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# Method Comparison of Pavement Condition Rating based on IRC & ASTM Guidelines

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**Abstract –** *In a developing country highway infrastructure is the backbone for economic development. With increase in traffic and loading, pavement detoriation occurs which needs to be monitored and captured continuously for preparing efficient maintenance proposals. Pavement condition rating through various distress identification and measurement is the need of an hour. The paper reviews the methodology and result of pavement condition rating by IRC & ASTM method over the four lanes 80 Km flexible pavement section. The pavement rating obtained by both of the methods are compared to each other to find out the correlation, accuracy and precision in results. The paper gives the concise view of pavement performance rating. This will help in finding the effectiveness and usefulness of each model of pavement ratings.*

***Key Words***: Pavement Distress, ASTM, IRC, Pavement Condition Rating, Evaluation, Indexation.

## 1. INTRODUCTION

The analysis and interpretation of various pavement performance parameter data as collected during NSV survey has been performed to assess the existing pavement condition of the project road and rate the pavement on its condition termed as Pavement Condition Rating (PCR). PCR provides a measure of present condition of pavement based on distress observed on surface of pavement. It provides an objective and rational basis for determining maintenance and repair needs and priorities. Continuous monitoring of the PCR is used to establish the rate of pavement deterioration, which permits early identification of major rehabilitation needs.

The study includes 80Km 4 Lane NH section in the State of Gujarat, India where the pavement surface distresses are collected using Network Survey Vehicle and linear measurements done for each distresses is recorded. The pavement condition rating is performed as per IRC: 82-2015 and ASTM D6433 separately.

## 2. CONDITION RATING METHODOLOGY

### 2.1 Method as per IRC: 82-2015

The IRC: 82-2015 gives guidelines for Practice of Maintenance of Bituminous Road. For a Highway, the IRC guidelines asks to collect measurement of following pavement distresses through visual observations; cracking, raveling, potholes, shoving, patching, settlement and rut depth. Based on the measured distresses the standard condition is as below in Table 1.

**Table 1:** Pavement Distress Rating for Highways

| 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 & Depression % | >5 | 1 to 5 | <1 |
| Rut depth in mm | >10 | 5 to 10 | <5 |
| **Rating** | **1** | **1.1 - 2.0** | **2.1 - 3.0** |
| **Condition** | **Poor** | **Fair** | **Good** |

After assigning rating to each parameter, an appropriate weightage is given to rating value of each parameter for calculation of Weighted Rating Value of each parameter. The following weightage has been fixed for each parameter as shown below in Table 2.

**Table 2:** Pavement Distress Weightage

| S. No. | Defects (Type) | 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 & Depression | 0.75 |
| 7 | Rut depth | 1.00 |

Based on the above guidelines a working excel sheet has been formulated to find the pavement condition rating of the road section as presented below in Figure 1.

| Distress Type | Input (%) | RATING AS PER NORMS | Weightage | Weighted Rating Value |
|---|---|---|---|---|
| Cracking (%) | 40.00 | 1.0 | 1.00 | 1.0 |
| Ravelling (%) | 35.00 | 1.0 | 0.75 | 0.8 |
| Potholes (%) | 20.00 | 1.0 | 0.50 | 0.5 |
| Shoving (%) | 10.00 | 1.0 | 1.00 | 1.0 |
| Patching (%) | 15.00 | 1.0 | 0.75 | 0.8 |
| Settelments (%) | 0.00 | 3.0 | 0.75 | 2.3 |
| Rut Depth (%) | 15.00 | 1.0 | 1.00 | 1.0 |
| | | | Final Rating | 1.0 |
| | | | Condition | Fair |

**Figure 1:** IRC Pavement Rating Sheet

### 2.2 Method as per ASTM D6433

This practice covers the determination of roads pavement condition through visual surveys using the Pavement Condition Index (PCI) method of quantifying pavement condition. The PCI is a numerical indicator that rates the surface condition of the pavement in a scale of 0 to 100. The PCI provides a measure of the present condition of the pavement based on the distress observed on the surface of the pavement, which also indicates the structural integrity and surface operational condition (localized roughness and safety).

The PCI of the pavement is calculated in following five steps:

- **Step I**

The entire project road is divided into sections on the basis of uniform construction, usage, maintenance, traffic volume and load intensity. The section is divided into number of sample units (SU) to survey for the pavement condition in order to obtain 95% confidence level for the section. The number of sample units to be inspected by the following equation

$$n = Ns^2 / ((e^2/4) (N-1) + s^2)$$

Where:
*e* = acceptable error in estimating the section PCI;
*s* = standard deviation of the PCI from one sample unit to another within the section.
*N* = total number of sample units in the section.
Size range of each sample unit is as:-

- Rigid Pavement: 20 contiguous slabs (+-8 slabs if the total number of slabs in the section is not evenly divided by 20.
- Flexible Pavement: 2500 contiguous square feet,+-1000 ft2 (225+-90 m2), if the pavement is not evenly divided by 2500.

- **Step II**

Inspection and measurement of various types of pavement distresses as per there severity for each SU both for flexible and rigid pavement and recording it in the proper format. The total distresses type for each severity level is added to record as total severity in the SU and the density of each in the SU is calculated.

- **Step III**

Based on the density and severity level of distresses type Deduct Value (DV) for each distress type based on Deduct Value is recorded based on DV Graphs as in Figure 2.

- **Step IV**

After the completion of Step III, Corrected Deduct Value (CDV) for each distress type is calculated. If none or only one DV is greater than two than sum of all DV is considered as maximum CDV to calculate PCI, else maximum allowable deducts calculated from the equation

$$m = 1+ (9/98) (100-HDV) <=10$$

Where:
m = allowable number of deducts including fractions (must be less than or equal to ten), and
HDV = highest individual deduct value.

The CDV is calculated iteratively for each distress type from the graphs given in Figure 3.

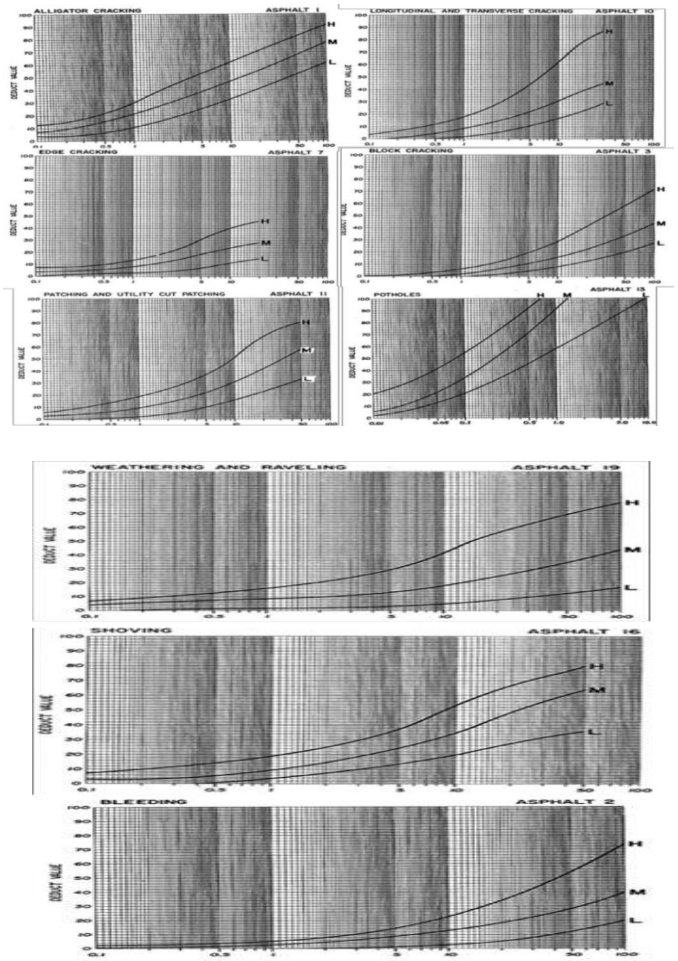


**Figure 2:** Deduct Value (DV) Graphs

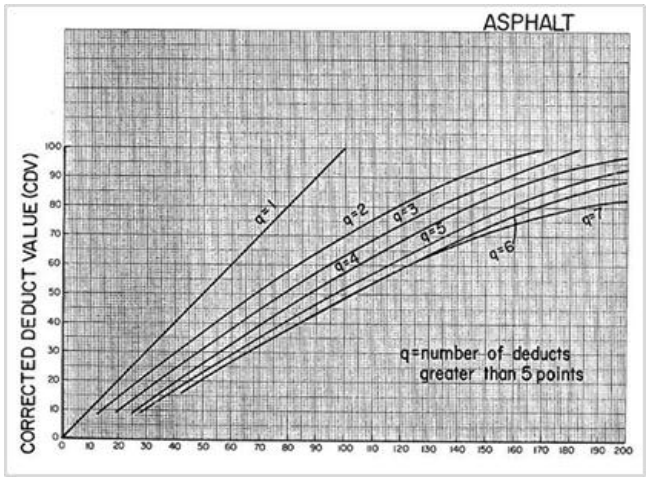


**Figure 3:** Corrected Deduct Value (CDV) Graph

- **Step V**

Compute Pavement Condition Index (PCI) = 100–CDV for each sample unit inspected.

The PCI is rated in the scale of 1 to 100 and condition assessed based on it. The PCI rating scale is as below in Figure 4.

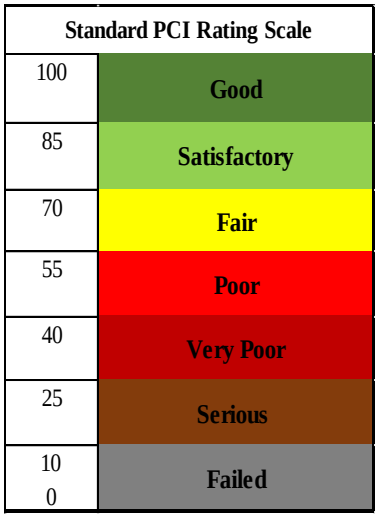


**Figure 4:** PCI Rating Scale

## 3. COMPARING PROCEDURE

The comparison between the pavement condition rating obtained by ASTM and IRC is done. As IRC classifies pavement condition only into Good, Fair and Poor, ASTM's vivid classification has been brought under similar categories for comparison study, which is explained below in Table 3.

**Table 3:** Clubbed Condition Classification

| Condition | |
|---|---|
| **IRC** | **ASTM** |
| Good | Good, Satisfactory |
| Fair | Fair, Poor |
| Poor | Very Poor, Serious, Failed |

Based on the clubbed condition classification of both IRC & AASTHO, the pavement ratings can also be clubbed as.

**Table 4:** Clubbed Condition Ratings

| Pavement Condition | Pavement Ratings | |
|---|---|---|
| | IRC | ASTM |
| Good | 2.1 to 3.0 | 70 to 100 |
| Fair | 1.1 to 2.0 | 41 to 69 |
| Poor | 0 to 1.0 | 0 to 40 |

Based upon the above curated comparative parameters, the rating by ASTM method will be converted to IRC rating scale for the comparison of pavement condition attained by both methods.

## 4. RESULTS AND OBSERVATIONS

Based on the guidelines of IRC & ASTM, the pavement condition rating for the project section was carried out as shown below in Table 5 & 6. For rating of the project road was divided in sections of 5 km length each.

**Table 5:** IRC Pavement Condition Rating

| Chainage, Km | | LHS | | RHS | |
|---|---|---|---|---|---|
| From | To | Rating | Condition | Rating | Condition |
| **441** | **436** | 1.92 | Fair | 2.0 | Fair |
| **436** | **431** | 1.98 | Fair | 2.1 | Good |
| **431** | **426** | 1.98 | Fair | 2.0 | Fair |
| **426** | **421** | 2.08 | Good | 2.1 | Good |
| **421** | **416** | 2.14 | Good | 2.1 | Good |
| **416** | **411** | 2.22 | Good | 2.2 | Good |
| **411** | **406** | 2.16 | Good | 2.1 | Good |
| **406** | **401** | 2.25 | Good | 2.2 | Good |
| **401** | **396** | 2.16 | Good | 2.1 | Good |
| **396** | **391** | 2.26 | Good | 2.2 | Good |
| **391** | **386** | 2.22 | Good | 2.2 | Good |
| **386** | **381** | 2.16 | Good | 2.3 | Good |
| **381** | **376** | 2.16 | Good | 2.2 | Good |
| **376** | **371** | 2.28 | Good | 2.3 | Good |
| **371** | **366** | 2.22 | Good | 2.1 | Good |
| **366** | **361** | 2.18 | Good | 2.1 | Good |

**Table 6:** ASTM Pavement Condition Rating

| Chainage, Km | | LHS | | RHS | |
|---|---|---|---|---|---|
| From | To | PCI Value | Condition | PCI Value | Condition |
| **441** | **436** | 59 | Fair | 59 | Fair |
| **436** | **431** | 62 | Fair | 62 | Fair |
| **431** | **426** | 56 | Fair | 56 | Fair |
| **426** | **421** | 45 | Poor | 52 | Poor |
| **421** | **416** | 68 | Fair | 77 | Satisfactory |
| **416** | **411** | 42 | Poor | 42 | Poor |
| **411** | **406** | 66 | Fair | 66 | Fair |
| **406** | **401** | 74 | Satisfactory | 74 | Satisfactory |
| **401** | **396** | 79 | Satisfactory | 78 | Satisfactory |
| **396** | **391** | 67 | Fair | 68 | Fair |
| **391** | **386** | 75 | Satisfactory | 77 | Satisfactory |
| **386** | **381** | 70 | Satisfactory | 70 | Satisfactory |
| **381** | **376** | 80 | Satisfactory | 80 | Satisfactory |
| **376** | **371** | 74 | Satisfactory | 74 | Satisfactory |
| **371** | **366** | 72 | Satisfactory | 76 | Satisfactory |
| **366** | **361** | 70 | Satisfactory | 70 | Satisfactory |

These pavement condition rating values evaluated will be further used for comparison in both the guidelines as per the comparing procedure enumerated earlier.

The conversion of the PCI value from ASTM has been converted to IRC scale of 0 to 3 based on sensible engineering guidelines wrt Table 4 criteria. The comparison between the pavement conditions has been presented below using a line graphs and pie charts.

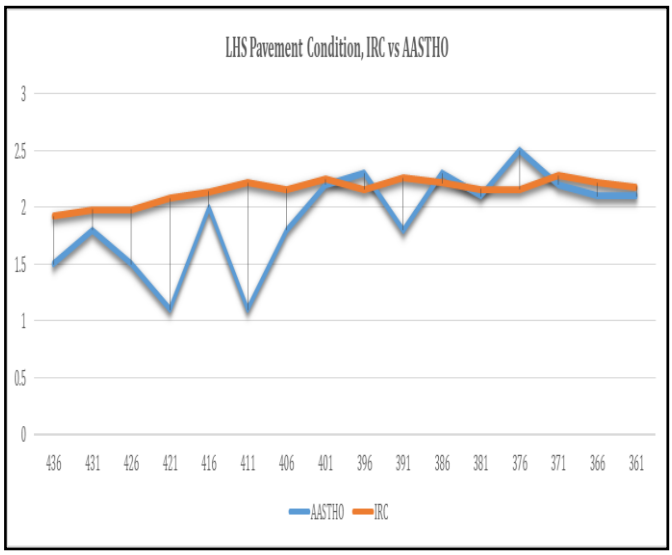


**Figure 5:** LHS Pavement Condition, IRC vs ASTM

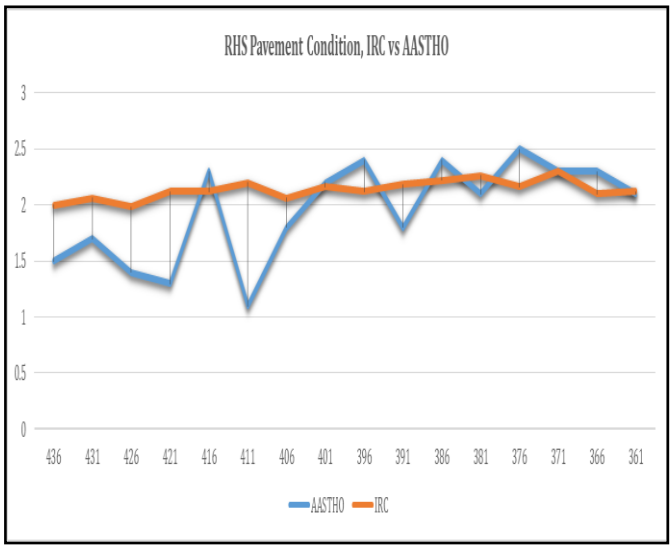


**Figure 6:** RHS Pavement Condition, IRC vs ASTM

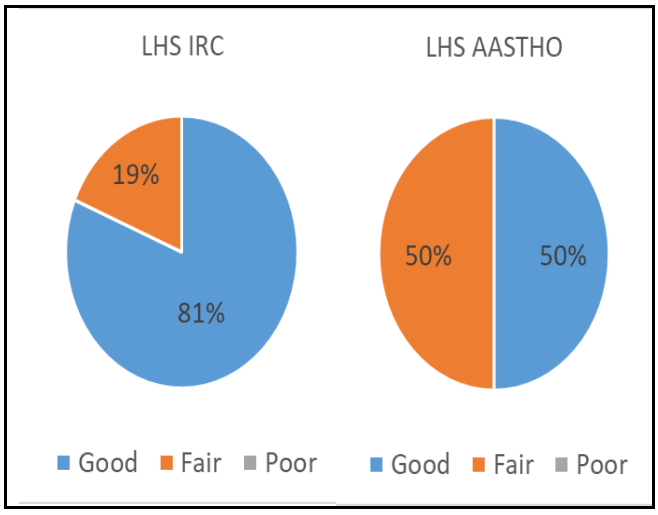


**Figure 7:** LHS Pavement Condition Distribution

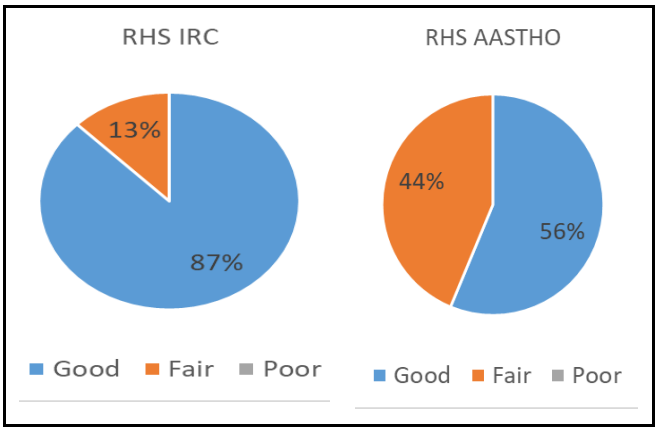


**Figure 8:** RHS Pavement Condition Distribution

Based on the above presented comparison result through line and pie charts following observations are made

a) The pavement condition criteria i.e., Good, Fair and Poor matches for the major pavement section both through IRC & ASTM method.

b) There is the difference in rating value of pavement condition within the same criteria which shows both method show different severity level for the same section.

c) ASTM method shows 50% in good condition against 81% by IRC on LHS while ASTM shows 56% in good condition against 87% by IRC on RHS.

d) None of the section is in poor condition as per both the methods.

## 5. CONCLUSIONS

On review of the method of pavement condition evaluation by both IRC & ASTM and based on the above results and discussions it can be concluded that the different model of pavement condition evaluation give different result for the same pavement section. The difference in the rating values from both the method is in range of 0.5 to 1.0.

IRC method is a direct rating system which do not consider the severity index of the distresses in evaluation. It admires the engineering judgment process for distress data collection and measurements. However for a project having scarce resource and fund, such method can be adopted.

The ASTM method is a deduct value approach method which considers and the types of possible distress and its severity parameter. The severity of the distress type is the most important index in pavement performance evaluation. The ASTM method is time consuming and requires accurate measurements and severity identification. The ASTM method supersedes the IRC method for following reasons

a) ASTM recommends to consider 19 types of flexible pavement distress while IRC recommends only 07 distress type for Highways to be used in pavement rating analysis.

b) ASTM recommends linear measurements usage in analysis while IRC recommends percentage measurement unit.

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