

Original Article

# Experimental Study on the Utilization of Glass Powder And Waste Oil in Bituminous Mixes

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**Abstract:** *The properties of bituminous mixes modified with glass powder and waste oil for use in road construction are examined in this study. The goal is to assess how waste oil as a modifier and glass powder as a partial replacement material affect bituminous mix performance. Standard tests including Marshall Stability, flow value, density, and air void analysis were used in the experimental analysis. The findings show that because of its angular shape and superior interlocking qualities, glass powder increases the mix's stiffness and load-bearing capability. Bitumen's workability and flexibility are improved by waste oil, which also lessens brittleness and increases crack resistance. The investigation determines the ideal proportion of waste oil and glass powder that yields the best results. The results imply that using these waste materials provides a cost-effective, ecologically friendly, and sustainable way to build flexible pavement.*

**Keywords:** *Glass Powder, Waste Oil, Bituminous Mix, Marshall Stability, Flexible Pavement, Sustainable Construction*

## I. INTRODUCTION

When building roads, bituminous materials and aggregates are essential. While aggregates give the pavement strength and stability, bitumen serves as a binding agent. The characteristics of these materials determine how well roads function overall.

Waste materials like glass and used oil are produced in significant amounts as a result of growing urbanization and industrialization. Pollution of the environment results from improper disposal of these materials. Concurrently, there is a growing demand for natural resources like bitumen and aggregates, which is causing their depletion.

Glass powder, which is made from leftover glass, has characteristics like angularity and hardness that enhance bituminous mix interlocking. Bitumen becomes more flexible and workable when waste oil is added. The evaluation of the combined impact of waste oil and glass powder on bituminous mix performance is the main goal of this study.

## II. LITERATURE REVIEW

### A. Zhang et al. (2024)

Zhang et al. (2024) investigated advanced methods for improving the performance of bituminous materials used in road construction. The study focused on modifying the composition of bitumen to enhance its mechanical properties. The results showed that improved bitumen exhibits higher resistance to deformation under heavy loads and elevated temperatures. It was observed that modified bitumen provides better durability and reduces the chances of cracking. The study concluded that proper modification techniques significantly improve pavement performance and service life.

### B. Chen et al. (2023)

Chen et al. (2023) examined the bonding characteristics between bitumen and aggregates in asphalt mixtures. The research highlighted that strong adhesion between binder and aggregates improves structural stability. The findings indicated that better bonding reduces moisture damage and enhances resistance to environmental stresses. It was also observed that improved adhesion contributes to uniform load distribution within the pavement. The study emphasized that good bonding plays a vital role in increasing the durability of bituminous mixes.

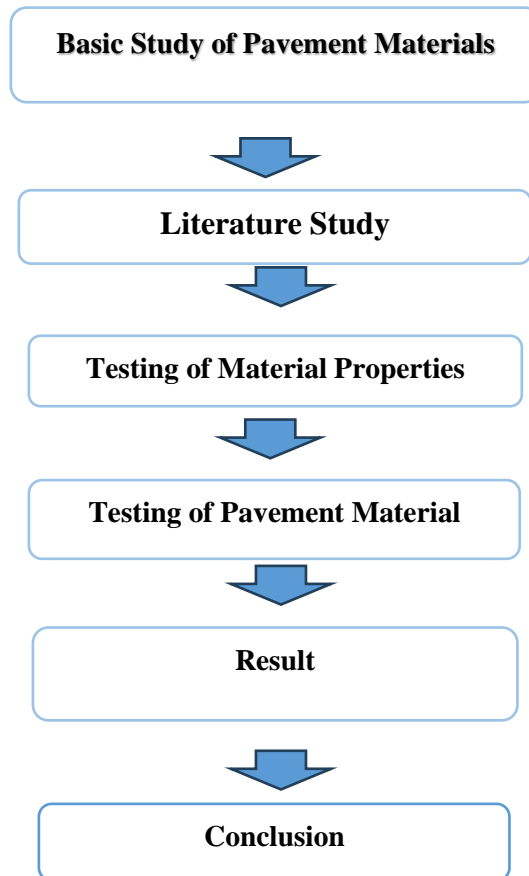
### C. Yao et al. (2020)

Yao et al. (2020) studied the use of waste materials such as glass powder in asphalt mixtures. The results showed that the inclusion of glass powder improves stiffness and stability of the mix. The angular shape of glass particles enhances interlocking and increases load bearing capacity. It was also observed that the modified mix exhibits better resistance to environmental effects. The study concluded that glass powder can be effectively used as a sustainable alternative material in pavement construction.

**D. Dalhat et al. (2021)**

Dalhat et al. (2021) investigated the performance of asphalt mixtures containing waste glass powder as a replacement for fine aggregates. The study found that the addition of glass powder improves Marshall Stability and fatigue resistance of the mix. Improved particle interaction resulted in better load distribution and structural strength. However, excessive replacement reduced bonding between bitumen and aggregates. The study concluded that optimum usage of glass powder enhances pavement performance and durability.

**III. METHODOLOGY**



**IV. MATERIAL USED**

The materials utilized in this investigation include waste oil, bitumen, glass powder, and coarse aggregates. In order to provide sufficient strength, durability, and stability in the bituminous mix, coarse aggregates were chosen in accordance with conventional gradation standards. Because of its appropriate viscosity and performance characteristics at different temperatures, VG-30 grade bitumen was utilized as the binding medium. Glass waste was gathered, cleaned, and ground into a fine powder by passing it through the appropriate sieve size. This powder was then added to the mixture as a modifier. To increase the bitumen's workability, flexibility, and resistance to cracking, waste oil was added. To verify their viability for pavement construction applications, all materials were evaluated in compliance with applicable IS requirements.

**Table1: Physical Properties of Aggregate**

PROPERTIES	TEST RESULT	MORTH specifications	TEST METHOD
Moisture content (%)	1.2	Max 2%	IS:2386 Part-III
Aggregate Impact value (%)	23.96	Max 24%	IS:2386 Part-IV
Specific Gravity of Coarse aggregate	2.75	Max 3	IS:2386 Part-III

**A. BITUMEN**

Viscosity grade VG-30 bitumen was used for preparation of mix and samples. Physical properties of bitumen.

**Table 2. Physical Properties of bitumen (VG-30)**

Property	Test Result	Requirement as per IR IS 73: 2013
Penetration at 25°C (0.1mm,100gm, 5sec)	55 cm	50-70
Ductility at 25°C, (cm)	34 cm	40
Softening Point (R&B) (°C)	44°C	47
Specific gravity	0.98	0.97-1.02

**V. PREPARATION OF MIX**

The experimental research was conducted using the Marshall Test procedure as outlined in ASTM D1559 and MoRTH requirements. The necessary gradation was used to make the bituminous concrete mixture, which is made up of glass powder and coarse particles. To reach the right viscosity, the bitumen was heated to around 150°C, and to guarantee homogeneous coating, the aggregates were heated to a temperature that was about 20°C higher than the bitumen. To ensure consistency in mixing, this procedure was followed in compliance with IRC and MoRTH norms.

To make the heated bitumen more flexible and workable, waste oil was added as a modifier in a predetermined percentage. Glass powder made from leftover glass was used as a partial substitute in the mix.

To produce a consistent consistency and appropriate coating, the heated aggregates, modified bitumen, and glass powder were well combined. To guarantee the mixture's homogeneity, the mixing operation was continued for two to five minutes. After that, the produced mixture was put into Marshall mould that had been preheated, and it was crushed with 75 blows on each side using a Marshall hammer. For a whole day, the crushed specimens were left to cool at room temperature. Following cooling, the specimens were taken out of the moulds and subjected to routine testing at 60°C.

**VI. EXPERIMENTAL PROCEDURE**

1. First, Marshall specimens with bitumen percentages ranging from 4% to 6% were prepared in order to determine the optimum bitumen content (OBC).
2. The ideal bitumen concentration was determined to be 5% after the Marshall Stability values and volumetric characteristics were examined.
3. Waste oil was added to the bitumen at a fixed proportion (4%) after the bitumen composition was fixed in order to examine its impact on workability and performance.
4. After that, glass powder was added in different amounts 5%, and 10% to see how it influences on stability and strength characteristics mix.
5. In order to evaluate performance improvement, the specimens made with the ideal amount of glass powder and waste oil were evaluated and contrasted with traditional mixes.

**Table 3: Marshall Stability Test Results**

S.no	Mix Types	Glass Powder %	Bitumen Content %	Stability (kN)	Flow (mm)
1	Conventional mix	0	5	10.5	2.32
2	Modified Mix	5	5	11.8	2.34
3	Modified Mix	10	5	12.6	2.36
4	Modified Mix	15	5	11.2	2.33

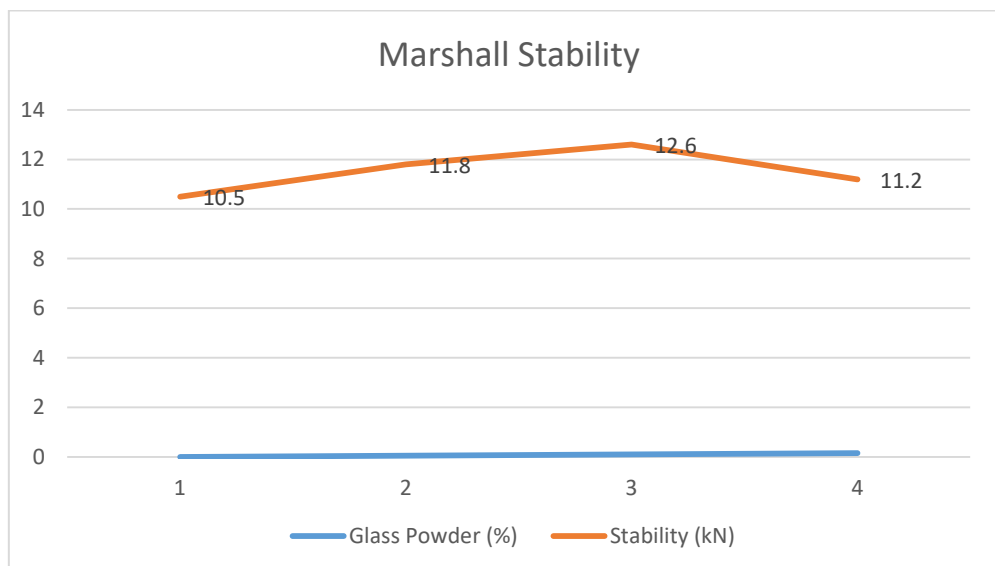
## VII. RESULT & DISCUSSION

The Marshall Stability test and flow value analysis were used to assess the performance of the bituminous mix amended with glass powder and waste oil. The experimental investigation's findings show that adding glass powder significantly affects the mix's stability and strength. The Marshall Stability values were found to rise as the glass powder content rose, reaching an ideal level. The highest stability was attained at 10% glass powder, indicating enhanced aggregate particle interlocking and increased load-bearing capability.

A decrease in stability was observed above the ideal percentage, which might be explained by the flat surface texture of bitumen and glass particles reducing the connection between them. The bitumen's workability and flexibility were enhanced by the addition of waste oil, leading to marginally higher flow values. This suggests that the altered mixture is more resilient to cracking under loading circumstances.

When glass powder was added up to the ideal level, the mix's density slightly increased, suggesting improved material packing and compaction. The air voids were maintained within acceptable limits, ensuring durability and resistance to moisture damage. The results clearly show that the modified mix performs better than the conventional mix in terms of stability and flexibility.

The graphical analysis also supports the experimental results, where the stability curve shows a peak at 10% glass powder content. Similarly, the comparison graph between conventional and modified mix indicates higher stability values for the modified mix. Thus, the combination of glass powder and waste oil enhances the overall performance of the bituminous mix.



**Figure 1: Marshall stability vs Glass powder**

## VIII. CONCLUSION

The experimental study on bituminous mix modified with glass powder and waste oil shows that adding these elements greatly enhances the mix's performance characteristics. Glass powder's angular shape and improved interlocking qualities increase the mix's stability and stiffness. By acting as a modifier, waste oil increases bitumen's workability and flexibility, decreasing brittleness and boosting its resilience to cracking. According to the Marshall Stability test results, the ideal glass powder content is about 10%, after which the stability declines since there is less bonding between the materials. Overall, the modified bituminous mix performs better than the traditional mix and provides a flexible pavement option that is both affordable and environmentally friendly.

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