

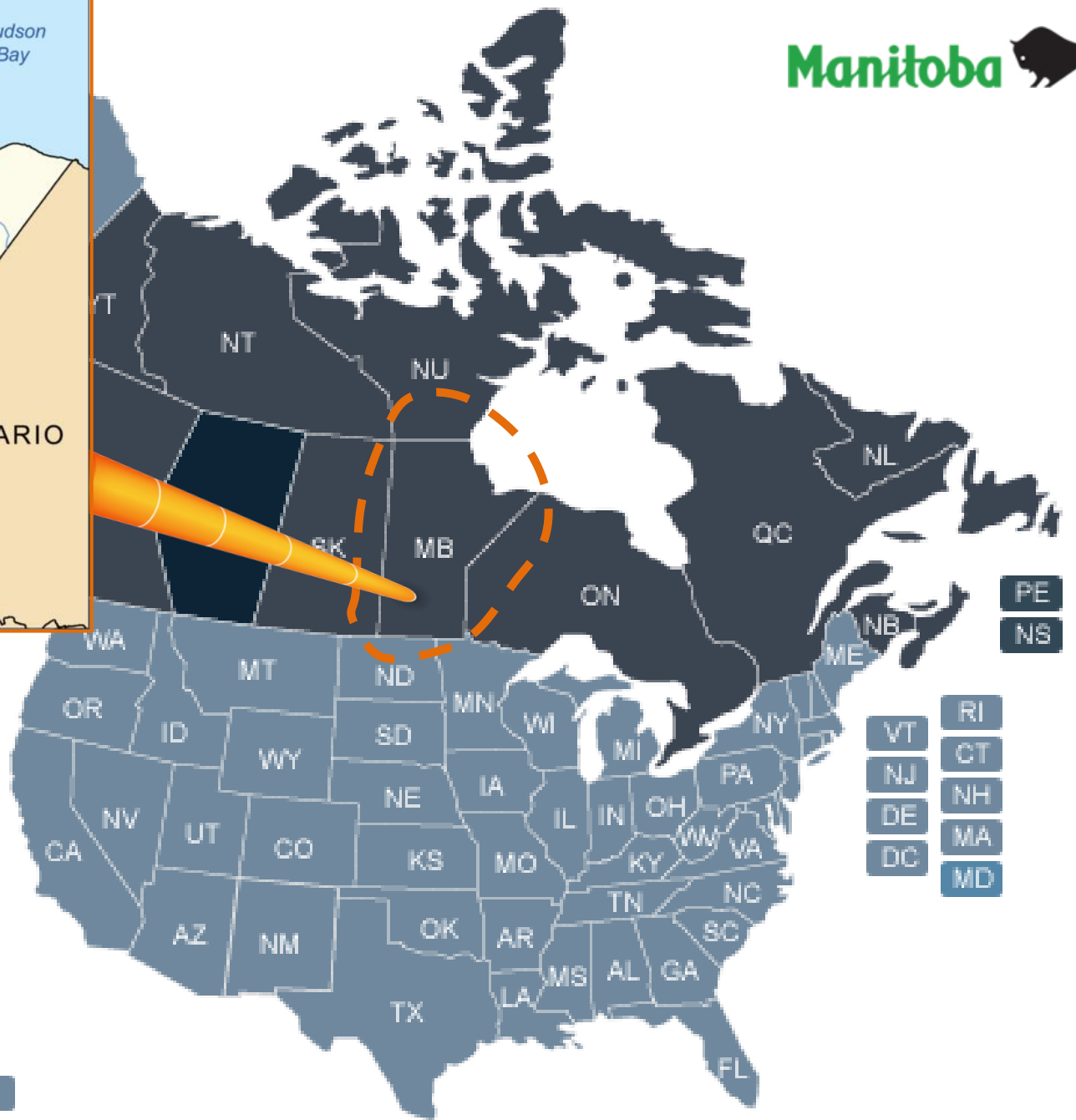
# **Manitoba RAP Binder and Mix Evaluation**

2012 Arizona Pavements/Materials Conference  
ASU, Tempe, Arizona, October 31, 2012

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**Western Regional Superpave Center – WRSC**





# Overall Objectives

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- ▶ 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: 1/2" NMAS
- ▶ 20 year design traffic of 1,950,000 ESAL.

~1.5 miles		~1.5 miles		~1.5 miles		~1.5 miles	
<b>4<sup>th</sup> lift:</b> HMA / 50% RAP		HMA / 50% RAP w/ grade change		HMA / 15% RAP		HMA / No RAP	
<b>3<sup>rd</sup> lift:</b> HMA / 50% RAP		HMA / 50% RAP w/ grade change		HMA / 15% RAP		HMA / No RAP	
2 <sup>nd</sup> lift: HMA / 50% RAP							
1 <sup>st</sup> lift: HMA / 50% RAP							

} Constructed in 2009  
  
  
  
 } Constructed in 2008

# 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.

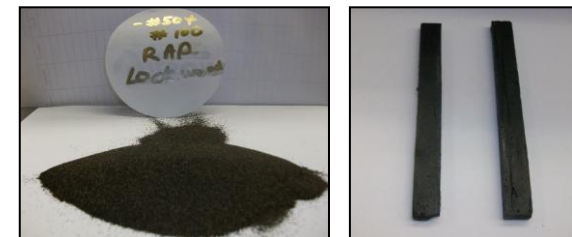
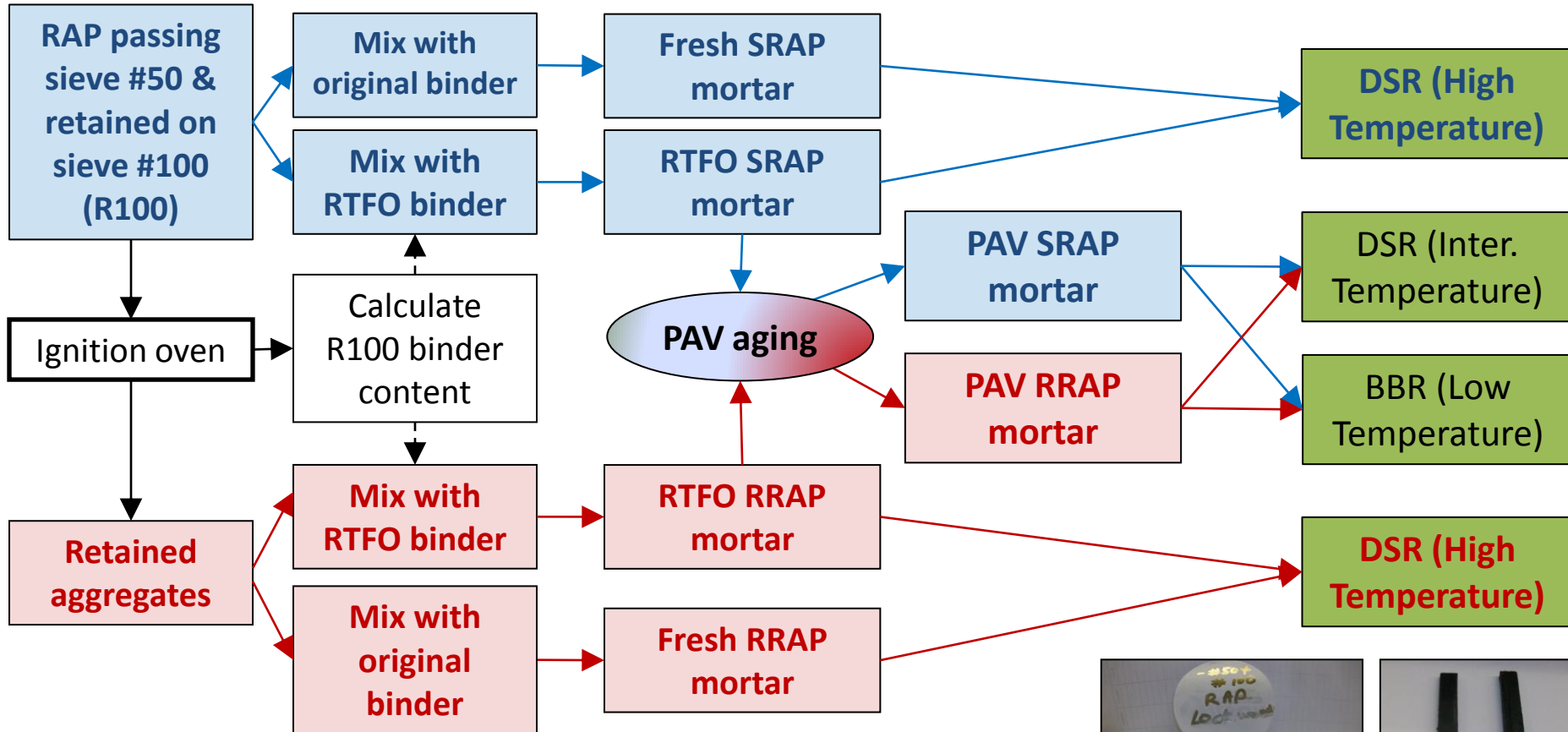
$$T_{virgin} = \frac{T_{Blend} - (\%RAPbinder \times T_{RAP})}{(1 - \%RAPbinder)}$$



**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



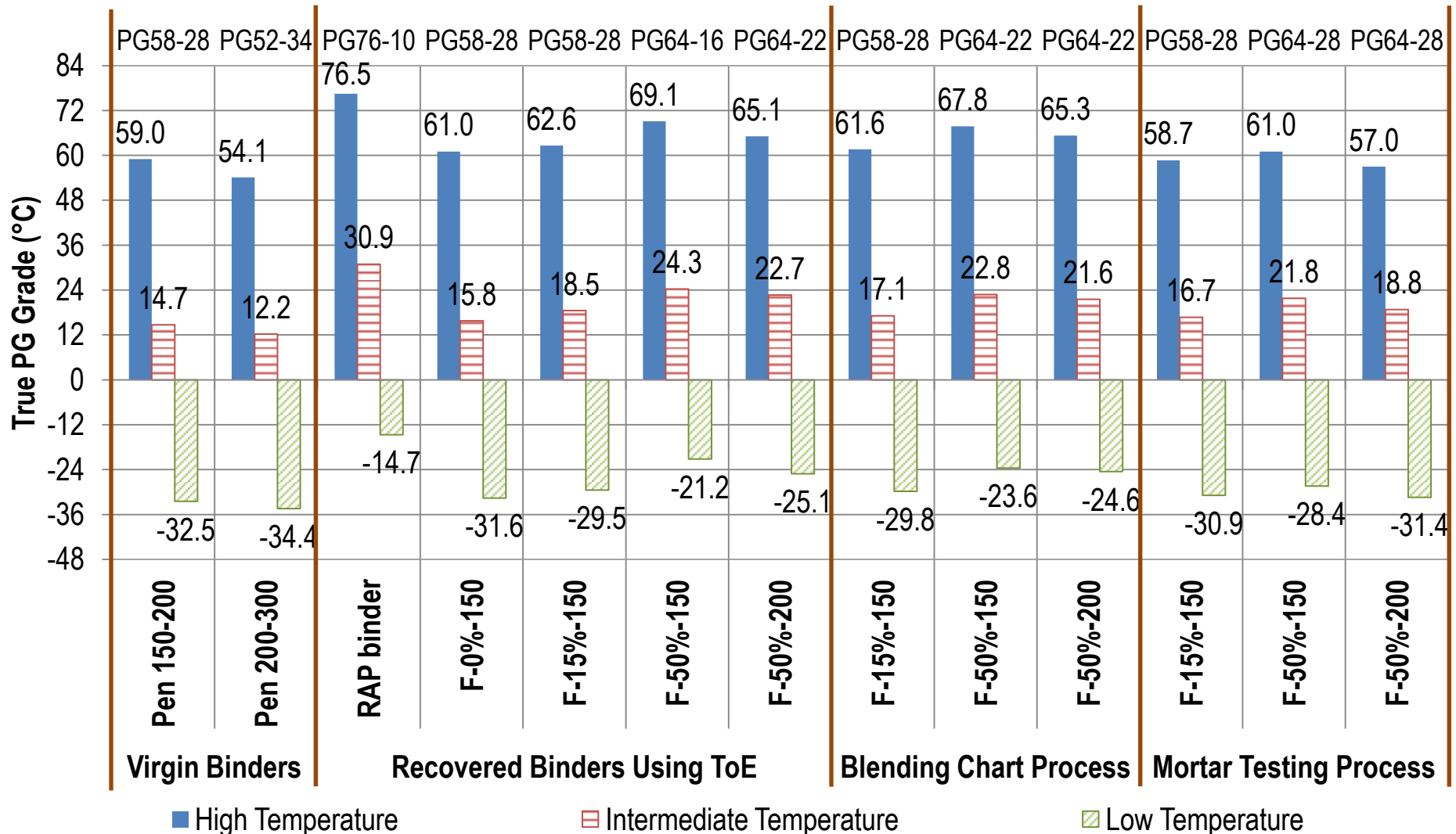
Property	F-0%-150	F-15%-150	F-50%-150	F-50%-200	L-0%-150	L-15%-150	L-50%-150	L-50%-200
Resistance to Moisture Damage								
- TS vs. F-T cycles: 0, 1 and 3 F-T	X	X	X	X	X	X	X	X
- TSR at 1 and 3 F-T	X	X	X	X	X	X	X	X
- E* vs. F-T cycles: 0, 1 and 3 F-T	X	X	X	X	X	X	X	X
Resistance to Thermal Cracking				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



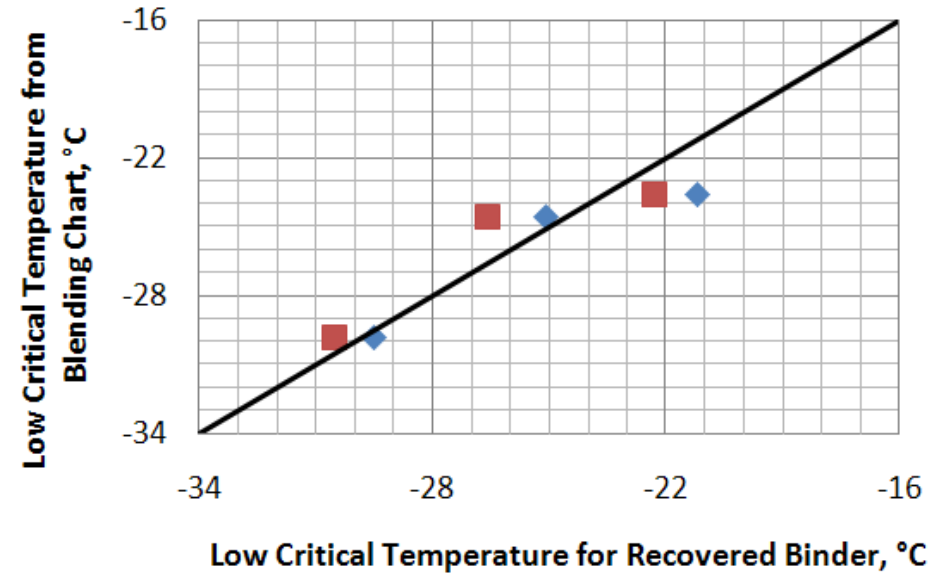
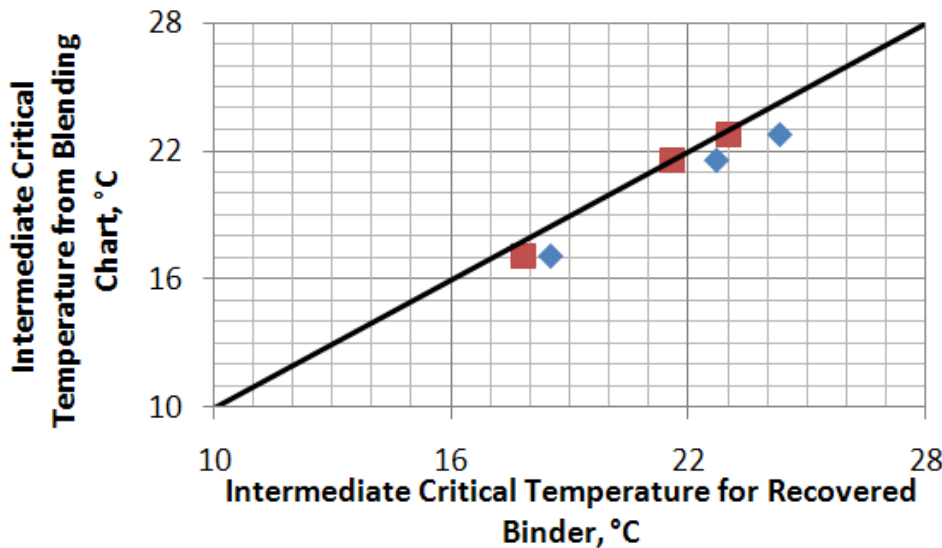
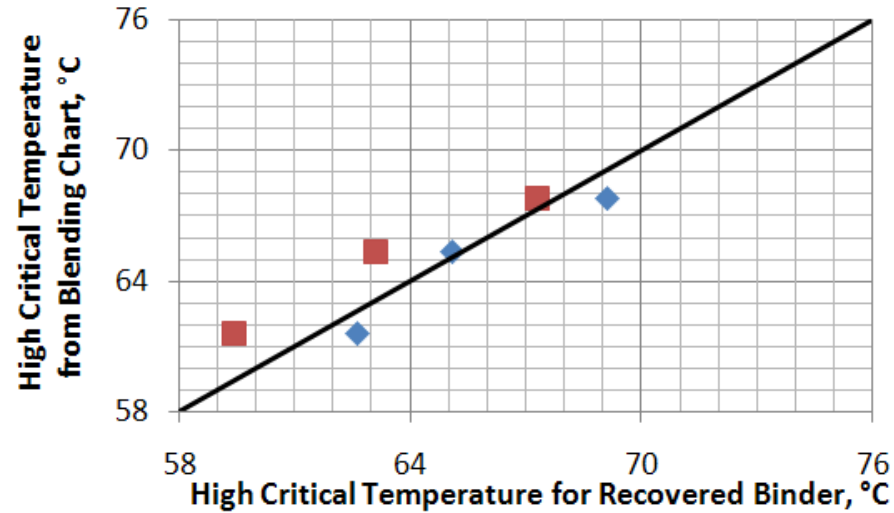
# BINDER TEST RESULTS

# True PG Grades

## Test Results



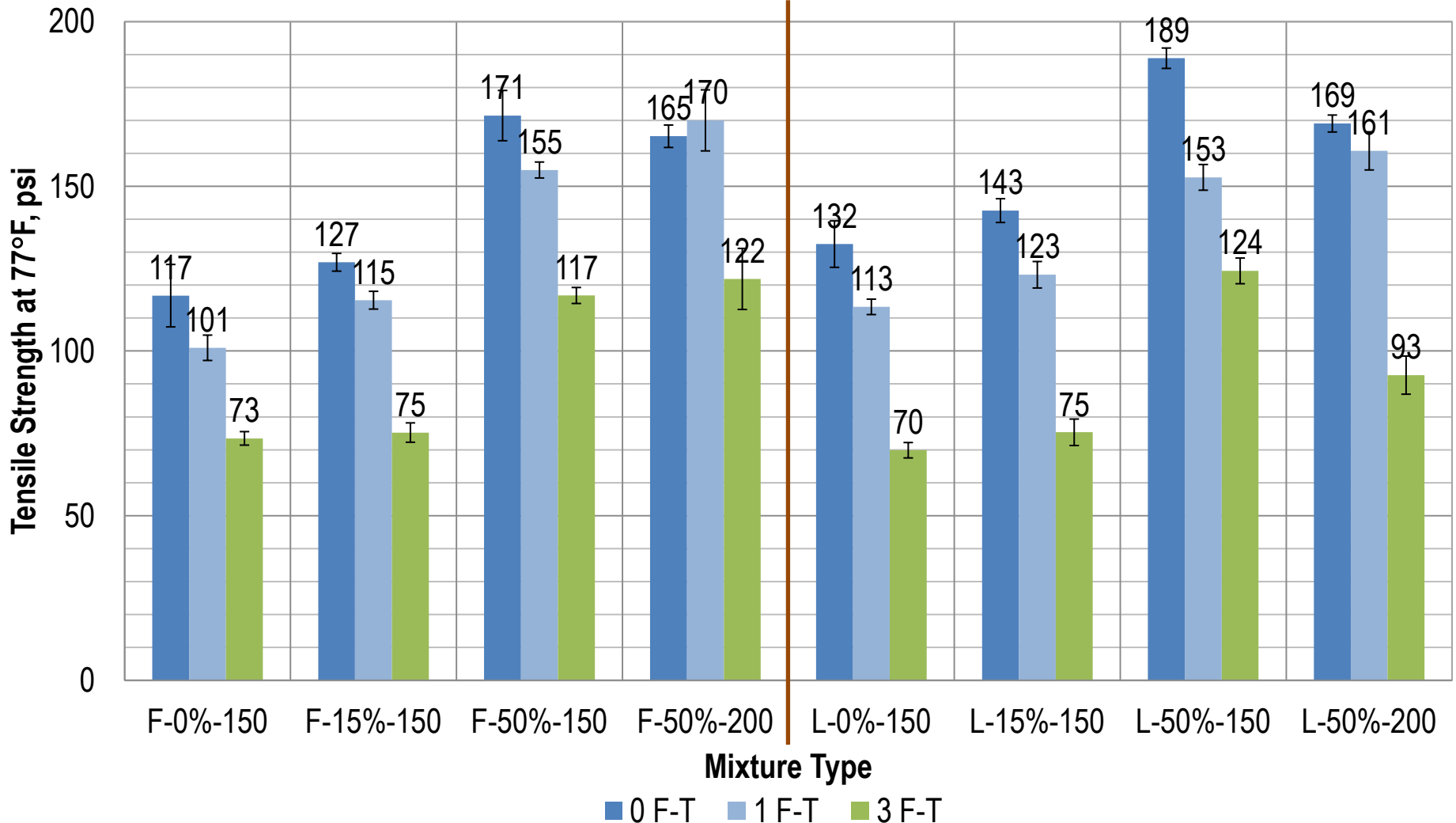
# Recovered Binders vs. Blending Chart Critical Temperatures



# MIXTURE TEST RESULTS

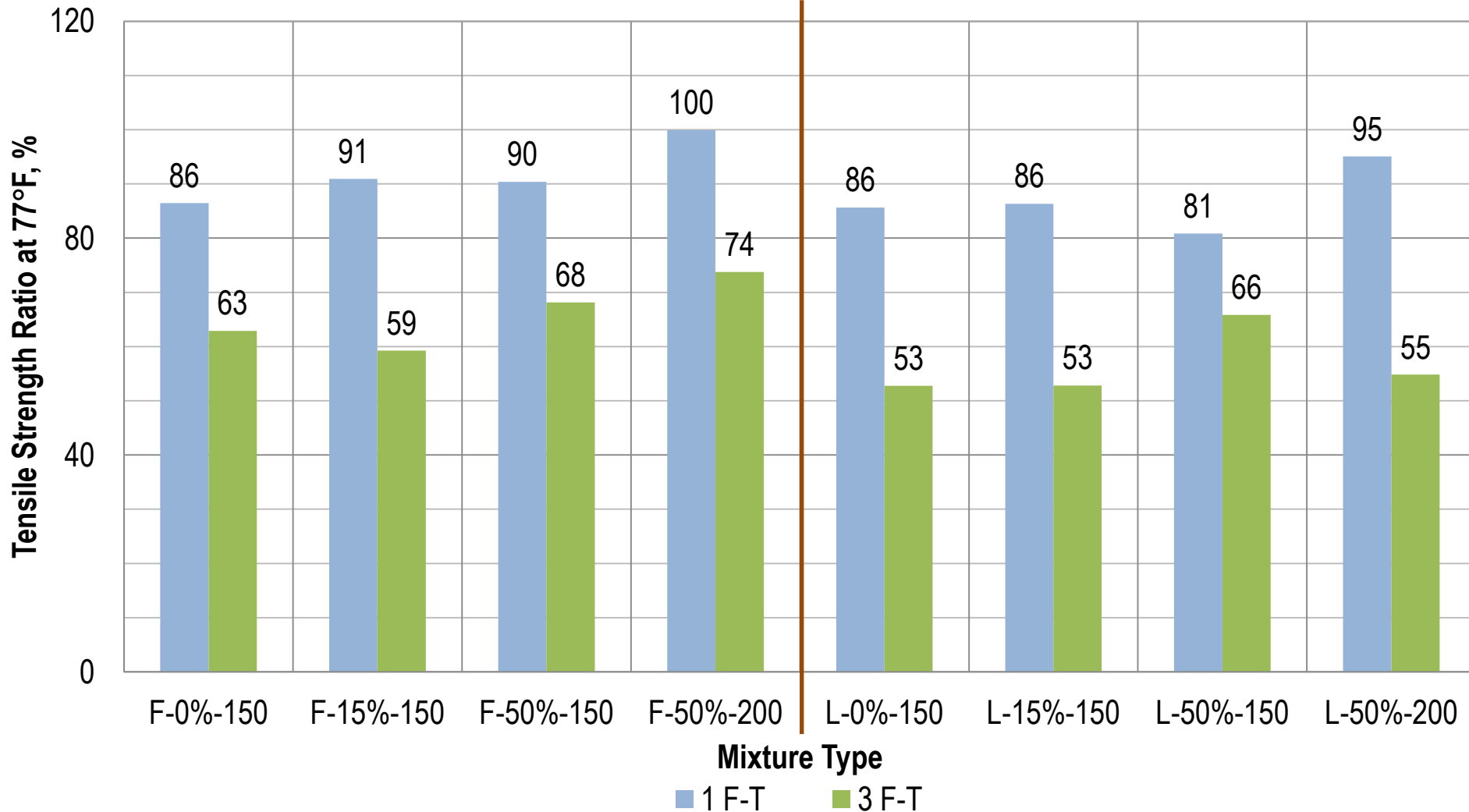
# Moisture Damage Resistance

## AASHTO T283 at Multiple Freeze-Thaw Cycles



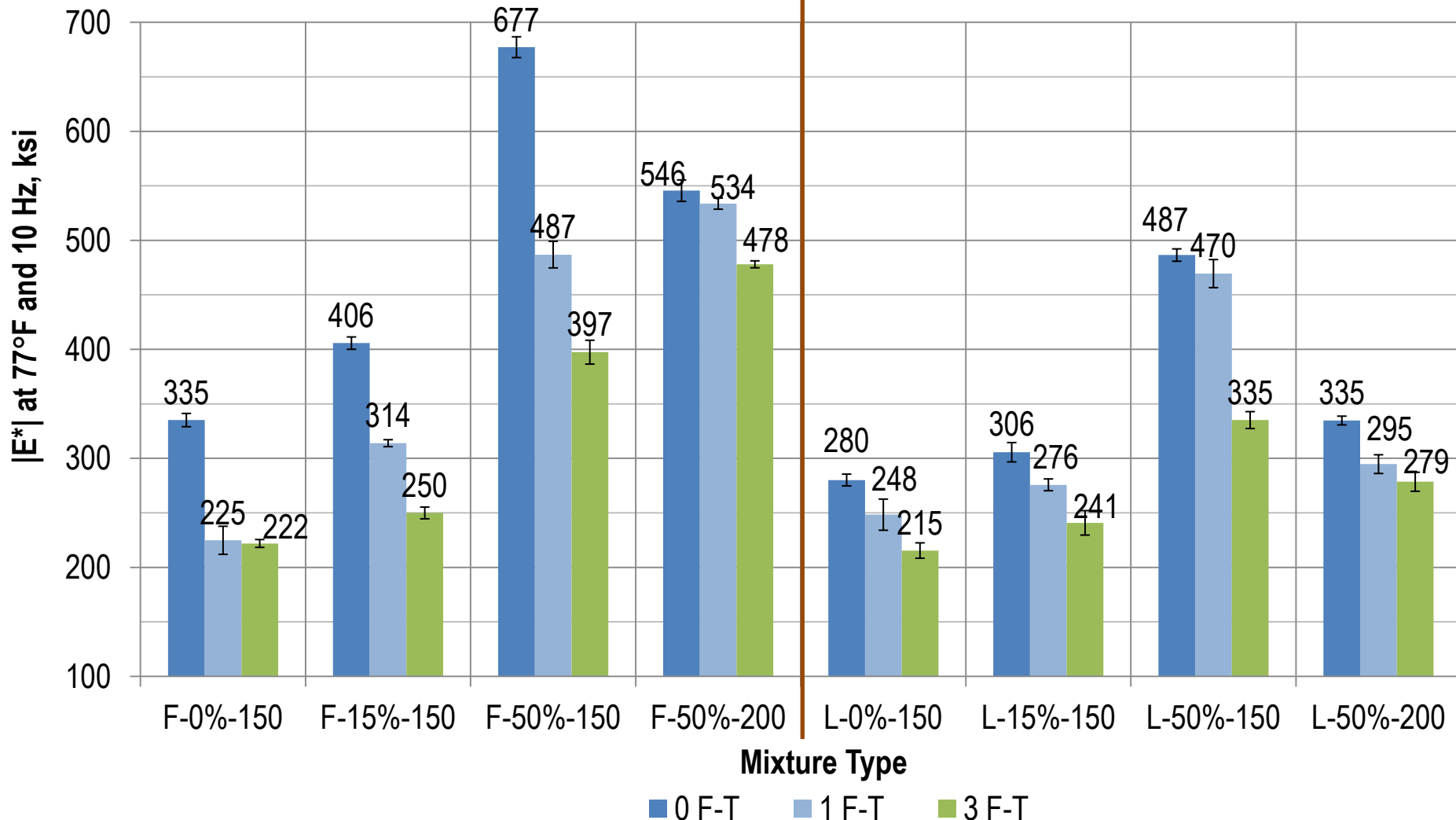
# Moisture Damage Resistance

## AASHTO T283 at Multiple Freeze-Thaw Cycles



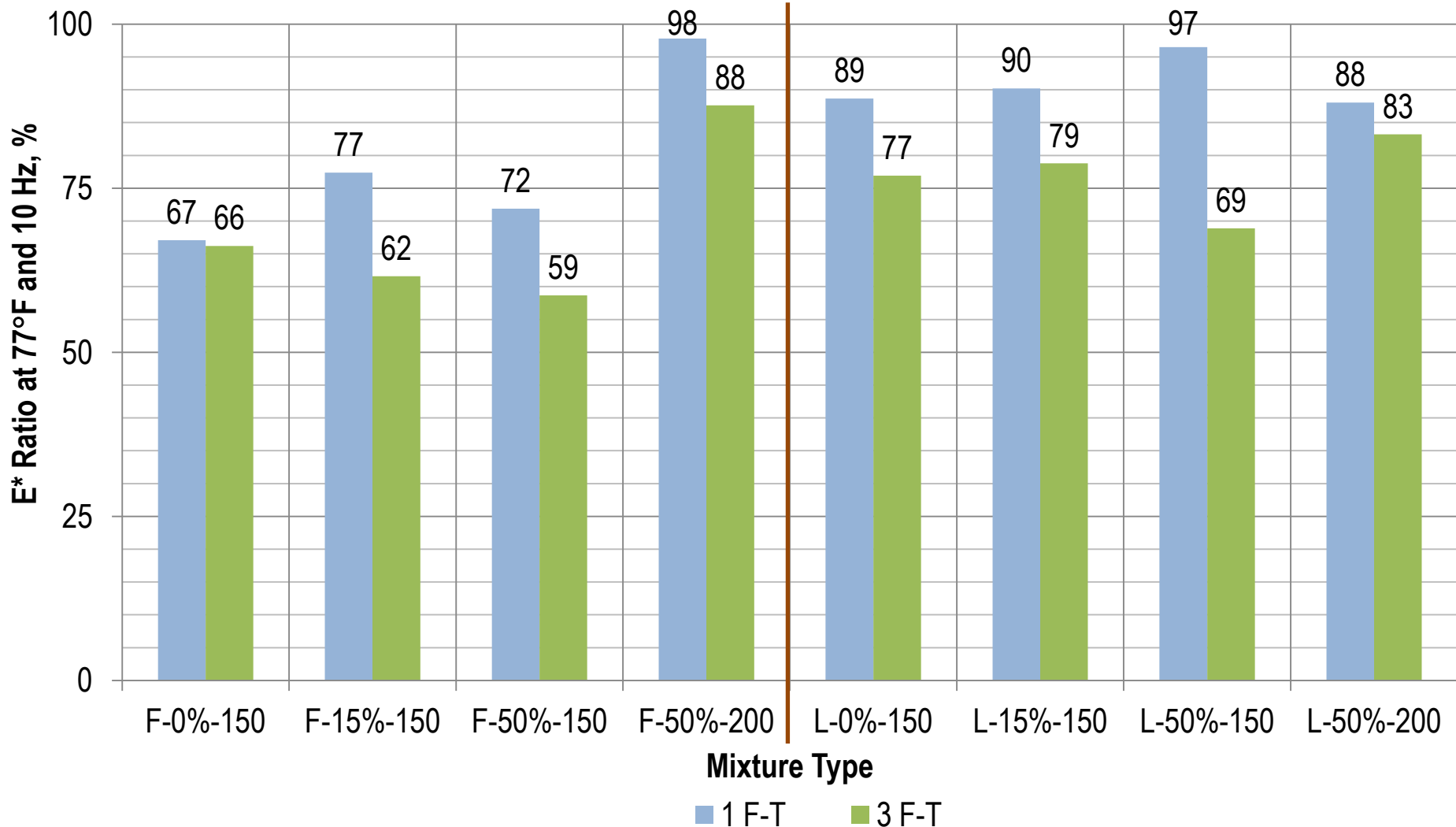
# Moisture Damage Resistance

## $|E^*|$ at Multiple Freeze-Thaw Cycles



# Moisture Damage Resistance

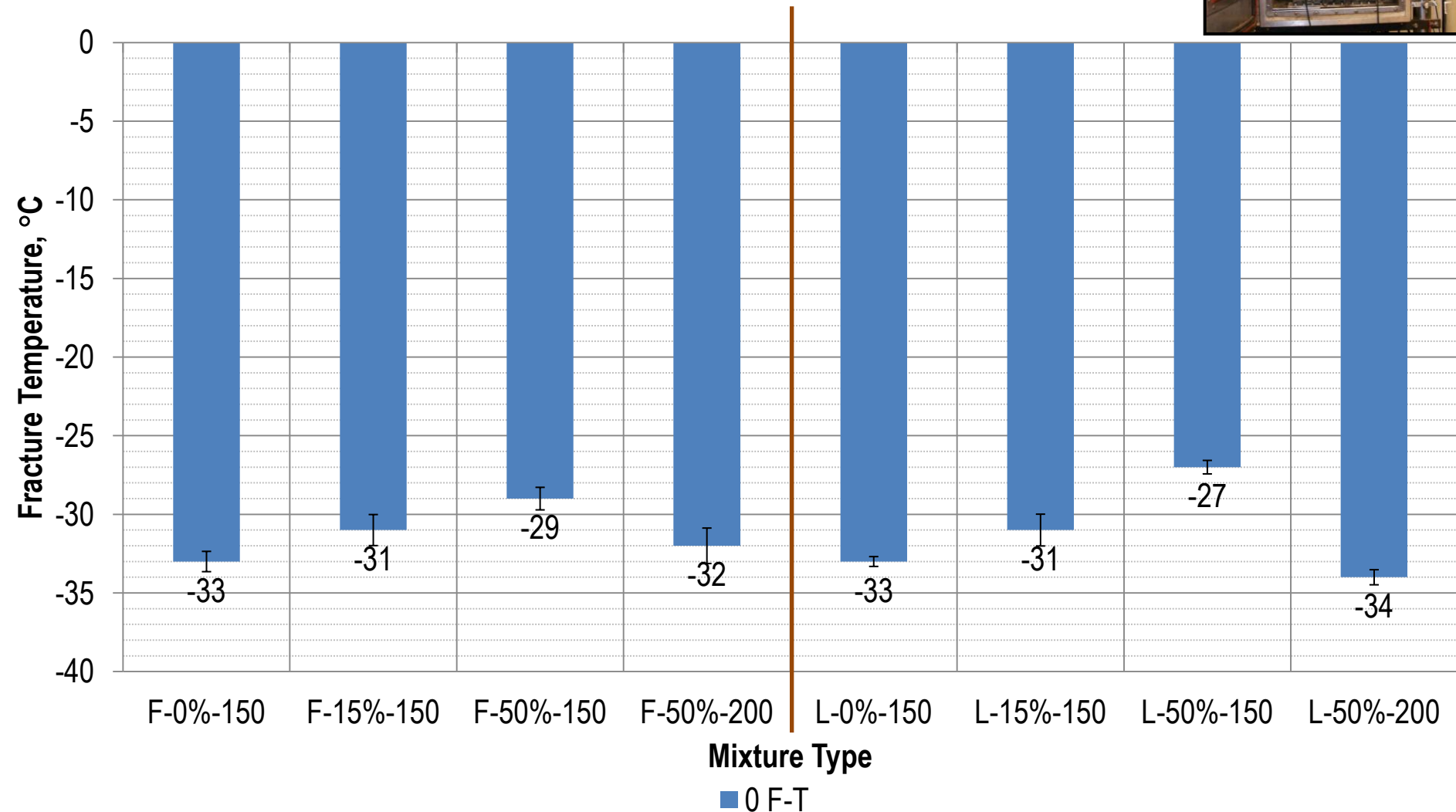
**|E\*| Ratios at Multiple Freeze-Thaw Cycles**





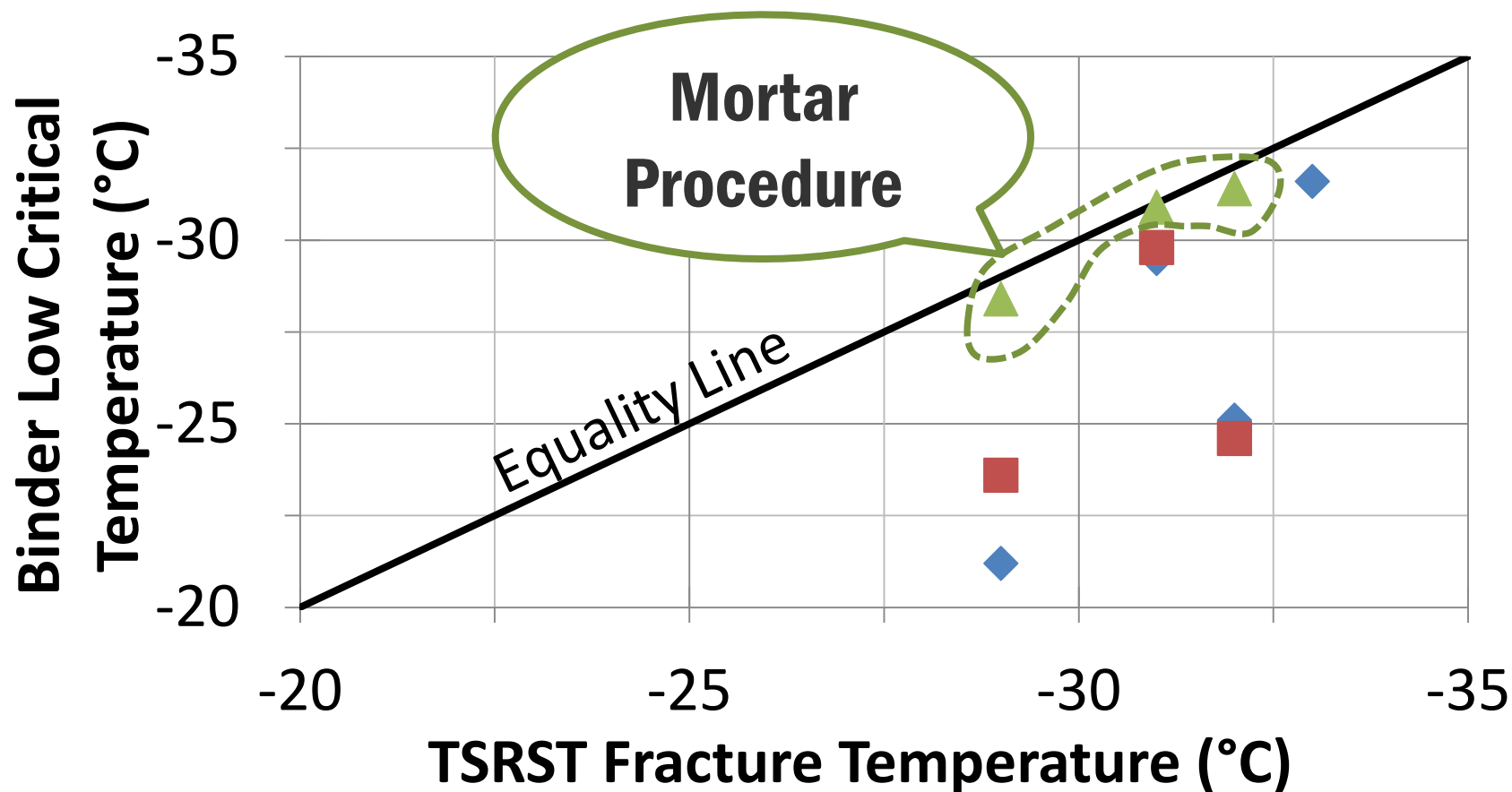
# Thermal Cracking Resistance

## Fracture Temperature



# **COMPARISON BETWEEN BINDER AND MIXTURE LOW TEMPERATURE PROPERTIES**

# Low Temperature Properties Comparison



◆ Recovered Binder True Grade    ■ Blending Chart Process    ▲ Mortar Procedure

# FIELD PERFORMANCE

# 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  $-35.6^{\circ}\text{C}$ .
- ▶ Overall, the pavement condition was good and uniformly the same along the total length of all test sections.



# OVERALL SUMMARY

## Overall Summary

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- ▶ 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

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- ▶ 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

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- ▶ 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

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- ▶ 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/>



## Asphalt Research Consortium

Home Outreach Project Team Software Publications Workshops Newsletters Contacts Links

### Home

Description  
Participants  
Program Area Leaders  
Strategic Plan

### Announcements

12-09-2011

[ARC Newsletter, Vol 5, Issue 3, now available online click here](#)

10-31-2011

## Asphalt Research Consortium

Western Research  
INSTITUTE

### Description

The Asphalt Research Consortium is a group of five organizations bringing an extraordinary depth and range of asphalt experience to bear on significant needs of the asphalt community. Under a cooperative agreement with the [Federal Highway Administration](#) (FHWA), they are initiating a new program in 2007 to:

- Assess existing technologies for fast-tracking to commercialization
- Generate a greater mechanistic understanding of fatigue and moisture damage
- Develop technologies, standards, and procedures to improve the performance and predictability of asphalt paving materials
- Validate new technologies in the field so they can be confidently adopted by industry and departments of transportation.

It is expected that this unprecedented team effort will accelerate progress in addressing key asphalt pavement performance issues.

### Strategic Plan

**Mission:** The mission of this Consortium is to, over the next five years, build upon prior asphalt and modified asphalt research as well as prior asphalt pavement research in order to substantially improve the understanding of the mechanisms of asphalt pavement failure modes; and employ this improved understanding of pavement failure modes to devise user-friendly, validated test methods applicable to all materials (including engineered materials) and construction methods to predict pavement performance. The improved understanding, which will lead to improved and unified



University of Nevada, Reno



# Acknowledgments

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- ▶ This study is part of the overall effort in the Asphalt Research Consortium (ARC) work elements E2b & VI.
- ▶ 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

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## Questions?

