INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 6.078
(Volume 6, Issue 5)
Available online at: https://www.ijariit.com

Incorporating polymers and fly ash in bitumen mix

Siddharth Nagal
Om Institute of Technology and Science, Hisar, Haryana

Somesh Jain
Om Institute of Technology and Science, Hisar, Haryana

ABSTRACT

Transport network is the bedrock of our country, which plays a significant role in its development. The rail network is the primary means of transport in our world. The government of India set up various schemes for both the development and maintenance of highway and roadway networks. Marshall quotient of an altered BC mixture has been observed to be greater to 4.38 especially in comparison to a Marshall quotient mix proportion of 3.06. This rise in the Marshall quotient expanded the rigidity of the modified mixture and improved its resistance to cracking.

Keywords: *Styrene Butadiene Styrene ,Bitumen, BC, VMA, VFB, VMA, Marshall Stability*

1. INTRODUCTION

Highways or highway grids are the key form of transportation throughout our country, accounting for around 865 per cent of total freight and 890 per cent of pedestrian traffic. Expressways and highway networks play a crucial role in the growth of a developed nation along with India. Via numerous planned projects like PMGSY, Bharatmala Pariyojana, etc., Indian government to install and run bridge and rail networks has indeed invested a great deal of money also. India has the second highest population in the area. Running congestion has also arisen in the last decade, with an rising population. It allows the state of the concrete to deteriorate and to crumble rapidly. In general, to provide an appropriate bridge and roadway network, we need to improve the stability of the transport network for passenger and freight transport by assessing the service pavement characteristics of its resistance tow fracture, rutting functionality, toughness, etc. All across the past couple of decades, different investigations have been reported out to raise the effectiveness of a robust highway, by with substitute content, i.e. swapping a fine aggregate or filling with a stronger product or by modifying polymers, i.e. utilizing glass containers or Styrene Butadiene Styrene (SBS), etc.The modification of the flexible highway used to have a beneficial influence on the functioning of the highway as well as its technical features, consequently improving the operability of the highway. The most recent research focused primarily on the technical properties of a BC blend formulated mostly with added filler content and the modification of bitumen with recyclable plastic.

Pattanaik and Sabat, (2010) studied the substitution of cement by 10% to 40% by fly ash. Twenty-eight days of maximum intensity of the mixture will be reached by mixing 30 per cent of fly ash with cement. The superplastizer aims to account for extremely young age failure by rising the water - to - cement ratio thereby growing the strength and durability of the combination. The power of the combination with a 40% substitution of fly ash is often smaller than those of the monitoring blend.

Vasudevan et al., (2011) The use of plastics waste in the construction of modular roads has been studied and can assist in the fast disposal of solid waste. Plastic waste was used to cover the granules, and all these PCA is being used as raw resources in bituminous mixture. The results showed that waste plastic use helps to improve the performance of asphalt pavements, and also the aggregate key elements. Additionally, that dry cycle helps to quickly remove waste material and reduce the burden on garbage dumps.

Rokade, (2012) Checked the use of plastics waste and rubber tyre for the preparation of the modified asphalt blend. To find out optimal LDPE and CR quality, the adjusted blend was contrasted with standard mixes. All LDPE and CR were combined and used the dry method and wet method respectively. The findings revealed also that inclusion of LDPE and CRMB in the SDBC blend at the same time improved the quality of a blend by 25 percent, but also raised the bulk density of the mixture.

Sangita et al., (2011) Researched the use of waste plastic in highway construction. The goal was therefore to increase the flexibility of a mix, enhancing the action of the rut andthe sensitivity to fatigue. Dry method was introduced to produce the bituminous blend, the optimal amount of waste plastic being specific amounts of plastic wastes of 8 per cent. The findings revealed the polymer alteration increased the consistency of the blend and the binding characteristics.

Moghaddam et al., (2012) Application of waste plastic containers in SMA combination questioned. The rigidity and fatigue properties of the SMA combination have been tested. The combination was mixed with specific PET and ITS quantities, and fatigue testing was performed. The result was always that the SMA mix's stiffness was initially improved with PET ratios, but instead reduced. It has also increased its fatigue resistance.

Yazici et al., (2012) analyzed the compressive and fracturing tensile forces of the concretes of 7, 28, 56, 90, 120 and 180 days with three separate finenesses of the fly ash. Fly ash can be used instead with cement at 0 percent, 5 percent, 10 percent and 15 percent. The fly ash of lignite composition with a white fineness of 2351 cm2 / g is processed in such a balls press. It is assumed that the compressive and tensile power of the concrete decreases as when the fineness of the fly ash rises. Maximum amount of a strain and fracturing tensile strength of the concrete with fly ash additions is achieved at 5% including its pace of removal of a fly ash. In fact, the compressive and break tensile strengths are reduced because there is an rise in the substitution rate.

Modarres et al., (2013) The use of plastic wastes containers as a kind of bitumen modifier for casting modified bituminous mixtures was investigated. The aim was to investigate the addition of PET mostly on mix's fatigue and rigidity properties and its contrast with the unmodified mix. The dry method used blended PET. The result suggests that addition PET thus strengthened the mix's fatigue properties and stiffness, enhancing the strength and plastic deformation properties.

Huang et al., (2013) studied the fresh and hardened concrete characteristics of two forms of Class F fly ash with 4.6 per cent and 7.8 per cent combustion losses. Sources say, by utilizing a much more acceptable Super Plasticizer (SP), concrete containing fly ash of up to 80 per cent of cemented material composition may be assessed to only have sufficient workability. The air quality of fly-ash concrete rises with an rise in the amount of cement substitution by fly ash. Fly ash with such an increased-LOI intensity can yield more air as well as a lower unit weight of concrete than with a reduced-LOI value. The concrete mixture having small-LOI fly ash has better mechanical characteristics to the same mixture having higher-LOI fly ash. Through these tests, it's also verified that now the viability of up to 80 per cent of Class F fly ash could be used as a cement substitute in concrete.

This section analyses the approach applied throughout the present analysis. The gradation and composition of aggregates was performed only after processing of Bituminous Beton (BC) mixture components is finished. The Marshall samples were produced and use the traditional filler (i.e. stone dust) and Fly-ash dust and Marshall research was conducted after the gradation of aggregate particles is introduced and mix proportions is completed. For all the fillers that OBC was calculated, and then for the blend made with Fly-ash Dust OFC as carried on. At OBC & OFC, a Converted Bituminous Concrete (BC) blend was packed along with Fly-ash Dust filler. Earlier, the samples are primed through examination of wear resistance and Permanent fracture.

1.1 Sample Preparation

In a stand, a specimen of roughly 1200gms of very well-graded aggregates is allotted and heat to roughly 150 to 170C. To obtain that required binder fluidity, the bitumen binder required must be warmed to 150 C to 165C. Until the mixture is squeezed, the cylindrical mould as well as the compaction rammer is preheated at around 100 C and lubricated or oiled. That bitumen filler with aggregates are now combined at almost 150C to 165C. Now even the heated mixture is poured into to the cylindrical mould mounted on the base plate with both the mould mostly on top of the collar. The blend has been compressed through 4.5KG rammer to reach a compacted thickness of 63.5±3 mm by providing 75 strikes from both sides of a sample, getting a free drop at elevation of 457 mm. A mould is twisted with collar just at base of the compaction, as well as the sample is removed from its mould. Initially, the Marshall samples were cast for both the mix proportion (i.e. the blend only with stone dust additives). The filler material used was 6 per cent by gross cumulative weight. The samples were treated for five different concentrations of bitumen ranging between 4.5 per cent to 6.5 per cent with 0.5 per cent progress. Three samples were produced for each binding intensity as well as the average of such 3 trials was deemed for observation. The Marshall specimens were then processed using Fly-ash Dust filler. Samples containing 3 independent compositions of fillers viz. 5%, 6% and 7% of the Fly- ash Dust filler was obtained as well as the bitumen content was ready with 4.5% to 6.5% with 0.5% ahead. For each binder content, three samples were cast and the average of 3 samples is assumed with analysis.

2. METHODOLOGY

2.1 Wet Method

Throughout the wet phase, the addition or agent is combined with both the bitumen at a temperature varying from approximately 160trecc to 170trec. Consistent mixing of the blend is performed using a mechanical stirrer to create a homogeneous mixture of bitumen and modificator. Wet methods are not widely used with the expense of the machinery and large plants.

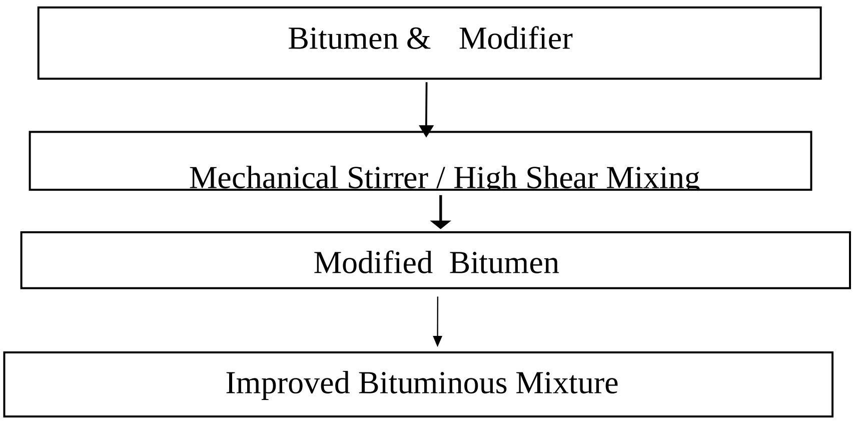

Fig. 1: Wet Mix process

2.2 Dry Method

In the dry method, at a temp of around 170 C, the waste plastic is heat - treated aggregate particles in ripped form. The granules were completely combined only with industrial waste, unless a flimsy plastic layer is applied over its aggregate particles. Now that the PCA is mixed with bitumen to create modified bituminous mixture. This approach is imple and cost-effective, and is therefore widely utilized.

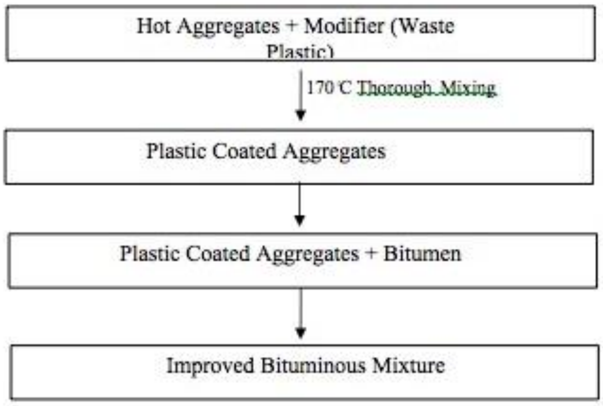

Fig. 2: Dry Mix Method

In the present research dry method was implemented using Recycled PET pellets to create a revised Bituminous Concrete Mix. Provided that the PET melting point is quite large, it's indeed challenging to shape a homogeneous mixture of bitumen and reused PET pellets utilizing wet method (Casey d et al.) [12]. Therefore, dry method was introduced for modifier blending.

3.EXPERIMENTS AND RESULTS

3.1 Fillers

Next, the Marshall stability experiment was done mostly on control mix, i.e. a combination of 6% Stone Dust filler, 55% CA and 39% FA. Three study samples were made from each binder concentration ranging between 4.5 per cent to 6.5 per cent as well as the average readings of such specimens were used for review. The OBC of the mixture was determined to have been 5.5 percent leading to a overall stability value of 10.79 KN, with such a flow value of 3.66 mm inside the stated limits, i.e. 2-4 mm. Table 5.1 displays the effects of the Marshall Test mostly on test combination.

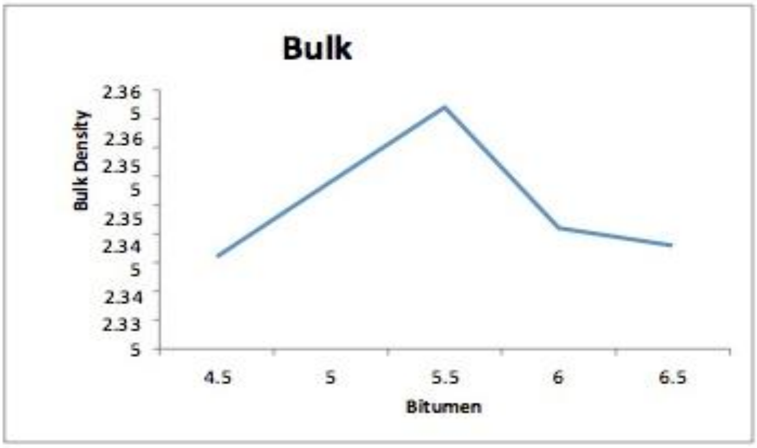

Fig. 3: Marshall Stability with % of asphalt

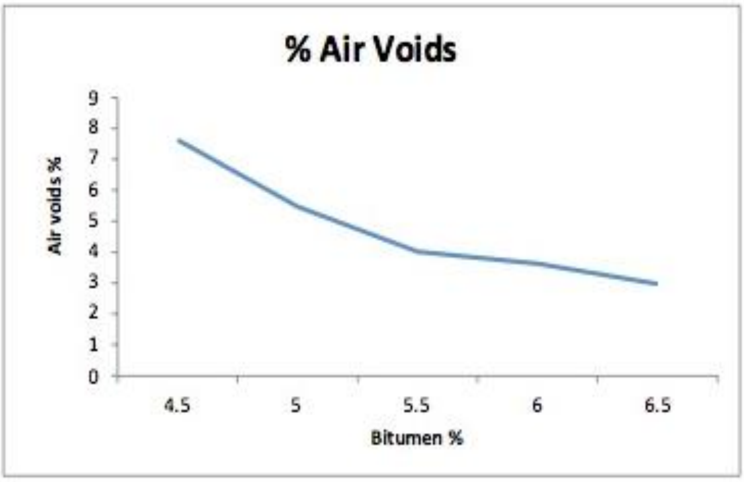

Fig. 4: Bulk density outcomes with asphalt mix

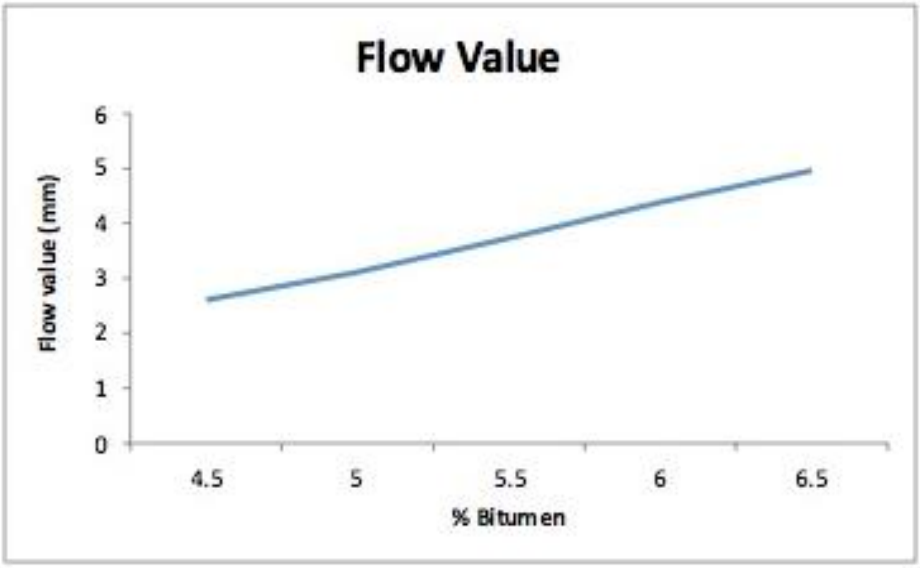

Fig. 5: Changes in air voids with bitumen

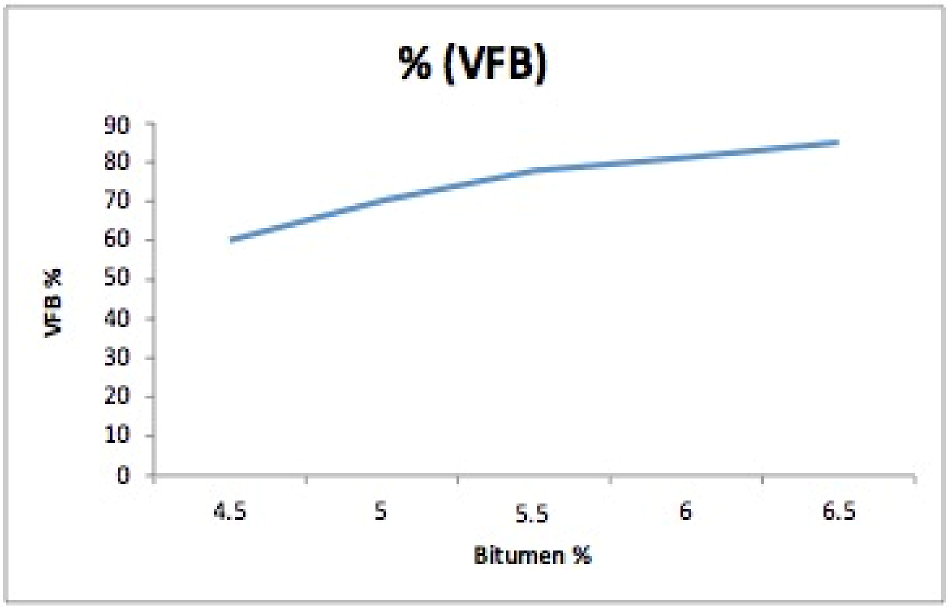

Fig. 6: % VFB vs bitumen

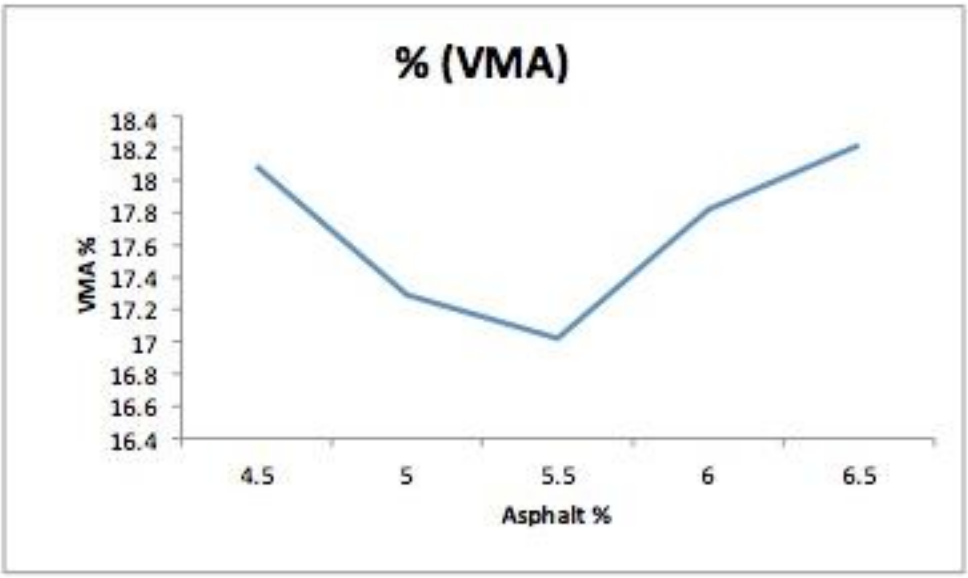

Fig. 7: % VMA vs Bitumen

The maximum bitumen value of both the regulated bituminous concrete mixture is calculated from the diagrams, taking into account the following values:

- Bitumen material equivalent to the average stability value = 5.50 per cent
- Bitumen volume equivalent to the average bulk density = 5.50 per cent
- Bitumen volume equivalent to 4 per cent air voids = 5.48 per cent

The mean bitumen content is calculated as OBC = 5.4933 per cent (rounded to 5.50 per cent).

Fly- as Filler

Earlier, the Marshall research was held with 4.0, 5.0 and 6.0 percent Fly-ash Dust filler at different BC binder concentrations. Three samples were produced for each binder different concentrations around 4.5 per cent to 6.5 per cent with 0.5 per cent progression, and also the average of the 3 trials was chosen with study. Chart 5.2, 5.3, 5.4 reveals Marshall check results at 4 percent, 5 percent and 6 percent.

With 4 % Fly ash

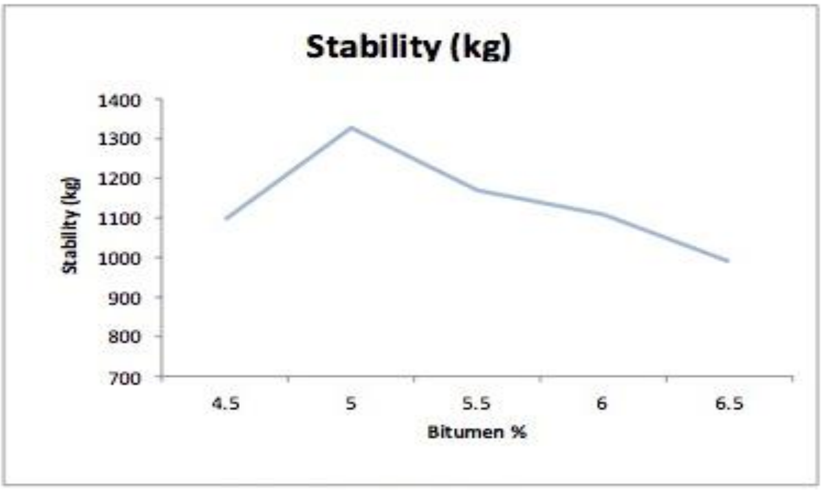

Fig. 8: Stability vs bitumen

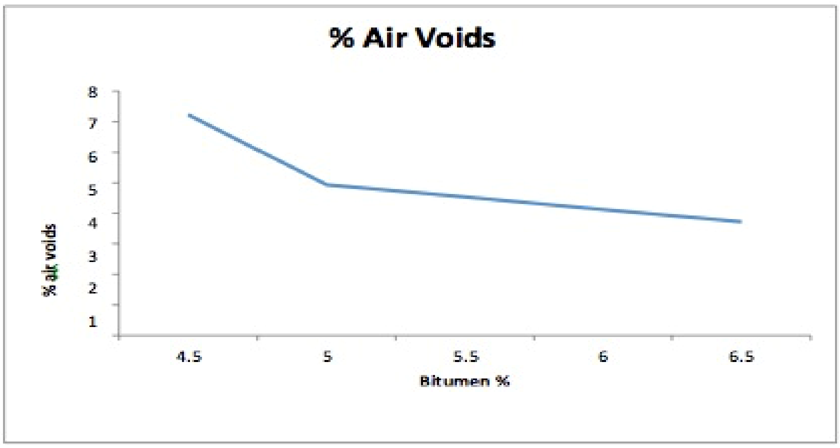

Fig. 9: Air voids vs. Bitumen

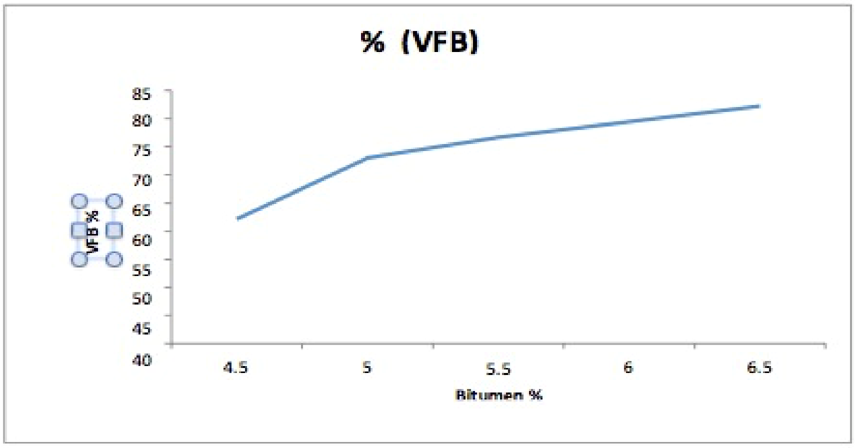

Fig. 10: VFB vs Bitumen (%)

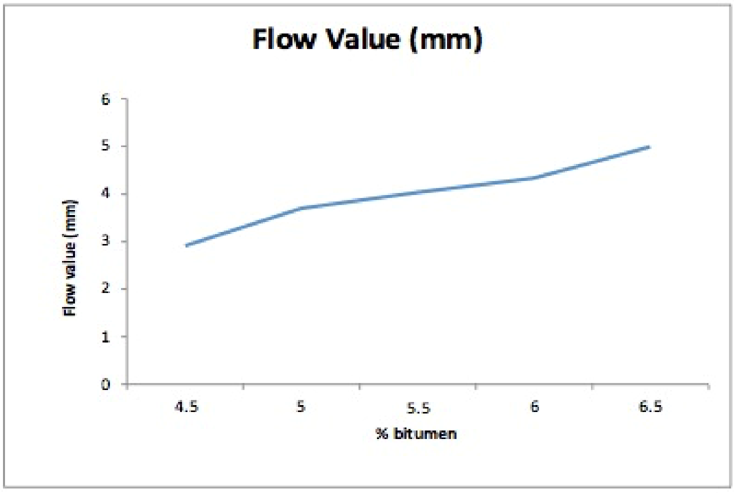

Fig. 11: Flow value (mm) vs Bitumen %

5. CONCLUSION

As per Marshall's study findings, the substitution of Stone powder with Fly-ash Dust (4 per cent) throughout the Bituminous Mix indicates a 9 per cent decrease throughout the OBC, rendering the mixture socioeconomic. Substitution of Stone Powder by Fly-ash Dust in the BC mixture fulfills all MORTH requirements and demonstrates enhanced strength properties. The rise in the PET composition of a mixture, the Marshall stability value goes up to 7% PET but instead began to decrease. Maximum stability was seen at 7% PET material, which would have been 56 percent greater than the control mixture. Marshall flow prices have also improved with a rise in PET content. Adding PET improves the mix's Marshall Quotient (MQ), trying to make it stiffer than that of the control mix, and enhancing deformation resistance. Sufficient PET material with highest capacity and high Marshall Quotient has been found to be 7 percent. Sufficient PET quality is considered to be 7%, including average longevity and a large Marshall Quotient. The persistent fracture / routing behavior of the ideal updated BC mixture were known to increase by 44% compared to the control combination. This enhancement throughout the permanent deformation behavior has been due to a decrease in the temp vulnerability of the mixture as well as an enhance in the stiffness of the mixture. The frictional resistance of a optimally altered BC blend has been enhanced by 32.26 percent, leading to enhanced texture of an aggregate particles due to increased melting point plastic coating. The findings of the analysis are therefore adequate, motivating use of polymers throughout pavement design inside an environmentally friendly manner, trying to make it cost effective and convenient to dump waste.

6. REFERENCES

[1] Al-Hadidy, A. I., & Yi-qiu, T. (2009). "Effect of polyethylene on life of flexible pavements". Construction and Building Materials, 23(3), 1456-1464.
[2] ASTM, E. 303-93 (2003). "Standard Method for Measuring Frictional Properties Using the British Pendulum Tester". Annual book of ASTM Standards, Road and Paving Materials.
[3] Bansal, Shubham, Anil Kumar Misra, and Purnima Bajpai. "Evaluation of modified bituminous concrete mix developed using rubber and plastic waste materials." International Journal of Sustainable Built Environment 6.2 (2017): 442-448.
[4] Casey D, McNally C, Gibney A, Gilchrist MD. "Development of a recycled polymer modified binder for use in stone mastic asphalt". J Resour Conserv Recy 2008; 52:1167–74.
[5] Chandra, Satish, and Rajan Choudhary. "Performance characteristics of bituminous concrete with industrial wastes as filler." Journal of materials in civil engineering 25.11 (2012): 1666-1673.
[6] Chavan, Miss Apurva J. "Use of plastic waste in flexible pavements."
[7] International Journal of Application or Innovation in Engineering and Management 2.4 (2013): 540-552.
[8] Gautam, Pradeep Kumar, et al. "Sustainable use of waste in flexible pavement: A review." Construction and Building Materials 180 (2018): 239-253.
[9] Gürü, M., Çubuk, M. K., Arslan, D., Farzanian, S. A., & Bilici, I. (2014). "An approach to the usage of polyethylene terephthalate (PET) waste as roadway pavement material". Journal of hazardous materials, 279, 302-310.
[10] IRC: 111. (2009). "Specification for dense graded bituminous mix". In Indian Road Congress.
[11] IRC: SP: 53. (2010). "Guidelines on Use of Modified Bitumen In Road Construction". In Indian Road Congress. New Delhi.
[12] IRC: SP: 98. (2013). "Guidelines for the Use of Waste Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses". In Indian Road Congress. New Delhi.
[13] IS: 1202 – 1209. (1978). "Indian Standard methods for testing tar and bituminous materials. Bureau of Indian Standards". New Delhi.
[14] IS: 2386- Parts 1 to 5. (1997). "Indian Standard Methods of Test for Aggregate for Concrete. Bureau of Indian Standards". New Delhi.
[15] IS: 73. (2013). "Indian Standard Specification for Paving Bitumen". Bureau of Indian Standards. New Delhi.

