What FORTA-FI® Can Do
Longer lasting road ahead
Drum & Batch Plant
How to add fiber!

**EASY TO USE**
- easily metered automatically or manually
- mixes in drum plants and batch plants
- mixes thoroughly in seconds
- distributes uniformly

**NO MODIFICATIONS needed to:**
- your current asphalt mixture
- asphalt plant
- placement or compaction practices

**TESTED AND PROVEN**

Extensively tested with proven results!
FORTA® Voyager Advantages

- **EXCEPTIONAL ACCURACY**: Reduce the opportunity for mistakes! Waste less fiber with the Voyager fiber dispenser.

- **EASY TO USE**: Simply add the fiber to the unit and step away.

- **IMPROVES INVENTORY TRACKING**: Easy-to-read displays allow for simple fiber tracking that updates in real time.

- **DISPENSES MOST TYPES OF FIBER**: The Voyager Fiber Dispenser is compatible with a variety of fibers.

- **IMPROVES EMPLOYEE SAFETY**: No need for workers to climb up stairs to introduce fiber into the mix.

- **CAN REDUCE WORKER COMPENSATION COSTS**: With improved safety - save money with fewer job related injuries!

- **REDUCES LABOR COSTS**: Less workers needed for a job.
Dispersion…

<table>
<thead>
<tr>
<th>State</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundle (Least Desired)</td>
<td>A group of many aramid fibers that shows no clear indication of disturbance. This is the original condition of aramid fibers.</td>
<td></td>
</tr>
<tr>
<td>Agitated Bundle (Least Desired)</td>
<td>A grouping of aramid fibers similar to the bundled condition, but that has been visually agitated and has lost some of the individual aramids.</td>
<td></td>
</tr>
<tr>
<td>Cluster (Less Desired)</td>
<td>A grouping of individual aramid fibers that are more dispersed than the agitated bundle.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specimen ID</th>
<th>Equivalent Aramid Dosage Rate (oz/ton)</th>
<th>State of Aramid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Agitated Bundle</td>
</tr>
<tr>
<td>FORTA-FI 1</td>
<td>2.2</td>
<td>2</td>
</tr>
<tr>
<td>FORTA-FI 2</td>
<td>2.2</td>
<td>0</td>
</tr>
</tbody>
</table>
➢ The cost of fiber-reinforced mixture per 1000 cycles of fatigue life per mile was $288, whereas for the unmodified mixture it was $543.

➢ The cost of fiber-reinforced modified mixture per cycles of rutting life per mile was $1712, while the unmodified mixture was $6567.

“The smallest calculated LCCA is 20%...”
Asphalt is made up of:

Rock, Sand, & Aggregates

+ Asphalt Cement (the binder)

Mix Design & = NO CHANGE
Rutting

✓ PSU - MMLS3
✓ 50% - Less

![Bar chart showing rutting comparison between Fiber Slab and Control Slab. The Fiber Slab has an accumulated rut of 5.5 mm, while the Control Slab has 11.3 mm.]
Rutting Evaluation

Flow Number:

- Measures Permanent Deformation
- Fiber had 11.6x higher flow number than the control
Rutting – Top Layer

64°C Test Temp.; 100 psi Hose Pressure; 100 lb Load Load

APA Rutting (mm)

Number of Loading Cycles

APA Rutting @ 8,000 Cycles

PennDOT HMA with Fibers = 10.33 mm
PennDOT HMA - No Fibers = 12.08 mm
Blowup of raveled area

Example photograph of raveling that would require remedial action per table 338-1
AutoBahn
* 10X Better Raveling Test
Jackson Hole
* 9 years, was 6-8

NCAT
* 20M ESALs, No Raveling
ASU PCI Study
* Reduced Raveling 100%
# Reduce Raveling

Table 1. Comparison between original calculated and verified PCIs

<table>
<thead>
<tr>
<th>Branch</th>
<th>Section</th>
<th>Description</th>
<th>Severity</th>
<th>Quantity</th>
<th>Units</th>
<th>Density</th>
<th>Original DVs</th>
<th>Original PCI</th>
<th>Verified DVs</th>
<th>Verified PCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 3036</td>
<td>1</td>
<td>Alligator CR</td>
<td>Low</td>
<td>18.50</td>
<td>SqFt</td>
<td>0.28</td>
<td>4.78</td>
<td>95</td>
<td>4.54</td>
<td>93.46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L&amp;T CR</td>
<td>Low</td>
<td>80.00</td>
<td>Ft</td>
<td>1.19</td>
<td>2.59</td>
<td>16.84</td>
<td>15.30</td>
<td>69.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patch/cut</td>
<td>Low</td>
<td>3.00</td>
<td>SqFt</td>
<td>0.04</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Alligator CR</td>
<td>Low</td>
<td>120.75</td>
<td>SqFt</td>
<td>1.80</td>
<td>15.64</td>
<td>15.64</td>
<td>15.30</td>
<td>69.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L&amp;T CR</td>
<td>Medium</td>
<td>18.00</td>
<td>SqFt</td>
<td>0.27</td>
<td>10.81</td>
<td>10.81</td>
<td>11.10</td>
<td>5.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L&amp;T CR</td>
<td>Low</td>
<td>73.00</td>
<td>Ft</td>
<td>1.09</td>
<td>2.28</td>
<td>2.28</td>
<td>1.97</td>
<td>18.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raveling</td>
<td>Medium</td>
<td>40.50</td>
<td>Ft</td>
<td>0.60</td>
<td>5.32</td>
<td>5.32</td>
<td>5.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>L&amp;T CR</td>
<td>Medium</td>
<td>746.00</td>
<td>SqFt</td>
<td>11.12</td>
<td>19.32</td>
<td>19.32</td>
<td>18.90</td>
<td></td>
</tr>
</tbody>
</table>
Reduce Cracking
Crack Testing

The diagram shows the overlay tester fatigue life in cycles for two mix types:
- **PennDOT HMA - No Fibers**: 579 cycles
- **PennDOT HMA - Fibers**: 1,674 cycles

The fatigue life for the mix type with fibers is significantly higher compared to the mix type without fibers.
Texas Overlay Tester Plates
Reduce Cracking

AVENUE D - LANCASTER, CA

7 Months After Paving

FORTAflex® Section
Control Section

TEST OVERLAY

GLEN DAVID DRIVE - O'HARA TOWNSHIP, PA

4 YEARS FORTAflex®

Asphalt pavement without fiber
FORTAflex® Asphalt

BEFORE PAVING

ROADWAY
% IMPROVEMENT

- Rutting
- Fatigue
- Long/Trans Crack
- Raveling
Thinning to compete against concrete

Save Now
Use 35% Less Asphalt Thickness
Stronger than your traditional asphalt mixture

Save Down the Road
Lasts 50% Longer
Reduce cracking and rutting
## Dense Graded HMA

![Dense Graded HMA](image)

### Project Profile

- **FORTA® FORTA-FI®**

### STATE ROUTE 3036 - LANCASTER COUNTY, PA

<table>
<thead>
<tr>
<th>Branch</th>
<th>Section</th>
<th>Description</th>
<th>Quantity</th>
<th>PCI</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber</td>
<td>Alligator CR L &amp; T CR Raveling</td>
<td>19 sq. ft. 80 ft None</td>
<td>95</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>SR 3036</td>
<td>Control</td>
<td>Alligator CR L &amp; T CR Raveling</td>
<td>139 sq. ft. 113 ft</td>
<td>72 Satisfactory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>746 sq. ft.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Egypt mud bricks reinforces horsehair and straw

Roman concrete at the Pantheon

Asbestos fibers used in concrete

Shotcrete

Synthetic Fibers for Asphalt

Mesopotamia Straw used in sunbaked bricks

Portland Cement discovered

The concept of composite material

Synthetic fibers enter US market

The application of steel, glass and synthetic fibers
Where in the world is FORTA-FI®?

Thank You

www.forta-fi.com