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Review on polymers and fly ADH in bitumen

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ABSTRACT

The bitumen top coat of the soil comprises of Asphaltic Mix consisting of an appropriate proportion of coarse aggregates (CA), fine aggregates (FA) and filler mixed with full bitumen. The lighter walkways have poor strength creation and could therefore break in action below the charging activity i.e. elastic

***Keywords**: Bitumen, Flexible, Polymer*

1. RIGID PAVEMENT

The outermost layers of the rigid pavement comprise of the latter PCC or RCC and have a strong flexural rigidity and maybe even some high elasticity modulus, and deliveries loads up to a wider area. Figure 1.1 showcases flexible and rigid pavement surfaces. Paved preparation can be broken into two sections

- Pavement Design
- Mix design

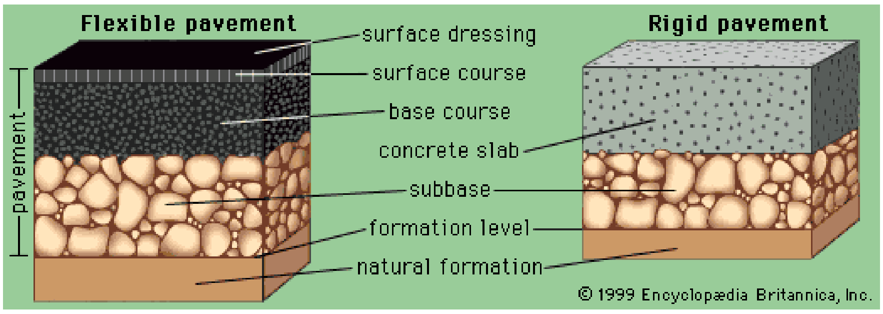

Fig. 1: Layers in Flexible and Rigid Pavement

It's identified research deals mainly for Flexible Pavement Mixture blend. The blend design of a flexible pavement applies to the collection of pellets and even the appropriate binding agent, and also to the commitment of its mixture to produce an suitable combination the meets the requirements of urban roads depending on existing environmental conditions.

1.1 Background

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., a great deal of money has indeed been invested also by Indian government to install and run bridge and rail networks.

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.

2. BITUMINOUS MIX DESIGN

2.1 General

The bituminous approach needs a combination of mineral aggregates, i.e., CA, FA, mineral filler with binding agent combine into a combination and compressing by means of axles to suit the consistency with air void. The goal of its bituminous mixing proportions is simply to work out this very acceptable CA, FA and mineral filler proportion along with an optimum bonding material ratio to build a blend that satisfies certain criteria as well as to extract another OBC mixture to establish a robust framework. The bituminous mixture must therefore be reliable, have such a high degree of durability and avoid fragmentation. The temperature sensitivity of the blend should be smaller, and even the soil should have a strong contact pressure.

2.2 Layers in Flexible Pavement

The simple layers of the versatile flooring are

- Base Course
- Binder Course
- Surface Course

The bituminous base course consists of crushed stone, rubble, etc., that can be consolidated or granular with a bituminous substitute. The base course serves as a foundation for the bonding agent and helps to deliver loading across a wider region. The bituminous binder course is constructed of combined and compacted bituminous aggregates to a have an of air voids. The binder course seems to be the middle base course intermediate sheet, and the layer track. The loading is spread evenly onto the foundation path. The bituminous top surface consists of very well developed mineral aggregates with a nominal size of 25 mm or 19 mm and a fitting mineral filler going through 75μ sieve combined with an ideal proportion of bituminous mixtures to create a mixture and compacted utilizing wheels to a appropriate air voids.

2.3 Types of Bituminous Mix

A bitumen combination is indeed a sufficiently proportioned combination of CA, FA and mineral filler, infused with optimum binder ratio (Bitumen) to establish a good mix which is easily workable and provides an excellent texture with high durability and elastic properties after combine compaction. Can be graded as the bituminous mix based on- -:

a) Production based classification
b) Grading based on nature of gradation

3. BASED ON PRODUCTION PROCESS

3.1 Hot Mix Asphalt (HMA)

HMA is treated at the batch tank. To remove excess moisture, the aggregates are heated at about 150°C to 170°C, and the Bitumen binder is heated to 150°C to 165°C to reduce its viscosity, so that the bitumen becomes fluidic enough to properly mix it with the aggregates. The granules and pavement will be combined at a temperature between 150 ° C and 160 ° C to ensure sufficient mixing. The compaction of the mix at higher temperatures could be easily accomplished only at full utilization of air voids. Relative to other blends the reliability of HMA is higher. Use HMA, the ground path and binding agent run of roads, runways etc. are constructed.

3.2 Warm Mix Asphalt (WMA)

WMA is extracted by combining minerals granules and bitumen binding agent at approximately 100 C to 135 C. Until combining granules and bitumen, other additions such as emulsified waxes or perhaps even moisture are applied to a bituminous mixture to give ample solidity to the binding material to support blend granules and bitumen binding agent at mild temperatures effectively. This significantly reduces the fuel usage and the co2 emissions. The downside of just using pavement in a heated mix is that they've been easily started to open to traffic.

3.3 Cold Mix Asphalt (CMA)

The CMA is introduced in areas where it is difficult to attain sufficiently hotter temperatures. Thus, bitumen is emulsifying agent with during liquid until combining bitumen and mineral aggregates, thereby growing its flexibility thus allowing the blend easy to operate. The emulsified bitumen is combined to aggregates, and the mixture is laid. Once the emulsification has evaporated the liquid the mixture behaves like a liquid HMA.

3.4 Cut back Asphalt

The bitumen binder is emulsified with kerosene or a smaller-fraction petroleum component previous to combining bitumen and aggregates to build a blend, rendering the binder functional and convenient to compress. The lighter fraction disintegrates just after placing of blend, creating a compacted smooth base. Condensation of the lighter component, though, contributes to contamination of organic materials.

3.5 Mastic Asphalt Concrete (MAC)

MAC is made with hard quality blew bitumen. The heat of its strong value blown bitumen is done is a green boiler until it is viscous in shape and then combined with aggregates. It tends to take about 6-8 hours to prepare food the blend, but when the mix has been prepared it is converted to the destination and carried in different thicknesses for walkways on highways etc.

4. BASED ON NATURE OF GRADATION

4.1 Dense Graded Bituminous Mix

A thick graded bituminous mix is one which includes all of the grading aggregates i.e. a well classified mixture. The blend comprises the aggregates of any and all sizes, and the mix's voids are routinely filled in. Because of adequate interconnecting the

power of the combination is improved. The numerous bituminous base course mixtures are -:
- Dense Bituminous Macadam (DBM)
- Bituminous Concrete (BC)

4.2 Open-Graded Mix
The transparent graded blend is absorbent in nature and is used for different applications such as in pavements with elevated speeds. The mineral filler and also fine aggregates are absent inside a free graded blend. They have been used in building high-speed major roads. The Free Standardized Blend forms shown are-:
- Built up Spray Grout (BUSG)
- Bituminous Macadam (BM)

4.3 Gap Graded mix
The aggregates with one particle size are absent in a gap graded combination. The gap classified combination is being used to increase the path rut resistance or under circumstances of overloading. The most widely used graded combination of holes is SMA. In US highways, the SMA is primarily used as a surface route.

5. MIX MODIFICATION
5.1 Present Scenario
The Lightweight surface is supremely used worldwide paving board. The bituminous binders were also popularly used only for binding the mineral aggregates in flexible pavements. The bonding essence of bitumen relies upon its elastic properties and the bitumen binder's chemical configuration. The significant traffic accession in terms of available automobiles (CV), seasonal and daily surface temperature has a detrimental impact on the condition of the pavement today. Therefore, we have to conceive of alternate solutions by changing the blend to improve the surface properties, thereby enhancing consistency and rendering it economic. Mix modification can be done by either of the two ways:
- Polymer Modification
- Modification by using substitute filler

5.2 Polymer Modification
Throughout today's modern world plastic are used for different uses in our everyday lives, such as wrapping food, drugs, holding containers, making water bottles, etc. Amount of plastic waste is continually growing. The disposal of these chemicals residues pollutes everything. Landfilling, incineration etc. are also the different methods followed for burning plastic wastes. Such management activities also cause rivers waste thereby impacting marine life and toxic gas emissions throughout combustion. Already these plastic wastes are capable and being used as raw resources from either new or reused ways to create versatile asphalt.

Elastomer nanoparticles (natural rubber, crumb rubber), plastomers, and thermoplastic polymers (HDPE, LDPE, PET) are the various synthetic polymers used in flexible paving. Polyethylene Terephthalate (PET) is a thermoplastic polymer of its polyester family that accounts for about 18 percent of global plastics supply. PET is commonly used only for plastic bag manufacturing, drug bottles, food processing, synthetic fibers etc. But, as already described, inadequate disposal procedures contribute to various environmental issues. Therefore, such PET wastes have had the potential to be used as raw resources in versatile pavement design. Its use of PET in building of pavements is not recent. A lot of work has indeed been conducted to assess the effect of PET waste on the properties of the mix. Those other plastic wastes can indeed be mixed with both the mix using some dry method or wet method, attempting to make moisture repulsive to the aggregates. Laboratory trials, though, recommend combining waste PET utilizing dry methods, since the PET melting point is quite large, making it nearly impossible to blend using wet method. Plastic wastes may be used either in fresh versions or in reused versions as raw resources. Using reusable content also appears to have a significant effect on the blend consistency. We just use reused sort of Waste material in the research.

Polymer Modification can indeed be regarded as a process for improving road surface temp vulnerability and also some improving road fatigue life. The improved bituminous blend of plastic does not have a long-lasting and stiffer material, and moreover approaches plastic waste processing inside an environmentally safe manner.

Soliman et al., (2012) Investigated use of Fly-ash microfibers in UHPC and their influence upon concrete early-age features. Today, for varying amounts, Fly-ash Microfibers have been applied, partly eliminating cement with its quantity throughout the mix. The findings revealed that the application of microfibers increased the compressive strength of concrete at a young age and then also increased the hydration cycle. Even the microfibers used to have a positive effect mostly on blend flexural strength power.

Niazi et al., (2008) Formation of the CIR mixture with Portland cement and lime preservatives was examined. It was concluded that the effect of Portland cement and lime preservatives on CIR mixtures of emulsified bitumen as well as the maximal cement and lime quality. These were collected the Reclaimed Asphalt Pavement (RAP), as well as the RAP gradation was calculated. The RAP modificatory asphalt concentration was calculated, and new aggregate classification were established then applied to the blend. Currently the Marshall samples have been processed with 3.5 per cent asphalt material and 3.6 per cent Portland cement including water and lime sludge. The tests indicate that Portland cement and lime have been identified to have an average value of 2 percent. Increased tensile strength, rutting tolerance, Marshall Stability, and exposure to moisture resistance.

Wahab et al., (2017) Considered it's use Fly-ash Powder mostly as fractional replacement for cement and sand. The work sought to strengthen the material characteristics of the mortar mix by substituting sand or cement from its mixture using Fly-ash Powder. For

10.0, 20.0 and 30.0 per cent of Fly-ash powder substituting cement and sand separately throughout the mixture, various specimens have been formulated currently. The findings revealed that the use of Fly- ash powder as either a fractional sand substitute increased the mix's flexural and compressive strength, and also reduced the initial setting time. Findings furthermore revealed whether substituting cement with Fly-ash powder decreases the mix 's strength. In each of these conditions the drying shrinkage of a mixture has been improved.

Karashain et al., (2006) Through use of marble dust (MD) wastes as filler material in BC mix was investigated. The goal was to investigate the possibility of using MD wastes in bituminous pavements. The research samples for Marshall was primed as filler including MD with lime stone soil, as well as the combination OBC were overcome. With the aid of filler /bitumen and filler ratio, the mix's OFC was figured out. The findings revealed that perhaps the deformation of plastics utilizing MD and calcareous dust as filler was approximately identical. The plastic deformation with MD was nevertheless larger. This combination will be used to build small volume highways.

Chandra et al. (2012) Investigated factory garbage used as filler in BC mix building. They utilized MD, granite dust & fly ash as filler. The BC blend was designed with specific filler material wide variation about 4.0 % to 8.5% of marble dust, granite dust including fly ash together with stone dust as a filler for the preparation of control mixture. The rutting of the axle, resistance to heat, flexural fatigue and persistent creep analysis were carried out. The OBC were developed for various filler and then was noticed to become the less for MD filler. Similar to traditional filler, the rutting properties were improved by 40 per cent for replacement filler. Comparison with the control mix, their fatigue properties of a blend ready using waste materials filler were increased. Susceptibility to a vulnerability to Moisture has also been increased.

Sayed et al., (1994) Sewage sludge ash used for minerals filling in bituminous mixtures. The study sought to determine the possibility of using ash from waste sludge as a building material. The Marshall stability research samples were produced using ash from waste sludge and were compared with the standard blend. The material requirements' physical and chemical characteristics had been calculated, and monitoring on Marshall samples wa conducted. The results showed that now the sample formulated using ash from waste sludge met the basic standards for sustainability. These were found that its efficiency of a mix of ash from sewage sludge is improved at higher temps.

Taha et al., (2013) Through use of cement scrap dust (CBPD) in BC mixtures has been investigated. The goal was to investigate CBPD 's usefulness as, mineral filler in bituminous blends. Next, it analyzed the effect of applying CBPD to either the mix's binder characteristics. The tests revealed a fall in the quantity of penetration and ductility even as intensity of the filler improved. The Marshall specimens had been later equipped with 5 percent calcareous, 5 percent CBPD and 13 percent CBPD as well as the findings revealed that now the best results were found at 5 percent CBPD swapping calcareous. The application of 13 per cent cement bypass dust (CBPD) improved the mix's OBC, making it inexpensive. Thus, the optimal level has been estimated to be 5 per cent cement bypass dust (CBPD).

6. POLYMERS OR PLASTICS IN PAVEMENT MIX

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 and the 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.

Guru et al., (2014) PET was used as roadbuilding material. The objective was to investigate the use of PET waste in highway construction and test its impact on the mix's engineering features. The PET was combined and use the wet method in the form of lean liquid polyol PET (TLPP) and venomous polyol PET (VPP), which had been collected through chemical PET waste glycolysis. The study revealed that TLPP and VPP increased bitumen penetration although decreasing viscosity and softening level. Susceptibility to cracking at low temp was improved. The Marshall properties as well as the mix's rutting resistance have been improved. Therefore, it could be inferred that updated asphalts using TLPP and VPP could be used in colder and humid regions within the pavement construction.

Ahmadinia et al., (2011) studied its use of SMA mixed waste plastic bottles. The material characteristics of the SMA blend were carried out on integrating wasted plastic containers into the blend. The garbage PET (plastic bottles) has been infused using dry method, since the PET melting point has been large a mainly comprised could not be established and used the wet method. Specific quantities of PET have been included, ranging around 0-10 weight percent of bitumen and arrangements were made for Marshall experiments. The findings suggest that addition PET to a mix at first improved the consistency of Marshall and the decreased with increasing levels of PET. Also, the mixture's stiffness was enhanced. The findings revealed that now the inclusion of PET in the SMA mixture increased the mix 's efficiency properties and allows to conserve waste in landfills practical and cost - effective manner.

Hadidy et al., (2008) The use of polyethylene in lifetime of bituminous pavements was investigated. The key study was designed to investigate its use of LDPE in the bituminous mix also as pavement substance to enhance its tolerance to temperature sensitivity and other environmental factors together with the advantage that use LDPE. The method for evaluating the binder's rheological property, Consistency of the marshall, ITS, and flexural stress checks is done. The penetration, ductility, and softening point check being performed, and afterwards the Modified Mix was designed at an appropriate asphalt material. The Wet Cycle was used to introduce the LDPE. Reports indicated a decrease in penetration and flexural strength as the LDPE content reduced and the softening level increased. Incorporation of LDPE has improved ITS, breakup stiffness & modulus, and resilience of Marshall. The mix's characteristics had been configured with LDPE material of 6 per cent.

Chavhan, (2013) the garbage plastics used in bituminous mixtures. The goal of the research was to use plastic waste in an environmentally sustainable manner and its purpose was only to contrast the characteristics of PCA with natural aggregates and also to evaluate the characteristics of mixed sample formulated with Plastic Coated Aggregates (PCA) produced. The plastic waste obtained on site, i.e. polyethylene and polypropylene, had first been crushed to the thickness of 2-3 mm in such a waste grinder. Then this twisted garbage is combined with aggregates for 30-45 secs before plastics is sprayed also on surface of the aggregates. The findings showed whether owing plastics covering of aggregates improved the aggregate hardness as well as the crushing force. The Plastic-Coated Aggregates (PCA) where determined to have zero stripping value and water absorption. Then we may assume that the use of PCA throughout the bituminous mix can reduce any need for bitumen while at the same time increase the mix 's performance. Such plastics highways will help to eliminate the deterioration of the roadway and minimize the amount of money required to install the paving.

Kalantar et al., (2012) Virgin and Recycled synthetic materials found in bituminous paving. The goal was to determine whether another pure or wasted polymer is much more efficient in pavement performance. These are observed that the effect of waste polymer on performance parameters is close to that of fresh polymer as well. Even so, waste polymer usage is considered to be far more beneficial because it assists in enhancing road efficiency and also reducing the dump levels. Any use of scrap polymer throughout the design mix is much more successful, because these polymers can be toxic if not recovered and recycled. Therefore, it suggests that it is much more beneficial to use wasted polymer rather fresh polymer.

Leng et al., (2018) The use of chemically treated Waste material as a replacement in CRMA was discussed. The practicability of reused PET the aminolysis method produced in the CRMA mixture has been investigated. An investigator researched the rheological and chemical characteristics of the asphalt binder. The substance derived from the chemical activation of the Waste material was BHETA. The findings revealed that adding BHETA had improved the rigidity of the CRMA mixture. Testing revealed that the mix 's storage quality has also increased. The strength of viscosity and fatigue of the CRMA combination has also been found to increase. This has also enhanced the elastic and recovery properties of the blend. Therefore, these are suggested that scrap PET-modified CRMA mix does have a favorable importance on road surfaces properties and aids in fast disposal of waste materials.

Karahrodi et al., (2016) Reviewed its use of PET scrap and surface tire rubber (GTR) mixes to adjust bitumen thermal and rheological features. We studied the behavior of blended bitumen utilizing wasted PET and GTR mixes. Mixing the wasted PET and GTR in such a spinning extruder is achieved by melt compounding. This mixture was then blended with bitumen, utilizing wet procedure in various concentrations. It also studied the thermal and structural features and chemical properties of the bituminous mixtures. It seemed that the diffusion of the changed bitumen were influenced by the deterioration in the composition of the GTR leading to a coarse connected structure of the GTR. The thermal and rheological characteristics demonstrated an increase in the strange mix 's viscosity, thermal stability, stiffness and rutting resistance at higher temperatures. Then it could be inferred that even in paving building scrap PET and GTR mix is being used as an additive.

Punith et al., (2011) Using polyethylene as additive for pavement blends in bituminous mixtures. It studied the impact of differing variables on the binder compositions as well as the bitumen's physicochemical characteristics. The recycled polyethylene became derived from site-collected LDPE carry bags. The polyethylene remained combined with filler using a mechanical stirrer, and was shown that now the combining temperatures often decreases as the polyethylene quantity rose. The changed bitumen efficiency at extreme temps was therefore improved. The penetration experiment method revealed an improvement throughout the rigidity while at the same time the binder aging. Penetration and flexural strength reduced with increasing in the polyethylene amount while the softening point and relative gravity improved. Polyethylene & bitumen mix has been determined to also be stronger in elastic recovery than standard bitumen. The binder viscosity improved with polyethylene incorporated in the binding material. Polyethylene derived through LDPE will thus enhance the binder abilities in such an affordable way.

Murphy et al., (2001) explored use of reused rubber as either a bitumen additive. The possibility of using Recycled Polymer as just a additive is discussed, rather than Styrene Butadiene Styrene (SBS). Features penetration, viscosity, softening point, rheological and stiffness analysis on bituminous blend samples. HDPE, LDPE, Polypropylene (i.e., homopolymer and copolymer), Truck tyre rubber (TTRB), Ground tire Rubber (GTR), and ethylene vinyl acetate were the polymers used in the analysis. The findings revealed that Polypropylenes could not be used as an additive because they had been hard to combine in the blend. The Truck tyre rubber (TTRB) shows substantial improvements in bitumen content. Using LPDE and HDPE demonstrated the much more enhanced features of modified bituminous mixing which could be used in mixing.

Bansal et al. (2017) the plastic waste and crumb rubber for use as additive in the BC mix has been examined. This studied the behavior of adjusted BC blends utilizing Marshall stability analysis. The research initially calculated the control mix's OBC and later concurrently preparing the binary blend with plastic wastes and CR, but instead ready tertiary mixes by combining plastic waste and CR. Around the same time, the dry method and wet method were used to blend waste material and CR, separately. The tests showed that now the capacity, consistency and steadiness of the blend throughout the changed formulations are increased. Therefore, can be inferred that now the effective use of such components improves the efficiency of the BC blend and decreases the expense of asphalt pavements.

7. REFERENCES

[1] AASHTO Designation: T245. (2004). “Standard method of test for resistance to plastic flow of bituminous mixtures using Marshall Apparatus”.

[2] AASHTO T 324. (2011). “Standard method of test for Hamburg wheel-track testing of compacted hot-mix asphalt (HMA)”. Standard Specifications for Transportation Materials and Methods of Sampling and Testing.

[3] AASHTO, T. (1997). 245, “Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus”. American Association of 59 State Highway and Transportation Officials, Washington, DC.

[4] Ahmad, A. F., Razali, A. R., & Razelan, I. S. M. (2017, May). “Utilization of polyethylene terephthalate (PET) in asphalt pavement: A review”. In IOP Conference Series: Materials Science and Engineering (Vol. 203, No. 1, p. 012004). IOP Publishing.

[5] Ahmadinia, E., Zargar, M., Karim, M. R., Abdelaziz, M., & Shafigh, P. (2011). “Using waste plastic bottles as additive for stone mastic asphalt”. Materials & Design, 32(10), 4844-4849.

[6] Al Sayed, Mohammed H., Ismail M. Madany, and A. Rahman M. Buali. "Use of sewage sludge ash in asphaltic paving mixes in hot regions." Construction and Building Materials 9.1 (1995): 19-23.

[7] Al-Hadidy, A. I., & Yi-qiu, T. (2009). “Effect of polyethylene on life of flexible pavements”. Construction and Building Materials, 23(3), 1456-1464.

[8] 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.

[9] 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.

[10] 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.

[11] 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.

[12] Chavan, Miss Apurva J. "Use of plastic waste in flexible pavements."

[13] International Journal of Application or Innovation in Engineering and Management 2.4 (2013): 540-552.

[14] Gautam, Pradeep Kumar, et al. "Sustainable use of waste in flexible pavement: A review." Construction and Building

Materials 180 (2018): 239-253.
[15] 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.
[16] IRC: 111. (2009). "Specification for dense graded bituminous mix". In Indian Road Congress.
[17] IRC: SP: 53. (2010). "Guidelines on Use of Modified Bitumen In Road Construction". In Indian Road Congress. New Delhi.
[18] 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.
[19] IS: 1202 – 1209. (1978). "Indian Standard methods for testing tar and bituminous materials. Bureau of Indian Standards". New Delhi.

