

Development of Red-Mud-Modified Bitumen Binder for Sustainable Asphalt Industry



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CHE



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PETE



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ME



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CIE

TEAM M115

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1. INTRODUCTION / BACKGROUND



Red Mud Waste

Bauxite residue (red mud) is an abundant industrial by-product with significant environmental disposal challenges.



Sustainability Focus

Utilizing red mud in bitumen promotes waste valorization and supports the circular economy in the asphalt industry.



Performance Potential

Red mud particles improve binder stiffness and high-temperature performance.



Project Objective

Develop and validate red-mud-modified bitumen binder to enhance high-temperature performance for sustainable asphalt applications.

2. PROTOTYPE DESIGN

Mixing Process

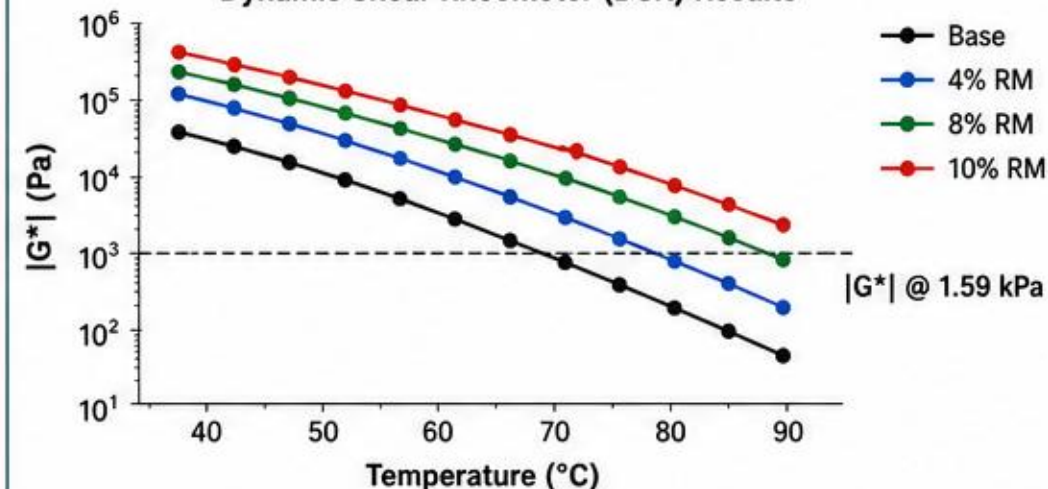


Red Mud Loading Levels



3. TESTING / VALIDATION

Dynamic Shear Rheometer (DSR) Results



Results Summary Table

Sample	High PG Temperature (°C)	Improvement vs. Base (°C)	Performance Gain (%)
Base	64.5	-	-
4% RM	68.2	3.7	5.8%
8% RM	71.3	6.8	9.7%
10% RM	73.3	8.8	14.5%

4. CONCLUSION & SPECIFICATIONS

Summary & Key Outcomes



- Red mud successfully enhances the high-temperature performance of bitumen.
- High PG temperature increased from 64.5°C (Base) to **73.3°C** (10% RM).
- Achieved **PG 70 grade (73.3°C)** with 10% red mud loading.
- Performance gain of 14.5% in high-temperature stiffness.
- Provides a sustainable pathway for red mud utilization in asphalt binders.

ACHIEVEMENT: 73.3°C PG 70 GRADE

Project Constraints & Specifications



Materials

- Base bitumen: PG 64-22
- Red mud: Dried, ground, sieved < 75 μm
- Red mud source: Aluminum industry



Mixing Conditions

- Mixing temperature: 140 ± 2°C
- Mixing speed: 3000 rpm
- Mixing time: 60 min
- High-shear mixer used



Testing Methods

- Dynamic Shear Rheometer (DSR) – AASHTO T 315
- Temperature sweep: 40–90°C
- Strain: 12%



Performance Criteria

- Superpave PG grading
- $|G^*|$ @ 1.59 kPa
- Higher PG high temperature desirable



Constraints

- Red mud variability
- Particle agglomeration risk
- High-temperature stability
- Workability at high loading
- Environmental compliance