

PERFORMANCE EVALUATION OF PAVEMENT ROUGHNESS- A CASE STUDY

Sandhya.M¹, Divya.P², Sreekala.M³, Haritha.K⁴, Purnachand.M⁵, Kishor.S⁶

¹Assistant Professor, Faculty of Civil Engineering, GEC College, India

²⁻⁶Student, Dept. of CIVIL, GEC College, India.

¹⁻⁶Dept. of Civil Engineering, Gudlavalleru Engineering College, Andhra Pradesh, India.

Abstract - An India has a large network of roads of length over 5 million kilometers, consisting of different categories of roads. The maintenance and management of such large road network with limited resources is a demanding task in emerging economics like India. The road users expect the performance of these road infrastructures to be above the desired level during the service life. The road authorities expect this performance to be achieved within the limited resources. This contradicting inevitability makes the problem quite interesting and challenging. In the present study, the selected road networks were investigated for International Roughness Index (IRI) and Roughness Index (RI) using machine of evaluating roughness using low-cost instrumentation (MERLIN). This method will measure the pavement condition Index (PCI) and used to evaluate the pavement international roughness index (IRI) and to decide the order of maintenance priority for the selected road networks based on the condition rating. For stretch-1 from Gudlavalleru to Chitram, IRI is 7.2 m/km and condition rating is 40% so we suggested to design the overlay and for stretch-2, from Gudlavalleru to Penjandra IRI is 6.9 m/km and condition rating is 90% so we suggested for good maintenance.

KeyWords: Pavement roughness, International roughness index, Roughness index, Pavement condition rating.

1. INTRODUCTION

- **Road roughness:** is the result of either the built-in-irregularities due to construction defects/deficiencies or it may also appear on the road surface due to the consolidation or displacement of different materials placed within the pavement structure due to traffic movement.
- **Roughness Index:** the pavement surface roughness is expressed as unevenness or roughness index (mm/km).
- **International Roughness Index:** It is the reference average rectified slope, which expresses the ratio of the accumulated suspension motion of a vehicle, divided by the distance travelled during the test. The recommended unit of IRI is m/km.

1.1 General Maintenance

Road maintenance is an important activity for safety and convenience of traffic using the road are governed to a large extent by the quality of maintenance. The operation economics of road transport is influenced by the degree of maintenance imparted to the road. The life of asset can be preserved and prolonged if adequate maintenance measures are under taken in a proper time in developing countries ,stage construction of payments is often resorted to with lesser pavement thickness and lower specifications that needed to the full design the proper maintenance of the road ,therefore assume greater significant in such situations .The financial resources at the command of maintenance engineer all always short of demand ,and it becomes to utilize the same in the most indicious manner, applying the best engineering practices and managerial skills

1.2 Types of Road Maintenance

Pavement preservation is a main focus of most municipal departments dealing with keeping the roadways intact. There are three main types of road maintenance.

- Emergency road maintenance.
- Reactive road maintenance.
- Preventative road maintenance.

1.3 What is Pavement Condition Index:

The PCI is a numerical indicator that rates the general surface condition of a pavement or road. It is a statically measure which requires manual / visual inspection and survey of the required roads.

Generally, failure of road pavement occurs because of following reasons:

1. Use of substandard material
2. Low bearing capacity of sub strata
3. Improper or no provision of drainage
4. Improper supervision at site
5. Faulty workmanship

For measuring PCI we have to identify the different types of cracks some of the cracks which we identify are given below.

Different types of cracks for flexible pavements:

- Crocodile cracking
- Longitudinal cracking
- Transverse cracking
- Edge break cracking
- Potholes& patching
- Reflection cracking
- Slippage cracking
- Block cracking
- Depression cracking
- Rutting cracking

2. METHODOLOGY

2.1 PAVEMENT CONDITION RATING:

- A number of previous studies have been done to quantify and assess the pavement cracks. Some Departments of Highways have also contributed to this rating previously, to get information about the pavement condition, the road agencies developed different methods of surveying of the pavement condition. The Asphalt Institute’s publication provides a system to inspect a road, rate it, and interpret the results such as the type of distress, the extent of the distress, and its relative seriousness. In this procedure, a numerical value is assigned to each type of pavement distress considering the extent of distress and its relative seriousness. Lower values are assigned to less serious problems and higher values to more serious problems. A rating of zero indicates that the pavement is relatively free of defects. A rating of 5 or 10 would indicate serious distress. After each defect has been noted and rated, the sum of these individual ratings provides a fairly accurate, though subjective, index of the general condition of the paved surface. The sum is then subtracted from 100 and the result is known as the condition rating for that particular section of the road. It is important that pavements are evaluated in a consistent manner. According to Asphalt Institute design guide, manual scale for rating pavement by number and lengths are shown in table.

| Length of Cracks Per 100 | Rating | Number of Cracks Per 100 | Rating |
|--------------------------|--------|--------------------------|--------|
| 0-1 | 1 | 1 | 1 |
| 1-2 | 2 | 2 | 2 |
| 2-3 | 3 | 3 | 3 |
| 3-5 | 4 | 4,5 | 4 |
| >5 | 5 | >5 | 5 |

The condition rating provides a rational method for ranking paved streets or facilities according to their condition and a general indicator of the type and degree of repair work necessary. As a very general rule, if the condition rating is between 80 and 100, normal maintenance operations such as crack sealing, pot hole repair, or perhaps surface treatment are usually all that is required. If the condition rating falls below 80, it is likely that an overlay will be necessary. If the condition rating is below 30, chances are that major reconstruction is necessary.

2.2 MERLIN

2.2.1 Principle of Operation

Merlin is a device with a probe and two feet which rests on the surface with course of wheel track whose roughness by this device is to be measured. This device is at 1.8 meters separated and the probe lies at the mid-path between two feet. At the contact of road surface and the two feet this instrument measures the vertical relocation between the way surface and the focal point. The measured vertical relocation is called as the mid-harmony deviation.

For determination of roughness of road surface profile, 200 estimations at consistent interims is to taken. The machine is situated with the wheels on its ordinary location and the back foot stabilizer probe in touch with the asphalt surface at each one measuring point. At that point the recording the position of the arm pointer on the graph with a cross in suitable section is carried out by the administrator. For keeping the record of aggregate number of readings, cross in the count box of chart is given.

For the further system of estimations the Merlin's handles are lifted up so that just the wheel stays in touch with the way surface and the machine is rolled in forward heading at the same methodology is rehashed. As long as the wheel is in the typical position the dividing between the measuring focuses does not make a difference. By taking the estimations at standard interims, will help in transforming both great normal specimens over the entire length of the area and decrease the danger of inclination because of the propensity of administrator to keep away from terrible areas of the street.

The chart is removed from the Merlin after 200 observations. Mid path between the eleventh and the tenth checking from each one end of the diagram underneath the columns as given in the sample frequently it may be important to insert between segment limits. "D" is the dividing between the two imprints is measured in millimeters and it’s characterized as the roughness on the Merlin scale.

3. DATA COLECTION

Condition Rating = 90

General This report gives the street harshness esteem in IRI scale by utilizing MERLIN instruments. By the utilization of merlin .By the utilization of merlin on 2 roads

Site1 length – **1.7km**, Site2 length - **2.3km**

The IRI scale and the Merlin scale are related by the following equation

For all type of pavement surface:

$$IRI=0.593+0.0471D$$

$$42 < D < 312 \quad (2.4 < IRI < 15.9)$$

IRI= International Roughness Index in m/km

D=roughness in Merlin scale measured in mm

Reading for site 1:

The value of D = 13 Divisions

$$= 13 * 10 \text{ mm}$$

$$= 130\text{mm}$$

Where: [D =Roughness on Merlin scale]

$$[1 \text{ Division} = 10\text{mm}]$$

$$[42 < D < 312]$$

Calculation of international Road Index (IRI):

$$IRI = 0.593 + 0.0471 D$$

$$= 0.593 + 0.0471 * 130$$

$$= \mathbf{6.716 \text{ m/km}}$$

$$[2.4 < IRI < 15.9]$$

Similarly readings were taken for 2 roads.

Site 1: Condition rating= 100- Sum of defects

$$= 100 - 60$$

$$= 40$$

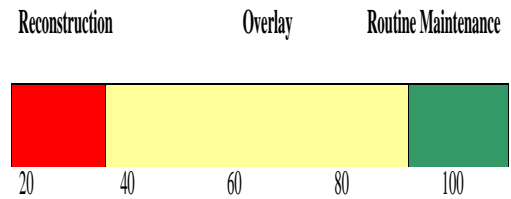
Condition Rating = 40

Similarly reading were taken for site2

Site 2: Condition rating= 100- Sum of defects

$$= 100 - 10$$

$$= 90$$



| Route: GUDLLAVALLERU to CHITRAM Length of Road: 1700 m Pavement Type: Flexible Pavement | | | | |
|---|--|--------------|-------|--------------|
| INTERVAL | DEFECTS | NO.OF CRACKS | RANGE | RATING |
| 1-100 | SLIPPAGES EDGE RUTTING POTHOLE DEPRESSIO NS LONGITUDI NAL | 11 | 0-10 | 5 |
| 100-200 | | 6 | 0-07 | 4 |
| 200-300 | | 4 | 0-07 | 4 |
| 300-400 | | 10 | 0-07 | 4 |
| 400-500 | | 4 | 0-07 | 4 |
| 500-600 | | 4 | 0-07 | 4 |
| 600-700 | | 5 | 0-07 | 4 |
| 700-800 | | 4 | 0-07 | 4 |
| 800-900 | | 5 | 0-07 | 4 |
| 900-1000 | | 4 | 0-05 | 2 |
| 1000-1100 | | 4 | 0-05 | 2 |
| 1100-1200 | | 5 | 0-05 | 3 |
| 1200-1300 | | 5 | 0-07 | 4 |
| 1300-1400 | | 4 | 0-05 | 2 |
| 1400-1500 | | 3 | 0-05 | 2 |
| 1500-1600 | | 4 | 0-07 | 4 |
| 1600-1700 | 4 | 0-07 | 4 | |
| SUM OF DEFECTS | | | | X= 60 |

Table 1: Pavement Condition Rating

4. RESULTS:

| SITE | CHAINAGE (1.8M) | IRI (M/KM) | AVERAGE IRI | PAVEMENT CONDITION RATING | REMARK |
|-------|-----------------|------------|-------------|---------------------------|------------------|
| Site1 | 1-200 | 6.716 | 7.3 m/km | 40% | Design overlay |
| | 201-400 | 7.187 | | | |
| | 401-600 | 6.716 | | | |
| | 601-800 | 7.187 | | | |
| | 800-1200 | 8.6 | | | |
| Site2 | 1-200 | 7.187 | 6.9 m/km | 90% | Good Maintenance |
| | 201-400 | 6.00 | | | |
| | 401-600 | 7.694 | | | |
| | 601-800 | 7.694 | | | |
| | 801-1200 | 6.481 | | | |
| | 1201-1400 | 7.158 | | | |

5. CONCLUSIONS:

Merlin cycle is normally considered to be simple devices for the measurement of road roughness. An attempt has been made in this study to pavement roughness and condition. Experiments have been carried out using this device. The results of the experiments on road roughness in terms of IRI and PCI using these devices have been considered.

- The result of the experiment condition rating for site-1 is 40
- The result of the experiment condition rating for site-2 is 90
- The results of the experiment site 1 gives the redesign the overlay for the average IRI of 7.3m/km and for Site - 2 gives the good maintenance work to the pavement for the average IRI of 6.9m/km

5.1 FUTURE SCOPE:

It is proposed that the following works using this new device can be taken up in future.

- A good number of experiments using these experiment are to be conducted **and** the results to be statistically reviewed and compared.
- The device is to be further modified to suit various roughness conditions.
- The same stretches should be tested for roughness by using other roughness measuring methods such as bump

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