Use of Polyethylene In Bituminous Road

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Abstract- *The use of polythene in bituminous road construction has gained significant attention in recent years due to its potential to enhance road performance and durability. This paper provides an overview of the current state of research on the use of polythene in bituminous road construction. The paper reviews the properties of polythene and its potential benefits when incorporated into bituminous road materials. The impact of polythene on various characteristics of bituminous mixes, including stability, deformation, and fatigue resistance, is also discussed. The study also examines the effect of polythene on the rutting and moisture susceptibility of bituminous mixes. The paper also explores the challenges and limitations of using polythene in bituminous road construction, including potential environmental impacts. Overall, the use of polythene in bituminous road construction has shown promising results and can potentially improve the performance and durability of roads. However, further research is needed to fully understand its long-term effects and environmental impacts.*

Keywords- polyethylene, bituminous road,asphalt mixture, modifier, performance, durability, rutting

I. INTRODUCTION

The use of polythene in bituminous road construction has gained widespread attention due to its potential benefits in terms of improved road durability and reduced environmental impact. Bituminous roads, also known as asphalt roads, are commonly used for both urban and rural road networks due to their low cost and easy maintenance. However, these roads are also prone to damage from environmental factors such as water infiltration, temperature fluctuations, and heavy traffic. As a result, the use of additives to improve the performance of asphalt has been a major focus of research in recent years. One such additive is polythene, a synthetic Polyethylene that is widely used in packaging and other applications. Polythene has been shown to have several beneficial properties when used as an additive in bituminous roads. These include improved resistance to cracking and rutting, reduced water penetration, and increased resistance to ageing. In addition, the use of polythene in bituminous roads can help reduce the amount of plastic waste in the environment, as it provides a new use for discarded plastic bags and other products. Research into the use of polythene in bituminous roads has been ongoing for several years, with many studies demonstrating its effectiveness in improving road performance. Some studies have also investigated the use of other types of plastics, such as polypropylene and high-density polythenes, as additives in bituminous roads. However, the use of plastic additives in bituminous roads is not without its challenges. One concern is the potential release of micro plastics into the environment as the roads wear down over time. This could have negative impacts on both human health and the environment, and further research is needed to fully understand the risks associated with this type of additive. Overall, the use of polythene in bituminous road construction has the potential to provide significant benefits in terms of improved road performance and reduced environmental impact. However, more research is needed to fully understand the long-term effects of this type of additive on both road performance and the environment and to develop best practices for its use in road construction. Plastic have become an integral part in our daily life and so the millions of tons' amount of plastic waste is generated annually today. Due to its low cost, easy manufacturing and impervious to water, plastics are used in an excessive and manufacturing wide range of products. Also due to fast growth of industries and vast population has resulted in creation of various varieties of polythene material. Also, basic sectors like agriculture to packing, automobile, electronics, electrical, building construction, communication sectors have been practically transform by the use of plastics. Plastic waste, if not recycled gets mixed with Municipal Waste or get thrown over land area. There are two methods of municipal waste disposal, land filled or incinerated. And both the methods are not eco-friendly. Incineration leads to air pollution whereas dumping the waste in open areas causes contamination of water bodies and soils.

Figure No.1 Polyethylene Material

1.1 Polyethylene

Polythene is a synthetic Polyethylene made from the Polyethyleneization of ethylene, a gas that is derived from natural gas and petroleum. It was first discovered by a German chemist, Hans von Pechmann, in 1898. Since then, polythene has become one of the most widely used plastics in the world. It is versatile, strong, and lightweight, which makes it ideal for a wide range of applications. Polythene is produced by Polyethylene zing ethylene gas under high pressure and temperature. The resulting material is a white, waxy substance that can be melted and molded into various shapes. Polythene can be manufactured in various forms, including films, sheets, tubes, and molded shapes. The properties of polythene can be altered by changing its molecular structure, which can be achieved through different Polyethyleneization techniques and the addition of various additives.

Polythene has a wide range of applications in different industries, including packaging, construction, agriculture, and healthcare. In the packaging industry, polythene is used to make various types of packaging materials, such as bags, films, and containers. Polythene packaging is lightweight, strong, and water-resistant, which makes it ideal for transporting and protecting a wide range of products. In the construction industry, polythene is used as a moisture barrier in building foundations and walls. Polythene sheets are also used as a vapor barrier in roofing applications. In agriculture, polythene is used to make greenhouse covers, mulch films, and irrigation tubing. Polythene films are used as a protective covering for crops, which helps to increase yields and protect them from pests and diseases.In the healthcare industry, polythene is used to make medical devices, such as syringes, catheters, and surgical gloves. Polythene is also used to make medical packaging materials, such as bags and films, which are used to package and sterilize medical instruments and supplies. Despite its many advantages, polythene has also been criticized for its environmental impact. Polythene is not biodegradable and can take hundreds of years to decompose. When polythene is discarded improperly, it can pollute the environment and harm wildlife. To address these concerns, various initiatives have been undertaken to promote recycling and reduce the use of polythene. Governments and organizations around the world are promoting the use of alternative materials and encouraging consumers to adopt sustainable practices.

1.2 Waste Plastic Low Density Polyethylene (LDPE)

The production of plastic in India is increasing day by day. LDPE can be used mostly in packaging industry. Milk pouches are generally made up of LDPE. Most of the garbage that generates in household is due dairy product packages like milk pouches, yogurt pouches, buttermilk pouches. Also there are around 40 to 50 milk pouches generated in every tea stall. This plastic can be recycled but if it does not reach the recycling unit then it can create problems. So here plastic is also used for stabilization process.

Figure No.1.2 LDPE Waste Plastic

1.3 Role of plastic or polyethylene in the pavement

Plastic or polyethylene has been used in pavement applications for many years due to its durability and ability to withstand heavy loads. It is commonly used as a reinforcing material in asphalt concrete, which helps to improve the strength and durability of the pavement. Recently, there has been an increased interest in the use of recycled plastic or polyethylene in pavement applications. The use of recycled plastic in pavement construction helps to reduce waste plastic, and it has been shown to improve the durability and performance of the pavement. The modification of polyethylene can also help to make it more compatible with asphalt and improve its performance as a reinforcing material. This can be achieved by adding additives to the polyethylene, which can improve its adhesion to asphalt and reduce its susceptibility to cracking. Another advantage of using modified polyethylene in pavement applications is its ability to reduce the temperature of the pavement surface. The modified polyethylene can reflect more sunlight than traditional asphalt, which helps to reduce the heat island effect in urban areas and improve the comfort of pedestrians and cyclists. The modification of polyethylene is a necessary step towards finding sustainable solutions to reduce plastic waste and minimize its impact on the environment. The use of modified polyethylene in pavement applications is a promising area for research and development, and it has the potential to significantly improve the performance and sustainability of pavement construction.

II. LITERATURE REVIEW

D. B. Eme et.al (2019) polyethylene or water sachet is a major environmental pollutant, a no biodegradable material. The usefulness of this pollutant (polyethylene) in the highway industry was investigated by studying its effects on some selected properties of Hot Mix Asphalt, such as, bulk density, stability and flow of the asphalt concrete mix. Specimen preparation was done using Marshall Mix design procedure. The optimum binder content was determined as 5.20% and three samples each for five variations of polyethylene content (2%, 4%, 6%, 8% and 10%) by weight of optimum binder content. It was observed from the study, that the stability and density of asphalt increased with polyethylene content, while a linear reduction in the flow and penetration values was observed with polyethylene content.

Neetu Rani et.al (2018) Bituminous concrete is a composite material mostly used in construction projects like roads surfacing, airports, parking lots etc. It consists of asphalt or bitumen and minerals aggregate which are mixed together & laid down in layers then compacted. Various percentage of polythene is used for preparation of mixes with a selected aggregate grading as in the given in the IRC code. The role of the polythene in the mix is studies for various engineering properties by preparation Marshall Samples of BC mixtures with and without Polyethylene. Marshall Properties such as stability, flow value used to determine optimum polythene content for given grade of bitumen (80/100). Polythene is used in bitumen in this work by 0 to 5%.

A.I. Al-Hadidy et.al (2020) The present study investigates the potential use of pyrolysis low density polyethylene (LDPE) as a modifier for asphalt paving materials. Five different blends including conventional mix were subjected to binder testing such as rheological tests, as well as to some other tests related to the homogeneity of the system. Further, its effect on the moisture sensitivity and low temperature performance of stone matrix asphalt (SMA) mixtures was studied. Research results indicate that modified binders showed higher softening point, keeping the values of ductility at minimum range of specification of (100+ cm), and caused a reduction in percentage loss of weight due to heat and air (i.e. increase durability of original asphalt). The results indicated that the inclusion of LDPE in SMA mixtures can satisfy the performance requirement of high-temperature, low temperature and much rain zone.

Jyoti Prakash Giri et.al (2018) Recycling or waste utilization in transportation construction industry is important for sustainability. Keeping this in mind, an attempt has been made in this study to explore the use of waste materials such as recycled concrete aggregates (RCA) and waste milk packaging polyethylene in bituminous paving mixes. In this study, dense bituminous macadam mixes were prepared with RCA as coarse aggregates and two different types of filler, i.e. cement and stone dust. For the purpose of comparison, paving mixes were also prepared using natural aggregate and other materials as above. It was observed that all the mixtures prepared with various combinations satisfy the requirements in terms of Marshall test parameters and moisture susceptibility specified by Ministry of Road Transport and Highways, India. Further, the use of waste polyethylene generally improves the engineering properties especially at a higher temperature, in terms of dynamic moduli value and rutting behaviour of mixtures.

Chalachew Nigussie et.al (2019) Increasing urbanization and industrialization have contributed for increased plastic generation in Ethiopia. Unsafe disposal of waste plastic is a serious environmental problem. The application of waste plastics to modify bitumen for asphalting of roads can possibly minimize those problems since the Polyethylene modified roads showed superior resistance to environmental stresses in countries if the technology has been implemented. PET plastic bottle is generated daily in Bahir Dar city and released as a waste after usage. Releasing them to the environment, they pose negative impact to the environment. So to overcome such problem reducing solid disposal there is an idea to utilize waste PET bottle plastic in bitumen modification for asphalt road construction pavement using wet process technology. The conditions used were: plastic content (0%, 2%, 3.5%, 5%, 6.5%, and 8%)by mass of bitumen, plain bitumen content in testing of its maximum stability (4.5%, 5%,, 5.5%, and 6.5%) by mass of aggregates.

III. RESEARCH METHODOLOGY

Figure No.3 Methodology Flowchart

The use of polythene in bituminous roads is a method of improving the performance and durability of roads by incorporating plastic waste in the construction process. The following methodology can be used for the implementation of this technique:

1. Collection of Polythene

Collect polythene waste from various sources such as households, commercial establishments, and industries. The collected polythene should be cleaned and sorted according to their quality.

2. Shredding:

The polythene collected needs to be shredded into small pieces using a shredding machine. The size of the shredded pieces should be such that they can be easily mixed with the bitumen.

3. Mixing with Bitumen

The shredded polythene needs to be added to the bitumen mix during the construction process. The amount of polythene added to the bitumen mix should be carefully determined so as to not affect the desired properties of the bitumen.

4. Preparation of Mix

The bitumen mix is prepared by heating the bitumen to a certain temperature and adding the required amount of aggregates. The shredded polythene is then added to the mix and thoroughly mixed to ensure a uniform distribution of the plastic waste.

5. Laying the Road

The prepared bituminous mix is then laid on the road surface using a paving machine. The thickness of the bituminous layer should be carefully controlled to ensure proper compaction.

6. Compaction

The laid bituminous layer is then compacted using a roller to ensure proper bonding between the bituminous layer and the road surface.

7. Quality Control

The quality of the constructed road should be tested to ensure that it meets the desired specifications. The durability, stability, and strength of the road should be assessed.

8. Maintenance

Regular maintenance of the road should be carried out to ensure its longevity and durability. The use of polythene in the bituminous mix can increase the lifespan of the road by reducing the formation of cracks and potholes.the use of polythene in bituminous roads is an effective way to improve the performance and durability of roads while also reducing plastic waste. The above methodology can be used for the implementation of this technique.

3.1 Tests on Aggregate

1. Sieve Analysis of Aggregate
2. Impact Value Test
3. Impact Value Test (Aggregate + Polyethylene)
4. Abrasion Test
5. Crushing Value Test

3.2 Test on Bitumen

1. Penetration Test
2. Ductility Test
3. Softening Point Test

3.3 Test on Bituminous Mix Design

1. Marshal Stability Test

IV. RESULTS AND DISCUSSION

4.1 Sieve Analysis for 4.5% Bitumen

Table No.1 Percentage Gradation of Aggregate for 4.5% Bitumen

Sieve Size	Desired Range	Passing % for mix	Retained Wt. in %	Retained Wt. in gm
16	100	100	0	0.0
12.5	90-100	100	0	0.0
9.5	70-88	76	24.0	275.0
4.75	53-71	53	23.0	263.6
2.36	42-58	42	11.0	126.1
1.18	34-48	34	8.0	91.7
0.6	26-38	26	8.0	91.7
0.3	18-28	18	8.0	91.7
0.15	12-20	12	6.0	68.8
0.075	4-10	4	8.0	91.7
Pan		0	4	45.8
Total			100	1146

As shown in above Table, Gradation given for 4.5% bitumen addition where stone aggregate retained on 4.75mm sieve partially replaced with polyethylene of size 4.75mm proportion is 2%, 4%, and 6% respectively.

4.2 Sieve Analysis for 5% Bitumen

Table No.2 Percentage Gradation of Aggregate for 5% Bitumen

Sieve Size	Desired Range	Passing % for mix	Retained Wt. in %	Retained Wt. in gm
16	100	100	0	0.0
12.5	90-100	100	0	0.0
9.5	70-88	76	24.0	273.6
4.75	53-71	53	23.0	262.2
2.36	42-58	42	11.0	125.4
1.18	34-48	34	8.0	91.2
0.6	26-38	26	8.0	91.2
0.3	18-28	18	8.0	91.2
0.15	12-20	12	6.0	68.4
0.075	4-10	4	8.0	91.2
Pan		0	4	45.6
Total			100	1140

Gradation shown in Table 4. for 5% bitumen addition where aggregate retained on 4.75mm sieve partially replace with Polyethylene of size 4.75mm of proportion is 2%, 4%, and 6% respectively.

4.3 Sieve Analysis for 5.5% Bitumen

Table No.3 Percentage Gradation of Aggregate for 5.5% Bitumen

Sieve Size	Desired Range	Passing % for mix	Retained Wt. in %	Retained Wt. in gm
16	100	100	0	0.0
12.5	90-100	100	0	0.0
9.5	70-88	76	24.0	272.0
4.75	53-71	53	23.0	261.1
2.36	42-58	42	11.0	124.9
1.18	34-48	34	8.0	90.8
0.6	26-38	26	8.0	90.8
0.3	18-28	18	8.0	90.8
0.15	12-20	12	6.0	68.1
0.075	4-10	4	8.0	90.8
Pan		0	4	45.4
Total			100	1135.2

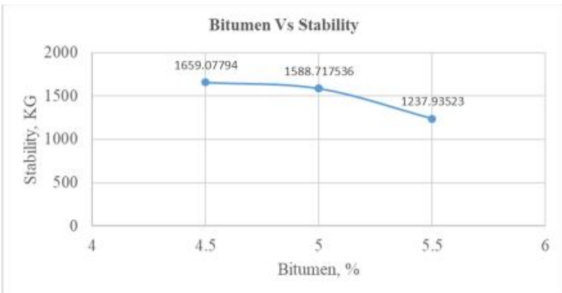
Gradation given for 5.5% bitumen given in Table 5. addition where aggregate retained 4.75mm aggregate partially replaced with Polyethylene of size 4.75mm of proportion is 2%, 4%, and 6% are respectively.

4.4 Marshal Test Result of Conventional Mix Specimen

Marshal test is conducted on conventional mix of 4.5%, 5%, 5.5 % bitumen to get flow and marshal stability value. To determine optimum binder content following results obtain from test:

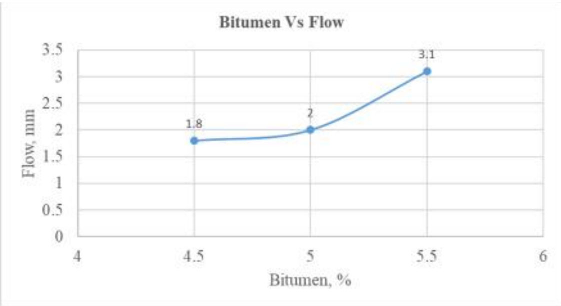
Table No.4 Marshal Test Result of Conventional Mix Specimen

Bitumen	Bulk density (gm/c)	V_r (%)	VMA	VFB	Stability (KG)	Flow
4.5	2.457	7.23	17.42	58.49	1659.078	1.8
5	2.468	5.60	17.52	66.34	1588.718	2
5.5	2.420	4.28	17.53	75.58	1237.935	3.1



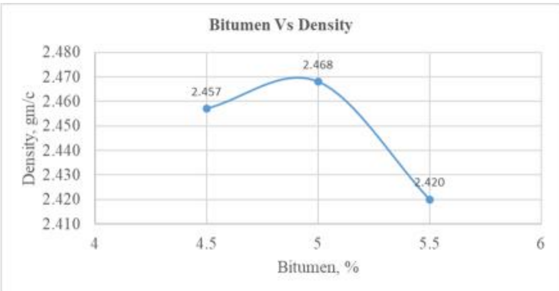
Graph No.1 Bitumen Vs Stability for Conventional Mix

Stability vs bitumen graph is plotted to get the bitumen content corresponding to maximum stability value with reference to above table at 4.5, 5 and 5.5% bitumen Content. With reference to above table, at 4.5% maximum stability shows.



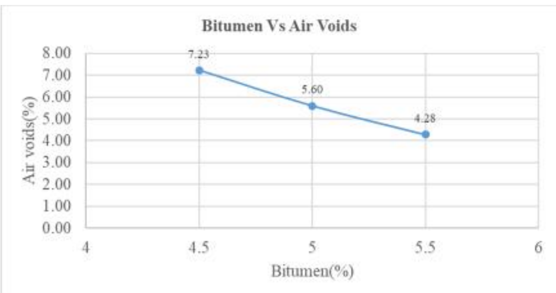
Graph No.2 Bitumen Vs Flow for Conventional Mix

Bitumen Vs Flow graph is plotted to get the bitumen content corresponding to flow value with reference to above table at 4.5, 5 and 5.5% bitumen Content.



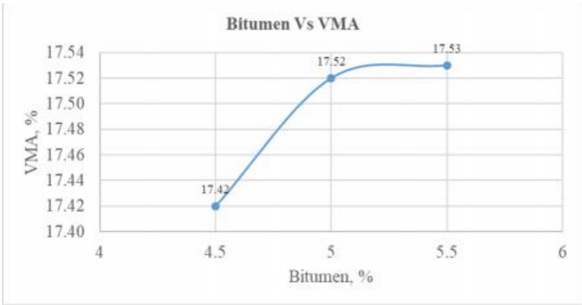
Graph No.3 Bitumen Vs Density for Conventional Mix

Bitumen Vs Density graph is plotted to get the bitumen content corresponding to maximum Density value with reference to above table at 4.5, 5 and 5.5% bitumen Content. Here maximum density is achieved at 5% Bitumen content.



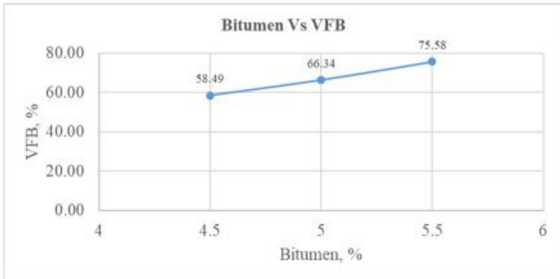
Graph No.4 Bitumen Vs Air Voids for Conventional mix

Bitumen Vs Air Voids graph is plotted to get the bitumen content corresponding to maximum Air Voids value with reference to above table at 4.5, 5 and 5.5% bitumen Content. From the graph, Bitumen content corresponding to 4.5% Air voids is 5.5.



Graph No.5 Bitumen Vs VMA for Conventional Mix

Bitumen Vs VMA graph is plotted to get the VMA value bitumen content corresponding to optimum binder content. VMA value is checked at optimum binder content, with specified design requirement of mix.



Graph No.6 Bitumen Vs VFB for Conventional Mix

Bitumen Vs VFB graph is plotted to get the bitumen content corresponding to VFB value with reference to above table at 4.5, 5 and 5.5% bitumen Content. VFB value is checked optimum binder content.

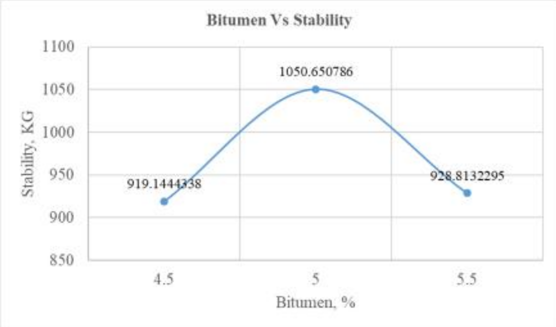
Now from the analysis for all graphs optimum binder content = (4.5+5+5.5)/3
= 5%

4.5 Marshal Test Result of 2% Polyethylene Replacement Mix

In this trial 2% Polyethylene is replaced with 4.75mm aggregates for Bitumen (by weight) 4.5, 5 and 5.5 respectively. Volumetric properties are calculated and written in table below.

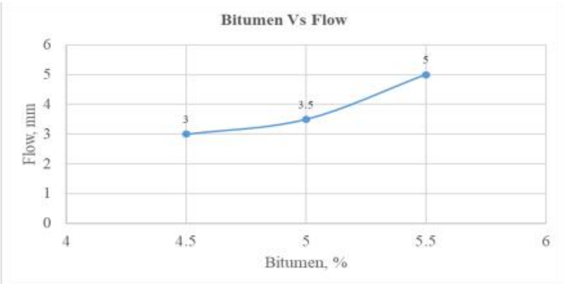
Table No.5 Marshal Test Result of 2% Polyethylene Replacement Mix

Bitumen (%)	Bulk density (gm/c)	V_T (%)	VMA (%)	VFB (%)	Stability (KG)	Flow (mm)
4.5	2.513	7.49	16.49	54.55	919.14	3
5	2.554	5.14	15.11	65.96	1050.65	3.5
5.5	2.538	4.92	16.65	68.55	928.81	5



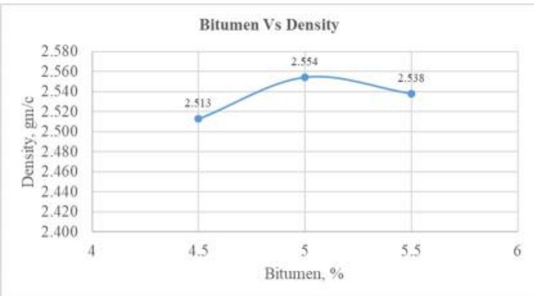
Graph No.7 Bitumen Vs Stability for 2% Polyethylene

Bitumen Vs Stability graph is plotted to get the bitumen content corresponding to maximum stability value with reference to above table at 4.5, 5 and 5.5% bitumen Content is shown maximum stability value. With reference to above table at 5% bitumen content shows maximum stability.



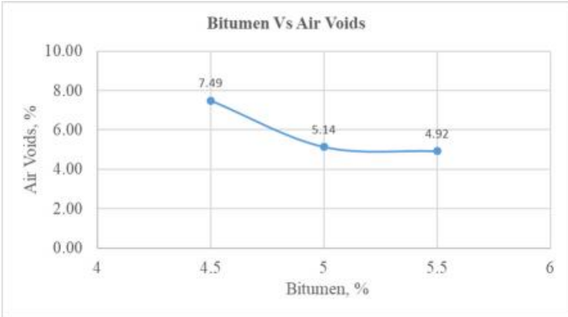
Graph No.8 Bitumen Vs Flow for 2% Polyethylene

Bitumen Vs Flow graph is plotted to get the bitumen content corresponding to flow value with reference to above table at 4.5, 5 and 5.5% bitumen Content.



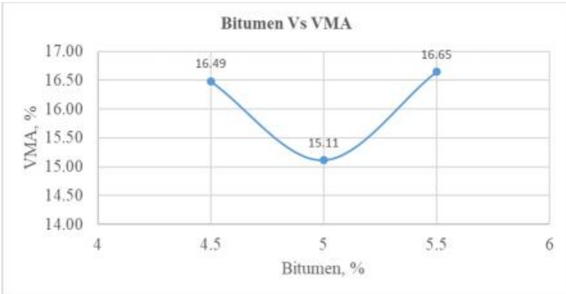
Graph No.9 Bitumen Vs Density for 2% Polyethylene

Bitumen Vs Density graph is plotted to get the bitumen content corresponding to maximum Density value with reference to above table at 4.5, 5 and 5.5% bitumen Content. Here maximum density is achieving at 5% bitumen content.



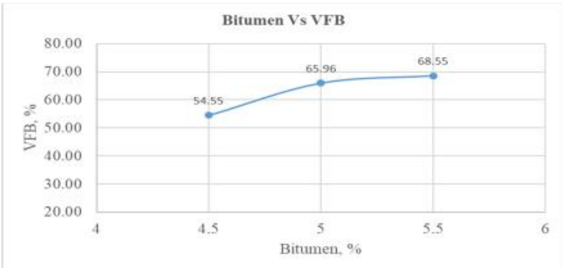
Graph No.10 Bitumen Vs Air Voids for 2% Polyethylene

Bitumen Vs Air Voids graph is plotted to get the bitumen content corresponding to Air Void value with reference to above table at 4.5, 5 and 5.5% bitumen Content. From the graph, the bitumen content corresponding at 5% air void is 5%.



Graph No.11 Bitumen Vs VMA for 2% Polyethylene

Bitumen Vs VMA graph is plotted to get the VMA value bitumen content corresponding to optimum binder content. VMA value is checked at optimum binder content, with specified design requirement of mix.



Graph No.12 Bitumen Vs VFB for 2% Polyethylene

Bitumen Vs VFB graph is plotted to get the bitumen content corresponding to VFB value with reference to above table at 4.5, 5 and 5.5% bitumen Content. VFB value is checked optimum binder content.

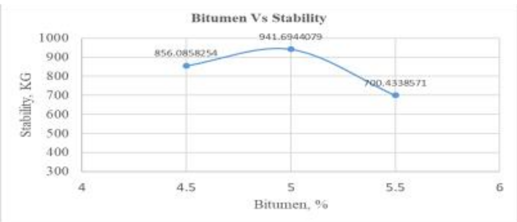
Now from the analysis for all graphs optimum binder content = (5+5+5)/3= 5%
Hence optimum binder content for conventional mix is 5%.

4.6 Marshal Test Result of 4% Polyethylene Replacement Mix

In this trial 4% Chunk Polyethylene is replaced with 4.75mm aggregates for Bitumen (by weight) 4.5, 5 and 5.5 respectively. Volumetric properties are calculated and written in table below.

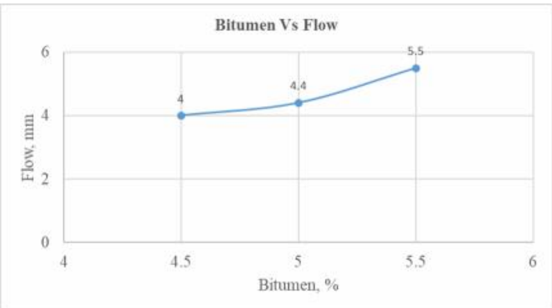
Table No.6 Marshal Test Result of 4% Polyethylene Replacement Mix

Bitumen (%)	Bulk density (gm/c)	V_v (%)	VMA (%)	VFB (%)	Stability (KG)	Flow (mm)
4.5	2.405	11.45	20.06	42.90	856.08	4
5	2.525	8.22	16.07	61.31	941.69	4.4
5.5	2.327	9.81	22.65	43.43	700.43	5.5



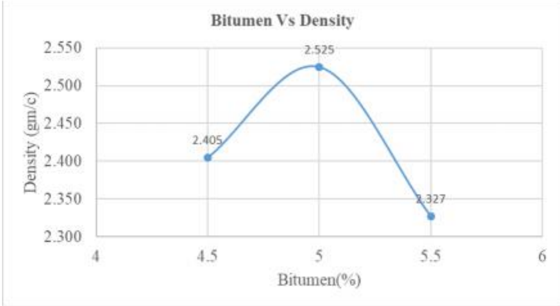
GraphNo.13 Bitumen Vs Stability for 4% Polyethylene

Bitumen Vs Stability graph is plotted to get the bitumen content corresponding to maximum stability value with reference to above table at 4.5, 5 and 5.5% bitumen Content is shown maximum stability value. With reference to above table at 5% bitumen content shows maximum stability.



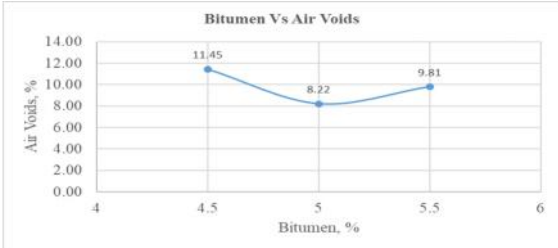
Graph No. 14 Bitumen Vs Flow for 4% Polyethylene

Bitumen Vs Flow graph is plotted to get the bitumen content corresponding to maximum Flow value with reference to above table at 4.5, 5 and 5.5% bitumen Content.



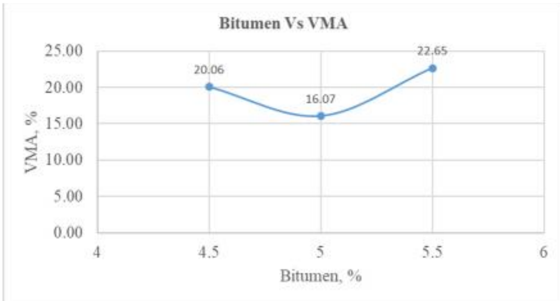
Graph No.15 Bitumen Vs Density for 4% Polyethylene

Bitumen Vs Density graph is plotted to get the bitumen content corresponding to maximum Density value with reference to above table at 4.5, 5 and 5.5% bitumen Content. Here maximum density is achieving at 5% bitumen content.



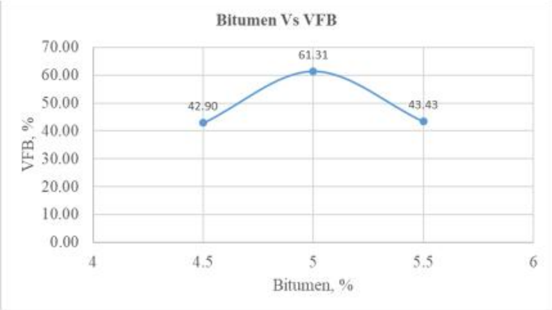
Graph No.16 Bitumen Vs Air Voids for 4% Polyethylene

Bitumen Vs Air Voids graph is plotted to get the bitumen content corresponding to Air Void value with reference to above table at 4.5, 5 and 5.5% bitumen Content. But for 4% Polyethylene replacement mix voids ratio is higher than 4% hence it is not possible to get the OBC.



Graph No.17 Bitumen Vs VMA for 4% Polyethylene

Bitumen Vs VMA graph is plotted to get the VMA value bitumen content corresponding to optimum binder content. VMA value is checked at optimum binder content, with specified design requirement of mix.



Graph No.18 Bitumen Vs VFB for 4% Polyethylene

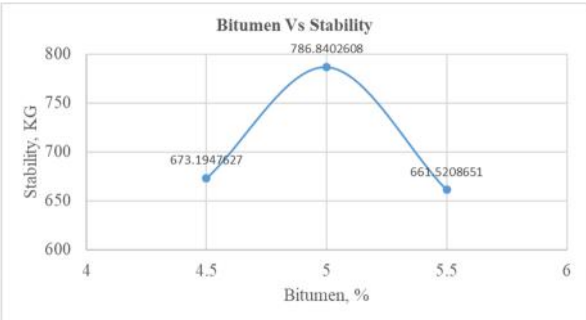
Bitumen Vs VFB graph is plotted to get the bitumen content corresponding to VFB value with reference to above table at 4.5, 5 and 5.5% bitumen Content.

4.7 Marshal Test Result of 6% Polyethylene Replacement Mix

In this trial 6% Chunk Polyethylene is replaced with 4.75mm aggregates for Bitumen (by weight) 4.5, 5 and 5.5 respectively. Volumetric properties are calculated and written in table below.

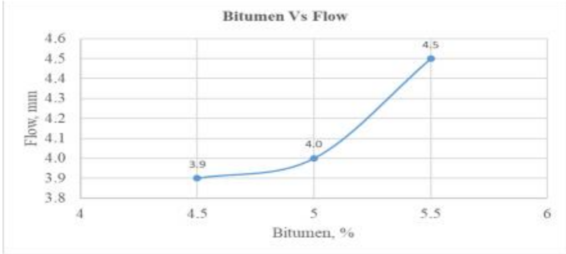
Table No.7 Marshal Test Result of 6% Polyethylene Replacement Mix

Bitumen (%)	Bulk density (gm/c)	V, (%)	VMA (%)	VFB (%)	Stability (KG)	Flow (mm)
4.5	2.428	12.63	19.31	44.98	673.19	3.9
5	2.472	9.21	17.85	54.03	786.84	4.0
5.5	2.327	10.81	22.65	43.43	661.52	4.5



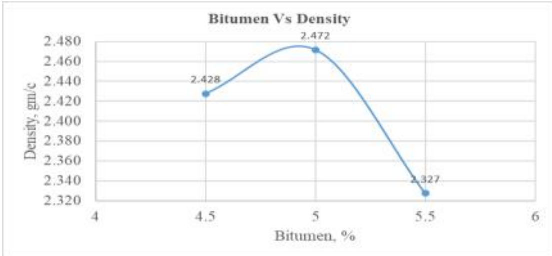
Graph No.19 Bitumen Vs Stability for 6% Polyethylene

Bitumen Vs Stability graph is plotted to get the bitumen content corresponding to maximum stability value with reference to above table at 4.5, 5 and 5.5% bitumen Content is shown maximum stability value. With reference to above table at 5% bitumen content shows maximum stability.



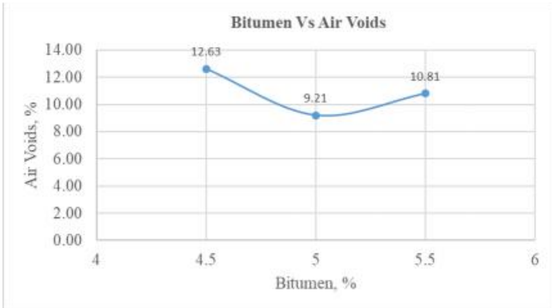
Graph No.20 Bitumen Vs Flow for 6% Polyethylene

Bitumen Vs flow graph is plotted to get the bitumen content corresponding to flow value with reference to above table at 4.5, 5 and 5.5% bitumen content.



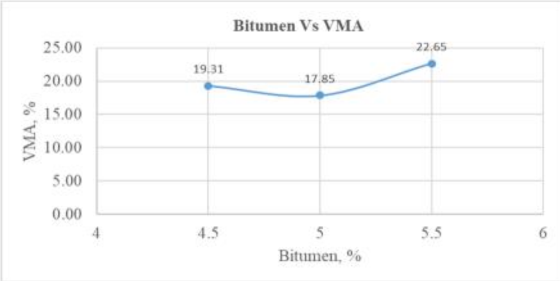
Graph No.21 Bitumen Vs Density for 6% Polyethylene

Bitumen Vs Density graph is plotted to get the bitumen content corresponding to maximum Density value with reference to above table at 4.5, 5 and 5.5% bitumen Content. Here maximum density is achieving at 5% bitumen content.



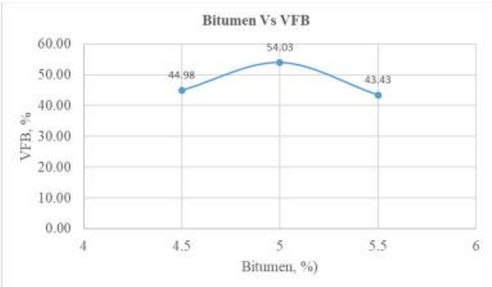
Graph No.22 Bitumen Vs Air Voids for 6% Polyethylene

Bitumen Vs Air Voids graph is plotted to get the bitumen content corresponding to Air Void value with reference to above table at 4.5, 5 and 5.5% bitumen Content. But for 6% Polyethylene replacement mix voids ratio is higher than 4% hence it is not possible to get the OBC.



Graph No.23 Bitumen Vs VMA for 6% Polyethylene

Bitumen Vs VMA graph is plotted to get the VMA value bitumen content corresponding to optimum binder content. VMA value is checked at optimum binder content, with specified design requirement of mix.



Graph No.24 Bitumen Vs VFB for 6% Polyethylene

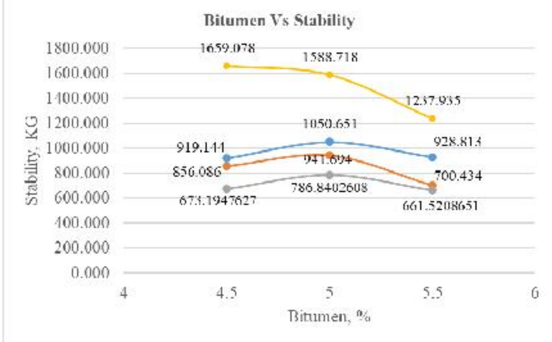
Bitumen Vs VFB graph is plotted to get the bitumen content corresponding to VFB value with reference to above table at 4.5, 5 and 5.5% bitumen Content. VFB value is checked optimum binder content.

4.8 Marshal Mix Results of Conventional and Polyethylene Mix

Now, various volumetric properties like bulk density, air voids, VFB, VMA, stability and flow are plotted bitumen of 4.5, 5 and 5.5 % content with conventional and each mix of Polyethylene replacement. The graphs for these combinations are superimposed with volumetric properties of conventional mix.

Table No.8 Combinations Are Volumetric Properties of Conventional and Polyethylene Mix.

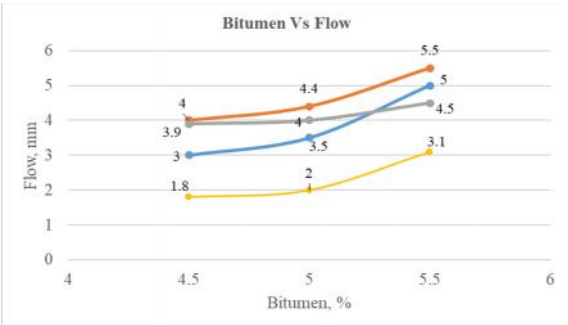
Bitumen (%)	Chunk Polyethylene (%)	Stability (KG)	Flow (mm)	Bulk density (gm/c)	Vv (%)	VMA (%)	VFB (%)
4	0%	1659.08	1.8	2.45	7.33	17.42	58.40
	2%	919.14	3	2.51	7.49	16.49	54.55
	4%	856.09	4	2.41	11.45	20.06	42.9
	6%	673.19	3.9	2.43	12.63	19.31	44.98
5	0%	1588.72	2	2.46	5.6	17.52	66.34
	2%	1050.65	3.5	2.55	5.14	15.11	65.96
	4%	941.69	4.4	2.35	8.22	16.07	61.31
	6%	786.84	4	2.47	9.31	17.85	54.03
5.5	0%	1237.94	3.1	2.42	4.28	17.53	75.58
	2%	928.81	5	2.54	4.97	16.65	68.55
	4%	700.43	5.5	2.43	9.81	22.65	43.43
	6%	661.52	4.5	2.33	10.81	22.85	44.34



Graph No. 25 Bitumen Vs Stability

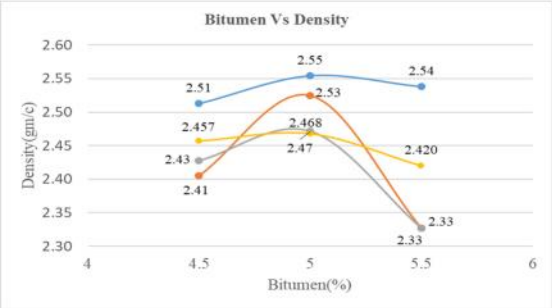
Variation in stability value with respect to increase in bitumen content are plotted for different mix in the graph no 25. For 2%, 4% and 6% stability increases when bitumen content increases for 4.5% to 5%, but further increment in bitumen 5.5% bitumen content stability slightly tends to decline. But all the stability values are lower than conventional mix but have higher value than the limiting value of stability i.e., 9kN. except 6% and 2% Polyethylene replacement. 4% Polyethylene replacement have stability value more than limiting value with all bitumen content. Maximum stability of the partial replacement Polyethylene mix obtained with 5 % bitumen. Optimum binder content corresponds to maximum Stability:

For 2% replacement, OBC = 5 %
For 4% replacement, OBC = 5 %
For 6% replacement, OBC = 5 %



Graph No.26 Bitumen Vs Flow

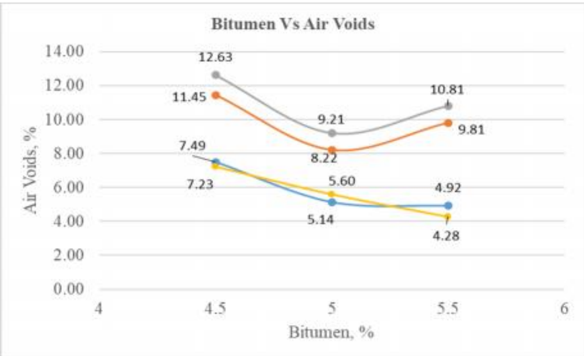
Flow Vs Bitumen graph no 26, for Polyethylene replacement mix shows linear trend as compare to conventional mix. It is observed that with increase bitumen content flow value increases. All the graphs of Polyethylene mix show similar trend as that of conventional mix. The flow values of Polyethylene mix are exceeding the limiting value as increase in bitumen content.



Graph No.27 Bitumen Vs Density

It is observing from graph no 27 that increase in bitumen content bulk density increases with bitumen content of 4.5% & 5% but later decreases significantly for 5.5% bitumen content. To get the optimum binder content for each mix, bitumen content corresponds to maximum bulk density is recorded.

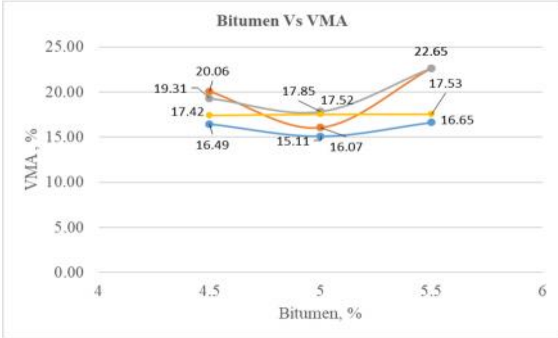
Optimum binder content corresponds to maximum bulk density:
For 2% replacement, OBC = 5 %
For 4% replacement, OBC = 5 %
For 6% replacement, OBC = 5 %



Graph No. 28 Bitumen Vs Air Voids

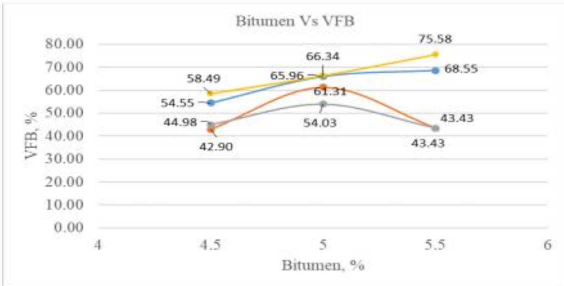
Is shows relationship between air void and bitumen content of the mix. With reference to above graph, for 6% Polyethylene void ratio slightly reduces with increases bitumen content. In case of 2% and 4% Polyethylene initially with 4.5% and 5% bitumen content shows slightly reduction in voids ratio, but further with 5.5% bitumen shows small increase.

Optimum binder content corresponds to maximum Stability:
For 2% replacement, OBC = 5 %
For 4% replacement, OBC = NA
For 6% replacement, OBC = NA



Graph No.29 Bitumen Vs VMA

Increase in bitumen content shows increase in VMA with reference to above graph, 29. For 2%, 4% and 6% Polyethylene shows initially decreasing VMA for 4.5% and 5% bitumen but for 5.5% bitumen VMA also increases. For conventional mix VMA is significantly constant for each bitumen content.



Graph No. 30 Bitumen Vs VFB

It shows increase VFB as bitumen content increases with reference to above graph no 30. For conventional mix and 2% Polyethylene mix shows increase in VFB with increase in bitumen content. For 4% and 6% Polyethylene mix initially VFB increased with increase in bitumen but further increase in bitumen shows reduction in VFB Initially.

V. CONCLUSION

The use of polythene in bituminous road construction has been a topic of debate for many years. While some argue that it can enhance the durability and strength of the road, others are concerned about the potential negative impacts on the environment. Based on the available research, it appears that the use of polythene in bituminous road construction can indeed improve the performance of the road.

Based on the results and discussion of experimental investigation carried out on bituminous mix of partially replaced Polyethylene. The following recommends the conclusion from the review.

1. The use of Polyethylene as a replacement for traditional coarse aggregates results in a weaker mix than traditional mix. Since Polyethylene is not as hard as the crushed stone aggregates, Marshall stability of Polyethylene aggregate mix would be lower than a conventional mix.
2. The Marshall Stability Test method is the comprehensive test method to determine the structural strength and deformation of the engineering properties of Polyethylene mix.
3. From the Marshall test results it is concluded that the all replaced Polyethylene mix shows good results for stability and flow values for 5% bitumen content. Results show that OBC is 5% with Polyethylene for mix as a partial replacement of the coarse aggregate.
4. For 2% Polyethylene replacement content gives better results in terms Marshal stability, Flow value etc. for each bitumen content. With 2% Polyethylene mix, optimum binder content of 5% showed the highest average marshal stability of 1050 KG.
5. The Polyethylene bitumen mix performance stability design mix identifies the aggregate gradation type, waste Polyethylene particles gradation and percentage, the optimum bitumen content, and the asphalt pavement type.
6. The use of Polyethylene in bituminous mixtures can improve flexible pavement performance and adheres to environmental compliance.
7. Polyethylene has property of sound absorption, which can help in reducing the sound pollution of heavy traffic roads.The use of Polyethylene may enhance the quality and performance of the road.
8. From estimation it is possible to save cost of construction and some amount of natural stone aggregate & majorly minimizes the pollution occurred due to waste tyre and also use of Polyethylene waste is economical.

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