Use of Plastic Waste In Flexible Pavement As An Ingredient

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Abstract- *This study explores the feasibility of using plastic waste as an ingredient in flexible pavement construction. Plastic waste is increasingly becoming a global environmental concern, and the construction industry seeks sustainable solutions. This paper reviews the mechanical properties, environmental impact, and economic viability of incorporating plastic waste into pavements. Case studies and field experiments demonstrate the potential benefits, including improved pavement performance and reduced environmental impact. Challenges such as optimal plastic content and long-term durability are also discussed. Overall, this research offers a promising avenue for sustainable pavement construction, contributing to a greener future.*

Keywords- Flexible pavement, Ingredient, Sustainability, Pavement construction, Environmental impact, Performance enhancement, Waste management, Recycling Sustainable, infrastructure

I. INTRODUCTION

Plastic is everywhere in today's lifestyle and its disposal is a great problem. It is a non-biodegradable product due to which these materials pose environmental pollution and problems like breast cancer, reproductive problems in humans and animals and genital abnormalities.

The accumulation of plastic waste has emerged as a pressing environmental challenge globally. Concurrently, the construction industry is seeking innovative solutions to address sustainability concerns. One such solution is the utilization of plastic waste as an ingredient in flexible pavement construction. This paper explores the feasibility and potential benefits of integrating plastic waste into pavement materials.

By repurposing plastic waste in pavement construction, we aim to tackle two critical issues: waste management and sustainable infrastructure development. This introduction provides an overview of the growing plastic waste problem, outlines the motivation for using plastic waste in pavement, and previews the key objectives and contributions of this research. Through this study, we aim to shed light on the feasibility, benefits, challenges, and potential impact of incorporating plastic waste into flexible pavement construction, paving the way for a more sustainable approach to infrastructure development.

Population Growth and Impact on Overall Waste Generation and Future Predictions

YEAR	POPULATION (MILLIONS)	PER CAPITA	TOTAL WASTE GENERATION (TONS/YEAR)
2001	198	0.439	31
2011	260	0.498	47
2021	342	0.569	71
2031	451	0.649	107
2041	595	0.741	160

In recent years, applications of plastic wastes have been considered in road construction with great interest in many developing countries. The use of these materials in road making is based on technical, economic, and ecological criteria. In the state of Maharashtra they laid the test road of length up to 1,500 km. Other states like Tamil Nadu, Karnataka, Pondicherry, Kerala and Andhra Pradesh have also laid test roads. These roads have withstand loads due to heavy traffic, rain and temperature variation.

II. LITRATURE REVIEW

Prof.C.E.G. Justo states that addition of 8.0 % by weight of processed plastic for the preparation of modified bitumen results in a saving of 0.4 % bitumen by weight of the mix or about 9.6 kg bitumen per cubic meter (m 3) of BC mix. Modified Bitumen improves the stability or strength, life and other desirable properties of bituminous concrete mix.

V.S. Punith (2001), states there is possibility to improve the performance of bituminous mixes of road pavements. Waste plastics (Plastic bottles.) on heating soften at around 130°C. Softened plastics have a binding property. Hence, it can be used as a binder for road construction.

Dr. R. Vasudevan (2007) investigated that the coating of plastics reduces the porosity, absorption of moisture and improves soundness**.** He stated that the polymer bitumen blend is a better binder compared to plain bitumen. Blend has increased softening point and decreased Penetration value with a suitable ductility. When it used for road construction it can withstand higher temperature and load. The coating of plastics reduces the porosity, absorption of moisture and improves soundness.

S. Rajasekaran et al (2013) explains that by coating the aggregate with the polymer has many advantages and which ultimately helps in improving the flexible pavement quality not only it improve the pavement quality but also improve the aggregate quality .This technology also helps in the disposal of waste plastic obtained from the domestic and industrial packing materials. The dry process is more valuable as it dispose the 80 % of waste polymer in eco-friendly way. And use of polymer reduces the equivalent bitumen quantity and therefore reducing the construction cost of road.

Sasane Neha .B et al (2015) investigated application increases the life of road. As the plastic content increase the property of bitumen and aggregate also increases compared to conventional flexible pavement the flexible pavement with the added plastic has good results. According to marshal stability test the optimum use of plastic is up to 10%.

Sabina (2001) studied the comparative performance of properties of bituminous mixes containing plastic/polymer (PP) (8% and 15% by weight of bitumen) with conventional bituminous concrete mix (prepared with 60/70 penetration grade bitumen). Improvement in properties like Marshall Stability, retained stability, indirect tensile strength and rutting was observed in Plastic modified bituminous concrete mixes.

Wayal and Wagle carried out research on use of waste plastic and waste rubber in aggregate and bitumen for road materials .InTheir research they used polymer and crumbed rubber as a binder with respect to aggregate and bitumen. They tested the material For crushing value, impact value, abrasion value, and specific gravity, bitumen penetration value, ductility, softening point.

III. AIM OF PROJECT

Here are the key aims of the research paper presented in bullet points:

- Assess the feasibility of using plastic waste as an ingredient in flexible pavement construction.
- Evaluate the potential benefits of incorporating plastic waste into pavement materials.
- Investigate the mechanical properties of plastic-modified pavements, including stability, durability, and resistance to deformation.
- Analyze the environmental impact of plastic-modified pavements, focusing on reductions in carbon emissions and landfill usage.
- Examine the economic viability of utilizing plastic waste in pavement construction, considering material costs and long-term maintenance requirements.
- Contribute to sustainable infrastructure development and waste management practices through the implementation of plastic-modified pavements

IV. DRY PROCESS

It is the process of mixing the appropriate quantity of dry shredded waste plastic with hot aggregate prior to production of bituminous mixes at hot mix plant by varying percentage of plastic by weight of mix. In this process first dry aggregate is heated to a temperature of 150-160 °C then required amount of plastic is spread on the aggregate. Due to high temp. Plastic get melted and it coats the aggregate then bitumen is added to this modified aggregate. Due to coating of plastic on aggregate the voids get covered which increase the resisting from acid and water entrance which ultimately results in better performance of pavement.

V. PROCESS DETAILS

1. **COLLECTION OF WASTE PLASTIC:** Waste Plastic is collected from roads, garbage trucks, dumpsites or compost plants ,or from school collection programs or purchase from rag pickers or waste buyers.

2. **SHREDDING PLASTIC:** -Plastic waste which is cleaned is cut into a size between 4.75 mm and 6mm and of maximum using a shredding machine or manually.

3. **MIXING OF PLASTIC , AGGREGATE AND BUITMEN :**The aggregate mix is heated to 150°C in a Central mixing plant. The requisite percentage of plastic waste to the weight of bitumen is injected with a pipe under compressed air in the drum of a drum mix plant. The waste plastic initially coats the heated aggregates. In the next stage, bitumen is added to the aggregates, the temperature of the binder shall conform to the temperature depending on the grade of binder and the type of mix. The plastics waste coated aggregate is mixed with hot bitumen for 15 secs and the resulting mix used for preparing mould.

4. **PREPRATION OF MOULD:**After the mixing we prepare a mould which dia is 101mm and height 63.5mm by using mould equipment.75 number of bolws are applied on the mould both side for compaction Then we kept the mould in room temperature for 24 hours. After then mould is used for testing

VI. TEST RESULTS OF MATERIAL

1. TEST RESULT OF AGGREGATE:

Sl. No.	Tests	Results			Specification as per (IRC:105-2019)
		20MM	10MM	06MM	
1	Combined Flakiness & Elongation Index (%)	24	26	-	Max 30%
2	Water Absorption (%)	0.54	0.64	0.95	Max 1%
3	Impact Value (%)	22	18	-	Max 24%
4	Stripping Value (%) (Minimum retained Coating)	97	96	-	>95%

2. TEST RESULTS OF BUITMEN:

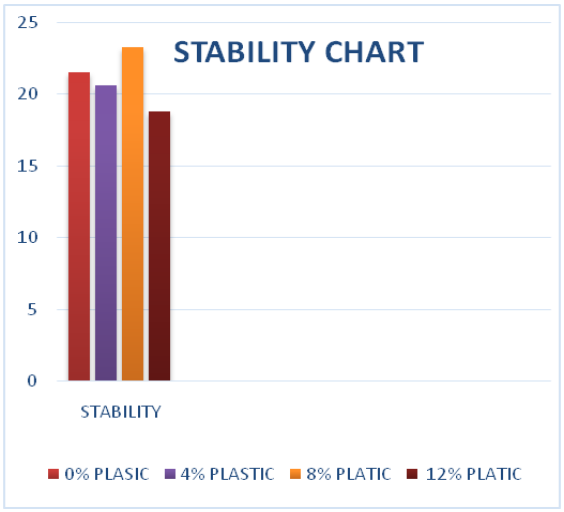
SN.	CHARACTERISTICS	GREDE (VG30)	TEST METHOD
1	Penetration at 25^{0}c ,0.1 mm ,min	45	IS 1203
2	Absolute Viscosity at 135^{0}c , min	2400-3600	IS1206 (PART-2)
3	Kinematic viscosity at 135^{0}C, cSt, min	350	IS 1206 (Part3)
4	Flash Point (COC method), ^{0}C, min	220	IS 448 [P:69]
5	Solubility in trichloroethylene, % min	99.0	IS 1216
6	Softening point (R&B) temperature, ^{0}C, min	47	IS 1205
7	Ductility at 25^{0}c, cm, min	40	IS 1208

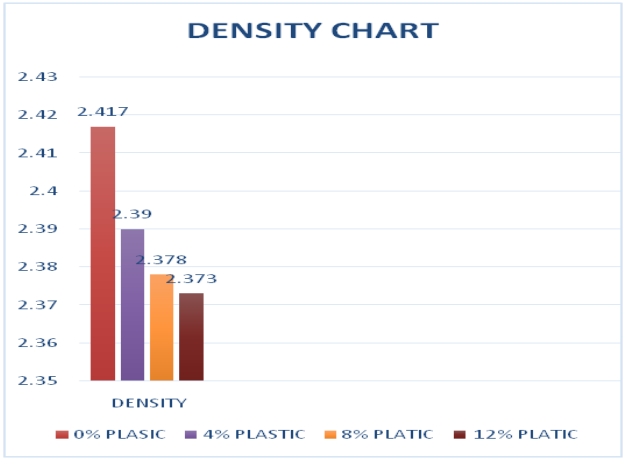
3.SPECIFIC GRAVITY OF INGRIDIENT:

SN.	INGRIDIENTS	SPECIFIC GRAVITY
1	Aggregate (20mm)	2.66
2	Aggregate (10mm)	2.62
3	Aggregate (06mm)	2.64
4	Stone Dust	2.71
5	Bitumen	1.03

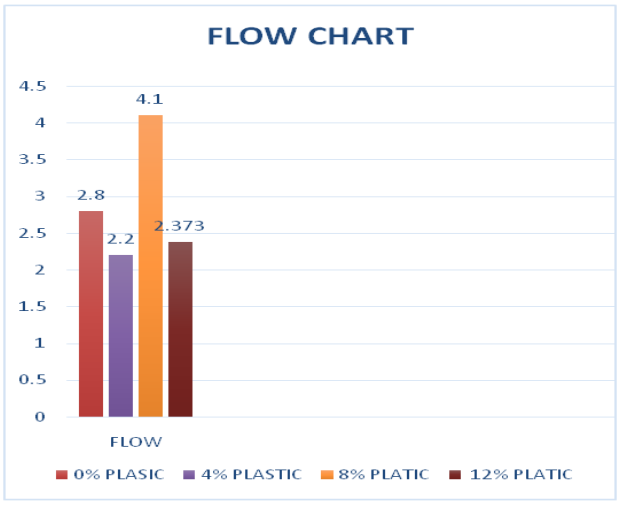
4.MARSHALL STABILITY TEST:

Sr. No	Binder Content (%)	Density (gm/cc)	Marshall Stability (kN)	Flow (mm)
1.	4.7 %	2.417	21.54	2.8
2.	At (4% Plastic+ Binder Content)	2.390	20.62	2.2
3.	At (8% Plastic+ Binder Content)	2.378	23.25	4.1
4.	At (12% Plastic+ Binder Content)	2.373	18.81	4.3





DENSITY CHART OF BITUMEN PLASTICCONTENT



FLOW CHART OF BITUMEN PLASTIC CONTENT

VII. CONCLUSION

Utilizing waste plastic in road construction not only benefits the environment and extends road lifespan but also reduces reliance on petroleum products while generating additional income for stakeholders. However, successful adoption of this technology hinges on widespread cooperation and involvement from the public and local authorities. Effective waste plastic segregation at the source and its transfer to self-help groups are crucial steps to prevent environmental pollution. Moreover, compared to conventional methods, road stretches resurfaced with plastic-coated aggregates exhibit superior functional performance, including enhanced surface conditions, delayed pothole and crack development, and improved skid resistance and texture.

The plastic mixed with bitumen and aggregates is used for the better performance of the roads. The polymer coated on aggregates reduces the voids and moisture absorption. This results in the reduction of ruts and there is no

pothole formation. The plastic pavement can withstand heavy traffic and are durable than flexible pavement. The use of plastic mix will reduce the bitumen content by 10% and increases the strength and performance of the road. This new technology is eco-friendly.

REFERENCES

[1] International Journal of ChemTech Research-2017 (R. Manju*; Sathya S; Sheema K)
[2] Manu Sasidharan, Dr Mehran Eskandari Torbaghan & Dr Michael Burrow University of Birmingham May 2019
[3] Application of Waste Plastic Materials in Road Construction by Amit Kumar Sahu1, R. K Singh
[4] International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181http:// www.ijert.org IJERTV5IS090574 Vol. 5 Issue 09, September-2016
[5] Implementation of Technology and Roll out (November 2014)
[6] JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN CIVIL ENGINEERING-MR. MAHESH M BARAD
[7] International Journal of Scientific and Research Publications, Volume 7, Issue 4, April 2017 137 ISSN 2250-3153