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Utilization of Waste Tyre In Flexible Bituminous Pavement

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ABSTRACT:

India's rapid urbanization and development are leading to a surge in road construction and vehicular traffic. This, in turn, is generating a significant and growing volume of scrap tires, with 15-20% of waste and worn-out tires accumulating annually. The global issue of waste tire disposal is a major environmental concern because tires are non-biodegradable. Annually, an estimated 1.5 billion tires are discarded worldwide.

Accumulated waste tires in landfills and stockpiles pose serious threats: they leach toxic chemicals, create breeding grounds for mosquitoes, and can fuel persistent fires. Industries are increasingly struggling with waste disposal. However, a promising solution involves using modified bitumen that incorporates granulated or crumb rubber from post-consumer waste tires. This mixture can partially replace fine stone aggregate in road construction.

The indiscriminate disposal and stockpiling of used tires highlight the urgent need for sustainable solutions due to their non-biodegradable nature and the resulting environmental and health hazards. Research is exploring the feasibility of blending waste tire rubber into bitumen for road construction. This approach not only offers a viable recycling opportunity for waste tires but also has the potential to improve the properties of bitumen, leading to significant environmental benefits

Keywords: Keywords are important word in paper. Example Weather Prediction, forecast accuracy.

Introduction:

The increasing number of vehicles worldwide has led to a rapid rise in waste tyre generation, creating serious environmental and disposal challenges. Tyres are non-biodegradable and often end up in landfills or are burned, releasing harmful pollutants and posing health hazards. In countries like India, millions of tyres are discarded annually, leading to concerns over land use, mosquito breeding, and fire risks. As a sustainable alternative, researchers and engineers have turned to the use of waste tyre rubber—especially in the form of crumb rubber—in road construction.

Incorporating crumb rubber into flexible bituminous pavement has proven to be an effective solution for both waste management and infrastructure improvement. Modified bitumen with rubber enhances key properties such as elasticity, rutting resistance, and fatigue life, making roads more durable under heavy traffic and extreme climates. Although initial costs may be higher, long-term benefits include reduced maintenance and extended pavement lifespan. This approach supports environmental protection and promotes circular economy practices in civil engineering.

Related work

Recycling Waste Rubber Tyres in Road Construction"

by Ivana Barišić, Matija Zvonarić, Ivanka Netinger Grubeša, and Sanja Šurdonja

This study presents a comprehensive overview of the incorporation of waste rubber tyres in road construction, aiming to mitigate the environmental issues associated with tyre disposal while enhancing pavement performance. It emphasizes Croatia's national framework and current research trends in integrating waste rubber into cement-bound and flexible pavement layers.

The paper explores various applications of crumb rubber, including:

- **Wet process**: where rubber is blended with bitumen to improve binder properties.
- **Dry process**: where rubber is added directly to aggregates.
- **Terminal blend**: a fully digested rubber-asphalt mixture.

Key performance enhancements include improved elasticity, reduced traffic noise, and higher resistance to rutting and thermal cracking. Despite these benefits, the study also notes drawbacks such as higher costs, increased emissions, and bitumen-rubber separation issues.

The research highlights alternative uses in unbound base/subbase layers, where small fractions of rubber can improve deformation resistance and CBR values. It identifies promising innovations like poroelastic surfacing, which reduces noise and increases fire safety.

By reviewing international and Croatian studies, and presenting ongoing experiments, the paper advocates for broader adoption of waste tyre recycling in road infrastructure. It also calls for further research on environmental impact, particularly concerning heavy metal leaching and long-term pavement behavior under traffic loads.

Let me know if you want similar summaries for the other uploaded papers.

2. "USE OF WASTE TYRE IN ROAD CONSTRUCTION"

By Ritika Sharma, Shreyansh Yadav, Utkarsh Dubey, Rohit Kumar, and Ms. Khushboo Tiwari
Published in *IRJMETS, Vol. 6, Issue 5, May 2024*
This paper explores the potential of utilizing waste tyre rubber in flexible pavements, emphasizing its environmental and economic advantages. Crumb rubber is introduced into bitumen through the wet process, enhancing properties such as softening point, elasticity, and durability. Laboratory tests like penetration, ductility, and softening point were conducted to validate improvements.
The authors highlight India's rapidly growing automotive sector as a major source of waste tyres, which pose serious environmental hazards if not managed. The paper also summarizes previous works including the Bangalore Process and studies by Siddharth Rokade and Nuha Mashaan, which demonstrated optimal strength at around 12% rubber inclusion.
The research concludes that incorporating crumb rubber into bitumen is a sustainable, cost-effective solution that also improves road longevity and reduces maintenance needs.

3. "Comprehensive Literature Review on Use of Waste Tyres Rubber in Flexible Road Pavement"

By Atul A. Pasalkar, Yogesh M. Bajaj, Amol A. Wagh, and Jitendra D. Dalvi
Published in *IJERT, Vol. 4, Issue 2, Feb 2015*
This literature review assesses various methods of incorporating waste tyres into flexible pavements. It documents global trends and highlights both environmental benefits and technical applications. The paper details multiple methods such as using chunk rubber in cold mixes, adding crumb rubber in sub-base layers, and mixing with fly ash or plastic waste.
Case studies, including the construction of a 300m tyre-reinforced road embankment, provide practical insight. The authors stress that rubberized bitumen can enhance durability, reduce cracking, and improve resistance to rutting and fatigue.
Overall, the paper recommends integrating waste rubber into pavement design as a viable approach for waste management, cost reduction, and road quality improvement.

4. "Use of Waste Tyres in Road Construction"

by Ajay V. Marotkar et al.
Published in *IJAITE, Vol. 6, No. 3, May 2021*
This study examines the integration of crumb rubber in bitumen for road surfacing using the wet process. It argues that India's growing vehicle population contributes to a major tyre waste problem, which can be partially mitigated through rubberized roads. Tests confirm that modified bitumen shows better skid resistance, higher softening points, and increased fatigue resistance compared to conventional bitumen.
The authors reference research by Siddharth Rokade and Nuha Mashaan, confirming enhanced Marshall Stability and durability at optimum crumb rubber dosages (up to 12%). The study also describes the types of crumb rubber and processing methods like cracker mill, granulator, and cryogenic processes.
The research concludes that waste tyre rubber can be a viable additive to extend pavement life, reduce costs, and address the pressing waste management crisis.

5. "Use of Waste Tyres in Road Construction"

by Shunyam Srivastava, Vishal Gupta, Lavina, Arief Shaikh, Heera Kumar, Er. Kulvinder Singh, and Er. Deepak Kumar
Published in *IJAEM, Vol. 3, Issue 6, June 2021*
This paper provides an in-depth study of rubberized bitumen production using both the wet and dry processes. The research presents historical developments such as the McDonald Process and the evolution of stress-absorbing membrane interlayers (SAMIs).
The benefits of rubberized bitumen are noted, including:

- Enhanced resistance to moisture and rutting
- Increased durability in extreme climates
- Reduced environmental footprint through recycling

The paper outlines key applications such as slurry seal, chip seal, and binder layers, citing real-world implementations in India and the U.S. It emphasizes the viability of rubber-modified asphalt in modern road construction and offers a cost-effective, environmentally responsible solution to tyre waste disposal.

Methodology:

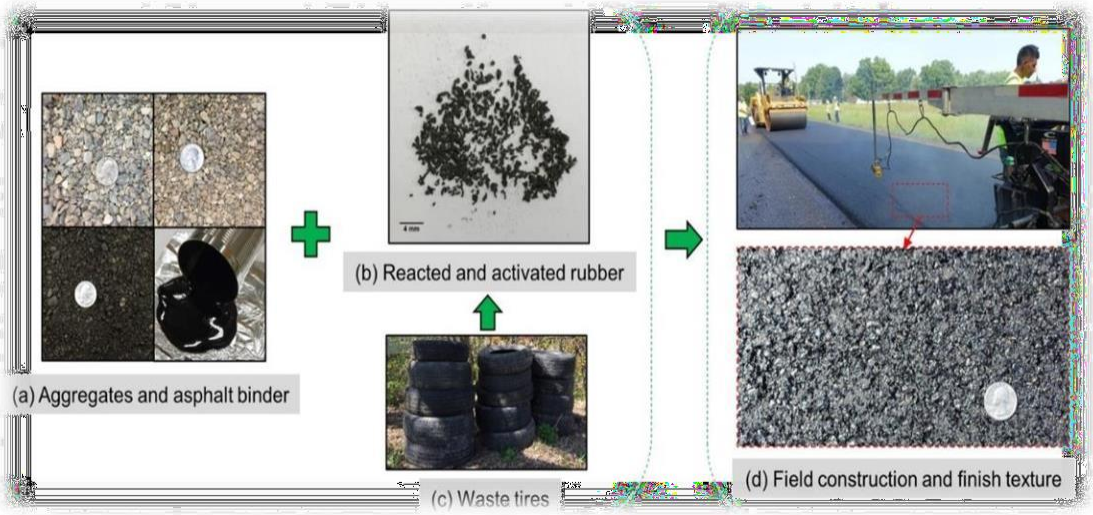
The methodology adopted in this study focuses on the systematic processing of waste tyres to produce Crumb Rubber Modifier (CRM), which is later used for modifying bitumen in flexible pavement construction. The procedure ensures safe handling and efficient conversion of waste tyres into usable materials while minimizing environmental hazards.

Step 1: Metal Wire Removal

Initially, waste tyres are subjected to a tyre ring cutter machine to extract the embedded steel wires. This step is crucial as it separates metallic components that could interfere with the shredding and mixing processes.

Step 2: Sidewall Cutting

After wire removal, the tyres are processed through a tyre sidewall cutter. This machine cuts the tyres



Into smaller and more manageable pieces by separating the sidewalls. This enhances operational safety and prepares the material for further size reduction.

Step 3: Shaping into Small Pieces

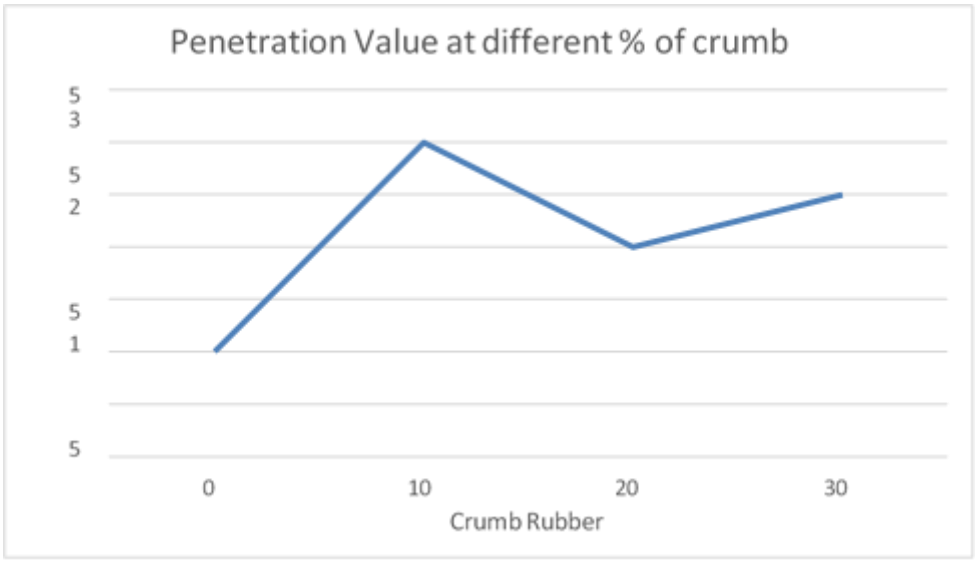
The separated tyre segments are then transferred to a RIM rubber machine. This machine breaks down the tyre material into smaller chunks, making it easier to process and handle in subsequent steps.

Step 4: Crumb Rubber Production

These small rubber pieces are finally processed through a tyre shredding machine to produce crumb rubber. The output is sorted into various categories, primarily:

- **Fiber** – which may be separated for alternative applications.
- **Coarse size** – used as Crumb Rubber Modifier (CRM) in the modification of bitumen.

This systematic approach ensures the transformation of waste tyres into a value-added material suitable for road construction, aligning with environmental sustainability goals. The crumb rubber produced is then used in specific proportions with bitumen to study its effects on pavement performance characteristics



Objective:

1. To research a variety of forecasting strategies for predicting future weather.
2. To predict the condition of a specific weather event in the near future.
3. To provide a weather forecasting platform.

Results

Penetration test:-
The penetration test for bitumen products was performed on samples made with partial replacement of 5-20 percent waste rubber tires respectively. Three experiments were carried out, with the average results being shown.

Formula of Penetration test :- :- $\frac{trail\ 1 + trail\ 2 + trail\ 3}{3}$

2.Specific

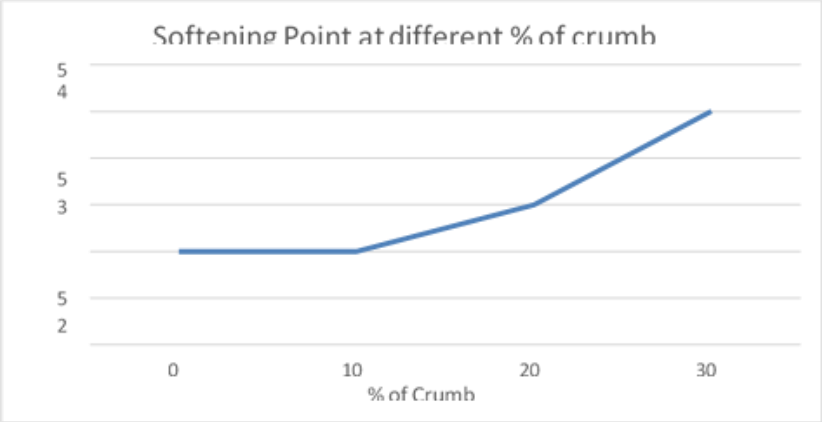
Sample	Trial 1	Trail 2	Trail 3	Avg value
10%	55	49	51	51.6mm
20%	48	47	54	49.6mm
30%	68	66	64	66mm

Gravity:- the ratio of the density of a substance to the density of some substance (as pure water) taken as a standard when both densities are obtained by weighing in air. now,

For 10%

Empty weight of bottle(a) =61.44gm

Wt of bottle filled with distilled water (b)=124.06gm



Wt of bottle half filled(C)=96.04gm

Wt of bottle filled(d)=126.27gm

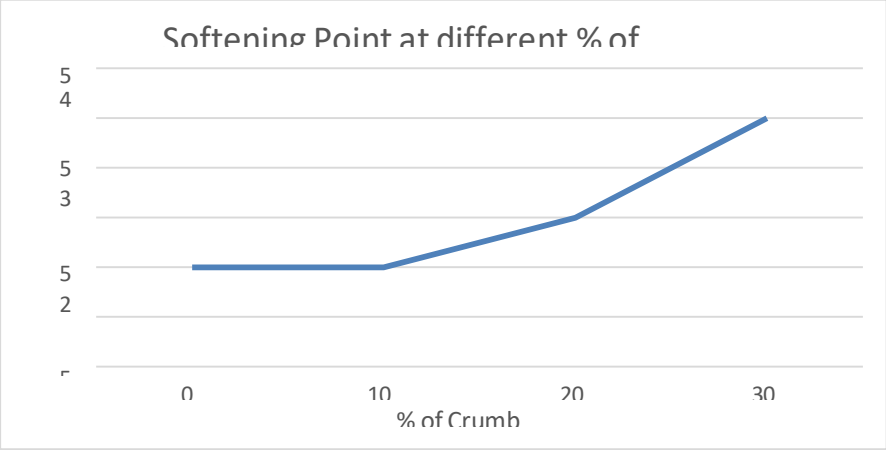
$$\textbf{Specific gravity} = \frac{(c-a)}{(b-a)} \times (d-c)$$

3.Softening point:-

The temperature at which the substance attains a particular. degree of softening under specified conditions of test.

Observation Table :-

Duration	**Increase in temperature**		
Time (min.)	**10% ($^{o}_{c}$)**	**20% ($^{o}_{c}$)**	**30% ($^{o}_{c}$)**
1.	**8°c**	**9 °c**	**8 °c**
2.	**12°c**	**12°c**	**13 °c**
3.	**17°c**	**17°c**	**18 °c**
4.	**22°c**	**22°c**	**23 °c**
5.	**27°c**	**27°c**	**28 °c**
6.	**32°c**	**32°c**	**33 °c**
7.	**37°c**	**37°c**	**38 °c**
8.	**42°c**	**42°c**	**43 °c**
9.	**47°c**	**47°c**	**48 °c**
10.	**50.2°c**	**50.8 °c**	**53 °c**



Conclusion

- In this laboratory study, the crumb rubber has been used as bitumen replacement by weight, i.e. 10%, 20% & 30%. And tests such as Penetration test, Specific Gravity test and Softening tests were also accomplished to evaluate the physical properties of modified bitumen.
- The use of crumb rubber also increases the percentage of air voids than conventional mix.
- By the use of crumb rubber in road construction also solves the problem of waste tire disposal and prevent environmental problems.
- The physical properties such as penetration and softening point of modified bitumen were also improved, the modified bitumen was found out to be of harder consistency making it more rutting resistant and less flexible.

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