NCHRP Asphalt Research Projects
*E*ngineering *M*aterials *C*haracterization *R*esearch *F*acility

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LA Transportation Research Center

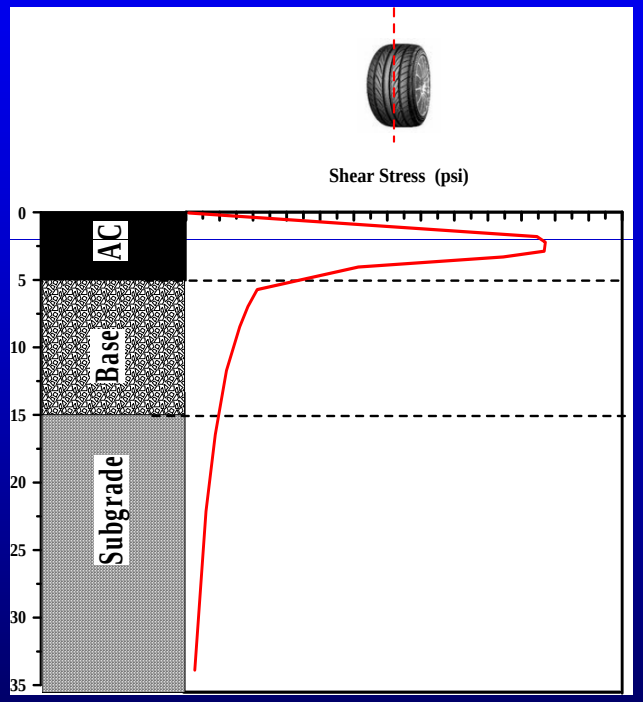
52nd Louisiana Asphalt Pavement Association Convention
June 1-5, 2011
Point Clear, Alabama

LOUISIANA STATE UNIVERSITY

My Story

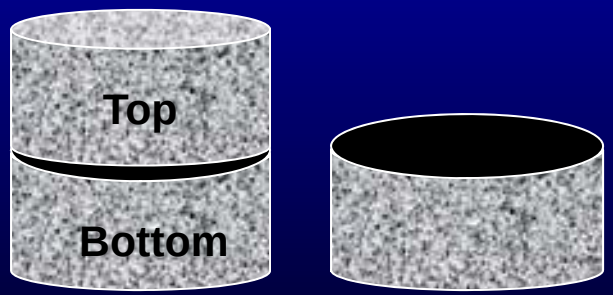
- Brief Update on two NCHRP Projects
- NCHRP project 9-40
  - Optimization of Tack Coat Materials
- NCHRP project 9-48
  - Field versus Laboratory Volumetrics and Mechanical Properties

NCHRP Project 9-40
Optimization of Tack Coat Materials



Objectives

- **Determine for the various uses of tack coats**
  - optimum application methods,
  - equipment type and calibration procedures,
  - application rates, and
  - asphalt binder materials
- **Recommend revisions to relevant AASHTO methods and practices related to tack coats**
  - Tack Coat Quality
  - Interlayer Bond Strength



Methodology

PHASE I

- Task 1: Literature Review
- Task 2: Design A Comprehensive Experiment To Study Tack Coat Variables
  - Identify Laboratory And Field Test Devices
  - Develop Laboratory Experiment To Evaluate Tack Coats
  - Develop Field Experiment To Evaluate Tack Coats
- Task 3: Prepare And Submit Interim Report

PHASE 2

- Task 4: Conduct Experiment Approved In Task 3
- Task 5: Recommend Test Methods, Criteria, And Construction Guidelines
- Task 6: Demonstrate The Use Of Recommended Test Methods And Construction Guidelines
- Task 7: Prepare Instructional Materials For A Training Course
- Task 8: Prepare And Submit Final Report

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Testing Factorial – Main Experiment

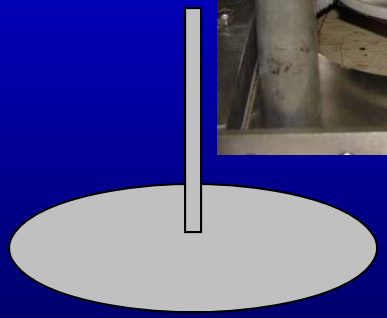
Variable	Content	Number of Levels
Tack Coat Material	CRS-1, Trackless, SS-1h, SS-1, PG 64-22	5
Residual Application Rate (l/m^2, gsy)	0.00-, 0.14-, 0.28-, 0.70- (0.00-, 0.031-, 0.062, 0.155)	4
Pavement Surface	HMA: Existing, Milled, New PCC: Existing	4
Surface Coverages (by tack coat)	50%, 100%	2
Surface Condition (Cleanliness)	Clean, Dirty	2
Wet (Rain) Condition	Wet, Dry	2
Specimen Preparation Method	LL, PF	2
Testing Temperature	25°C	1
Testing Confinement Pressure	0-, 138 KPa (0-, 20 Psi)	2
Testing Replicates	3	3

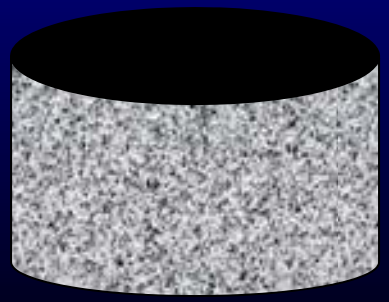
Testing Factorial – Temperature Experiment

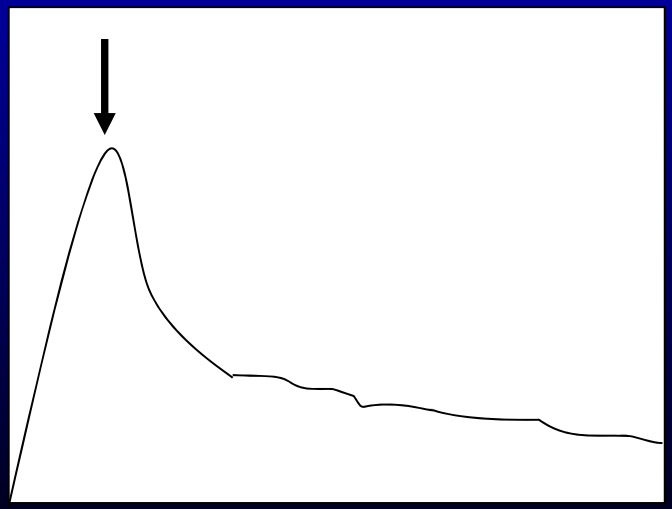
Variable	Content	Number of Levels
Tack Coat Material	CRS-1, Trackless	2
Residual Application Rate (l/m^2, gsy)	0.00-, 0.14-, 0.28-, 0.70- (0.00-, 0.031-, 0.062, 0.155)	4
Pavement Surface	HMA: Existing	1
Specimen Preparation Method	PF	1
Testing Temperature	-10, 0, 10, 20, 30, 40, 50, and 60°C	8
Testing Replicates	3	3

Characterization of Tack Coat Quality
Louisiana Tack Coat Quality Tester -- LTCQT

- **Developed equipment**
  - **Tack coat quality -- residual**
  - **Tension**
- **User friendly, Easy to use**
- **Laboratory and field**
- **Draft test method in AASHTO format**
- **Tensile load**
  - **Displacement**
  - **Tensile Force**
  - **Time**







Summary

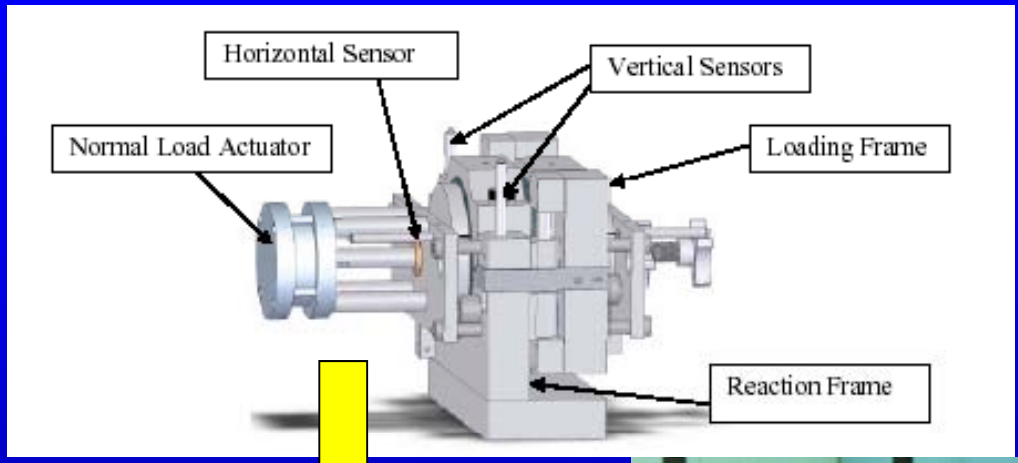
- LTCQT could serve as a valuable tool for highway agencies to perform comparative evaluations of various tack coat materials and application rates in the field.
- Repeatability of measurements
  - average coefficient of variation of less than 14%

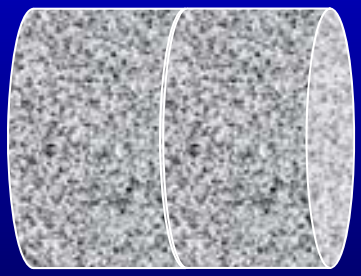
Reference

- "Development Of Pull-Off Test Device And Methodology To Evaluate The Bond Strength Of Tack Coat Materials In The Field." Journal of the Transportation Research Board, TRR No. 2126, 2009, pp.1-11.

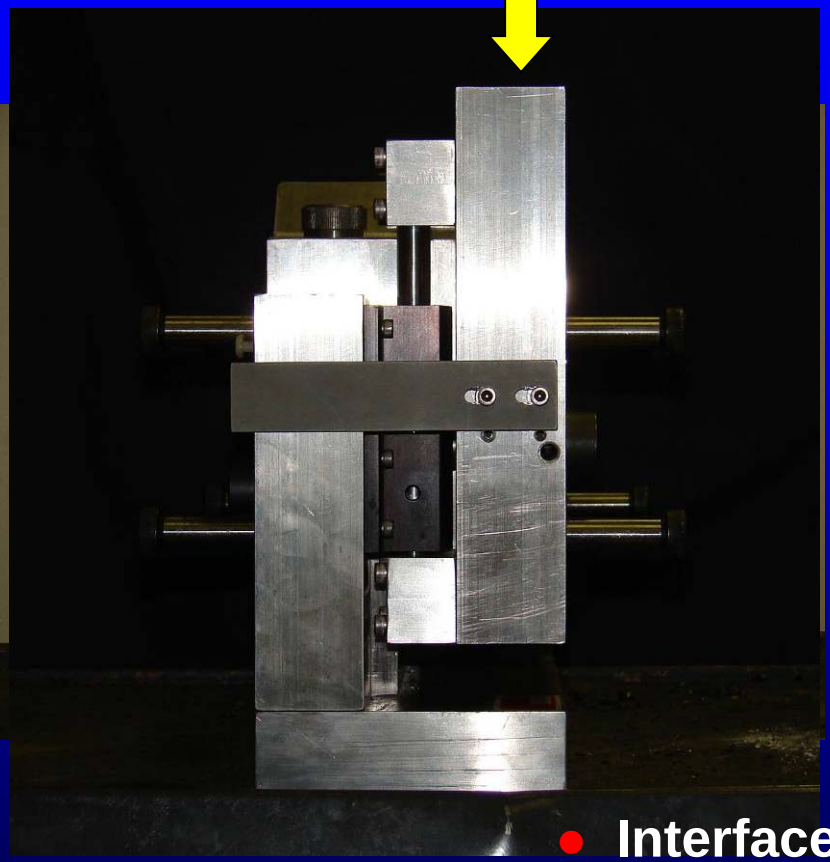
Direct Shear Test Device
Louisiana Interlayer Shear Strength Tester (LISST)

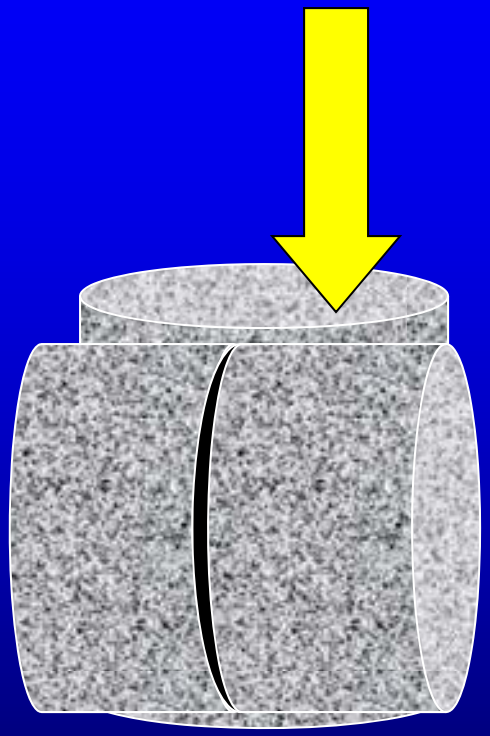
- **Two Main Parts**
  - **Shearing frame,**
  - **Reaction frame**
  - **Frictionless linear bearing**
    - **Maintain vertical travel**
- **Easy to use**
- **Portable**
- **Adoptable to exiting load frames**
- **Reasonable cost**
- **accommodate both 100 and 150-mm sample diameter**
- **Comparison**
  - **Superpave Shear Tester**



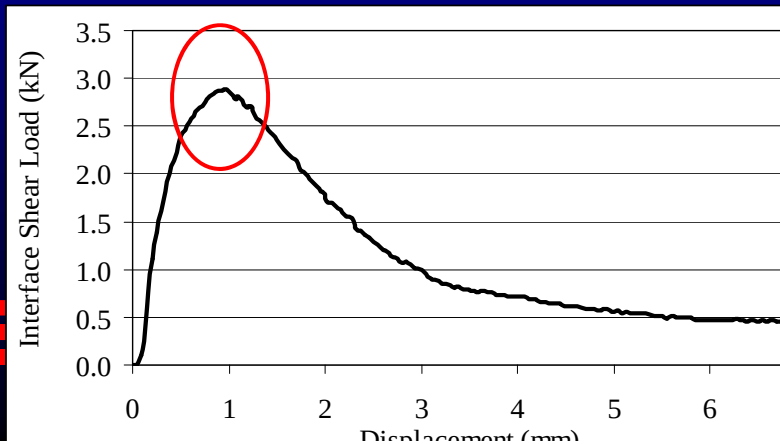


Interface Shear Strength (ISS) Test Results

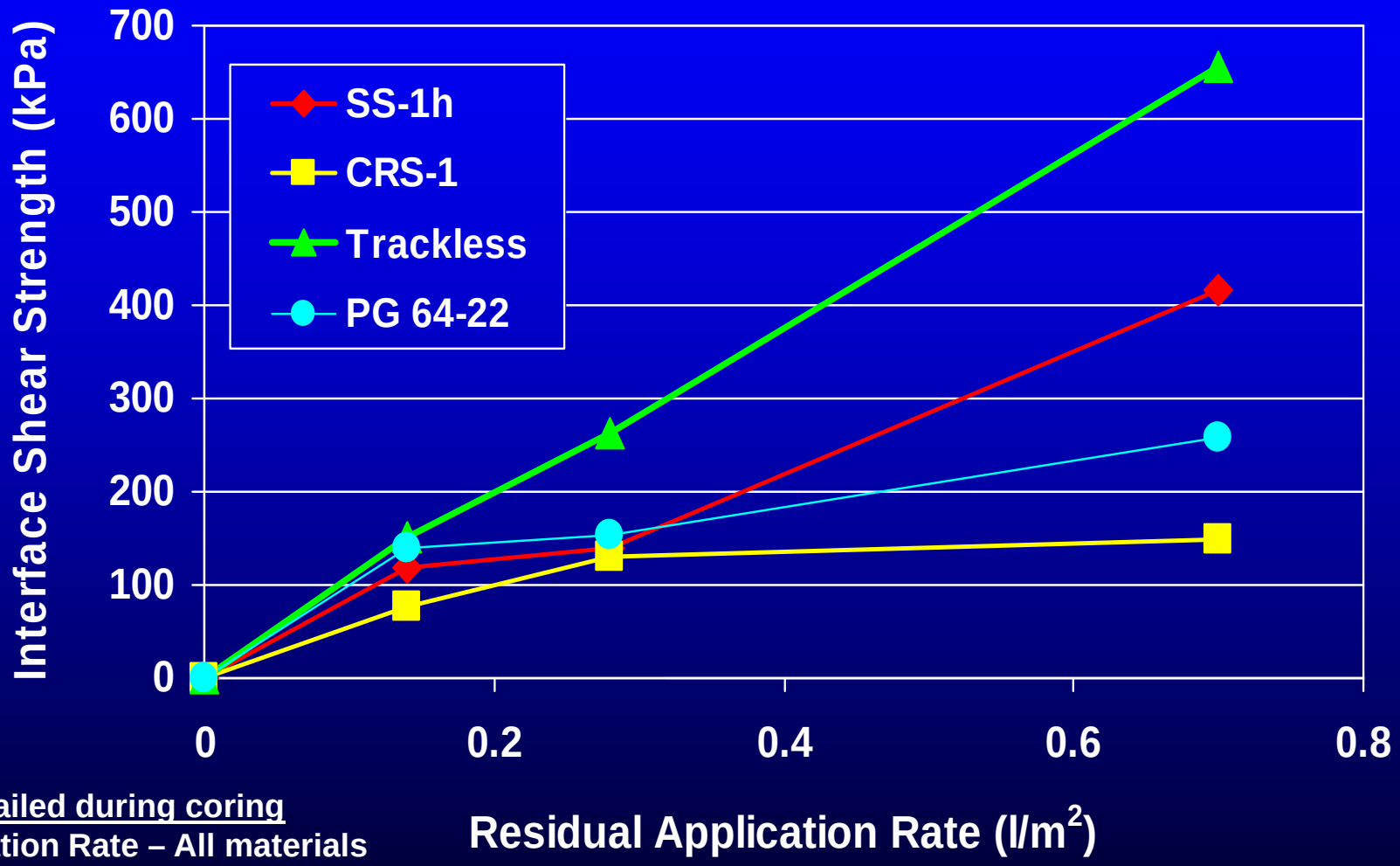




- **Interface Shear Strength**
  - **ISS**
  - **% CV < 15%**

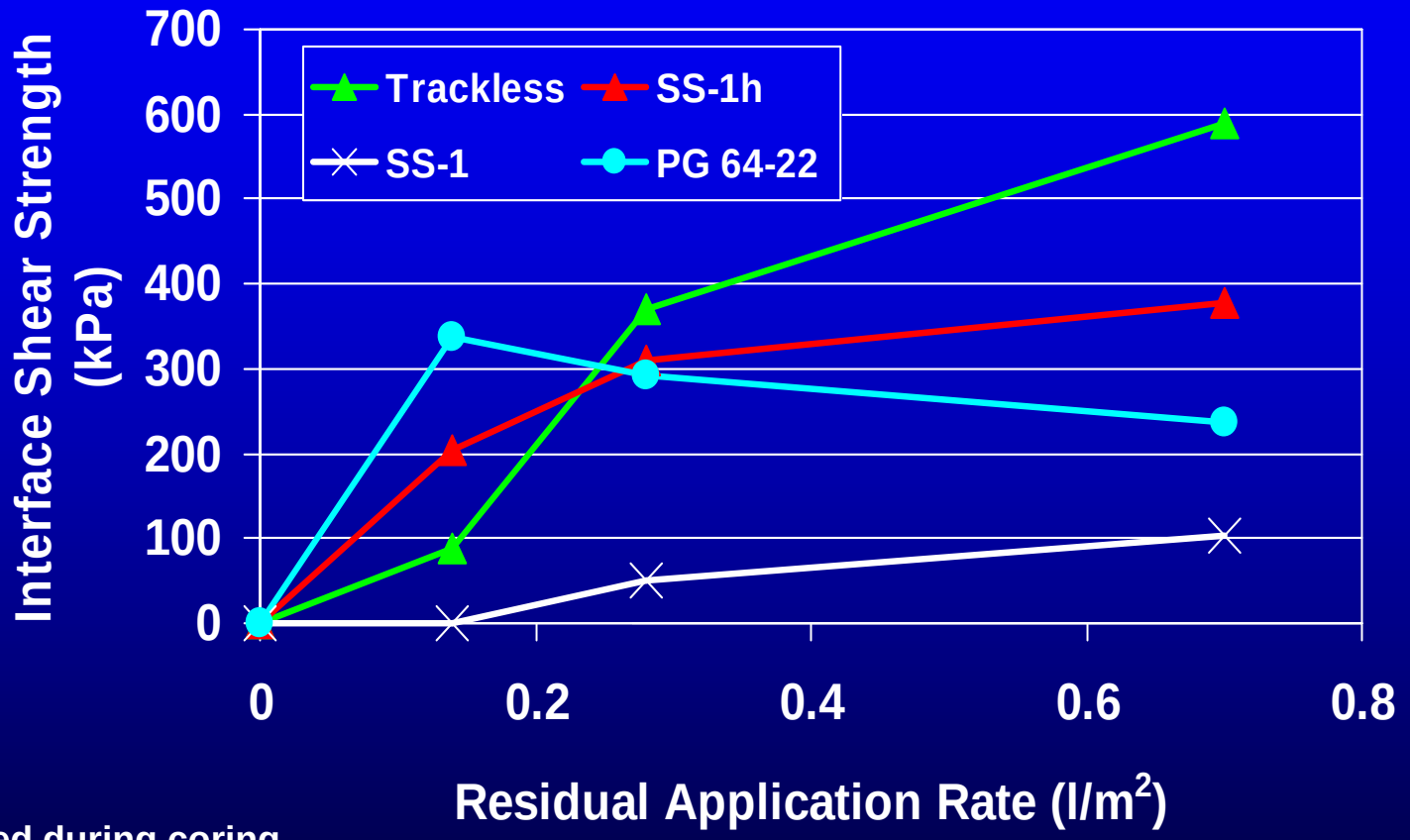


Effect of Residual Application Rates on ISS: Pavement Surface: Existing HMA



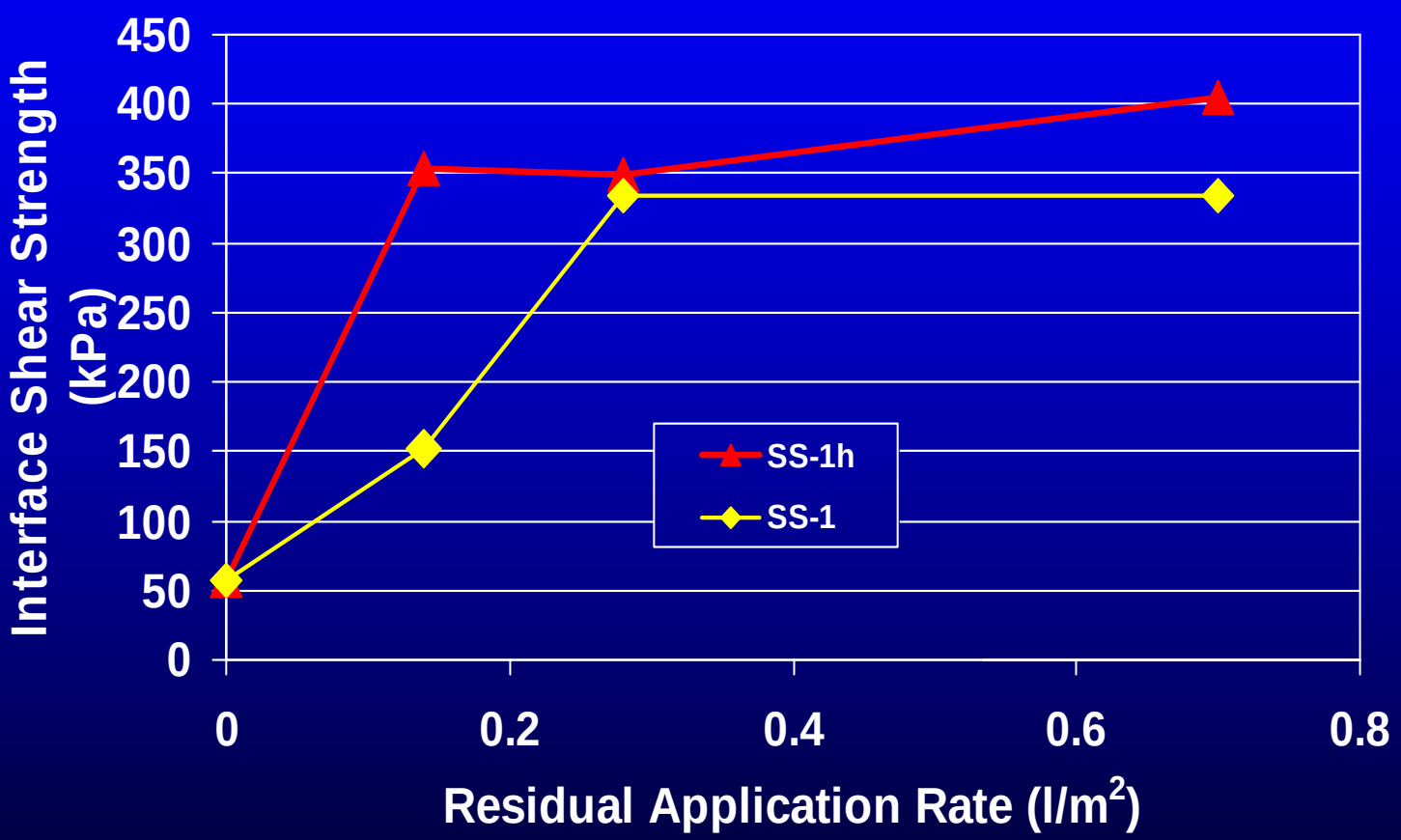
Sample failed during coring
0 Application Rate – All materials

Effect of Residual Application Rates on ISS : Pavement Surface: Existing PCC

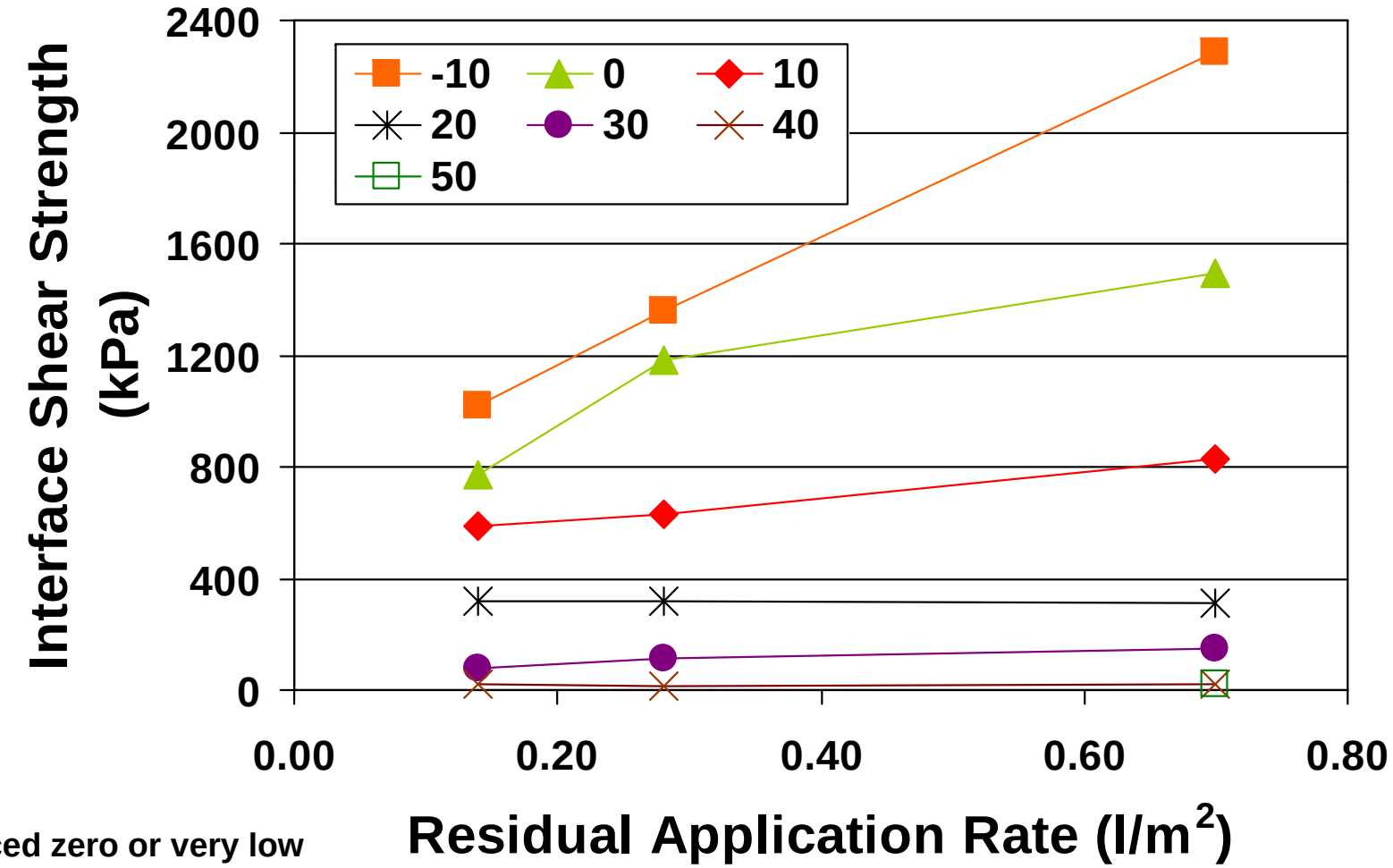


Sample failed during coring
0.14 l/m² SS-1

Effect of Residual Application Rates on ISS : Pavement Surface: Milled HMA

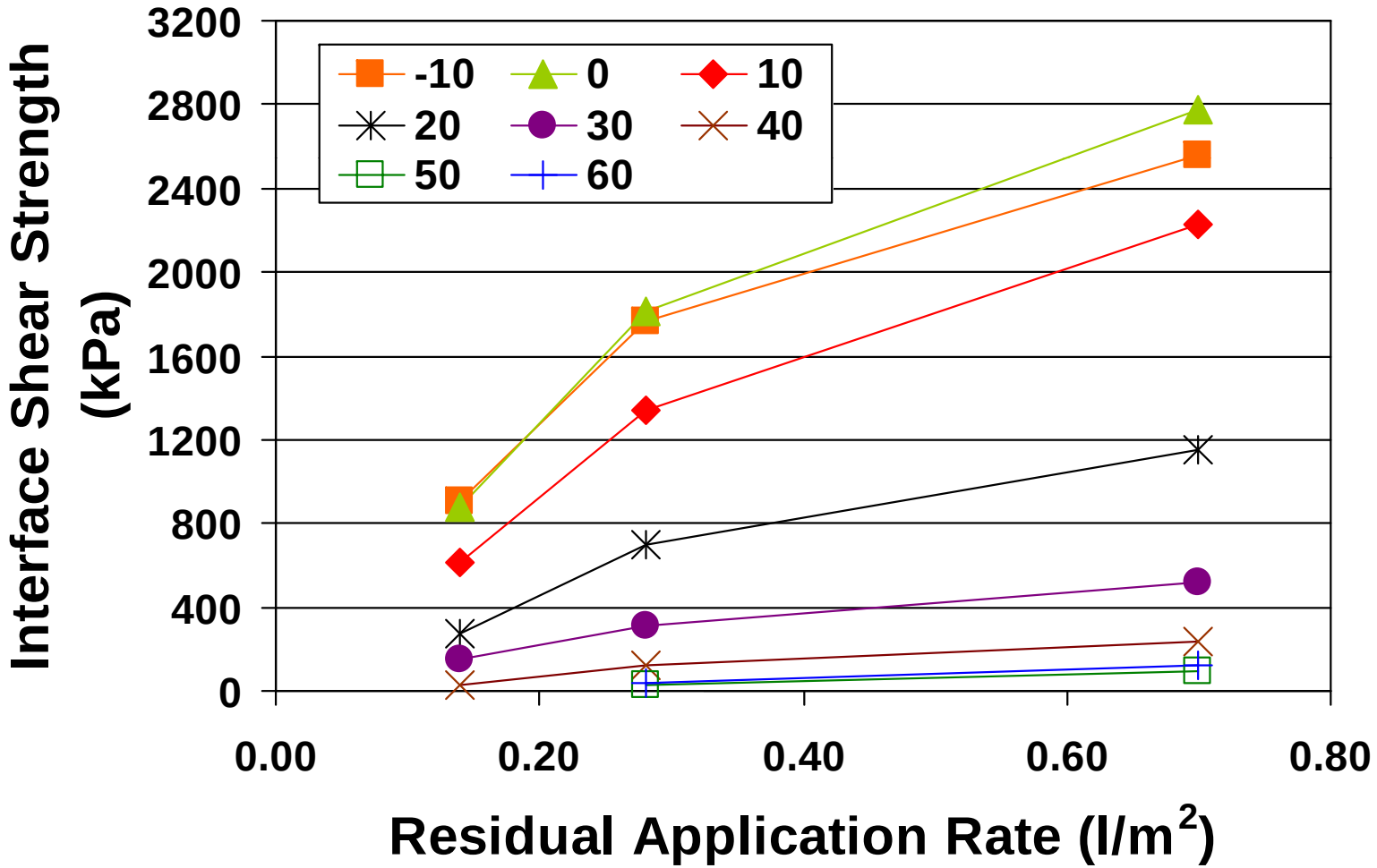


ISS vs Residual Application Rate at Various Temperature – CRS-1

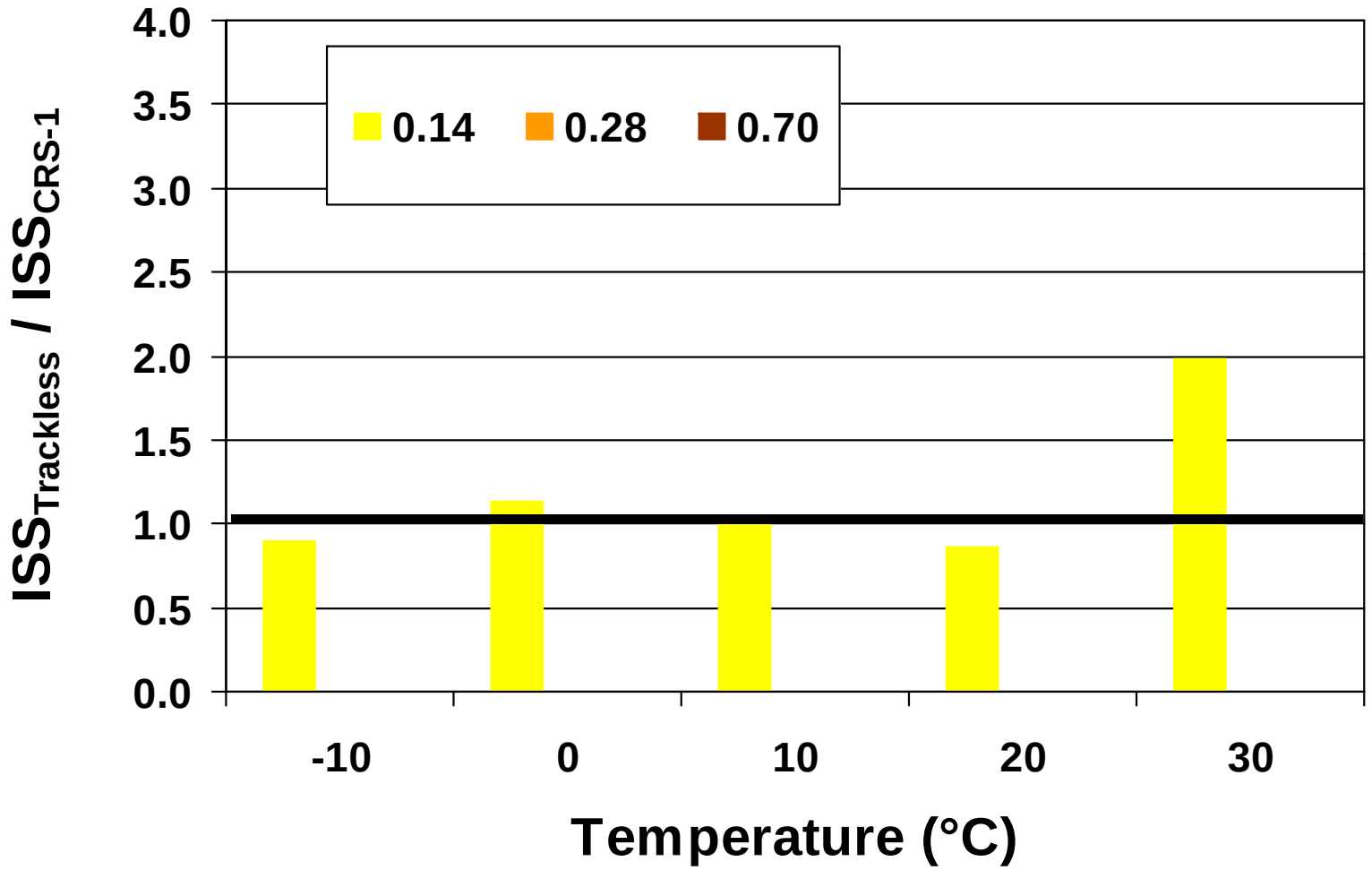


40°C - 60°C:
CRS-1 produced zero or very low ISS

ISS vs Residual Application Rate at Various Temperature – Trackless

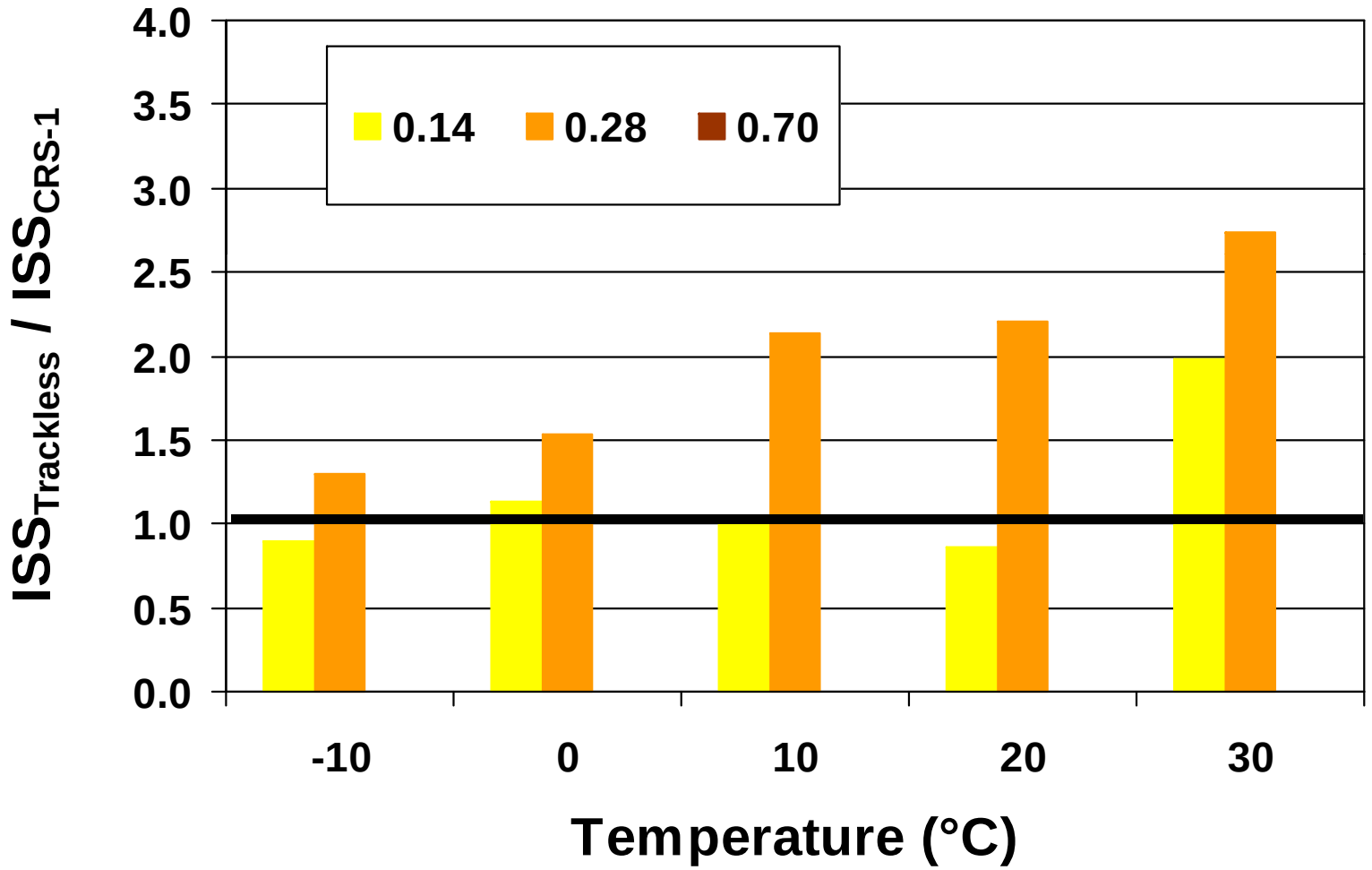


ISS Ratio of Trackless to CRS-1



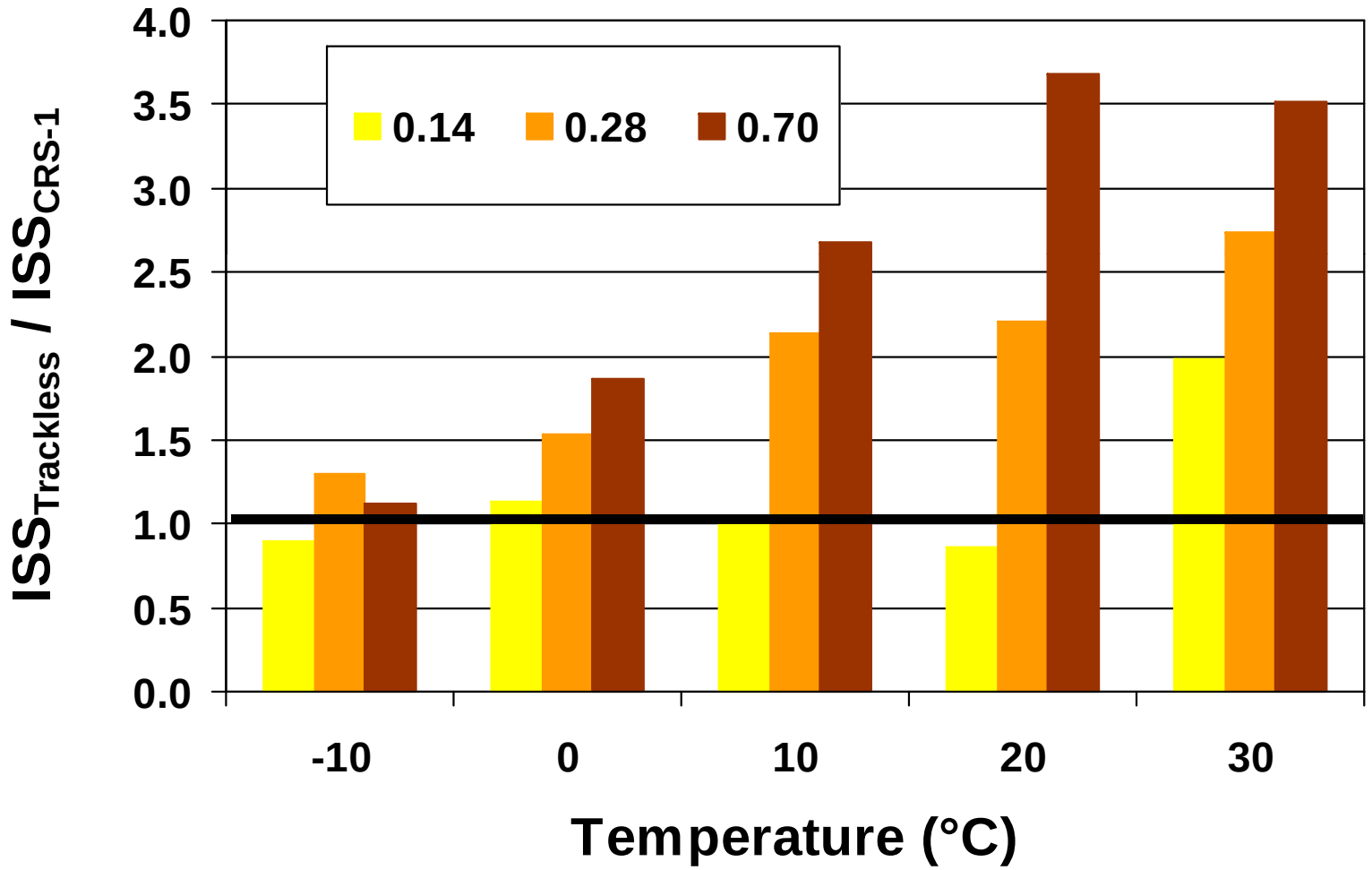
40°C - 60°C:
CRS-1 produced zero or very low ISS

ISS Ratio of Trackless to CRS-1



40°C - 60°C:
CRS-1 produced zero or very low ISS

ISS Ratio of Trackless to CRS-1



40°C - 60°C:
CRS-1 produced zero or very low ISS

Conclusions

- **Effect of tack coat materials type**
  - trackless exhibited the highest ISS at all application rates
    - » Existing HMA, PCC
  - CRS-1 resulted in the lowest ISS
    - » Existing HMA
  - SS-1 presented lowest ISS
    - » PCC
- **Effect of application rate**
  - In general, ISS increased with an increase in the application rate
  - Existing HMA
    - » Rate of increase: Trackless, SS-1h, PG 64-22, and CRS-1
  - PCC
    - » Rate of increase: Trackless, SS-1h, SS-1
      - Except PG 64-22: Decrease
  - Milled HMA
    - » ISS is not sensitive to increase in application rate
    - » Texture is more dominant

Future Activities

- Relate laboratory-measured parameters to pavement performance at the interface
  - ISS
  - Supply vs demand (traffic, environment)
- Allow agencies to design tack coat application in the laboratory based on field performance
- Development of performance-based guidelines
  - selection of emulsion-based tack coat materials.

Recommended Application Rates LADOT Specification Sam: Check with Bill for latest and confirm W/ me.

- **Total, Gal/Sq Yd**
- **New Hot Mix**
  - **0.06**
- **Existing Hot Mix**
  - **0.09**
- **Portland Cement Concrete**
  - **0.09**
- **Cold Planed/Milled**
  - **0.08**

NCHRP Project 9-40 Acknowledgement

- **NCHRP**
  - Project 9-40
    - » Optimization of Tack Coat for HMA Placement
  - Technical Review Panel
- **LDOTD**
- **Asphalt Products Unlimited**
  - Distributor Truck
  - SS-1h, CRS-1
- **Coastal Bridge**
  - HMA
  - Construction
- **Blacklidge**
  - Trackless

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ASPHALT SALES 225-223-0226

Blacklidge Emulsions, Inc.

NCHRP Project 9-48
Field versus Laboratory Volumetrics and Mechanical Properties

Laboratory Mixed
Laboratory Compacted
(LL)

Plant Mixed
Laboratory Compacted
(PL)

Plant Mixed
Field Compacted
(PF)

NCHRP Project 9-48 Objectives

- Assess the ***cause*** and ***magnitude*** of the differences and variances
  - volumetric and mechanical properties within and between
    - three specimen types: LL, PL, PF
- Prepare a recommended practice for state DOTs to incorporate these results in specifications and criteria for
  - quality assurance,
  - mix design verification or validation, and
  - structural design and forensic studies

NCHRP Project 9-48 Methodology

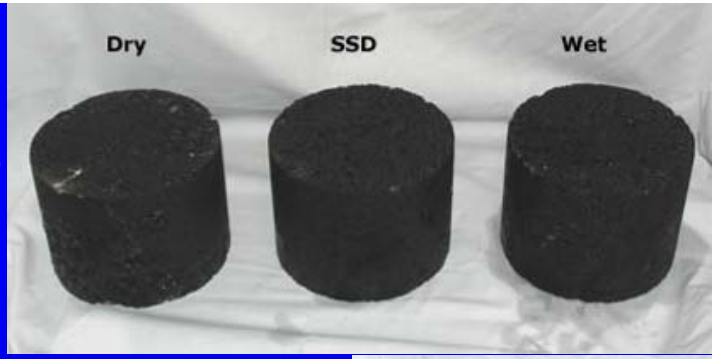
- Quantify the differences
  - Delta (Δ) between PL, LL, and PF
  - Quantitative measure of between-specimen variability
  - Determine the effects of selected process-based factors
    - on between-specimen variability
- Quantify levels of variability
  - standard deviation
  - Quantitative measure of within-specimen variability
  - LL, PL, and PF specimens

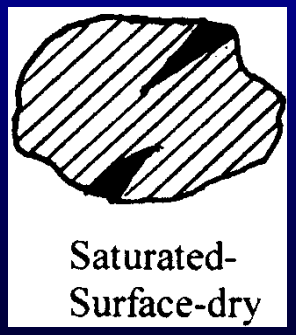
Experimental Factorial Design Process-based factors

- **Baghouse fines**
  - Two levels
  - With and without
- **Mixture re-heating**
  - Two levels
  - time = 0, and time = ~ 3 days
- **Aggregate absorption**
  - Two levels of water absorption
  - low ~ 1% and high ~ 4 to 5%
- **Aggregate Degradation**
  - Two levels
  - soft or hard aggregates
- **Aggregate Moisture**
  - Two levels
  - Dry and wet stockpiles (2 and 9% moisture content)

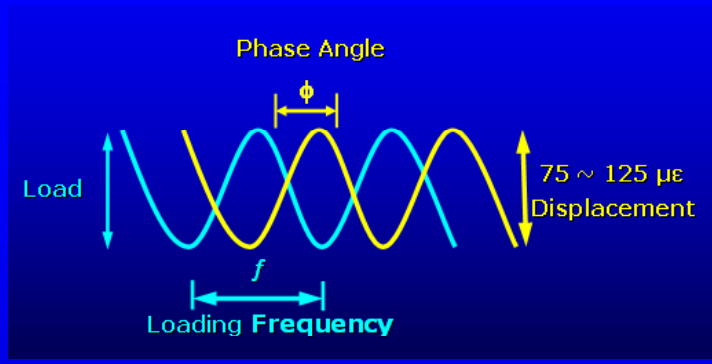
NCHRP Project 9-48
Physical and Volumetrics

- Aggregate gradation
- Aggregate bulk specific gravity
- Mixture bulk specific gravity
- Mixture maximum specific gravity
- Asphalt content
- Voids in the total mixture
- Voids in the mineral aggregate
- Dust/ Asphalt Ratio

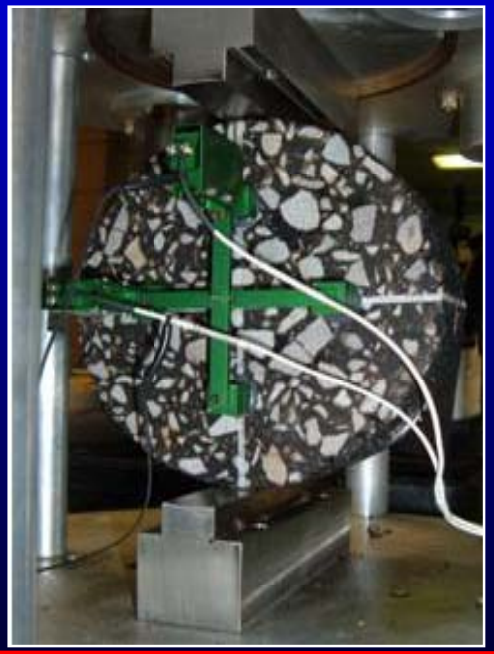




NCHRP Project 9-48
Mechanistic Properties



- Hamburg Loaded Wheel Test
- Axial Dynamic Modulus Test
- Indirect Dynamic Modulus Test



NCHRP Project 9-48
Partial Test Factorial

Mixture ID	Baghouse Fines	Reheating	Aggregate Absorption	Aggregate Degradation	Aggregate Moisture Content
Mix 1	No	No	Low	Soft	High
Mix 2	No	No	High	Hard	Low
Mix 3	No	Yes	Low	Hard	Low
Mix 4	No	Yes	High	Soft	High
Mix 5	Yes	No	Low	Hard	High
Mix 6	Yes	No	High	Soft	Low
Mix 7	Yes	Yes	Low	Soft	Low
Mix 8	Yes	Yes	High	Hard	High

NCHRP Project 9-48
Field versus Laboratory Volumetrics and Mechanical Properties

Need Volunteers

Louaym@Lsu.Edu

Laboratory Mixed
Laboratory Compacted
(LL)

Plant Mixed
Laboratory Compacted
(PL)

Plant Mixed
Field Compacted
(PF)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THANK YOU