Automated Fault Measurement (AFM) in ProVAL

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WORK ZONES NEED OUR UNDIVIDED ATTENTION.

TAKE CARE OUT THERE. OVER 700 PEOPLE WERE KILLED IN WORK ZONE CRASHES LAST YEAR.
Acknowledgement

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What is ProVAL AFM

• **Automated Fault Measurement** based on profile data
• FHWA HPMS requires joint fault data
• Implement revised AASHTO R36 “Standard Practice for Evaluating Faulting of Concrete Pavements”
Challenges for AFM - Pavements

- Filled joints
- Closed joints
- Spalled joints
- Curl/warp features
- Cracks and other distresses/patches
- Joint spacing patterns
- Skewed joints
- Grade
Challenges for AFM - Profiles

- Repeatability/accuracy
- Fault validation tests with physical devices
- Sampling intervals
- Repeated profile runs
- DMI drifts
Revised AASHTO R36-04

• Grade Adjustment (physical devices)
• Automated procedure (profiles)
• Validation devices (automated procedure)
Physical Fault Devices

Georgia Fault Meter

Courtesy of FDOT
Adjustment for Grades

\[ F = (L_2 - L_3) + (L_2 - L_3) \times \frac{B}{A} \]
Profile Requirements

• Repeatability and Accuracy requirements (AASHTO PP49)
• Fault validation with physical devices
• No additional pre-filtering
• Collect profiles at both wheel tracks
• Max sampling intervals
  – Basic level: 1.5” (38 mm)
  – Advanced level: 0.75” (19 mm)
Candidate Field Validation Devices

MS DOT

Top View

Side View

Retractable wheel

Handle

Transducer

B = 12"

L1 L2 L3

A = 18"

B1 = 6"

B2 = 6"
Candidate Field Validation Devices

FL DOT

0.24"

48"
ProVAL AFM

- Multiple profiles
- Joint locations ID
- Edit joint locations
- Compute faults
- Individual faults and segment summary
Joint ID Methods

- Downward Spike (SMK, FLDOT)
- Step (MSDOT)
- Curled-Edge
Downward Spike Detection

- Anti-smoothing filtering
- Normalize the filtered profile (/RMS)
- Detect profile spikes (-4.0)
- Screen joint locations
Step Detection

- Deduct profile elevations between consecutive data points
- Detect large step (0.08 in.)
- Screen joint locations
Curled-Edge Detection

- Bandpass filtering
- Rolling straightedge simulation
- Detect high RSE (0.12”) 
- Screen joint locations
Joint ID Methods Selection

• **Downward Spike Detection**
  - Shorter sampling intervals
  - Downward spikes present

• **Step Detection**
  - Apparent faults present

• **Curled-Edge Detection**
  - Noticeable slab curling and warping
Joint ID Methods Selection

- Downward Spike
Joint ID Methods Selection

• Step
Joint ID Methods Selection

- Curled-Edge
Fault Computation

- Crop a profile segment
- Separate profile slices
- Least-square fits
- Compute faults
Profile Slices
Fault Computation

![Graph showing elevation vs. normalized distance with profiles and fitted shapes for approach and leave.]
ProVAL AFM Inputs
ProVAL AFM Joint Faults

Graph: US49ES_NOF_01 - Left Elevation

- Distance (ft)
- Faulting (in)

Faulting ranges from -0.2 to 0.6
ProVAL AFM Joint Faults
Summary
Save Lives with ProVAL AFM

Please Slow Down My Dad Works Here