

USE OF WASTE POLYETHYLENE AND CRUMB RUBBER IN BITUMINOUS MIXES

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ABSTRACT: Bituminous mixture is most commonly used all over the world in flexible pavement construction. It consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together to lay down in layers and then compacted. Today's asphaltic concrete pavements are expected to perform good strength as they are experiencing increased volume of traffic, increased loads and increased variations in daily or seasonal temperature over what has been experienced in the past. In addition, the performance of bituminous pavements is found to be very poor in hilly areas. Considering this in view that lot of work has been done on use of additives in bituminous mixtures and as well as on modification of bitumen. My research has indicated that the addition of polymers and crumb rubber to asphalt binders helps to increase the strength and interfacial cohesiveness of the bond between the aggregate and the binder which can enhance many properties of the asphalt pavements to help meet these increased demands. However, the additive that is to be used for modification of mixture or binder should satisfy both the strength requirements as well as economical aspects. The present study aims in investigating the experimental performance of the bitumen modified with 15% by weight of crumb rubber and polythene varying its sizes. Four different categories of size of crumb rubber will be used, which are coarse (1 mm - 600 μ m); medium size (600 μ m - 300 μ m); fine (300 μ m - 150 μ m); and superfine (150 μ m - 75 μ m). Common laboratory tests will be performed on the modified bitumen using various sizes of crumb rubber, polythene and thus analyzed. Marshall Stability method is adopted for mix design. Finally a comparative study is made among the modified bitumen samples using the various sizes of Crumb Rubber particles and various percentages of polythene and the best size is suggested for the modification to obtain best results.

Keywords: Crumb Rubber, Asphalt pavements, Bitumen, Binders

I. INTRODUCTION

The polymer and crumb rubber used in bitumen to modify its properties for road construction and plastic waste can find its use in this process and this can help solving problem of pollution. The good binding property of waste plastic and crumb rubber in its molten state has helped in finding out a method of safe disposal of crumb rubber and waste plastic. Due to its low cost, easy manufacturing and impervious to water, plastics and rubbers are widely used and manufacturing in range of products. Disposal of waste plastic and crumb rubber in an eco-friendly way is the substance

area of today's research. The waste plastic and the crumb rubber for the construction of road material which give a durability resistance, better solidity and strength to the road as compared to the ordinary roads. The conventional rubber is non-biodegradable thus can be used as a modifier in bitumen and aggregate to increase road pavement strength. Fly ash is also used as filler in bitumen mixes for a long time and has the advantage of increasing the resistance of bitumen mixes to moisture damage. In addition to filling voids, fly ash was reported to have the good ability to work as a bitumen extender. Bituminous binders are widely used by paving industry. In general pavements are categorized into two groups, i.e. flexible and rigid pavement.

Flexible Pavement: The flexible pavement, having less flexural strength, acts like a flexible sheet (e.g. bituminous road). On the contrary, in rigid pavements, wheel loads are transferred to sub-grade soil by flexural strength of the pavement

Rigid Pavement: If the surface course of a pavement is made of plain cement concrete, then it is called as rigid pavement since the total pavement structure can't bend or deflect due to traffic loads. Pavement design and the mix design are two major parts in field of pavement engineering. The present study is only related to the mix design of flexible pavement considerations. The design of flexible mixtures consists of many processes of selecting binders and aggregate materials and makes a good proportion, to provide an appropriate compromise among several variables that affect mixture behavior, considering external factors such as traffic loading and climate conditions.

Bituminous mix design

The bituminous mix design is used to measure the quantity of bitumen, filler, fine aggregates, and coarse aggregates to produce a mix which have good workability, good strength, durable and economical. There are two types of the mix design, i.e. dry mix design and wet mix design.

Dry Mix Design: The objective of dry mix design is to measure the amount of various sizes of mineral aggregates and binding materials which is used to get a mix of maximum density. The dry mix design involves three important steps,

- Selection of aggregates
- Aggregates gradation
- Proportion of aggregates .

Requirements of bituminous mixes: Bituminous mixture used in construction of flexible pavement should have

following properties:

- Stability
- Durability
- Flexibility
- Skid resistance
- Workability

Different layers in a pavement

- Bituminous base course is a mixture of mineral aggregate such as stone, gravel, and sandbonded together by a bituminous material, are used as a foundation upon which to place a binder or surface course.
- In bituminous binder course a bituminous-aggregate mixture are used as an intermediate course between the base and surface courses are as the first bituminous layer in a two-layer bituminous resurfacing.

Role of waste plastic and crumb rubber in bituminous pavements: Today availability of plastic waste is higher. The use of plastic materials such as carrybags, polythene bags, milk bags, cups, crumb rubber etc is constantly increasing. Nearly 50% to 60% of total plastic are consumed for packing. Once used, then plastic packing materials are thrown outside and they remain as waste. Plastic wastes and crumb rubber are durable and non-biodegradable. These plastic wastes get mixed with water, disintegrate, and take the forms of small pellets which cause the death of fishes and other aquatic life who mistake them as food material. Sometimes they are land filled or incinerated. Plastic wastes get mixed with the municipal solid waste or thrown over a land area. All the above processes are not eco-friendly as they pollute the land, air and water. Under these circumstances, an alternative use of these plastic wastes is required. So any method that can use this plastic waste for purpose of construction is always welcomed. The population growth, industrialization, development create many waste products. Plastic and rubber user friendly but not eco-biodegradable. Proper waste disposal is of great importance in both rural and urban areas. Utilization of waste plastic and crumb rubber in bituminous mixes have proved. That the properties of mix are improved and disposal problems are also solved to some extent. Since these are not disposal scientifically and possibility to create ground and water pollution. These waste plastic and waste rubber partially replaced the conventional material to improve desired mechanical characteristics of road pavement, and also by additional of fly ash, waste plastic and waste rubber modified bitumen mix show good binding properties such as stability, stiffness, density and extra resistant to water. As well as will help to reduce the environmental pollution.

Role of polyethylene in bituminous pavements: Use of polyethylene and crumb rubber in road construction is good step to increase the properties of bituminous. Polyethylene and crumb rubber added to hot bitumen mixture and the mixture is laid on the road surface like a normal tar road. These roads use plastic carry-bags, disposable cups, polyethylene packets, crumb rubber and PET bottles that are

collected from industrial areas, households, are as very important ingredients of the construction material. Polymers are modified by considered as one of the solution to improve the fatigue life, reduce the rutting and thermal cracking in the pavement.

II. RAW MATERIALS

Bituminous mix is a mixture of tar and aggregates, having aggregate size less than 25 mm, and the fine filler that is smaller than 0.075mm and tar is formed by destructive distillation of crude petroleum. This tar is modified by adding polythene and crumb rubber, thus increases the strength of the bituminous. The bituminous mix design is used to measure the proportion of bitumen, filler, fine aggregates and coarse aggregates to produce a mix which is workable, strong, durable and economical.

The basic materials used are as follows:

- Aggregates
- Fly Ash
- Slag
- Bituminous Binder
- Polyethylene
- Crumb rubber

Aggregates: There are various types of crusher aggregates, which are used to manufacture bituminous mixes can be obtained from different natural sources such as glacial deposits or mines and crushers, can be used with or without further processing. The aggregates can be further cleaned and graded to achieve good performance characteristics. Industrial by-products such as steel slag, blast furnace slag, fly ash etc, sometimes we use these products in shortage of natural aggregates to enhance the performance characteristics of the mix. Aggregate contributes up to 90% - 95% of the mass and contributes to most of the load bearing and strength characteristics of the mixture.

Hence, the quality and physical properties of the aggregates should be controlled to ensure a good pavement.

Aggregates are of 3 types:

- **Coarse aggregates:** Those aggregates which retained on 4.75mm sieve are called coarse aggregates. Coarse aggregates should be formed by crushed rock, which are angular in shape, free from dust particles, clay, vegetation and organic matters, which offers high compressive and shear strength and shows good interlocking properties. In present study, crusher aggregates are used as coarse aggregate with specific gravity 2.75.
- **Fine aggregates:** Fine aggregate are graded as which passing 4.75mm sieve and retained on 0.075mm and should be free from clay, loam, vegetation or organic matter. Fine aggregates, formed by crushing stone dusts were collected from a local crusher. It fills the voids in the coarse aggregate and stiffens the binder. In present study, fine stones and slag are used as fine aggregate whose size are less than 4.75mm and whose specific gravity has been found to be 2.6 and 2.45.

- **Filler:**Aggregates which passing through 0.075 mm IS sieve is called filler. It is used to fill the voids, stiffens the binder and offers permeability. In present study, stone dust and fly ash are used as filler whose specific gravity has been found to be 2.7 and 2.3.

3.1.2 Fly Ash: At present, as per the report by the Fly Ash Utilization Program (FAUP), which shows that huge quantity of fly ash produced, only about 35% which are required use in commercial applications such as mass concrete, asphalt paving filler, lightweight aggregate, stabilizer to road bases, raw material for concrete, additives to soil, construction of bricks etc. The remained fly ash is requiring large disposal area, causing a huge capital loss to power plants and simultaneously causing an ecological imbalance and related environmental problems (Dhir,2005). In this investigation fly ash is used as one type of filler, which we use in bituminous.

3.1.3 Bituminous Binder: Bitumen is used to bind the aggregates, fines and stabilizers in bituminous mixtures. Bitumen is a visco-elastic material which acts both viscous as well as elastic properties at the normal pavement temperature. At low temperature it acts like an elastic material and at high temperatures its acts like a viscous fluid. Asphalt binder VG30 is used in this research work. Grade of bitumen used in the pavements should be depends on the basis of climatic conditions and their performance in past. It fills the voids,cause particle adhesion and offers impermeability.

3.1.4 Polyethylene: Polyethylene is used as stabilizing additives in the mixture, to provide better binding property. Now-a day's polypropylene, polyester, mineral and cellulose are commonly used as fibers. In present study polyethylene is used as stabilizing additive to improve performance characteristics of pavement.

3.1.5 Crumb rubber Crumb rubber is obtained from truck tyres or automobile tyres. Whole truck tyres contain 18% natural rubber compared to 9 percent in automobile tyre. And the scrap tyre is shredded into small pieces by the help of mechanical blades up to sizes of 1mm-75µm.in present study, we use crumb rubber in bitumen mix, thus increase the properties of bitumen.

III. CONCLUSION AND FUTURE SCOPE

In this study, there are three types of mixes i.e. SMA, DBM and BC are prepared with VG30 grade bitumen used as a binder. The effect of addition of waste polyethylene and crumb rubber in form of locally available artificial milk with brand verka packets and automobiles and truck tyres respectively in the bituminous mixes has been studied by varying concentrations of polyethylene and crumb rubber from 1.5% to 2% (interchanging) at an increasing rate of 0.5%.

By studying the test results of common laboratory tests on plain bitumen and crumb rubber and polyethylene modified bitumen it is concluded that the penetration values and softening points of plain bitumen can be improved significantly by modifying it with addition of crumb rubber and polyethylene which is a major environment pollutant.

From the above observations it is concluded that use of waste polyethylene and crumb rubber in form of packets used in milk packaging locally and tyres, results in improved engineering properties of bituminous mixes. Hence, this investigation explores not only in utilizing most beneficially, the waste non-degradable plastics, but also provides an opportunity in resulting in improved pavement material in surface courses thus making it more durable.

Future scope

- Many properties of SMA, BC and DBM mixes such as Marshall properties, static tensile strength, drain down characteristics and static creep characteristics have been studied in this work by using only VG 30 penetration grade bitumen, polyethylene and crumb rubber. However, some of the properties such as fatigue properties, resistance to rutting, dynamic indirect tensile strength characteristics and dynamic creep behavior needed to be investigated.
- In present study polyethylene and crumb rubber is added to them mix in dry mixing process. Polyethylene and crumb rubber can also be used for bitumen modification by wet mixing process and comparisons made.
- Microstructure of modified bituminous mixture should be observed by using appropriate technique to ascertain the degree of homogeneity.

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