Determining Condition of Road Surface and Contribution of Roadside Frictions Towards Traffic Flow to Estimate Effective Road Width

By

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Declaration

I declare that this report was composed by myself, that the work contained herein is my own works & efforts, except where explicitly stated otherwise in the text, and that this work has not been submitted anywhere for any awards. The entirety of contents included here is totally based on my own labor along with my groupmates assigned for the completion of the Roadway Condition Survey. Necessary references have been included for further study, along with all the sources of information.

Acknowledgement

All praise is due to the Almighty, the most merciful and most beneficent.

I would like to express my sincere appreciation, deepest gratitude to Dr. Md. Shamsul Hoque, Professor, Department of Civil Engineering, BUET and Sumaiya Afrose Suma, Lecturer, Department of Civil Engineering, BUET, for their continuous guidance and meticulous help throughout the progress of the study.

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Abstract

A condition survey is the process of collecting data to determine the structural integrity, distresses, skid resistance, and overall riding quality of the pavement. The way surveys are conducted has vital influence on designs, on production of quantities and cost estimates and finally on execution of the work. In this study, the condition survey of the corridor from Russel Square to Panthapath Intersection was conducted to identify various geometric and operational conditions of the road. The survey was conducted manually, by walking survey method with photographs. Various roadway features, availability of constituents was observed, noted, and analyzed. Causes of side-friction and loss of road width were identified with approximate loss incurred by the deterrents. The study found the road to be adequate in terms of road conditions, however, aligning the condition with the initial purpose of the road made the condition to be unsatisfactory. Side frictions were constantly present with high frequency, leading to a low level of service at times. Various traffic control devices were installed in places, but they were dysfunctional or not operational, leading to flow being hindered. Furthermore, pedestrian crossing facilities were found to not be adequate with respect to the road being a link road with high-speed traffic. Various recommendations have been made to improve the condition of the road, both geometrically and operationally.

Contents

Chapter One

Introduction

1.1 Background

A condition survey is the process of collecting data to determine the structural integrity, distresses, skid resistance, and overall riding quality of the pavement. The highway project may consist of either construction of a new road or improvements to an existing one. In either case, the working drawings must be prepared after detailed surveys, design and investigations. The way surveys are conducted has vital influence on designs, on production of quantities and cost estimates and finally on execution of the work. Thus, high responsibility rests upon those organizing the surveys and investigation.

Technical requirements for planning and design of roads are outlined so that survey services are uniform and standardized. The survey data requirement is dependent on the project type and can be collected by aerial photography, ground survey, or a combination of the two. The designer is responsible for identifying the appropriate survey data requirements (type of data, area of coverage and accuracy), selecting the method of data collection, and obtaining the survey data.

1.2 Objectives

The specific objectives of the study are to identify the following conditions of the road:

A) Geometric Condition: the overall structural geometry, configuration, and condition of the corridor under analysis. It should include the following observations:

   i. Geometric Layout of Roadway (road length, width, no. of lane, median height and width, shoulder height and width)

ii. Geometric Layout of Intersections (geometric measurement and position of channel/islands. Dimension and location of pedestrian refuge)

iii. Surface Condition Parameters: By Skid-Resistance Tester and Qualitative observation of various surface distresses

B) Operating Conditions: the overall conditions pertaining to the flow within the corridor. It should include the following observations:

i. Location and width of side roads

ii. Roadside land use pattern (residential, commercial etc.)

iii. Loss of effective width at different locations due to loading/unloading, illegal parking, construction utility etc.

iv. To show location of bottlenecks.

v. To show various control devices like Road sign, Marking, Signal, Speed breaker.

vi. To find density of road obstructions (manholes, speed breakers, potholes etc.)

vii. Density of side roads.

viii. Finding out the faults of that intersection and making proposals to remove them

ix. Planning for reducing congestion and minimize delay in intersection.

x. To make some recommendations for the betterment of the existing situation of our study intersection.

xi. Layout of street lightening system

1.3 Scope of the Study

The following are the scope of the study, along which the findings of this study can be expanded upon:

A) It will provide general information of road width, its lane quantity and width, surface quality, vehicle, pedestrians and passengers' maneuvers and regulatory controls.
B) A ranking system to prioritize maintenance needs
C) A summary of the overall condition of the pavements in any area of the road section.
D) A uniform rating system for each side.
E) A means to monitor the condition of any section of pavement (particular special design, use of materials or construction projects)
F) An historical record of pavement performance and maintenance practices

Chapter Two

Literature Review

To design a roadway there are specific road elements that must be determined. Some of these are the number of lanes, lane width, median type and width, length of acceleration and deceleration lanes for on and off ramps, need for truck climbing lanes for roadways with steep grades, curve radii required for vehicle turning, and the roadway alignment required to provide adequate stopping and passing sight distance (Mannering & Kilareski, 1998). The geometric features of the road such as horizontal and vertical alignment sight distance and in many cases, cross-section, are sensitive to the design speed.

2.1 Existing Studies

There are several research have been completed based on roadway survey condition. They are given below:

Misbah Uddin khan and Jennaro B Odoki (2010) worked for establishing the optimum pavement maintenance standards by using HDM- 4 model.

A.K Fazlul Karim (Roads & Highways Department, GoB, 2012) has worked all over the roadway condition of Bangladesh. This work is mainly related with roadway maintenance cost.

S. M. Khan and Md. Shamsul Hoque (2013) have found the interruption of traffic flow which is caused by the roadway condition and recommendations to improve the condition.

Mahbub Alam (2013) has worked over rural road maintenance. This project was financed by Local Government Engineering Department.

Mohammad Shah Alam et. al. (2011) were worked about a comprehensive study based on road accident trends in Bangladesh. This work was mainly related with roadway safety situation in Bangladesh.

2.2 Definitions of Related Terms

Intersection: Intersection can be defined as the place or point where two or more things come together, especially the place where two or more streets meet or cross each other. Mainly they depend on the number of roads come together in intersections. Based on the number of roads

3way, 4way, 5way etc. The principal objectives in the design of at grade intersections are:

A) To minimize the potential for and severity of conflicts,

B) To provide adequate capacity,

C) To assure the convenience and ease of drivers in making the necessary maneuvers.

Islands: A traffic island is a solid or painted object in a road that channelizes traffic. It can also be a narrow strip of island between roads that intersect at an acute angle. If the island uses road markings only, without raised curbs or other physical obstructions, it is called a painted island. Traffic islands can be used to reduce the speed of cars driving through. Nose treatment is an important factor for islands. It helps for turning the vehicles.

Traffic Signs: Traffic signs or road signs are signs erected at the side of or above roads to give instructions or provide information to road users.

Traffic Lights: Traffic lights also known as traffic signals, traffic lamps, signal lights, stop lights and robots, are signaling devices positioned at road intersections, pedestrian crossings and other locations to control competing flows of traffic.

Roadway markings: Road surface marking is a kind of device or material that is used on a road surface to convey official information. They can also be applied in other facilities used by vehicles to mark parking spaces or designate areas for other uses.

Pedestrian crossings: A pedestrian crossing or crosswalk is a designated point on a road at which some means are employed to assist pedestrians wishing to cross. They are designed to keep pedestrians together where they can be seen by motorists, and where they can cross most safely across the flow of vehicular traffic.

Median: It is a narrow area of land that separates the two sides of a big road in order to keep traffic travelling in different directions apart.

Roadway surface condition: Road surface or pavement is the durable surface material laid down on an area intended to sustain vehicular or foot traffic, such as a road or walkway. In the past, gravel road surfaces, cobblestone and granite sets were extensively used, but these surfaces have mostly been replaced by asphalt or concrete. Road surfaces are frequently marked to guide traffic

2.3 Various Survey Methods

There are generally four types of surveys:

1. Distress Surveys

2. Structural Capacity

3. Roughness (ride quality)

4. Skid Resistance (surface friction)

Distress Surveys: Surface distress is damage observed on the pavement surface. Distress surveys are performed to determine the type, severity, and quantity of surface distress. This information is often used to determine a pavement condition index (PCI), which helps compute a rate of deterioration and is often used to project future condition. Surface distress and the current or future PCI values are often used to help identify the timing of maintenance and rehabilitation as well as funding needs in the PMS process. Distress is the measure most used by maintenance personnel to determine what type of maintenance treatment is required and when maintenance is needed. It is typically the most important type of condition survey.

Structural Capacity: Structural capacity is the maximum load and number of repetitions a pavement can carry before reaching some defined condition. Structural analysis is normally conducted at the project-level to determine the pavement load-carrying capacity and the capacity needed to accommodate projected traffic. Non-destructive deflection testing of the pavement is a simple and reliable method to assist in making this evaluation; however, destructive testing such as coring, and component analysis techniques may be used as well. Pavement structural evaluation is important in the selection of treatments at the project-level.

Roughness (Ride Quality): Roughness, or ride quality, is a measure of pavement surface distortion along a linear plane or an estimate of the ability of the pavement to provide a comfortable ride to the users. Roughness is often converted into an index such as the Present Serviceability Index (PSI) or the International Roughness Index (IRI). Pavement roughness is considered most important by the using public, and it is especially important on pavements with higher speed limits, those above 45 miles (70km) per hour. It is considered very important by state highway agencies but is generally of less importance to cities because of the difference in speed limits as well as the causes of roughness. Pavement roughness is important for many reasons. Two of the most

important are:

A) Public Perception – Roughness is the primary criteria by which the public judges the ability of a highway agency to maintain not only its pavements, but its entire highway network.

B) Pavement Performance – Roughness leads to more rapid deterioration of pavement structures. Some amplitude-wavelength combinations can cause dynamic forces of 50% - 100% more than static weights.

<u>Skid Resistance (Surface Friction):</u> Skid resistance, or surface friction, indicates the ability of the pavement surface to provide sufficient friction to avoid skid related safety problems. Skid resistance is most important on pavements with high speeds. It is generally considered a separate measure of the condition of the pavement surface and often can be used to determine the need for remedial maintenance by itself. Many agencies use accident maps to identify high accident areas, and then an assessment is made as to whether the accidents are related to friction problems. Measurements of surface friction can be used to help eliminate potential problem spots before accidents occur. Skid resistance measurements are expressed as a skid number. On highway pavements, skid measurements are usually made with locked wheel skid trailers. Measurement of skid resistance is not typically associated with a PMS at the local level. Types of Machines used Internationally are as follows:

A) Portable field devices
- The Keystone Tester
- The California Skid Tester

B) Trailer devices
- Locked Wheel Tester
- Mu-Meter
- Spin-Up Tester
- Laser or Image Processing

The basic purpose of a pavement is to provide a safe and smooth surface for the travelling public. The travelling public is primarily interested in this functional condition, which is primarily measured with roughness and surface friction. The engineers and managers are interested in developing the most cost-effective maintenance and rehabilitation program. They are interested in an engineering analysis of the condition, as well as the functional condition. Distress surveys and structural testing are normally used in the engineering analysis. Distress surveys can be performed manually, or automated equipment may be used. In either case, the surface of the pavement is viewed, and evaluation is made to determine the following:

i. Type of distress.
ii. Severity.
iii. Quantity of distress present on the pavement surface.

The type of distress tells us what type of damage has developed; the severity tells how bad the damage is; and the quantity gives us the extent of the type and severity of damage that is present. All three of these factors are required to get a full picture of the damage that has developed on the pavement surface and are used to determine the type and timing of maintenance, rehabilitation, and reconstruction. There are different types of surveys among them only Video Survey and Photographic Survey method are followed worldwide for roadway condition survey.

Chapter Three

Methodology

3.1 Introduction

This chapter outlines the techniques for the collection of data and the procedures applied to accomplish / carry out the study. Its methodology expresses a systematic way through which any study can be done in fruitful way. This chapter delineates the overall design of the study and research mythologies that have been followed to achieve the objectives set out in Chapter 1. It also describes data collection procedures and techniques. Eventually, the difficulties or problems faced during data collection process and limitation of the study has been illustrated.

3.2 Outline of the Survey Methodology

The study, basically, aimed at evaluating the various geometric & operating condition of the corridor from Russel Square to Panthapath Intersection on a very elementary level. The study will help the participants to understand basis of Roadway condition survey and also help relevant authorities to find appropriate information to plan their various maintenance and planning processes. Moreover, it will help in assessing causes of flow delays and speed variabilities in the corridor for future studies to work on.

Following process / methods are applied for achieving the target which is set out as objective in the opening chapter:

A) <u>Reconnaissance:</u> At the very outset of the study, an extensive table-top reconnaissance and subsequent literature review had been carried out to condition, types, nature, limitations, recommendations, etc. of previous research, project reports conducted on the corridor. Lecture notes were provided by course coordinators and lecture regarding the processes were delivered. The enumeration spots, identification and various types of conditions were outlined through the use of Google Maps & Earth. Various necessary reference buildings and positions were identified for ease of action.

B) Survey Design: The initial survey process was designed based on previous works done by course coordinators. The whats and whys were delineated, however the hows were to be conceived entirely by the assigned teams. The work was divided in geometric features and operational features identification and thus, teams were divided in two for simultaneous data collection. The data that were needed to be collected were identified, however which method to adopt was to be identified from the subsequent step.

C) Piloting: Early on the day of the survey, the corridor was visited by the assigned team and was preliminarily surveyed with the consideration of budget, time, and resource availability. The preliminary survey led to the decision of conducting a walking survey with photography to identify the various road conditions. The geometric features were to be measured with the help of measuring tapes.

D) Problem Identification: The problems that were identified regarding the methods adopted were the risk of collision while measuring various road furniture. Furthermore, the visual identification of road surface conditions took proper attention which led to some hindrances on the sidewalk. Additionally, the initially set group needed to be subdivided for simultaneous working capabilities. Various safety measures were adopted with highlighted safety vests with traffic cones for stopping traffic during measurements. Teams were divided into geometric & condition surveying groups for fast data collection.

E) Main Survey: At first, we carried out the geometric condition survey at Panthapath Signal. We measured road width, lane width, shoulder width and all other geometric conditions using tape measure. Then we started the pavement and operating condition survey from a traffic police stand, which was the closest reference object to Panthapath signal that could be used. Using the stand as a reference point we walked towards Russell Square. We recorded the location and width of the side roads. We used the tape measure to measure length from one side road to the adjacent one. As we walked along, we also recorded pavement distresses, pedestrian crossings etc. The skid resistance test was carried out in BUET using the pendulum method. It was supposed to be carried out at the intersection, high-speed areas and at zebra crossings, but this could not be carried out due to safety issues.

3.3 Existing Methods

A variety of methods are available to conduct a road condition survey. In this section, we will briefly review some of these methods and provide justification for the one we chose for our survey. The methods can be broadly categorized into two parts:

1. Manual Methods
2. Automatic Methods

Manual Methods: Although the use of automated pavement condition surveys have become more common in recent times, many agencies still make use of manual pavement condition surveys to provide their pavement condition data. There are two basic methods for conducting manual pavement condition surveys, walking and windshield surveys. Oftentimes walking and windshield surveys are combined to provide a more complete pavement network survey.

Walking Survey: Walking surveys are conducted by a rater who is trained to rate distresses according to the agency's distress identification specifications. The rater walks along the side of the pavement and fills out a pavement condition form that describes the amount, extent, and severity of each distress present on the roadway. When the raters have been properly trained and are experienced, walking surveys provide the most precise data about the condition of the rated pavement (Haas, 1994). However, walking surveys can only be used on a small sample of the entire pavement network as the process is time consuming. For example, the pavement network could be represented by only surveying the first 100 ft of each mile. Agencies often use the following methods to pick a site for a sample: sample at fixed distance intervals, make a predetermined random selection, and have the rater pick a "representative" sample. Random selection can sometimes be difficult to accept because the pavement under review may have a considerable amount of distress, but the random sample has, for example, recently been patched. However, selecting a more "representative" sample will distort or bias the data about the condition of the pavement network (Haas, 1994). Under the theory of random selection some of the samples will have more distress than the pavement actually has and some of the samples will have less distress than the pavement actually has. Therefore, the overall condition of the network will average out, provided the sample size is large enough.

Windshield Survey: A windshield survey is completed by driving along the road or on the shoulder of the road. The pavement is rated by a rater through the windshield of the vehicle. This method allows for a greater amount of coverage in less time; however, the quality of the pavement distress data is compromised. The entire network could possibly be surveyed using this method or samples may still be used.

Walking + Windshield Survey: Combining a walking survey with a windshield survey is a good method to achieve detailed pavement distress data and complete pavement surveys on a greater 15 percentage of the network. Haas (1994) states that this method is acceptable only if the same procedure is used on every section in the network, and a random method is used for selecting the sample where the walking survey will be performed.

Automatic Methods: Several automatic methods exist to conduct the various aspects of a road condition survey. Some methods are:

1. Video camera
2. GIS method
3. Automated road analyzer

Video Camera: A high-resolution video camera is fixed to traffic post or some other fixture. Alternatively, the video camera can be fixed onto a surveying vehicle. The video feed is recorded and can be later viewed. This method is mainly used for pavement condition surveys and can also be used to record some aspects of operating condition surveys. Attaching the camera to a vehicle greatly increases coverage area. One disadvantage is that this method cannot be used in night and in low light conditions.

GIS Method: GIS is a system designed to capture, store, manipulate, analyze, manage and present all types of geographical data. GIS is a very powerful tool which can be used to store, analyze and present data that has been collected by other means provided that the data has the required location data to go with it. In addition, GIS can also be used to capture to distance measurements in horizontal plane from satellite images, through a process known as digitization. Thus, in the case of road condition surveys, GIS is the best tool for storing and presenting data captured by other methods. In addition, GIS can be used to capture data such as road length, no. of lanes and even road width, from satellite images through digitization, to certain degree of accuracy.

Automated Pavement Condition Survey: Over the past two decades the concept of a fully automated pavement condition survey has grown closer to a reality through research and major technological advancements. The automated pavement condition survey vehicle and some types of data it is capable of collecting are described in this section. Also, surface distress surveys and technology used in completing them are discussed. Lastly, pavement condition survey protocols are examined.

Automated Pavement Condition Survey Vehicle: One of the most important parts of an automated pavement condition survey is the data collection process. This process is completed by technologically complex vehicles traveling down the road at highway speeds collecting and storing data. There are numerous types of automated pavement condition survey vehicles available, and some utilize different kinds of data collection technology.

3.4 Rationale for Adopted Method

For our survey, we chose manual methods and walking survey. This was because of several reasons.

1. Firstly, a walking survey is the most straightforward method for capturing all the data required for our road condition survey.

2. Our survey area was relatively small and walking surveys are good for small lengths.

3. Manual methods tend to be labor intensive, but we had adequate manpower at our disposal.

4. Automatic methods require expensive equipment for which funds were not available.

5. Short lengths do not usually require automatic methods.

6. We did not have to the requisite training to operate the required equipment.

3.5 Data Collection Method Brief

- Location: Panthapath-Rusell Square Road (about 20 feet way from Panthapath Mor intersection)
- Method – Manual
- Equipment – Tape, Camera etc.
- Date: 23/12/21
- Day: Thursday
- Status: Working Day
- Time Schedule: 8am to 12pm
- Weather condition: Sunny.
- Temperature: 25 degrees Celsius
- Duration – 4 hrs.
- Number of Enumerator – 35 students in 6 groups collectively

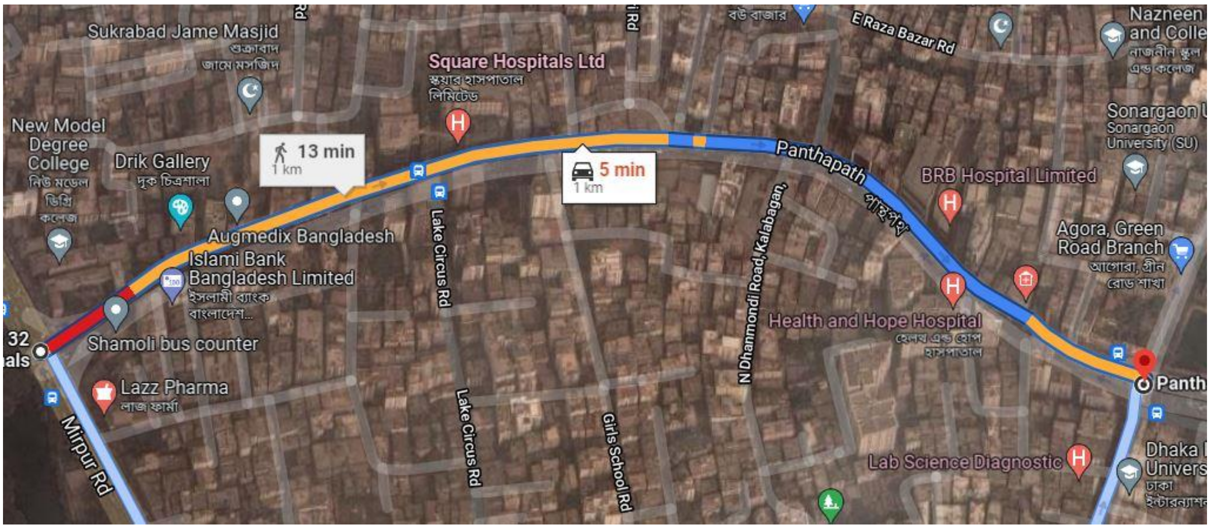

Figure 1: Bir Uttam Kazi Nuruzzaman Road

3.6 Study Area Description

The corridor under study is a segment from Bir Uttam Kazi Nuruzzaman Road, which is a link road connecting Mirpur Road with Kazi Nazrul Islam Avenue, with one node being in Russel Square and the other at SAARC Fountain, Kawran Bazar. As it was designed to be a link road, the route is expected to carry high-speed traffic with no non-motorized vehicle allowed. The road has 3 intersections in total, while our study includes the corridor from Russel Square to Panthapath intersection, which is in 1 kilometer of length. The road has multiple side roads acting as access roads to residential built-up areas nearby. Despite being considered a link road; the road consists of various commercial spaces on the roadside which creates various impedance for the flow. Various hospitals are also located in this road, leading to loading and unloading of vehicles with various parking facilities, legal or else. The path also consists of various shopping complex, especially one of the largest of Dhaka City, the Bashundhara City Shopping Complex, which generates much of the incoming traffic. However, no short route public buses are available for the route, leading to traffic comprising of mostly personal vehicles and motorcycle. The availability of various restaurants and commercial spaces lead to some traffic generation which creates impedance for passing traffic, leading to the road not being utilized as a link road whatsoever and rather a typical business district road of Dhaka City.

Chapter 4

Data Collection & Analysis

Collected Data has been presented and correspondingly analyzed in this chapter with respect to objectives stated in chapter one.

4.1 Data Collection

4.1.1 Geometric Conditions

A. Geometric Layout of Roadway: the various geometric property of the roadway, the findings of their measurements along with appropriate figures are outlined below.

Table 1: Roadway Geometric Features and Measurements

Features	**Measurement with Appropriate Units (if any)**
Road Length	1 Kilometre
Width	29 Feet
Number of Lanes	3 Nos.
Lane Width	7.86 Feet
Median Height	1 Feet 3 Inches
Median Width	4 Feet
Shoulder Height	1 Inch to 3 Inches (variable)
Shoulder Width	1 Feet 5 inches
Sidewalk Height	1 Feet
Sidewalk Width	6 Feet 4 Inches

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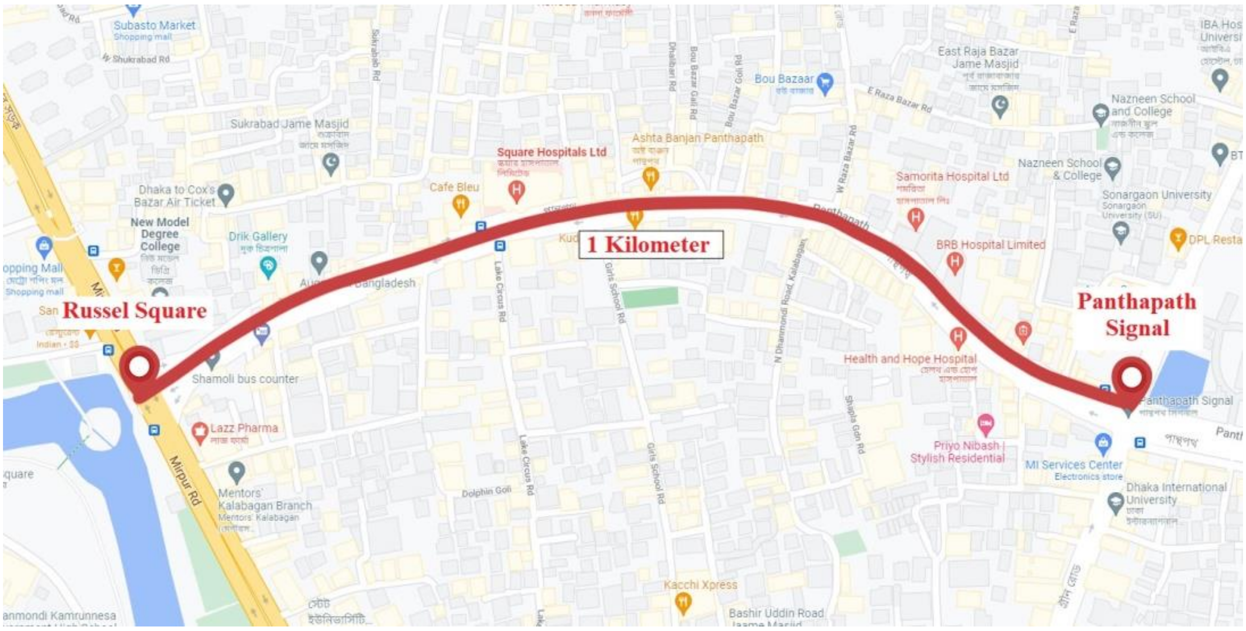

Figure 2: Length of the Corridor measured through Google Maps

Figure 3: Width Characteristics of the Road

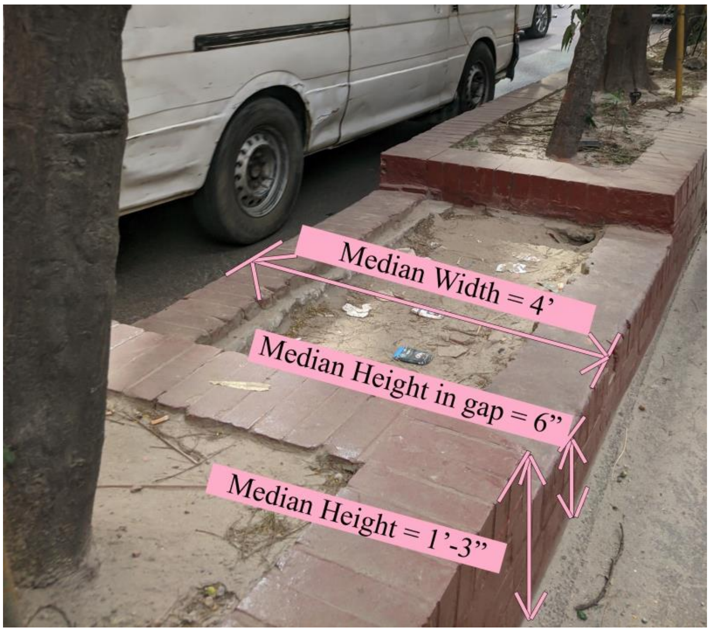

Figure 4: Median Property

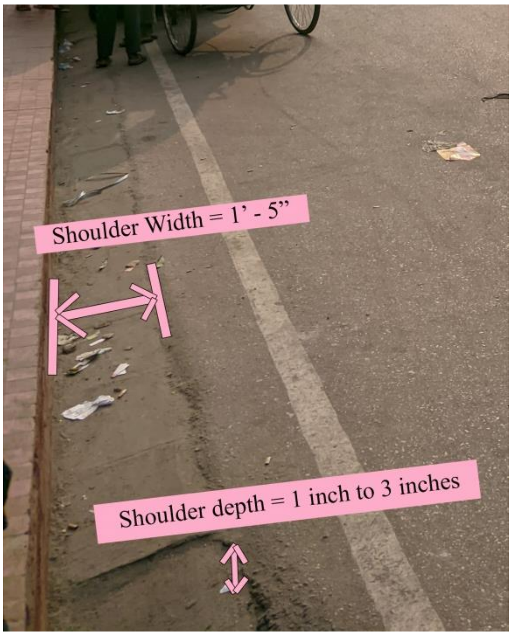

Figure 5: Shoulder Property

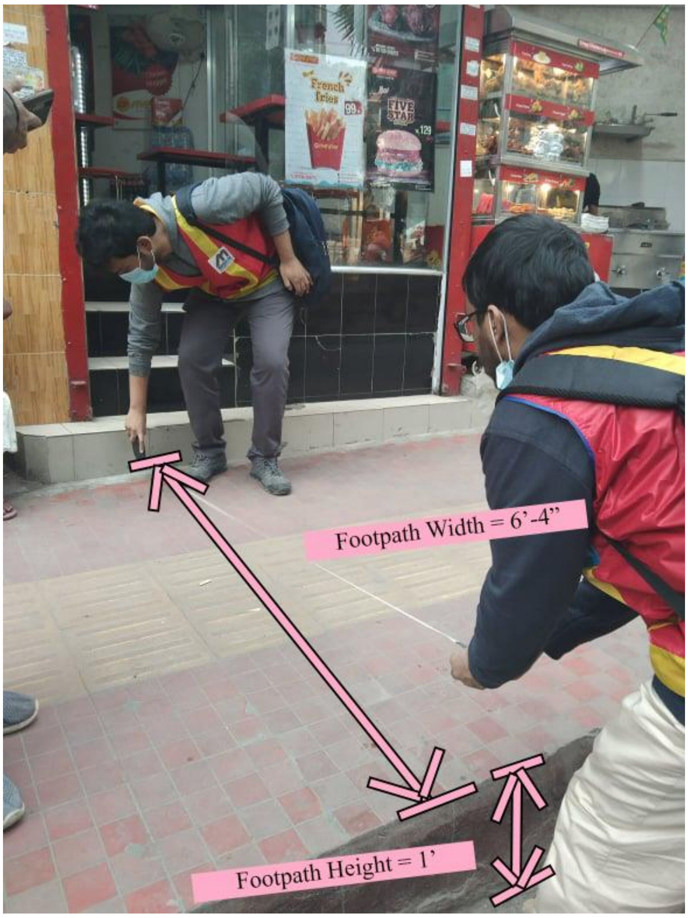

Figure 6: Sidewalk Properties

Figure 7: Loss of Roadway Width

The roadway width was measured at various points with somewhat consistency in the results. However, in some locations, lane width was found to be reduced structurally due to curvatures in the path and loss of width by external factors such as illegal parking, Median features were very consistent throughout the route, with some opening for pedestrian crossings at some points. The shoulder depth was found to be variable at various points of measurement. Sidewalk width was also reduced at some points by temporary establishments and external hindrances.

B. Geometric Layout of Intersection

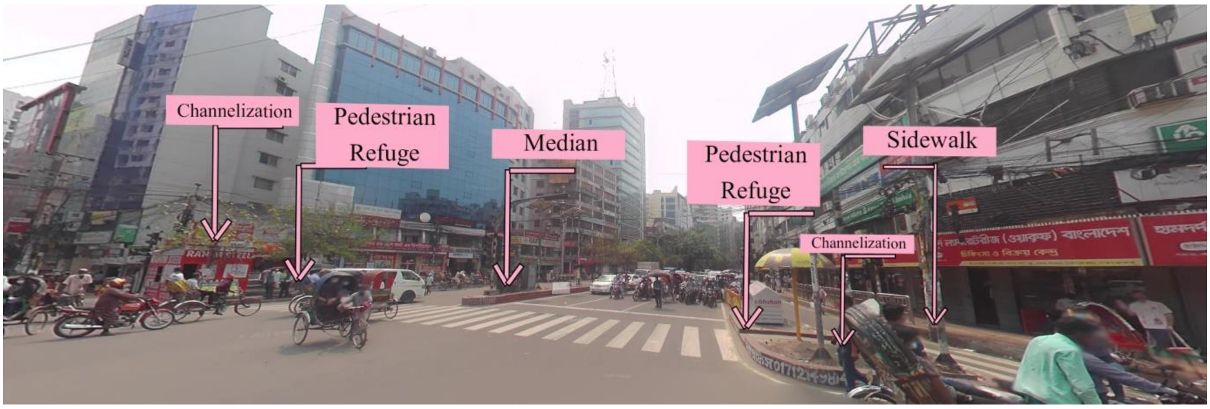

Figure 8: Various Intersection Components on Panthapath Intersection

Optimum channelization with proper flaring was available. There were multiple pedestrian refuge available in the channels with Police Box on one side. However, there was no pedestrian refuge available in the median.

C. Surface Conditions

i. By Skid Resistance Tester: a sample test was conducted at a pavement in BUET using Skid Resistance Tester. The Skid Resistance was found to be 74

Figure 9: Skid Resistance being Tested

ii. Qualitative Observation:

Table 2: Qualitative Observation various Geometric hindrances

Characteristics	**Observed Attribute**
Potholes	Present
Manhole Elevation	Present
Rutting	Absent
Alligator Cracks	Absent

Patches	Present
Depressed Utility Hatches	Present
Utility Cuts	Present
Speed Breakers	Absent

Figure 10: Pothole

Figure 11: Elevated Manhole

Figure 12: Pothole

Figure 13: Patching

Figure 14: Depressed Utility Hatch

Figure 15: Drain Inlet

Figure 16: Unhinged Utility Hatches

4.1.2 Operating Conditions

A. Side Road Condition: Data was collected by all 6 groups.

Table 3: Location and dimension of side roads in the direction of Panthapath to Russel Square

No. of Side Road	Measured length started from Russell square (ft)	Width (ft)	Comment
1	163	19	Wide
2	262	19.5	wide
3	753	19	wide
4	982	10	Narrow
5	1148	20.5	Wide
6	1943	10	Narrow
7	2568	13	Narrow
8	2926	12	Narrow

Table 4: Location and dimension of side roads in the direction of Russel Square to Panthapath

No. of Side Road	Measured length started from Russell square (ft)	Width (ft)	Comment
1	174	5	Too narrow
2	207	9	Narrow
3	285	6	Narrow
4	358	10	Narrow
5	915	13	Narrow
6	1023	13	Narrow
7	1174	10	Narrow
8	1222	11	Narrow

9	1244	11	Narrow
10	1469	13	Narrow
11	2184	13	Narrow

Figure 17: Side Road 10, inclined intersection

Figure 18: Side Road 3 from Panthapath to Russel Square Direction

Despite being a link road, the corridor had numerous side roads leading to inner residential areas, which created mass of non-motorized vehicle inflow. Furthermore, the high density of such road incurred uncontrolled vehicle inflow, leading to various vehicles taking shortcuts which caused impedance for main flow.

B. Road-side Land Use Pattern

The built-up areas were mostly of commercial class with some mixes. With various hospitals, offices, banks, restaurants, small scale consumer service facilities, etc. there were various sources of impedances for free-flowing traffic.

Table 5: Types of roadside buildings observed

Classification	**Observed Attribute**
Residential	Present
Shopping Complexes	Present
Hospitals	Present
Commercial Hub	Present
Small Convenience Stores	Present
Car & Vehicle Maintenance	Present

Figure 19: Hospitals

Figure 20: Vehicle Maintenance

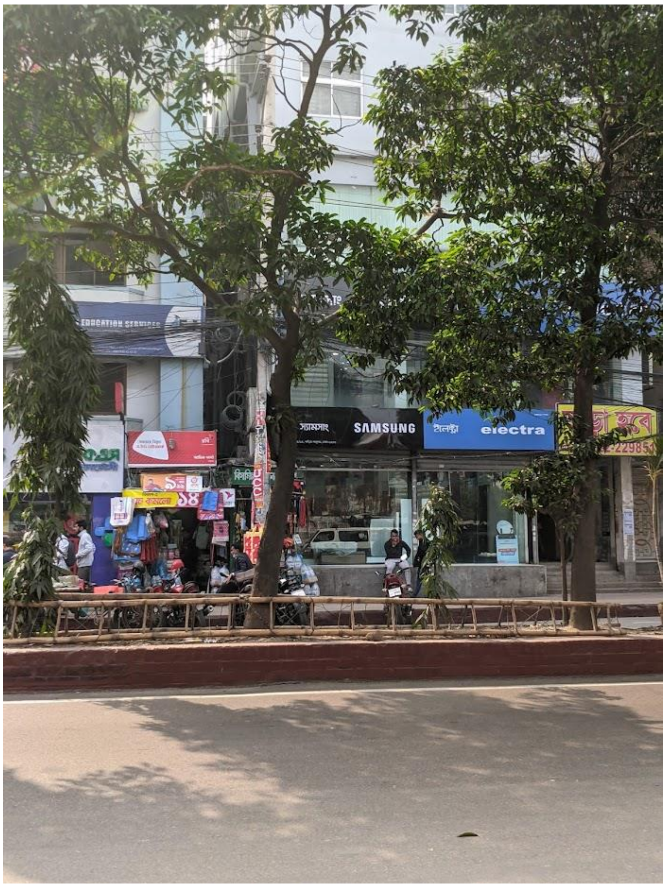

Figure 21: Commercial Hubs & Offices

Figure 22: Restaurants and Small Convenience Stores

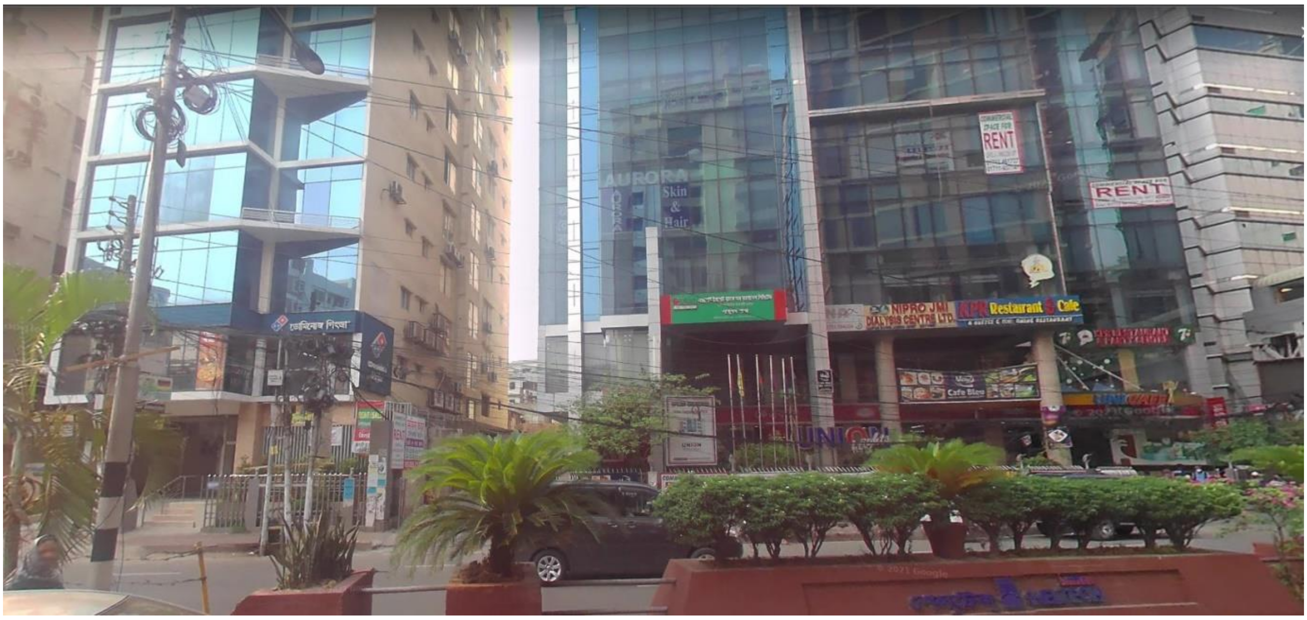

Figure 23: Shopping Complex & Commercial Points

C. Pedestrian Crossing Facilities

Table 6: Observation of Pedestrian Crossing Facilities

Classification	Observed Attribute
Foot Over Bridge	Absent (Publicly Inaccessible)
Subway Crossing	Absent
Crossing Strip/Zebra Crossing	Present
Median Opening	Present
Signalized Crossing	Absent
Vehicle Barring	Present
Channelization Island Refuge	Present
Median Refuge	Absent
Kerb Extensions	Absent
In-Pavement Flashers	Absent

Figure 24: Median Opening

Figure 25: Median Opening with Vehicle Barring

Figure 26: Pedestrian Crossing Strip & Median Opening

Figure 27: Channelization Island Pedestrian Refuge

D. Signal & Marking

i. Traffic Signs: They were mostly unavailable with no guideline on speed, accessibility or service availabilities.

Figure 28: Handicap Movement Sign

Figure 29: Pedestrian Crossing Sign

Figure 30: Parking Facility Sign

ii. Road Markings: Mostly Lane markings, shoulder markings were present. However, intersection wafer marking, channelization ladder marks, pedestrian 15" strips were also present.

Figure 31: Road Markings

Figure 32: Intersection Wafer Marking

Figure 33: Channelization Island Marking

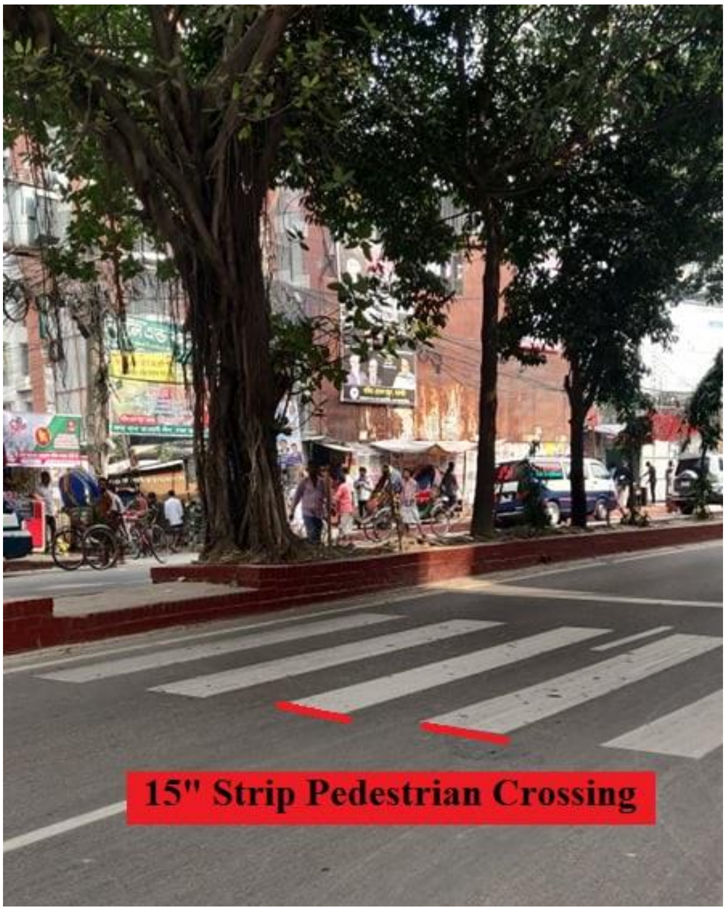

Figure 34: 15” Strip Pedestrian Crossing Marking

iii. Signal: Signals were provided at both ends of the corridor. However, the signals are not operational as, hand signals are provided by traffic police at each intersection.

Figure 35: Traffic Sign at Russel Square Node

Figure 36: Traffic Signals at Panthapath Intersection Node

iv. Layout of Street Lighting System: Lighting system were adequately spaced; however, their effectiveness could not be checked due to daylight. Furthermore, in some cases streetlights were covered by median trees' branches

Figure 37: Street Lights in the Corridor

Figure 37: Street Lights Obstructed by Tree

E. Loss of Road Width: in various places road width was reduced due to obstruction by various external factors. The following were found to have contributed to this ordeal.

Table 7: Observation of Causes of Loss of Road Width

Classification	**Observed Attribute**	**Approximate Loss**
Illegal Roadside Parking	Present	Variable
Hospital Roadside Parking	Present	1 Lane width
Temporary Carts & Establishments	Present	Shoulder Width
Rickshaw Stands	Present	1 and a half lane
Objects	Present	Shoulder Width
Construction Materials	Absent	
Dangling Wires	Present	Half a Lane
Median Tree Influence	Present	Half a Lane
Kerb Extensions	Absent	
Extension of Driveway	Present	Half a Lane
Parking & Side Road Weaving	Present	One Lane

Figure 38: Illegal Parking

Figure 39: Illegal Parking

Figure 40: Hospital Loading & Unloading

Figure 44: Hospital On Road Parking

Figure 42: Parking & Side Road Weaving

Figure 43: Rickshaw Stand

Figure 44: Objects & Temporary Carts

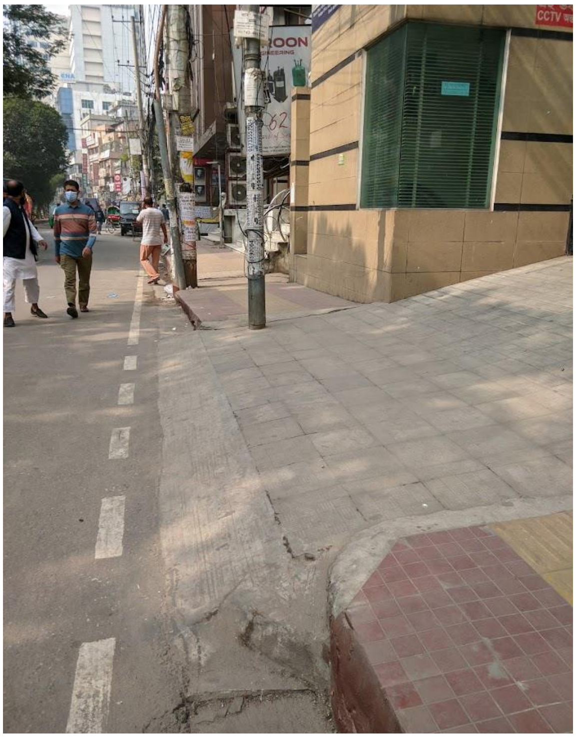

Figure 45: Driveway Extension

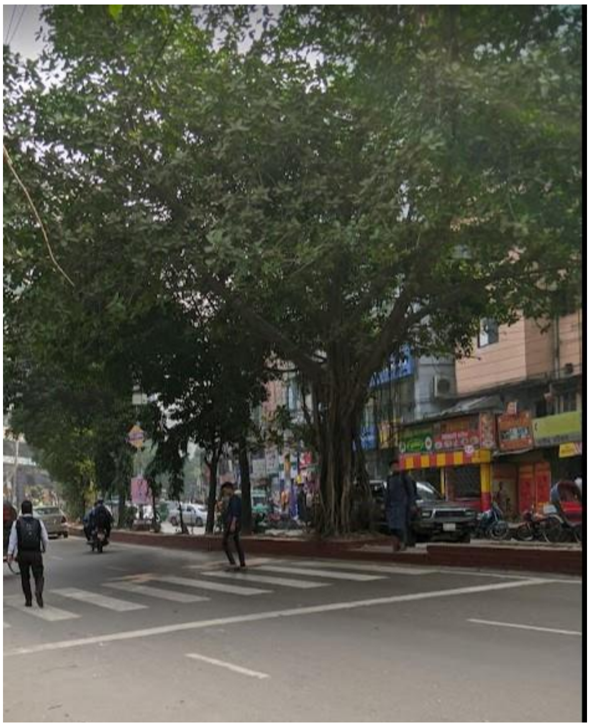

Figure 46: Banyan Tree Dangling Branches

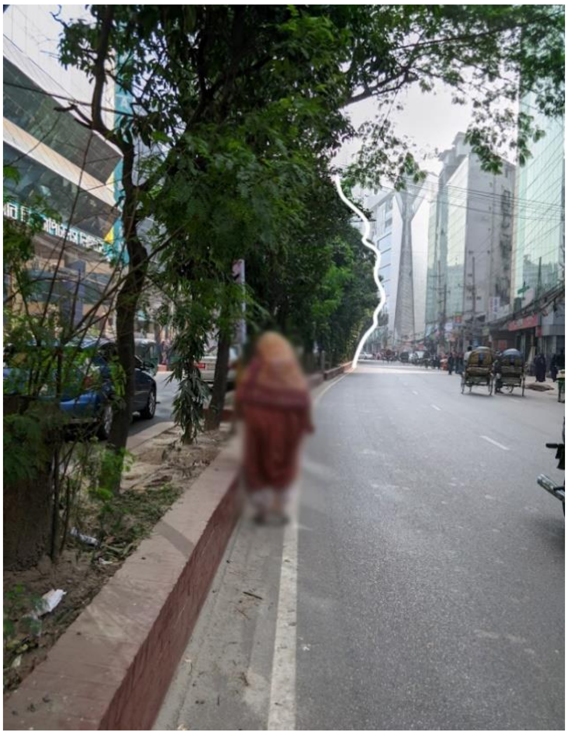

Figure 47: Increased Median Influence Area

Figure 48: Dangling Wire

4.2 Data Analysis

A) Frequency of Various Bottlenecks:

Table 8: Density of various features observation

Characteristics	Panthapath to Russell Square	Russell Square to Panthapath
Density of side road	8	11
Density of opening	2	1
Density of pedestrian crossing in median	7	7
Density of bus stops on road	0	0
Density of dustbin	0	0
Density of Construction Materials	0	0
Density of Potholes	1	1
Elevated Manhole	2	3
Depressed Manhole	1	1
Speed Breakers	0	0

B) Approximate Width Loss:

Table 7: Approximate width loss

Cause	Approximate Loss	In Feet
Illegal Roadside Parking	Variable	1’-5” to 9’-4"
Hospital Roadside Parking	1 Lane width + 1 Shoulder	9’-4”
Temporary Carts & Establishments	1 Shoulder Width	1’-5”
Rickshaw Stands	1 and a half lane	12’-9”
Objects	Shoulder Width	1’-5”
Dangling Wires	Half a Lane	5’-5”
Median Tree	Half a Lane	5’-5”
Extension of Driveway	Half a Lane	5’-5:
Parking & Side Road Weaving	One Lane + 1 Shoulder	9’-4”

C) Average Skid Resistance Values

Table 8: Skid Resistance Values of different Groups

Group No.	Skid Resistance Values
1	70
2	69
3	72
4	74
5	75
6	76

Hence, average skid resistance = $\frac{70+69+72+74+75+76}{6}$

= 72.66667

= 73

Chapter Five

Conclusion & Recommendations

5.1 Introduction

In this chapter, observations and insights made in the previous chapter are presented in a summarized form. These leads to some recommendation for the improvement of this roadway. Though the study is done with proper attention, there is always a scope for better study. Recommendation for both the improvement of roadway and for further study is under the scope of this chapter

5.2 Findings

A. Geometric Conditions of Roadway:

   i. Adequate Lane spacing, shoulder width, median and sidewalk were provided

   ii. Effective width of each component was heavily reduced by external factors, from 1’5” to 12’9”

B. Geometric Layout of Intersections:

   i. Some features were employed to facilitate intersection flow, however channelization was blocked due to non-motorized vehicle movement and aggressive overtaking

   ii. Pedestrian crossing facility was found to be inadequate with no proper planning

   iii. Traffic signals were positioned at proper places but were dysfunctional and led to manual controlling of flow

C. Surface Conditions

i. Skid Resistance was found to be 73, which implied good skid resistance. The result was recorded in wet condition; thus, it can be expected to be better in dry conditions

ii. Various geometric hindrances were found, but in small density, 3 or 4 per characteristic. This can be implied to be somewhat good road condition, however, for a link road as the one under study, such hindrances can cause accidents due to high-speed traffic movement.

D. Operating Conditions

i. There was high density of side-road along both sides of the road. The roads were too narrow in most cases and inclined without any safety measures for weaving of traffic. Furthermore, unregulated traffic flow led to various vehicles taking shortcuts through the side roads, causing side friction.

ii. Built-up area’s land use is heterogeneous, which is very unlikely of a link road, creating various impedances from loading and unloading of passengers. This created various side frictions for oncoming flow.

iii. There were some pedestrian crossing facilities, however, the use of such was not enforced. In most cases, the crossing facilities seemed to be inadequate for a link road with high velocity traffic. Unrestricted road crossing led to various traffic impedance.

iv. Vehicles were barred from unrestricted U-turns, which seemed appropriate for the road type. However, in authorized U-turns, median tree’s branches blocked vision

v. Traffic signs were inadequate and did not have any proper use for the cases from traffic control authorities.

vi. Road markings were adequately imprinted, however, in most cases the markings were removed from heavy usage and needs to be repainted.

vii. Signals were provided at both intersection, which were not operational leading to manual flow control, leading to improper planning-oriented congestion on both ends of the corridor

viii. Street lighting's effectiveness could not be checked; however, they were spaced in appropriate distances. In some cases, street lighting was blocked by median trees.

ix. Road width was found to be reduced from 1'-5" to 12'-9" at various locations, adds up to nearly half of the road width being unutilized.

5.3 Recommending Improvement Measures

A) Effective monitoring methods & law enforcement need to be applied to nullify causes of road width losses

B) Intersection flaring & channelization islands need to be kept distinctly exclusive for effective intersection usage

C) Pedestrian crossing facilities need to be planned with the road's characteristics and necessary infrastructures need to be developed

D) Traffic signals need to be made functional and operative. They are placed at proper places, however, negligence towards them is causing error for the bigger picture of link road connectivity.

E) Surface conditioning survey needs to be conducted for thorough analysis regarding maintenance planning of the road

F) Side roads need to be restricted and access control must be ensured for bypassing and non-motor vehicle traffic

G) Homogeneity needs to be ensured for the roadside built-up area, depending on the changed purpose of the road. Mixed land use is causing most of the problem for the road.

H) Adequate traffic signs, road markings and signals need to be provided. Signalized pedestrian crossing needs to be ensured.

I) Median furniture needs to be re-assessed and proper trees & herbs need to be planted for effective traffic transmission.

J) Parking spaces need to be implemented with proper flaring methods for weaving of traffic

5.4 Limitations

A) Skid resistance test was not performed on-site due to limitation of resources

B) Visual survey by inexperienced enumerators may lead to some errors and misunderstandings of features

C) Continuous recording of road was not possible, leading to some intermittent missing of data

D) As the survey was performed the day before government holidays, the traffic measurement and corresponding values may not provide accurate information

5.5 Recommendation for Future Studies

A) Proper reconnaissance and table-top analysis must be done before start of piloting

B) Higher resource and manpower need to be ensured

C) Protective equipment needs to be always worn

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