Asphalt Pavement Pothole Repair with Recycled Material and Preheating

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Background

- Pothole is a bowl-shaped depression in asphalt pavement surface that affects pavement deterioration and traffic safety
- Potholes are usually caused by water infiltration through surface cracks and freezing-thaw cycles
- Pothole repair is one of the most important and frequent maintenance treatments for highway agencies
- Pothole pathing may fail in raveling, debonding, rutting etc. and require re-patch.

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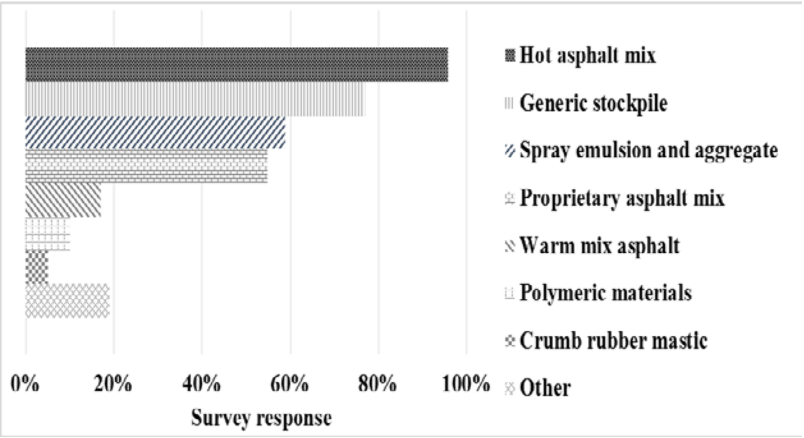
Current Practice

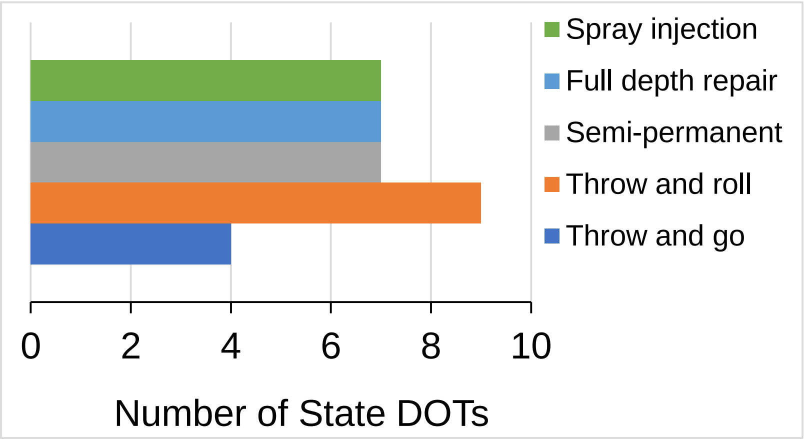
- **Current practice for pothole repair**

Materials:



(NCHRP Synthesis 463, 2014)

Techniques:



(Survey response; Hajj et al. 2021)

HMA patching material and throw and roll method are most widely used by state agencies in US.

Objective

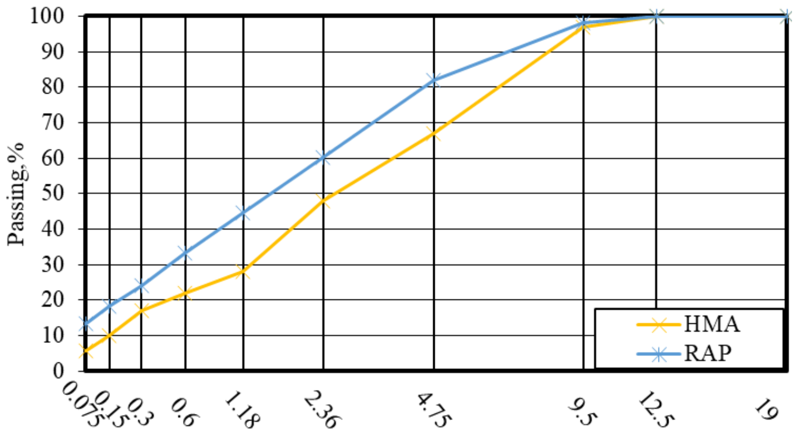
Investigate an innovative approach of pothole repair method using HMA with RAP and preheating.

- Evaluate the performance of HMA with different RAP contents through laboratory tests to select the most appropriate content.
- Evaluate the in-site strength of repaired pothole with field cores to quantify the benefits of repair quality due to preheating.

Patching Materials

- **Patching Materials**
  - 9.5mm HMA with PG64-22 asphalt binder (collected from plant)
  - Recycled asphalt pavement (RAP)

RAP



Gradation

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Laboratory Testing (1)

- **Marshall Specimens**
  - Control HMA
  - HMA +15% RAP
  - HMA +30% RAP
  - HMA +50% RAP

- **Mechanical Tests**
  - Indirect tensile strength test (Rutting resistance)
  - Interface shear strength test (Interface bonding)
  - Cantabro test (Abrasion/Raveling resistance)

Laboratory Testing (2)

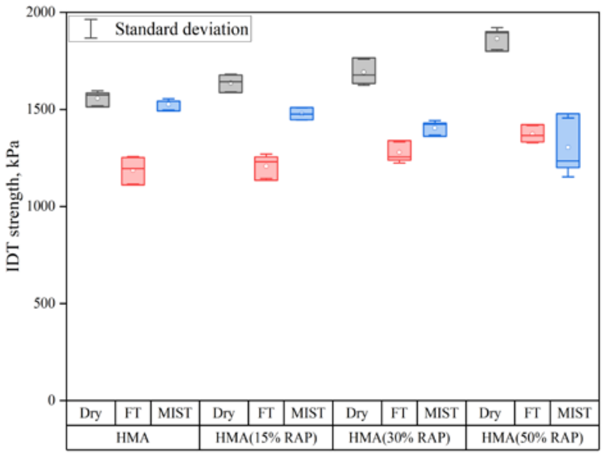
- **Environmental Conditioning of Specimens**
  - Freezing-thaw (AASHTO T-283)
  - Moisture Induced Stress Tester (MIST) (ASTM D7870) (278 kPa dynamic pore water pressure, 3500 cycles, 60°C)

MIST external view

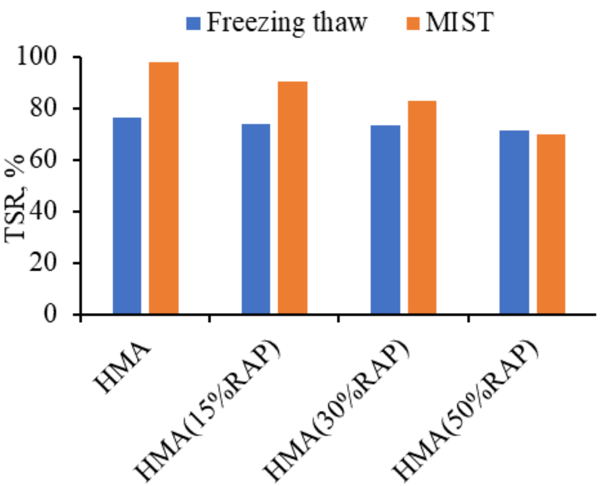
MIST internal view

Laboratory Testing (3)

- **IDT Strength of Lab Specimens**



Dry, FT and MIST



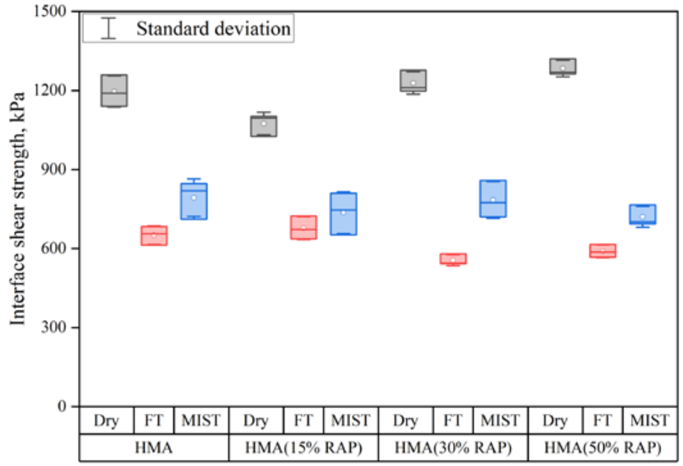
Strength ratio

As RAP content increased, IDT strength of patching material increased under dry and FT conditions while decreased under MIST condition.

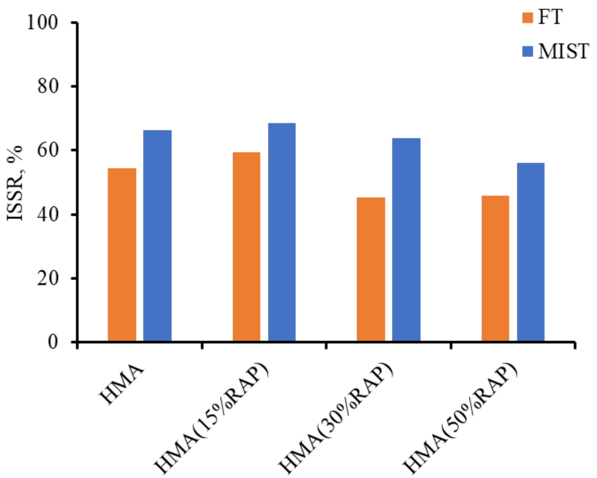
As RAP content increased, IDT strength was less resistance to moisture, especially FT.

Laboratory Testing (4)

- **Interface Shear Strength of Lab Specimens**



Dry, FT and MIST



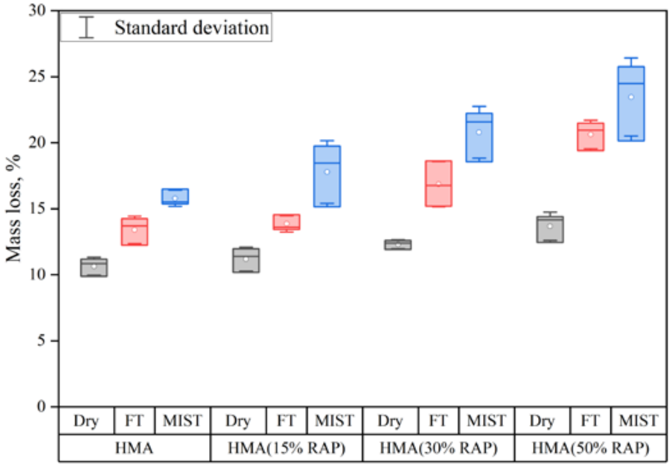
Strength ratio

The addition of RAP did not have significant impact on interface bonding.

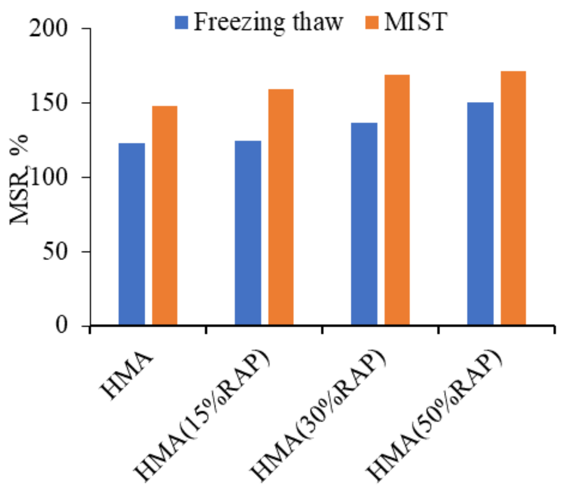
The impact of FT was more significant than pore water pressure on interface bonding condition.

Laboratory Testing (5)

- **Mass Loss of Lab Specimens**



Dry, FT and MIST



Strength ratio

As the RAP content increased, mass loss increased accordingly, regardless of the conditioning environments.

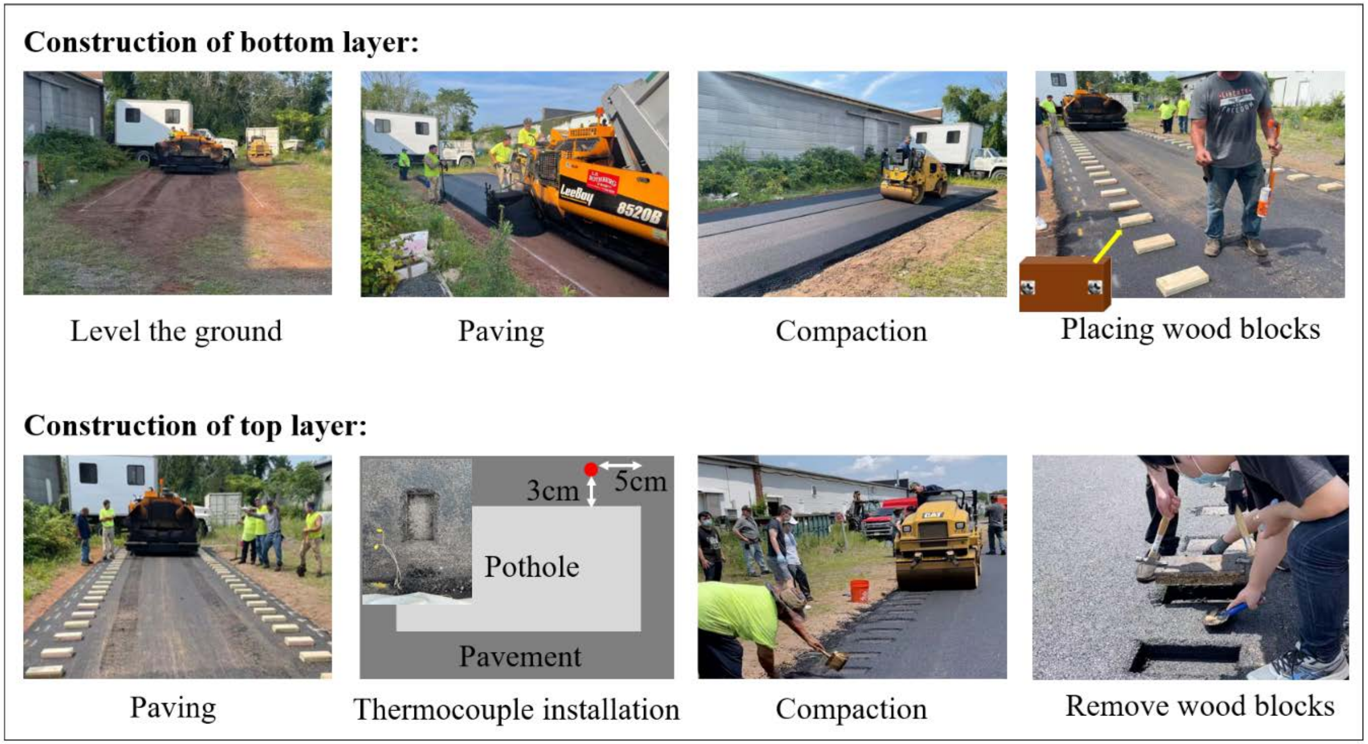
The impact of FT was more significant than pore water pressure for abrasion loss.

Material Selection for Field Test

- **30% RAP was selected considering the balance of material performance and environmental benefits.**
  - FT conditioned TSR value meets the minimum requirement of 70% from AASHTO T283.
  - MIST conditioned TSR value meets the recommendation of 80% proposed by LaCroix et al. (2016).
  - Interface bonding condition is close to that of HMA.
  - Abrasion resistance decreases with the increase of RAP content.

Field Section and Test (1)

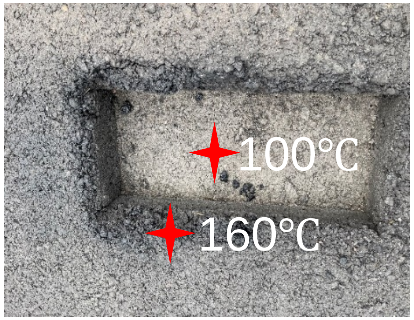
- **Construction of test section**
  - The test section was constructed in two lifts (3.5”+2.5”)
  - 9.5mm HMA with PG64-22
  - 0.305m long, 0.127m wide and 0.062m thick artificial pothole



Field Section and Test (2)

- **Pothole Repair with Preheating Method**
  - 5 minutes of infrared preheating (4300W)
  - HMA + 30% RAP
  - 10 sec. vibratory plate compaction

(1) Preheating



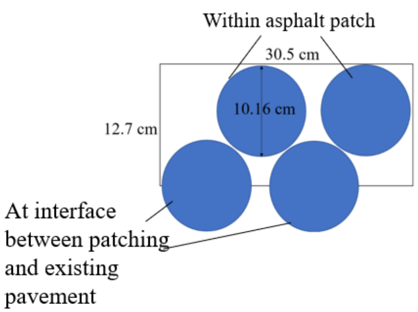
(2) Heated pothole

(3) Compaction

(4) Asphalt patch

Field Section and Test (3)

- **Field Coring and Test Plan**
  - IDT and Cantabro tests on cylindrical patching material that were detached from old pavement.
  - Interface tensile strength test on vertical interface between patching and old pavement.
  - FT conditioning for IDT and interface tensile strength tests, and MIST conditioning for Cantabro test.



(1) Coring plan

(2) Drilling

(3) Cores

(4) Patch + old pavement

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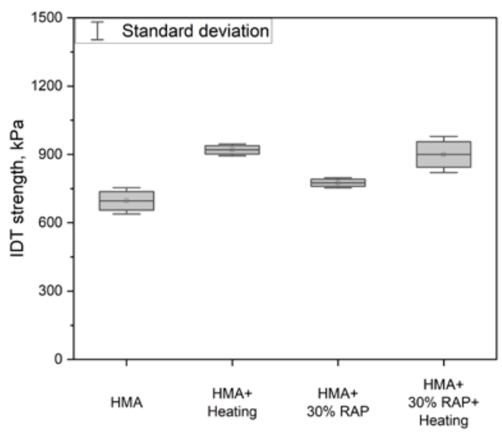
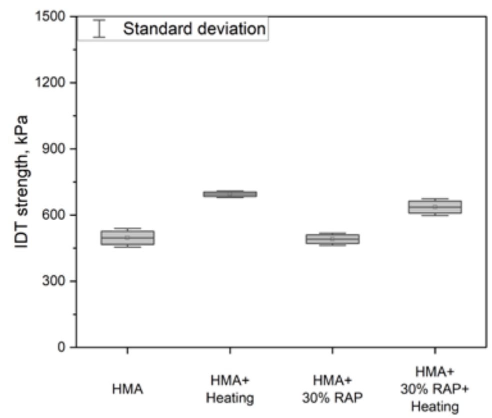
Field Section and Test (4)

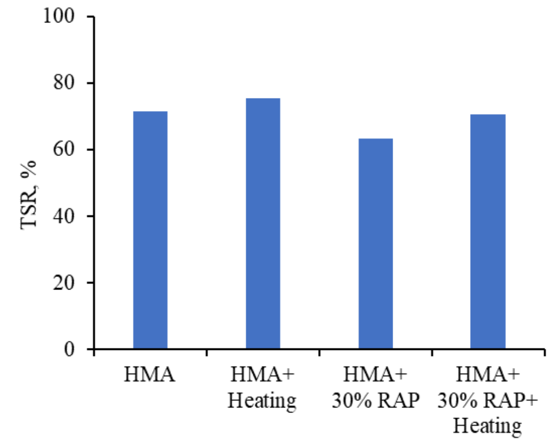
- **IDT Strength of Field Cores**



Dry



FT



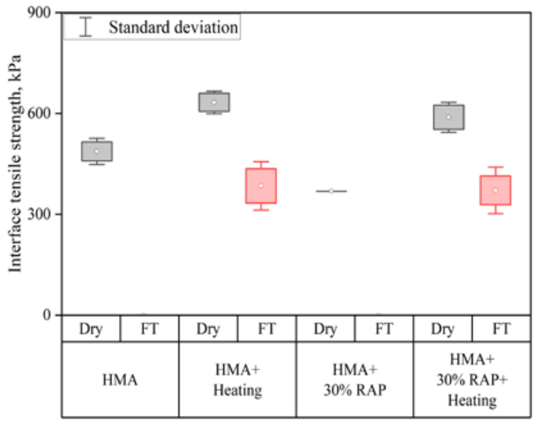
Strength ratio

When preheating was applied, IDT strength increased under both conditions.

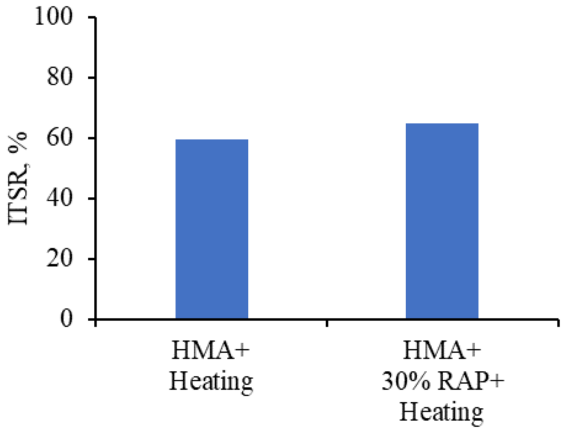
Without preheating, HMA with 30% RAP has the lowest TSR, while it increases after preheating and becomes comparable with that of pure HMA.

Field Section and Test (5)

- **Interface Tensile Strength of Field Cores**



Dry and FT



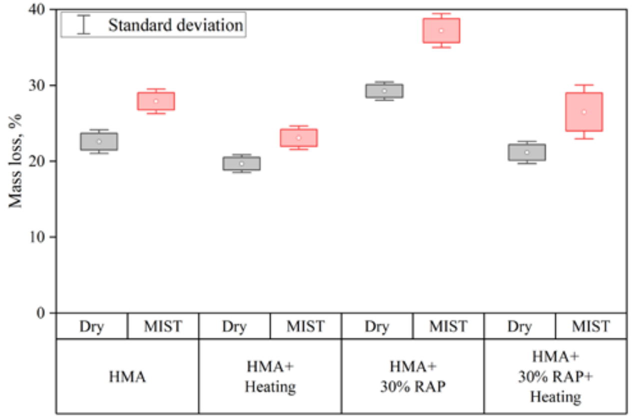
Strength ratio

Without preheating, adding RAP and experiencing FT can cause interface debonding, while preheating can remarkably enhance interface bonding condition under both dry and FT conditions.

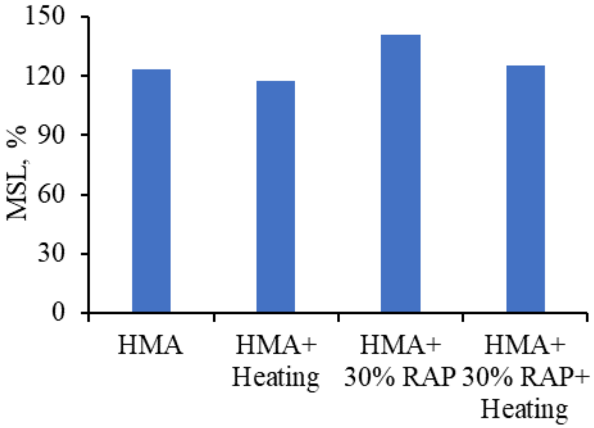
When preheating was performed, the moisture sensitivity of HMA with 30% RAP was similar with that of the HMA without RAP.

Field Section and Test (6)

- **Mass Loss of Field Cores**



Dry and FT



Mass loss ratio

Without preheating, the addition of RAP led to high mass loss and increased moisture sensitivity, while preheating can mitigate its negative impact and lead to comparable abrasion resistance with pure HMA.

Conclusions

- Preheating can enhance interface bonding between patching material and surrounding pavement, and increase cohesive strength of patching material itself.
- The abrasion loss, IDT strength, and interface bonding strength of patching material are less resistant to moisture as RAP content increases.
- The overall performance of HMA containing 30% RAP with preheating is satisfactory as compared to HMA.
- Long-term performance monitoring of pothole repair in the real pavements are recommended.

Acknowledgement

- Technical Project Panel at New Jersey Department of Transportation
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Thank You !
Questions ?