COMPARING ROAD CONDITION INDEXES USING AUTOMATED PCI, PASER AND PSCI METHODS ON STANDARD LCMS ROAD CONDITION DATA OUTPUTS

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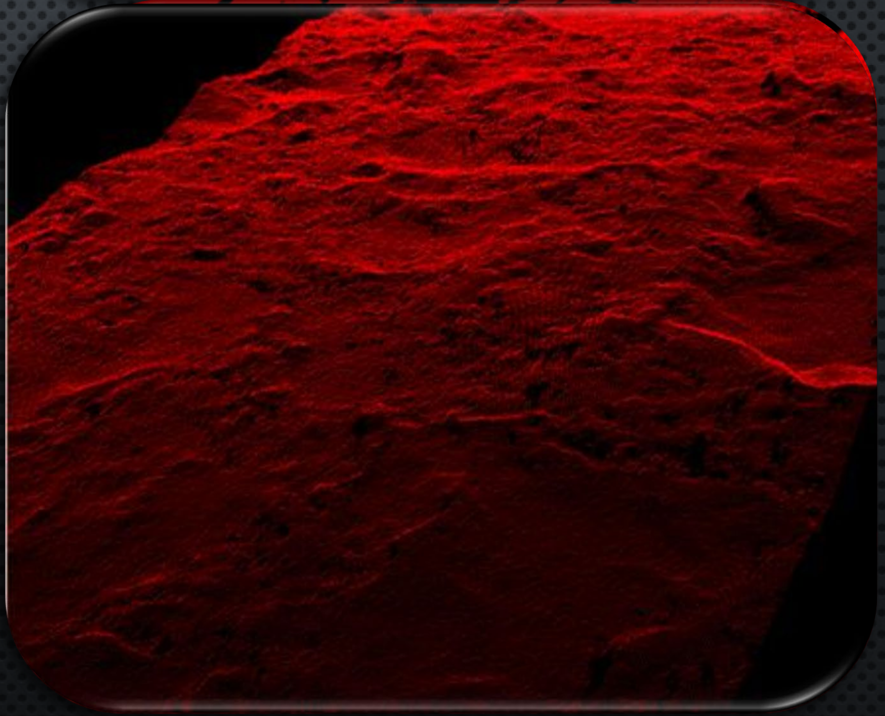
RPUG
Road Profile Users' Group

Laser Profiling of Aggregates

- High resolution (±7.5 microns) laser profiler characterizes surface features of aggregates
- 8x20cm sample scanned in under 1 min
- Can scan before, during, and after accelerated aging and polishing
- Software automatically evaluates micro-surface characteristics and reports number and the average angles of surface texture descriptors



LCMS-2 vs. LCMS-4M

LCMS-2

- Dual sensor system
- 4m scan width
- 1mm profile spacing

LCMS-4M

- Single sensor system
- 4m scan width
- 5mm profile spacing

LCMS-2

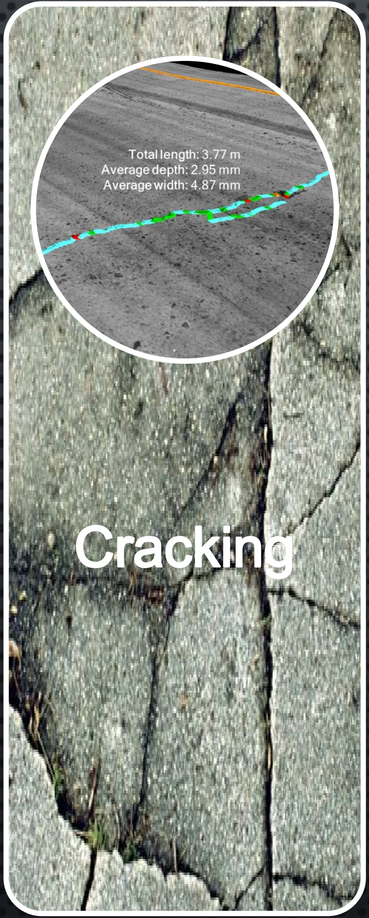
GNSS Antenna

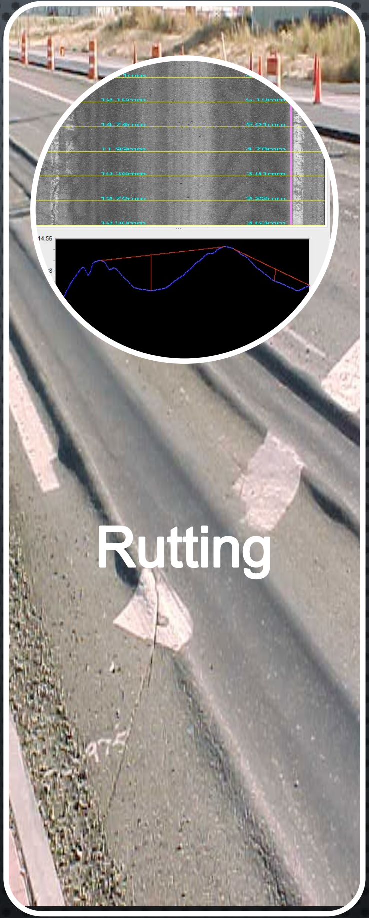
LCMS Sensors

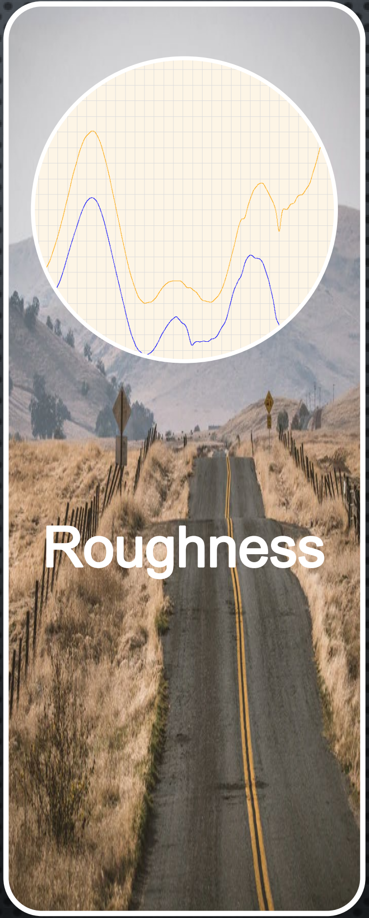
Wheel encoder

NEW LCMS-4M (SINGLE SENSOR)

FULLY AUTOMATED DATA PROCESSING







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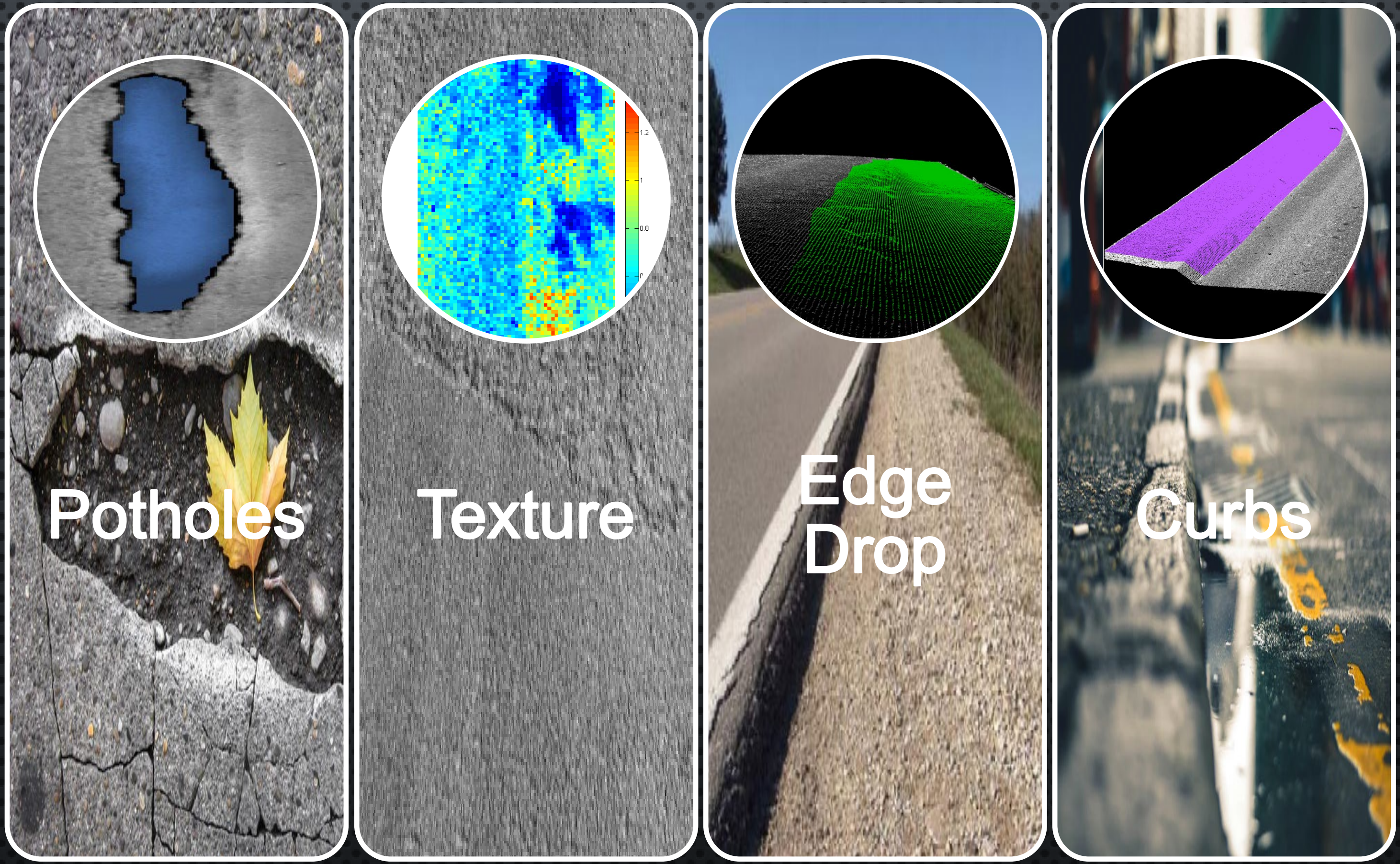

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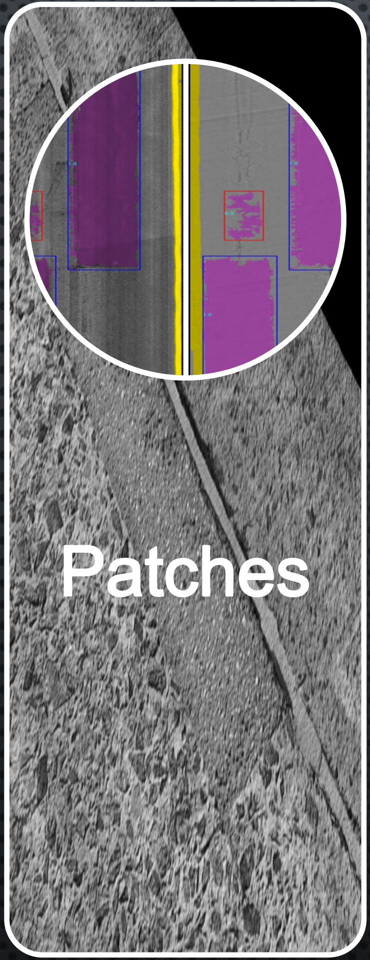
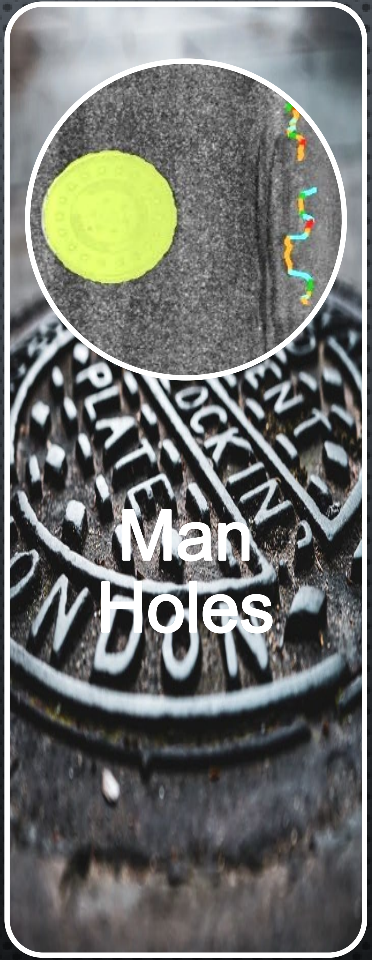




THE DETAILED DISTRESS DATA IS SUMMARIZED ACCORDING TO 3 STANDARD INDEXES

PCI (NEW!)

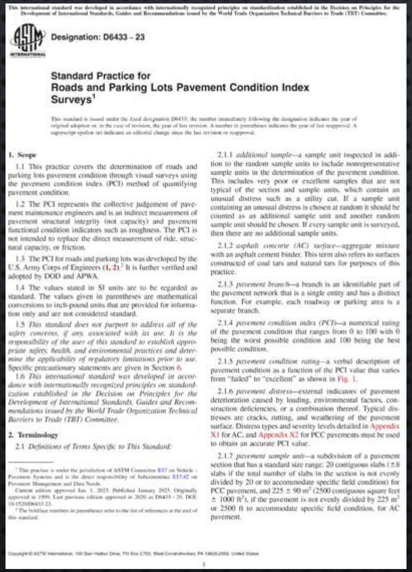
- 0-100 INDEX
- 19 DISTRESS
- *MORE-COMPLEX* MATHEMATICAL CALCULATION

PASER

- 1-10 INDEX
- 5 DISTRESS
- *SUBJECTIVE* KIND OF ASSESSMENT

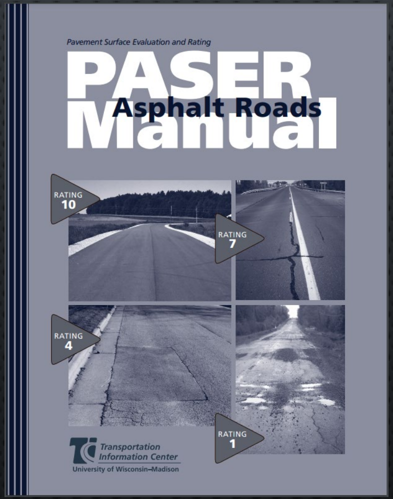
PSCI

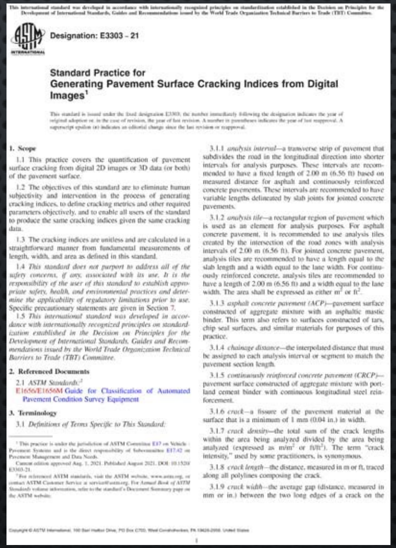
- 0-100 INDEX
- 1 DISTRESS (CRACKING)
- *SIMPLE* MATHEMATICAL CALCULATION



Designation: D6433 – 23

Standard Practice for
Roads and Parking Lots Pavement Condition Index Surveys[1]

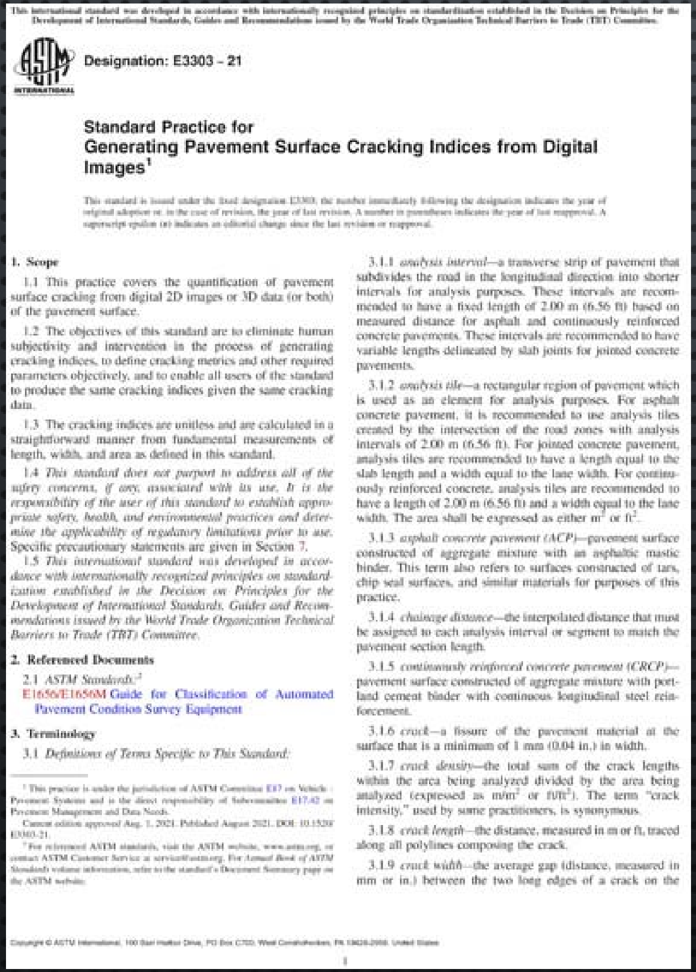




Designation: E3303 – 21

Standard Practice for
Generating Pavement Surface Cracking Indices from Digital Images[1]

PSCI STANDARD (ASTM E3303) OVERVIEW



This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: E3303 – 21

Standard Practice for Generating Pavement Surface Cracking Indices from Digital Images[1]

This standard is issued under the fixed designation E3303; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the quantification of pavement surface cracking from digital 2D images or 3D data (or both) of the pavement surface.

1.2 The objectives of this standard are to eliminate human subjectivity and intervention in the process of generating cracking indices, to define cracking metrics and other required parameters objectively, and to enable all users of the standard to produce the same cracking indices given the same cracking data.

1.3 The cracking indices are unitless and are calculated in a straightforward manner from fundamental measurements of length, width, and area as defined in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 7.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1656/E1656M Guide for Classification of Automated Pavement Condition Survey Equipment

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *analysis interval*—a transverse strip of pavement that subdivides the road in the longitudinal direction into shorter intervals for analysis purposes. These intervals are recommended to have a fixed length of 2.00 m (6.56 ft) based on measured distance for asphalt and continuously reinforced concrete pavements. These intervals are recommended to have variable lengths delineated by slab joints for jointed concrete pavements.

3.1.2 *analysis tile*—a rectangular region of pavement which is used as an element for analysis purposes. For asphalt concrete pavement, it is recommended to use analysis tiles created by the intersection of the road zones with analysis intervals of 2.00 m (6.56 ft). For jointed concrete pavement, analysis tiles are recommended to have a length equal to the slab length and a width equal to the lane width. For continuously reinforced concrete, analysis tiles are recommended to have a length of 2.00 m (6.56 ft) and a width equal to the lane width. The area shall be expressed as either m^2 or ft^2.

3.1.3 *asphalt concrete pavement (ACP)*—pavement surface constructed of aggregate mixture with an asphaltic mastic binder. This term also refers to surfaces constructed of tars, chip seal surfaces, and similar materials for purposes of this practice.

3.1.4 *chainage distance*—the interpolated distance that must be assigned to each analysis interval or segment to match the pavement section length.

3.1.5 *continuously reinforced concrete pavement (CRCP)*—pavement surface constructed of aggregate mixture with portland cement binder with continuous longitudinal steel reinforcement.

3.1.6 *crack*—a fissure of the pavement material at the surface that is a minimum of 1 mm (0.04 in.) in width.

3.1.7 *crack density*—the total sum of the crack lengths within the area being analyzed divided by the area being analyzed (expressed as m/m^2 or ft/ft^2). The term "crack intensity," used by some practitioners, is synonymous.

3.1.8 *crack length*—the distance, measured in m or ft, traced along all polylines composing the crack.

3.1.9 *crack width*—the average gap (distance, measured in mm or in.) between the two long edges of a crack on the

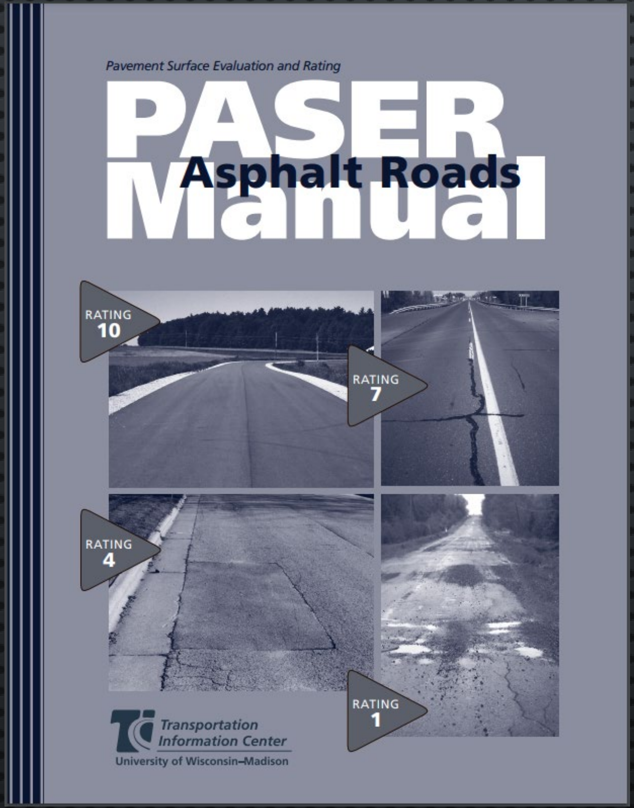
[1] This practice is under the jurisdiction of ASTM Committee E17 on Vehicle - Pavement Systems and is the direct responsibility of Subcommittee E17.42 on Pavement Management and Data Needs.

Current edition approved Aug. 1, 2021. Published August 2021. DOI: 10.1520/E3303-21.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- ONLY FOCUSED ON CRACKING
- AIM IS TO PROVIDE AN OBJECTIVE, UNITLESS, CRACKING METRIC BASED ON THE LENGTH, WIDTH, AREA OF CRACKS IN 2D OR 3D IMAGES
- THERE IS NO CONCEPT OF CRACK CLASSIFICATION OR TYPE IN THE STANDARD
- PSCI CAN BE CALCULATED IN EACH AASHTO BAND

PASER DISTRESS RATING PROTOCOL OVERVIEW



1-10 Score Based on:

- Cracking
- Rutting
- Potholes
- Raveling
- Patching

Quality	Rating	Treatment (Asphalt)
Excellent	9-10	No Maintenance Required
Good	7-8	Crack Sealing and Minor Patching
Fair	5-6	Preservation Treatments (Non-Structural)
Poor	3-4	Structural Renewal (Overlay)
Failed	1-2	Reconstruction

https://epd.wisc.edu/tic/documents/paser-manual-asphalt-pubpas01/

PASER RATING SYSTEM

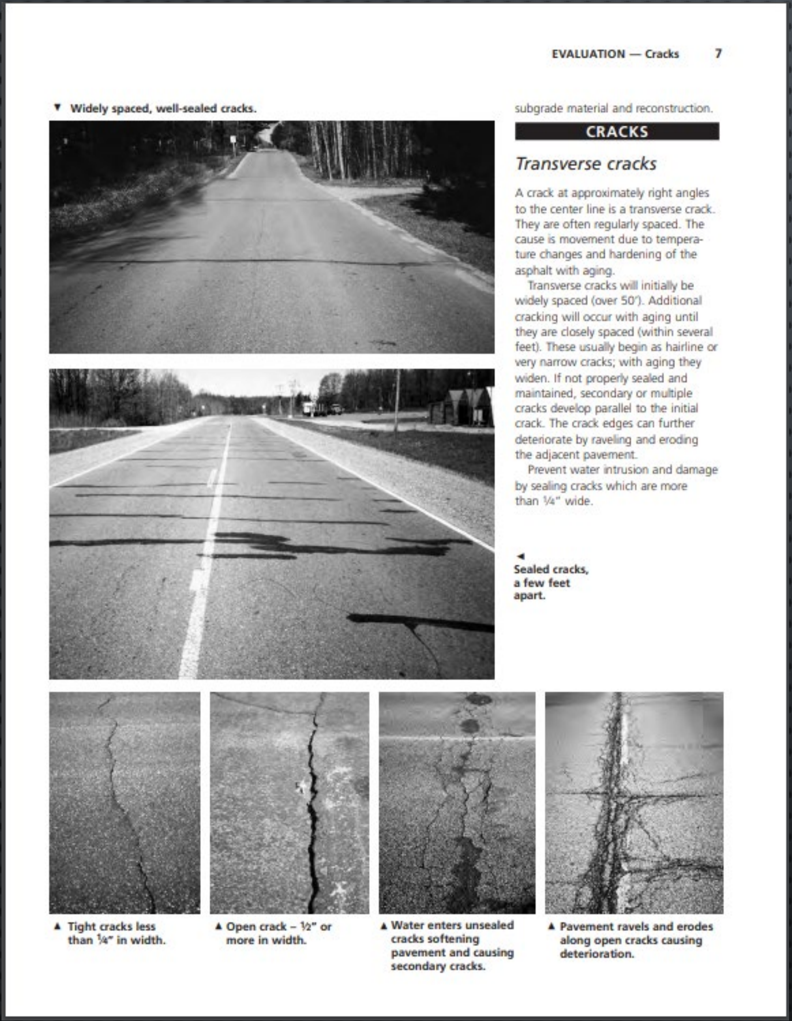
Surface Rating	Visible Distress	General Condition / Treatment Measures
10 Excellent	None	New construction.
9 Excellent	None	Recent overlay. Like new.
8 Very Good	No longitudinal cracks except reflection of paving joints. **Occasional transverse cracks, widely spaced** (40’ or greater). **All cracks sealed or tight** (open less than 1/4”).	Recent sealcoat or new cold mix. **Little or no maintenance Required.**
7 Good	**Very slight or no raveling**, surface shows some traffic wear. **Longitudinal cracks (open 1/4”)** due to reflection or paving joints. **Transverse cracks (open 1/4”)** spaced 10’ or more apart, little or slight crack raveling. **No patching or very few** patches in excellent condition.	First signs of aging. Maintain with routine **crack filling.**
6 Good	**Slight raveling** (loss of fines) and traffic wear. **Longitudinal cracks (open 1/4”– 1/2”)**, some spaced less than 10’. **First sign of block cracking**. Sight to moderate **flushing or polishing**. Occasional patching in good condition.	Shows signs of aging. Sound structural condition. Could extend life with **sealcoat**.

*Individual pavements will not have all of the types of distress listed for any particular rating…they may have only one or two types.

PASER RATING SYSTEM

Surface Rating	Visible Distress	General Condition / Treatment Measures
5 Fair	**Moderate to severe raveling** (loss of fine and coarse aggregate). **Longitudinal and transverse cracks (open 1/2")** show first signs of slight raveling and secondary cracks. First signs of longitudinal cracks near pavement edge. **Block cracking up to 50% of surface**. Extensive to **severe flushing or polishing**. Some patching or edge wedging in good condition	Surface aging. Sound structural condition. Needs sealcoat or thin **non-structural overlay** (less than 2").
4 Fair	**Severe surface raveling**. **Multiple longitudinal and transverse cracking** with slight raveling. **Longitudinal cracking in wheel path**. **Block cracking (over 50% of surface).** Patching in fair condition. **Slight rutting or distortions (1/2" deep or less**)	Significant aging and first signs of need for strengthening. Would benefit from a **structural overlay** (2" or more).
3 Poor	**Closely spaced longitudinal and transverse cracks** often showing raveling and crack erosion. **Severe block cracking**. **Some alligator cracking (less than 25% of surface).** Patches in fair to poor condition. **Moderate rutting** or distortion (1" or 2" deep). **Occasional potholes**.	**Needs patching and repair prior to major overlay**. Milling and removal of deterioration extends the life of overlay
2 Very Poor	**Alligator cracking (over 25% of surface).** **Severe distortions** (over 2" deep) **Extensive patching** in poor condition. **Potholes.**	Severe deterioration. Needs **reconstruction with extensive base repair**. Pulverization of old pavement is effective
1 Failed	Severe distress with extensive loss of surface integrity.	Failed. Needs **total reconstruction.**

PASER DISTRESS RATING PROTOCOL



EVALUATION — Cracks 7

▼ Widely spaced, well-sealed cracks.

subgrade material and reconstruction.

CRACKS

Transverse cracks

A crack at approximately right angles to the center line is a transverse crack. They are often regularly spaced. The cause is movement due to temperature changes and hardening of the asphalt with aging.

Transverse cracks will initially be widely spaced (over 50'). Additional cracking will occur with aging until they are closely spaced (within several feet). These usually begin as hairline or very narrow cracks; with aging they widen. If not properly sealed and maintained, secondary or multiple cracks develop parallel to the initial crack. The crack edges can further deteriorate by raveling and eroding the adjacent pavement.

Prevent water intrusion and damage by sealing cracks which are more than ¼" wide.

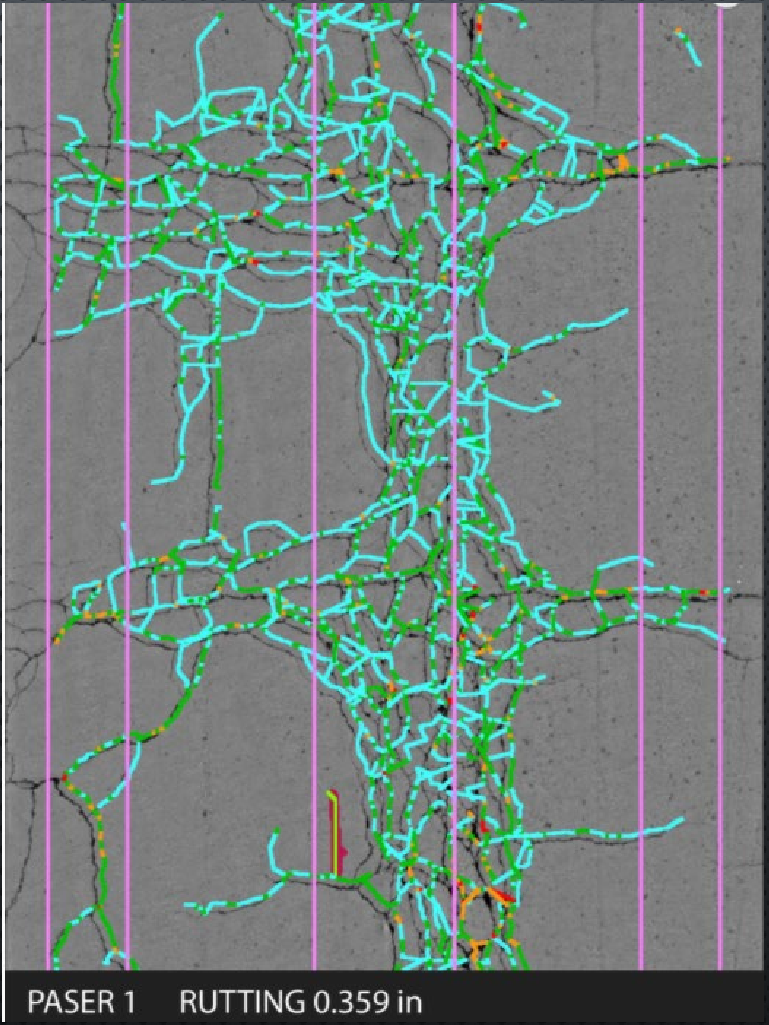
◄ Sealed cracks, a few feet apart.

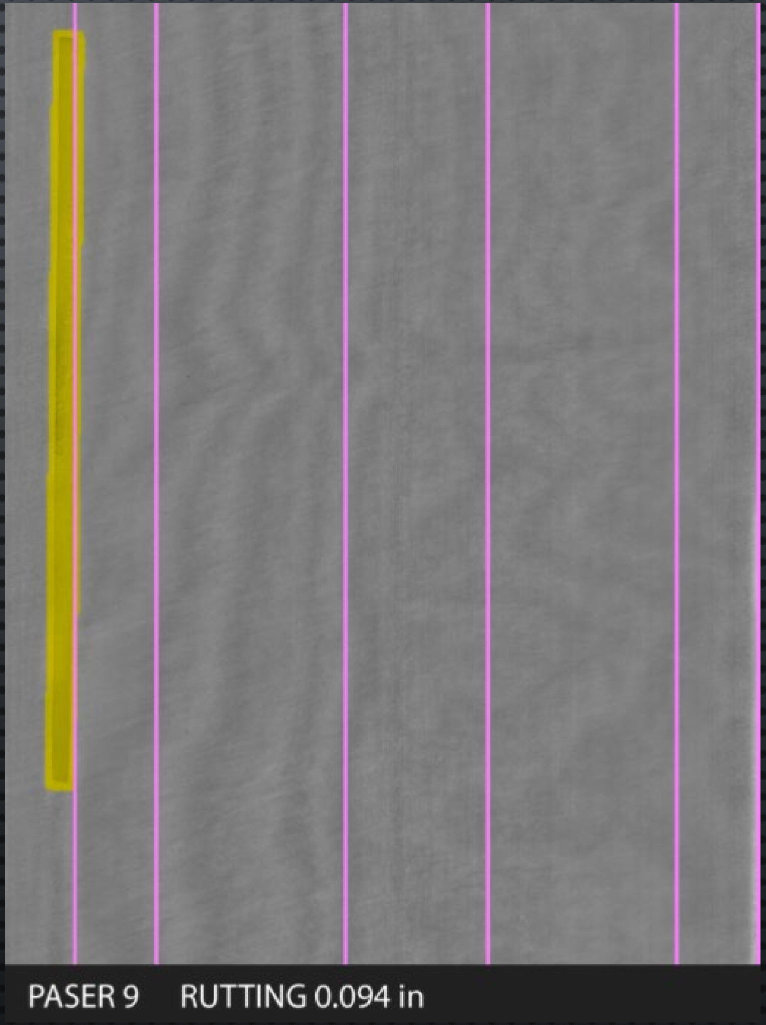
▲ Tight cracks less than ¼" in width.

▲ Open crack – ½" or more in width.

▲ Water enters unsealed cracks softening pavement and causing secondary cracks.

▲ Pavement ravels and erodes along open cracks causing deterioration.





PCI STANDARD (ASTM D6433) OVERVIEW

Designation: D6433 – 23

Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys[1]

1. Scope

1.1 This practice covers the determination of roads and parking lots pavement condition through visual surveys using the pavement condition index (PCI) method of quantifying pavement condition.

1.2 The PCI represents the collective judgement of pavement maintenance engineers and is an indirect measurement of pavement structural integrity (not capacity) and pavement functional condition indicators such as roughness. The PCI is not intended to replace the direct measurement of ride, structural capacity, or friction.

1.3 The PCI for roads and parking lots was developed by the U.S. Army Corps of Engineers (1, 2).[2] It is further verified and adopted by DOD and APWA.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 6.

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *additional sample*—a sample unit inspected in addition to the random sample units to include nonrepresentative sample units in the determination of the pavement condition. This includes very poor or excellent samples that are not typical of the section and sample units, which contain an unusual distress such as a utility cut. If a sample unit containing an unusual distress is chosen at random it should be counted as an additional sample unit and another random sample unit should be chosen. If every sample unit is surveyed, then there are no additional sample units.

2.1.2 *asphalt concrete (AC) surface*—aggregate mixture with an asphalt cement binder. This term also refers to surfaces constructed of coal tars and natural tars for purposes of this practice.

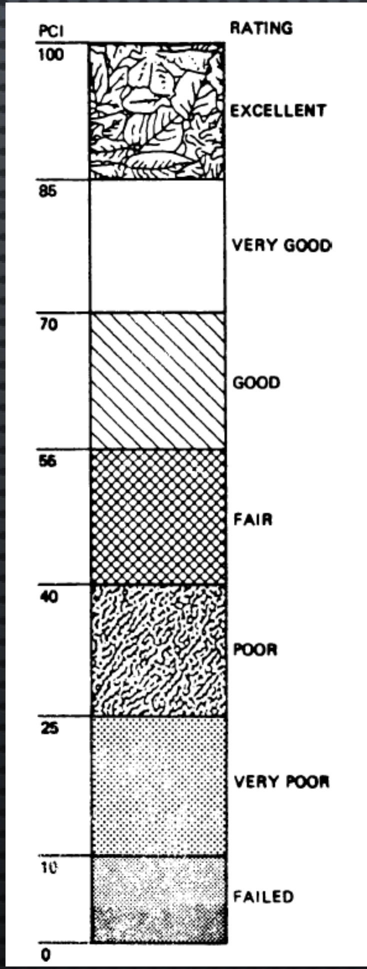
2.1.3 *pavement branch*—a branch is an identifiable part of the pavement network that is a single entity and has a distinct function. For example, each roadway or parking area is a seperate branch.

2.1.4 *pavement condition index (PCI)*—a numerical rating of the pavement condition that ranges from 0 to 100 with 0 being the worst possible condition and 100 being the best possible condition.

2.1.5 *pavement condition rating*—a verbal description of pavement condition as a function of the PCI value that varies from "failed" to "excellent" as shown in Fig. 1.

2.1.6 *pavement distress*—external indicators of pavement deterioration caused by loading, environmental factors, construction deficiencies, or a combination thereof. Typical distresses are cracks, rutting, and weathering of the pavement surface. Distress types and severity levels detailed in Appendix X1 for AC, and Appendix X2 for PCC pavements must be used to obtain an accurate PCI value.

2.1.7 *pavement sample unit*—a subdivision of a pavement section that has a standard size range: 20 contiguous slabs (±8 slabs if the total number of slabs in the section is not evenly divided by 20 or to accommodate specific field condition) for PCC pavement, and $225 \pm 90\ m^2$ (2500 contiguous square feet $\pm$ 1000 ft^2), if the pavement is not evenly divided by 225 m^2 or 2500 ft to accommodate specific field condition, for AC pavement.



- 19 flexible distress types
- Developed in late 1990s (computer vision not ready)
- Walking inspection
- Use of samples as opposed to 100% of the driven lane
- Condition is reported using a numeric index from 0-100

PCI STANDARD (ASTM D6433) OVERVIEW

D6433 – 09

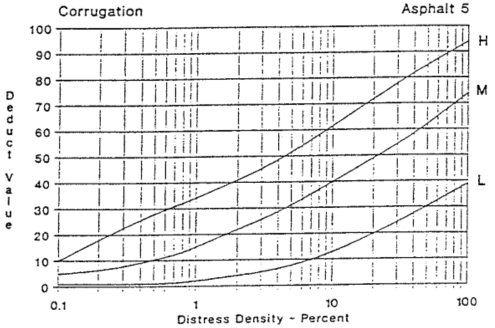


FIG. X3.6 Corrugation

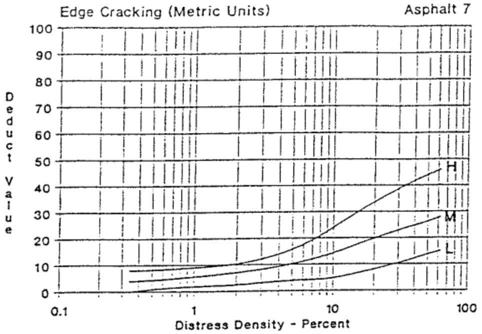


FIG. X3.9 Edge Cracking (metric units)

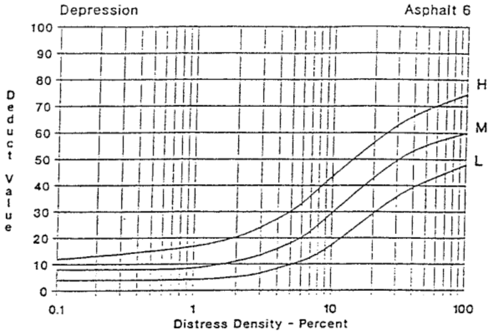


FIG. X3.7 Depression

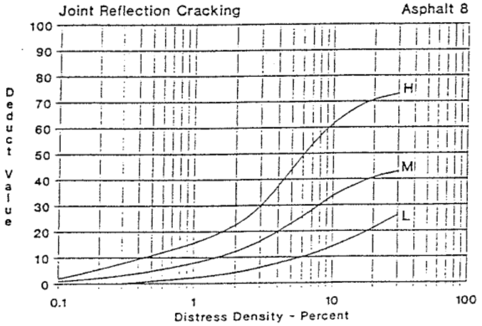


FIG. X3.10 Joint Reflection Cracking

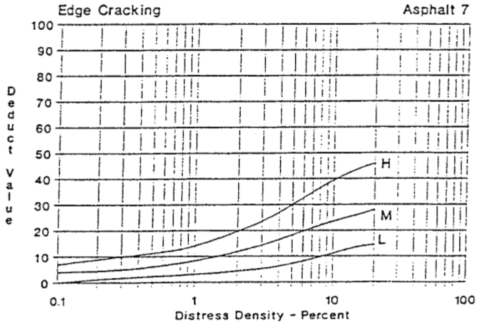


FIG. X3.8 Edge Cracking

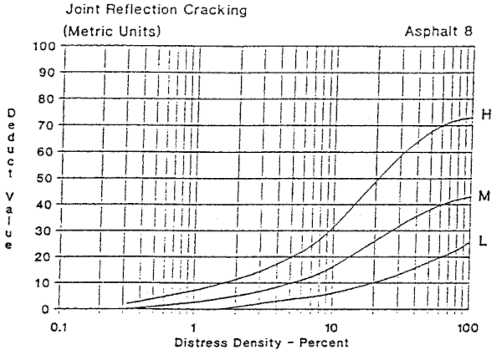


FIG. X3.11 Joint Reflection Cracking (metric units)

D6433 – 09

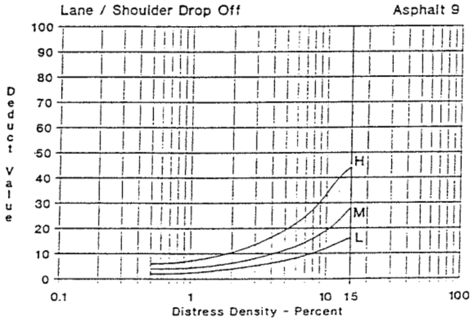


FIG. X3.12 Lane/Shoulder Drop-Off

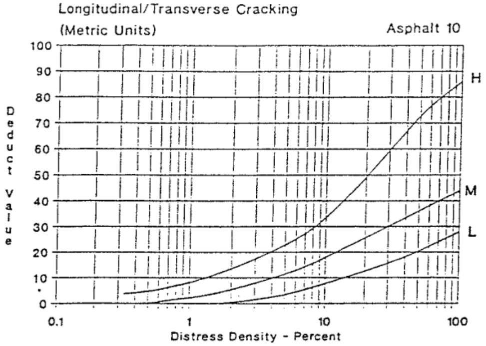


FIG. X3.15 Longitudinal/Transverse Cracking (metric units)

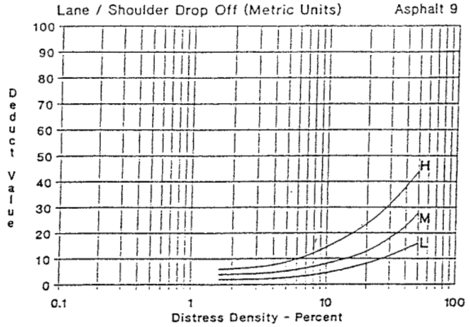


FIG. X3.13 Lane/Shoulder Drop-Off (metric units)

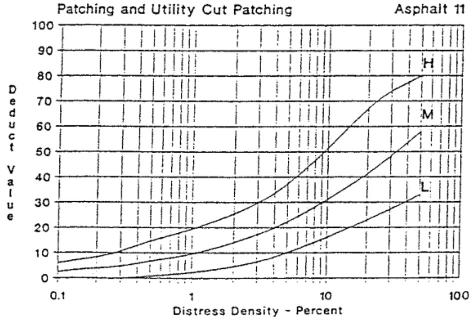


FIG. X3.16 Patching and Utility Cut Patching

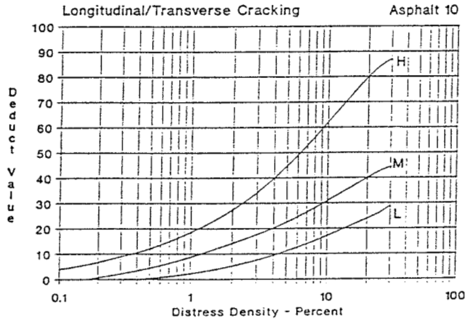


FIG. X3.14 Longitudinal/Transverse Cracking

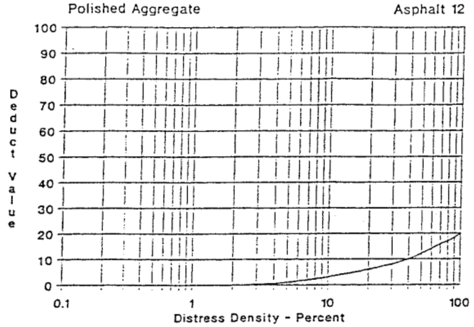


FIG. X3.17 Polished Aggregate

PCI Sensitivity to Different Distress Types

- By comparing the DV curves for the nineteen (19) different flexible pavement distress, it is possible to better understand the relative contribution of each distress type to the PCI
- Some distress types have a much greater impact on the resulting PCI than others
- Thus, it is possible to rank the nineteen (19) flexible distress types from highest to lowest in order of impact to the PCI
- The following comparison presents the estimated resulting deduct points for each distress type assuming an extent of 10% of the road section, ranging from low to high severity

PCI Sensitivity to Different Distress Types (10% of Road Section)

- **PCI is highly sensitive to:**
  - **Bumps and Sags: 40-100**
  - **Potholes: 55-100**
  - **Alligator cracking: 30-60**
  - **Slippage cracking: 28-65**
  - **Rutting: 28-60**
- PCI is moderately sensitive to:
  - Corrugation: 13-60
  - Depression: 18-44
  - Long and Trans cracking: 18-62
  - Patch and Utility: 15-50
  - Joint reflect crack: 15-64
  - Edge Cracking: 12-40
  - RR crossing: 12-70
  - Shoving: 20-53
  - Swell: 12-55
  - Raveling: 18-42
  - Lane drop: 12-35
- PCI has a low sensitivity to:
  - Block: 8-30
  - Bleeding: 5-25
  - Polish aggregate: 5-11
  - Weathering: 1-10

MAPPING PCI DISTRESS TO LCMS ALGORITHMS

No.	PCI Distress	LCMS Module Used	Comments
1	Alligator Cracking	Cracking	Standard LCMS algorithm with an additional crack classification algorithm applied. User can adjust weighting to increase or decrease the number of deduct points calculated.
2	Bleeding	Bleeding	Standard LCMS algorithm. User can adjust weighting to increase or decrease the number of deduct points calculated.
3	Block Cracking	Cracking	Standard LCMS algorithm (treated as long and trans cracking). It should be noted that block cracking has a relatively minor impact on the resulting PCI score. User can adjust weighting to increase or decrease the number of deduct points calculated.
4	Bumps and Sags	Roughness	International Roughness Index (IRI) was used to measure this condition. An IRI of 3.5 to 6m/km was classified as low severity, 6 to 8 as medium and greater than 8 as high. This range is based on the International Roughness Index scale (Michael Sayers, 1986). User can adjust weighting to increase or decrease the number of deduct points calculated. In the future, this data could be replaced by the new LCMS Bumps and Sags algorithm.

MAPPING PCI DISTRESS TO LCMS ALGORITHMS

No.	PCI Distress	LCMS Module Used	Comments
5	Corrugation	Roughness	Same comment as Bumps and Sags.
6	Depression	Roughness	Same comment as Bumps and Sags.
7	Swell	Roughness	Same comment as Bumps and Sags.
8	Edge Cracking	Edge Cracking	Enabled via a parameter. User can adjust weighting to increase or decrease the number of deduct points calculated.
9	Joint Reflection Cracking	Cracking	This distress is problematic to evaluate as it effectively requires the rater to have knowledge of the composition of the sub layers of asphalt underneath the running surface. As this knowledge is not always available, this type of cracking will simply be detected and reported as a transverse or a longitudinal crack. As the deduct curve for joint reflection cracking is very similar to the curve for longitudinal and transverse cracking, it is likely to have only a minor impact on the resulting PCI score.

MAPPING PCI DISTRESS TO LCMS ALGORITHMS

No.	PCI Distress	LCMS Module Used	Comments
10	Lane/shoulder Drop Off	Edge Drop	Standard LCMS algorithm. User can adjust weighting to increase or decrease the number of deduct points calculated.
11	Patching and Utility Cuts	Patching	Standard LCMS algorithm; however, user can adjust weighting to increase or decrease the number of deduct points calculated.
12	Potholes	Potholes	Standard LCMS algorithm; however, user can adjust weighting to increase or decrease the number of deduct points calculated.
13	Railroad Crossing	Roughness	Same comment as Bumps and Sags.

MAPPING PCI DISTRESS TO LCMS ALGORITHMS

No.	PCI Distress	LCMS Module Used	Comments
14	Rutting	Rutting	Standard LCMS algorithm. User can adjust weighting to increase or decrease the number of deduct points calculated.
15	Shoving	Roughness	Same comment as Bumps and Sags.
16	Slippage	Cracking	In terms of visual appearance, slippage cracking is similar to fatigue cracking and will be detected and reported as such. In terms of deduct values, the curve for slippage cracks is similar to the curve for alligator cracking thus detecting and reporting slippage cracking as fatigue cracking is likely to have only a minor impact on the resulting PCI score.
17	Weathering	Raveling	Standard LCMS algorithm. User can adjust weighting to increase or decrease the number of deduct points calculated.

MAPPING PCI DISTRESS TO LCMS ALGORITHMS

No.	PCI Distress	LCMS Module Used	Comments
18	Polished Aggregate	Raveling	Standard LCMS algorithm. User can adjust weighting to increase or decrease the number of deduct points calculated.
19	Longitudinal and Transverse Cracking	Cracking	Standard LCMS algorithm. User can adjust weighting to increase or decrease the number of deduct points calculated.

6 STEP PCI CALCULATION

1. Individual distress density percentage calculation
2. Individual deduct value calculation (DV)
3. Total deduct value calculation (TDV)
4. Q value determination (q)
5. Corrected deduct value calculation (CDV)
6. PCI calculation (PCI)

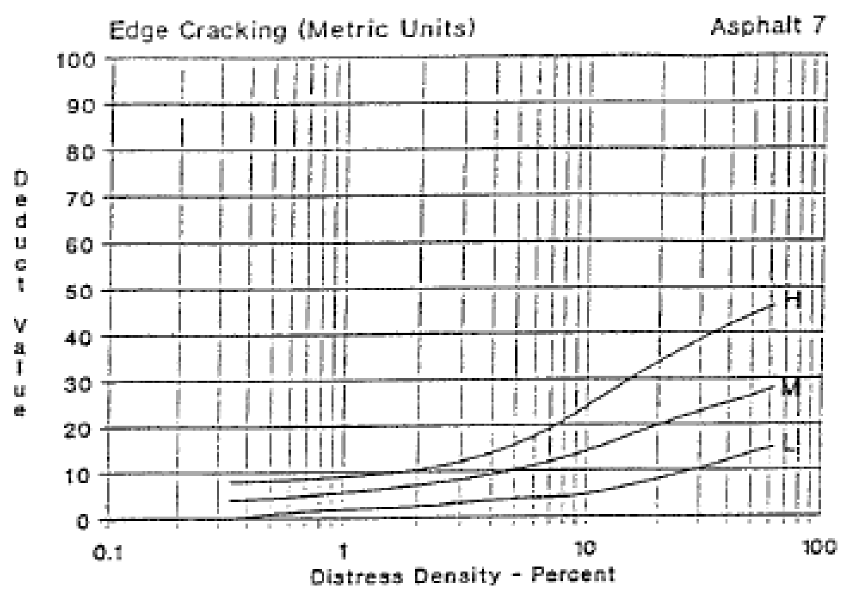


FIG. X3.9 Edge Cracking (metric units)

Step 1: Individual Distress Density Calculation

- A density percentage is calculated for each summed quantity of each distress type (e.g., 10 lineal meters of longitudinal cracking) in each 40 square meter road section.
- For area distress the summed area of the distress is divided by the total area of the pavement section and then multiplied by 100.
- For linear distress the summed length of the distress is divided by the total area of the pavement section and then multiplied by 100.
- For count-type distress, e.g., potholes, the count of the defect is divided by the total area of the pavement section and then multiplied by 100.

STEP 2: INDIVIDUAL DEDUCT VALUE CALCULATION (DV)

$$DV = \sum_{i=0}^{N} A_i \cdot (\log(D))^i$$

Where,

D = Density (%) of a specific distress of low, moderate and high severities

N = Highest-degree of polynomial function

i = index of polynomial

Ai, Bi= Coefficients of polynomial, determined by polynomial simulation

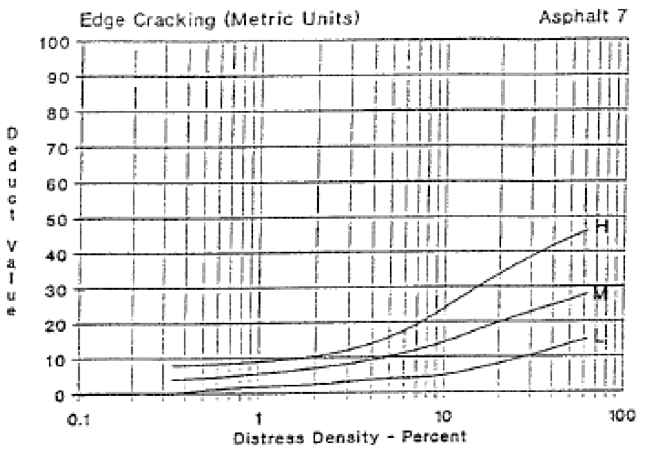


FIG. X3.9 Edge Cracking (metric units)

- For example, if there were nine (9) distress types present, a total of nine (9) DVs would be calculated
- This step replaces the traditional manual method of determining the DV for a distress type by looking-up its distress density percent value on the x-axis and the corresponding DV on the y-axis of the appropriate Deduct Value Curve

Step 3: Total Deduct Value Calculation (TDV)

$$M = 1 + (9/98)*(100 - HDV)$$

Where:

i. ***M*** = Maximum allowable number of deducts including fractions, must be less than or equal to ten.

ii. ***HDV*** = highest individual deduct value.

- The top M number of DVs (including the HDV) are then selected from the list with the remaining individual deducts being discarded (if less than M values were found then all of the values are retained)
- If M is a fraction, a fractional portion is taken of the last deduct value
- The individual DVs (up to M number of them) are then summed to create a Total Deduct Value (TDV) for each distress type and severity for the road section

Step 4: Q Value Determination

- A Q value is determined for each section by counting the number of individual deduct values with a score of greater than 2
- For example, if there are 6 individual deducts ranging from 20 to 5, then the Q value would be 6

STEP 5: CORRECTED DEDUCT VALUE CALCULATION (CDV)

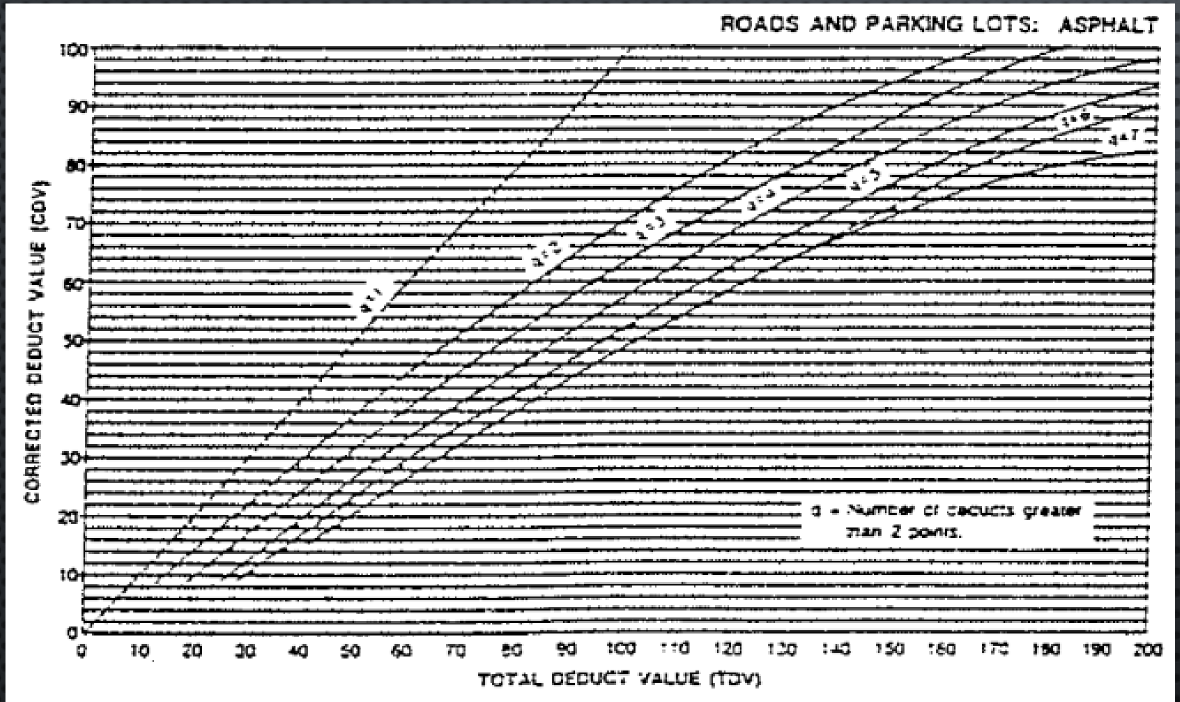


FIG. X3.27 Total Deduct Value

- First the individual DVs for each distress type are summed to create a single TDV for the road section
- Then the q value for the road section is used to select the appropriate curve from the Total Deduct Value graph and the section TDV is used to select the appropriate position on the x-axis, and finally the corresponding CDV (for the TDV and q value) is resolved on the y-axis
- The process is repeated, with individual DVs for the road section being again summed but with the smallest individual DV being replaced (each time) by a value of two (2) and the q value being reduced by 1 (thus shifting one curve to the left in the Total Deduct Value graph each time)
- Each time the resulting section TDV and the revised q value are used to select the appropriate curve and position on the x-axis in order to determine the corresponding CDV value on the y-axis. This process is repeated until a q value of 1 is reached

Step 6: PCI Calculation

- The PCI for each road section is then determined by subtracting the Max CDV (the highest individual CDV value) from one hundred (100)
- In order to report the resulting PCI for a given pavement management section (as opposed to a forty square meter segment), the user simply sums the individual PCI scores for the entire management section and then divides the number of scores by the number of summed sections
- For example, for a pavement management section that is 1.5 kilometers (1,500 meters) long, the user would sum the one hundred and fifty (150) individual PCIs (each corresponds to a ten meter length of pavement) and divide the sum by one hundred and fifty (150) to obtain the overall PCI for the 1,500 meter section

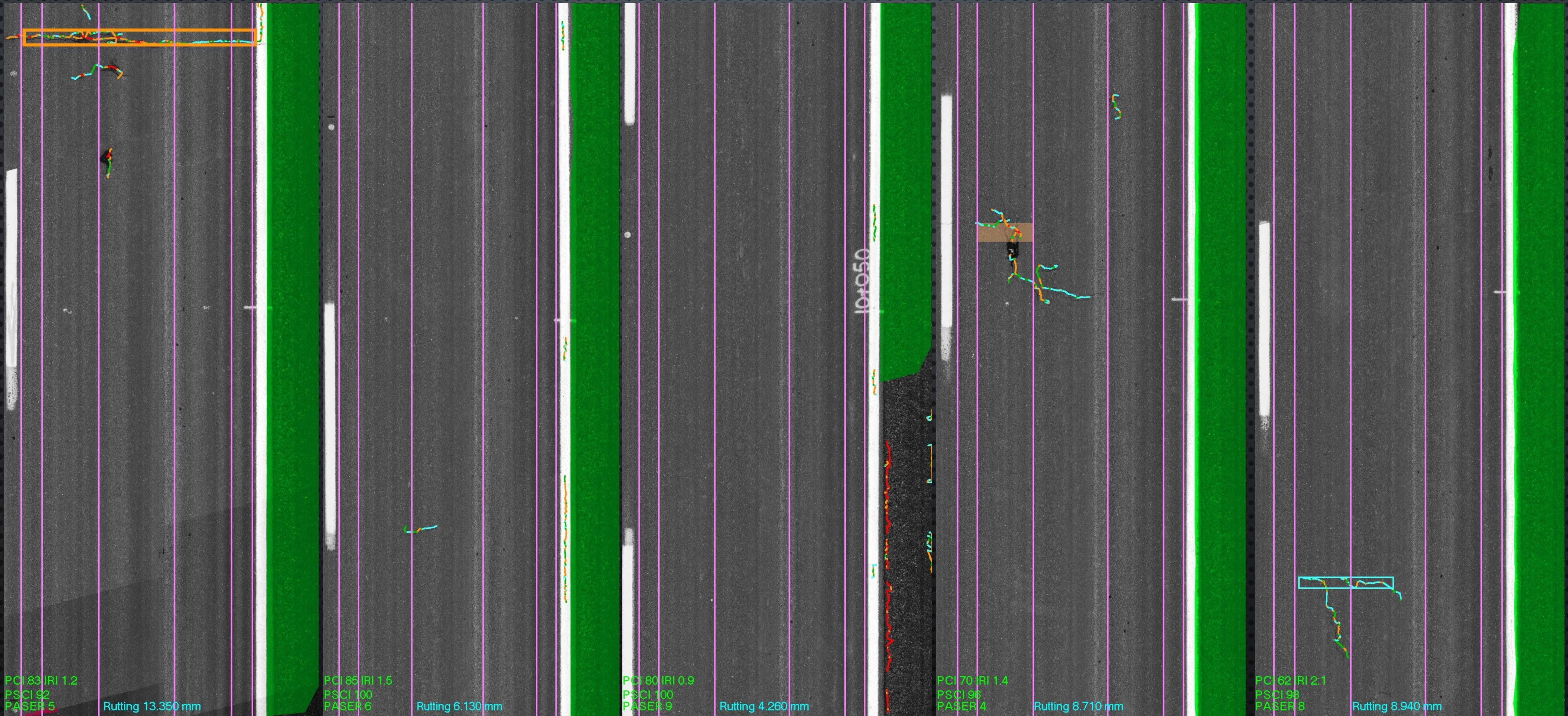
Test Plan

- Three 400m road sections were chosen with three different levels of IRI (smooth, average, high) to help determine accuracy.

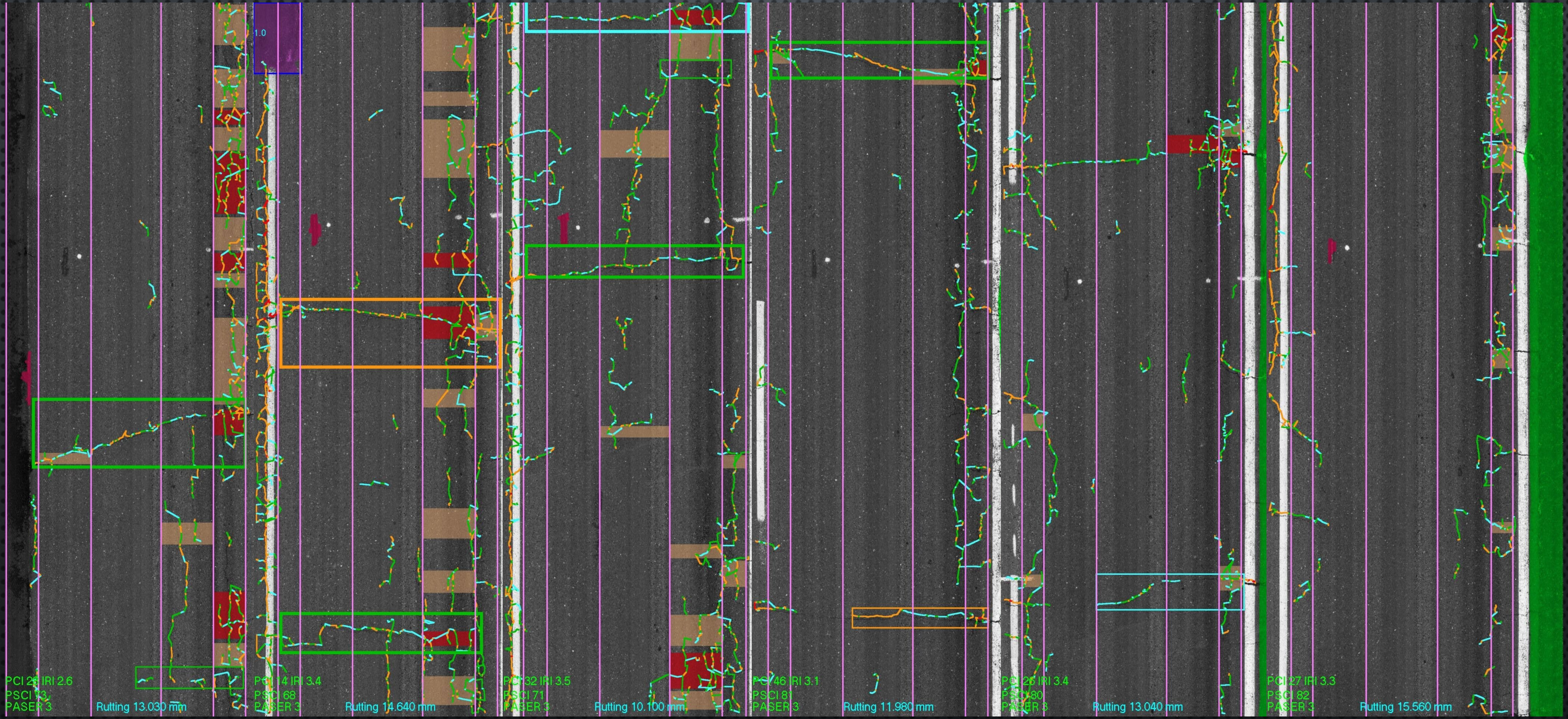
	Left	Right
Low :	1.33	1.45
Medium :	3.34	3.01
High :	7.46	8.05

- All three sections were scanned three times using LCMS-2 system to determine repeatability.
- All runs were compiled after evaluating each 10m road section and classifying them using the PCI, PASER and PSCI protocols.

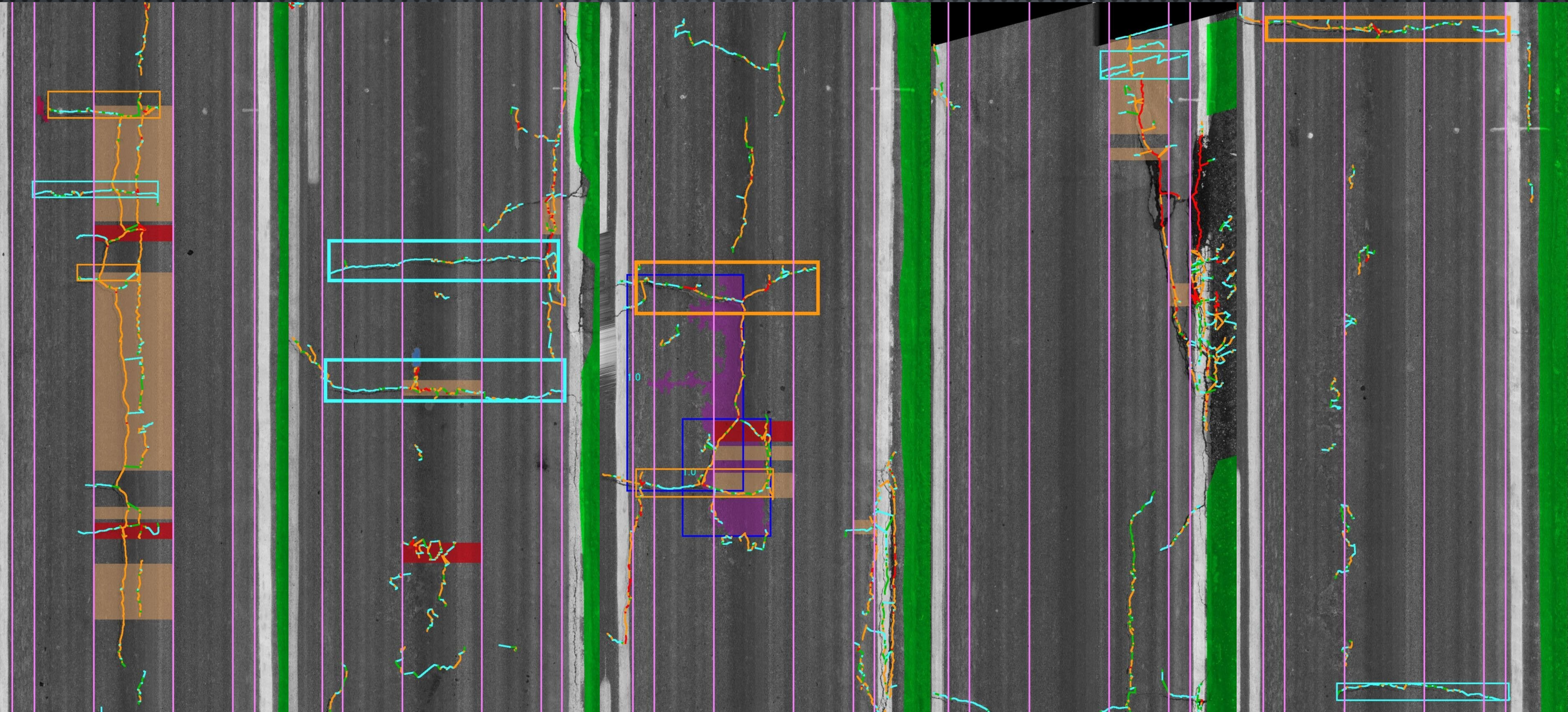
LOW IRI ROAD SECTION



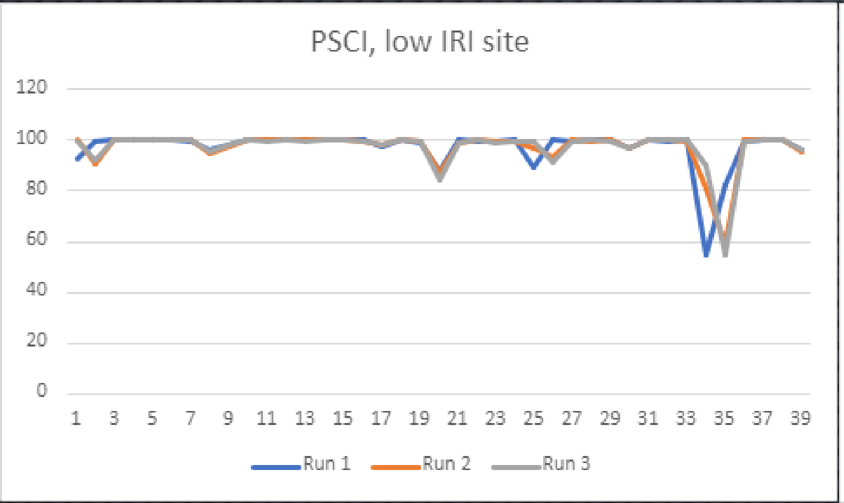
MEDIUM IRI ROAD SECTION

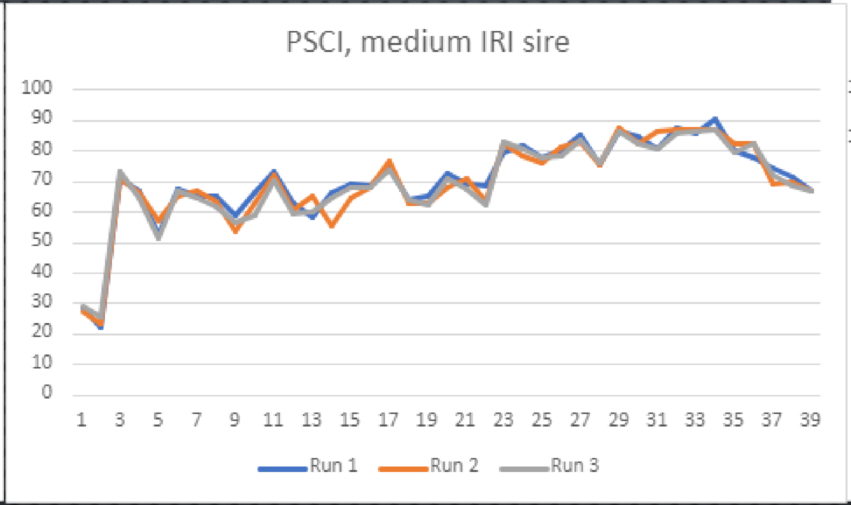


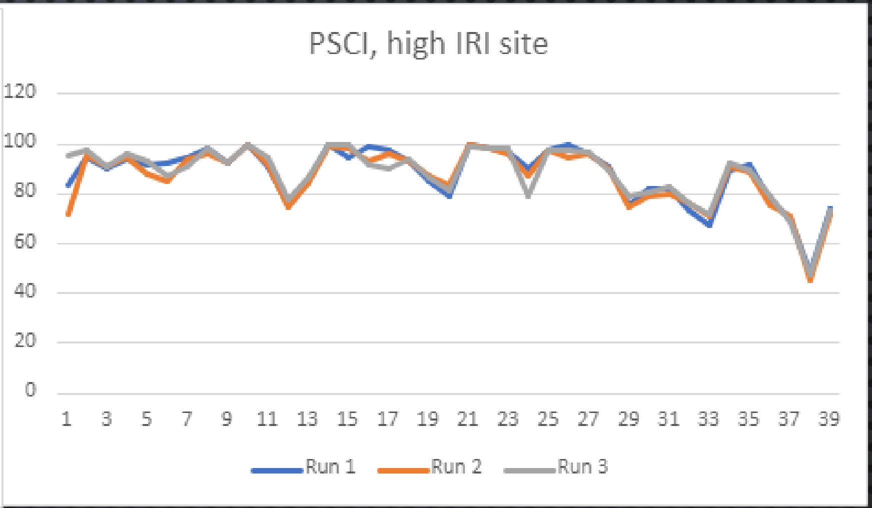
HIGH IRI ROAD SECTION



EVALUATION OF RESULTS - PSCI





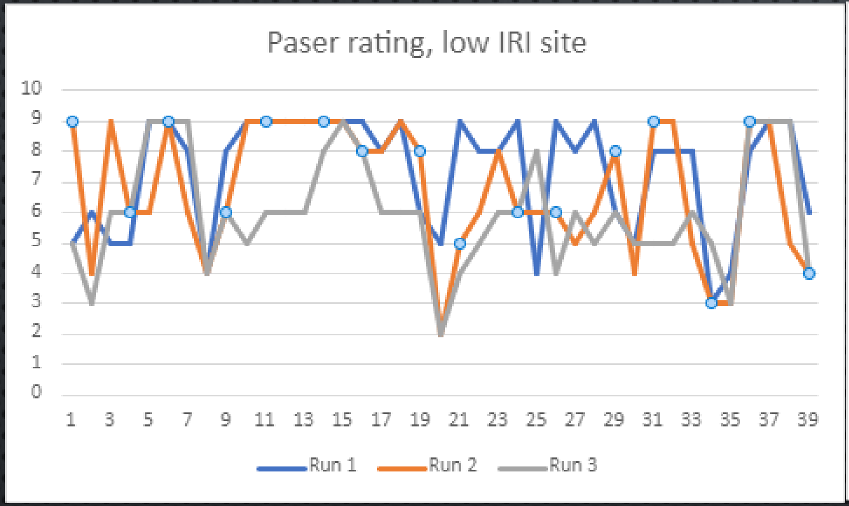


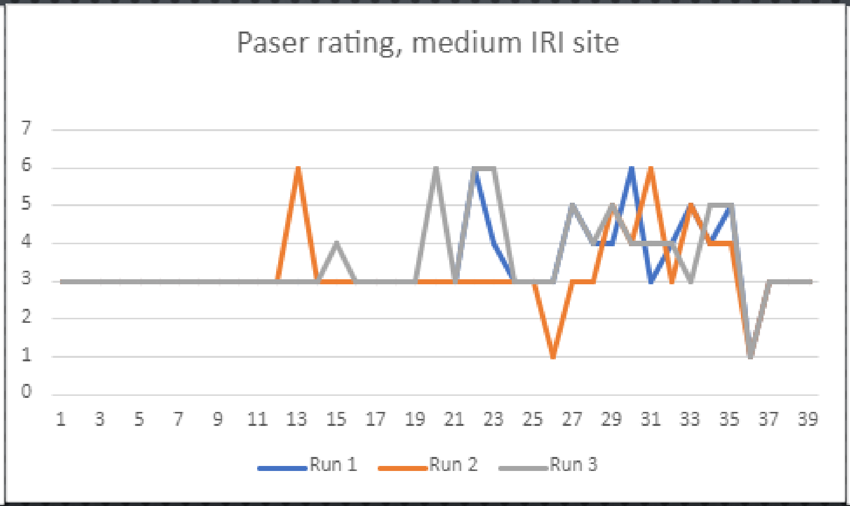
	Run 1	Run 2	Run 3	STD
Mean	97.17	97.19	97.26	0.04%

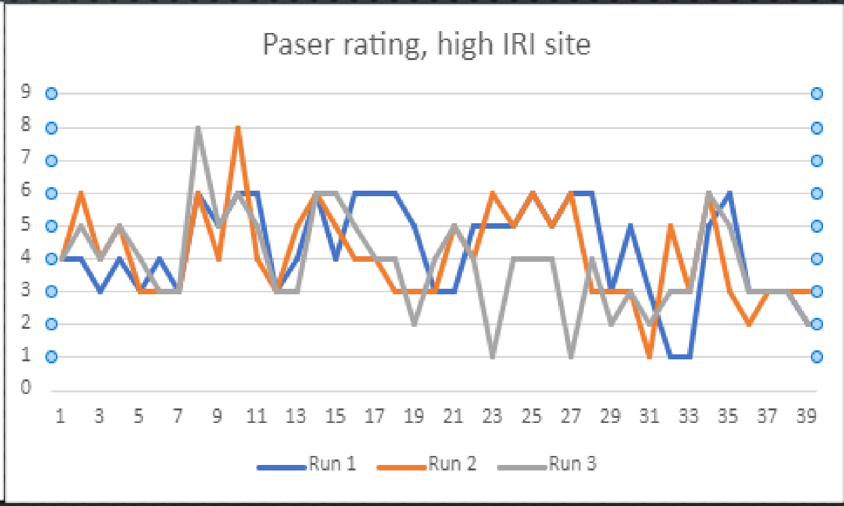
	Run 1	Run 2	Run 3	STD
Mean	70.38	69.60	69.33	0.64%

	Run 1	Run 2	Run 3	STD
Mean	87.97	86.99	88.19	0.60%

EVALUATION OF RESULTS - PASER





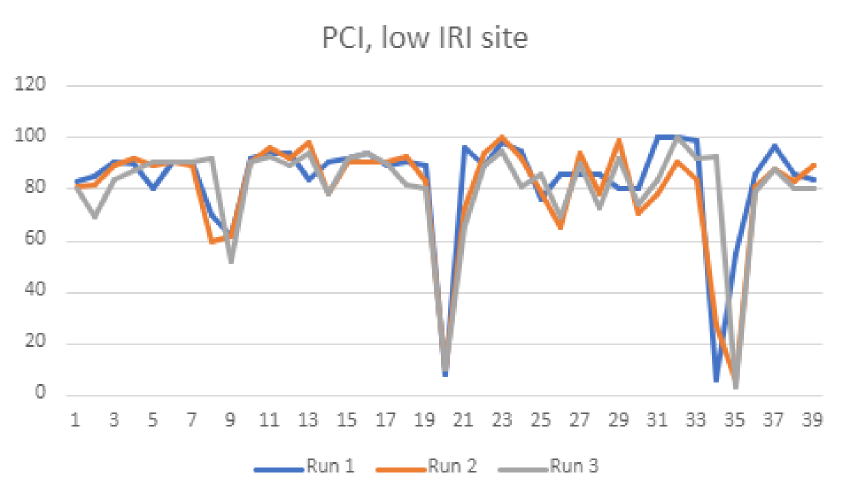


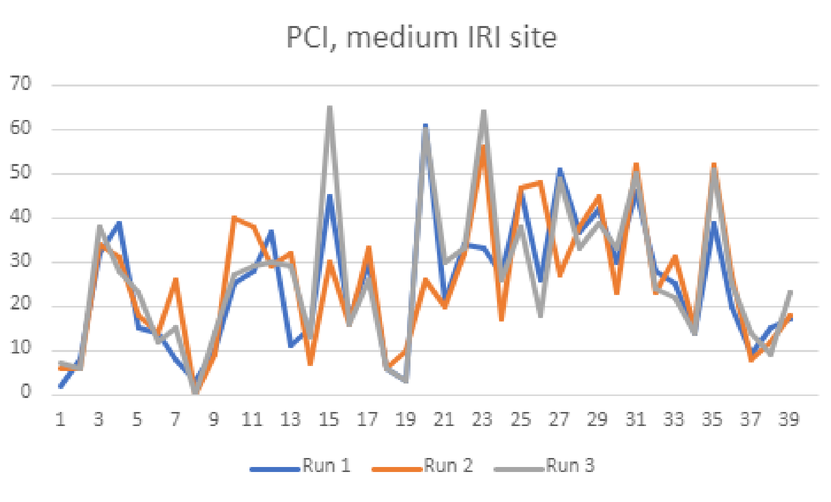
	Run 1	Run 2	Run 3	STD
Mean	7.38	6.77	6.03	8.3%

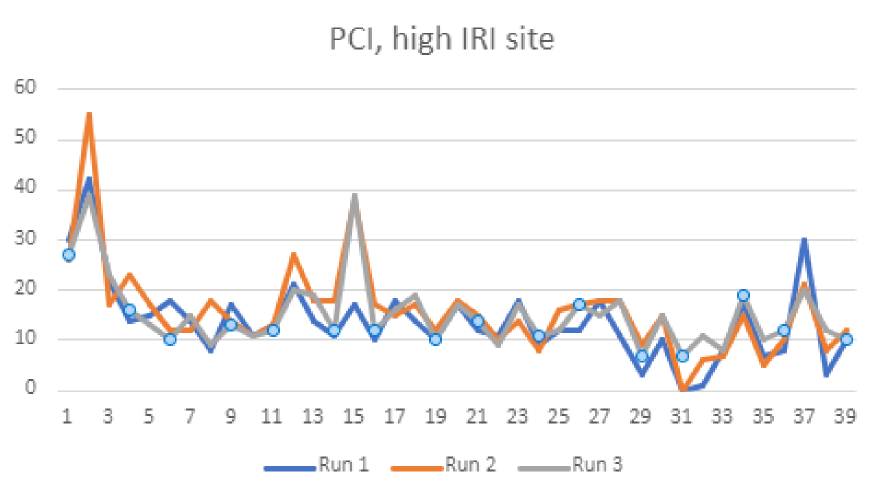
	Run 1	Run 2	Run 3	STD
Mean	3.38	3.23	3.51	3.4%

	Run 1	Run 2	Run 3	STD
Mean	4.28	4.13	3.87	4.1%

EVALUATION OF RESULTS – PCI





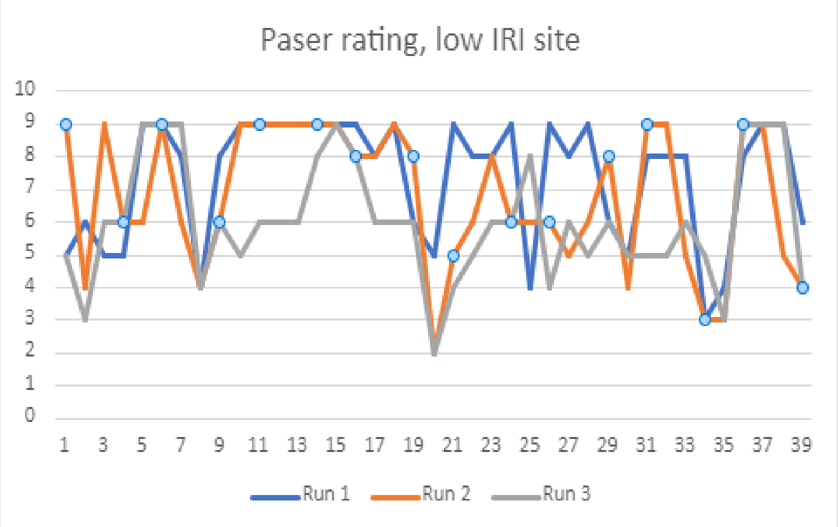


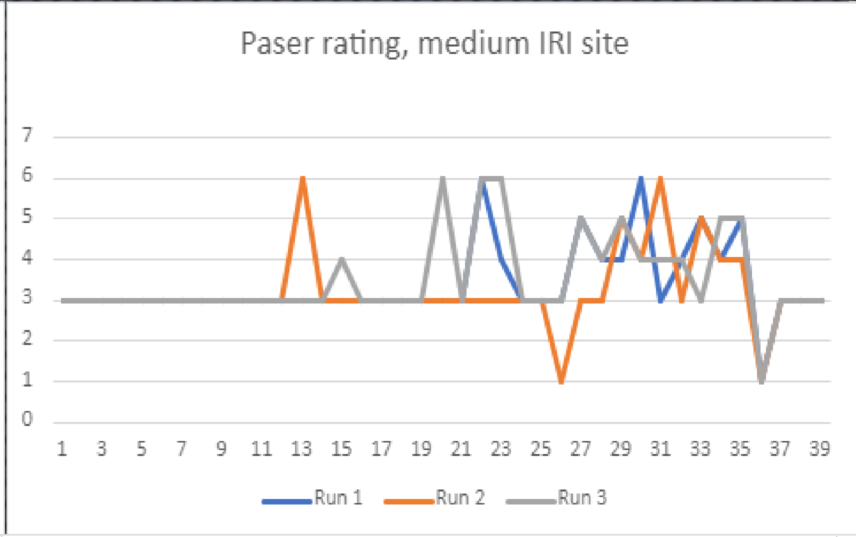
	Run 1	Run 2	Run 3	STD
Mean	83.23	80.00	80.62	1.72%

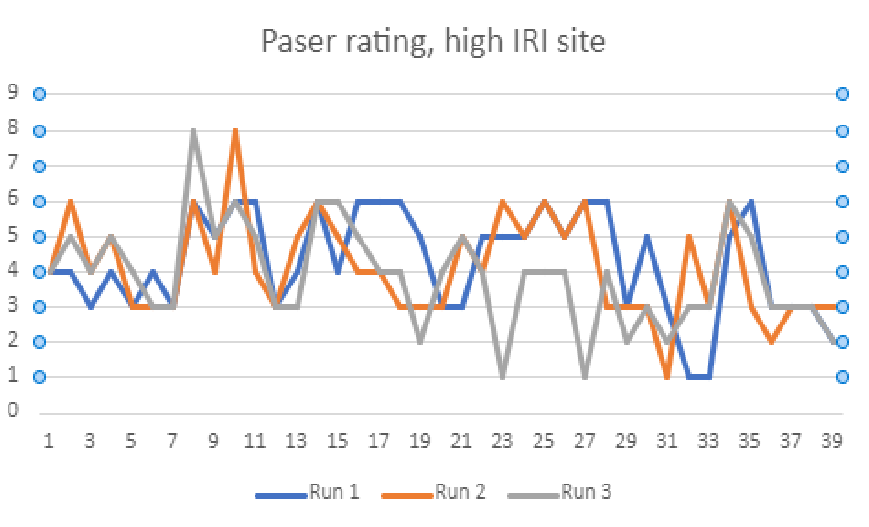
	Run 1	Run 2	Run 3	STD
Mean	24.85	25.69	26.72	2.97%

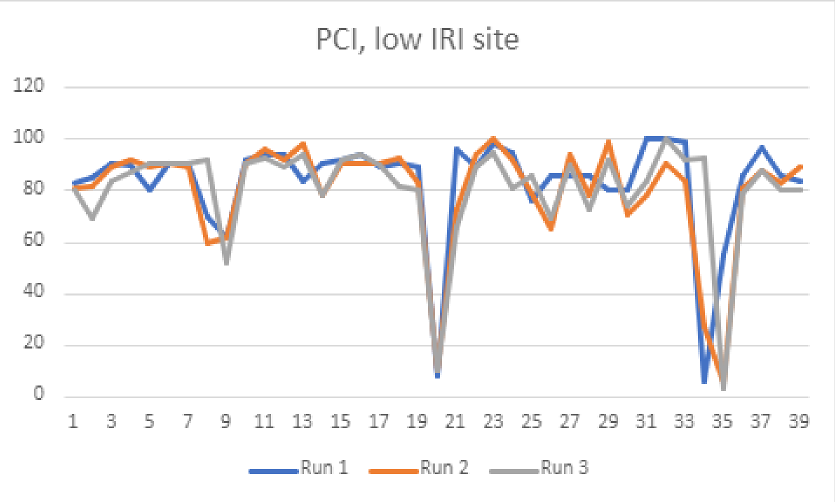
	Run 1	Run 2	Run 3	STD
Mean	13.74	15.95	15.28	6.16%

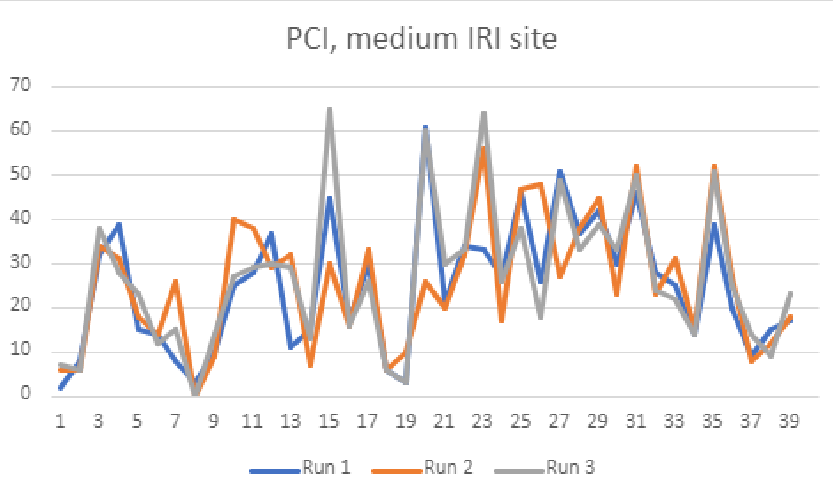
COMPARISON OF PASER VS PCI

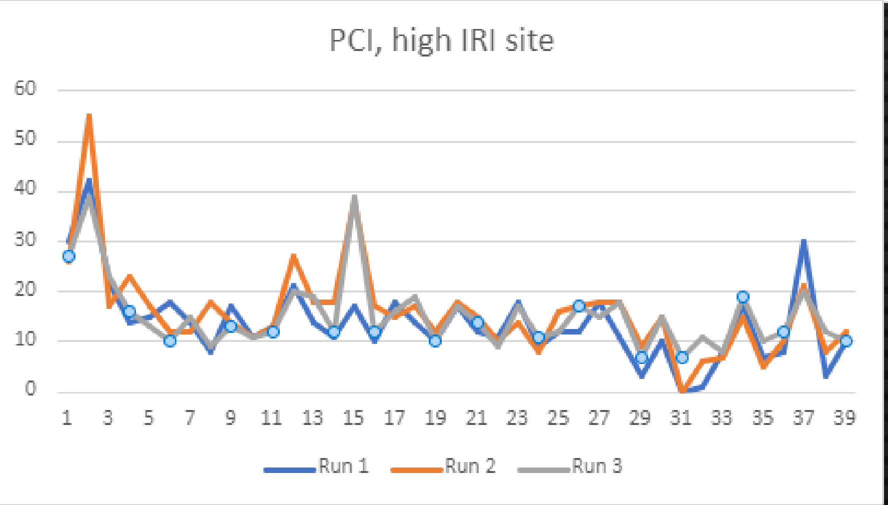












COMPARISON OF RESULTS

Low IRI | Medium IRI | High IRI

PSCI

Low IRI

	Run 1	Run 2	Run 3	STD
Mean	97.17	97.19	97.26	0.04%

Medium IRI

	Run 1	Run 2	Run 3	STD
Mean	70.38	69.60	69.33	0.64%

High IRI

	Run 1	Run 2	Run 3	STD
Mean	87.97	86.99	88.19	0.60%

PASER

Low IRI

	Run 1	Run 2	Run 3	STD
Mean	7.38	6.77	6.03	8.3%

Medium IRI

	Run 1	Run 2	Run 3	STD
Mean	3.38	3.23	3.51	3.4%

High IRI

	Run 1	Run 2	Run 3	STD
Mean	4.28	4.13	3.87	4.1%

PCI

Low IRI

	Run 1	Run 2	Run 3	STD
Mean	83.23	80.00	80.62	1.72%

Medium IRI

	Run 1	Run 2	Run 3	STD
Mean	24.85	25.69	26.72	2.97%

High IRI

	Run 1	Run 2	Run 3	STD
Mean	13.74	15.95	15.28	6.16%