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Experimental Analysis of Utilization of Waste Polyethylene in Bituminous Concrete Mixes

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ABSTRACT:

Bituminous concrete (BC) is a composite material mainly used in construction projects such as road paving, airports, parking lots, etc. It consists of asphalt or bitumen (used as a binder) and mineral aggregates that are mixed and deposited layered and then compacted. Currently, the constant increase in high traffic intensity in terms of commercial traffic vehicles, and the significant variation in daily and seasonal temperature put us in a situation demanding situation to think of some alternatives for the improvisation of the pavement characteristics and quality through the application of some necessary modifications that satisfy both strength and economics. Also considering the environmental approach, due to the excessive use of polyethylenes On a day-to-day basis, the pollution of the environment is enormous. From the polyethylenes are not biodegradable, the current need is to use the waste polyethylene for some beneficial purposes. This article presents an investigation carried out to study the behavior of the mixture of BC modified with polyethylene waste. Various percentages of polyethylene are used for the preparation of mixtures with a rating added as indicated in the IRC Code. The role of polyethylene in the mixture is studied various engineering properties by preparing Marshall samples of BC mixtures with and without polymer. Marshall properties such as stability, flow value, unit weight, air voids are used to determine the optimum polyethylene content for the given grade of bitumen(80/100).

1. INTRODUCTION

1.1 GENERAL

Bituminous binders are widely used by the paving industry. A pavement consists of different layers.The main components of bituminous concrete (BC) are aggregate and bitumen.

Generally, all types of hard surface Pavement are classified into 2 groups i.e. Flexible and rigid.

1.1.1 Flexible Pavement:

If the surface layer of the pavement is bituminous it is said to be "flexible" because Traffic loads may cause the entire pavement structure to bend or deflect.

1.1.2 Rigid Pavement:

If the surface layer of the pavement is PCC it is called "rigid" because The entire pavement structure may not bend or deflect due to traffic loads. Like this Pavements are more rigid than flexible pavements due to higher modulus

Concrete simple cement of material elasticity. The important thing is that we can use

Reinforcing steel in hardened pavements, to reduce or eliminate joints.

1.2 Mix Design

1.2.1 Summary

The construction of the road implies a large investment outlay. precision engineering The design can save considerable investment; As well as from reliable road performance, It can be achieved.

1.2.2 Objectives of Mixture Design

The purpose of the design of bituminous mixtures is to estimate the proportion of bitumen, the filler material.

To produce a mixture of fine aggregates, coarse aggregates and polyethylene which should be

- Sufficient workability so that no isolation occurs under load
- Sufficient strength to withstand heavy loads on wheels and tire pressure.
- Sufficient Durability
- Must be economical

1.3 Plastic waste is a matter of concern

Plastics are durable and non-biodegradable; chemical bonds make plastics very Durable and resistant to normal natural erosion processes. Since 1950, about 1 Billions of tons of plastic have been thrown away, and they may remain in hundreds or even Thousands of years Plastic mixes with water, does not decompose and takes small paddle form that causes the death of fish and many other aquatic animals who mistake them for food ingredients. Nowadays the availability of plastic waste is very high, because plastic material is in become an integral part of our daily life.

1.4 Role of Plastic or Polymer in Pavement

BC modification with a synthetic polymer binder can be considered as a solution. To remove the problems arising due to rapid increase in wheel load and Change in weather conditions. Polymer modification can be considered as one of Solution to improve fatigue life, reduce pit and thermal cracking pavement.

Asphalt, when combined or mixed with polymers, forms a multiphase system, Containing abundant asphaltene which is not absorbed by the polymer. it grows The viscosity of the mixture from the formation of a more complex internal structure.

2. LITERATURE REVIEW:

1. Mohammad T. Awwad et al (2007), polyethylene as one sort of polymers is used to investigate the potential prospects to enhance asphalt mixture properties. The objectives also include determining the best type of polyethylene to be used and its proportion. Two types of polyethylene were added to coat the aggregate High Density Polyethylene (HDPE) and Low Density Polyethylene (LDPE). The results indicated that grinded HDPE polyethylene modifier provides better engineering properties. The recommended proportion of the modifier is 12% by the weight of bitumen content. It is found to increase the stability, reduce the density and slightly increase the air voids and the voids of mineral aggregate.

2. **Shankar et al (2009),** crumb rubber modified bitumen (CRMB 55) was blended at specified temperatures. Marshall's mix design was carried out by changing the modified bitumen content at constant optimum rubber content and subsequent tests have been performed to determine the different mix design characteristics and for conventional bitumen (60/70) also. This has resulted in much improved characteristics when compared with straight run bitumen and that too at reduced optimum modified binder content (5.67%).

3. Justo et al (2002), at the Centre for Transportation Engineering, of Bangalore University used processed plastic bags as an additive in asphalt concrete mixes. The properties of this modified bitumen were compared to that of ordinary bitumen. It was noted that penetration and ductility values, of modified bitumen was decreasing with the increase in proportion of the plastic additive, up to 12 % by weight.

3. RAW MATERIAL:

The materials used are as follows.

(i). Aggregates

(ii). Bituminous Binder

(iii). Mineral Filler

(iv). Polythene

3.1 AGGREGATE

Aggregate constitutes the granular part in bituminous concrete mixtures which contributes up to 90-95 % of the mixture weight and contributes to most of the load bearing & strength characteristics of the mixture. Hence, the quality and physical properties of the aggregates should be controlled to ensure a good pavement.

3.2 BITUMEN

Asphalt binder 60/70 and 80/100 are used in this research. The bitumen used should have the following properties.

a) Grade of bitumen used in the pavements should be selected on the basis of climatic conditions and their performance in past.

b) It is recommended that the bitumen should be accepted on certification by the supplier (along with the testing results) and the State project, verification samples. The procedures for acceptance should provide information, on the physical properties of the bitumen in timely manner.

3.3 MINERAL FILLER

Mineral filler consists of, very fine, inert mineral matter that is added to the hot mix asphalt, to increase the density and enhance strength of the mixture. These fillers should pass through 75μm IS Sieve. The fillers may be cement or fly ash.

3.4 POLYTHENE

The polythene used in OMFED milk packets was used as raw material for preparation of the samples. These polythene packets were collected; they were washed and cleaned by putting them in hot water for 3-4 hours. They were then dried.

Specific Gravity of polythene = 0.905

3.5 BITUMINOUS MIX DESIGN

Bituminous mix designing is a process to determine optimum bitumen content along with appropriate proportioning of aggregate to fulfil the requirement of an ideal mix. The desirable properties of an ideal bituminous mix are stability, durability, flexibility, skid resistance and workability. The requirements of bituminous mixes are explained as below –

- Sufficient stability to satisfy the service requirements of pavement without undue displacement.
- Sufficient amount of bitumen to ensure a durable pavement by coating and bonding of aggregate and water proofing of mix.
- Sufficient voids for slight amount of additional compaction due to traffic load
- Sufficient flexibility to prevent cracking due to repeated application of loads.
- Sufficient workability during placing and compacting
- Sufficient resistance of pavement against skidding and a function of surface texture and bitumen content.

4. RESULT ANALYSIS

For each % of polythene, 3 samples have been tested. So the average value of the 3 were taken. The mean values are shown in Table – 5.1

Table – 5.1: Data for plotting curves

Polythene Content (%)	Unit weight (Gmb)	Mean VMA (%)	Mean VA (%)	Mean VFB (%)	Mean S (kN)	Mean F (mm)
0	2.668241	16.24080718	4.896817	69.86649	14.3566	2.314173
1	2.628602	15.08037043	3.793693	74.86333	14.25	2.302481
2	2.584494	14.2135156	3.020358	78.88036	14.55666	2.283403
3	2.56012	13.8734538	2.837953	79.56232	15.53	2.251241
4	2.52277	13.61238477	2.738914	79.9287	17.71	2.218187
5	2.457956	13.21231978	2.478064	81.2728	15.93	2.189787

5. CONCLUSIONS

From the study of the behaviour of polythene modified BC it was found that the modified mix possesses improved Marshall Characteristics as mentioned below.It is observed that Marshall stability value increases with polyethylene content upto 4% and thereafter decreases. we observe that the marshall flow value decreases upon addition of polythene i.e the resistance to deformations under heavy wheel loads increases. Also the values of the parameters like VMA, VA, VFB are within the required specifications. Polymer modified pavements would be a boon for India's hot and extremely humid climate, where temperatures frequently rises past 50°C and torrential rains create havoc, leaving most of the roads with heavy distresses. This adversely affects the life of the pavements. The polymer modified bitumen show improved properties for pavement constructions. This also can reduce the amount of plastics waste which otherwise are considered to be a threat to the hygiene of the environment.

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