HEAT DESIGN EQUIPMENT INC.

SWIFT
SEPT 25-28 2023 WINNIPEG

captg

HIGH RAP CONTENT PATCHING MIXES : FIELD STUDIES

Presented by Matt Kieswetter

OUR MISSION

To change the way the world constructs and maintains asphalt infrastructure utilizing infrared technology for longer lasting pavements.

WHAT WE DO !

A World Leader in Manufacturing of Infrared Heaters for the Asphalt Industries

- Longitudinal Joint Heaters
- Pre-Heaters - Asphalt Heating – Repair / Maintenance
- Asphalt Hot box Storage Boxes / Reclaimers
- Asphalt Recyclers
- Longitudinal Joint Repair System
- Aggregate Conveyor Heaters

WHAT IS
INFRARED?

- Infrared heating: the transfer of radiant energy from a hot surface through the air to cooler surfaces, without the use of an air mover.
- No energy loss until the infrared rays hit the asphalt then energy is transformed to penetrating heat.
- IR offers the ability to efficiently reheat asphalt without burning the AC in the mix

WHAT IS AN INFRARED HEATER ?

- HAS NO OPEN FLAME
- Surface of the IR heater is 750 to 1000C (1300 to 1850F) degree which emits high intensity infrared rays
- The radiation is absorbed by asphalt, quickly penetrates and turns to heat
- Same as re-heating up a lab sample
- No open flame that will burn or weaken the asphalt prior to the penetration into the surface.

UNIVERSITY OF WATERLOO
FACULTY OF ENGINEERING

All members of Centre for Pavement and Transportation Technology (CPATT)

CPATT
CENTRE FOR PAVEMENT AND TRANSPORTATION TECHNOLOGY

VA Asphalt Pavement Technologies Inc.

ASPHALT PAVEMENT TECHNOLOGIES

IPR
INFRARED PAVEMENT REPAIR CORPORATION
Think Green!

HEAT DESIGN EQUIPMENT INC.
The Infrared People

Performance Assessment of High Content Reclaimed Asphalt Pavement Patching Mixes

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INTRODUCTION

- Background
- Pavement construction, maintenance, and rehabilitation activities require significant virgin aggregates and asphalt materials.
- RAP has been deemed a high-value sustainable material.
- The percentage of RAP allowed in a particular mix design varies among road agencies and municipalities.
- Past research presented a positive effect of adding rejuvenator into HMA mix with RAP.
- Objective

Explore the feasibility of using 100% RAP mix for pavement patching using infrared heaters, particularly for small areas.

MATERIALS

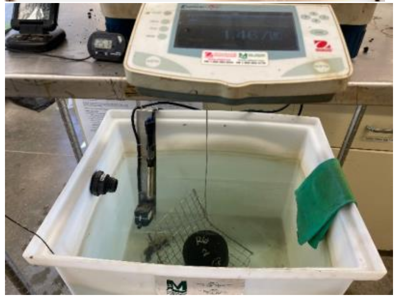
- Mix A – Plant, RAP + Rejuvenator A
- Mix B – Plant, RAP + Rejuvenator B
- Mix F – In-place, RAP on site + Rejuvenator B

- RAP in Mix A and Mix B was from the same RAP source.
- Rejuvenator dosage in Mix F > Mix B

TEST METHODS

Test Method	Test Sample	Test Parameter	Standard
Binder Extraction	Min 1.5 kg	Binder Content	LS-282
Gradation	Min 2 kg	Particle size distribution	LS-602
Theoretical Maximum Relative Density (MRD)	Min 1.5 kg	MRD and air void	LS-264
Bulk Relative Density (BRD)	Compacted sample	BRD and air void	LS-262
Compaction (Gyratory)	Specified by tests	N/A	AASHTO T 312
Hamburg Wheel Tracking Test (HWTT)	Cylindrical Ø150 mm x 63 mm	Rut depth @ 10000 cycles	AASHTO T 342
IDEAL-CT	Cylindrical Ø150 mm x 63 mm	CT Index	ASTM D8225
Fatigue (4PBB)	Beam 380 x 50 x 63 mm	Fatigue life	AASHTO T 321
Dynamic Modulus (DM)	Cylindrical ⌀150 mm x 100 mm	Dynamic complex modulus	AASHTO T 342

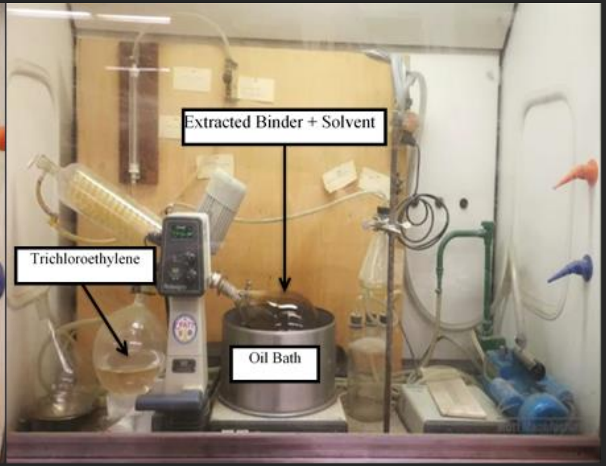


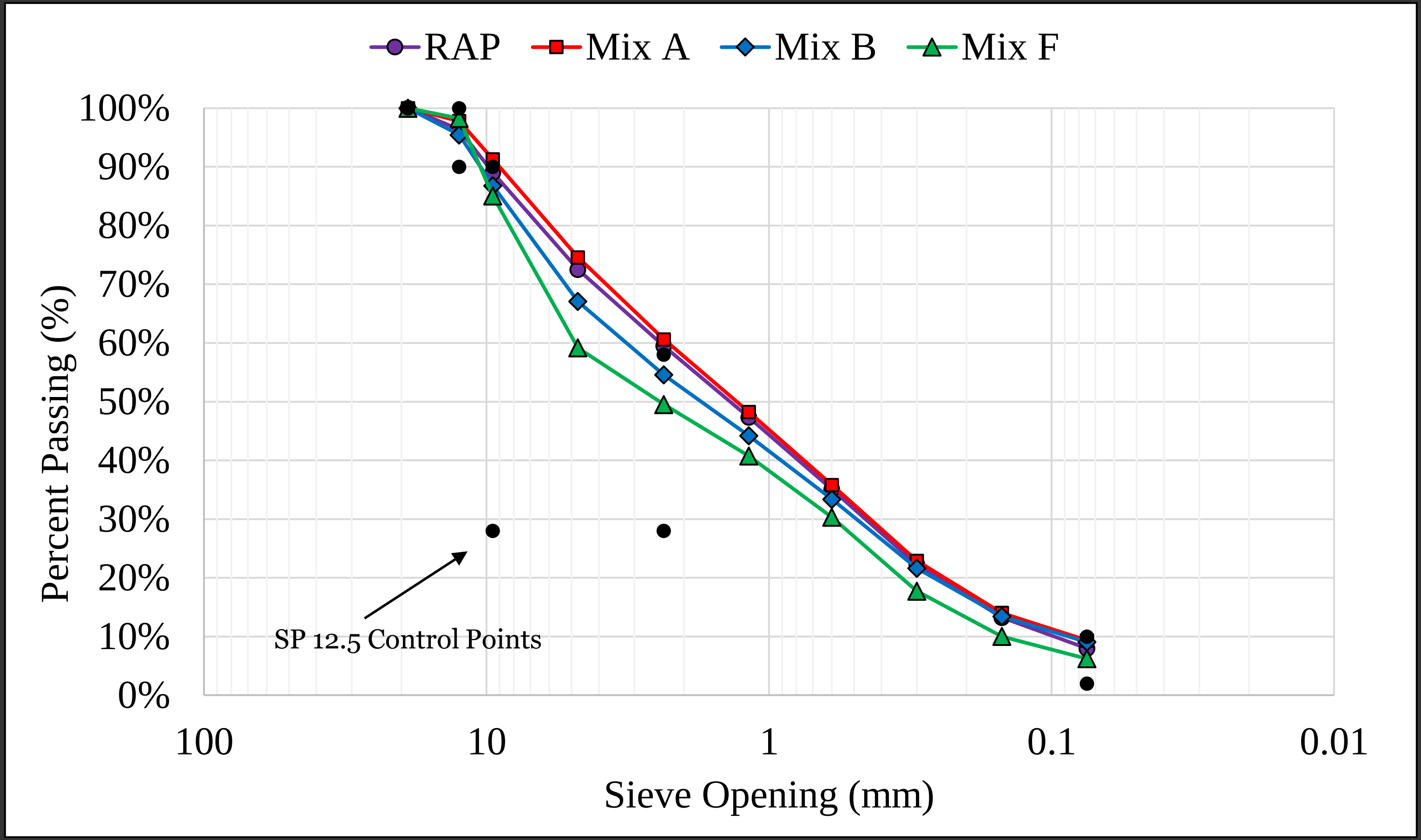
RESULTS AND DISCUSSION
- FUNDAMENTAL TEST RESULTS: BINDER CONTENT & GRADATION

	RAP	Mix A	Mix B	Mix F
Binder Content (%)	4.59%	6.83%	6.15%	6.11%
MRD (g/cm^3)	2.558	2.517	2.531	2.518

Sieve Opening (mm)	RAP	Mix A	Mix B	Mix F
19	100.0%	100.0%	100.0%	100.0%
12.5	96.4%	97.8%	95.5%	98.3%
9.5	89.0%	91.3%	86.8%	85.0%
4.75	72.5%	74.6%	67.1%	59.2%
2.36	59.5%	60.6%	54.6%	49.5%
1.18	47.3%	48.2%	44.2%	40.7%
0.6	35.1%	35.8%	33.4%	30.3%
0.3	22.3%	22.9%	21.6%	17.7%
0.15	13.2%	14.0%	13.4%	10.0%
0.075	8.0%	9.3%	9.1%	6.2%



RESULTS AND DISCUSSION
- FUNDAMENTAL TEST RESULTS: GRADATION



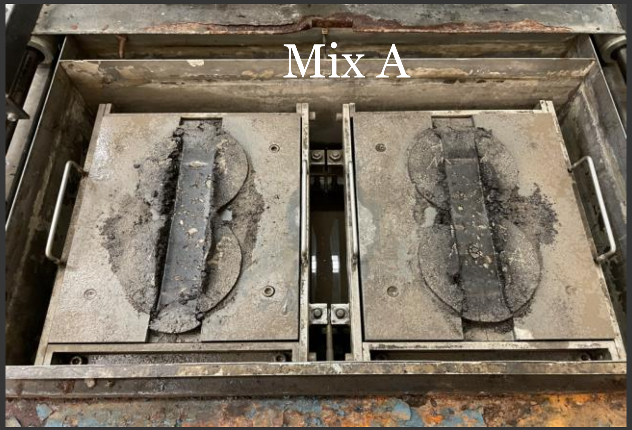
RESULTS AND DISCUSSION
- FUNDAMENTAL TEST RESULTS: VOLUMETRICS OF COMPACTED SAMPLES

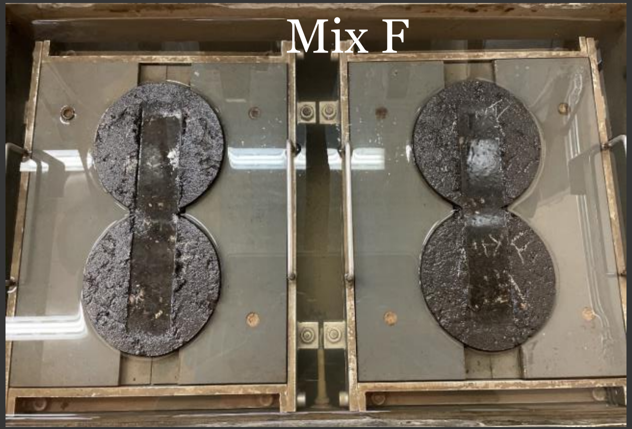
Mix	MRD (g/cm^3)	DM		HWTT		IDEAL-CT		4PBB	
		BRD (g/cm3)	Air Voids	BRD (g/cm3)	Air Voids	BRD (g/cm3)	Air Voids	BRD (g/cm3)	Air Voids
RAP	2.558	2.364	7.7%	2.376	7.2%	2.387	6.8%	2.372	7.4%
Mix A	2.517	2.325	7.6%	2.333	7.3%	2.361	6.2%	2.339	7.2%
Mix B	2.531	2.345	7.4%	2.340	7.5%	2.351	7.1%	2.350	6.7%
Mix F	2.518	2.357	6.4%	2.342	7.0%	2.348	6.8%	2.351	6.7%

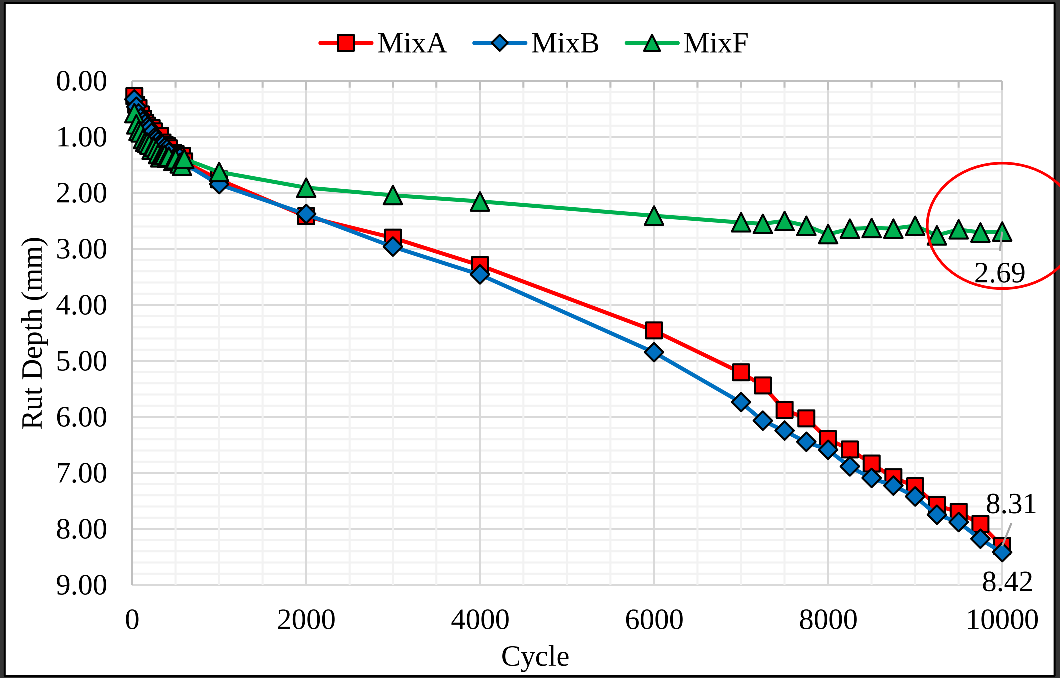
RESULTS AND DISCUSSION
- RUTTING PERFORMANCE BY HWTT

- Compacted samples with 7% air voids
- Sample submerged in water
- Test the sample at 50 °C
- Max number of cycles: 10,000
  equal to 20,000 wheel passes

Results and Discussion
- Rutting Performance by HWTT



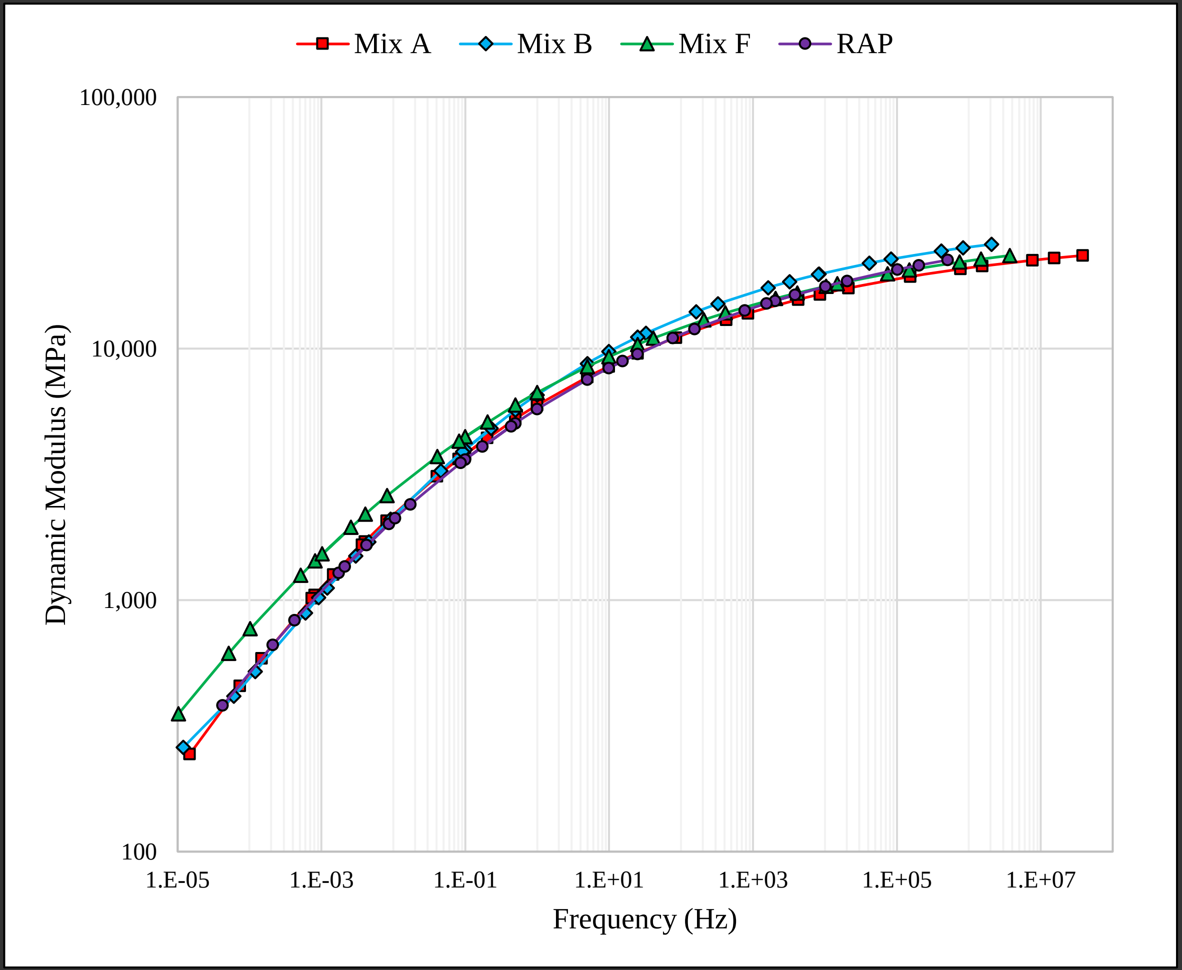




RESULTS AND DISCUSSION
- RUTTING PERFORMANCE BY DM

- Samples are subjected to a repetitive sinusoidal compressive axial load in the dynamic modulus test under various temperatures (-10, 4, 21, 37, and 54°C).
- Within each temperature, five loading frequencies (0.1, 0.5, 1, 5, 10, and 25 Hz) are applied to the unconfined samples.
- The master curves can be constructed with the sample stiffness based on the time-temperature superposition sigmoidal model.
- The master curves can also be used to evaluate the sample's capability to resist permanent deformation.

RESULTS AND DISCUSSION
- RUTTING PERFORMANCE BY DM



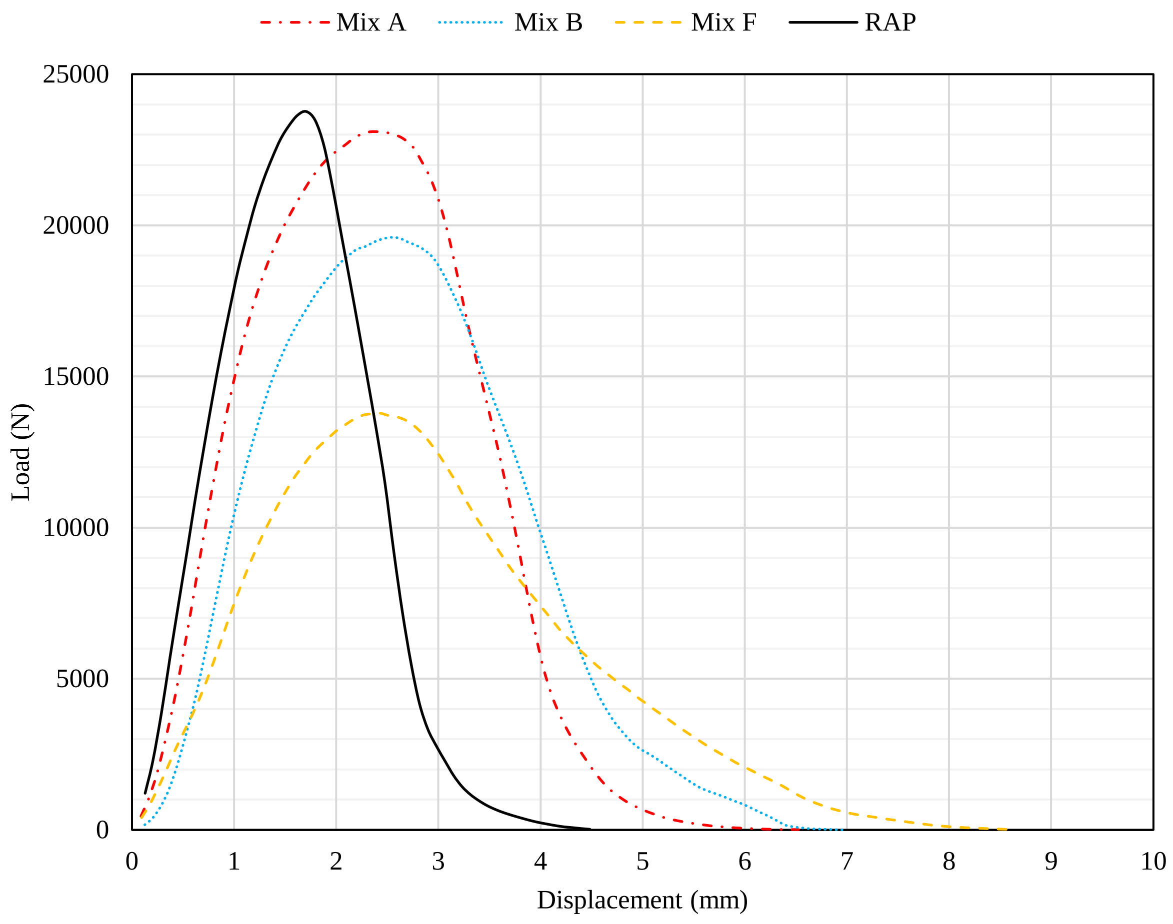
The master curves show:

- Dynamic modulus tests could not adequately differentiate among the mix types at low temperatures, corresponding to the high loading frequency.
- At a high temperature that corresponds to the low loading frequency, the dynamic modulus for Mix F is clearly higher than the rest of the mixes, indicating that Mix F can be expected to have better resistance to permanent rutting.
- This conclusion is consistent with the HWTT results.

RESULTS AND DISCUSSION
- CRACKING PERFORMANCE BY IDEAL-CT

- Test temperature: 25 °C
- Loading rate: 50 mm/min
- Compacted samples with 7% air voids

Results and Discussion
- Cracking Performance by IDEAL-CT



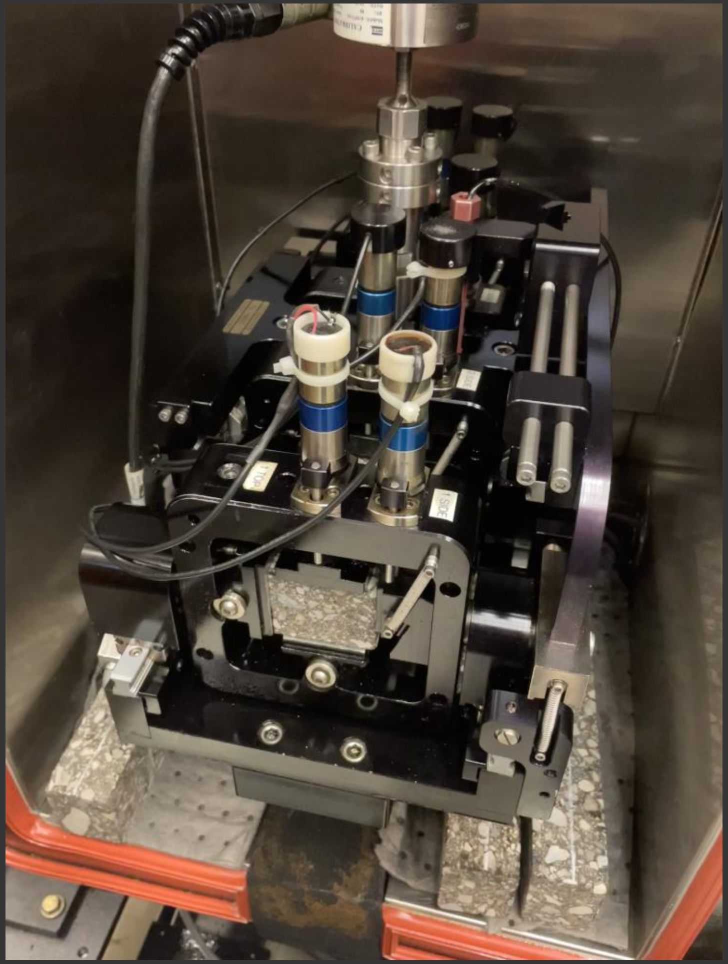
CTIndex	Mix A	Mix B	Mix F
Mean	9.42	13.60	16.44
Std	0.99	2.44	6.67
COV	10%	18%	41%

- Mix F exhibits a relatively higher cracking resistance, which may be due to the type and dosage of the rejuvenators used.
- CT_{Index} results of Mix A and B show less variation than Mix F.

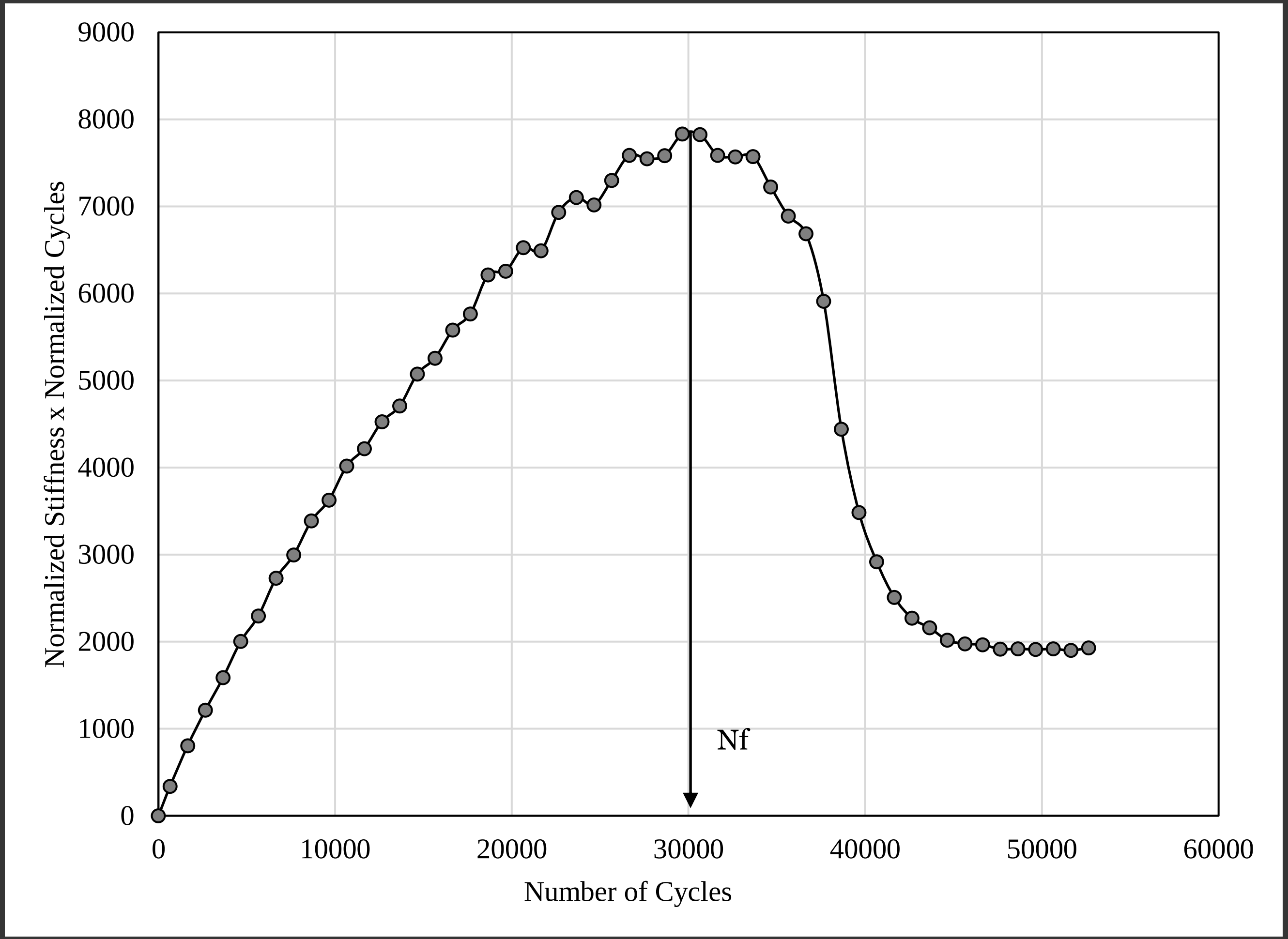
RESULTS AND DISCUSSION
- FATIGUE PERFORMANCE BY 4PBB

Sample preparation and test initiation

- 2h condition at 20 °C
- Loading frequency: 10 Hz
- Strain level: 300 - 600 microstrain

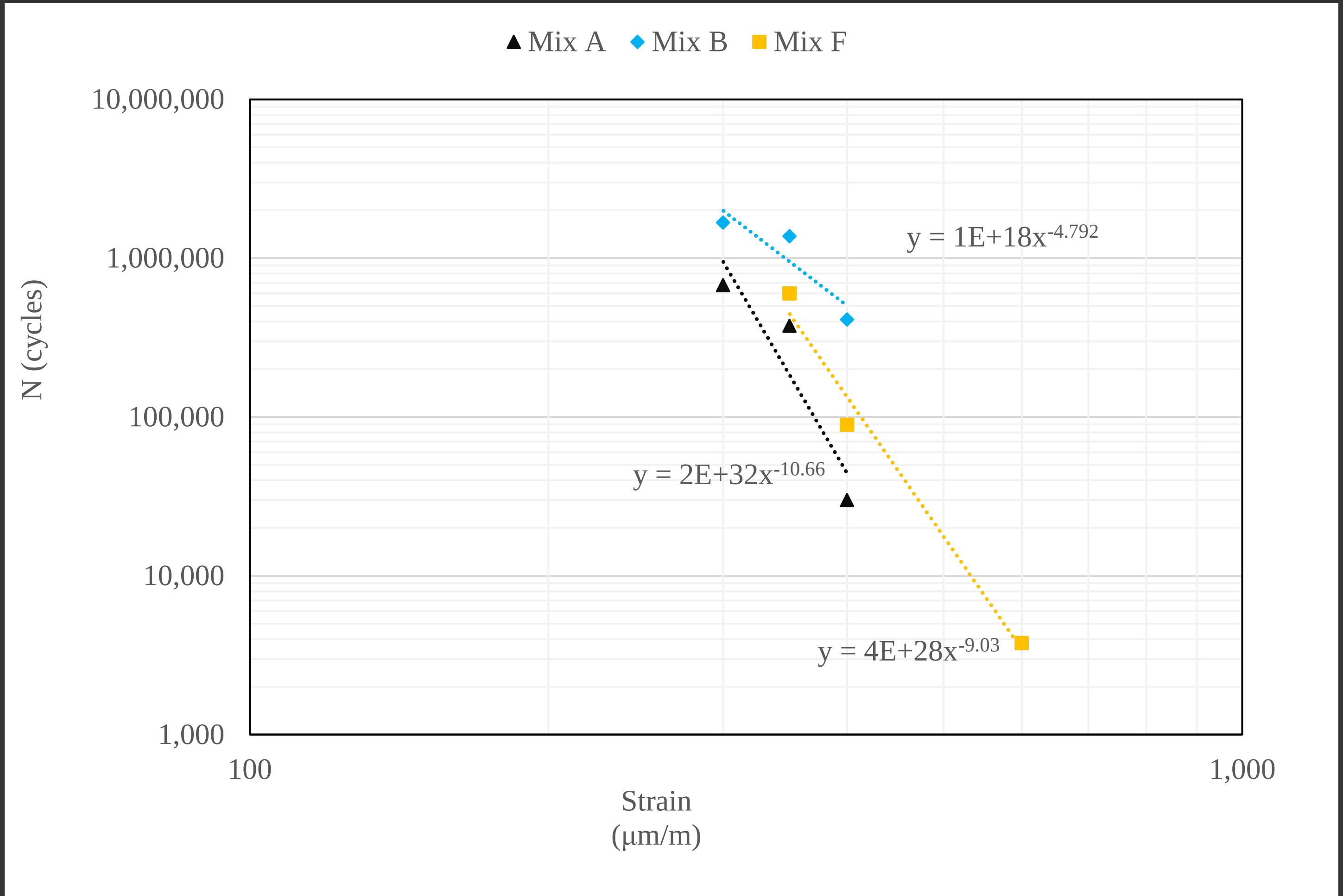


RESULTS AND DISCUSSION
- FATIGUE PERFORMANCE BY 4PBB



- The number of cycles to failure (Nf) at each strain level was determined by fitting the curve and locating Nf corresponding to the largest normalized stiffness × normalized cycles.
- On the left, this is an example showing such a curve and Nf for Mix A at a 400 microstrain.

Results and Discussion
- Fatigue Performance by 4PBB



- The Nf for each mix was computed at three different strain levels. For instance, at a strain level of 400 με, Nf for Mix A, B, and F is 30,043, 411,099, and 89,397, respectively.
- Mix B has the longest fatigue life at the higher strain level, followed by Mix F and A.

CONCLUSIONS

Findings

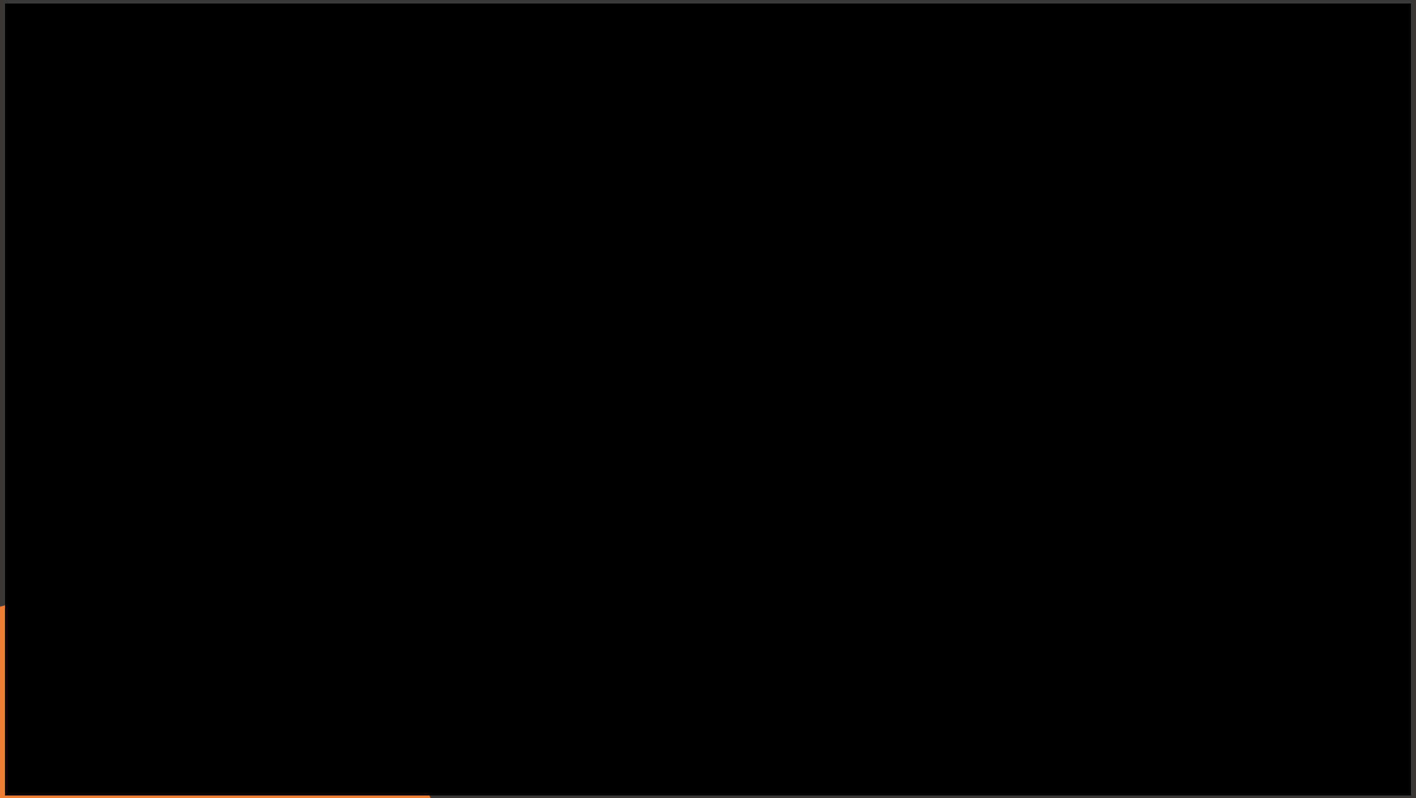
- To evaluate permanent deformation, the DM results are consistent with the HWTT results, in which Mix F performed better than Mix A and B. Mix F has more large-sized aggregates than Mix A and Mix B, which may have resulted in a better aggregate interlock.
- The IDEAL-CT test results indicate that all the mixtures with rejuvenators show improvements in cracking resistance. Mix F seems to have the best cracking resistance, followed by Mix B and A.
- The 4PBB tests indicate that Mix B has the longest fatigue life at a higher strain level. The fatigue resistance for Mix A is relatively poor compared to Mix B and Mix F.

Recommendations

- It is recommended that research be done to improve the 100% RAP patching mixes by controlling the rejuvenator dosage and type and the RAP source, particularly on aggregate gradation and binder content.
- Work is ongoing to evaluate the field performance of infrared patching mixes to develop life cycle cost benefits.
- Evaluate benefit of high RAP mixes in combination with Hot In Place Patch Repair (Its HIPPR) to reduce CO2e

ASPHALT RAP RECYCLING

RAP RECYCLING VIDEO



- INFRARED HEAT (no OPEN FLAME)
- DUAL HOPPER
- RIBBON MIXER
- PREHEAT HOPPER
- CONTINUIOS MIX

ASPHALT ADDITIVE & REJUVENATORS

- 1-8 pound packages
- No need to keep hot
- Minimum of 3 pounds per ton depending on the quality of the RAP
- Melts and Blends with the Recycled asphalt as it heats

RAP RECYCLING + H.I.P.P.R

- Ability to control asphalt quality
- Ability to service remote areas
- No need for Cold Mixes
- Work can be done year round
- Gradually increase temperature to max

ASPHALT RECYCLING FAQ

Questions:

Does infrared affect the asphalt binder?

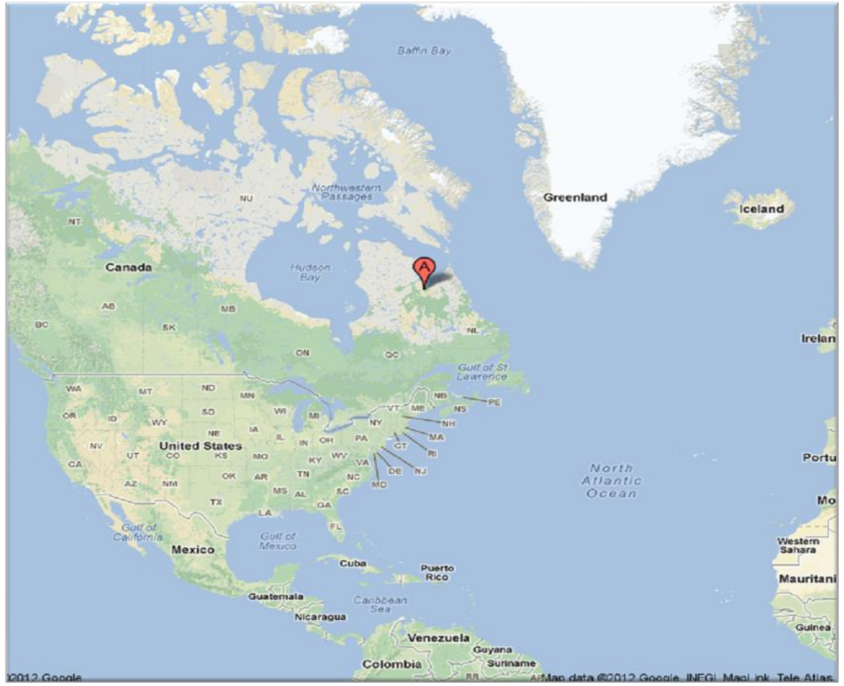
Can you Recycle Chunks of Asphalt ?

Can it be done year round ?

MINI ASPHALT RECYCLERS

HDE MR75-T
HDE 150-T

INFRARED ASPHALT RECYCLERS



INFRARED CRACK REPAIR

- **Kuujjuaq , PQ Airport**

INFRARED CRACK REPAIR: AIRPORT PAVEMENT

- Runway crack was 1.5 inch (40cm) wide
- Depression to 4 ' (1.2 m) wide
- Problems with planes going airborne at crack
- Risk of airport not meeting standard with budget repaving years away

INFRARED CRACK REPAIR

- First Challenge: Remove heavy lift of crack-filler
- Heated with infrared heater for 2-3 minutes to gooiness
- Scraped with Ice Scraper

INFRARED CRACK REPAIR

- Level Check across crack

INFRARED CRACK REPAIR: AIRPORT

- Crack repair at bottom of end of runway
  - Using 4′ x 3′ infrared asphalt heater

INFRARED CRACK REPAIR

- Hot mix asphalt is available every 3-4 years when a plant is shipped in.
- Instead we use bagged 3/8" (10mm) cold mix, sprinkled on scarified material.
- Then it was heated, leveled and compacted.

  - CAUTION: loose material does not transfer heat, so easily overheats

INFRARED CRACK REPAIR

- Level check across crack after compaction

INFRARED CRACK REPAIR

- The finished Surface withstood a 747 landing 30 minutes later
- The airport purchased the infrared equipment for continued repairs
- The runway was repaved in 2021

IN CONCLUSION

ASPHALT

100% RECYCLABLE

THANK YOU!

Acknowledgments

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