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BITUMINOUS CONCRETE MIX DESIGN USING DIFFERENT PERCENTAGE OF WASTE POLYETHYLENE TO IMPROVE THE STRENGTH OF ROAD

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ABSTRACT

Use of recycled waste materials in road pavements is nowadays considered not only as a positive option in terms of sustainability, but also, as an attractive option in means of providing enhanced performance in service. This is especially true in the case of recycled plastics. Thin plastic bags are mainly composed of low density Polyethylene (LDPE) and it's commonly used for packaging, protecting and many other applications. However disposal of waste plastic bags (WPB) in large quantities constitutes an environmental problem, as they considered non-biodegradable materials. Hence, there is a real need to find useful applications for these growing quantities of wastes. In this research, Waste Plastic Bags (WPB) as one form of polymers is used to investigate the potential prospects to enhance asphalt mixture properties. Aims include studying the effect of adding different percentages of grinded WPB as an aggregate coat on the properties of asphalt mix comparing it with conventional mix properties besides identifying the optimum percent of WPB to be added in the hot mix asphalt.

Key words- asphalts mix, LDPE, flexible pavements, filler, marshal apparatus, WPB.

I. INTRODUCTION

As a result of rapid industrial growth in various fields together with population growth, an obvious increase in waste generation rates for Recycling waste into useful products is considered to be one of the most sustainable solutions for this problem So that, research into new and innovative uses of waste material is Extensively encouraged. Bhopal produces a huge amount of solid waste daily, it's about (1420 ton/day) of solid waste. Plastic waste constitutes significant part of municipal solid waste (MSW), which generally comprises nearly 12% by weight of MSW (172 tons/day).

Flexible Pavement:-In flexible pavement bituminous concrete is applied, flexible pavement is popular in road construction due to its bending nature.

Objectives of mix design:-

The bituminous mix design aims to estimate the proportions of bitumen. Filler material fine aggregates, coarse aggregates & polythene to produce a mix which should have

- Sufficient workability so that there is no segregation under load.
- Adequate strength to bear heavy wheel loads & tire stress during traffic.
- Sufficient durability
- Should be economical

Need of the present study:-

Present study is based on to improve the service of the road, to avoid the regular maintenance, to reduce the overall cost of road construction, and to utilize the plastic waste which become the serious problem of present scenario.

Waste plastic is a concern: -

Plastic are durable & non-biodegradable; the chemical bonds make plastic very durable & resistant to normal natural process of degradation. Under these circumstances, an alternate use for these plastic wastes is required.

This increases the viscosity of the mix by the formation of a more internal complex structure.

Flow chart for laboratory testing procedure:

II. METHODOLOGY AND LABORATORY TESTING

In the present study finding of OBC and cost analysis is kept into focus:

a) Literature review of previous studies which include revision of books, scientific papers and reports in the field of recycled polymer modifiers of asphalt mix.
b) Site visits and investigations of the recycled plastic processing plants to get more information and collect samples.
c) Different percentages of bitumen have been examined to extract the best percentage of bitumen. Which includes 5%, 5.5%, 6%, 6.5%, and 7% by weight of the mix?
d) Mix properties comparing it with conventional mix in terms of bulk density, Marshal Stability, flow and air voids. Intended percentages are from 6% to 10 % by weight of OBC.
e) Discussion of testing results.
f) Drawing conclusions and recommendations.

Number of samples

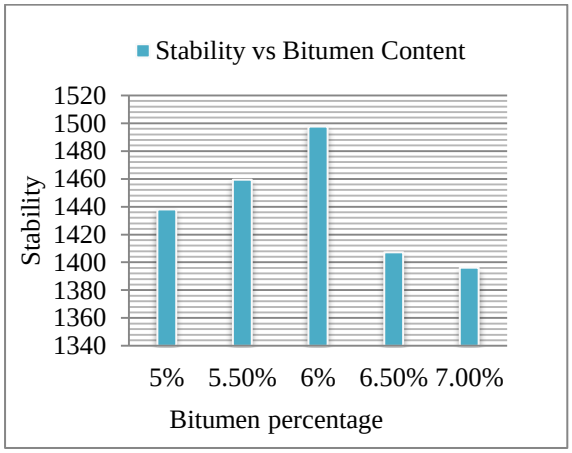
- Marshal test design procedure: 5 percentages x 3 samples for each percentage = 15 samples.
- Conventional mix tests (0% WPB) = 5 samples.
- WPB addition tests: 3 different percentages of WPB (from 6%, 8% and 10 % with 2% of incremental by weight of OBC) x 3 samples for each percentage = 15 sample.
- Samples made= approximately 60 samples.

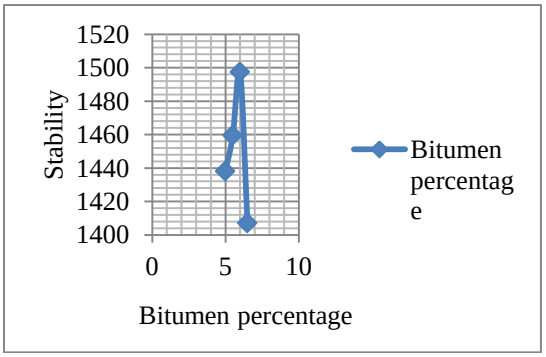
Laboratory Test Procedure:-This study is based on laboratory testing as the main procedure to achieve study goals. All the testing is conducted using equipment and devices available in the laboratories. Laboratory tests are divided into several stages, which begin with evaluation of the properties of used materials as aggregates, bitumen, and plastics.

The value of the optimum bitumen is used to prepare mixes modified with various percentages of waste plastic bags. Marshal Test will be utilized to evaluate the properties of these modified mixes. Finally, laboratory tests results are obtained and analyzed. Figure below, shows the flow chart of laboratory testing procedure.

III. RESULTS

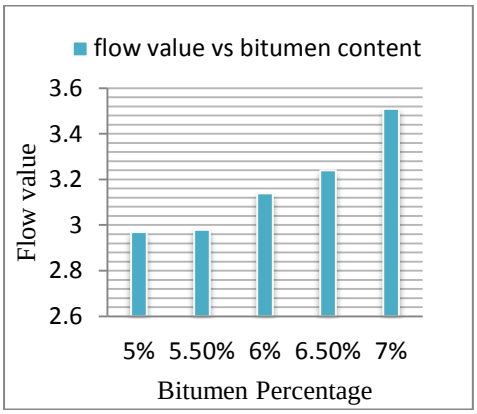
Stability – Bitumen Content Relationship:-Stability is the maximum load required to produce failure of the specimen when load is applied at constant rate 50 mm / min. In Figure it is shown, stability results for different bitumen contents are represented.

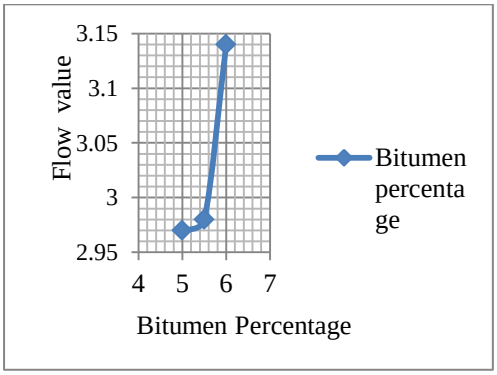




Flow–Bitumen content Relationship:-Flow is the total amount of deformation which occurs at maximum load (Jendia, 2000). In Figure, Flow results for different bitumen contents are represented. Flow of asphalt mix increases as the

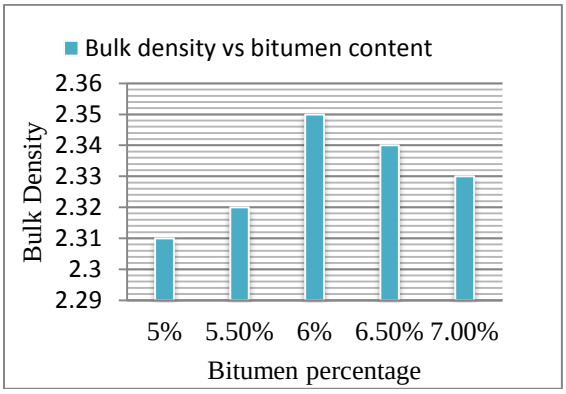
bitumen content increase till it reaches the peak at the max bitumen content 7 %.

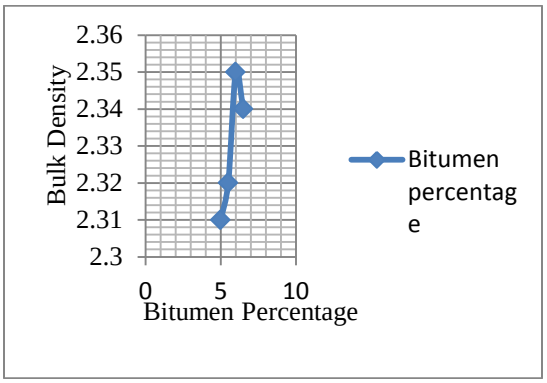




Bulk Density–Bitumen Content Relationship

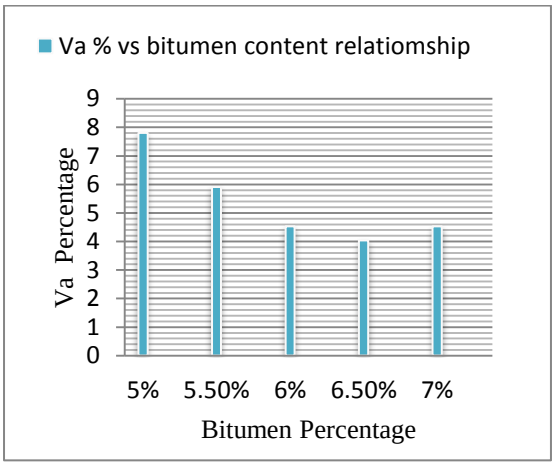
Bulk density is the actual density of the compacted mix. In Figure Bulk density results for different bitumen contents are represented. Bulk density of asphalt mix increases as the bitumen content increase till it reaches the peak (2.35 g/cm^3) at bitumen content 6 % then it started to decline gradually at higher bitumen content.

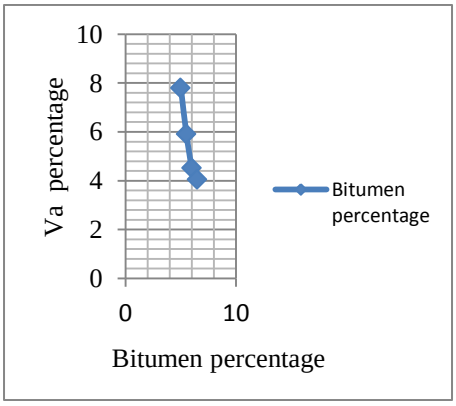




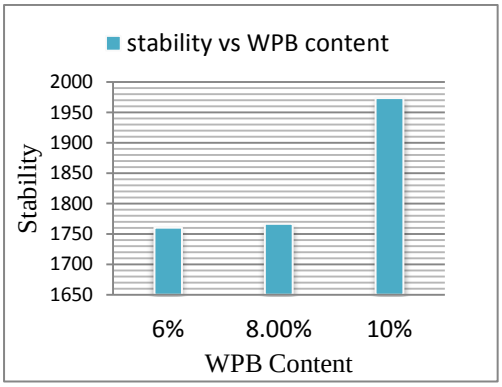
Va% – Bitumen Content Relationship:-

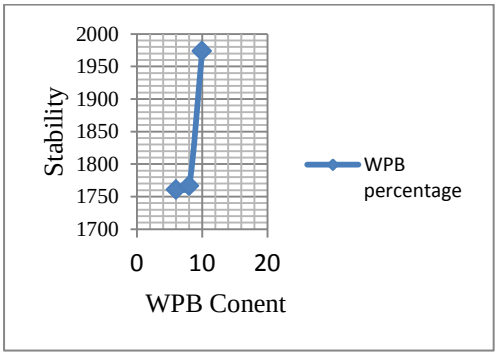
Va % is the percentage of air voids by volume in specimen or compacted asphalt mix (Jendia, 2000). In Figure Va% results for different bitumen contents are represented. Maximum air voids content value is at the lowest bitumen percentage (5%), Va% decrease gradually as bitumen content increase due to the increase of voids percentage filled with bitumen in the asphalt mix.



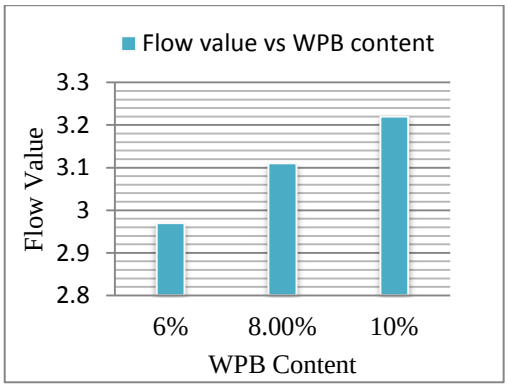


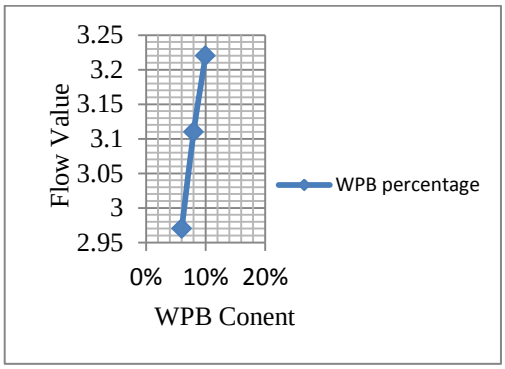
Flow – WPB with Bitumen content relationship Generally, the flow of modified asphalt mix is higher than the conventional asphalt mix (2.97 mm). Figure shows that the flow increases continuously as the WPB modifier content increase. The flow value extend from (3mm) till it reach (4mm) at WPB content (18%).





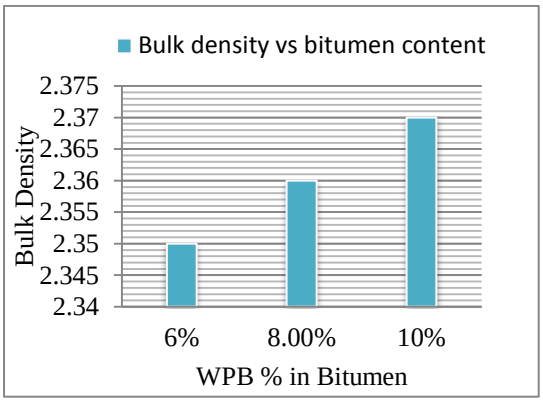
Asphalt mix Stability – WPB content relationship

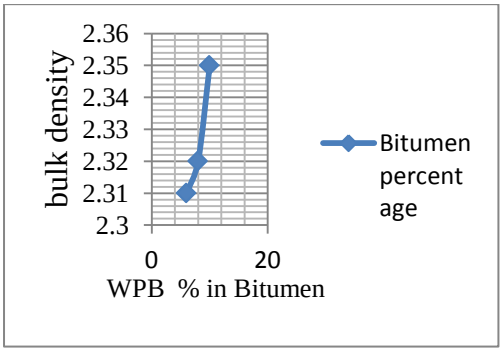




Bulk Density – WPB with Bitumen content relationship:-

The bulk density of WPB modified asphalt mix is lower than the conventional asphalt mix (2.36 g/cm^3).





IV. RESULTS AND DISCUSSION

Finding of OBC The value of polythene content at which the sample has maximum Marshall Stability Value and minimum Marshall Flow Value is called as Optimum Polythene Content. From the Figures, we get the Optimum Polythene Content as 6%. Strength is 31.79% is higher when polythene is added.

V. CONCLUSIONS

Based on experimental work results for WPB modified asphalt mixtures compared with conventional asphalt mixtures, the following conclusions can be drawn:

1. WPB can be conveniently used as a modifier for asphalt mixes for sustainable management of plastic waste as well as for improved performance of asphalt mix.
2. The optimum amount of WPB to be added as a modifier of asphalt mix was found to be (6.0 %) by weight of optimum bitumen content of the asphalt mix.
3. Asphalt mix modified with (6.0 % WPB by OBC weight) has approximately 31.79 % higher stability value compared to the conventional asphalt mix.
4. Bitumen mix modified with WPB exhibit lower bulk density as the WPB percentage increased. This decrease in bulk density can explained to be as a result of the low density of added plastic material.

VI. SCOPE FOR FURTHER STUDY

1. WPB is very good option in using with bitumen for road construction,
2. As proper disposal of Polythene is compulsory to save environment so it the best use of polythene as a reducing cost and content of bitumen.
3. It also provides strength for road and road will be long lasting.
4. Bitumen can be also used in waterproofing and sealant compound

VII. RECOMMENDATIONS

1. Study recommends local authorities to confirm using WPB in asphalt mix with the proposed percentage (6.0% by OBC weight) for improved performance of asphalt mix.
2. Many previous studies show an obvious improvement in rutting resistance for polymer modified asphalt mix.
3. It is recommended to conduct similar studies on the wearing course layer of asphalt pavement.

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