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STUDY OF FLEXIBLE PAVEMENT DISTRESSES ON NATIONAL HIGHWAY-146 (BHOPAL TO SAGAR)

[1]Y. Namdev, [2]Dr. P. Purohit, [3]Dr. R. Mehar
[1]M.E. Scholar, [2]Associate Professor, [3]Assistant Professor
[1]Department of Civil Engineering, Samrat Ashok Technological Institute, Vidisha, M.P.

Abstract: A study was conducted on the NH-146 Bhopal-Sagar National Highway to assess the pavement quality and distress type using the Pavement Condition Index (PCI). A study of flexible pavement distress has been conducted on the NH-146 Bhopal-Sagar National Highway for 1.0 km from Agarwal Restaurant to Asha Ramji Ashram towards Bhopal. The PCI is a quantitative and qualitative assessment based on visual inspection, classified in natural numbers between 0 and 100. The study aimed to investigate typical failures of flexible pavement under the Vidisha City Corporation area and NHAI. This methodology is a prominent tool for road management and life-cost analysis. The results showed that the PCI values are high at some chains for all distress. For alligator cracks, rehabilitation is required on the top layer and a proper additional surface course is needed with a fresh layer of bitumen as per design and quality standards. This may be economical then by providing the overlay for the whole pavement. Potholes, it can be covered by premix material after cleaning and painted with the bituminous binder. Patches are the one kind of improvement for the pavement. An entire damaged area is selected and covered/filled with a fresh layer of bitumen. So, it can be economical as compared to demolishing the whole pavement ground. The Total maintenance cost of the 1km stretch is 198509.04 Indian Rupees.

Index Terms **- AASTHO, Corrected Deduct Value, Deduct Value, Pavement Condition Index, Pavement, Maintenance Programs, Department of Transportation**

I. INTRODUCTION

Roads are public thoroughfares used for vehicles, people, and animals. Before the invention of motorized vehicles, people relied on animal-drawn carriages, which had fewer traffic requirements. This led to the need to assess pavements and refine materials and construction methods. Flexible pavements consist of layers of natural granular material covered by waterproof bituminous surface layers, designed for a 15-year design life. [1] These pavements can be redesigned with a thin bituminous resurfacing layer. Pavement performance is crucial for determining the rehabilitation needs of existing sections. Two types of indices are employed in the current pavement evaluation process: individual indices for project level and combined indices for network level. At the project level, specific information on the pavement section's distress roughness and structural capacity is required. At the network level, composite indices define priorities for project strategy selection. [3] Integrated indices for pavement performance metrics include the existing serviceability index, the pavement condition index specified in PAVER, reflective cracking, and the international roughness index (IRI). The overall pavement index is a total aggregate of various pavement condition metrics, applying weighting factors to each measure.[5] However, the outcomes of the evaluation are subjective due to different interpretations and perspectives. The observed surface distress determines the pavement condition index (PCI) rating, which is an objective technique for evaluating a highway section's maintenance and regeneration (M-and-R) demands in relation to the entire pavement system. PCI has various uses and benefits, including identifying the need for immediate M-and-R of roads, constructing road networks, planning preventative maintenance programmers and budgets, and evaluating pavement materials and designs.[7]

II. PAVEMENT CONDITION INDEX (PCI)

PCI is a numerical rating of the pavement condition based on the type and severity of distresses observed on the pavement surface. The PCI value of the pavement condition is represented by a numerical index between 0 and 100, where 0 is the worst possible condition and 100 is the best possible condition. The PCI history of a pavement section can help establish its rate of deterioration and identify future major rehabilitation needs. PCI values are also used in prioritizing, funding and executing Maintenance and Rehabilitation (M&R) on the pavement section. PCI following the procedures defined in “ASTM D5340 Standard Test Method for Airport Pavement Condition Index Surveys” and “ASTM D6433 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys. IRC Code 82:2015 for the maintains of Bituminous Concrete Road. [8],[9],[10]

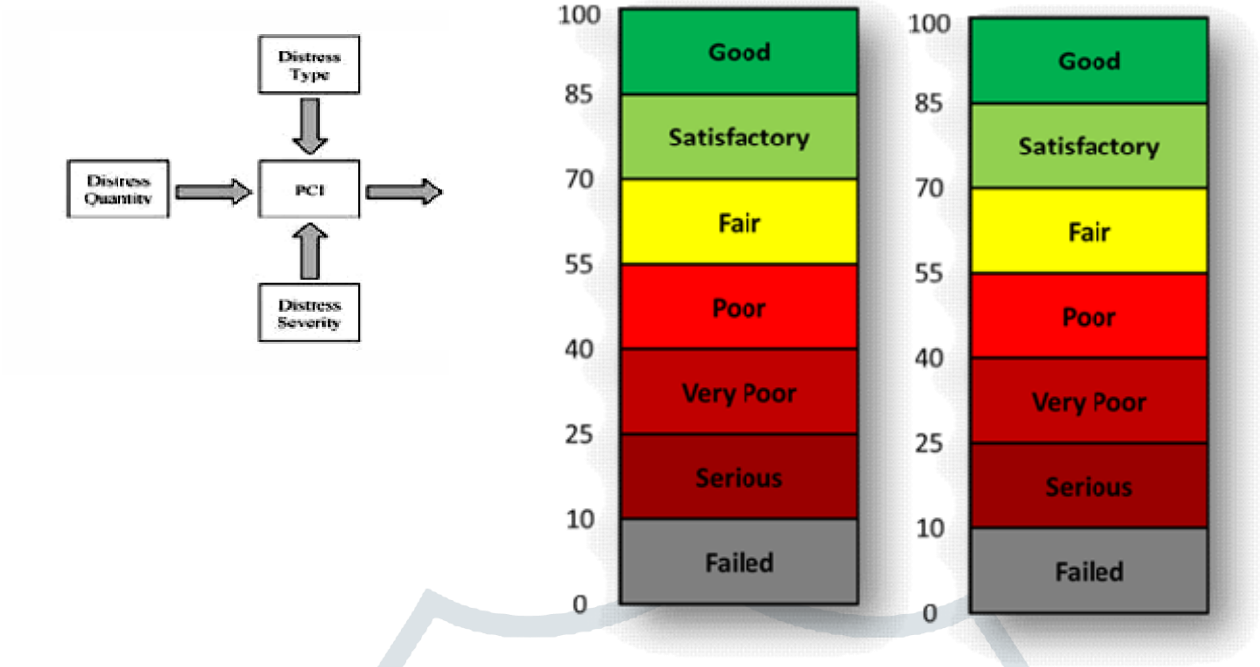

Figure 1 Pavement Condition Index

PCI is a numeric index that rates the surface condition of the pavement from 0 to 100, where 0 it's poor condition and the 100 the best possible condition (ASTM – D5340, 2011).

$$PCI_s = PCI_r = \frac{\sum_{i=1}^{n}(PCI_{ri} \cdot A_{ri})}{\sum_{i=1}^{n} A_{ri}}$$

Where: -
PCIr Area weighted PCI of randomly surveyed sample units;
PCIri- PCI of random sample unit
Ari - Area of random sample unit I;
n - Total number of sample unit surveyed

III. OBJECTIVE OF THE STUDY: -

a) To investigate the typical failures & Distress of flexible pavement of NH-146 from Bhopal to Sagar.
b) To review the causes and remedies to upgrade the serviceability of the flexible pavement on NH-146 from Bhopal to Sagar.
c) Analysis all types of distress and suggests a remedy measure.

IV. SCOPE OF THE RESEARCH

This research study is about identifying defects and cracks in roads as well as maintaining a case study on NH-146 from Bhopal to Sagar. The study spot is near Vidisha on the bypass road from Agrawal Restaurant to Asharamji Asharam (1km) stretch. By visiting the site and doing a thorough assessment, the most commonly occurring forms of cracks and faults on the stretch have been considered in the study. The causes of pavement faults are investigated, and then for each type of fracture, an inventory has been developed in ch-3 to calculate the PCI index (ch-4), and the maintenance cost has been calculated.

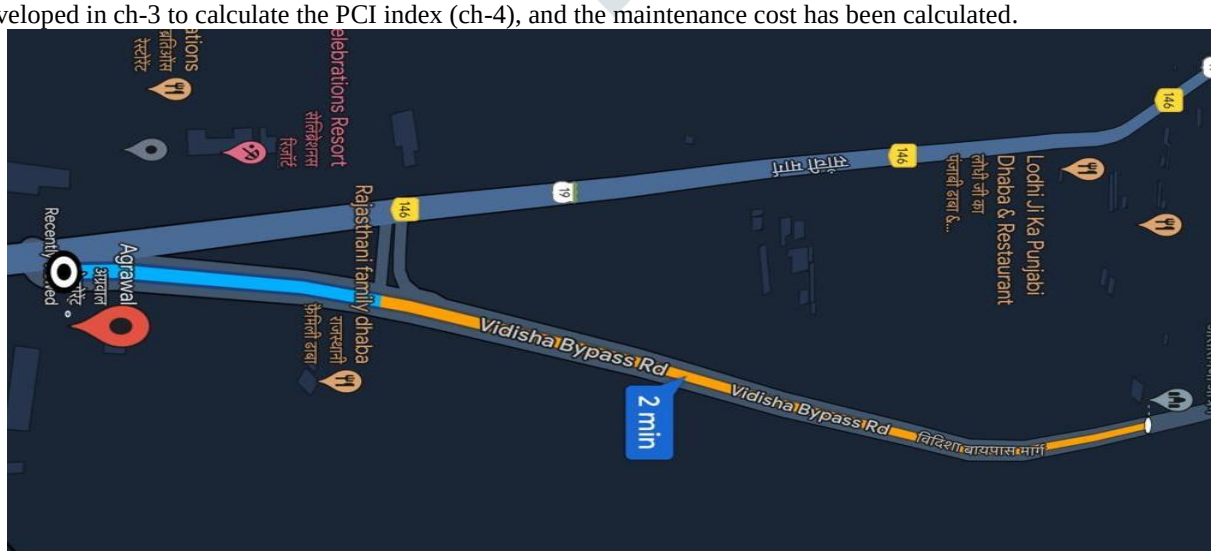

Figure 2 Map Showing Project Location

V. LITERATURE REVIEW

Fatma Sarie, Mohammad Bisri (2015) The pavement failure problems are caused due to several factors such as the water stagnation problems, traffic, the condition of the sub grade, climate, the poor-quality material, and problems of compaction. This study classified the typeof road pavement damages for the road under the case study. The type of road damages in the case study are depressions, hair cracks, edge cracks, Revelling and alligator cracks, potholes. Road repairs have been done but the damage occurs because of the rain that falls on the surface of road pavement and does not flow into the drainage channel in the vicinity due tothe elevation of the road. The land next to the road does not allow rainwater to flow into the drainage channels, this leads to flooding of water at the edge of the road and enter through the cracks are beginning to occur and becoming more severe because it is not addressed immediately. [1]

Arnold et al. Assessed and commented that 30% to 70% of surface rutting is attributed tothe unbound granular material layers. They added that the available natural materials can, however, be assessed for their suitability for use in a pavement by considering performance criteria such as resistance to permanent deformation and degradation instead of relying on compliance with inflexible specifications.[2]

Dar-Hao chen, Moon Won, (2007) Field investigations of cracking on concrete pavement Investigations were performed to classify the nature of the mechanism(s) that were conscientious for asymmetrical Longitudinal Cracking in some concrete pavement.[3]

T.S.Vepa, K.P.George,(1997). Deflection Response Models for Cracked Rigid Pavements The static elastic layer model is normally used for evaluate deflection measurements and back calculate pavement layer moduli. Although the fact thatthe falling weight deflector meter (FWD) load induces a dynamic load, dynamic impact analysis routines are seldom.[4]

Jacob Hiller, Jeffery Roessler, (2008) Location and Timing of Fatigue Cracks on Jointed Plain Concrete Pavements**.** The calculation of fatigue cracking in jointed concrete pavements has usually alert on transverse cracking instigate from the bottom of the slab and spread both up and across the slab width [5]

Samy Mezhoud et.al, (2016) Field Investigations on Injection Method for Sealing Longitudinal Reflective Cracks Forensic investigation of Causes of premature longitudinal cracking in a newly constructed highway with composite pavement system. A compoundpavement is a multilayer structure where an uppermost layer is located over a rigid layer [6]

R.Christopher Williams, et. al, (2015) Assessment of Composite Pavement Performance by Survival Analysis Assessment of Composite pavement Performance by Survival analysis. Classify the most proper rehabilitation technique for composite pavements and to calculate three pavement performance displays: reflective cracking, international roughness index (IRI), and pavement condition index (PCI).[7]

VI. METHODOLOGY

This test method envelops the determination of road pavement condition through visual surveys of Distress, and Flexible pavement, using the Pavement Condition Index (PCI) method of measure pavement condition. The PCI evaluate is recorded manually by a visual evaluation survey walking above every 10m Chainage of the sample unit, recording and drawing all distresses existing in the Chainage along their severity level on the data sheet. The PCI is a subjective method in terms of evaluate the structural and functional condition of the pavement as it not either measures the bearing capacity, nor quantities the measure of surface characteristics but gives feedback on pavement conduct for authentication or improvement of current pavement design and conservation procedures. Data sheet, or other field recording instruments that record at a minimum the following information: date, location, branch, section, sample unit size, Chainage no. and size, distress types, severity levels quantities and name of surveyors. A study of flexible pavement distress has been conducted on the NH-146 BhopalSagar National Highway for 1.0 km from Agrawal Restaurant to Asha Ramji Asharam Bhopal to Sagar.

VII. RESULTS

For distresses analysis of the road using pavement condition index (PCI) evaluate is recorded manually by a visual evaluation survey walking above each slab of the sample unit, recording and drawing all distresses existing in the slab along their severity level on the data sheet. In the given we do survey on of 1km section on the NH146 road and identify the crack and measure the cracks and find the PCI Value. The PCI Value are of different cracks are as follow:

Table 1 Represents the PCI Value of Different Cracks

PCI INDEX VALUE																				
Chainage No.	Reveling		Slippage		Pothole		Longitudinal Crack		Alligator Crack		Shoving		Rutting		Block Crack		Edge Crack		Transverse Crack	
	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R
0-10	58	58							-											
10-20	58																			
20-30	94							76												
30-40					28															
40-50		90																		
50-60	78	24																		
60-70	78	24																		
70-80																				
80-90							15													
90-100							21													
100-110					42															

110-120							75												
120-130										24									
130-140						42													
140-150								32			48								
150-160											55	48							
160-170														28					
170-180														36					
180-190																			
190-200																			
200-210						18	57												

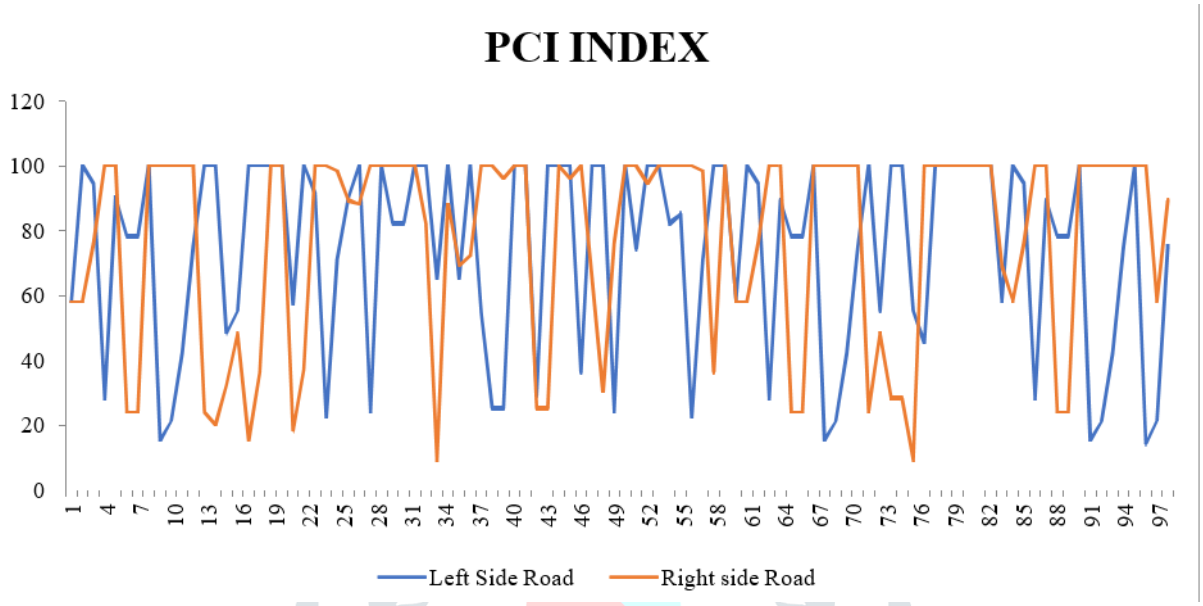

Figure 3 Comparison of Distress from Left & Right Side of Road

A survey has been done on NH-146 from Agrawal Restaurant to Asha Ramji Asha ram Bhopal to Sagar. In the given survey, first we decided the location for the distress survey of flexible pavement, then we measured the crack properly and noted its dimensions (length, width, and depth). Then we calculated the density using the density chart, calculated the deduct value, and found the PCI value of the crack. After finding this, we decided the service city level of the crack, whether it was high, medium, or low. Table 2 shows the presentation of the PCI value and service city level of the given crack. For measuring the PCI value, one first has to do a survey on a 1 km stretch, then calculate the density value of the given crack, calculate the deduct value, and then from the graph calculate the PCI value (figure 6)

deduct value of each distress is evaluated. The deduct value is obtained by comparing the density of that distress in the standard graph. Graph is of deduct value against distress density. There are three curves in the graph representing severities of distresses as low, medium and high. According to the severity of the distresses. Once all deduct values are calculated, total deduct value is obtained. Total deduct value is sum of all deduct value. Then Corrected deduct value is obtained. The corrected deduct value is taken from the graph. The graph is corrected deduct value against total deduct value. The graph is comprised of various curves having different q values. The q is the total number of deduct values greater than 2. Then, by selecting appropriate curve of q, the corrected deduct value for corresponding total deduct value is obtained. While determining the CDV, if any individual deduct value is higher than the CDV, the CDV is set equal to the highest individual deduct value. Figure 4 represent the deduct value graph and Figure 5 represent the Deduct Value Graph for Longitudinal & Transverse Cracking

$$\frac{Area\ of\ Sample\ Unit}{Area\ of\ Chainage} \times 100 = \textbf{Density of Crack}$$

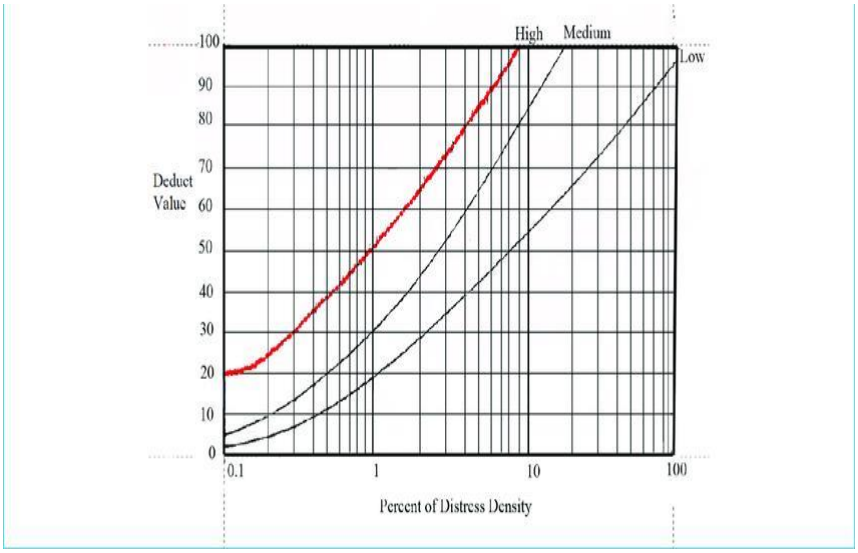

Figure 4 Deduct value Graph

Figure 4 represents the deducted value of a graph or different distress after finding the density of the given distress. This graph helps to find out the PCI value of distress.

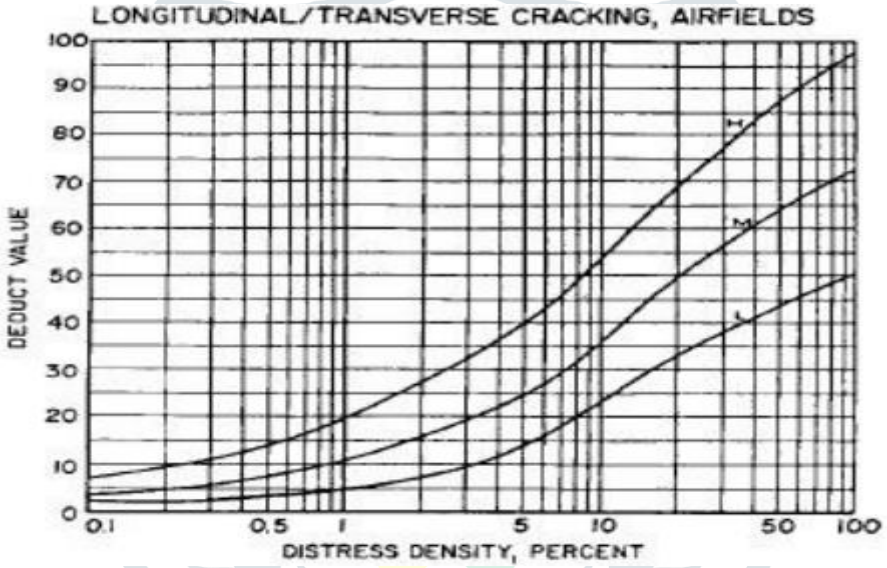

Figure 5 Deduct Value Graph for Longitudinal & Transverse Cracking

Once Corrected Deduct Value is obtained, PCI value is calculated by subtracting Corrected Deduct Value from 100. Then, by comparing value the PCI value with given range, rating of the road is given. The PCI can be found out .

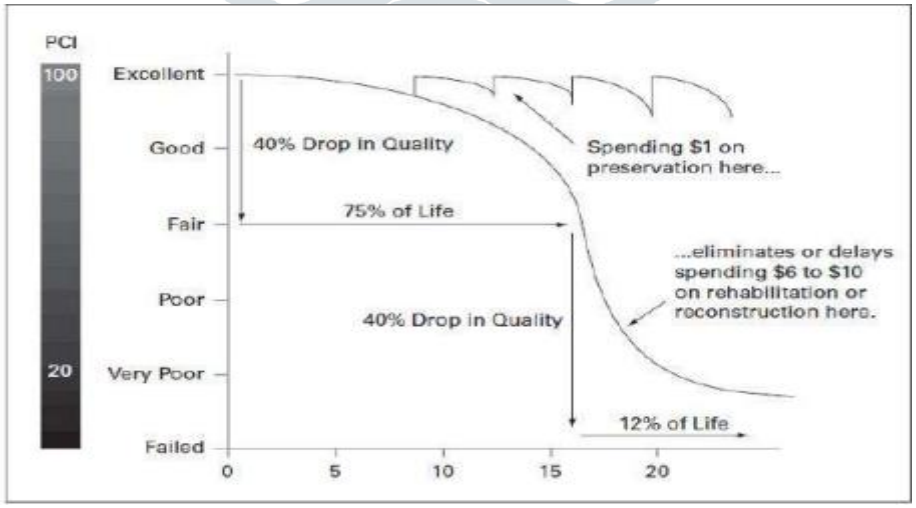

Figure 6 Graph for PCI Value

Figure 6 represent the PCI Graph for the different distress. Through this graph will find out the servicity level of given distress what kind of maintenance it required. Either its high medium or low

VIII. ESTIMATION OF MAINTENANCE COST OF DISTRESS OF 1KM STRETCH

The given estimate is for the maintenance of the crack on the Bhopal to Sagar National Highway (NH-146) 1km stretch from Agarwal resort to Asha ramji asharam. Table 2 represent the total cost of maintenance of 1km stretch.

Table 2 Estimation of maintenance Cost of Distress of 1km Stretch

S. No.	Item No.	Quantity	Amount (INR)
1	2.2	0.75(hec)	29526
2	10.3	31.446	104778.45
3	5.2	19.85	277.95
Amount			134582
Labor Cost (20% of Amount)			26916.48
Wastage (5%)			6729.12
GST (18% of Total Amount)			30281.04
Net Amount (Indian Rupees)			198209.04

IX. CONCLUSION

From the graph of severity level, alligator cracks are the main reason of pavement defects.

- Alligator cracks, rehabilitation is required on the top layer and a proper additional surface course is needed with a fresh layer of the bitumen as per design and quality standards. This may be economical then by providing the overlay for whole pavement.
- For potholes, it can be covered by premix material after cleaning and painted with bituminous binder. Patches are the one kind of improvement for the pavement. An entire damaged area is selected and covered/filled with fresh layer of bitumen. So, it can be economical as compared to by demolishing the whole pavement ground.
- Block cracking also can be improved by surface treatment or by providing a thin overlay on the surface course.
- Edge cracks are improved either by the improvement of drainage or a also we can fill the cracks by making the slurry of bituminous emulsion or emulsified bituminous crack seal.
- Longitudinal and transverse cracks also have the same techniques as edge cracking. By improvement of drainage by clearing off the source that collects water on the pavement and also by bituminous slurry to fill the cracks on the joints.
- Making the side drainage is also a good idea for this. Slippage cracking can be maintained by making a full depth patch by selecting the entire area of the crack.
- Weathering is ravelling is improved by any surface treatment or thin coat of the bitumen

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