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Use of Waste Polythene in Bituminous Concrete Mixes for Highways

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Abstract: Bituminous Concrete (BC) normally used in construction projects like road surfacing, airports ,parking lots etc is a composite material . It consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together & laid down in layers then compacted. In these days the large increment in high traffic intensity in terms of commercial vehicles, and the compelling variation in daily and seasonal temperature put us in a demanding situation to think of some alternatives for the improvisation of the pavement characteristics and quality by applying some necessary modifications which shall satisfy both the strength as well as economical aspects .Also considering the environmental approach, due to excessive use of polythene in day to day life the pollution to the environment is increased significantly . Since the polythene is non-biodegradable the need of the current hour is to use the waste polythene in some beneficial purposes .This paperpresents a research conducted to analyse the behavior of BC mix modified with waste polythene. Various percentages of polythene are used for preparation of mixes with a selected aggregate grading as given in the IRC Code. By preparing Marshall samples of the concrete mix the role of polythene in bituminous is studied for various engineering properties BC mixtures with and without polymer. Marshall properties such as stability, flow value, unit weight, air voids are used to determine optimum polythene content for the given grade of bitumen (80/100).

Keywords waste polythenes, bituminous concrete, Marshall stability value.

I. INTRODUCTION

Bituminous binders mostly used by paving industry have a vast civil engineering applications. There are different layers of pavement. The main constituents of bituminous concrete(BC) mix are aggregate and bitumen. Generally, all the hard surfaced pavements are categorized into two groups, i.e. Flexible Pavement and Rigid Pavement.

A. Flexible Pavement

If the upper layer of a road surface or of a pavement is bitumen material then it is called "flexible" sice the total pavement structure can bend or deflect due to heavy traffic loads.Flexible pavements in on the whole have low flexural strength and are rather flexible in their structural action under heavy loads.These types of pavement layers reflect the deformation of lower layers on-to the surface of the layer.

B. Rigid Pavement

If the surface course of a pavement is of concrete mix other than bitumen then it is called "rigid" since the pavement structure can,t bend or deflect due to traffic loads.These types of pavements are notably stiffer than the flexible pavements due to the high modulus of elasticity of the PCC material .Importantly ,we can use RCC in the rigid pavements, to decrease or eliminate the joints.

II. POLYMER MODIFICATION OF BC

The steady increase of wheel loads, tyre pressure, change in climatic conditions & daily wear and tear severely affect the performance of bituminous mix pavements.Hence any improvement in the property of the pavement is Highly essential considering the present scenario.

III. LITERATURE REVIEW

During 1900’s, the technique, of using bitumen in pavements, was first used on rural roads in order to prevent rapid removal of the fine particles such as dust, from Water Bound Macadam, which was caused due to fast growth of automobiles.

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This new technology of using plastic waste in construction of roads not only increases the road life also retain good environment to live.

PROPERTIES	PLASTICROAD	ORDINARYROAD
Marshall stability value	More	Less
Bindind property	Better	Good
Softening point	More	Less

IV. STATUSOFONGOINGRESEARCHES

A. Evolution of Mix Design Concepts

Roberts et al .2002 During 1900 in order to prevent rapid removal of the fine particles such as dust from Water Bound Macadam, the technique, of using bitumen in pavements, was first used on rural roads, which was Caused due to fast growth of automobiles At initial stages, heavy oils were used as dust palliative.

Fransis Hveem 1942 project engineer of California Department of Highways developed the Hveem stabile meter in 1927.He does not have any previous experience to recognise, the required mix from its colour, so he decided to measure various mixture parameters.He decided to use surface area calculation concept in order to find the optimum quantity (which was already in use,at that time for the cement concrete mix design),to estimate the quantity of bitumen actually required.

Bruce Marshall just before the World War-II developed the Marshall testing machine. It was adopted in the US Army Corpes of Engineers in 1930ís and subsequently modified in 1940ís and 50ís.

B. Marshall Stability Value

It is defined as the maximum load at which the specimen fails under the application of the vertical load. It is the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute (2 inches/minute). Generally, the load was increased until it reached the maximum & then when the load just began to reduce ,the load was stopped and the maximum load was recorded by the proving ring

V. EXPERIMENTAL WORK

A. Determination of Specific Gravity of Polythene

The procedure adopted is given below

1) The weight of the polythene in air was measured by a balance.Let it be denoted by “a”.
2) An immersion vessel full of water was kept below the balance.
3) A piece of iron wire was attached to the balance such that it is suspended about 25 mm above the vessel support.
4) The polythene was then tied with a sink by the iron wire and allowed to submerge in the vessel and the weight was measured. Let it be denoted as “b”
5) Then polythene was removed and the weight of the wire and the sink was measured by submerging them inside water. Let it be denoted as “w”.

The specific gravity is given by where:
a=apparent mass of specimen, without wire or sinker, in air
b=apparent mass of specimen and of sinker completely immersed and of the wire partially immersed in liquid w = apparent mass of totally immersed sinker and of partially immersed wire.
From the experiment, it was found that
a= 19 gm
b = 24 gm w= 26 gm
=>s = 19 /(19+26-24) = 19/21 =0.90476
Takes =0.905

B. Mixing Procedure

The mixing of ingredients was done as per the following procedure (STP 204-8).

1) Required quantities of coarse aggregate, fine aggregate & mineral fillers were taken in an iron pan.
2) This was kept in an oven at temperature 1600C for 2 hours. This is because the aggregate and bitumen are to be mixed in heated state so preheating is required.

3) The bitumen was also heated up to its melting point prior to the mixing.
4) The required amount of shredded polythene was weighed and kept in a separate container.
5) The aggregates in the pan were heated on a controlled gas stove for a few minutes maintaining the above temperature.
6) The polythene was added to the aggregate and was mixed for 2 minutes.
7) Now bitumen (60 gm), i.e. 5% was added to this mix and the whole mix was stirred uniformly and homogenously. This was continued for 15-20 minutes till they were properly mixed which was evident from the uniform colour throughout the mix.
8) Then the mix was transferred to a casting mould
9) This mix was then compacted by the Marshall Hammer. The specification of this hammer, the height of release etc.
10) 75 no. Of blows were given per each side of the sample so subtotal of 150 no.of blows was given per sample.
11) Then these samples with moulds were kept separately and marked

C. Polymer Modification

1) Bahia and Anderson, 1984; studied the visco-elastic nature of binders and found that, the complex modulus & phase angles of the binders, need to be measured, at temperatures and loading rates which different resemble climatic and loading conditions.
2) Shukla and Jain (1984) described that the effect of wax in bitumen can be reduced by adding EVA (Ethyl Vinyl Acetate), aromatic resin and SBS in the waxy bitumen. The addition of 4% EVA or 6% SBS or 8% resin in waxy bitumen effectively reduces the Susceptibility to high temperatures, bleeding at high temperature and brittleness at low temperature of the mixes.
3) The findings of the studies conducted by the Shell Research and Technology Centre in Amsterdam indicated that the rutting rate is greatly reduced as a result of SBS modification of the binder. Button and Little (1998) on the basis of stress controlled fatigue testing at 20 and 00C, reported that SBS polymer exhibited superior fatigue properties as compared to straight AC-5 bitumen.
4) Shuler et al. (1987) found that the tensile strength of SBS modified binder increased significantly as compared to unmodified asphalt mix at minus 21, 25 and 410C.
5) Collins et al. (1991) and Baker (1998) observed that SBS modified asphalt mixes have longer lives than unmodified asphalt mixes. The addition of SBS polymer to unmodified bitumen also increases its resistance to low temperature cracking.
6) Denning and Carswell (1981) reported that asphalt concrete using polyethylene modified binders were more resistant to permanent deformation at elevated temperature.
7) Palit et al. (2002) found improvement in stripping characteristics of the crumb rubber modified mix as compared to unmodified asphalt mix.
8) Sibal et al. (2000) evaluated flexural fatigue life of asphalt concrete modified by 3% crumb rubber as part of aggregates
9) Goodrich (1998) reported that fatigue life and creep properties of the polymer modified mixes increased significantly as compared to unmodified asphalt mixes.

VI. RECENT APPLICATIONS

1) Rajagopalan Vasudevan responsible for laying down more than 5000km worth of plastic road in at least 11 states across the country. Popularly known as the plastic man of India.
2) A 25 km plastic modified bituminous concrete road was laid in bangalore. This plastic road showed superior smoothness, uniform behaviour as compared to a plastics-free road which was laid at same time, which began developing" crocodile cracks" very soon after. The process has also been approved ,in 2003 by the CRRI(Central Road Research Institute Delhi).
3) NHAI is building 270km Jammu-Srinagar NH with plastic waste.
4) About 1.6 tonnes of plastic waste was used in the 2km long stretch of Delhi-Meerut.

VII. CONCLUSION

The results indicated that the utilization of waste polythene in bituminous concrete mixtures shows improved property of the mixtures thus formed. The waste polythene utilized in the mix will get coated over Aggregate of the mixture and reduces porosity, absorption of moisture and improves binding property. The bitumen modified with 4% Polythene Waste is showing better Performance as compared to other mixes. The Marshall Stability which is a strength parameter has shown increasing trend with a maximum increase percent of 34.26% as compared to Conventional mix when modified with 4% Polythene Waste. It is observed that Marshall Stability value increases with polythene content upto4% and thereafter decreases. Thus the use of higher percentage of waste polythene is not preferable.

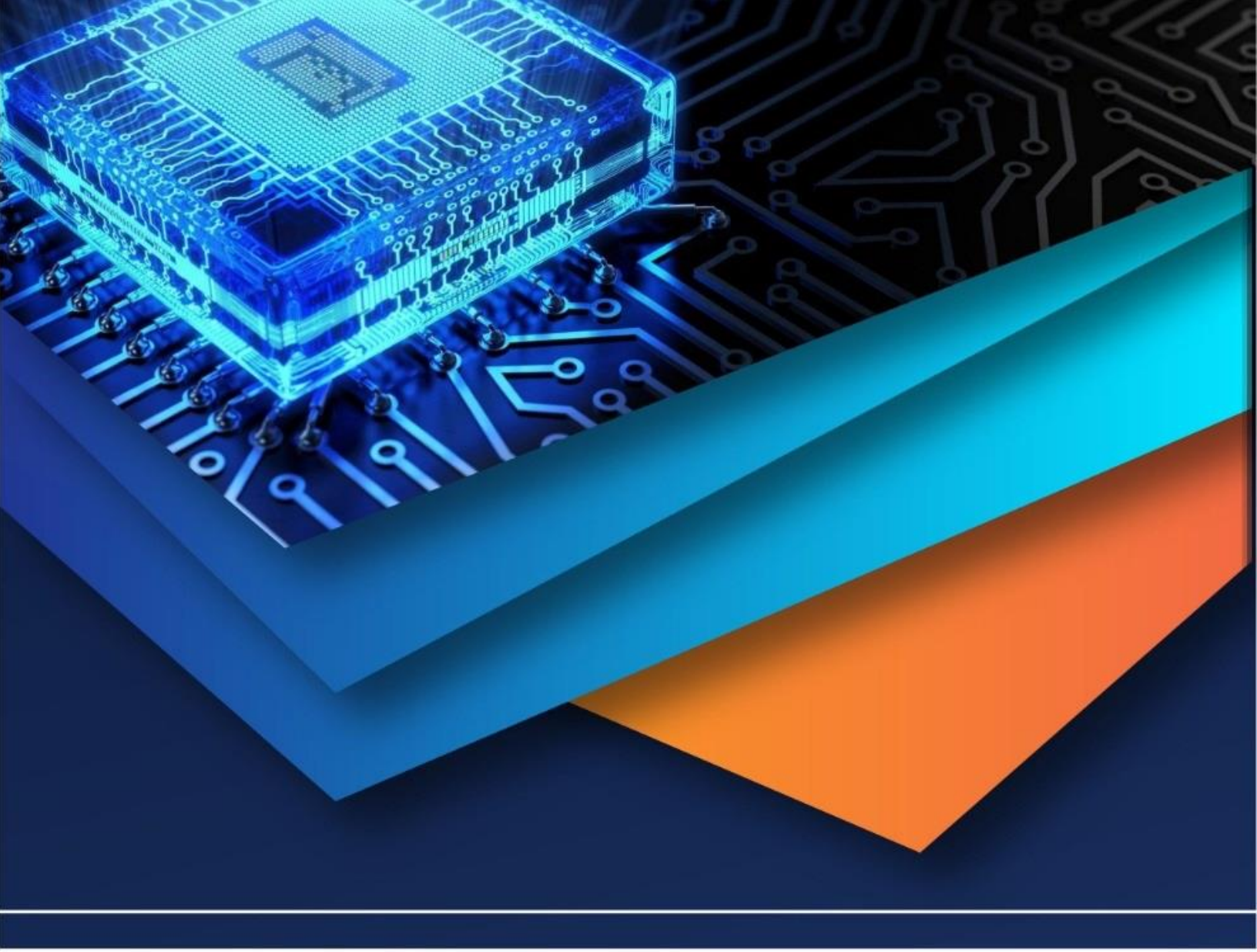
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While talking to environmental pollution due to these non-biodegradable plastics waste where disposal of such materials has become a serious problem, its use in construction of flexible pavement will give a better place for their burying and thus solving the problem of their disposal on one hand and providing a better flexible pavement with improved performance on other hand.

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