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# Functional and Structural Evaluation of a Link Road subjected to frequent deteriorations

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**_Abstract_**
*Many roads in India face accelerated deterioration due to lack of studies conducted prior to the construction. This paper attempts to evaluate a stretch of asphalt pavement on its functional performance. This evaluation gives an idea of the vital distresses happening on the pavement and gives a general review of the pivotal factors influencing the same. The external factors aiding to functional deterioration of pavement are climatic conditions, drainage efficiency, effective vehicle load (including effect of repetitions) and subgrade properties. The estimation of current traffic condition of the roadway and checking adequacy of existing pavement also forms the purview of the study. The stretch of roadway selected is Kollam- Ashramam Link road in Kollam district, Kerala state, India. The evaluation made use of various methods like visual examination survey (which involves the identification of potholes, cracks, rutting, patches, bleeding among other distresses), International Roughness Index (IRI) measured using MERLIN (Machine For Evaluating Roughness using Low cost Instrument). From the analysis of functional evaluation, concentrated areas of dilapidation and its most probable causes are ascertained. The suitable remedial measures are suggested for renewal. A graphical representation of distribution of distresses along the roadway using Geosetter software is done. Based on the traffic data collected, a new pavement design is also put forth.*

**_Keywords:_** *Functional Evaluation, International Roughness Index, Pavement Condition Rating, Geosetter.*

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## I. INTRODUCTION

In India, the blame of pavement deterioration is mostly put on the adverse climatic conditions and erratic soil characteristic existing at a particular area. Even though the reasons of pavement distresses may be heavy traffic condition, climatic condition, drainage efficiency, temperature and inconsistent subgrade performance round the year, the actual root cause of this situation is found to be improper studies carried out before construction of roadway. It is a fact that pavement's condition begins to deteriorate from the first day following completion, but the rate at which the decay occurs is a direct reflection of insufficient studies conducted and improper planning during execution of work.

The lack of timely maintenance works carried out also accelerates the process of decay. Flexible pavement deteriorates more rapidly than rigid pavement and it continues to deteriorate even in idle condition of traffic due to combined action of climatic and environmental factors. The deterioration in roadway can be scrutinized under two heads, functional and structural. Even if one influences the other, both are analyzed separately for ease in study.

Road pavement performances are measured by conducting functional and structural evaluations. Functional evaluations aims at finding the utility provided to the user. This includes riding quality, surface roughness and skid resistance. Structural evaluations concentrate on the responses of pavement under the application of vehicle loads. This includes deformations/deflections of the pavement due to traffic load. All these evaluations help in identification of pavement distresses and helps in formulating appropriate remedial measures. Hence it is important to carry out proper pavement evaluation at right time and using right methods.

The present study focuses on the Evaluation of Kollam-Ashramam Linkroad in Kollam district. The functional evaluation consist of pavement condition rating of the pavement using visual examination survey, which include identification of potholes, cracks, rutting, patches, bleeding etc. International Roughness Index of the pavement is measured using MERLIN (Machine for Evaluating Roughness using Lowcost Instrument). From the evaluation results possible causes of the failures are identified and remedial measures are suggested. Also representation of the distresses using Geosetter software is done. Based on the current traffic condition a new pavement design is also proposed.


**Figure 1: Road section with patch works**

### 1.1 Problem Statement

The Link road connects Chinnakada, Ashramam and Taluk Kachery area in Kollam city and stretches for a length of 0.9 km. The development of the road started in 2006 and initially it was a mud road formed by dumping laterite soil. The entire length of the land overlooks the Ashtamudi lake and rests on marshy soil. The black topped asphalt pavement was completed in 2011. Since then there has been a lot of maintenance and patch works on the pavement. But still distresses continue to occur and a huge amount of money is being spend on the maintenance activities (Figure 1). So it is necessary to find the actual cause of the failure and propose necessary remedial measures. As an initial step functional evaluation of the pavement needed to be carried out and type and extent of distress identified. Serviceability of the road condition should also be analysed.

## II. LITERATURE REVIEW

### 2.1 Functional Deterioration in Pavement

Functional deterioration of pavement occurs due to varying factors such as traffic load, climatic factors, environmental factors, moisture content etc especially on pavement surface. These pavement deteriorations are marked by undulations such as rutting, cracks, potholes. These affect the riding quality and vehicle operation cost of all automobiles. Different types of pavement failures and their possible causes are depicted in the Table 1 (Al-Arkawazi et al., 2017).

**Table 1: Surface distresses (Source: Al-Arkawaziet al., 2017)**

| Failure Type | Expected or Possible Causes |
|---|---|
| Alligator cracking | • Fatigue failure due to flexible/brittle base.<br>• Inadequate pavement thickness. |
| Block cracking | • Reflection of joints cracking in underlying base. |
| Longitudinal cracking | • Reflection cracking.<br>• Poor paving lane joint.<br>• Pavement widening.<br>• Cut/fill differential settlement.<br>• Fatigue failure of asphalt concrete. |
| Transverse cracking | • Reflection of shrinkage cracking.<br>• Construction joints. |
| Rutting | • Inadequate pavement thickness.<br>• Post construction compaction.<br>• Instability of base surfacing. |
| Shoving | • Poor bond between layers.<br>• Lack of edge containment.<br>• Inadequate pavement thickness. |
| Depression | • Settlement of service trench or embankment.<br>• Isolated consolidation.<br>• Volume change of subgrade |
| Corrugation | • Instability of asphalt concrete or base course. |
| Edge drop | • Inadequate pavement width.<br>• Erodible shoulder material (lack of plasticity). |
| Edge break | • Inadequate pavement width.<br>• Inadequate edge support.<br>• Traffic travelling on shoulder edge drop.<br>• Weak seal coat/loss of adhesion. |
| Raveling | • It is a result of insufficient adhesion between the asphalt cement and the aggregate.<br>• Initially, a fine aggregate break loose and leaves small, rough patches in the surface of the pavement. |
| Potholes | • Potholes are often located in areas of poor drainage.<br>• Potholes are formed when the pavement disintegrates under traffic loading, due to inadequate strength in one or more layers of the pavement, usually accompanied by the presence of water. |
| Polishing | Caused by traffic movement (vehicles movement). |

Subramanyam et al. (2017) conducted functional and structural valuation on state highway 99. In this study the entire pavement is divided into 8 samples where 5 samples were considered for evaluation. Various distresses like rutting, potholes, raveling etc were identified using manual distress studies. As per IRC 82:2015 guide line those pavements were classified as poor, good, fair. Each pavement section is rated based on the distress percentage and final rating value of entire pavement is computed by taking average.

Magdi et al. (2015) studied Obeid khatim road in Khartoum to identify various failures in the road section and propose suitable remedial measures for the same. The study consisted of two sections, one to identify the distresses using visual survey and second, to find the actual cause of the distress. The data obtained from field survey were analysed. Each pavement distress was categorized into different levels such as heavy, moderate, low. Further each pavement distress was classified based on covered area percentage. From the study it was concluded that about 70% of distress in that pavement stretch is caused due to alligator cracking and rutting. Untung et al. (2017) evaluated the structural and functional properties of south arterial road in Yogyakarta. Based on the study they provided recommendations for maintenance and rehabilitation of the road stretch. In functional evaluation process International Roughness Index and Pavement Condition Indexes were found and pavement was classified as good, damaged and seriously damaged. PCI value is calculated based on the visual studies and IRI value is obtained from the roughness measurement using MERLIN. In a similar kind of study, Tiza et al. (2016) proposed that the major cause of most of the pavement distresses are due to poor drainage condition of the pavement or inability of the pavement to with stand heavy traffic due to poor design. She also added that in almost every case the pavement distresses occur as combinations and there is a necessity to separate each distress into their respective class and severity level. In a study conducted by Alaamri et al. (2017), in Ikzi road different pavement stresses such as pot holes, rutting, alligator cracks, block cracks were identified and measured. The possible causes of these distresses were categorized into 2 sections: during and after implementation process such as improper compaction of pavement layers, asphalt mixture arrival delay, Heat shrinkage after laying, stress and drainage effect.

**2.2 Structural Deterioration and Evaluation Methods**

In case of flexible pavement, structural deterioration is marked by increase in the deflection of pavement under the applied traffic load or rutting on the surface of the pavement which indicate permanent deformation of the pavement including subgrade under the wheel load. Structural evaluation of pavement is done to identify the present structural condition of pavement, extent of deterioration, estimation of residual life, design of overlay thickness of the pavement (Khanna, 2018). Structural evaluation can be done in two different ways: destructive method and Nondestructive method. In destructive method, the pavement layer thickness is evaluated using field core data in which a pavement section is removed using a core cutter. Subramanyam et al. (2017) conducted structural evaluation of the pavement using Benkelman beam deflectometer, which identifies the static deflection in the pavement layer. This data along with the CBR value was utilized for determination of traffic load (msa) which in turn helps in overlay design. Rusmanto et al. (2018), conducted structural evaluation of pavement by considering Structural Condition Index (SCI). SCI is the ratio of structural number effective to structural number in future. Another important parameter required is resilient modulus. Both these parameters can be found by using Falling weight deflectometer test. Based on the SCI value suitable maintenance measure is adopted (Table 2).

**Table 2: SCI values and treatments (source: Rusmanto et al., 2018)**

| SCI Values | Treatment |
|---|---|
| > 1 | Maintenance |
| 0.7 – 1 | Functional Overlay |
| 0.5 – 0.7 | Structural Overlay |

Aher et al. (2019), conducted structural evaluation of a stretch of road in national highway 753J using Falling weight deflectometer. Traffic volume count, pavement layer thickness were also collected for data analysis purpose. The structural evaluation of pavement is done using FWD to find the deflection of pavement stretch. FWD test data were examined using KUAB software for flexible pavement crust design. The FWD test result can be used to calculate the remaining life of current layers and layer moduli for realistic and cost effective designs. A basic comparison between FWD and BBD was done by Zhou et al. (2010). From the study it can be inferred that FWD test provide a better result compared to BBD test. This is mainly because of the fact that, in BBD method static deflection is used where as in FWD test we uses rebound deflection. In FWD test back calculation is used to find the elastic modulus of pavement layer, which in turn helps in the overlay design of the pavement.

**2.3 Indices And Models For Pavement Maintenance**

Pavement conditions can be assessed by a number of indices such as Pavement Condition Index (PCI), Pavement Serviceability Index (PSI), International Roughness Index (IRI), Maintenance Priority Index, Modified Maintenance Index etc. Pavement condition index is commonly used as a measure to determine the need and type of maintenance work needed in a pavement section. Visual examination survey is done on the pavement surface and individual distresses are noted. Each distress will be given a particular weightage value as per IRC 82-2015 and based on that final rating will be provided (Mala et al. (2017)). Minu et al. (2014) developed a maintenance priority index for 6 sections (HS1 to HS6) of road in Kerala. The various factors that affect the MPI were pavement condition, roughness, traffic characteristics and deflection of pavement. Pavement condition index for each section of road was developed and roughness was calculated based on Bump integrator value. For deflection measurement Benkelman beam was used. Using multiple linear regression analysis, a relationship between pavement roughness and distress were developed. MPI value indicates the need and importance of maintenance in each study section. The various factor considered for MPI calculation is given in Table 3. Each priority value was multiplied by its weightage and the summation of all the factors gives the MPI value of each road section. A more comprehensive index called Modified Maintenance Priority Index

(MMPI) was proposed by Avinash et al. (2014) in which, Road condition index was formulated considering Deflection index (BBD) and Roughness Index Values (MERLIN). This RCI value along with the strain ratio obtained from KENLAYER software is used for calculation of MMPI. MMPI value gives a better prioritization of road section than Maintenance Priority Index.

**Table 3: Factors and their importance (source: Pk et al. 2014)**

| Factors | Weightage |
|---|---|
| Traffic | 0.52 |
| Structural condition | 0.27 |
| Functional condition | 0.15 |
| Land use | 0.06 |

Ali et al. (2021) studied a road section in the city of St. John's, Newfoundland and the International Roughness Index (IRI), Present Serviceability Rating (PSR), and Pavement Condition Index (PCI) of roads were determined. IRI values were calculated using a smartphone software called Totalpave. The ASTM International D6433-18 standard was used to calculate PCI, and questionnaires were issued to the drivers to determine PSR. Correlation analysis using SPSS software shows that PCI AND IRI values are negatively correlated with high correlation coefficient, whereas IRI and PSR doesn’t provide a good correlation which may be because of the subjective evaluation method adopted. If one of the performance indices is known, it can be used to find out other 2 indices using IRI-PCIPSR interrelationship model. A similar study was done by Gupta et al. (2020), in which pothole volume prediction model was developed when physical dimension parameters such as mean diameter, maximum depth of parameters were given as input parameters. Non linear regression model was used for analysis and it gives better result than linear regression models.

### 2.4 Application of GIS In Pavement Evaluation

The Pavement Condition Index (PCI) used in the Urban Pavement Management System can be examined objectively and subjectively using GIS. Pearson’s correlation coefficient is used for the evaluation of pavement. Based on that, maps can be created using Arc GIS software. Pearson's correlation is used to show that the findings of the objective and subjective evaluations are similar. A significant connection between the data can be established if correlation coefficient is near to 1. Subjective evaluation provides a better and quicker method of determining PCI value recommended for cities where maintenance is done irregularly. It is a quick and easy technique to assess the pavement and get good results. The use of a GIS application made it easier to visualize the state of the pavement (Pinatt et al., 2020).

Geographic information system (GIS) is a computerized database management system that manages geographically defined data. The capacity to convey information visually, in a way that the user can understand, is a unique benefit over traditional data base management systems that present data in tabular form. For example, the MICRO-PES package is a set of computer applications designed to help Engineers with network level pavement management. Small-scale research was done in this regard to assess the feasibility of using GIS technology within the MICRO-PES environment to meet the districts' need for graphics output capacity. A prototype GIS module was created that allowed the output from the MICRO-PES analysis sub systems to be graphically displayed. The creation of a prototype GIS option for graphically displaying output from current MICRO-PES analysis subsystems is a significant step toward fulfilling the need for graphics output capability across engineering districts. (Paredes et al., 1990) GIS-enhanced PMS can be combined with life-cycle assessment and is intended to improve pavement preservation plans and decision-making processes. The system includes a framework and technique for integrating life-cycle and environmental data to create an accurate pavement deterioration prediction model that can be used to prioritize maintenance and calculate life-cycle costs. The interaction of information technology, represented by GIS, with the pavement management system can be depicted by this model. It enables highway engineers and agencies to formulate future plans in accordance with precise data on road conditions, allowing them to accurately distribute maintenance funds and prevent widespread deterioration of highway infrastructure. (Al-Mansoori et al.2020).

Early diagnosis of road cracks can help with maintenance than expensive repair. "Geotagging" refers to adding geographic identification metadata to images. The method comprises of obtaining GPS data while taking a photo of road surface distress and then linking the photo to a map. The digital map gains attributes as a result of the location disclosure during the geo-tagging of a photo. In this regard, the GIS dataset becomes particularly rich when the road surface distress photographs are revealed. The data from the field, including geo-tagged photographs, is entered into a database using a quick and flexible interface (Fendi et al., 2014). ArcGIS software can be utilized as a decision support tool for road network maintenance. The digital map of the road network, the coordinates of the defect's position, defect kind, picture and size, and other spatial and visual information of the road network were utilized to construct a relational database. The database created in EXCEL programme was transferred into Arc GIS software to make database analysis and querying as well as visual and graphical presentations of findings simpler. It is a quick and cost-effective method for collecting database for road surface monitoring purposes (Rajan et al., 2017).

## III. METHODOLOGY

The study location identified in the present work is 900m long Kollam Ashramam link road stretch. The width of the carriageway is 10m (2 lane of 5m) with shoulder width of 2 to 2.5m. Pavement evaluation is carried out to find the adequacy of the pavement section in terms of structural and functional adequacy.

### 3.1 Field survey and data collection

Manual distress data collection was done to identify various distresses present in the pavement section. As per IRC 82:2015 pavement condition rating can be provided on each homogeneous section selected. The entire road stretch is divided into 3 sections of 300*10 and pavement condition ratings are provided in the scale of 1 to 3. The various distresses considered are cracking, rutting, shoving, ravelling, potholes, patching and settlement. Based on the percentage of each distress present, rating of the distress can be provided as per IRC 82:2015. This is represented in Table 4.

**Table 4: Defects and range of distress (Source IRC 82:2015)**

| Defects (type) | Range of Distress | | |
|---|---|---|---|
| Cracking (%) | >10 | 5 to 10 | <5 |
| Ravelling (%) | >10 | 1 to 10 | <1 |
| Potholes (%) | >1 | 0.1 to 1 | <0.1 |
| Shoving (%) | >1 | 0.1 to 1 | <0.1 |
| Patching (%) | >10 | 1 to 10 | <1 |
| Settlement and Depression (%) | >5 | 1 to 5 | < 1 |
| Rut depth (mm) using 3 m straight edge | >10 | 5 to 10 | <5 |
| Rating | 1 | 1.1 - 2 | 2.1 - 3 |
| Condition | Poor | Fair | Good |

Each distress represented posses its own weightage value (Table 5) that must be multiplied with the rating provided. The Final Rating Value is calculated by taking the average of the Weighted Rating Values of all parameters viz. cracking, ravelling, potholes, shoving, patching, settlement and rut depth.

**Table 5: Weightage given to each distress as per IRC (Source IRC 82:2015)**

| S.No. | Parameter | Weightage (Fixed) (Multiplier Factor) |
|---|---|---|
| 1 | Cracking | 1.00 |
| 2 | Ravelling | 0.75 |
| 3 | Potholes | 0.50 |
| 4 | Shoving | 1.00 |
| 5 | Patching | 0.75 |
| 6 | Settlement | 0.75 |
| 7 | Rut Depth | 1.00 |

### 3.2 International Roughness Index Measurement Using MERLIN

The roughness of the given stretch of road is measured using MERLIN. 200 observations were conducted at regular intervals to gauge the roughness of a section of road. The equipment is placed on the ground for each observation with the wheel in its normal position and the back foot, probe, and stabilizer in contact with the pavement. The location of the pointer on the chart is then noted with a cross in the relevant column, and a cross is also noted in the tally box on the chart to keep track of the total number of observations made.

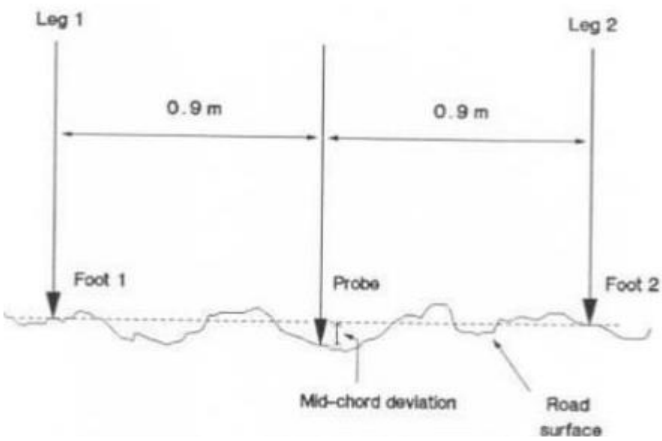


Figure 2: Merlin mid chord deviation(Source:http://www.pavementinteractive.org)

The MERLIN is then advanced to the following sample point, where the procedure is repeated, with the handles lifted so that only the wheel is still in touch with the ground. Although it is not necessary, it is most practical to space the sample places one wheel circumference apart since readings must always be obtained with the wheel in its normal position. The chart is taken out of the MERLIN after the 200 observations have been made. On the chart below the columns, a mark is shown at the intersection of the tenth and eleventh cross, counted in crosses from one end of the distribution. For the other end of the distribution, the process is repeated. It may be necessary to interpolate between column boundaries. The spacing between the two marks, D, is then measured in millimeters. This result is the roughness on the MERLIN scale (Figure 3 and 4).

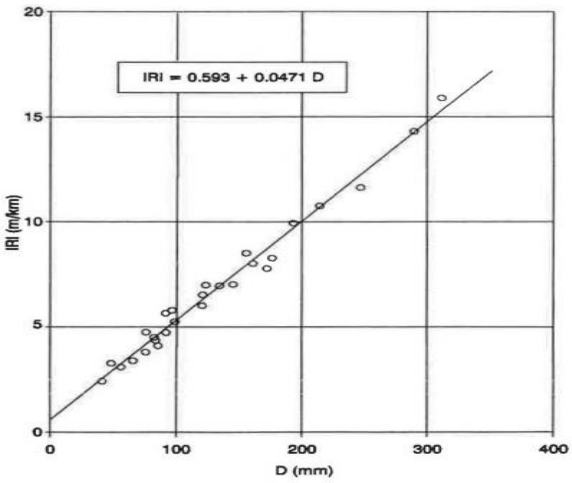


Figure 3: Relation between IRI and D (Source: AIMIL Ltd.)

Figure 4: Measurement using MERLIN

### 3.3 GIS Database For Roadsurface Monitoring

Various distresses in the road segment are measured and their location are identified. Every picture captured for each point includes the geographical identification metadata, such as latitude and longitude. Road distress photographs are first captured without any geographic information, and they are processed afterwards using the GPS data and a dialogue box called "Edit Data" in the GeoSetter programme version 3.4.16. To get the information for each of these photographs, click on it separately after saving it to a folder.

A free application for manipulating digital picture metadata, GeoSetter places a particular focus on geographic information. It has a Google Map function that indicates the location of the photograph. Additionally, editing is possible for EXIF and other picture data. In the GeoSetter main window, the picture has to be chosen in order to make changes to its data.

GeoSetter interface is split into two sections. An embedded Google Map on the right allows viewing geo-tagged photos as graphics on the GIS map, while file browser and image preview windows are located on the left. A comprehensive settings page with 10 tabs for setting up File Options, Camera, Start-up, Exif Tool, and other options is also displayed when the software first launches.

The ability to see the precise place where a photo was taken on a map is known as geo-tagging. Additionally, it enables searching for images shot at or close to a specific area. Additionally, it is possible to trace a route on a certain day, which might enhance local government's future management of pavement distresses.

### 3.4 Proposed Pavement Design

Based on the traffic data available from the PWD department Kollam on the given road stretch, pavement can be designed as per IRC 37:2018. The steps adopted are as follows

#### 3.4.1 Cumulative number of Million Standard Axles

Design traffic considers mixed vehicular traffic in terms of Cumulative Number of Standard Axles (8160 kg) to be carried by the pavement during the design life. For estimating design traffic, the following information is needed

- Initial traffic after construction in terms of number of Commercial Vehicles Per Day (CVPD).
- Traffic Growth Rate during the design life in percentage
- Design Life in number of years
- Vehicle Damage Factor (VDF)
- Distribution of Commercial Traffic over the carriageway

***Initial Traffic***

Estimation of initial daily average traffic for any road should normally be based on at least 7days, 24 hour classified traffic counts. In case of new roads, traffic estimates shall be made on the basis of potential land use and traffic on existing routes in the area

***Traffic Growth Rate***

Traffic growth rates should be estimated by-

- Studying the past trends of traffic growth and
- Establishing economic models, as per the procedure outlined in IRC 108" Guidelines for the traffic Prediction on Rural Highways"

***Design Life***

For the design of pavement, the design life is defined in terms of the cumulative number of standard axles that can be carried before strengthening of the pavement is necessary. IRC 37-2018 recommended that the pavements for National Highways and State Highways should be designed for a life of 15 years.

***Vehicle Damage Factor***

The Vehicle Damage Factor (VDF) is a multiplier to convert the number of commercial vehicles of different axle loads and axle configuration to the number of standard axle load repetitions. It is defined as equivalent number of standard axles per commercial vehicle.

***Distribution of Commercial Traffic over the Carriageway***

A realistic assessment of distribution of commercial traffic by direction and by lane is necessary as it directly affects the total equivalent standard axle load applications used in the design. In the absence of adequate and conclusive data for Indian conditions, distribution factor as recommended in IRC 37-2018 is considered for pavement design.

***Design California Bearing Ratio (CBR)***

The selected bearing ratio used to design the pavement. It is based on a statistical evaluation of the CBR test results on the soil samples.

***Lane Distribution Factor***

As per IRC 37:2018, Lane distribution factor for 2 lane divided carriageway is 50%

Based on the above said parameters the design traffic in terms of CMSA is computed for a design period 15 years.

$N=365*\{(1+r)\ n-1\}\ *A*D*(F/r)$

Where,

N=The cumulative number of standard axle to be catered for in design in terms of MSA

A=Initial traffic in the year of completion of construction in CVPD

D=Lane distribution and Directional distribution factor

F=Vehicle Damaging factor

n=Design life in years

r=Annual growth rate of commercial vehicles

The traffic in the year of completion is estimated using the formula

**$A=P(1+r/100)^{x}$**

Where

P=Number of commercial vehicles as per count

X=Number of year between the count and the year of completion of construction=1

## IV. RESULT AND DISCUSSION

### 4.1 Pavement Condition Rating

The entire region is divided into 3 sections of 300*10 m. The various distresses identified in the section are alligator cracking, rutting, potholes, transverse and longitudinal cracks, Patch works, Ravelling etc. The percentage of each distress in each section is represented in the tables below.

Table 6 : Final rating value of section 1

| DISTRESS TYPE | INPUT(%) | RATING | WEIGHTAGE | WEIGHTED RATING VALUE |
|---|---|---|---|---|
| Cracking | 0.2 | 2.1 | 1.0 | 2.1 |
| Ravelling | 0.4 | 2.1 | 0.75 | 1.5 |
| Potholes | 0.02 | 2.1 | .5 | 1.05 |
| Shoving | 0 | 3 | 1 | 3 |
| Patching | 1.6 | 1.5 | 0.75 | 1.125 |
| Settlement | 0.2 | 2 | 0.75 | 1.5 |
| Rutdepth | | 2 | 1 | 2 |
| | | | rating | 1.7 |

Table 7: Rating of section 2

| DISTRESS TYPE | INPUT(%) | RATING | WEIGHTAGE | WEIGHTED RATING VALUE |
|---|---|---|---|---|
| Cracking | 0.3 | 2.1 | 1 | 2.1 |
| Ravelling | 0.2 | 2.1 | 0.75 | 1.5 |
| Potholes | 0.11 | 1.2 | 0.5 | 0.6 |
| Shoving | 0 | 3 | 1 | 3 |
| Patching | 2.7 | 1.1 | 0.75 | 0.825 |
| Settlement | 1 | 2.1 | 0.75 | 1.6 |
| Rutdepth | | 1 | 1 | 1 |
| | | | rating | 1.5 |

Table 8: Rating of the section 3

| DISTRESS TYPE | INPUT(%) | RATING | WEIGHTAGE | WEIGHTED RATING VALUE |
|---|---|---|---|---|
| Cracking | 2.5 | 1.2 | 1 | 1.2 |
| Ravelling | 0.1 | 2.1 | 0.75 | 1.5 |
| Potholes | 0.03 | 2.1 | 0.5 | 1.05 |
| Shoving | 0 | 3 | 1 | 3 |
| Patching | 0.6 | 2.1 | 0.75 | 1.57 |
| Settlement | 0 | 3 | 0.75 | 2.25 |
| Rutdepth | | 2.1 | 1 | 2.1 |
| | | | rating | 1.8 |

Final rating of the entire stretch of road section= (1.5+1.7+1.8)/3= 1.6

As per IRC 82 the pavement section is under fair condition but requires maintenance. The middle section of the pavement i.e. 300 to 600m stretch possess less pavement condition rating compared to the other sections. This can be due to the poor drainage facility in the region and effect of the water body adjacent to the section. Compared to other section this region has more number of patch works and maintenance activities. Also rutting in this region is more compared to the other regions representing poor load bearing capacity of the pavement section.

**4.2 IRI using MERLIN**

The position mid-way between tenth and eleventh crosses counted from each end of distribution is marked below the chart as D (Figure 5). It is measured in millimeter scale and this is the roughness on MERLIN scale.

D =16 *5 = 80mm

IRI = 0.593+0.0471*D = 4.361m/km

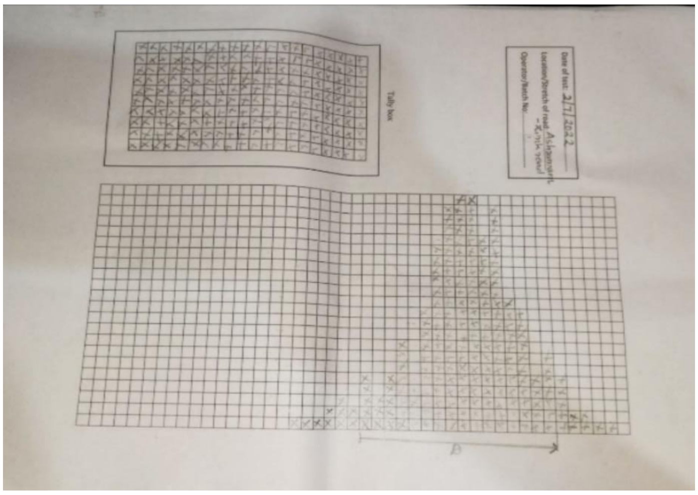

Figure 5: Specimen result

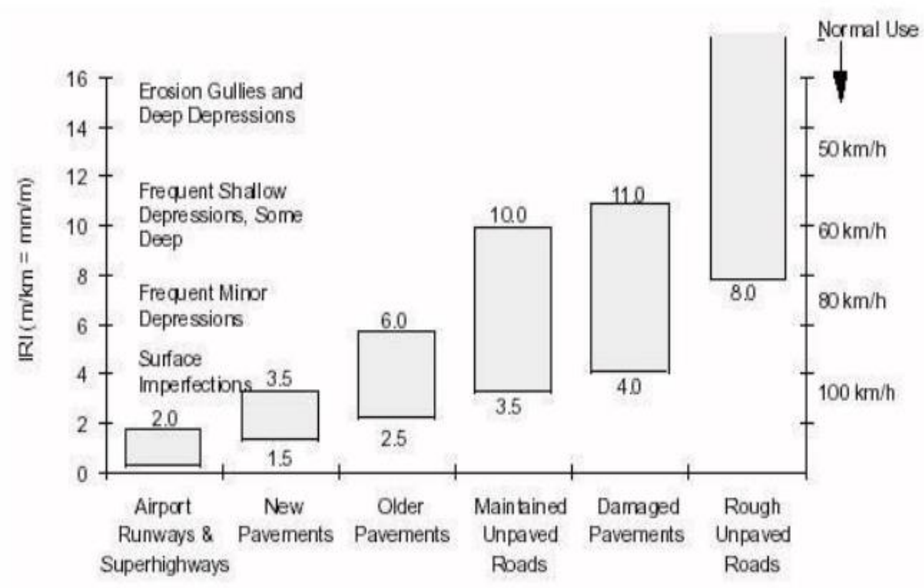


Figure 6: Range of roughness value (Source: AIMIL Ltd)

Since the IRI value is above 4, it can be inferred that the pavement is under damaged condition (Figure 6).

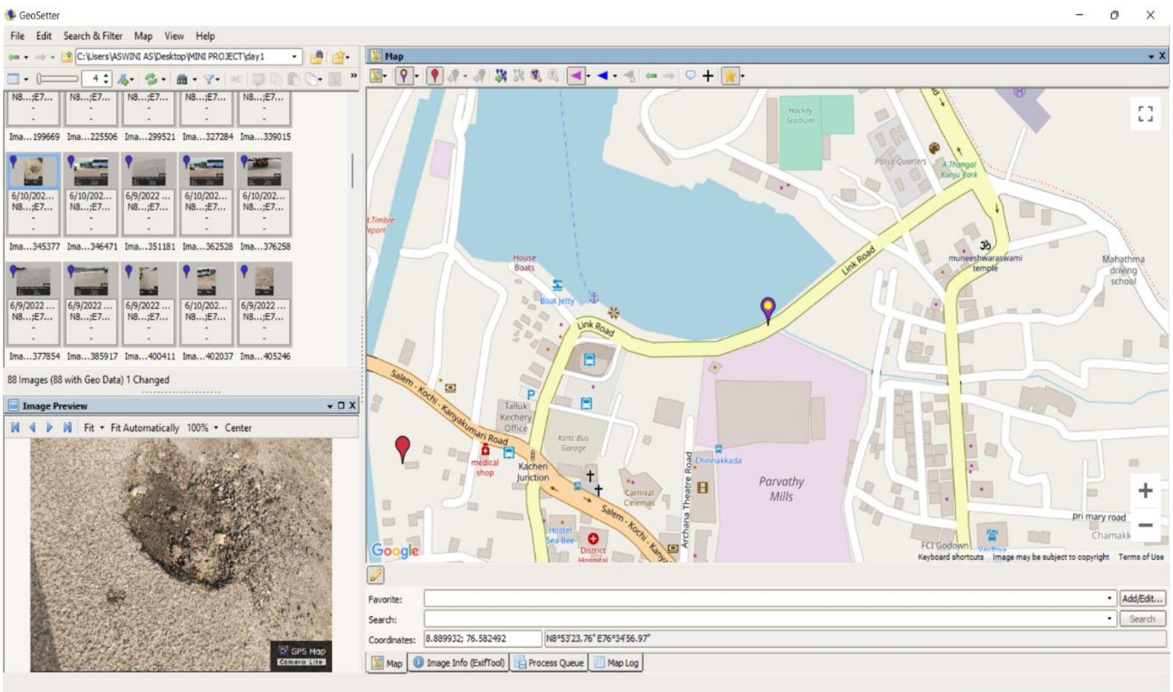


Figure 7: Representation of a single distress using Geosetter

With the help of geosetter location of each distress can be identified and it can be geotagged as shown in Figure 7 and Figure 8.

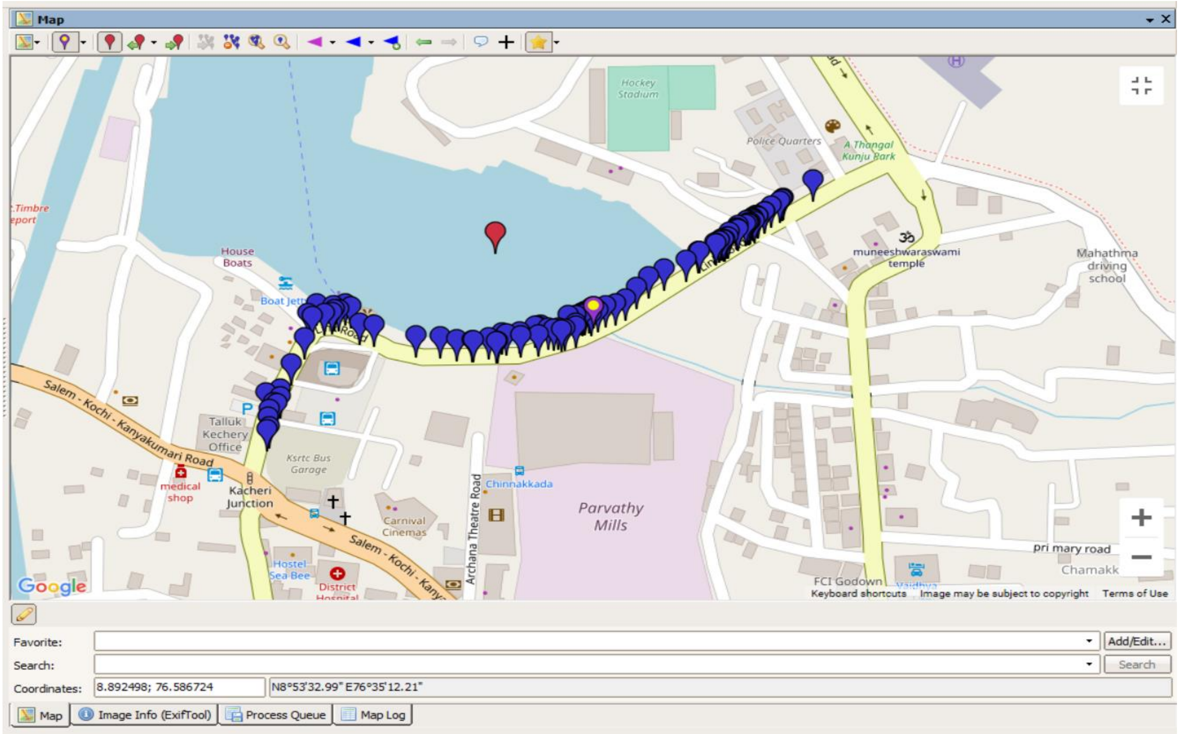


Figure 8: Representation of distress on entire stretch of road.

### 4.3 Proposed Pavement Design Thickness

#### 4.3.1 Computation of design traffic

As per IRC 37:2018, Design traffic in terms of cumulative number of standard axles is represented as

$$N = 365\times[(1+r)^{n}-1]/r \times A \times D \times F$$

Where,

N= cumulative number of standard axle

r: Growth rate=6%

D: Lane distribution factor=50%(For two lane)

F: Vehicle damage factor=3.9

A: Initial traffic in CVPD in year of completion of construction.

n: Design period =15 years

Therefore from the traffic survey data for 7days (24hr) from PWD department kollam, we can calculate the N value for 15 years as 19.9 msa. From the previous studies conducted on the road section ,it is clear that the road is build over a marshy land with zero N value .Hence taking that into consideration we can provide a CBR value of 5% for the section as it is the lowest value specified by the code.

For 20 MSA and 5% CBR pavement thickness to be provided as per Plate 1 of IRC 37: 2018.


Figure 9: Pavement thickness as per IRC (Source IRC 37:2018)

Table 9: Design pavement thickness

| DESIGN PAVEMENT THICKNESS | | | | | |
|---|---|---|---|---|---|
| ROAD NAME | CBR | MSA | BC | DBM | WMM |
| ASRAMOM LINK ROAD | 5% | 20 | 40 | 105 | 250 |

## V. CONCLUSION

In this study the entire road stretch is divided into 3 sections and distresses in each section is identified. From the distress calculated Pavement Condition Rating of each section is founded. Later the serviceability of the section is found out by evaluating the IRI value of the pavement using MERLIN. All the distresses identified were plotted on the map using geosetter software. It helps in geotagging of the distresses and helps in future comparison. Also, based on the Traffic data available a pavement design model was also proposed. From the functional evaluation of pavement it is found that the entire road stretch possess considerable amount of pavement distresses. The most prominent form of distress present is alligator cracking. Section 3 possess highest amount of alligator cracking. This may be due to more traffic in this region and turning movement of vehicle is more in this region. Among the 3 subsections of the pavement, Section 2 has the least pavement condition rating. This can be due to the proximity of the pavement to the lake. Overall condition of the pavement is Fair but serviceability of the section is poor. The possible cause of fatigue failure in pavement is excessive traffic load due to heavy trucks and buses. Similarly the main cause of distresses such as potholes, patches, edge and block cracks are improper construction or poor maintenance and poor drainage. Ravelling and polished aggregates are formed due to the excessive traffic condition. The longitudinal and cross drains need attention under routine maintenance. The percentage of patch works done on the pavement is high compared to other distresses, this shows that the pavement has undergone frequent maintenance works. But even after frequent maintenance activities the pavement continues to show distresses which may be due to structural deficiency of the pavement.

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