Comparing Friction Reducers for Use in AMPT Testing

Outline

- Background
- Objectives
- Testing plan
- Results
- Findings

Background

- NCHRP 9-29
  - Conclusion: variability of unconfined Fn was not suitable for rutting criteria developed in NCHRP 9-33
  - Suggestion: improved guidance for fabrication and use of friction reducers could reduce test variability
- Friction reducers for Fn in AASHTO TP 79-13
  - Two layers of latex membrane
  - Paste silicone grease at 0.25 ± 0.05 g

Objectives

- Investigate the effect of friction reducers on Fn test results and variability:
  - Paste silicone (latex)
  - Teflon
  - Spray silicone (latex)
- Select appropriate friction reducers for Fn
- Confirm selected friction reducers not affecting E* results

Testing Plan - Fn

Test Procedure	Friction Reducer Type	Application Rate
• Unconfined Flow Number (NCHRP 09-33 Method): o Confinement: None o Deviator: 600kPa (87 psi) o Contact: 30kPa (4.35 psi) o Temperature: 60.5°C	Paste Silicone Latex	0.25 ± 0.02 g (baseline)
	(DOW Corning 112 HP)	0.15 ± 0.02 g
	Silicone Spray A Latex	0.25 ± 0.02 g
	(3M Dry Type)	0.10 ± 0.02 g
	Silicone Spray B Latex	0.25 ± 0.02 g
	(Permatex Wet Type)	0.15 ± 0.02 g
	Teflon	0.01-in. Thick Sheet
Notes:		
1 Test Method x 7 Friction Reducers = 7 Sets of Flow Number Specimens		
4 Replicates per Flow Number Test.		

Testing Plan – E*

- Same set of 3 specimens
- Same 7 friction reducers as in Fn testing
  - Except 0.15 ± 0.02 g for 3M dry type
- Testing conducted from low to high temperature and high to low frequency
  - Order randomized at each temperature

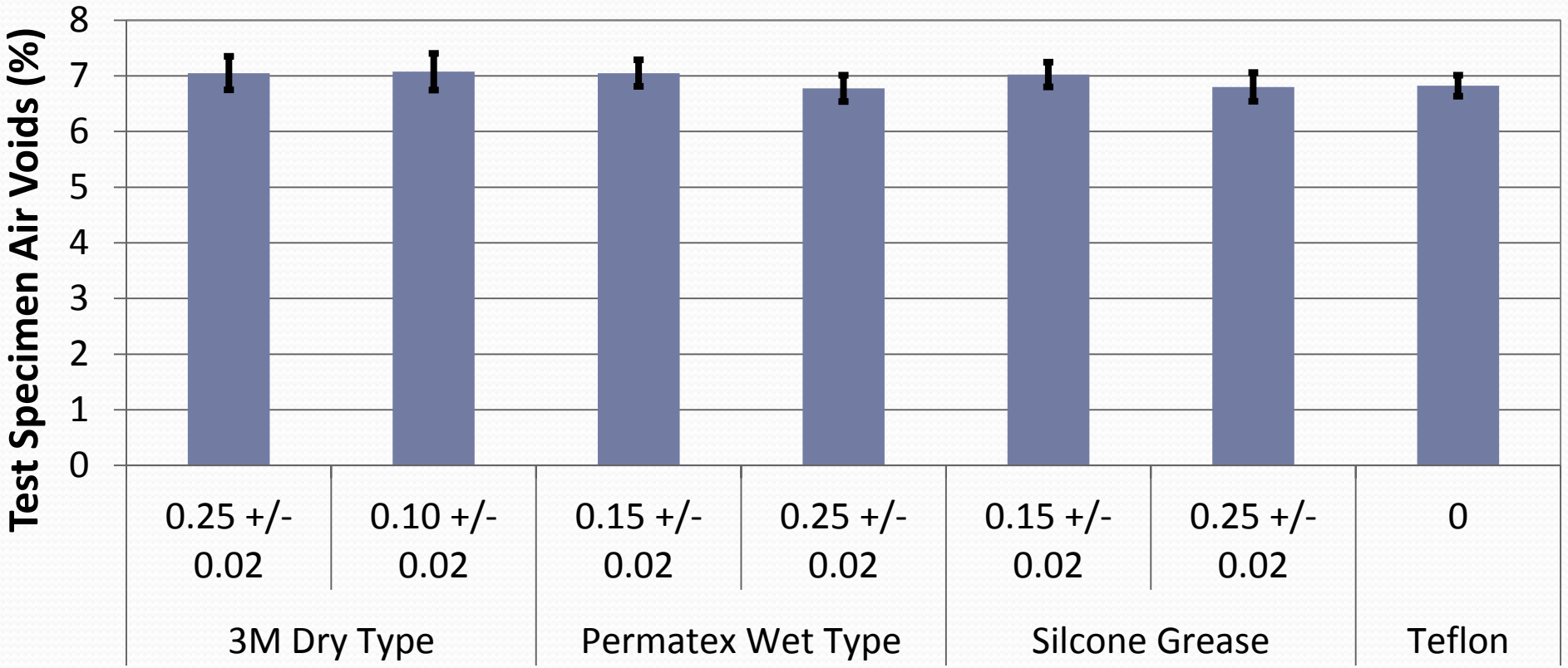
Test Temperature (°C)	Test Frequency (Hz)
4	10,1,0.1
20	10,1,0.1
40	10,1,0.1,0.01

Asphalt Mixture Used

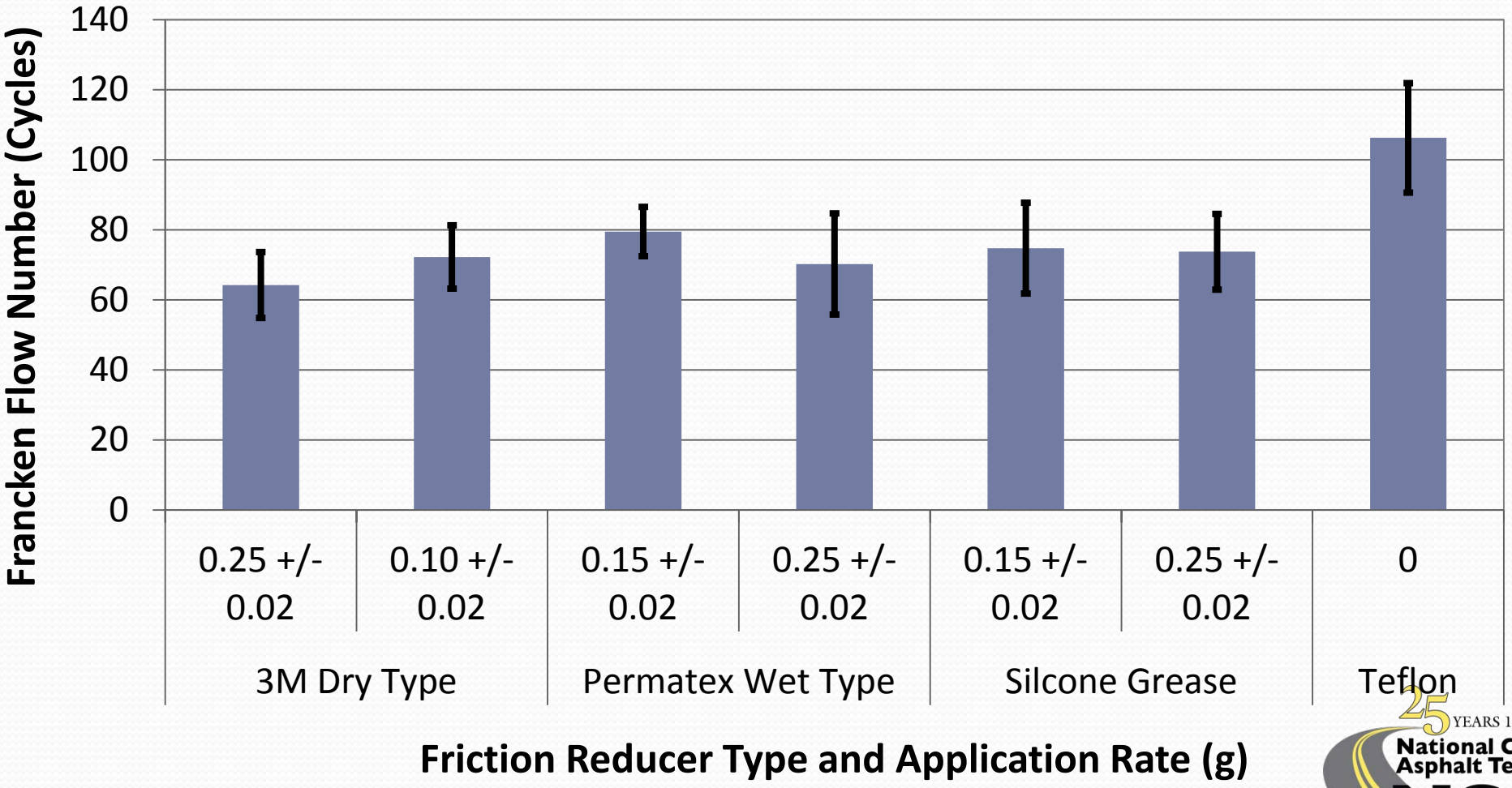
- Dense-graded mix
  - 9.5-mm NMAS
  - PG 67-22
  - 20% RAP by weight of aggregate
    - Total AC = 5.50% (4.38% virgin binder; 1.12% RAP binder)
  - N_{des} = 60
  - Plant produced

Effect of Friction Reducers on Fn Test Results

Specimen Air Voids



Fn Test Results



Statistical Analysis

Analysis of Variance for Francken Flow Number, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Mix ID	6	4430.2	4430.2	738.4	5.39	0.002
Error	21	2875.5	2875.5	136.9		
Total	27	7305.7				

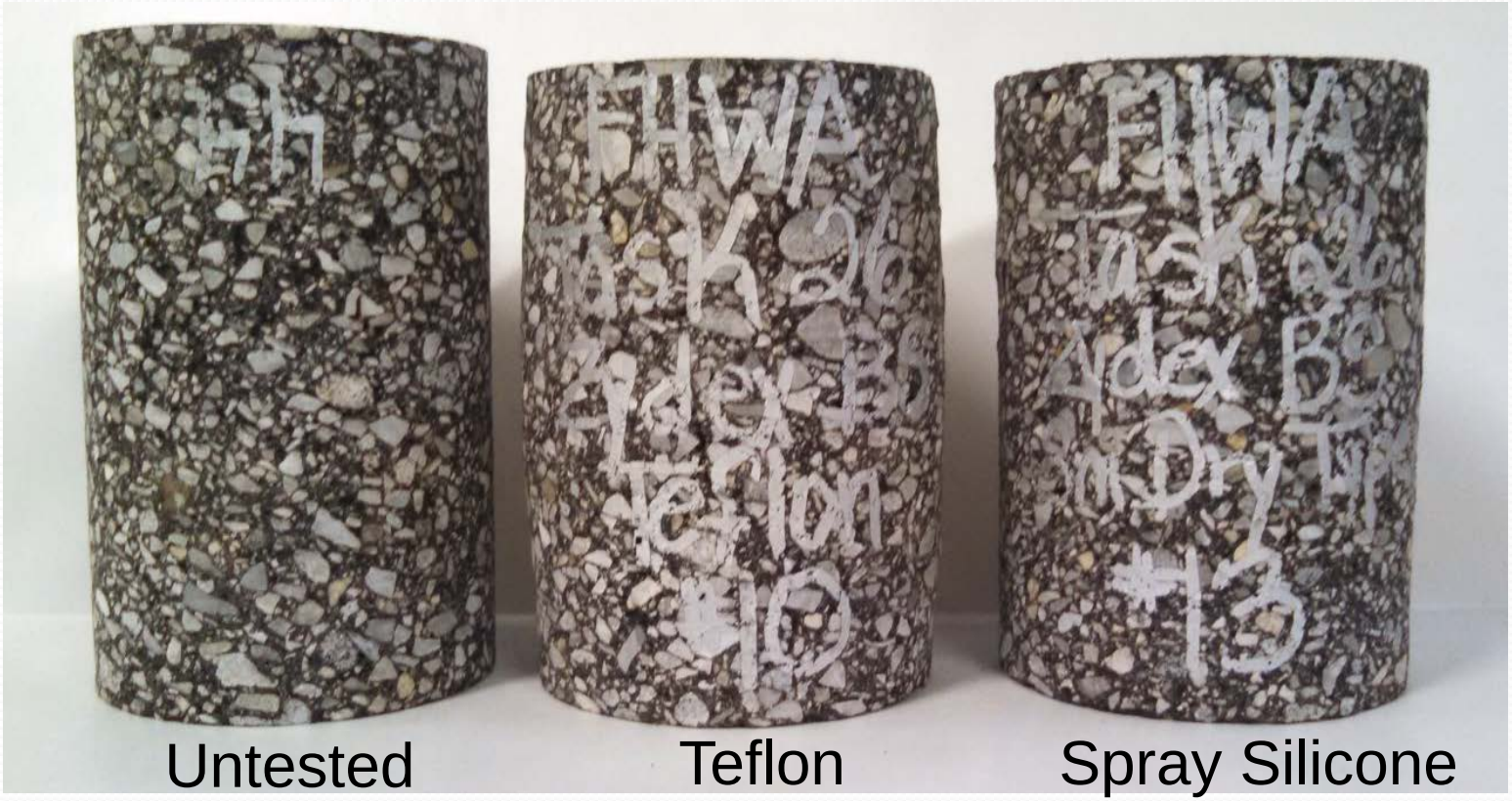
S = 11.7016 R-Sq = 60.64% R-Sq(adj) = 49.39%

Grouping Information Using Tukey Method and 95.0% Confidence

Mix ID	N	Mean	Grouping
Teflon	4	106.25	A
Permatex Wet Type - 0.15	4	79.50	A B
Silicone Grease - 0.15	4	74.75	B
Silicone Grease - 0.25	4	73.75	B
3M Dry Type - 0.10	4	72.25	B
Permatex Wet Type - 0.25	4	70.25	B
3M Dry Type - 0.25	4	64.25	B

Means that do not share a letter are significantly different.

Specimen Deformation

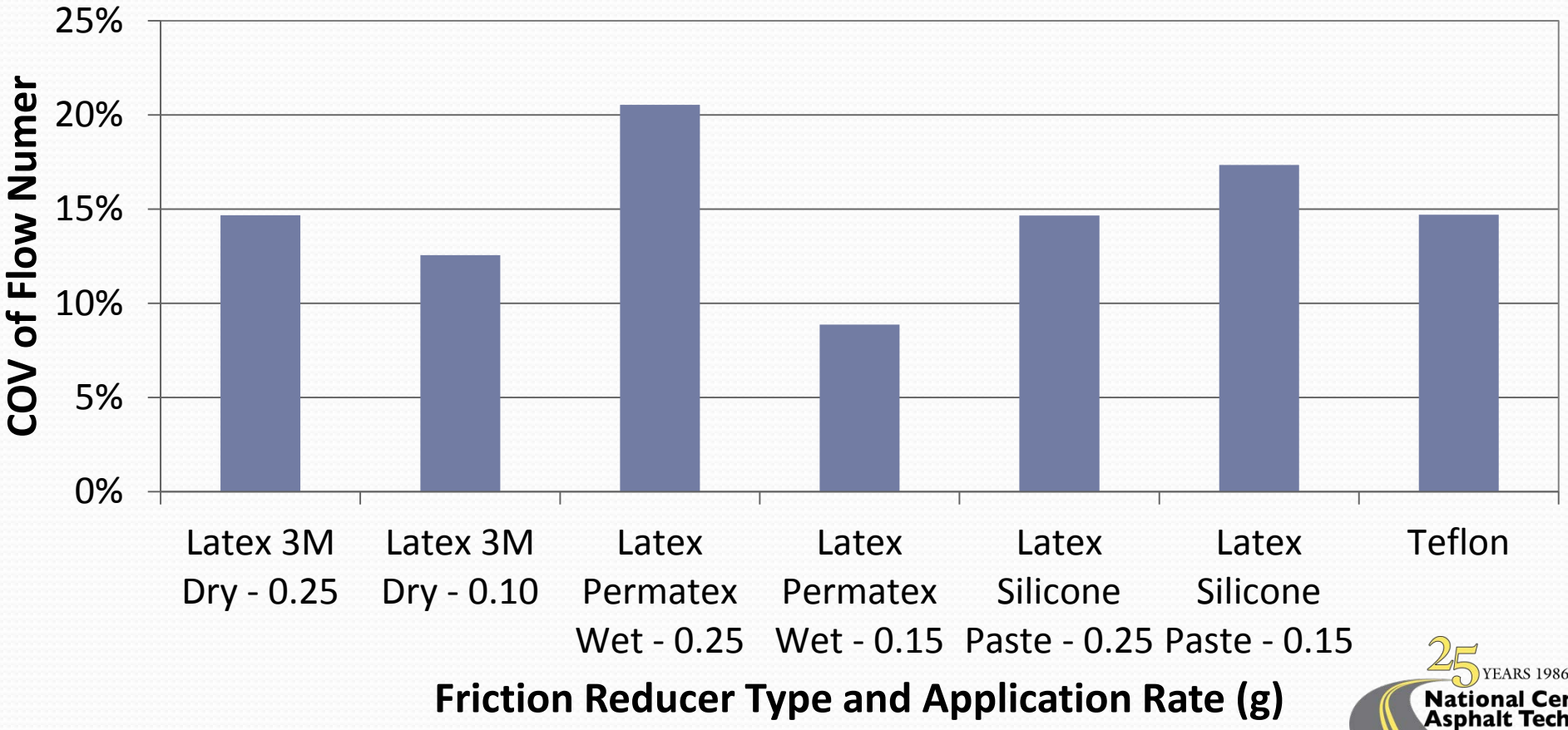


Untested

Teflon
"bulging"

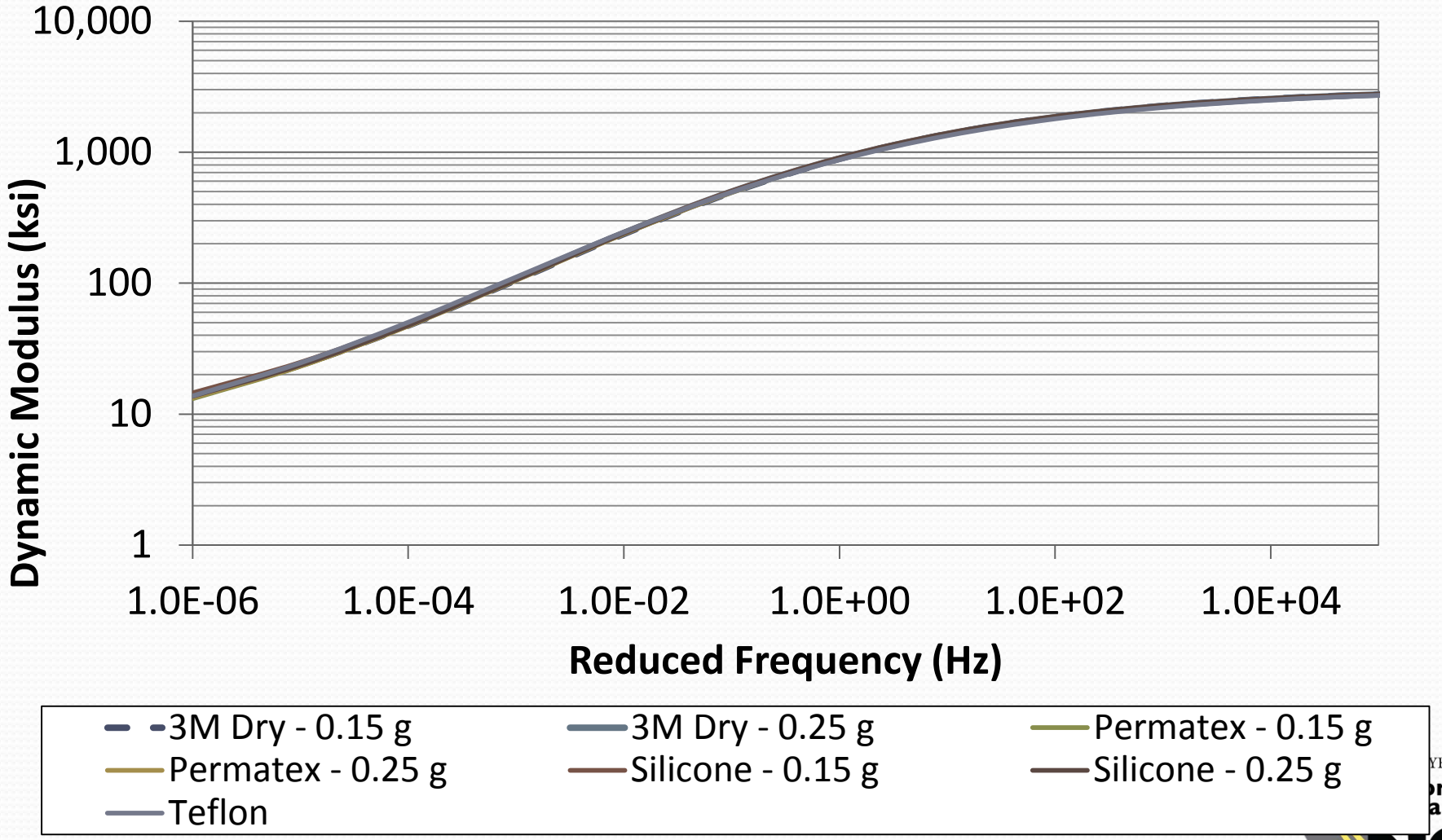
Spray Silicone
"constant
deformation"

COV of Fn Results



Effect of Friction Reducers on E* Test Results

E* Test Results



Statistical Analysis

Test Temperature (°C)	Test Frequency (Hz)	p-Value
4	10	0.419
4	1	0.553
4	0.1	0.743
20	10	0.710
20	1	0.892
20	0.1	0.887
40	10	0.856
40	1	0.880
40	0.1	0.864
40	0.01	0.512

Findings

- Fn test
  - Teflon friction reducer yielded higher Fn results
  - Latex friction reducers did not statistically affect Fn results
- E* test
  - Teflon and latex friction reducers did not statistically affect E* results

Recommendations

- Only 2-layer latex friction reducers be used for Fn test
  - Paste silicone, dry-type silicone spray, or wet-type silicone spray
  - Application rate: 0.20 ± 0.05 g
- Latex or Teflon friction reducer be used for E* test
  - For a latex friction reducer, any of the silicones can be used and application rate is 0.20 ± 0.05 g

Acknowledgments

- This inter-laboratory study is sponsored by AMPT Pooled Fund Study TPF-5(178)