RESEARCH PAPER ON BITUMINOUS CONCRETE MIXES MADE FROM WASTE POLYMETHYLENE

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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. 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 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 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 polythene varying its sizes. Four different categories of size of will be used, which are coarse (1 mm - 600 µm); medium size (600 µm - 300 µm); fine (300 µm150 µm); and superfine (150 µm - 75 µm). Common laboratory tests will be performed on the modified bitumen using various sizes of, 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 plastic particles and various percentages of polythene and the best size is suggested for the modification to obtain best results.

***Keywords*: polyethylene, aggregates, sand dust and filler.**

INTRODUCTION: The waste plastic and the 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 & rigid pavement considerations. The design of flexible and rigid 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.

1.2 Bituminous mix design

1.2.1 Overview: 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 different 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

1.2.2 Objective of Bituminous mix design: The main objectives of bituminous mix design are to find:

- Optimum bitumen content (OBC) to ensure a durable pavement.
- Traffic at higher temperature, good strength to resist shear deformation.
- Proper amount of air voids in the compacted bitumen and concrete to allow for additional compaction done by traffic.
- Sufficient workability.
- Sufficient flexibility to avoid cracking and ruts due to repeated traffic load.

1.2.3 Requirements of bituminous mixes: Bituminous mixture used in construction of flexible & rigid pavement should have following properties:

- Stability

- Durability
- Flexibility
- Skid resistance
- Workability

1.2.4 Different layers in a pavement

- Bituminous base course is a mixture of mineral aggregate such as stone, gravel, and sand bonded 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.
- Asphaltic bituminous concrete is a mixture of aggregates which continuously graded from maximum size 25 mm, through fine filler that is smaller than 0.075 mm. sufficient bitumen and concrete materials are added to the mix, so that the compacted mix is effectively impervious and will have acceptable dissipative and elastic properties.

TESTS AND RESULTS

4.1 General

This chapter describes the test works carried out in this present investigation. It involves mainly two processes. i.e.

- Preparation of Marshall samples.
- Tests on samples

There are many experimental works, such as to determine specific gravity, tensile strength, & softening point of polythene used in this investigation is calculated.

When the moulds are prepared their dimensions is measured to note the volume and their weight in air, weight in water, and weight of dry SSD are taken. After that they are kept in water tab to maintain at 25 for 30 minutes. The moulds are tested within 4 to 5 minutes after taken out from water bath. The mould is put out on Marshall Apparatus and Marshall Stability and flow dial gauge readings are recorded.

Marshall Stability test using polyethylene:

It is observed from graphs that with increase in bitumen concentration the Marshall stability value increases up to certain bitumen content & there after it decreases. In present study ORC for conventional SMA, BC, & DBM mixes are found as 1.5%, 2%, similarly OPC are found as 2% & 1.5% for modified SMA, BC & DBM mixes with polyethylene & rubber at different concentration. From the graphs it can be observed that with addition of polyethylene & rubber stability value also increases up to certain limits & further addition decreases the stability. This may be due to excess amount of polyethylene & rubber which is not able to mix in asphalt properly. That polyethylene concentration in mix is called optimum polyethylene content (OPC) which is found as 2% for SMA & DBM & 1.5% for BC mixes concentration in mix is called optimum rubber contents.

Table 4.1 Polyethylene with stability.

Types of mix	Optimum polyethylene Content (%)	Stability (kN)
SMA without polyethylene	0%	12.38
SMA with polyethylene	2%	13.85
DBM without polyethylene	0%	14.76
DBM with polyethylene	1.5%	17.55
BC without polyethylene	0%	11.89
BC with polyethylene	2%	17.78

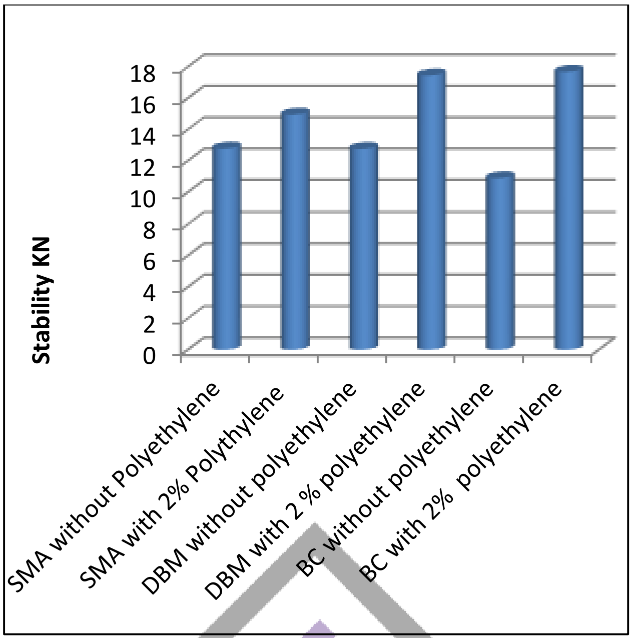

Fig 4.2 Variations of Marshall Stabilities of SMA with different contents polyethylene contents.

4.3.2 Flow value

It is observed from graphs that with increase in binder content flow value increases but by addition of polyethylene flow value decreases than that of conventional mixes, again further addition of polyethylene after OPC the flow value starts to increase.

Table 4.2 Optimum binder contents with flow value.

Types of mix	**Optimum polyethylene Content (%)**	**Flow Value (%)**
SMA without polyethylene	0%	3.8
SMA with polyethylene	2%	3.2
DBM without polyethylene	0%	4.53
DBM with polyethylene	1.5%	2.97
BC without polyethylene	0%	3.65
BC with polyethylene	2%	2.35

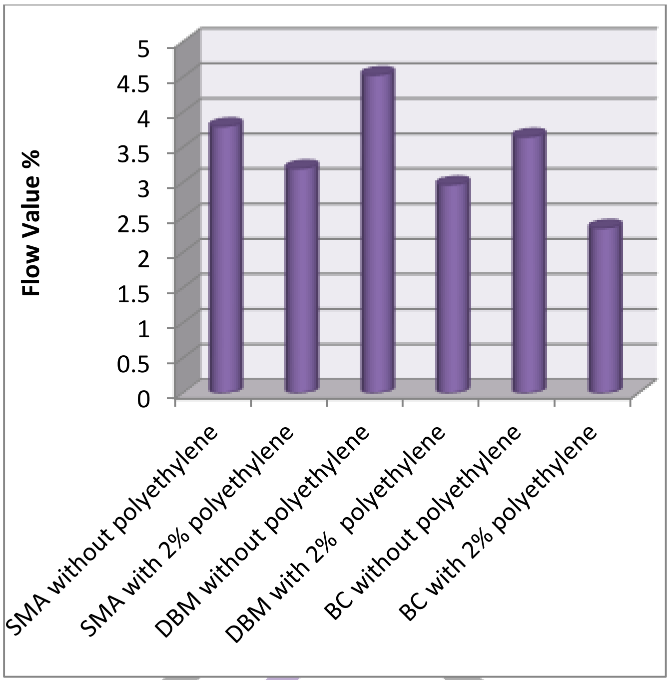

Fig. 4.3 Variations of flows value of SMA, DBM & BC with polyethylene contents.

4.3.5 Static creep test:

It is observed from the time Vs stain graphs that BC mixes with polyethylene give the minimum strain as compared to other mixes. Fig.5.4 show the relationships between creep strain and time in 30˚C, 40°C, 50˚C & 60℃ respectively. Creep curve can be divided into three stages. The first stage is the transient creep region, which includes the elastic strain region. The second is constant creep region which is called secondary creep, and the last one is the tertiary creep region. So, creep strain at first and second stages can be written as follows.

Table 4.5: Relationship between strain and time at temperature 30^{0}C

Time (hours)	Max. Strain (%)
0	0.2
10	0.25
48	0.28
100	0.35

Fig. 4.7: Relationship between strain and time at temperature 30^{0}C

Table 4.6: Relationship between strain and time at temperature 40^{0}C

Time (hours)	Max. Strain (%)
0	0.26
10	0.29
48	0.34
100	0.39

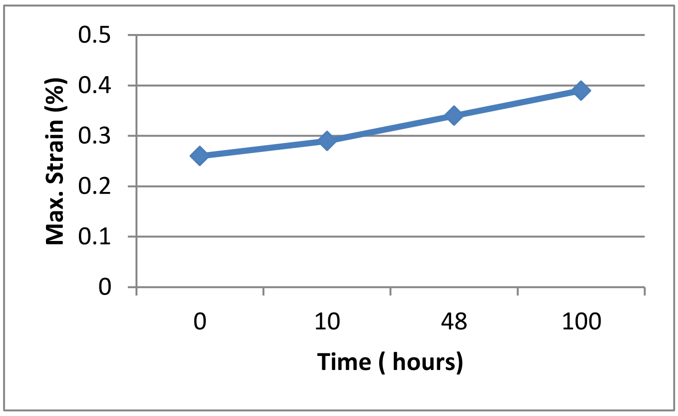

Fig. 4.8: Relationship between strain and time at temperature 40^{0}C

For creep test at elevated temperature, in the case that the weight content of rubber particles is big, there is an improvement of creep strain rate in the secondary state.

CONCLUSION & FUTURE SCOPE

6.1 General

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

It can be observed that the sample prepared using concentration 1.5% & polyethylene 2% give the highest stability value of 17.78 KN, minimum flow value, maximum unit weight, & maximum air voids. So the best size to be used for modification can be suggested as (0.3-0.15mm) size for commercial production of CRMB.

It is observed that by addition of polyethylene to the mixture, the resistance to moisture susceptibility of mix also increases. BC with polyethylene results in highest tensile strength ratio followed by DBM mixes with polyethylene & SMA mixes with polyethylene for both cases.

From the above observations it is concluded that use of waste polyethylene in form of packets used in milk packaging locally & tyres, results in improved engineering properties of bituminous mixes. Hence, this investigation shows 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.

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