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Use of Waste Tyres in Road Construction

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Abstract

The disposal of waste tyres has become a significant environmental challenge due to their non-biodegradable nature and large volumes of accumulation. One innovative and sustainable solution to address this issue is the use of waste tyres in road construction. Incorporating tyre-derived materials, such as crumb rubber and shredded rubber, into asphalt or concrete pavements offers multiple benefits. Rubberized asphalt enhances the durability, flexibility, and skid resistance of roads while reducing the likelihood of cracking and rutting. Additionally, it improves noise reduction and shock absorption, contributing to safer and more comfortable driving conditions. The use of waste tyres in road construction also promotes environmental sustainability by reducing landfill waste and lowering the need for natural aggregates. It can contribute to lower construction costs, as recycled rubber is often more economical than traditional materials. Moreover, rubberized roads have shown improved resistance to temperature fluctuations, making them suitable for regions with varying weather conditions. Despite the numerous benefits, challenges such as initial setup costs, technical expertise, and quality control need to be addressed. Proper design, mixing, and testing processes are essential to ensure the longevity and performance of rubberized roads. Overall, the use of waste tyres in road construction offers an eco-friendly and economically viable solution to the growing tyre disposal problem. It not only enhances road quality and longevity but also supports sustainable waste management practices, making it a promising approach for future infrastructure development.

Introduction

The rapid increase in vehicle usage has led to a significant rise in the production of waste tyres, creating an environmental challenge due to their non-biodegradable nature. Disposing of waste tyres in landfills or through incineration is not sustainable, as it contributes to pollution and wastes valuable materials. To address this issue, researchers and engineers have explored innovative ways to reuse waste tyres, one of which is in road construction. Incorporating waste tyres into road construction offers multiple benefits. Tyre-derived materials, such as crumb rubber, are added to asphalt or

concrete mixtures to enhance the durability, flexibility, and resistance of roads. Rubberized asphalt, created by blending crumb rubber with bitumen, improves road performance by reducing cracking, increasing skid resistance, and minimizing noise pollution. More over, using waste tyres in road construction reduces the demand for natural resources, promoting sustainable infrastructure development.This eco-friendly practice also addresses the issue of waste tyre accumulation, which otherwise poses fire hazards and breeding grounds for disease-carrying pests. By repurposing waste tyres in road construction, countries can reduce environmental pollution while simultaneously improving the quality and lifespan of their road networks. Therefore, utilizing waste tyres in road construction is an innovative and sustainable solution that contributes to waste management, resource conservation, and enhanced road performance.

Figure no. 1:- Waste Rubber Tyres from waste into concrete

AIM & OBJECTIVES

Aim: use of waste tyres in road construction.

Objectives

1. To study environmental Sustainability
2. To study Material Performance
3. To study Economic Feasibility
4. To study technical Development.
5. To study Practical Implementation

Research Work

Problems due to waste tyres

- Pollution:- Waste tyres can pollute the air and soil with harmful substances.
- Leachate:- Waste tyres can release harmful chemicals and heavy metals into the soil and groundwater.
- Non-biodegradable:- Many waste tyres are non-biodegradable and can create environmental pollution.
- Tyre fires: Tyre fires can pollute the air with carbon smoke, hydrocarbons, and residue. Tyre fires can be difficult to extinguish.

Figure no. 2 :- waste tyres

Bitumen

Bitumen is a black, viscous, and sticky material derived from crude oil through the refining process. It is primarily used as a binder in road construction and in waterproofing applications. Bitumen is composed of complex hydrocarbons and has adhesive and waterproofing properties, making it an essential material in infrastructure projects.

Properties of bitumen

Sr.No.	Characteristics	80/100	60/70	30/40	10/20
1	Specific Gravity at 27 °C min	0.98	0.99	0.99	1.00-1.05
2	Water percent by wt.max	0.2	0.2	0.2	-
3	Flash point, °C	175	175	175	225
4	Softening point °C	35-50	40-55	50-65	65-80
5	Penetration at 25 °C, 100 g 5 sec in 1/100 cm	80-100	60-70	30-40	10-20
6	Ductility at 27 °C, in cm. min	75	75	50	2.5
7	Loss on heating, percentage by wt.Max	1	1	1	0.10
8	Penetration of residue	60	60	60	-
9	Percent by wt. soluble in carbon di- sulphide, min	99	99	99	99

Table no. 1 :- Properties of bitumen Test for bitumen with IS codes

Type of test	Test Method
Penetration Test	IS: 1203-1978
Ductility test	IS: 1208-1978
Softening Point test	IS: 1205-1978
Specific gravity test	IS: 1202-1978
Viscosity test	IS: 1206-1978
Flash and Fire Point test	IS: 1209-1978
Float Test	IS: 1210-1978
Determination of water content	IS: 1211-1978
Determination of Loss on heating	IS:1212-1978

Table no. 2 :- Test for bitumen with IS codes

Crumb rubber

Crumb rubber is a material made by shredding and grinding recycled rubber tires into small, uniform particles. It is commonly used in various applications, including playground surfaces, athletic fields, rubberized asphalt, and landscaping. The process of making crumb rubber involves removing steel and fiber from old tyres, followed by mechanical or cryogenic

grinding to achieve the desired particle size.

Physical properties of crumb rubber

Physical properties	Unit
Density	1320 kg/m^3
Young's modulus (E)	2600-2900 MPa
Tensile strength (σ_t)	40-70 MPa
Elongatian at break	25-50%
Melting point	200 °C
Price	0.25-0.50 €/kg

Table no. 3:- physical properties of crumb rubber Road Construction

Applications

- Asphalt Rubber Binder:- The most common application. Waste tyres are processed into crumb rubber and blended with asphalt to form a flexible pavement.
- Rubberized Asphalt Concrete:- Asphalt concrete mixes modified with crumb rubber, which improves performance and extends service life.
- Subbase and Base Layers:- Shredded tyres can be used in the base layers, providing drainage benefits and reducing the use of natural aggregates.
- Concrete Roads:- Steel fibres from tyres can be incorporated into concrete for reinforcement and crack resistance.

Case Studies and Research Findings

- **India:-** Trials have shown that using rubberized asphalt increases pavement life by 30-40% in high-traffic areas.
- **United States:-** States like California, Arizona, and Florida have successfully used rubberized asphalt pavements, reducing noise and improving road longevity.
- **Australia :-** Research shows that adding crumb rubber improves pavement resistance to rutting by 50%.

Figure no. 3:- using waste tyres in road construction

Advantages of using waste tyres in road construction

1. **Enhanced Flexibility :-** Rubberized asphalt offers better flexibility, reducing cracks caused by temperature changes.
2. **Increased Durability :-** Roads become more resistant to wear and tear, extending their lifespan.
3. **Improved Skid Resistance :-** Provides better grip, enhancing road safety, especially in wet conditions.
4. **Noise Reduction :-** Reduces road noise, creating quieter driving conditions.
5. **Eco-Friendly Waste Management :-** Reduces landfill waste by recycling non-biodegradable tyres.
6. **Lower Maintenance Costs :-** Rubberized roads require less frequent repairs, cutting maintenance expenses.
7. **Better Water Drainage :-** Porous rubberized asphalt allows efficient water drainage, preventing hydroplaning.

Figure no. 4 :- waste tyres in road construction

RESULTS

Enhanced Flexibility:- The rubberized asphalt demonstrated improved flexibility and resistance to cracking under temperature variations.

Increased Durability:- Rubber-modified pavements showed higher resistance to wear and tear compared to conventional roads.

Reduced Maintenance Costs:- The improved elasticity reduced the formation of cracks and potholes, lowering maintenance costs.

Eco-Friendly Solution:- The reuse of waste tyres reduced landfill waste and minimized environmental hazards.

Cost-Effectiveness:- Though the initial cost of rubber-modified asphalt is slightly higher, the long-term maintenance costs are significantly lower.

CONCLUSION

In conclusion, the use of waste tyres in road construction has the potential to provide sustainable solutions to the environmental and economic challenges associated with waste tyre disposal. By incorporating waste tyres into road construction projects, municipalities and transportation agencies can not only reduce the environmental impact of waste tyres but also improve the performance and longevity of road surfaces. Further research and development are needed to address the challenges and limitations of using waste tyres in road

construction and to promote the widespread adoption of this innovative and sustainable practice. Overall, the use of waste tyres in road construction represents a promising approach toward sustainable infrastructure development, combining environmental benefits with enhanced road performance.

Future Scope

Large-Scale Implementation:

- Wider adoption of rubberized asphalt in national and international road construction projects.
- Integration into government infrastructure policies and road development programs.

Government Regulations and Policies:

- Development of policies and standards promoting the use of recycled tyres in road construction.
- Incentives for contractors and companies using eco-friendly materials.

Public Awareness and Acceptance:

- Increasing public awareness about the environmental benefits of using waste tyres in road construction.
- Gaining public and industry support for large-scale implementation.

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