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'Design And Modelling Of Urban Street As Per The Guidelines Of Institute Of Urban Transport'

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Abstract

Local commercial streets are the complex pathways where high density of vehicles and pedestrians commute. Due to their continued economic growth, they play a vital role in the development of an urban area. Upon comprehension and analysis, the major downsides observed are traffic congestion, lack of parking space, and rapid increase in the number of street vendors. These are some grave concerns for anyone entering the streets which are to be mitigated to the maximum extent possible. Fully functioning and sustainable street corridor must be designed and executed such that the safety aspects of the street will not be compromised. So, as to achieve the goal of transforming the existing corridor into a safe urban street, the following studies were carried out. Road inventory, traffic volume count, spot speed studies, parking accumulation, pedestrian count and pedestrian speed. Taking into consideration of the data obtained from the following studies, feasible recommendations are proposed and necessary drawings were modelled using AutoCAD with reference from the guidelines of Institute of Urban Transport. The study stretch is now equipped with the parking facility, pedestrian safety, various street furniture and smooth flow of the traffic. The utilization of the conservancy roads to their full potential solves the problem of street vendors, as a result of which a safe and congestion free carriageway is achieved.

Keywords: *Urban Street, Pedestrian, Institute of Urban Transport (IUT), Conservancy.*

Introduction

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General

For any individual residing in a city, it is not long before their happy day starts going downhill and one of the main perpetrators messing up their day is none other than "traffic". Every individual from a child to an adult, a pedestrian to a motor biker, a school student to an office goer, or it may be someone unlucky enough to have their home/workplace near the road which gets jammed more often than not etc., are its victims [1]. The traffic on roads comprises of road users including vehicles, pedestrians, herded or ridden animals and other forms of conveyances while using public roadway for travel.

Residents of metropolitan cities such as Bengaluru (which is officially the world's most traffic-congested city in February, 2020 are daily victims of the annoyances caused by traffic [4]. Every resident of the city including the general public, taxi drivers, traffic police, traffic engineers etc., all have their comprehension as to why such traffic exists and rightly so because they all have experienced it differently [2].

The quest to identify the reason behind traffic in such cities, with an engineer's perspective gave rise for several number of answers, among which the "urban Streets" were the one that stood out from the rest The main reason for that being the not so well planned and poorly designed streets of Bengaluru and the lack of proper modelling of these streets, making them unsafe for every commuter.[3]

The sheer thought of how much more that can be accomplished in reducing the traffic just by changing up the design of the street was fascinating. So, as a part of coursework fulfilment for 8th semester in B.tech Civil Engineering, it was decided to take up the designing and modelling of one of these urban streets as the project.

Project Location

A section of Malleshwaram 8th Cross Road, that lies between Margosa road and Sampige road is selected as the location for the project. Malleshwaram is the North-Western suburb of the metropolitan city of Bengaluru, located at the state of Karnataka, with pin code-560003 (map link: location).

Project Objectives

The main goal of the project is to create a modal street which is aesthetically appealing, safe and free from traffic congestion. To realise the project goal, here are the objectives to be achieved through this project.

- To study the existing scenario of the street.
- Design a systematic parking system that can prevent the inappropriate parking of vehicles on the street.
- Relocation of street vendors by providing them with a different space for doing business, convenient locations are to be identified to achieve this.
- Clearing up the footpath for pedestrian usage and discouraging them from using the roadway for walking.
- To develop a proper and functioning traffic management strategy.

Methodology

This chapter contains details regarding the methods used for surveying the project location and the techniques and software used for analysis and modelling of the survey data, pertaining to the project objectives and the specifications of Institute of Urban Transport. Below there are two lists, [3] List A-represents the methods used for surveying the project location, analysing and designing the data obtained, and the List B-represents the software used for the purpose of modelling.

List A:

1. Road Inventory Studies
2. Traffic Volume Count
3. Speed Studies
4. Parking Accumulation Studies
5. Parking Load Graph and Efficiency
6. Pedestrian Count

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7. Pedestrian Speed

List B:

1. Auto CAD

Road Inventory Survey

Road inventory survey can be defined as an all-inclusive survey that can be used for studying and detailing the profile of the roads in the area of study with at most accuracy. Road inventory also helps creating and maintaining an up to date record of street traffic signs and data bases.

Pertaining to lack of resources and the requirement of the project, the best method for carrying out the 'Road Inventory' study is the 'Field Inventory' method [2] . This is a rapid and inexpensive method of the survey that is carried out manually. The steps involved in the study are:

- A detailed road inventory has been carried out for the entire stretch of the project.
- For every 50 metres, existing road features have been recorded in the road inventory format

The following details were noted

- Width of Carriage way
- Width of Median
- Width and Type of Footpath
- Width and Type of Shoulder
- Purpose of Land use
- Parking details
- Type and Width of drains

Traffic Volume Count (TVC)

Traffic Volume is defined as the total number of vehicles that are crossing a particular section of road per unit time at any selected period. It is a quantitative measure of traffic flow whose units of measurements are vehicles per day and vehicles per hour. Traffic volume study includes the classified volume of various types and classes of vehicular traffic, distribution by direction, and turning moments[1].

The equipment needed for Manual counters are:

- A Stopwatch
- Pencils, Erasers and Pencil Sharpeners
- Clip board
- Sufficient amount of blank field data sheets

The steps involved in the 'Manual counters' method are:

- Intersection between Sampige road and Malleshwaram 8th Cross road was selected as the location for survey.
- Traffic counts were taken during the rush hour of Saturday morning (08:00 AM to 12:00 PM), Sunday evening (04:00 PM to 08:00 PM), Monday morning (08:00 AM to 12:00 PM), and Tuesday evening (04:00 PM to 08:00 PM) for an interval of every 15 mins.
- Based on the data obtained through the TVC survey the 24-hour data was approximated.

Spot Speed Studies

The Spot Speed is the instantaneous speed of a vehicle at a specified location. These Studies are performed to obtain the speed distribution data of the stream of traffic at a particular location. The data thus obtained are used to determine various vehicle speed percentiles, that are used for determining effective and passable speed limits[2].

Parking Accumulation Studies

Traffic on the urban streets is increasing rapidly leading to insufficiencies in parking space for the vehicles, especially in central business areas, the demand for parking space is very high. Data

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concerning the availability of parking space, degree of its usage and the demand for parking space is vital for taking measures for the betterment of the conditions [3].
There are two major types of Parking:

1. On Street Parking
2. Off Street Parking

In accordance with the requirement of the project, the method deemed to be suitable for carrying out the Parking survey is 'In-Out survey'. The project location provides facilities for bike parking only, and the standard dimensions of the bike is considered as a width of 0.85 m and a length of 2.5 m. The steps involved in the In-Out parking survey are:

- Considering Right angled parking, the entire length of the street section was divided into bays that are having a width of 0.85 m and a length of 2.5 m. The total number of bays obtained were two hundred.
- At the beginning of the survey, the number of bays occupied were noted down.
- Later on, the number of vehicles that enter and exit the parking lot for a particular time interval is counted and entered into the Parking Accumulation Data table and the parking data is obtained accordingly.

Pedestrian Count

A person who is on foot, either walking or running on the footpath or road, this also includes any physically disabled person who is using a propelled wheelchair. Before getting in to a vehicle and after getting out of a vehicle, every person on the street is a pedestrian [4].

Pedestrian Speed

Pedestrian speed can be defined as the pace at which the pedestrian walks. It plays an important role in transportation planning and design of pedestrian crossing facilities under mixed transportation conditions [5].

The steps involved in the calculation of pedestrian speed are:

- Intersection of Sampige road and Malleshwaram 8^{th} Cross Road has been selected for carrying out the survey.
- Study length of 5 metres was selected and an entry and exit point was marked.
- As soon as a pedestrian crossed the entry point the stopwatch was started and then it was stopped as soon as the pedestrian left the study stretch.
- The observer recorded the observations in the pedestrian speed raw data form.

Computational Survey Analysis

The traffic volume count data obtained through survey has been analyzed to arrive at Average Daily Traffic (ADT), hourly variation and composition. ADT has been worked out in terms of total number of vehicles and Passenger Car Units (PCU).

Table 1: Average Daily Traffic Representation

ADT				
Type	**Mode**	**Malleshwaram 8th cross to Sampige**	**One Way**	**Both Directions**
Passenger	**Two-Wheeler**	**2437**	**0**	**2437**
	Auto Rikshaw	**1240**	**0**	**1240**
	Car/ Jeep / Taxi	**858**	**0**	**858**

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	Mini Bus	208	0	208
	Std Bus	0	0	0
Goods	LCV	93	0	93
	2 Axle	0	0	0
	3 Axle	0	0	0
	MAV	0	0	0
Tractor	Agri. Tract	0	0	0
Slow Moving Vehicles		86	0	86
Total Vehicles		4922	0	4922
Total PCUs		3933	0	3933

Table 2: Annual Average Daily Traffic Representation

AADT				
Type	Mode	Malleshwaram 8th cross to Sampige	One Way	Both Directions
Passenger	Two-Wheeler	2437	0	2437
	Auto Rikshaw	1240	0	1240
	Car/ Jeep / Taxi	885	0	885
	Mini Bus	218	0	218
	Std Bus	0	0	0
Goods	LCV	98	0	98
	2 Axle	0	0	0
	3 Axle	0	0	0
	MAV	0	0	0
Tractor	Agri. Tract	0	0	0
Slow Moving Vehicles		86	86	0
Total Vehicles		4922	4964	0
Total PCUs		3933	3983	0

Spot Speed Studies:

The tools that are used for determining the adequate and effective speed limits are 'Speed Percentiles'. There are two major speed percentiles obtained from cumulative percentile column of the frequency distribution table (Speed Percentiles are effected by Weather Conditions),,they are:

1. 50th Percentile: This percentile is the median speed that represents the average speed of the traffic stream.
2. 85th Percentile: This percentile is the uppermost safe speed for a section of roadway, It is considered for fixing up of the speed limit for roadway and as design speed for designing of roadway.

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Sometimes exact 50th Percentile speed and 85th Percentile speed are not found in the table they can be calculated using the given equation.

Equation 1: Exact Speed Percentiles

$$S_D = \frac{P_D - P_{min}}{P_{max} - P_{min}}(S_{max} - S_{min}) + S_{min}$$

Where,
S_D = Speed at P_D, P_D = Percentile Desired, P_{max} = Higher Cumulative Percentile, P_{min} = Lower Cumulative Percent , S_{max} = Higher Speed , S_{min} = Lower Speed

Equation 2: Parking Index equation

$$Parking\ Index = \frac{\text{Parking Load}}{\text{Parking Capacity}} \times 100$$

Table 3: Parking Survey representation

Time	No. of bays filled	No. of bays available for Parking	Parking Index
08:00 AM to 08:15 AM	**75**	**125**	**37.50**
08:15 AM to 08:30 AM	**97**	**103**	**48.50**
08:30 AM to 08:45 AM	**109**	**91**	**54.50**
08:45 AM to 09:00 AM	**124**	**76**	**62.00**
04:00 PM to 04:15 PM	**193**	**7**	**96.50**
04:15 PM to 04:30 PM	**204**	**0**	**102.00**
04:30 PM to 04:45 PM	**215**	**0**	**107.50**
04:45 PM to 05:00 PM	**202**	**0**	**101.00**

Parking Index

Info: Total number of bays available for parking = 200

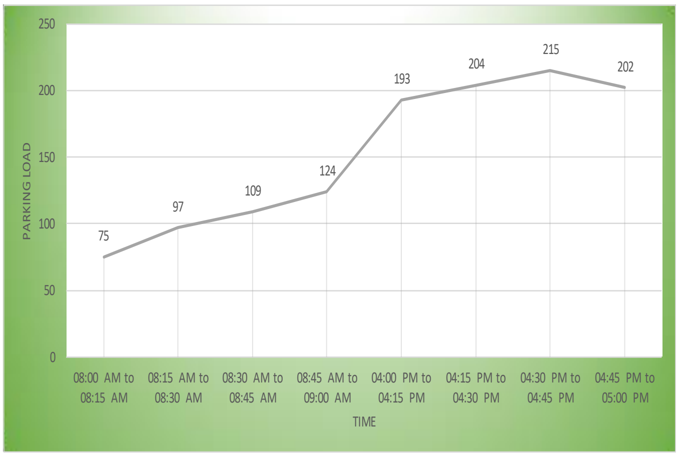

Figure 1: Representation of Parking Load v/s Time

Pedestrian Speed
Below table and graph represents the results obtained from the Pedestrian Speed. It plays an important role in transportation planning and design of pedestrian crossing facilities under mixed transportation conditions.

Table 4: Cumulative Frequency Distribution table (Morning Peak hour)

Speed	No. of	Cumulative	Cumulative

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(km/h)	people	no.	%
1	0	0	0
2	4	4	10
3	30	34	85
4	6	40	100

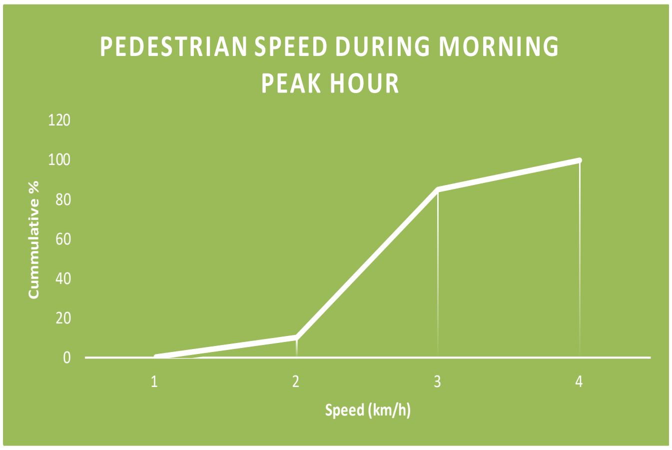

Fig 2: Graph of Cumulative frequency percentage v/s Speed (Morning peak hour)

Table 5: Cumulative Frequency Distribution table (Evening Peak hour)

Speed (km/h)	No. of people		Cumulative no.	Cumulative %
1	0		0	0
2	1		1	2.5
3	35		36	90
4	4		40	100

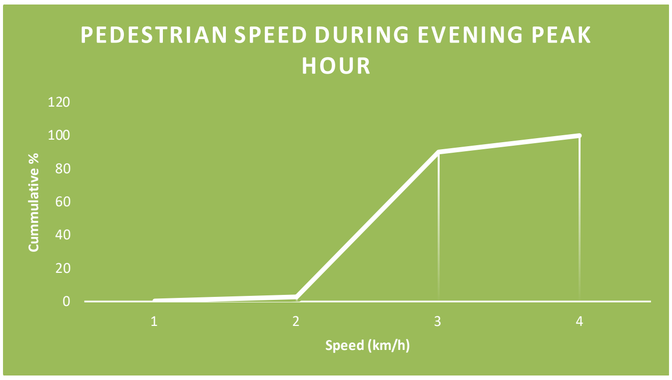

Figure 3: Graph of Cumulative frequency percentage v/s Speed (Evening peak hour)

Design and Modelling

Design of Street Lights

Street lights are raised sources of light that are mounted on a post to illuminate the pathway in which they are placed. The purpose of providing the street lights is to assist the drivers and pedestrians in giving them a clear vision of the path ahead. To achieve the proper illumination of the study street, proper arrangement is neccessasary and it is achieved through the following design:

The width of the roadway in the study stretch is 6.8 m.

As per Urban Street Design guidelines

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For a local street, the dimension of the street lights are

- Height of the pole= 10 m.
- Length of the outreach arm= 1.5 m.
- Spacing between poles= 27 m.

Step 1 - Now to find the type of arrangement of street lighting,

Equation 3: An equation for finding the ratio between the width of road to the to the height of pole

$$= \frac{width\ of\ the\ road}{height\ of\ the\ pole} = \frac{6.8}{10} = 0.68$$

As 0.68 is less than 1, we shall give a single-sided arrangement.
Step 2 – calculation of number street lights required,

Equation 4: An equation for calculating number of Poles

$$= \frac{lenght\ of\ the\ street}{spacing\ between\ the\ poles} = \frac{200}{27} = 7.4$$

Rounding it to 7 numbers.
Hence, we can provide single-sided street light arrangement with 7 number of street poles with a height of 10m and outreach of 1.5m.

Design of Vending Zone for Street vendors

Street vendors create a havoc on urban streets. They are considered to be one of the major challenges faced in transforming the street into safe corridors, so as to tackle this situation we have introduced a concept named conservancy roads. These are the empty spaces which are available backwards of two different buildings. They generally have a width of 3-5 m . Hence all the street vendors and all the unauthorised commercials activities will be shifted to those conservancy road
Design of the conservancy
There are 4 conservancy streets.
Considering one of the conservancy road of length 190m and width as 4.0m
Now assuming the area for each street vendor is 2X3 m.

The total number of street vendors on the considered street

Equation 5: An equation for calculating total number of vendors

$$\frac{length\ of\ the\ road}{length\ of\ the\ vending\ shop} = \frac{190}{3} = 63.33$$

Rounding it to 63 number of shops.
As the considered road is smallest, we can assume that every street has a minimum of 63 shops.
63 X 4 = 252.
There are a total 252 shops.
The shops will be provided with numbers and they will allotted to the vendor on first come basis.
The vendors have to vend on conservancy streets only, vending on the 8^{th} cross road is strictly prohibited. Thus provides the road to fullest use to the commuter.

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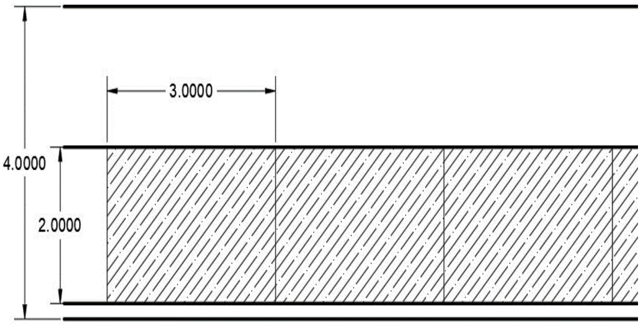

Fig 4: Plan of Slots for Street Vendors on Conservancy Road

Modelling the street using AutoCAD.

The modelling of the section is done as per the IUT guidelines. Firstly, the present scenario was analysed and the present sections were drawn. Later the ideal section was studied from the guidelines and the most feasible section was modelled with discussed recommendations. This gave the ideal recommended section for the study corridor. As the initial sections were modelled, they were compared with the ideal recommended section and the new urban model or the new recommended section we created on AutoCAD. The new models are purely based on the Urban Street Design guidelines.

Recommendations & Conclusions

As per the results obtained from parking accumulation studies it is observed that smart parking system must be provided with dedicated parking slots for two wheelers and four wheelers.

- Giant wheel parking system is provided as it optimizes minimum parking space into multi-car park space.

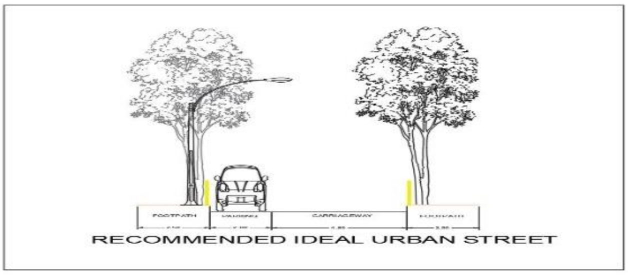

Figure 5: Recommended Ideal Urban Street as per IUT Standards

1. The results from the pedestrian count suggest that the pedestrian need the footpath to fullest use.
2. From the road inventory studies the following recommendations are provided:
   - Plantation plays a prime role in the aesthetic appearance of the street scape.
     They are essential for the following reasons

Cooler atmosphere is achieved as the ambient heat reduces.

They provide shade to the pedestrian. Improved quality of air is seen. Aesthetically pleasing streets are observed.

- Tree grates help to protect roots, assist in drainage and encourage healthy urban tree growth. It improves the aesthetics of footpath.
- Equipping the street with storm water harvesting.
- Permeable footpath is provided such that it acts as a drainage system.
- Easily accessible toilet units to be provided.

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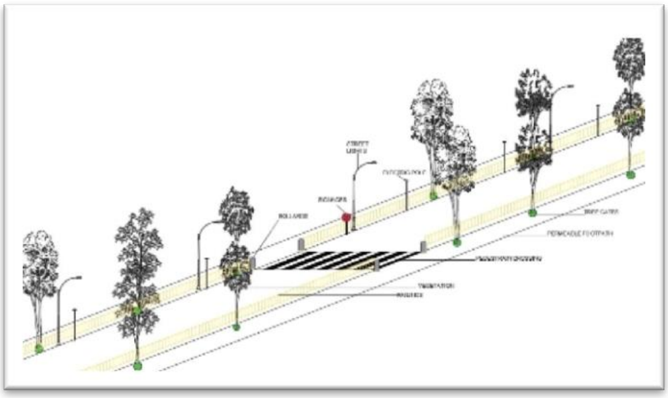

Figure 6: Ideal Project View

- Garbage containers should not be placed on the footpaths.
- Advertisements boards must be placed in such a way that it does not cause physical and visual obstructions to the commuter.
- Equipping the street with street furniture, such as seating benches, bollards, signage's and kiosks system.
- Railings to be provided at the edges of the footpath with a height of 1.1m.
- Providing proper street markings throughout the street.

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