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Analysis of Road Pavements using LDPE in Surface Course by Varying Surface Course properties

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Abstract - *Waste material management is one of the most powerful concepts in recent years. The threat has emphasized the need to find appropriate solutions for effective waste management. The additive used in the modified bitumen for the construction of road pavements is low density polyethylene (LDPE), which has been derived from the everyday plastic waste. The disposal of plastic has caused lot of menace in the environment causing excess levels of pollution. This plastic can be recycled and reused in the bituminous layer by mixing it in certain specified proportions according to the specifications. This report deals with the analysis of using LDPE with the bituminous mixture on the surface course of the flexible pavements. Addition of various percentages of LDPE in the bituminous layer improves the physical and engineering properties of it. With the valuable information obtained from the tests carried out, according to the Indian Standard specifications, the strength of the surface layer is determined. Based on this values the analysis and design procedure for the flexible pavement will be carried out. Which will be used to determine the utility of plastic in the pavements, which would have otherwise been an issue for its disposal.*

***Key Words*: Low Density Polyethylene, LDPE, Plastic, Flexible pavements, Bituminous layer, Engineering properties.**

1. INTRODUCTION

Nowadays, the disposal of plastic waste has become a vast problem. Due to its improper disposal it causes problems like Soil pollution, water pollution and aesthetic pollution. Plastic pellets is a material produced by shredding and commutating used plastic materials in daily life. These pellets can be used in road construction with great interests in many developing countries. Utilizing these materials in highway road construction, the pollution and disposal problems can be successfully reduced. Modification of bitumen by the addition of polymers can lead to significant changes in the mechanical properties of the bitumen. To utilize the non-biodegradable material which is otherwise a threat to the environment, in highway bituminous mixes substantially improving the stability or strength, fatigue life and other desirable properties of bituminous concrete mix, even under adverse water-logging conditions. Therefore, the life of the pavement surfacing course using the modified bitumen is also expected to increase substantially in comparison to the use of ordinary bitumen.

1.1 Types of pavements

Bituminous binders are widely used by paving industry. In general pavements are categorized into 2 groups, i.e., flexible and rigid pavement. Flexible pavements are those, which on the whole have low flexural strength and are rather flexible in their structural action under loads. These types of pavement layers reflect the deformation of lower layers on-to the surface of the layer. If the surface course of a pavement is 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 considerations in case of pavement engineering. The present study is only related to the mix design of flexible pavements by combining waste plastic in proportions suitably.

1.2 Objective of Bituminous Mix Design

Main objectives of bituminous mix design are to find:
1. Optimum bitumen content to ensure a durable pavement,
2. Sufficient strength to resist shear deformation under traffic at higher temperature,
3. Proper amount of air voids in the compacted bitumen to allow for additional compaction done by traffic,
4. Sufficient workability, and
5. Sufficient flexibility to avoid cracking due to repeated traffic load.

1.3 Role of Polyethylene in Road Pavements

Plastics are user friendly but not eco-friendly as they are non-biodegradable. The better binding property of plastics in its molten state has helped in finding out a method of safe disposal of waste plastics, by using them in road laying. Modified Bitumen is one of the important construction materials for flexible pavements. It is also worth mentioning that, the modifier raw material has been sourced from disposed waste plastics. This not only allows us to collect modifier raw material at low cost, but also provides a solution towards ecological menace posed by increased use of plastics (non-biodegradable). In the present study, an attempt has been made to use blended waste plastic using

dry process for LDPE and wet process for it combination with the bituminous material. Marshal method of bituminous mix design was carried out for varying percentages of LDPE and bituminous material to determine the different mix design characteristics.

2. LITERATURE REVIEW

Sabina (2009): evaluated the performance of waste plastic/polymer modified bituminous mix and observed that the results of marshal stability and retained stability of polythene modified bituminous concrete mix increases 1.21 and 1.18 times higher than that of conventional mix by using 8% and 15% (by weight of bitumen) polythene with respect to 60/70 penetration grade of bitumen. But modified mix with 15% polyethylene showed slightly decreased values for Marshall Stability than that of the mix with 8% modifier in their results.

Swami (2012): investigated that the total material cost of the project is reduced by 7.99% with addition of plastic to bitumen between the ranges of 5% to 10%. They concluded that by modification of bitumen the problems like bleeding in hot temperature regions and sound pollution due to heavy traffic are reduced and it ultimately improves the quality and performance of road.

Ms. Apurva J Chavan (2013): Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to improve the environment.

Vasudevan et al. (2015): also observed that the polymer blended bitumen has better properties regarding Softening point, Penetration point, Ductility, Stripping Value and Marshall Stability value. Hence the blend can be used for laying flexible pavement. In this study both dry and wet processes were employed to prepare modified bituminous mixes.

3. MATERIALS USED

The materials used were as follows:

1. **Bitumen** acts as a binding agent to the aggregates, fines and stabilizers in bituminous mixtures. Bitumen must be treated as a visco-elastic material as it exhibits both viscous as well as elastic properties at the normal pavement temperature. At low temperature it behaves like an elastic material and at high temperatures its behaviour is like a viscous fluid. Bitumen with a grade of 60/70 is being used in this work. Grade of bitumen used in the pavements should be selected on the basis of climatic conditions and their performance in past.

Table 1: Properties of Bituminous binder

Properties	Range
Specific gravity	1-1.02
Penetration test	60mm-70mm
Ductility test	70mm-75mm
Softening Point	50-55°C

2. **Aggregates:** There are various types of mineral aggregates used to manufacture bituminous mixes. Aggregate contributes up to 90-95 % of the mixture weight and contributes to most of the load bearing & strength characteristics of the mixture. The different types of aggregates used are coarse aggregates, fine aggregates and filler materials. Their analysis for Engineering and Physical properties is done by using MORTH specifications gradation table.

Table 2: Properties of Coarse aggregates

Properties	Range
Specific gravity	2.53-2.62
Water absorption test	0.16%
Aggregate crushing test	24%
Los Angeles Abrasion test	11.42%
Aggregate Impact test	32.63%

3. **Low Density Polyethylene (LDPE) pellets:** Stabilizing additives are used in the mixture to provide better binding property. Nowadays, polypropylene, polyester, mineral and cellulose are commonly used as fibers. In this present study polyethylene is used as stabilizing additive to improve performance characteristics of pavement. LDPE is defined by a density range of 0.917–0.930 g/cm^3. It is not reactive at room temperatures, except by strong oxidizing agents, and some solvents cause swelling. It can withstand temperatures of 80°C continuously and 90°C (194°F) for a short time. Made in translucent or opaque variations, it is quite flexible and tough. Due to its low density properties (branching) it breaks down more easily over time, leading to higher surface areas.

4. 4. METHODOLOGY

5. The Bitumen of grade 60/70 used is modified with the inclusion of a polymer- Low Density Polyethylene (LDPE). This modified bitumen has been analyzed for the physical and engineering properties in the laboratory using basic tests as per IS specifications and the results are tabulated with the permissible values.

6. Coarse aggregates along with fine aggregates are taken for the analysis of engineering properties as per MORTH Specifications gradation table which is used for the construction of the surface coarse. Plastic wastes collected

are ground and then cut in to small pellets of size 1.18mm using a shredding machine.

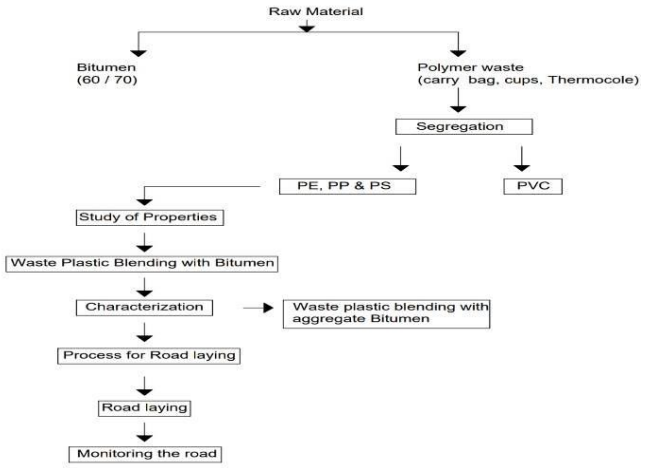

Figure1: Flowchart showing method for construction of Road Pavements

After the tests for the Materials have been conducted a suitable design mix is done for conventional bitumen. The molds are prepared and it is tested for Marshal Stability test to get the Optimum Binder Content for the Bituminous Concrete. Then Plastic Pellets are added in increments in the design mix for the modified Bituminous Concrete and the molds are prepared. These molds were allowed to cure for 24 hours and the Marshall stability value is determined. This stability value was obtained when 5% LDPE was added to the bituminous mix which shows the toughness of the mix.

5. RESULT AND DISCUSSION

The result analysis of properties of bitumen with percentage variation of LDPE in bituminous binder was obtained.

Table 3: Test results for Optimum Binder content

Percentage of bitumen	Marshall stability value
3	347
3.5	410
4	450
4.5	510
5	580
5.5	470
6	360

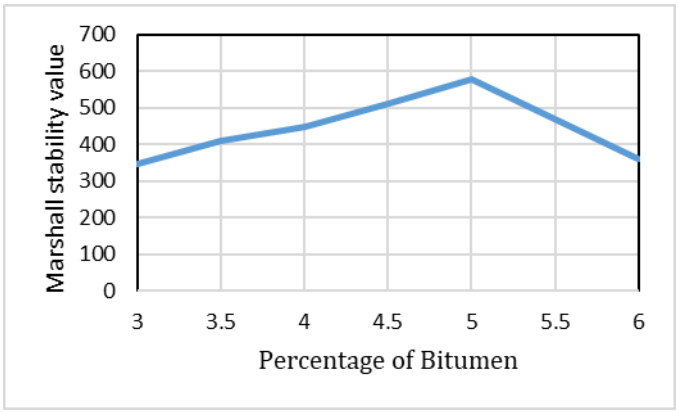

Chart 1: Marshall stability value for Conventional bitumen

From Chart 1, it is noticed that as the percentage of bitumen was increased in intervals of 0.5%, that is 3, 3.5, 4, 4.5, 5, 5.5 and 6; the Optimum Binder content(OBC) obtained is 5%. With this value of OBC, the Marshall mix design for modified bituminous concrete was done. The values obtained are shown in the table below

Table 4: Marshall Stability Test for optimum Binder content with plastic waste

Percentage of Plastic	Marshall stability value	Increase in stability (%)
0	11.39	-
2.5	21.53	89
5	33.55	194.6
7.5	32.47	185.1
10	31.50	176.6
12.5	26.40	131.8

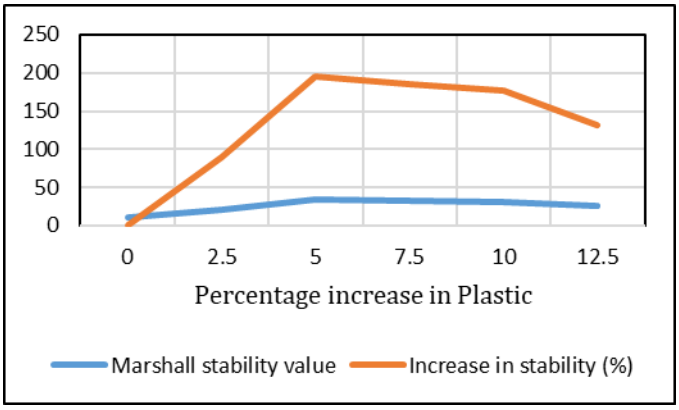

Chart 2: Optimum binder content for samples with LDPE

From Chart 2, the addition of waste plastics (LDPE) at 5% increased the stability value which results in the improvement of the toughness of the mix. Subsequently, the flow value of the mix increases which results in the workability of the mix.

7. CONCLUSIONS

Based on the experimental results the following conclusions can be drawn:

[1] Penetration value of conventional bitumen is higher than that of modified bitumen.
[2] Stability of modified bitumen is higher than that of conventional bitumen by a value of 2.63 in this analysis.
[3] The addition of 5% of LDPE improves the stability of the mix, which results in the increase in the toughness of the mix.
[4] In large scale usage, the need of bitumen can be reduced by at least 10% and the issues related to the disposal of plastic waste can also be resolved

8. FUTURE SCOPE

[1] The tests can be conducted by varying the percentage of Bitumen.
[2] Floating tests can be conducted.
[3] Tests can be conducted by varying the percentage of bitumen and the grade of bitumen.
[4] The chemical test on plastic mix in bitumen can be carried out.
[5] Alterations can be done for mixing process of aggregate and bitumen with plastic.
[6] The type of material used as binder in this project (i.e., Low Density Polyethylene) can be replaced by any other material such as rubber, fly ash, slag furnace, etc.
[7] Alterations can be done for mixing process of aggregate and bitumen with plastic.

REFERENCES

[1] "Study on Utililization of Waste Plastic in Bituminous Mixes for Road Construction"- K V R Prasad, Dr. S P Mahendra, Dr. N S Kumar, Vijay V, Yogesh B P.
[2] 'Low Density Polyethylene Modified Dense Graded Bituminous Macadam'- Dr. Malik Shoeb Ahmad.
[3] Brown, E.R. and Mallick, R.B. (1997), "Stone matrix asphalt -properties related to mixture design", National Center for Asphalt Technology, NCAT Report No. 94-2.
[4] Little, D. N. (1993), "Enhancement of asphalt concrete mixtures to meet structural requirements through the addition of recycled polythene, use of waste materials in hot mix asphalt".
[5] Sabina., Tabrez, A. Khan., Sangita., D.K. Sharma. and B. M. Sharma. (2009), "Performance Evaluation of Waste Plastic/Polymer modified Bituminous Concrete Mixes", Journal of Scientific and Industrial research, Vol.68, 975-979.
[6] Tapkın, S. (2008), "The effect of polypropylene fibres on asphalt performance", Building and Environment,