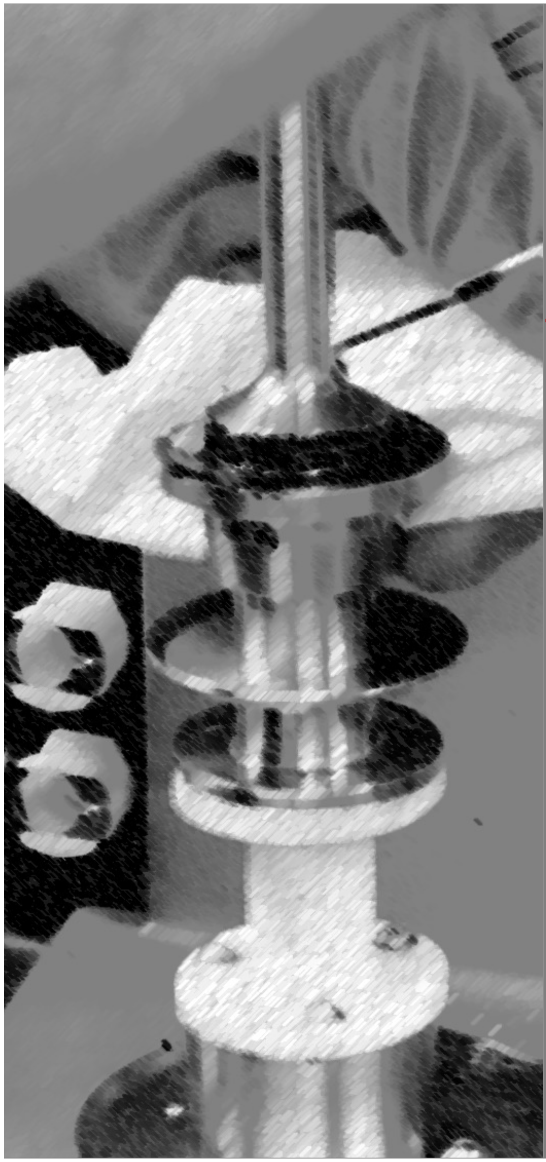

Defining Asphalt Binder Performance and the Need to Define Consensus!

North East Asphalt User Producer Group (NEAUPG) 2024
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NEAUPG

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Objectives

1. Evaluate point and shape rheological parameters of asphalt binders.
2. Identify effective parameters for distinguishing binder quality.
3. Validate selected parameters with the IDEAL-CT test.
4. Develop a rapid testing method for use during production.

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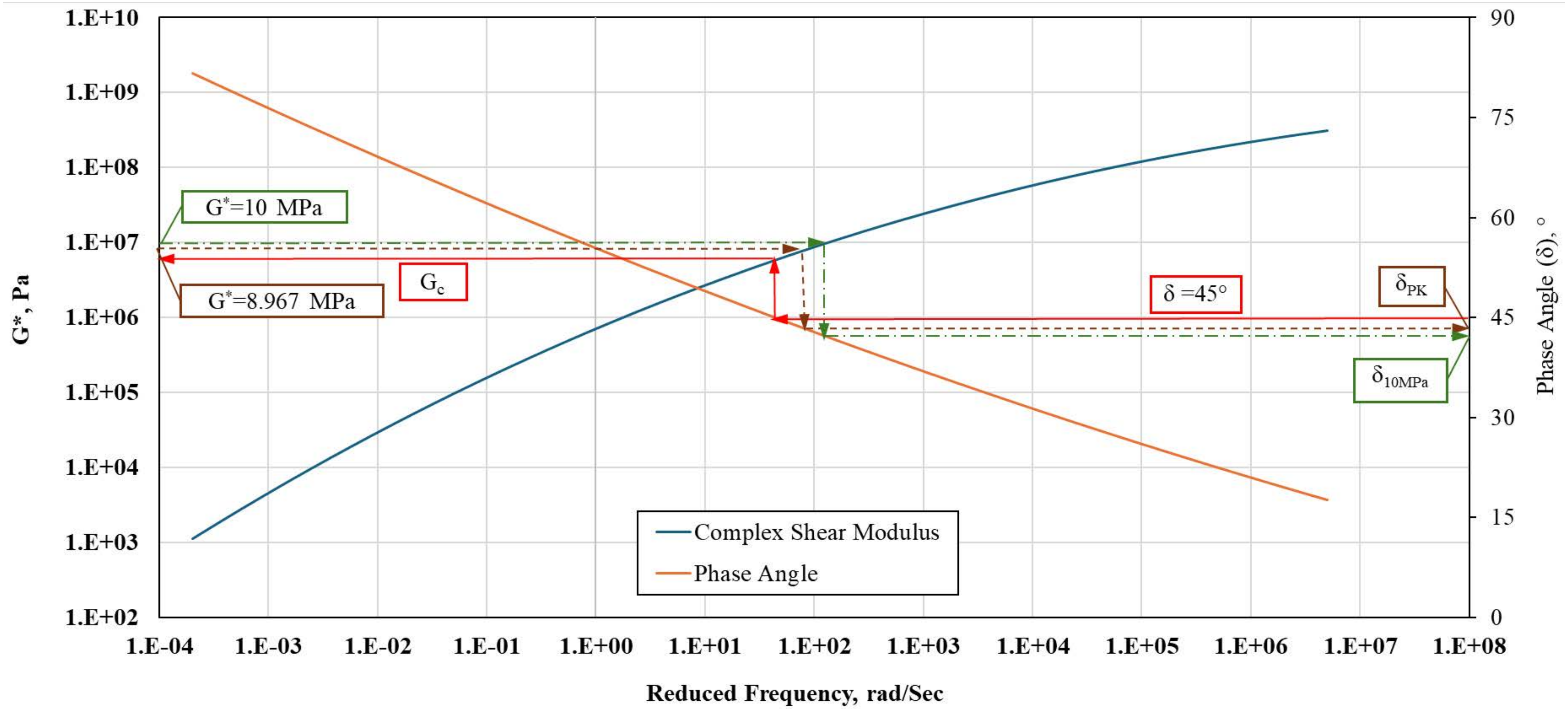
Master Curve Insights

- Master Curve: Relationship between stiffness and frequency.
- Time-temperature superposition principle applied for data shifts.
- Provides a holistic view of binder behavior across temperatures.


1.E+10
1.E+09
1.E+08
1.E+07
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
G*, Pa
90
75
60
45
30
15
0
Phase Angle (δ), °
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06
1.E+07
1.E+08
Reduced Frequency, rad/Sec
G*=10 MPa
G*=8.967 MPa
Gc
δ =45°
δPK
δ10MPa
Complex Shear Modulus
Phase Angle

Point & Shape Rheological Parameters

Point	Shape
• These can be considered to capture the **hardness** of asphalt binders. They include specific values on the master curve, such as the G*, ω_c and the G-R parameter at a reference temperature and frequency.	• These capture the rheological type of asphalt binders. They describe the overall shape/form of the master curve, reflecting the **asphalt binder's response** over a wide range of conditions. In industry, currently four parameters are being considered as additional specification parameters that effectively describe the shape of the master curve: (1) R-value, (2) log G_c, (3) δ_{PK} or δ_{10MPa} and (4) ΔT_c.

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Materials Overview

- Seventeen (17) asphalt binders sourced from various suppliers.
- Inclusion of three poor-quality binders for benchmarking.
- Types: Unmodified, polymer-modified, and asphalt rubber.

Experimental Plan

- Materials: 20 asphalt binders from four different sources, including high and low-quality samples.
- Testing: DSR and BBR tests, master curve construction, and IDEAL-CT validation.
- Analysis: Ranking of binders based on parameters to correlate with CT_{Index}.

Experimental Plan

- Superpave Mix Design: Designed using seven binders to validate parameters.

- Testing Conditions: Binders tested in unaged, RTFO, and PAV-aged conditions.

Asphalt Binders

	Source A	Source B	Source C	Source D	Source E (Poor Quality)	Lab Formulated (Poor Quality)
PG52-34 (Base Binder)		×		×		
PG58-28 (Base Binder)	×		×	×		
PG64-28 (Base Binder)		×				
PG64-16					×	
PG64-22						×
PG64S-28	×	×	×	×		×
PG64E-28	×	×		×		
PG64E-34	×					
PG76E-34		×				
Asphalt Rubber	×			×		

Point Parameters Analysis

- G-R Parameter: Evaluated at 15°C and 10 rad/s.
- Distinguishes between high and low-quality binders.
- Provides insights into binder stiffness and potential for cracking.

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Shape Parameters Analysis

- δ_{10MPa}: Phase angle at a specific modulus of 10 MPa.
- Effective in differentiating binder performance at intermediate temperatures.
- Correlates well with mixture cracking resistance.

Numerical Rankings of Point and Shape Parameters

(1 = Best & 20 = Worst)

	Point Parameter G-R at 15°C and 10 rad/s		**Shape Parameter** Phase angle at 10 MPa (δ_{10MPa})		**Shape Parameter** Log cross-over modulus (log G_c)	
	RTFO	**20 Hour PAV**	**RTFO**	**20 Hour PAV**	**RTFO**	**20 Hour PAV**
PG52-34	2	4	2	4	2	4
PG76-34	4	3	8	7	8	7
PG64-28 Base	7	19	7	10	7	9
PG64E-28	17	11	16	12	16	13
PG64-16	20	20	3	2	4	2
PG64-22 Lab Formulated	10	17	20	20	20	20
PG64-28 Lab Formulated	11	13	17	19	17	19

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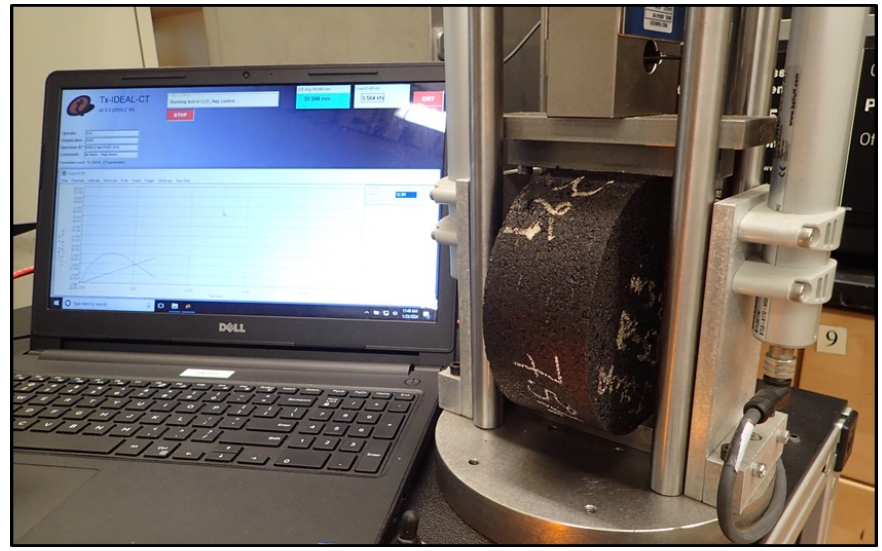
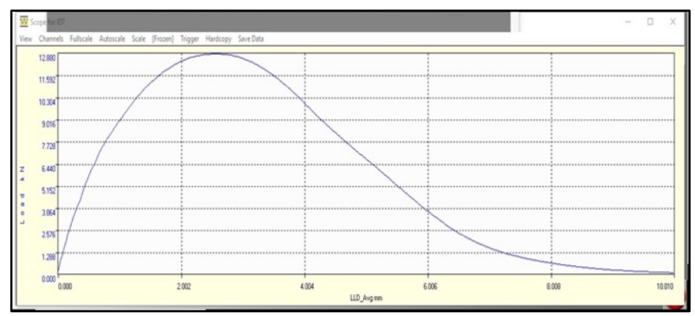
Superpave Mix Design

- 12.5 mm dense-graded asphalt mixture.
- Used <u>seven</u> selected binders to validate parameters.

IDEAL-CT Test Overview

- ASTM D8225-19 method used for intermediate temperature cracking assessment.
- CT_{Index}: Higher values indicate better cracking resistance.
- Validation of selected binder parameters through mixture testing.





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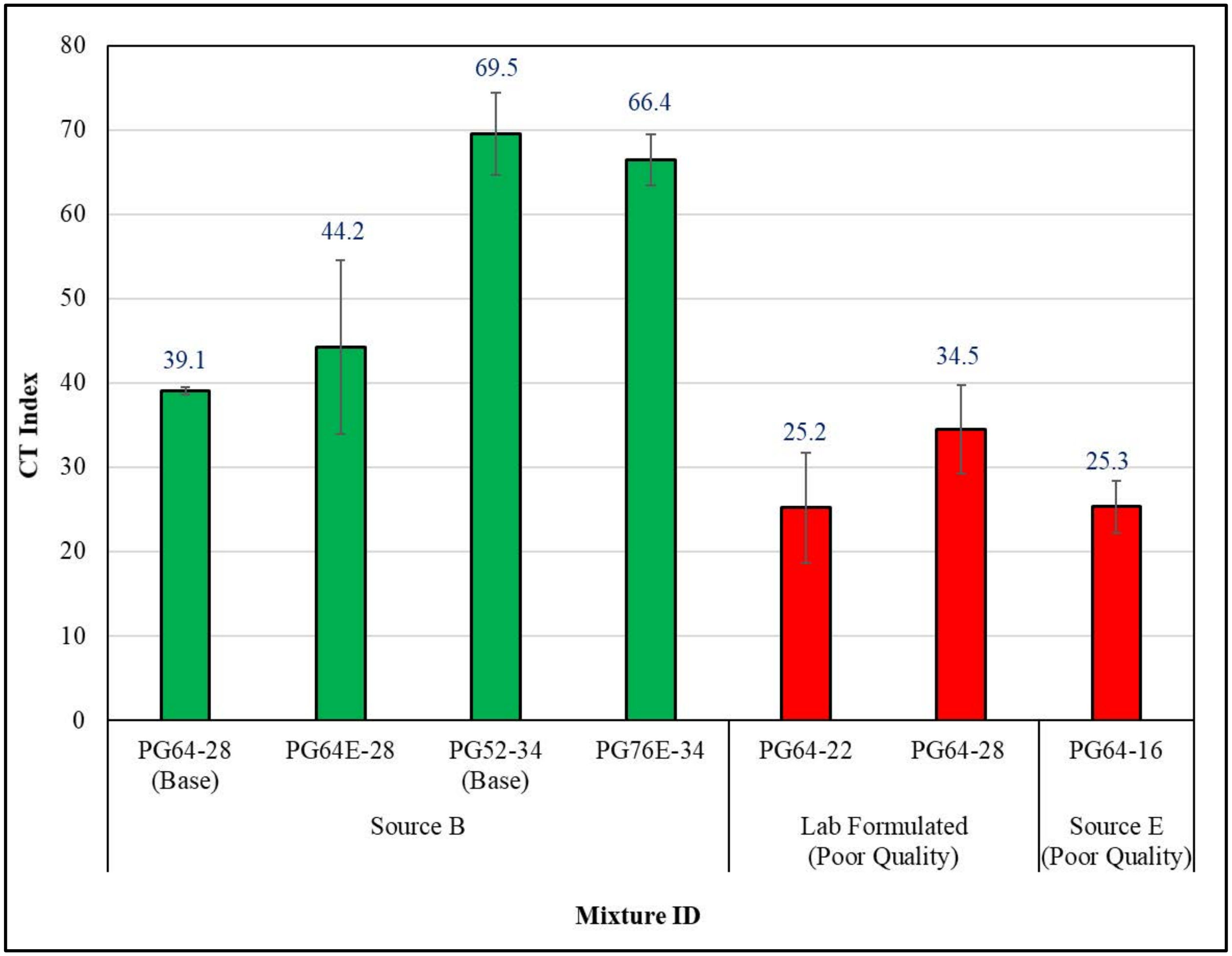
IDEAL-CT Results



IDEAL-CT Results

- Mixtures with poor-quality binders showed lower CT_{Index} values.
- Correlation with G-R and δ_{10MPa} rankings verified.
- Supports use of these parameters for quality control.

Rapid Testing Method Development

- Goal: Simplified DSR method for G-R and δ_{10MPa}.
- Reduces testing time while maintaining accuracy.
- Focus on practical application in production environments.

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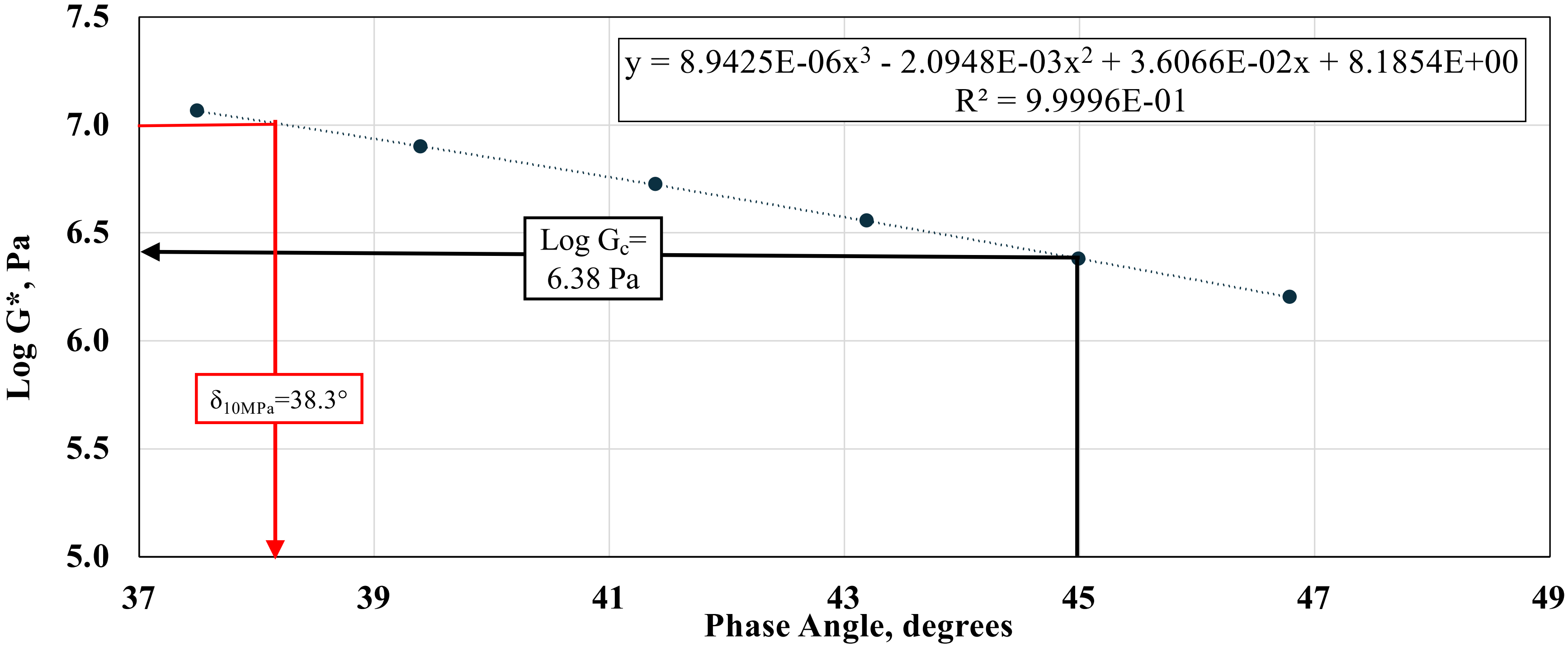
Rapid Testing Method Development



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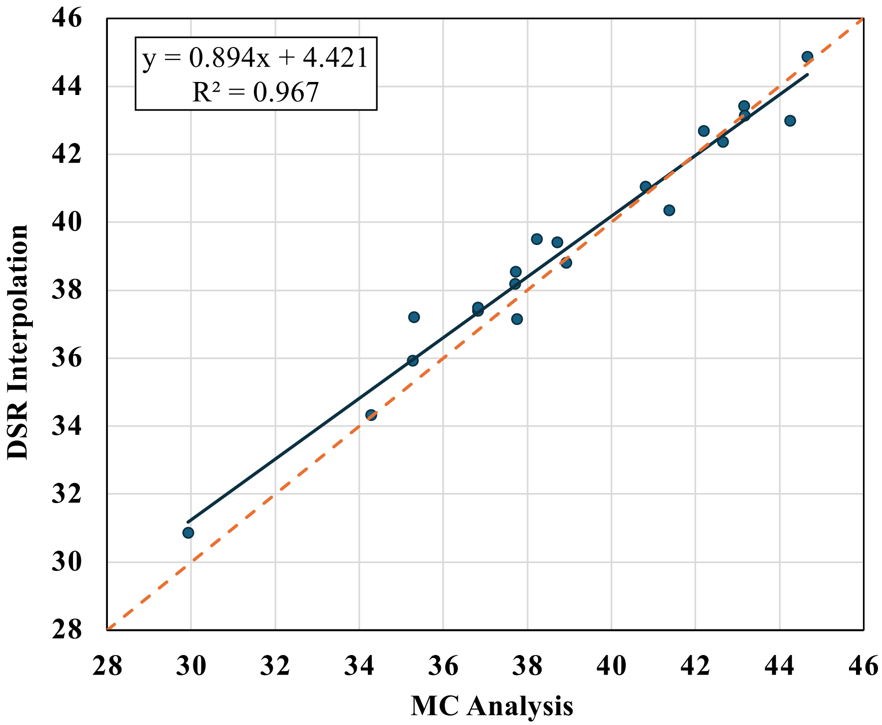
Comparison of Testing Approaches

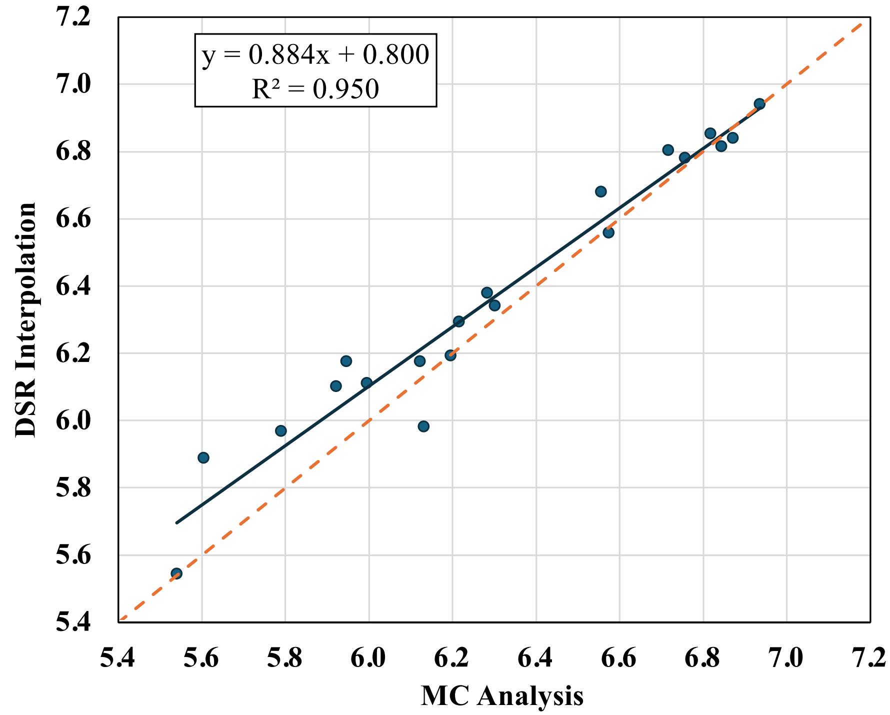
- Traditional Master Curve vs. Simplified Method.
- Advantages of time savings and ease of use.

Validation of Simplified Approach

- Strong agreement between simplified and traditional methods.
- Ensures practical applicability without compromising data integrity.

Validation of Simplified Approach





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Recommendations for Implementation

- Incorporate G-R and δ_{10MPa} into BMD specifications.
- Use simplified method for routine binder evaluations.
- Focus on training for testing personnel to ensure consistency.

Conclusions

1. G-R and δ_{10MPa} are effective for assessing binder quality.

2. Simplified testing method ensures consistency and efficiency.

Thank you

Questions?