

# FDOT IMPLEMENTATION TO AUTOMATED DISTRESS RATING

WILLIAM (THAD) BRYANT

PAVEMENT EVALUATION MANAGER - FDOT

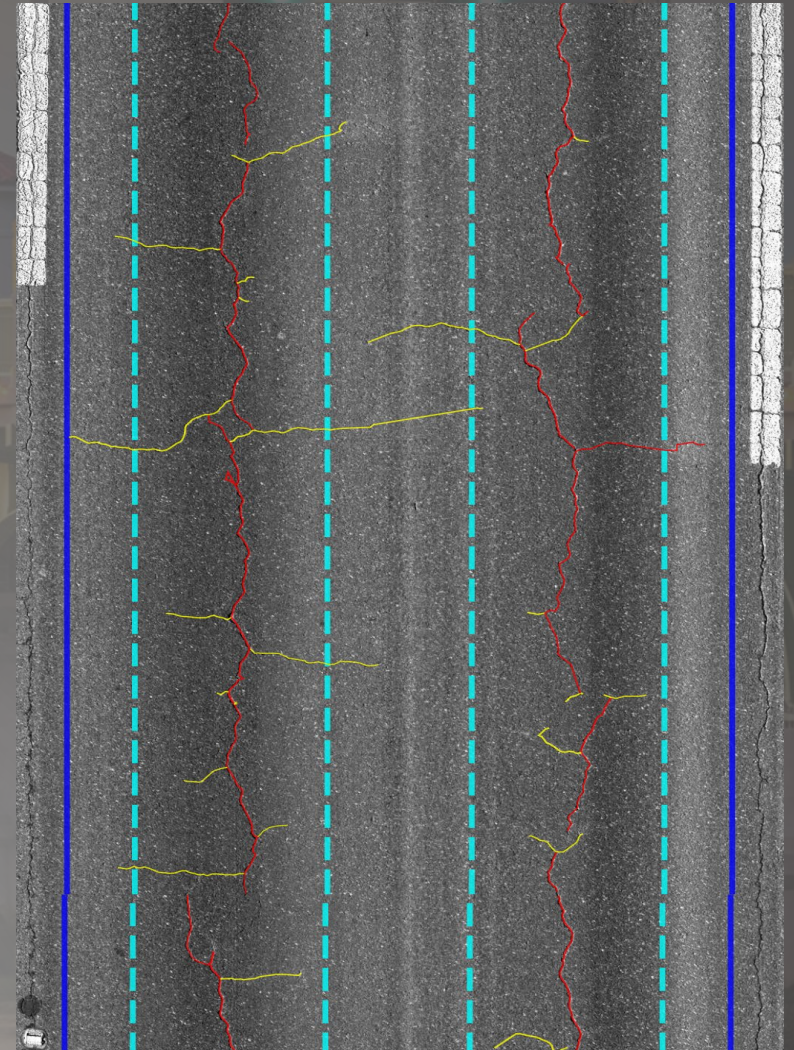


**RPUG**  
Road Profile Users' Group

# OUTLINE



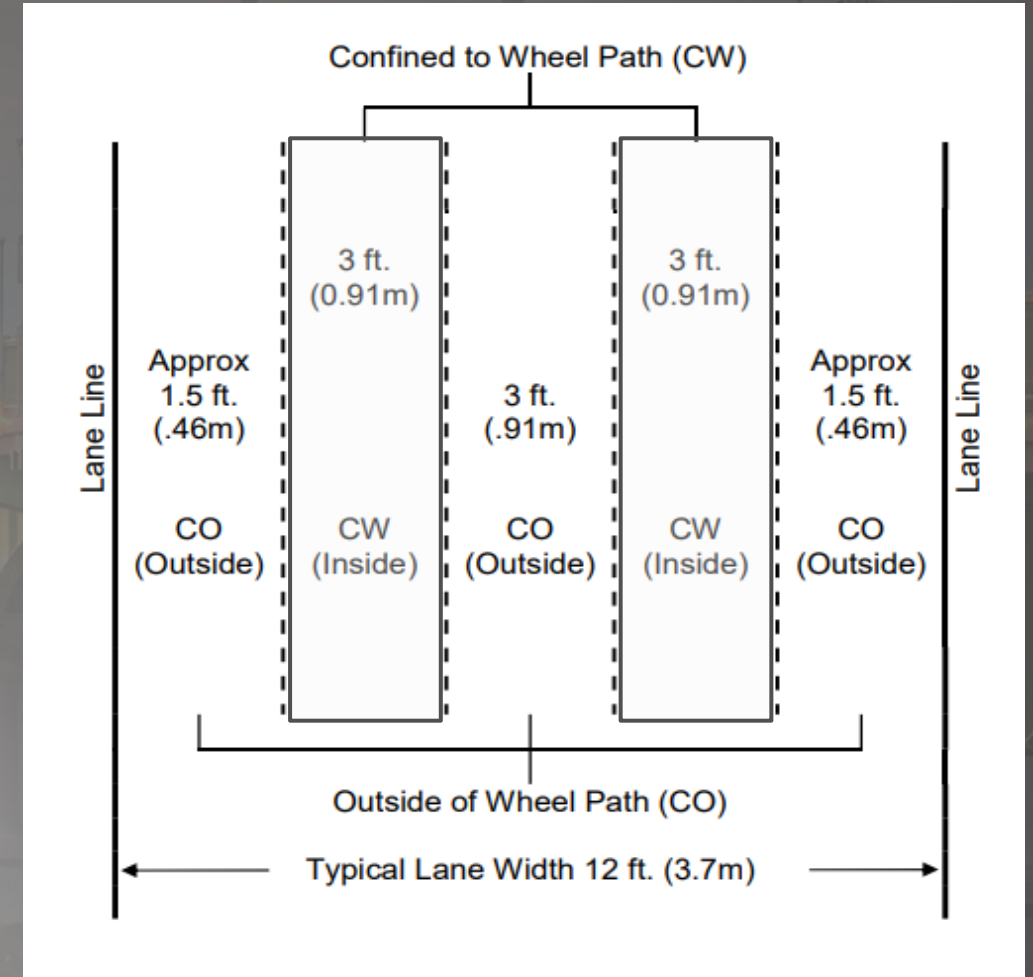
- Background – Legacy Method
- Legacy Distress Rating Challenges
- Automated Distress System
- Automated Distress Model
- Automated Distress Segmentation
- Automated Rut Depth
- Data Sharing Tools
- Future Enhancements



# LEGACY METHOD - CRACKING DISTRESS RATING

| PERCENT OF PAVEMENT AREA AFFECTED BY CRACKING | CONFINED TO WHEEL PATHS (CW)<br>PREDOMINANT CRACKING CLASS |  |  |
|---|--|--|--|
|   | CLASS I CRACKING<br>Width < 1/8"                           | CLASS II CRACKING<br>1/8" < Width ≤ 1/4" | CLASS III CRACKING<br>Width > 1/4"<br>(Including Raveling, Patching & Pumping) |
|   | <u>DEDUCT</u>  | <u>DEDUCT</u>                            | <u>DEDUCT</u>  |
| 0 – 5   | 0.0  | 0.5                                      | 1.0  |
| 6 – 25  | 1.0  | 2.0                                      | 2.5  |
| 26 – 50                                       | 2.0  | 3.0                                      | 4.5  |
| 51+   | 3.5  | 5.0                                      | 7.0  |

| PERCENT OF PAVEMENT AREA AFFECTED BY CRACKING | OUTSIDE OF WHEEL PATHS (CO)<br>PREDOMINANT CRACKING CLASS |  |  |
|---|---|--|--|
|   | CLASS I CRACKING<br>Width < 1/8"                          | CLASS II CRACKING<br>1/8" < Width ≤ 1/4" | CLASS III CRACKING<br>Width > 1/4"<br>(Including Raveling, Patching & Pumping) |
|   | <u>DEDUCT</u>   | <u>DEDUCT</u>                            | <u>DEDUCT</u>  |
| 0 – 5   | 0.0   | 0.0                                      | 0.0  |
| 6 – 25  | 0.5   | 1.0                                      | 1.0  |
| 26 – 50                                       | 1.0   | 1.5                                      | 2.0  |
| 51+   | 1.5   | 2.0                                      | 3.0  |



$$\text{CRACK RATING} = 10 - (\text{CW} + \text{CO})$$



# LEGACY – DISTRESS RATING CHALLENGES

- Not easy to determine crack width & extent while driving at traffic speed
- Subjective & rater dependent
- Assigned as representative condition of entire section (0.500 to 30 miles, construction limits)
- Same rating for wide range of distress level and amount
  - ✓ Not ideal for performance modeling
  - ✓ Crack rating can plateau for several years
- Not accepted by FHWA for HPMS reporting

| <b>% Distressed Area</b> |
|--------------------------|
| <b>01 -- 05</b>          |
| <b>06 -- 25</b>          |
| <b>26 -- 50</b>          |
| <b>51+</b>               |

# AUTOMATED DISTRESS SYSTEM



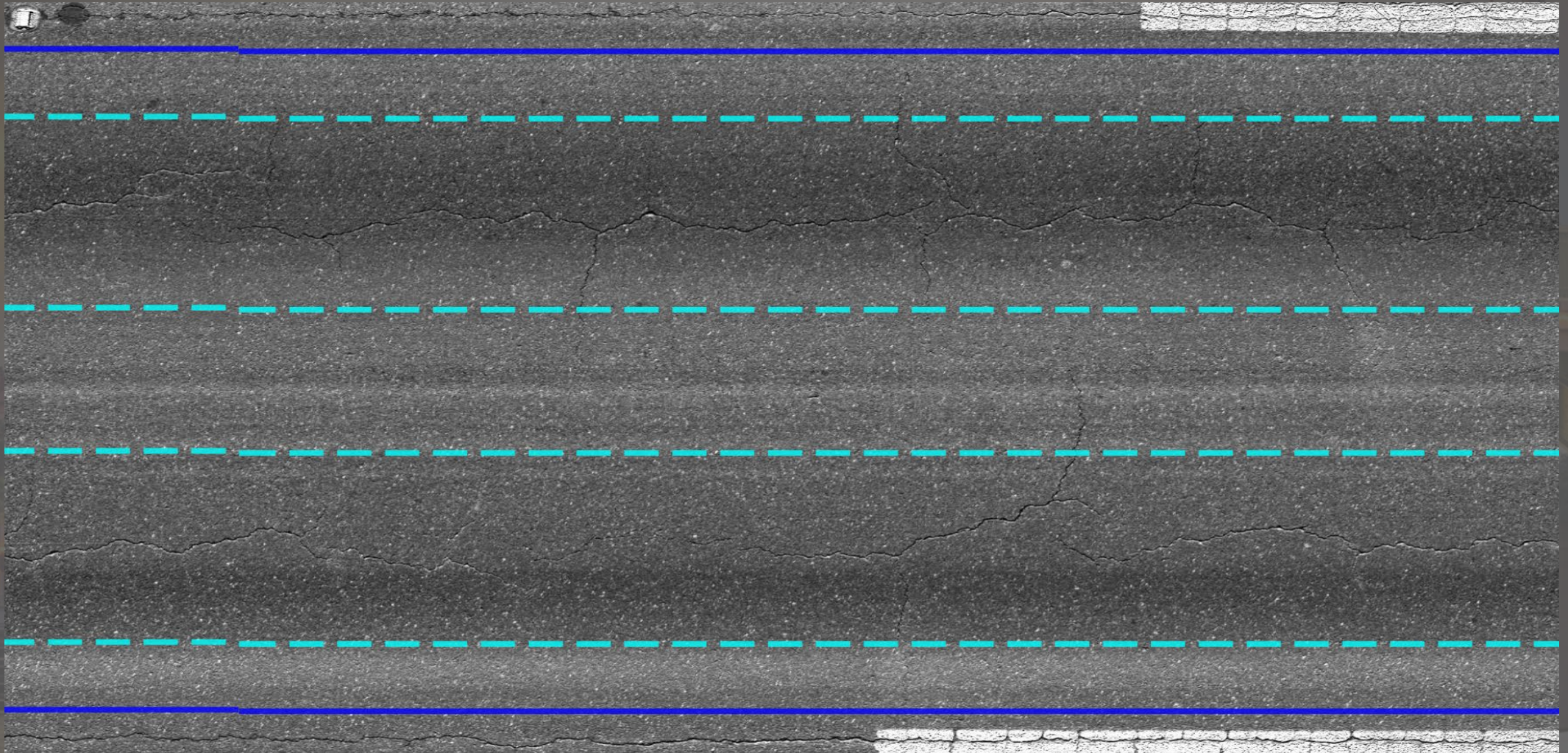


# AUTOMATED DISTRESS SYSTEM

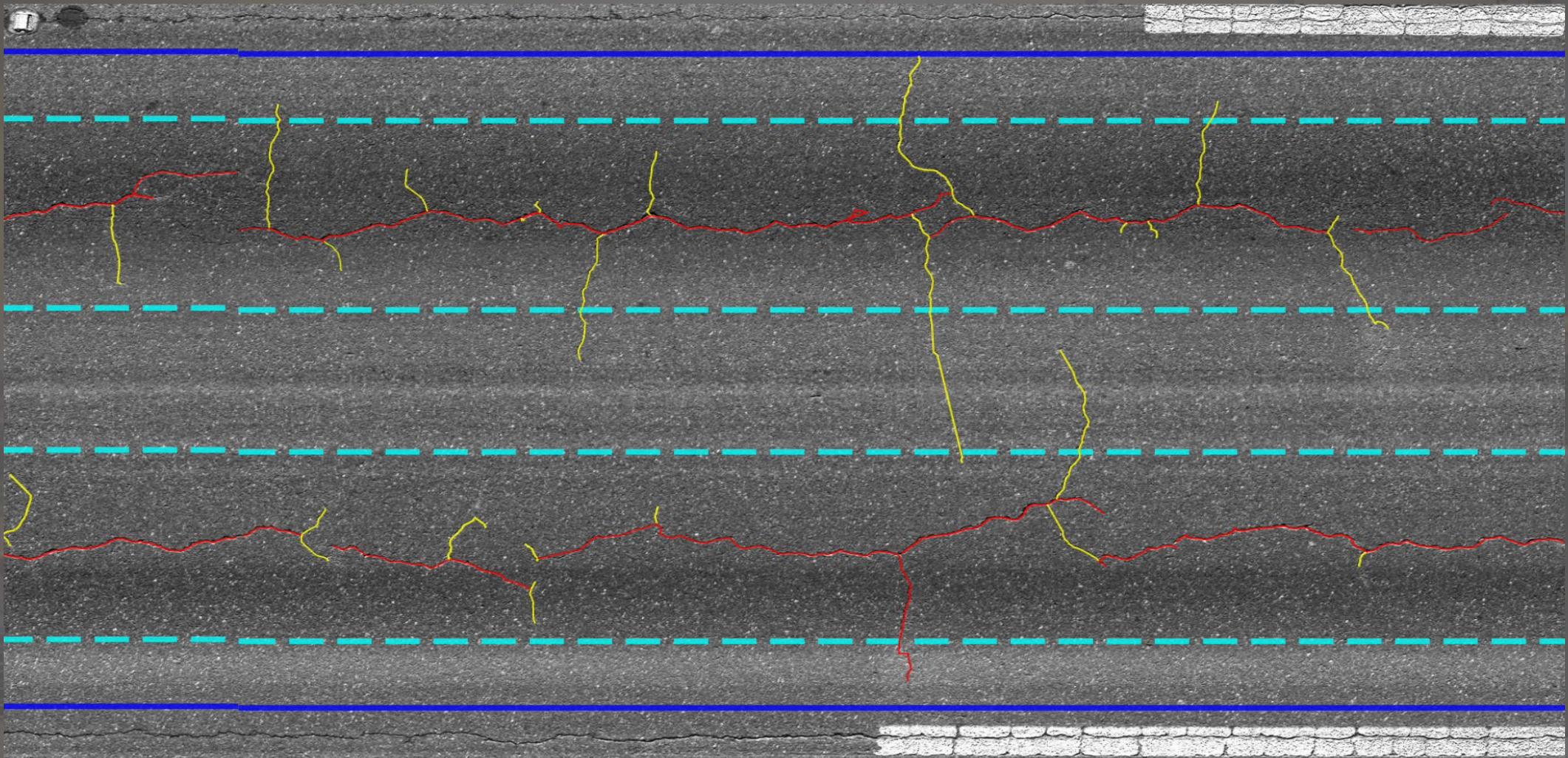
- 3D laser data for crack, rut, fault & other features
  - ✓ 4-meter transverse profile consisting of 4160 points
  - ✓ Sampling Interval 2 mm
- Inertial profiling system (smoothness)
- Cross-slope & grade
- Forward imaging
- GPS (sub-meter accuracy)
- All distresses reported at selected intervals (e.g., 0.1-mile, section limits, etc.)



# AUTOMATED CRACK DETECTION



# AUTOMATED CRACK DETECTION

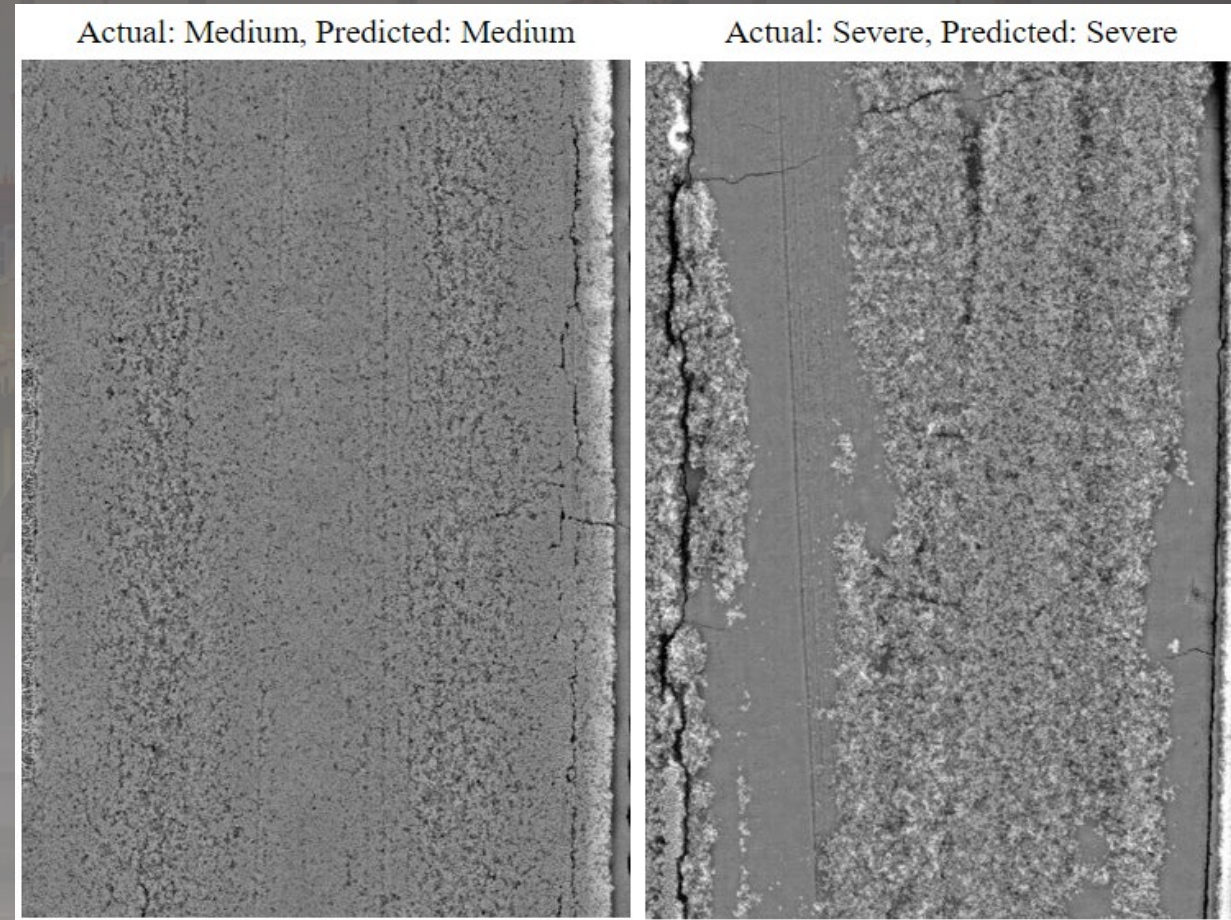




# AUTOMATED RAVELING DETECTION



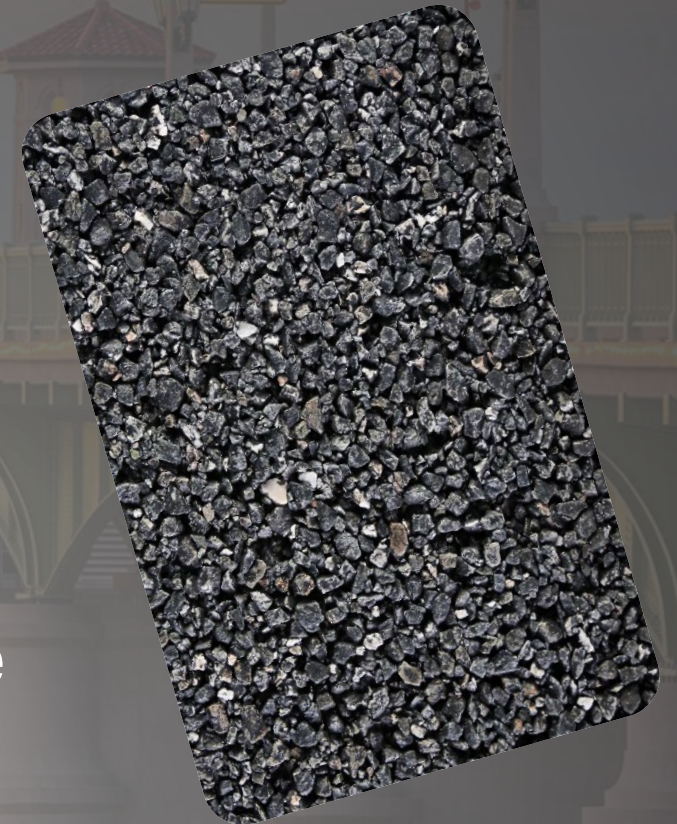
- Macrotexture features calculated from Range images
- Images with known raveling severity & calculated macrotexture features used to train machine learning model
- Machine Learning Technology (Random Forest)



# AUTOMATED RAVELING REPORTING

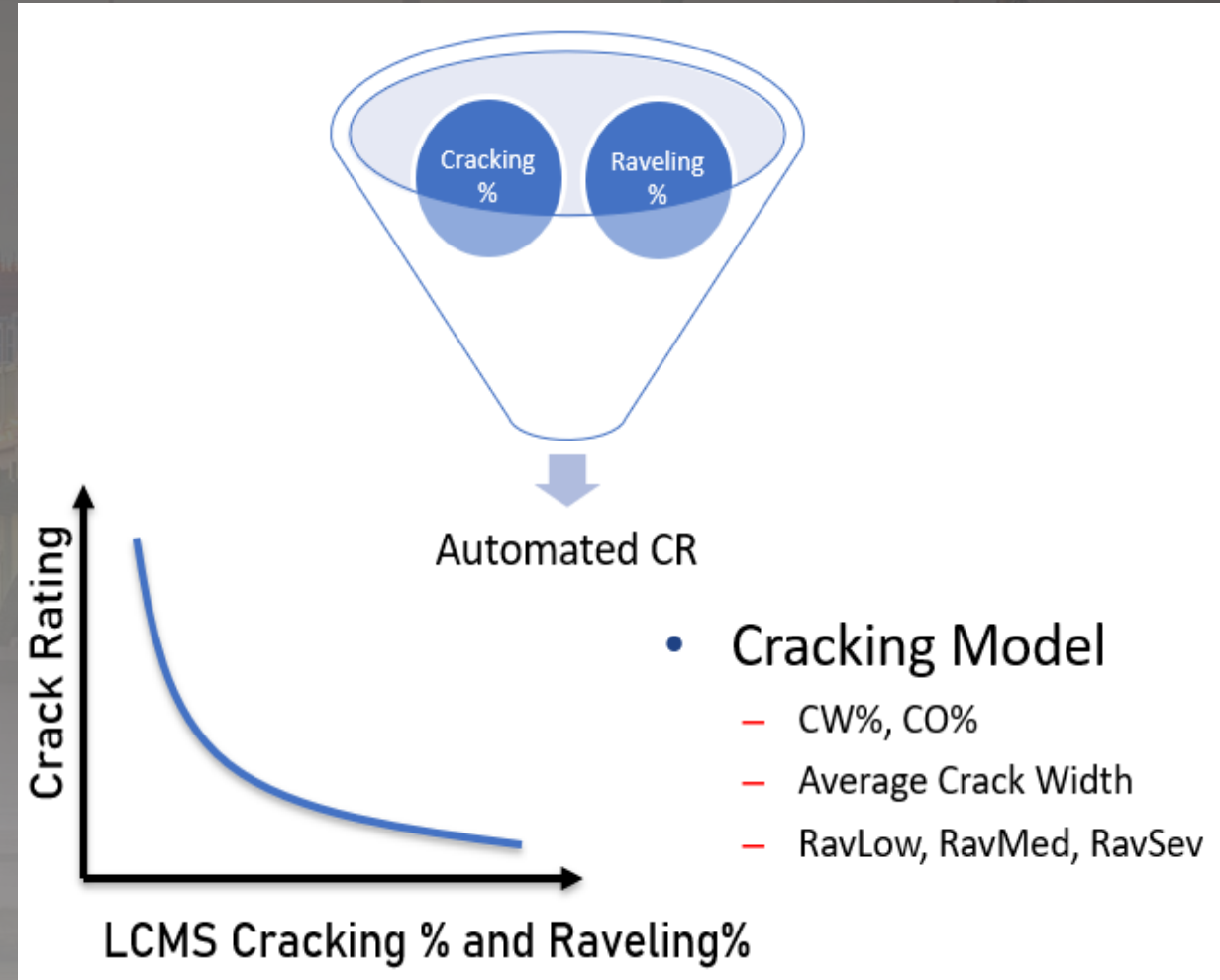


- Raveling severity assessed every image (20 ft.) & summarized in 0.1-mile intervals
- Problem areas within a section can be identified
- Ravel Rating can be used to identify OGFC only candidates
- Coded and stored separately but included in the overall Crack Rating calculations

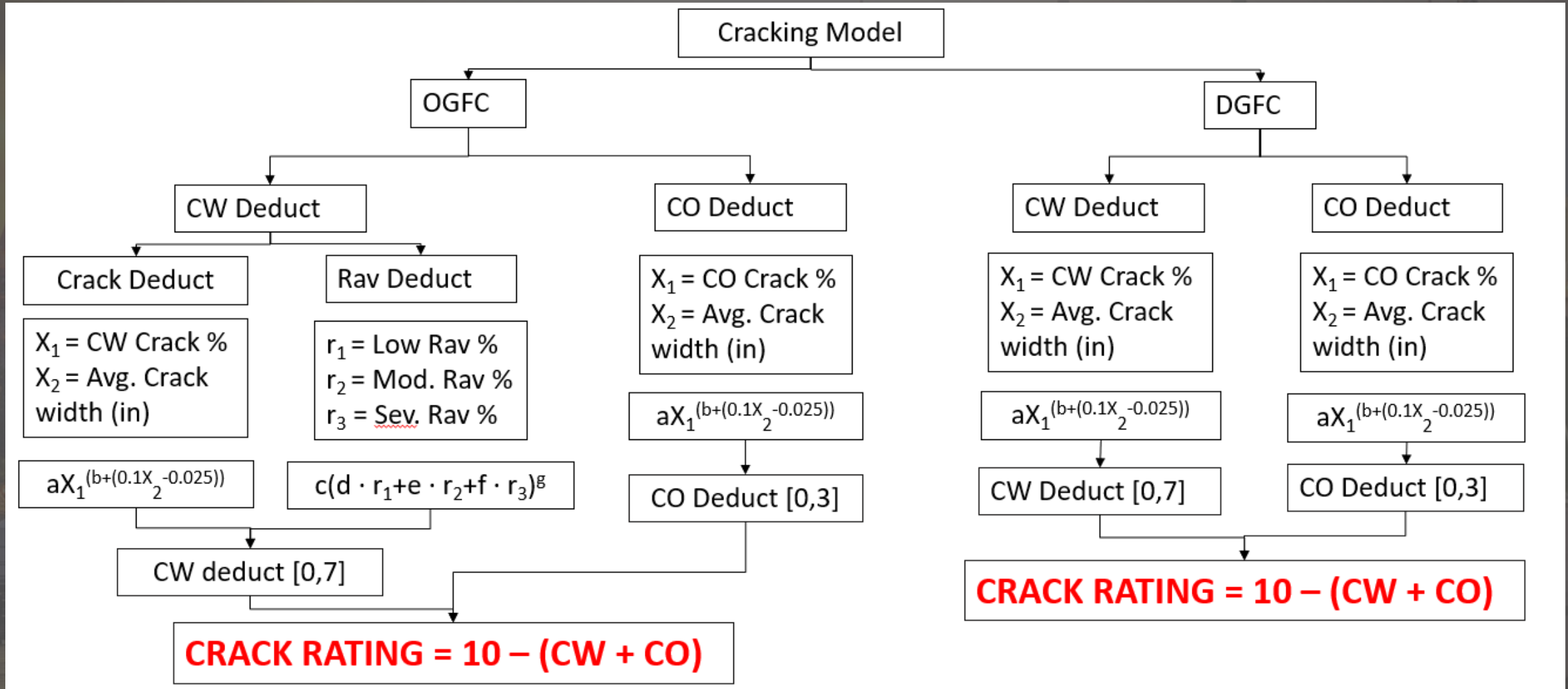


# AUTOMATED DISTRESS MODEL

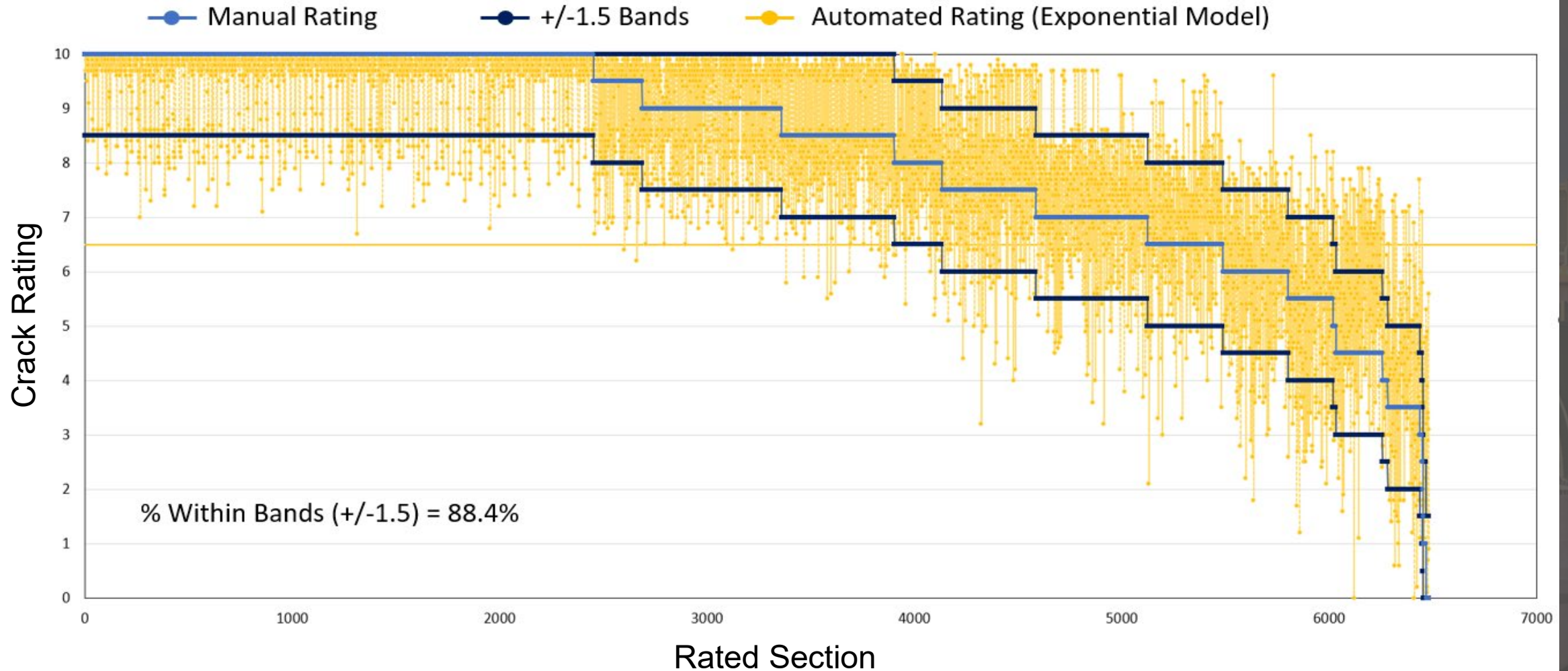
- To determine a model whose inputs are automated cracking and raveling percents and the output is the Automated Crack Rating
- “Crack Rating Transition”:
  - ✓ Similar number of failing miles
  - ✓ Highest percent of matching miles
- Model easy to explain and apply



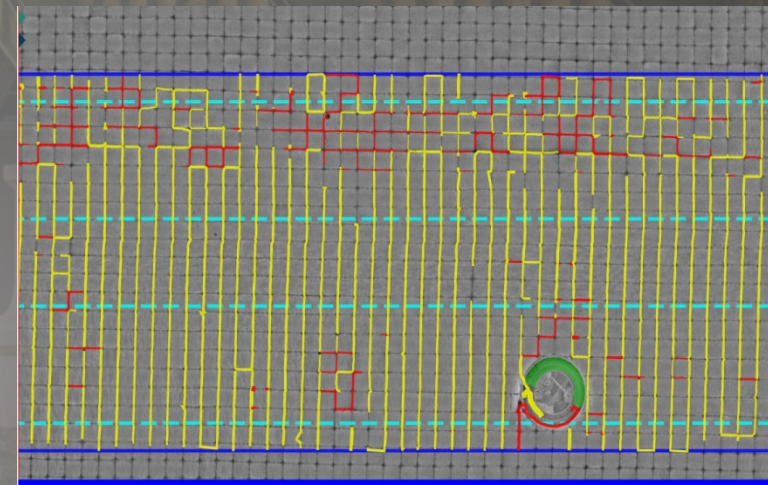
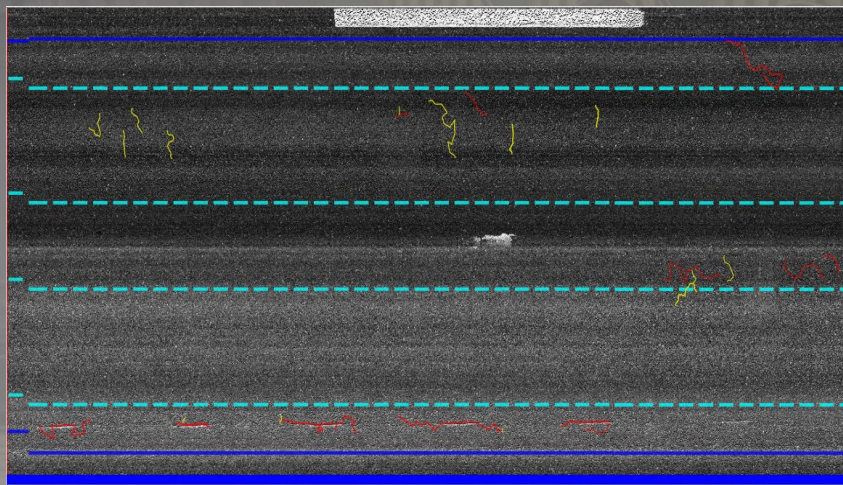
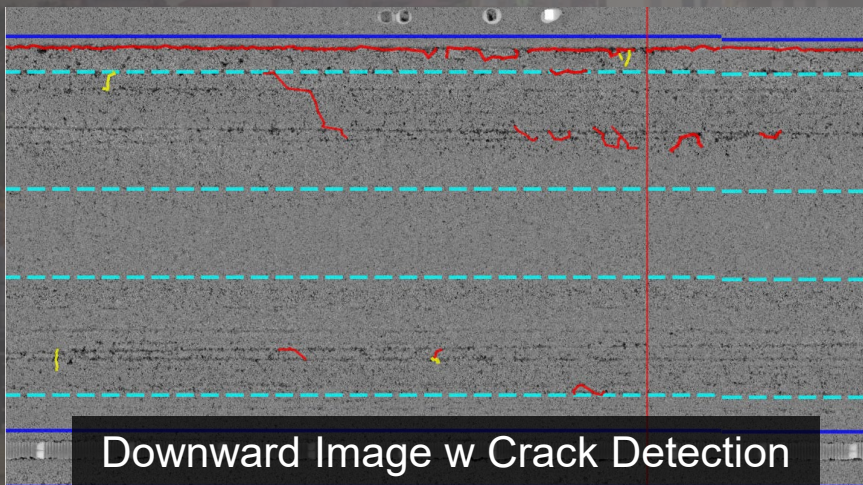
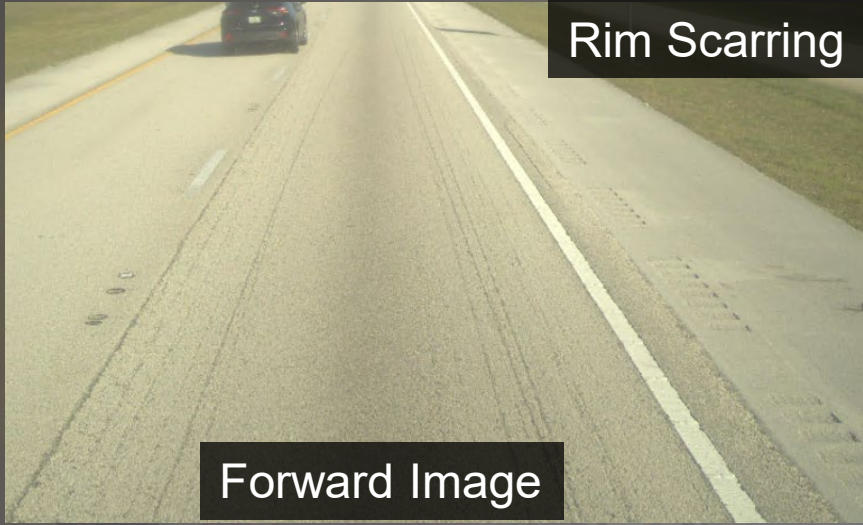
# AUTOMATED DISTRESS MODEL



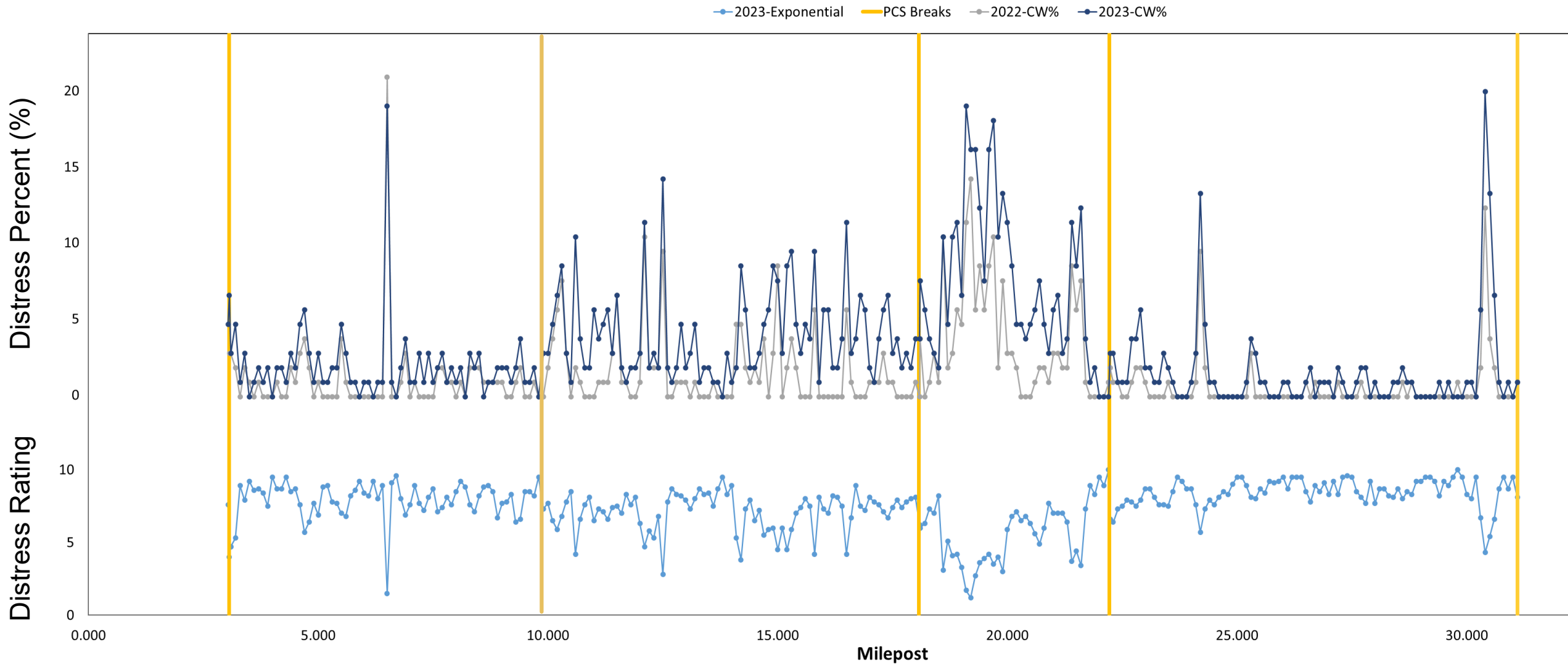
# AUTOMATED DISTRESS MODEL



# FALSE CRACK DETECTION



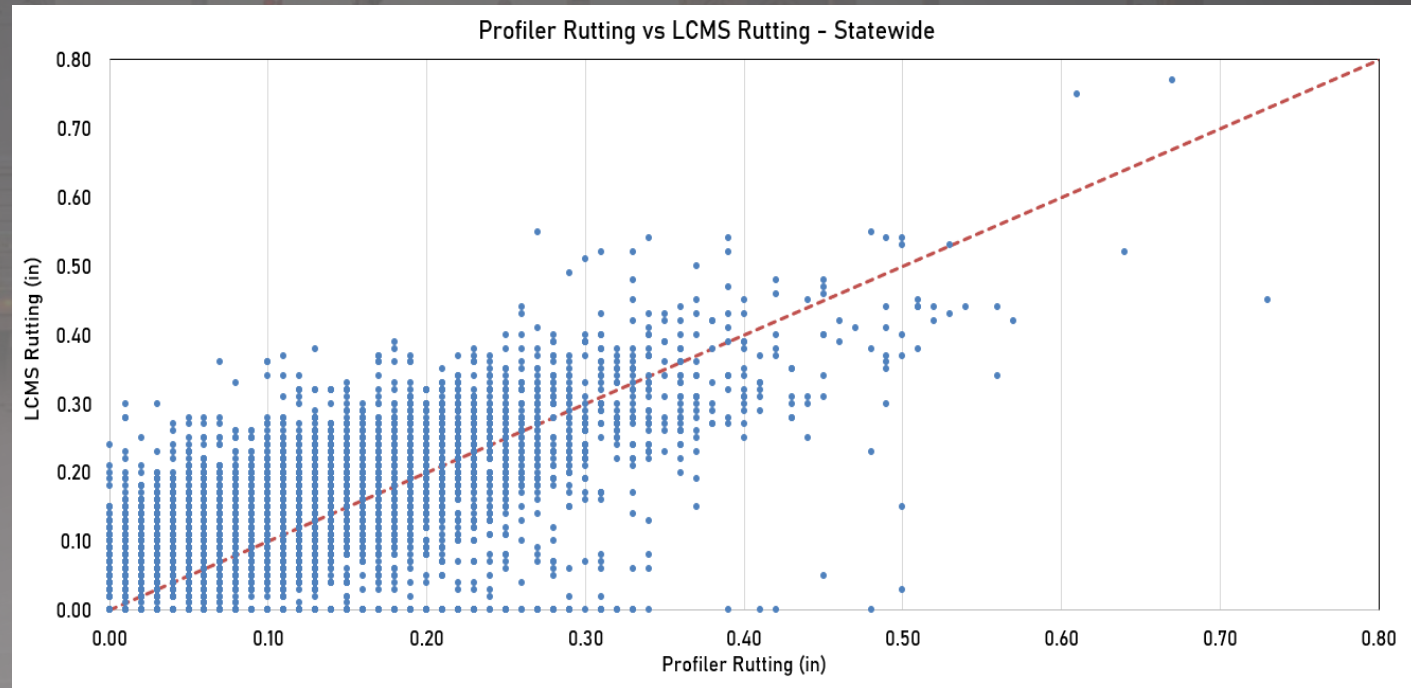
# AUTOMATED DISTRESS SEGMENTATION



# AUTOMATED RUT DEPTH



- Automated rut provides a more realistic rut depth since wheel path tracking is not critical
- Developed a cross-walk between methods & rut depth
- New process will maintain an equivalent 10 scale rating





# DATA SHARING TOOLS




**FDOT** FDOT State Materials Office - LCMS Image Viewer

Survey Year: 2023 | District: All | Roadway ID: 92010000\_U | Milepost: 0.000 - 63.689

Show/Hide Map:  CLEAR FILTERS

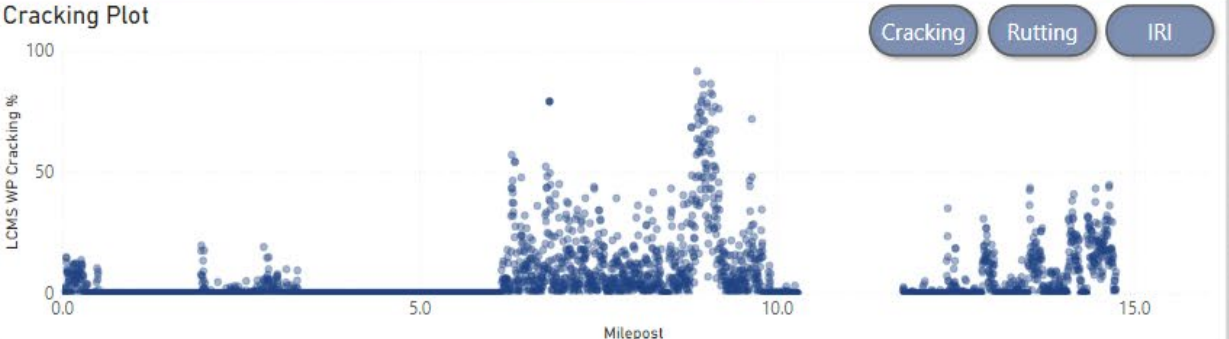
Both Images | Range Images | 3D Images



GPS Coordinates: 28.257915 | -81.449258 | Milepost: 6.821

Cracking Plot

LCMS WP Cracking %



Cracking | Rutting | IRI

Display Milepost Navigator

Questions or Feedback: Mateo.Carvajal@dot.state.fl.us

# DATA SHARING TOOLS



FDOT
FDOT State Materials Office - Crack Rating Calculator
Questions or Feedback: Mateo.Carvajal@dot.state.fl.us

SurveyYear

 2023  
 2024

District

Rdwyld\_Dir

BMP(mi)

0.000

63.689

BMP

EMP

0.002

14.753

% Cracking OWP and % Cracking WP by BMP(mi)

| Rdwyld_Dir | PCS_BMP | SurveyYear | PCS_EMP | SurfType | PCS_C |
|------------|---------|------------|---------|----------|-------|
| 92010000_U | 0.000   |            | 0.536   | Dense    | 6     |
|            | 1.915   |            | 2.770   | Dense    | 7     |
|            | 2.770   |            | 3.523   | Dense    | 8     |
|            | 3.745   |            | 6.000   | Open     | 10    |
|            | 6.000   |            | 9.928   | Open     | 1     |
|            | 6.149   |            | 9.624   | Open     | 1     |
|            | 9.624   |            | 10.298  | Dense    | 6     |
|            | 9.928   |            | 10.298  | Dense    | 9     |
|            | 11.764  |            | 12.228  | Dense    | 10    |
|            | 12.228  |            | 13.706  | Dense    | 7     |

% Cracking WP

5.63

% Cracking OWP

1.78

% Raveling

24.15

LCMS Crack Rating

6.5

CW Crack Width (in)

0.102

CO Crack Width (in)

0.165

| % Low | % Mod | % Sev |
|-------|-------|-------|
| 14.75 | 8.29  | 1.11  |

LCMS CR = 10 - CW - CO - RAV

CW Deduct (CW)

1.27

CO Deduct (CO)

0.73

Raveling Deduct (RAV)

1.47

# DATA SHARING TOOLS



## FDOT State Materials Office - Crack Rating Calculator

Questions or Feedback: Mateo.Carvajal@dot.state.fl.us

**SurveyYear**

2023  
 2024

**District**

All

**Rdwyld\_Dir**

92010000\_U

**BMP(mi)**

|       |        |
|-------|--------|
| 0.000 | 63.689 |
| BMP   | EMP    |
| 0.002 | 14.753 |

### Raveling Severity

Severe Raveling  
  Moderate Raveling  
  Low Raveling

| Rdwyld_Dir | PCS_BMP | SurveyYear | PCS_EMP | SurfType | PCS_C |
|------------|---------|------------|---------|----------|-------|
| 92010000_U | 0.000   |            | 0.536   | Dense    | 6     |
|            | 1.915   |            | 2.770   | Dense    | 7     |
|            | 2.770   |            | 3.523   | Dense    | 8     |
|            | 3.745   |            | 6.000   | Open     | 10    |
|            | 6.000   |            | 9.928   | Open     | 1     |
|            | 6.149   |            | 9.624   | Open     | 1     |
|            | 9.624   |            | 10.298  | Dense    | 6     |
|            | 9.928   |            | 10.298  | Dense    | 9     |
|            | 11.764  |            | 12.228  | Dense    | 10    |
|            | 12.228  |            | 13.706  | Dense    | 7     |

| <b>% Cracking WP</b>       | <b>% Cracking OWP</b>      | <b>% Raveling</b>  |       |       |       |       |      |      |
|----------------------------|----------------------------|--|-------|-------|-------|-------|------|------|
| <b>5.63</b>                | <b>1.78</b>                | <b>24.15</b>   |       |       |       |       |      |      |
| <b>CW Crack Width (in)</b> | <b>CO Crack Width (in)</b> | <table border="1" style="width: 100%; text-align: center; font-size: small;"> <tr> <th>% Low</th> <th>% Mod</th> <th>% Sev</th> </tr> <tr> <td>14.75</td> <td>8.29</td> <td>1.11</td> </tr> </table> | % Low | % Mod | % Sev | 14.75 | 8.29 | 1.11 |
| % Low                      | % Mod                      | % Sev  |       |       |       |       |      |      |
| 14.75                      | 8.29                       | 1.11   |       |       |       |       |      |      |
| <b>CW Deduct (CW)</b>      | <b>CO Deduct (CO)</b>      | <b>Raveling Deduct (RAV)</b>   |       |       |       |       |      |      |
| <b>1.27</b>                | <b>0.73</b>                | <b>1.47</b>  |       |       |       |       |      |      |

**LCMS Crack Rating**

6.5

LCMS CR = 10 - CW - CO - RAV



# FUTURE ENHANCEMENTS

- Continued effort to clean-up outliers (approximately 3,000 miles)
  - ✓ @ 1 mile per hour roughly 3,000 hrs. of review for 1 person
- Automated detection of patterned pavements (crosswalks)
- Automated approach to quantify the effects of patching and pumping in the Crack Rating
- Improve automation for rigid pavement distresses (semi-automated)
- Enhance QC and data visualization tools
  - ✓ Automated Distress Image Viewer
  - ✓ Crack Rating Calculator/Slicer

# QUESTIONS???



*Behind the wheel, the focus must be on only one task:*

***Safe Driving***

