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ANALYSIS OF HIGHWAY PERFORMANCE AND IT'S MAINTENANCE: A CASE STUDY OF NH-53 (KHOTE NAGAR TO AJINTHA CHAUFULLI)

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ABSTRACT

Highways are vital for economic and social connectivity, yet their performance depends on effective maintenance to ensure safety and longevity. This study investigates the performance of National Highway 53 (NH-53) between Khote Nagar and Ajintha Chaufulli, Maharashtra, India, analyzing pavement failures and proposing maintenance strategies. Through field surveys, soil testing, and literature analysis, the research identifies key distresses such as cracking, rutting, and potholes, driven by heavy traffic, poor drainage, and environmental factors. Soil tests, including sieve analysis and direct shear tests, reveal subgrade characteristics critical for pavement design. The study proposes a structured maintenance methodology, emphasizing preventive measures, drainage improvements, and innovative materials like geotextiles. Findings highlight the need for proactive maintenance, data-driven planning, and sustainable practices to enhance highway durability and reduce lifecycle costs. These insights are valuable for transportation agencies and policymakers aiming to optimize highway infrastructure.

KEYWORDS: Pavement Failures, Maintenance Strategies, Soil Testing, Geotextiles, Drainage Improvement, Sustainable Practices

1. INTRODUCTION

Highways are critical infrastructure, facilitating trade, mobility, and regional development. However, their performance is challenged by factors such as traffic loads, environmental conditions, and material degradation. National Highway 53 (NH-53), a key transportation corridor in Maharashtra, India, experiences distresses like cracks, potholes, and rutting, necessitating systematic maintenance. This study evaluates the performance of NH-53 (Khote Nagar to Ajintha Chaufulli) and develops a maintenance framework to enhance its functionality. The objectives are to assess pavement conditions, identify failure causes, and recommend cost-effective maintenance strategies. By integrating field data, soil testing, and global best practices, the research contributes to sustainable highway management.

Following are the Objectives of Research **1. Evaluate the Performance of NH-53 (Khote Nagar to Ajanta Chaufulli) 2. Identify and Analyze the causes of pavement failure**

2. LITERATURE REVIEW

1. Ahmad et al. (2020) Economic and Social Significance of Highways - "emphasize highways as economic lifelines, critical for safety and efficiency, requiring regular inspections and preventive maintenance."
2. Landge et al. (2021) Rigid Pavement Failures -" identify failures in rigid pavements due to poor material properties and inadequate maintenance, advocating for field surveys to diagnose issues."
3. Kumar and Mishra (2021)Importance of Drainage Systems - "highlight the role of drainage systems in mitigating water-induced damage, classifying distresses such as cracks and potholes by severity."
4. Ankur and Patel (2018) Flexible Pavement Vulnerabilities - "note that flexible pavements are prone to fatigue and thermal cracking, particularly in tropical climates."
5. Ubale and Dange (2022)Bituminous Pavement Failures - "document failures in bituminous pavements, such as alligator cracking and bleeding, linked to heavy wheel loads and poor quality control."
6. Moghe et al. (2023) Innovative Materials for Stabilization - "highlight the use of innovative materials like Coir Geotextiles to enhance pavement stabilization."

3. METHODOLOGY

The study adopts a systematic approach to assess NH-53 and recommend maintenance strategies, comprising field surveys, soil testing, and maintenance planning.

3.1 Field Survey and Pavement Assessment

Visual inspections and surveys were conducted to identify distresses such as cracks, potholes, rutting, and corrosion. Problem areas were prioritized based on severity and traffic impact.

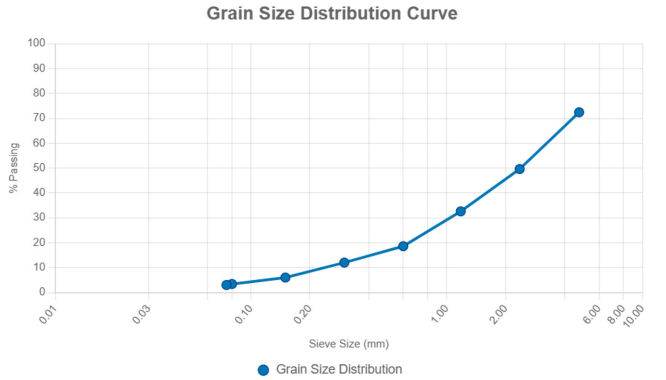
3.2 Soil Testing

Six soil tests were performed to evaluate subgrade properties:

3.2.1 Sieve Analysis: Determined particle size distribution for drainage and compaction assessment.

Sieve analysis data

sieve size	wt of rt	% wt rt	cu % wt rt	passing
4.75	138	27.6	27.6	72.4
2.36	114	22.8	50.4	49.6
1.18	87	17.4	67.8	32.6
0.6	70	14	81.8	18.6
0.3	31	6.2	88	12
0.15	30	6	94	6
0.08	13	2.6	96.6	3.4
pan	15	3	99.6	0.4

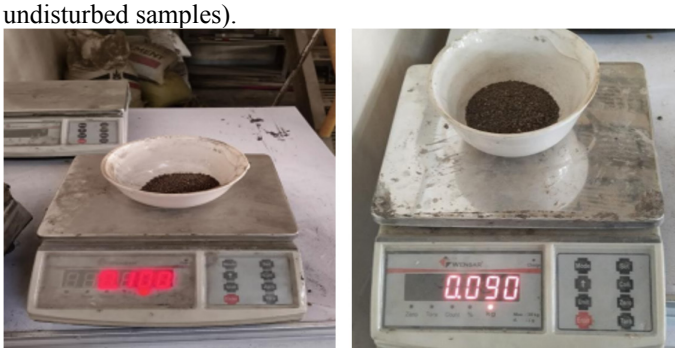


Standard: The semi-logarithmic plot aligns with IS 2720-Part 4:1985, used in Indian geotechnical engineering.

Soil Classification: Silty Sand (SS) per IS 1498:1970, ideal for well points due to high permeability.

3.2.2Proctor Test: Identified optimum moisture content (e.g., 10% for a sample) for maximum dry density.

3.2.3 Moisture Content Test: Measured water content (10% in undisturbed samples).



3.2.4 Water Absorption Test: Assessed soil permeability for drainage design.

3.2.5 Specific Gravity Test: Calculated soil density (e.g., 2.6) for compaction analysis.

$$\text{Specific gravity of soil} = \frac{\text{Density of water at 27 C}}{\text{Weight of water of equal volume}}$$

$$= \frac{(W_2 - W_1)}{(W_4 - W_1) - (W_3 - W_2)}$$

$$= \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)}$$

$$= \frac{719\text{-}619}{(719\text{-}619) - (1706\text{-}644)}.$$

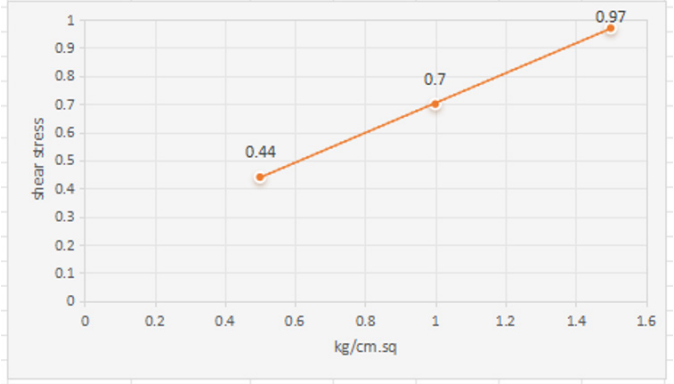
$$= \frac{100}{100\text{-}62}$$

Specific Gravity = 2.6

3.2.6 Direct Shear Test: Evaluated shear strength to assess subgrade stability under traffic loads.

Direct shear test Data , Graph , Angle ϕ.

shear stress	weight applied	kg/cm.sq
0.44	15.7	0.5
0.7	25.39	1
0.97	35.06	1.5



cohesion	0.173333333
Angle ϕ	27.92358972

3.2.7 Cbr Value By Using Co Relation Equation

CBR = 0.17 (MDD^2/OMC)
OMC = 10%
MDD = 1.92 g/cc

Let's plug those into the correlation:
CBR = 0.17 (MDD2 /OMC)
=0.17((1.922) / 10)
= 0.17((3.6864)/10)
= 0.17 * 0.36864
≈ 0.0627
Estimated CBR = 6.27%

3.3 Maintenance Framework

The maintenance methodology includes:

Planning: Identify and prioritize repair areas through surveys.
Scheduling: Plan work during low-traffic periods to minimize disruption.
Material Selection: Use high-quality asphalt or concrete meeting Indian Roads Congress (IRC) standards.
Execution: Clear debris, repair cracks/potholes, and resurface damaged sections.
Drainage Improvement: Clean and upgrade drainage systems to prevent waterlogging.
Quality Control: Monitor work and test materials for durability.
Traffic Management: Deploy signage and alternate routes for safety.
Inspection: Conduct final checks to ensure quality.
Reporting: Document processes and outcomes for stakeholder review

4. RESULTS AND DISCUSSION

4.1 Pavement Failures

The NH-53 segment exhibited:

Cracks: Alligator, longitudinal, and thermal cracks due to repetitive traffic loads and temperature fluctuations.

Potholes and Rutting: Caused by heavy vehicles and poor drainage.

Corrosion and Bleeding: Linked to water infiltration and inadequate surface sealing.

These failures align with findings by Ubale and Dange (2022), who attribute bituminous pavement distresses to wheel loads and poor quality control.

4.2 Soil Test Results

Sieve Analysis: Indicated a balanced particle size distribution, suitable for drainage.

Proctor Test: Confirmed optimal compaction at 10% moisture content.

Specific Gravity: A value of 2.6 suggests typical subgrade density.

Direct Shear Test: Revealed adequate shear strength for pavement stability.

These results guide material selection and pavement design, ensuring subgrade compatibility with traffic demands.

4.3 Maintenance Recommendations

Preventive Maintenance: Regular crack sealing, surface coats (e.g., seal, tack, prime), and periodic inspections.

Drainage Upgrades: Install robust drainage systems to mitigate water-induced damage.

Innovative Materials: Use Coir Geotextiles for soil stabilization and Polyguard for waterproofing, as recommended by Moghe et al. (2023).

Subgrade Strengthening: Provide a 100mm sub-base for weak soils, per IRC guidelines.

Quality Control: Implement continuous monitoring and material testing to ensure durability.

5. CONCLUSION

The study of NH-53 (Khote Nagar to Ajintha Chaufulli) reveals significant pavement distresses driven by traffic, environmental factors, and design limitations. Soil testing confirms the subgrade's suitability, while the proposed maintenance framework emphasizes preventive strategies, drainage improvements, and innovative materials. Proactive maintenance, supported by data-driven planning and stakeholder collaboration, is critical for enhancing highway performance, safety, and longevity. These findings offer actionable insights for transportation agencies to optimize NH-53 and similar highways, supporting economic and social development.

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