"USE OF PLASTIC WASTE IN CONSTRUCTION OF BITUMINOUS ROAD"

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

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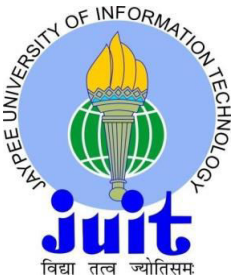

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HIMACHAL PRADESH, INDIA

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Use of Plastic Waste in Construction of Bituminous Road"** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Manan Gupta (131625)** and **Mudit Sharma (131699)** during a period from July 2016 to May 2017 under the supervision of **Aakash Gupta,** Assistant Professor and **Anirban Dhulia,** Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

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ABSTRACT

Waste materials transfer including plastic sacks waste has turned into a noteworthy issue and plastic wastes are singed for transfer which make extreme harms the earth. Utilization of waste plastics in bituminous blends has demonstrated that these enhance the properties of blend notwithstanding diminishing transfer issues. Plastic waste which is isolated and cleaned is sliced with the end goal that it goes through the sieve having 2 mm - 3 mm size utilizing shredding machine. The utilization of this advancement won't just fortify the development of roads additionally increment the life expectancy of roads and in addition help to enhance the natural conditions. Plastic roads would be an advantage for India's hot and sticky atmosphere, where temperatures as often as possible cross 50 °C and downpours make extraordinary devastations, leaving a large portion of the asphalts with enormous pot gaps. In our examination work we have done an intensive review on the technique of utilizing waste plastic in bitumen and with aggregates and exhibited the different tests performed on bitumen and aggregates. This waste plastic changed bitumen blend demonstrate better restricting property, strength, thickness and show more imperviousness to water. Since the vast majority of the streets in India are of adaptable sort, the utilization of such techniques is effortlessly versatile on an extensive scale. The investigations of properties of the plastic waste-mixed bitumen demonstrate that the expansion of plastic waste to bitumen expands softening point, specific gravity (then sudden diminishing is seen in the wake of accomplishing most extreme point), diminishes penetration value and ductility. The coating of plastic changed bitumen and aggregates enhanced the fundamental properties of both aggregates and bitumen to an advantage. The present review will come about lesser road repairs and utilisation of plastic wastes will use non-biodegradable wastes.

KEYWORDS: Waste Disposal, Modified Bitumen, Modified Aggregate, Highway Construction, Plastic Waste.

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CHAPTER 1

INTRODUCTION

A material that contains at least one natural polymers of huge atomic weight, strong in its completed state and at some state while assembling or handling into completed articles, can be molded by its stream, is called as 'Plastic'. Plastics are tough and debase gradually; the compound bonds that make plastic so strong make it similarly impervious to common procedures of corruption. Plastics can be isolated into two noteworthy classes: thermosets and thermoplastics. A thermoset sets or "sets" irreversibly when warmed. They are helpful for their toughness and quality, and are in this way utilized basically in vehicles and development applications. These plastics are polyethylene (Fig. 1.1), polypropylene, polyamide, polyoxymethylene, polytetrafluorethylene, and polyethyleneterephthalate. A thermoplastic diminishes when presented to warmth and comes back to unique condition at room temperature. Thermoplastics can without much of a stretch be formed and shaped into items, for example, drain containers, floor covers, Visas, and cover filaments. These plastic sorts are known as phenolic, melamine, unsaturated polyester, epoxy gum, silicone, and polyurethane. As indicated by late reviews, plastics can remain unaltered for whatever length of time that 4500 years on earth with increment in the worldwide populace and the rising interest for nourishment and different basics, there has been an ascent in the measure of waste being produced every day by every family unit. Plastic in various structures is observed to be just about 5 % in city strong waste, which is dangerous in nature. It is a typical sight in both urban and rustic ranges to discover exhaust plastic sacks and other kind of plastic pressing material littering the roads and in addition channels. Because of its biodegradability it makes stagnation of water and related cleanliness issues. To contain this issue tests have been done whether this waste plastic can be reused beneficially. The experimentation at a few foundations showed that the waste plastic, when added to the cover is found to give higher quality, higher imperviousness to water and better execution over a timeframe. Waste plastic, for example, convey sacks, dispensable containers and covered pockets like chips, skillet masala, aluminium thwart and bundling material utilized for bread rolls, chocolates, drain and basic supply things can be utilized for surfacing roads. Utilization of plastic alongside the bitumen in development of streets expands its life and smoothness as well as makes it monetarily solid and condition neighbourly. Plastic waste like disposable bottles (Fig. 1.2) are utilized as

modifier of bitumen and aggregates to enhance some of bitumen and aggregates properties. Roads that are built utilizing plastic waste are known as Plastic Roads (Fig. 1.3) and are found to perform better contrasted with those developed with regular bitumen.

Plastic Production and Consumption in India

The gigantic development of populace and plastic reliance has prompted immense measure of plastic era. What's more, since plastic is a non-biodegradable substance, it holds in nature for a considerable length of time. This causes a tremendous test for the Solid Waste Management. It can't be dumped in landfills since it stays there for basically everlastingly; it can't be burned as a result of arrival of to a great degree hurtful Carbon Monoxide gas; it can't be decayed in light of non-biodegradable nature. Therefore there is a desperate need to discover a technique to deteriorate plastic waste.

1.1 General

Waste plastic material is pounded and made into powder; by and large 5% - 10% plastic is blended with the bitumen. It builds the dissolving purpose of the bitumen and makes the street hold its adaptability amid winters bringing about its long life. Utilization of destroyed plastic waste goes about as a solid "restricting specialist" for tar making the bitumen keep going long. By blending plastic with bitumen the capacity of the bitumen to with stand high temperature increments. The plastic waste is liquefied and blended with bitumen in a specific proportion. Regularly, mixing happens when temperature achieves 45.5 °C yet when plastic is blended, it stays stable even at 55 °C. The tests at the research center level demonstrated that the bituminous blends arranged utilizing the treated bitumen fastener satisfied all the predefined Marshall blend outline criteria for surface course of street asphalt. There was a significant increment in Marshall Stability estimation of the bituminous blend, of the request of a few times higher incentive in examination with the common bitumen. Another imperative perception was that the bituminous blends arranged utilizing the treated fastener could withstand antagonistic drenching conditions submerged for longer term.

Figure 1.1 - Plastic Waste-Polyethylene, plastic bags

Figure 1.2 - Plastic Waste-Disposable Bottles in JUIT Highway Lab

Figure 1.3 - Plastic Waste Road - Bangalore

1.2 Plastic Roads

Plastic waste use in street development is not new. It is as of now being used as PVC (polyvinyl chloride) or HDPE (high-thickness poly-ethylene) pipe tangle intersections worked by cabling together PVC or HDPE channels to frame plastic mats. The plastic streets incorporate move mats to facilitate the entry of tires up to and down from the intersection. Both choices help shield wetland pull streets from rutting by conveying the heap over the surface. In any case, the utilization of plastic-waste has been a worry for researchers and designers for a very long time. Late reviews toward this path have demonstrated some expectation as far as utilizing plastic-squander in road development i.e., Plastic roads (Fig. 1.4). A Bangalore-based firm and a group of specialists from R. V. School of Engineering, Bangalore, have built up a method for utilizing plastic waste for street development. An underlying review was led in 1997 by the group to test for quality and strength. Plastic streets basically utilize plastic convey sacks, expendable containers and PET jugs that are gathered from rubbish dumps as an imperative element of the development material. At the point when blended with hot bitumen, plastics liquefy to frame a slick coat over the total and the blend is laid out and about surface like a typical tar road.

Figure 1.4 - Plastic Road in Bangalore

1.3 Research Contribution

The plastic wastes could be utilized as a part of development of streets and the field tests withstood the anxiety and demonstrated that plastic squanders utilized after appropriate handling as an added substance would enhance the life of the streets and furthermore understand natural conditions. The present study highlights the advancements in utilizing plastics waste to make plastic streets. The fast rate of urbanization and improvement has prompted expanding plastic waste era. Disposal of plastic waste (Fig. 1.5) is difficult as plastic is non biodegradable in nature, it stays in condition for quite a while and arranging plastic squanders at landfill are dangerous since harmful chemicals filter out into the dirt, and under-ground water and dirty the water bodies. Because of littering propensities, lacking waste administration framework/foundation, plastic waste transfer keep on being a noteworthy issue for the city specialists, particularly in the urban regions. As expressed above, plastic transfer is one of the significant issues for creating nations like India, at a same time India needs a substantial system of streets for its smooth financial and social improvement. Shortage of bitumen needs a profound thought to guarantee quick development of roads.

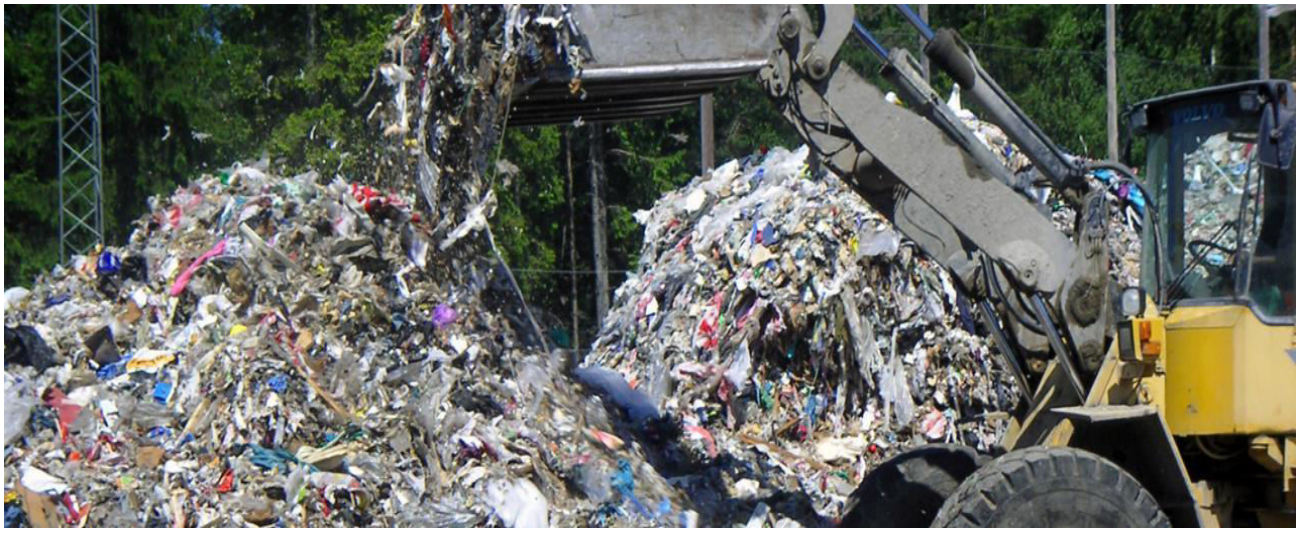

Figure 1.5 - Plastic Wastes Disposal in India

CHAPTER 2

LITERATURE REVIEW

The idea of utilization of waste plastic in development of adaptable road asphalt has been done since 2000 in India. There is a stark increment in change of asphalt qualities because of rising activity, expanded wheel burdens and outrageous climatic conditions. Every one of these variables emphatically impact the execution of bituminous blend road. In the development of adaptable asphalts, bitumen assumes the part of restricting the total together by covering over the total. It likewise enhances the quality and life expectancy of road. Be that as it may, its resistance towards water is poor. A general strategy to enhance the nature of bitumen is by changing the rheological properties of bitumen by mixing with engineered polymers like elastic and plastics. Usage of plastic waste in the bitumen is like polymer changed bitumen. The mixing of reused LDPE required no change to existing plant offices or innovation. Plastic altered bitumen has better imperviousness to temperature, water and so forth. This altered bitumen is one of the vital development materials for adaptable Road asphalt. Since 90's, significant research has been done to decide the reasonableness of plastic waste modifier in development of bituminous blends. Zoorab and Suparma (2000) revealed the utilization of reused plastics made overwhelmingly out of polypropylene and low thickness polyethylene in plain bituminous solid blends with expanded sturdiness and enhanced weariness life. Thick bituminous macadam with reused plastics, chiefly low thickness polyethylene (LDPE) supplanting 30 % of 2.36 mm – 5 mm totals, diminished the blend thickness by 16 % and demonstrated a 250 % expansion in Marshall Stability.

It is found that the reused polyethylene sacks might be helpful in bituminous asphalts bringing about diminished lasting twisting through rutting and lessened low temperature breaking of asphalt surfacing. Due to better authoritative of bitumen with plastic, the recurrence of empty spaces is additionally lessened because of expanded holding and range of contact amongst polymers and bitumen. This aides in diminishing dampness ingestion and oxidation of bitumen by ensnared air.

2.1 Plastics Recycling

As of late, there has been a sensational increment in examining courses in which blended plastics can be reused or recovered for reprocessing (Fig. 2.1). There are normally two strategies when managing reusing blended plastics that comprise of various polymers. One technique is to crush the blended material and after that to include a little measure of this regrind once again into the way toward making new parts or items. The other technique is to isolate the blended polymers, so as to re-acquire the immaculate segments. The range of partition is researched to decide its innovative potential to be utilized to isolate thermotropic fluid crystalline polymer from composites produced from polypropylene and these fluid crystalline polymers. The region of reusing thermotropic fluid crystalline polymer/thermoplastic composites is investigated to exhibit how this strategy prompts misfortunes in properties, as well as can not be utilized to prepare new composites that have the most elevated properties conceivable.

Figure 2.1 - Plastic waste for Recycling

2.2 Reclamation via Shredding and Density Separation

A general type of blended plastics reusing is destroying the blend and after that utilizing contrasts in thickness to realize a buoyancy partition. This kind of process takes a shot at the supposition, that the mixed framework can be destroyed into sufficiently little pieces, that the subsequent blend contains an appropriation of immaculate part pieces. These pieces are then isolated by utilizing some kind of gadget that uses the distinction in densities to achieve a mass partition of the different materials. This specific gadget works by first destroying the material, then washing the material to expel contaminants, then blowing the material into a tower for thickness characterization, then crushing the material down into littler pieces, then going the pieces through an air classifier framework, then washing and drying the pieces, and after that going the pieces through an extruder for exacerbating purposes. Dilly-Louis, built up a procedure for isolating rug materials into three particular segments: nylon, polyester, and polypropylene. This framework takes a shot at a similar rule that if the aggravated material can be destroyed into little pieces, the subsequent appropriation will contain just immaculate segments of every one of the three sorts of plastics. What's more, on the grounds that these materials have distinctive densities, the particles can be isolated by utilizing a buoyancy sort gadget. The uniqueness to this specific development is that the procedure for thickness partition uses fluids, rather than air, as the division media. This sort of troublesome division, utilizing fluids, is just conceivable by controlling the thickness of the isolating arrangement. The pre-destroyed pieces are dumped into a twofold cone full-jacketed screw rotator that contains this fluid, whose thickness has been specifically changed in accordance with be higher than one of the immaculate materials and lower than different materials. In this way, just the immaculate segment of one of the materials will buoy to the finish to be screened off after centrifugation.

2.3 Developments

The workplace of the main clergyman, New Delhi has a given a green flag to a privately owned business for supply of bitumen blended with plastic which is utilized for development of streets. The organization has as of now built a 2 km street in Bangalore with bitumen blended with plastic. The administration of Karnataka was satisfied by the accomplishment of the analysis and the state boss pastor himself initiated the field trial of development 500 m of street in three places in and around Bangalore with the assistance of PWD utilizing the creative innovation.

CHAPTER 3

MATERIAL AND METHODS USED

3.1 Bitumen

Bitumen is utilized as fasteners in development of roads. Bitumen might be gotten from the deposit left by the refinery from actually happening black-top. According to definition given by the American Society of Testing Materials bitumen (Fig.3.1) has been characterized as "Blends of hydrocarbons of normal or pyrogenous inception, or mix of both, as often as possible joined by their non-metallic subordinates, which might be vaporous, fluid, semi-strong or strong, and which are totally dissolvable in carbon disulphide." Bitumen exist in like manner state called dark top contains extensive amounts of strong mineral matter. At the point when oil unrefined is refined in a refinery, they are isolated by partial refining in the request of diminishing unpredictability. On refining of the lingering bituminous build up, straight-run bitumen is gotten. This sort of bitumen is known as infiltration review bitumen or steam refined oil bitumen. The levels of bitumen utilized for street development is known as clearing levels and that utilized for water sealing of structures is known as modern levels. The level of straight run bitumen is picked relying on the climatic states of the locale in which surface dressing is to be developed. In many parts of India 80/100 and 180/200 review bitumen is utilized. Heavier review cut backs, fast setting emulsions or heavier review tars may likewise be utilized. The review of fundamental bitumen is adjusted either by controlled refining or by blending with diesel oil or different oils. For single dressings on WBM base course, amount of bitumen required reaches from 17 to 195 kg for every 10 m^2 zones and 10 kg to 12 kg for each 10 m^2 zone if there should be an occurrence of re-establishment of dark top surfacing. For second layer of surface dressing, the amount of bitumen required extents from 10 kg to 12 kg for each 10 m^2 range. Mass bitumen Lorries with tanks of limit going from 5000 litres to 15000 litres are utilized to transport mass bitumen. According to PMC, the bitumen content in a blend ought to be 4 % of weight by aggregate blend for B.M. The clearing bitumen accessible in India is ordered into two classifications: Paving bitumen from Assam oil signified as A-sort and assigned as evaluations A35, A90, and so on. Clearing bitumen from different sources meant as S-sort and assigned as evaluations S35, S90, and so on. Critical properties of bitumen are: Viscosity of bitumen ought to be sufficient at the season of blending and compaction. It is accomplished by warming preceding blending and by

utilization of reductions and emulsion. In nearness of water bitumen ought not peel off from total. Bitumen ought to be sturdy in all seasons. It ought not turn out to be too delicate amid summers and create splits amid winters.

Figure 3.1 - Bitumen for testing in JUIT Highway Lab

Cut-back Bitumen: The asphaltic bitumen is frequently blended with relatively unpredictable solvents to enhance the workability of the material. The dissolvable gets dissipated abandoning the particles together. This reduction bitumen is characterized into moderate, medium and quick curing relying on the sort of dissolvable utilized.

Emulsions: An emulsion is a blend of regularly two immiscible fluids. Black-top gets separated into moment globules in water within the sight of the emulsifiers. It enhances the workability of bitumen or black-top. Therefore of emulsification, black-top is accessible at ordinary temperature in the fluid shape.

Bitumen: 40-viscosity grade bitumen.

3.2 Plastic Material

Plastics are typically arranged by their compound structure of the polymer's spine and side chains. Some critical gatherings in these orders are the acrylics, poly-esters, silicones, polyurethanes, and halogenated plastics. Plastics can likewise be characterized by the concoction procedure utilized as a part of their amalgamation, for example, buildup, poly-expansion, and cross-connecting. There are two sorts of plastics: thermoplastics and thermosetting polymers. Thermoplastics are the plastics that don't experience any concoction change in their structure when warmed and can be formed over and over. Illustrations incorporate polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluoroethylene (PTFE In the thermosetting procedure, a synthetic response happens that is irreversible. The vulcanization of elastic is a thermosetting procedure. Before warming with sulphur, the polyisoprene is a cheap, marginally runny material, yet after vulcanization the item is inflexible and non-crude. The properties of plastics are characterized primarily by the natural science of the polymer. for example, hardness, thickness, and imperviousness to warmth, natural solvents, oxidation, and ionizing radiation.

3.2.1 Types of Plastics

a) PET, polyethylene terephthalate

b) HDPE, high-density polyethylene

c) PVC, polyvinyl chloride

d) LDPE, low-density polyethylene

e) PP, polypropylene

f) PS, polystyrene.

3.2.2 Classification of Plastic Waste

a) Polyethylene: LDPE (Low Density Poly-Ethylene): Low thickness poly-ethylene this plastic waste accessible as convey packs by and large in stores these plastic sacks are thin and furthermore effectively accessible.

HDPE (High Density Poly-Ethylene): High thickness poly-ethylene sort of plastic waste is accessible as convey sacks and effortlessly accessible in the market.

b) Polypropylene

This plastic might be accessible as convey sacks or strong plastic. It relies on the utilization and necessity of the businesses. It is accessible as plastic containers and sheets and so on.

3.3 Preparation of Plastic Waste Material

3.3.1 Plastic Waste Scenario

The utilization of plastic materials, for example, convey packs, mugs, and so forth is continually expanding. The utilization of plastics has expanded from 4000 tons/annum to 4 million tons/annum and it is relied upon to rise 8 million tons/annum amid the year 2010. About 50 % to 60 % of the aggregate plastics are devoured for pressing.

3.3.2 Waste Plastic Shredding

Shredding is the way toward cutting the plastic into little sizes between 2.36 mm to 4.75 mm with the assistance of the plastic destroying machine viz. Agglomerater and Scrap Grinder. In Agglomerater, thin movies of poly-ethylene and poly-propylene convey sacks are destroyed and in Scrap Grinder a strong plastic material are shredded i.e. plastic jugs, trickle lines, electric link lines and so on (Fig. 3.2).

Figure 3.2 - Shredded Plastic Wastes in JUIT Highway Lab

3.3.3 Shredding Machine:

Agglomerator: For shredding of poly-ethylene "Agglomerator" is utilized. In this procedure, a thin waste plastic convey packs cut in little pieces with the assistance of settle and rotator. This entire procedure required 20 minutes - 25 minutes for shredding.

3.4 Plastic Waste Blending

3.4.1 Preparation of Blend

Polyethylene convey sacks are cut into pieces utilizing a destroying machine. They are sieved and the plastic pieces going through 4.75 mm strainer and holding at 2.36 mm sieve gets gathered. These pieces are added gradually to the hot bitumen of temperature around 170 ˚C – 180 ˚C. The blend mixed well utilizing mechanical stirrer for around 20 minutes - 30 minutes. Plastic waste-bitumen blends of various organizations can be arranged and utilized for completing different tests.

3.4.2 Separation Test (IRC-SP: 53-1999)

Tests of various creation can be subjected to the partition test. Homogeneity can be gotten roughly up to 1.5 % mix. Past this sythesis, the adjustment in softening point esteem is substantially higher for the top and base layer of the test tests demonstrating that there is a partition of plastic waste from bitumen on standing.

3.4.3 Preparation of Plastic-Waste Coated Aggregate

The aggregates are warmed to around 170 ˚C; the plastic waste destroyed to the size fluctuating in the vicinity of 2.36 mm and 4.75 mm. This destroyed plastic waste is included over hot aggregate with ceaseless blending to give a uniform dispersion. The plastic get mellowed and covered over the aggregates (Fig. 3.3). The hot plastic covered totals are blended with hot bitumen having consistency review 40 (160 ˚C).

Figure 3.3 - Plastic Waste Coated Aggregates in JUIT Highway Lab

3.5 Basic processes

1. Segregation

2. Cleaning process

3. Shredding process

4. Collection process

3.5.1 Two Processes Used in the Construction of Plastic Roads

1. Wet Process

In this procedure, the plastic waste is specifically blended with hot Bitumen at 160 ˚C and this blend is then appropriately blended utilizing a mechanical stirrer. This blend likewise contains extra stabilizers and requires legitimate cooling. This strategy is very little famous in light of the fact that it needs colossal speculations, bigger plants and more hardware than the Dry Process.

2. Dry Process

To begin with the plastic waste is gathered, isolated and put away. The isolation is done in light of the fact that a few sorts of plastic like poly-vinyl chloride (PVC) and flux sheets can't be utilized as a part of street developments for well being concerns. The following stride includes the cleaning of the plastic. This is vital on the grounds that the vast majority of the plastic waste gathered has been utilized for bundling (55 % in India) and subsequently is probably going to

contain leftover substances, for example, little bits of nourishment which must be expelled. After this the plastic experiences the way toward destroying which lessens it to the right thickness of 2 mm – 4 mm. The total is warmed to around 160 ˚C-170 ˚C and afterward the plastic is included and following 30 seconds - 40 seconds, a uniform covering is watched. This covering gives it a slick look. The bitumen is then included and the blend is altogether blended before laying. The bitumen is included at a temperature of around 155 ˚C-163 ˚C. This temperature is deliberately directed to ensure that the coupling is solid.

3.5.2 Types of Plastics Used in Plastic Roads

The mostly utilized plastics in this procedure are polyethylene, poly-styrene, poly-ester, and poly-propylene. Poly-ethylene can be made in 3 distinctive ways. Each of these 3 diverse courses brings about poly-ethylene with various qualities. Subsequently, every one is given a somewhat extraordinary name. Low thickness polyethylene is typically used to make plastic sacks. Poly-ethylene having high thickness is utilized for making plastic seats, dustbins, bowls and so on while poly-ethylene having low thickness is utilized to make plastic sheets and wraps. Polystyrene is commonly utilized as a part of fast food containers and as protection. Polyester (Polyethylene terephthalate) is for the most part utilized as a texture for garments. Poly-propylene is utilized for garments and is connected in radio controlled toy planes. These plastics, amid cremation handle produce a lot of carbon dioxide and water if adequate measure of oxygen is utilized, generally carbon monoxide is framed alongside water. Poly-vinylchloride (PVC) can't be utilized for development of plastic streets in light of the fact that on warming, it can discharge dioxin which is poisonous gas.

CHAPTER 4

RESULTS AND DISCUSSIONS

In the present study various tests have been performed in the laboratory using plastic wastes with bitumen and aggregate as a replacement to determine the change in properties of bitumen and aggregates. These tests have been performed using 5 %, 7 %, 9 %, 12 % and 15 % plastic wastes as a replacement of bitumen and aggregates. The results are shown below with plots:

4.1 Tests on Modified Bitumen:

4.1.1 Ductility test: This test is done to decide the pliability of bitumen. The standard of this test is that the malleability of a bituminous material is measured by separation in cm to which it will stretch before breaking.

4.1.2 Determination of softening point: The softening is the temperature at which the substance achieves a specific level of softening under determined state of test. The softening purpose of bitumen is typically dictated by Ring and Ball test. The examples of various rate of plastic squanders have been readied and their softening focuses were resolved. It is watched that the softening point increments by the expansion of plastic waste to the bitumen. Higher the rate of plastic waste included, higher is the benefit of softening point.

4.1.3 Specific gravity test: The specific gravity of bituminous materials is dictated by making a specimen in semi solid or solid state and by weighing in air and water.

4.1.4 Penetration Test: The penetration test is done to know the hardness or non-abrasiveness of bitumen utilized as a part of road development by measuring the separation to which the needle penetrates. Tests having distinctive rate of plastic wastes in bitumen is readied and their penetration values are determined. The penetration estimations of the diverse specimens are diminishing relying on the rate of plastic wastes included.

4.2 Experimental Results:

Table 4.1-Test Results with Modified Bitumen

Test	Normal Bitumen	5 % Plastic Added Bitumen	7 % Plastic Added Bitumen	9 % Plastic Added Bitumen	12 % Plastic Added Bitumen	15 % Plastic Added Bitumen
Ductility (cm)	72	42	23	16	4	0.5 0.8
Softening point (˚C)	52	73	86	92	90	87
Specific Gravity	1.02	1.04	1.05	1.03	0.97	0.93
Penetration Test (0.1 mm)	47	31	26	19	13	7

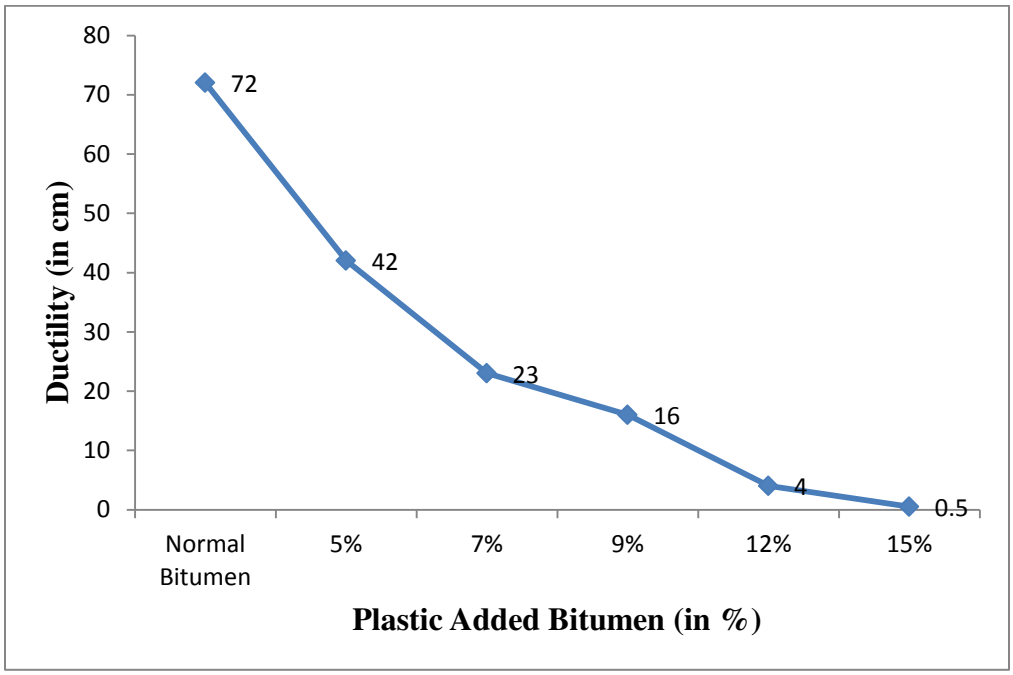

Figure 4.1 - Ductility vs Modified Bitumen

Discussion: This graph shows that the ductility value of bitumen is decreasing with the increase in plastic waste content due to interlocking of plastic with bitumen.

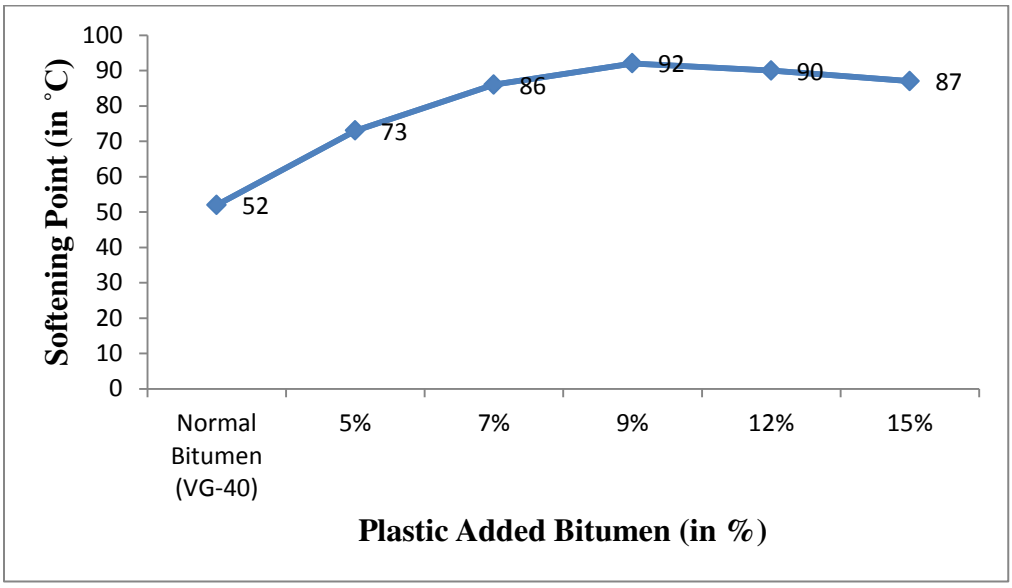

Figure 4.2 - Softening Point vs Modified Bitumen

Discussion: This graph shows that the softening point of bitumen is increasing with the increase in plastic waste content upto 9 %, then it started decreasing with the increase in plastic content. Higher softening point value shows that there is decrease in the vulnerability. Hence the optimum content of plastic waste obtained is 9 % to 10 %

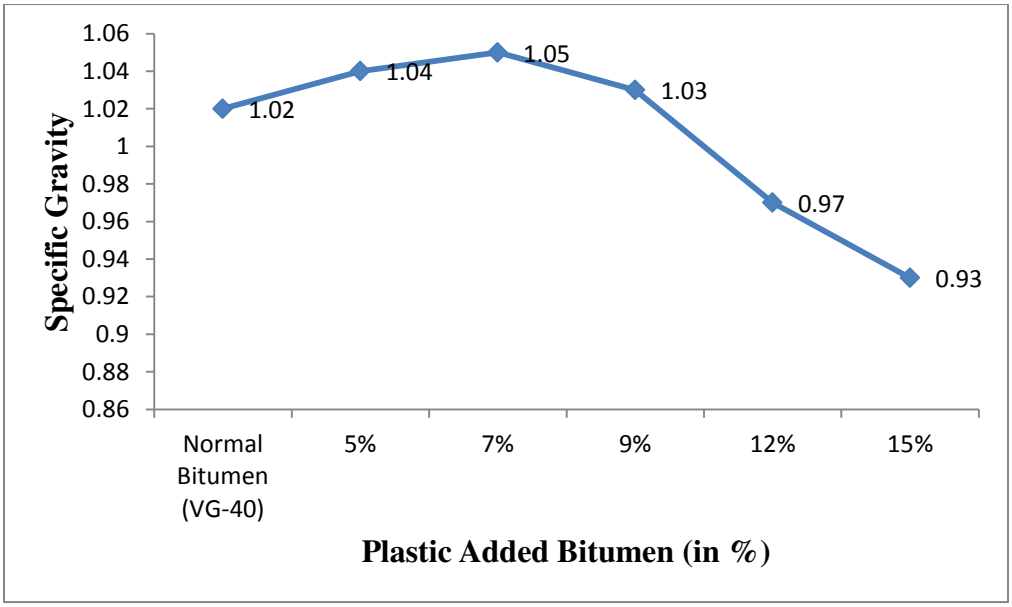

Figure 4.3 - Specific Gravity vs Modified Bitumen

Discussion: The changes in the specific gravity as shown in the graph is due to high surface thickness of bitumen without any changes in its weight. The optimum results obtained is 7 % to 9%.

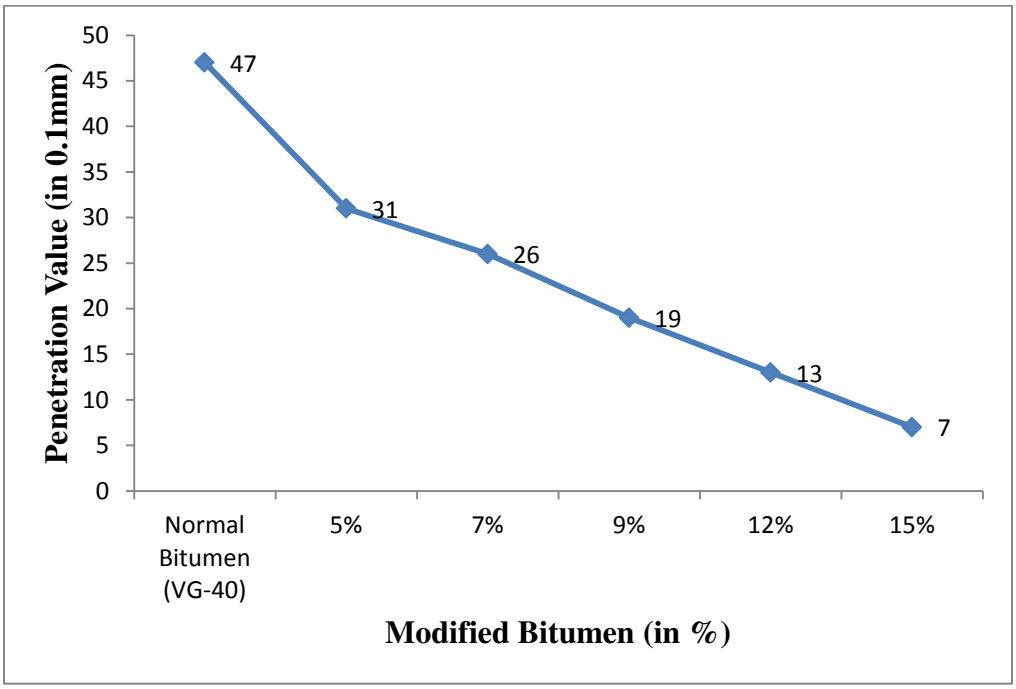

Figure 4.4 - Penetration vs Modified Bitumen

Discussion: This graph shows that the penetration value of bitumen is decreasing with the increase in plastic waste content. It shows that the hardness of specimen is increasing with the addition of plastic waste.

4.3 Tests on Modified Aggregate:

4.3.1 Moisture absorption test: The moisture absorption test is done to decide the degree to which the aggregates retain moisture. On the off chance that the water absorption is high, the asphalt is probably going to separate and present pot gaps in case of any water logging. Keeping in mind the end goal to decide how safe the road is to water absorption a predetermined mass of the blend was taken and drenched in water. Following 24 hours the blend was evacuated and reweighed. The distinction in mass was the mass of water absorbed. This was recognized for plastic groupings of 5 %, 7 %, 9 %, 12 % and 15 %. The moisture consumed has been expressed as a rate of the mass of the blend included. The outcomes were 0.5 %, 0.45 %, 0.45 %, 0.3 % and 0.3 % as shown below in result's table. For various rate of plastic, insignificant measures of water were absorbed. This shows the plastic makes the blend less vulnerable to moisture.

4.3.2 Los Angeles abrasion value test: This test measures whether the road aggregate is sufficiently hard to withstand abrasion. This is measured by rubbing the blend with steel balls. This should be possible by setting the blend on a sieve having 1.70 mm size inside a pivoting drum. A predefined number of steel balls were turning in round design at a rate of 30 rpm – 33 rpm until 500 upsets had been finished. The blend was put at a particular point on the perimeter to such an extent that as each steel ball passed it rubbed the blend. The % mass going through the sieve ought to be under 35 %. The trial was led for 5 %, 7 %, 9 %, 12 % and 15 % of plastic and the % mass going through the sieve were observed to be 18.4 %, 17.6 %, 16.9 %, 16.6 % and 16.4 % separately as shown below. This recommends the plastic covering over aggregates enhances the imperviousness to abrasion fundamentally and is basic keeping in mind the end goal to bring it beneath the 35 % value.

4.3.3 Aggregate impact value test: The test is utilized to decide the aggregate's imperviousness to cracking. It measures the capacity of the road to oppose affect or to quantify how tough the road is. Consistent development of substantial vehicles out and about subjects them to relentless effect making it crumble. Frequently, in the first place, it looks like a crocodile skin before totally separating. So as to quantify this an example of the blend is brought and hit with a 14 kg pound 15 times. The % of mass that winds up plainly powdered ought not surpass 30 %. The powdered mass will be recognized as the mass going through a 2.36 mm sieve. The analysis was directed for 5 %, 7 %, 9 %, 12 % and 15 % of plastic and the outcomes were observed to be 22.3 %, 17.3 %, 15.6 %, 12.2 %, 10.6 % and 9.3 % individually. This proposes the plastic makes the blend less helpless to cracking in case of an expansive force.

4.3.4 Aggregate Crushing Value test:

The aggregate with lower crushing value demonstrate a lower crushed part under load and would give a more extended administration life span to the road. Normal aggregate would get crushed under traffic load. It is clearly observed from Table-that plastic covered aggregates demonstrates the lower crushing value and which can be withstand to traffic load more proficiently than the plain aggregates. The outcomes demonstrate that the aggregates are inside the range as indicated by ISS. Its range ought to be under 30 % - 35 %.

4.4 Experimental Results:

Table 4.2-Test Results with Modified Aggregate

Test	Normal Aggregate	5 % Plastic Added Aggregate	7 % Plastic Added Aggregate	9 % Plastic Added Aggregate	12 % Plastic Added Aggregate	15 % Plastic Added Aggregate
Water Absorption Test (in %)	0.5	0.5	0.45	0.45	0.3	0.3
Stripping Test (in %)	2%(72 Hrs) 5%(96 Hrs)	0 (72 Hrs) 0 (96 Hrs)	0 (72 Hrs) 0 (96 Hrs)	0 (72 Hrs) 0 (96 Hrs)	0 (72 Hrs) 2% (96 Hrs)	2%(72 Hrs) 4%(96 Hrs)
Abrasion Test (in %)	25.2	18.4	17.6	16.9	16.6	16.4
Impact Value Test (in %)	22.3	17.3	15.6	12.2	10.6	9.3
Crushing Value Test (in %)	21.46	19.8	18.2	17.4	15.7	12.9

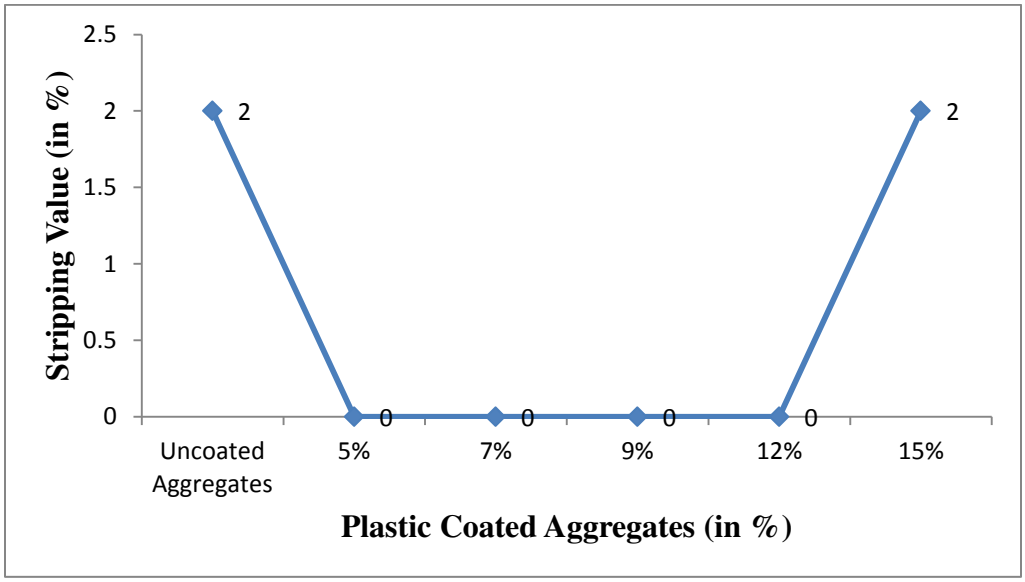

Figure 4.5 - Stripping value vs Plastic Coated Aggregates (72 Hours)

Discussion: This graph shows that stripping value of aggregates after 72 hours is decreasing with the increase in plastic content. It means that the coated aggregates are far better for road development than plain aggregates. The optimum content of plastic waste obtained is 7 % to 9 %.

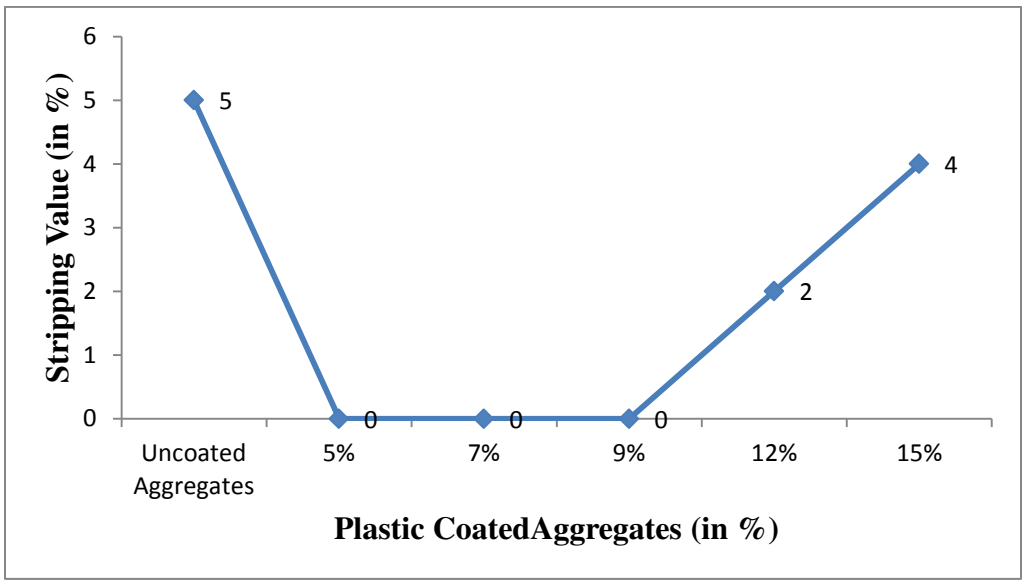

Figure 4.6 - Stripping value vs Plastic Coated Aggregates (96 Hours)

Discussion: This graph also shows that the stripping value of aggregates after 96 hours is decreasing with the increase in plastic content. It means the coated aggregates are far better for road development than plain aggregates. The optimum content of plastic waste obtained is 7 % to 9 %.

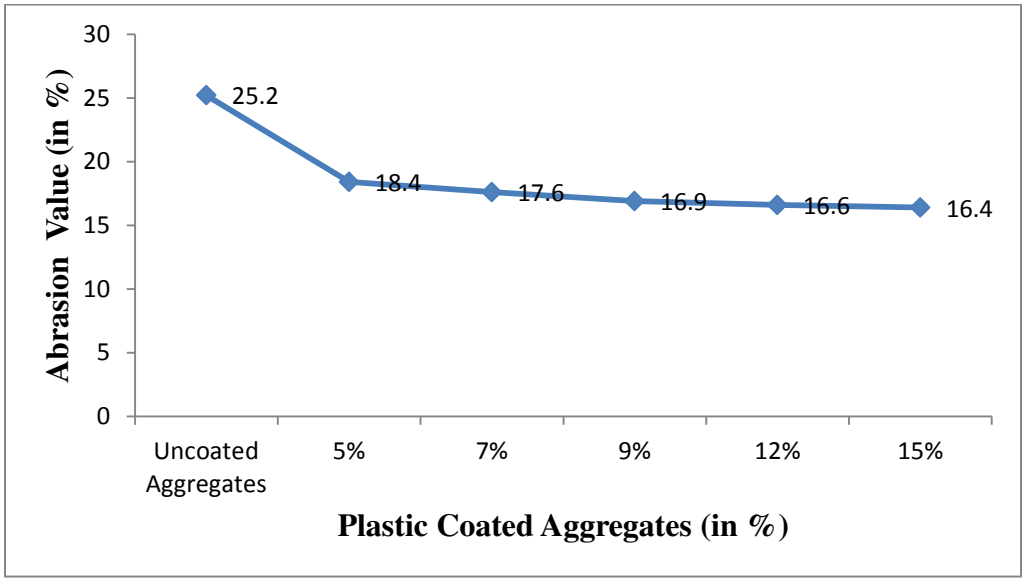

Figure 4.7 - Los Angeles Abrasion value vs Plastic Coated Aggregates

Discussion: This graph shows that the abrasion value is decreasing with the increase in plastic waste content. This demonstrates the hardness of the specimen.

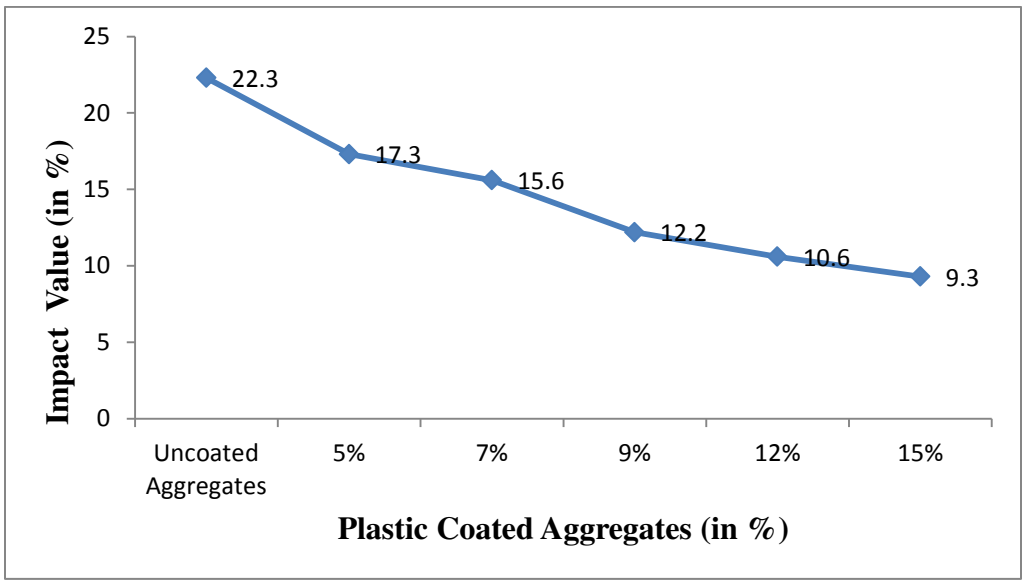

Figure 4.8 - Impact Value vs Plastic Coated Aggregates

Discussion: The impact value of aggregates is also decreasing after coating of plastic wastes. This reduction in value demonstrates that the strength of the aggregate is increasing to confront the effects.

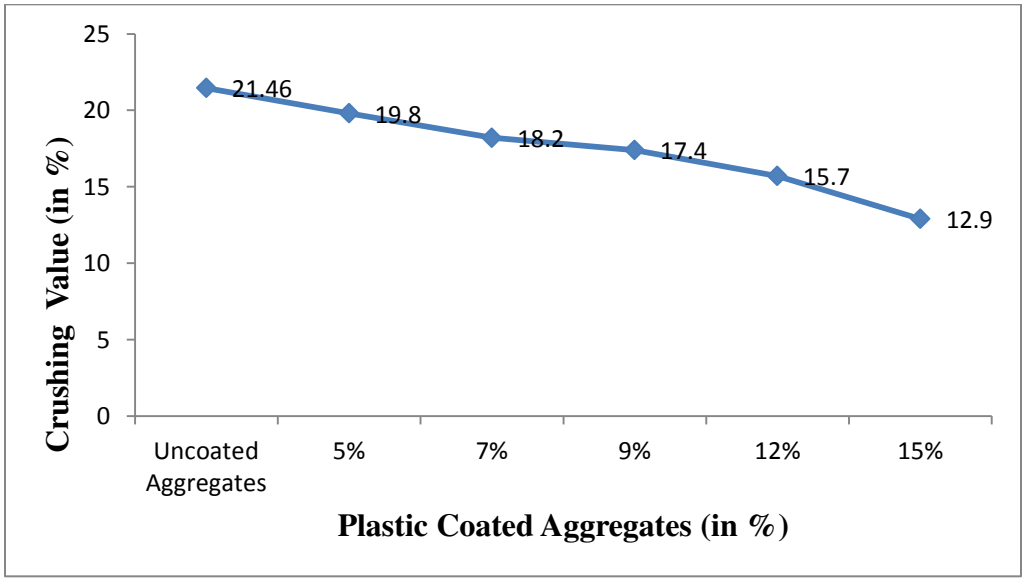

Figure 4.9 - Crushing Value vs Plastic Coated Aggregates

Discussion: This decrease in the crushing value as shown in the graph demonstrates the solid aggregates and low crushing value. This shows that stability of aggregates is increasing with the increase in plastic content.

4.5 Marshall Stability and Flow Value test:

Marshall stability of a sample is the most extreme load required to create failure when the sample is preheated to an endorsed temperature set in an extraordinary test head and the load is connected at a consistent strain (5 cm for every moment). While the stability test is in advance dial gauge is utilized to analyse the vertical deformation of the sample. The deformation at the cracking point communicated in units of 0.25 mm is known as the Marshall flow value of the sample. We have performed this test in the laboratory using plastic wastes with bitumen and aggregate as a replacement to determine the change in properties of bitumen and aggregates. We have performed this test using 5 %, 7 %, 9 %, 12 % and 15 % plastic wastes coating over aggregates with 4 % bitumen content. The results are shown below with plots:

4.5.1 Experimental Results of Marshall Stability Test:

Table 4.3-Test Results of Marshall Stability and Flow with varying Bitumen content

Bitumen (in %)	Gt	Gm	Vv	V_b	VMA	VFB	Stability (kg)	flow (mm)
4	2.55	2.39	6.27	9.10	15.37	59.21	1495	3.48
5	2.51	2.41	3.98	11.48	15.46	74.26	1581	3.53
6	2.49	2.42	2.81	13.83	16.64	83.11	1380	3.55

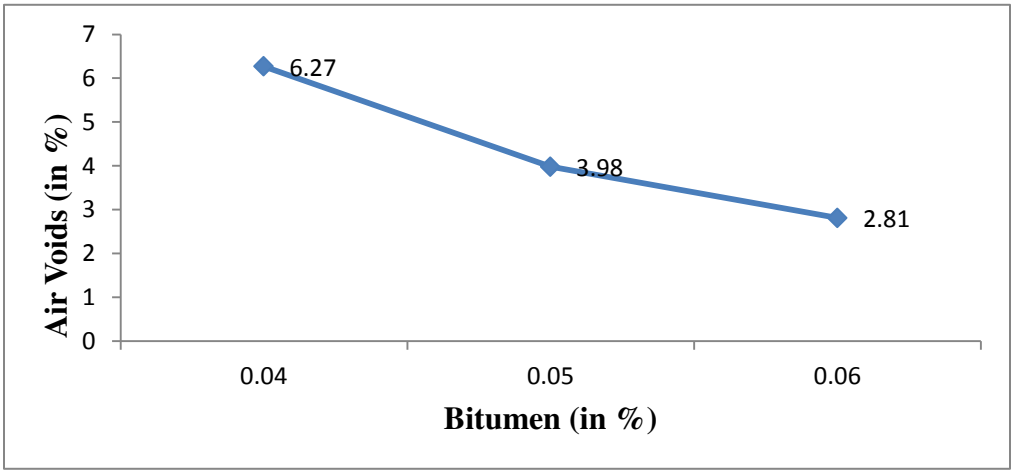

Figure 4.10 - Air Voids vs Bitumen (in %)

Discussion: This graph shows that there is decrease in the air voids percentage with the increase in bitumen content. Lesser the air voids, more will be the strength of the specimen. It also prevents the moisture absorption.

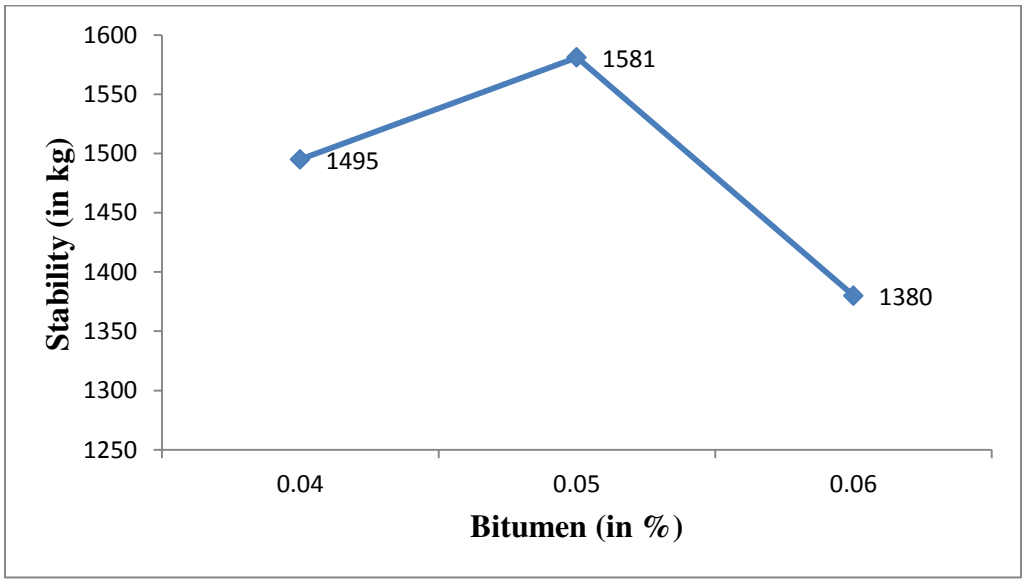

Figure 4.11 - Stability vs Bitumen (in %)

Discussion: In this graph, the stability value goes up first then it started decreasing with the increase in bitumen content. Higher stability value builds the thickness of the blend.

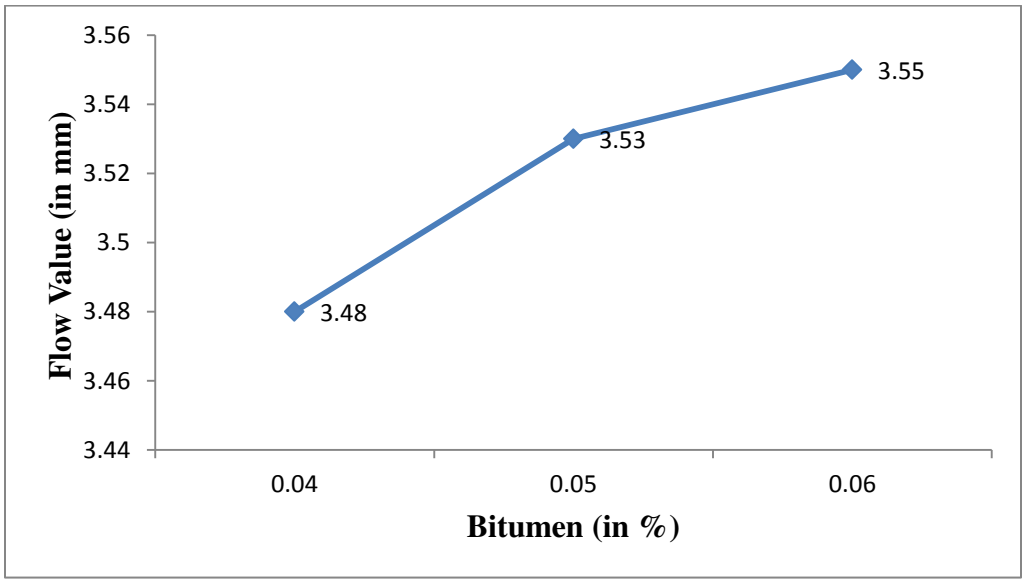

Figure 4.12 - Flow Value vs Bitumen (in %)

Discussion: This graph shows the changes in the flow value of the blend with the increase in bitumen content. The increase in flow value reduces the stability of the blend due to increase in deformation.

Table 4.4-Test Results of Marshall Stability and Flow with varying Plastic content

Plastic (in %)	**Bitumen (in %)**	**Vv**	**V_b**	**VMA**	**VFB**	**Stability (kg)**	**flow value (mm)**
5	4	6.73	9.62	16.35	58.84	1651	4.64
7	4	6.03	9.41	15.44	60.95	1944	4.63
9	4	5.27	9.2	14.47	63.58	1700	4.71
12	4	8.9	10.02	18.92	52.96	1492	4.51
5	5	7.35	13.36	20.71	64.51	1626	4.53
7	5	6.58	13.08	19.66	66.53	1676	4.61
9	5	5.59	12.83	18.42	69.65	1966	4.64
12	5	3.75	12.25	16	76.56	1526	4.74
5	6	5.19	12.95	18.14	71.39	1621	4.50
7	6	4.52	12.69	17.21	73.74	1664	4.63
9	6	3.67	12.43	16.1	77.20	1947	4.65
12	6	2.14	12.18	14.32	85.06	1529	4.73

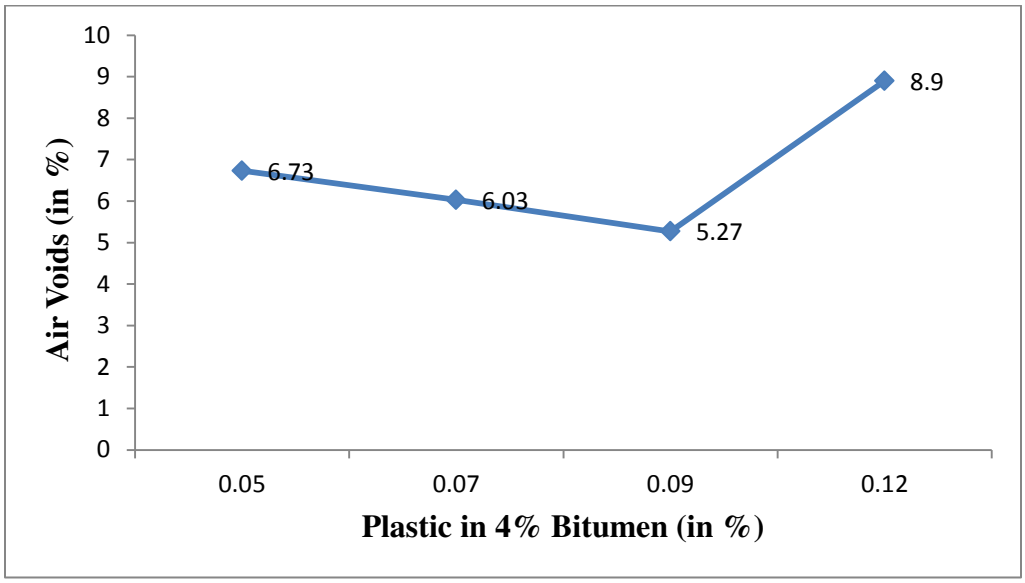

Figure 4.13 - Air Voids vs Plastic content (in %)

Discussion: This graph shows that there is decrease in the air voids percentage with the addition of plastic waste upto 9 %, then it started increasing in 4 % bitumen content. The strength of the bitumen is increasing with the lesser air voids.

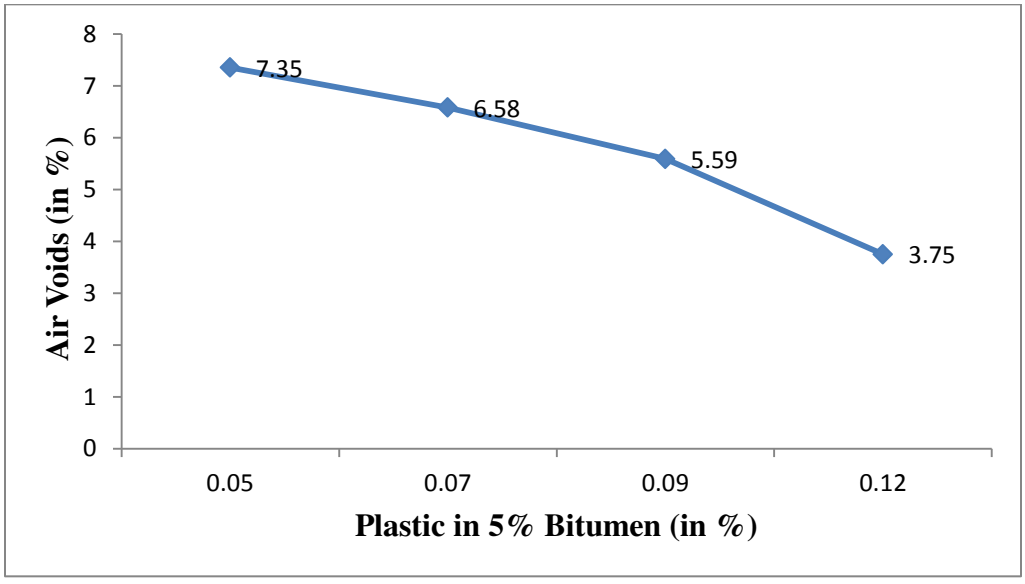

Figure 4.14 - Air Voids vs Plastic Content (in %)

Discussion: This graph shows that there is decrease in the air voids percentage with the addition of plastic waste in 5 % bitumen content. It increases the strength of the blend.

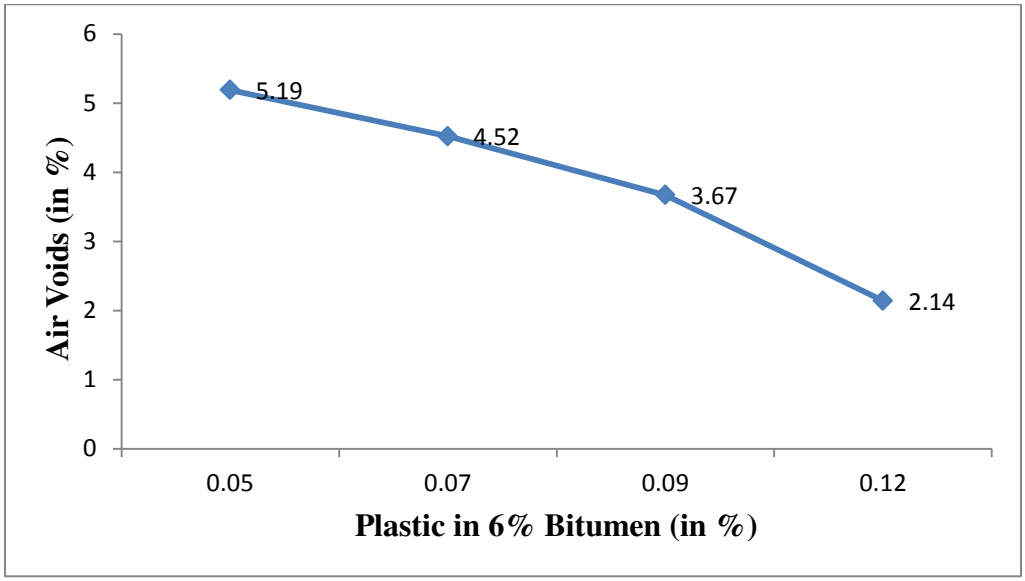

Figure 4.15 - Air Voids vs Plastic content (in %)

Discussion: This graph also shows that there is decrease in the air voids percentage with the addition of plastic waste but now the bitumen content is 6 %. The strength of the bitumen is increasing with the lesser air voids.

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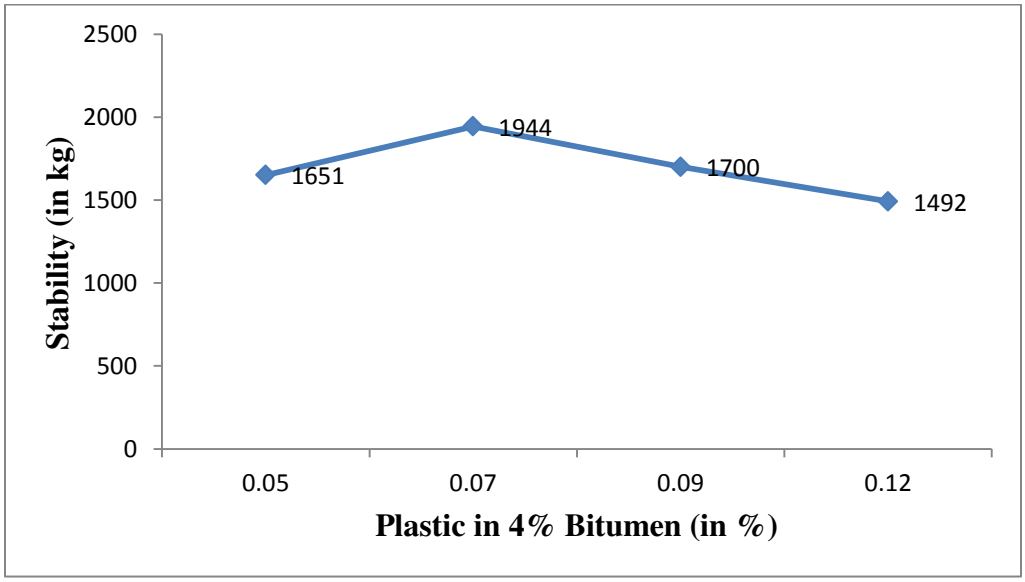

Figure 4.16 - Stability vs Plastic content (in %)

Discussion: In this graph, the stability value goes up first then it started decreasing with the increase in plastic content in 4 % bitumen. This means the thickness and strength of the blend is decreasing.

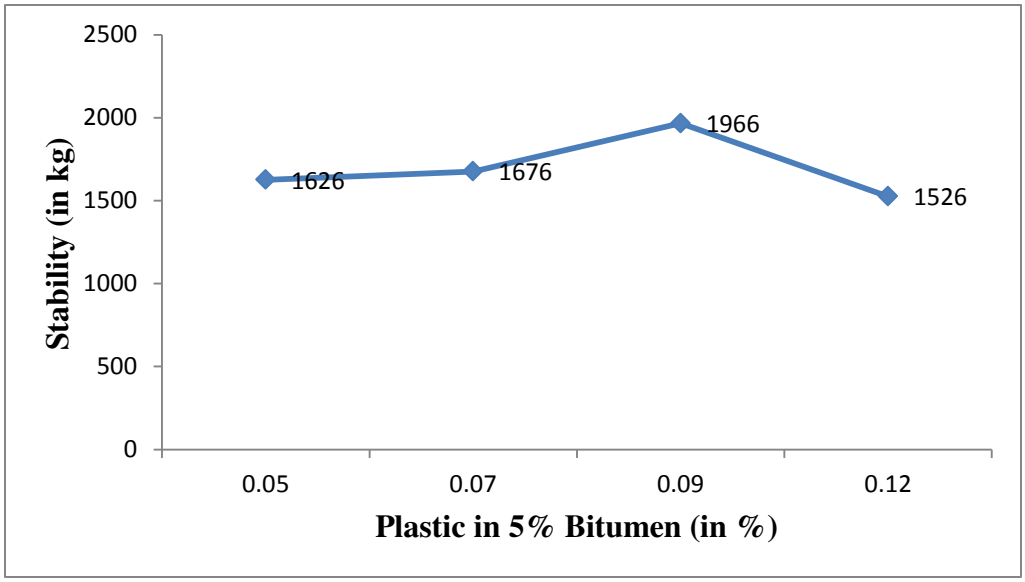

Figure 4.17 - Stability vs Plastic content (in %)

Discussion: This graph shows the same stability test with the change in bitumen content i.e. 5 % having almost same outcomes.

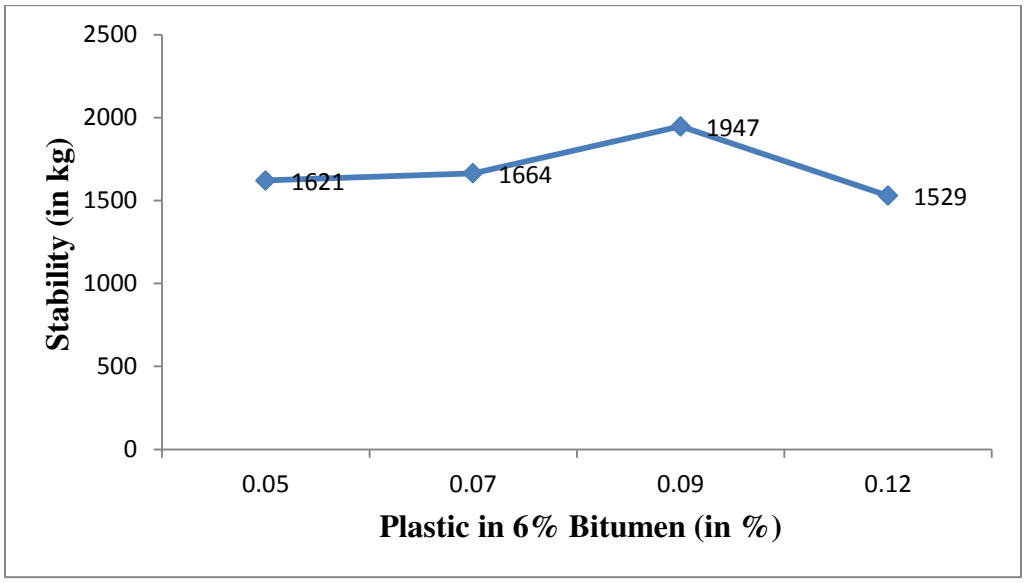

Figure 4.18 - Stability vs Plastic content (in %)

Discussion: The graph shows the variation in stability values with change in plastic content in 6 % bitumen content. The optimum plastic content is 7 % to 8 %.

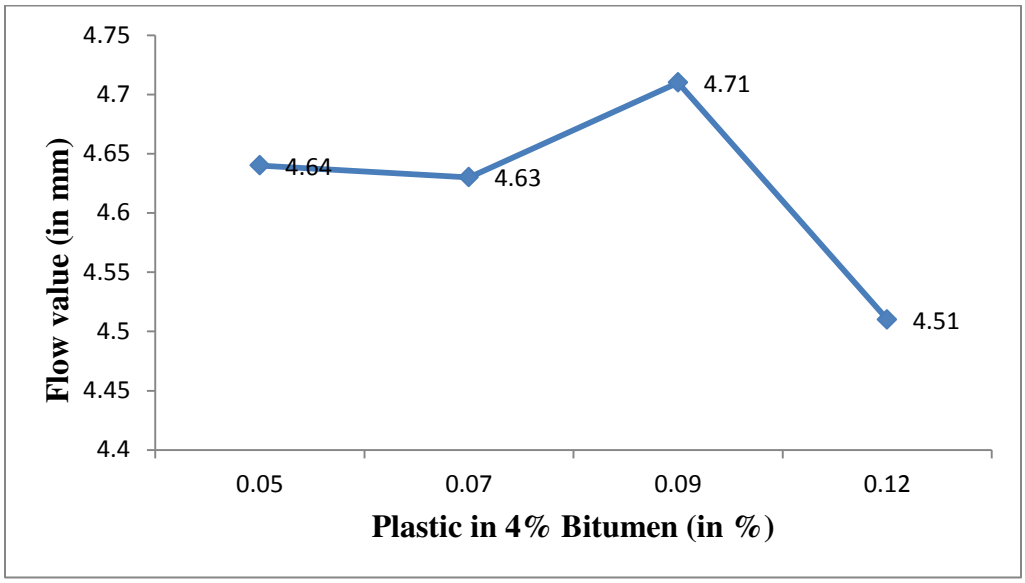

Figure 4.19 - Flow value vs Plastic content (in %)

Discussion: This graph shows the changes in the flow value of the blend with the increase in bitumen content. The reduction in the flow value demonstrates lesser deformation. Hence it stability increases.

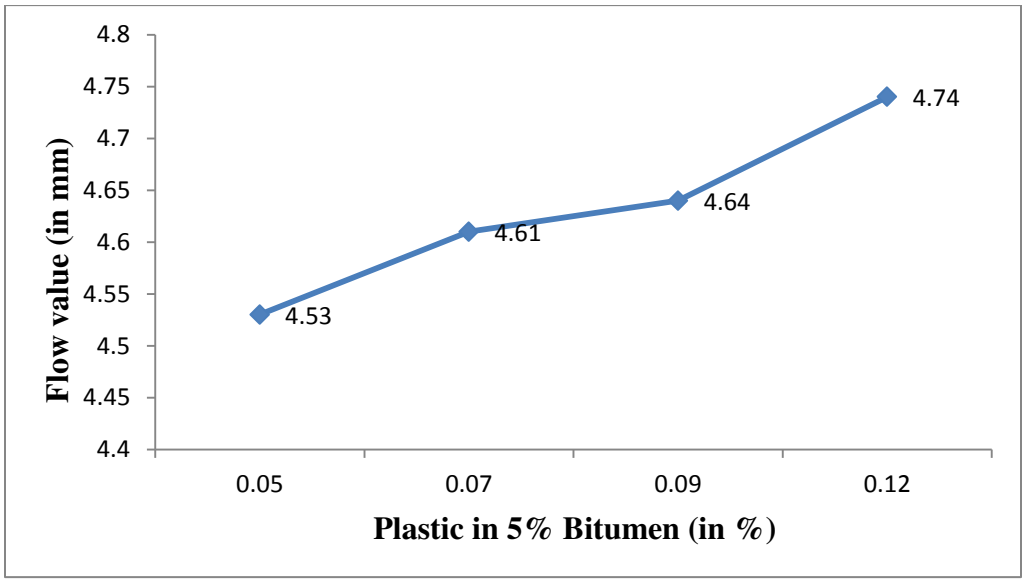

Figure 4.20 - Flow value vs Plastic content (in %)

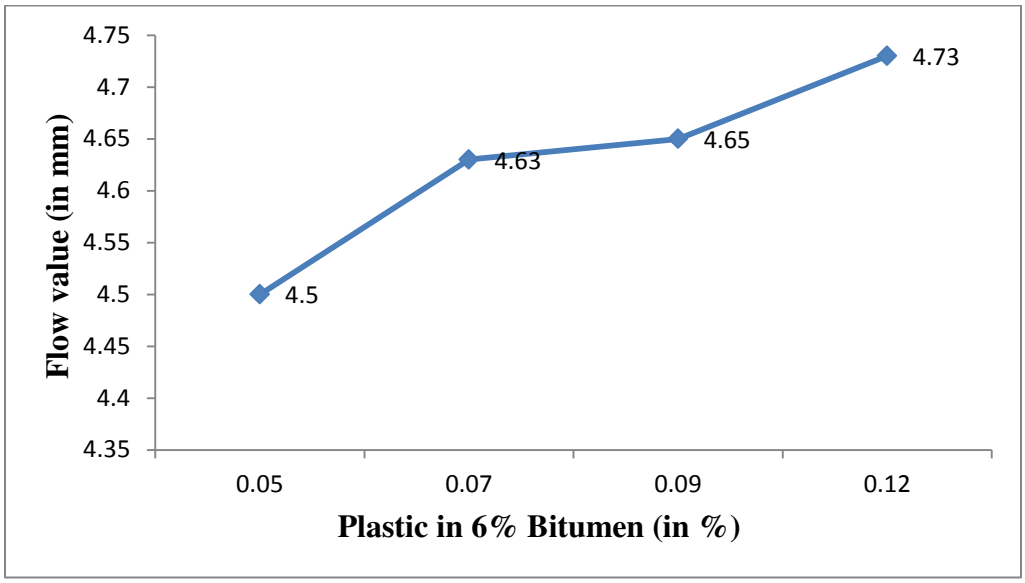

Figure 4.21 - Flow value vs Plastic content (in %)

Discussion: The graphs shown in Fig. 4.20 and Fig. 4.21 show that the flow value is increased with the addition of plastic waste thereby reduces its strength and increases the deformation value.

CHAPTER 5
CONCLUSION

The expansion of plastic waste adjusts the properties of bitumen. The utilization of plastic wastes in development of roads draws out a superior execution. Since there is better authoritative of bitumen with plastic. The recurrence of purge spaces is likewise diminished because of expanded holding and contact territory between plastic wastes and aggregates or bitumen. This eventually helps in lessening the absorption of moisture and oxidation of bitumen by entangled air. Henceforth, the roads can hold up under substantial activity, in this way expanding their toughness.

- In penetration test (0.1 mm) of bitumen with plastic, the value diminished from 47mm to 31 mm for 5 % plastic waste in bitumen and decreasing persistently on expanding plastic squanders rate and for 15 % plastic waste, the esteem lessened to 0.7mm when contrasted with ordinary bitumen on account of expanded hardness.
- The ductility value has additionally diminished from 72 cm to 42 cm for 5 % plastic waste in bitumen and consistently diminishing on expanding plastic wastes rate and for 15 %, the value diminished to 0.5 cm and 0.8 cm and weak disappointment is acquired because of interlocking of plastic material with bitumen.
- Softening point and specific gravity values expanded with the expansion in rate of plastic waste however subsequent to achieving the ideal level, the qualities began diminishing.

So it is fitting to utilize adjusted bitumen in pavement development to limit issues like, Rutting and Skidding of vehicles amid hot atmosphere conditions. By and large increment in softening point values demonstrates bring down temperature defenselessness and is predominantly favoured in hot atmospheres. The adjustment in the softening point qualities might be because of the chemical nature of plastic wastes included. The reason for changes in particular gravity qualities is high surface thickness without any adjustments in its weight. So we analysed that 7-9% plastic waste expansion in bitumen gives ideal outcomes. Likewise, notwithstanding easing the natural issues of these substances, bitumen and different materials will be additionally devoured less (thickness of different layers can be lessened through expanding thickness of pavement).

Thus the utilization of waste plastics for flexible pavement is one of the best techniques for simple transfer of waste plastics. The usage of changed bitumen and altered total is superior to

the utilization of ordinary bitumen and typical totals in numerous angles. For instance, if every one of the asphalts in India are changed over into plastic roads, all the plastic wastes accessible will be utilized as a part of the development of street and waste plastics transfer will never again be an issue.

- Stripping Value was lessened from 5 % for control example to nil for plastic indicated 9 %, after that it gave some value. This shows covered aggregates are more appropriate for bituminous street development than plain totals.
- Water Absorption is additionally lessened to nearly nil. Los Angeles Abrasion Value of the control example was observed to be 25.2 %.
- Covering of plastic over aggregates decreased scraped spot an incentive to 18.4 % for 5 % plastic expansion. This demonstrates the hardness of the aggregate.
- Aggregate Impact value of control sample was 22.3 %. It diminished to 17.3 % for 5 % plastic waste included and 10.6 % for 12 % plastic addition. This reduction in value demonstrates that the sturdiness of the aggregate was expanded to confront the effects.
- Crushing Value was reduced from 21.46 % to 19.8 % and 15.7 % for 5 % and 12 % plastic expansion individually.

Low aggregate crushing value shows solid aggregates, as the crushed portion is low. In short we can infer that, utilizing plastic waste in blend will help lessening needing bitumen by around 10%, expansion the quality and execution of street, maintain a strategic distance from utilization of hostile to stripping specialist, stay away from transfer of plastic waste by cremation and land filling and at last build up an innovation, which is eco amicable. Expanded activity conditions are decreasing the life expectancy of streets. Plastic roads are methods for avoidance and at last will be the cure. It will spare a great many dollars in future and diminish the measure of assets utilized for development of roads.

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