MTO's Experience Incorporating Fibres in Hot Mix Asphalt

Pamela Marks, P.Eng.
Head, Bituminous Section
Materials Engineering and Research Office
Ministry of Transportation of Ontario

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Outline

- Why Add Fibres to Hot Mix Asphalt?
- Our History with Fibres
- Current Reinforcing Fibre Trials
- Incorporating Reinforcing Fibres
- Challenges & Benefits
- Performance
- Conclusions

Why Add Fibres to Hot Mix Asphalt?

To control drain down of asphalt cement

To reinforce the pavement against cracking and rutting

Why Add Fibres to Hot Mix Asphalt?

Transportation agencies typically use fibres in Stone Mastic Asphalt (SMA) and open-graded mixes to control draindown

Use of fibre for reinforcement is not common

Research results and performance of fibre reinforced Hot Mix Asphalt (HMA) have mixed results

Fibres have rarely been detrimental, but if they do not improve performance, they may not be cost-effective

Source: NCHRP Synthesis 475

Our History: Mineral Fibres

Naturally occurring or manufactured by melting minerals

Absorptive, but not as much as cellulose fibres

Use: prevent draindown

Dosage:

0.4%

Form: Loose or pellet

MTO currently allows in SMA

Our History: Cellulose Fibres

Plant-based fibres

Absorbs asphalt cement

Use: prevent draindown

Dosage: 0.3%

Form: Loose or pellet

Low tensile strength

MTO currently allows in SMA

Our History: Polyester Fibres

Synthetic polymer fibre
High tensile strength

Use: increase strength and stability of mix

Dosage:
0.36%

Requires extra asphalt cement

Length:
6 mm

Tensile Strength:
500 MPa

Melt Temperature:
250°C

In 1980's used on Highway 403 EB in Burlington

Our History: Polypropylene Fibres

Synthetic polymer fibre derived from petroleum

Disperses easily in asphalt cement

Begins to shorten at 150°C

Resistant to acids and salts

Bonds strongly with asphalt cement

Lower melting point requires control of production temperatures

Requires extra asphalt cement

In 2000's used polypropylene fibres on Highway 655

Our History: Polyethylene Terephthalate (PET) Fibres

Synthetic polymer fibre from recycled pop bottles

Use: increase mix strength

Dosage: 0.3% (and extra asphalt cement)

Length:

9.5 to 12.5 mm

Melt Temperature: 200°C

In 2000's used on Highways 655, 427, and 417

Our History: Aramid Fibres

Synthetic polymer fibre	High tensile strength: 3,000 MPa	Use: increase mix strength
Form: Monofilament	Dosage: 0.0065 to 0.013%	Length: 19 mm
Melt Temperature: 400 to 450°C	Used on several trials since 2016	

Current Reinforcing Fibre Trials

Now

Aramid Fibres

● 2016 ● 2017 2018 2019 Potential

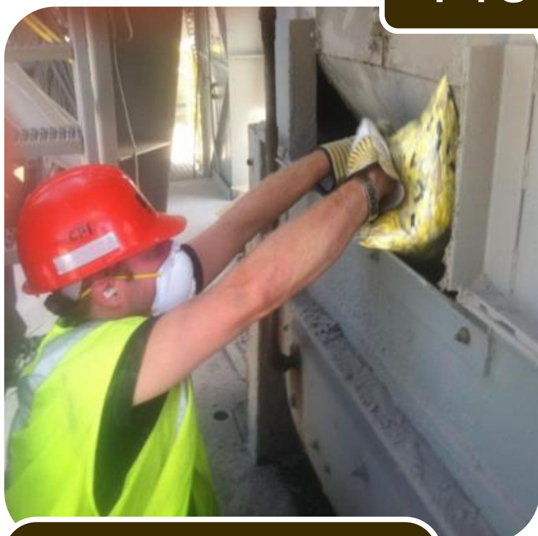
Aramid Fibre Distribution Methods

Blend of polyolefin and aramid fibres

Sasobit coated aramid fibres

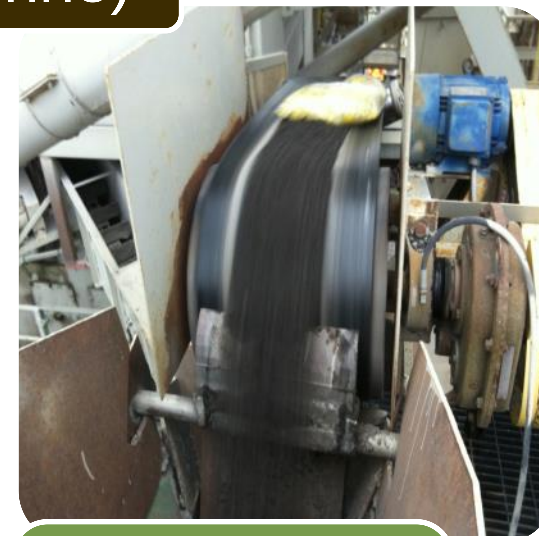
Incorporating Reinforcing Fibres

Pre-measured bags (1 bag/tonne)



Manual insertion directly into pugmill

Pneumatic tube



Conveyor

Incorporating Reinforcing Fibres

Loose Fibres

Manual weighing and pneumatic tube

Automated metering system

Challenges

The plant temperature may need to be increased in order to melt the bags or Sasobit wax

No issues paving or rolling, but harder to rake

May require some additional cleaning of equipment

Past Challenges

Polyethylene Terephthalate (PET) fibres used in the 2000's clumped

Solution was to add the PET fibres more slowly

Advantage or Disadvantage?

Fibres (and more asphalt cement) for more durable stronger mix?

Increased cost of fibres (and additional asphalt cement to coat fibres)

Potential Benefits

Thus far, we cannot comment on the long term benefits or disadvantages of mixing aramid fibres with HMA

The reported benefits include:

- Extends life of pavement
- Reduces rutting
- Higher resistance to all crack propagation and growth

Performance: Semi-Circular Bend (SCB)

According to AASHTO TP124

- Test Temperature: 25ºC
- Specimen Thickness: 50 mm
- Notch Depth: 15 mm
- Monotonic load of: 50 mm/min

Outcome:

- Flexibility Index (FI)
- Fracture Energy (J/m^2)

Testing limited to field cores from one contract

Fibre mixes had more variable results than control mix

Fatigue properties did not improve with addition of fibres

Performance: Disk-Shaped Compact Tension (DCT)

According to ASTM D7313

- Test Temperature: 10º C higher than low PG grade
- Crack Mouth Opening Displacement (CMOD) Rate: 1mm/min

Outcome:

- Fracture Energy (J/m^2)

- Testing limited to field cores from one contract
- DCT results less variable than SCB results for fibre mixes
- Very minimal increase in fracture properties noted for fibre mixes

Performance: Hamburg Wheel Tracking

According to AASHTO T324

- Samples submerged in water
- Test Temperature: 50ºC
- Number of cycles: 10,000 cycles

Outcome:

- Rut depth vs. # of load cycles

Testing limited to loose mix from one contract

Rutting resistance of fibre mixes were better than the control mix

Performance: Texas Overlay

According to Tex-248-F

# of Cycles:
1000 cycles
(1500 or 2000?)

Temperature:
25°C
(15°C or 10°C?)

Outcome

# of cycles to failure

Resistance to reflective cracking did not improve with addition of fibres

Testing limited to loose mix from one contract

Lowered test temperature for softer asphalt grade and increased cycles in order to capture a fracture response

Performance: One Year Field

Many are performing similarly to the control

Two started exhibiting reflective cracking within a few months of being placed

Continued monitoring is required to determine long term benefits

Performance: Summary

Preliminary Results

- Based on very limited testing, no significant difference in fracture properties found between fibre and control mixes
- Fibre mix test results more variable than control
- Rutting resistance increased with the addition of fibres

Next Steps

- Complete Texas Overlay testing
- Run SCB and DCT on loose mix from the same contract
- Run Cyclic Fatigue and Dynamic Modulus
- Evaluate fibre mix vs control from other contracts
- Monitor field performance vs test results over time

Conclusions

- Mixed reviews on initial performance
- A delay in propagation of working cracks through fibre reinforced mix is not assured
- Review of non-working cracks is inconclusive at this stage
- MTO is still in the exploratory phase regarding reinforced fibre mixes

Next Steps

Continue to monitor existing fibre reinforcing trials

Conduct more mix performance testing on fibre reinforced mix vs. control mix

Establish a method to check fibre dosage and distribution during construction

Questions?

Pamela Marks, P.Eng.
Head, Bituminous Section
Materials Engineering and Research Office
Ministry of Transportation, Ontario

145 Sir William Hearst Avenue, Room 238
Downsview, Ontario M3M 0B6
(416) 235-3725

Pamela.Marks@ontario.ca

Heather Bell, P.Eng.
Senior Bituminous Engineer
Materials Engineering and Research Office
Ministry of Transportation, Ontario

145 Sir William Hearst Avenue, Room 238
Downsview, Ontario M3M 0B6
(416) 235-3717

Heather.Bell@ontario.ca