Crackscope—
Automated System for Pavement Cracking Inspection

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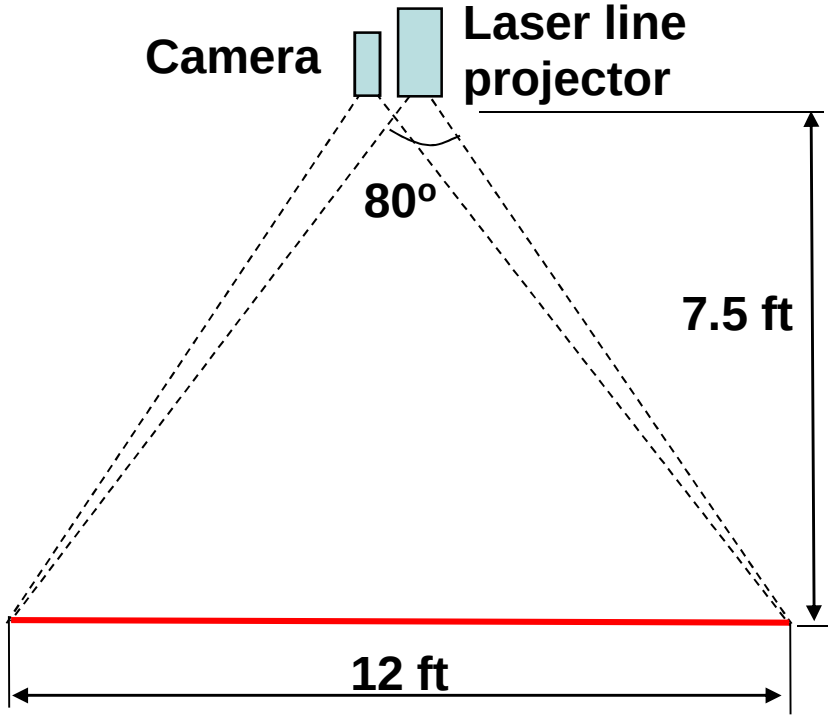
System Evolution
(in 1999-2010)

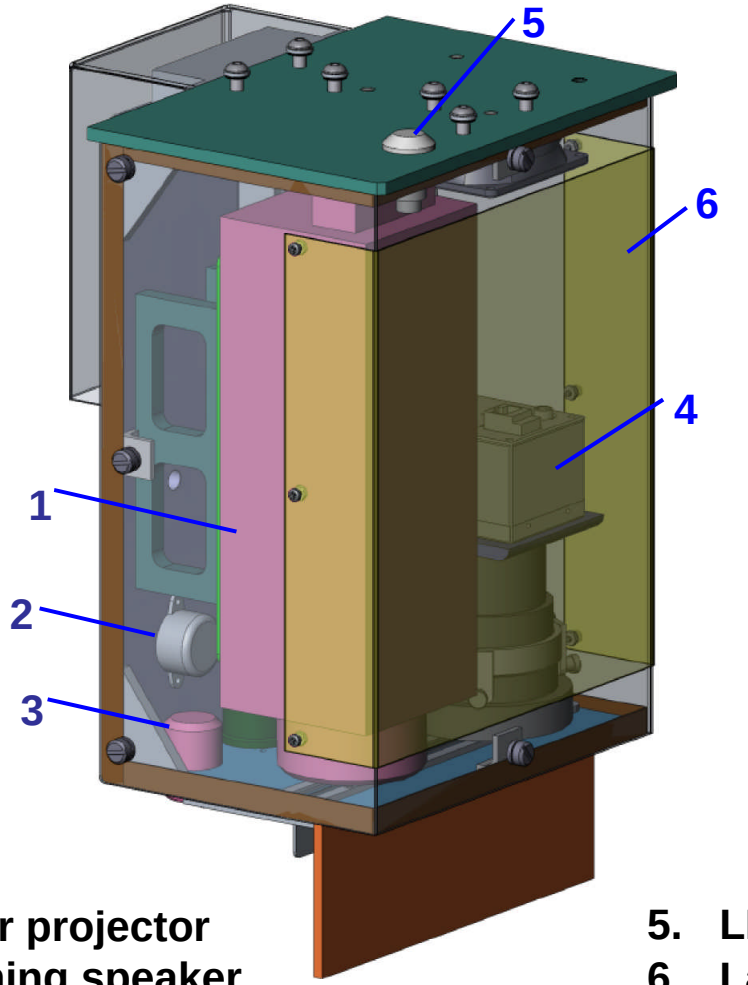
- **LED light bar, 2k linescan camera**
- **Laser line projector, 2k linescan camera**
- **Laser line projector, 4k linescan camera**
- **Natural light, dual 2k linescan cameras**

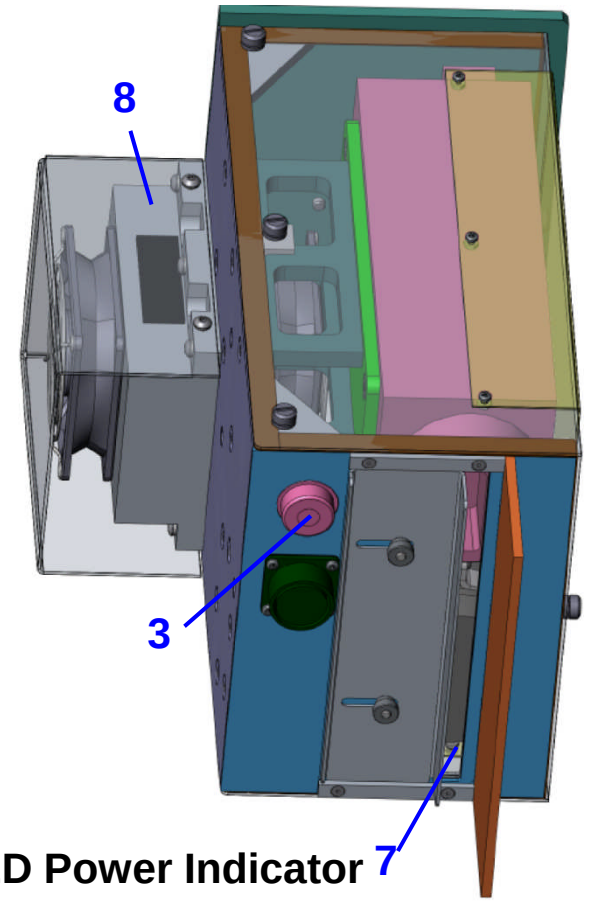
Laser Illumination



Crackscope

Crackscope





1. Laser projector
2. Warning speaker
3. Proximity sensor
4. Linescan camera
5. LED Power Indicator
6. Laser warning Sign
7. Open window
8. Thermoelectric cooling assembly

Performance

1. Power consumption: <150w
2. Image: 2k x (2~6)k, in JPEG, BMP, AVI
3. Dimension: 13x9x7 inches
4. Laser safety: automatic and manual
5. Camera calibration: automatic
6. Real-time image saving and analysis.
7. PMIS and AASHTO data and crackmap
8. Severity estimate (crack width)

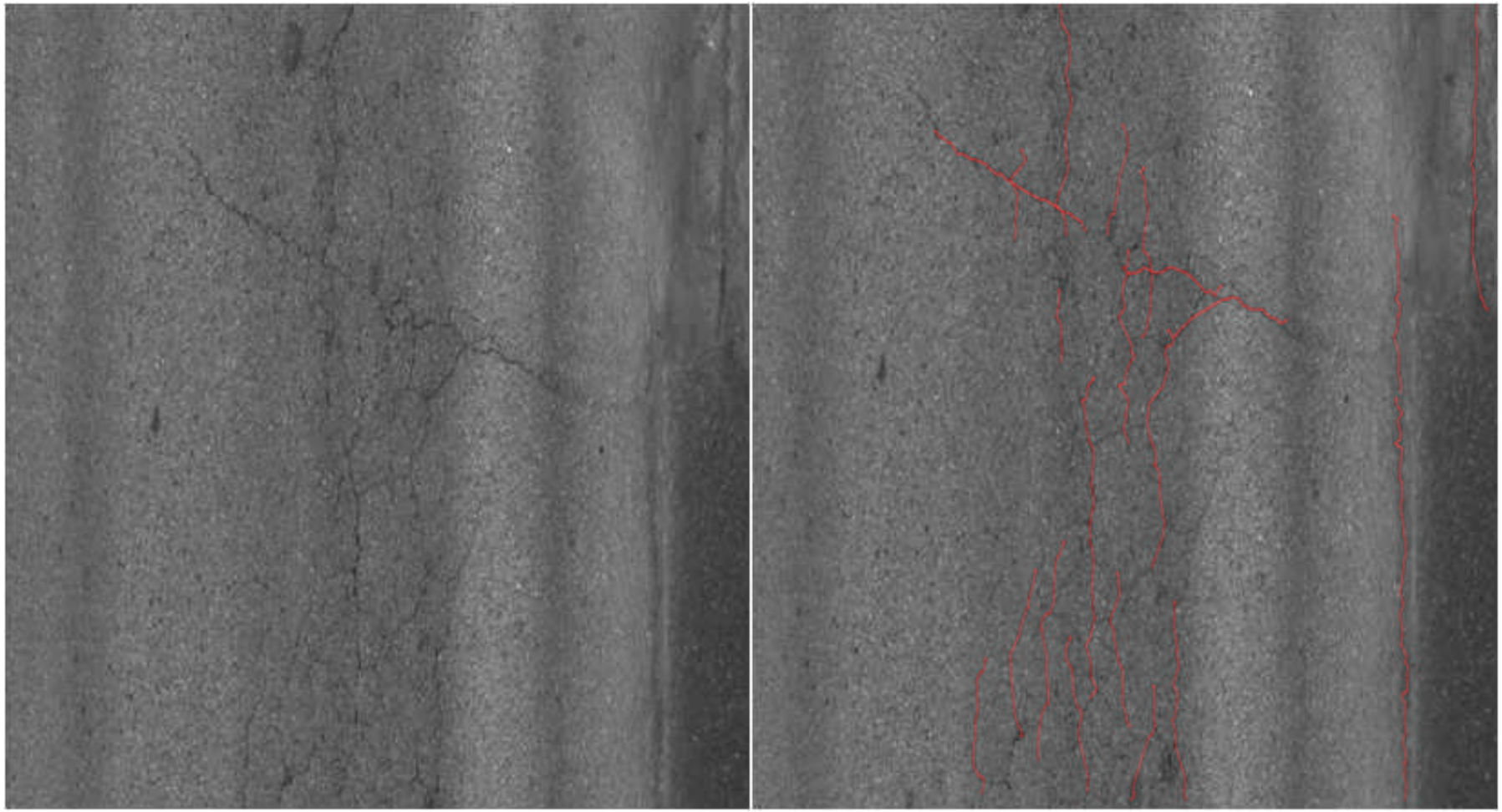
Laser Safety

1. **Proximity sensors: alarm at 4ft; shut off laser at 2ft**
2. **Speed modulation: shuts off laser at 5mph**
3. **Interlock switch: arbitrarily shuts off laser.**

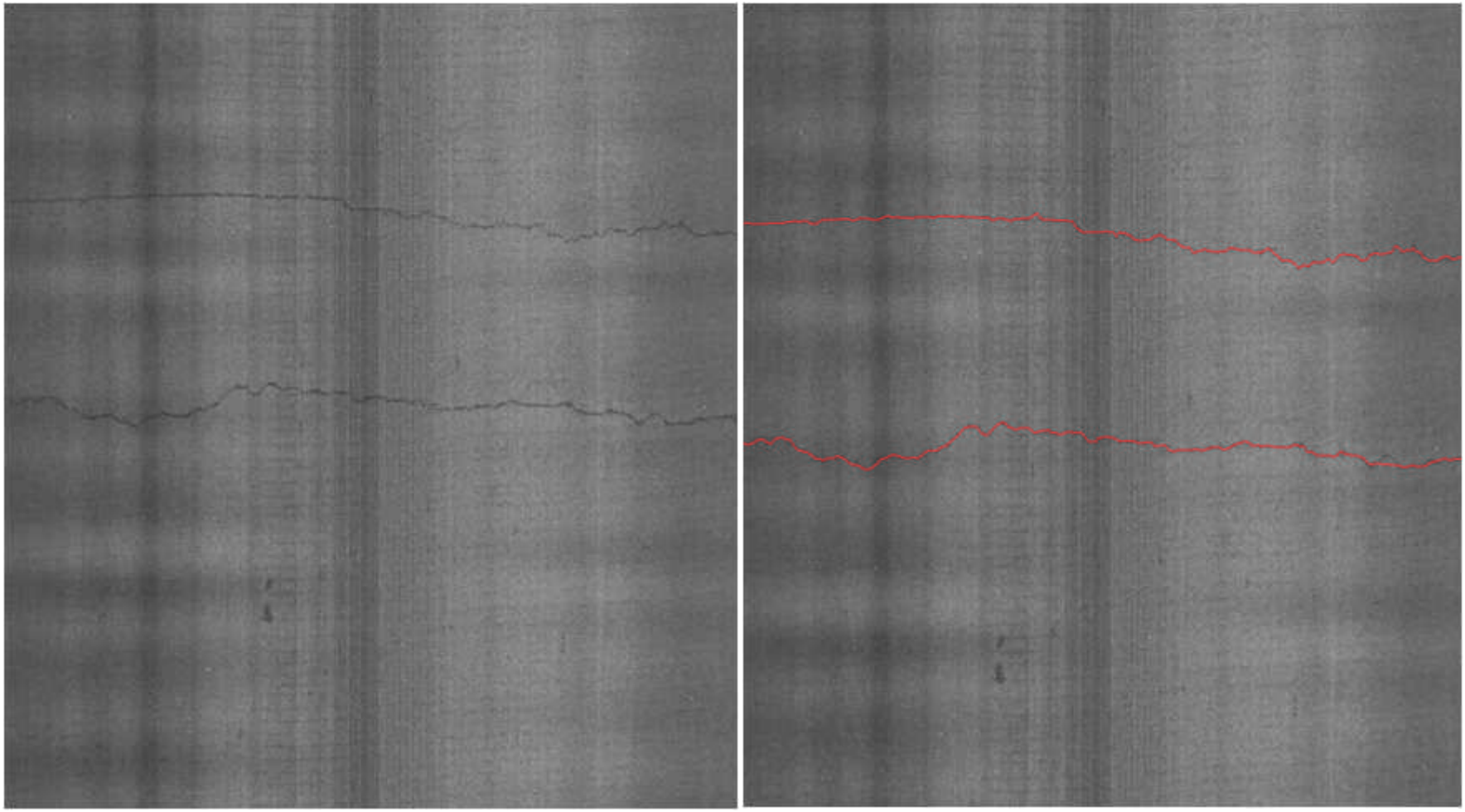
Camera calibration

1. Provide a white, clean object to cover the entire width.
2. Adjust pixel coefficients through the software.
3. Proceed automatically in 2-3 minutes.

Asphalt Alligator Cracking



Concrete Transverse Cracks

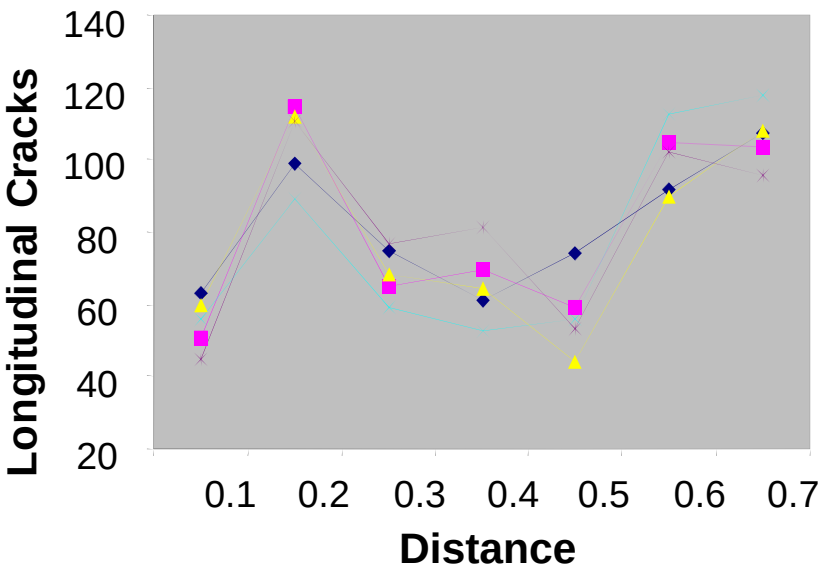


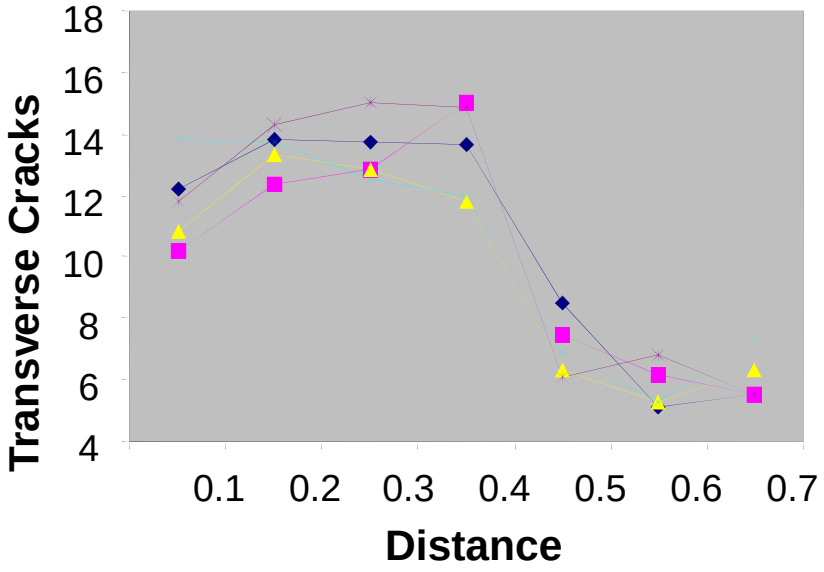
Concrete Transverse Cracks

Pavement Scanned on 4/23/08

Longitudinal Cracks (ft)								
	0.1 mi	0.2 mi	0.3 mi	0.4 mi	0.5 mi	0.6 mi	0.7 mi	Total
average	54.89	105.02	68.79	65.74	57.44	100.22	106.50	558.60
std	7.33	10.77	7.22	10.59	10.81	9.63	8.04	12.49
cv	0.13	0.10	0.11	0.16	0.19	0.10	0.08	0.02

Transverse Cracks (count)								
	0.1 mi	0.2 mi	0.3 mi	0.4 mi	0.5 mi	0.6 mi	0.7 mi	Total
average	11.78	13.49	13.42	13.46	7.05	5.76	6.05	71.01
std	1.39	0.72	1.03	1.55	0.95	0.73	0.79	2.92
cv	0.12	0.05	0.08	0.11	0.13	0.13	0.13	0.04

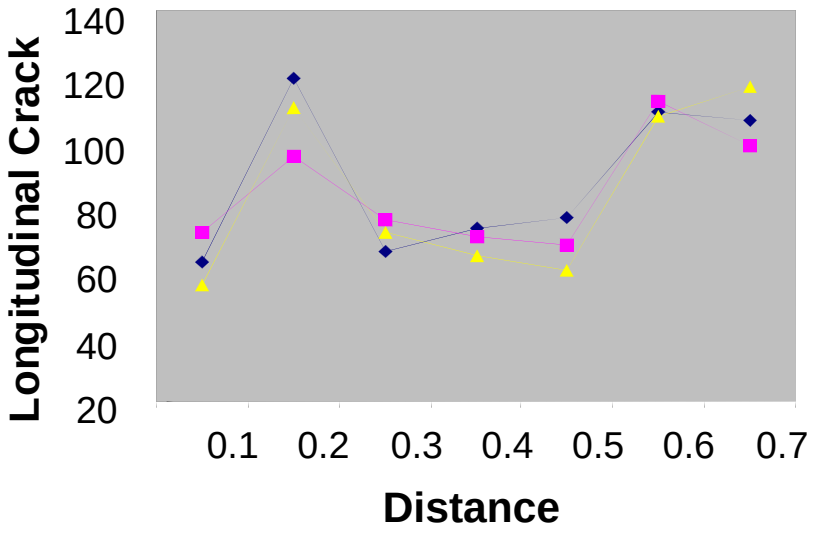


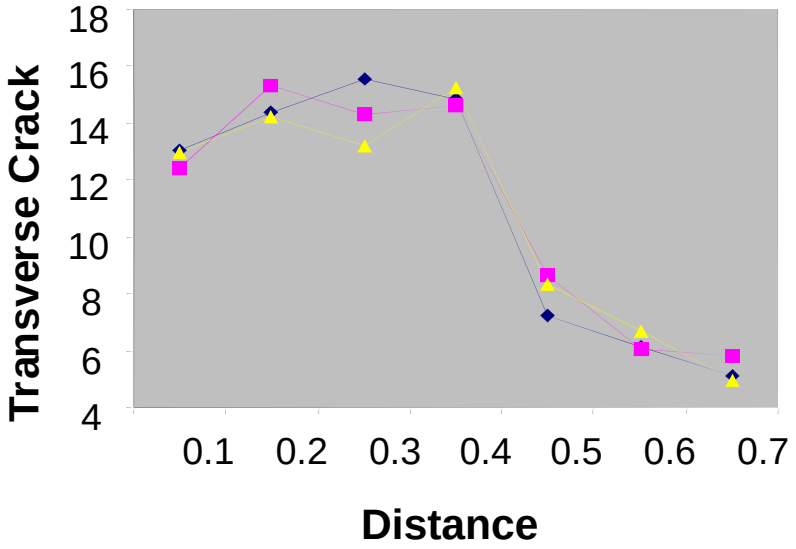


Pavement Scanned on 05/06/08

Longitudinal Cracks (ft)								
	0.1 mi	0.2 mi	0.3 mi	0.4 mi	0.5 mi	0.6 mi	0.7 mi	Total
average	63.50	108.08	71.18	69.47	68.11	109.22	107.11	596.67
std	8.02	12.10	5.01	4.24	8.28	2.33	8.98	13.67
cv	0.13	0.11	0.07	0.06	0.12	0.02	0.08	0.02

Transverse Cracks (count)								
	0.1 mi	0.2 mi	0.3 mi	0.4 mi	0.5 mi	0.6 mi	0.7 mi	Total
average	12.81	14.65	14.35	14.90	8.03	6.27	5.30	76.31
std	0.35	0.61	1.20	0.31	0.74	0.35	0.46	0.78
cv	0.03	0.04	0.08	0.02	0.09	0.06	0.09	0.01

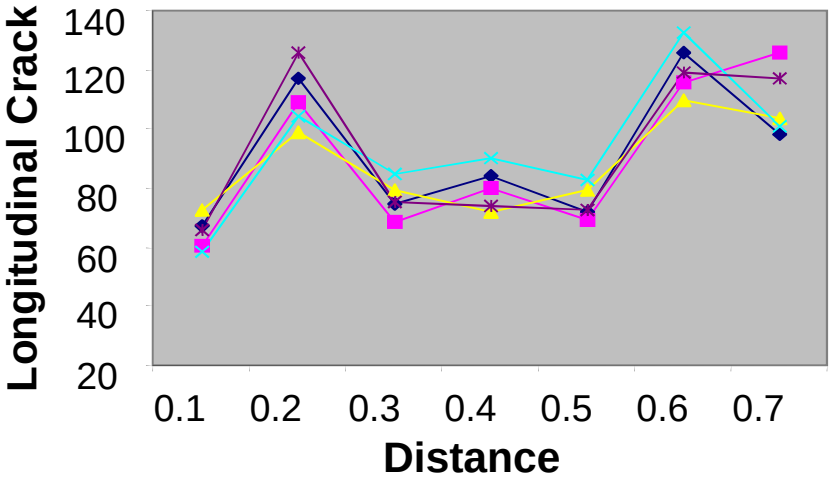


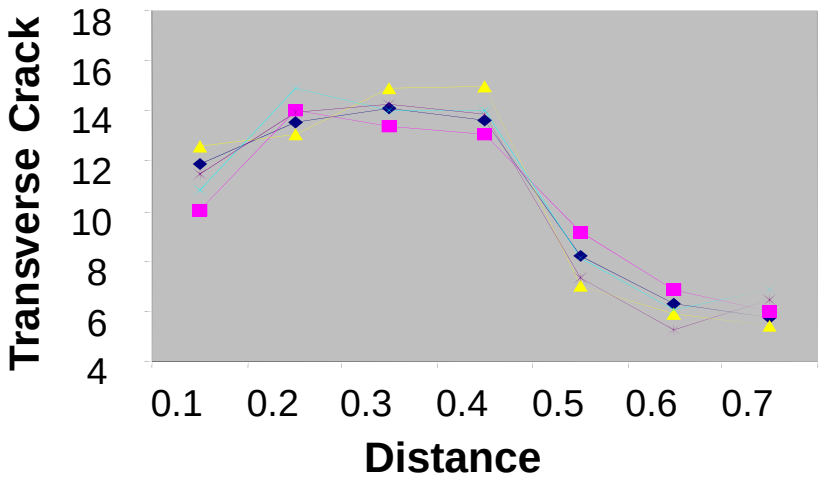


Pavement Scanned on 06/11/08

Longitudinal Cracks (ft)								
	0.1 mi	0.2 mi	0.3 mi	0.4 mi	0.5 mi	0.6 mi	0.7 mi	Total
average	64.77	111.20	76.59	79.95	75.28	120.54	109.05	637.38
std	5.65	10.66	6.04	7.33	5.68	8.94	11.83	15.91
cv	0.09	0.10	0.08	0.09	0.08	0.07	0.11	0.02

Transverse Cracks (count)								
	0.1 mi	0.2 mi	0.3 mi	0.4 mi	0.5 mi	0.6 mi	0.7 mi	Total
average	11.36	13.90	14.12	13.91	7.99	6.08	6.10	73.47
std	0.96	0.69	0.54	0.69	0.85	0.56	0.54	0.96
cv	0.08	0.05	0.04	0.05	0.11	0.09	0.09	0.01

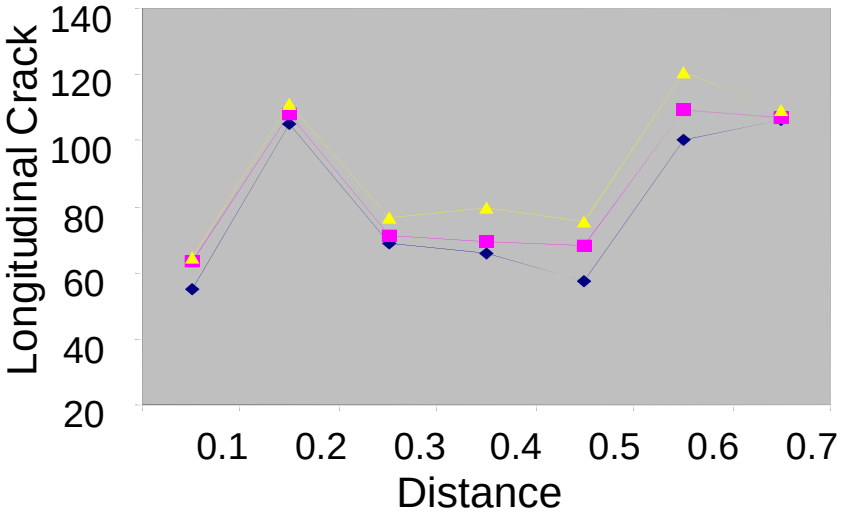


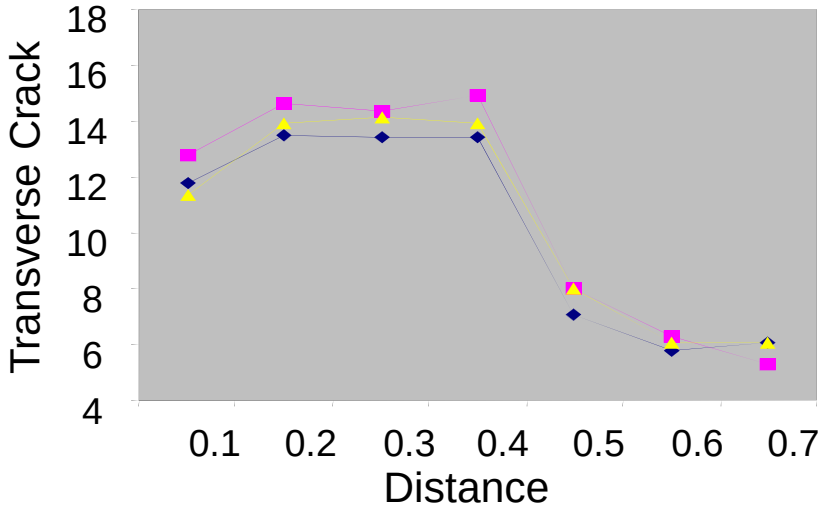


All Scans

Longitudinal Cracks (ft)								
	0.1 mi	0.2 mi	0.3 mi	0.4 mi	0.5 mi	0.6 mi	0.7 mi	Total
average	**60.68**	**108.10**	**72.34**	**72.06**	**66.76**	**110.11**	**107.62**	**597.69**
std	**7.89**	**10.44**	**6.85**	**10.13**	**11.32**	**12.03**	**9.11**	**38.22**
cv	**0.13**	**0.10**	**0.09**	**0.14**	**0.17**	**0.11**	**0.08**	**0.06**

Transverse Cracks (count)								
	0.1 mi	0.2 mi	0.3 mi	0.4 mi	0.5 mi	0.6 mi	0.7 mi	Total
average	**11.85**	**13.92**	**13.90**	**13.97**	**7.64**	**6.00**	**5.90**	**73.18**
std	**1.14**	**0.78**	**0.93**	**1.14**	**0.93**	**0.59**	**0.68**	**2.78**
cv	**0.10**	**0.06**	**0.07**	**0.08**	**0.12**	**0.10**	**0.11**	**0.04**





Complementary Imaging
(Dual cameras and Natural light)

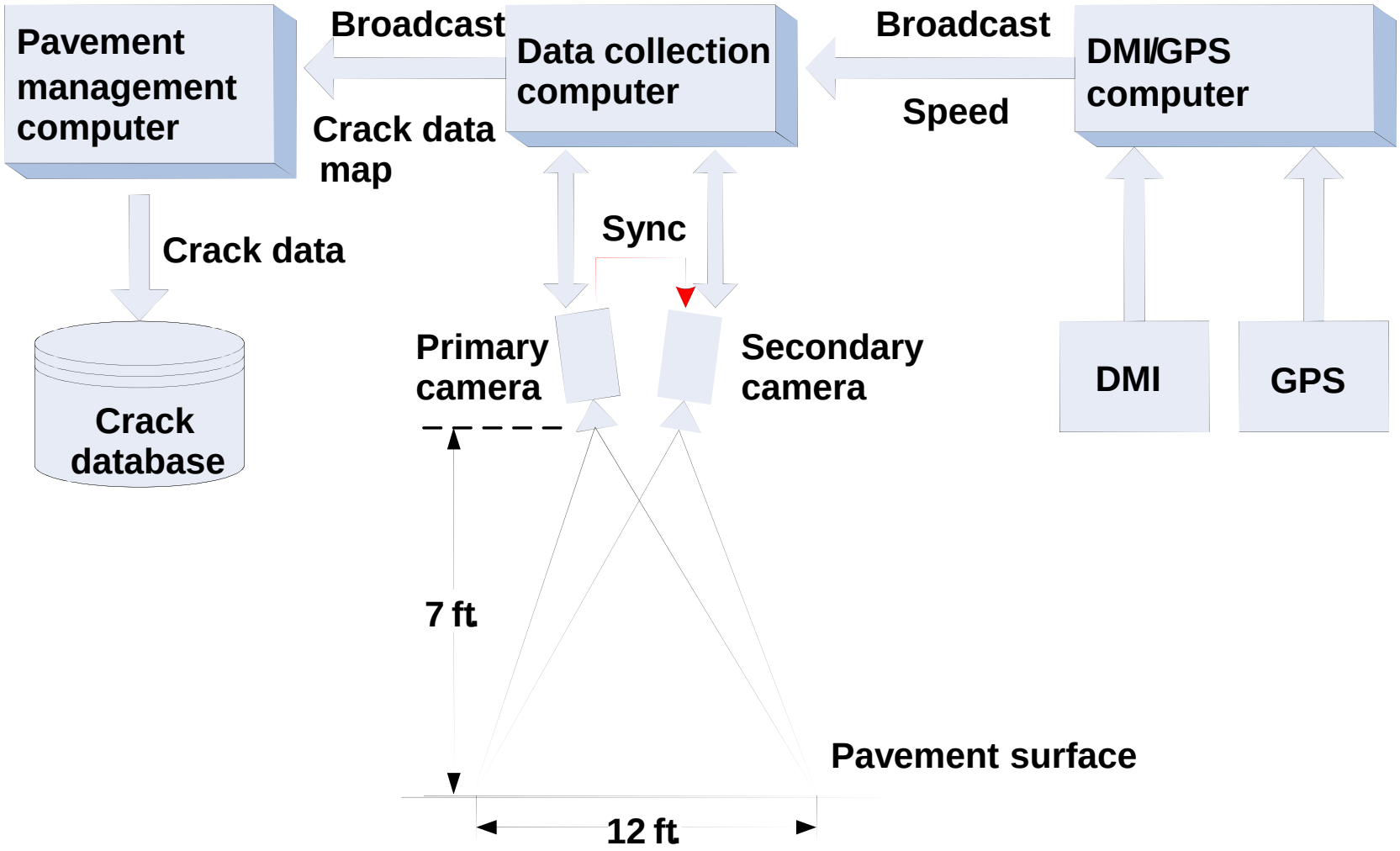
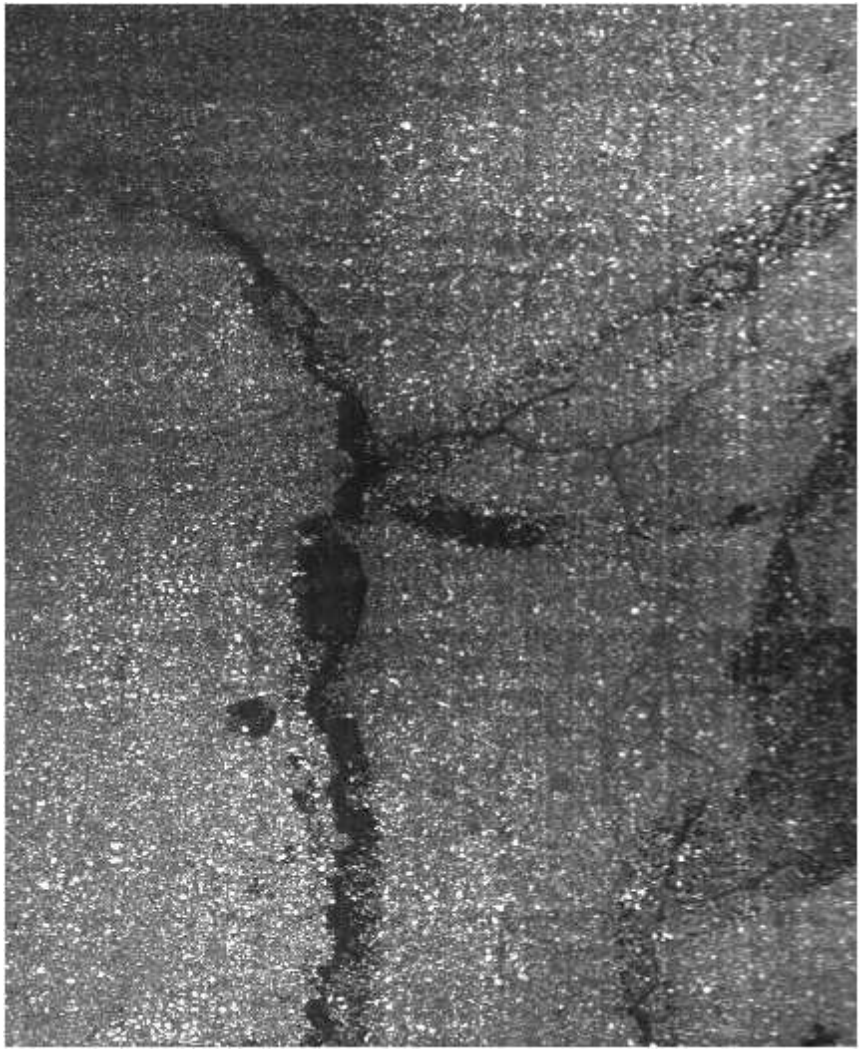


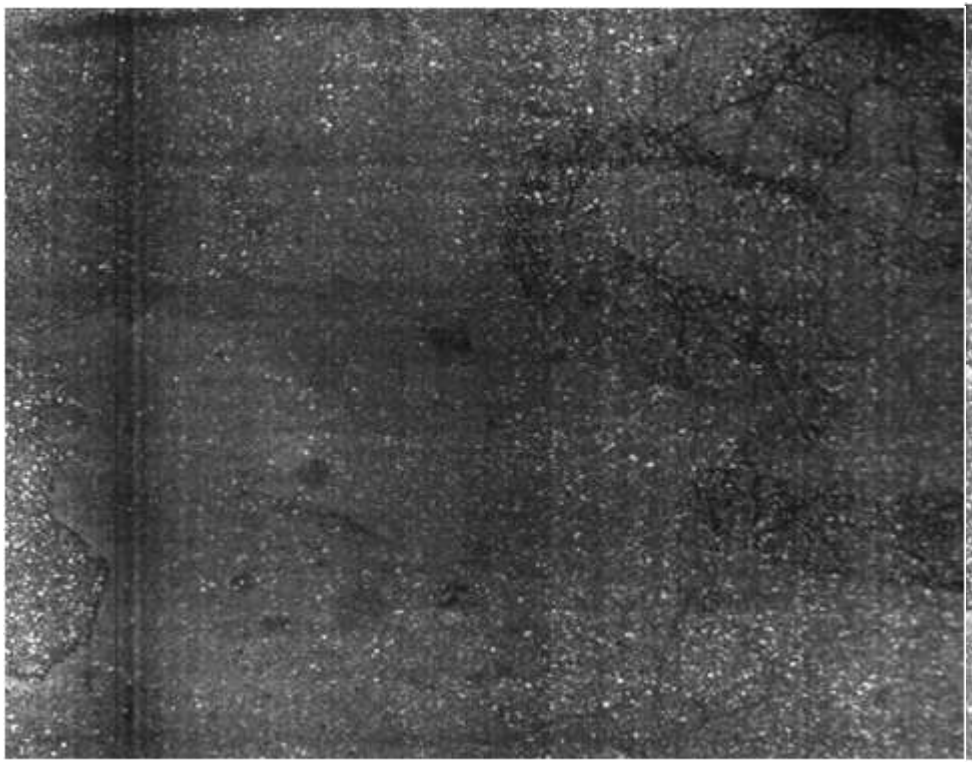
Image Comparisons



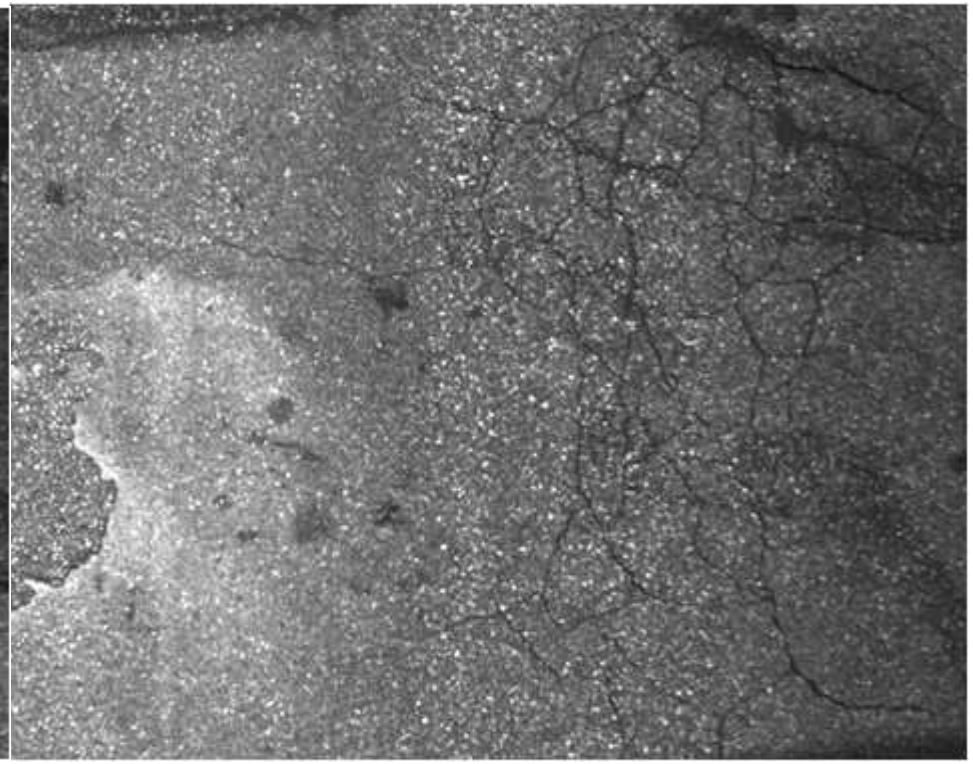
Laser illumination

Daylight

Image Comparisons

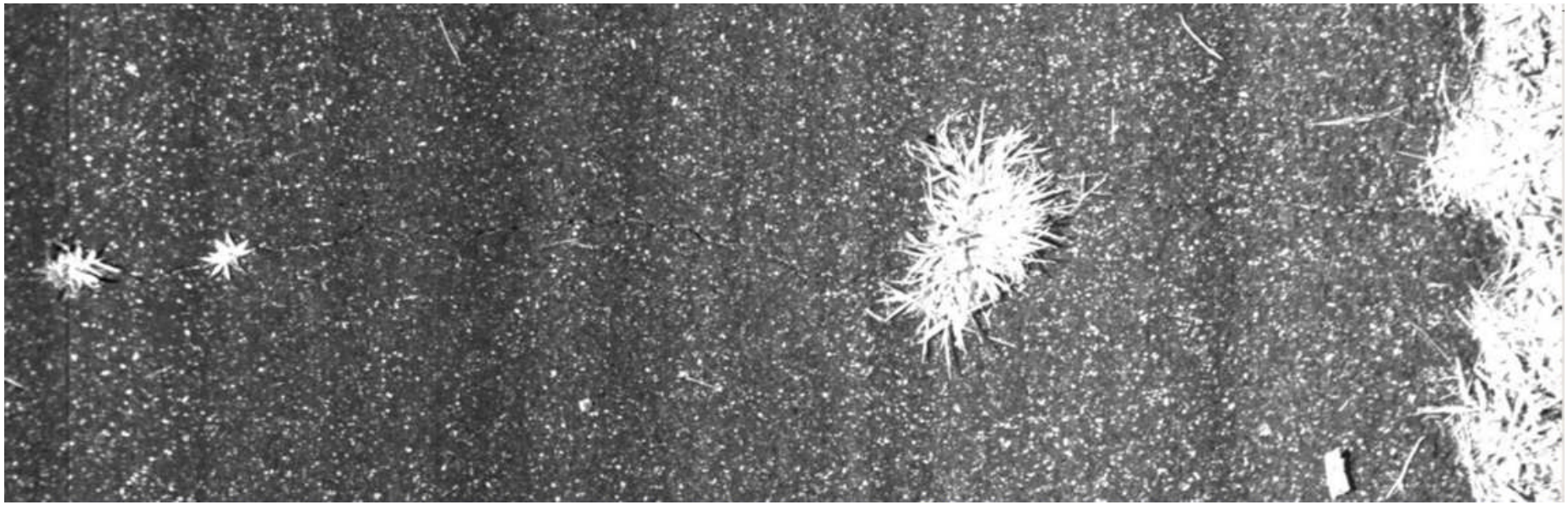


Laser illumination



Daylight

Undetected Cracks



Dual Camera Images

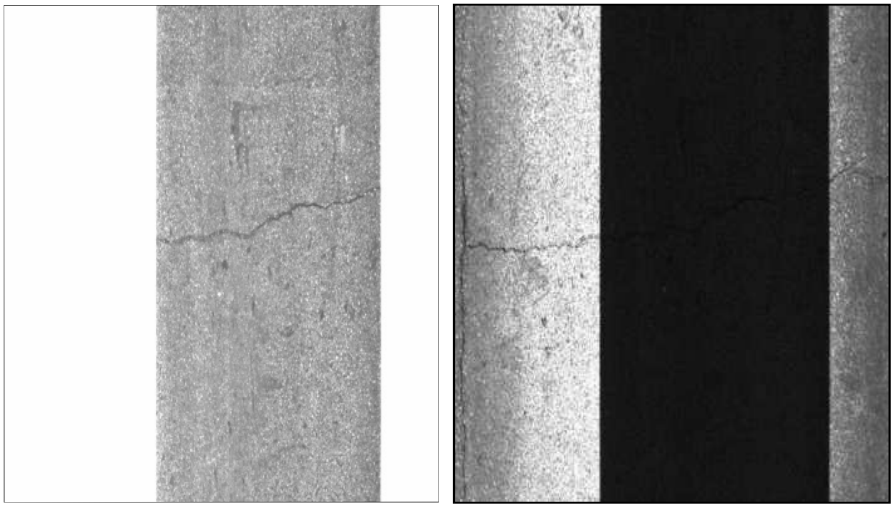
Primary camera:

Overexposed image for shadowed surfaces.

Secondary camera:

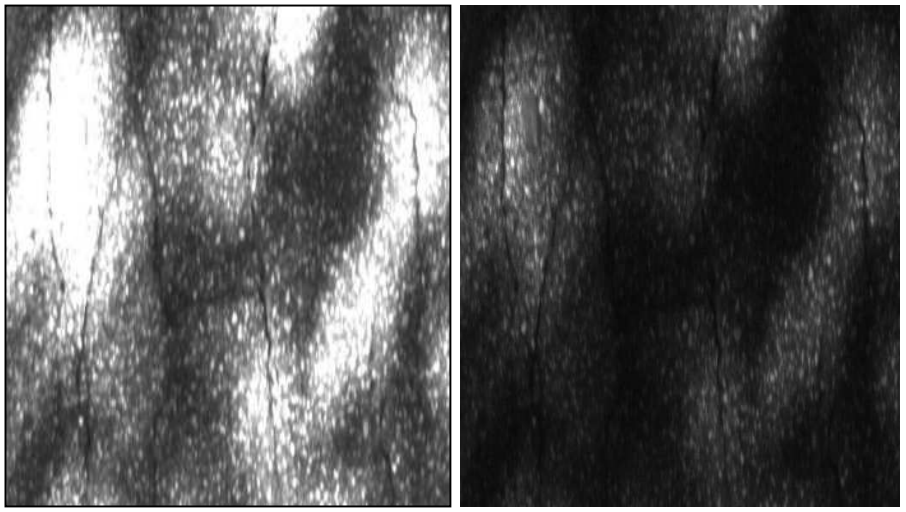
Underexposed image for sunlit surfaces.

Vehicle shadowed



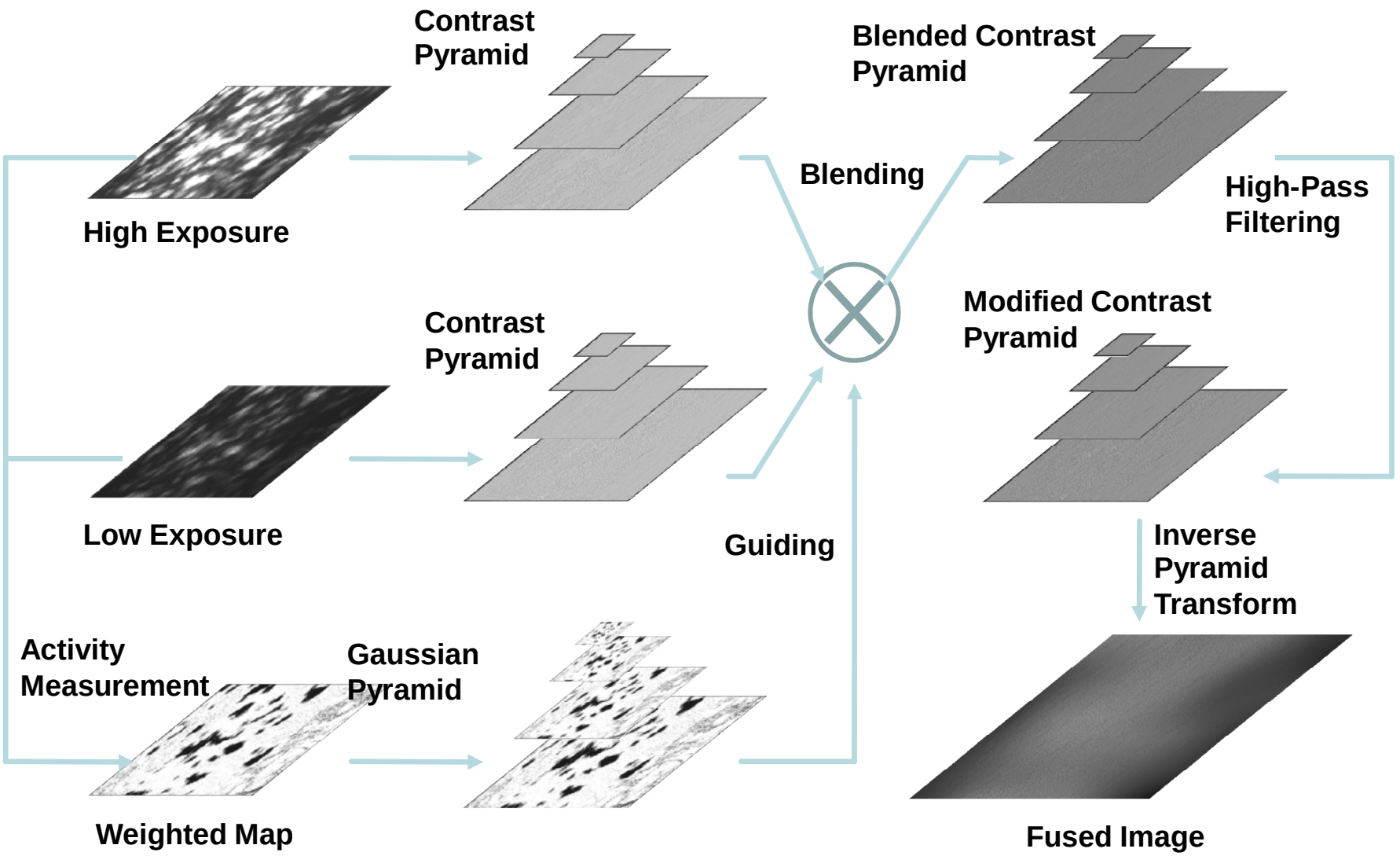
Overexposed **Underexposed**

Tree shadowed

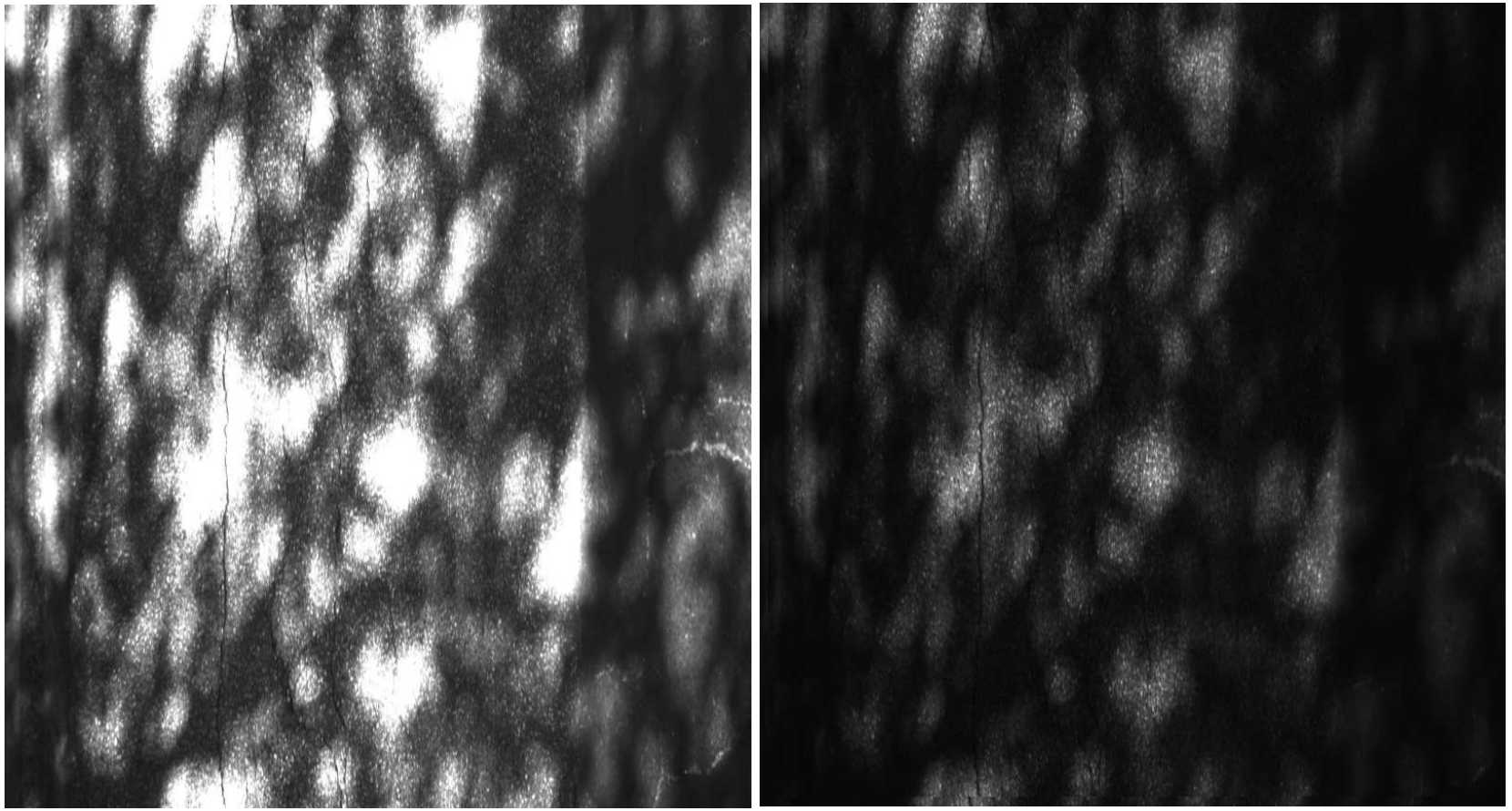


Overexposed **Underexposed**

Multi-resolution image fusion

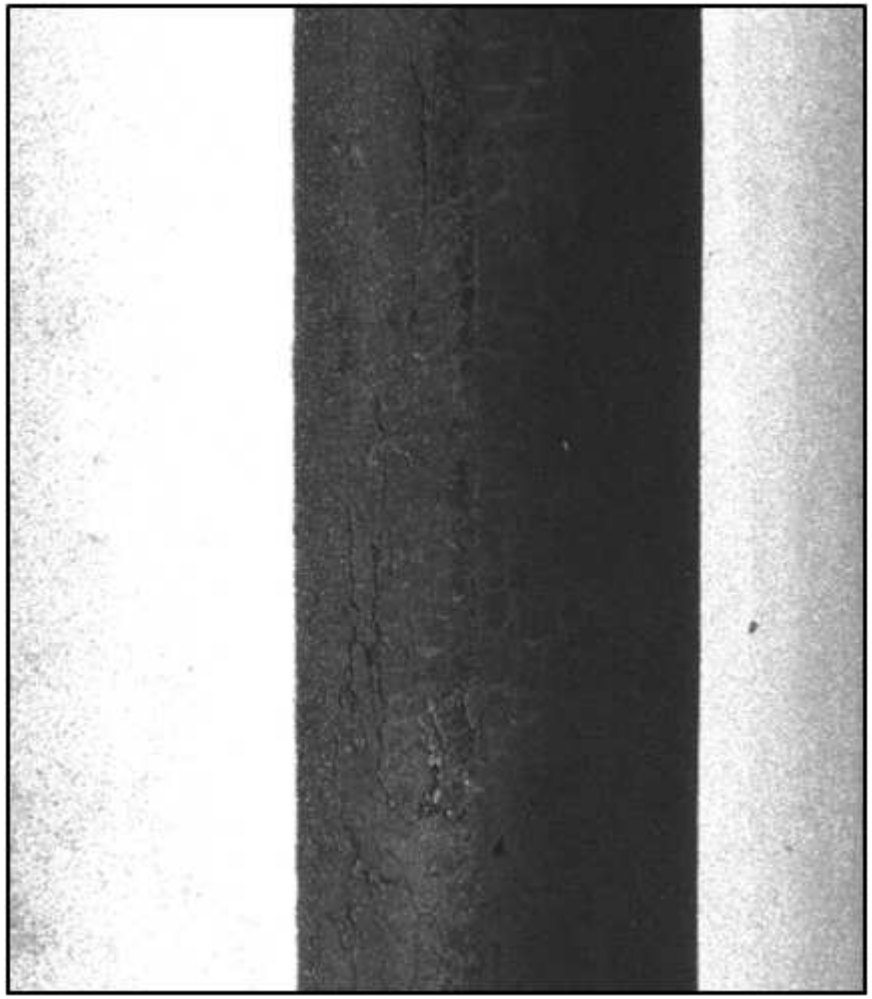


Multi-exposure Images



Fused Image

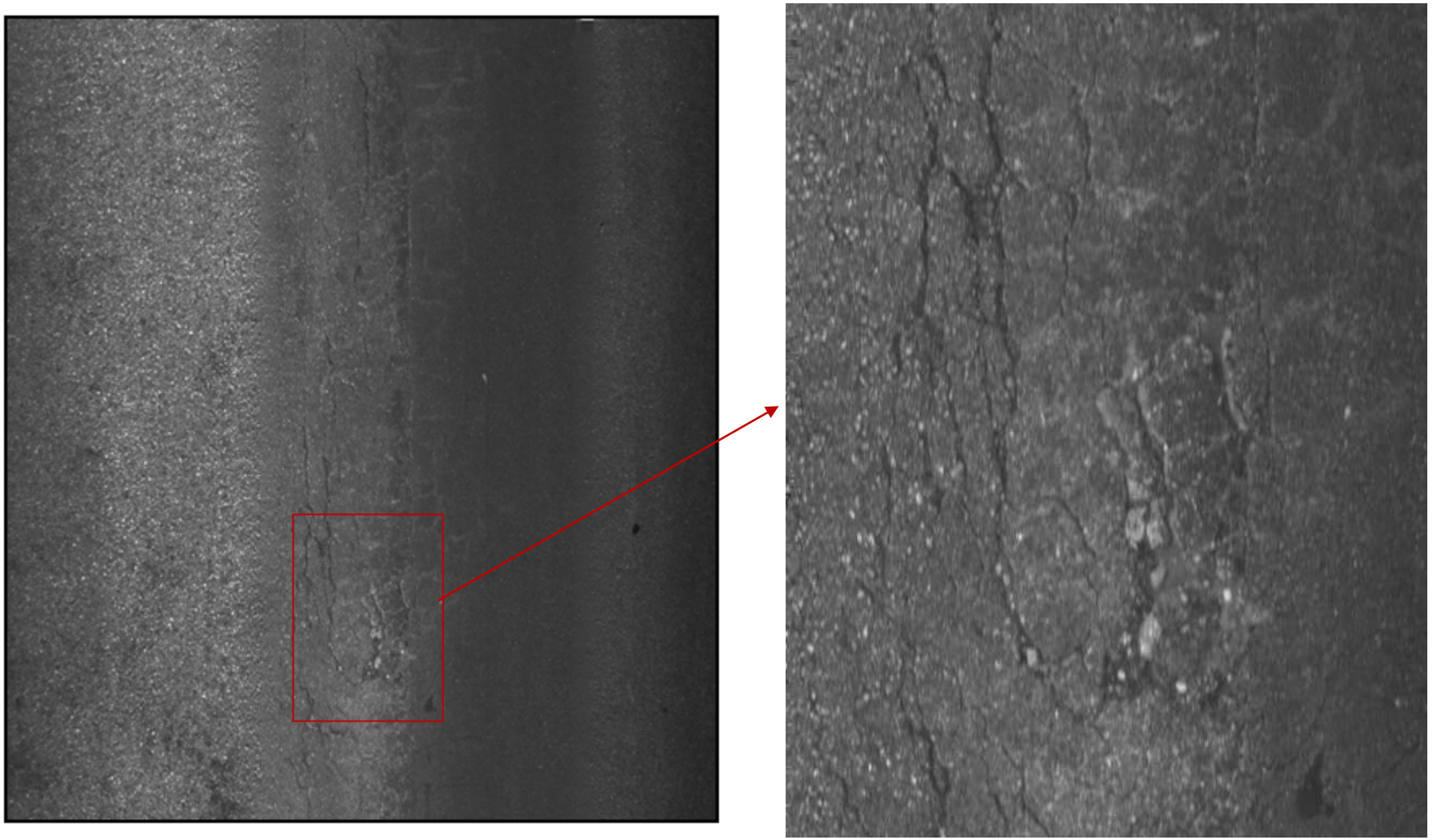
Multi-exposure Images



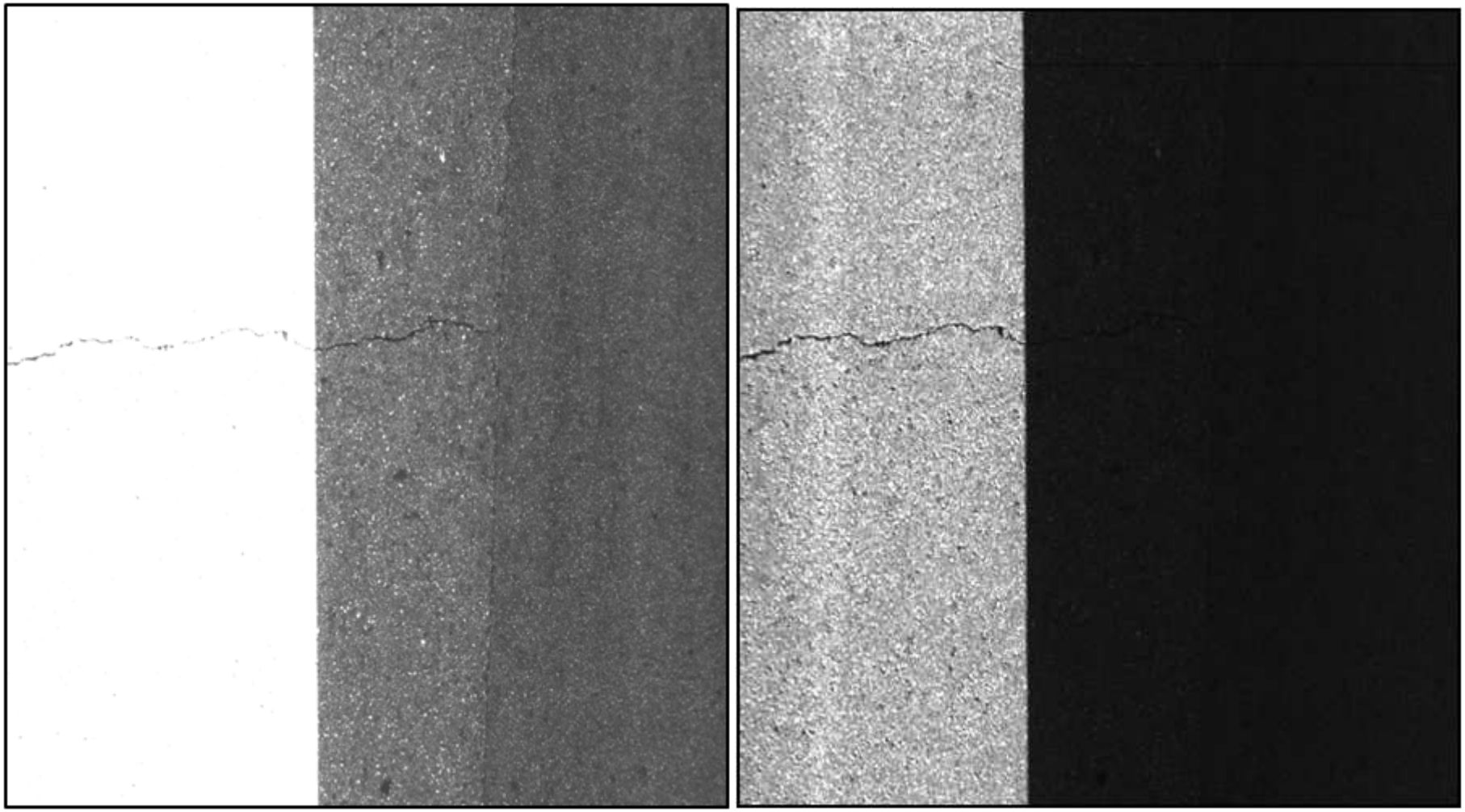
High Exposure Source Image

Low Exposure Source Image

Fused Image



Multi-exposure Images



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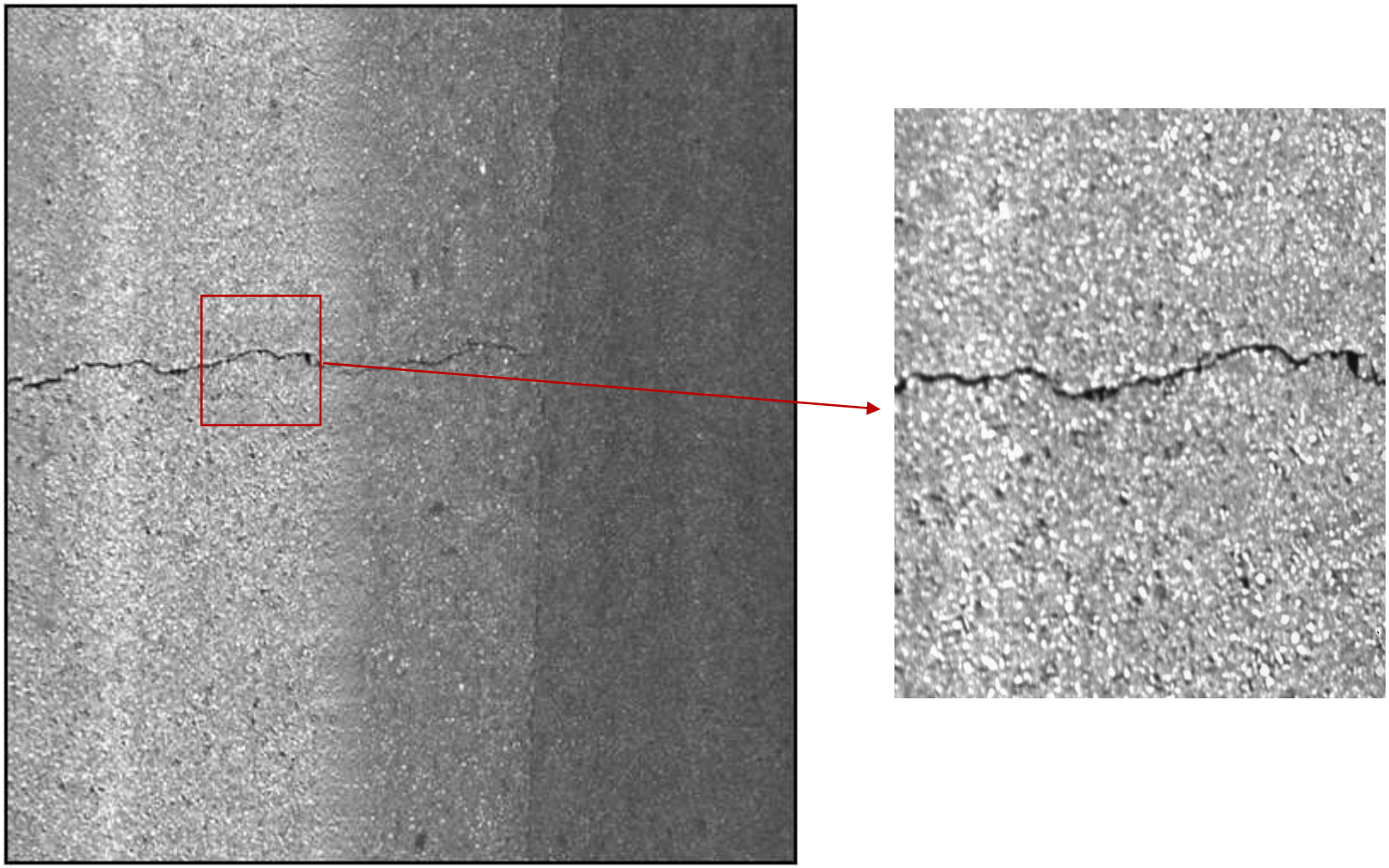

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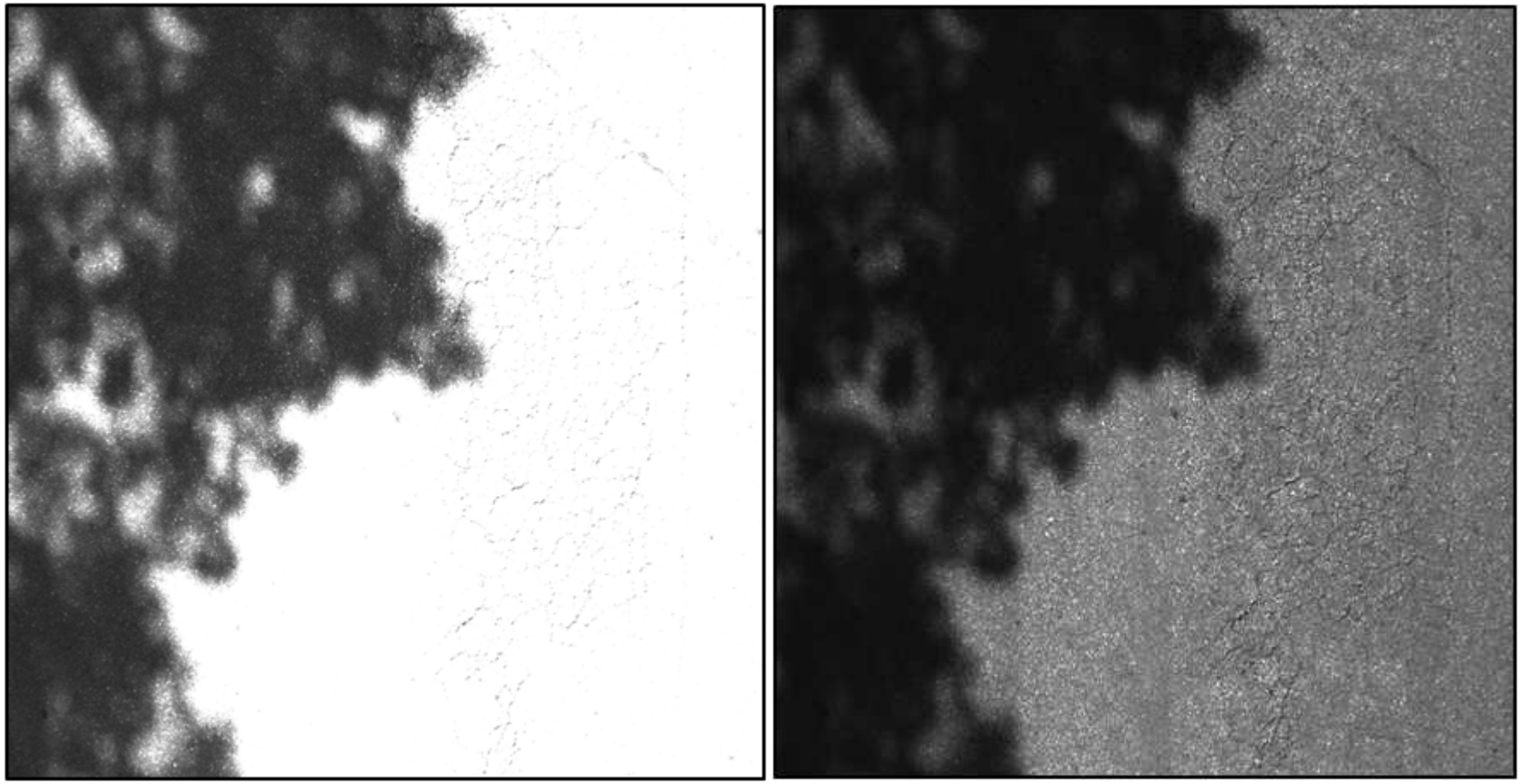

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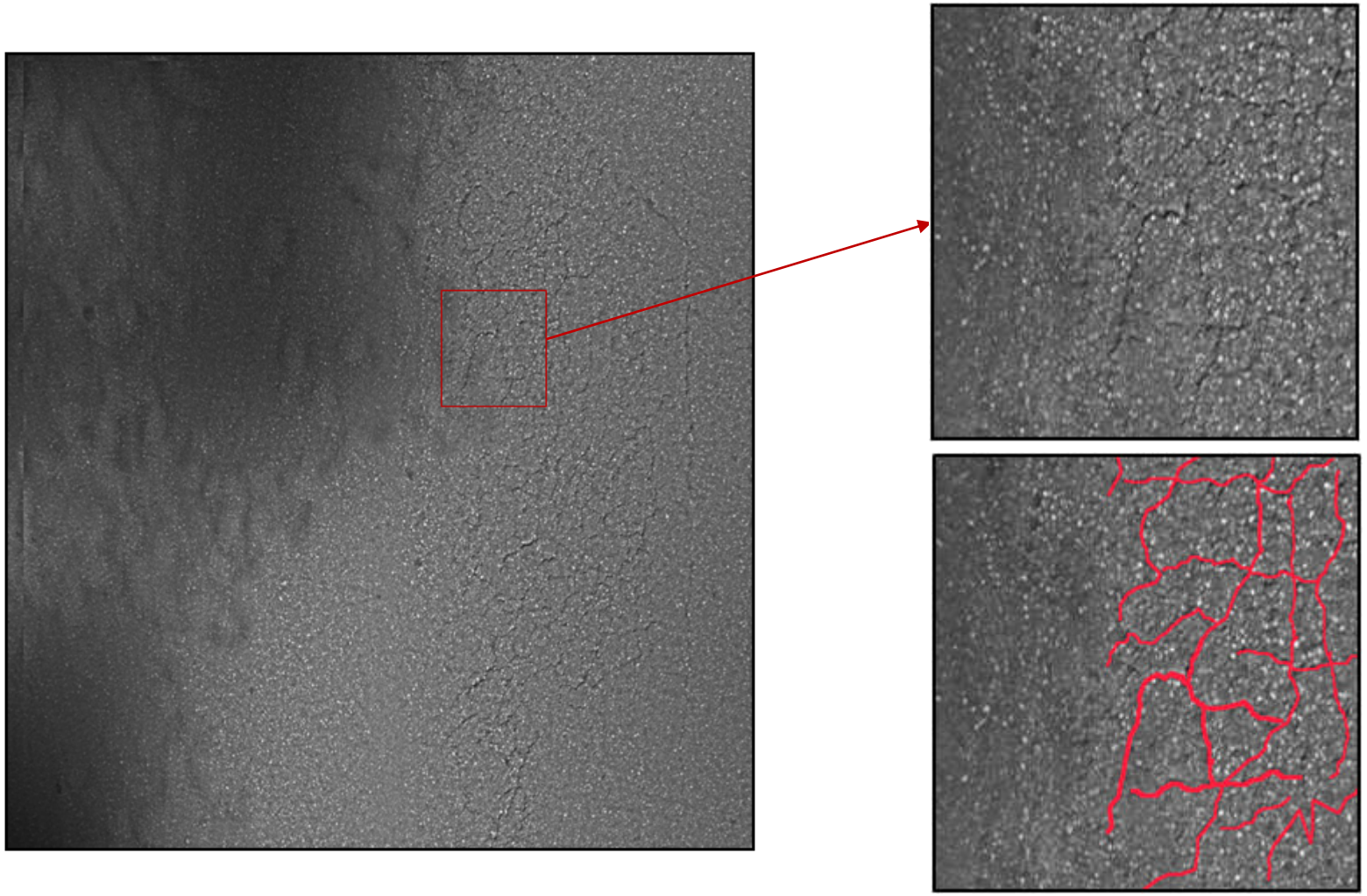

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