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Effect of Replacement of Bitumen by Optimum Quantity of Waste Plastic in Road Pavement

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Abstract: *Plastic is everywhere in today's lifestyle and its disposal is a major problem. India alone generates more than 1, 00,000 metric tons of solid wastes per day that includes12% to 15 % of waste plastic. This is toxic in nature, it is a non-biodegradable product due to which these materials pose environmental pollution and problems like breast cancer, reproductive problems in humans and animals and genital abnormalities. Rapid industrial and enormous population growth has resulted in increasing the various types of waste materials. Considerable measures have been done for the disposal of these waste products. These plastics are considerably non-biodegradable thus can be used as a modifier in bitumen and aggregates to increase their strength.*

Keywords: Plastic

I. INTRODUCTION

Plastic is everywhere in today's lifestyle and its disposal is a major problem. India alone generates more than 1, 00,000 metric tons of solid wastes per day that includes12% to 15 % of waste plastic. This is toxic in nature, it is a non-biodegradable product due to which these materials pose environmental pollution and problems like breast cancer, reproductive problems in humans and animals and genital abnormalities. Rapid industrial and enormous population growth has resulted in increasing the various types of waste materials. Considerable measures have been done for the disposal of these waste products. These plastics are considerably non-biodegradable thus can be used as a modifier in bitumen and aggregates to increase their strength.

Plastic is a non-degradable waste, causes greenhouse effect and global warming. The various experiments have been carried out whether the waste plastic can be reused productively. The various literatures indicated that the waste plastic when added to hot aggregates will form a fine coat of plastic over the aggregate and such aggregates when mixed with binder is found to have higher strength, higher resistance and better performance over a period of time. Along with bitumen, use waste plastic and admixtures for increasing its life and smoothness. It is economical and eco-friendly. Addition of plastic waste in construction of pavements reduces the plastic shrinkage and drying shrinkage.

This study presents the proper utilization of waste in hot bitumen and aggregate to enhance pavement performance, to protect environment and to provide low cost roads. Most of the paved roads in our country have granular sub base and base; bituminous base and wearing courses. Plastic is a very versatile material. Due to the industrial revolution, and its large scale production plastic seemed to be a cheaper and effective raw material. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4500 years without degradation. Several studies have proven the health hazard caused by improper disposal of plastic waste. Plastic being a versatile material and a friend to common man became a problem to the environment after its use. Disposal of a variety of plastic & rubber wastes in an eco-friendly way is the thrust area of today's research. Looking forward to the scenario of present lifestyle a complete ban on the use of waste plastic cannot be put, although the waste plastic is taking the face of a devil for the present and the future generation. But the use of waste plastics in road construction is gaining importance these days because plastic roads perform better than ordinary ones and the plastic waste considered to be a pollution menace, can find its use. The use of waste plastic for coating the aggregates of the bituminous mix found to improve its performance characteristics .Recycled polyethylene carry bags were shredded into small sizes and is coated on aggregates of the mix at a specified temperature. Bituminous mixes were prepared with 60/70 bitumen and plastic coated aggregates/ordinary aggregates with admixtures. The uses of plastic waste helps in substantially improving the abrasion and skid resistance of flexible

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pavement and also allow to obtain values of splitting tensile strength satisfied the specified limits while plastic waste content is almost 50% by weight of actual bitumen. If the consistent mixing time and mixing temperature are not provided for bitumen– modifier mix, modified bitumen cannot exhibit good performance in situ, thus premature failures will occur. Therefore, there are certain recommended mixing time, mixing temperature and modifier content for all the polymers with a trademark. This all should be taken in mind while mixing and laying of roads is to be done using plastic waste. The plastic road would be a boon for India. In hot and extremely humid climate durable and eco-friendly plastic roads are of greatest advantages. This will also help in relieving the earth from all type of plastic waste.

It is a common sight in both urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains. Due to poor biodegradability it creates stagnation of water and associated hygiene problems. In order to resolve this problem, experiments have been carried out to know whether this waste-plastic can be reused productively. The experimentation at several institutes, private organizations indicate that the waste plastic, when added to admixtures, hot aggregate and bituminous mix will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength to the road, higher resistance to the water and better performance of the road over a period of time.

1.1 Problem Statement

To reduce volume of plastic waste which would be difficult for final disposal

To improve the continuous and frequent damage to road due to seeping water through section of road**.**

1.2 Objectives

- To improves the quality of flexible pavement.
- To reduce the disposal problem of plastics.
- Promoting reuse and recycle of waste plastic.
- To minimize water absorption.
- To compare the various properties and experimented results of the bituminous road and plastic bituminous road.

1.3 Scope of the Project Work

1. To minimize the global warming, greenhouse gases and pollution.
2. The life span of roads can be increased.
3. To eradicate potholes.
4. To develop an eco-friendly technology.

1.4 Organization of Project

Report is based on the effect of replacement of bitumen by optimum quantity of waste plastic in road pavement and organization chapter wise report in brief is given as below:

Chapter 1 – Brief introduction about project and definitions related to Effect of Replacement of Bitumen by Optimum Quantity of Waste Plastic in Road Pavement.

Chapter 2 – It deals with literature review with the past studies on Effect of Replacement of Bitumen by Optimum Quantity of Waste Plastic in Road Pavement by the various authors and data required in the project in published technical papers.

Chapter 3 – It deals with research methodology of present study.

Chapter 4 – It deals with experimental analysis related to the all procedures and tests.

Chapter 5 – It deals with results and discussion about project and also gives suggestions and recommendations for effective performance.

Chapter 6 – Conclude all Report in few points or Conclusion.

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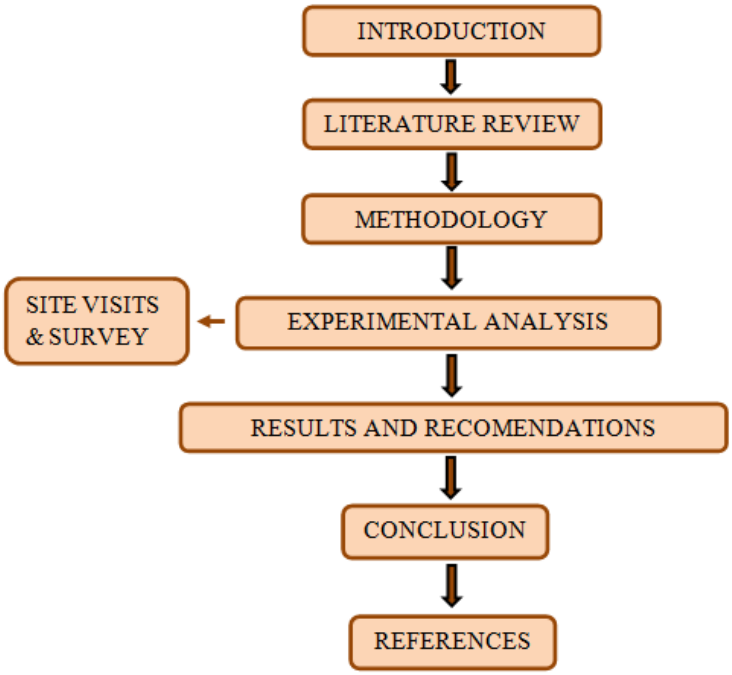
1.5 Flow of the Project



II. LITERATURE REVIEW

Manju, etal[6] (2017) - She has concluded in this research paper about how to use plastic in a bituminous pavement. The plastic mixed with bitumen and aggregate is used for better performance of the roads. The polymer coated on aggregates reduces the voids and moisture absorption. This result in the reduction of ruts and there is no pothole formation. She concluded the plastic pavement can withstand heavy traffic and are durable than flexible pavement. The use of plastic mix will reduce the bitumen content by 10% and increase the strength and performance of the road.

Pandey. [09] (2017) - The author is concluded that, Use of innovative materials with sustainable application such as plastic bottles can have considerable benefits including finding the best optimization in energy consumption of the region, reducing environmental degradation. Generally the bottle houses are bio-climatic in design, which means that when it is cold outside is warm inside and vice versa In this journal the authors concluded that re-using the plastic bottles as the building materials can have substantial effects on saving the building embodied energy by using them instead he bricks in walls and reducing the CO2 emission in manufacturing the cement by reducing the percentage of cement used. And they also concluded that cost compression between bottles wall is roughly half than the conventional brick masonry. Plastic bottles can cause the green construction by saving energy and resources, recycling materials, minimizing the emission, having significant operational savings and increasing work place productivity.

Shaikh, etal[12] (2017) - They concluded that modified mix possesses improved Marshall characteristics and addition of plastic waste enhances the various properties of an ordinary bituminous road. It has been studied that Marshall stability value increases with increase in plastic content and decreases with addition of polythene They investigated that their study will have positive impact on environment as it will reduce the volume of plastic waste to be disposed of by incineration and land filling. This experiment will also help in relieving he earth from all types of plastic waste. Their investigation not only utilizes beneficially, the waste non-degradable plastics but also provides improved pavement with better strength and longer life period.

Trimbakwala.[13] (2017) - In this journal the author compared plastic road with normal road on the basis of various test and observation. He concluded the durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix. Roads laid with plastic waste mix are found to be better than the conventional ones. The binding property of plastic makes the road last longer besides giving added strength to

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withstand more loads. While a normal 'highway quality' road lasts four to five years it is claimed that plastic-bitumen roads can last up to 10 years. Rainwater will not seep through because of the plastic in the tar. So, this technology will result in lesser road repairs. And as each km of road with an average width requires over two tons of poly blend, using plastic will help reduce non-biodegradable waste. The cost of plastic road construction may be slightly higher compared to the conventional method. However, this should not deter the adoption of the technology as the benefits are much higher than the cost. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. Already, a kilometer long test-track has been tested in Karnataka using this technology. The government is keen on encouraging the setting up of small plants for mixing waste plastic and bitumen for road construction. It is hoped that in near future we will have strong, durable and eco-friendly roads which will relieve the earth from all type of plastic-waste.

Bajpai, etal[01] (2017) - Plastic found in different forms is almost 5% amongst municipal solid waste, which can prove to be toxic in nature. It is a common sight in both urban and rural areas to find empty plastic bags and another type of plastic packing material littering the roads as well as drains. Due to its biodegradability, it creates stagnation of water and associated hygiene problems. In order to contain this problem experiments have been carried out whether this waste plastic can be reused productively in the construction of roads. The experimentation at several institutes indicated that the waste plastic, when added to hot aggregate will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength, higher resistance to water and better performance over a period of time. Therefore, it is proposed that we may use waste plastic in the construction of Rural Roads.

Chandramouli, etal[02] (2016) - They concluded that plastic increases the melting point of the bitumen. So use of plastics in road construction proves to be innovative technology which strengthens the road as well increases road life. To construct strong, durable and eco-friendly roads which will relieve the earth form all types of plastic waste in near future. They reported that asphalt concrete using polyethylene modified binders were more resistant to permanent deformation at elevated temperature and found improvement in stripping characteristics of the crumb rubber modified mix as compared to unmodified asphalt mix.

Sahu, etal[10] (2016) - They studied on the performance of plastic tar road and concluded that it is good for heavy traffic due to its properties like better binding; increased strength and better surface condition under exposure to variation in climatic changes. The properties of modified bitumen were compared to that of ordinary bitumen. It was noted that penetration and ductility values of modified bitumen was decreasing with the increase in proportion of the plastic additive, up to 12% by weight. The results indicated that there was an improvement in strength properties when compared to t conventional mix. Therefore, the life of pavement surfacing the plastic is expected to increase substantially in comparison to the use of conventional bituminous mix.

Menaria, etal [07] (2015) - He have written research paper on use of waste plastic. In this he is use different type of plastic material like Wrappers of betel nuts, chocolates, chips, hand bags, cold drink bottles and all other forms of plastic create significant environmental and economic problem. They consume massive energy and other natural resources, depleting the environment in various ways. In manufacturing firms, construction industries and products delivery services, use of plastic is a priority to handle and pack things comfortably due to its light weight, cost effectiveness and strength. Plastics cannot be banned as it will result in usage of natural resources like paper, wood at a great extent. It is made up of various chemical elements and is regarded as a highly pestilent material which does not easily degrade in the natural environment after its usage. Waste plastics are made up of Polyethylene, Polystyrene and Polypropylene. Temperature varying between 120˚C - 160˚C gives the softening point of these plastics [5]. They do not produce any toxic gases during heating but the softened plastics have tendency to form a lamination or coating over the aggregate, when it is sprayed over the hot aggregate at 160˚C. The main objective of this paper is to discuss the significance of plastic in terms of cost reduction, increase in strength and durability when these plastics are heated and coated upon the aggregates (160˚C) to compensate the air voids with plastic and binds with aggregate to provide stability.

Mir. [08] (2015) - He studied the viscos-elastic nature of binders and found that the complex modulus and phase angles of the binders, need to be measured, at temperatures and loading rates which different resemble climatic and loading conditions. He concluded that cost difference for the roads laid with compound as against without it is Rs. 500/cubic meter. There is increase in compressive strength and indirect tensile strength value increased by 3 times. This review

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intended to find the effective ways to reutilize the hard plastic waste particles as bitumen modifier for flexible pavements.

Sasane, etal [11] (2015) - She has concluded in this research paper about waste plastic how can use. She says Preservation of road infrastructure requires a systematic approach for the good performance of roads keeping in mind the future condition and maintenance scenarios. Now-a-days pavements are subjected to various kinds of loading which affects the pavement performance condition that causes various distresses. These distresses include rutting, fatigue cracking, and temperature cracking. Looking forward to the environmental condition, complete ban on plastic cannot be made. Thus, using of plastic as an innovative technology not only strengthened the road construction but also increase the road life. This paper includes the results of the various laboratory tests conducted on bitumen, aggregate and bitumen-aggregate plastic mix.

Gawande, etal[04] (2012) - The quantum of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization, development activities and changes in lifestyle with leading widespread littering on the landscape. Thus disposal of waste plastic is a menace and become a serious problem globally due to their non-biodegradability and un aesthetic view. Since these are not disposed scientifically and possibility to create ground and water pollution. This waste plastic partially replaced the conventional material to improve desired mechanical characteristics for particular road mix. In conventional road making process bitumen is used as binder. Such bitumen can be modified with waste plastic pieces and bitumen mix is made which can be used as a top layer coat of flexible pavement. This waste plastic modified bitumen mix show better binding property stability, density and more resistant to water.

Kalantar, etal[05] (2012) - Many researchers on PMA mixture have been concluded for the past two decades. Although addition of virgin polymers to asphalt for the purpose of enhancing the properties of asphalt over a wide temperature range in paving applications was contemplated quite some time ago, recycled polymer added to asphalt have also shown almost the same result in An improving the road pavement performance as compared to virgin polymers. This paper is a review of the use of polymers in asphalt pavement. In this study, a critical review on the history and benefits of using waste and virgin polymer in asphalt is presented followed by a review of general studies on using polymers in asphalt in order to improve the properties of pavement.

III. METHODOLOGY

3.1 RESEARCH METHODOLOGY

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge.

Based on the literature review, suitable innovative methods were adopted for sample preparation and their testing.

Collection of Material

3.2.1. Bitumen VG 30

3.2.2. Aggregate: Well graded

3.2.3. Plastic Waste: Surrounding and Dumping yard

3.2.4. Admixture : Ethylene vinyl acetate

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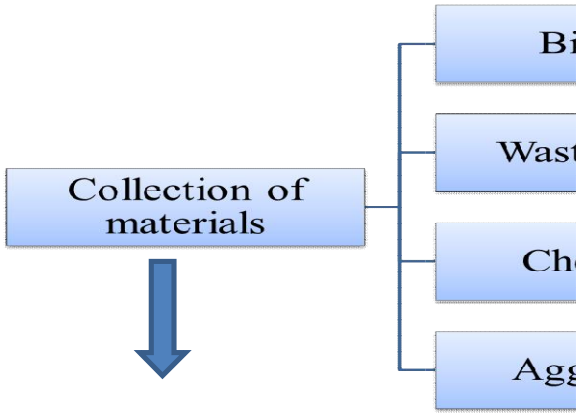
MATERIAL FLOW CHART



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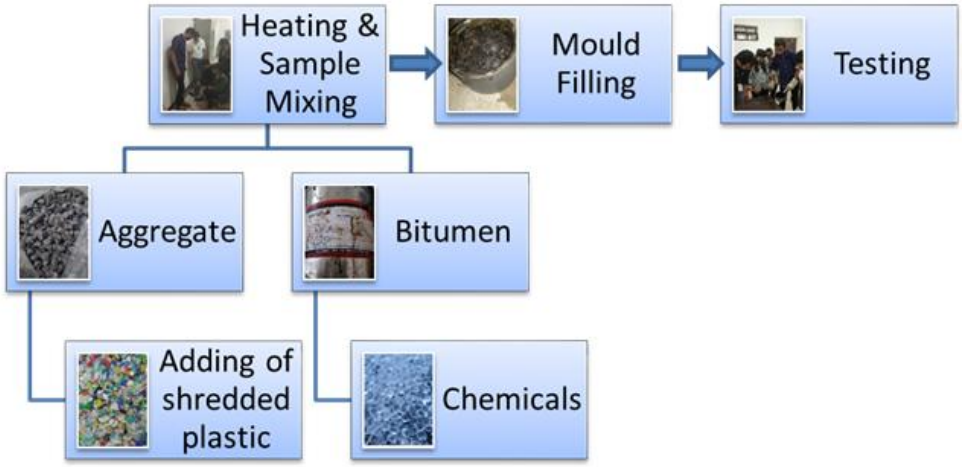

3.3 Preparation of Materials

Aggregates were dried and sieved according to IS specifications.
All types of plastic wastes were shredded into very fine size.
Bitumen and Admixture was kept ready as per proportion required.

3.3.1 Testing on Materials

As per IS recommendation, tests were conducted on bitumen and aggregate and results are calculated and are briefly explained in chapter 4.

3.4 Preparation of Sample

After testing of materials the samples with various mix proportions were prepared as follows:

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Sample No.	Bitumen content (gm)	Plastic content (gm)	Admixture(4% of Bitumen Content) (gm)
1	60	0	0
2	54	6	2.4
3	51	9	2.4
4	48	12	2.4
5	45	15	2.4
6	42	18	2.4

In this process the pan is heated to a required temperature and waste shredded plastic (dry process) is mixed with aggregates.
Bitumen and admixture is mixed with the plastic coated aggregates and mixed thoroughly.
The moulds were pre-heated at 90℃ and greased.
The moulds were filled followed by tamping with 75 blows on each side.
Later the moulds were kept in room temperature for 24 hours.
Using sample extractor the samples were removed from moulds and dry weight was recorded.
The sample was kept in water bath for 40 minutes at 60℃ and wet weight was recorded.
The sample is placed in Marshall Test head and the required readings are noted.

IV. EXPERIMENTAL ANALYSIS

4.1 INTRODUCTION

It is a collection of research designs which use manipulation and controlled testing to understand innovative processes. Generally one or more variables are manipulated to determine their effect on a dependent variable.
In this research various tests were performed on the samples as per Is recommendation using different methods for sample preparation.
Following tests were conducted:

4.2 TESTS ON AGGREGATE [IS: 2386 (PART IV) – 1963]

4.2.1 Aggregate impact value

The test is performed to evaluate the toughness of aggregates or the resistance of the aggregates to fracture under repeated impacts is called as impact value test. The aggregate impact test is commonly carried out to evaluate the resistance to impact of aggregate and has been standardized by IS recommendation. The procedure is given below.

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The test sample shall consist of aggregates passing through 12.5 mm IS Sieve and is retained on a 10 mm IS Sieve. The aggregate comprising the test sample shall be dried in an oven for a period of four hours at a temperature of 100 to 110°C and cooled.

The mould shall be filled about one-third full with the aggregate and tamped with 25 blows of the rounded end of the tamping rod. Further similar quantity of aggregate shall be added and a further tamping of 25 blows given. The measure shall finally be filled to overflowing, tamped 25 times and the surplus aggregate struck off, using the tamping rod as a straight edge. The net weight of aggregate in the measure shall be determined to the nearest gram (W1).

The impact machine shall rest without wedging or packing upon the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.

The cup shall be fixed firmly in position on the base of the machine and the whole of the test sample placed in it and compacted by a single tamping of 25 blows of the tamping rod.

The hammer shall be raised until its lower face is 380 mm above the upper surface of the aggregate in the cup, and allowed to fall freely on to the aggregate. The test sample shall be subjected to a total of 15 such blows each being delivered at an interval of not less than one second.

The crushed aggregate shall then be removed from the cup and the whole of it sieved on the 2.36 mm IS Sieve until no further significant amount passes in one minute. The fraction passing the sieve shall be weighed to an accuracy of 0.1 g (W2).

The fraction retained on the sieve shall also be weighed (W3) and, if the total weight (W2+W3) is less than the initial weight (W1) by more than one gram, the result shall be discarded and a fresh test made. Two tests shall be made.

Calculation

The ratio of the weight of fines formed to the total sample weight in each test shall he expressed as a percentage, the result being recorded to the first decimal place:

Total weight of dry sample taken=W1 g
Weight of portion passing 2.36 mm siev
Aggregate impact=(W2/W1)*100 Value

Aggregate impact value mean =12.95%

4.2.2 Los angles abrasion value

Abrasion test is carried out to test the hardness property of aggregates. The principle of Los Angeles abrasion test is to find the percentage wear due to relative rubbing action between the aggregate and steel balls used as abrasive charge. The procedure is given below.

The machine shall be so driven and so counter-balanced as to maintain a substantially uniform peripheral speed. If an angle is used as the shelf, the machine shall be rotated in such a direction that the charge is caught on outside surface of the angle.

At the completion of the test, the material shall be discharged from the machine and a preliminary separation of the sample made on a sieve coarser than the l.70 mm IS Sieve.

The material coarser than the 1.70 mm IS Sieve shall be washed dried in an oven at 105 to 110°C to a substantially constant weight, and accurately weighed to the nearest gram (B).

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Calculation

The difference between the original weight and the final weight of the test sample is expressed as a percentage of the original weight of the test sample. This value is reported as the percentage of wear.

Total weight of dry sample taken=W1 gm
Weight of portion passing 2.36 mm sieve=W2 gm
Aggregate abrasion value=(W2/W1)*100 Value (%

Aggregate abrasion value mean =31.52%

4.2.3 Aggregate crushing value

The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. With aggregate of aggregate crushing value 30 or higher, the result may be anomalous, and in such cases the ten percent fines value should be determined instead. Procedure as per follow.

The material for the standard test shall consist of aggregate passing a 12.5 mm IS Sieve and retained on a 10 mm IS Sieve, and shall be thoroughly separated on these sieves before testing.

The aggregate shall be tested in a surface-dry condition. If dried by heating, the period of drying shall not exceed four hours, the temperature shall be 100 to 110°C and the aggregate shall be cooled to room temperature before testing.

The appropriate quantity may be found conveniently by filling the cylindrical measure in three layers of approximately equal depth, each layer being tamped 25 times with the rounded end of the tamping rod and finally leveled off, using the tamping rod as a straight-edge.

The weight of material comprising the test sample shall be determined (Weight A) and the same weight of sample shall be taken for the repeat test.

The cylinder of the test apparatus shall be put in position on the base plate and the test sample added in thirds, each third being subjected to 25 strokes from the tamping rod. The surface of the aggregate shall be carefully levelled and the plunger inserted so that it rests horizontally on this surface, care being taken to ensure that the plunger does not jam in the cylinder.

The apparatus, with the test sample and plunger in position, shall then be placed between the platens of the testing machine and loaded at as uniform a rate as possible so that the total load is reached in 10 minutes. The total load shall be 400kN.

The load shall be released and the whole of the material removed from the cylinder and sieved on a 2.36 mm IS Sieve for the standard test. The fraction passing the sieve shall be weighed (Weight B).

Calculation

The ratio of the weight of fines formed to the total sample weightin each test shall be expressed as a percentage.

Total weight of dry sample taken=W1 gm
Weight of portion passing 2.36 mm sieve=W2 gm
Aggregate crushing value=(W2/W1)*100 Value (%)

Aggregate crushing value mean =19.625%

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4.3 TESTS ON BITUMEN

4.3.1 Specific gravity Test [IS: 1202-1978]

This test is done to determine the specific gravity of semi solid bitumen road tas. The principle is that it is the ratio of mass of a given volume of bitumen to the mass of an equal volume of water, both taken at a recorded/specified temperature.

Procedure:

The clean, dried specific gravity bottle is weighed let that be A gm.

Then it is filled with fresh distilled water and then kept in water bath for at least half an hour at temperature 27°C±0.1°C.

The bottle is then removed and cleaned from outside. The specific gravity bottle containing distilled water is now weighed. Let this be B gm.

Then the specific gravity bottle is emptied and cleaned. The bituminous material is heated to a pouring temperature and the material is poured half the bottle, by taking care to prevent entry of air bubbles. Then it is weighed. Let this be C gm.

The remaining space in specific gravity bottle is filled with distilled water at 27°C and is weighed. Let this be D gm. Then specific gravity of bituminous material is given by formula.

samples	A(gm.)	B(gm.)	C(gm.)	D(gm.)	Specific gravity
1	59.921	130.051	107.45	127.64	0.952
2	64.513	130.001	109.368	128.792	0.973
3	67.369	132.958	112.916	132.835	0.997

Specific gravity =(C-A) / [(B-A)-(D-C)]

Average specific gravity: 0.984

Where:

Empty weight of specific gravity jar in (gm.)

Weight of jar full with distilled water in(gm.)

Weight of jar partially full with bitumen in(gm.)

Weight of jar full with distilled water and partially full with bitumen in (gm.)

4.3.2 Penetration Test [IS: 1203-1978]

Penetration test is used to determine the hardness of bitumen. The penetration of bitumen is the tenths of millimeter that a standard needle will penetrate into the bitumen under a load of 100gm applied for 5 seconds at 25°C. Penetration value indicates the softness of bitumen (higher the penetration, softer is the bitumen).

Procedure:

The bitumen is softened to a paving consistency between 75° and 100°C above the approximate temperature at which bitumen softens. The sample material is thoroughly stirred to make it homogeneous and free from air bubbles and water.

The sample containers are cooled in atmosphere of temperature not lower than 13°C for one hour. Then they are placed in temperature controlled water bath at a temperature of 25°C for a period of one hour.

The weight of needle, shaft and additional weight are checked. The total weight of this assembly should be 100gm

Using the adjusting screw, the needle assembly is lowered and the tip of the needle is made to just touch the top surface of the sample.

The needle assembly is clamped in this position. The contact of the tip of the needle is checked using the mirror placed on the rear of the needle.

The initial reading of the penetrometer dial is either adjusted to zero or the initial reading is noted.

Then the needle is released by pressing a button and a stop watch is started. The needle is released exactly for a Period of 5.0secs.

At least 3 measurements are made on this sample by testing at distance of not less than 100mm apart.

The difference between the initial and final penetration readings are taken as the penetration value.

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Observation table

		Test 1	Test2	Test 3	Mean (mm)
Penetrometer dial reading	Initial	170	172	171	
	Final	280	279	279	
Penetration value		110	107	108	108.33

Penetration value- 10.8 cm

4.3.3 Softening Point Test [IS: 1205-1978]

The principle behind this test is that softening point is the temperature at which the substance attains a particular degree of softening under specified condtion of the test. Softening point denotes the temperature at which the bitumen attains a particular degree of softening under the specification of this test.

Procedure:

Sample material is heated to a temperature between 75°and 100°C above the approximate softening point until it is completely fluid and is poured in heated rings placed on the metal plate.

To avoid sticking of the bitumen to metal plate, coating is done to this with grease.

After cooling the rings in air for 30 minutes, the excess bitumen is trimmed and rings are placed in the support.

At this time the temperature of distilled water is kept at 5°C. This temperature is maintained for 15 minutes after which the balls are placed in position.

Then the temperature of water is raised at uniform rate of 5°C per minute with a controlled heating unit, until the bitumen softens and touches the bottom plate by sinking of balls. At least two observations are made. For material whose softening point is above 80°C, glycerin is used for heating medium and the starting temperature is 35°C instead of 5°C.Prepared By: Mr. Sanjay Saini Page 18

The temperature at the instant when each of the ball and sample touches the bottom plate of support is recorded as softening point value.

Observation and Calculation

Temperature when the ball touches bottom in ^{0}c	1	2	Average
	47 ^{0}c	49 ^{0}c	48 ^{0}c

The softening point of given sample is 47 ^{0}c.

4.3.4 Ductility Test [IS: 1208-1978]

The test is done to determine the ductility of bitumen. The principle of this test is that the ductility of bituminous material is measured by distance in cm to which it will elongate before breaking.

Procedure:

The bitumen sample is method to a pouring temperature (75°C to 100°C) and poured into the mould assembly and placed on a brass plate, where grease is applied at all surfaces of briquette mould exposed to bitumen.

After the sample is poured to the mould, thirty to forty minutes the entire assembly is placed in a water bath at 27°C.

Then the sample is removed from the water bath maintained at 27°C and excess bitumen material is cutoff by leveling the surface using hot knife.

After trimming the specimen, the mould assembly containing sample is replaced in water bath maintained at27°C for 85 to 95 minutes. Then the sides of mould are removed and the clips are carefully booked on the machine without causing any initial strain. Two or more specimens may be prepared in the moulds and clipped to the machine so as to conduct these test simultaneously

The pointer is set to read zero. The machine is started and the two clips are thus pulled apart horizontally.

While the test is in operation, it is checked whether the sample is immersed in water at depth of at least10mm. The distance at which the bitumen thread of each specimen breaks is recorded (in cm) to report as ductility value

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Reading	Briquette no			Mean (cm)
Initial	1	2	3	
Final	0	0	0	
Ductility in cm	74	80	77	77

Ductility of given sample 77cm

4.3.5 Flash and Fire point Test [IS: 1209-1978]

The flash point of a material is the lowest temperature at which the vapor of substance momentarily takes fire in the form of a flash under specified conditions of test".

Fire Point: "The fire point is the lowest temperature at which the material gets ignited and burns under specified condition of test".

Procedure:

All parts of the cup are cleaned and dried thoroughly before the test is started.

The material is filled in the cup up to a mark. The lid is placed to close the cup in a closed system. All accessories including thermometer of the specified range are suitably fixed.

The bitumen sample is then heated. The test flame is lit and adjusted in such a way that the size of a bed is of 4mm diameter. The heating of sample is done at a rate of 5° to 6°C per minute. During heating the sample the stirring is done at a rate of approximately 60 revolutions per minute.

The test flame is applied at intervals depending upon the expected flash and fire points and Corresponding temperatures at which the material shows the sign of flash and fire are noted

Observation table

Flash point	240	232	235
Fire point	253	245	250

Flash point of given sample is 235.67 ^{0}c

Fire point of given sample is 249.33 ^{0}c

4.4 Marshall Stability Test [IRC: 29-1968]

Bituminous mixes are used in the surface course of road and airfield pavements. The desirable bituminous mix properties include stability, density, durability, flexibility, resistance to skidding and workability during construction. Stability is defined as resistance of the paving mix to deformation under load and is thus a stress level which causes strain depending upon anticipated field conditions. Stability is function of friction and cohesion. Durability is defined as the resistance of the mix against weathering which causes hardening and this depends upon loss of volatiles and oxidation. In this method the resistance to plastic deformation of cylindrical specimen of bituminous mixture is measured when the same is loaded at the periphery at 5 cm per minute. This test procedure is used in designing and evaluating bituminous paving mixes

Procedure

The coarse aggregates, fine aggregates and mineral filler material should be proportioned and mixed in such a way that final mix after blending has the gradation within the specified range.

Approximately 1200 gms of aggregates and filler are taken and heated to a temperature of 175° to 190° C.

The compaction mould assembly and rammer are cleaned and mould is kept pre -heated to a temperature of 90°C to 145°C. The bitumen is heated to temperature of 121°C to 138°C and the required quantity of first trail percentage of bitumen is added to the heated aggregate and thoroughly mixed using a mechanical mixer or by hand mixing with trowel.

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Then the mix is heated and a temperature of 150° to 160°C is maintained and then the mix is transferred into the pre-heated mould and compacted by giving seventy five blows on each side Prepared specimens have cooled to room temperature, the weight, average thickness and diameter of the specimen are noted.

Then the specimens to be tested are kept immersed under water in a thermostatically controlled water bath maintained at 60° + 1° C for 30 to 40 minutes. The specimens are taken out one by one, placed in the Marshall Test head and the Marshall Stability value and flow value are noted.

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Sample No.	Bitumen content (%)	Plastic content (%)	Marshall stability (kg)	Flow value (mm)
1	5	0	1563	3.6
2	4.5	10	1250.4	3.3
3	4.25	15	1224.35	3.0
4	4	20	1198.3	2.8
5	3.75	25	1120.15	2.2
6	3.5	30	729.4	2.0

V. RESULTS AND DISCUSSIONS

In this project work we compared and finalised the results of bituminous aggregate and bituminous plastic mix aggregate.

PENETRATION TEST

Penetration value- 10.8 cm.

SOFTENING TEST

Temperature when the ball touches bottom in ^{0}c	1	2	Average
	47 ^{0}c	49 ^{0}c	48 ^{0}c

The softening point of given sample is 47 ^{0}c.

DUCTILITY TEST

Reading	Briquette no			Mean
Initial	1	2	3	
Final	0	0	0	
Ductility in cm	74	80	77	77

Ductility of given sample 77cm.

FLASH AND FIRE POINT TEST

Flash point	240	232	235
Fire point	253	245	250

Flash point of given sample is 235.67^{0}c

Fire point of given sample is 249.33^{0}c.

SPECIFIC GRAVITY TEST

Samples	A(gm)	B(gm)	C(gm)	D(gm)	Specific gravity
1	59.921	130.051	107.45	127.64	0.952
2	64.513	130.001	109.368	128.792	0.973
3	67.369	132.958	112.916	132.835	0.997

Specific gravity =(C-A) / [(B-A)-(D-C)]

Average specific gravity: 0.984

Where:

Empty weight of specific gravity jar in (gm)

Weight of jar full with distilled water (gm)

Weight of jar partially full with bitumen(gm)

Weight of jar full with distilled water and (gm).

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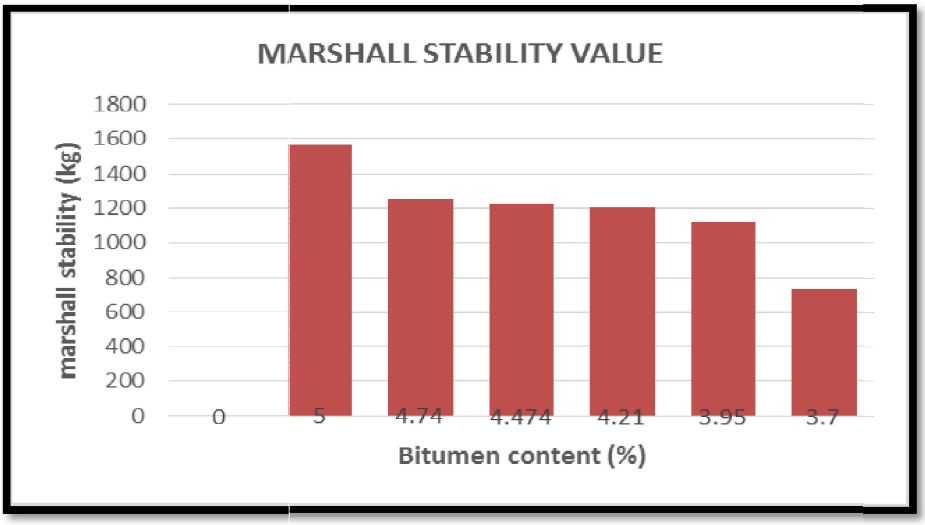
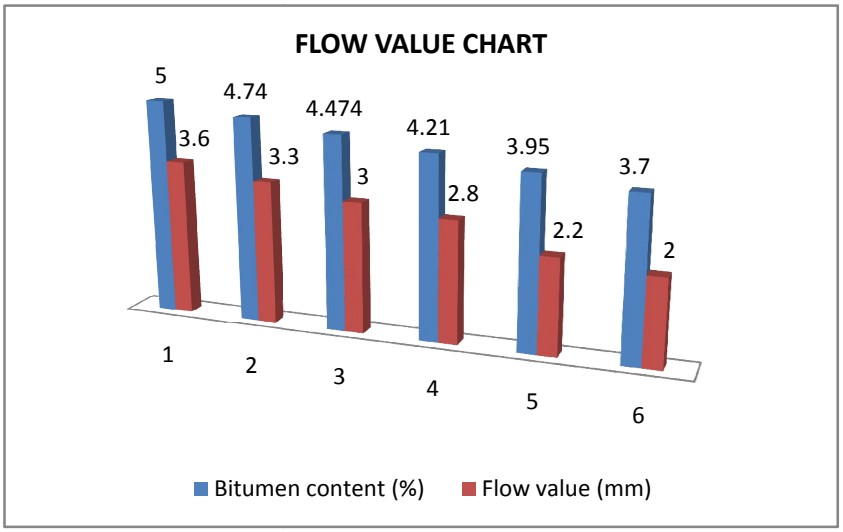
6. **Marshall Stability Test**

Sample No.	Bitumen content (%)	Plastic content (%)	Marshall stability (kg)	Flow value (mm)
1	5	0	1563	3.6
2	4.74	10	1250.4	3.3
3	4.474	15	1224.35	3.0
4	4.21	20	1198.3	2.8
5	3.95	25	1120.15	2.2
6	3.7	30	729.4	2.0





VI. CONCLUSION

From the study of the Behavior of plastic waste modified Bituminous Concrete, we can conclude that the modified mix possesses decrease in value of Marshall Stability Characteristics with proportional increase in content of plastic waste. The comparison of results made us understand the behavior of samples of different mix proportions and their utility

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Hence it is concluded by us that only 10-15% of Bitumen content can be replaced by plastic waste to get expected results.

By using this quantity not only better strength and longer life period will be achieved but also the non- degradable waste plastic will be utilized beneficially.

This study will have a positive impact on the environment as it will reduce the volume of plastic waste to be disposed of by incineration and land filling.

It will not only add value to plastic waste but also develop an Eco-friendly technology.

REFERENCES

[1]. Bajpai etal. (2017) *"A Study on the Plastic Waste Treatment Methods for Road Construction"*, International Journal of Advance Research, Ideas and Innovations in Technology. 3 (6), pp. 559-566.

[2]. Chandramouli, etal (2016) *"Plastic Waste:It's Use in Construction of Roads"*, 3rd International Conference on Recent Innovations in Science Engineering and Management. Pp. 774-779.

[3]. Chhabra, etal (2014) *"Use of plastic waste & waste rubber tyres in pavement"*, International Jounal of Core Engineering and Management. 5.

[4]. Gawande, etal (2012) *"Utilization of waste plastic in asphalting of roads"*, Scientific review and chemical communications (ISSN 2277-2669), 11.

[5]. Kalantar, etal (2012) *"A review of using waste and virgin polymer in pavement"*Constuction and building materials. 8.

[6]. Manju, etal (2017) *"Use of Plastic in Bituminous Pavement"*, International Journal of Chem Tech Research. 10 (8), pp. 804-811.

[7]. Menaria, etal (2015) *"Use of Waste Plastic in Flexible Pavements-Green Roads"*, Open Journal of Civil Engineering. 5 pp 299-311.

[8]. Mir. (2015) *"Use Of Plastic In Pavement Construction",*IOSR Journal of Engineering. 5 (2), pp. 11.

[9]. Pandey, etal (2017) *"Waste Plastic Bottle as Construction Material"*, International Advance Research Journal in Science, Engineering and Technology. 4 (3), pp 1-6.

[10]. Sahu.etal. (2016) *"Application of Plastic Materials in Road Construction"*, 2nd International Seminar On - Utilization of Non-Conventional Energy Sources for Sustainable Development of Rural Areas. pp. 1-5.

[11]. Sasane, etal (2015) *"Application Of Waste Plastic As An Effective Construction Material In Flexible Pavement"* . International Research Journal of Engineering and Technology. 2 (3), pp. 1943-1948.

[12]. Shaikh, etal (2017) *"Use of Plastic Waste in Road Construction"*, International Journal of Advance Research and Development. 2 (5), pp. 14-19.

[13]. Trimbakwala, etal (2017) *"Use of Waste Plastic in Road Construction"*, International Journal of Scientific and Research Publication, 7 (4), pp. 137-139.

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LIST OF PUBLICATION

Name of Authors	Title of Paper	Name of Journal	Year / Volume / Issue / page no.
1) Prerana manohar mahakal 2) Akshay dinesh mahale 3)Nisha sunatilalChavan 4)more Saurabh jayawant	Effect of Replacement of Bitumen by Optimum Quantity of Waste Plastic.	Resincap Journal of Science and Engineering	Volume 3, Issue 5, may 24, ISSN: 2456-9976

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