International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 11 | Nov 2022 www.irjet.net p-ISSN: 2395-0072

An Investigation Into The Use Of Waste Polyethylene In Bituminous Paving Mixtures

Mohammad Junaid Dar [1], ER. Manish Goel [2],

[1]M.tech (T.E) student at Desh Bhagat University Mandi Gobindgarh
[2]Asst. Professor in deptt of Civil Engg. At Desh Bhagat University Punjab ,India

---

Abstract - *The road network has been continuously deteriorating due to the ongoing rise in traffic and the insufficient level of maintenance caused by a lack of funding. Various sorts of actions, such as obtaining finances for maintenance, improving route design, using higher quality materials, and using more efficient building methods are believed to be useful in easing this process. In the wake of the rise in usage, it had been demonstrated that improving the quality of the materials used in road building might improve road service performance. Asphalt concrete can benefit from various different modifications to the bituminous binder that are made with polymer additives, as demonstrated by practical experience over the past 40 years. The country has seen a significant increase in the usage of polythene materials for clean water sachets because to its plentiful availability and good resistance to insects, fungus, animals, moulds, mildew, rot, and many chemicals. However, it has been difficult to dispose of the waste polythene materials in huge numbers across the nation. Therefore, the purpose of this investigation was to ascertain the impact of polythene as it was present in pure water sachets on the characteristics of asphalt and concrete. As a binder modification, grinded polythene was added. By melting it in the bitumen used to prepare the combination, it was added.*

Key Words: Bitumen , Aggregates , polythene , Plastic etc

1. INTRODUCTION

Bituminous binders, which are substantially utilised in the paving business, have several uses in civil engineering. The pavement is made up of numerous layers. Aggregate and bitumen are the two major factors of bituminous concrete(BC) blend. In general, Flexible Pavement and Rigid Pavement are the two classes into which all hard surfaced pavements fall.Plastics is a material that contains one or further organic polymer of large molecular weight, solid in its finished stated and it also can flow under specific state. It's durable and has veritably slow process of declination. Plastic can be divided into two major orders which are thermoses and thermoplastics. Thermos is a fettle of plastic when it's in solid form. This type of plastic is veritably useful in their continuity and strength.

Currently, the use of the plastic bag with several of sizes has been growing day by day. This development led to an increase in the quantum of waste. This dangerous waste is disposed by land stuffing or incineration. Waste plastic doesn't suffer bio-decomposition. thus, whether it's land filled or incinerated, it still pollutes the land and the atmosphere. still, the discovery of the list property of plastic in its molten state which can be used in road laying has help to well manage this waste plastic. Road pavement that uses plastic waste as one of it material is called plastic road.Plastic bag isnon-biodegradable but utmost of it's recyclable. The recycled products are more environmentally dangerous than the first time manufactured bones ,because every time plastic is reclaimed it's subject to high intenseness heat. This can make it to deteriorate and lead to environmental pollution. That's why, it's necessary to determine the effective way to deal with thisnon-biodegradable waste

Bitumen grade of 60- 70 was used in this exploration. Physical tests for the density, penetration and also softening points for both unmodified and modified bitumen of 60- 70 penetration grades were included in this study. In addition, the rheological parcels of modified binders will suitable to help for the identification of the significance of using the modifiers in pavement diligence. The test for rheological will be conducted by using a Direct Shear Rheometer(DSR) outfit grounded on the abecedarian of dynamic mechanical analysis. All the procedures used for the laboratory workshop are appertained to Indian standard Testing and Material(IS) specifications

1.1 LITERATURE REVIEW

- When the composites were put through performance testing including Marshall Stability, tensile strength, compressive strength tests, and tri-axial tests, Bindu and Beena(2010) delved how Waste plastic functions as a stabilizing addition in Stone Mastic Asphalt. The findings showed that 10 tattered plastic may give flexible pavement with great performance and continuity.

- Using the thermoplastic elastomer styrene butadiene styrene(SBS), Fernandez etal.(2008) explored the rheological assessment of polymer modified asphalt binders. To increase their comity, they estimated the changed binder's rates by adding oil painting shale and sweet oil painting. In a dynamic shear rheometer(DSR), the rheological parcels of the SBS PMBs were examined, and luminescence optic microscopy was used to pierce the morphology. The findings showed that the goods of sweet and shale canvases on the microstructure, storehouse stability, and viscoelastic geste of the PMBs were similar. Shale oil painting might thus effectively serve as a compatibilizer agent without immolating rates or indeed take the place of sweet oil painting.

- According to Awwad and Shbeeb's 2007 exploration, the changed admixture has a lesser stability and VMA chance than thenon-modified composites, which appreciatively affects the fusions' resistance to rutting. They claim that adding HDPE polyethylene to asphalt admixture improves the admixture's characteristics far more than adding LDPE polyethylene does.

- According to Khan and Gundaliya (2012),the process of modifying bitumen with waste polythene improves the overall performance of roads over a long period of time by adding softening point, hardness, and reducing stripping due to water. This improves resistance to cracking, pothole conformation, and rutting. They claim that the used waste polythene fleeces the admixture's summations, reducing porosity and humidity immersion while also enhancing binding parcels.

- Jain et al. (2011) studied the mitigation of rutting in bituminous roads by use of waste polymeric packaging materials and came to the conclusion that adding the right amount of polyethylene to bituminous mix for road construction can reduce rutting of bituminous mix to 3.6 mm from a value of 16.2 mm after application of 20,000 cycles, ultimately improving pavement performance and alleviating disposal issues of WPPM for a clean and safe environment.

1.2 METHODOLOGY AND MATERIAL USED

The basic materials used are as follows:

- Aggregates
- Fly Ash
- Slag
- Bituminous Binder
- Polyethylene

Bitumen (80/100), aggregates, and waste polythene nylons were the materials employed for this study. Waste polythene nylons are gathered, cleaned, sorted, and dried in the sun for a few days until all the samples are dry. To maximise its surface area of contact with the bitumen during blending, the shredding machine was used to shred the dried samples of the waste polythene into pieces ranging from 0.6mm to 2.36mm. In asphalt concrete, polymers are often used as aggregate or as a binder modifier. As a binder modifier for this study, polythene material was employed. By heating bitumen with shreds of polythene ranging in size from 0.6mm to 2.36mm, modified bitumen was created. Six polythene content ratios by bitumen weight (2.5, 5, 7.5, 10, 12.5 and 15%) were taken into consideration. When the mixture reached 265°C, it was blended uniformly after constant steering. Graduation criteria are often sufficiently flexible that they allow the use of paving mixes with varying degrees of stability, from coarse to fine. To manage certain grading ranges, various combinations of sieve sizes are provided, which complicates the situation further.

EXPERIMENTAL WORK

This experimental works carried out in this present investigation. It involves mainly 2 processes. i.e.

- Preparation of Marshall samples

- Tests on samples

The specific gravity, tensile strength, and softening point of polythene were calculated

Determination of specific gravity of polyethylene

Specific gravity of polyethylene was found out by following the guidelines of ASTM D792-
The procedure adopted is given below;

The weight of the polyethylene in air was measured by a balance. Let it be denoted by "a".

An immersion vessel full of water was kept below the balance.

An iron wire was attached to the balance so that it is suspended about 25 mm above the support.

The polyethylene 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".

Then polyethylene was extracted and the weight of the wire , sink was measured by soaking them inside water. Let it be denoted as "w".

The specific gravity is given by

s = a / (a + w - b) 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

Take specific gravity of polyethylene = 0.905.

- Methods

1 . Sieve analysis
2 . Marshal stability test

Mechanical shakers were used to conduct the sieve analysis. The diameters of the sieves range from 0.075 to 19mm. Each sieve's weight retention was measured and noted. It was determined what percentage of each size passed. To determine if the chosen aggregates fall inside the designated envelop, a graph of percentage weight passing against sieve size was generated. To get an all-in combination grade that satisfies the standard, test mixes combining the coarse and fine aggregates were created.

It is required to conduct mix design to identify the ideal bitumen content for the mix using unmodified bitumen as the binder in order to assess the impact of modified binder on the characteristics of asphalt concrete.

- Retained stability test

Retained Stability measures streaking in the blend caused by humidity and the consequent loss of stability as a result of the weaker link between the summations and binder. The test was run on the Marshall machine using the standard Marshall samples after STP 204- 22. After putting the samples in a water bath at 60 °C for 30 twinkles and 24 hours, the stability was assessed.

2. RESULT ANALYSIS AND DISCUSSION

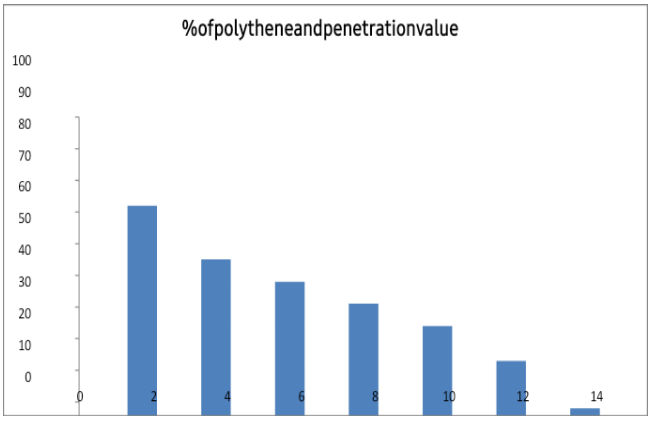
The Marshall stability value improves with an increase in bitumen attention up to a specific bitumen content before it starts to decline. The ideal binder content is that specific bitumen content(OBC). The OBC in the current disquisition was decided to be 6,4.5, and4.5 for traditional SMA, BC, and DBM mixes, and 4 for modified SMA, BC, and DBM mixes with polyethylene at colorful attention. The graphs show that the stability value improves with the addition of polyethylene up to a point and also declines with fresh addition. This may be because there's too important polyethylene present and it can not duly mix with the asphalt. The quantum of polyethylene in the admixture is known as optimum polyethylene content(OPC) which is set up as 2 for SMA and DBM and1.5 for BC mixes.

S.No	Bitumen Content (%)	Weight of mix(g)	Weight in air(g)	Weight in water (g)	Stability of bitumen		Flow (mm)	Diame -ter (cm)	height (cm)
					Stability of modified				
					Plain bitumen	Modified bitumen			
1	4.5	1255.5	1256.5	733	14.7	17.95	1.99	10	6.3
2	5	1253	1255.5	734	19.47	23.44	2.38	10	6.4
3	5.5	1257	1259	736	13.46	18.21	2.88	10	6.5
4	6	1268	1270	748	8.9	13.10	2.59	10	6.4

Retained Stability

For SMA, BC, and DBM fusions, retained stability is reckoned both with and without polyethylene. It has been shown that when polyethylene is added to the admixture, the conserved stability value rises. Following DBM with polyethylene and SMA with polyethylene, analysis shows that BC with polyethylene produces the maximum maintained stability..

Types of mix	Avg. stability after 1hour in water at 2 60°c	Avg. stability after 24 hours in water at 60°c	Avg. retained Stability in %
SMA without polyethylene	10.93	8.49	73.2
SMA with polyethylene	10.87	8.49	78.13
DBM without polyethylene	12.76	9.96	74.04
DBM with polyethylene	14.96	12.01	80.2
BC without polyethylene	17.58	14.13	76.38
BC without polyethylene	17.44	14.21	81.46



Penetration Index (PI)

Penetration indicator(PI) The penetration indicator(PI) represents the quantitative measure of the reaction of bitumen to variation in temperature. The information of penetration indicator of particular bitumen can be used to prognosticate its gusted in an application. Therefore, bitumen with high penetration figures that can be called as soft are used for cold climates while asphalt binders with low penetration figures that known as hard are used for warm climates.

% Plastic waste by weight	Penetration Index (PI)
0	-0.02
1.5	-0.23
3.0	-0.39
4.5	-0.10
6.0	-1.31

Chart -1: Name of the chart

3. CONCLUSIONS

After conducting several studies, I have come to the conclusion that waste polythene may be utilized for good as it might cause problems if not handled properly. As a result, it is essential that various waste plastics be gathered and added to bituminous mix.

In this study, VG30 grade bitumen is employed as a binder to create three different types of mixtures, namely SMA, DBM, and BC. By adjusting polyethylene concentrations from 0% to 2.5% at an increment of 0.5%, the effect of adding waste polyethylene in the form of locally accessible imitation milk with brand OMFED packages in the bituminous mixes has been explored.

The ideal bitumen content (OBC) and ideal polyethylene content (OPC) for various types of mixes have been found using the Marshall Method of mix design. When using stone dust as a filler, it has been shown that adding 2% polyethylene for SMA and DBM mixes and 1.5% polyethylene for BC mixes yields the best Marshall Properties. The best Marshall Properties for all types of mixes, however, are obtained with only a 1.5% addition of polyethylene when a tiny portion of fine aggregates are replaced by granulated blast furnace slag and filler is replaced by fly ash. The OBCs in modified SMA, BC, and DBM mixes that contain stone dust as a filler are detected at 4%, and the OBCs in modified SMA, BC, and DBM mixes that using fly ash and slag are found to be 5% and 4% respectively.

FUTURE SCOPE

Using just VG 30 penetration grade bitumen and polyethylene, several attributes of SMA, BC, and DBM mixes, including Marshall Properties, drain down characteristics, static tensile strength, and static creep characteristics, have been examined in this experiment. However, it was necessary to look at some of the qualities, including dynamic creep behaviour, dynamic indirect tensile strength characteristics, and dynamic fatigue properties

In the current investigation, dry mixing is used to add polyethylene to the mixture. Polyethylene may likewise be used to modify bitumen by wet mixing, and similarities can be drawn.

To determine the degree of homogeneity, the microstructure of the modified bituminous mixture should be examined using the proper technique.

In order to adequately investigate the possibilities of locating appropriate materials for paving mixes in the event of the current challenging circumstances, a combination of paving mixes formed with other types of plastic wastes that are widely available, wastes to replace conventional fine aggregates and filler, and different types of binders including modified binders, should be tried.

REFERENCES

- González U. O. 2008. Rheological property of bitumen modified with polyethylene and polyethylene based blends
- Mohammad T. A., Awab and Lina S. 2007. The use of Polyethylene in Hot Asphalt Mixture's. American Journal of Applied Sciences.
- Qi X, Sebaly P E & Epps J A, J Mater Civil Eng, 7 (1995)7627. polyethylene T. Baghae Moghadam, M. R. Karimm and T. Syamaun, (2012), Dynamic properties of stone mastic asphalt mixtures containing waste plastic bottles, Construction and Building Materials 34, 236-242.
- T. Baghae Moghadam, M. Soltani and M. R. Kariim, (2014), Evaluation of permanent deformation characteristics of unmodified and terephthalate modified asphalt mixtures using dynamic creep test, Materials & Design 53, 317-324.
- B. Moghadamm T, Soltani M, Kariim MR, (2014), Experimental characterization of rutting performance of polyethylene terephthalate modified asphalt mixtures under
- Gayle and King Et.al, "polymer modified Bitumen", Third International Road Federation, Middle East Regional Meeting, Riyadh, Saudi Arabia, February 1998.
- "Sinan Hinislioglu Et.al, "Use of High Density Waste Polyethylene as a bitumen modifier." Materials Letters 58(2004)267-271, Science Direct.
- "R. Vasudevan Et.al," Proceedings of the International Conference on Sustainable Solid Waste Management, 5 - 7 September 2007, Chennai, India. Pp.105-111
- Y.Adnan.,H.Arshad.,I.Muhammad.,A.Anwaar.,2014. Performance Evaluation of AsphalticMixtures Using Bakelite .Life Science Journal2014; 11(7s).[6] Dwivedi. A., Mattoo.M., Prabhu.J., Dwivedi.A., Jain.P.,2014.A Survey on Cost Comparison ofSustainable Plastic Road with Regular BitumenRoad,IJIRSET.2017,p.0602011.[7]