

Association Mondiale de la Route
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PIARC Technical Committee 4.2 "Vehicle/Road Interaction" - WG D "Automated cracks detection"

International workshop on automated monitoring of pavement surface cracking conditions

**Standardisation method for qualifying and validating automated measurement systems :
 PIARC – WG D works**

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Former committee C1 "Surface Characteristics"

- 1996 - 1999 : "Surface distress assessment"

PIARC efforts towards harmonization
 Main recommendations :

- dimension of extent
- classes of severity
- reporting (research, project and network level)
- overall indices

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Former committee C1 "Surface Characteristics"

- 2000 - 2003 : "Automated pavement cracking assessment equipment – State of the art"

Overall view on :

- Identification harmonization efforts
- Status of technologies (2D and 3D)
- Evaluating the performance of automated equipment
- Experience with measuring distress in network mode

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TC 4.2 "Vehicle / road interaction"

- 2004 - 2007 : "Evaluating the performance of the automated pavement cracking equipment"

- 1) Inventory of the methods to detect cracks with the aim to increase reproducibility of their measurements
- 2) Setting up a method or procedure to assess and classify the crack automated measuring devices
- 3) Inventory of the methods to characterize and to record surface distress on unpaved roads

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1) INCREASE THE REPRODUCIBILITY OF THE CRACKS MEASUREMENTS

A. SURVEYED AREA

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1) INCREASE THE REPRODUCIBILITY OF THE CRACKS MEASUREMENTS

B. CRACKS DEFINITION

Type	Definition
Transversal cracking	Crack with an orientation $\leq 1:3$ (1 parallel and 3 perpendicular to the road axis) and which is present in 2 or more strips.
Longitudinal cracking	Crack with an orientation $> 1:3$
Edge cracking	Longitudinal crack distant less than 0.25 m from the edge-line. It is entirely in strip number 5.
Alligator cracking	Agglomeration of cracks in the form of a grid (at least 3 peaces in each direction). The diameter of peaces is less than 300 mm. If diameter is greater than 300 mm, then cracks are considered as distinct.
Multiple cracks	Agglomeration of cracks that run parallel and that are less than 300 mm apart (if more they are considered as distinct).

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1) INCREASE THE REPRODUCIBILITY OF THE CRACKS MEASUREMENTS

C. DEGREE OF SEVERITY

Cracks more than 1 m long

Simple	Multiple	Alligator or spalled
Degree corresponding to the maximum aperture encountered on more than 25 % of the length	Medium or high severity depending on the maximum aperture encountered on more than 25 % of the length	Always high severity

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1) INCREASE THE REPRODUCIBILITY OF THE CRACKS MEASUREMENTS

D. EXTENT OF CRACKS

Three phases

Calibration under controlled conditions	Validation at project level	Validation at network level
Real length	Allocated cells

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2) SETTING A METHOD TO ASSESS THE AUTOMATED CRACK MEASUREMENT DEVICES PERFORMANCES

Phase 1 – Calibration under controlled conditions

Artificially fissured tracks

Sampling unit	Crack
Number of tracks	1
Number of cracks per tracks	170
Number of longitudinal cracks	150 (1 cell)
Number of transversal crack	20 (5 cells)
Track length	300m (2 directions = 600m)
Available cells	300
Used cells	250
Number of repetitions	5

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Phase 1 – Calibration under controlled conditions

Data and data analysis

Track #	Rep #	Location Start	Location Finish	Band #	Length (m)	Severity (mm)
SAW	1	0+000	0+010	1		
SAW	1	0+000	0+010	2		
SAW	1	0+000	0+010	4		
SAW	1	0+000	0+010	5		
SAW	1	0+010	0+020	9		
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Phase 1 – Calibration under controlled conditions

Example of results : portion of detected cracks

Repetition	Band #1 (n=27)	Band #2 (n=29)	Band #3 (n=29)	Band #4 (n=30)	Band #5 (n=33)	Transversal (n=20)	All (n=168)
1	100 %	97 %	87 %	97 %	72 %	100 %	91 %
2	96 %	100 %	93 %	90 %	72 %	100 %	91 %
3	93 %	100 %	93 %	100 %	70 %	100 %	92 %
4	93 %	97 %	93 %	97 %	76 %	100 %	92 %
5	89 %	97 %	93 %	90 %	70 %	100 %	89 %
All	94 %	98 %	92 %	95 %	72 %	100 %	91 %

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Phase 1 – Calibration under controlled conditions

Example of results : crack length (m)

Direction	Start	Band	Reference	Mean of 5 reps.	Std. Dev.	C.V.	Bias	Relative Bias
South	0	1	5	5.04	0.18	0.036	0.04	0.8 %
South	20	1	5	4.71	0.12	0.024	-0.30	-5.9 %
South	30	1	5	4.66	0.10	0.020	-0.34	-6.8 %
South	50	1	3	2.87	0.08	0.027	-0.13	-4.4 %
South	70	1	8	7.85	0.13	0.016	-0.15	-1.8 %
South	110	1	3	2.85	0.14	0.047	-0.15	-4.9 %
South	140	1	5	3.16	2.20	0.440	-1.84	-36.9 %

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Phase 1 – Calibration under controlled conditions

Example of results : crack severity (mm)

Direction	Start	Band	Reference	Mean of 5 reps.	Std. Dev.	C.V.	Bias	Relative Bias
North	0	1	3	5.9	1.20	0.400	2.9	96.7 %
North	20	1	3	5.5	1.18	0.393	2.5	83.3 %
North	40	1	2	4.8	1.95	0.975	2.8	140.0 %
North	70	1	8	7.6	2.66	0.333	- 0.4	- 5.0 %
North	110	1	8	7.9	1.20	0.150	- 0.1	- 1.3 %
North	130	1	5	5.3	1.16	0.232	0.3	6.0 %

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2) SETTING A METHOD TO ASSESS THE AUTOMATED CRACK MEASUREMENT DEVICES PERFORMANCES

Phase 1 – Calibration under controlled conditions

Classification thresholds
 For detection and bias

Class	Correctly detected cracks	Length (cracks with relative bias < 7.5 %)	Severity (Cracks with relative bias < 20 %)
AAA	100 %	100 %	100 %
AA	> 90 %	> 90 %	> 85 %
A	> 80 %	> 80 %	> 70 %
B	> 70 %	> 70 %	> 60 %
C	< 70 %	< 70 %	< 60 %

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Phase 1 – Calibration under controlled conditions

Classification thresholds
 For repeatability

Class	Length (cracks with C.V. < TBD %)	Severity (Cracks with C.V. < TBD %)
AAA	100 %	100 %
AA	> 90 %	> 85 %
A	> 80 %	> 70 %
B	> 70 %	> 60 %
C	< 70 %	< 60 %

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2) SETTING A METHOD TO ASSESS THE AUTOMATED CRACK MEASUREMENT DEVICES PERFORMANCES

Phase 2 – Project level validation test

Description of the tracks

Sampling unit	1m section
Number of tracks	10
Number of cracks per tracks	Variable
Number of longitudinal cracks	Variable
Number of transversal crack	Variable
Length of the tracks	50m
Cells per track	250
Total number of cells	2500
Repetitions for bias	3
Repetitions for repeatability	3

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Phase 2 – Project level validation test

Data and data analysis

- Cracking rate : number of allocated cells divided by 250 (total number of cells);
- Concordance with the reference :
 - Position of the allocated cells;
 - Severity of allocated cells.

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Phase 2 – Project level validation test

Classification thresholds

For detection and bias

Class	Cracking rate	Cells with crack Concordance with reference	Crack severity Concordance with reference
AAA	± 1 % from reference	100 %	100 %
AA	± 2.5 % from reference	> 95 %	> 90 %
B	± 5 % from reference	> 90 %	> 80 %
C	± 10 % from reference	> 80 %	> 70 %
D	> 10 % from reference	< 80 %	< 70 %

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2) SETTING A METHOD TO ASSESS THE AUTOMATED CRACK MEASUREMENT DEVICES PERFORMANCES

Phase 2 – Project level validation test

Classification thresholds

For repeatability

Class	Cracking rate	Crack presence (cells concordance)	Crack severity (cells concordance)
AAA	C.V. < TBD	C.V. < TBD	C.V. < TBD
AA	C.V. < TBD	C.V. < TBD	C.V. < TBD
B	C.V. < TBD	C.V. < TBD	C.V. < TBD
C	C.V. < TBD	C.V. < TBD	C.V. < TBD
D	C.V. < TBD	C.V. < TBD	C.V. < TBD

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2) SETTING A METHOD TO ASSESS THE AUTOMATED CRACK MEASUREMENT DEVICES PERFORMANCES

Phase 3 – Network level validation test

- Test conditions (texture, weather, ruts, aso)
- 50 km-long section
- Once per month

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