IMPACT OF PAVEMENT CONDITION ON CAPACITY AND LEVEL OF SERVICE FOR URBAN ROAD

By

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Civil Engineering,

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CERTIFICATE

It is certified that the work contained in this dissertation thesis entitled **'IMPACT OF PAVEMENT CONDITION ON CAPACITY & LEVEL OF SERVICE FOR URBAN ROAD'** submitted by **KHIRASARIYA DEEP KUMAR RASIKBHAI, 190041009** studying at Civil Engineering Department, Faculty of Engineering & Technology, for the award of M.Tech in Transportation Engineering is absolutely based on her own work carried out under my supervision and that this work/thesis has not been submitted elsewhere for any degree/diploma.

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Place: Rajkot

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Date:

Place: RAJKOT

External Examiners' Sign and Name:

1) _____

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Dedicated To,

For Every Success of my life,
for being worm and caring,
Great Enthusiasm, Inspiration,
Support & Love are Heart of My
Achievement

Thank you

My Mom, Dad,
Brother & My beloved
Friends

ACKNOLEDGEMENT

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IMPACT OF PAVEMENT CONDITION ON CAPACITY AND LEVEL OF SERVICE FOR URBAN ROAD

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ABSTRACT

The flexible pavement can be rated on the basis of different types of parameters which can be measured and worked upon to get the desired results. This study deals with the flexible pavement condition and its impact on capacity and LOS of urban road. In this study, evaluate the flexible pavement conditions to determine and specify the types of the distress parameter in the flexible pavement for the selected roads. The distress parameter are included cracking(%), raveling(%), potholes(%), shoving(%), patching(%), settlement and depression(%) and Rut depth(%). Rating of pavement have been done on the pavement condition assessment by using MoRTH (Guidelines Maintenance Management of Primary, Secondary and Urban Roads, IRC 2004) on selected urban roads, and evaluated traffic volume in terms of PCU/hr of a urban road and according to capacity find out the Level of Service (LOS) as per Indo HCM on urban road.

Keywords: flexible pavement, condition assessment, rating, capacity, Level of service.

CHAPTER – 1

Introduction

1.1 General

Every structure that has been constructed deteriorates with passing time. Therefore it is important that these built structures, like in this case flexible pavements, are assessed periodically to evaluate their present condition and furthermore to assess the rest of the life of the roads and the amount of additional time the road can be used by the people effectively. Thus, for that we must have some devices to assess preexisting condition of the pavements, gather some reasonable data and to use the information which is acquired with a motive to increase the durability and improve the condition of pavements. Functional analysis of roads involves the ride quality, texture and safety of a road.

1.2 Terminology to functional evaluation

Surface Distress are explained as conditions associated with cracking, raveling, potholes, shoving, patching, depression and settlement, rutting.

1. **Cracking:**

These include type of Alligator cracking, Longitudinal cracking, Transverse cracking, Edge cracking.

(i) Alligator Cracking (AC): Alligator cracking is characterized as a series of interconnected cracks, having small irregular blocks in pavement surface which resemble the skin of an alligator.

(ii) Longitudinal Cracking (LC): Cracks that appear parallel to centerline or along the road are called longitudinal cracking.

(iii) Transverse Cracking (TC): The forms of cracks that is created perpendicular to the pavement's centerline direction is called transverse cracking.

(iv) Edge Cracking (EC): Edge cracking is defined as cracks which develop parallel to outer edge of pavement.
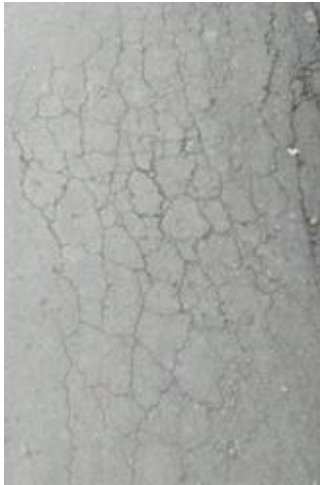
Fig.1.1 Alligator crack   **Fig.1.2** Longitudinal crack   **Fig.1.3** Transverse crack
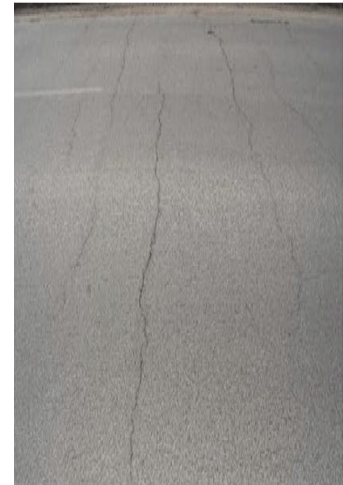
1. Ravelling:

Raveling is defined as progressive separation and dissociation of fine aggregate particles and binder from the bituminous surface.

2. Potholes:

Potholes are bowl shaped cavities of varying sizes of bituminous surface or extending into the binder/base course, caused by localized disintegration of material.

3. Shoving:

Shoving is a form of plastic movement within the bituminous layers resulting in bulging of the pavement surface.

4. Patching:

When some portion of the pavement is replaced by new material to repair the pavement is called patching.

5. Depression and settlement:

Depression is Localized pavement surface areas with slightly lower elevations than the surrounding pavement and settlement is characterized by relatively large deformations of the pavement compared to depressions.

6. Rutting:

Rutting is longitudinal depression or groove in the pavement along the wheel path.

Fig.1.4 potholes

Fig.1.5 Rutting

Fig.1.6 patching
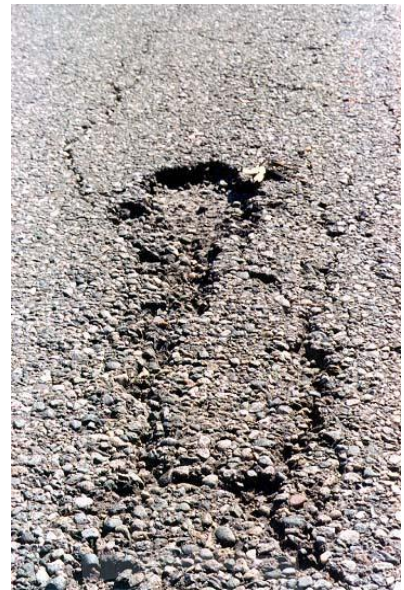
Fig.1.7 ravelling

1.3 Introduction to Capacity and Level of service:

Traffic flow in most cities of India may be a mixed traffic characteristics and also the traffic jam is that the common problem in most major cities in India. Capacity is a quantitative measure, whereas LOS is a qualitative measure. Level of Service (LOS) is one such parameter in terms of compatibility that gives a quality measure for the operational conditions within a traffic stream, i.e., generally in terms of service that is provided by the road to the user.

1.4 Definition & Terminology:

Flow (or volume)**:** It is the number of vehicles that pass through a given point on a road during a designated time interval. Since road have a certain width and the required number of lanes is accommodated within the available width, flow is always expressed in relation to the given width i.e. per lane or per direction etc. The time unit selected is one hour.

Volume capacity ratio: the ratio of flow rate to the capacity of road segment.

Passenger Car Unit (PCU)**:** It is the amount of interaction (or impedance) caused by the vehicle to a traffic stream with respect to a standard passenger car.it is used to convert a heterogeneous traffic stream into a homogeneous equivalent to express flow and density in a common unit.

Capacity: It defined as the maximum hourly volume (vehicle per hour) at which vehicles can be reasonably expected to traverse a point or a uniform segment of a lane or roadway during a given time period, under prevailing roadway, traffic and control conditions.

Level of Service (LOS): It is defined as a qualitative measure, describing operational conditions within a traffic stream and their perception by drivers/passengers. LOS definition generally describes these conditions in terms of factors such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience and safety.

1.5 Concept:

1.5.1 Capacity

Capacity of a transport facility is defined as the maximum number of vehicles, passengers, or the like, per unit time which can be accommodated under given conditions with a reasonable expectation of occurrence. Capacity of a road is represented by the most rate at which vehicles can taste a given point in an hour under prevailing operational conditions. It is a quantitative assessment of the ability of a traffic facility to handle vehicles or people for which it is designed. Volume-to-capacity ratio is one in every of the operational measures of effectiveness employed in measuring LOS.

Capacity is independent of the demand. It speaks about the physical amount of vehicles and passengers that a road can afford. It does not depend on the total number of vehicles demanding service. Generally the highway capacity depends on certain conditions as listed below;

    1. Road way characteristics: This are associated with the geometric characteristics and design elements of the facility, which include type of facility, number of lanes, lane width, shoulder width, horizontal and vertical alignments, lateral clearance, design speed, and availability of queuing space at intersections. For example, a curved road has lesser capacity compared to a straight road.

    2. Traffic conditions: Capacity is expressed in terms of units of some specific thing (car, people, etc.), so it also does depend on the traffic conditions. The traffic conditions are associated with the characteristics of the traffic stream on the segment of the highway. These include the distribution of the different types of vehicles in the traffic stream or traffic composition such as the mix of cars, trucks, buses etc. and the directional and lane distribution of the traffic volume on the highway segment. Furthermore it includes peaking characteristics, proportions of turning movements at intersections etc.

1.5.2 Level of service:

Level-of-Service(LOS) of a traffic facility is a introduced to relate the quality of

traffic service to a given flow rate. The concept, as defined, relates solely to measures and characteristics that directly affect the quality of service provided to the driver. Measures included in the definition are those that are directly perceivable by the individual motorist, and are intended to describe, in relative terms, the quality of the driving experience. Level-of-Service is introduced by HCM to denote the level of quality one can derive from a local under different operation characteristics and traffic volume. HCM proposes LOS as a letter that designates a range of operating conditions on a particular type of facility. Six LOS letters are defined by HCM, namely A, B, C, D, E, and F, where A denote the best quality of service and F denote the worst. These definitions are based on Measures of Effectiveness (MoE) of that facility. Typical measure of effectiveness includes speed, travel-time, density, delay etc. There will be an associated service volume for each of the LOS levels. A service volume or service flow rate is the maximum number of vehicles, passengers, or the like, which can be accommodated by a given facility or system under given conditions at a given LOS.

Table 1.1 Level of service to quality and their description

LOS	Quality	Description
A	Free-flow	High level of physical and psychological comfort
B	Reasonable free flow	Reasonable level of physical and psychological comfort
C	Stable flow	Local deterioration possible with blockages
D	Approaching unstable flow	Non-recoverable local disruptions
E	Unstable flow	Minor disturbances resulting breakdown
F	Congested flow	Break down of flow capacity drops

1.6 Need of study:

- To improved riding quality of flexible pavement.

- An assessment requires an evaluation of existing pavement conditions and knowledge of future rehabilitation plans.

- Due to the expansion of Rajkot city urbanization and increasing number of private vehicles in most parts of city badly affected the capacity and level of service of roads.

1.7 Objective of study:

- To determine rating of pavement condition.

- To determine capacity of urban road.

- To determine the level of service (LOS) of urban road.

1.8 Scope of study:

- This study is limited to urban road in which capacity and LOS are calculated based on Indo HCM-2017 and pavement rating is determine as per guidelines Maintenance Management of Primary, Secondary, and Urban Roads, IRC, 2004.

CHAPTER – 2

Literature Review

2.1 General

The study of distress evaluation is assessing pavement condition & rating of pavements. The distress considered for the study is raveling, potholes, shoving, patching, depression, and rutting. Based on the functional distresses, rating of pavement as v.poor, Poor, Fair, Good, v.good are assessment by using guidelines Maintenance Management of Primary, Secondary, and Urban Roads, IRC, 2004. The evaluation is assessing capacity and level of services by using Indo HCM-2017 method.

2.2 Literature Review

A literature review is a text written by someone to consider the critical points of current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources, and as such, do not report any new or original experimental work. Also, a literature review can be interpreted as a review of an abstract accomplishment.

1. WADALKAR SHRUTI S., LAD R. K., JAIN R.K. (2020)

"Rating and Condition Assessment of Urban Roads Based on Functional Distresses" (International Journal of Recent Technology and Engineering)

The pavement management system deals with a pavement condition assessment. Rating of pavement can be done on the pavement condition assessment. Structural and functional distress is responsible for the failure of pavements. In this work, significant functional distresses which occur in flexible pavements are considered for the rating and assessment of road sections. The functional distress considered are Raveling, Potholes, Shoving, Patching, Depression, and Rutting as these are common and frequently occurred in the flexible pavements. The study of these distresses is done by authors. The measurement of distresses is done as per guideline given by the Indian Road Congress 1982 is used. For the condition, assessment guideline provided in Maintenance Management of Primary,

Secondary, and Urban Roads, IRC, 2004, is used. Total five road section in the Pune region is considered for the study. All are flexible pavements.

In this work, major functional distresses are considered for the condition assessment of urban roads. Flexible pavements are considered for the study as the majority of urban roads are constructed as flexible pavements. Functional distresses Viz. Raveling, Potholes, Shoving, Patching, Depression, and Rutting are considered for the assessment as these are common and frequently occurred in the flexible pavements. Condition assessment of road is done based on the guideline for pavement condition rating given by Guidelines for Maintenance Management of Primary, Secondary, and Urban Roads, IRC, 2004.

2. HARITA C. KORINGA , BINDIYA N. PATEL , RAVINDRA V. SOLANKI (2020)

"Estimation of Capacity and Level of Service for Urban Arterial Road – A Case Study of Rajkot City"

(International Journal of Innovative Research in Science, Engineering and Technology)

In this study signify the concept of capacity and level of service for urban roads for heterogeneous traffic condition. In study is carried out two stretches Dr. Yagnik Road and 150ft. Ring Road in Rajkot Urban road. Various Speed - Density relationships have been established in this study, which in turn have been deployed towards the development of relationship between speed and flow eventually leading to the estimation of the roadway capacity. Factors influencing capacity are classified volume of vehicle, average speed and density. Level of Service is found out from density and speed. The anxiety about the deterioration in the LOS is due to the uninhibited growth of vehicular traffic volume, shortfall of supply side of transportation capacity, resulting in the supplementary delay, additional fuel consumption, user cost etc.

The actual capacity analysis is fundamental to plan and improve the existing traffic facilities. Capacity is increase with increase in width of carriageway for selected different road section and Level of service is increase with the decrease in the width of carriageway. The observed capacity value by the static PCU method is 11% higher than the suggested value by IRC. By using the Artificial Neural Network is give the exact R value in the training data set and in validation check the data set is fail minimum time.

3. SILPA SEKHAR G , VINCY VARGHESE (2020)

"Influence of Pavement Condition on Headway and Average Travel Speed"

(International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering)

To evaluate the capacity and service level of road section accurately, it is necessary to study the quantified influence of pavement on headway and average travel speed. In this project work, pothole width, rut depth etc. were used as indicators to evaluate the status of damaged pavements. Based on the parameter surveyed on different pavement sections, the effects of pavement condition on headway and average travel speed are analysed. The main objective of this study is to evaluate the influence of pavement condition on headway and average travel speed. From the study it was identified that the pavement condition has a greater influence on speed and headway. Section 5, 7, 10, 11 are in good condition and section 15 is rated as serious. Maximum speed obtained is 52.5 kmph and minimum speed obtained is 25 kmph.

It is identified that pavement condition has a greater influence on speed and headway. The pavement condition is inversely proportional to the headway and directly proportional to speed. Flow has least influence on speed and headway. It is found that at distressed sections headway value is high and average speed value obtained is less.

4. CHETAN R. PATEL, DR. G.J.JOSHI (2012)

"Capacity and LOS for urban arterial road in Indian mixed traffic condition"

(Elsvier, Transport research arena -2012)

The present study is an empirical investigation in the behavior of mixed traffic stream speed and flow rate on an access controlled urban arterial in Surat city in Gujarat state of India. Field traffic surveys are carried out to capture the classified volume and speed data through manual as well as video graphic technique. Thresholds of level of service based on volume to capacity ratio are established by cluster analysis approach. The results are very useful for evaluation of traffic quality for access controlled urban arterials in mixed traffic condition.

The traffic flow behaviour in heterogeneous traffic in Indian urban context is observed to be quite complex with loose lane discipline and diverse static and dynamic characteristics of the vehicles. The present study is carried out on access controlled arterial road which could be the base for capacity calculation of arterial road with other traffic, control and roadway condition.

5. B. SUBRAMANYAM, ARAVIND S, PRASANNA KUMAR R (2017)

"Functional and structural evaluation of a road pavement"

(International Journal of Civil Engineering and Technology (IJCIET))

In the present research work the pavement is evaluated using destructive and nondestructive methods. An attempt is made to evaluate the condition of a selected section of a pavement from Budalur to Pudupatti on State Highway 99. Based on the analysis of distress data, the pavement is rated by making use of IRC: 82 - 2015. Structural evaluation of pavement is carried out with Benkelman Beam to determine the capacity of the pavement to withstand future traffic loading. From the analysis of data the overlay thickness required to maintain the pavement in serviceable condition is determined.

The pavement is in fair condition with the percentage of surface area of distresses varying between 10% and 20%. This indicates that proper maintenance activity needed in the near future. Further, there is heavy traffic present in the pavement section which in turn leads to premature failure of the pavement.

6. PALA GIREESH KUMAR , SATHYA RANJAN SAMAL , L. PRASANTHI , V. BHAVITHA , J. MOUNIKA DEVI (2020)

"Level of Service of Urban and Rural Roads- A Case study in Bhimavaram"

(IOP Conference Series: Materials Science and Engineering)

This paper investigates on the existing level of service models for urban and rural roads given by researchers globally. To determine the Level of service of a particular road section, there are few commonly used methods like, Cluster Analysis, Genetic Algorithm, Fuzzy Set Theory and Neural Network etc., which are used, were discussed and reported in this paper. A new approach for finding level of service was introduced, i.e., using volume

to capacity ratio (v/c), average speed of the vehicles, percentage speed reduction is also discussed and presented. The objective of this project is to study Los for various selected roads by using HCM method.

LOS criterion based on various factors are discussed and presented in detail. A keen insight into level of service concept for urban and rural roads was given and methods to define compatibility level of urban roads under heterogeneous traffic were addressed based on the literature survey study. Volume to capacity ratio is found to be the easiest method to determine LOS from the various methods which are available.

7. MIR FAISAL MANZOOR, MUDASIR NABI DAR (2020)

"Study on capacity and level of service for urban areas under mixed traffic conditions: A case study of srinagar city"

(International Research Journal of Engineering and technology)

The objective of the display considers is to progress the performance operation of the urban street arrange by proposing the correct choices to improve the activity capacity by finding out the level of services of the different roads. in this study the same will be done to find the suitable solution to enhance the traffic conditions ,traffic management, capacity and level of service of the above mentioned roads by performing the various traffic studies on the given road stretches.

Parimpora-Qamarwari Road has LOS of "E AND F" during peak hours which means the vehicle approaches unstable flow and traffic congestion and having LOS 'C' during mid hour with stable flow. The Urban streets should have minimum LOS of 'C', Worst LOS comes during peak hour .so to avoid these traffic congestion during peak hour on Parimpora-Qamarwari Road we have to increase the carriage width of the lane and also we can construct an median of suitable length.

8. BHARATH BOYAPATI AND R. PRASANNA KUMAR (2015)

"Prioritization of Pavement Maintenance based on Pavement Condition Index"

(Indian Journal of Science and Technology)

This study is to determine the Pavement Condition Index (PCI) through field data

collection and analysis to prioritize the maintenance of pavements. Distress data such as cracks, patches, potholes, ruts etc. was collected along the identified sections of pavements selected based on severity of distress. Corrected deduct values were obtained by assigning weightages to different types of distress and PCI obtained. PCI is an evaluation process which is determined according to the procedures contained in ASTM D 5340. It was found from the analysis of data that a thin overlay was required as a rehabilitation measure for one of the study stretches. The road authorities of this location also came out with the same remedy thorough their own study, there by establishing one of the findings of this study. Suitable remedial measures for rehabilitating the pavement to different study locations were suggested.

Extent and amount of cracking and patching values plays a vital relation with pavement condition rating values. From the acceptability levels we can state that the level of pavements for accepting was just found to be fair. PCI provides a subjective way for finding the maintenance needs of pavements and for prioritizing the pavement sections based on priority. Pavements with high PCI do not require any maintenance activity on priority and the pavements with lower PCI requires maintenance on priority. It was found that all the selected pavement sections exhibits the all the distresses with the medium and high severity levels.

9. MOHAMMAD MARDANI NOKANDEH , INDRAJIT GHOSH AND SATISH CHANDRA (2016)

"Estimation of Capacity for Two-Lane Inter-Urban Roads in India using Free Speed Data" (International Conference on Transportation and Traffic Engineering (ICTE))

One of the fundamental concepts of traffic flow theory and estimation of road capacity is the free-flow speed. It is referred to a condition where vehicle movement is not influenced by presence of other vehicles in the stream. Under such condition, the free speed of a vehicle represents the overall roadway condition. From HCM (2010) it is indicated that the capacity is influenced by free flow speed. The objective of this study is to propose a model which provides a quick estimation of capacity by removing the complexities, while accuracy is maintained.

The effect of all geometric, pavement conditions and traffic mix could be presented with the speed a passenger car can take on a road section. The aim of this study was to develop a model to estimate the capacity of two-lane two-way inter-urban roads from filed data. It was found that capacity increases with increase in operating speed. The advantage of the proposed model is that it gives an accurate and yet quick estimation of capacity of two-lane inter-urban roads instead of complicated data extraction and analysis procedure.

10. SHAMIL AHMED FLAMARZ AL-ARKAWAZI (2017)

 "Flexible Pavement Evaluation: A Case Study"

(Kurdistan Journal for Applied Research)

This study is a survey to evaluate the flexible pavement conditions to determine and specify the types of the failures in the pavement for the selected Khanaqin-Kalar rural highway in northest iraq.

The study had two major and critical goals which covered by considering the following three tasks; the first was the visual evaluation and inspection of existing flexible pavement conditions including the failures, the second to determine and find out the actual causes of these failures in the pavement, and the third is to select the most and effective treatments and maintenance types.

Most the types of the failures and deterioration were found along the Khanaqin-Kalar rural highway. The severity of the failures and deteriorations ranges from medium to high in the pavement of the rural highway.

CHAPTER – 3

Study Area & Methodology

3.1 General:

Study area is most important part of the project and it gives the effectiveness of the research area. Methodology for this study depends on different parameters like functional condition, Traffic volume count, roadway capacity & level of service.

3.2 Study Area:

Rajkot is the 4th largest city in Gujarat and 28th largest city in India with population more than 2.0 million as per survey in 2021. It is the capital of Saurashtra region. It is located at 22.3˚ N and 70.78˚ E and is spread in the area of 104.9km2 and located 138m above mean sea level. Climatic condition of Rajkot is generally semi-arid and average low temperature is 20˚C and average high temperature is 40˚C

3.3 Study Area characteristics:

- The selected case study of Rajkot urban road as below:

    1. Raiya Road

    2. Field Marshal road

- The selected roads are flexible pavement.

- Two lane undivided road has selected for the study.

- Both road is classified of sub arterial class road.

- Raiya road study area = total length of road × width of lane

$$= 1000 \text{ m} \times 6.6 \text{ m}$$

$$= 6600 \text{ m}^2$$

- Field Marshal road study area = total length of road × width of lane

$$= 1000\text{m} \times 6.6\text{m} = 6600 \text{ m}$$
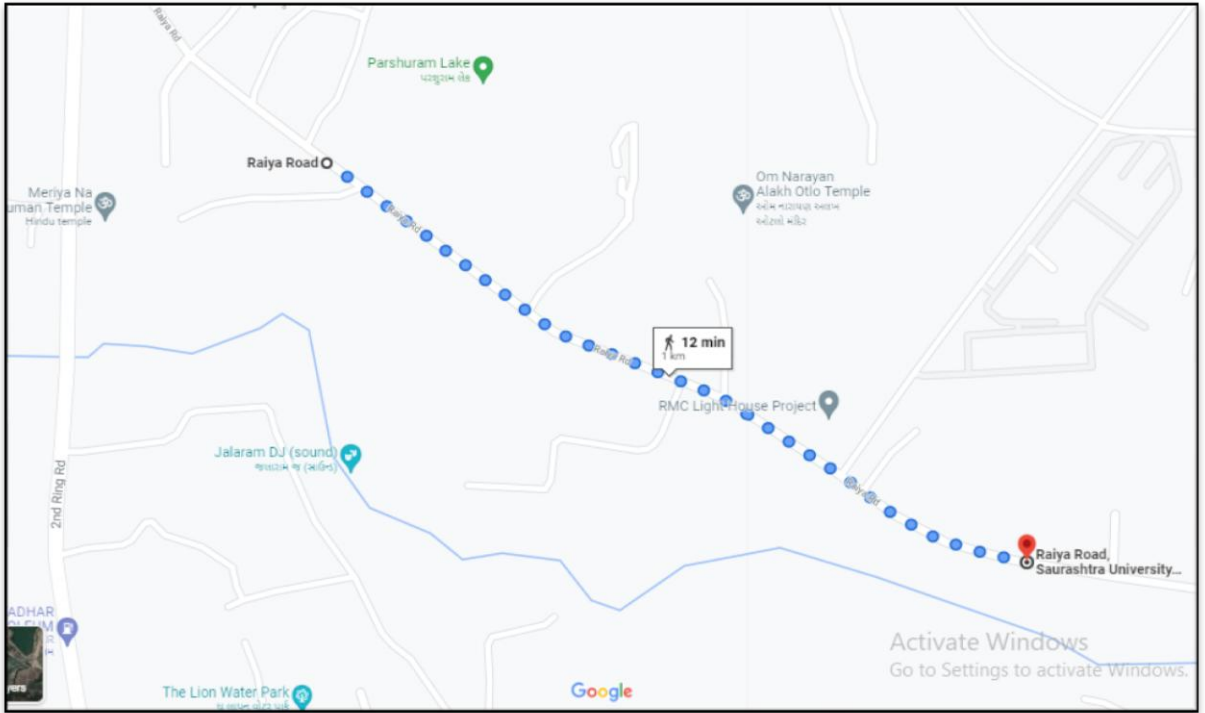
Figure 3.1 Map of Raiya road
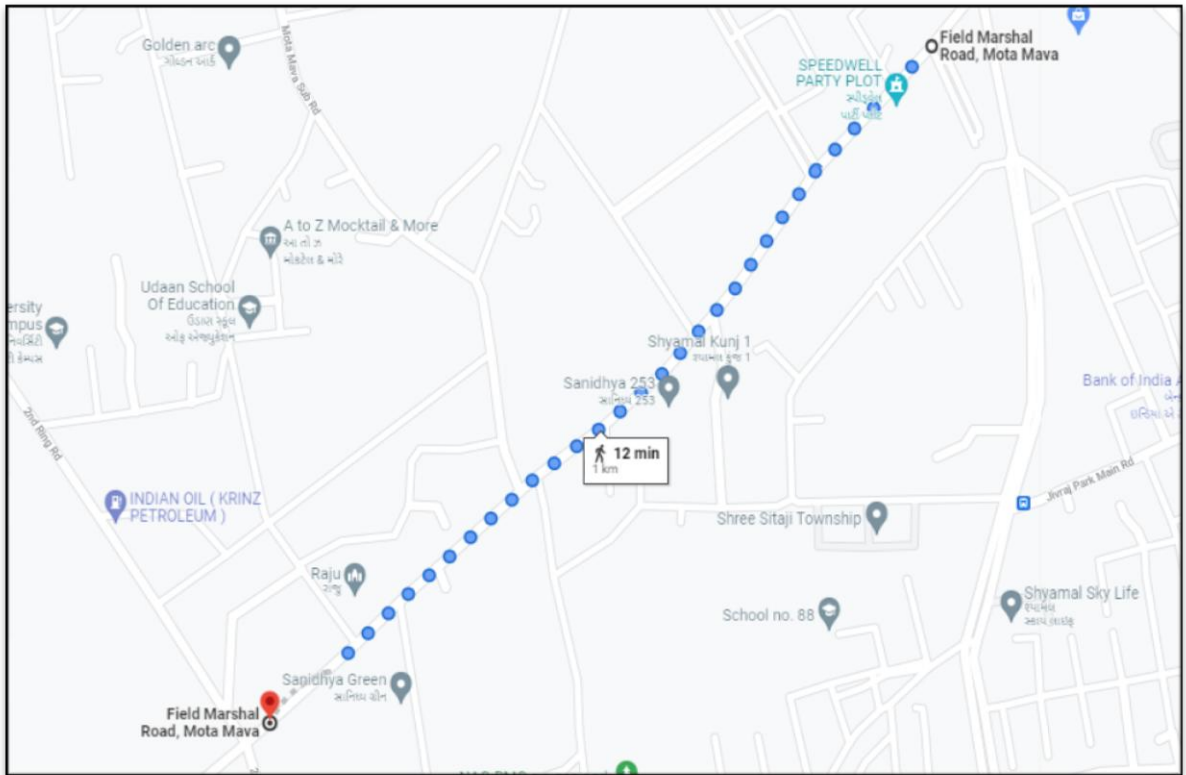
Figure 3.2 Map of Field Marshal Road

3.4 METHODOLOGY CHART

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                    │   Problem Statement     │
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                    │     Scope of Study      │
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                    │    Literature Review    │
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                    │     Data collection     │
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| 1. Functional Evaluation
-Pavement condition rating (PCR) | 2. Capacity
-Traffic volume survey | 3. Level of service (LOS)
-Traffic volume survey
-Capacity |

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                    ┌─────────────────────────┐
                    │  Data analysis & Result │
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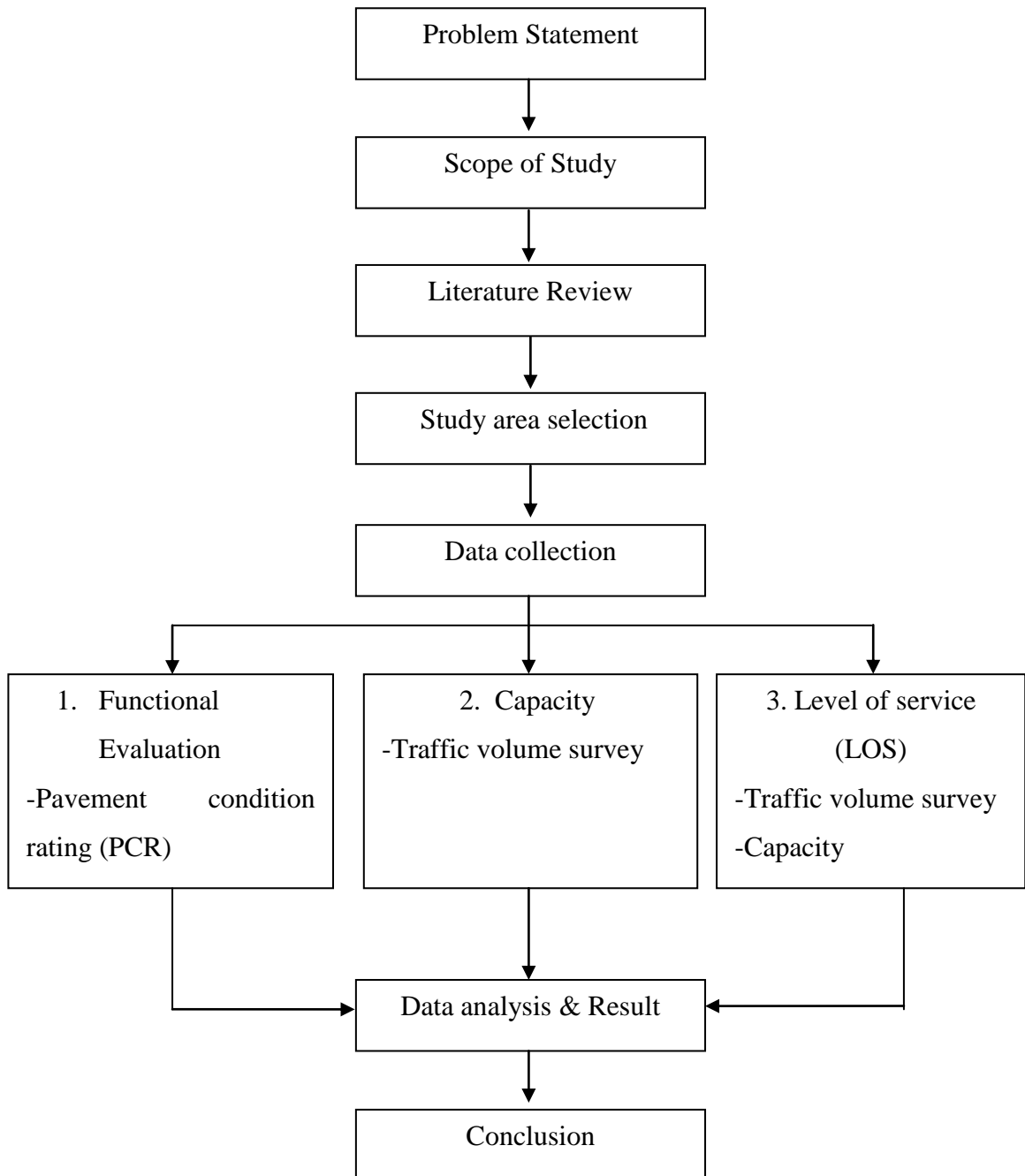
Figure 3.3 Methodology chart

3.5 Methods used for Data Collection

3.5.1 Functional Evaluation:

- The functional distress considered for the study is cracks, ravelling, potholes, shoving, patching, depression and rutting.

- Various distress area was collected in selected road.

- Percentage of various distress = <u>Total distress area</u> x100

  Selected area of road

Table 3.1 guidelines of guidelines maintenance management of

Primary, secondary and urban roads, IRC 2004

Pavement distress based rating for urban roads					
Defects (type)	Range of distress				
Cracking %	>30	21 to 30	11 to 20	5 to 10	<5
Ravelling %	>30	11 to 30	6 to 10	1 to 5	0
Potholes %	>1	0.6 to 1.0	0.1 to 5	0.1	0
Shoving %	>1	0.6 to 1.0	0.1 to 5	0.1	0
Patch %	>30	16 to 30	6 to 15	2 to 5	<2
Depression%	>5	3 to 5	Up to 2	Up to 1	0
Rutting %	>50	21 to 50	11 to 20	5 to10	<5
Rating	1	2	3	4	5
Condition	Very Poor	Poor	Fair	Good	Very good

3.5.2 Estimation capacity:

- Data should be collected at two stretches for classified volume count at 60m mid-block section and it should be free from effect of intersection, curvature, bus stop or any other side friction.

- Traffic volume data was collected in morning 9:00am to 12:00pm and in evening

5:00pm to 8:00pm at mid-block section by manual method.

- The suggested passenger car unit values for two lane undivided roads given in below table.

Table 3.2 Suggested PCU values for two lane undivided urban roads

Vehicle type	Two wheeler	Auto rickshaw	Car (small &big)	Bus	LCV	Truck	Tractor -trailer	cycle
PCU value	0.50	0.73	1.00	3.77	2.30	3.70	4.5	0.39

3.5.3 Evaluation of Level of service (Los):

- Calculate LOS based on volume to capacity (v/c) ratio by using Indo HCM-2017 method.

- Suggested capacity of two lane undivided roads is 2400 pcu/hr.(Indo HCM-2017)

- Traffic volume data should be in terms of pcu/hr.

Table 3.3 LOS of two lane urban roads based on V/C ratio

Level of service	Volume/capacity ratio
A	≤0.35
B	0.36-0.55
C	0.56-0.70
D	0.71-0.85
E	0.86-1.00
F	>1.00

CHAPTER – 4

Data Collection & Analysis

4.1 General:

Data collection and analysis process is most important part of the thesis to accomplice the objectives with proper effectiveness.

4.2 Distress Measurement:

4.2.1 Distress measurement at Raiya Road:

- Following table show the various distress which is measured at raiya road.

Table 4.1 distress area (m^2) at Raiya road

Chainage	Cracking	Ravelling	Potholes	Shoving	Patch	Depression	Rutting
0-100	1.21	35.5	0.50	1.00	50.2	0.00	0.00
100-200	2.67	40.2	0.70	0.60	21.5	0.00	0.00
200-300	1.80	25.3	0.90	0.80	20.6	0.00	0.00
300-400	0.00	29.7	0.00	0.00	18.4	0.00	0.00
400-500	0.85	42.6	0.50	0.70	17.3	0.00	0.00
500-600	0.00	55.7	0.70	0.00	25.8	0.00	0.00
600-700	2.58	70.5	1.80	1.80	42.5	0.00	0.00
700-800	0.70	26.8	1.20	0.00	15.9	0.00	0.00
800-900	0.00	0.00	0.00	0.00	38.9	0.00	0.00
900-1000	1.62	13.8	1.45	1.50	80.9	0.00	0.00
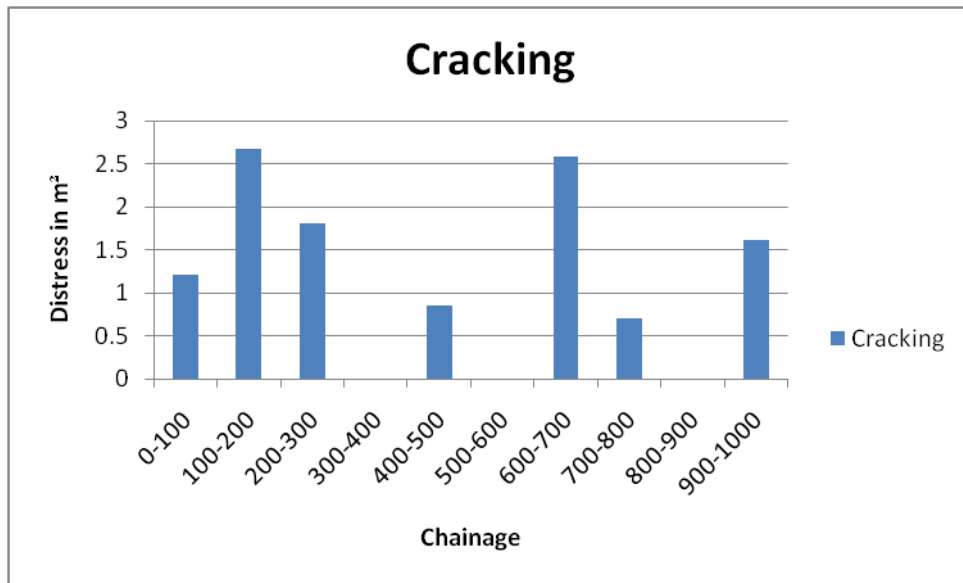
Figure 4.1: Chart of Cracking at raiya road
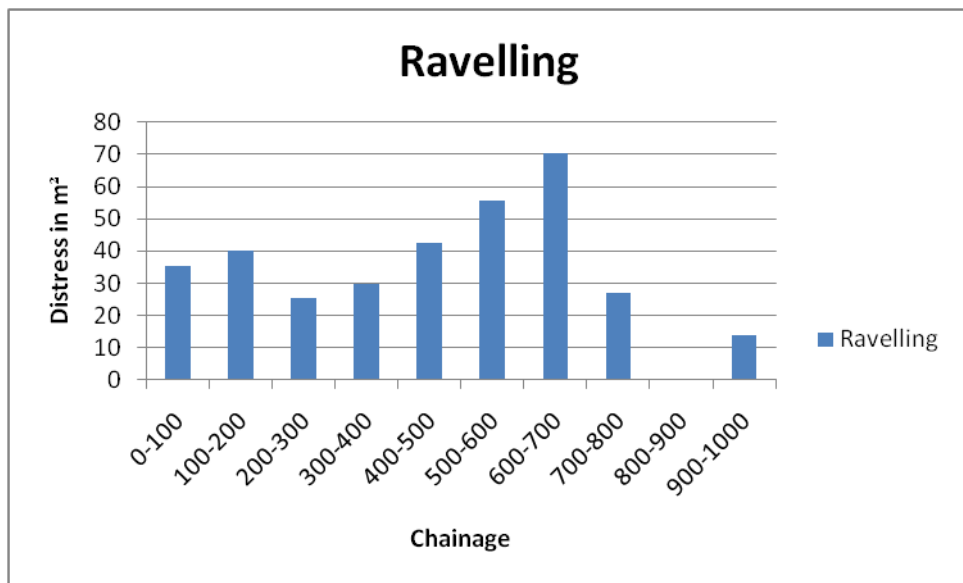
Figure 4.2: Chart of Ravelling at raiya road
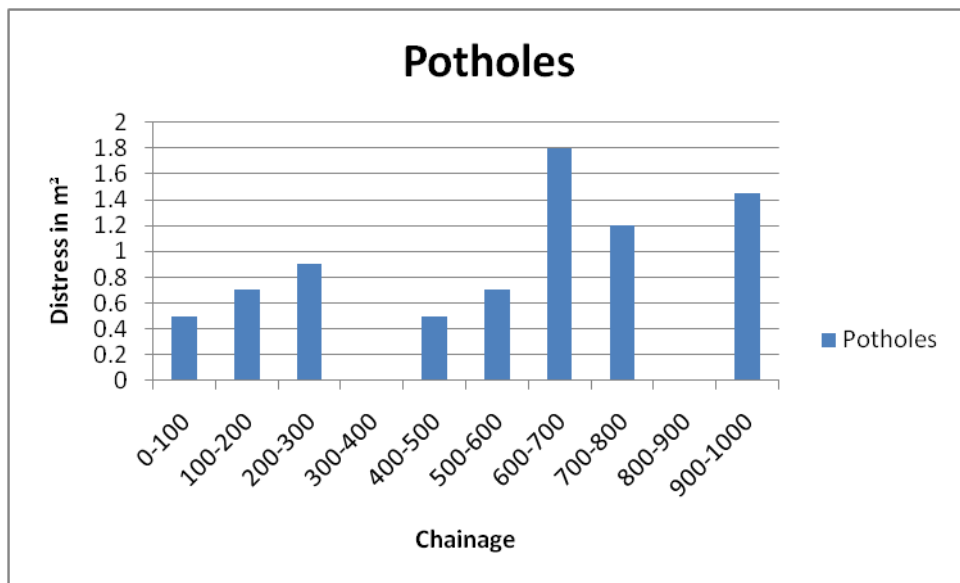
Figure 4.3: Chart of Potholes at raiya road
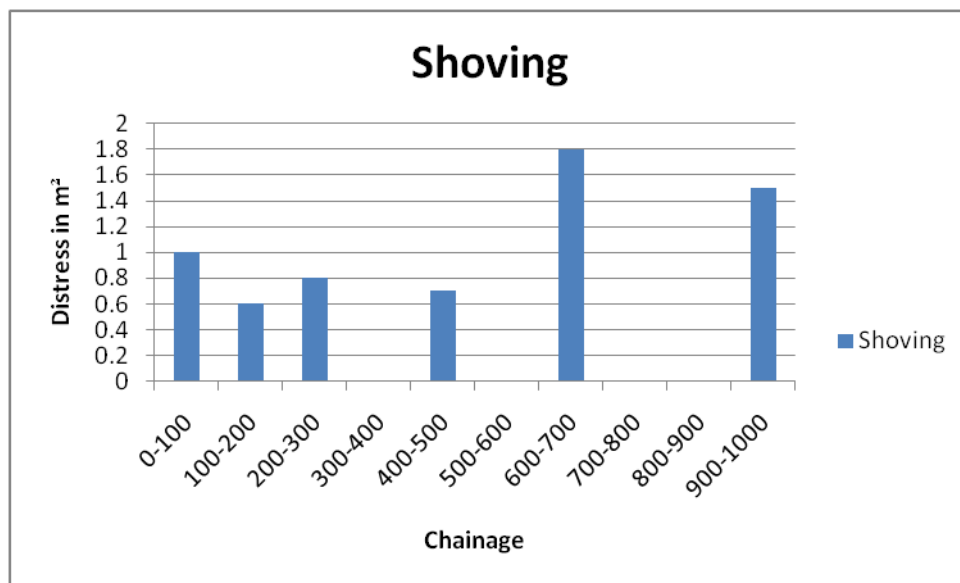
Figure 4.4: Chart of shoving at raiya road
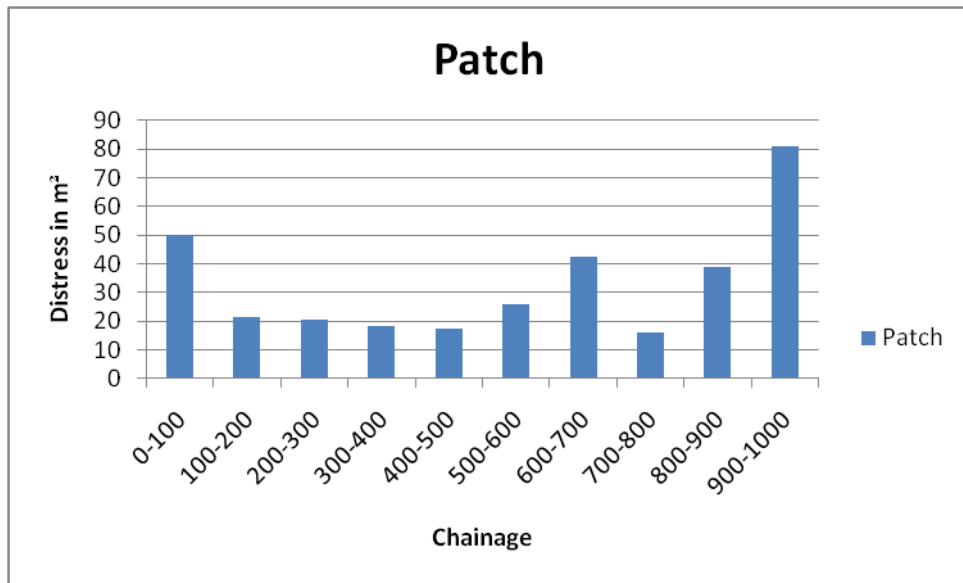
Figure 4.5: Chart of patch at raiya road
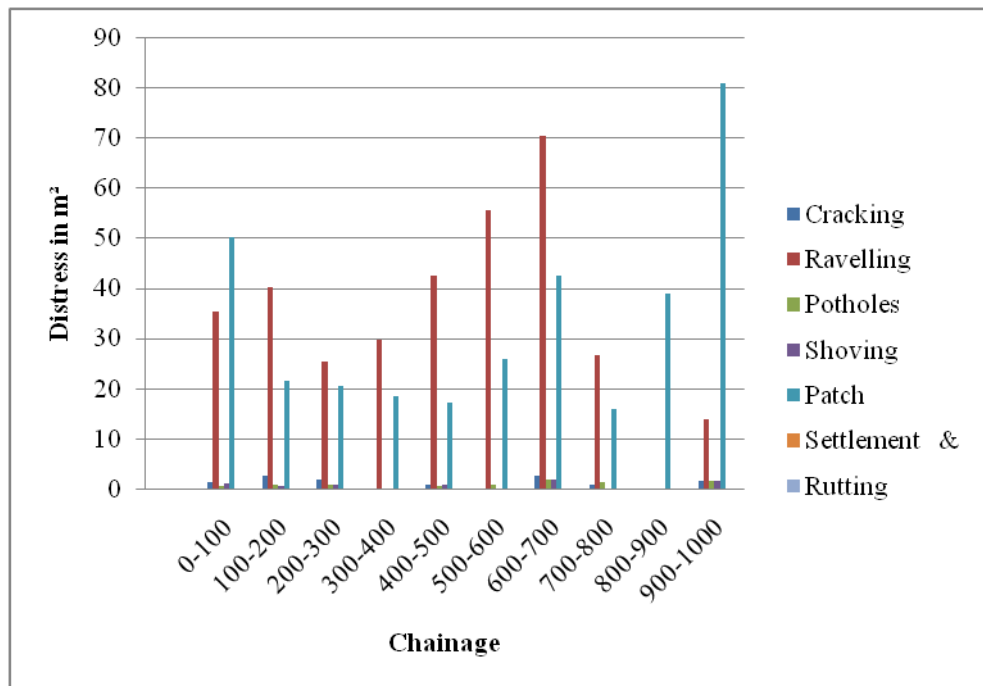
Figure 4.6: Combined Distress Chart at Raiya road

4.2.2 Distress measurement at Field Marshal Road:

- Following table show the various distress which is measured at Field marshal Road.

Table 4.2 distress area (m^2) at Field marshal road

Chainage	Cracking	Ravelling	Potholes	Shoving	Patch	Settlement & Depression	Rutting
0-100	15.7	72.3	1.6	8.5	107.3	7.9	0.00
100-200	12.5	26.7	0.9	5.1	95.7	18.2	0.00
200-300	21.6	50.6	1.5	11.3	115.5	15.6	0.00
300-400	12.8	52.9	0.0	24.6	50.2	27.2	0.00
400-500	13.3	82.5	2.6	4.8	143.1	26.2	0.00
500-600	16.2	78.6	1.2	1.5	64.6	12.5	0.00
600-700	10.2	92.4	3.8	5.7	118.4	24.3	0.00
700-800	8.5	55.7	2.3	12.3	194.5	0.0	0.00
800-900	7.5	85.6	1.2	7.2	157.2	27.4	0.00
900-1000	9.2	83.4	4.2	9.3	33.5	44.1	0.00
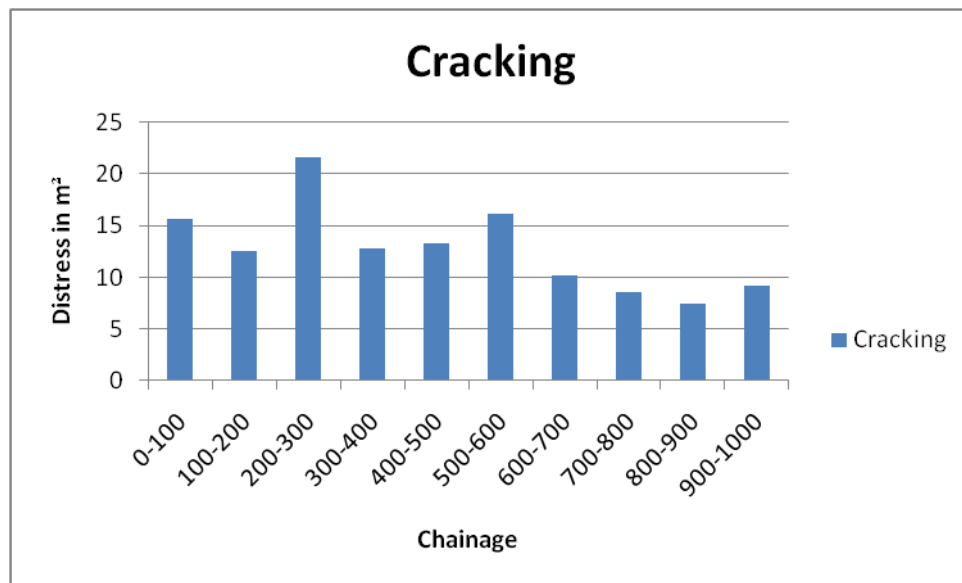
Figure 4.7: Chart of cracking at Field marshal road
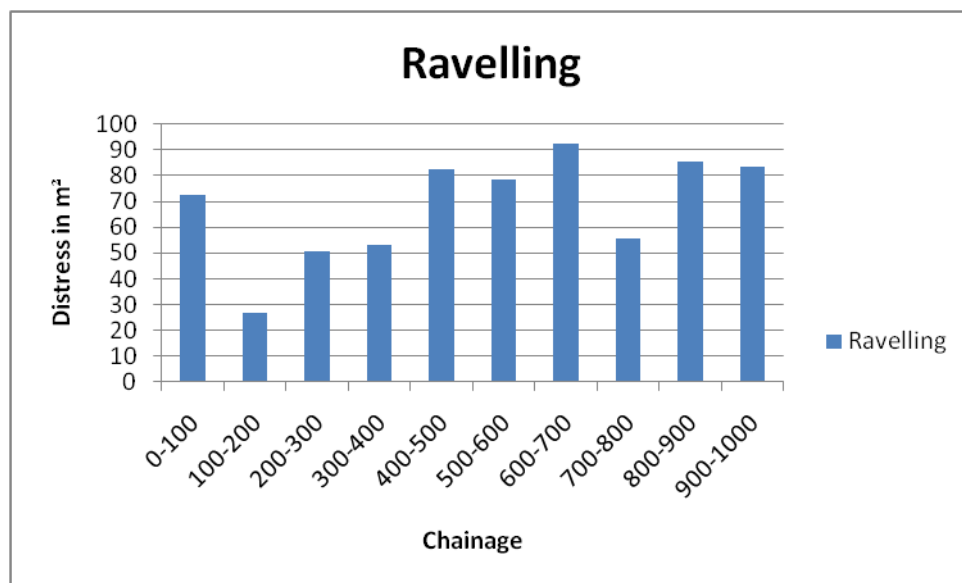
Figure 4.8: Chart of Ravelling at Field marshal road
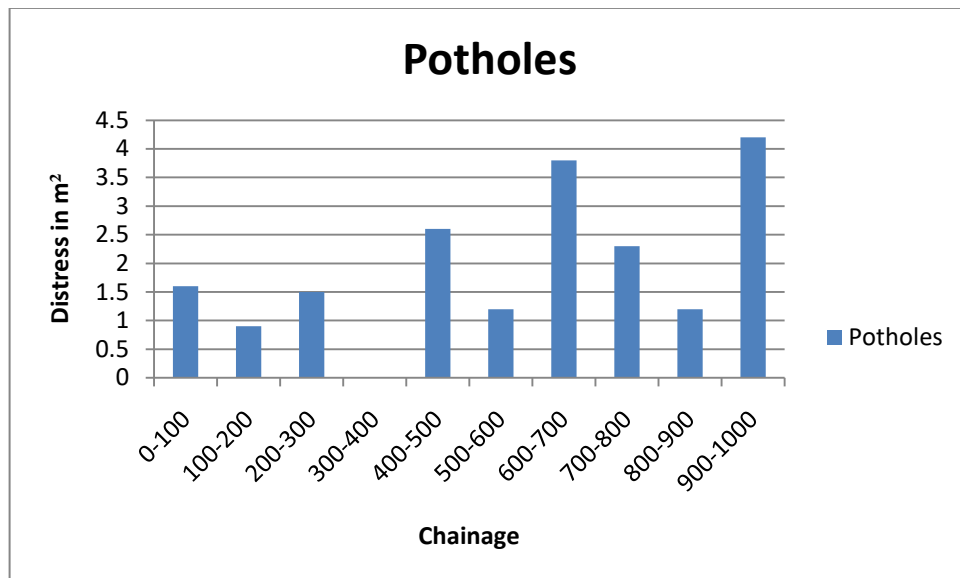
Figure 4.9: Chart of Potholes at Field marshal road
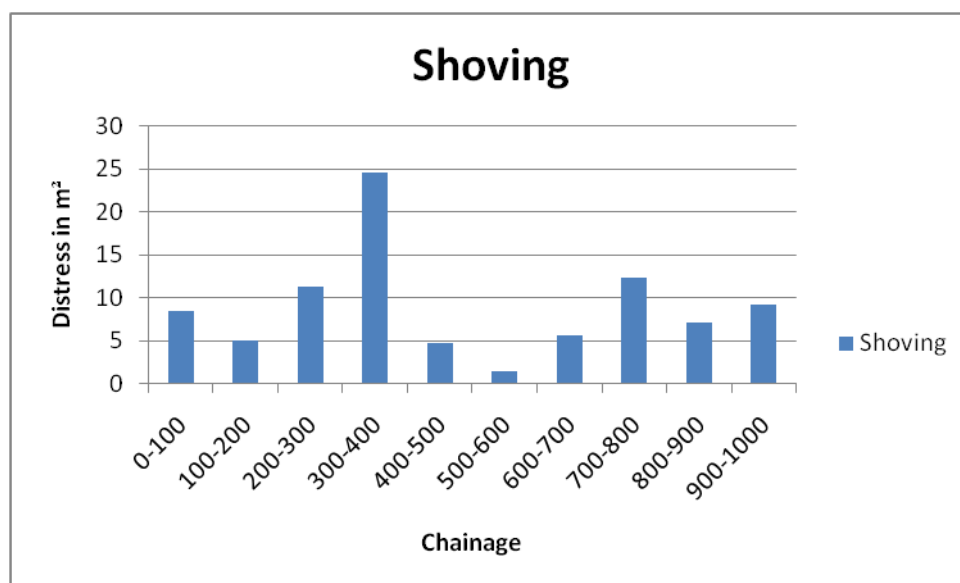
Figure 4.10: Chart of Shoving at Field marshal road
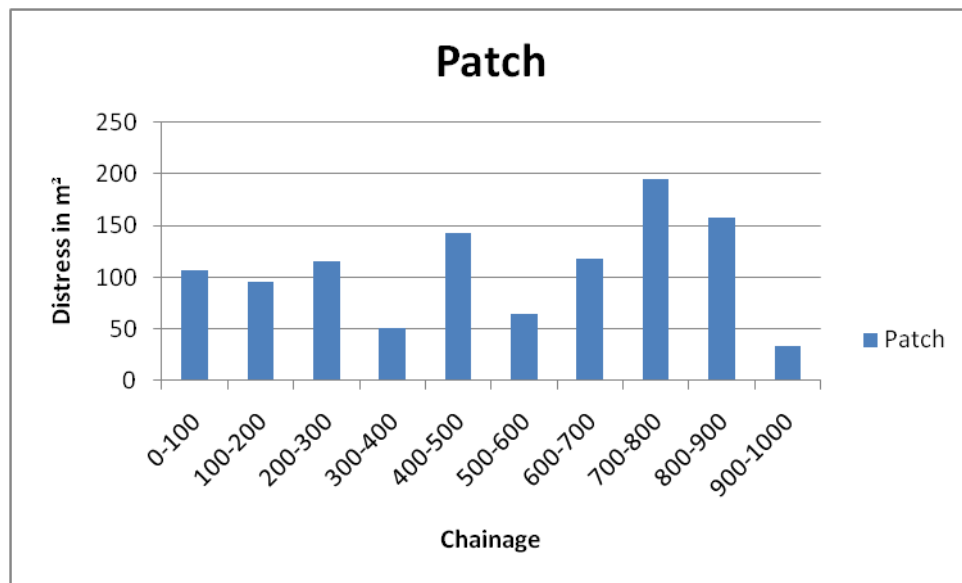
Figure 4.11: Chart of Patch at Field marshal road
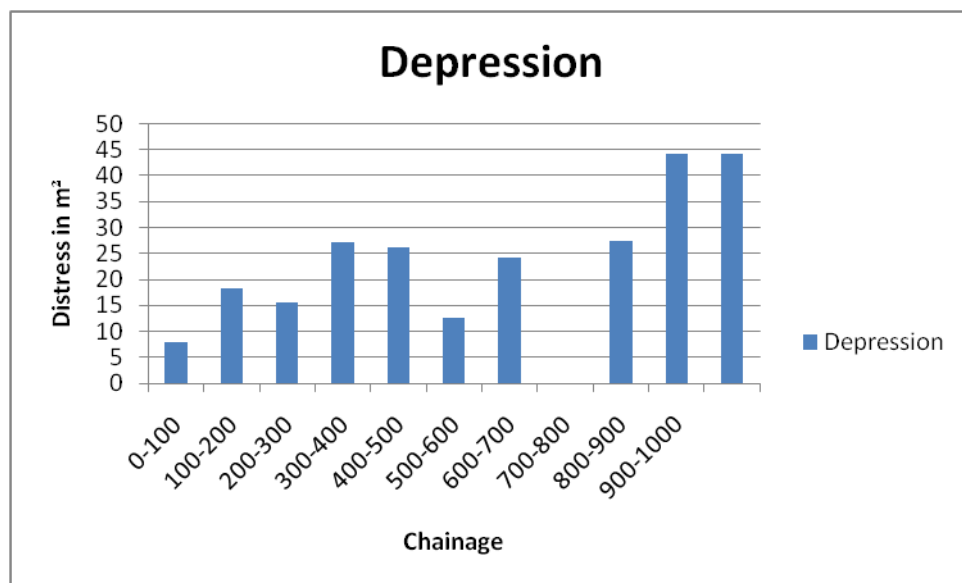
Figure 4.12: Chart of Depression at Field marshal road
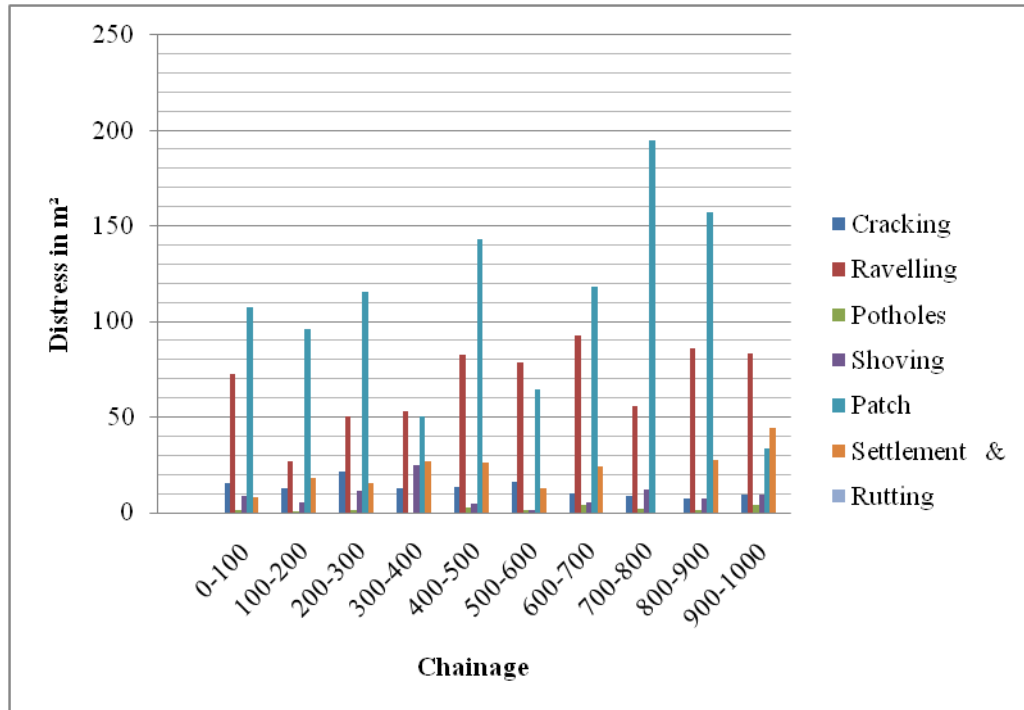
Figure 4.13: Combined Distress Chart at Field marshal road

- The Following table 4.3 show total distress area at raiya road and field marshal road.

Table 4.3 Total distress areas (m²)

Types of distress	Cracking	Ravelling	Potholes	Shoving	Patch	Settlement & Depression	Rutting
Raiya Road	11.43 m²	340.10 m²	7.75. m²	5.50 m²	332.00 m²	0.00 m²	0.00 m²
Field Marshal road	127.5 m²	680.70 m²	18.30 m²	90.30 m²	1080.5 m²	186.4 m²	0.00 m²
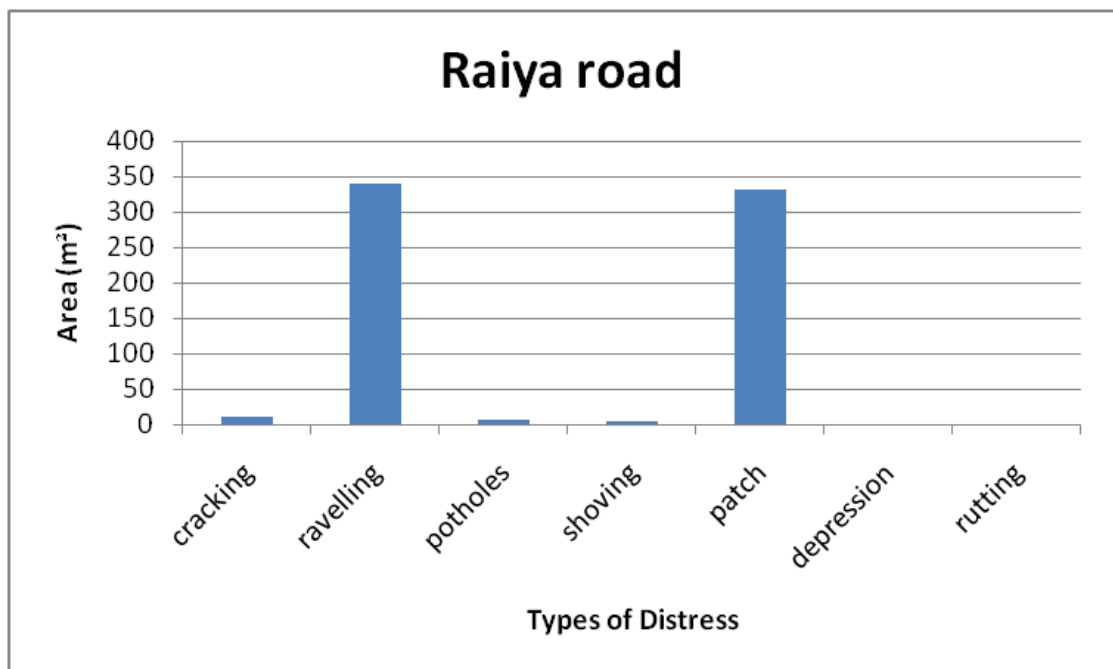
Figure 4.14 Chart of Distress at raiya road
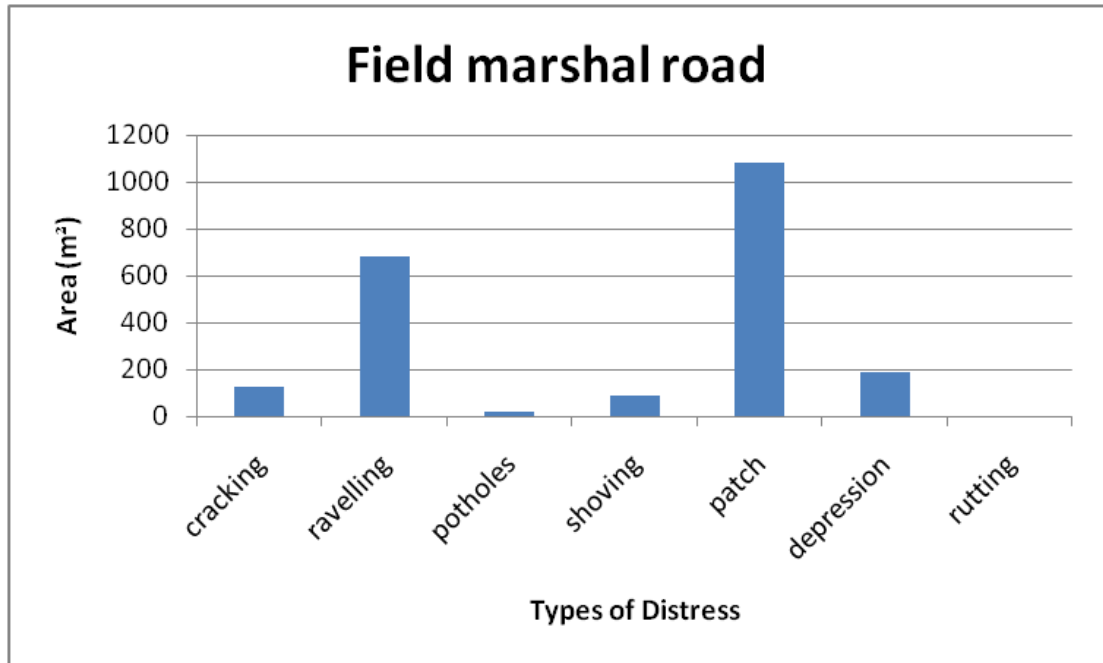
Figure 4.15 Chart of Distress at Field marshal road

Table 4.4 Percentage of distress (%)

Types of distress	Cracking	Ravelling	Potholes	Shoving	Patch	Settlement & Depression	Rutting
Raiya Road	0.17%	5.15%	0.12%	0.08%	5.03%	0%	0%
Field Marshal road	1.93%	10.31%	0.27%	1.37%	16.37%	2.82%	0%

4.3 Determine Pavement Condition Rating

- The following table 4.5 shows pavement condition rating & analysis by using guidelines of maintenance management primary, secondary, urban roads IRC-2004.

Table 4.5 Rating & condition analysis

Road section	Rating of basis of percentage distress							Avg. rating	Condition
	Cracking	Ravelling	Potholes	Shoving	Patch	Settlement & Depression	Rutting		
Raiya road	5	3	3	4	3	5	5	4	**Good**
Field Marshal road	5	2	3	1	2	2	5	2.86	**Poor to Fair**

4.4 Estimation of Capacity:

4.4.1 Traffic volume survey at Raiya road

- Traffic volume data was collected in morning 9:00am to 12:00pm and in evening 5:00pm to 8:00pm.

Table 4.6 Vehicle Composition at Raiya road (09/10/2021, Saturday)

Time	2W	3W	Car	Bus	LCV	Truck	Tractor	Cycle
9:00to10:00AM	1492	21	352	3	35	11	2	3
10:00to11:00AM	1286	18	449	2	42	15	4	0
11:00to12:00PM	1332	16	366	2	19	16	5	0
5:00 to 6:00 PM	1416	25	372	2	18	19	4	0
6:00 to 7:00 PM	1703	14	389	0	26	17	2	0
7:00 to 8:00 PM	1879	12	482	1	31	16	2	2
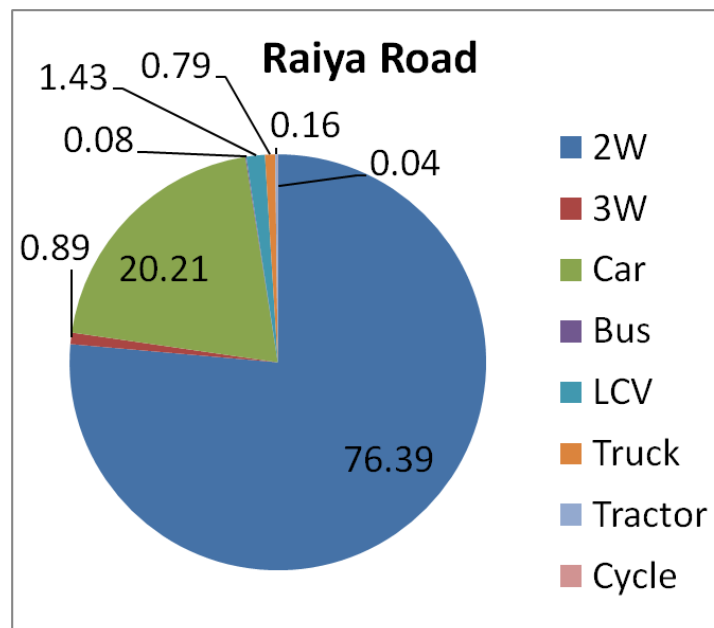
Figure 4.16 Percentage of traffic volume at raiya road (saturday)

Table 4.7 Vehicle Composition at Raiya road (Date:10/10/2021Sunday)

Time	2W	3W	Car	Bus	LCV	Truck	Tractor	Cycle
9:00 to 10:00 AM	1557	25	456	2	47	16	5	5
10:00 to 11:00 AM	1361	15	409	1	45	15	4	0
11:00 to 12:00PM	1332	13	337	1	19	11	2	0
5:00 to 6:00 PM	1506	21	372	2	18	19	2	0
6:00 to 7:00 PM	1562	24	414	0	26	17	2	2
7:00 to 8:00 PM	1829	27	507	1	31	16	6	0
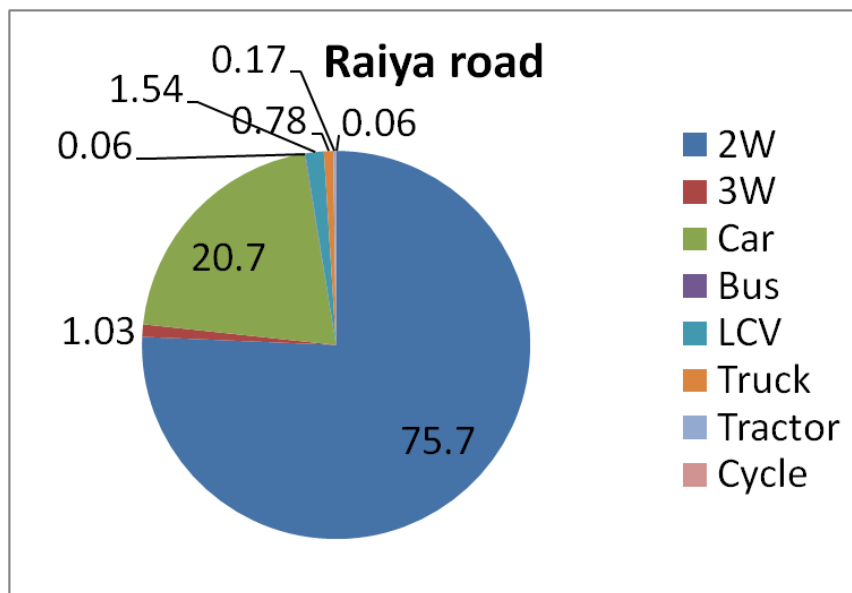
Figure 4.17 Percentage of traffic volume at raiya road (sunday)

4.4.2 Traffic volume survey at Field marshal Road

- Traffic volume data was collected in morning 9:00am to 12:00pm and in evening 5:00pm to 8:00pm.

Table 4.8 Vehicle Composition at Field marshal Road(16/10/2021, Saturday).

Time	2W	3W	Car	Bus	LCV	Truck	Tractor	Cycle
9:00 to 10:00 AM	2215	15	655	2	43	21	5	5
10:00 to 11:00 AM	1987	17	731	1	36	58	4	2
11:00 to 12:00PM	2113	10	511	1	56	36	7	0
5:00 to 6:00 PM	1862	11	662	1	33	35	6	0
6:00 to 7:00 PM	1911	18	755	1	45	47	11	1
7:00 to 8:00 PM	1971	13	653	1	71	58	7	4
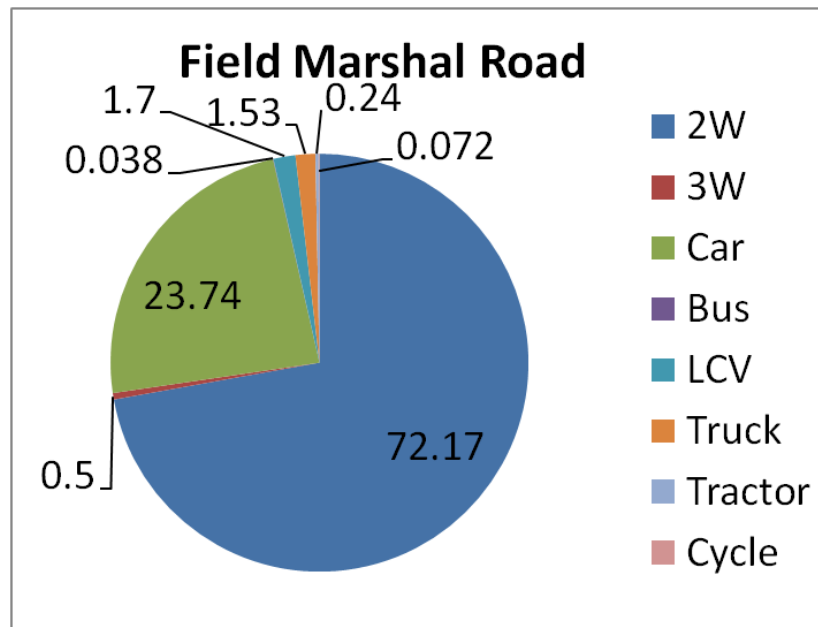
Figure 4.18 Percentage of traffic volume at Field marshal road (saturday)

Table 4.9 Vehicle Composition at Field marshal road (17/10/2021, Sunday)

Time	2W	3W	Car	Bus	LCV	Truck	Tractor	Cycle
9:00 to 10:00 AM	2116	17	757	2	52	58	6	3
10:00 to 11:00 AM	1954	15	661	1	39	44	4	2
11:00 to 12:00PM	1933	11	598	2	40	36	3	2
5:00 to 6:00 PM	1755	13	675	2	42	35	4	2
6:00 to 7:00 PM	1950	15	755	1	45	47	5	1
7:00 to 8:00 PM	2057	21	727	1	71	51	10	4
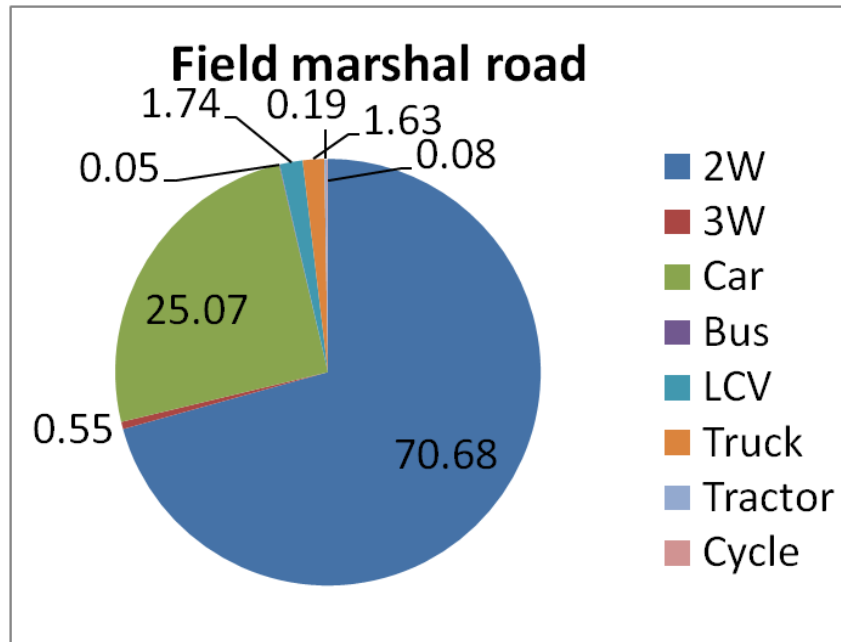
Figure 4.19 Percentage of traffic volume at Field marshal Road (Sunday)

4.5 Determination of capacity:

- The observed capacity is analyzed in terms of pcu/hr.(Refer Table 4.2)

Table 4.10 Capacity of road (pcu/hr)

Time	Traffic Volume(pcu/hr) at Raiya Road		Traffic volume(pcu/hr) at Field Marshal road	
	Date:09/10/2021 Saturday	Date:10/10/2021 Sunday	Date:16/10/2021 Saturday	Date:17/10/2021 Sunday
9:00 to 10:00 AM	1256.01	1452.04	1982.04	2197.32
10:00 to 11:00 AM	1282.78	1281.22	2056.86	1924.00
11:00 to 12:00PM	1176.62	1109.66	1872.07	1819.55
5:00 to 6:00 PM	1235.49	1216.57	1837.2	1814.41
6:00 to 7:00 PM	1382.42	1345.00	2054.7	2045.01
7:00 to 8:00 PM	1574.31	1602.48	2062.72	2173.16

4.6 Estimation of Level of service

- Calculate Level of service

LOS = V/C

Where, V= observed traffic volume in term of pcu/hr.

C= two lane undivided capacity is 2400 pcu/hr (Indo HCM-2017)

Table 4.11 V/C ratio at selected stretch

Time	V/C ratio at raiya road		V/C ratio at Field marshal road	
	Date:9/10/2021 Saturday	Date:10/10/2021 Sunday	Date:16/10/2021 Saturday	Date:17/10/2021 Sunday
9:00 to 10:00AM	0.52	0.60	0.83	0.91
10:00 to 11:00AM	0.53	0.53	0.86	0.80
11:00 to 12:00PM	0.49	0.46	0.78	0.76
5:00 to 6:00 PM	0.51	0.53	0.77	0.76
6:00 to 7:00 PM	0.57	0.56	0.86	0.85
7:00 to 8:00 PM	0.66	067	0.86	0.90

Table 4.12 Determination of LoS

Time	LOS at raiya road		LOS at Field marshal road	
	Date:9/10/2021 Saturday	Date:10/10/2021 Sunday	Date:16/10/2021 Saturday	Date:17/10/2021 Sunday
9:00 to 10:00 AM	B	C	D	E
10:00 to 11:00 AM	B	C	E	D
11:00 to 12:00PM	B	B	D	D
5:00 to 6:00 PM	B	B	D	D
6:00 to 7:00 PM	C	C	E	D
7:00 to 8:00 PM	C	C	E	E

CHAPTER – 5

CONCLUSION

5.1 CONCLUSION

After data collection and data analysis, to evaluate functional condition on selected stretches and also found observed capacity in terms of pcu/hr. to calculate level of service by volume capacity ratio using Indo HCM-2017.

- It is observed from the data that raiya road rating is 4 and condition is good by using guidelines of maintenance management of primary, secondary and urban roads, IRC 2004.

- It is found that the raiya road observed capacity is low.

- It is found that the level of service of raiya road is B & C by using Indo HCM-2017.

- It is learned that the condition of raiya road is good, and the level of service are B & C and capacity is law.

- It is observed from the data that Field marshal road rating is 2.86 and condition is poor to fair by using guidelines of guidelines maintenance management of primary, secondary and urban roads, IRC 2004.

- It is found that the Field marshal road observed capacity is high.

- It is found that the Field marshal road level of service is D & E by using Indo-HCM-2017.

- It is learned that the condition of Field marshal road is poor to fair, then the level of service is D & E and capacity is high.

CHAPTER – 6

REFERENCES

6.1 REFERENCES

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[10] Shamil Ahmed Flamarz Al-Arkawazi "Flexible Pavement Evaluation: A Case Study" (Kurdistan Journal for Applied Research) *(Volume 2, Issue 3, August 2017)*

[11] Guidelines Maintenance Management of Primary, Secondary and Urban Roads, IRC-2004.

[12] Indian highway capacity manual (Indo HCM-2017)

MEASUREMENT OF SURFACE DISTRESS DATA SHEET

Table A: Data sheet for distress measurement

MEASURMENT OF SURFACE DISTRESS

(FLEXIBLE PAVEMENT SECTION)

Chainage of test Section (km):
Chainage of test Sub-Section (m):
Section name:

Carriageway width (m):
Date of observation:
Weather condition:

CHAINAGE	Cracks			Patch Work			Potholes			Depression			Ravelling			Showing			Rut Depth (mm)
	Size (mt.)		Area	Size (mt.)		Area	Size		Area	Size		Area	Size (mt.)		Area	Size (mt.)		Area	
	L	B		L	B		L	B		L	B		L	B		L	B		

ANNEXURE-B

TRAFFIC VOLUME COUNT TALLY SHEET

Table B: Traffic Volume Count Tally Sheet Format

Traffic volume count tally sheet							
Date:_____							
Name of Road:_____							
Direction: From_____To_____							
Hour Counted	2W	3W	Car	Bus	LCV	Truck	Tractor	cycle
: to :								
: to :								
: to :								
: to :								

RESEARCH PAPER CERTIFICATE

ANNEXURE-D

REVIEW CARD

ATMIYA UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

Master of Technology

(Dissertation Review Card)

Name of Student : Deep kumar Rasikbhai Khirasariya

Enrollment No. : 1 9 0 0 4 1 0 0 9

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Student's Contact No. : 81403 19819

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College Code : 0 5 1

Branch Name : Civil [Transportation]

Theme of Title : Pavement Maintenance

Title of Thesis : Distress evaluation of flexible Pavement : A case study of Rajkot urban Roads

Supervisor's Detail	Co-supervisor's Detail
Name : Mr. Ashraf Mathakiya	**Name :**
Institute : Atmiya University	**Institute :**
Institute Code : 051	**Institute Code :**
Mail Id : ammathakiya@aits.edu.in	**Mail Id :**
Mobile No. : 99740 78377	**Mobile No. :**

~ 1 ~

❖ **Comments For Internal Review (** **)** **(Semester 3)**

Sr. No.	Comments given by Internal review panel (Please write specific comments)	Modification done based on Comments
1.	give slide Number	
2.	Include more literatures which are relevent to the study	done
3.	Change Methodology chart.	
		(Guide Sign.)

Particulars	Internal Review Panel	
	Expert 1	Expert 2
Name :	Ms. Mayursinh Jadeja	Mr. Ashraf Mathakiya
Institute :	Atmiya University	Atmiya University
Institute Code :	051	051
Mobile No. :	78748 00 84	99740 78377
Sign :		

Particulars	Internal Guide Details	
	Expert 1	Expert 2
Name :	Mr. Ashraf Mathakiya	
Institute :	Atmiya University	
Institute Code :	051	
Mobile No. :	99740 78377	
Sign :		

~ 2 ~

Enrollment No. of Student : 1 9 0 0 4 1 0 0 9

❖ **Comments of Dissertation Phase-1 (**   **)**   **(Semester 3)**

Exam Date : 0 9 / 0 2 / 2021

Title : Distress evaluation of Flexible pavement : A Case study of Rajkot urban roads.

....

1. Appropriateness of title with proposal. (Yes/ No) _____

2. Whether the selected theme is appropriate according to the title ? (Yes / No) _____

3. Justify rational of proposed research. (Yes/ No) _____
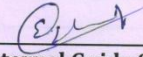
4. Clarity of objectives. (Yes/ No) _____

~ 3 ~

Enrollment No. of Student : 1 9 0 0 4 1 0 0 9

Exam Date : 0 9 / 02 / 2021

Sr. No.	Comments given by External Examiners (DP-I) : (Please write specific comments)	Modification done based on Comments
1.)	Relate capacity to functional failure of road.	
2.)	Relate LOS to pavement condition.(functional condition)	done
3.)	Find capacity in terms of PCU/Hr.	
		(Internal Guide Sign.)

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on.

If approved/approved with suggestion then put marks ≥ 50 %.

➢ **Details of External Examiners :**

Particulars	Full Name	University / College Name & Code	Mobile No.	Sign.
Expert 1	Mr. Darshan Dave	DIET Rajkot	9687517456	
Expert 2				

~ 4 ~

Enrollment No. of Student : 1 9 0 0 4 1 0 0 9

❖ **Comments of Mid Sem Review (**) **(Semester 4)**

Exam Date : _____ / _____ / _____

Sr. No.	Comments given by External Examiners : i) The appropriateness of the major highlights of work done; State here itself if work can be approved with some additional changes. ii) Main reasons for approving the work. iii) Main reasons if work is not approved.	Modification done based on Comments
1.	Modify title	
2.	Add Literature Review relevent to your title and objectives	
3.	Summarize the statistical Data in Tabular fermat	
4.	Modify methodology	done
5.	1 Hour data collection is not sufficient so add more in it	
6.	Reframe the references alphabetically in order	
7.	Re.	
		Internal Guide Sign.

- *Approved* ☐
- *Approved with suggested recommended changes* ☑
- *Not Approved* ☐

Please tick on any on.
If approved/approved with suggession then put marks ≥ 50 %.

➢ **Details of External Examiners :**

Particulars	Full Name	University / College Name & Code	Mobile No.	Sign.
Expert 1	Mr. Jay kedarien	M U - Rajkot	9879470878	(online)
Expert 2				

~ 5 ~

Enrollment No. of Student : | 1 | 9 | 0 | 0 | 4 | 1 | 0 | 9 |

❖ Comments of DP-II Review (   )   (Semester 4)

Exam Date : _____ / _____ / _____

Sr. No.	Comments given by External Examiners : i) Main reasons for approving the work. ii) Main reasons if work is not approved.	Modification done based on Comments

▪ *Approved* ☐ ⎫ *Please tick on any one.*
▪ *Not Approved* ☐ ⎭ *If approved then put marks* ≥ *50 %.*

➢ **Details of External Examiners :**

Particulars	Full Name	University / College Name & Code	Mobile No.	Sign.
Expert 1				
Expert 2				

~ 6 ~

ANNEXURE-E

PLAGIARISM REPORT

Curiginal

Document Information

Analyzed document	Report-converted.pdf (D118316915)
Submitted	2021-11-12 10:10:00
Submitted by	Dr. Sheetal Tank
Submitter email	librarian@atmiyauni.ac.in
Similarity	8%
Analysis address	librarian.atmiya@analysis.urkund.com

Sources included in the report

SA	**Full Thesis for Plag detection.docx** Document Full Thesis for Plag detection.docx (D115443500)	2
SA	**DP 2 report (Autosaved).docx** Document DP 2 report (Autosaved).docx (D29405801)	7
SA	**Jahangir.pdf** Document Jahangir.pdf (D109775024)	2
W	URL: https://www.nap.edu/read/25812/chapter/12 Fetched: 2021-11-12 10:11:00	1