

# EXPERIMENTAL STUDY ON MODIFIED BITUMEN USING LDPE AND CRUMB RUBBER

Mehruniza K N, Megha Meenu Unni

Minnu P Prasad, Midhun Sethu

Students: Dept of Civil Engineering

Mangalam College of Engineering Ettumanoor

Kottayam, Kerala, India

Ann Mary Jose

Asst. Professor

Dept of Civil Engineering

Mangalam College of Engineering Ettumanoor

Kottayam, Kerala, India

**Abstract**-Low density polyethylene (LDPE) and crumb rubber (CR), both recycled from used tyres, were combined in order to produce a plastic-elastomer admixture. For the purpose of strengthening the base bitumen binder's characteristics, two waste materials—LDPE and CR—were used. A mixture of molten bitumen and CR powder with particle sizes less than 0.7 mm was used. The weight of LDPE, CR, and an LDPE/CR combination was used in the same way to produce the various compositions. When compared to base bitumen, these modified mixtures perform better in terms of penetration, softening point, and viscosity. In 2023, 157 million tonnes of polyethylene is expected to be produced annually throughout the world. These statistics demonstrate that polyethylene is the most widely used and consumed polymer worldwide. Bitumen can be modified to improve pavement performance at a low cost and with ease of access by utilising crumb rubber. n. Since these modified bituminous binders cover aggregates better than base bitumen over base bitumen alone, it is expected that using them in pavement will result in a durable pavement surface.

**Keywords:** Bitumen; LDPE; Crumb rubber

## I. INTRODUCTION

The network of roads have a major role in the development of an area. The paving industry makes extensive use of bituminous binders. Mineral aggregate and bituminous binders are used to create the bituminous pavement. Due to an increase in traffic volume, conventional binders cannot maintain asphaltic pavement's present performance standards. Bitumen is modified using crumb rubber and low density polyethylene. The study analyses the usage of crumb rubber and low density polyethylene (LDPE) for bitumen modification.

Today, disposing of plastic garbage has become a major issue. Its improper disposal results in issues including water pollution and soil pollution. The

mechanical properties of bitumen can be significantly modified by adding polymers, which can modify it. These non-biodegradable materials are utilised in bituminous pavements. In highways, bituminous mixes considerably improve the stability, strength, fatigue life, and other desired features of bituminous concrete mix, even under unfavourable conditions of water logging. As a result, compared to the use of regular bitumen, it is expected that the life of the pavement surfacing course using the modified bitumen will also significantly increase. By shredding remaining plastic items from daily life, plastic pellets are created. The difficulties with pollution and disposal can be effectively solved by using these materials in the construction of highway roads. Crumb rubber is the substance that results when worn tyres are properly crushed.

## II. LITERATURE REVIEW

According to Professor Lokesh Kumar's 2022 study, "Effect of LDPE/CR admixture on the properties of bituminous binder used in paving applications," using modified bituminous binders that include Low Density Polyethylene (LDPE) and crumb rubber in pavement ends in a durable pavement surface due to these modified binders coat aggregates and gravel better than base bitumen does. According to the study, pavement built with this modified bituminous binder performs better in terms of durability, resistance to rutting and cracking, temperature sensitivity, and fatigue resistance.

A comprehensive evaluation of binder is done by Angelo Filonzi, Satyavati Komaragiri, K Lakshmi Roja, and Anand Sreeram (2021). The main goal of this research was to assess LDPE's potential as a modifier for use in asphalt mixtures. The rheological and performance-related

characteristics of two very distinct types of asphalt binders, as well as asphalt mixtures made with a subset of these binders, were thoroughly assessed for this study.

Deven Ramole and Rutuja Sathe "Utilisation of Crumb Rubber in Flexible Pavements" (2020) Due to wetness, heat, and axle load, bituminous pavement is poorly resistant. Modified bitumen, which is created by combining bitumen and crumb rubber, is the answer. There are two ways to combine tyres with bitumen: dry process and wet process.

Researchers Haopeng Wang, Xueyan Liu, Sandra Erkens, and Athanasios Skarpas (2020) "Experimental characterization of storage stability of crumb rubber modified bitumen with warm-mix additives" The problem with storage stability is one of the main downsides of crumb rubber modified bitumen (CRMB). CRMB's inability to store consistently prevents future applicability. The goal of this research is to create a reliable method for testing the morphological and mechanical stability of CRMB binders during storage.

III. MATERIAL

The bitumen used for the present research work was VG30 grade and the modifiers used for the experiment are LDPE and Crumb rubber having size less than 7 mm. Recycled LDPE and crumb rubber is used for the experiment. VG30 bitumen is mainly used in the construction of heavy duty roads. By keeping the amount of LDPE constant different ratio of crumb rubber is added to the bitumen and values on each addition is identified. Properties of bitumen is changed on different ratios of LDPE and crumb rubber.

TABLE1. Properties of VG30 Bitumen

Sl No	Tests	Value
1.	Penetration Test	45-75mm
2.	Softening point	47 <sup>0</sup> c-57 <sup>0</sup> c
3.	Ductility	>75mm
4.	Viscosity	2400-3600poise

IV. PREPARATION

For the preparation of test sample 500 gm of VG30 bitumen is taken in a steel vessel. The bitumen is heated at 160<sup>0</sup>-170<sup>0</sup>C until it turn into loose consistency. To this bitumen LDPE is added and stir well at the same temperature. Two ratios of LDPE and crumb rubber 1:2 and 1:3 are prepared.

V. TEST METHODS

The softening point of bitumen is determined by using ring and ball method. In this test, disks of specimen were cast in shouldered ring. The temperature at which bitumen softens to a given degree under the test's predetermined parameters is known as the softening point. The device is submerged in USP glycerin (above 80 to 157°C) or distilled water (30 to 80°C).

An indirect method of determining high temperature viscosity and low temperature stiffness is the penetration test. The penetration value, which measures the consistency or hardness of bituminous material, is a measure of consistency known as penetration. It is the vertical distance that a conventional needle can penetrate into a bituminous material under particular load, time, and temperature circumstances. One tenth of a millimetre is used to measure this distance.

A viscometer was applied to measure the viscosity of the bitumen test. This test evaluates the resistance to flow or helps assess if the modified bitumen has an adequate amount of workable fluidity. The aim of a viscosity test is to obtain data on a material's viscosity that will enable manufacturers to forecast how the material will behave in the real world. Viscosity acts as a representation of significant resistance to the compaction done by rolling equipment during construction and by traffic in service in the case of roads.

The bitumen ductility test will be used to assess the ductility of a particular bitumen sample and the acceptability of bitumen for use in road building. The goal of the ductility test is to provide a useful and practical method to assess a specimen's capacity for plastic deformation before breaking. You will be able to apply it to a wide range of materials and discover where each material bends or fractures.

VI. RESULT AND DISCUSSION

For the modification of base bitumen crumb rubber and low density polyethylene having size less than 0.7 mm is used for the study. The admixtures of LDPE/CR is used in the form of concentrate in order

to improve the mechanical and rheological properties of base bitumen. This modified bituminous binders is used in pavement, it is expected that these produce a durable pavement surface. The pavement are made by these modified binders could serve for a long time.

**A. TEST ON PLAIN BITUMEN**

TABLE 2. Test Result of Plain Bitumen

Sample	1	2	3
Penetration	53	55	54
Softening point	50 <sup>0</sup> C	53 <sup>0</sup> C	52 <sup>0</sup> C
Ductility	81	80	78
Viscosity	2.75	2.77	2.74

The obtained value of bitumen tests such as penetration, softening point, ductility and viscosity are within the specified limit.

**B. TEST ON BITUMEN + 5% LDPE**

TABLE 3. Test result of bitumen+5% LDPE

Trial	1	2	3
Penetration mm	51	53	50
Softening point <sup>0</sup> C	51	52.1	52.3
Ductility cm	87	83	82
Viscosity min	2.83	2.84	2.85

**C. TEST ON MODIFIED BITUMEN**

**PENETRATION**

TABLE 4. Penetration value

Sample	Value
Plain	54
1:2	66 mm
1:3	62 mm

**SOFTENING POINT**

TABLE 5. Softening point value

Sample	Value
Plain	51.6 <sup>0</sup> C
1:2	48.4 <sup>0</sup> C
1:3	43.4 <sup>0</sup> C

**DUCTILITY**

TABLE 6. Ductility value

Sample	Value
Plain	79.6 cm
1:2	84.6 cm
1:3	83 cm

**VISCOSITY**

TABLE 7. Viscosity value

Sample	Value
Plain	2.84 min
1:2	3.10 min
1:3	2.95 min

Based on the experimental study, the change in the properties of base bitumen by the addition of crumb

rubber and Low Density Polyethylene (LDPE) is identified. For conducting the experiment firstly the base bitumen is tested for identifying the standard values. 5% of LDPE is added to the bitumen sample and its values are calculated. The modified bitumen is prepared by adding two different ratio of crumb rubber into the bitumen and LDPE mixture. The ratio of 1:2 and 1:3 are prepared for conducting the experiment.

After conducting test the penetration value is decreases for 1:3. The softening point value is lesser for 1:3 ratio as compared to 1:2 ratio. The ductility value is high for 1:2 ratio. Viscosity value is greater for 1:2 as compared to 1:3 ratio.

## VII. CONCLUSION

In this study recycled materials such as crumb rubber and Low Density Polyethylene is used for the modification of the VG30 bitumen. Two ratios are examined. After conducting the experiment it is identified that the VG30 bitumen modified with LDPE:Crumb rubber as 1:2 is more suitable than the 1:3 ratio. By adding components in 1:2 ratio the properties of bitumen is changed and the durability of the pavement is increases. The construction cost and maintenance cost are also reduces as it has a change in its physical properties.

## VIII. REFERENCE

- [1]**Nadia Abduljabbar, Shakir Al-Busaltan, Anmar Dulaimi, Rand Al-Yasari, Monower Sadique, Hassan AlNageim (2022)** The effect of waste low-density polyethylene on the mechanical properties of thin asphalt overlay
- [2]**Arturs Riekstins, Viktors Haritonovs, Verners Straupe (2022)** Economic and environmental analysis of crumb rubber modified asphalt
- [3]**Minati Mohanty, Sagarika Panda (2019)** Crumb Rubber: A sustainable road paving material
- [4]**Utibe J. Nkanga Johnson, A. Joseph Feyisayo, V. Adams Obioma, U. Uche (2017)** The Characterization Of Bitumen And Plastic Blends For The Flexible Pavement Application
- [5]**Andri Heriawan (2020)** An Alternative Solution to Technical Challenges- Upcycling Plastic Waste for Rural Road Construction in India
- [6]**Anurag V. Tiwari, Y R M Rao (2018)** A Study on compressive strength of plastic waste bituminous concrete for the road construction
- [7]**Ivana Barisic, Matija Zvonaric, Ivanka Netinger Grubesa, Sanja Surdonja (2021)** Recycling Waste Rubber Tyres In Road Construction
- [8]**Rahul R G, Nidhin G. Raj, Nadhiya F M, Hima Mohan, Athira K S, Goutam Divakar Santhish (2016)** Effect of Crumb Rubber on Asphalt Mixture Performance