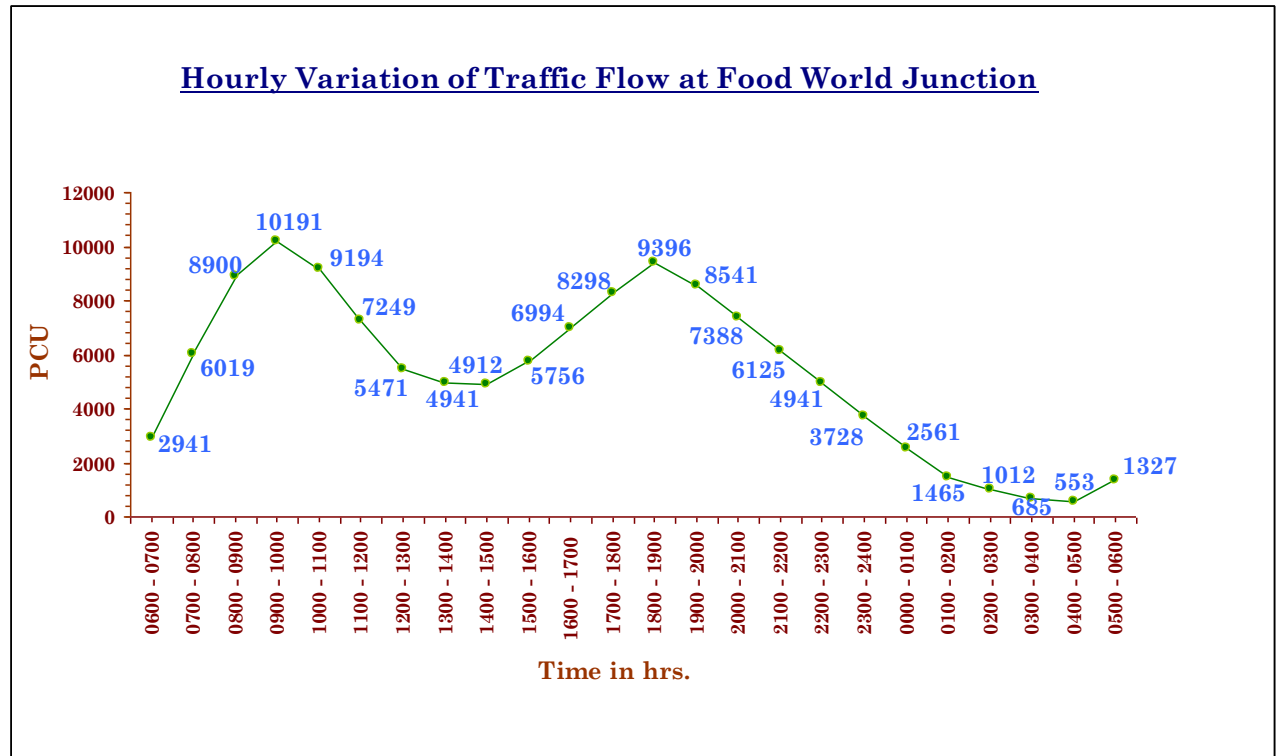


Fig. 4.7

4.7.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.8** for Food World Junction. The major flow is along Outer Ring Road in which current Peak Hour Flow is 3885 PCU, which amounts to 38.12% of Junction Volume.

4.7.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Food World Junction and is shown in **Fig. 4.9**. Share of Two Wheelers is high (38.73%). 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 54.91% while Buses account for 5.84%.
- **Freight Vehicle Category:** LCV constitutes 2.09%.
- **Non Motorised Vehicle Category:** Cycle constitutes 0.53%.

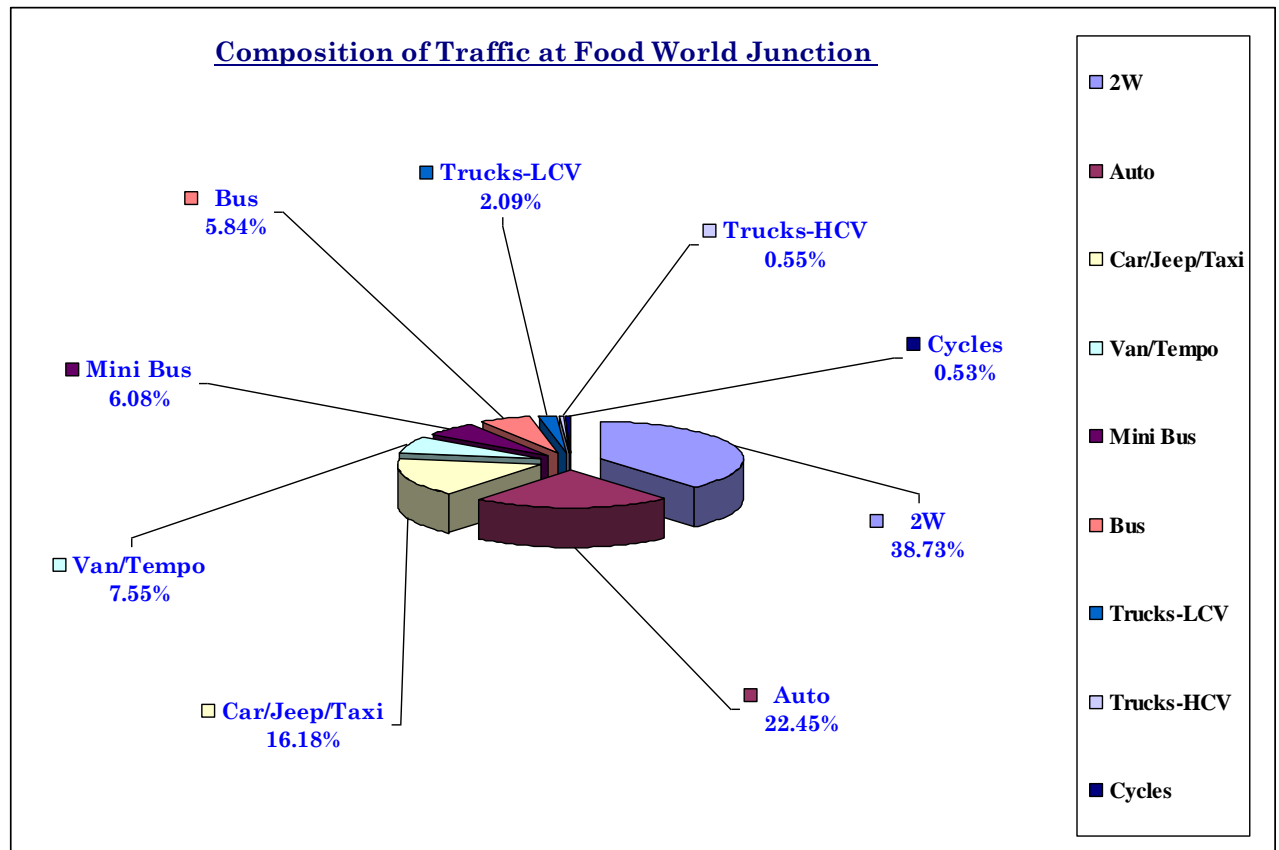


Fig. 4.9

4.8 Kamakhya Theatre 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 541 – 10289 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1100 hrs. in the morning (10289 PCU) and 1800 – 1900 hrs. in the evening (8749 PCU). This Junction handles more than 5500 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 Kamakhya Theatre Junction is given in **Annexure A.4.4**.

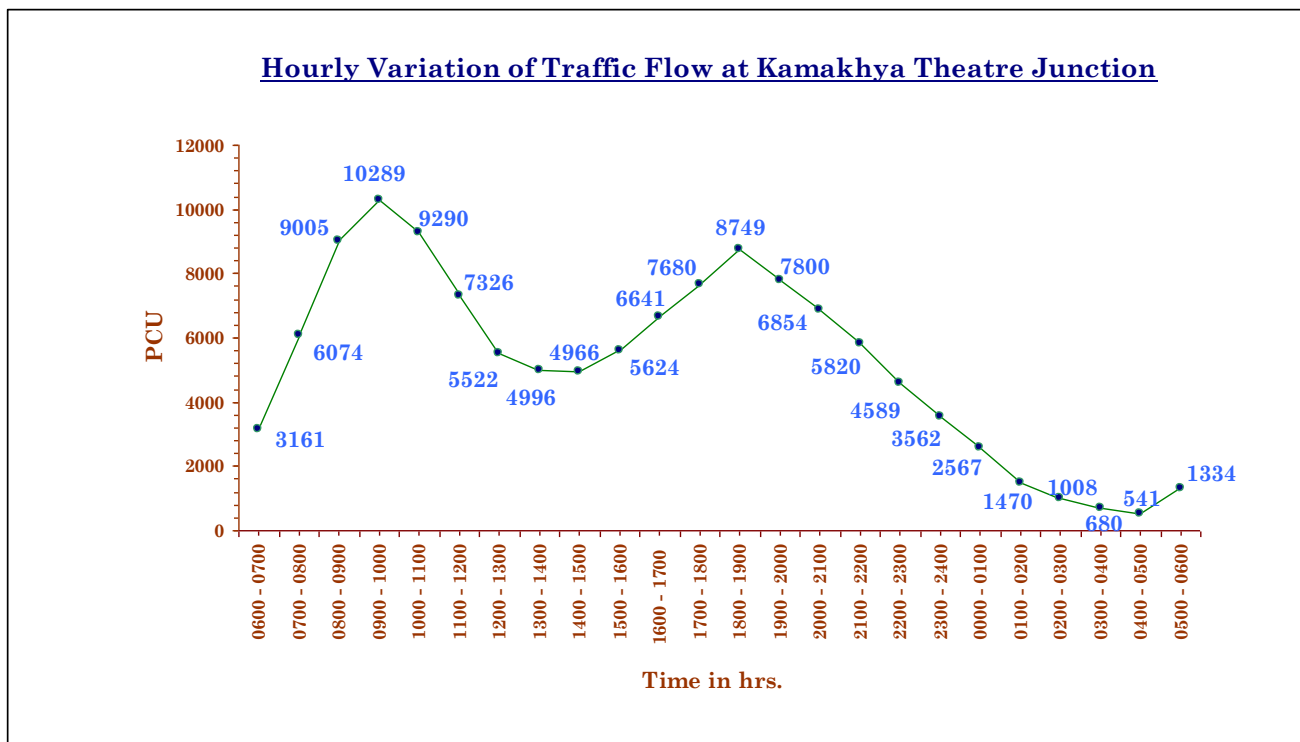


Fig. 4.10

4.8.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.11** for Kamakhya Theatre Junction. The major flow is along Outer Ring Road in which current Peak Hour Flow is 4411 PCU, which amounts to 42.87% of Junction Volume.

4.8.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Kamakhya Theatre Junction and is shown in **Fig. 4.12**. Share of Two Wheelers is high (39.67%). 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 57.07% while Buses account for 4.2%.
- **Freight Vehicle Category:** LCV constitutes 1.67%.
- **Non Motorised Vehicle Category:** Cycle constitutes 0.49%.

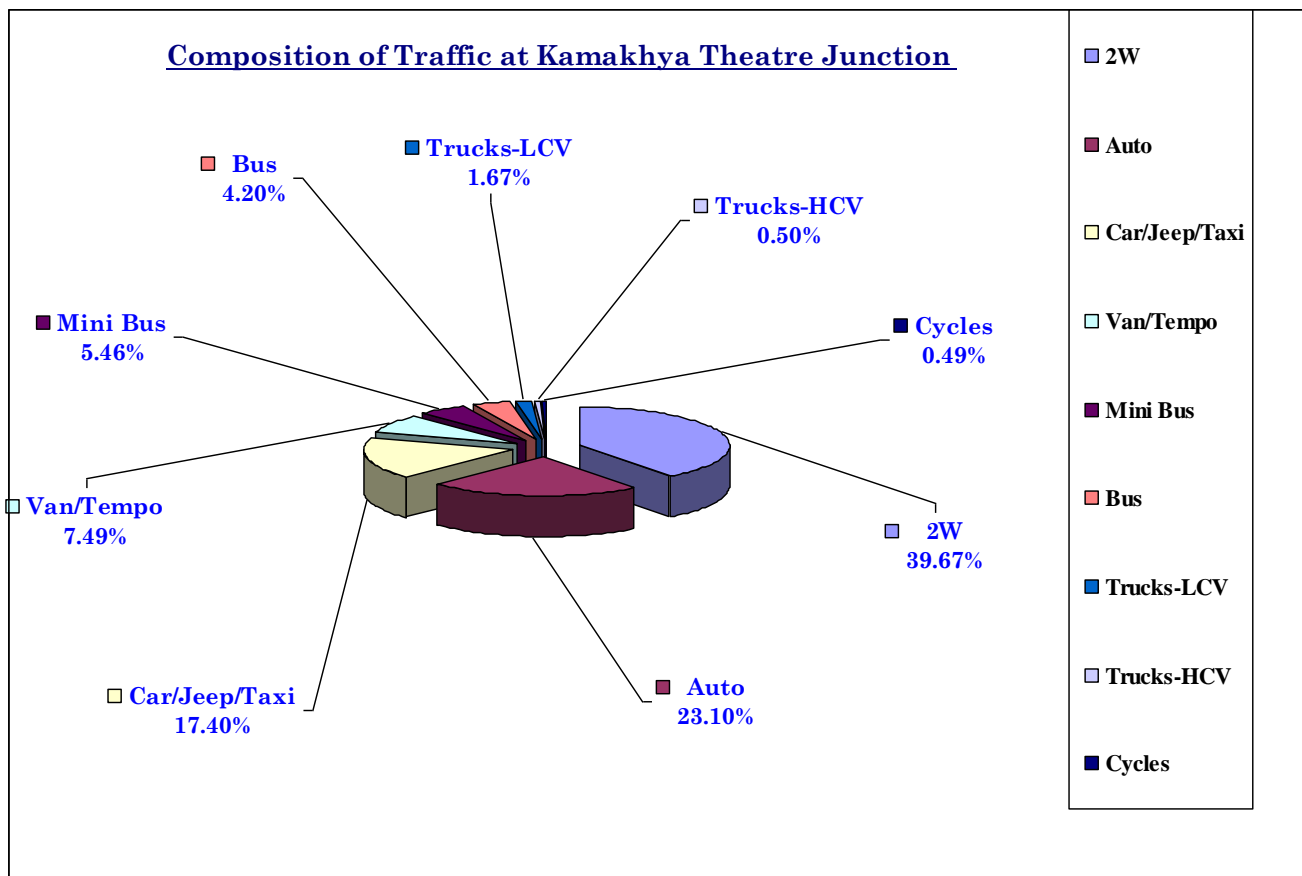


Fig. 4.12

4.9 Kanakapura Road Junction

4.9.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.13**. The Hourly Traffic Volume observed at the Junction varied in the range of 739 – 14105 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1100 hrs. in the morning (14105 PCU) and 1800 – 1900 hrs. in the evening (12423 PCU). This Junction handles more than 6500 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 Kanakapura Road Junction is given in **Annexure A.4.5**.

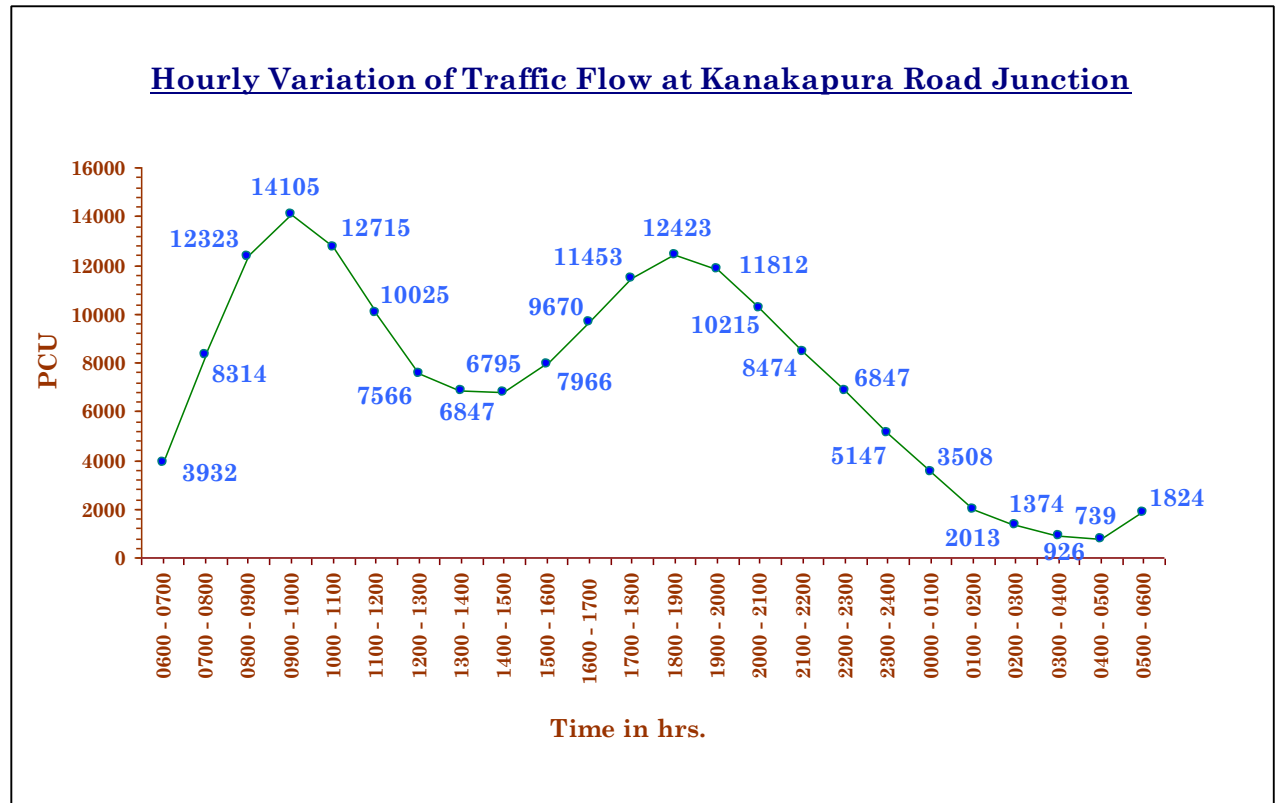


Fig. 4.13

4.9.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.14** for Kanakapura Road Junction. The major flow is along Outer Ring Road in which current Peak Hour Flow is 4055 PCU, which amounts to 28.74% of Junction Volume.

4.9.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Kanakapura Road Junction and is shown in **Fig. 4.15**. Share of Two Wheelers is high (36.91%). 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 53.83% while Buses account for 5.45%.
- **Freight Vehicle Category:** LCV constitutes 2.39%.
- **Non Motorised Vehicle Category:** Cycle constitutes 0.44%.

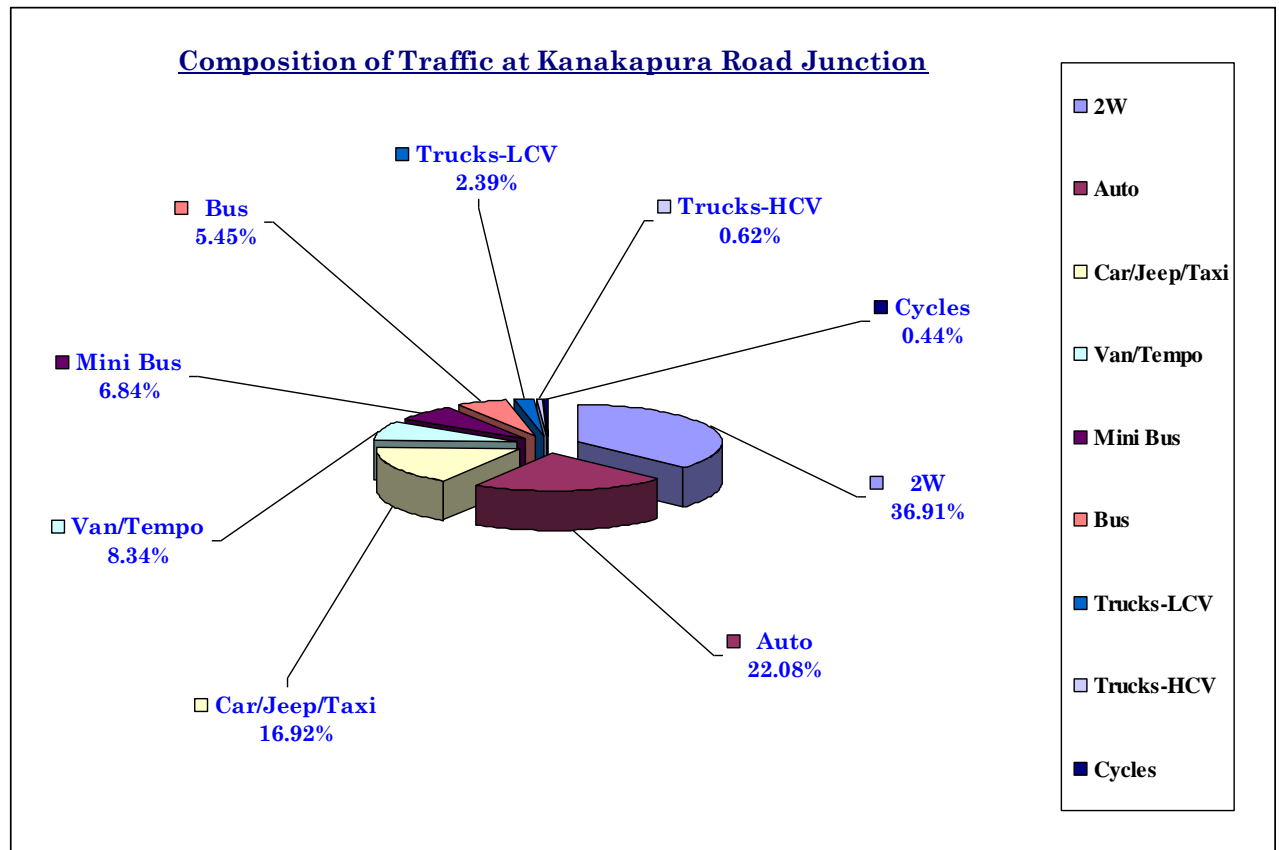


Fig. 4.15

4.10 Dollar's Colony Junction

4.10.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.16** The Hourly Traffic Volume observed at the Junction varied in the range of 446 – 8208 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1100 hrs. in the morning (8208 PCU) and 1800 – 1900 hrs. in the evening (7768 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 Dollar's Colony Junction is given in **Annexure A.4.6**.

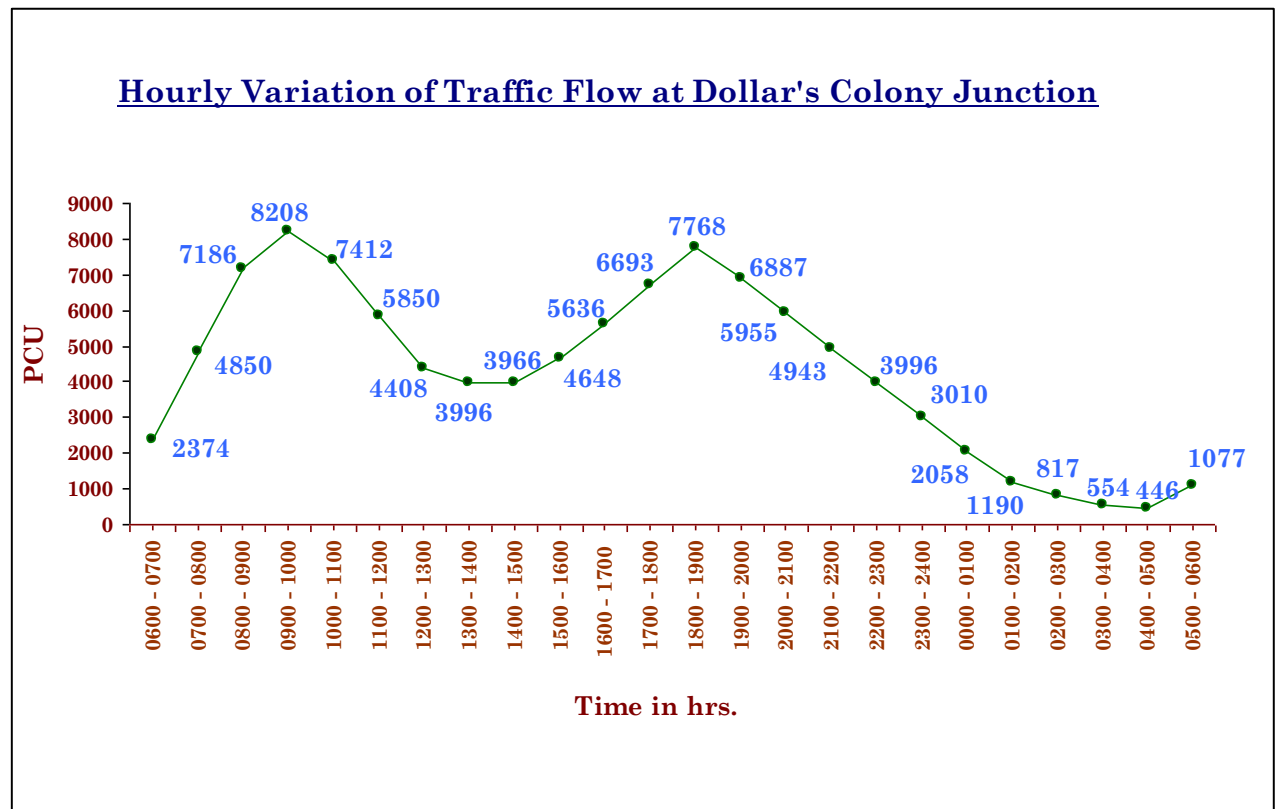


Fig. 4.16

4.10.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.17** for Dollar's Colony Junction. The major flow is along Outer Ring Road in which current Peak Hour Flow is 3026 PCU, which amounts to 38.95% of Junction Volume.

4.10.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Dollar's Colony Junction and is shown in **Fig. 4.18**. Share of Two Wheelers is high (38.93%). 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 56.47% while Buses account for 4.98%.
- **Freight Vehicle Category:** LCV constitutes 1.45%.
- **Non Motorised Vehicle Category:** Cycle constitutes 0.68%.

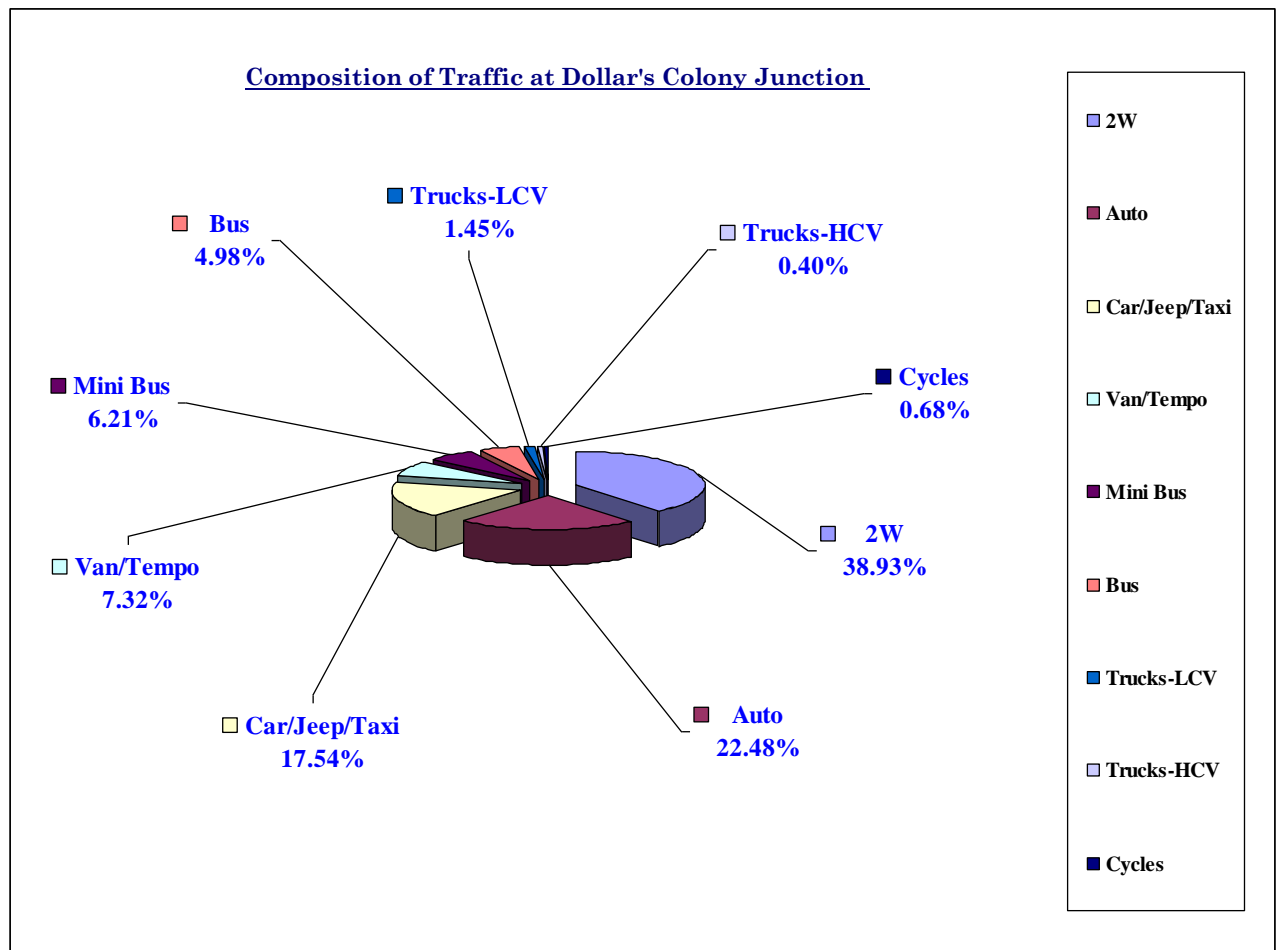


Fig. 4.18

4.11 Udupi Garden Junction

4.11.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.19**. The Hourly Traffic Volume observed at the Junction varied in the range of 654 – 12508 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1100 hrs. in the morning (12508 PCU) and 1800 – 1900 hrs. in the evening (11124 PCU). This Junction handles more than 7000 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 Udupi Garden Junction is given in **Annexure A.4.7**.

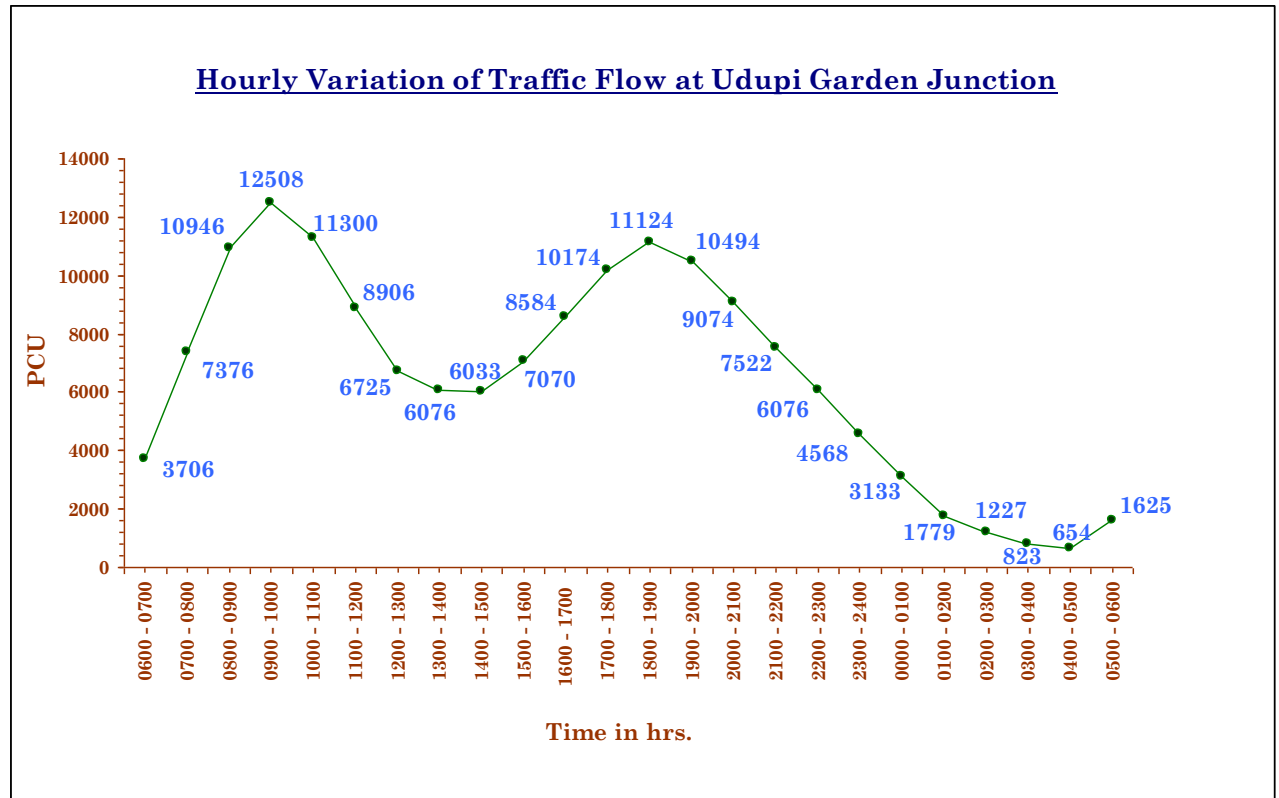


Fig. 4.19

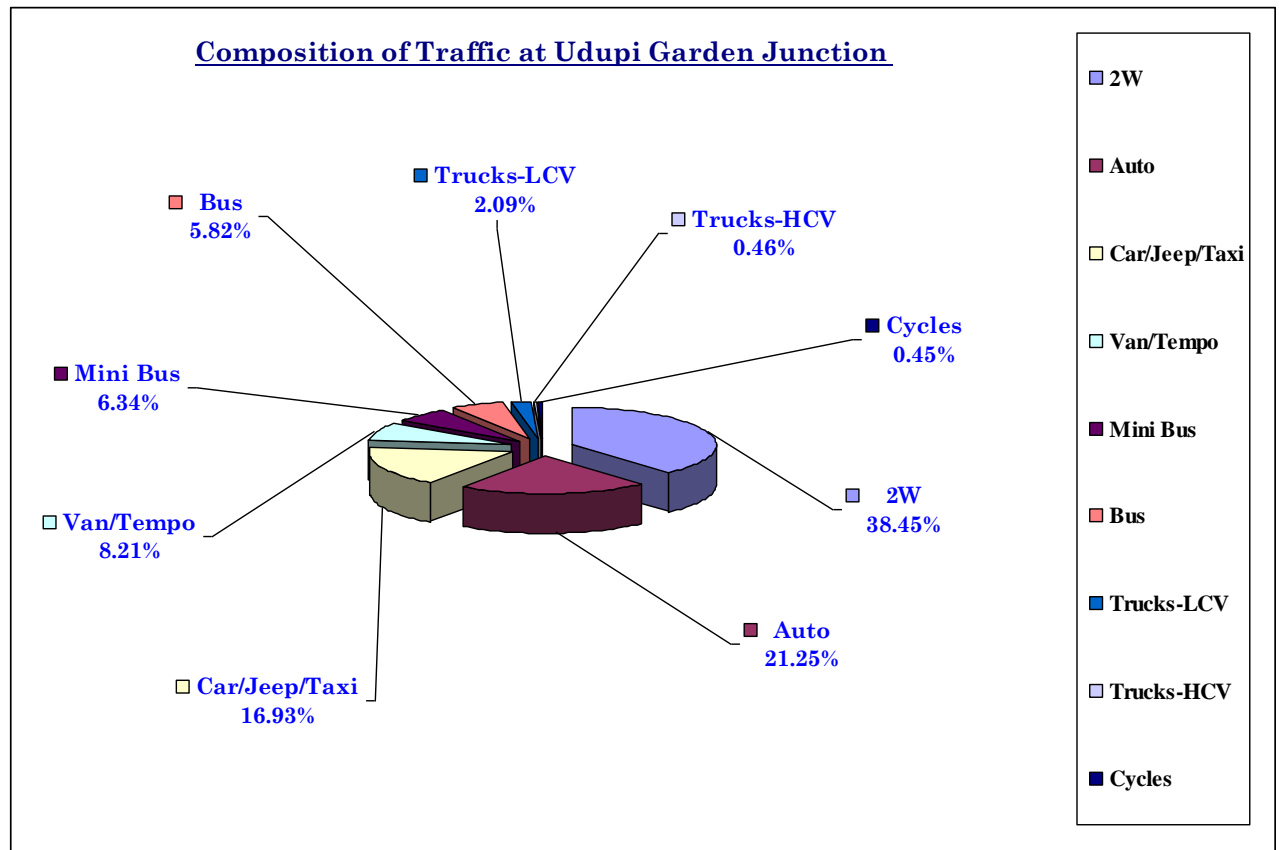
4.11.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.20** for Udupi Garden Junction. The major flow is along Outer Ring Road in which current Peak Hour Flow is 4879 PCU, which amounts to 39.02% of Junction Volume.

4.11.3 Traffic Composition

Composition of Traffic (on 24 hour basis) has been observed at Udupi Garden Junction and is shown in **Fig. 4.21**. Share of Two Wheelers is high (38.45%). 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 55.38% while Buses account for 5.82 %.
- **Freight Vehicle Category:** LCV constitutes 2.09%.
- **Non Motorised Vehicle Category:** Cycle constitutes 0.45%.



4.12 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 13 – Drawings**.

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

4.13 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.4.8.**

- K.E.B Junction near PESIT College.
- Dr. Muthuraj Road Junction.
- Food World Junction.
- Kamakhya Theatre Junction.
- Kanakapura Road Junction.
- Dollar's Colony 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**.

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	
	• Median	1m
	• Footpath at grade level	3m
	• 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, 5.5m.
	• At – grade junction	IRC: SP: 41 – 1994 – “Guidelines on Design of At Grade Intersections in Rural and 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 / on Grade Separator 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 / on the Grade Separator 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 Junctions, Link Improvements such as Provision of Footpath, etc. For the near future, BBMP is having the plan to widen this Corridor to 45m and then the Provisions of Dedicated Bus Bays and Pedestrian Subway will be taken care of. Other Improvements such as Improvements to Drainage System, Provision of Effective Illumination, Lane Marking, Provision of Studs and Delineators, etc. have been accommodated in the Project Proposal.

The Concept proposed for each Project Junction has been presented to the Technical Advisory Committee (TAC), BBMP and based on the suggestion / instruction by the TAC, the Concepts for each Junction has been finalised and accordingly approved by the TAC. The Approved Concept for each Junction is briefly explained below.

6.2 Mysore Road Junction

Bangalore Development Authority has taken up this Junction for Improvement. Hence, no other Improvement has been proposed for this Junction in the present DPR.

6.3 Veerabhadreshwara Nagar Junction

This Junction is included in NICE Corridor Scheme. Hence, no other Improvement has been proposed for this Junction in the present DPR.

6.4 KEB Junction near PESIT College

At this Junction, a 2 lane uni directional Flyover has been proposed along Outer Ring Road for the traffic from Mysore Road Junction Side to Dr. Muthuraj Road Junction Side with Slip Road and 3m wide Footpath on either side of Outer Ring Road at Grade Level.

Following are the Salient Features of the Flyover at KEB Junction.

• Total Length of Flyover	263.71m.
• Number of Lane	2 lane uni directional
• Carriageway Width	7.5m
• Length of Obligatory Span	30m
• Vertical Clearance	4.5m
• Ruling Gradient	5%
• Length of Viaduct towards Mysore Road Junction	40m
• Length of Solid Ramp towards Mysore Road Junction	81.16m
• Length of Viaduct towards Dr. Muthuraj Road Junction	40m
• Length of Solid Ramp towards Dr. Muthuraj Road Junction	72.55m
• Required Land Acquisition	3210.04 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / KEBJ / GAD / 402** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / KEBJ / LA / 404**.

6.5 Dr. Muthuraj Road Junction

At this Junction, a four lane divided bi directional Underpass with 1m wide Central Median has been proposed along Outer Ring Road with 10.4m wide Slip Road and 3m wide Footpath on either side of Outer Ring Road at Grade Level.

Following are the Salient Features of the Underpass at Dr. Muthuraj Road Junction.

• Length of Underpass	273.9m
• Number of Lane	4 lane divided bi directional
• Carriageway Width	7.5m X 2
• Vertical Clearance	5.5m
• Length of Covered Portion	30m
• Ruling Gradient	5%
• Length of Approach Ramp towards KEB Junction	77.86m
• Length of Approach Ramp towards Janata Bazar Junction	166.04m
• Required Land Acquisition	7964.84 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / MRJ / GAD / 502** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / MRJ / LA / 504**.

6.6 Janata Bazar Road Junction

Dedicated U Turn of Turning Radius 11.5m with Physical Separator has been proposed near this Junction with 3m wide Footpath on either side of the Outer Ring Road. To accommodate all these Provisions, 4456.47 Sqm of Land needs to be acquired.

Concept Plan is presented in **Drawing No. MC / BBMP / JBJ / CP / 602** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / JBJ / LA / 603**.

6.7 Food World Junction

At this Junction, a four lane divided bi directional Underpass with 1m wide Central Median has been proposed along Outer Ring Road with 10.4m wide Slip Road and 3m wide Footpath on either side of Outer Ring Road at Grade Level.

Following are the Salient Features of the Underpass at Food World Junction.

• Total Length of Underpass	204.09m.
• Number of Lane	4 lane divided bi directional
• Carriageway Width	7.5m X 2
• Length of Covered Portion	35m
• Vertical Clearance	5.5m

• Ruling Gradient	5%
• Length of Approach Ramp towards Dr. Muthuraj Road Junction	109.95m
• Length of Approach Ramp towards Kamakhya Theatre Junction	59.14m
• Required Land Acquisition	7008.74 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / FWJ / GAD / 702** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / FWJ / LA / 704**.

6.8 Kamakhya Theatre Junction

Dedicated U Turn of Turning Radius 11.5m with Physical Separator has been proposed near this Junction with 3m wide Footpath on either side of the Outer Ring Road. To accommodate all these Provisions, 5658.69 Sqm of Land needs to be acquired.

Concept Plan is presented in **Drawing No. MC / BBMP / KJ / CP / 802** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / KJ / LA / 803**.

6.9 Between Kadirenahalli Road Junction and Kanakapura Road Junction

Dedicated U Turn of Turning Radius 11.5m with Physical Separator at a distance of 600m away from Kadirenahalli Road Junction along with 3m wide Footpath on either side of the Outer Ring Road has been proposed. To accommodate all these Provisions, 387.99 Sqm of Land needs to be acquired.

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / KJ&KRJ / CP / 1102** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / KJ&KRJ / LA / 1103**.

6.10 Kanakapura Road Junction

At this Junction, a four lane divided bi directional Underpass with 1m wide Central Median has been proposed along Outer Ring Road with 10.4m wide Slip Road and 3m wide Footpath on either side of Outer Ring Road at Grade Level.

Followings are the Salient Features of the Underpass at Kanakapura Road Junction.

• Total Length of Underpass	281.81m.
• Number of Lane	4 lane divided bi directional
• Carriageway Width	7.5m X 2
• Length of Covered Portion	35m
• Vertical Clearance	5.5m
• Ruling Gradient	5%
• Length of Approach Ramp towards Kadirenahalli Road Junction	83.81m
• Length of Approach Ramp towards Puttenahalli Road Junction	163m

- Required Land Acquisition 5453.26 Sqm.

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / KRJ / GAD / 1202** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / KRJ / LA / 1204**.

6.11 Dollar's Colony Junction

At this Junction, a four lane divided bi directional Flyover with 1m wide Central Median has been proposed along Outer Ring Road with 11m wide Slip Road and 3m wide Footpath on either side of Outer Ring Road at Grade Level.

Followings are the Salient Features of the Flyover at Dollar's Colony Junction.

- Total Length of Flyover 291.48m
- Number of Lane 4 lane divided bi directional
- Carriageway Width 7.5m X 2
- Obligatory Span 30m
- Vertical Clearance 4.5m
- Ruling Gradient 5%
- Length of Viaduct towards Puttenahalli Road Junction 40m
- Length of Solid Ramp towards Puttenahalli Road Junction 102.42m
- Length of Viaduct towards Bannerghatta Road Junction 40m
- Length of Solid Ramp towards Bannerghatta Road Junction 79.06m
- Required Land Acquisition 6039.8 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / DCJ / GAD / 1402** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / DCJ / LA / 1404**.

6.12 Bannerghatta Road Junction

BBMP has taken up this Junction in other Phase of Corridor Improvement Scheme (Proposed Signal Free Corridor from Hosur Luskar Road Junction to Hulimavu Gate Junction along Bannerghatta Road). Hence, no other Improvement has been proposed for this Junction in the present DPR.

6.13 Udipi Garden Junction

At this Junction, a four lane divided bi directional Flyover with 1m wide Central Median has been proposed along Outer Ring Road with 11m wide Slip Road and 3m wide Footpath on either side of Outer Ring Road at Grade Level.

Followings are the Salient Features of the Flyover at Udupi Garden Junction.

• Total Length of Flyover	458.48m
• Number of Lane	4 lane divided bi directional
• Carriageway Width	7.5m X 2
• Obligatory Span	35m
• Vertical Clearance	4.5m
• Ruling Gradient	5%
• Length of Viaduct towards Jayadeva Hospital Junction	40m
• Length of Solid Ramp towards Jayadeva Hospital Junction Side	80.47m
• Length of Viaduct towards Central Silk Board Junction	120m
• Length of Solid Ramp towards Central Silk Board Junction	183.01m
• Required Land Acquisition	6282.69 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / UGJ / GAD / 1702** and Land Acquisition Details are presented in **Drawing No. MC / BBMP / UGJ / LA / 1704**.

6.14 Pedestrian Crossing

The Pedestrian Crossing across the Study Corridor is considerable and the No. is quite significant near PESIT College, Food World Junction, Kamakhya Theatre, Jayadeva Hospital, Central Silk Board. As BBMP is having its near future plan to provide Pedestrian Subways hence for the time being Pedestrian Crossing has been proposed to be managed by Signalled Zebra Crossing.

6.15 Bus Bays

The presence of existing Bus Stops in the Carriageway near many Junctions are causing bottlenecks and creating obstruction to the flow of other Vehicular Movements. Provision of Dedicated Bus Bays will be accommodated in the Corridor Widening Project.

CHAPTER 7

DESIGN OF GRADE SEPARATOR

7.1 Planning and Investigations

The Corridor Improvement Scheme has been discussed in detail in Chapter 6. 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 Loads

1. Live Load

Class 70R Loading has been considered.

2. Wind Force

Wind Forces have been considered in the following two ways. The design shall be governed by the one producing the worst effect.

- Full wind force at right angles to the superstructure.
- 65% of wind force as calculated above acting perpendicular to the superstructure and 35% acting in traffic direction.

The appropriate wind force on 10m high Lighting Poles @ 30m c/c. has been considered in the design.

3. Seismic Force

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

4. Earth pressure

- The Soil Properties for Embankment like Dry Density of Soil 1.85 t / cum.; Saturated Density 2.00 t / cum.; $\Phi = 30^\circ$ 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.

5. Temperature Range

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

$$(DL) = \alpha Lt,$$

The value of “t” shall be $\pm 17^{\circ}\text{C}$.

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 Design of Underpass

7.4.1 General

The Length of the Underpass has been determined based on the Depth of Deck Slab, where a minimum Vertical Clearance of 5.5m 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. Based on the Economy of the Project and Site Condition, the Covered Portion of the proposed Underpass has been designed as cast – in – situ 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**.

7.4.2 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 Design of Flyover

7.5.1 General

The length of the Flyover has been determined by the depth of the superstructure of the Obligatory Span, where a minimum vertical clearance of 4.5m has to be provided. The roads in the project area have a number of underground services like water, sewer, electricity, etc. and diverting these service lines are not so easy and hence the foundation has been designed in such a way that there will be minimum obstruction for executing the work. Hence, Open Foundation, though economical is not considered, as it requires shoring as well as temporary support to service lines in addition to prolonged time of construction. Further, diversions of these services have been programmed to carry out prior to the execution work.

The depth of pile has been taken as 15m in the cost estimate upon the cut off level. The boreholes shall be taken at the time of execution one at each pier and one at each

abutment prior to the commencement of the work. The termination level of the borehole shall be determined by conducting SPT tests. Three consecutive SPT tests at an interval of 1.5m each with 'N' values greater than 100 shall be carried out before termination. If rock is encountered, drilling shall continue upto 3m in rock with rock samples taken for testing. All the soil / sub soil investigations shall be strictly in accordance with the relevant code provisions.

While checking the stresses at the base of foundations it has to be ensured that under the worst combination of forces no tension is permitted. The safe bearing capacity at the foundation level shall be verified during construction so that to ensure that the stresses imposed on the foundation strata are within permissible limits.

7.5.2 Foundation

With the presence of underground services and foundation of adjoining existing structures, Open Foundation is not permitted considering the time for execution, importance from traffic point of view and location of the Flyover. Pile Foundation is considered for speedy construction and minimum traffic disruption. As far as possible, the Piles will be installed by bypassing the underground services and the Pile Caps will be constructed below the ground level at a minimum depth of 0.75m from the surface. The piles are of bored cast – in – situ type and resting on hard strata, where 'N' values are more than 100. The construction of pile foundation design has been done as per the relevant specifications of IS: 2911.

The Piles are essentially end bearing and are socketed into the hard strata at least to a depth equal to 1.5 times the diameter of the pile. The presence of hard strata shall be established by conducting SPT Tests in the pile bore. On ascertaining the hard strata through SPT, further chiseling shall be done for socketing. The number of drops of a given chisel falling at a constant fall for a specific depth of penetration shall be noted and these chiseling criteria (in terms of number of drops) shall be used to ascertain hard strata in the surrounding bores. Based on the available soil data for the area, a pile length of 15m has been assumed for the purpose of estimation. The capacity has to be derived by working out the actual load capacity of a laterally supported, freestanding column. However, the Construction Agency shall submit the Design Calculation for Pile Load Capacity to the Engineer on the basis of the results of initial load test on piles. The test piles shall be installed as directed by the Engineer.

Metal Casings with thickness not less than 6mm has been proposed to support the unstable sides at the top of the borehole.

- **Minimum Length of the Embedment**

A minimum depth of embedment of 9m (including socket length) in soil has been proposed to be maintained where the pile cannot be driven any further. However, the termination level of the pile shall be as per specific instructions of the Engineer – in – Charge or his authorized representative. In the event of presence of rock or very hard strata at a shallow depth, the Construction Agency shall be advised by the Engineer regarding the termination level and the same shall be in conformity with the code provisions.

- **Pile Diameters**

1200mm dia Piles have been proposed for Obligatory Span and 1000mm dia Piles for Standard Spans. Pile groups with 10 nos. of piles for abutments and 4 to 6 nos. of piles for pier locations have been proposed.

The grade of concrete for the pile is M35. The cement content for pilling work has been assumed as 400 kg/m³ with Ordinary Portland Cement of grade 43. However, the Pile Foundations shall satisfy the following requirements.

- Only bored cast in situ piles will be accepted.
- The pile foundations shall be designed as per the requirements of IS: 2911 (Part I / Section – 2) – Latest Revision.
- The design capacity assumed for the piles shall be verified by the initial load testing of test piles in non working areas, in the vicinity of the flyover site. These piles shall be tested for 2.0 times the design load and number of such tests shall be done for each diameter of pile. Additional one pile for each diameter, which is actually going to be used for piers and abutments, shall be tested for 1.5 times the design load.
- Annular Piles filled or unfilled shall not be accepted.
- Design with single row of piles shall not be accepted.
- Design shall ensure that no pile is subjected to tension.
- Concreting shall be done by Tremie Method after ensuring proper tip zone cleaning by flushing only.
- The top of concrete in piles shall be brought above the cut off level by minimum 750mm to permit removal of all laitance and weak concrete before pile is laid.

7.5.3 Ramps / Retaining Walls

The adoption of Reinforced Earth Wall is economical and the construction can be faster compared to Conventional Retaining Walls. Hence, Solid Ramp Portion of the Flyover has been proposed to be constructed with Reinforced Earth Retaining Structure. This Work consists of reinforced soil structures as per Terramesh Reinforced Soil Wall with Concrete Panel / Segmental Block Fascia comprising of Mechanically Woven Double Twisted Hexagonal shape, (Zn + PVC) Coated Wire Mesh as per detailed specifications.

The work is generally done in conformity to the MORT&H Specification / BS: 8006 Specifications. The detailed design and drawings of the work have been done in accordance with the MORT&H Specification and Guidelines contained in the IRC. Patentee's Specifications has been incorporated wherever relevant.

The Materials shall be procured from the supplier of the Reinforced Soil Technology approved by the Engineer. The Designs and Drawings shall be got approved from BBMP before execution of work.

7.5.4 Substructure

The Substructure shall satisfy the following Requirements.

- **Dimensions**

- Dimension of any Element of Substructure shall not be less than 300mm.
 - All RCC Piers shall be of solid type.
 - The height of pedestals on pier cap supporting bearings shall not be more than 300mm.
- **Layout and Design**
- All Bearings shall be supported directly on Pier Stem. However, bearings resting on overhangs are acceptable provided the differential deflection of pier cap is accounted in the transverse analysis of superstructure.
 - Scope for accessibility for inspection of bearings and arrangement for lifting of the superstructure for future replacement of bearings shall be provided in the design of Substructure and Superstructure.

7.5.4.1 Abutments

The Abutments and Returns have been designed for live load surcharge equivalent to earthfill of 1.2m height. The minimum density of filling for calculations of Surcharge Pressure has been considered as 2 T / cum. The Surcharge Effect has been considered for the purpose of evaluating Earth Pressure and not for Vertical Loads.

7.5.4.2 Piers

The Piers considered for design is of two types. One type is for Standard Spans and other type is for Obligatory Span. The Design has been based on the Combination of Design Loads producing the worst effect. One span dislodged condition has also been taken into consideration while designing the piers.

7.5.5 Superstructure

The choice of Superstructure mainly depends on the Span and the Aesthetic Importance. The Spans are determined based on the Superstructure and feasibility of transporting long span Precast Girders. It is advisable that construction of superstructure proceeds with surface level construction like pier or abutment construction.

For standard spans, Precast Pre Tensioned I girders of 16.75m with Cast – in – Situ Concrete Deck Slab have been adopted. Geometrical Variation like Curvature of the Deck can be easily constructed with Concrete Decks using Straight Precast Girders.

The Selection of the type of Obligatory Span depends on Availability of Space, Curvature and Aesthetic Importance. The minimum thickness of 200mm for Deck Slab has been proposed to be maintained.

7.5.5.1 Prestressed Concrete Girder and Slab

For ease and speed of construction, Precast Concrete Superstructure has been proposed to be adopted for the Standard Span. While designing such element / structure, Aspects of Durability and Minimum Maintenance have been kept in view. Precast Panel Slab Deck / Girders and Cast – in – Situ Slab Construction shall be designed as Composite Construction.

Concrete Girder and Slab Type Superstructure shall satisfy following stipulations.

- Minimum Thickness of Slab shall be 200 mm.
- Minimum Thickness of Web shall be 250 mm.
- Where Prestressed Cables pass through the webs, the thickness shall be same as that stipulated for Webs of Box Girder.

The Components shall be designed for Lifting and Erection Loads and Stresses. Proper Lifting Arrangements shall be arranged by the Construction Agency for handling the Precast Unit.

7.5.5.2 Post Tensioned PSC Box Girder

For Obligatory Span Box Girder has been proposed. The following Method has been adopted for Analyzing and Designing the Box Girder.

- Calculate the Main Girder Moments, Shear Forces and Torsional Moments for a single beam for all loading conditions.
- Also add to above, the Forces due to the Restraint of Warping Torsion at the ends.
- In addition, calculate the Bending Moments in the Roadway Slab considering the Slab, the Web and Soffit Slab as a closed frame.
- Reinforcement in the Slabs and Webs due to the Transverse Moments shall be provided in addition to the Steel, which is required for Shear or Torsion in the Box as a Main Girder.
- Distortion of Box Girder due to Transverse Moment can be neglected if minimum numbers of Diaphragms are provided.
- In the absence of Rigorous Analysis (A) for the Torsional Moment (B) for Forces due to Restraints of Warping Torsion at ends, the Design Live Load Moments and Shear Force in the Longitudinal Direction shall be increased by 20% and Transverse Reinforcement Steel be increased by 5%.
- For Prestressed Concrete Structure, where Cables pass through Webs, minimum Web Thickness shall be greater of 150mm + outer dia of Duct or 250mm whichever is greater.
- The Cross Diaphragms shall be minimum one number at each support and at ends of cantilever, if any. In addition, for Abrupt Change in Soffit Geometry, Stiffening Frame or Diaphragm shall be provided to cater to Forces arising out of Change in Direction.
- Minimum Thickness of Diaphragms at Supports shall be 500mm and those of other Locations shall be 300mm.
- Minimum Untensioned Reinforcement shall be as per Clause 15 of IRC: 18 – 2000. The Spacing of the Bars shall not exceed 200mm c/c. The Minimum Diameter of Bars to be used is 10mm.
- No Tension under Full Permanent Design Load is allowed.

7.5.5.3 Precast Pretensioned Girders

These Girders are not specifically covered in IRC Specification. The Preliminary Design carried out herein follows AASHTO Specification. Some of the important Guidelines are given below.

- Pretensioned Girders shall be designed as Simple Span Girders for Positive Moments, without regard to Live Load Continuity. The Girders shall be designed to account for Live Load Continuity for Shear and Negative Moment Design. The Girders are assumed to be continuous because they are embedded into the Continuity Diaphragm that is poured in place with the Deck Slab. Additional Reinforcement Steel shall be placed in the cast – in – place Deck Slab to resist the Continuous Live Load Negative Moments.
- The Temporary Tension Stress in the Top Fibre near the ends of the Prestressed Girders shall be deduced as much as possible by debonding.
- A future Wearing Surface of 600N / m² in Dead Load shall be added to the Clear Roadway Width for Design.

7.5.6 Bearing below Superstructure

Bearing controls the Transfer of the Forces from Superstructure to Substructure. Bearings under superstructure shall be within the external line of the Pier / Abutment. The Bearings shall be provided below the Diaphragm at Suitable Locations.

- The Type of Bearing generally allowed is as below.

Span	Type of Bearing
For effective spans upto 20m	Restrained Elastomeric / POT cum PTFE / POT
For effective spans more than 20m	POT cum PTFE / POT

- The Bearing shall be easily accessible for Inspection / Maintenance.
- Scope for Lifting the Superstructure for Future Replacement of Bearing shall be provided in the Design of Bearing. The Scheme of Lifting shall be indicated on the Drawing to be submitted along with the Technical Bid.
- Inspection of Bearing by Director General of Supplies and Disposal (DGSD) during manufacturing is essential. The Construction Agency shall have to produce necessary Certificate and Inspection Marks from the DGSD at his own cost.
- The bearing shall conform to the requirements of the MoRT&H Specifications.
- The Dimensions of Top Plate of Bearing shall be such that the Contact Surface of the Superstructure projects beyond the Edge of Bearing Plate by a minimum distance of 50mm at any location.

7.5.7 Expansion Joints

Elastomeric Strip Seal Type Expansion Joint conforming to Clause 2607 of MoRT&H Specifications has been considered. Calculations for the Adequacy of the Expansion Extent for which the Joint is selected by the Engineer shall be submitted along with the Name of Manufacturer and their Technical Details. During installation of these Joints, Manufacturer's Engineer shall be required to supervise the same including the Thermal Presetting, if required.

7.6 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.

7.7 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.

7.8 Approach Slab

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

7.9 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.

7.10 Drainage

Drainage of Storm Water collected in / on the Grade Separator 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.

7.11 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.

7.12 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).

7.13 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.

7.14 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: 5	General Features of Design
IRC: 6	Loads and Stresses
IRC: 18	Design Criteria for Prestressed Concrete Road Flyovers (Post Tensioned Concrete). This Code will also be applicable to Continuous Structures with Pertinent Particulars.
IRC: 21	Cement Concrete (Plain and Reinforced)
IRC: 35	Code of Practice for Road Markings
IRC: 78	Foundation and Substructure
IRC: 83 (All Parts)	Standard Specifications and Code of Practice for Road Bridges – Bearings
IRC: 92	Guidelines for the Design of Interchanges in Urban Areas
IS: 875 (Part 3)	Code of Practice for Design Loads (Wind Load)
IS: 1893	Criteria for Earthquake Resistant Design of Structures
IS: 2911 (All Parts)	Pile Foundations

- 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.

7.15 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 10 months in case of Underpass and 12 months in case of Flyover 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

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 & IWTDR 2009 – 10, Bangalore Circle and NHSR 2009 – 10, National Highways Circle, Bangalore. The Rates as given in PW, P & IWTDR 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 & IWTDR 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 analysed keeping in view of the basic rates as per SR and their respective lead.

To accommodate the proposed Corridor Improvement Scheme, 45462.52 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. No existing structure needs to be demolished completely.

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. 165.174 Crore**. Further, the Abstract of the Junction wise Project Cost is detailed in **Table 9.2, 9.3, 9.4, 9.5, 9.6 and 9.7** 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 Flyover at K. E. B. Junction near PESIT College	106800000.00
2.	Proposed Construction of Vehicular Underpass at Dr. Muthuraj Road Junction	139250000.00
3.	Dedicated U Turn with Physical Separator at Janata Bazar Junction	20530000.00
4.	Proposed Construction of Vehicular Underpass at Food World Junction	127920000.00
5.	Dedicated U Turn with Physical Separator at Kamakhya Theatre Junction	20880000.00
6.	Dedicated U Turn with Physical Separator between Kadirenahalli Road Junction and Kanakapura Road Junction	30340000.00
7.	Proposed Construction of Vehicular Underpass at Kanakapura Road Junction	148620000.00
8.	Proposed Construction of Flyover at Dollar's Colony Junction	196000000.00
9.	Proposed Construction of Flyover at Udupi Garden Junction	246600000.00
	Sub Total	1036940000.00
10.	Widening of Outer Ring Road from Mysore Road Junction to Central Silk Board Junction	614800000.00
	Total	1651740000.00

Table 9.2
Abstract of Project Cost for KEB Junction near PESIT College

Sl. No.	Particulars	Cost in Rs.
1.	Site Clearance and Dismantling	551379.00
2.	Surface Level Roads / Slip Roads	21702856.00
3.	Drain Works	
	a. For Road Side Drains	4331259.00
	b. For Culvert	1032332.00
	c. For Storm Water Drain across Ring Road and Retaining Wall	8726392.00
4.	Footpath, Median and Kerb	2710698.00
5.	Road Furniture and other Works	3267621.00
6.	Flyover Works	31471698.00
7.	Flyover Approaches	4980435.00
8.	Electrical Works for Flyover	2105340.00
	Construction Cost	80880010.00
9.	Add Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1213200.15
10.	Utility Shifting Charges @ 25%	20220003.00
11.	Add Cost for Topographical Survey and Soil Investigation	250000.00
12.	Add Cost for Landscaping Works	1500000.00
13.	Contingencies (@ 3% of Construction Cost)	2426400.00
	Sub Total	106489613.15
14.	Miscellaneous and Rounding Off	310386.85
	Total	106800000.00

Table 9.3
Abstract of Project Cost for Dr. Muthuraj Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Construction of Covered Portion of Underpass	16450000.00
2.	Construction of Retaining Wall	33820000.00
3.	Construction of Ramp and Formation of Service Road	33730000.00
4.	Providing Drainage Facility to Underpass	10010000.00
5.	Construction of Approach Road to Underpass and Other Allied Works	14510000.00
	Sub Total	108520000.00
6.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1627800.00
7.	Add for Utility Shifting Charges @ 25%	27130000.00
8.	Add Cost for Topographical Survey	40000.00
9.	Add Cost for Soil Investigation	120000.00
10.	Add Cost for Electrical Works	1750000.00
		139187800.00
11.	Miscellaneous and Rounding Off	62200.00
	Total	139250000.00

Table 9.4
Abstract of Project Cost for Food World Junction

Sl. No.	Particulars	Cost in Rs.
1.	Construction of Covered Portion of Underpass	19000000.00
2.	Construction of Retaining Wall	26270000.00
3.	Construction of Ramp and Formation of Service Road	25490000.00
4.	Providing Drainage Facility to Underpass	12890000.00
5.	Construction of Approach Road to Underpass and Other Allied Works	15900000.00
	Sub Total	99550000.00
6.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1493250.00
7.	Add for Utility Shifting Charges @ 25%	24887500.00
8.	Add Cost for Topographical Survey	40000.00
9.	Add Cost for Soil Investigation	120000.00
10.	Add Cost for Electrical Works	1780000.00
		127870750.00
11.	Miscellaneous and Rounding Off	49250.00
	Total	127920000.00

Table 9.5
Abstract of Project Cost for Kanakapura Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Construction of Covered Portion of Underpass	18960000.00
2.	Construction of Retaining Wall	27860000.00
3.	Construction of Ramp and Formation of Service Road	32630000.00
4.	Providing Drainage Facility to Underpass	19790000.00
5.	Construction of Approach Road to Underpass and Other Allied Works	16690000.00
	Sub Total	115930000.00
6.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1738950.00
7.	Add for Utility Shifting Charges @ 25%	28982500.00
8.	Add Cost for Topographical Survey	40000.00
9.	Add Cost for Soil Investigation	120000.00
10.	Add Cost for Electrical Works	1750000.00
		148561450.00
11.	Miscellaneous and Rounding Off	58550.00
	Total	148620000.00

Table 9.6
Abstract of Project Cost for Dollar's Colony Junction

Sl. No.	Particulars	Cost in Rs.
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1.	Site Clearance and Dismantling	1558521.00
2.	Surface Level Roads / Slip Roads	22801231.00
3.	Drain Works	
	a. For Road Side Drains	5357529.00
	b. For Culvert	707940.00
	c. For Storm Water Drain across Ring Road and Retaining Wall	6490409.00
4.	Footpath, Median, Kerb and Compound	6341301.00
5.	Road Furniture and other Works	3358232.00
6.	Flyover Works	92261198.00
7.	Flyover Approaches	8606376.00
8.	Electrical Works for Flyover	2273650.00
	Construction Cost	149756387.00
9.	Add Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	2246345.81
10.	Utility Shifting Charges @ 25%	37439097.00
11.	Add Cost for Topographical Survey and Soil Investigation	250000.00
12.	Add Cost for Landscaping Works	1500000.00
13.	Contingencies (@ 3% of Construction Cost)	4492692.00
	Sub Total	195684521.81
14.	Miscellaneous and Rounding Off	315478.19
	Total	196000000.00

Table 9.7
Abstract of Project Cost for Udupi Garden Junction

Sl. No.	Particulars	Cost in Rs.
1.	Site Clearance and Dismantling	2363836.00

2.	Surface Level Roads / Slip Roads	31272491.00
3.	Drain Works	
	a. For Road Side Drains	10022181.00
	b. For Culvert	1407941.00
4.	Footpath, Median, Kerb and Compound	6300422.00
5.	Road Furniture and other Works	4177938.00
6.	Flyover Works	116914836.00
7.	Flyover Approaches	13012382.00
8.	Electrical Works for Flyover	3311755.00
	Construction Cost	188783782.00
9.	Add Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	2831756.73
10.	Utility Shifting Charges @ 25%	47195946.00
11.	Add Cost for Topographical Survey and Soil Investigation	250000.00
12.	Add Cost for Landscaping Works	1500000.00
13.	Contingencies (@ 3% of Construction Cost)	5663513.00
	Sub Total	246224997.73
14.	Miscellaneous and Rounding Off	375002.27
	Total	246600000.00

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 **306 Days** in case of Underpass and **365 Days** in case of Flyover.

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 **351 Days** in case of Underpass and **410 Days** in case of Flyover 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

11.1 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 Present Study Area spans from Mysore Road Junction to Central Silk Board Junction along Outer Ring Road covering a distance of 13.4km. in the Southern part of Bangalore City. The Study Corridor interfaces with Mysore Road (SH – 17) at Mysore Road Junction, NICE Road near Veerabhadreshwara Nagar Junction, National Highway – 209 at Kanakapura Road Junction, State Highway – 48 at Bannerghatta Road Junction and National Highway – 7 at Central Silk Board Junction. Hence, the Project Corridor acts as a major link between National Highways. Most of the heavy commercial traffic moving via Bangalore to other part of National Highways is being diverted through this Corridor. 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. Further, 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 along the Corridor. The Study Area caters to considerable local and outside traffic destined towards different parts of National Highways. With the setting up of Electronics City on Hosur Road, the growth of the techno polis has led to increase in traffic. The traffic originating from the various quarters of the City passes through this Corridor to reach Kumaraswamy Layout, J. P. Nagar, Bannerghatta, BTM Layout and Hosur Road to reach Electronic City. Further, many large Residential Sites have been converted into Apartments / Flats along this Corridor and a site that would house either a family or two now will be able to house multiple number of families and with this the number of Vehicle / Traffic also has increased manifold in last 10 years. These being the Background, the Bruhath Bangalore Mahanagara Palike has proposed to construct Grade Separator using Pre Cast Element Technology at Major Junctions and to close Median at Minor Junctions with Appurtenant Link Improvements from Mysore Road Junction to Central Silk Board Junction along Outer Ring Road covering a total of 16 Junctions (out of which, 9 Junctions have been taken for improvement) for a total length of 13.4km in order to provide Uninterrupted, Seamless Traffic Flow and to Increase Level of Service along the Corridor.

11.2 Existing Junctions along the Project Corridor

The following Junctions are present along the Project Corridor.

- Mysore Road Junction – Four Arm Junction.
- Veerabhadreshwara Nagar Junction – Four Arm Junction.
- KEB Junction near PESIT College – Three Arm Junction (“T” Shaped).
- Dr. Muthuraj Road Junction – Four Arm Junction.
- Janata Bazar Junction – Three Arm Junction (“T” Shaped).
- Food World Junction – Four Arm Junction.
- Kamakhya Theatre Junction – Four Arm Junction.

- Kittur Rani Chennamma Circle – Four Arm Junction.
- Kadirenahalli Road Junction – Four Arm Junction.
- Kanakapura Road Junction – Four Arm Junction.
- Puttenahalli Road Junction– Four Arm Junction.
- Dollar's Colony Junction – Four Arm Junction.
- Bannerghatta Road Junction – Three Arm Junction.
- Jayadeva Hospital Junction – Four Arm Junction.
- Udupi Garden Junction – Four Arm Junction.
- Central Silk Board Junction – Four Arm Junction.

11.3 Junctions proposed for Improvements

The following Junctions have been taken for the proposed Improvements.

- KEB Junction near PESIT College.
- Dr. Muthuraj Road Junction.
- Janata Bazar Junction.
- Food World Junction.
- Kamakhya Theatre Junction.
- Between Kadirenahalli Road Junction and Kanakapura Road Junction.
- Kanakapura Road Junction.
- Dollar's Colony Junction.
- Udupi Garden Junction.

11.4 For the proposed Corridor Improvement Scheme, total Cost of the Project has been worked out as **Rs. 165.174 Crore** with Implementation Period for each Junction as **351 Days** in case of Underpass and **410 Days** in case of Flyover from the Date of Notice Inviting Tender.

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