Global Road Infratech Summit & Expo (GRIS-2026)
05-06th February 2026, New Delhi, India

Paper ID: 12

Structural Pathways to HiMA: Understanding SBS Architectural Effects on Network Evolution and Binder Performance

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INTRODUCTION

+

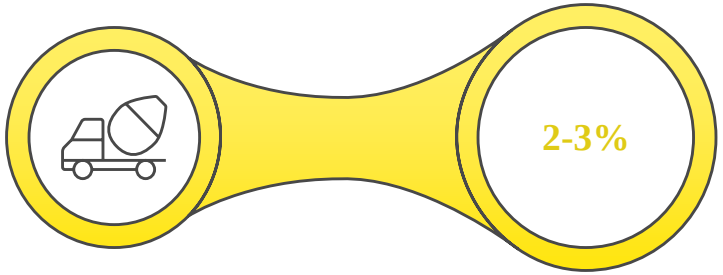
Asphalt **SBS**

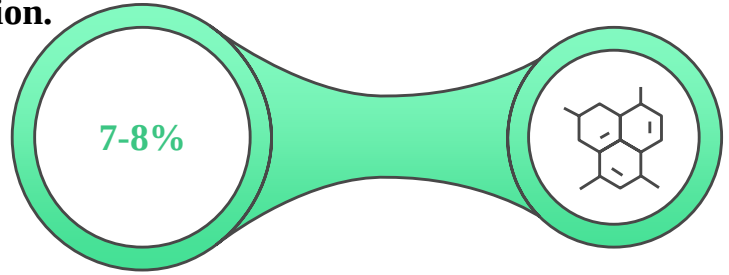
Image Source – Google

HiMA Polymer Content

Road Construction Polymer Content

Standard polymer content in road construction.



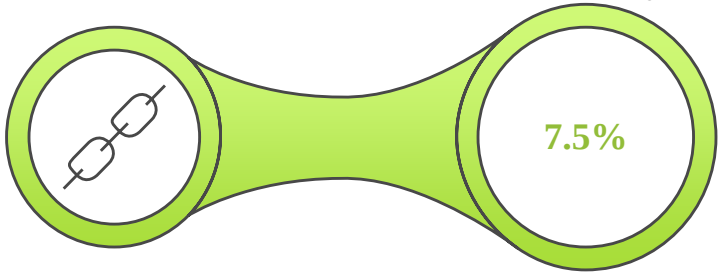


Delft University HiMA Polymer

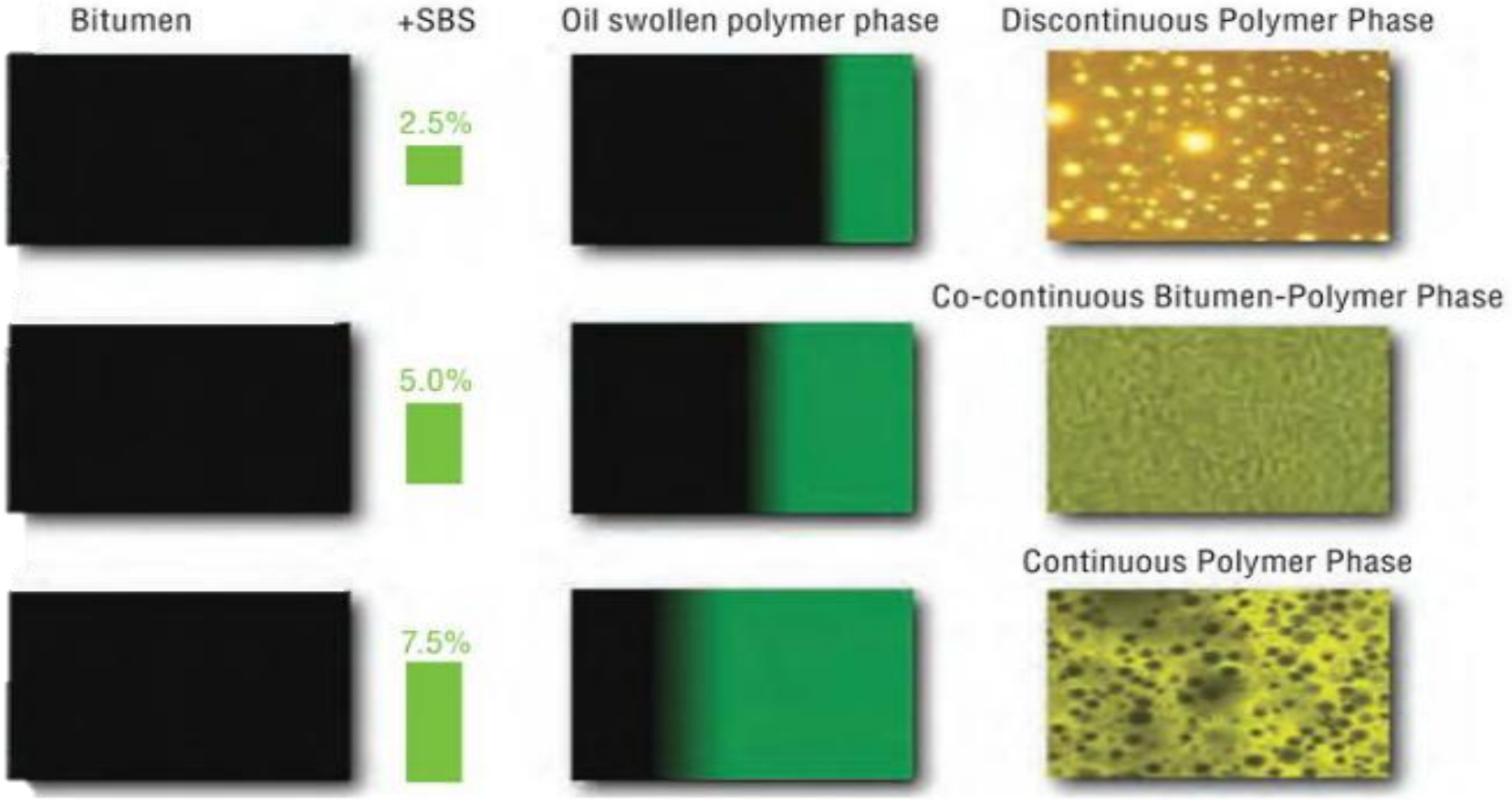
HiMA polymer content by weight of binder.

HiMA Polymer Content Augmentation

Modified binder with dispersed polymer phase.



HiMA DEFINITION



Source - Vargas-Nordcbeck and Musselman, 2021

LITERATURE

ELSEVIER

Review

Differing perspectives on tl
polymer-modified bitumen

Wangjie Wu [a,b], Maria Chiara Cav

Journal of Testing and Evaluation

doi:10.1520/JTE20180584

Transportation Research Record
Volume 2676, Issue 5, May 2022, Pages 297-314
© National Academy of Sciences: Transportation Research Bo
https://doi.org/10.1177/03611981211056642

*Asphalt Paving Technology 2021: Sele
Technologists*

**Multi-Level Laboratory Pe
Conventional and High Pol**

Jhony Habbouche [1], Ilker Boz [1], I

Construction and Building Materials 351 (2022) 128902

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Comprehensive performance evaluation of high polymer-modified asphalt binders beyond linear viscoelastic rheological surrogates

Michael Elwardany [a,*], Jhony Habbouche [b], Adrian Andriescu [c], David J. Mensching [d], Elie Y. Hajj [e], Murugaiyah Piratheepan [f]

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Fuel 252 (2019) 417–426

INTERNATIONAL JOURNAL OF PAVEM
2021, VOL. 22, NO. 13, 1688–1696
https://doi.org/10.1080/10298436.202

**Evaluation of the
pavement testing**

O. Kwon, B. Choubane, J

State Materials Office, Florida D

ABSTRACT

A full-scale experiment wa
pavement testing (APT)
commonly referred to as
three dense-graded Supe
gradation. One mixture
requirements, another co
also used HiMA binder b
showed that, under simil
rutting and fatigue cracki
HiMA binder content res
HiMA binder at the desig
Shear Rheometer (DSR),
strength confirmed the im

Journal of Testing and Evalua
10.1520/JTE20180584

ELSEVIER

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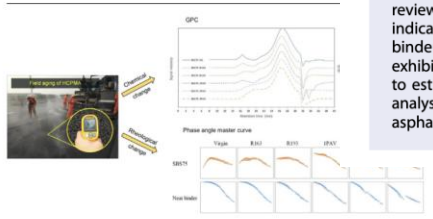
Full Length Article

Chemical and rheological evalu
polymer modified asphalt

Chuanqi Yan[a], Weidong Huang[a], Peng I

[a] Key Laboratory of Road and Traffic Engineering of Ministry of Educ
[b] College of Engineering Department of Civil and Environmental Engine
United States

GRAPHICAL ABSTRACT



INTERNATIONAL JOURNAL OF PAVEMENT ENGINEERING
2020, VOL. 21, NO. 6, 686–702
https://doi.org/10.1080/10298436.2018.1503273

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A critical review of high polymer-modified asphalt binders and mixtures

Jhony Habbouche, Elie Y. Hajj, Peter E. Sebaaly and Murugaiyah Piratheepan

Pavement Engineering & Science Program, Department of Civil & Environmental Engineering, University of Nevada, Reno, NV, USA

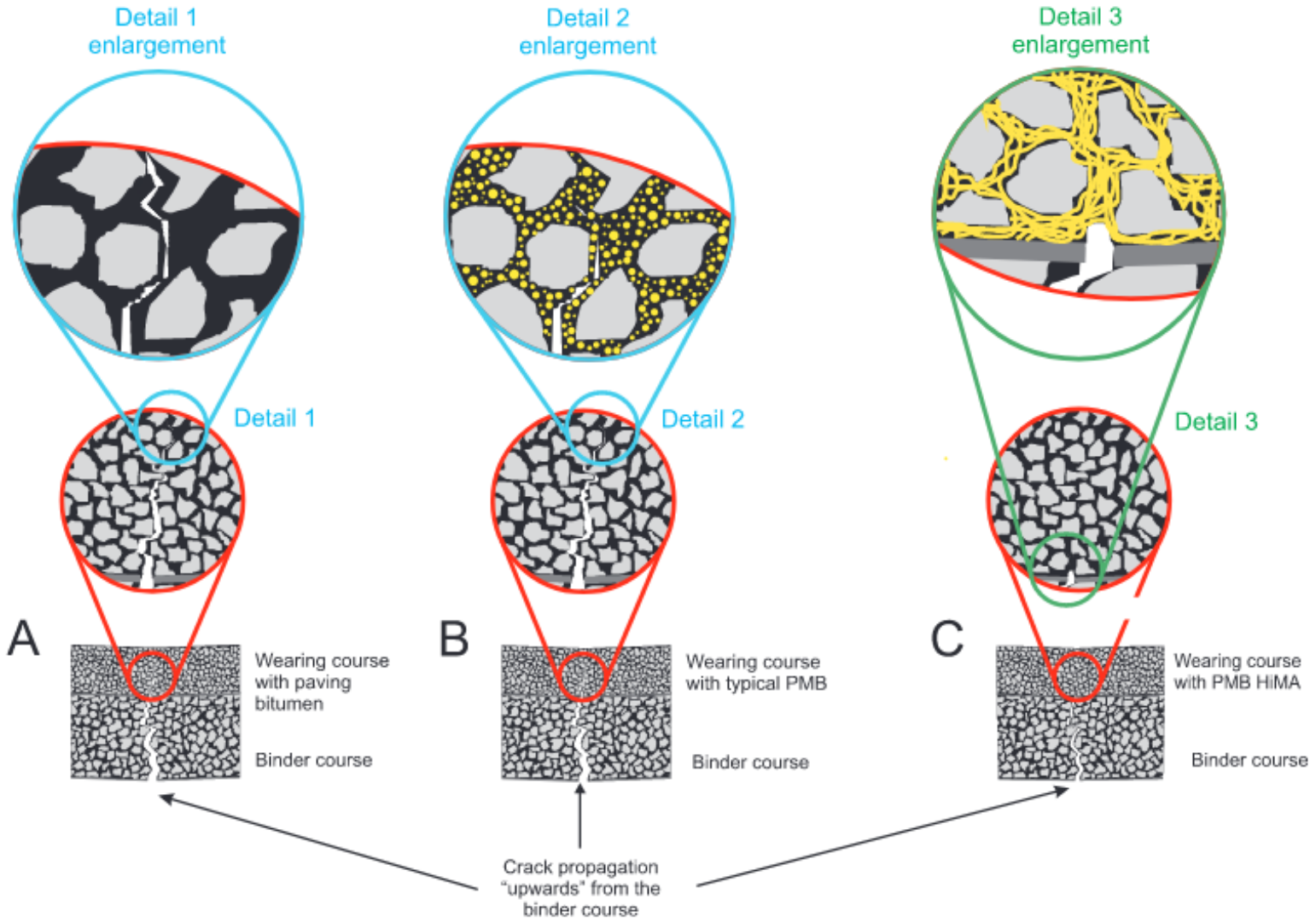
ABSTRACT

The introduction of modified asphalt binders provided transportation agencies an effective tool to design balanced mixtures that can resist conflicting distresses while maintaining good long-term durability. While conventional polymer modified asphalt mixtures have shown improved long-term performance, it is also believed that asphalt mixtures with high polymer (HP) content may offer additional advantages in flexible pavements subjected to heavy and/or slow moving traffic loads. While no unique and detailed handy guide that discusses the HP modification of binders and mixtures exists at this time, and while asphalt industry is moving towards the use of much more durable materials for a better long-term performance of newly constructed roads, this manuscript summarizes the findings from the literature review on the performance of HP asphalt binders and mixtures. The reviewed laboratory studies indicated that the increase in polymer content continues to improve the performance properties of binders and mixtures. The reviewed field projects showed encouraging early field performance without exhibiting any construction related issues. In addition, this article presents attempts that were explored to estimate a structural coefficient of HP mixes based on the available information from literature. This analysis led to the conclusion that the designed HP mixtures may lead up to 40% reduction in the asphalt layer thickness resulting in considerable upfront cost-savings.

ARTICLE HISTORY
Received 16 May 2018
Accepted 14 July 2018

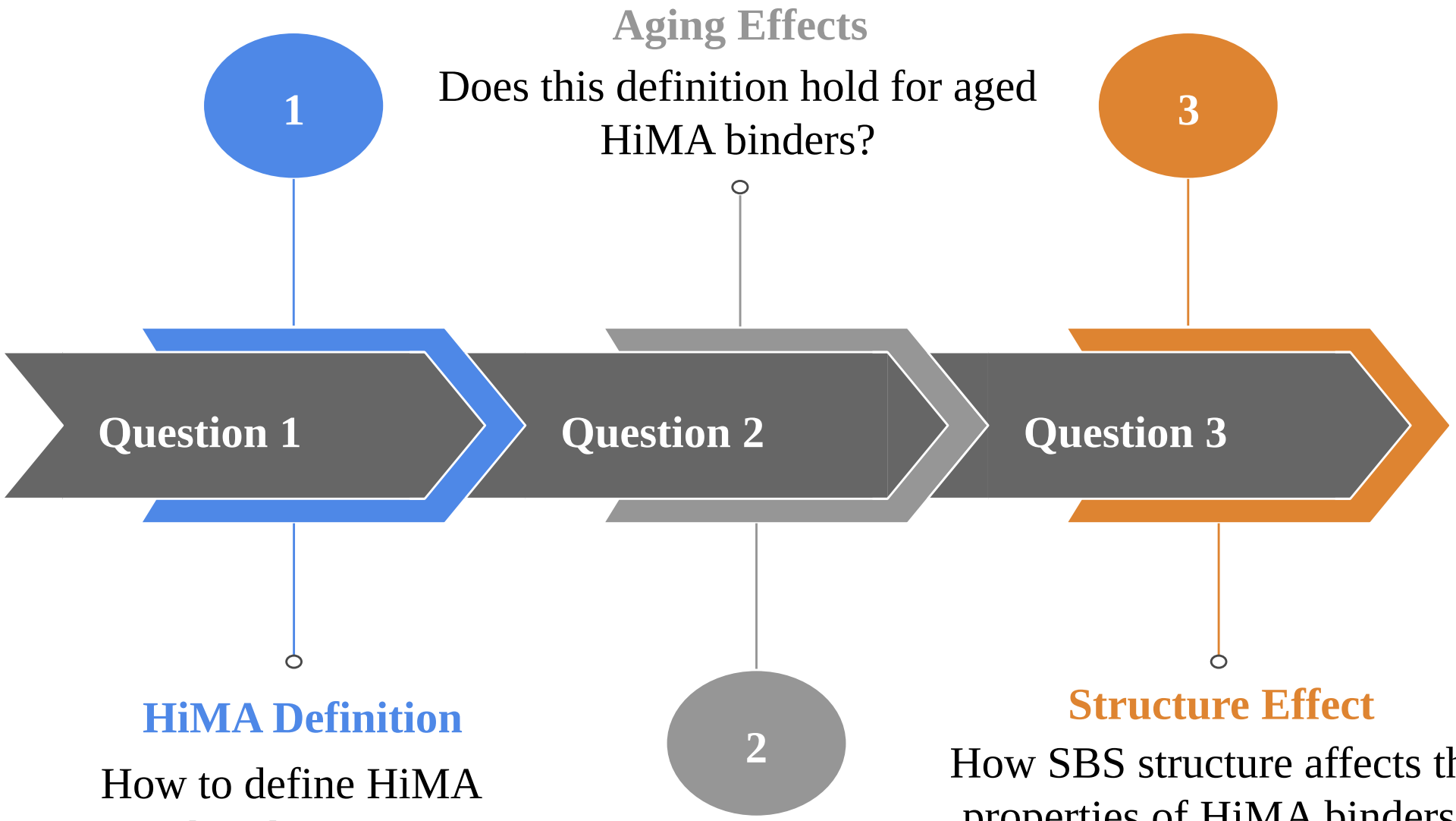
KEYWORDS
High polymer; modified binders; fatigue cracking; rutting; moisture damage; layer coefficient; and cost-savings

USE OF HiMA

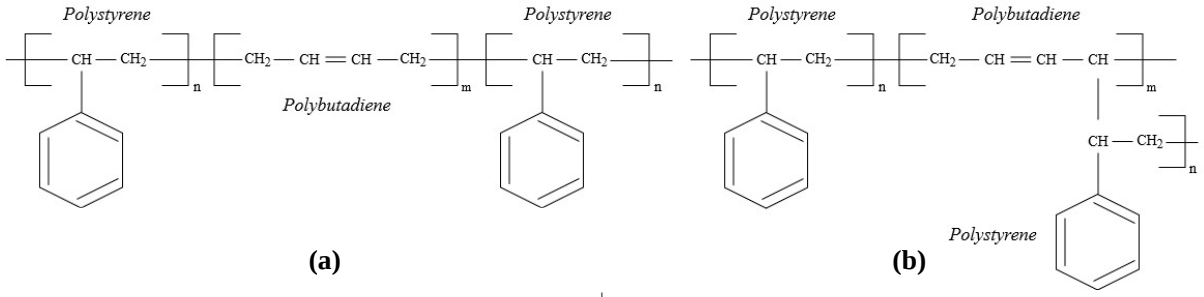


Source – Orlen Asphalt

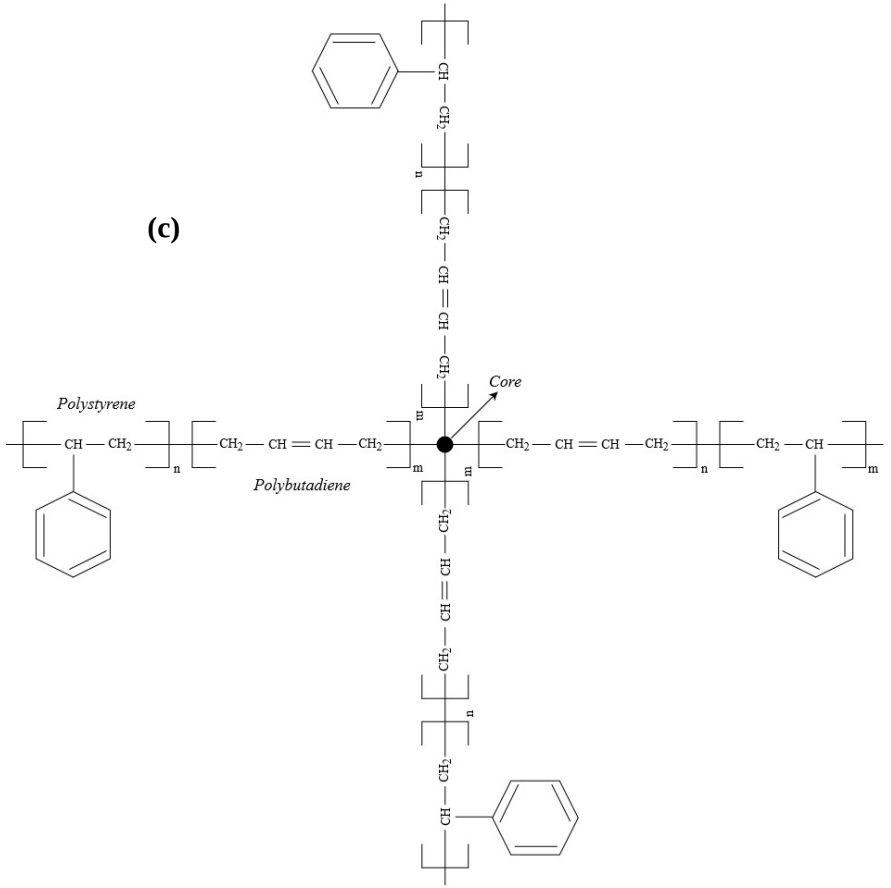
QUESTIONS ARISE?



SBS STRUCTURES



(a) **(b)**



(c)

(a) Linear structure (LSBS)
(b) Branched structure (BSBS)
(c) Radial structure (RSBS)

BLENDING OF SBS

perature

30 °C.

High Shear

4200 RPM
90 mins

Sulphur

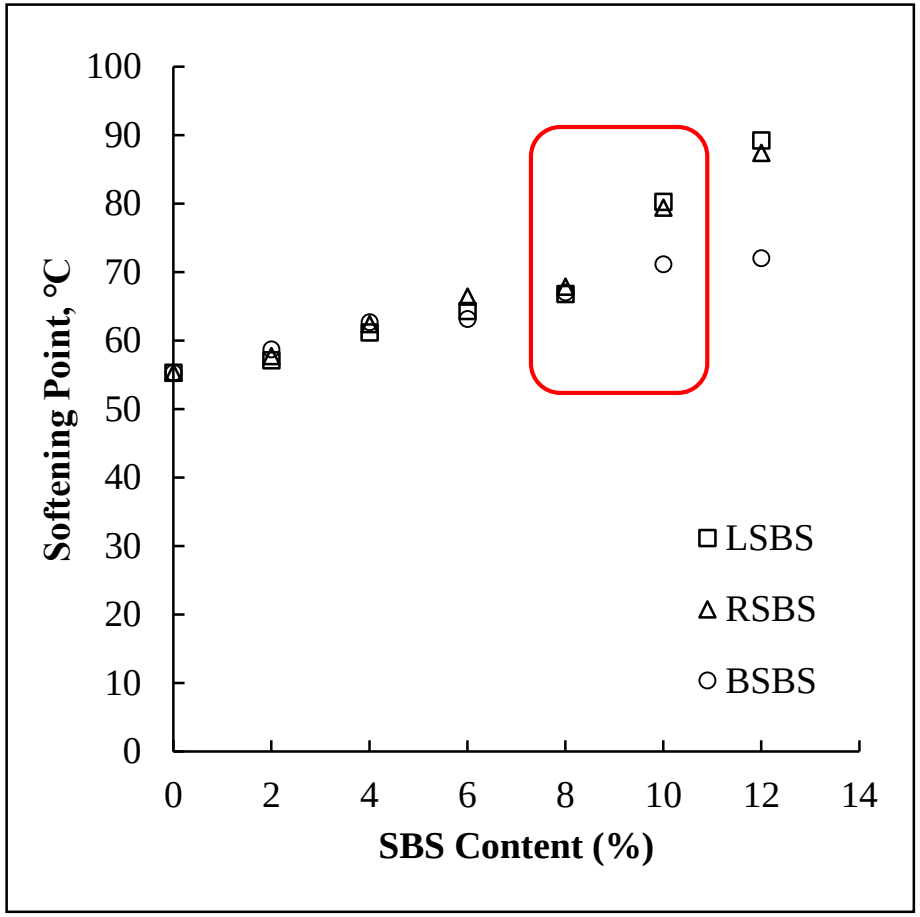
0.15% by weight
of base binder.

Low Shear

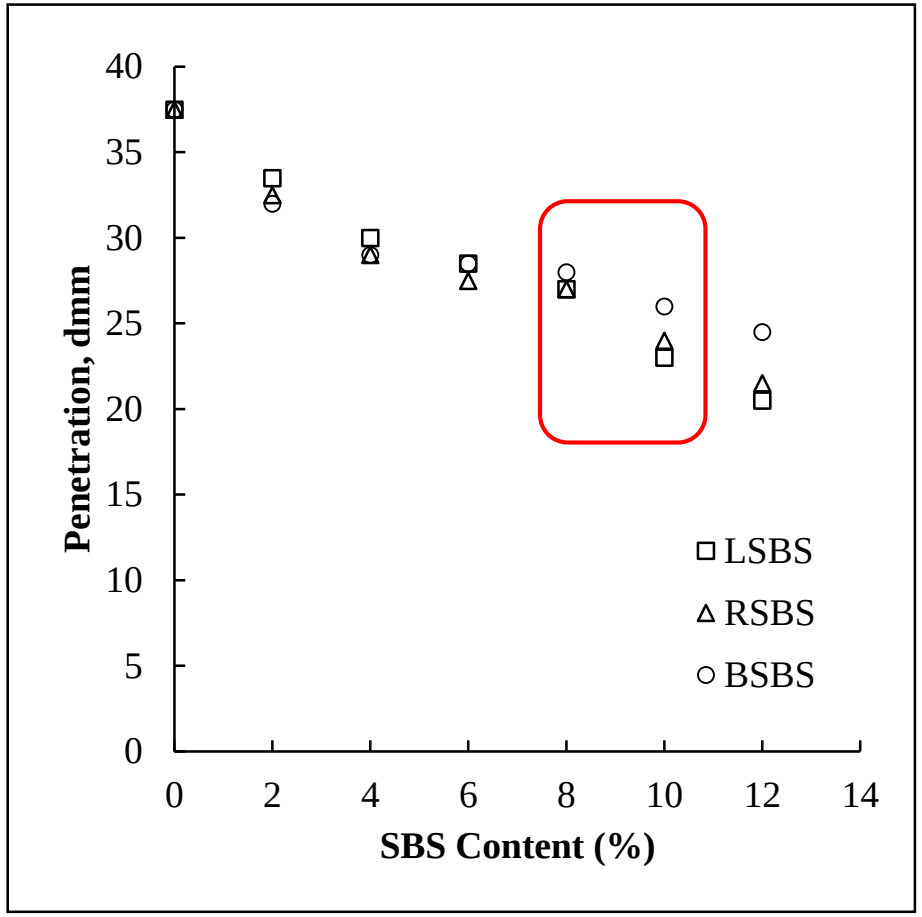
288 RPM
90 mins

CONVENTIONAL TESTS RESULTS

Softening Point Results

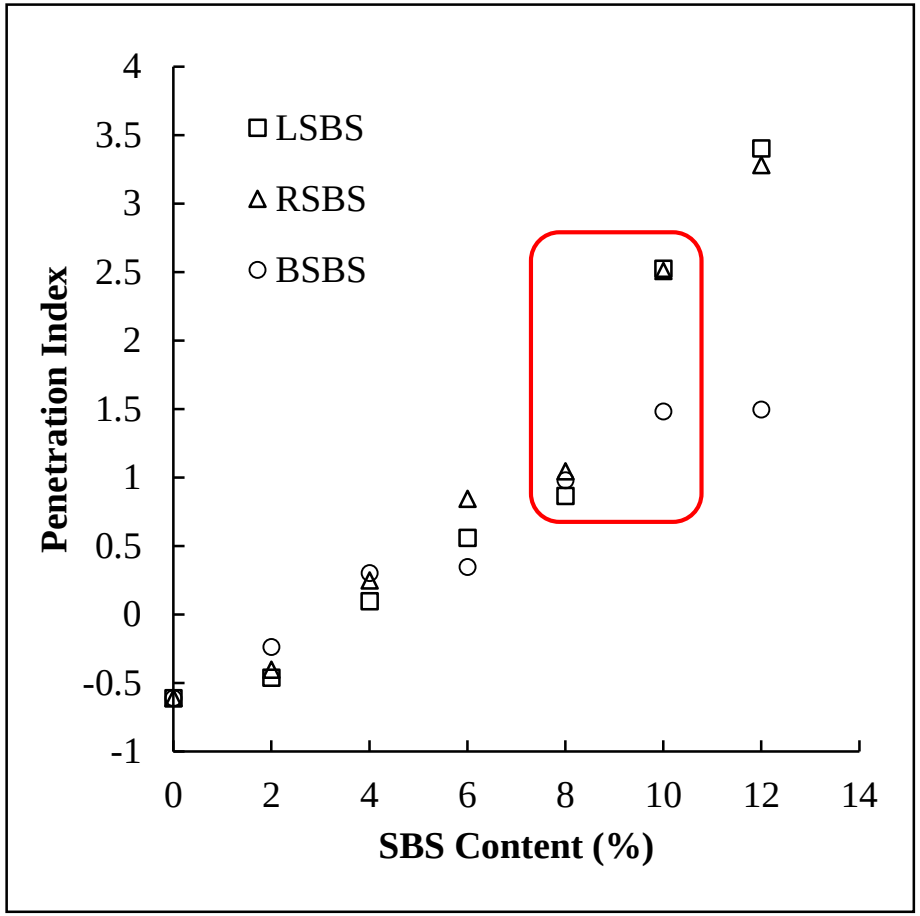


Penetration Results

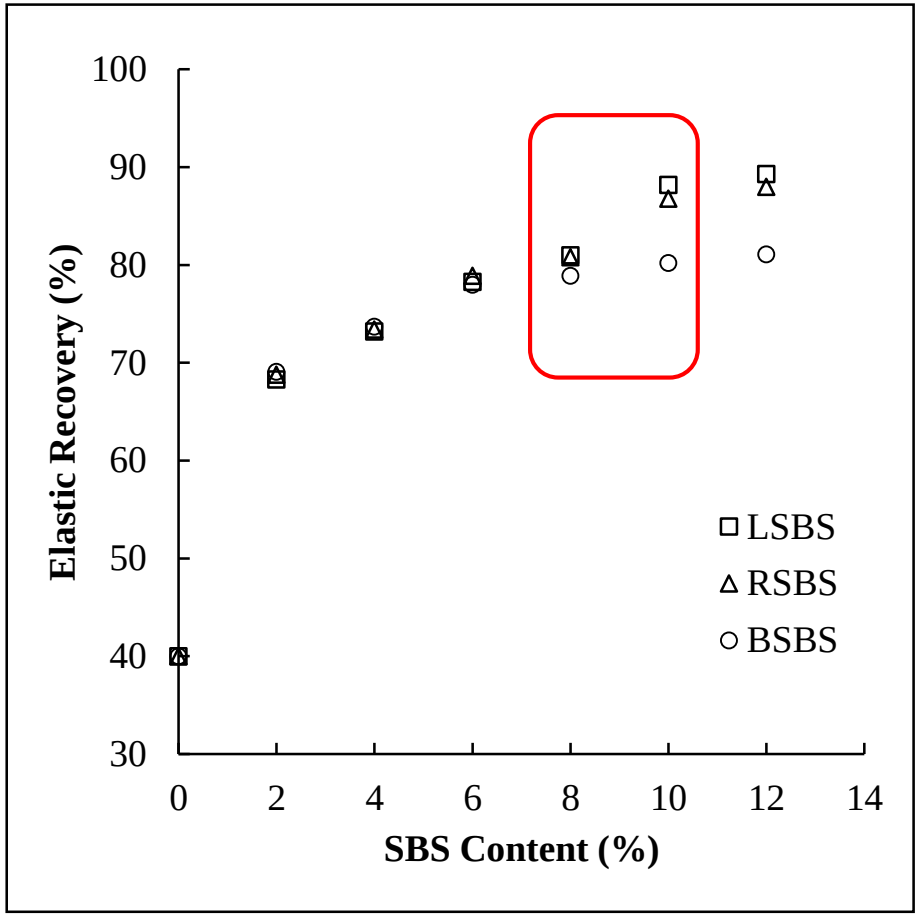


CONVENTIONAL TESTS RESULTS

Penetration Index Results



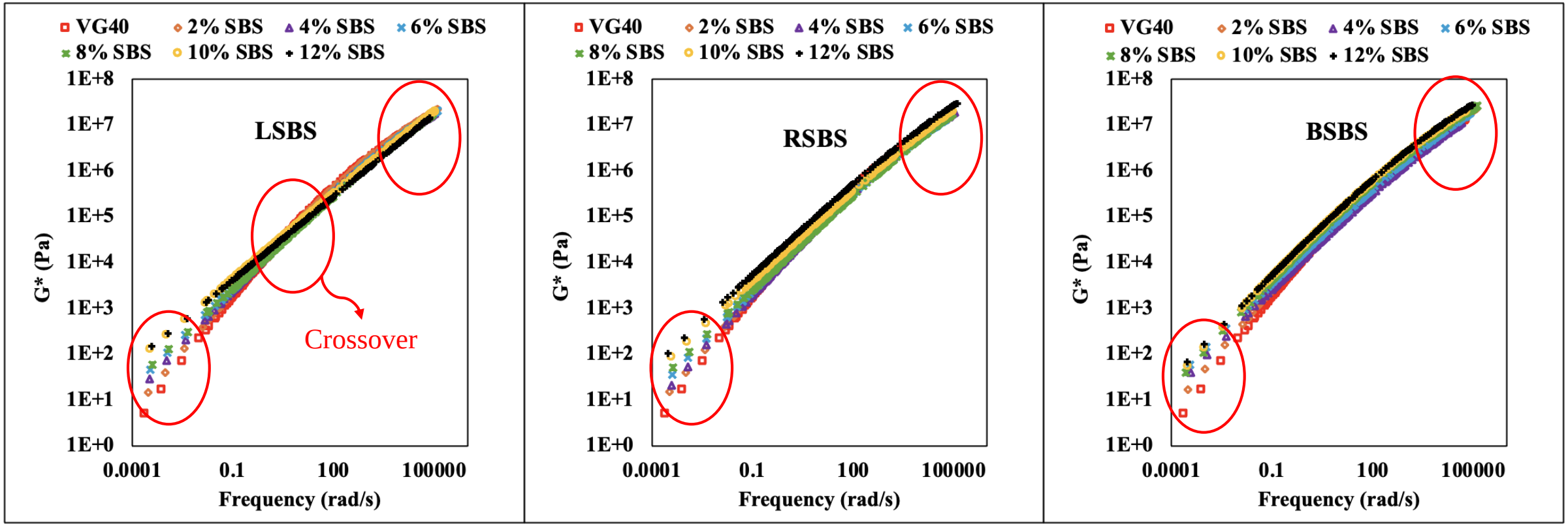
Elastic Recovery Results



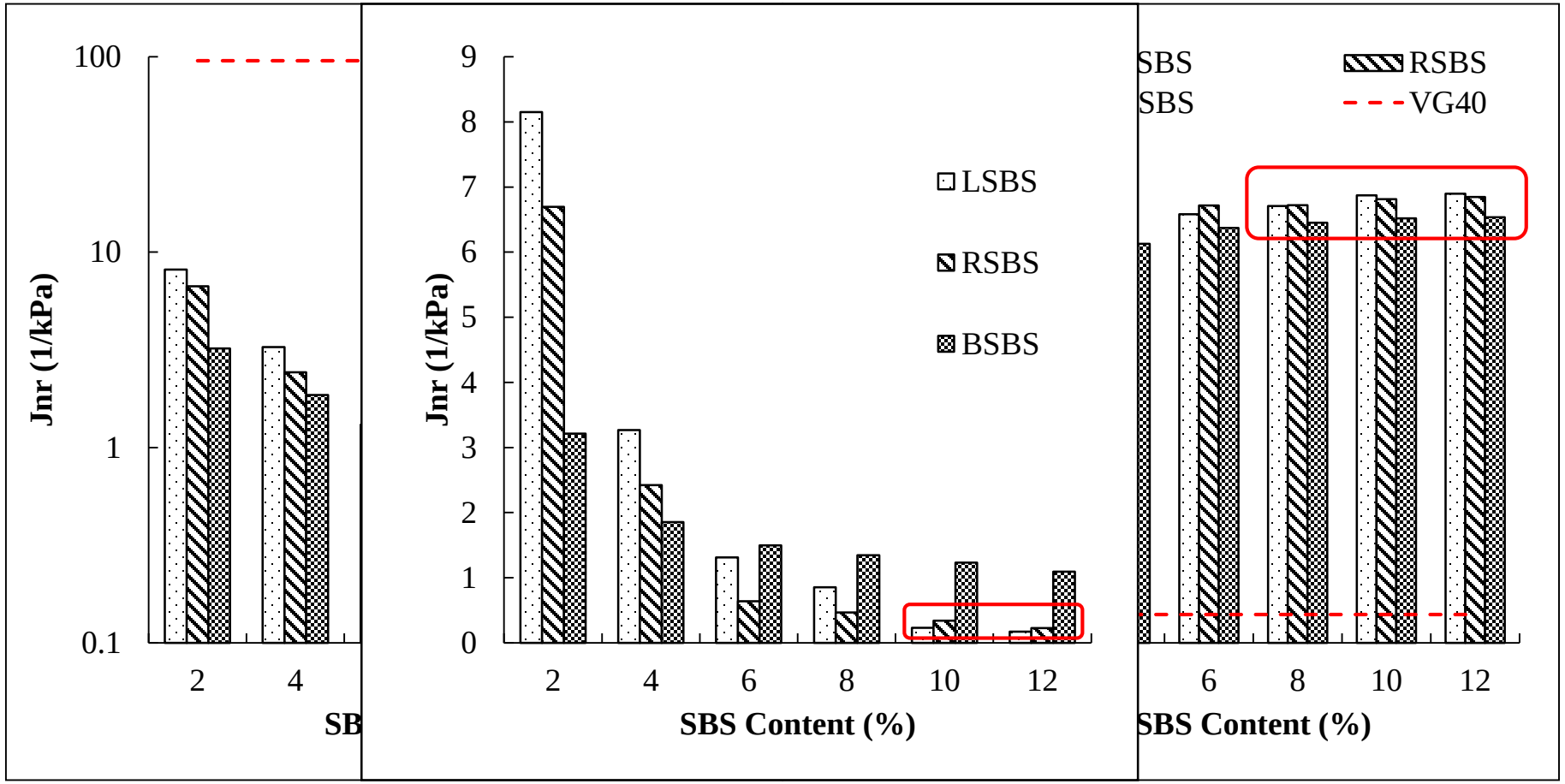
PG GRADING

Structure	SBS Content (%)	High PG fail temperature (UA,°C)	High PG fail temperature (STA,°C)	Intermediate PG temperature (LTA,°C)
Base binder	VG40	74.65	76.55	19.6
LSBS	2	77.85	82.05	18.25
	4	80.6	82.6	17.1
	6	84.75	90.1	16.25
	8	85.45	91.55	16
	10	95.25	102.1	12.5
	12	98.6	102.75	10
RSBS	2	78.05	82.15	18.15
	4	81.1	84.2	16.9
	6	84.8	91.15	16.2
	8	86.6	94.55	15.2
	10	91.85	97.9	12.9
	12	94.8	98.6	10.3
BSBS	2	78.65	84.2	18.1
	4	81.75	91.3	16.8
	6	84.5	92.1	16.4
	8	85.55	94.9	16.3
	10	85.95	95.55	13.65
	12	88.95	98.05	12.9

MASTER CURVES (CAM MODEL)



MULTIPLE STRESS CREEP RECOVERY(MSCR)



MIXING AND COMPACTION TEMPERATURES

Structure	SBS Content (%)	Mixing Temperature (°C)	Compaction temperature (°C)
LSBS	2	166.6	152.6
	4	173.3	159.9
	6	176.7	162.2
	8	178.8	165.4
	10	180.2	168.3
	12	181	169.5
RSBS	2	172.5	158.3
	4	174.5	160.6
	6	178.9	165.4
	8	183.2	169.3
	10	183.9	170.9
	12	186.5	173.5
BSBS	2	172.7	158.6
	4	180.8	166.9
	6	181.1	167.1
	8	181.2	167.4
	10	181.9	168.2
	12	186	171.65

CONCLUSIONS AND FUTURE SCOPE

- **HiMA formation becomes evident at 8-10% for LSBS and RSBS,** however, no HiMA formation was found to take place for BSBS as indicated consistently by the conventional test results.

- **The PG grading results confirmed the trend and indicated increased rheological properties even after short term and long term aging**.

- **Jnr decreases and %R increases with SBS dosage for all structures,** but once HiMA is formed (LSBS and RSBS), the effect of increasing stress is largely neutralized. This indicates that **higher stress levels are required to meaningfully differentiate MSCR behaviour** beyond the HiMA threshold.

- Based on **MS-2 workability limits**, the maximum practical mixing temperature of ~180 °C restricts SBS usage to **approximately 10% for LSBS,** beyond which the mixture becomes difficult to handle for pavement construction.

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THANK YOU!