STAMFORD UNIVERSITY BANGLADESH

DEPARTMENT OF CIVIL ENGINEERING

A STUDY ON FLOW-DENSITY RELATIONSHIP AT MINTO ROAD TO HOTEL INTER CONTINENTAL ROUTE (BOTH DIRECTION)

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NOVEMBER 2020

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The project and thesis title 'A STUDY ON FLOW DENSITY RELATIONSHIP MINTO ROAD TO HOTEL INTER CONTINENTAL ROUTE IN (BOTH DIRECTION)', submitted by Md. Kafil Uddin, ID NO.: CEN 062 09489; Md. Fazlerabbi, ID NO.: CEN 062 09488; Md. Jakir Hossain, ID NO.: CEN 062 09427; students of the Department of Civil Engineering has been satisfactorily accepted in partial fulfillment of the requirements for the degree of Bachelor of Science (B.Sc.) in Civil Engineering on November, 2020.

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DECLARATION

We, Md. Kafil Uddin, Md. Fazlerabbi and Md. Jakir Hossain; the students of B.Sc. in Civil Engineering hereby solemnly declare that the works presented in this thesis & project has been carried out by me and has not previously been submitted to any other University / College / Organization for any academic qualification / certificate / diploma / degree.

We warrant that the present work does not breach any copyright.

We, further undertake to indemnify the University against any loss or damage arising from breach of the foregoing obligations.

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DEDICATION

We dedicate this thesis to our parents and to all of our honorable faculties of Department of Civil Engineering, **Stamford University Bangladesh**.

ACKNOWLEDGEMENT

The research ‘A Study on Flow Density Relationship Minto Road to Hotel Inter Continental (Both Direction)’ has been conducted in partial fulfillment of the requirements for the degree of Bachelor of Science (B.Sc.) in Civil Engineering. This critical work came to life due to the unconditional help and co-operation in different ways by many people. We express our gratefulness and thank them for their assistance in preparation of this project and thesis.

First of all, we like to show my highest gratitude to the Almighty Allah Subhana WaTa’la for his mercy, blessings and guidance while we were preparing our thesis.

It is the broadness of the government to pass the Private University Act 1993 for making a scope of education for all. It wouldn’t have been possible on my behalf to have earned the bachelor degree in civil engineering if a private university like “Stamford University Bangladesh” would not have taken the challenge to create civil Engineers. We are grateful to Prof. Dr. M. A. Hannan Feroz, the Honorable President and Vice Chancellor of the Stamford University Bangladesh for this praise worthy step.

We are indebted to the supervisor of my project and thesis, Mrs Anika Nowshin Mowrin, Assistant Professor of the Department of Civil Engineering, Stamford University Bangladesh for making me believe that logic is power, and with the right principles and dedication a man can achieve anything. Thank you for your assistance and your patience, you are our role model.

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ABSTRACT

Bangladesh is a developing country containing heterogeneous traffic, which is characterized by wide variations in traffic characteristics. The new technologies offer the greatest challenge and hope for improving the quality of traffic system. The ability to apply traffic flow fundamentals is an essential ingredient in working toward improving the transportation system. The present study is concerned with traffic flow characteristics observed on 2-lane divided carriageway. The objective of the study was to analyze traffic flow, density, and speed and space mean speed. Traffic flow fundamental diagrams are used to characterize the relationship between these parameters. Study of traffic flow involves selection of location, photographic survey analysis statistical analysis and calculation of basic parameters of traffic flow. Data extracted are compiled for each direction. Scatter diagrams flow-density, space mean speed-flow, speed-density were plotted for both direction. Explanations of all diagrams were given with and there were some limitation. Flow-density relationships in these routes were found similar of the fundamental diagram of traffic flow from the plotted diagrams. As these routes become very congested in the peak hours this research will help to find out the way to overcome the congestion during peak hours.

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LIST OF ACRONYMS & ABBREVIATIONS

BBS = Bangladesh Bureau of Statistics

SMA = Statistical Metropolitan Area

SMS = Space Mean Speed

MPH = Mile per Hour

VPH = Vehicle per Hour

VPM = Vehicle per Mile

LOS = Level of Service

AHS = Average Highway Speed

PCU = Passenger Car Unit

ADT = Average Daily Traffic

AADT = Annual Average Daily Traffic

CHAPTER- I

INTRODUCTION

INTRODUCTION

1.1 General:

Traffic Flow Theory is a tool that helps transportation engineers understand and express the properties of traffic flow. At any given time, there are millions of vehicles on our roadways. These vehicles interact with each other and impact the overall movement of traffic, or the traffic flow.Speed is one of the basic parameter of traffic flow and time mean speed and space mean speed are the two representation of speed. Time mean speed and space mean speed and the relation between them will be discussed in detail in this chapter. The relation between the fundamental parameter of traffic flow will also be derived. In addition this relationship can be represented in graphical from resulting in the fundamental diagram of traffic flow.

1.2 Background:

Dhaka is the capital city of Bangladesh and the center of administrative, political, economic and social life for the country. Dhaka is centrally located within Bangladesh and an important destination for millions who decide to changes their lives by migrating from rural to urban area. According to Bangladesh bureau of statics, the Dhaka statistical metropolitan area (SMA) is home to 20 million people (BBS) which is 40% of the total urban population of Bangladesh (World Bank). Transportation is a major issue in Dhaka not only the transportation system provides day to day mobility but it’s a critical part of the growth pattern of Dhaka city. There are a current challengers related to rapid urban growth such as increasing housing rents new amenities, infrastructure investment which have shifted lower income people to the periphery of the city. Comprehensive and efficient transportation system with good inters and intra city linkage is essential to ensure Dhaka position as a modern city and to serve the administrative financial and commercial capital of the country. The city must be able to provide an efficient and equitable transport infrastructure which allows the all member of the community equal access so that everyone can enjoy the maximum benefit of the city life. Traffic flow theory involves the development of

mathematical relationship among the primary element of a traffic stream flow density speed volume data are needed to research planning designing and regulation phase of traffic engineering and are also used in establishing priorities and schedule of traffic movements. The engineer must acquire general knowledge of traffic volume characteristics in order to measure and understand the magnitude, composition and time and route distribution of volume for each area under his jurisdiction.

1.3 Objective:

The major objective of our study can be summarized as follow-

- To evaluate and analyze the flow density relationship of the selected area in Dhaka city.
- To assess the flow parameter of an urban heterogeneous traffic and various roadway characteristics.

1.4 Scope of Study:

Scope of traffic volume study Magnitudes, classification and the time and directional split of vehicular flow Proportions of scope vehicles flow function of different approaches at a junction Hourly, daily, yearly and seasonal variation of vehicular flow.

1.5 Organization of Thesis:

Chapter ONE: The first chapter is introduction which discusses the general information, objectives, scope of study and summary of the survey work.

Chapter TWO: It is the literature review, which discusses the basic concepts of flow density relationship.

Chapter THREE: It discusses about the site selection and work procedure.

Chapter FOUR: The four chapters are data collection and analysis which we are survey of flow density relationship in selected area.

Chapter FIVE: It presents the conclusions and limitation of study and recommendation.

1.6 Summary:

Speed flow density relationship is very important for finding the existing condition of roads and for planning out of the future infrastructure of the road. It is used to find out the capacity of road finding these relationships at peak hour and (LOS) level of service of the road can also be found out. Speed limit for a particular road can also be estimated. It is the basic step to note down the flow pattern of the road and serviceability of the road.

CHAPTER- II

LITERATURE REVIEW

LITERATURE REVIEW

2.1 General:

Important terminology and basic concept are carried out in this chapter. Different roads have different speed flow and density. Development of speed flow density the model is the basis of finding different types of traffic characteristics for a traffic road. These relationships are used for planning out of the future infrastructure of the road. In this chapter we show basic concepts of flow, density, speed, space mean speed, time head way and space head way.

2.2 Review of Literature:

Traffic-flow theories seek to describe in a precise mathematical way the interactions among vehicles, drivers, and the infrastructure. The infrastructure consists of the highway system and all its operational elements, including control devices, signage, and markings. These theories are an indispensable element of all traffic models and analysis tools that are being used in the design and operation of streets and highways. The scientific study of traffic flow had its beginnings in the 1930s with the application of probability theory to the description of road traffic and with the pioneering studies conducted by Bruce D. Greenshields at the Yale Bureau of Highway Traffic on the study of models relating volume and speed and the investigation of performance of traffic at intersections. After World War II, with the tremendous increase in the use of automobiles and the expansion of the highway system, there was also a surge in the study of traffic characteristics and the development of traffic-flow theories. In December 1959, the First International Symposium on the Theory of Traffic Flow was held at the General Motors Research Laboratories in Warren, Michigan. This was the first of what has become a series of triennial symposia on the theory of traffic flow and transportation. The field of traffic-flow theory and transportation has become too diffuse to be covered by any single type of meeting, and numerous other symposia and specialty conferences about a variety of traffic-related topics are held on a regular basis. Yet, even as traffic-flow theory is increasingly better understood and more easily characterized through advanced computation technology, the fundamentals are just as

important today as in the early days. They form the foundation for all the theories, techniques, and procedures that are being applied in the design, operation, and development of advanced transportation systems. This elementary and brief introduction to traffic-flow theory is included to extend the engineer's knowledge in this vital area and to relate the theory to other aspects of traffic engineering.

The first beginnings for traffic flow descriptions on a highway are derived from observations by Green shields, firstly shown to the public exactly 75 years ago (Proc., 13th Annual Meeting of the Highway Research Board, Dec. 1933). He carried out tests to measure traffic flow, traffic density and speed using photographic measurement methods for the first time. A short look on his CV shows that Green shields started his career as a traffic engineering scientist with this publication which leads to a PhD thesis at the University of Michigan in 1934.

While Green shields is well known for his development of The Fundamental Diagram in Traffic Flow Theory, it is less known that he also made fundamental contributions to the study of traffic behavior at signalized intersections. This was done while he was associated with the famed Yale Bureau of Highway Traffic at Yale University in New Haven, Connecticut in the mid-1940s and culminated in a seminal report entitled Traffic Performance at Urban Street Intersections. Green shields developed instrumentation for the study of traffic behavior at intersections. He then used this instrumentation to study the time–space relationships of vehicle movements at intersections. "It is the total time required to pass a given number of vehicles through the intersection that is of primary interest to the traffic engineer. In analytical categories, this time depends on the integration of individual patterns of reaction time, acceleration, speed and spacing." He went on to determine the famed "Green shields Numbers" which measure the time required by successive vehicles to cross a signalized intersection when starting from a standing queue. This led to the determination of signal-controlled approach capacity. Green shields also studied behavior patterns at unsignalized intersections: "In the absence of a signal to control his crossing, the driver selects the gaps in opposing traffic that he considers large enough to be safe. The

rapidity with which the driver makes up his mind and the rate at which he accelerates once he has decided are factors to be considered." Whence, the well-known method of gap acceptance. Green shields was also a pioneer in the application of probability theory to traffic problems. Among the typical problems he analyzed are: traffic delay caused by drawbridge, accident exposure due to obscured vision, size of temporary storage space at parking lot unnecessary stops at stop sign, and optimum signal timing (1). Another concept that he proposed was "the quality of flow index" Q. This index may be defined as a number expressing the desirable ratio of the flow factors of time, change of speed, change of direction and distance. Thus Q is a rate per unit distance. The quality of traffic flow may be expressed by the equation $Q = T \times S \times D/L$ where Q = quality, T = time, S = change of speed, D = change of direction, and L = distance. The smaller the Q, the better the travel.

The understanding of empirical traffic congestion occurring on unsignalized multilane highways and freeways is a key for effective dynamic traffic management, control, organization, and other applications of transportation engineering. However, the traffic flow theories and models (see references 1–6) that dominate up to now in transportation research journals, scientific conferences, and teaching programs of most universities cannot explain either traffic breakdown or most features of the resulting congested patterns. These theories are also the basis of most dynamic traffic assignment models and freeway traffic control methods, which therefore are not consistent with features of real traffic. For this reason, the author introduced in 1996–2002 an alternative traffic flow theory called three-phase traffic theory, which can predict and explain the empirical spatiotemporal features of traffic breakdown and the resulting traffic congestion. There are three phases in this theory: 1. Free flow (F), 2. Synchronized flow (S), and 3. Wide-moving jam (J). The synchronized flow and wide-moving jam traffic phases are associated with congested traffic. In this article, a brief review of hypotheses of three-phase traffic theory and their applications for traffic modeling is presented. A much more detailed account of three-phase traffic theory, traffic flow control methods based on this theory, and the criticism of earlier traffic flow theories, models, and traffic control methods can be found in the books The Physics of Traffic (7) and Introduction to Modern Traffic Flow Theory and Control: The Long Road to Three-Phase

Traffic Theory (8) and reviews by Kerner (9–11).

The motorcycle is a popular mode of transport in Malaysia and developing Asian countries, but its significant representation in the traffic mix results in high rates of motorcycle accidents. As a result, the Malaysian Government decided to segregate motorcycle traffic along its new federal roads as an engineering approach to reduce accidents. However, traffic engineers needed to know the maximum traffic a motorcycle lane could accommodate. Despite substantial literature related to speed–flow–density relationships and capacities of various transport facilities, there is a knowledge gap regarding motorcycle lanes. This paper establishes motorcycle speed–flow–density relationships and capacities of exclusive motorcycle lanes in Malaysia. Observations of motorcycle flows and speeds were conducted along existing and experimental motorcycle lanes. Motorcycle speed–density data were aggregated and plotted for two types of observable motorcycle riding behavior patterns that were influenced by the widths of a motorcycle lane: the headway pattern (lane width ≤ 1.7 m) and the space pattern (lane width > 1.7 m). For both riding patterns, regression analysis of motorcycle speed–density data best fits the logarithmic model and consequently the motorcycle flow–density and speed–flow models are derived. Motorcycle lane capacities for headway and space riding patterns are estimated as 3300 mc/hr/lane and 2200 mc/hr/m, respectively.

2.3 Basic Concepts of Flow, Density & Speed , Space Mean Speed Flow:

Flow is the equivalent hourly rate at which vehicle pass a point during a time less than 1hr. It can be determined by

$$\mathbf{q} = \frac{\mathbf{n}*\mathbf{3600}}{\mathbf{T}} \text{ vph}$$

Where,

q= The equivalent hourly flow

n= The number of vehicle passing a point the road way in T sec

Density-

Sometimes referred to as concentration is the number of vehicle travelling over a unit length of highway at an instant in time. The unit length is usually 1 mile thereby taking vehicles per mile (vpm) the unit of density. It can be determined by

$$\mathbf{K = \frac{n}{L} * 5280\ vpm}$$

Where,

n= The number of vehicle passing a point the road way in T sec

L= Total length (ft)

Speed-

The distance traveled by a vehicle during a unit of time. It can be expressed in mile per hour (km/hr) or feet per second (ft/sec). The speed of a vehicle at any time t is the slope of the time space diagram for that vehicle at a time. It can be determined by

$$U_s = \frac{\mathbf{L}}{\mathbf{T}}$$

Where,

L= Total length (ft)

T= Time (sec)

Time Mean Speed (TMS)-

Time mean speed is the arithmetic mean of the speed of vehicle passing a point on a highway during an interval of a time. Time mean speed is found by

$$\bar{u}i = \frac{1}{n}\sum_{i}^{n} ui$$

n= number of vehicles passing a point on the high-way

ui = speed of the ith vehicle (ft/sec)

Space Mean Speed (SMS)-

Space mean speed is the harmonic mean of the speed of vehicle passing a point highway during an interval of time. It is obtained by dividing the total distance travelled by two or more vehicle on a section of highway by the total time required by these vehicles to travel that distance. This is the speed that is involved in flow, density relationship. Space mean speed is found by,

$$\bar{us} = \frac{n}{\sum_{i=1}^{n}(\frac{1}{ui})}$$

$$= \frac{nL}{\sum_{i=f1}^{n}(ti)}$$

Where,

$\bar{us}$ = Space mean speed (ft/sec)

u = Number of vehicles

ti = The time it takes the vehicle to travel across a section of highway (sec)

ui = Speed of vehicle (ft/sec)

L= Length of section (ft)

Time Headway-

Time head way is the difference between the time the front of a vehicle arrives at a point o the highway and the time the front o the next vehicle arrives at the same point. Time head way is usually expressed in seconds.

Speed Headway-

Speed head way is the distance between the front of a vehicle and the front of the following vehicle. It is usually expressed in feet.

2.4 Fundamental Diagram of Traffic Flow:

The relationship between the density (vpm) and the corresponding flow of traffic on highway generally is referred to as a fundamental diagram of traffic flow. The following theory has been postulated with respect with to the shape of the curve depend this relationship.

When the density on the road is zero the flow is also zero. Because there are no vehicle on the road. As the density increases the flow also increases.

However when the density reaches its maximum generally referred to as the jam density (kj) the flow must be zero because vehicle will tend to line up end to end.

It follows that as density increases from zero, the flow will also initially increase from zero to a maximum value. Further continuous increase in density will then result in continuous

reduction of the flow, which will eventually be zero when the density is equal to the jam density. The shape of the curve therefore takes the form in figure.

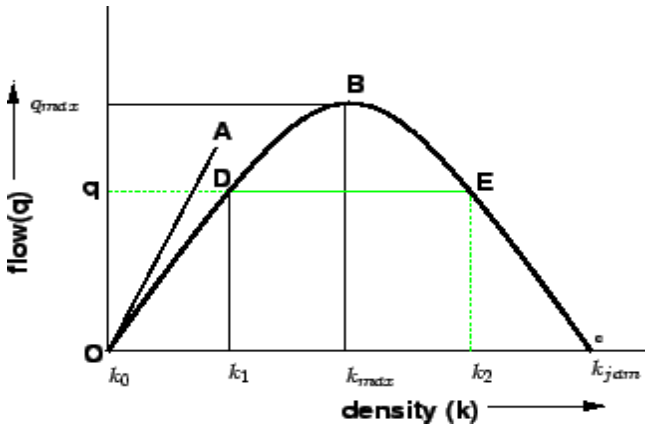


Figure (2.4.1): Flow vs. Density

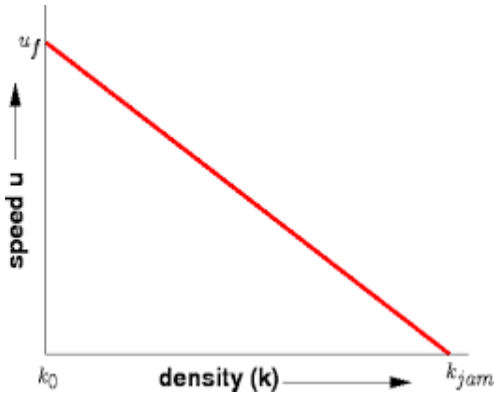


Figure (2.4.2): Speed vs. Density

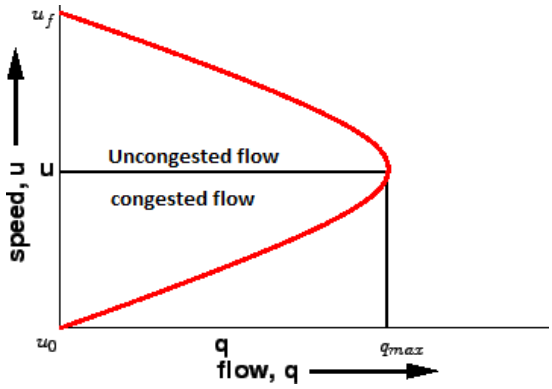


Figure (2.4.3): Speed vs. Flow

Data have been collected that tend to confirm the argument postulated above but there is some controversy regarding the exact shape of the curve. A similar argument can be can be postulated for the general relationship between the space mean speed and flow. When the flow is very low there is little interaction between individual vehicles. Drivers are therefore free to travel at the maximum possible speed. The absolute maximum speed is obtained of the flow tends to zero and it is known as the mean free speed. The magnitude of the mean free speed depends on the physical characteristics of the highway. Continuous increase in flow will result in a continuous decrease in speed. A point will be reach however when further addition of vehicles will result in the reduction of the actual number of the vehicles that pass a point on the highway (that is reduction flow). These results in congestion and eventually both the speed and the flow become zero.

2.5 Summary:

This chapter represents review of the literature the basic concept of flow, density relationship development a fundamental diagram of traffic flow which will be helpful to understand the traffic management process of the selected area.

CHAPTER- III

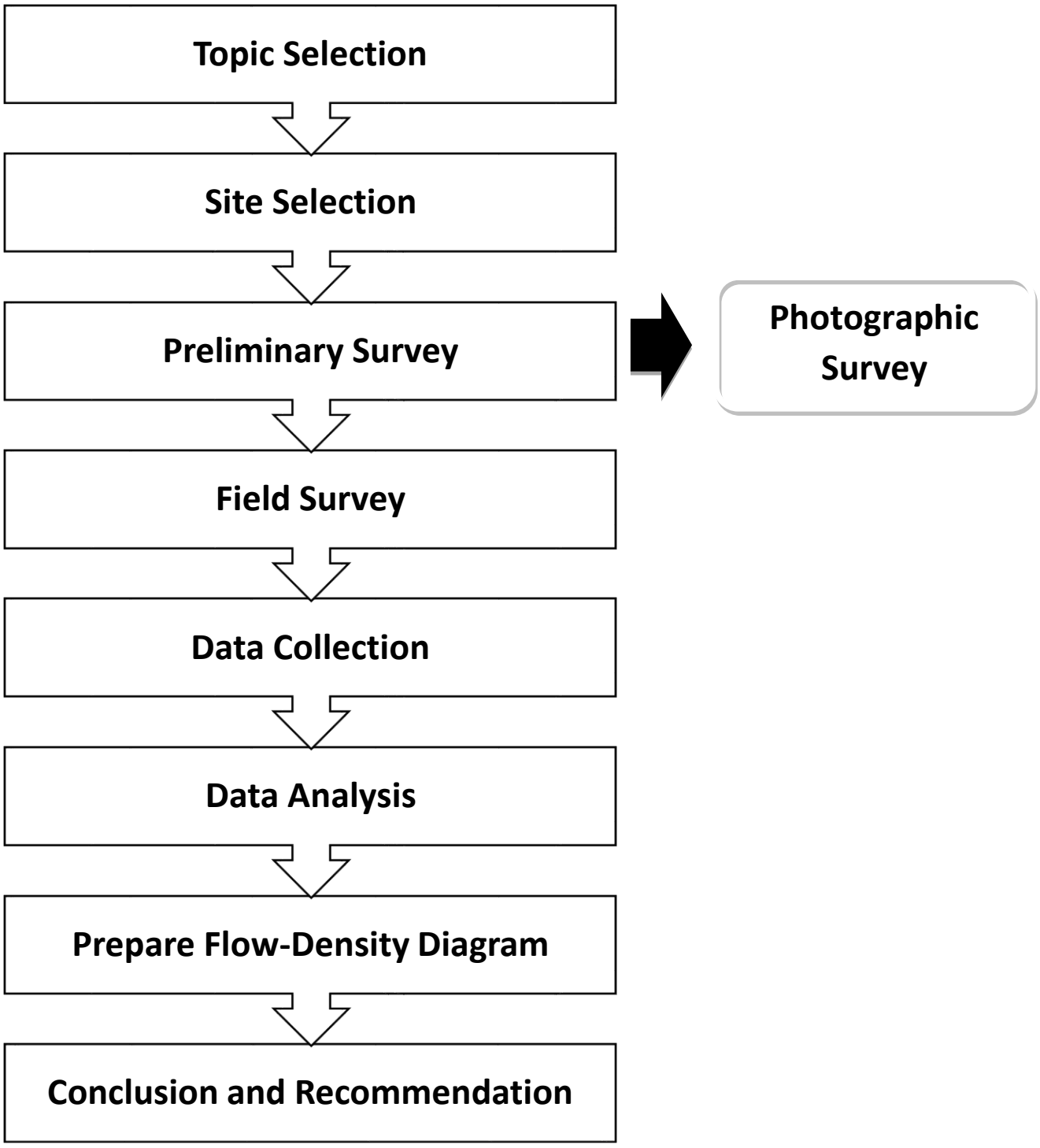
METHODOLOGY

METHODOLOGY

3.1 Introduction:

This chapter represents the comprehensive study of one way two lanes operation. The development of the methodology used microscopic simulation field data, and theoretical planning. This is very important part of the total system of methodology. The study we have been done that divided many parts. Investigation of roads and lanes then gets important information about road then the traffic data at specific route and collecting all the data and calculates all of them using face to face technique imperial data were collected for the study by sample survey method.

3.2 Flow Chart of Methodology:



3.3 Selection of Study Area:

Minto Road intersection was selected as study location and Minto Road to Hotel Inter Continental was selected as study route. It was taken as study area because it is one of the busiest intersections in Dhaka Metropolitan, where traffic volume is high and the roadway width is 90ft and total lengths are taken 100m.

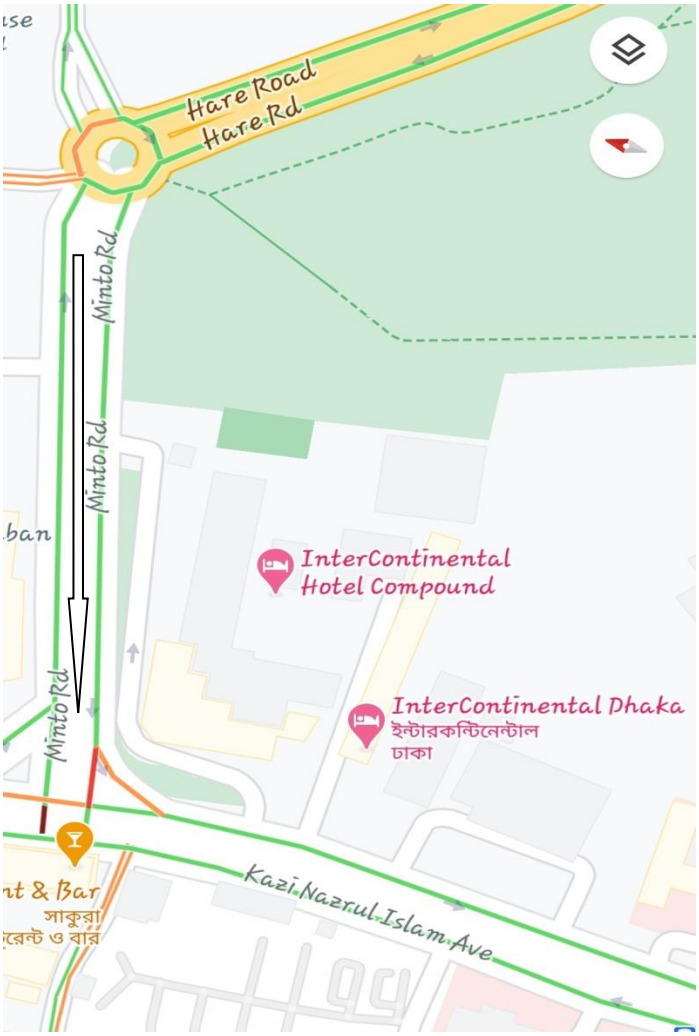


Figure 3.3.1: Minto Road Intersection (From Google Map)

Figure: 3.3.2: Minto Road to Hotel Inter Continental Route

Figure 3.3.3: Zebra Crossing

Figure 3.3.4: Minto Road Roundabout

Figure 3.3.5: Minto Road Entry

Figure 3.3.6: Hotel Inter Continental Entry

3.4 Methodology:

Flow chart of methodology is the important part of the study. The roads which have been chosen for study area are Minto Road to Hotel Inert Continental in both directions.

3.4.1 Topic Selection:

Flow-density is one of the major parameters to evaluate the traffic management in any route. Topic selection is the first and important thing of a research. After evaluating many topics we selected a topic title A Study on Flow Density Relationship Minto Road to Hotel Inert Continental Route in Both Directions.

3.4.2 Site Selection:

After selecting the study topic then go to the site and select the site which site is more suitable for study and select Minto Road to Hotel Inter Continental in both directions.

3.4.3 Preliminary Survey & Photographic Survey:

After topic and site selection it is needed to go for a preliminary survey at the study area. This is important for analysis and gain a primary knowledge. Our road-way pattern was two lanes which width was 46ft measured by a tape and opposite direction two lanes and 44ft and captured some picture such as intersection, zebra crossing etc. Photographic survey also called photograph icing is a method of surveying in which plans or maps are prepared from photographic taken at a suitable camera. Photographic is the science of making measurement from photographs.

3.4.4 Field Survey:

Field survey is the collection and gathering of information at the location by conducting primary survey. These are an essential component of geographic enquiry and are carried out through observation, interviews, sketching, measurement etc.

3.4.5 Data Collection:

After preliminary and field survey, data was collected which are taken manually and need a extra attention because data need to be taken carefully. Data of taken 200 vehicles were taken and total time required 11.27 minutes and opposite's direction data collection time was 10.56 minutes and data was taken 2nd September 2020 and the day was sunny.

3.4.6 Data Analysis:

Analysis of data which solved carefully because of the total study result depends on it and calculation should be handling properly. After set up all kind of information and analysis data correctly then get a final result.

3.4.7 Prepare Flow Density Diagram:

When get a final result and all kind of correct information then prepare flow density, speed-density, space mean speed-flow diagram that was shown in next chapter.

3.4.8 Conclusion:

The research methodology and results presented here offer insight into fundamental traffic relations, suggesting that the flow-density curve can be substantially influenced by roadway users, their vehicles, and weather conditions. As shown here, a flow-density model's predictive power rises significantly when one supplements density data with other relevant information, and most variables examined produce results that are highly statistically significant and intuitively acceptable.

3.5 Summary:

This chapter represents the flow chart of study and selection of study area which was shown in map and takes some useful photo in study area and a short of description in flow chart.

CHAPTER- IV

DATA COLLECTION AND ANALYSIS

DATA COLLECTION AND ANALYSIS

4.1 General:

Basically, we surveyed all of the groups together and collected data by Method. In both cases, surveys have been conducted on selected routes from Hotel Inter Continental to Minto Road.

Guide- The purpose of this study is very closely monitored and the flow density relationship is identified. All information collected by the management field.

Survey- The field survey included car, C-N-G, motorcycle. The day was bright when the information was collected. Total length is taken for 100m both sides and data is collected at 10.47 minutes and reverse The collection time was 10.56 minutes.

4.2 Data Collection:

The most important traffic characteristics to be collected from the field include speed, travel time, flow and density. In addition, the occupancy, i.e. percentage of time a point on the road is occupied by vehicles is also of interest. The measurement procedures can be classified based on the geographical extent of the survey measurement at point on the road, measurement over a short section of the road measurement over a length of the road wide area samples obtained from number of locations, and the use of an observer moving in the traffic stream. In each category, numerous data collection is there. However, important and basic methods will be discussed the most important point measurement is the vehicle volume count. Data can be collected manually. In manual method, the observer will stand at the point of interest and count the vehicles with the help of hand tallies. Normally, data will be collected for short interval of one minutes or less than one minutes, five minutes or fifteen minutes etc. and for each type of vehicles like cars, two wheelers, three

wheelers, trucks, traffic like bullock cart, hand cart etc. From the flow data, flow and density and speed can be derived.

4.3 Data Analysis:

Flow,

$$\mathbf{q} = \frac{\mathbf{n}*\mathbf{3600}}{\mathbf{T}} \text{ (vph)}$$

When,

n= 1

T= 8.87 second (from table 1) cumulative

$$\mathbf{q} = \frac{\mathbf{n} * \mathbf{3600}}{\mathbf{T}}$$

$$= \frac{\mathbf{1} * \mathbf{3600}}{\mathbf{8.87}}$$

= 405.86(vph)

Similarly,

when, n= 2

$$\mathbf{q} = \frac{\mathbf{2} * \mathbf{3600}}{\mathbf{17.65}}$$

= 407.93(vph)

Density,

$$\mathbf{K} = \frac{\mathbf{n}}{\mathbf{L}} * \mathbf{5280}\ (\mathbf{vpm})$$

When,

n= 1

L= 100m

= 100*3.28

= 328ft

$$\mathbf{K = \frac{n}{L} * 5280(vpm)}$$

$$\mathbf{= \frac{1}{328} * 5280}$$

= 16.10 (vmp)

Similarly,

$$\mathbf{K = \frac{n}{L} * 5280\ vpm}$$

When,

n = 2

$$\mathbf{= \frac{2}{328} * 5280}$$

= 32.20(vpm)

Speed

$$U_s = \frac{\mathbf{L}}{\mathbf{T}}$$

Where,

L= 100m

= 100*3.28

= 328ft

T= 8.87 sec

So,

$$U_s = \frac{\mathbf{328}}{\mathbf{8.87}}$$

= 36.98*0.682

= 25.22

Similarly,

Where,

T= 8.78 sec

$$U_s = \frac{\mathbf{L}}{\mathbf{T}}$$

$$U_s = \frac{\mathbf{328}}{\mathbf{8.78}}$$

= 37.36 (ft/sec)

= 37.36*0.682= 25.48 (mph)

Space Mean Speed (SMS)

$$\bar{us} = \frac{\mathbf{n}}{\sum_{\mathbf{i=1}}^{\mathbf{n}}(\frac{\mathbf{1}}{\mathbf{ui}})}$$

$$= \frac{\mathbf{nL}}{\sum_{\mathbf{i=f1}}^{\mathbf{n}}(\mathbf{ti})}$$

When,

n = 1

t_i = 629.8 sec

L= 100m

= 100*3.28 = 328ft

$$SMS = \frac{1*328}{629.8}$$

= 0.52(ft/sec)

= (.52*0.682)

= 0.35 (mph)

Similarly,

When,

n = 2

$$SMS = \frac{2*328}{629.8}$$

= 1.04(ft/sec)

= (1,04*0.682)

= 0.71 (mph)

4.4 Flow Density Analysis:

Flow-

Flow is the equivalent hourly rate at which vehicle pass a point during a time less than 1hr. It can be determined by

$$\mathbf{q} = \frac{\mathbf{n}*\mathbf{3600}}{\mathbf{T}} \text{ vph}$$

Where,

q= The equivalent hourly flow (vph)

n= The number of vehicle passing a point the road way in T sec

Density-

Sometimes referred to as concentration is the number of vehicle travelling over a unit length of highway at an instant in time. The unit length is usually 1 mile thereby taking vehicles per mile (vpm) the unit of density. It can be determined by

$$\mathbf{K} = \frac{\mathbf{n}}{\mathbf{L}} * \mathbf{5280\ vpm}$$

Where,

n= The number of vehicle passing a point the road way in T sec L= Total length (ft)

Time and location are the factors for the variation of flow and density.

From the figure we can find the relation in between the flow and density and some of the characteristics are mentioned below.

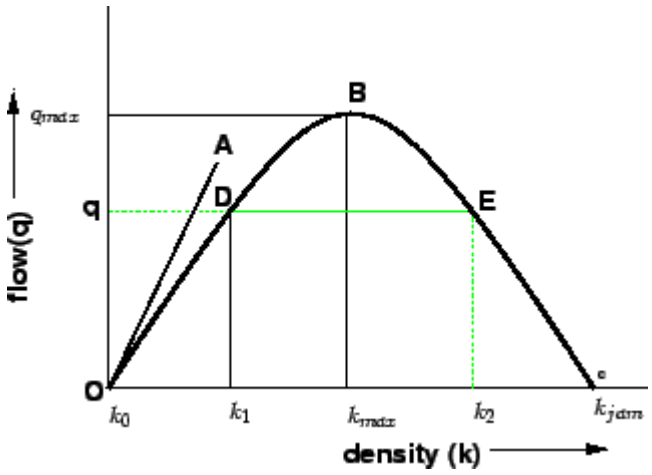


Figure : (4.4.1) Flow vs. Density

When the density on the road is zero the flow is also zero. Because there are no vehicle on the road. As the density increases the flow also increases.

However when the density reaches its maximum generally referred to as the jam density (KJ) the flow must be zero because vehicle will tend to line up end to end.

It follows that as density increases from zero, the flow will also initially increase from zero to a maximum value. Further continuous increase in density will then result in continuous reduction of the flow, which will eventually be zero when the density is equal to the jam density.

4.5 Tabular Form of Flow Density Analysis:

Flow, density, speed calculation for Minto Road to Hotel Inter Continental in a tabular form is given below where the total lengths were taken 100m by tape and time was taken 1.47 minutes.

Table 1: Flow-Density Calculation for Minto Road to Hotel Inter Continental:

SN	Time (sec)	Speed (mph)	Density (vpm)	Flow (vph)	SMS (mph)	Cumulative Time (sec)
1	8.87	25.22	16.10	405.86	0.36	8.87
2	8.78	25.48	32.20	407.93	0.71	17.65
3	8.27	27.05	48.29	416.67	1.07	25.92
4	8.21	27.25	64.39	421.92	1.42	34.13
5	7.37	30.35	80.49	433.73	1.78	41.5
6	7.7	29.05	96.59	439.02	2.13	49.2
7	7.22	30.98	112.68	446.65	2.49	56.42
8	7.17	31.20	128.78	452.90	2.84	63.59
9	6.81	32.85	144.88	460.23	3.20	70.4
10	6.84	32.70	160.98	466.08	3.55	77.24
11	7.87	28.42	177.07	465.28	3.91	85.11
12	8.84	25.30	193.17	459.82	4.26	93.95
13	5.87	38.11	209.27	468.84	4.62	99.82
14	6.03	37.10	225.37	476.15	4.97	105.85
15	5.26	42.53	241.46	486.00	5.33	111.11
16	6.27	35.68	257.56	490.71	5.68	117.38
17	5.87	38.11	273.66	496.55	6.04	123.25
18	7.89	28.35	289.76	494.13	6.39	131.14
19	5.82	38.44	305.85	499.42	6.75	136.96
20	6.03	37.10	321.95	503.53	7.10	142.99
21	6.24	35.85	338.05	506.60	7.46	149.23

22	6.33	35.34	354.15	509.13	7.81	155.56
23	7.87	28.42	370.24	506.64	8.17	163.43
24	7.25	30.85	386.34	506.21	8.52	170.68
25	6.44	34.74	402.44	508.13	8.88	177.12
26	6.21	36.02	418.54	510.55	9.23	183.33
27	6.27	35.68	434.63	512.66	9.59	189.6
28	6.5	34.41	450.73	514.02	9.95	196.1
29	7.02	31.87	466.83	513.98	10.30	203.12
30	6.33	35.34	482.93	515.64	10.66	209.45
31	6.02	37.16	499.02	517.94	11.01	215.47
32	5.34	41.89	515.12	521.72	11.37	220.81
33	5.39	41.50	531.22	525.20	11.72	226.2
34	6.21	36.02	547.32	526.66	12.08	232.41
35	6.03	37.10	563.41	528.43	12.43	238.44
36	6.18	36.20	579.51	529.80	12.79	244.62
37	6.47	34.57	595.61	530.49	13.14	251.09
38	6.37	35.12	611.71	531.34	13.50	257.46
39	6.24	35.85	627.80	532.42	13.85	263.7
40	5.26	42.53	643.90	535.40	14.21	268.96
41	5.12	43.69	660.00	538.53	14.56	274.08
42	5.2	43.02	676.10	541.39	14.92	279.28
43	5.98	37.41	692.20	542.66	15.27	285.26
44	4.85	46.12	708.29	546.00	15.63	290.11
45	4.59	48.74	724.39	549.71	15.98	294.7
46	4.92	45.47	740.49	552.70	16.34	299.62
47	4.7	47.59	756.59	555.99	16.69	304.32

48	4.59	48.74	772.68	559.39	17.05	308.91
49	5.21	42.94	788.78	561.57	17.40	314.12
50	5.33	41.97	804.88	563.47	17.76	319.45
51	5.28	42.37	820.98	565.39	18.11	324.73
52	5.2	43.02	837.07	567.39	18.47	329.93
53	5.39	41.50	853.17	569.01	18.82	335.32
54	5.1	43.86	869.27	571.06	19.18	340.42
55	5.33	41.97	885.37	572.67	19.54	345.75
56	4.29	52.14	901.46	575.93	19.89	350.04
57	5.26	42.53	917.56	577.54	20.25	355.3
58	5.21	42.94	933.66	579.18	20.60	360.51
59	5.91	37.85	949.76	579.66	20.96	366.42
60	5.93	37.72	965.85	580.10	21.31	372.35
61	4.19	53.39	981.95	583.20	21.67	376.54
62	5.27	42.45	998.05	584.58	22.02	381.81
63	4.22	53.01	1014.15	587.52	22.38	386.03
64	5.66	39.52	1030.24	588.22	22.73	391.69
65	6.54	34.20	1046.34	587.60	23.09	398.23
66	7.62	29.36	1062.44	585.44	23.44	405.85
67	5.2	43.02	1078.54	586.79	23.80	411.05
68	5.11	43.78	1094.63	588.24	24.15	416.16
69	5.98	37.41	1110.73	588.43	24.51	422.14
70	5.78	38.70	1126.83	588.90	24.86	427.92
71	4.2	53.26	1142.93	591.50	25.22	432.12
72	5.33	41.97	1159.02	592.52	25.57	437.45
73	6.44	34.74	1175.12	592.04	25.93	443.89

74	5.33	41.97	1191.22	593.03	26.28	449.22
75	6.55	34.15	1207.32	592.40	26.64	455.77
76	6.9	32.42	1223.41	591.35	26.99	462.67
77	6.23	35.91	1239.51	591.17	27.35	468.9
78	5.69	39.31	1255.61	591.67	27.70	474.59
79	5.6	39.95	1271.71	592.27	28.06	480.19
80	6.89	32.47	1287.80	591.28	28.41	487.08
81	6.72	33.29	1303.90	590.52	28.77	493.8
82	6.88	32.51	1320.00	589.60	29.13	500.68
83	8.59	26.04	1336.10	586.72	29.48	509.27
84	6.42	34.84	1352.20	586.40	29.84	515.69
85	6.77	33.04	1368.29	585.69	30.19	522.46
86	7.89	28.35	1384.39	583.77	30.55	530.35
87	5.41	41.35	1400.49	584.59	30.90	535.76
88	6.13	36.49	1416.59	584.62	31.26	541.89
89	5.59	40.02	1432.68	585.23	31.61	547.48
90	7.51	29.79	1448.78	583.79	31.97	554.99
91	6.24	35.85	1464.88	583.72	32.32	561.23
92	6.22	35.96	1480.98	583.66	32.68	567.45
93	6.29	35.56	1497.07	583.54	33.03	573.74
94	7.26	30.81	1513.17	582.44	33.39	581
95	9.02	24.80	1529.27	579.64	33.74	590.02
96	8.24	27.15	1545.37	577.68	34.10	598.26
97	7.33	30.52	1561.46	576.63	34.45	605.59
98	7.89	28.35	1577.56	575.08	34.81	613.48
99	8.34	26.82	1593.66	573.16	35.16	621.82

100	7.98	28.03	1609.76	571.61	35.52	629.8

Table 2: Flow-Density Calculation for Hotel Inter Continental to Minto Road:

SN	Time (sec)	Speed (mph)	Density (vpm)	Flow (vph)	SMS (mph)	Cumulative Time (sec)
1	8.22	27.21	16.10	437.96	0.36	8.22
2	7.49	29.87	32.20	458.31	0.73	15.71
3	7.57	29.55	48.29	463.92	1.09	23.28
4	7.29	30.69	64.39	471.05	1.45	30.57
5	6.32	35.39	80.49	487.94	1.82	36.89
6	7.99	28.00	96.59	481.28	2.18	44.88
7	6.12	36.55	112.68	494.12	2.54	51
8	6.12	36.55	128.78	504.20	2.91	57.12
9	6.36	35.17	144.88	510.40	3.27	63.48
10	7.1	31.51	160.98	510.06	3.63	70.58
11	6.33	35.34	177.07	514.89	4.00	76.91
12	6.51	34.36	193.17	517.86	4.36	83.42
13	6.22	35.96	209.27	522.09	4.72	89.64
14	6.3	35.51	225.37	525.33	5.09	95.94
15	5.99	37.34	241.46	529.78	5.45	101.93
16	6.12	36.55	257.56	533.09	5.81	108.05
17	7.49	29.87	273.66	529.69	6.18	115.54
18	5.33	41.97	289.76	536.11	6.54	120.87
19	6.2	36.08	305.85	538.29	6.90	127.07
20	6.33	35.34	321.95	539.73	7.27	133.4
21	6.89	32.47	338.05	538.88	7.63	140.29

22	5.33	41.97	354.15	543.88	7.99	145.62
23	5.99	37.34	370.24	546.14	8.36	151.61
24	6.51	34.36	386.34	546.42	8.72	158.12
25	6.98	32.05	402.44	545.12	9.08	165.1
26	6.29	35.56	418.54	546.12	9.45	171.39
27	5.66	39.52	434.63	549.00	9.81	177.05
28	5.29	42.29	450.73	552.81	10.17	182.34
29	6.28	35.62	466.83	553.49	10.54	188.62
30	6.37	35.12	482.93	553.87	10.90	194.99
31	5.55	40.31	499.02	556.50	11.26	200.54
32	5.98	37.41	515.12	557.82	11.63	206.52
33	5.3	42.21	531.22	560.85	11.99	211.82
34	6.18	36.20	547.32	561.47	12.35	218
35	6.2	36.08	563.41	562.00	12.72	224.2
36	5.12	43.69	579.51	565.15	13.08	229.32
37	7.39	30.27	595.61	562.71	13.45	236.71
38	4.92	45.47	611.71	566.15	13.81	241.63
39	5.19	43.10	627.80	568.84	14.17	246.82
40	5.26	42.53	643.90	571.25	14.54	252.08
41	5.2	43.02	660.00	573.69	14.90	257.28
42	7.29	30.69	676.10	571.49	15.26	264.57
43	5.33	41.97	692.20	573.55	15.63	269.9
44	7.62	29.36	708.29	570.77	15.99	277.52
45	6.73	33.24	724.39	569.92	16.35	284.25
46	6.39	35.01	740.49	569.78	16.72	290.64
47	5.29	42.29	756.59	571.76	17.08	295.93

48	5.26	42.53	772.68	573.72	17.44	301.19
49	4.8	46.60	788.78	576.49	17.81	305.99
50	5.3	42.21	804.88	578.24	18.17	311.29
51	5.72	39.11	820.98	579.16	18.53	317.01
52	5.42	41.27	837.07	580.59	18.90	322.43
53	4.8	46.60	853.17	583.08	19.26	327.23
54	5.29	42.29	869.27	584.63	19.62	332.52
55	5.3	42.21	885.37	586.11	19.99	337.82
56	5.56	40.23	901.46	587.10	20.35	343.38
57	5.29	42.29	917.56	588.52	20.71	348.67
58	5.92	37.79	933.66	588.85	21.08	354.59
59	5.2	43.02	949.76	590.34	21.44	359.79
60	5.33	41.97	965.85	591.59	21.80	365.12
61	5.29	42.29	981.95	592.86	22.17	370.41
62	5.27	42.45	998.05	594.12	22.53	375.68
63	5.69	39.31	1014.15	594.70	22.89	381.37
64	6.22	35.96	1030.24	594.44	23.26	387.59
65	7.03	31.82	1046.34	592.98	23.62	394.62
66	6.33	35.34	1062.44	592.59	23.98	400.95
67	6.39	35.01	1078.54	592.13	24.35	407.34
68	6.3	35.51	1094.63	591.82	24.71	413.64
69	5.9	37.91	1110.73	592.08	25.07	419.54
70	6.28	35.62	1126.83	591.80	25.44	425.82
71	6.33	35.34	1142.93	591.46	25.80	432.15
72	6.06	36.91	1159.02	591.50	26.16	438.21
73	6.39	35.01	1175.12	591.09	26.53	444.6

74	5.09	43.95	1191.22	592.41	26.89	449.69
75	5.92	37.79	1207.32	592.61	27.25	455.61
76	6.03	37.10	1223.41	592.67	27.62	461.64
77	5.69	39.31	1239.51	593.16	27.98	467.33
78	5.76	38.84	1255.61	593.54	28.34	473.09
79	6.32	35.39	1271.71	593.23	28.71	479.41
80	6.09	36.73	1287.80	593.20	29.07	485.5
81	6.09	36.73	1303.90	593.18	29.43	491.59
82	5.36	41.73	1320.00	594.02	29.80	496.95
83	5.92	37.79	1336.10	594.19	30.16	502.87
84	6.69	33.44	1352.20	593.45	30.52	509.56
85	5.93	37.72	1368.29	593.61	30.89	515.49
86	5.88	38.04	1384.39	593.82	31.25	521.37
87	6.29	35.56	1400.49	593.56	31.61	527.66
88	5.99	37.34	1416.59	593.65	31.98	533.65
89	6.28	35.62	1432.68	593.41	32.34	539.93
90	5.56	40.23	1448.78	593.96	32.70	545.49
91	6.47	34.57	1464.88	593.52	33.07	551.96
92	6.26	35.73	1480.98	593.31	33.43	558.22
93	5.62	39.80	1497.07	593.79	33.79	563.84
94	7.05	31.73	1513.17	592.76	34.16	570.89
95	6.97	32.09	1529.27	591.84	34.52	577.86
96	6.34	35.28	1545.37	591.58	34.88	584.2
97	7.69	29.09	1561.46	589.97	35.25	591.89
98	8.06	27.75	1577.56	588.05	35.61	599.95
99	7.59	29.47	1593.66	586.63	35.97	607.54

100	8.06	27.75	1609.76	584.80	36.34	615.6

4.6.1 Flow-Density Relationship for Minto Road to Hotel Inter Continental and Explanation of Graph:

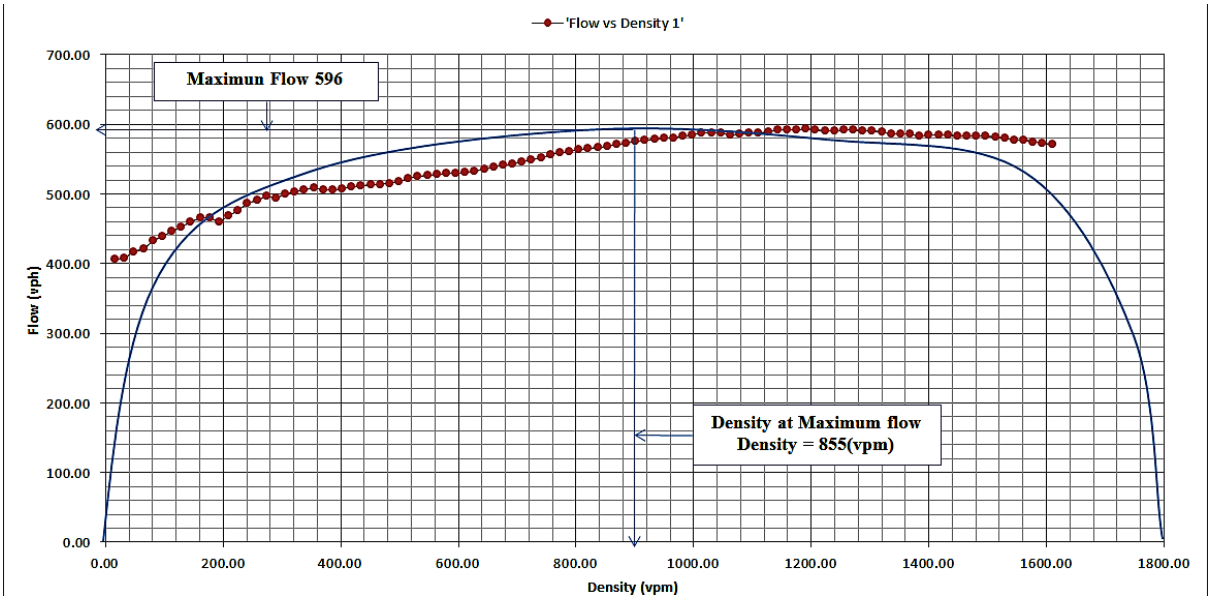


Figure: 4.6.1 Flow vs Density

Time and location are the factors for the variation of flow and density. From the figure we can find the relation in between the flow and density and some of the characteristics are mentioned below.

From graph we find the maximum flow 596 vph and at this time occurs density at maximum flow 855 vpm and jam density (KJ) 1800 vpm which is called jam density.

When there are no vehicles on the road then the density is zero and automatically the flow is zero. The density and flow will increase when the number of vehicles increases on the road.

When the number of vehicle increases at its maximum then the vehicle's movement is quite impossible which is known as maximum density or jam density. The flow is

zero at the position of jam density because vehicles are not moving.

From the figure it is clear that the relation is in parabolic shape as shown in graph 4.6.1

4.6.2 Relationship Between Space Mean Speed and Flow for Minto Road to Hotel Inter Continental and Explanation of Graph:

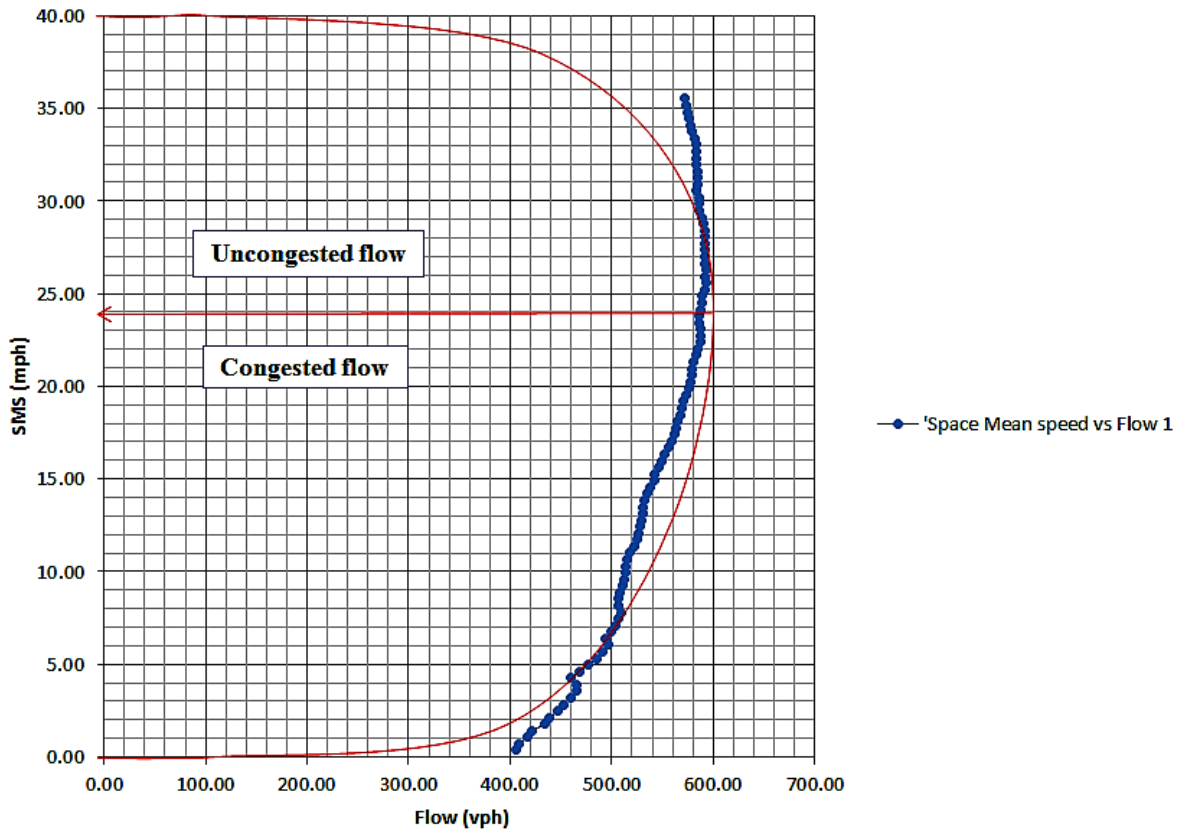


Figure 4.6.2 Space Mean speed vs Flow

When the flow is zero then speed should be zero, on the other hand as the flow continues to increase then speed will be increase.

From graph, at maximum speed of 40 mph the flow is uncongested.

The maximum flow occurs at the speed 24 mph At the speeds above this limit, flow is uncongested and below is congested.

The flow become maximum when the speed is either zero or free flow speed.

4.6.3 Speed and Density Relationship for Minto Road to Hotel Inter Continental and Explanation of Graph:

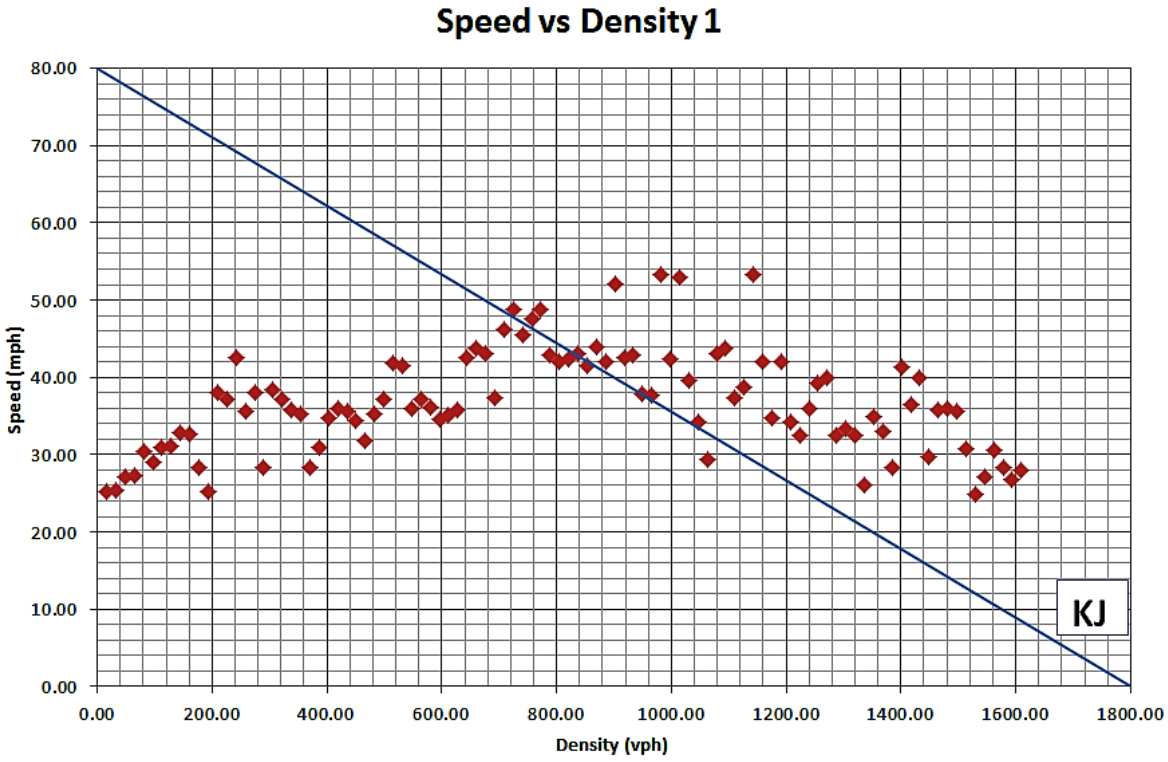


Figure 4.6.3 Speed vs Density

From graph it's found that when the density is maximum then speed is zero because of movement of vehicles are not possible on the road because of the space constrain. From graph it is found that maximum speed 80mph maximum density 1800 vpm which is called jam density (KJ).

4.6.4 Flow-Density Relationship for Hotel Inter Continental to Minto Road and Explanation of Graph:

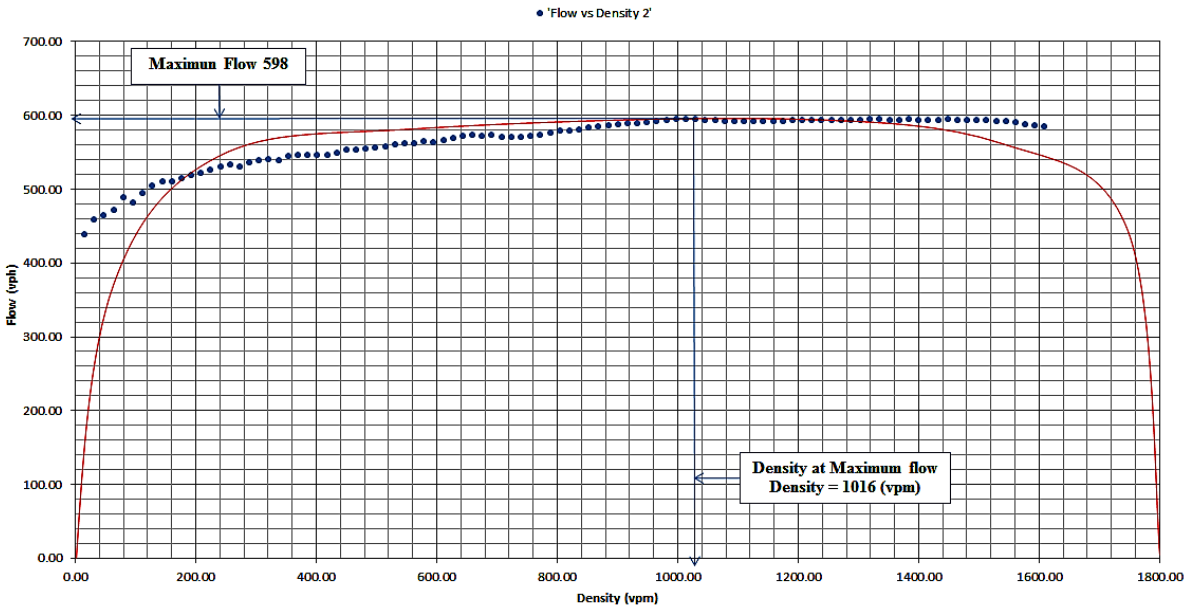


Figure 4.6.4 Flow vs Density

From graph we find the maximum flow 598 vph and at this time density at maximum flow 1016 vpm and jam density (KJ) 1800 vpm which is called jam density.

If vehicles go on increasing then the vehicles can't move which is known as maximum density or jam density. The flow is zero at the position of jam density because vehicles are not moving.

4.6.5 Speed and Density Relationship for Hotel Inter Continental to Minto Road:

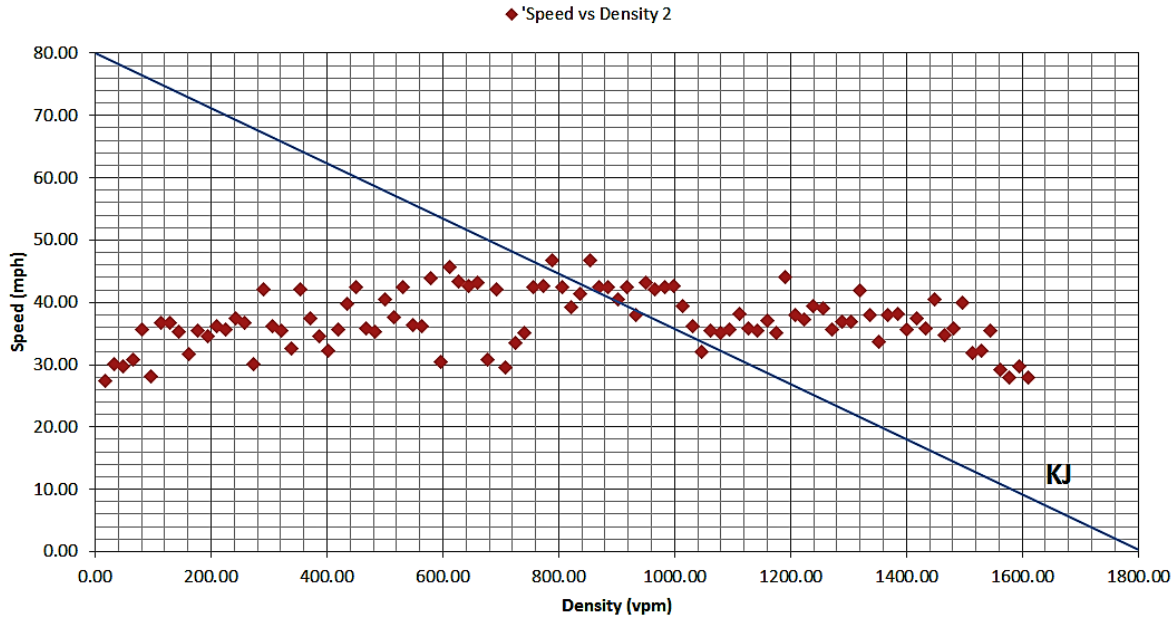


Figure 4.6.5 Speed vs Density

From graph it's found that when the density is maximum then speed is zero because of no vehicles are not possible on the road because of the space constrain.

From graph it is found that maximum speed 80mph and maximum density 1800 vpm which is called jam density (KJ).

4.6.6 Space Mean Speed-Flow relationship for Hotel Inter Continental Route to Minto Road and Explanation of Graph:

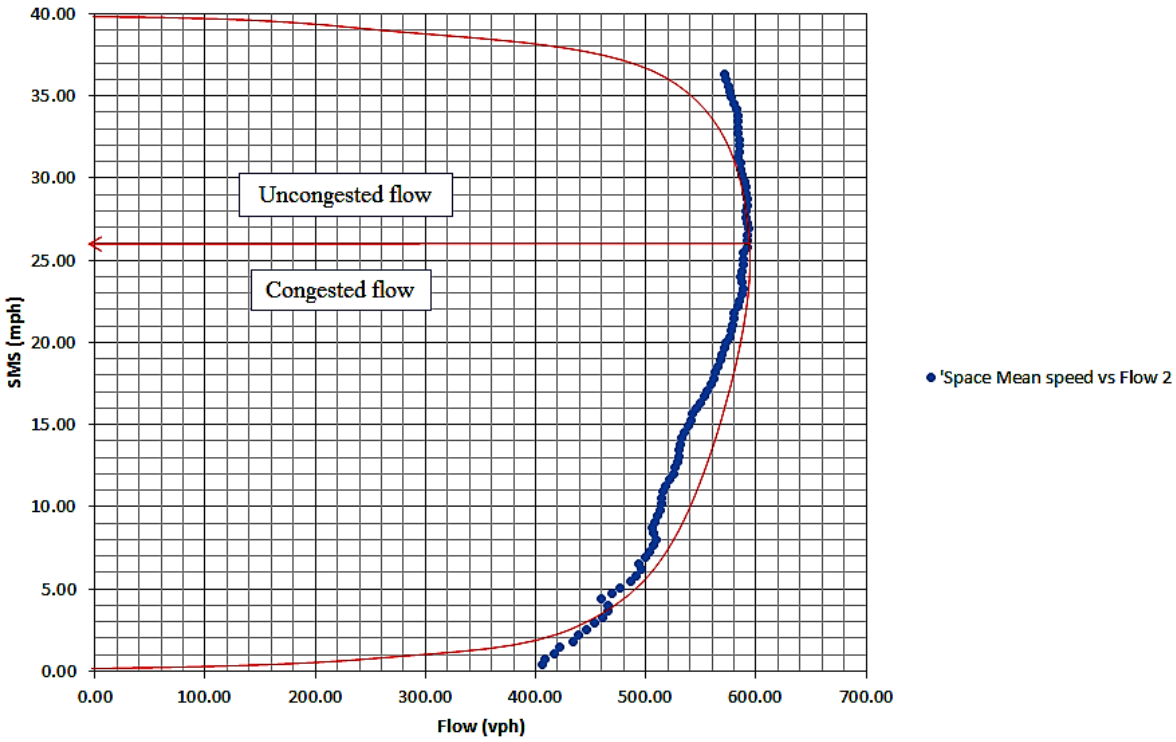


Figure 4.6.6 Space Mean Speed vs Flow

When the flow is zero then speed should be zero, on the other hand as the flow continues to increase then speed will be increase.

From graph, at maximum speed of 40 mph the flow is uncongested.

From graph it is found that the maximum flow occurs at the speed 26 mph. The speeds above this limit, the flow is uncongested and below is congested.

The flow become maximum when the speed is either zero or free flow speed.

Speed-Flow-Density Relationship-

Speed, flow, and density are all related to each other. The relationships between speed and density are not difficult to observe in the real world, while the effects of speed and density on flow are not quite as apparent .Under uninterrupted flow conditions, speed, density, and flow are all related by the following equation:

$$q = k*v$$

Where,

q = Flow (vehicles/hour)

v = Speed (miles/hour, kilometers/hour)

k = Density (vehicles/mile, vehicles/kilometer)

Because flow is the product of speed and density, the flow is equal to zero when one or both of these terms is zero. It is also possible to deduce that the flow is maximized at some critical combination of speed and density.

Two common traffic conditions illustrate these points. The first is the modern traffic jam, where traffic densities are very high and speeds are very low. This combination produces a very low flow. The second condition occurs when traffic densities are very low and drivers can obtain free flow speed without any undue stress caused by other vehicles on the roadway. The extremely low density compensates for the high speeds ,and the resulting flow is very low.

4.7 Summary:

This chapter represents data collection, data analysis, flow density analysis, tabular form of flow density analysis and flow density relationship for selected location and explanation of graph both directions.

CHAPTER- V

CONCLUSIONS & RECOMMENDATIONS

CONCLUSION & RECOMMENDATIONS

5.1 General:

Eventually we will finish our research. This chapter will represent the end of our research. Everyone in the group has worked together. A study on the relationship of flow density Minto Road to Hotel Inter Continental (both directions) and also point out some recommendation that can be address in future studies.

5.2 Summary of Result:

All the collection of the data are taken manually for flow density relationship Minto Road to Hotel Inter Continental route both direction because of the flow vehicle on the road is high and all the data analysis of Minto Road to Hotel Inter Continental route the value we can find for flow-density Figure 4.6.1 the maximum flow 596vph and density 1800vpm which is called jam density and density at maximum flow 855vpm, but at this same time opposites directions Hotel Inter Continental to Minto Road route Figure show 4.6.4 maximum flow 598vph and density 1800vpm which is called jam density and density at maximum flow 1016vpm. And the Figure 4.6.2 shown space means speed-flow and where maximum flow occurs at the speed 24 mph divided in two parts upper parts are uncongested flow and lower parts congested flow. Figure 4.6.3 shown speed-density relation when jam density 1800vpm. Graph 4.6.5 shown speed versus density relation when jam density 1800vpm. From Figure 4.6.6 (space mean speed versus flow) it is found that the maximum flow occurs at the speed 26 mph.

Route	Maximum Flow (vph)	Jam Density (vpm)	Space Mean Speed (mph)	Speed Limit For Congested and Uncongested Flow (mph)
Minto Road to Hotel Inter Continental	596	1800	40	24
Hotel Inter Continental to Minto Road	598	1800	40	26

5.3 Conclusion:

In this research the flow density relationship for Hotel Inter Continental to Minto Road and Minto Road to Hotel Inter Continental has been carried out. After that fundamental diagram for traffic flow for these routes have been prepared. From these diagrams it is found that for Hotel Inter Continental to Minto Road route the maximum flow 598vph and jam density 1800vpm at this same time opposite's direction i.e. Minto Road to Hotel Inter Continental maximum the flow is 596vph and jam density is 1800vpm. Maximum speed found at Hotel Inter Continental to Minto Road and Minto Road to Hotel Inter Continental 40mph and 40mph respectively. Speed limit for both congested and uncongested flow is 26mph and 24mph which are very close for both directions because the data was collected at the same time. Finally it can be said that if it was rainy day or peak hours or off days then the results could have been different.

5.4 Limitations:

There are some issues with collecting the information below-

• Weather Condition (Clear).

• Traffic police are not cooperatives for many reasons.

• Speed gun are not used in study time.

• There were no pedestrians but drivers often slow down because of the VIP road Vehicles so that we get irregular speed density and flow.

5.5 Recommendations:

The following recommendations may be considered for further improvement of the study-

• From this data we get the flow density and speed but from these it can be obtained Power analysis and design on the road to the future.

• We have calculated the flow density and speed relationship for all types of vehicles but You can also find specific vehicle flow concentrations and speeds, such as motorcycles, Ambulances and non-motorized vehicles.

• From here we get flow density and speed analysis from Hotel Inter Continental to Minto Road route on both sides and it can be done on the highway.

• Traffic rules and regulations should be followed by everyone.

• While use road crossing pedestrian need to be used zebra crossing in due time and avoid interrupted flow density and speed.

• For approximate speed data speed gun can be used for getting spot speed.

5.6 Summary:

This chapter represents and discusses about study conclusion and showed the limitation of work what we faced our study place and recommendation some point which will help future work.

REFERENCES

REFERENCES

- A research from S. L. DHINGRA ISHTIYAQ GULL IIT Bombay, India
- A research from REINHART D. KÜHNE German Aerospace Center, Transportation Studies, Berlin
- A research from NATHAN H. GARTNER University of Massachusetts, Lowell
- A research from BORIS S. KERNER Daimler AG
- A research from Hussain Hamid and Ahmad Farhan Mohd Sadullah University Putra Malaysia, Establishing speed–flow–density relationships for exclusive motorcycle lanes
- J. M. DEL CASTILLO, F. G. B. On the Functional Form of the Speed-Density Relationship–I: General Theory. Transportation Research Part B: Methodological, 1995, 29B,
- Lehoczky, J. P. Stochastic Models in Traffic Flow Theory. Intersection Control Highway Research Record, 1970, 3,
- Greenshields, B. D. A Study in Highway Capacity. Highway Research Board Proceedings, 1935, 14,
- Chao Chen, Zhanfeng Jia, and Pravin Varaiya. Causes and cures of highway congestion. IEEE Control Systems Magazine, pages 26–32, December 2001.
- Ashish Dhamaniya, Satish Chandra;" Speed Prediction Models for Urban Arterials under Mixed Traffic Conditions", 2 nd conference of Transportation Research Group Of India, Procedia - Social and Behavioral Sciences 104 (2013) 342 – 351
- Douglas I. Rouse. Stochastic Modeling of Plant Disease Epidemic Processes, Handbook of Applied Mycology Sail and Plants, Vol. 1 edited by Dilip K. Arora etc, 1991

- Edie, L. C. Car-Following and Steady-State Theory for Noncongested Traffic. Operation Research, 1961, 9
- Geistefeldt, J. Empirical Relation Between Stochastic Capacities and Capacities Obtained From The Speed-Flow Diagram. Symposium on The Greenshields Fundamental Diagram: 75 Years Later, Sponsored by Transportation Research Board, Woods Hole, Massachusetts, 2008.

- Greenshields, B. D. A Study in Highway Capacity. Highway Research Board Proceedings, 1935, 14.
- Li, M. Z. F. A Generic Characterization of Equilibrium Speed-Flow Curves. Transportation Science, 2008, 42,
- Lonnie E. Haefner, M. L. Traffic Flow Simulation for an Urban Freeway Corridor, Transportation Conference Proceedings, 1998.
- May, A. D. Traffic Flow Fundamentals, Prentice Hall, Englewood Cliffs, 1990
- Pipes, L. A. Car-Following Models and the Fundamental Diagram of Road Traffic. Transportation Research, 1967, 1
- Roger G. Ghanem, P. D. S. Stochastic Finite Elements: A Spectral Approach. SpringerVerlag, New York, 1990.
- Reinhard Mahnke, Christof Liebe, R. K. H. Wang. Traffic Flow Perspectives: From Fundamental Diagram to Energy Balance. Symposium on The Greenshields Fundamental Diagram: 75 Years Later, 2008.
- Rene Boel, L. M. A compositional stochastic model for real time freeway traffic simulation, Transportation Research Part B: Methodological, 2006, 40
- XU Cheng, QU Zhao-wei, CHEN Xiao-ming,"Analysis of Traffic Speed-Density Relation Model Characteristics", Journal of Highway and Transportation Research and Development, 2014.
- Md. Enamul Hoque, Jenifar Tanziba, Shubasis Chandra Das, Md. Tauhidul Islam, "A STUDY ON FLOW-DENSITY RELATIONSHIP", Thesis Book of Batch 59, Department of Civil Engineering, Stamford University Bangladesh.

- https://www.scribd.com/document/433987878/Traffic-Flow-Theory-edited-docx
- https://www.chegg.com/homework-help/questions-and-answers/literature-review-literature-review-importance-purpose-critical-literature-review-q50598277?trackid=f676c69cdff9&strackid=c959ef6bbb3b
- https://www.chegg.com/textbooks/the-literature-review-2nd-edition-9781452240886-1452240884?trackid=0b018301be9c&strackid=c959ef6bbb3b
- https://www.chegg.com/search/LITERATURE%20REVIEW/federated?trackid=17db04895439&strackid=c959ef6bbb3b#p=1
- https://www.chegg.com/homework-help/questions-and-answers/3-state-fundamental-mathematical-relationship-density-flow-speed-draw-basic-figures-speed--q40741729?trackid=09d8c082cc2d&strackid=71c31664e62c
- https://www.scribd.com/document/422461651/PE-Civil-Exam-Review-Transportation
- https://www.scribd.com/presentation/397101094/Traffic-4-TrafficFlowFundamentals-ppt
- https://www.scribd.com/document/433987878/Traffic-Flow-Theory-edited-docx
- https://www.scribd.com/document/396134086/The-Concept-of-Flow