EFFECT OF PAVEMENT CONDITIONS ON ROAD ACCIDENTS

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INTRODUCTION

1.1 GENERAL BACKGROUND

Effect of pavement surface failure on road traffic accident was the concern of our globe. researchers define road pavement structure in different approaches. Road pavement structure was made of multiple layer processed and compacted material in different thicknesses; primarily supports vehicle loads as well as provides a smooth riding quality. other researcher supports pavement was hard and high strength surface that separates the underlying well-compacted foundation of road from the weight of vehicles. even if, pavement layers was well compacted and highly qualified to be a traffic load, due to that and other related factor pavement may be under risk of failure. pavement failure occurs as soon as pavement surface no longer holds its original shape and develops material stress. when pavement reaches its terminal life the pavement surface suffers from distresses which unable to provide smooth surface for users. categorically; pavement failure includes cracking, potholes, depressions, rutting, shoving, upheavals and raveling. that caused by several factors like: water intrusion, stress from heavy vehicles load, enlargement and shrinkage from seasonal temperature changes, and sun exposure. Pavement failure was a process by which weakness developed on pavement under the combined effects of traffic load and environmental condition. due to the presence of pavement failure; particularly, surface condition in line with other factors road traffic accident happen immensely. most pavement failures primarily reflected at the wearing course or surface of the structure. as a result; pavement surface condition was a commencement and indicator for the occurrence pavement failure that contribute their own impact for the incidence of road traffic accident. this review considers failures on pavement surface those contribute road traffic accident, particularly; pavement friction, roughness and rutting. in different research paper scholars consider factors causes road traffic accident differently.

1.2 AIM

To identify the accident rate and pavement surface conditions on selected road stretches. The selected roads will be having different pavement surfaces. After data collection, data analysis is done by SPSS software. Using the formulas, a ranking will be given to the selected road stretches and appropriate conclusions or recommendations are given.

1.3 OBECTIVES

The main objective of this study is to investigate the relationship between accident rate and pavement condition. The study focuses on ride quality and rutting as the two main distress types that could affect accidents. General models that relate accident rates to pavement condition are developed. Accident data and pavement conditions from different geographic locations and climatic conditions are collected. Accident severity levels are separated in order to investigate which accident severity is largely affected by pavement condition. Data is collected from authorities since data on accident rates and pavement conditions are readily available. Both flexible and rigid pavements are studied without distinction. Roughness and rut depth threshold values above which crash rate largely increases are determined. If roughness and rut depth are kept below these critical values, the crash rate would largely decrease.

1.4 SCOPE OF THE STUDY

Pavement rut depth has a direct influence on traffic safety and it gives a good idea about the general road condition. A rut is a depression or groove worn into a road or path by the travel of wheels or skis. Ruts can be formed by wear, as from studded snow tires common in cold climate areas, or they can form through the deformation of the asphalt concrete, pavement or sub base material. In modern roads the main cause is heavily loaded trucks. These heavy loaded trucks imprint their tire impressions on roads over time, causing ruts. Rut is a common pavement distress and is often used in pavement performance modeling. Pavement type can also be used as one of the parameter which helps in getting more idea about the pavement condition. Basically, all hard surfaced pavement types can be categorized into two groups, flexible and rigid. Each of these pavement types distributes load over the sub grade in a different fashion. Rigid pavement, because of PCC's high elastic modulus, tends to distribute the load over a relatively wide area of sub grade.

LITERATURE SURVEY

2.1 STUDIES ON PREVIOUS LITERATURES

Rahma Mkwata, and Elizabeth Eu Mee Chong (2022) "Effect of pavement surface conditions on road traffic accident - A Review": This study aims to establish an overview of the state-of-the-art relationship between accident risks and pavement surface conditions. The symptoms of pavement surface failure are indicated by roughness, rutting, and skid resistance. To analyze the relationship between traffic accident and pavement surface conditions, an extensive review of the literature was conducted on the related titles. The findings showed that pavement surface conditions have a strong positive effect on accident risks. Pavement surface distresses directly affect ride comfort and indirectly cause distraction to the driver resulting in loss of control of the vehicle, which may lead to injuries or deaths. The ranges of acceptable pavement surface conditions were also presented.

Debela Deme (2020) "A Review on Effect of Pavement Surface Failure on Road Traffic Accident": Pavement surface condition was parameter used to define quality of road traffic system. In this review pavement surface condition inspected were pavement friction, roughness and rutting. In order to analysis the study considers all previous papers done by researcher in specified and related title. Due to data constraints and other related issues to signify the outcome this review randomly selects forty-five researches paper. As per the examination most researchers argue that the affinity of pavement surface condition for the occurrence of road traffic accident was irrelevant in respect to another related factor (Vehicle speed, Road geometry, Wet pavement surface, Pavement edge and etc.). Even though; the impact was insignificant the number of people dies and injured kin with other accident triggering factor was significant. As a result; stakeholder must play substantial role to overcome road traffic accident due to lack of proper maintenance and management of pavement surface condition.

Hashem.R. Al-Masaeid (2020) "Impact of Pavement Condition on rural road accidents": Because of the limited resources and the inappropriate maintenance technique, many rural roads in developing countries such as Jordan are characterized by a high level of roughness. Empirical evidence and accident reports revealed that many rural road accidents are associated with severe road defects. This study investigated the effect of pavement conditions, road geometry, and roadside conditions on rural road accidents. Mathematical modeling using regression technique was used to investigate the effects of included variables on single-vehicle, multiple- vehicle, and total accident rates. Results of statistical analysis indicated that pavement condition, expressed in terms of the international roughness index or present serviceability rating, had significant effects on single and multiple vehicle accident rates, but it had no statistical influence on the total accident rate. Furthermore, the results of this study indicated that the number of sharp horizontal curves and the roadside condition, expressed in terms of the roadside hazard rating, were found to have significant effects on the single-vehicle accident rate. Finally, regression models were developed to qualify the effects of the included variables on the previous accident rates.

Aimin Sha , Zhuangzhuang Liu, Wei Jiang, Lin Qi, Liqun Hu (2021) "Advances and development trends in eco-friendly pavements": The major contemporary inroad pavement engineering is related to the creation of green and sustainable infrastructures, e.g., reduction of environmental impacts, increase in traffic safety, and transportation efficiency, etc. This review presents the recent trends in research and the technical solutions developed so far to address these challenges. After the analysis of research status in the past decades, a novel technology system of eco-friendly pavements is proposed considering two solutions, materials modification and structure improvement. The construction of an eco-friendly pavement can be achieved thanks to several different technologies ensuring permeable, noise-reducing, self-luminous, and exhaust-decomposing properties as well as supporting lower heat absorbing and enhanced anti-/de-icing characteristics. A systematic review of these technologies is presented pivoting on four main aspects: technical principle, material and structural composition, performance evaluation, and engineering application. The current trend in road engineering is combining the pavement infrastructure with various eco-friendly functions, e.g., water permeability, noise reduction, low heat absorption, exhaust gas decomposition, and anti-/de-icing. Finally, the review lists the drawbacks of the existing technologies, including high cost, single function, etc., and depicts the future developing direction and architecture of the next generation of eco-friendly pavements in which the road infrastructure should have more environmentally friendly functions than the existing technology.

Sangyum Lee , Jeong-Jun Park , Byoung Hooi Cho (2022) "Management of cavities under flexible pavement road network in metropolitan area: Detection, evaluation, and rehabilitation": This study evaluated a management program of cavities under flexible pavement road network in Seoul Metropolitan City. Consequently, directions for improvement were suggested. The underground cavities beneath the pavement layer were scanned using a vehicle-type multichannel ground penetrating radar (GPR).

In addition, the size information including overburden thickness, cavity height, and lengths in longitudinal and transverse directions of the cavities were estimated and compared with the volume of cavities measured via a digital cavity imaging (DCI)system. Moreover, the change in the cavity dimensions with time was monitored.

Through field investigation, the cavity volume near the asphalt pavement surface was observed to be smaller than the cavity located in the deep. For certain locations where the cavity existed, pavement cracks on the asphalt surface were identified. Thus, the crack width and depth were measured for the selected 14 locations and compared with the dimensions of the cavities. The results demonstrated that the depth of crack rather than the width exhibited a meaningful correlation with the cavity size. Additionally, the cavities under the flexible pavement layer were repaired using a low-strength filling repair material. Further, the elastic modulus on the pavement surface above cavity was assessed using a light weight deflect meter (LWD) before and after the rehabilitation process and compared with the value of elastic modulus on the normal surface with no cavity but near the repair work. The results demonstrated that although the rehabilitation process increased the elastic modulus of the pavement layer, it could not be fully recovered owing to the characteristics of the repair material. Furthermore, the rehabilitation process was found to be more effective as the size of cavity was small.

Sujata Basu , Pritam Saha (2022) "Evaluation of risk factors for road accidents undermined traffic: Case study on Indian highways": This paper presents an evaluation of risk factors for highway crashes under mixed traffic conditions. The basis for selecting study sites was abutting land use, roadway, and traffic characteristics.

Accordingly, the study selected thirteen segments on the existing highway network inthe state of West Bengal of India, covering a wide spectrum of such road attributes. A systematic investigation based on site-specific accident data to capture the highway sections' safety features revealed that the crash rate has steadily increased for years with traffic regardless of roadway category and conditions. A number of risk factors that affect road accidents were identified; they are mid-block access, pavement and shoulder conditions, vehicle involvement, time of day, and road configuration, i.e., two and multi-lane. The empirical observation indicates that the crash rate is relatively lower on multi-lane highways; however, the severity of any crash on such a road is relatively high.

Notably, the crash frequencies on such roads are less during daylight hours due to the lane-based unidirectional traffic movement. This is quite the opposite during night-time when drivers exhibit an inability to meet traffic contingencies, thereby increasing crash risk. Most crashes on two-lane highways are, on the other hand, due to unsafe driving man oeuvres. The study also observed that frequent mid-block accesses and poor shoulder conditions reduce scopes to rectify driving errors and increase crash risk consequently. The paper subsequently suggests proactive approaches to identify safety deficits at the time of planning and designing.

Ruben Kazaryana, Ivan Doroshina, Boris Jadanovskiya, Elen Bilonda Tregubovaa (2022) “Organization and technology of arranging access roads with asphalt concrete pavement in the preparatory period of construction”: The study analyses the formation of indicators and criteria for the effectiveness (quality) of theuse of certain modes of transport. Methods. System analysis, logical and mathematical modeling, systems theory, as well as methods of operations research, economic and mathematical methods, economic and visual modeling, research methods of operations. Results. Development of criteria for assessing intelligent systems of economic efficiency of the use of information modeling technology in the organization of construction production of transport systems (automobile and road complex). Conclusion. The construction of permanent access roads with asphalt concrete pavement, which after the subsequent current repair and modification remain at the construction project site for further operation, is advisable to organize in stages, thus making adjacent temporary roads shorter. This approach makes it possible to reduce significantly the overall labor intensity of works and the energy intensity of production operations, and to increase the level of labor mechanization. The arrangement of asphalt concrete pavements of temporary and access roads is in many respects similar to the arrangement of road surfaces of streets.

Takahiro Tsubotaa, Celso Fernandoa , Toshio Yoshiia , Hirotoshi Shirayanagi(2018) “Effect of Road Pavement Types and Ages on Traffic Accident Risks”: This study aims to reveal the relationship between the age of road pavement and traffic accident risks through empirical analysis. The current pavement maintenance is planned based on the road surface survey that measures the physical damage on the pavement surface. The indices for the physical damage on road surface are good representation for the structural healthiness and the driving comfort, but they do not measure the traffic safety levels of the pavement. This limitation hinders planning the pavement management scheme ideal in achieving safer driving environment. This study empirically analyses the relationships between the pavement conditions and accident risks. The pavement conditions are represented by the pavement age – the years since construction or last repair of the pavement. The accident frequency is modeled based on the Poisson regression analysis. The model estimation results show that the age of road pavement has a positive effect on the accident risk, and that the ageaffects differently in difference pavement types. The results also show that theaccident risk is different if the pavement types are different.

Amir Shtayat, Sara Moridpour, Berthold Best, Avinash Shroff, Divyajeetsinh Raol (2020) “A review of monitoring systems of pavement condition in paved and unpaved roads”: The rising number of vehicles on roadways expedites the urge to increase efforts in implementing monitoring systems that look after road pavement conditions. This rising in number of vehicles on roadways also cause more damages and distresses on road pavement. Road pavement conditions should be accurately evaluated to identify the severity of pavement damages and types of pavement distress. Therefore, monitoring systems are considered a significant step of maintenance processes. Paved roads and unpaved roads require regular maintenance to provide for and preserve users’ usability, accessibility, and safety. Transport agents and researches would spend a lot of time and money in inspecting some sections ofthe roadway surface; that inspection would then be followed by results recording and data analysis to diagnose the type of treatment required. These monitoring systems have been developed using various methods that include smart technologies and prepared equipment. Many related studies evaluate road pavement degradation and distress, while others focus on identifying the best maintenance monitoring approach in terms of time and cost. This paper set out to explore different monitoring techniques used to evaluate road pavement surface condition. Also, this study introduces dynamic and static monitoring systems used inboth paved and unpaved roads to identify the severity of pavement degradations and types of pavement distress on road surfaces.

2.2 SUMMARY OF LITERATURES

Road accidents are now the leading cause of injuries and death globally. The cause of road accidents can be due to human error, road conditions, and vehicle conditions. As road condition is considered a factor; we focus mainly on how pavement conditions pave the way for road accidents. The surveys conducted regarding this topic is focusing mainly on the pavement condition characteristics such as pavement friction, roughness, and rutting. Hence, proper management and periodic maintenance of pavement surface as per specification was mandatory and has a significant impact on the reduction of road traffic accidents.

2.3 RESEARCH GAP

There are no researchers who came to a solid conclusion about the effect of pavement conditions on road accidents. In this project, we focus mainly on the pavement surface conditions on accident rates. We will be collecting the accident data and form a linear regression model.

METHODOLOGY

Essentially, a methodology is a collection of methods, practices, processes, techniques, procedures, and rules. In this project report, methodologies are specific, strict, and contain a series of steps and activities for each phase of the project's life cycle. Overarching strategy and rationale of the research project. It involves studying the methods used in the field and the theories or principles behind them, in order to develop an approach that matches the project objectives. In this case, the methodology reaches out to the procedures and activities involved in the completion of the project, by which the validity and reliability of the work done can be put into perspective to assess it better. The Methodology used are:

1. Selection of road stretches.
2. Identification of parameters
3. Data Collection.
4. Development of Model.
5. Testing of the model.

3.1 SELECTION OF ROAD STRETCHES

The accident rate in Kothamangalam – Muvattupuzha region is found to be high.

This has resulted in an increased number of deaths and injuries. So far, our project road stretches are Kothamgalam – Muvattupuzha Road, Pezhakkapilly Road, Karayamparambu Junction, Kothamangalam Bypass, Ramapuram, Ambalappady Road, and Concrete Pavement.

3.2 IDENTIFICATION OF PARAMETERS

The parameters taken for the model development are:

1. Accident rate: The accidents happened from the year 2018 to 2021 for the

selected road stretches are noted.

2. PCR: Visual observation and pavement condition rating based on this observation is made for the selected road stretches.

3. Width of the road stretch: geometry/width of selected road stretches are obtained from the AutoCAD drawing of the road stretches obtained.

DATA COLLECTION AND PROCESSING

4.1 AIM

We have taken 7 road stretches surrounding the Kothamangalam – Muvattupuzha

region and the accident rate of these roads for the years 2018 to 2021 are noted.

NAME	2018	2019	2020	2021
KOTHAMANGALAM-MUVATTUPUZHA ROAD	134	156	92	207
PEZHAKKAPILLY JUNCTION	146	195	83	220
KARAYAMPARAMBU JUNCTION	368	429	140	495
RAMAPURAM ROAD	160	143	30	193
AMBALAPPADY ROAD	8	13	6	28
KOTHAMANGALAM BYPASS	22	41	19	87
CONCRETE PAVEMENT	0	0	0	0

4.2 PAVEMENT CONDITION RATING

The visual observation or pavement condition rating of the selected road stretches are taken. For this rating, we have taken parameters such as: Ravelling: Raveling is the disintegration of an asphalt road surface. It is due to the dislodgment of aggregate materials (gravel, sand, and crushed stone). It reduces skid resistance, roughens the road surface, and exposes the layers underneath to further deterioration. Raveling also results in loose gravel which can be dangerous for your vehicles.

Patching: Patching is the process of filling potholes or deteriorated parts of asphalt pavement. It consists of sending a patching crew to a site with a set amount of asphalt that they shovel into the holes and compact with a small roller.

Rutting: A rut is a permanent, longitudinal surface depression that occurs in the wheel paths of a flexible asphalt road surface due to the passage of traffic. Ruts accumulate incrementally: every time a heavy vehicle passes a small, permanent deformation or consolidation is caused. Further into the lifespan of the pavement, the surface deformation may be accompanied by heave, along each side of the rut. A road rut appears as a pavement depression, which is a contained part of the pavement surface area that is lower than the surrounding area. The depressions can be categorized by low, medium, or high, starting at a low-intensity pavement depression that is only visible after rain, to an easily observable depression that can cause hydroplaning.

Settlement: A drop of the pavement’s layers, normally due to the compaction of these or of the underlying layers. The settling of pavements normally causes vertical unconformities that from certain aspects can even affect the traffic. Cracks form assisting water seepage to the lower layers. The repair of the pavements means re-laying the affected material layers, at least on the upper section, with its corresponding cost in time, money, and interruptions in the use of the related road. Occasionally, in reduced area settings, the cracks that have formed are surface sealed. Potholes: A pothole is a depression in a road surface, usually asphalt pavement, where traffic has removed broken pieces of the pavement. It is usually the result of water in the underlying soil structure and traffic passing over the affected area. Water first weakens the underlying soil; traffic then fatigues and breaks the poorly supported asphalt surface in the affected area.

Longitudinal Cracking: Longitudinal cracks are long cracks that run parallel to the center line of the roadway. These may be caused by frost heaving or joint failures, or they may be load induced. Understanding the cause is critical to selecting the proper repair. Multiple parallel cracks may eventually form from the initial crack. This phenomenon, known as deterioration, is usually a sign that crack repairs are not the proper solution.

Transverse Cracking: Transverse cracks extend across the pavement at approximately right angles to the pavement center line or direction of laydown. They may be caused by shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or a reflective crack caused by cracks beneath the surface course, including cracks in PCC slabs.

Bleeding: : Bleeding or flushing is a shiny, black surface film of asphalt on the road surface caused by the upward movement of asphalt in the pavement surface. Common causes of bleeding is too much asphalt in asphalt concrete, hot weather, low space air void content, and quality of asphalt.

Edge Cracking: Typically starts as crescent shape at edge of pavement. This type of cracking results from lack of support of the shoulder due to weak material or excess moisture. They may occur in a curbed section when subsurface water causes a weakness in the pavement. At 2low severity the cracks may be filled. As the severity increase, patches and replacement of distressed areas may be needed.These parameters are measured for the given road stretches using tapes and scales and the data is noted.

4.3 PAVEMENT CONDITION RATING PROCEDURES

The rating method is based on visual inspection of pavement distress. Although the relationship between pavement distress and performance is not well defined, there is general agreement that the ability of pavement to sustain traffic loads in a safe and smooth manner is adversely affected by the occurrence of observable distress. The mathematical expression for Pavement Condition Rating (PCR) provides an index reflecting the composite effects of varying distress types, severity, and extent upon the overall condition of the pavement.

The model for computing PCR is based upon the summation of deduct points for each type of observable distress. Deduct values are a function of distress type, severity, and extent. Deduction for each distress type is calculated by multiplying distress weight times the weights for severity and extent of the distress. Distress weight is the maximum number of deductible points for each different distress type. The mathematical expression for PCR is as follows:

$$PCR = 100 - \sum_{I=1}^{n} Deduct_i$$

Where:

n = Number of observable distresses

Deduct = (Weight of distress) (Weight of severity) (Weight of extent)

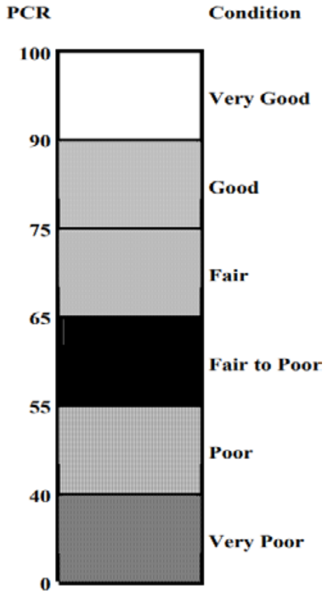

Fig.4.1:Pavement Condition Rating form

It is based on this rating forms, the PCR rating of roads can be predicted:

Section:________ **KEY** Date: ________

Log Mile: ____ to ____ **FLEXIBLE PAVEMENT CONDITION** Rated by: ________

Sta:____ to____ **RATING FORM** # of Utility Cuts ________

DISTRESS	Distress Weight	SEVERITY*			EXTENT**			STR ***
		L	M	H	O	F	E	
RAVELING	10	Slight Loss of Sand	Open Texture	Rough or pitted	<20%	20-50%	>50%	
BLEEDING	5	not rated	Bit and Agg visible	Black Surface	<10%	10-30%	>30%	
PATCHING	5	<1 ft^2.	<1 yd^2	>1 yd^2	<10/mile	10-20/mile	>20/mile	
DEBONDING	5	depth <1" area <1 yd^2	<1", >1 yd^2 >1",<1 yd^2	>1" and >1 yd^2	<5/mile	5-10/mile	>10/mile	
CRACK SEALING DEFIC.	5	Not considered			<50%	>50%	No Sealant	
RUTTING	10	1/8" - 3/8"	3/8" - 3/4"	> 3/4"	<20%	20-50%	>50%	U
SETTLEMENTS	0	Noticeable effect on ride	Some Discomfort	Poor Ride	<2/mi	2-4/mi	>4/mi	
POTHOLES	10	depth <1" area <1 yd^2	<1", >1 yd^2 >1",<1 yd^2	>1" and >1 yd^2	<5/mile	5-10/mile	>10/mile	U
WHEEL TRACK CRACKING	15	Single/multiple cracks <1/4"	Multiple cracks >1/4"	Alligator >1/4" Spalling with	<20%	20-50%	>50%	U
BLOCK & TRANSVERSE CRACKING	10	> 6' X 6' or Transverse Crk.	6' x 6' to 3' x3'	< 3' x 3'	<20%	20-50%	>50%	
LONGITUDINAL CRACKING	5	Single, <1/4", no Spalling	single/multiple 1/4-1", some Spalling	Multiple, >1", Spalling	< 50' per 100'	50-150' per 100'	>150' per 100'	U
EDGE CRACKING	10	Tight, <1/4"	>1/4", some Spalling	>1/4",moderate Spalling	<20%	20-50%	>50%	U
THERMAL CRACKING	10	<1/4"	1/4-1"	>1"	CS > 200'	CS 75-200'	CS <75'	

*L = LOW **O = OCCASIONAL ***STR = DISTRESS INCLUDED IN STRUCTURAL DEDUCT CALCULATIONS.
M = MEDIUM F = FREQUENT
H = HIGH E = EXTENSIVE

Fig. 4.2: Flexible Pavement Condition Rating form

Section: ____________________
Log mile: ______ to__________
Sta: __________ to__________

FLEXIBLE

Date: __________________
Rated by: ________________
# of Utility Cuts ____________

PAVEMENT CONDITION RATING FORM

DISTRESS	DISTRESS WEIGHT	SEVERITY WT.*			EXTENT WT.**			DEDUCT POINTS***
		L	M	H	O	F	E	
RAVELING	10	0.3	0.6	1	0.5	0.8	1	
BLEEDING	5	0.8	0.8	1	0.6	0.9	1	
PATCHING	5	0.3	0.6	1	0.6	0.8	1	
DEBONDING	5	0.4	0.7	1	0.5	0.8	1	
CRACK SEALING DEFICIENCY	5	1	1	1	0.5	0.8	1	
RUTTING	10	0.3	0.7	1	0.6	0.8	1 **T**	
SETTLEMENT	0	0.0	0.0	0.0	0.0	0.0	0.0	
POTHOLES	10	0.4	0.8	1	0.5	0.8	1 **T**	
WHEEL TRACK CRACKING	15	0.4	0.7	1	0.5	0.7	1 **T**	
BLOCK AND TRANSVERSE CRACKING	10	0.4	0.7	1	0.5	0.7	1	
LONGITUDINAL CRACKING	5	0.4	0.7	1	0.5	0.7	1 **T**	
EDGE CRACKING	10	0.4	0.7	1	0.5	0.7	1 **T**	
THERMAL CRACKING	10	0.4	0.7	1	0.5	0.7	1	

*L = LOW, M = MEDIUM, H = HIGH
**O = OCCASIONAL, F = FREQUENT, E = EXTENSIVE

TOTAL DEDUCT =
SUM OF STRUCTURAL DEDUCT (**T**) =
100 - TOTAL DEDUCT = PCR =

Fig. 4.3: Pavement Condition Rating form

After putting the values to the equations, the PCR rating we got are:

NAME OF ROAD	PCR	CONDITION
KOTHAMANGALAM-MUVATTUPUZHA ROAD	85.3	GOOD
PEZHAKKAPILY JUCTION	80.5	GOOD
KARAYAMPARAMBU JUNCTION	71.8	FAIR
RAMAPURAM ROAD	67	FAIR
AMBALAPPADY ROAD	68.4	FAIR
KOTHAMANGALAM BYPASS	85.3	GOOD
CONCRETE PAVEMENT	59.2	FAIR TO POOR

MODEL DEVELOPMENT

5.1 INTRODUCTION

5.1.1 SPSS

SPSS is short for Statistical Package for the Social Sciences, and it is used by various kinds of researchers for complex statistical data analysis. The SPSS software package was created for the management and statistical analysis of social science data. It was originally launched in 1968 by SPSS Inc. and was later acquired by IBM in 2009.

• Core functions of SPSS: SPSS offers four programs that assist researchers with your complex data analysis needs.

• Statistics Program: SPSS's Statistics program provides a plethora of basic statistical functions, some of which include frequencies, cross-tabulation, and vicariate statistics.

• Modeler Program: : SPSS's Modeler program enables researchers to build and validate predictive models using advanced statistical procedures.

• Text analysis for Surveys program: SPSS's Text Analytics for Surveys program helps survey administrators uncover powerful insights from responses to open-ended survey questions.

• Visualization Designer: : SPSS's Visualization Designer program allows researchers to use their data to create a wide variety of visuals like density charts and radial box plots from their survey data with ease. In addition to the four programs mentioned above, SPSS also provides solutions for data management, which allow researchers to perform case selection, create derived data, and perform file reshaping.SPSS also offers data documentation, which allows researchers to store a metadata dictionary.

• Advantages of using SPSS: The advantages of analyzing data with the help of SPSS software are as follows:

1. Not much effort is needed for the researcher to use this software.

2. Even the time required for analyzing the data with the help of SPSS is comparatively less than any other statistical tool.

3. It is beneficial for both types of data, quantitative as well as qualitative.

4. The users get the freedom of selecting a preferable graph type that matches the requirements of their data distribution.

5. The possibility of the occurrence of errors is minimum with the use of SPSS.

5.1.2 Linear Regression Model

As the name suggests, linear regression folows the linear mathematical model for determining the value of one dependent variable from value of one given independent variable. Linear regression is used to predict a dependent variable that consists of" count data" given one or more independent variables. The variable we want to predict is called the dependent variable which is taken as the Accident rate. The variables we are using to predict the value of the dependent variable are called the independent variables which are PCR and width of the road.

5.2 WORKING PROCEDURE

The following are the steps:

Step 1: The collected data, which are Accident Rate, Width of the Road Stretches, Pavement Condition Rating are inserted into data section of SPSS.

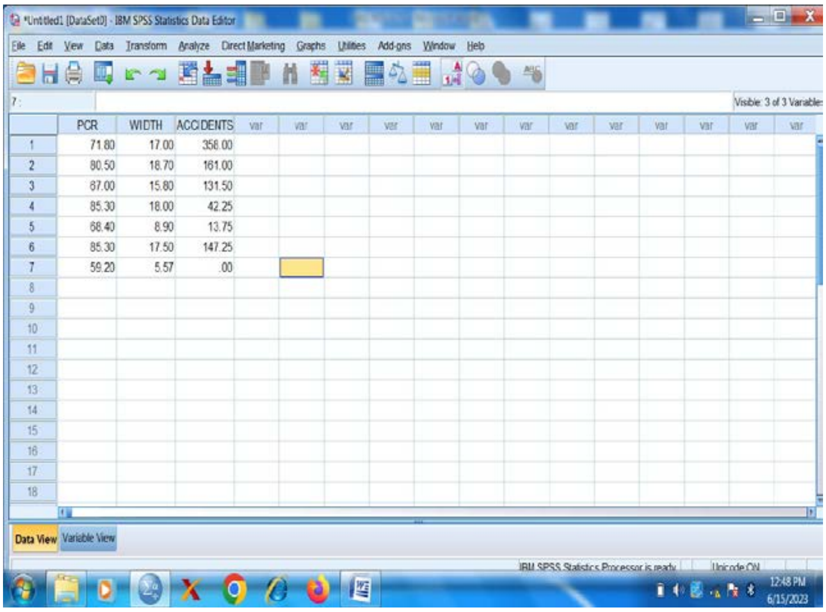

Fig. 5.1: Step 1

Step 2: Click on the analyze option and select linear from regression in the dropdown menu.

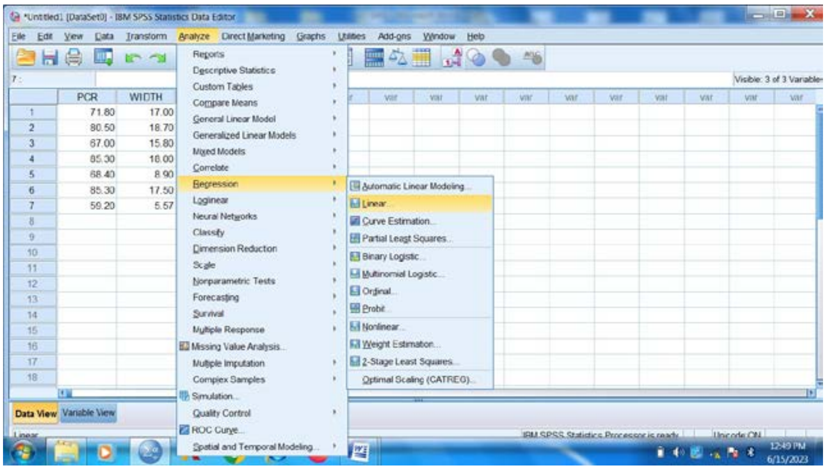

Fig. 5.2: Step 2

Step 3: : After the dialogue box appears, select accident as the dependent variable and the other two which is the width and PCR as independent variable.

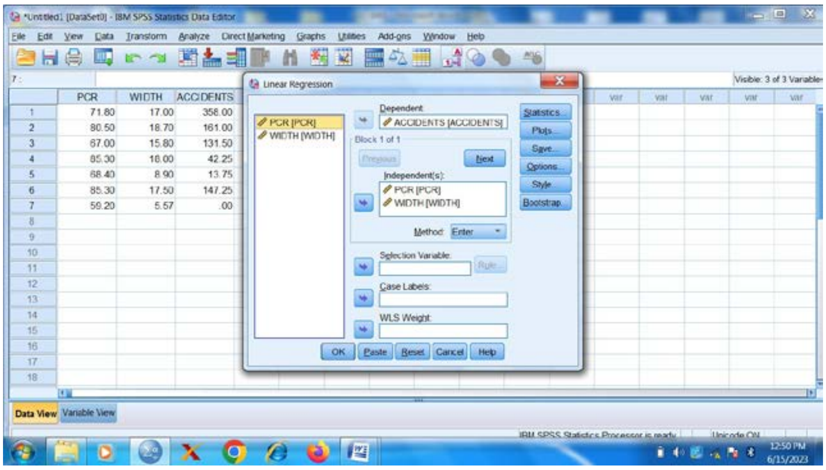

Fig. 5.3: Step 3

Step 4: Select statistics and select the needed columns. Step 5: After that, select plots and put ZPRED at Y axis and ZRESID at X axis and click continue.

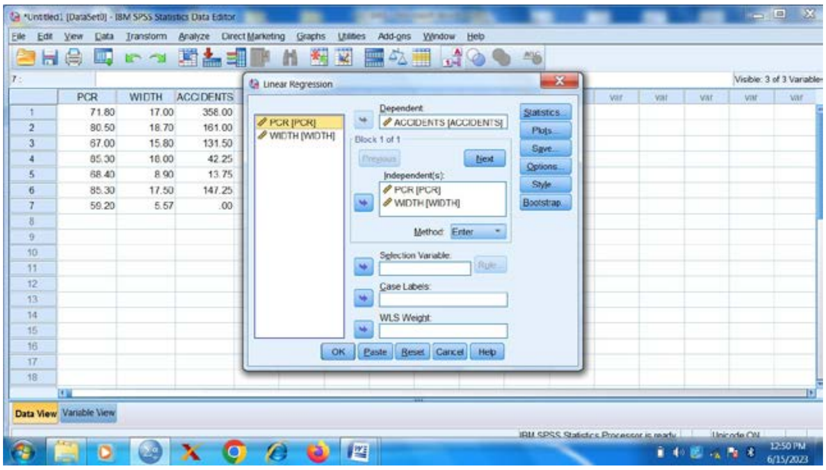

Fig. 5.4: Step 5

Step 6: Then the output of Regression model is developed.

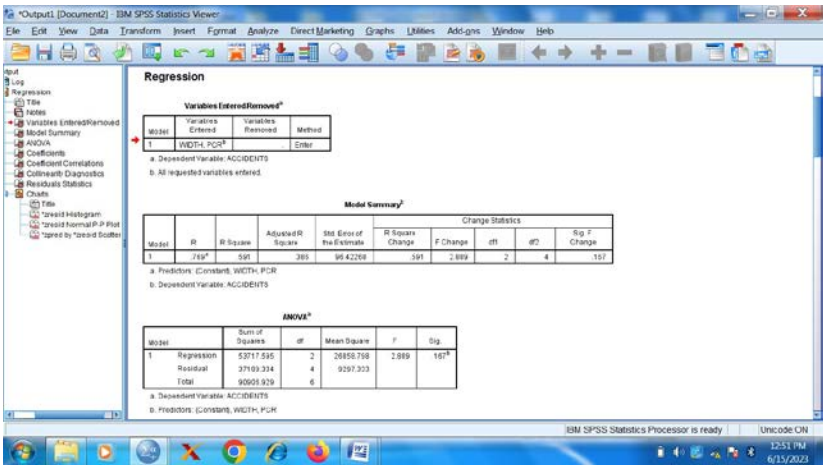

Fig. 5.5: Step 6

RESULTS AND DISUSSIONS

6.1 RESULTS

• Variables Entered: SPSS allows you to enter variables into a regression in blocks, and it allows stepwise regression. Hence, you need to know which variables were entered into the current regression. If you did not block your independent variables or use stepwise regression, this column should list all of the independent variables that you specified.

• Variables Removed: SPSS allows you to enter variables into a regression in blocks, and it allows stepwise regression. Hence, you need to know which variables were entered into the current regression. If you did not block your independent variables or use stepwise regression, this column should list all of the independent variables that you specified.

• Method: This column tells you the method that SPSS used to run the regression. “Enter” means that each independent variable was entered in usual fashion. If you did a stepwise regression, the entry in this column would tell you that.

• R: R is the square root of R-Squared and is the correlation between the observed and predicted values of dependent variable.

• R-Square: R-Square is the proportion of variance in the dependent variable (Accident rate) which can be predicted from the independent variables (PCR and width).

• Adjusted R Square: The adjusted R-square attempts to yield a more honest value to estimate the R-squared for the population. The value of R- square was .637, while the value of Adjusted R-square was .516. Adjusted R- squared is computed using the formula 1 – ((1 – Rsq) (N – 1)/ (N – k – 1)).

• Std. error of the estimate: The standard error of the estimate, also called the root mean square error, is the standard deviation of the error term, and is the square root of the Mean Square Residual (or Error).

• df: These are the degrees of freedom associated with the sources of variance. The Effect of Pavement Conditions on Road Accidents Project Report 2022-23 Deptartment of Civil Engineering 19 ICET total variance has N-1 degrees of freedom. In this case, there were N=7 Accident rate, so the DF for total is 6. The model degrees of freedom correspond to the number of predictors minus 1 (K-1). You may think this would be 2-1. But, the intercept is automatically included in the model. Including the intercept, there are 3 predictors, so the model has 3-1=2 degrees of freedom. The Residual degrees of freedom is the DF total minus the DF model, 6–2 is 4.

• Mean Square: These are the Mean Squares, the Sum of Squares divided by their respective DF. For the Regression, 53717.595/2 = 26848.79. For the Residual,

37189.334/4 = 9297.33.

• F and Sig: The F-value is the Mean Square Regression (26848.79) divided by the

Mean Square Residual (9297.33), yielding F=2.88. The p-value associated with

this F value is very small (0.048). These values are used to answer the question

“Do the independent variables reliably predict the dependent variable?”. The p- value is compared to your alpha level (typically 0.05) and, if smaller, you can conclude “Yes, the independent variables reliably predict the dependent variable”. You could say that the group of variables PCR and width can be used to reliably predict Accident rate (the dependent variable). If the p-value were

greater than 0.05, you would say that the group of independent variables does not show a statistically significant relationship with the dependent variable, or that the group of independent variables does not reliably predict the dependent variable.

This column shows the predictor variables (constant, PCR and width). The first variable (constant) represents the constant, also referred to in textbooks as the Y intercept, the height of the regression line when it crosses the Y axis. In other words, this is the predicted value of science when all other variables are 0.

• B: These are the values for the regression equation for predicting the dependent variable from the independent variable. These are called unstandardized coefficients because they are measured in their natural units. As such, the coefficients cannot be compared with one another to determine which one is more influential in the model, because they can be measured on different scales.

The column of estimates (coefficients or parameter estimates, from here on Effect of Pavement Conditions on Road Accidents Project Report 2022-23Deptartment of Civil Engineering 19 ICET labeled coefficients) provides the values for b0, b1 and b2 for this equation.

Expressed in terms of the variables used in this example, the regression equation is:

Accident rate = 433.459 – 10.17*PCR + 30.376*width

These estimates tell you about the relationship between the independent variables and the dependent variable.

• Std. Error: These are the standard errors associated with the coefficients. The standard error is used for testing whether the parameter is significantly different from 0 by dividing the parameter estimate by the standard error to obtain a t-value (see the column with t-values and p-values). The standard errors can also be used to form a confidence interval for the parameter, as shown in the last two columns of this table.

• Beta: These are the standardized coefficients. These are the coefficients that you would obtain if you standardized all of the variables in the regression, including the dependent and all of the independent variables, and ran the regression. By standardizing the variables before running the regression, you have put all of the variables on the same scale, and you can compare the magnitude of the coefficients to see which one has more of an effect. You will also notice that the larger betas are associated with the larger t-values.

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
				R Square Change	F Change	df1	df2	Sig. F Change
.769[a]	.591	.386	96.42268	.591	2.889	2	4	.167

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	53717.595	2	26858.798	2.889	.167[b]
	Residual	37189.334	4	9297.333		
	Total	90906.929	6			

a. Dependent Variable: ACCIDENTS

b. Predictors: (Constant), WIDTH, PCR

6.2 MODEL OUTPUT

The developed model is Accident rate = 433.459 – 10.17*PCR + 30.376*width. Herenthe constant value is give to be 433.459, which is a positive value which is subtracted with 10.17 times PCR and 30.376 times width of the road stretch which equals to output.

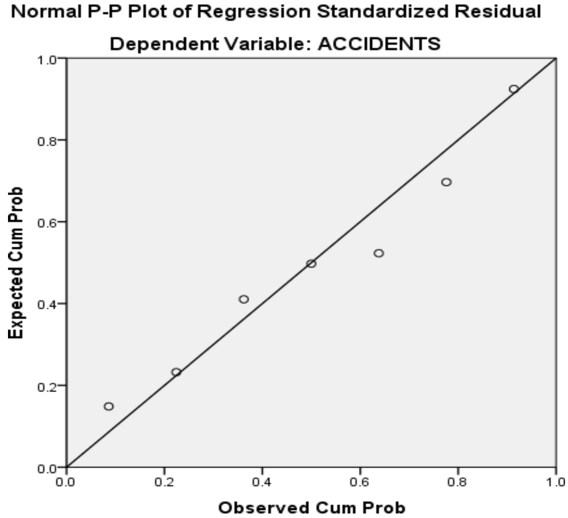

Fig. 6.1: Linear Graph

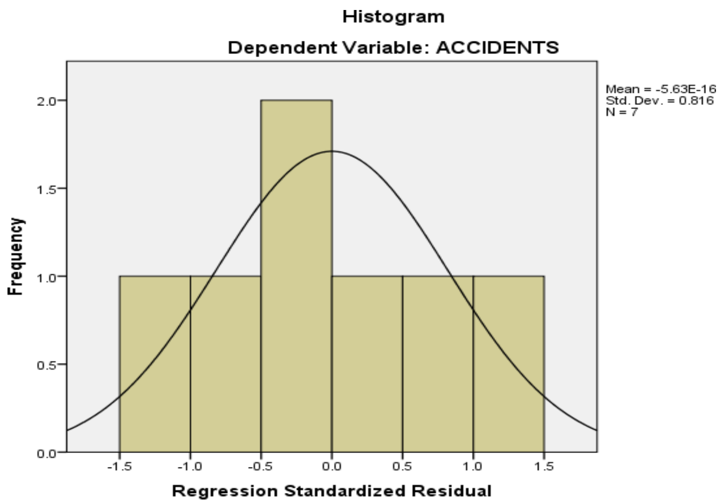

Fig. 6.2: Histogram

The above plot is a check on normality; the histogram should appear normal; a fitted normal distribution aids us in our consideration. Serious departures would suggest that normality assumption is not met. Here we have a slight suggestion of positive skewers but considering we have only 9 data points we have no real cause for concern.

CONCLUSIONS

• This study explored the effect of pavement surface condition on the accident rate on urban routes'

• About 9 road stretches were taken for this project and the model was developed by taking accident rate as dependent variable and parameters such as, PCR and width where taken as independent variable.

• From the accident rate estimation model based on the Linear regression analysis, we found that the pavement surface condition has a positive significant effect on the accident rate.

• The impact of PCR was noted to be more effective than the width of the road stretches.

• The model was later tested using Anova and r square tests and was verified to be useful the graph obtained was also linear which concludes that our project has obtained the result we hoped for.

• The graph for expected cumulative probability vs observed cumulative probability gives of a linear relationship thus making it a satisfactory output.