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A Result Paper on Evaluation of Different Paving Mixes Using Optimum Stabilizing Content

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ABSTRACT

Bituminous mixes are 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, laid down in layers and then compacted. Under normal circumstances, conventional bituminous pavements if designed and executed properly perform quite satisfactorily but the performance of bituminous mixes is very poor under various situations. Today's asphaltic concrete pavements are expected to perform better as they are experiencing increased volume of traffic, increased loads and increased variations in daily or seasonal temperature over what has been experienced in the past. In addition, the performance of bituminous pavements is found to be very poor in moisture induced situations.

KEYWORDS: *Bituminous Mix, Asphalt, Binder, Mineral Aggregate*

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1. INTRODUCTION

The use of bituminous binders is very frequent for construction of pavement in day to day life. Generally, the pavements are majorly classified into two groups: namely flexible pavements and rigid pavements.

Flexible Pavement

The flexible pavements are the type of pavements which consists of having lower flexural strength but are highly flexible from structural point of view when subjected to heavier loads. The deformations occurred in the lower layers of these pavements gets directly reflected to its surface completely.

Rigid Pavement

The rigid pavements are the type of pavements in which top most surface (also called as the surface course) is made up of PCC i.e. plain cement concrete. Moreover, the complete pavement as a whole structural component is not able to undergo bending or deflection when subjected to external traffic load.

The design of pavements and their concerned mix designs are found to be the major considerations for the study of pavement behavior. This present study concerns to the mix designs used for the design of flexible pavements. The design of asphalt based paving mix is multi-tread phenomenon right from selection of type of binder to materials for aggregates, formation of their mix proportions, etc. which essentially helps to maintain a proper balance between some variables which may affect the behavior the mix proportion including some external parameters like loading due to traffic movements and climatic factors also.

2. REVIEW OF LITERATURE

- Awwad and Shbeeb (2007) indicated that the modified mixture has a higher stability and VMA percentage compared to the non-modified mixtures and thus positively influence the rutting resistance of these mixtures. According to them modifying asphalt mixture with HDPE polyethylene enhances its properties far more than

the improvements realized by utilizing LDPE polyethylene.

- Gawande et al. (2012) gave an overview on waste plastic utilization in asphalting road by using both wet and dry method. They said that use of modified bitumen with the addition of processed waste plastic of about 5- 10% by weight of bitumen helps in improving the longevity and pavement performance with marginal saving in bitumen usage and according to them use of waste plastics in the manufacture of roads and laminated roofing also help to consume large quantity of waste plastics. Thus, these processes are socially highly relevant, giving better infrastructure.
- Khan and Gundaliya (2012) stated that the process of modification of bitumen with waste polythene enhances resistance to cracking, pothole formation and rutting by increasing softening point, hardness and reducing stripping due to water, thereby improving the general performance of roads over a long period of time. According to them the waste polythene utilized in the mix forms coating over aggregates of the mixture which reduces porosity, absorption of moisture and improves binding property.
- Prusty (2012) studied the behaviour of BC mixes modified with waste polythene. He used various percentages of polythene for preparation of mixes with a selected aggregate grading as given in the IRC Code. 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) in his study. Considering these factors he observed that a more stable and durable mix for the pavements can be obtained by polymer modifications.

3. MATERIALS

The bituminous mix contains the mixture of aggregates having a continuous gradation with size range from 25 mm as highest particle size to filler which has size even less than 75 microns. A sufficient quantity of bitumen is added such that the bituminous mix must be effectively non-porous along with permissible elastic and dissipative characteristics. The design of bituminous mix includes the process of calculating the ratio of bitumen, fine aggregates, coarse aggregates and filler. This design mix must be strong enough, durable, economical and workable. The basic materials which are used for the mix are listed below:

1. Bituminous Binder
2. Fly Ash
3. Aggregates
4. Slag
5. Polyethylene

The binder course, consist of a mixture of bitumen and aggregate is used in the form of an intermediate course or layer. This layer lies in the middle of the surface course and base course. This layer might also be as the first layer of bitumen for the bituminous resurfacing of two layers.

The asphaltic concrete or bituminous concrete is the perfect aggregate mixture in which the grading of aggregate is such that the highest size of the aggregate should be 25 mm and minimum size in the form of filler should be 0.075 mm. The quantity of bitumen to be added should be such that the it should help to create a proper bond between the aggregates and the mix in compacted state should be non-porous, impermeable and elastically stable.

4. RESULTS AND DISCUSSIONS

The impacts of concentration of polyethylene on Marshall Characteristics of all the mixes having dust in the form of filler have been explained separately. However, the concentration of polyethylene is considered to be 0 to 2.5 % for DBM & SMA having 0.5 % increment for every trial but in case of BC, the concentration of polyethylene is considered to be 0 to 2.0 % only for DBM & SMA having 0.5 % increment for every trial.

MARSHALL STABILITY

From the figure , it has been observed that the rise in the value of bituminous content to the mix, the value of Marshall Stability gets increased up to some value of bituminous content and then gets decreased. The concentration of bitumen at which the value of Marshall Stability attains is maximum value represents the optimum binder content (OBC). For this present case, the value of OBC for these traditional DBM, BC and SMA are observed to be around 5.5 %, 4 % and 4.5 % respectively. In a similar manner, the concentration of OBC is observed as same (4 %) for all the three mixes even having polyethylene of distinct quantity. From the fig. , it is interesting to note that the increase in quantity of polyethylene to the mix, the stability value of all the mixes gets increased up to some value and then gets decreased. There might be possibility that the excess concentration of polyethylene may not be able to get mixed properly to the asphalt. The concentration of polyethylene at which the value of stability value attains is maximum value represents the optimum polyethylene content (OPC). The value of OPC is found to be 1.5% for bituminous concrete mix (BC) while, it is 2% for DBM and SMA.

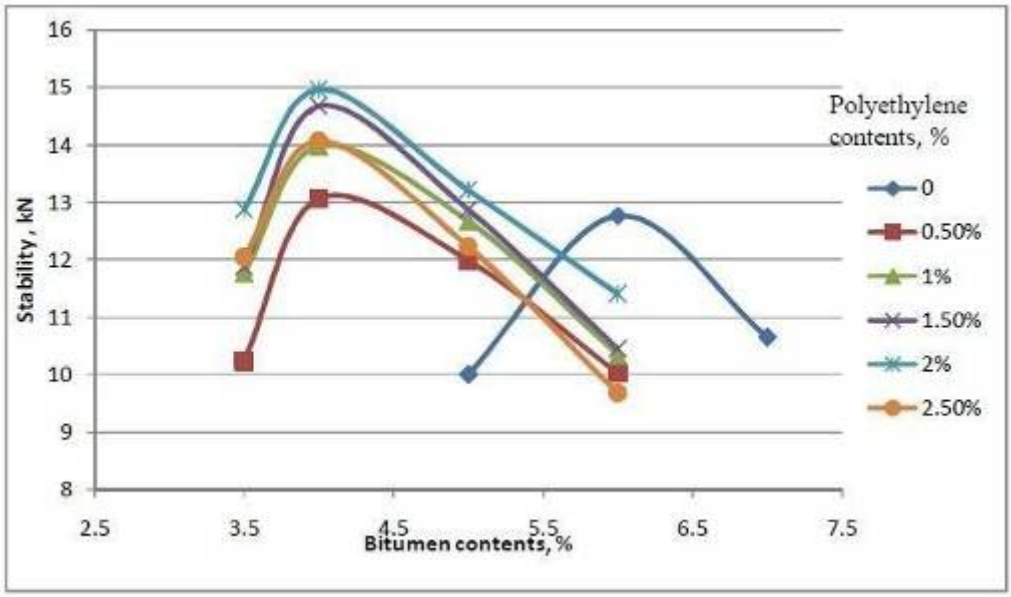

Fig : Deviations of Marshall Stability Values of SMA having Various Content of Binder and Polyethylene

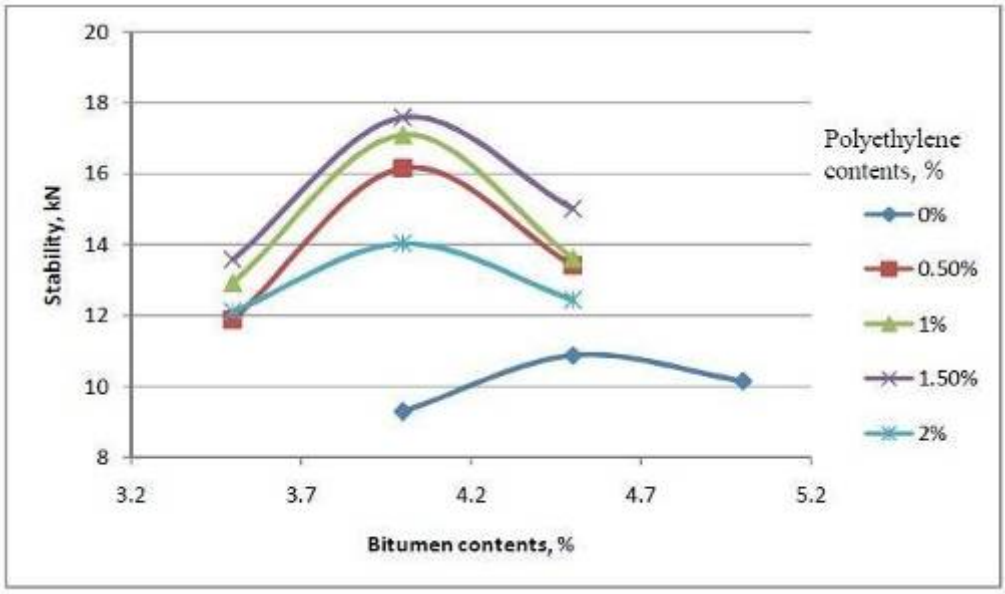

Fig. : Deviations of Marshall Stability Values of BC having Various Content of Binder and Polyethylene

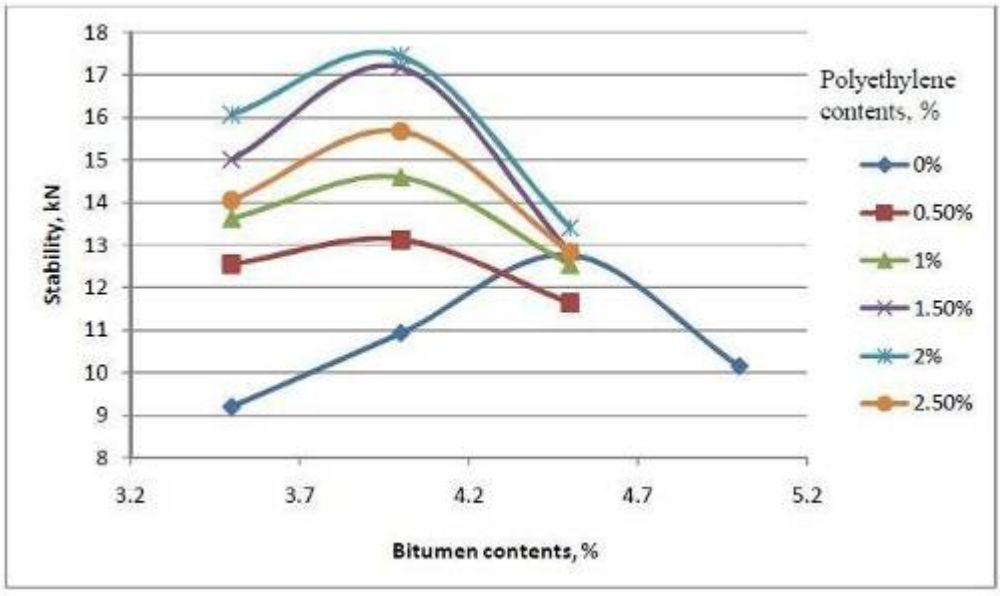

Fig. : Deviations of Marshall Stability Values of DBM having Various Content of Binder and Polyethylene

FLOW VALUE

From the figure , the increase in the value of binder content leads to the increase in flow value but the addition of content of polyethylene leads to decrease in the flow value as compared to traditional mix. However, the increase in the polyethylene value beyond the optimum polyethylene content (OPC), the flow value increases.

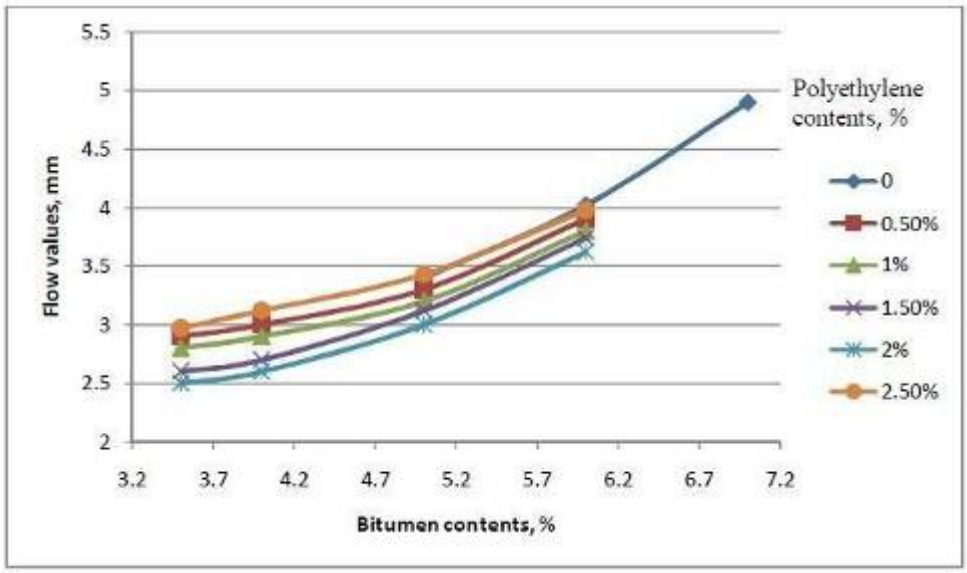

Fig : Deviations of Flow Value of SMA having Various Content of Binder and Polyethylene

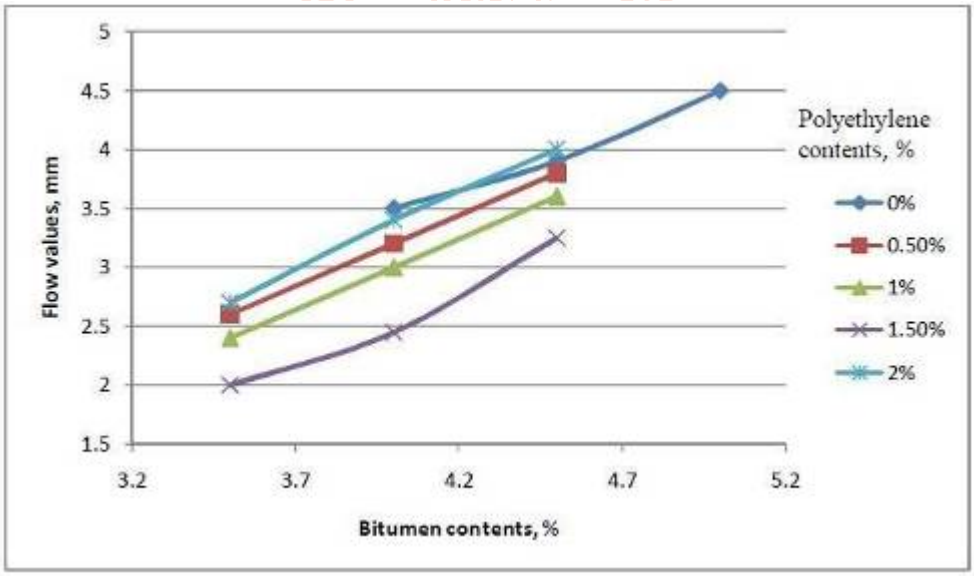

Fig : Deviations of Flow Value of BC having Various Content of Binder and Polyethylene

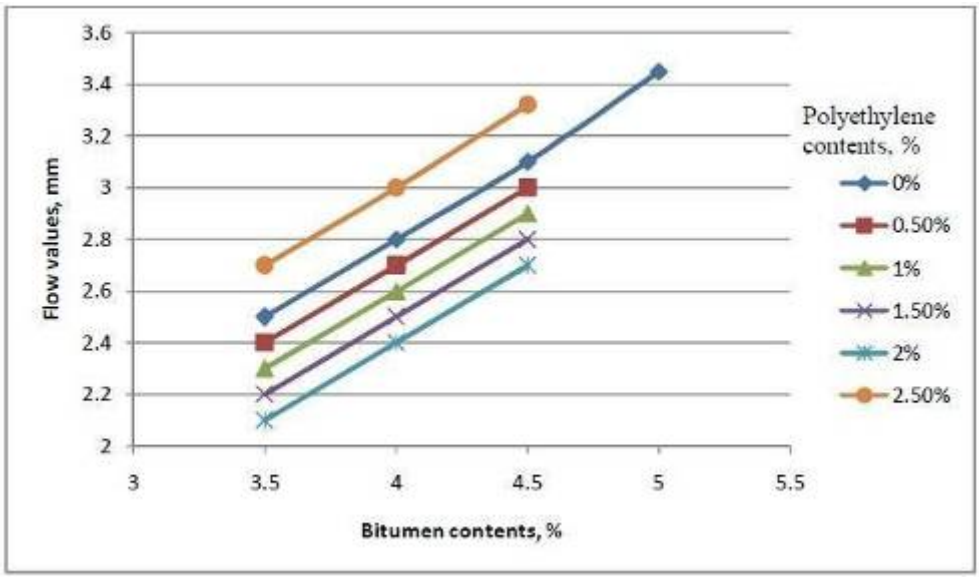

Fig : Deviations of Flow Value of DBM having Various Content of Binder and Polyethylene

DENSITY

The effects of all parameters over the density of all the three mixes are almost similar as that of Marshall Stability. The density or unit weight of the mixes gets increased initially up to certain value of bitumen binder content and then, it gets reduced. The bitumen binder content at which the maximum value of density is attained referred as OBC. However, in case of polyethylene content, the decrease in the value of mixes has been observed and these values are even lesser the traditional bituminous mixes. The main reason behind this behavior might be the lesser self weight of polyethylene used when compared to the bitumen.

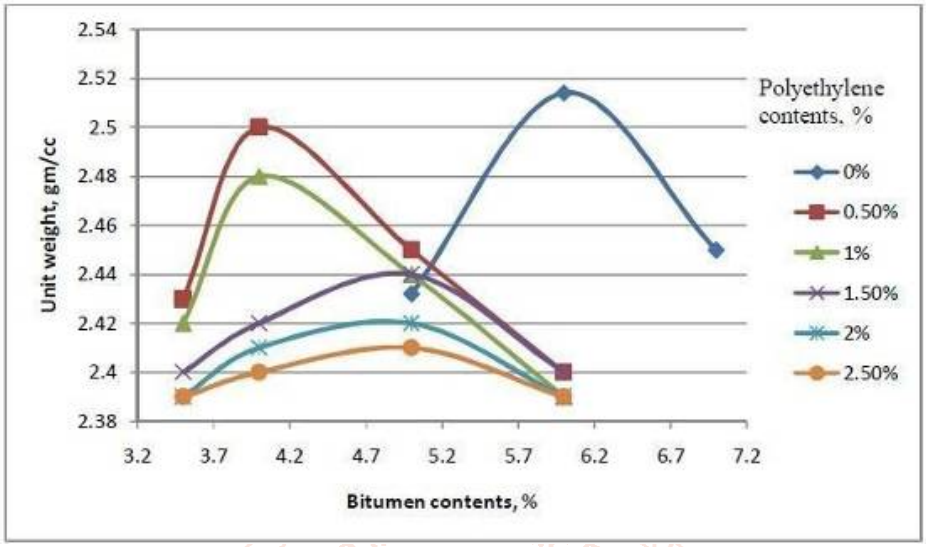

Fig : Deviations of Density of SMA having Various Content of Binder and Polyethylene

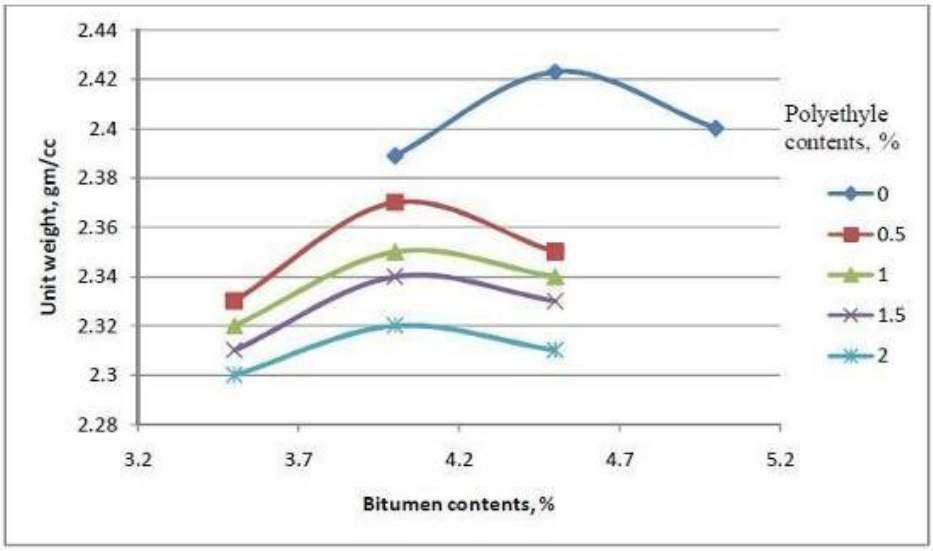

Fig : Deviations of Density of BC having Various Content of Binder and Polyethylene

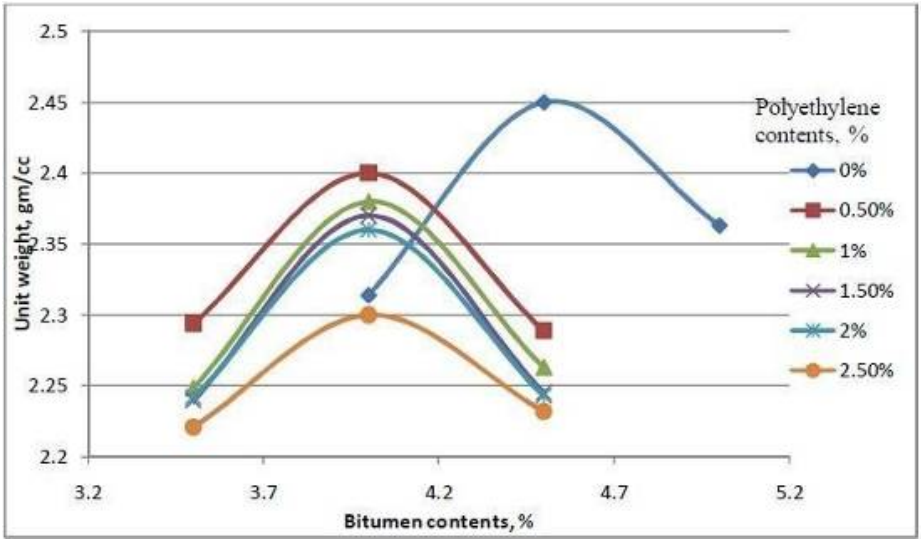

Fig : Deviations of Density of DBM having Various Content of Binder and Polyethylene

AIR VOIDS (VA)

This case is completely opposite to the above case. The value of air voids in the mixes gets reduced gradually with the increase in content of binder. However, the value of air voids in the mixes increased gradually with the increase in content of polyethylene as compared to that of traditional mixes.

5. CONCLUSION

- The optimum content of bitumen as binder, termed as OBC and optimum content of polyethylene, termed as OPC have been calculated for the various mixes by the use of Marshall Method of design mixes. It is noted that the for DBM and SMA design mixes, 2 % content of polyethylene imparts the desired level of Marshall characteristics and for BC, only 1.5 % content of polyethylene imparts the desired level of Marshall characteristics in which the stone dusts are used in the form of filler. However, when the fly ash is used as a replacement of filler and blast furnace slag is used as the replacement of minute fraction of fine aggregates, the satisfactory results for the optimum characteristics of Marshall are attained with addition of 1.5 % polyethylene content. The optimum concentration of bitumen for the modified form of BC, DBM and SMA design mixes is found to be 4% when stone dust is used in the form of filler. It is observed to be 4% and 5% when it is used with fly ash and slag respectively.
- It is also concluded that increase in the value of retained stability takes place due to the addition of polyethylene for the design mixes when the same samples (prepared as per the Marshall standards) on their respective OPC's and OBC's values by the use of stone dust (replacement of filler) and slag (replacement of fine aggregate) for tests subjected to normal conditions and wet conditions. The bituminous concrete containing polyethylene content results into highest value of retained stability. It is followed by DBM and then SMA having polyethylene content.
- It is interesting to note that the increase in the concentration of polyethylene decrease the effect of drain-down, however, these are not of considerable amount. It is also observed that no drain-down is observed for all the types of bituminous mixes at respective OPC values.
- It is always believed that the indirect strength of the mix in tension generally decreases with rise of temperature. But, if some particular binder (polyethylene in this present study) is added, the value eventually gets increased in both the cases. The BC designed mix having polyethylene content leads to gain the highest strength value as compared to the SMA and then followed by DBM.
- In case of static creep test, due to addition of polyethylene content, the deformations of the design mix decreases at all the temperature. The Bituminous concrete results to give minimum deformations as compared with the other two.
- The above observations conclude that the engineering characteristics of the bituminous designed mix gradually get improved by the use of polyethylene as waste in the form of milk packets.
- This present study ultimately imparts an opportunity for the improvement of pavement characteristics in surface course to make it highly durable in nature.

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