Manitoba RAP Binder and Mix Evaluation

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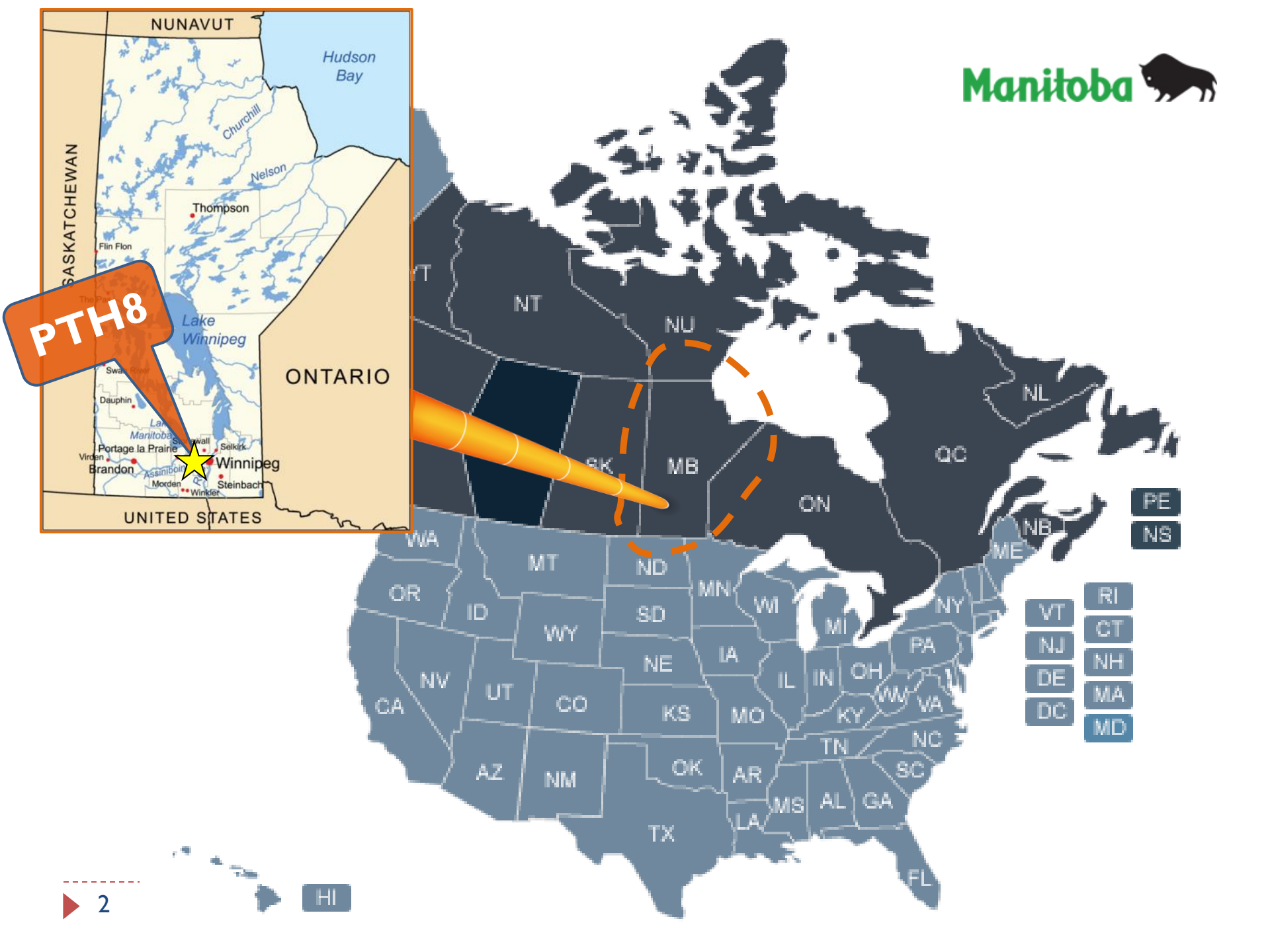
Manitoba
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Hudson Bay
Churchill
Nelson
Thompson
Flin Flon
SASKATCHEWAN
PTH8
Lake Winnipeg
ONTARIO
Dauphin
Portage la Prairie
Brandon
Winnipeg
Selkirk
Steinbach
Morden
Winkler
UNITED STATES
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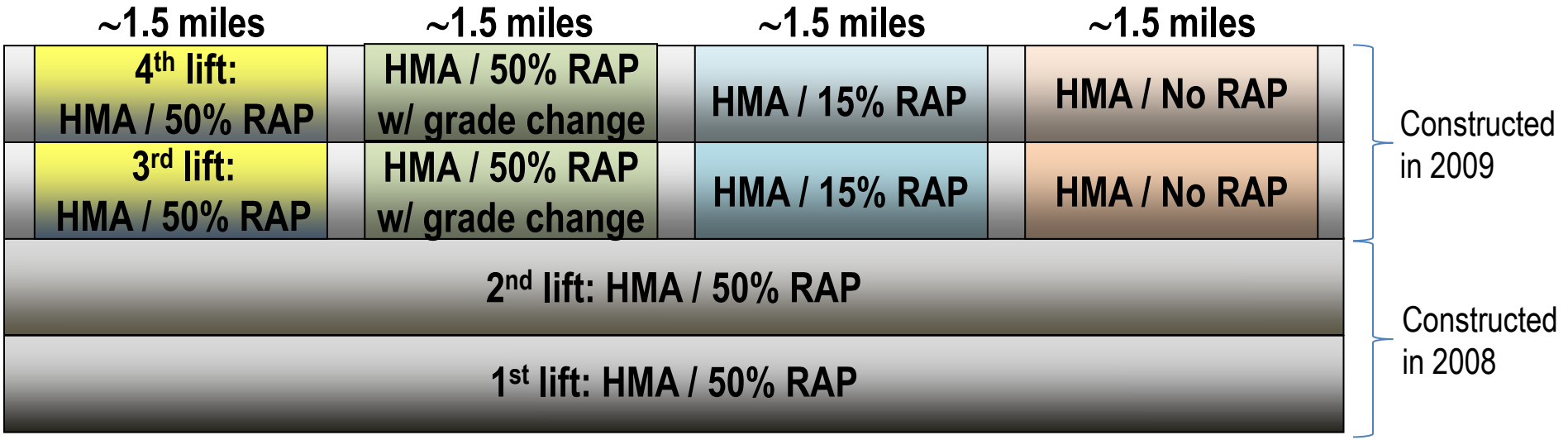
Overall Objectives

- The objectives of the RAP pavement sections were to:
  a) Determine if current design techniques can be used to design high RAP contents;
  b) Validate existing and new procedures for characterizing RAP materials;
  c) Construct field test sections so that HMA with high RAP and HMA without RAP performance could be compared side by side and;
  d) Determine if the properties of the laboratory-produced mixtures can be used to ensure quality field-produced mixtures.

Description of Project

- Located on Provincial HW-8 between Gimli & Hnausa
- Construction date = Sep. 2009 (3rd & 4th lifts)
- RAP: ½" NMAS
- 20 year design traffic of 1,950,000 ESAL.



Manitoba RAP Sections (PTH8)

Mixtures Types and Nomenclatures

Mixture	Binder	Field Mix Lab Compacted	Lab Mix Lab Compacted	RAP Binder %*
0% RAP no grade change	Pen 150-200	F-0%-150	L-0%-150	0.0
15% RAP no grade change		F-15%-150	L-15%-150	13.8
50% RAP no grade change		F-50%-150	L-50%-150	49.0
50% RAP grade change	Pen 200-300	F-50%-200	L-50%-200	49.0

* Based on RAP binder content of 4.7% (from Ignition Oven)

Manitoba RAP Sections (PTH8)
Test Matrix – Binder

- PG of extracted/recovered asphalt binder
  - Toluene-Ethanol (ToE) – 85:15.
- Blending chart process (NCHRP 9-12)
  - Linear relationship between critical temperature and RAP content.

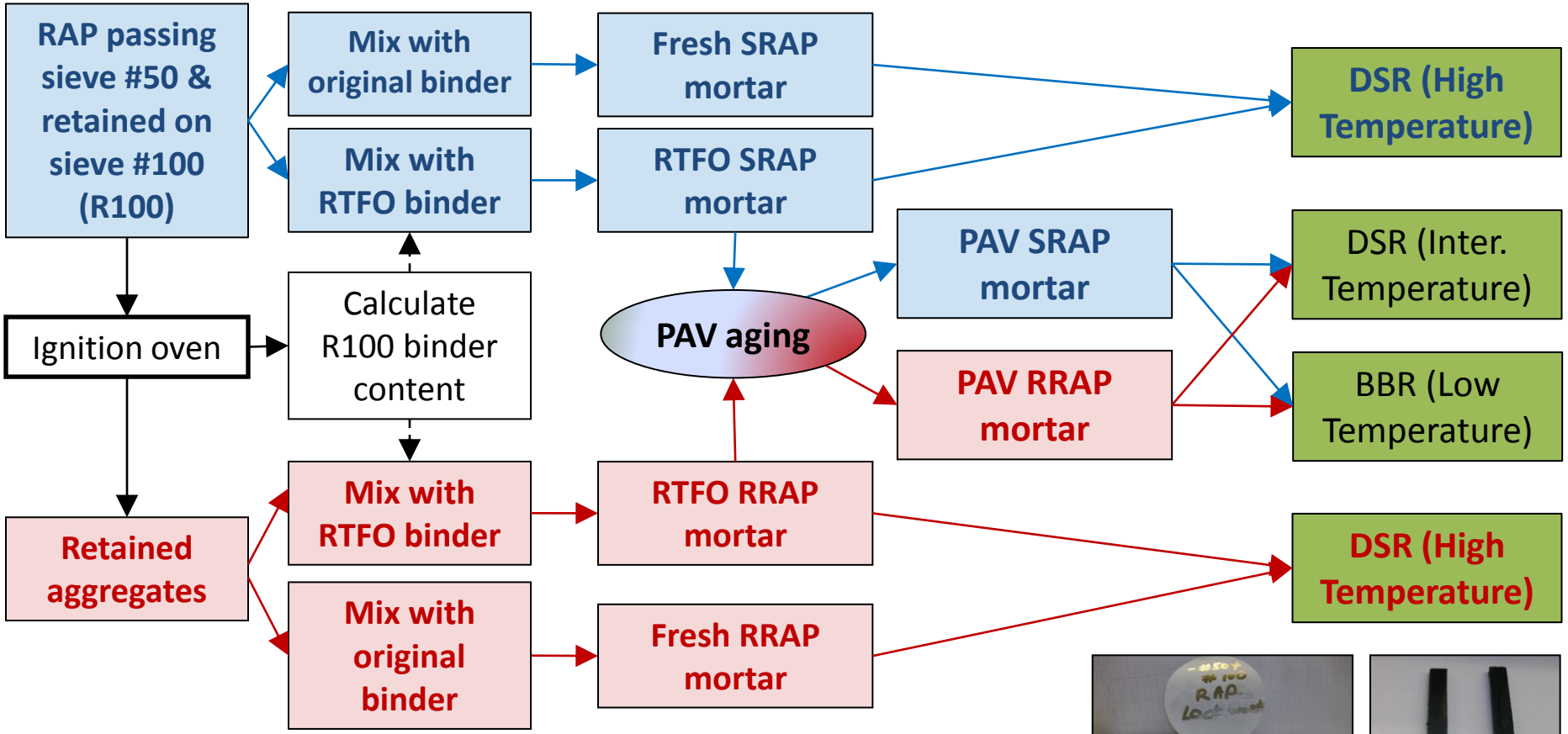
$$T_{virgin} = \frac{T_{Blend} - (\%RAPbinder \times T_{RAP})}{(1 - \%RAPbinder)}$$



Full Blending Between RAP & Virgin Asphalt Binders

Manitoba RAP Sections (PTH8)

Test Matrix – Binders (cont'd)



Developed by ARC (UWM/UNR)

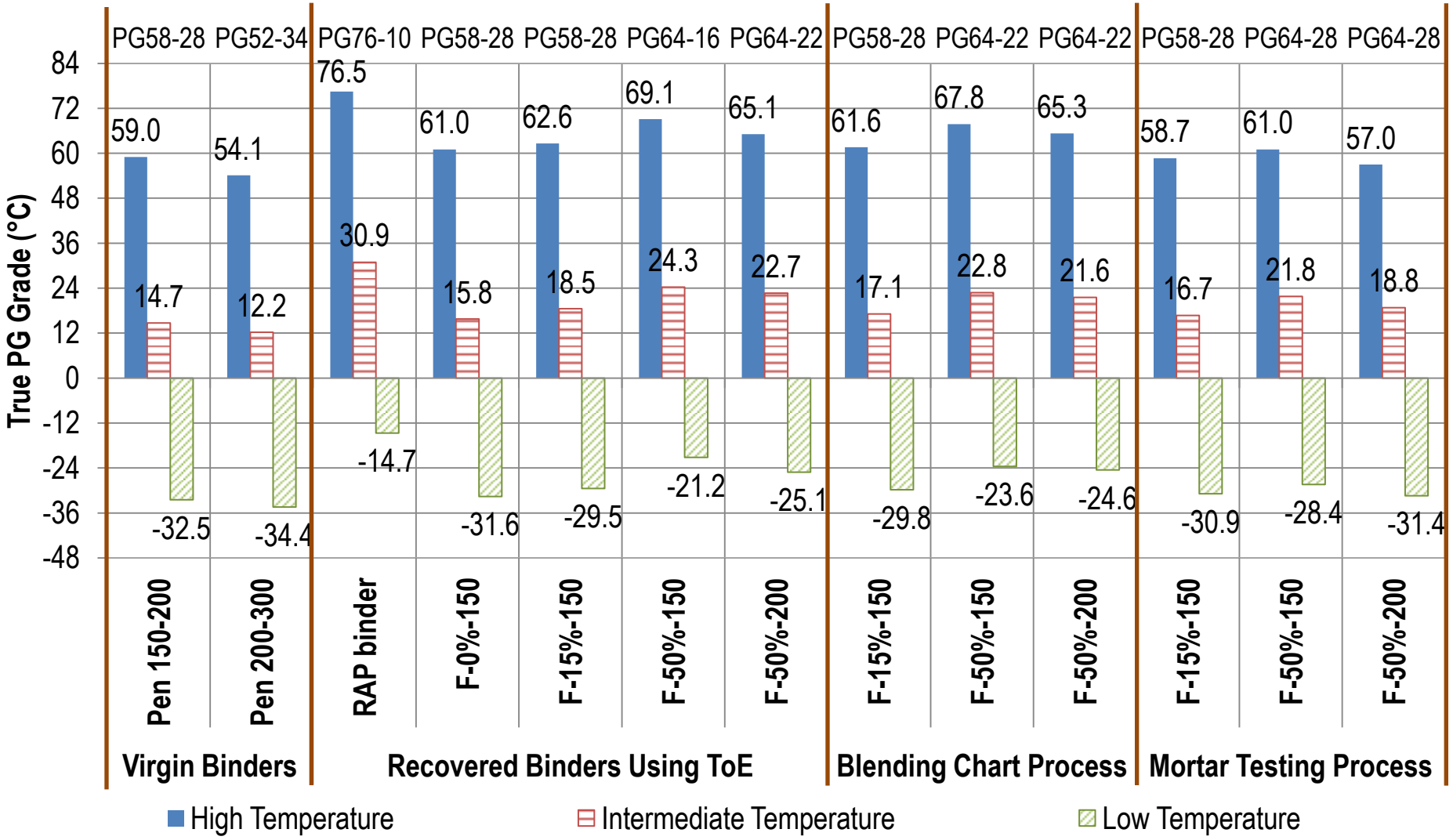
Manitoba RAP Sections (PTH8)

Test Matrix – Mixtures

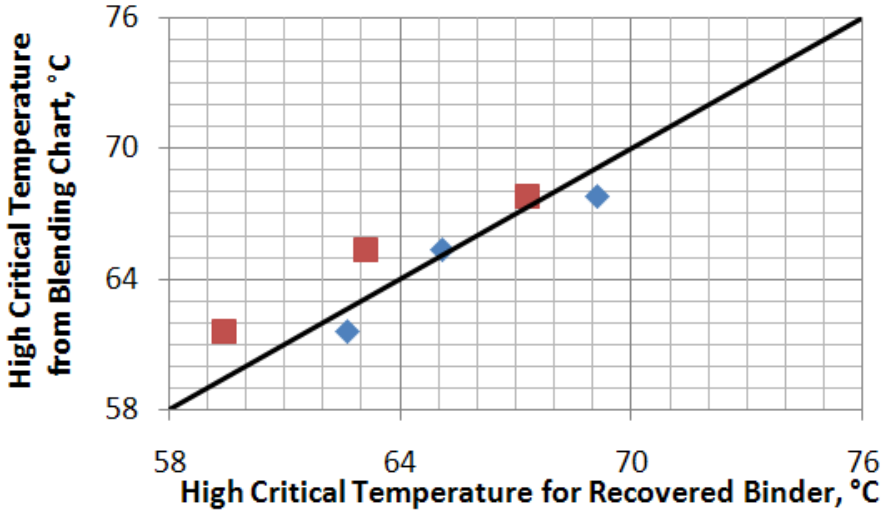
Property	F-0%-150	F-15%-150	F-50%-150	F-50%-200	L-0%-150	L-15%-150	L-50%-150	L-50%-200
Resistance to Moisture Damage								
- TS vs. F-T cycles: 0, 1 and 3 F-T	X	X	X	X	X	X	X	X
- TSR at 1 and 3 F-T	X	X	X	X	X	X	X	X
- E* vs. F-T cycles: 0, 1 and 3 F-T	X	X	X	X	X	X	X	X
Resistance to Thermal Cracking								
- TSRST: 0 F-T	X	X	X	X	X	X	X	X

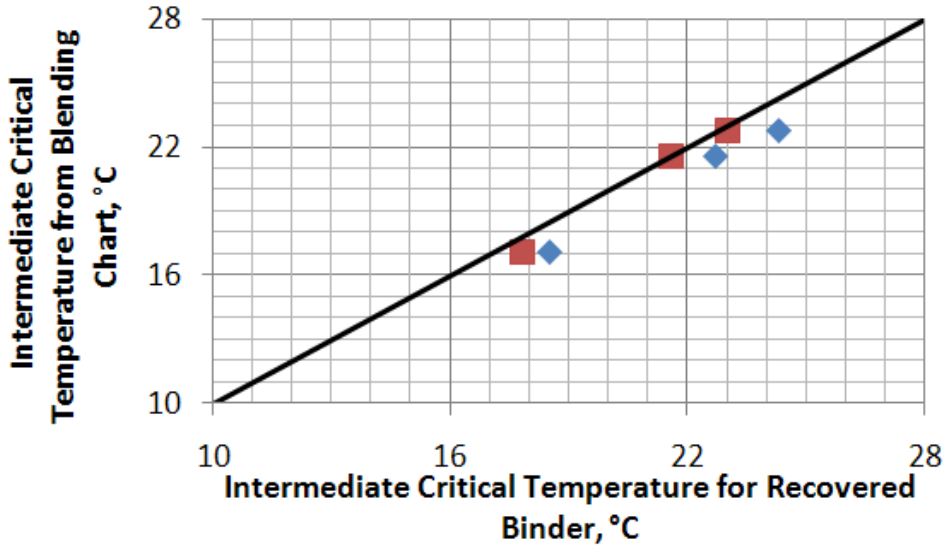
BINDER TEST RESULTS

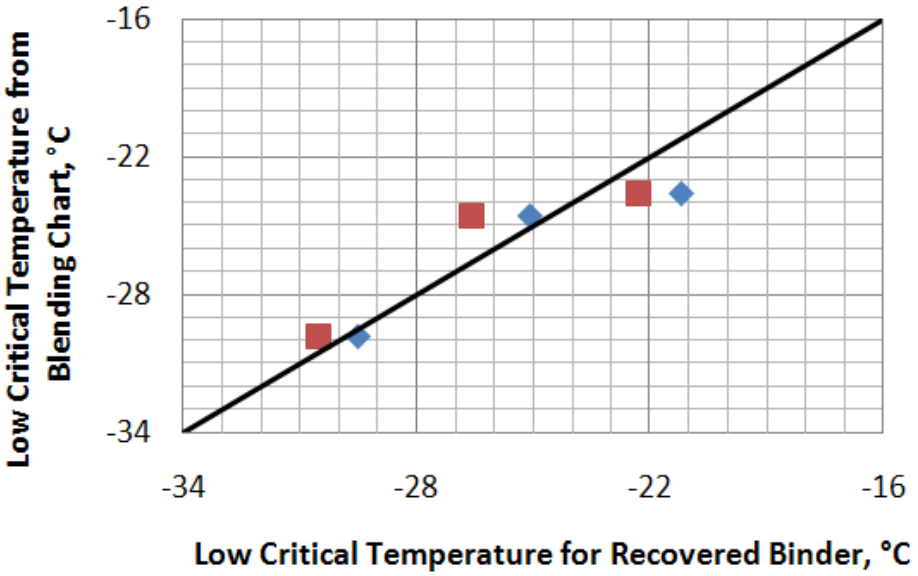
True PG Grades
Test Results



Recovered Binders vs. Blending Chart Critical Temperatures



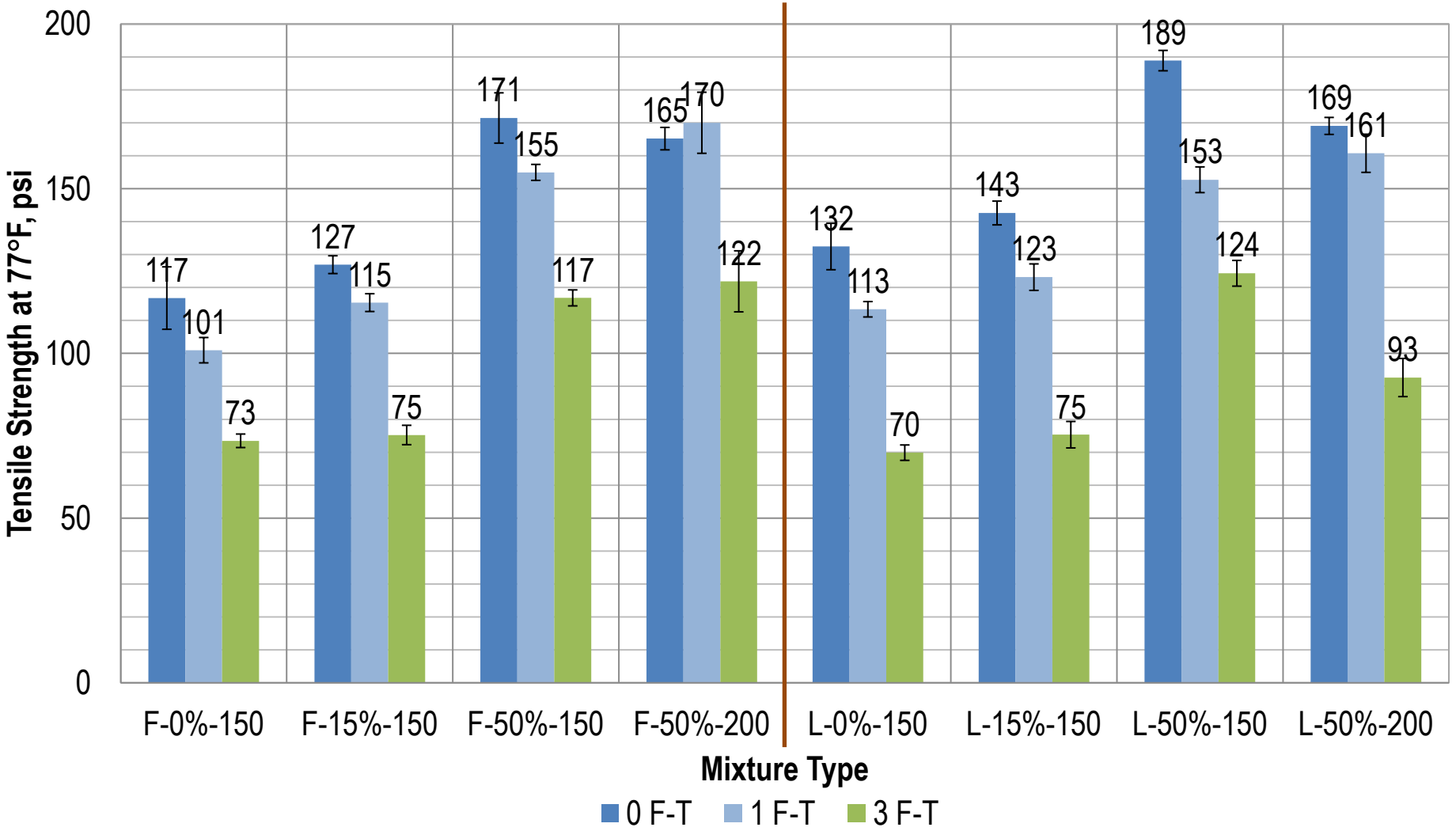




MIXTURE TEST RESULTS

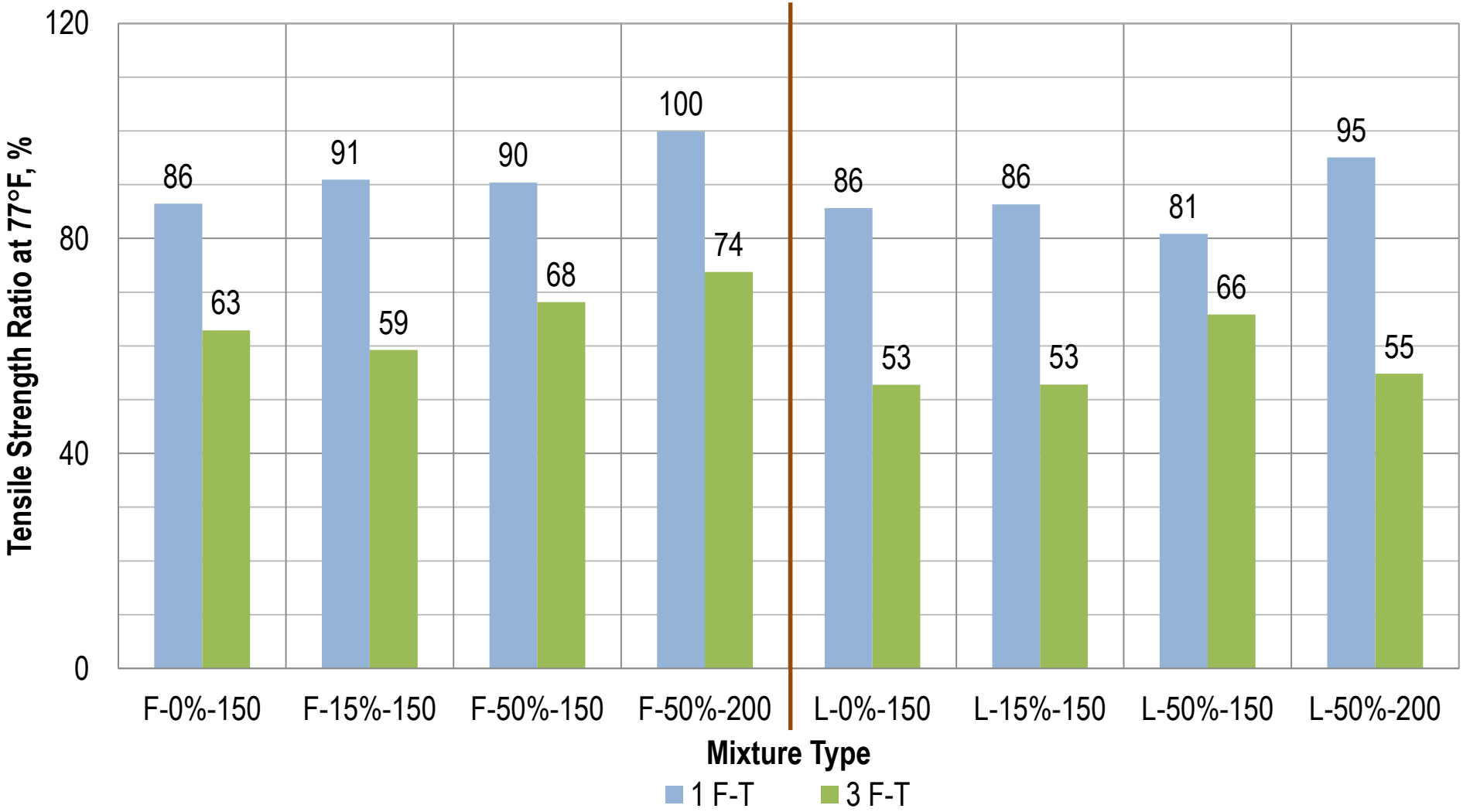
Moisture Damage Resistance

AASHTO T283 at Multiple Freeze-Thaw Cycles



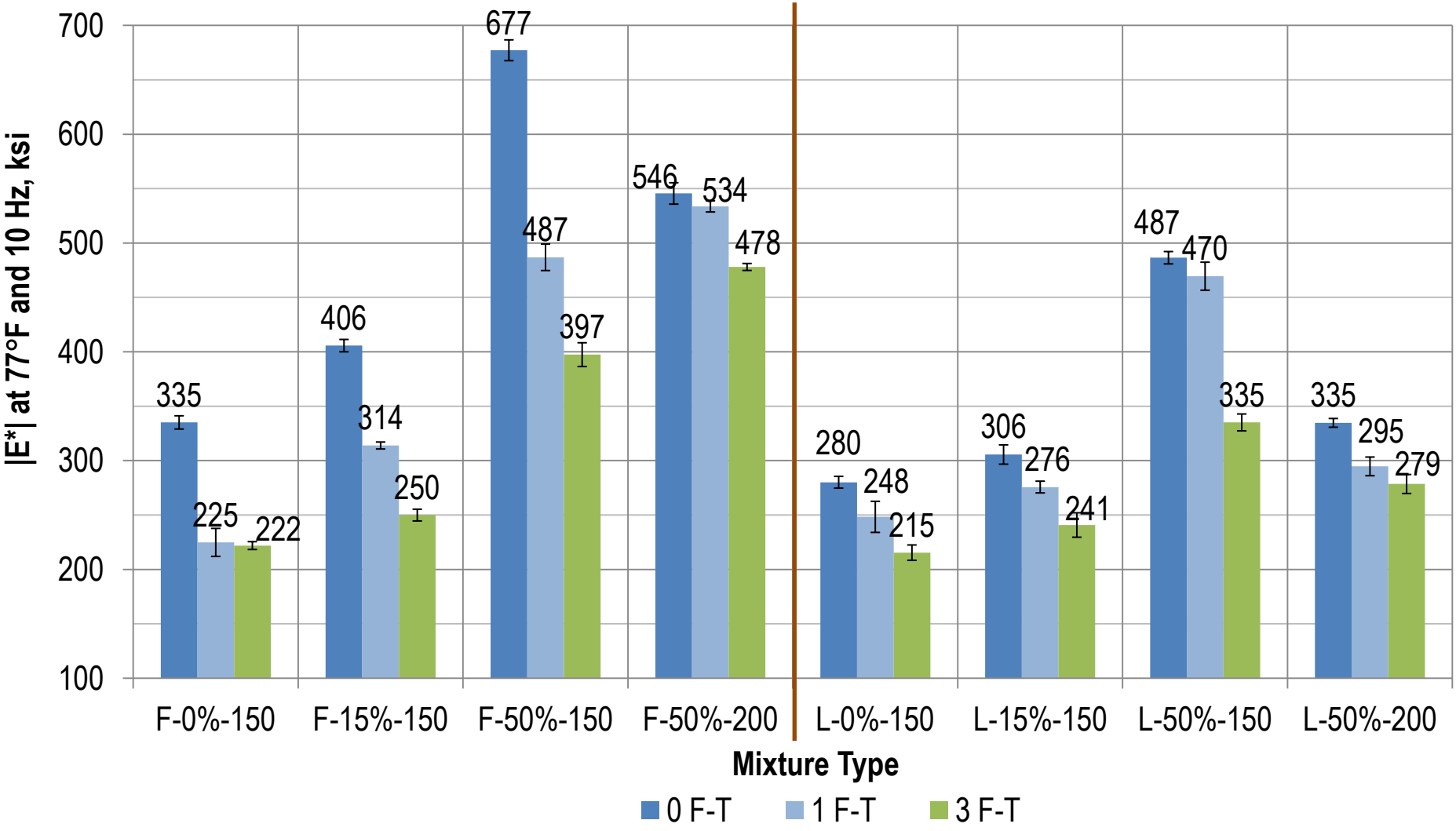
Moisture Damage Resistance

AASHTO T283 at Multiple Freeze-Thaw Cycles



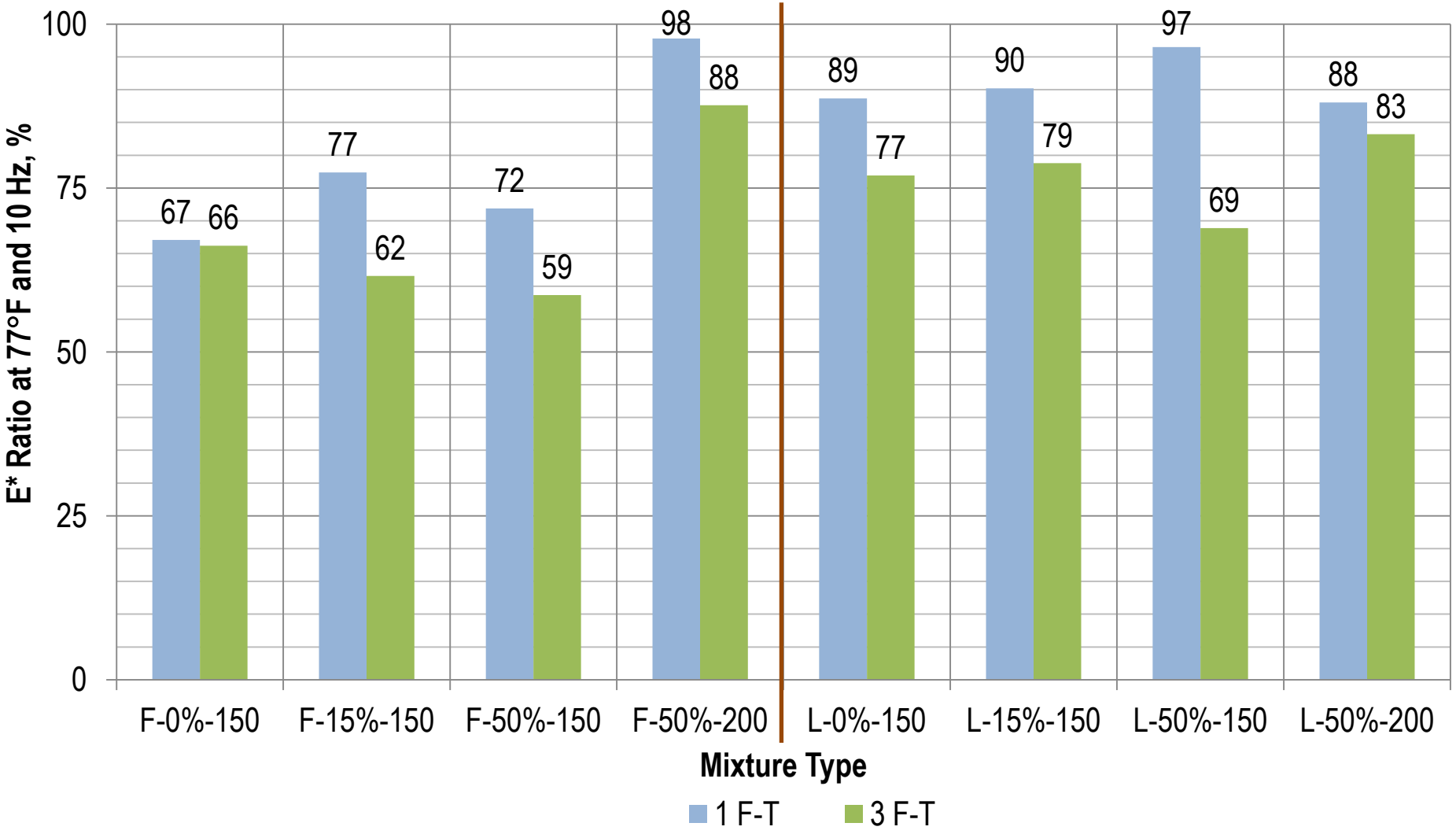
Moisture Damage Resistance

|E*| at Multiple Freeze-Thaw Cycles



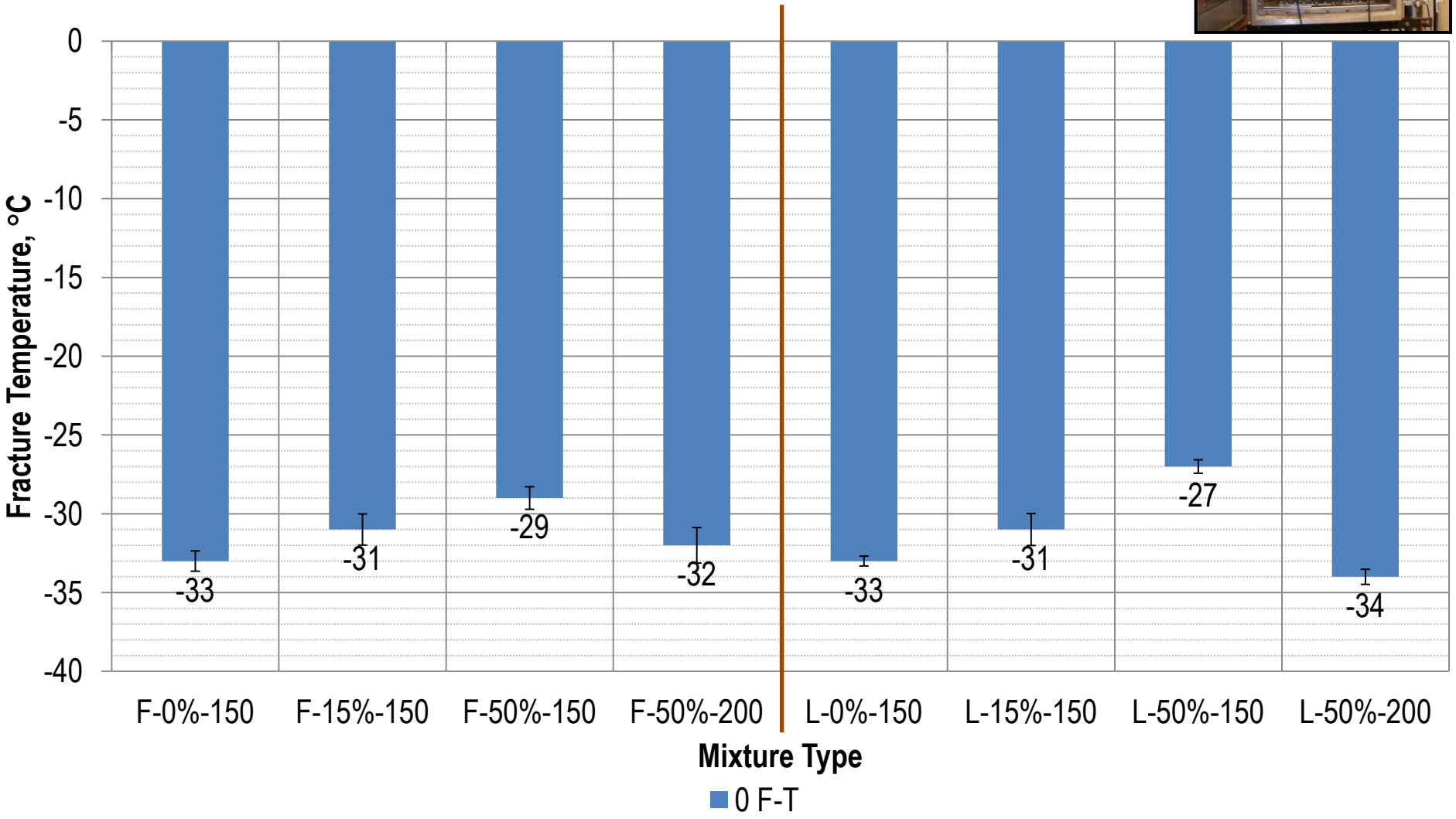
Moisture Damage Resistance

|*E**| *Ratios at Multiple Freeze-Thaw Cycles*



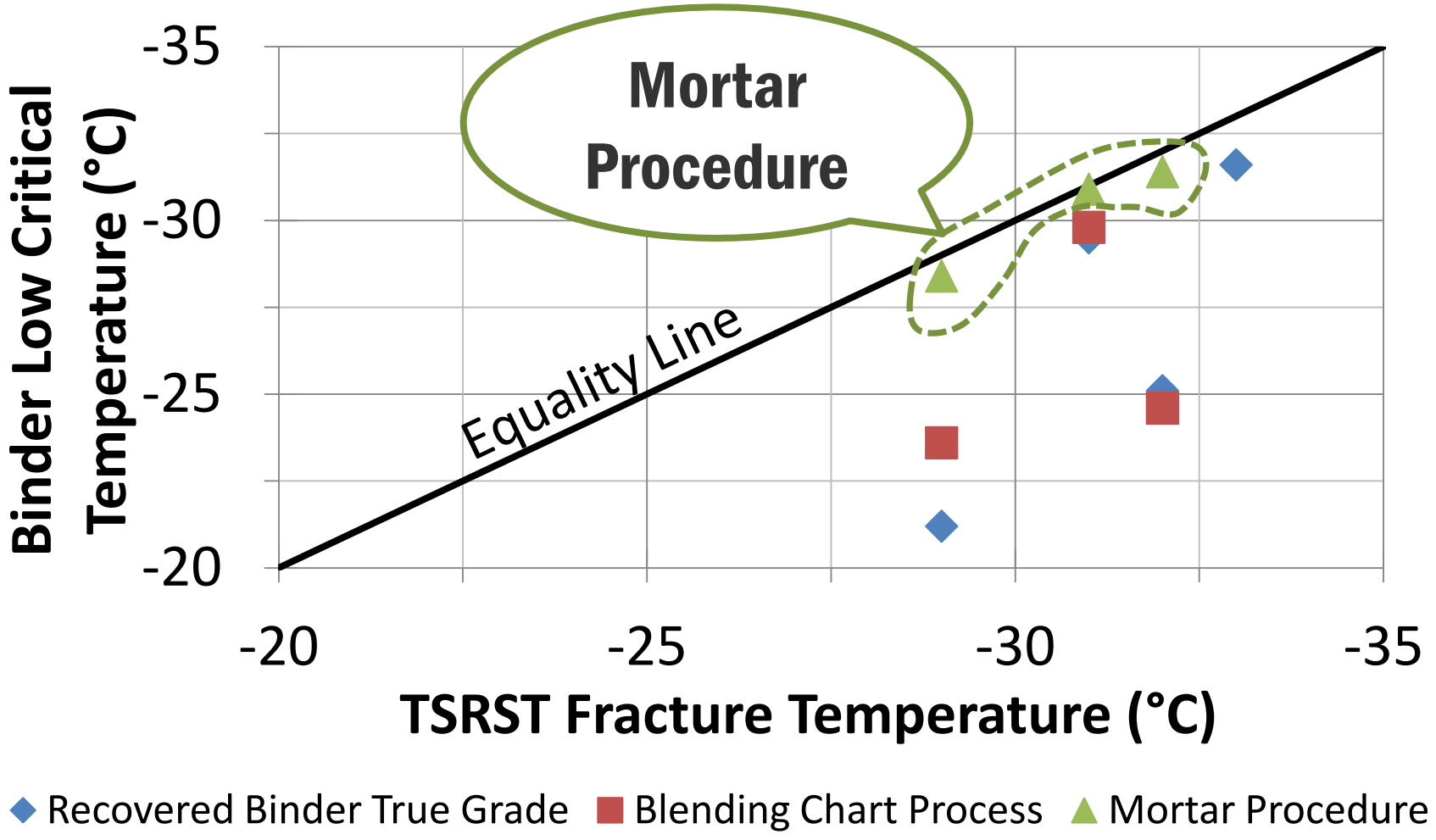
Thermal Cracking Resistance

Fracture Temperature



COMPARISON BETWEEN BINDER AND MIXTURE LOW TEMPERATURE PROPERTIES

Low Temperature Properties Comparison

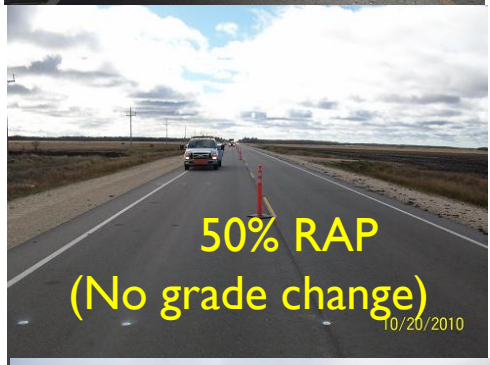


FIELD PERFORMANCE

(a) (b)

Field Performance

- Yearly condition survey has been conducted by WRI.
  - As of 2012, minimal thermal cracking was apparent after 3 years of service in two sections (15% RAP and 50% RAP w/o grade change).
- Lowest air temp recorded at the project site during the first 2 years of service was -35.6°C.
- Overall, the pavement condition was good and uniformly the same along the total length of all test sections.



OVERALL SUMMARY

Overall Summary

- Good correlations between estimated critical temperatures from blending chart process & grading of recovered binders.
  - In some cases, blending chart process underestimated or overestimated critical temps of recovered binders by 2°C.

- Both grading and blending chart methods showed significant increase in the binder critical temperatures (i.e. warmer temperatures) by increase in RAP content, especially at 50%.

Overall Summary

- Mortar approach: promising results.
  - Overall, mortar procedure resulted in high, intermediate and low critical temps that are lower (i.e. softer) than those determined for recovered asphalt binders.
  - Mortar results for low critical temps were further confirmed with measured fracture temperatures on mixes.
  - Procedure may be well indicating that a **certain level of blending** is occurring between virgin & RAP binders in a mix.

Overall Summary

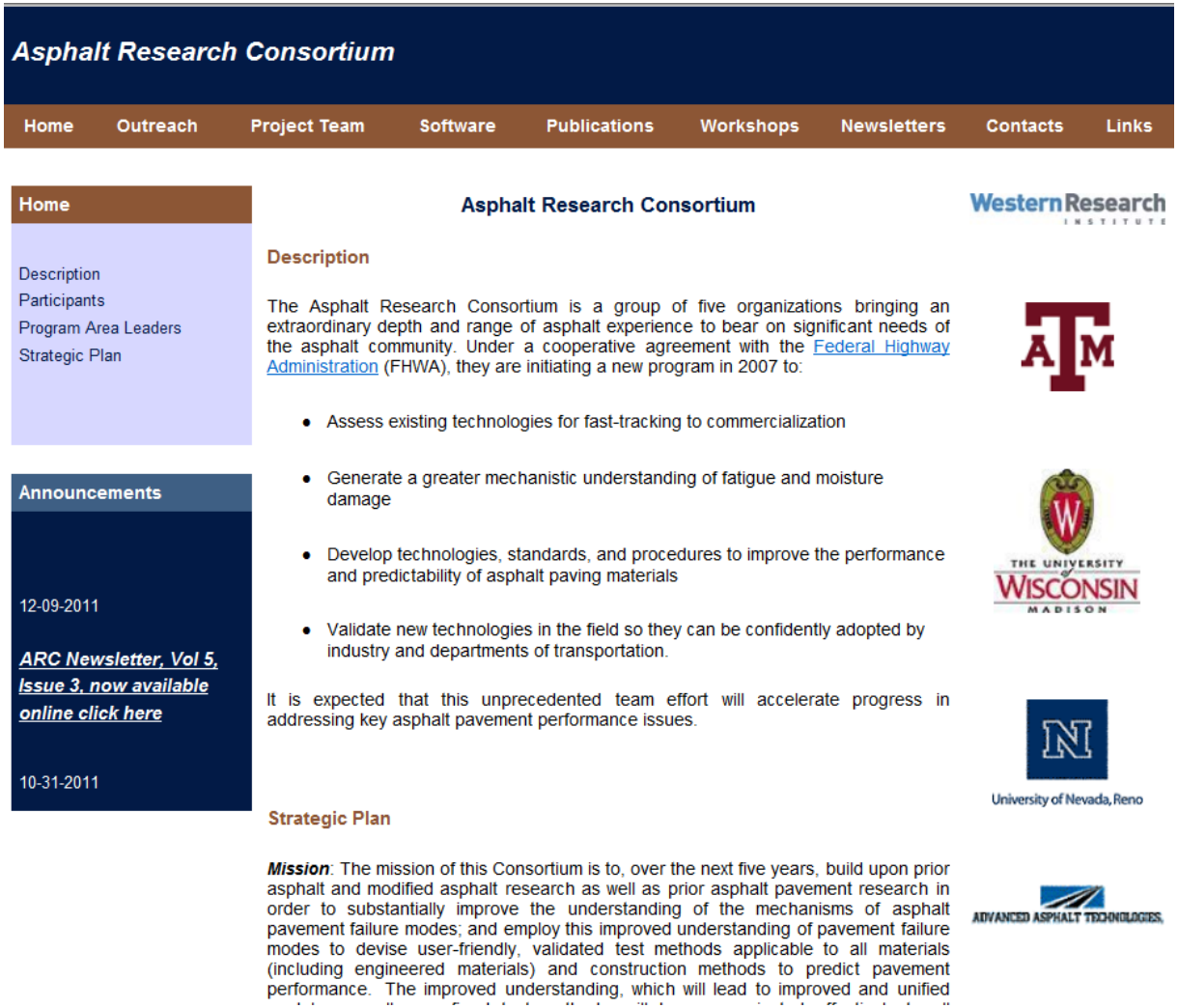
- In general, the use of multiple F-T cycles provided a better characterization of the mixtures resistance to moisture damage.
- Mixtures with 50% RAP resulted in acceptable resistance to moisture damage with a better resistance for the mixture with PG52-34 (i.e., Pen 200-300).
  - The observed difference has to do more with the compatibility of the PG52-34 virgin binder with the RAP binder.
- Mixtures with 50% RAP exhibited acceptable resistance to thermal cracking in TSRST with a better resistance for the mixture with PG52-34.

Overall Summary

- Regardless of the RAP content, the Superpave procedure of 4 hours at 275°F in a forced draft oven did not simulate in this case the aging of the field-produced mixtures.

- Overall, all test results showed that laboratory-produced mixtures can be used to evaluate the relative resistance of the field-produced mixtures to moisture damage and thermal cracking.
  - However, some differences in the measured values were observed between field and laboratory-produced mixtures which may require adjustment to any criteria used until at least the correct aging procedure is determined.

Resources
http://www.arc.unr.edu/



Acknowledgments

- This study is part of the overall effort in the Asphalt Research Consortium (ARC) work elements E2b & V1.
- FHWA support and Manitoba Infrastructure and Transportation (MIT) are gratefully acknowledged.
- This study reflects the views of the authors and do not necessarily reflect the official views and policies of the FHWA.

THANK YOU FOR YOU ATTENDANCE

Questions?