

General Relativity of Pavement Condition Rating and Its Global Impact

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• Highlights

- **Pavement Condition Survey and Evaluation**
- **Concept of Relativity of Pavement Condition Rating and Its Global Impact**
 - **Diversity in pavement condition survey and assessment**
 - **Relativity due to diversity in road condition ratings**
 - **Issues on diversity and relativity**
- **Research and Practical Values of this Study**

Example diversities in pavement condition survey and evaluation

- **Different types of pavement surface distress defined by road agencies**
 - Number of pavement surface distresses to be surveyed and used in road condition rating
 - Severity and density of each pavement distress is defined differently
 - Different condition rating scales and categories are used by different road agencies
- **Different condition rating scales and categories are used by different road agencies**

Pavement Condition Indices

- **Structural Assessment of a pavement section**
 - Structural - rutting, strength/deformation, durability/deflection, surface distresses, etc.
 - Measurement – direct measures and performance indices (rut depth, potholes, cracks, RDI, PCI/DMI)
- **Functional Assessment of a pavement section**
 - Functional – comfortability/roughness, safety/friction, environment/noise, etc.
 - Measurement – indirect and relative measures (profiles, skid resistance, and noise, etc.) and performance indices (IRI, IFI/FN, dB)
- **Overall Assessment of a Pavement Section**
 - Combined structural and functional measures – subjective rating and performance indices (PSI, PCI, PQI, KPI, etc.)

Condition Surveys

Ride Quality, Surface Distress, Rutting

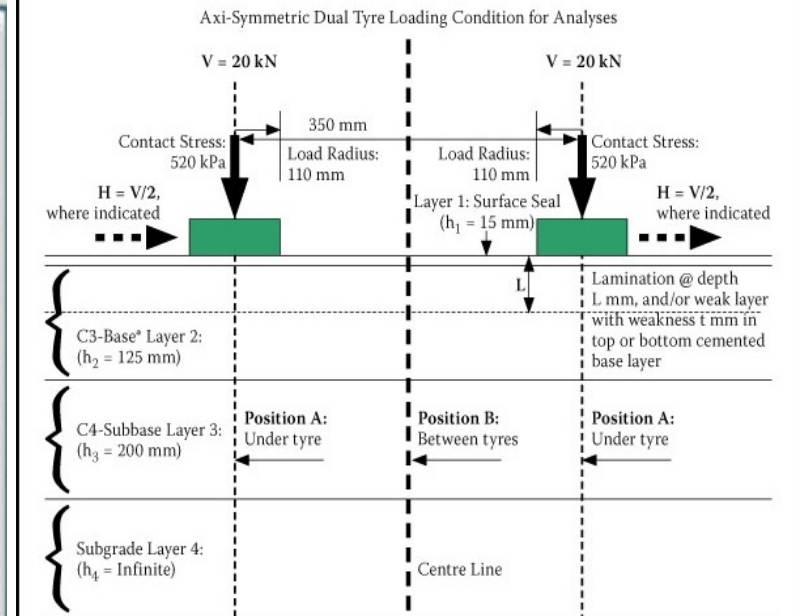
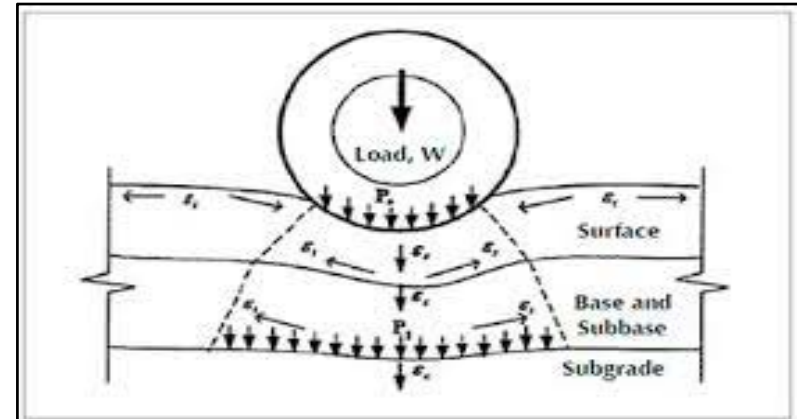
Pavement Indices

Pavement Wheel Path Profile	Ride Quality Index IRI
Pavement Surface Distresses	Surface Distress Index
Rutting	Average Pavement Rut Depth
Structural Capacity Deflections	Structural Capacity Index



Converts collected data to single value




Type I - Condition Assessment Index



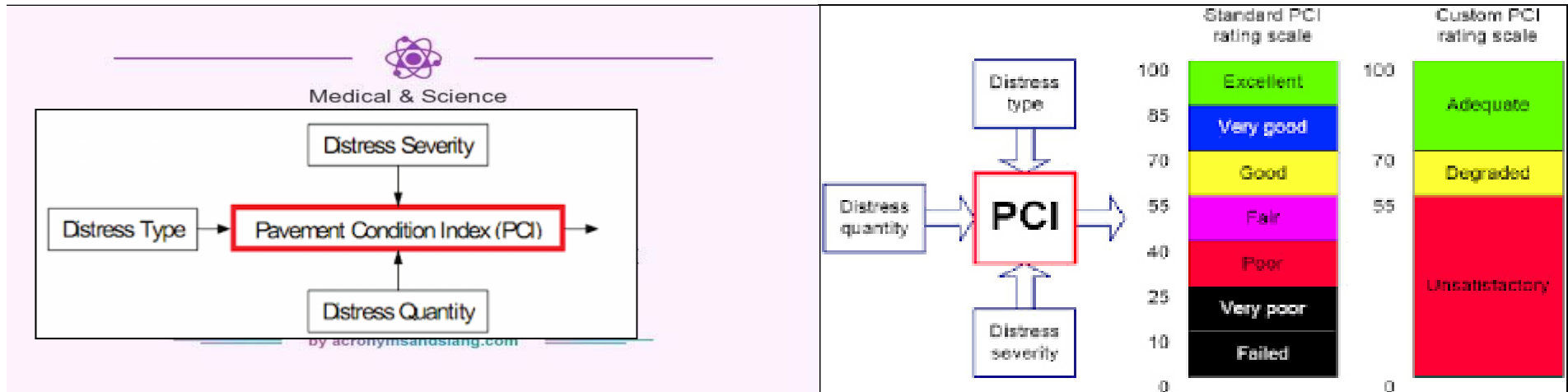
• Diversity in Pavement Condition Rating and Condition Index

Condition Rating	Condition Index	Condition Description	
F	0 to 19	No longer functioning or complete failure	Failure
E	20 to 39	Serious Damages that affect the function	Poor
D	40 to 59	Some defects are recorded but do not significantly affect the function	Fair
C	60 to 74	Good Conditions with minor defects that do not significantly affect the function	Good
B	75 to 89	Very good condition with very minor defects	Very Good
A	90 to 100	Excellent conditions, no defects.	Excellent

• Diversity in Pavement Condition Rating and Its Impact

	PCI	PCI	REPRESENTATIVE PAVEMENT SURFACE	REPAIR ALTERNATIVE
ROUTINE MAINTENANCE	86 - 100	90		Pavements with PCIs above 85 will benefit from routine maintenance actions, such as periodic crack sealing, periodic joint resealing, or patching.
PAVEMENT PRESERVATION	56-85	65		Pavements with a PCI of 56 (65 for PCC pavements) to 85 may require pavement preservation, such as a surface treatment, thin overlay, or PCC joint resealing.
MAJOR REHABILITATION	0 - 55	25		Pavement allowed to deteriorate below a PCI of 55 (65 for PCC) will require costly reconstruction to restore it to operational condition.

Type II Pavement Condition Indices



Key Measures for Pavement Condition: Roughness

Present Serviceability Rating (PSR)

Acceptable? Yes No Undecided

5 Very Good
4 Good
3 Fair
2 Poor
1 Very Poor
0

Section Identification _____ Rating _____
Rater _____ Date _____ Time _____ Vehicle _____

International Roughness Index (IRI)

$$PQI = w_{PCI} PCI + w_{RQI} RQI + w_{RDI} RDI + w_{SRI} SRI$$

式中：
 w_{PCI} —— PCI 在 PQI 中的权重，按表 6.2.1-1 取值；
 w_{RQI} —— RQI 在 PQI 中的权重，按表 6.2.1-1 取值；
 w_{RDI} —— RDI 在 PQI 中的权重，按表 6.2.1-1 取值；
 w_{SRI} —— SRI 在 PQI 中的权重，按表 6.2.1-1 取值。

Pavement Evaluation

- **Data Collection for Structural Assessment**
 - Manual and static measures – rut, deformation, cracks, deflection/strength
 - Automatic and dynamic measures – quantity measures with some limitations (rutting, cracks, etc)
- **Data Collection for Functional Assessment**
 - Visual and subjective inspection and evaluation – comfortability/roughness, safety/friction, environment/noise, etc.
 - High-speed and automatic process – indirect measures (profiles, macro-textures, and noise, etc.) and convert measurement to performance indices (IRI, IFI/FN, dB)
- **Data Collection for Overall Assessment**
 - Subjective rating for performance evaluation (PCR, PCI, PQI, etc.)

Relativity of Pavement Performance Assessment

- **Issues on factors causing diversity and relativity in pavement evaluation**
 - **No unified measurement (including unit, scale, levels of severity and density of distresses, etc.)**
 - **No standard data collection device and equipment (varies in precision and accuracy)**
 - **Not the same data components are used in assessment of overall pavement condition**
 - **No consistent criteria and methods across region/globe**

Relativity of Pavement Performance Assessment

- **Impacts of diversity on pavement condition assessment**
 - **Relativity or absence of standards of absolute and universal applications**
 - **Making a performance index as dependent variable of road agency/location, and relative to each other given the same value but used in two or more different locations/countries**
 - **Introduce new concepts:**
 - **Type I performance index (physically measurable index, such as rutting, deflection, cracking length and width, etc.)**
 - **Type II performance index (subjective and non-measurable index, PCI, PSI, PQI, KPI, which is a function of two or more individual measurable and/or non-measurable indexes)**
 - **Potential impacts on many other operational components of pavement management, reporting/comparison, etc.**

Type II Performance Assessment Index

Present Serviceability Index (PSI)

- Values from 0 through 5
- Calculated value to match PSR

$$PSI = 5.41 - 1.80 \log(1 + \overline{SV}) - 0.9 \sqrt{C + P}$$

SV = mean of the slope variance in the two wheelpaths
(measured with the CHLOE profilometer or BPR Roughometer)

C, P = measures of cracking and patching in the pavement surface

C = total linear feet of Class 3 and Class 4 cracks per 1000 ft² of pavement area.
A Class 3 crack is defined as opened or spalled (at the surface) to a width of 0.25 in. or more over a distance equal to at least one-half the crack length.
A Class 4 is defined as any crack which has been sealed.

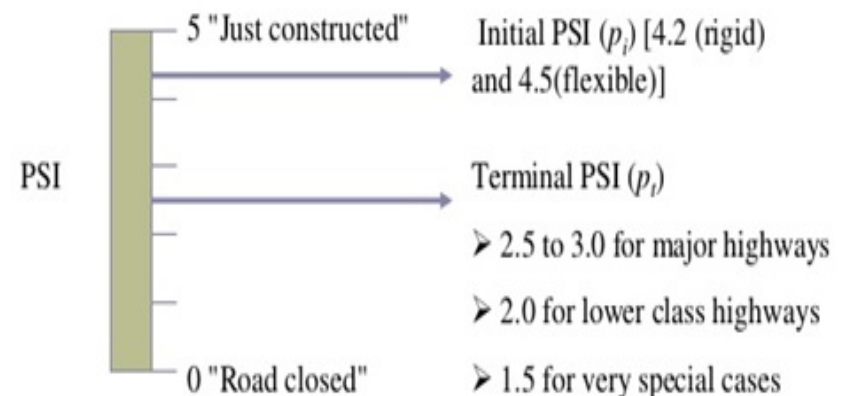
P = expressed in terms of ft² per 1000 ft² of pavement surfacing.

Serviceability (contd.)

Structural → Cracking, faulting, raveling, etc.

Functional → Riding comfort (measured in terms of roughness of pavement.)

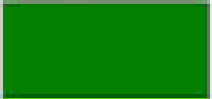






Serviceability Performance: Measured by PSI → Present Serviceability Index with scale 0 to 5.



Diversity in Pavement Evaluation Contents

Flexible	Composite	Concrete
Coarse Aggregate Loss	Coarse Aggregate Loss	Coarse Aggregate Loss
Flushing	Flushing	Joint Sealant Loss
Alligator Cracking	Joint Failure	Joint Failure
Single and Multiple Cracking	Single and Multiple Cracking	Single and Multiple Cracking
Wheel Track Rutting	Wheel Track Rutting	Transverse Joint Creep
Roughness (IRI)	Roughness (IRI)	Roughness (IRI)
Joint Separation	Joint Separation	Longitudinal Joint Separation
Skid Resistance	Skid Resistance	Skid Resistance

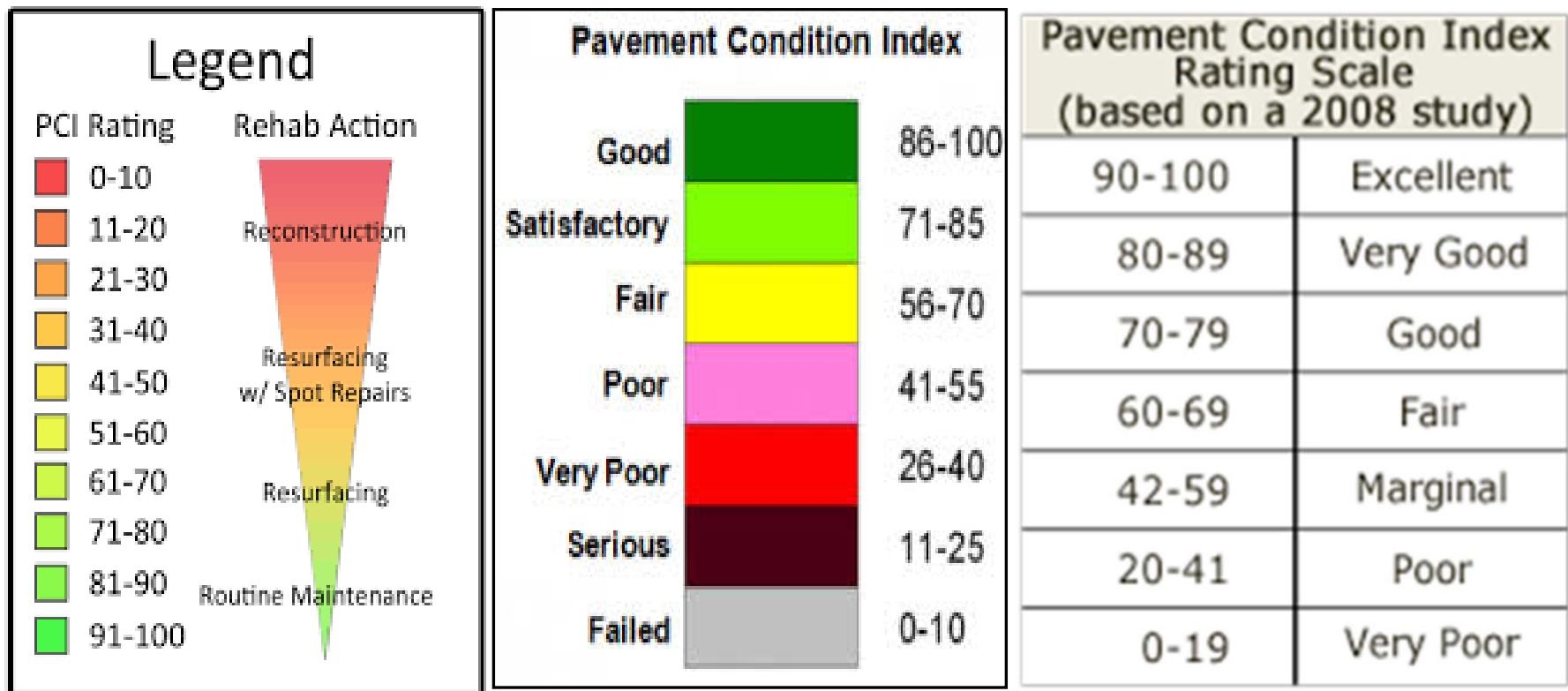
Diversity of Pavement Performance Rating Scales and Evaluation Categories

Pavement Condition Index			Condition Category	Pavement Condition Index (PCI)	Pavement Condition Index Rating Scale (based on a 2008 study)	
Good		86-100	Excellent	100 – 86	90-100	Excellent
Satisfactory		71-85	Good	85 – 75	80-89	Very Good
Fair		56-70	Fair	74 – 58	70-79	Good
Poor		41-55	Poor	57 – 40	60-69	Fair
Very Poor		26-40	Failed	39 – 0	42-59	Marginal
Serious		11-25			20-41	Poor
Failed		0-10			0-19	Very Poor

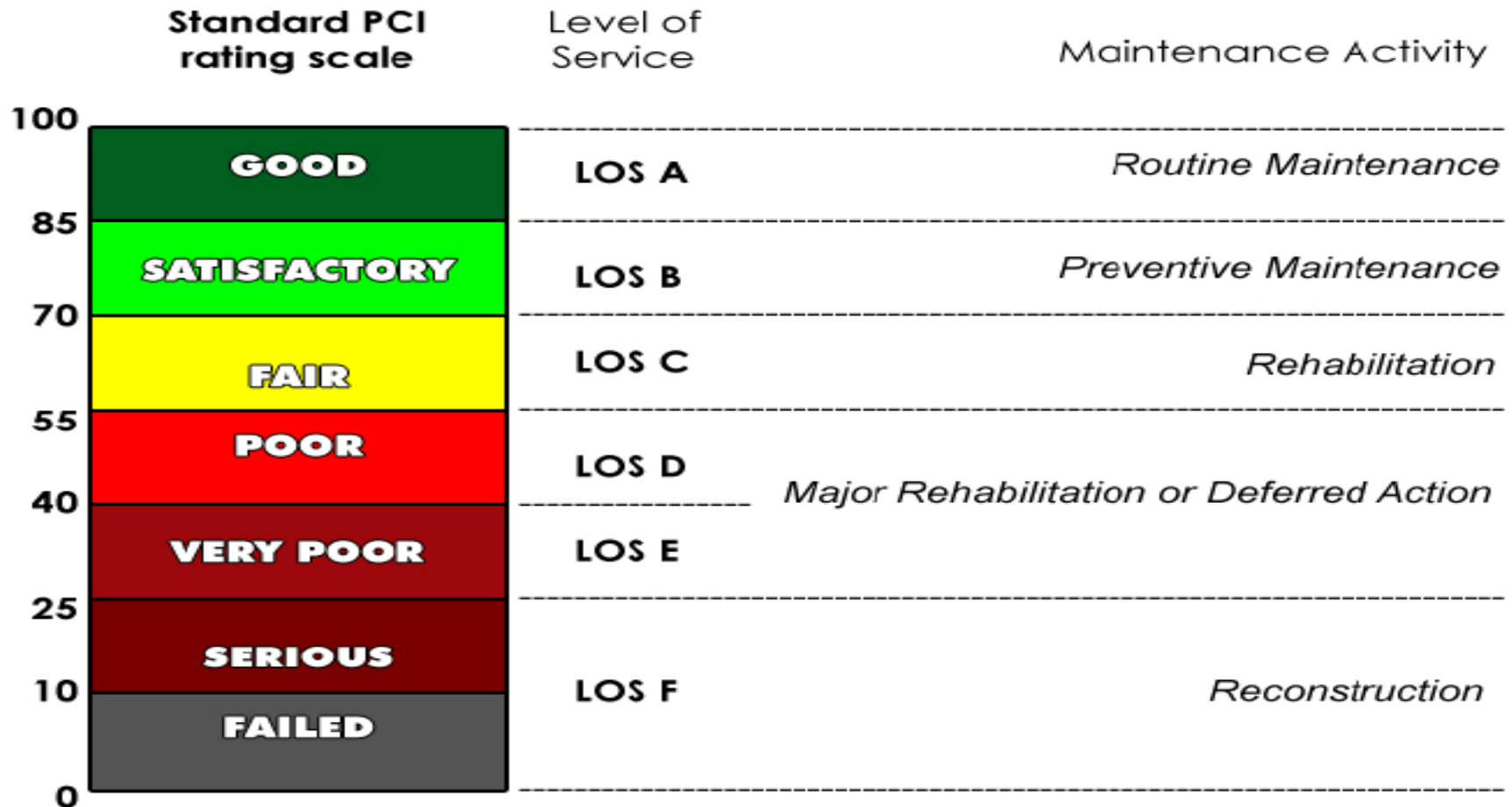
Relativity of Pavement Performance Assessment

- **Solution to exploring relationships between diversity and relativity**
 - **Review all overall or integrated pavement performance assessment indexes used international and explore their relationships by same index and different indexes**
 - **Make performance index comparable and adjustable through calibration in the global wide**
 - **Type I performance index (consistent in scale of range, severity and density of measurement, such as rutting, deflection, cracking length and width, etc.)**
 - **Type II performance index (consistent in definition and scale of PCI, PSI, PQI, KPI, etc.)**
 - **Establish international standards for pavement performance assessment, including performance indexes (Type I and Type II), objectives or components of performance evaluation**

Impacts of Pavement Performance Assessment on M&R Treatment Decisions

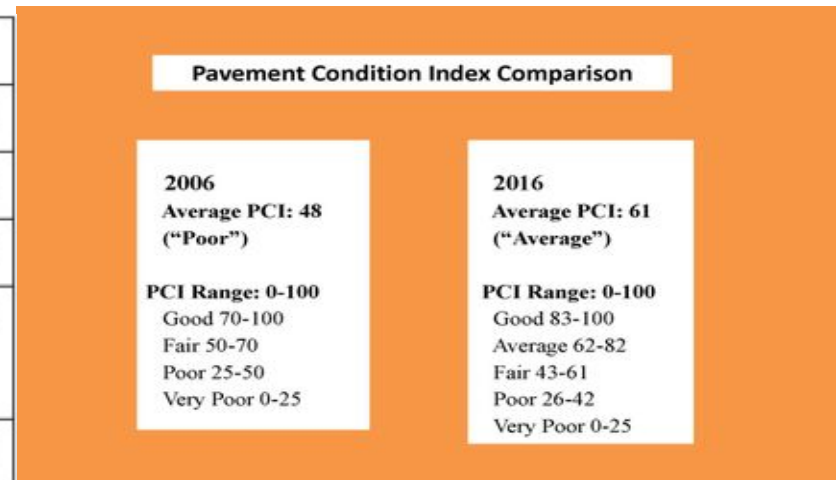


Impacts on Preservation/Planning Decisions



Impacts of Performance Scale and Triggers

Category	Threshold Value			
	1	2	3	4
Rut Depth (mm)	10	12	15	20
Cracking (% Area)	2	5	7.5	10
Riding Comfort Index (RCI) Scale: 5 – 0	4	3	2.5	2
Unevenness (mm/km)	3000	3500	4500	6000



Condition Category	Pavement Condition Index		General Treatment Strategy
	Upper Limit	Lower Limit	
Excellent	100	86	do nothing / corrective maintenance
Good	85	75	preventative maintenance
Fair	74	58	resurface
Poor	57	40	rehabilitation
Failed	39	0	reconstruction

Discussion and Conclusion

- **Diversity in the current road condition survey and rating systems, which has significant impacts on pavement performance assessment**
- **Quantify impacts of the diversity in road condition rating and performance index**
- **Need to establish uniform pavement condition rating and evaluation methods**
- **Theoretical and practical values of this study**

THANK YOU

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