Evaluation of J_{nr} Criterion for Unmodified Asphalt Binders

Mike Anderson

Asphalt Binder Expert Task Group Meeting
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Minneapolis, MN

Acknowledgments

- DTFH61-08-H-00030
  - Cooperative Agreement between the FHWA and the Asphalt Institute
  - John Bukowski, AOTR
- DTFH61-11-H-00033
  - Cooperative Agreement between the FHWA and the Asphalt Institute
  - Michael Arasteh, AOTR
- Member Companies of the Asphalt Institute
  - Technical Advisory Committee

Evaluation of Straight run binders

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Sample ID	Name	Grade	true grade	Temp	Jnr 3.2kPa
ALF 6727	Control	70-22	72.7-74.2	72.7	4.39
BBRS3	straight	64-22	66.1-27.3	66.1	4.18
MN county rd 112	neat Valero	58-28	60.8-33.4	60.8	3.68
MN county rd 112	neat Citgo	58-28	59.5-29.8	59.5	5.30
MN county rd 112	AshlandM	58-28	60.7-31.4	60.7	4.30
Minn Road	straight	58-28	61.8-30.8	61.8	3.03
Miss I-55	CSL	67-22	68.3-25.1	68.3	2.67
Shandong	straight	64-22	64.4-23.5	64.4	4.44
BBRS3	straight	70-22	71.4-24.8	71.4	4.81
BBRS3	straight	58-28	61.3-30	61.3	4.00
MD project	straight	64-28	64.8-29.6	64.8	4.59
average					4.13

U.S. Department of Transportation
Federal Highway Administration

Unmodified Asphalt Binders: Source A

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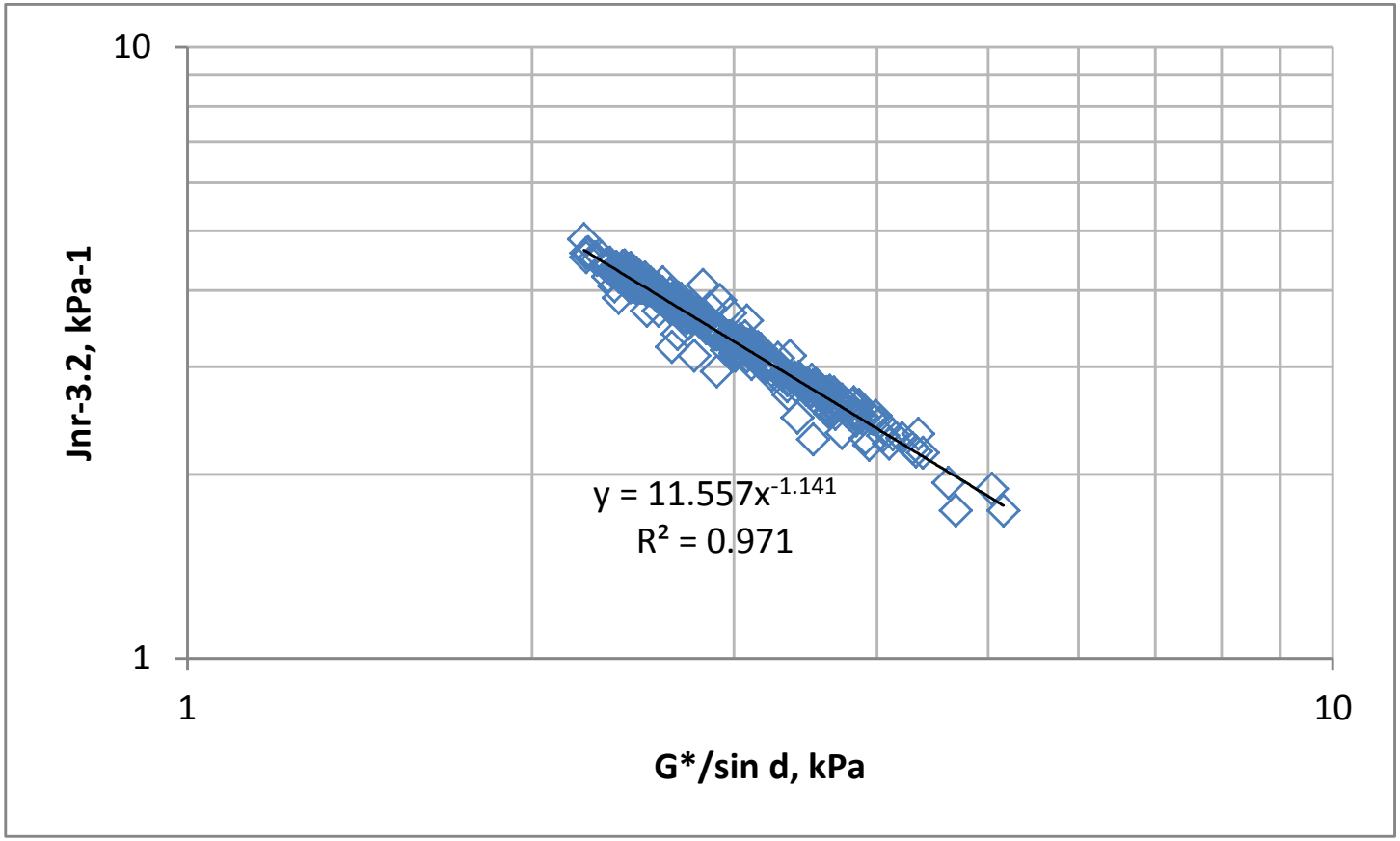

A	11.557
B	-1.141
G*/sin d	2.2
Jnr-3.2	4.700
Jnr-3.2	4
G*/sin d	2.53

Unmodified Asphalt Binders: AI MSCR Database

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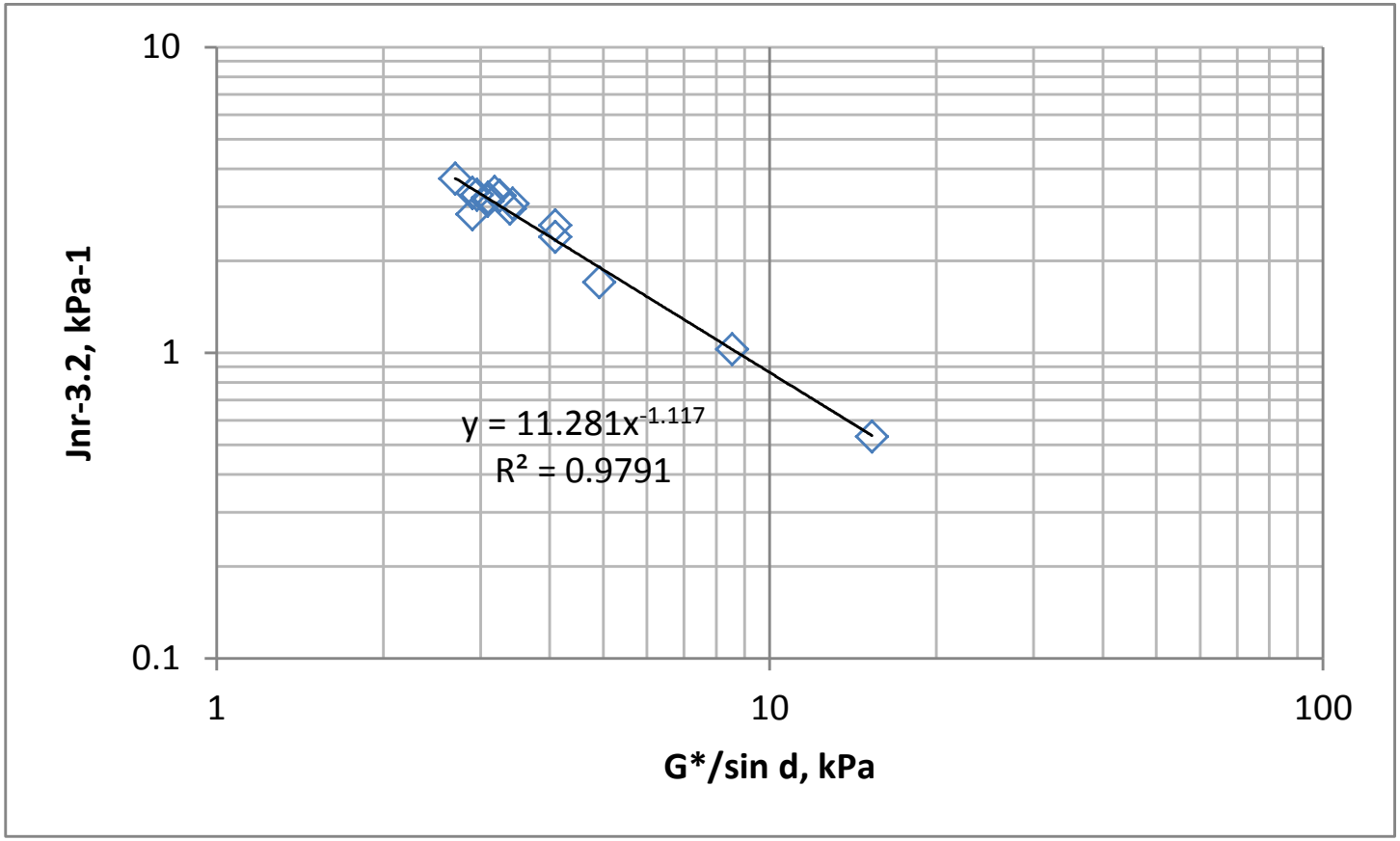

A	11.281
B	-1.117
G*/sin δ	2.2
Jnr-3.2	4.676
Jnr-3.2	4
G*/sin δ	2.53

Summary

- Criterion for unmodified asphalt binders may need to change?
  - J_{nr} = 4.00 kPa^{-1} equates to G*/sin δ value of 2.53 kPa
  - Could be problem for some unmodified asphalt binders
- If “S” grade criterion changes, do we change criterion for other AASHTO MP19 grades?

MRL Asphalt Binders
Comparison of Jnr and G*/sin δ

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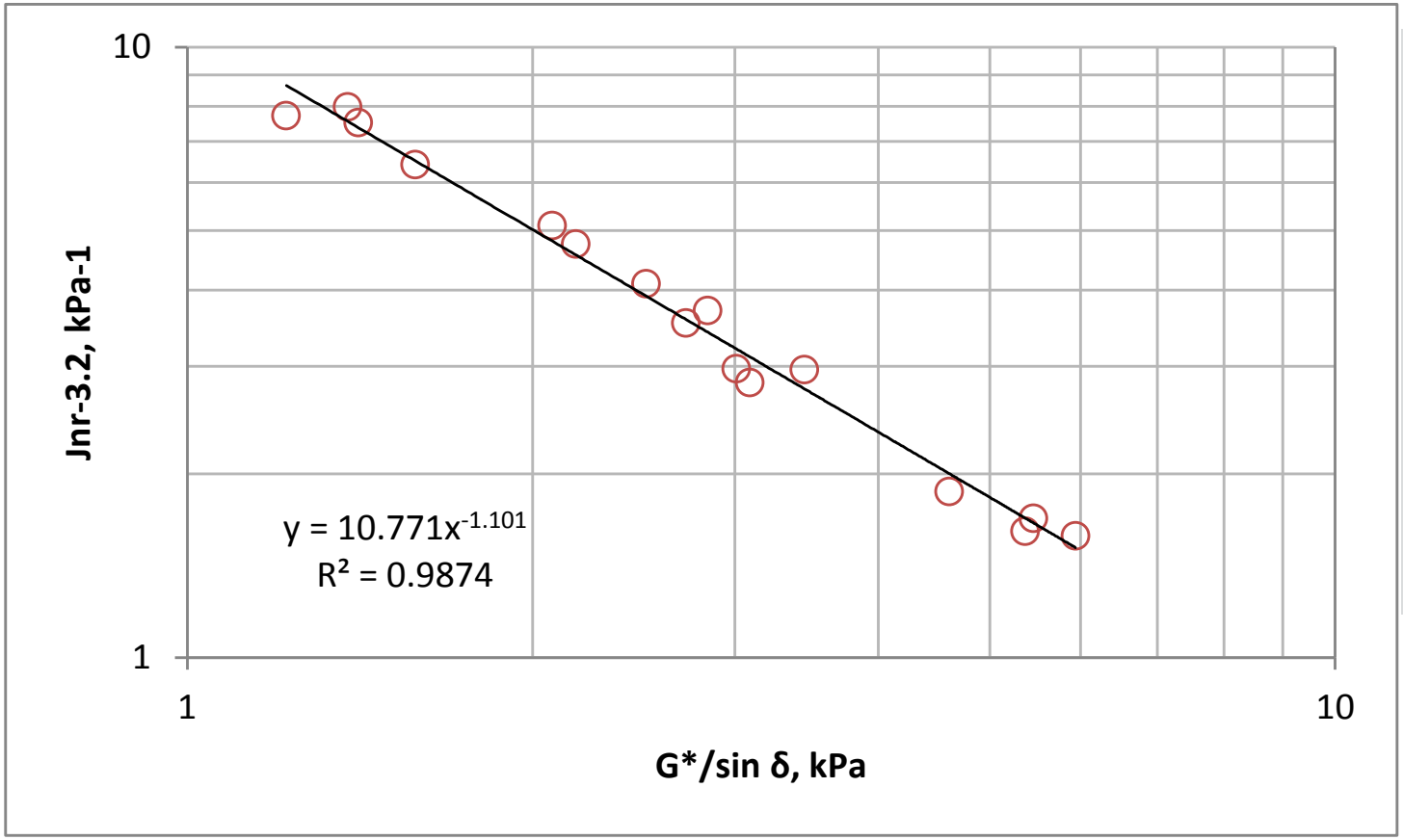
	AAA	AAB	AAC	AAD	AAF	AAG	AAK	AAM
MSCR Jnr-3.2, kPa^{-1}								
58°C	2.97	1.87	2.82	1.61		1.69		
64°C	7.52	5.10	7.98	4.09	3.70	4.75	1.58	2.96
70°C					7.71		3.53	6.41
RTFO DSR G*/sin δ, kPa								
58°C	3.01	4.61	3.09	5.37		5.46		
64°C	1.41	2.08	1.38	2.51	2.84	2.18		3.45
70°C				1.20	1.22		2.72	1.58
T_c, Jnr-3.2 = 4.0 kPa^{-1}	59.9	62.5	60.0	63.9	64.6	63.0	70.9	66.3
T_c, G*/sinδ =2.20 kPa	60.5	63.6	60.5	65.1	65.8	63.9	71.8	67.5

MRL Asphalt Binders



A	10.771
B	-1.101
G*/sin δ	2.2
Jnr-3.2	4.521
Jnr-3.2	4
G*/sin δ	2.46

Unmodified Asphalt Binders: AI MSCR Database

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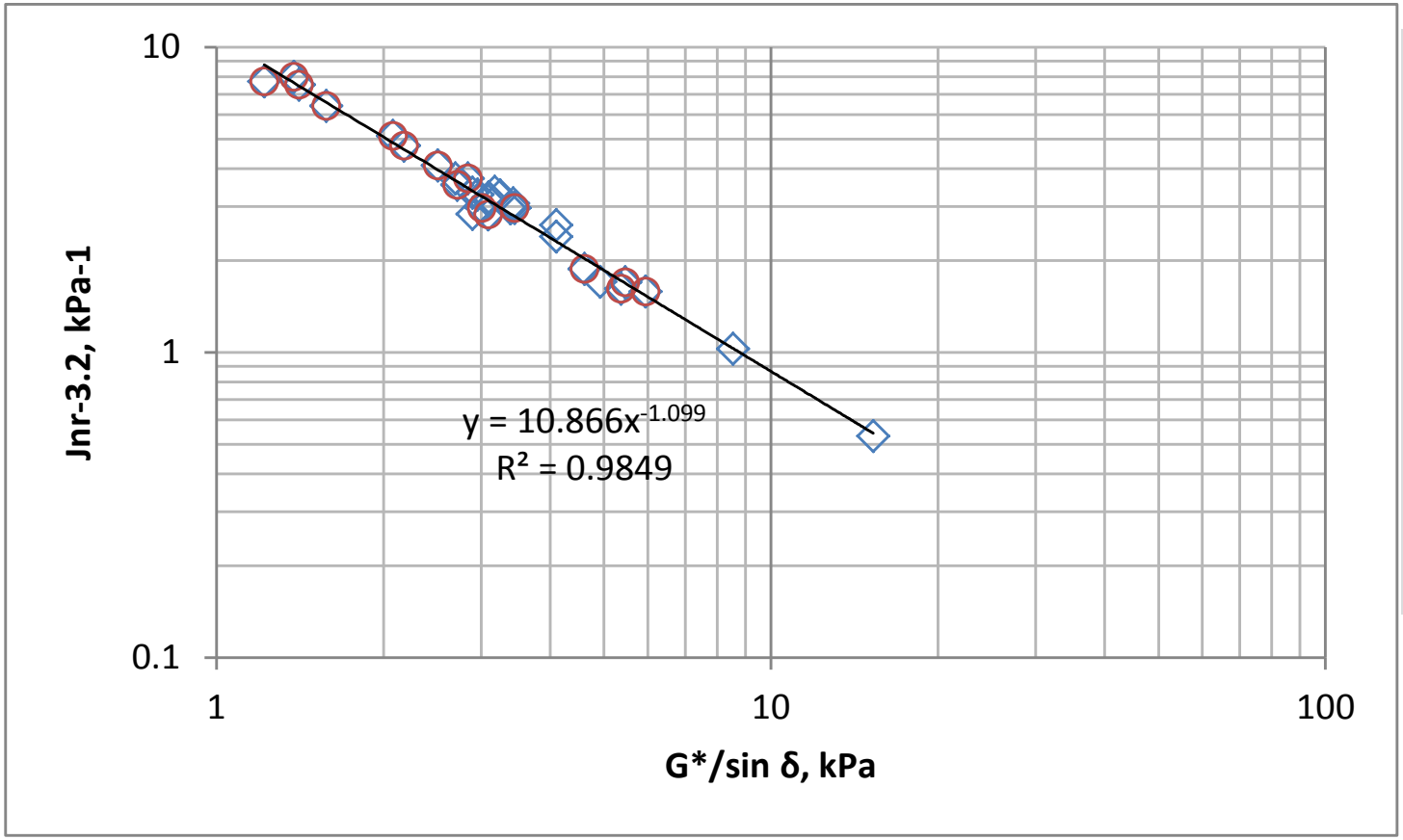
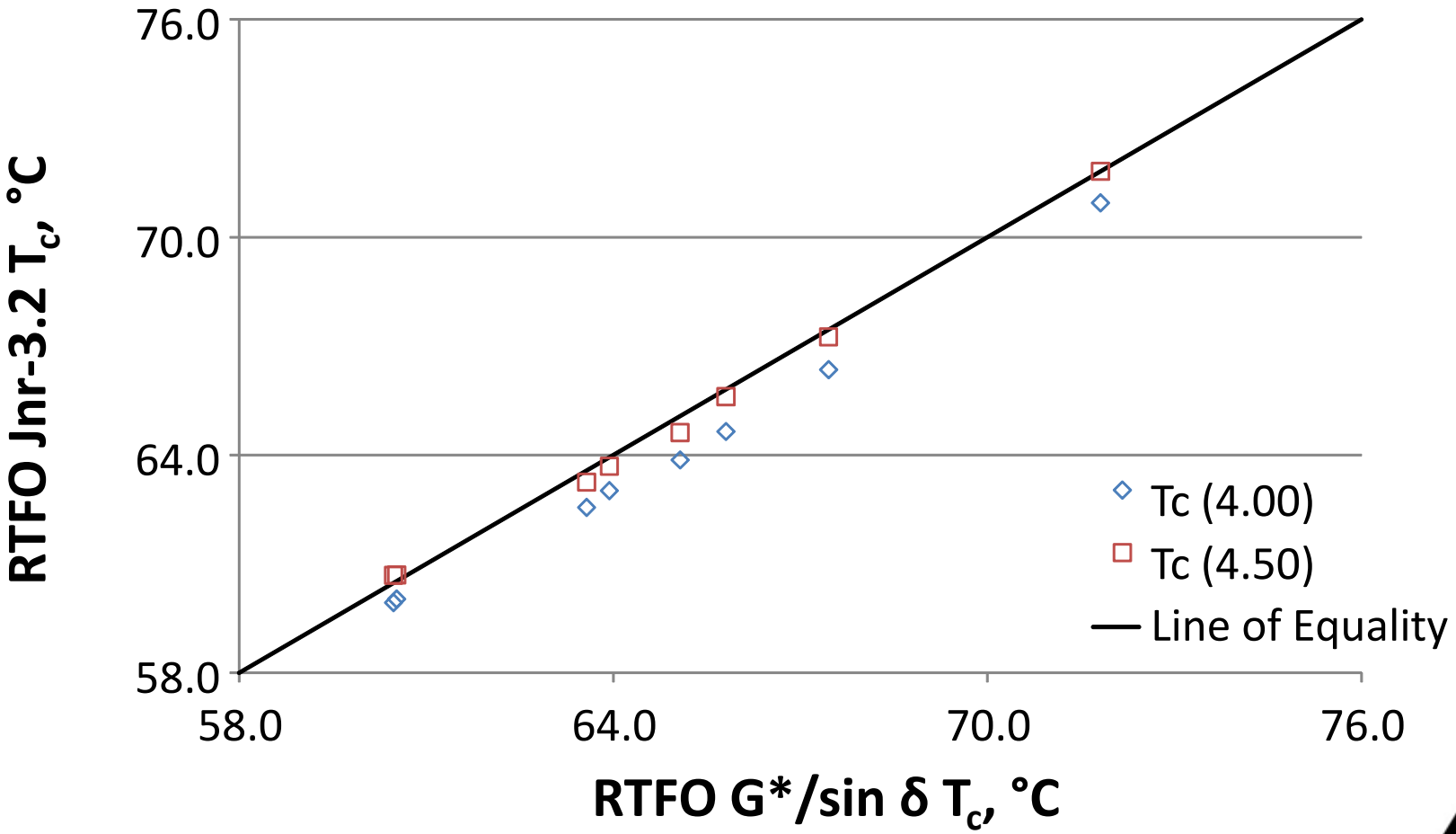


A	10.866
B	-1.099
G*/sin δ	2.2
Jnr-3.2	4.568
Jnr-3.2	4
G*/sin δ	2.48

MRL Asphalt Binders



TAC Evaluation of SHRP MRL Asphalt Binders

- Purpose
  - (1) to provide additional data to the Asphalt Binder Expert Task Group (ETG) to evaluate if the 4.0 kPa^{-1} criterion for unmodified asphalt binders (“S” grades in AASHTO MP19) needs to be changed; and
  - (2) to evaluate if there is a bias in MSCR results dependent on DSR manufacturer

TAC Evaluation of SHRP MRL Asphalt Binders

- Task Force formed at TAC Meeting in April 2012 (Baltimore)
  - Seven Labs
    - PRI Asphalt Technologies
    - Asphalt Technologies Group (Meigs)
    - Jebro **(2)**
    - Flint Hills Resources
    - MTE **(3)**
    - FHWA **(2)**
    - Asphalt Institute

TAC Evaluation of SHRP MRL Asphalt Binders

- 11 Dynamic Shear Rheometers
  - Anton Paar
    - Smartpave **(5)**
  - TA Instruments
    - AR-2000 **(3)**
    - AR-G2 **(1)**
    - DHR-3 **(1)**
  - Malvern
    - Kinexus **(1)**

TAC Evaluation of SHRP MRL Asphalt Binders

- SHRP MRL Asphalt Binders
  - AAA Lloydminster 150/200 (PG 58-28)
  - AAB WY Sour AC-10 (PG 58-22)
  - AAC Redwater AC-8 (PG 58-16)
  - AAD CA Coastal AR-4000 (PG 58-28)
  - AAF West TX Sour AC-20 (PG 64-10)
  - AAG CA Valley AR-4000 (PG 58-10)
  - AAK Boscan AC-30 (PG 64-22)
  - AAM West TX Intermediate AC-20 (PG 64-16)

TAC Evaluation of SHRP MRL Asphalt Binders

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- Test Temperatures
  - AAA, AAB, AAC, AAD, AAG
    - 58, 64C
  - AAF, AAK, AAM
    - 64, 70C
- AASHTO T315
  - G*/sin δ
  - T_c (where G*/sin δ = 2.20 kPa)
  - G*/sin δ @ $T_{c,Jnr-3.2}$
- AASHTO TP70
  - Jnr-3.2
  - T_c (where Jnr-3.2 = 4.00 kPa^{-1})
  - Jnr-3.2 @ $T_{c,G*/sin\ \delta}$

TAC Evaluation of SHRP MRL Asphalt Binders

- Labs receive 3 tins (1-oz) of RTFO-aged binder
  - 6 of 8 asphalt binders received
  - Resulted in 6-9 evaluations of each MRL asphalt binder
- Use one tin for TP70 at each temperature
  - Do not reheat sample
- Use one tin for T315 at both temperatures
  - Alternatively, pour sample and run T315 followed by TP70 at one temperature

Data

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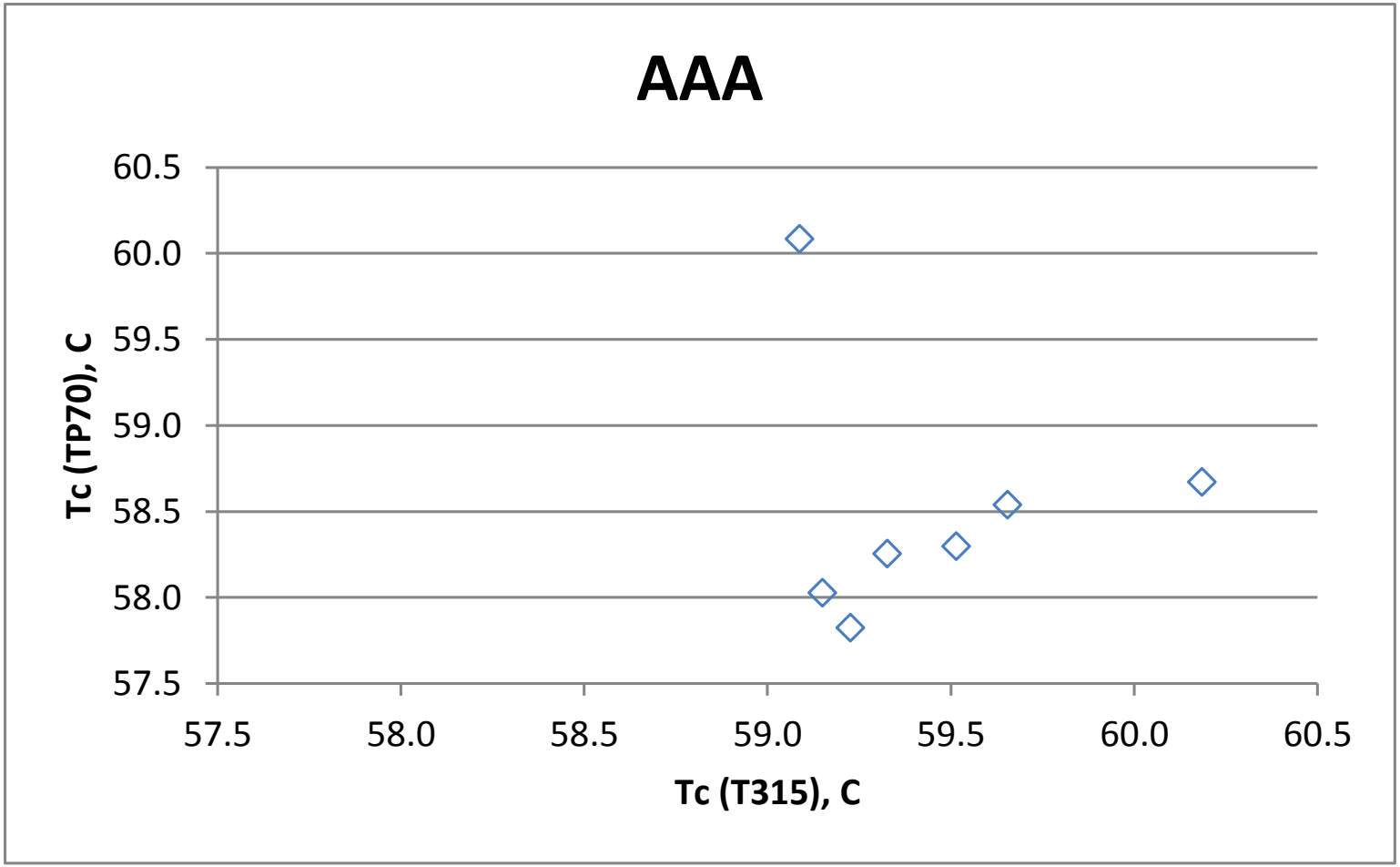
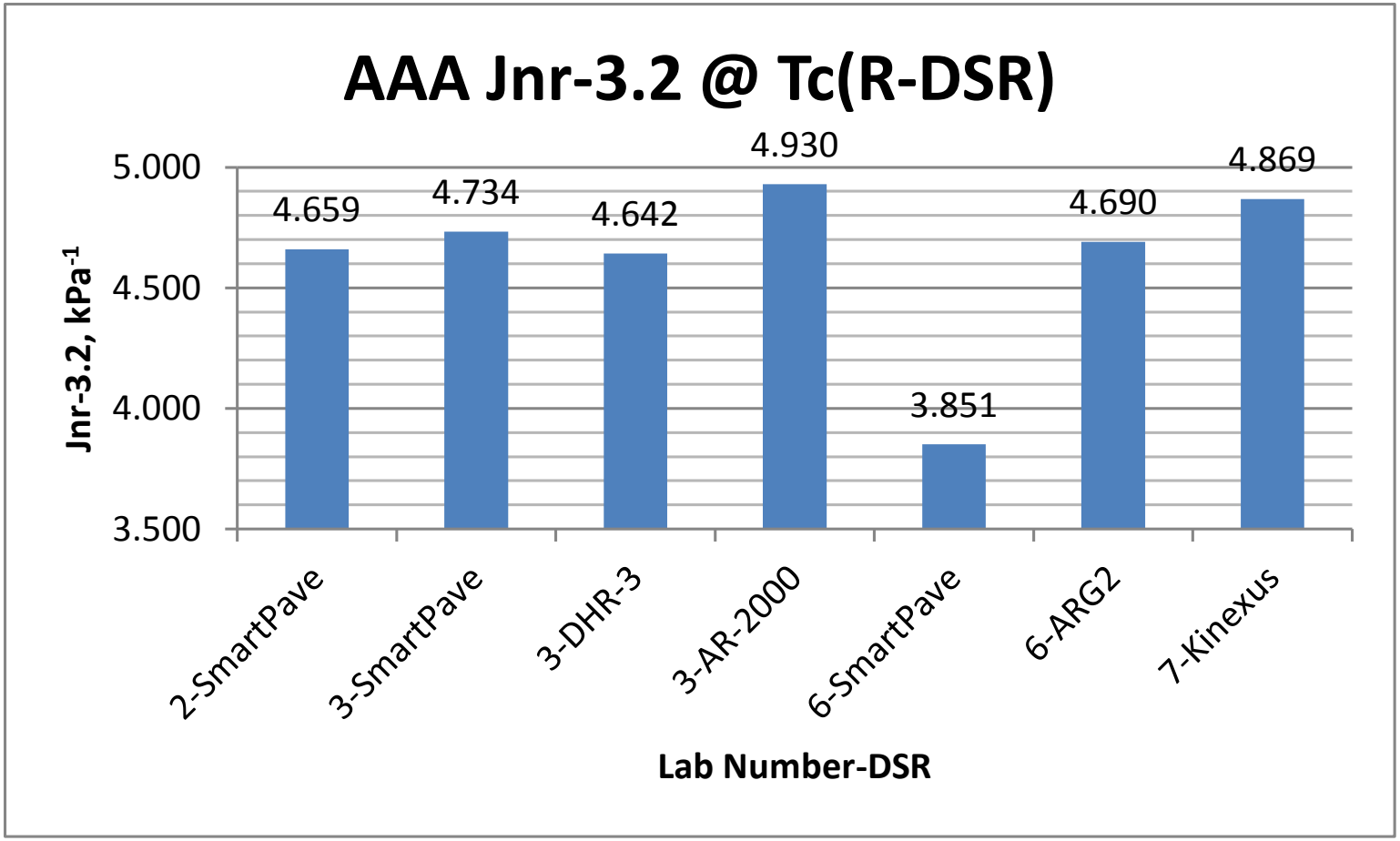
				1-AR2000	2-SmartPa	3-SmartPa	3-DHR-3	3-AR-2000	4-TA	4-SmartPa
AAC	G*/sin δ		58	3.26	2.35	3.19	3.20	3.34	2.88	3.06
			64	1.31	0.96	1.31	1.31	1.41	1.24	1.27
		Tc		60.6	58.4	60.5	60.5	60.9	59.9	60.3
	Jnr-3.2		58	3.399	4.310	3.488	3.467	3.298	3.632	3.479
			64	8.929	10.756	9.033	9.039	8.591	9.094	9.033
		Tc		59.0	57.5	58.9	58.9	59.2	58.6	58.9
		$T_{R\text{-}DSR}$		5.155	4.610	5.189	5.183	5.240	4.864	4.977
		$T_{Jnr\text{-}3.2}$		2.79	2.53	2.81	2.80	2.80	2.63	2.69

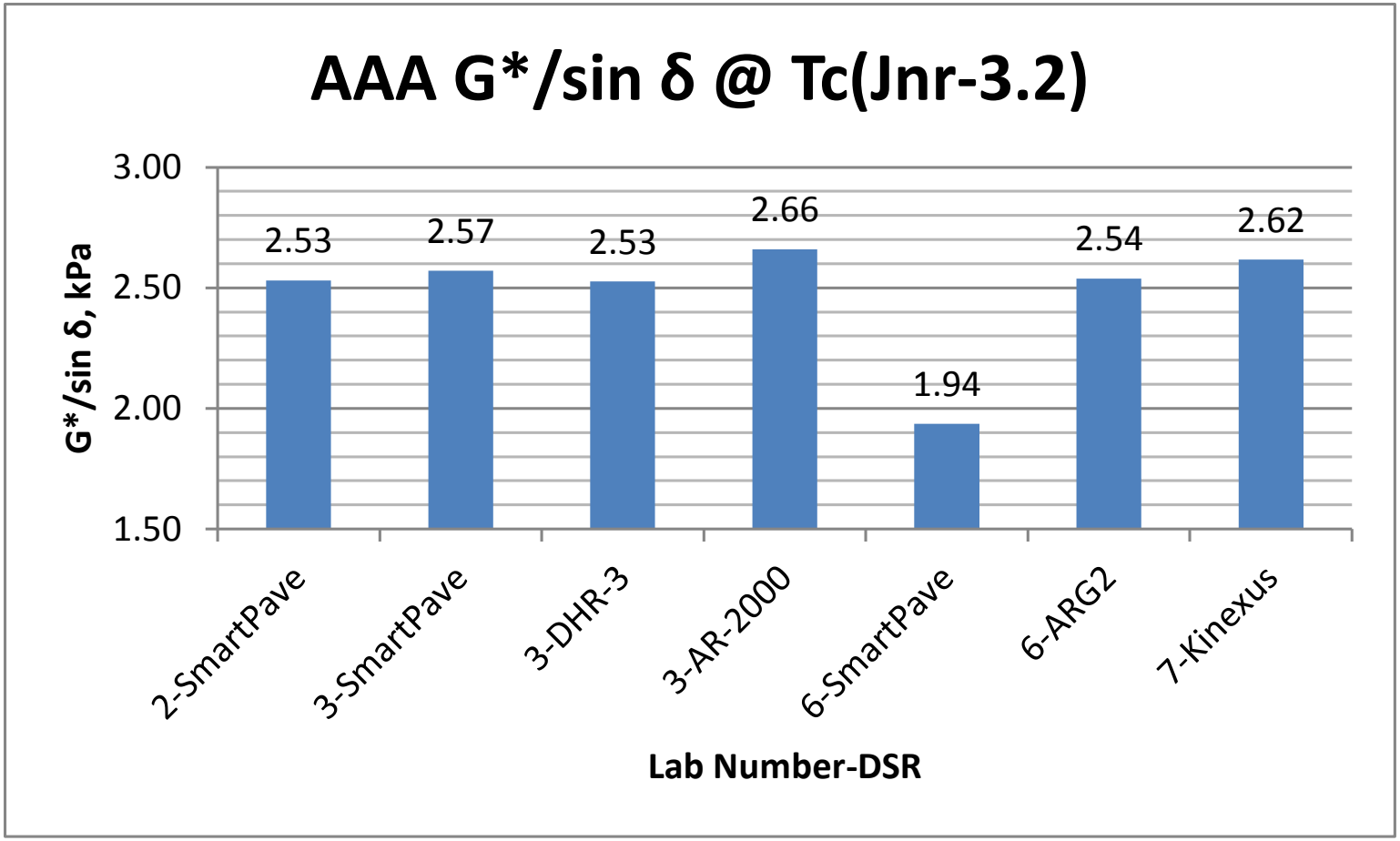
Comparison of T_c Determined by TP70 and T315: AAA



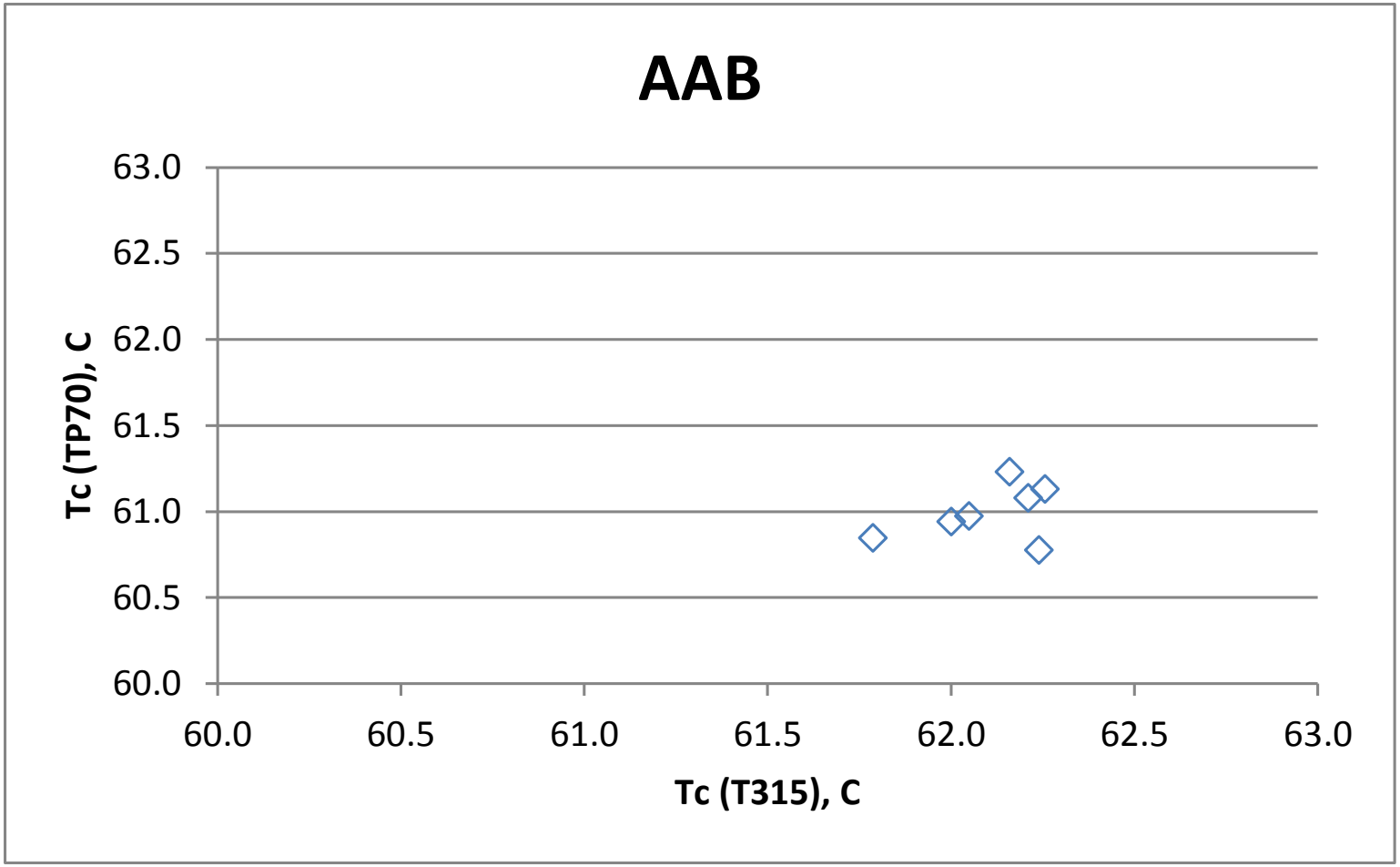
Jnr-3.2 Determined at T315 T_c: AAA



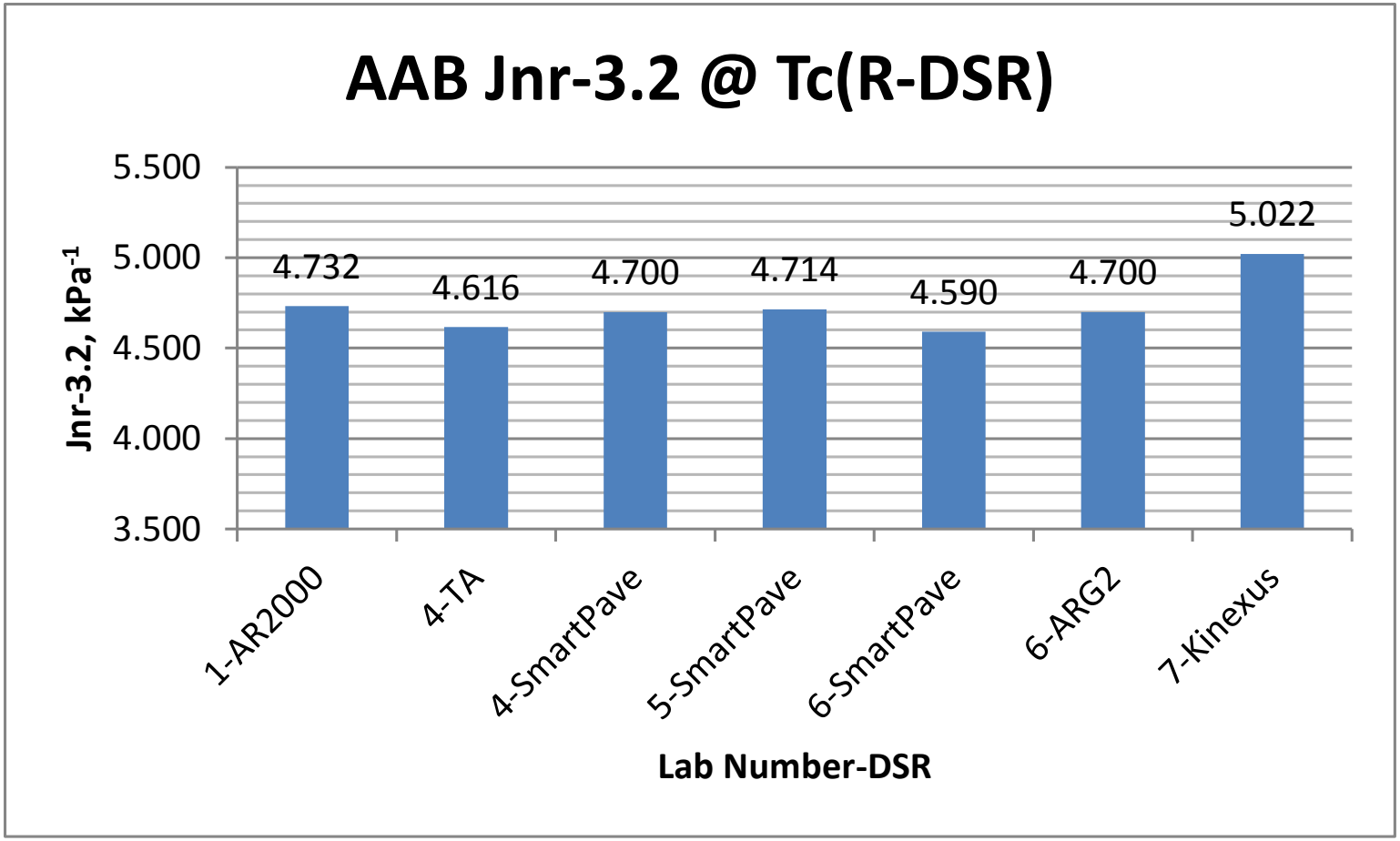
G*/sin δ Determined at TP70 T_c: AAA



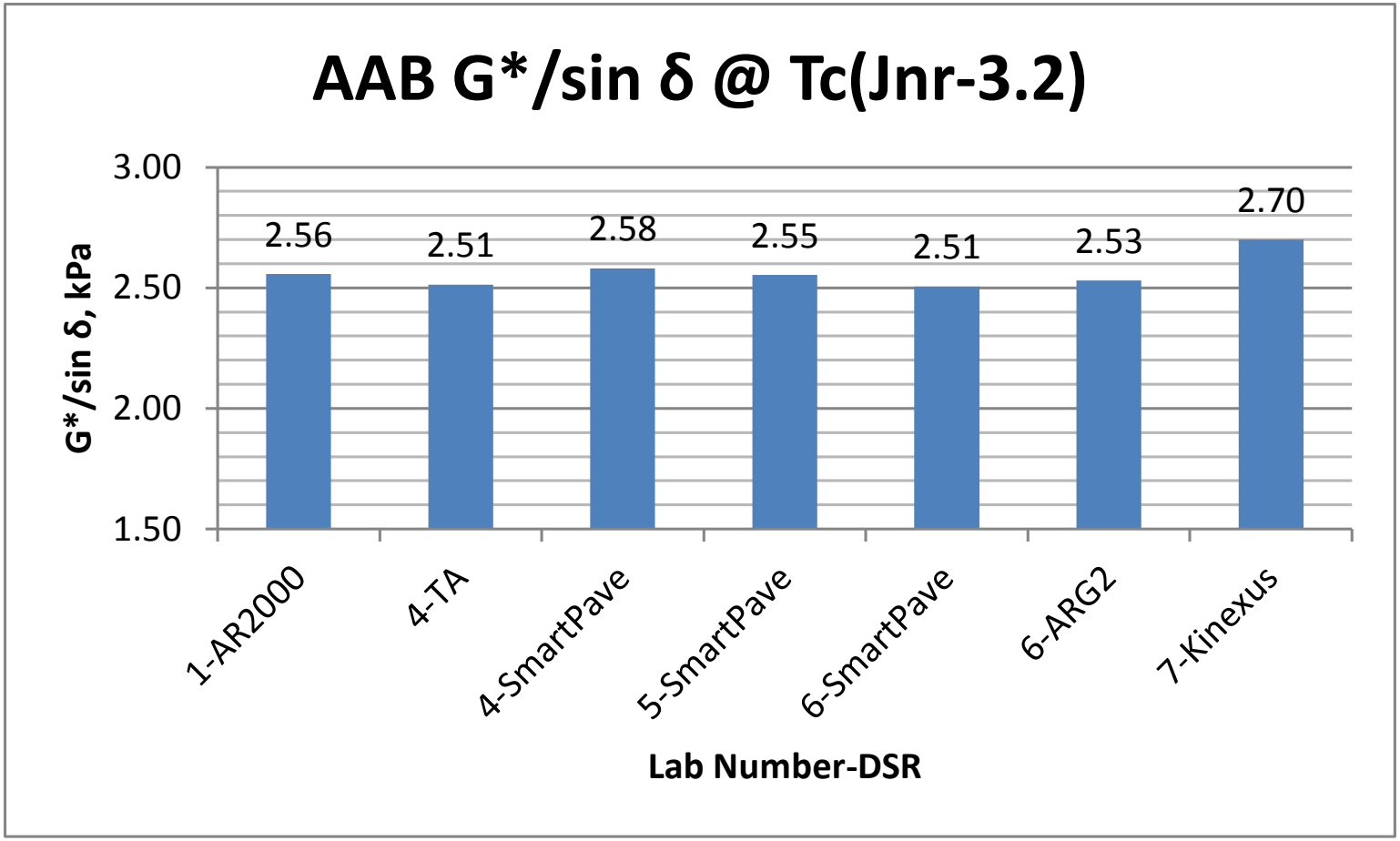
Comparison of T_c Determined by TP70 and T315: AAB



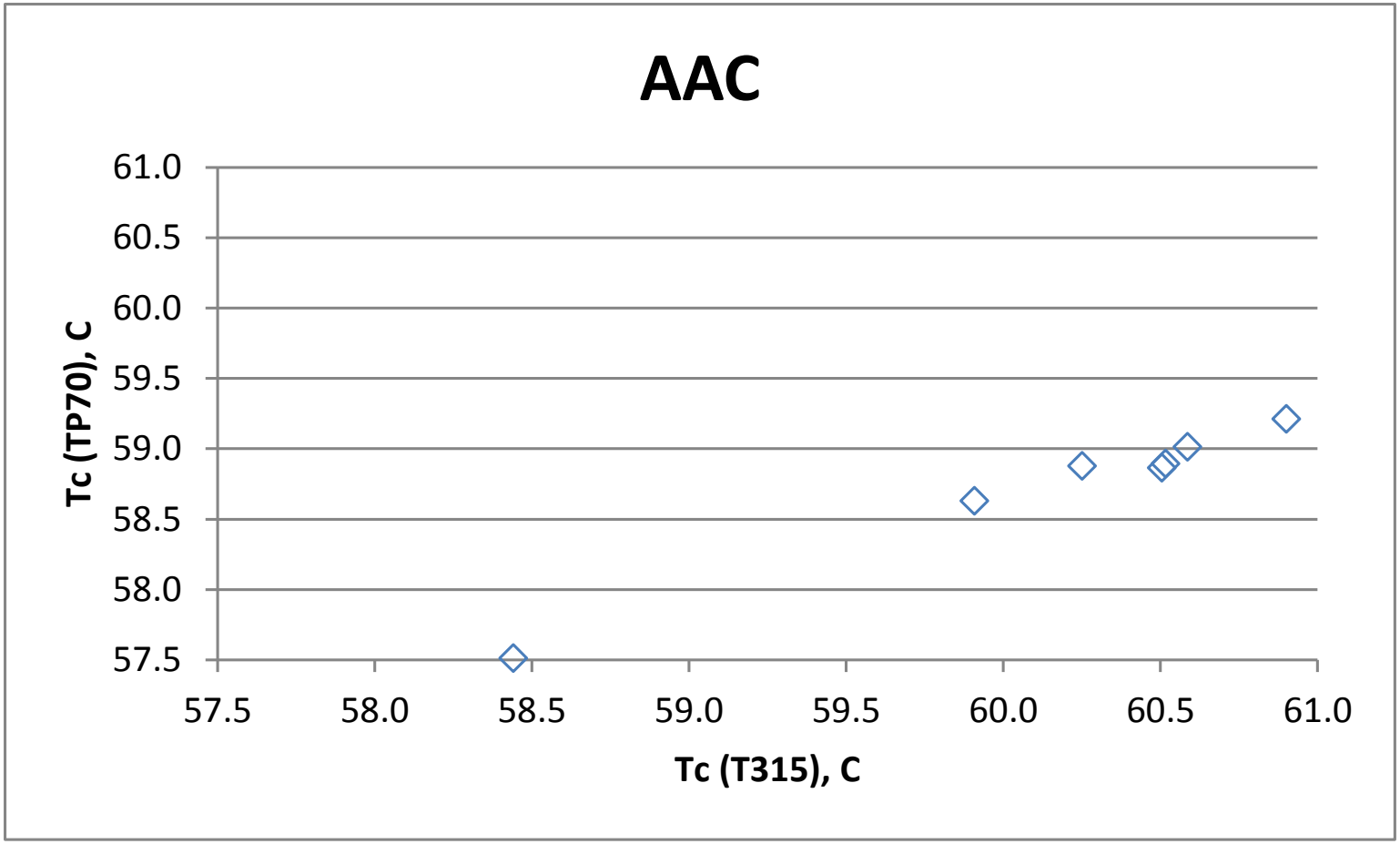
Jnr-3.2 Determined at T315 T_c: AAB



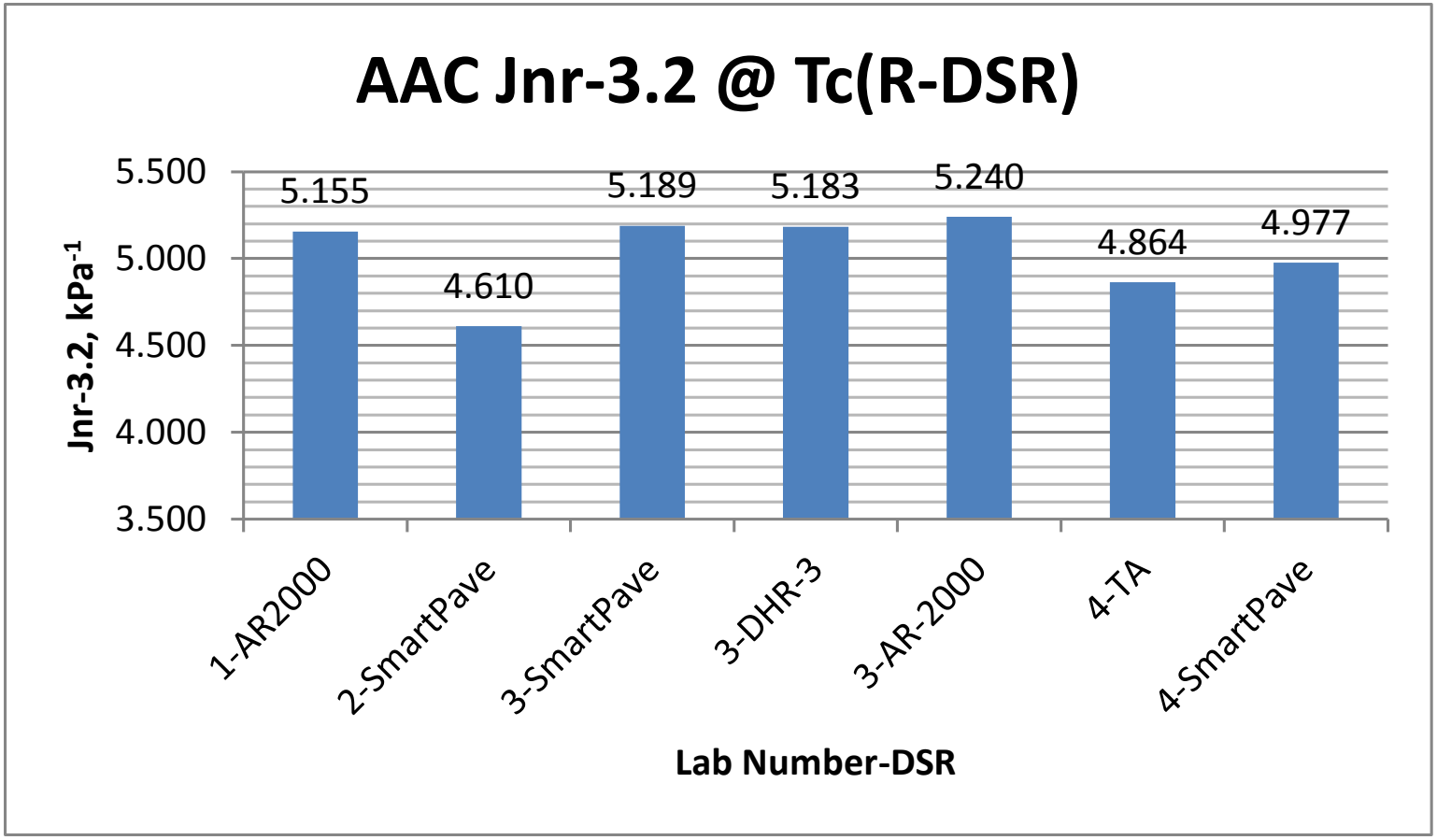
G*/sin δ Determined at TP70 T_c: AAB



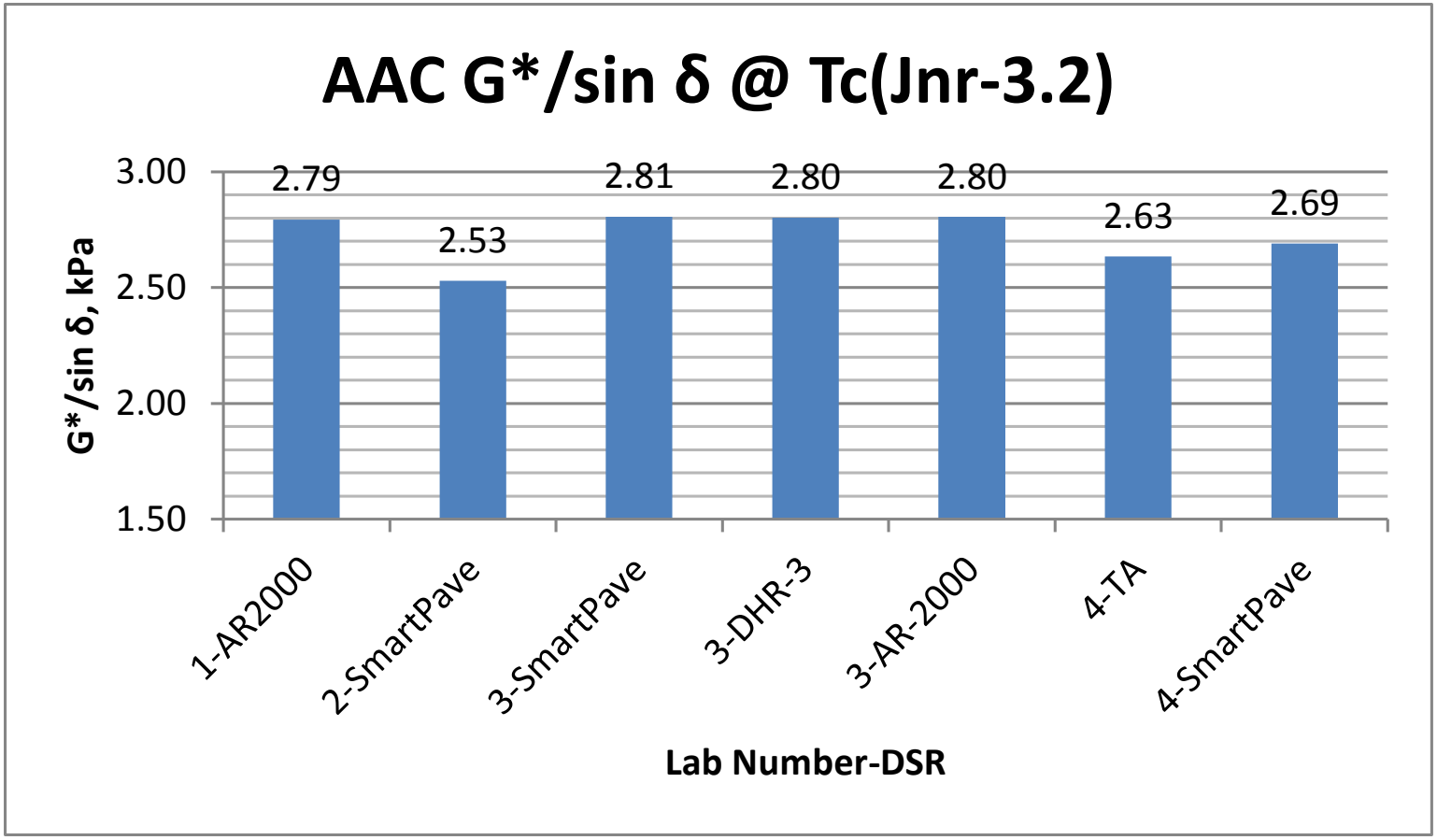
Comparison of T_c Determined by TP70 and T315: AAC



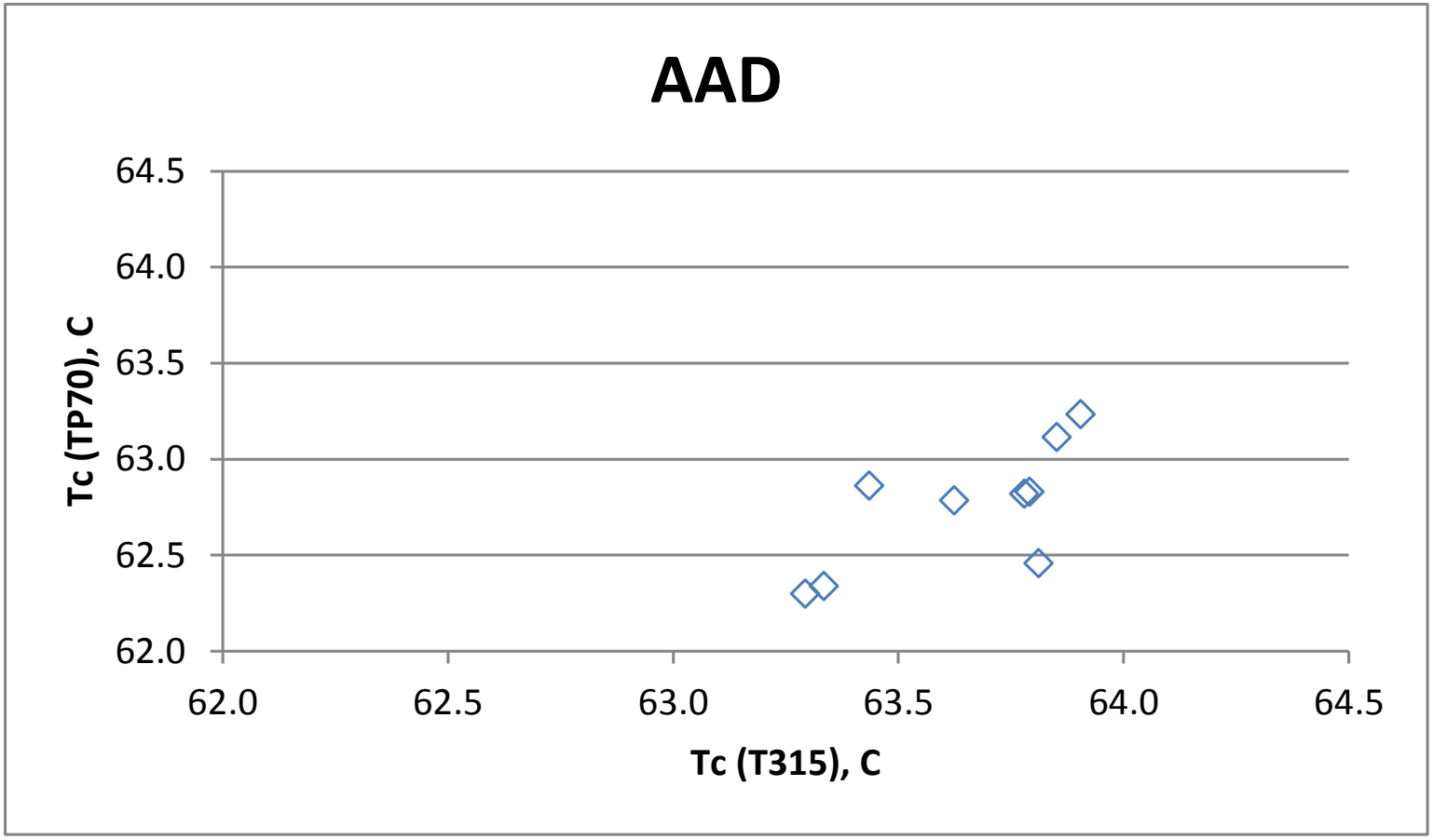
Jnr-3.2 Determined at T315 T_c: AAC



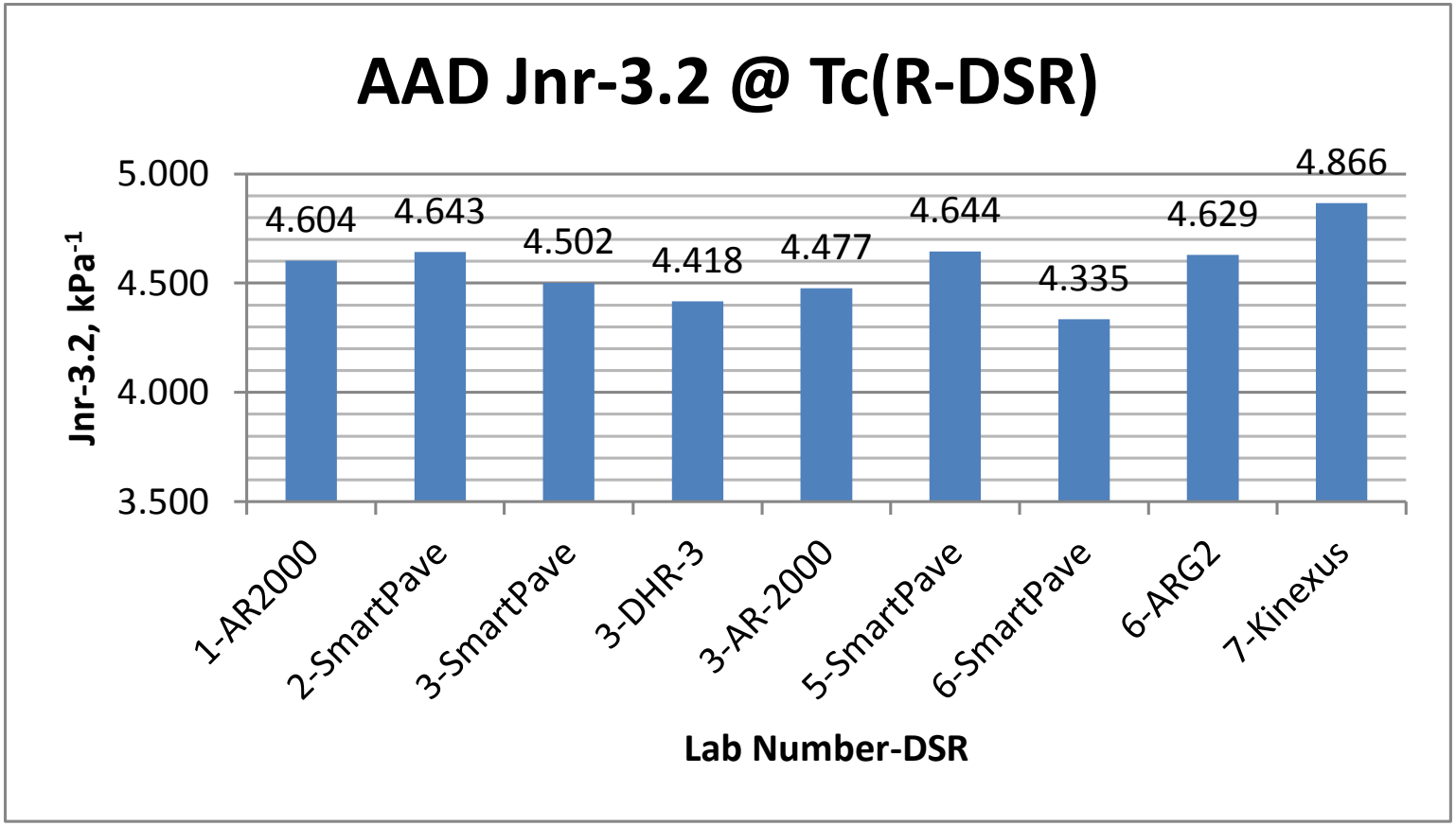
G*/sin δ Determined at TP70 T_c: AAC



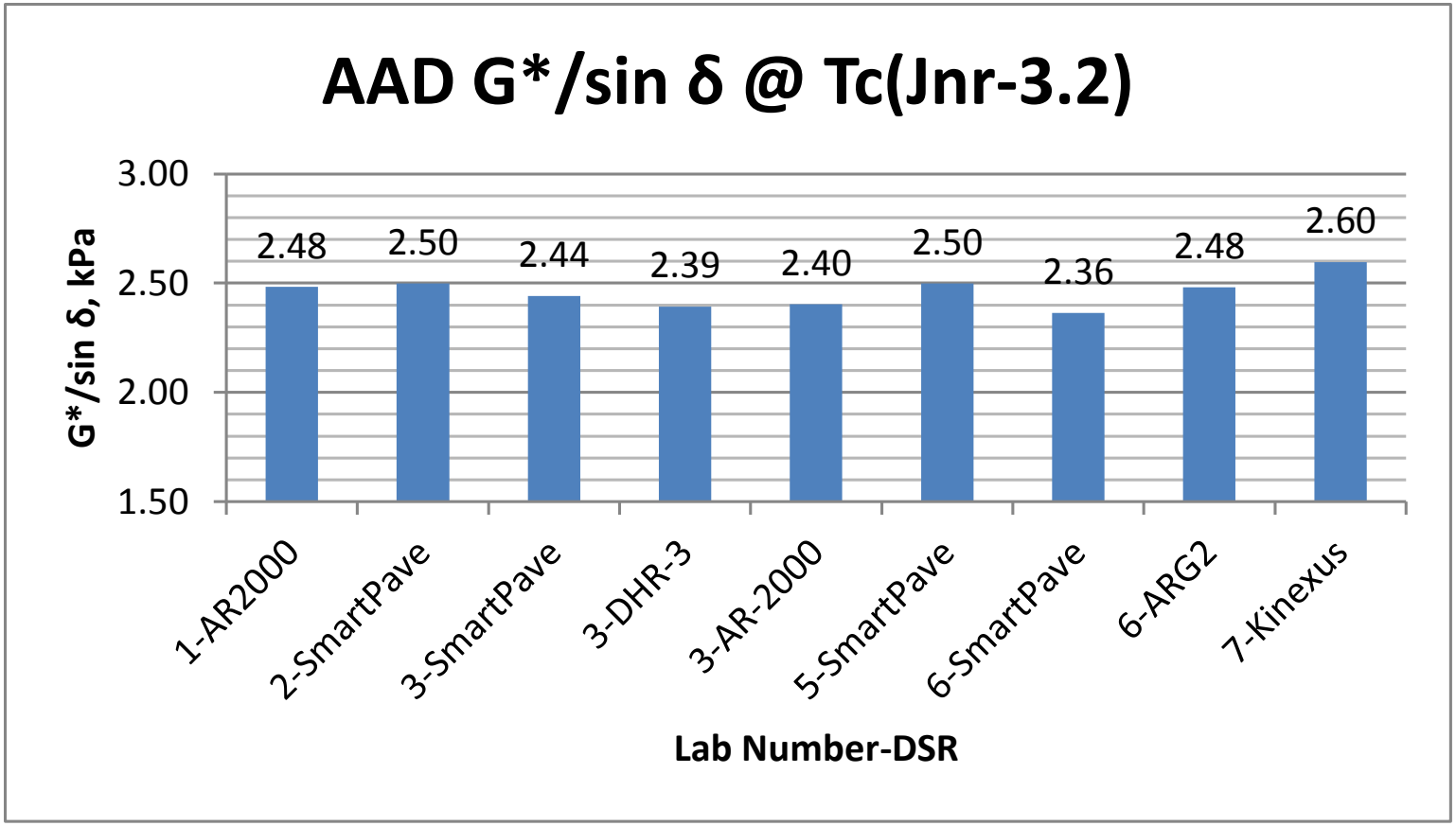
Comparison of T_c Determined by TP70 and T315: AAD



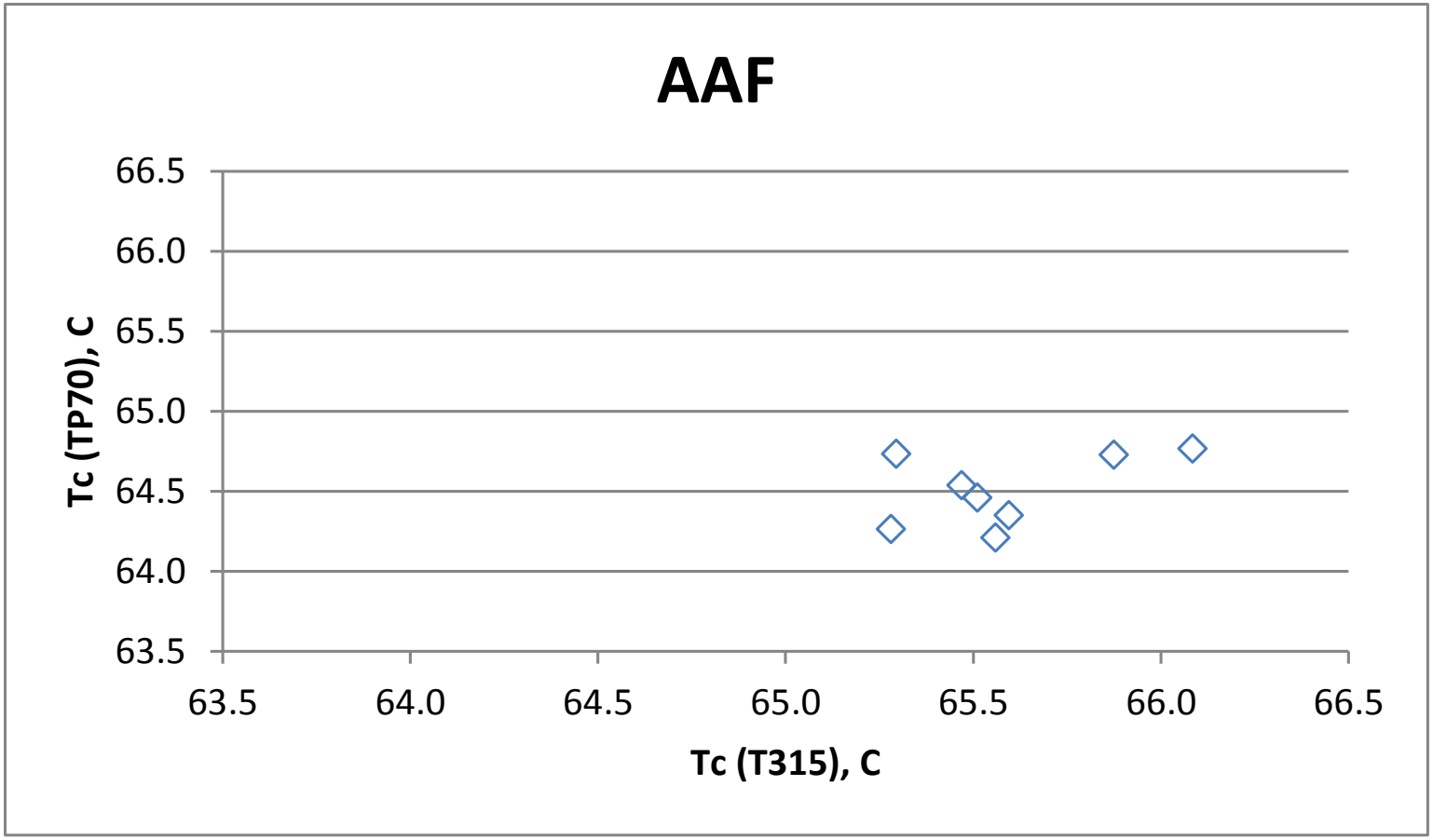
Jnr-3.2 Determined at T315 T_c: AAD



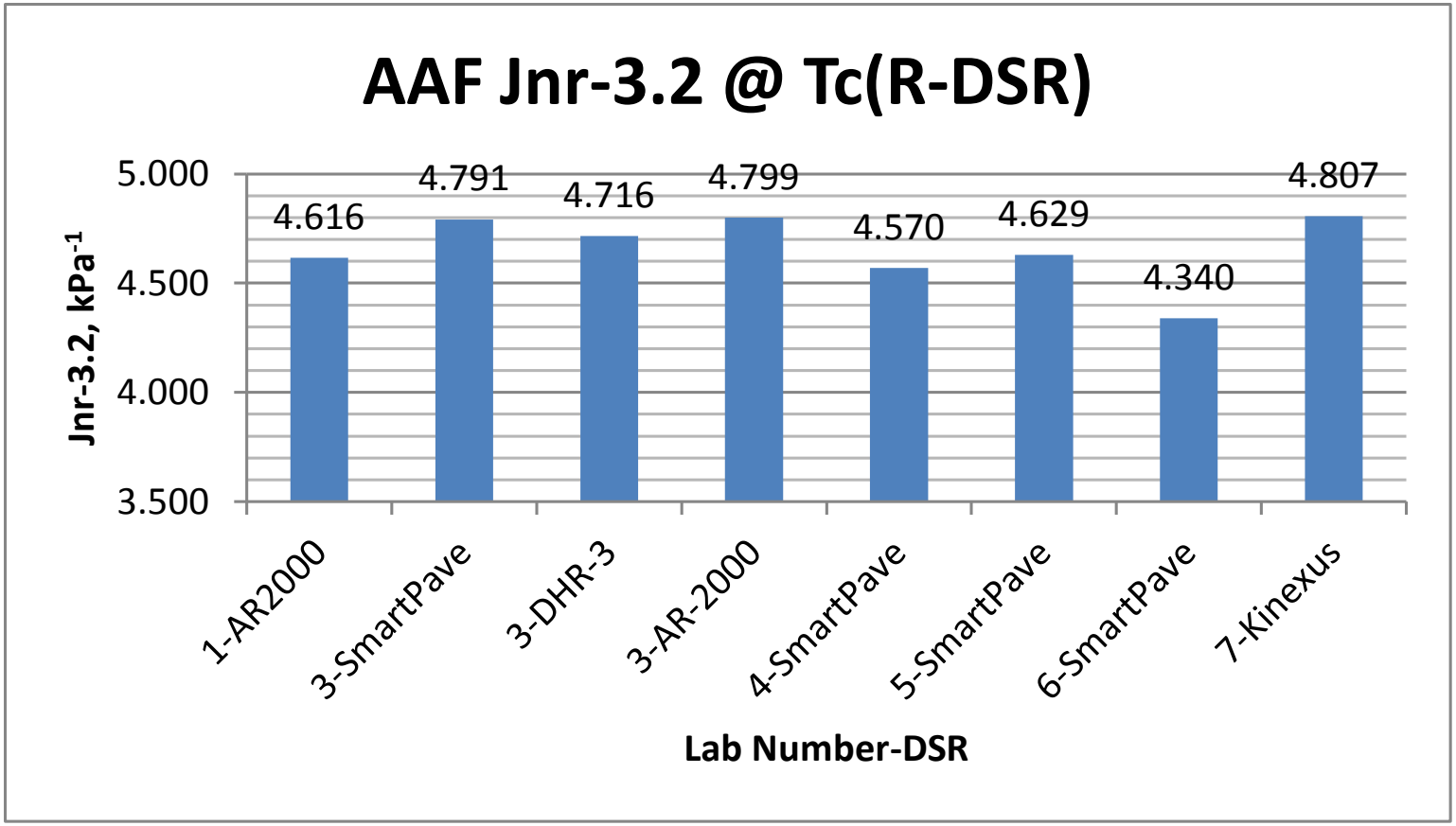
G*/sin δ Determined at TP70 T_c: AAD



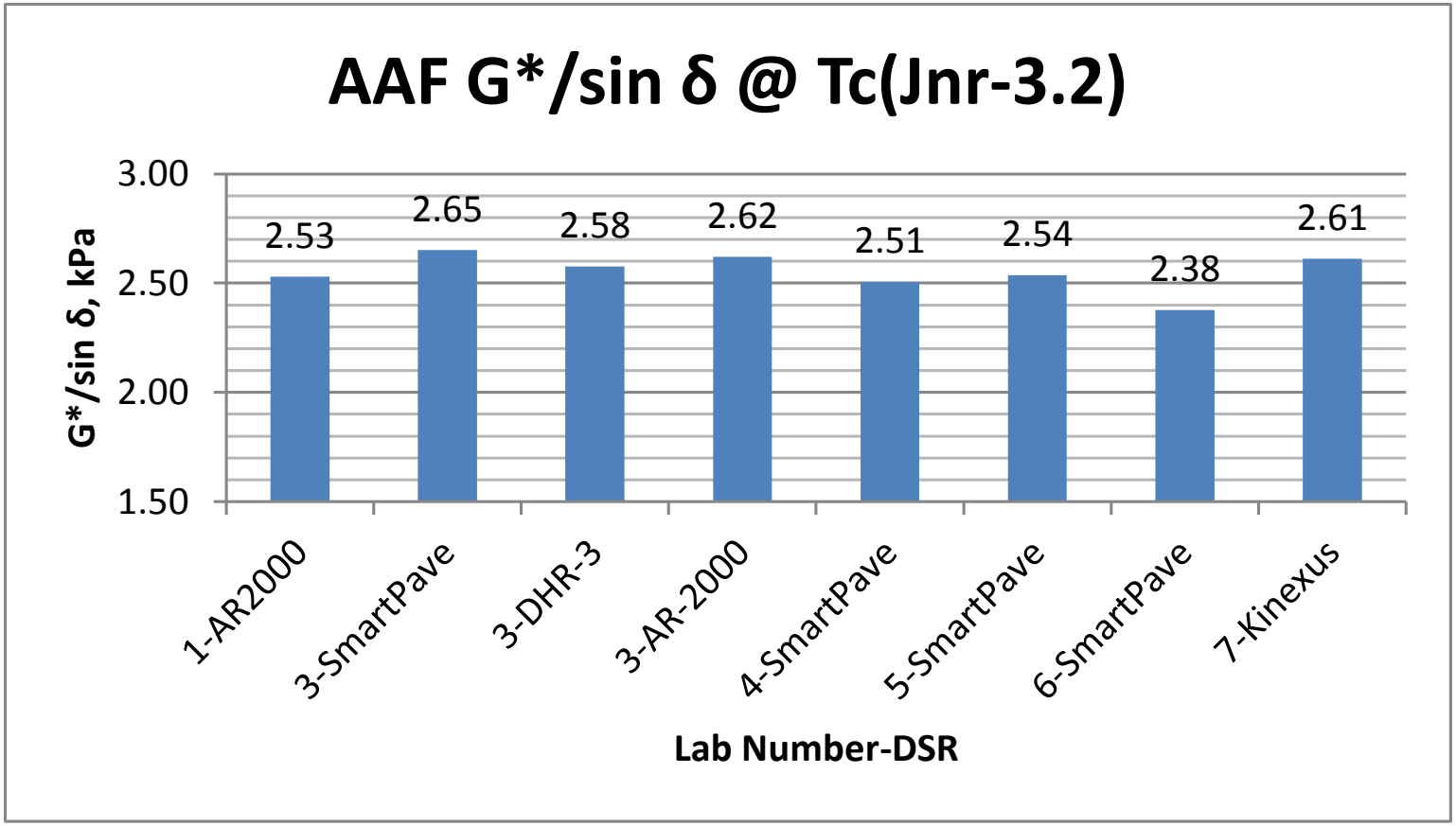
Comparison of T_c Determined by TP70 and T315: AAF



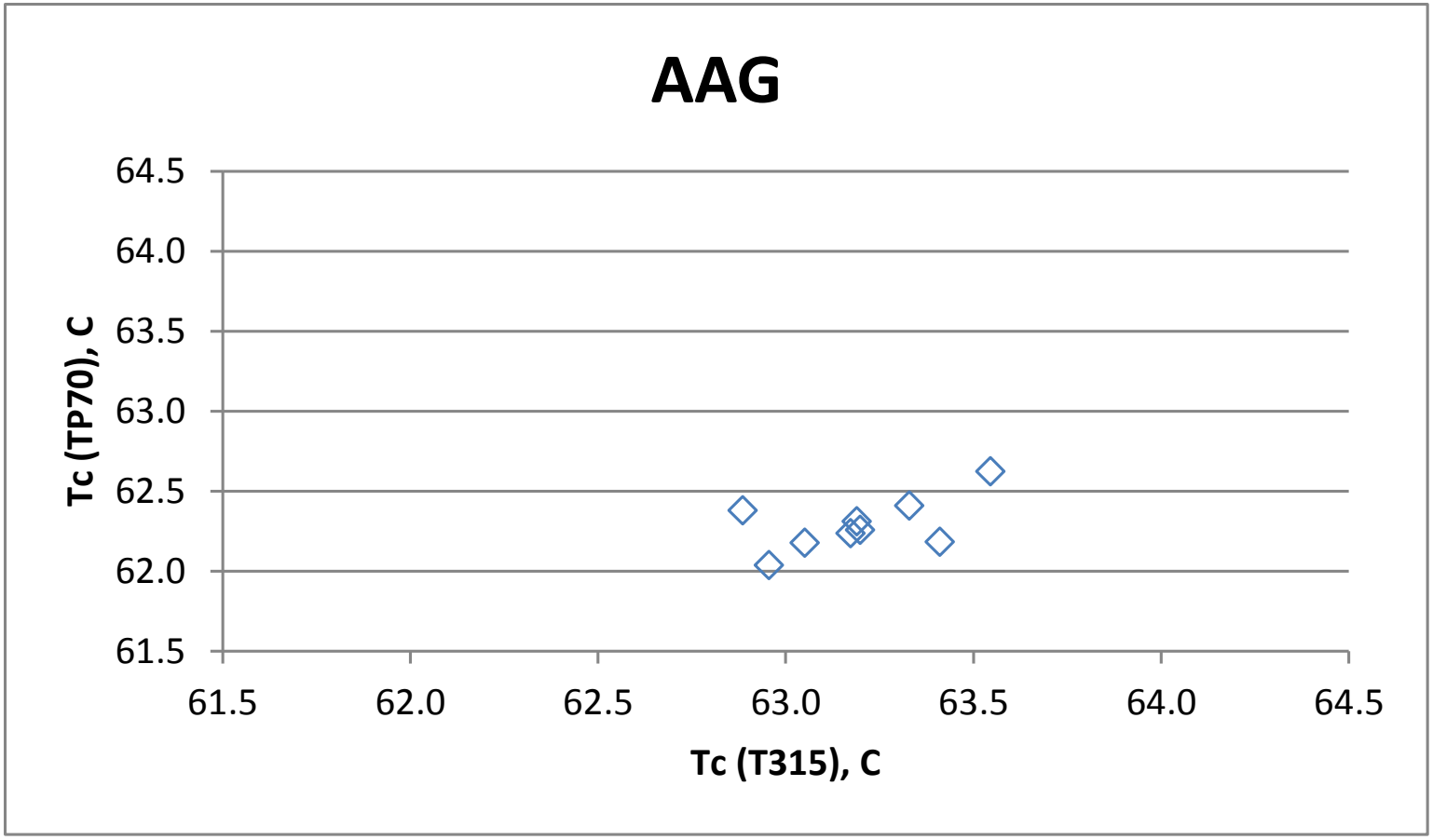
Jnr-3.2 Determined at T315 T_c: AAF



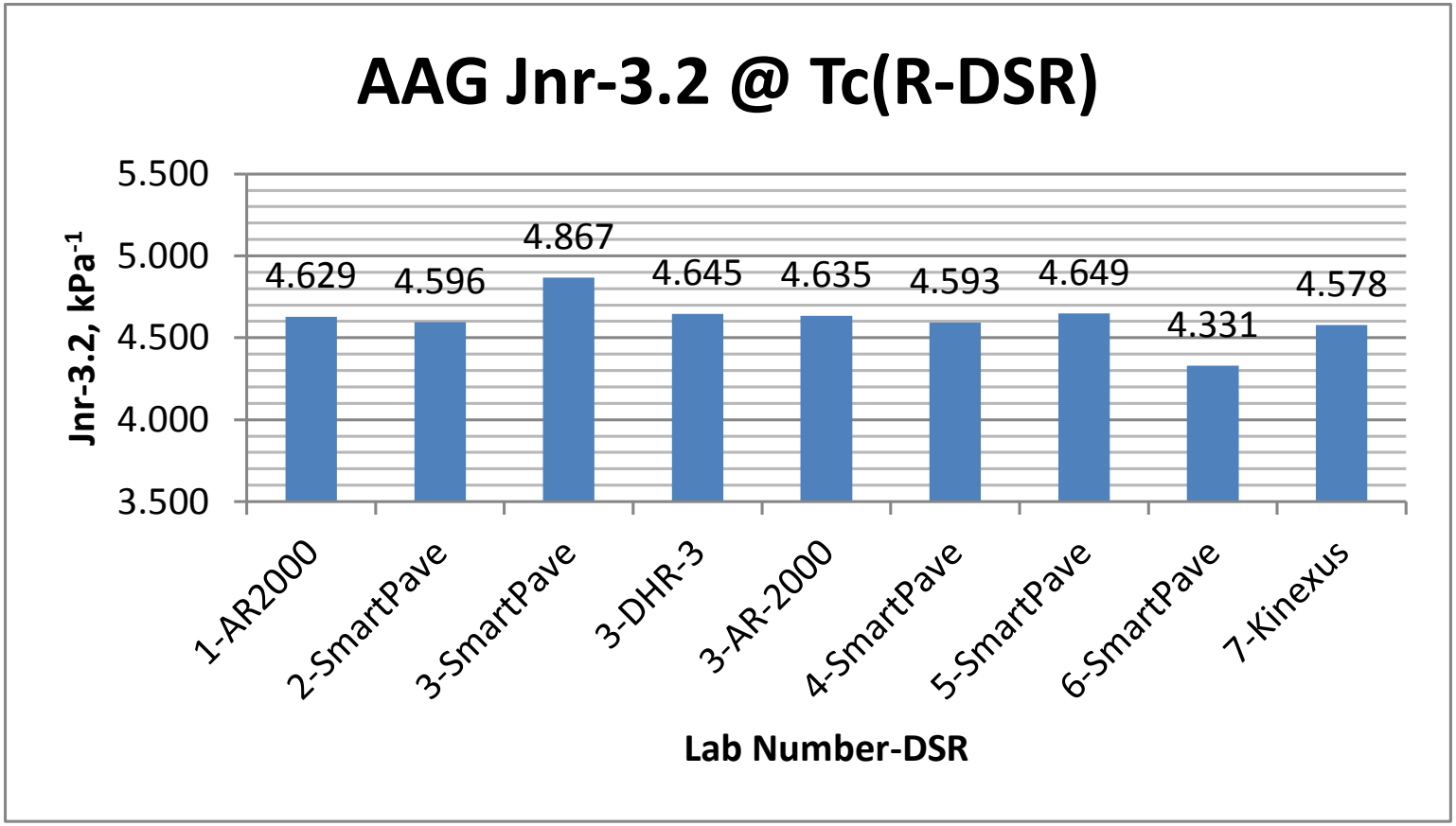
G*/sin δ Determined at TP70 T_c: AAF



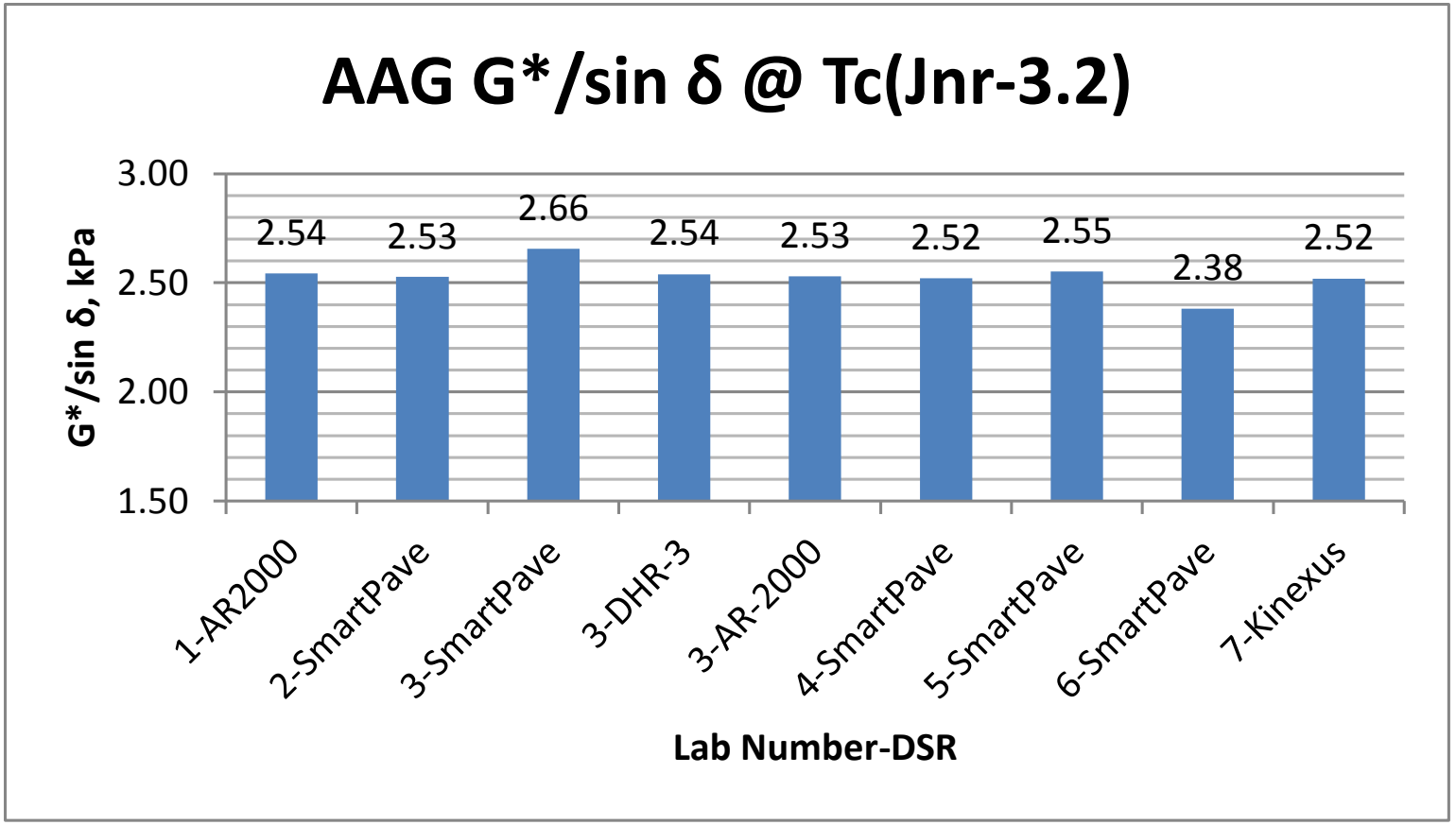
Comparison of T_c Determined by TP70 and T315: AAG



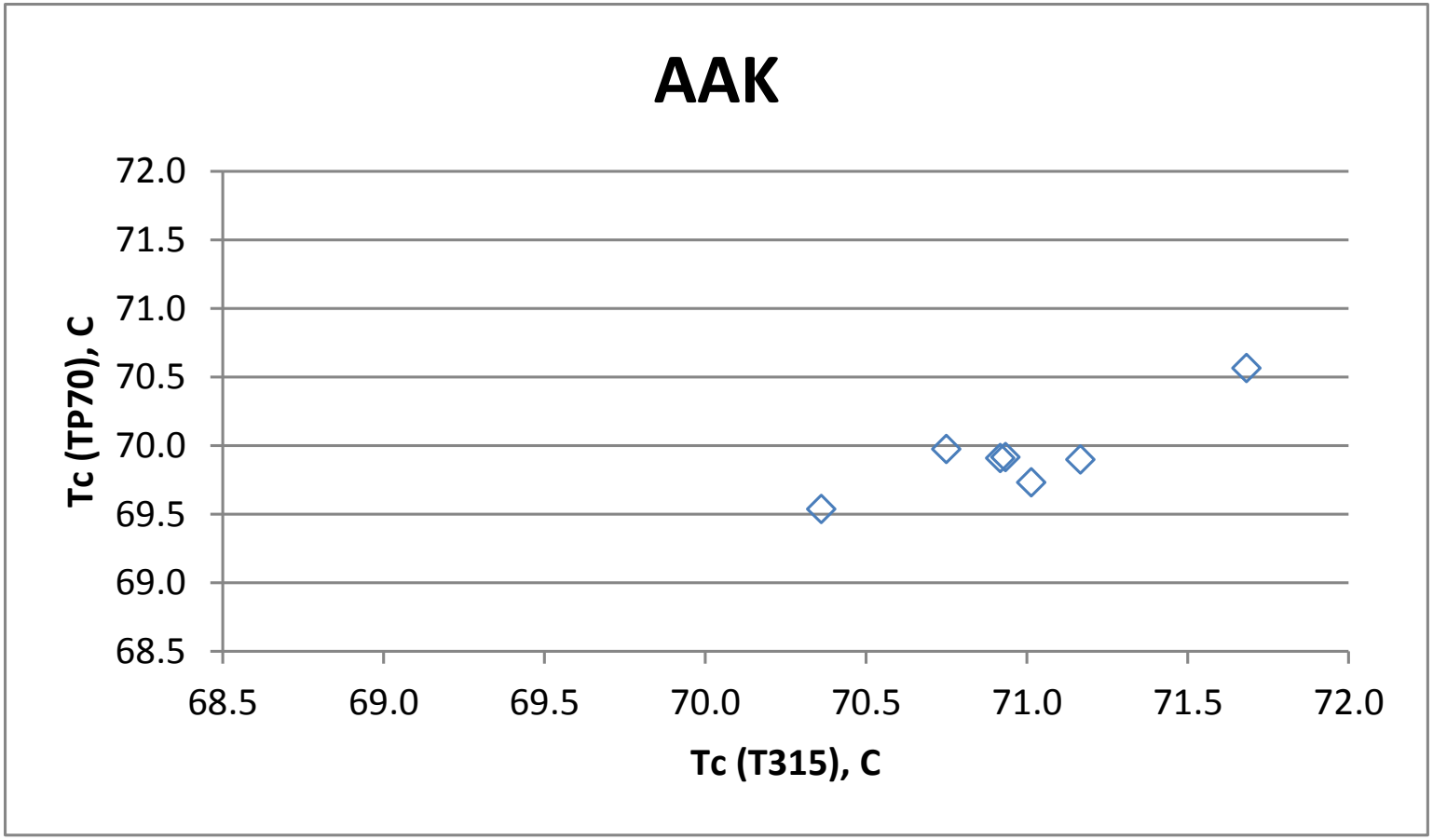
Jnr-3.2 Determined at T315 T_c: AAG



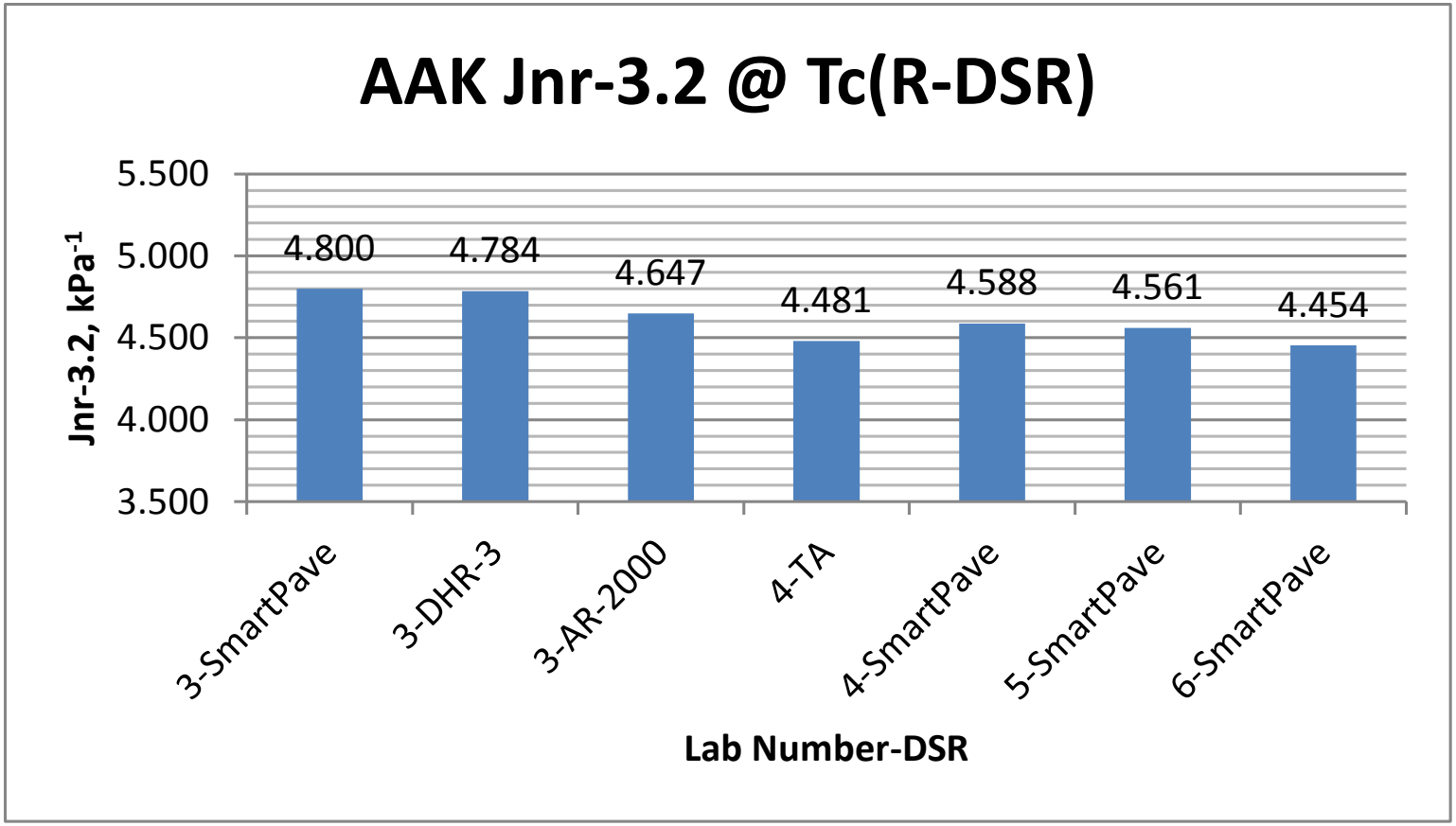
G*/sin δ Determined at TP70 T_c: AAG



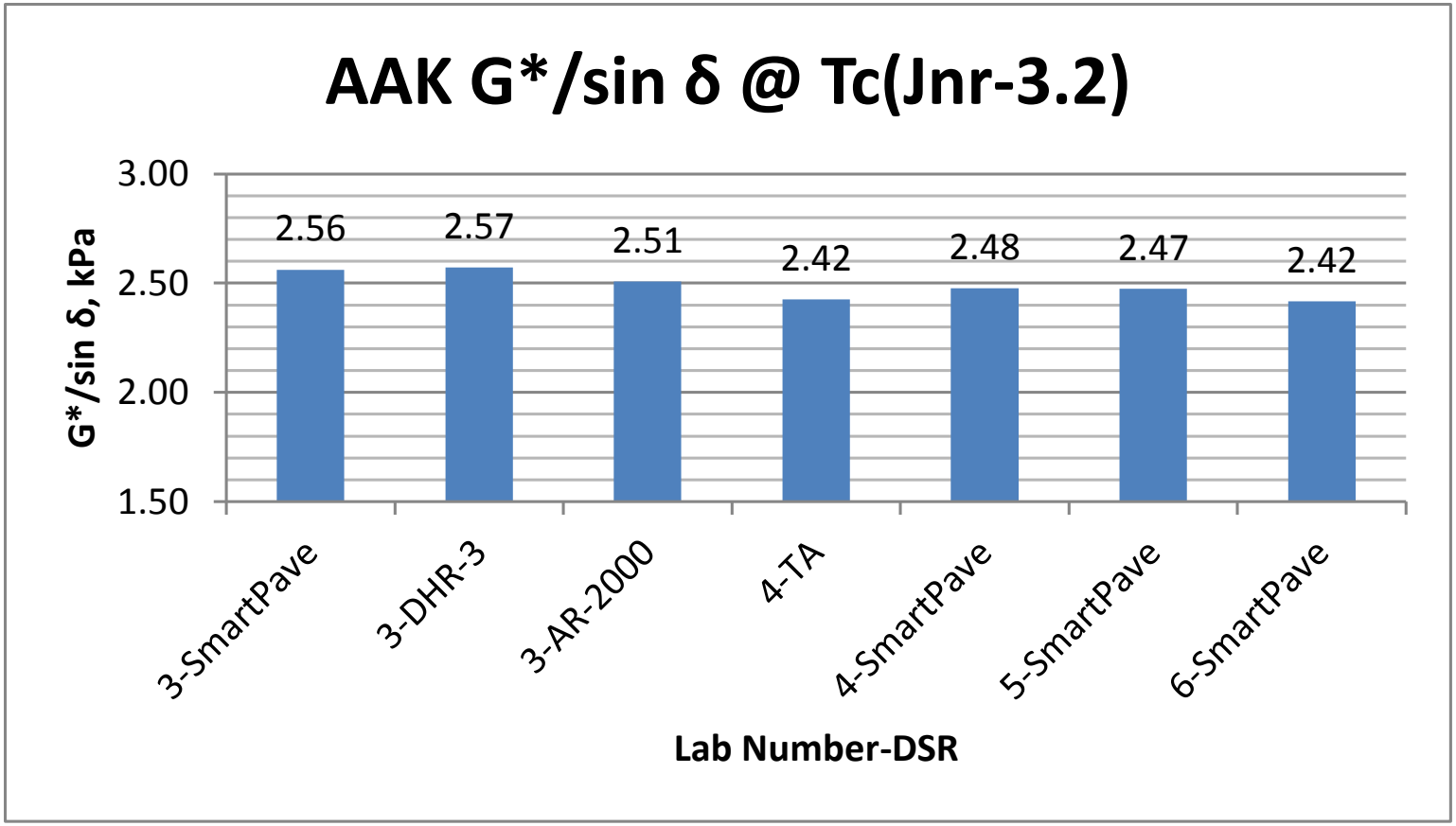
Comparison of T_c Determined by TP70 and T315: AAK



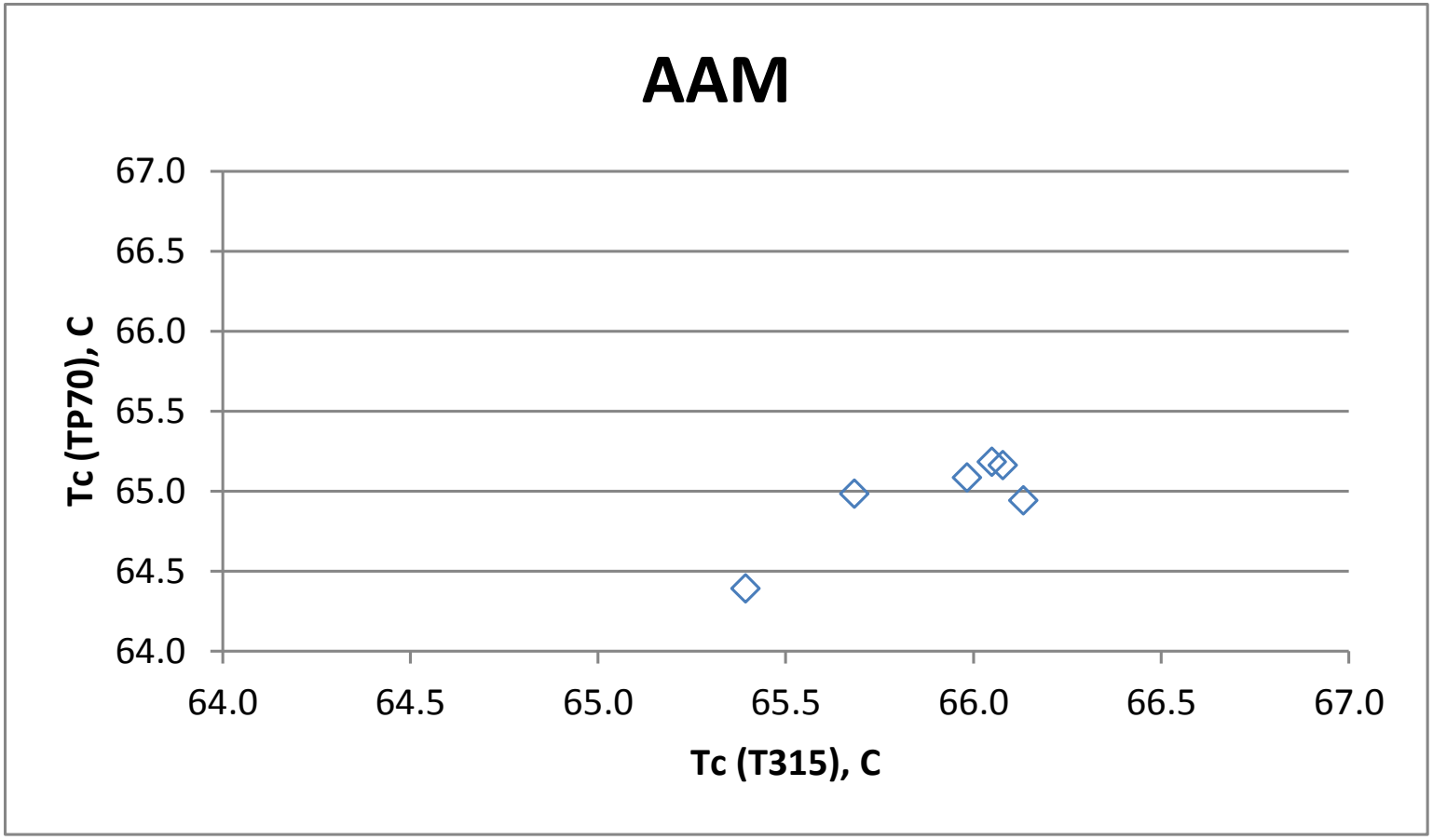
Jnr-3.2 Determined at T315 T_c: AAK



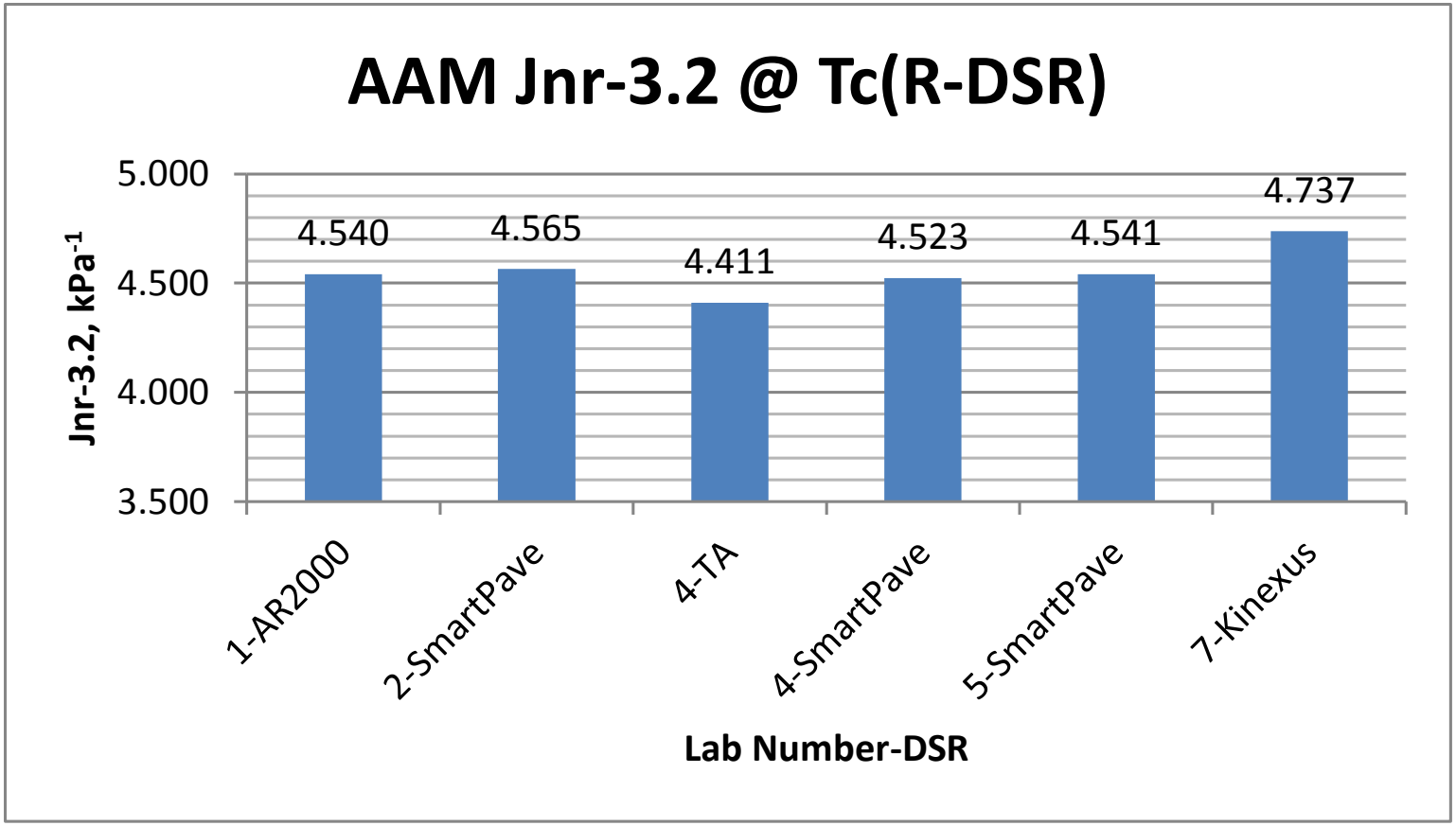
G*/sin δ Determined at TP70 T_c: AAK



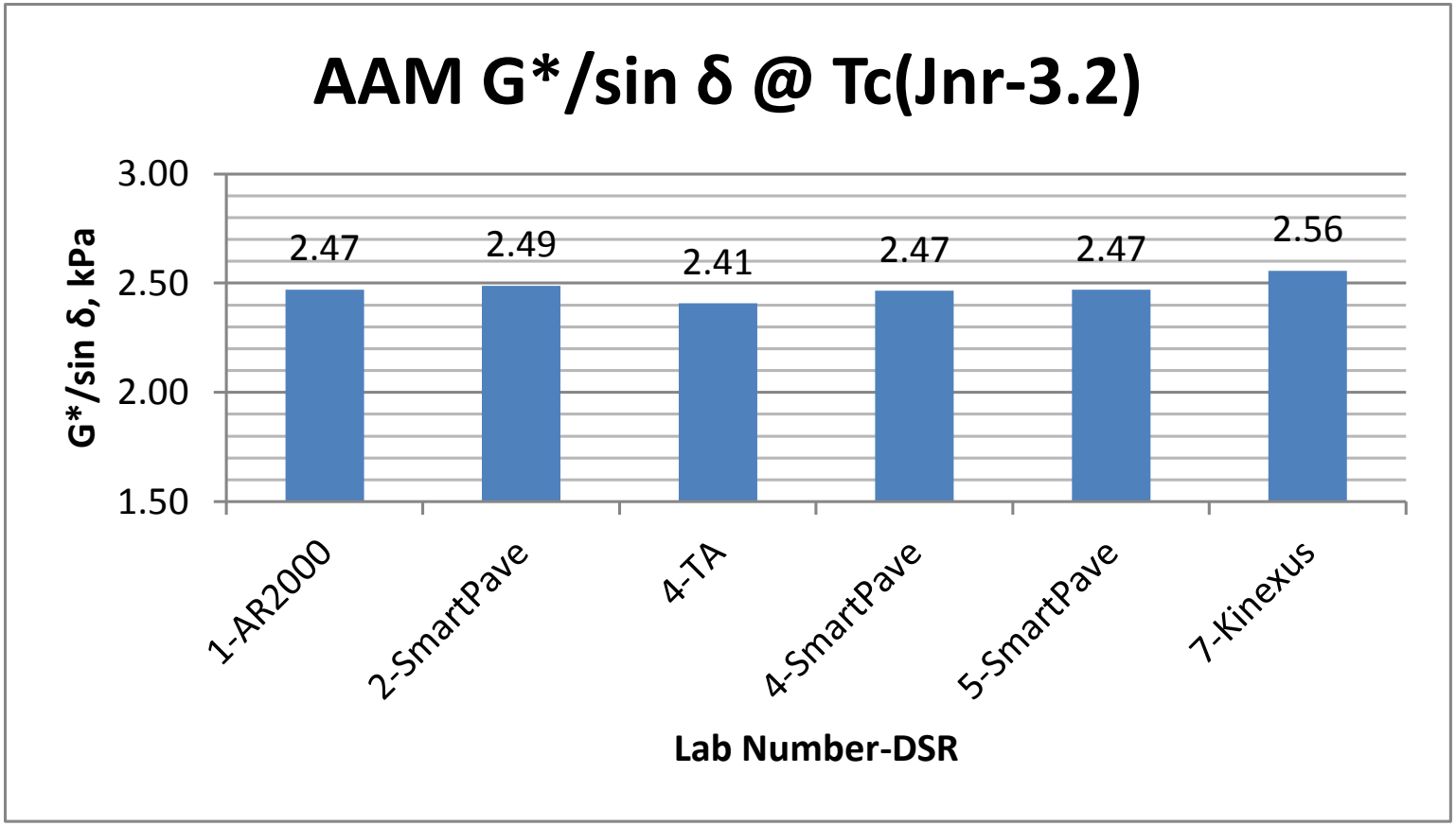
Comparison of T_c Determined by TP70 and T315: AAM

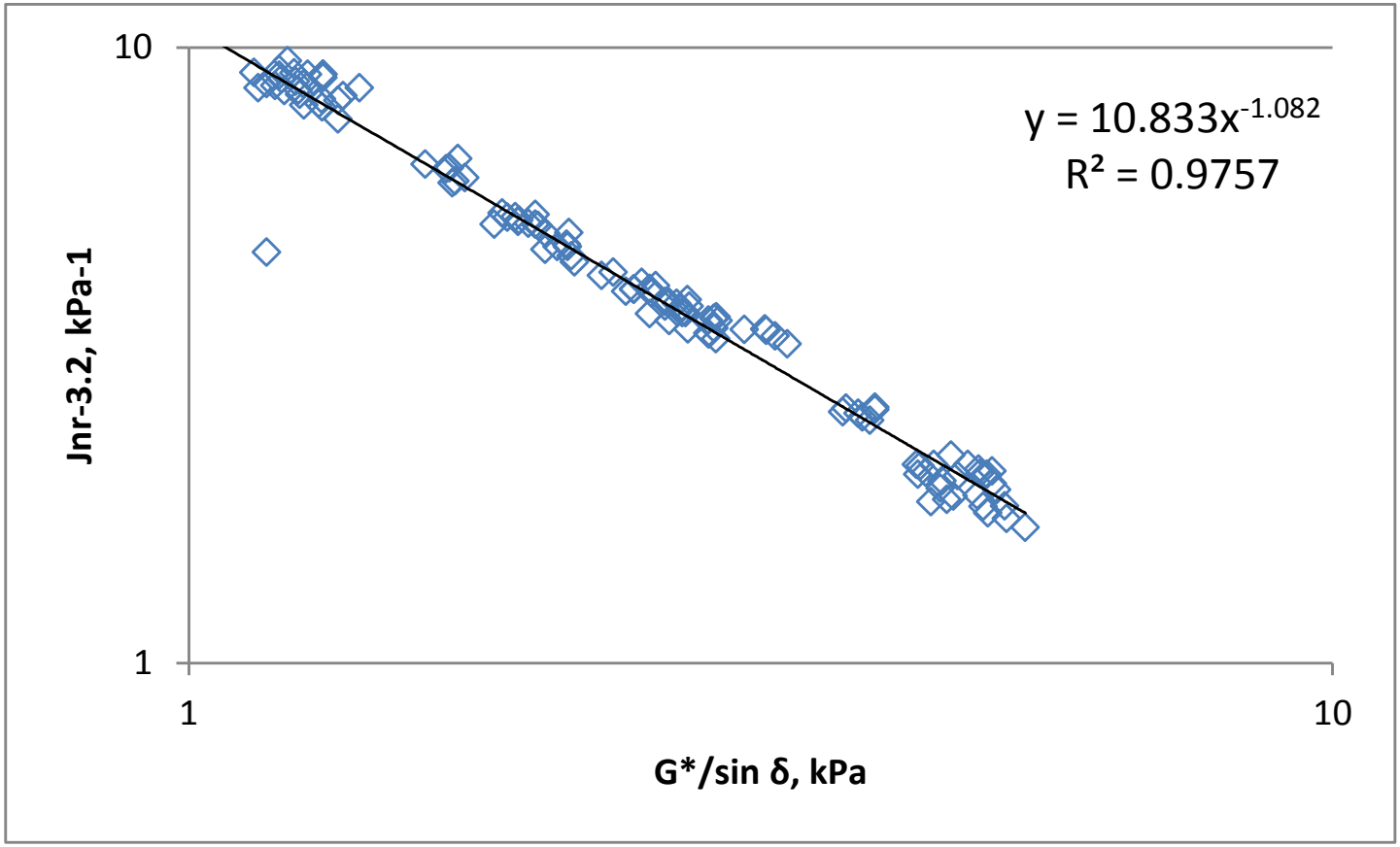


Jnr-3.2 Determined at T315 T_c: AAM



G*/sin δ Determined at TP70 T_c: AAM





A	10.833
B	-1.082
G*/sin δ	2.2
Jnr-3.2	4.616
Jnr-3.2	4
G*/sin δ	2.51

TAC Evaluation of SHRP MRL Asphalt Binders

- Summary
  - Evaluation Program
    - Eight Unmodified Asphalt Binders
    - Seven Participating Labs
    - Three DSR Manufacturers
  - $T_{c,Jnr}$
    - Consistently lower than $T_{c,G^*/\sin\delta}$
    - 0.5 – 1.7°C
  - Results generally confirm earlier findings
    - T(R-DSR) = 4.62 kPa^{-1}
    - T(Jnr-3.2) = 2.51 kPa

TAC Evaluation of SHRP MRL Asphalt Binders

- Summary
  - No evident bias in DSR manufacturer
    - Statistical analysis still needed
  - d2s% values similar for TP70 and T315
    - G*/sin δ
      - Average: 12.1%
      - Range: 6.0% to 29.5%
    - Jnr-3.2
      - Average: 11.5%
      - Range: 4.6% to 24.6%

TAC Evaluation of SHRP MRL Asphalt Binders

- Next Steps
  - Present information to Asphalt Binder ETG
    - September 24-25, 2012
    - Minneapolis, MN
  - Recommendation from TAC
    - Should we recommend a change for AASHTO MP19 for “S” grades?
      - Jnr-3.2 = 4.5 kPa^{-1} ?

AASHTO MP19 Criterion for Neat Asphalt Binders

- Asphalt Institute Technical Advisory Committee Recommendation
  - Recommend that the AASHTO MP19 criterion for J_{nr} for "S" graded asphalt binders be changed from 4.0 kPa^{-1} to 4.5 kPa^{-1}.
    - Mathematical exercise to allow unmodified asphalt binders graded by M320 to map directly over to MP19 grading with no change in properties.
    - Does not affect stiffness of currently produced unmodified asphalt binders

Thanks!