CHAPTER 1 - INTRODUCTION

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as 'Plastic'. Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Plastics can be divided in to two major categories: thermoses and thermoplastics. A thermo set solidifies or "sets" irreversibly when heated. They are useful for their durability and strength, and are therefore used primarily in automobiles and construction applications. These plastics are polyethylene, polypropylene, polyamide, polyoxymethylene, polytetrafluorethylene, and polyethyleneterephthalate. A thermoplastic softens when exposed to heat and returns to original condition at room temperature. Thermoplastics can easily be shaped and moulded into products such as milk jugs, floor coverings, credit cards, and carpet fibres. These plastic types are known as phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane.

According to recent studies, plastics can stay unchanged for as long as 4500 years on earth with increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. Plastic in different forms is found to be almost 5% in municipal solid waste, which is toxic in nature. 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 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. 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. Waste plastic such as carry bags, disposable cups and laminated pouches like chips, pan masala, aluminum foil and packaging material used for biscuits, chocolates, milk and grocery items can be used for surfacing roads.

Use of plastic along with the bitumen in construction of roads not only increases its life and smoothness but also makes it economically sound and environment friendly. Plastic waste is used as modifier of bitumen to improve some of bitumen properties Roads that are constructed using plastic waste are known as Plastic Roads and are found to perform better compared to those constructed with conventional bitumen. Further it has been found that such roads were not subjected to stripping when come in contact with water. Use of higher percentage of plastic waste reduces the need of bitumen by 10%. It also increases the strength and performance of the road. Plastic increases the melting point of bitumen and hence missing can be done in more better and easier way. plastic waste replaces 10% to 15% of bitumen, and thereby saves approximately Rs.35000 to Rs.45000 per kilometer of a road stretch. Inclusion of plastic waste in road construction eliminates the plastic shrinkage cracking of road surface and reduces the drying shrinkage to some extent.

The uses of plastic waste helps in substantially improving the abrasion and slip resistance of flexible pavement and also allows to obtain values of splitting tensile strength satisfied the specified limits while plastic waste content is beyond 30% by weight of mix. 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 missing and laying of roads is to be done using plastic waste. 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 reliving the earth from all type of plastic waste.

PROBLEM STATEMENT

The debate on the use and abuse of plastics vis-à-vis environmental protection can go on, without yielding results until practical steps are initiated at the grassroots level by everyone who is in a position to do something about it. The plastic wastes could be used in road construction and the field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems. The present write-up highlights the developments in using plastics waste to make plastic roads. The rapid rate of urbanization and development has led to increasing plastic waste generation. As plastic is non biodegradable in nature, it remains in environment for several years and disposing plastic wastes at landfill are unsafe since toxic chemicals leach out into the soil, and under-ground water and pollute the water bodies. Due to littering habits, inadequate waste management system / infrastructure, plastic waste disposal continue to be a major problem for the civic authorities, especially in the urban areas. As stated above, plastic disposal is one of the major problems for developing countries like India, at a same time India needs a large network of roads for its smooth economic and social development. Scarcity of bitumen needs a deep thinking to ensure fast road construction.

CHAPTER 2 - LITERATURE REVIEW

2.1 Awwad and Shbeeb (2007) indicated that the modified mixture has a higher stability and VMA percentage compared to the non-modified mixtures and thus positively influence the rutting resistance of these mixtures. According to them modifying asphalt mixture with HDPE polyethylene enhances its properties far more than the improvements realized by utilizing LDPE polyethylene.

2.2 Gawande et al. (2012) gave an overview on waste plastic utilization in asphalting road by using both wet and dry method. They said that use of modified bitumen with the addition of processed waste plastic of about 5-10% by weight of bitumen helps in improving the longevity and pavement performance with marginal saving in bitumen usage and according to them use of waste plastics in the manufacture of roads and laminated roofing also help to consume large quantity of waste plastics. Thus, these processes are socially highly relevant, giving better infrastructure.

2.3 Khan and Gundaliya (2012) stated that the process of modification of bitumen with waste polythene enhances resistance to cracking, pothole formation and rutting by increasing softening point, hardness and reducing stripping due to water, thereby improving the general performance of roads over a long period of time. According to them the waste polythene utilized in the mix forms coating over aggregates of the mixture which reduces porosity, absorption of moisture and improves binding property.

2.4 Prusty (2012) studied the behaviour of BC mixes modified with waste polythene. He used various percentages of polythene for preparation of mixes with a selected aggregate grading as given in the IRC Code. Marshall Properties such as stability, flow value, unit weight, air voids are used to determine optimum polythene content for the given grade of bitumen (80/100) in his study. Considering these factors he observed that a more stable and durable mix for the pavements can be obtained by polymer modifications.

2.5 Swami et al. (2012) investigated that the total material cost of the project is reduced by 7.99% with addition of plastic to bitumen between the ranges of 5% to 10%. They concluded that by modification of bitumen the problems like bleeding in hot temperature regions and sound pollution due to heavy traffic are reduced and it ultimately improves the quality and performance of road.

2.6 Pareek et al. (2012) carried out experimental study on conventional bitumen and polymer modified binder and observed a significant improvement in case of rutting resistance, indirect tensile strength and resilient modulus of the bituminous concrete mix with polymer modified bitumen. They also concluded that Polymer modified bitumen results a high elastic recovery (79%) and better age resistance properties (The loss in weight on heating in thin film oven is 6 times higher as compared to conventional bitumen of 60/70).

2.7 Sangita et al. (2011) suggested a novel approach to improve road quality by utilizing plastic waste in road construction. According to them India spends Rs 35,000 crores a year on road construction and repairs, including Rs 100,000 crores a year just on maintenance and roads by bitumen modification lasts 2-3 times longer, which will save us Rs 33,000 crores a year in repairs, plus reduced vehicle wear and tear.

CHAPTER 3 - OBJECTIVES

Basic intention is to efficiently utilize the waste plastic in constructive way so that it can be beneficial to society. However, the main objectives of current project work are:

- To coat the aggregates with the waste plastic materials.
- To check the properties of bituminous mix specimen.
- To check the properties of bituminous mix specimen due to coating of waste polyethylene plastic.
- To compare the properties of bituminous mix specimen with the properties of aggregates coated with foil covered plastic.

CHAPTER 4 - METHODOLOGY

Following Tests were conducted to investigate the properties of the aggregate as well as bitumen.

4.1 TESTS FOR AGGREGATE

4.1.1 Sieve Analysis of Aggregates

4.1.2 Specific Gravity & Water Absorption Test [IS: 2386 (Part 3) 1963]

4.1.3 Aggregate Impact Value Test [IS: 2386 (part 4) 1963]

4.1.4 Aggregate Crushing Value [IS: 2386 (Part 4) 1963]

4.1.5 Flakiness & Elongation Index Test [is: 2386 (part 1) 1963]

4.2 TESTS FOR BITUMEN

4.2.1 Penetration Test [Is: 1203-1978]

4.2.2 Softening Point Test [Is: 1205-1978]

4.2.3 Ductility Test [IS: 1208-1978]

4.2.4 Viscosity Test:

4.2.5 Flash Point and Fire Point

4.1 TESTS ON AGGREGATE

4.1.1 Sieve Analysis of Aggregates

Procedure

i) The test sample is dried to a constant weight at a temperature of 110 + 5˚C and weighed.

ii) The sample is sieved by using a set of IS Sieves.

iii) On completion of sieving, the material on each sieve is weighed.

iv) Cumulative weight passing through each sieve is calculated as a percentage of the total sample weight.

v) Fineness modulus is obtained by adding cumulative percentage of aggregates retained on each sieve and dividing the sum by 100.

4.1.2 Specific Gravity & Water Absorption Test [IS: 2386 (Part 3) 1963]

Procedure

i) The sample should be thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22 and 32oC.

ii) After immersion, the entrapped air should be removed by lifting the basket and allowing it to drop 25 times in 25 seconds. The basket and sample should remain immersed for a period of 24 + ½ hrs. Afterwards.

iii) The basket and aggregates should then be removed from the water, allowed to drain for a few minutes, after which the aggregates should be gently emptied from the basket on to one of the dry clothes and gently surface-dried with the cloth, transferring it to a second dry cloth when the first would remove no further moisture. The aggregates should be spread on the second cloth and exposed to the atmosphere away from direct sunlight till it appears to be completely surface-dry. The aggregates should be weighed (Weight 'A').

iv) The aggregates should then be placed in an oven at a temperature of 100 to 110oC for 24hrs. It should then be removed from the oven, cooled and weighed (Weight 'B')

4.1.3 Aggregate Impact Value Test [IS: 2386 (part 4) 1963]

Preparation of sample

i) The test sample should conform to the following grading:- Passing through 12.5mm IS Sieve 100% - Retention on 10mm IS Sieve 100%

ii) The sample should be oven-dried for 4hrs. at a temperature of 100 to 110oC and cooled.

iii) The measure should be about one-third full with the prepared aggregates and tamped with 25 strokes of the tamping rod A further similar quantity of aggregates should be added and a further tamping of 25 strokes given. The measure should finally be filled to overflow, tamped 25 times and the surplus aggregates struck off, using a tamping rod as a straight edge. The net weight of the aggregates in the measure should be determined to the nearest gram (Weight 'A').

Procedure

i) The cup of the impact testing machine should be fixed firmly in position on the base of the machine and the whole of the test sample placed in it and compacted by 25 strokes of the tamping rod.

ii) The hammer should be raised to 380mm above the upper surface of the aggregates in the cup and allowed to fall freely onto the aggregates. The test sample should be subjected to a total of 15 such blows, each being delivered at an interval of not less than one second.

4.1.4 Aggregate Crushing Value [IS: 2386 (Part 4) 1963]

Procedure

i) The aggregates passing through 12.5mm and retained on 10mm IS Sieve are oven-dried at a temperature of 100 to 110oC for 3 to 4hrs.

ii) The cylinder of the apparatus is filled in 3 layers, each layer tamped with 25 strokes of a tamping rod.

iii) The weight of aggregates is measured (Weight 'A').

iv) The surface of the aggregates is then levelled and the plunger inserted. The apparatus is then placed in the compression testing machine and loaded at a uniform rate so as to achieve 40t load in 10 minutes. After this, the load is released.

v) The sample is then sieved through a 2.36mm IS Sieve and the fraction passing through the sieve is weighed (Weight’s').

vi) Two tests should be conducted.

4.2 TESTS ON BITUMEN

4.2.1 Penetration Test [Is: 1203-1978]

Preparation of Test Sample

Soften the material to a pouring consistency at a temperature not more than 60°C for tars and pitches and not more than 90°C for bitumen’s above the respective approximate softening point and stir it thoroughly until it is homogeneous and is free from air bubbles and water. Pour the melt into the container to a depth at least 10 mm in excess of the expected penetration. Protect the sample from dust and allow it to cool in an atmosphere at a temperature between 15 to 30°C for lY2 to 2 h for 45 mm deep container and 1 to lY2 h when the container of 35 mm depth is used. Then place it along with the transfer dish in the water bath at 25.0 ± 0.1°C and allow it to remain for 1 to $1\frac{1}{2}$ hour for 45 mm and 35 mm deep container respectively.

In the case of cutback bitumen and Digboi type cutback bitumen, residue left after distillation shall be used for the test. The procedure for handling the residue shall be in accordance with the method described under 3.2.4 of the distillation test (see IS: 1213-1978*).

Unless otherwise specified, testing shall be carried out at 25.0 ± O.I°C. Fill the transfer dish with water from the water bath to a depth sufficient to cover the container completely; place the sample in it and put it upon the stand of the penetration apparatus. Adjust the needle (previously washed clean with benzene, carefully dried, and loaded with the specified weight) to make contact with the surface of the sample. be accomplished by placing the needle point in contact With Its Image reflected by the surface of the material from a suitably placed source of light. Unless otherwise specified, load the needle holder with the weight required to make a total moving weight (that is, the sum of the weights of the needle, carrier and superimposed weights) of 100± 0.25 g. Note the reading of the dial or bring the pointer to zero. Release the needle and adjust the points, if necessary to measure the distance penetrated. Make at least three determinations at points on the surface of the sample not less than 10 nun apart and not less than 10 mm from the side of the dish. After each test, return the sample and transfer dish to the water bath, and wash the needle clean with benzene and dry. In the case of material of penetration greater than 225, three determinations on each of two identical test specimens using a separate needle for each determination shall be made, leaving the needle in the sample on completion of each determination to avoid disturbance of the specimen. For determining the penetration ratio, testing shall also be carried out a 4.0° ± 0.1°C.

4.2.2 Softening Point Test [Is: 1205-1978]

Preparation of test sample

Heat the material to a temperature between 75°C and 100°C above its softening point. Stir until it is completely fluid and free from air bubbles and water, and filter, if necessary, through IS Sieve 30 (see IS: 460-1962*). Place the rings, previously heated to a temperature approximating to that of the molten material, on a metal plate which has been coated with a mixture of equal parts of glycerine and dextrin, and fill with sufficient

·Specification for test sieves (revised).melt to give an excess above the level of cooled. term cooling for 30 minutes in air, level the material in the ring by removing the excess with a warmed, sharp knife.

Materials of Softening Point Below 80˚C - Assemble the apparatus with the rings. Thermometer and ball guides in position, and fill the bath to a height of 50 mm above the upper surface of the rings with freshly boiled distilled water at a temperature of 5°C. Maintain the bath at a temperature of 5°C for 15 minutes after which place a ball. Previously cooled to a temperature of 5°C, by means of forceps in each ball guide. Apply heat to the bath and stir the liquid so that the temperature rises at a uniform rate of 5.0 ± 0.5°C per minute until the material softens and allows the ball to pass through the ring. The rate of temperature rise shall not be averaged over the period of the test, and any test in which the rate of temperature rise does not fall within the specified limits after the first three minutes shall be rejected. Make the determination in duplicate. Materials of Softening Point Above 80aC - The procedure for materials of softening point above 80°C is similar to that described under 4.2 with the difference that glycerine is used in place of water in the bath and the starting temperature of the test is 35°C. Make the determination in duplicate.

4.2.3 Viscosity Test [IS: 1208-1978]

Procedure

Adjust the tar viscometer so that the top of the tar cup is level. Heat the water in the water bath to the temperature specified for the test and maintains it within ± O.l°e of the specified temperature throughout its bulk for the duration of the test, the stirrer being gently rotated at frequent intervals or, preferably, continuously. Clean the tar cup orifice of the viscometer with a suitable solvent and dry thoroughly. Warm and stir the material under examination to 200e above the temperature specified for the test, and cool, while continuing the stirring. When the temperature has fallen to slightly above the specified temperature, pour the tar into the tar cup until the levelling peg on the valve rod is just immersed when the latter is vertical. Pour into the graduated receiver 20 ml of mineral oil, or a one percent by weight solution of soft soap, and place it under the orifice of the tar cup. Place a second standard thermometer in the tar and stir the latter until the temperature is within ± O.loe of the specified temperature. When this temperature has been reached, suspend the thermometer co-axially with the cup and with its bulb approximately at the geometric centre of the tar .Allow the assembled apparatus to stand for five minute during which period the thermometer reading shall remain within 0.05°C of the specified temperature. Remove the thermometer and quickly remove any excess of tar so that the final level is on the centre line of the levelling peg when the valve is in vertical position. Lift the valve and suspend it on the valve support. Start the stop watch or the time recording device when the reading in the cylinder is 25 ml and stop it when it is i5 ml. Note the time in seconds.

4.2.4 Ductility Test [IS: 1208-1978]

Procedure

Unless otherwise specified, the test shall be conducted at. A temperature of 25.0 ± 0.5°C and at a rate of pull of 50.0 ± 2.5 mm/mm.When a low temperature ductility test is desired, the test shall be made at a temperature of 4.0 ±O.5°C and at a rate of pull of 10.0 ± 0.5 mm/min. Completely melt the bituminous material to be tested to a temperature of 75 to 100°C above the approximately softening point until it becomes thoroughly fluid. Assemble the mould on a brass plate and in order to prevent the material under test from sticking, thoroughly coat the surface of the plate and interior surfaces of the sides of the mould with a mixture of equal parts of glycerine and dextrin. In filling, pour the material in a thin stream back and forth from end to end of the mould until it is more than level full. Leave it to cool at the room temperature for 30 to 40 min, and then place in a water bath maintained at the specified temperature for 30 min after which cut off the excess bitumen by means of a hot, straight-edged putty knife or spatula so that the mould shall be just level full.

Testing - Place the brass plate and mould with briquette specimen, in the water bath and keep at the specified temperature for about 85 to 95 minutes. Then remove the briquette from the plate, detach the side pieces, and test the briquette immediately. Attach the rings at each end of the clips to the pins or hooks in the resting machine and pull the two clips apart horizontally at a uniform speed as specified until the briquette ruptures. Measure the distance in centimetres through which the clips have been pulled to produce rupture. While the test is being made, make sure that the water in the tank of the testing machine covers the specimen both above and below it by at least 25 mm and is maintained continuously within ±O.5°C of the specified temperature.

4.2.5 Flash Point and Fire Point

Procedure

Clean and dry all parts of the cup and its accessories thoroughly before the test is started. Take particular care to avoid the presence of any solvent used to clean the apparatus after a previous test. Fill the cup with the material to be tested up to the level indicated by the filling mark. Place the lid on the cup and set the latter in the stove. Take care that the locating devices are properly engaged. Insert the thermometer, high or low range, as required. Light and adjust the test-flame so that it is of the size of a bead of 4 mm in diameter. Apply heat at such a rate that the temperature recorded by the thermometer increases between 5 to GOC per minute. Turn the stirrer at a rate of approximately 60 revolutions per minute. Apply the test-flame at each temperature reading which is a multiple of 1°C up to 104°C. For the temperature range above 104°C, apply the test-flame at each temperature reading which is a multiple of 2°C, the first application of the test-flame being made at a temperature at least 17°C below the actual flash point. Apply the test-flame by operating the device controlling the shutter and test-flame burner so that the flam e is lowered in 0.5 seconds, left in its lowered position for one second, and quickly raised to its high position. Discontinue the stir ring during the application of the test-flame.

CHAPTER 5 - PREPARATION OF DESIGN MIX

5.1 Plain Bituminous Mix:

Bitumen is a black, oily, viscous material that is a naturally-occurring organic byproduct of decomposed organic materials. Also known as asphalt or tar, bitumen was mixed with other materials throughout prehistory and throughout the world for use as a sealant, adhesive, building mortar, incense, and decorative application on pots, buildings, or human skin. The material was also useful in waterproofing canoes and other water transport. A good design of bituminous mix is expected to result in a mix which is adequately

(i) strong

(ii) durable

(iii)resistive to fatigue and permanent deformation

(iv) Environment friendly

(v) Economical and so on.

5.1.1 Selection of Mix Constituents

Binder and aggregates are the two main constituents of bituminous mix. This section discusses some of the issues involved in selection of binder and aggregates.

Binder

Generally binders are selected based on some simple tests and other site-specific requirements. These tests could be different depending of the type of binder viz. penetration grade, cutback, emulsion, modified binder etc. For most of these tests, the test conditions are pre-fixed in the specifications. Temperature is an important parameter which affects the modulus as well as the aging of binder. Acceptability tests are to be carried out at the prevalent field temperatures, not in a laboratory specified temperature.

This is an important consideration because, binder from two different sources may show same physical properties at a particular temperature, but their performances may vary drastically at other temperatures. The acceptable test values are recommended and not the test temperatures. The temperature values are found out from the most prevalent maximum and minimum temperatures at the field at a given probability level.

Aggregate

Number of tests is recommended in the specifications to judge the properties of the aggregates, e.g. strength, hardness, toughness, durability, angularity, shape factors, clay content, adhesion to binder etc. Angularity ensures adequate shear strength due to aggregate interlocking, and limiting flakiness ensures that aggregates will not break during compaction and handling. Theoretically, it is difficult to predict the aggregate volumetric parameters, even the resultant void ratio, when the gradation curve is known. experimental study for minimum void distribution. MORTH 5th gradation is used as the reference gradation, with certain restricted zones and control points. The restricted zone and control points are incorporated in order to ensure certain proportion of fines for

(i) proper interlocking of aggregates

(ii) to avoid the fall in shear strength of mix due to excess of fines and

(iii) To maintain requisite Voids in Mineral Aggregates (VMA).

Table-1 gives some idea of how the mix design requirements have changed from past to present.

Table 1: Requirements of Bituminous Mix Design

Past	Present
Stability Durability Economy	Stability Durability Economy Stiffness Permanent deformation Fatigue Temperature susceptibility Low temperature cracking Moisture susceptibility Freeze-thaw Permeability Economical Environment friendly Workability Economy

Some of the above requirements are sometimes mutually conflicting. For, example, the higher is the bitumen content; the better is the fatigue life, provided all the other parameters are kept unchanged. But with the increase of bitumen content, the resistance to rutting may decrease. Increase in bitumen content not accompanied by adequate amount of air voids will result in the fall of stability of the mix, the chances of bleeding will increase. The only way to increase bitumen content keeping sufficient air voids (VA) is by maximizing VMA and suitably gradation can be designed. Heavy duty bituminous pavements are composed of bituminous binder course and wearing course, for example, Dense Bituminous Macadam (DBM) and BC [MORT&H 5th code], as per Indian specification. Same grades of bitumen are generally used for construction of these layers. Generally same grades of bitumen are used for construction of these layers. Stiffer grade of bitumen has higher value of stiffness, and it causes lesser stains to the pavement layers and also it is expected to show lesser rutting. On the other hand, higher fatigue life as observed for bituminous mixes with softer grade of bitumen, indicates greater longevity of the pavement against fracture. It can be shown computationally that if a pavement is constructed with softer grade of bitumen at the lower layer, and harder grade at the top layer, the pavement is expected to last longer, than a pavement constructed with same grades for both the layers – this technique is known as rich-bottom pavement construction in other countries.

5.2 Coated Bituminous Mix:

The generation of waste plastics is increasing day by day. The major polymers are namely polyethylene, polypropylene, polystyrene show adhesion property in their molten state. The plastic coated aggregate bitumen mix and plastic modified bitumen forms better materials for flexible pavement construction as the mixes shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for flexible pavement is one of the best methods of easy disposal of waste plastics. The use of polymer coated aggregate is better than the use of polymer modified bitumen in many aspects. The studies on the thermal behavior and binding property promoted a study on the preparation of plastic waste-bitumen blend and its properties to find the suitability of the blend for road construction. Following procedure can be adopted for using plastic in road construction.

CHAPTER 6 - DATA COLLECTION AND ITS ANALYSIS

6.1 General

Investigation of plastic waste materials aggregates and bitumen requires various field test and lab tests as explain in previous chapter. This chapter presents material which is collected from site given below for plastic coated aggregates in detail. The present chapter divided into three main sections. First section presents the physical requirement of aggregates and bitumen. Second section presents the properties of plastic. Third section presents the preparation plastic waste materials for shredding on aggregates.

6.2 Aggregates

The aggregates are bound together either by bituminous materials or by cement. In a few cases, the rock dust itself when mixed with water forms slurry which acts as a binding medium.

The aggregates may be classified into natural and artificial aggregates. The natural aggregates again are classified as coarse aggregates consisting of crushed rock aggregates or gravels and fine aggregates or sand. Stone aggregate used for road work should be hard, tough, durable and hydrophobic for bituminous surface. Gravel should be well graded (6.4mm to 38mm) and should have a fineness modulus of not less than 5.75. Sand should be sharp, well graded, clean of all silts, clay and organic matter. The quantity of aggregates used in first coat of surface dressing should be 0.15 m^3 per 10 m^2 area of 12mm nominal size. On the other hand, the quantity of aggregate used in second coat of surface dressing should be 0.15 m^3 per 10 m^2 areas and of 10mm nominal size. Aggregates of 20mm, 10 mm and down size were used in this study. The standard requirements of aggregates is shown in Table 2

Table 2: Physical Requirements of Coarse Aggregates

Sr. No	Test	Permissible values
1.	Abrasion Test a. Using Los Angeles machine (max) b. Aggregates impact test (max)	 35% 30%
2.	Stripping test (max)	25%
3.	Water absorption (expect in the case of slag) max	1%
4.	Soundness test: Loss with sodium sulphate 5 cycles (in case of slag only) max	12%
5.	Weight unit or Bulk density (in slag only)	1120 per m^3

6.3 Bitumen

Bitumen is used as binders in pavements constructions. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. As per definition given by the American Society of Testing Materials bitumen has been defined as “Mixtures of hydrocarbons of natural or pyrogenous origin, or combination of both, frequently accompanied by their non-metallic derivatives, which may be gaseous, liquid, semi-solid or solid, and which are completely soluble in carbon disulphide.” Bitumen found in natural state known as asphalt contains large quantities of solid mineral matter.

When petroleum crude is refined in a refinery, they are separated by fractional distillation in the order of decreasing volatility. On distillation of the residual bituminous residue, straight-run bitumen is obtained. This bitumen is known as penetration grade bitumen or steam refined petroleum bitumen. The grades of bitumen used for pavement construction is known as paving grades and that used for water proofing of structures is known as industrial grades. The grade of straight run bitumen is chosen depending upon the climatic conditions of the region in which surface dressing is to be constructed. In most parts of India 80/100 and 180/200 grade bitumen is used. Heavier grade cut backs, rapid setting emulsions or heavier grade tars may also be used. The grade of basic bitumen is altered either by controlled refining or by mixing with diesel oil or other oils. For single dressings on

WBM base course, quantity of bitumen needed ranges from 17 to 195 kg per 10 m^2 areas and 10 to 12 kg per 10 m^2 area in case of renewal of black top surfacing. For second coat of surface dressing, the quantity of bitumen needed ranges from 10 to 12 kg per 10 m^2 area. Bulk bitumen Lorries with tanks of capacity ranging from 5000 to 15000 liters are used to transport bulk bitumen. As per PMC, the bitumen content in a mix should be 4% of weight by total mix for B.M.

The paving bitumen available in India is classified into two categories:

Paving bitumen from Assam petroleum denoted as A-type and designated as grades A35, A90, etc.

Paving bitumen from other sources denoted as S-type and designated as grades S35, S90, etc.

Important properties of bitumen are:

Viscosity of bitumen should be adequate at the time of mixing and compaction. It is achieved by heating prior to mixing and by use of cutbacks and emulsion. In presence of water bitumen should not strip off from aggregate. Bitumen should be durable in all seasons. It should not become too soft during summers and develop cracks during winters.

6.4 Plastic material

Plastics are usually classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, poly addition, and cross linking. There are two types of plastics: thermoplastics and thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be moulded again and again. Examples include polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetra fluoroethylene (PTFE In the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is a thermosetting process. Before heating with sulfur, the polyisoprene is a tacky, slightly runny material, but after vulcanization the product is rigid and non-tacky. The properties of plastics are defined chiefly by the organic chemistry of the polymer. such as hardness, density, and resistance to heat, organic solvents, oxidation, and ionizing radiation.

6.4.1 Types of Plastics

PET, polyethylene terephthalate

HDPE, high-density polyethylene

PVC, polyvinyl chloride

LDPE, low-density polyethylene

PP, polypropylene

PS, polystyrene

Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Since the 1950s, one billion tons of plastic have been discarded and may persist for hundreds or even thousands of years. Perhaps the biggest environmental threat from plastic comes from nurdles, which are the raw material from which all plastics are made. They are tiny pre-plastic pellets that kill large numbers of fish and birds that mistake them for food. Prior to the ban on the use of CFCs in extrusion of polystyrene (and general use, except in life-critical fire suppression systems; see Montreal Protocol), the production of polystyrene contributed to the depletion of the ozone layer; however, non-CFCs are currently used in the extrusion process. Thermoplastics can be remelted and reused, and thermo set plastics can be ground up and used as filler, although the purity of the material tends to degrade with each reuse cycle. There are methods by which plastics can be broken back down to a feedstock state.

6.4.2 Classification of Plastic Waste:

a) Polyethylene:

LDPE (Low Density Poly-Ethylene):

Low density poly-ethylene this plastic waste available in the form of carry bags generally in stores these plastic bags are very thin and also easily available.

HDPE (High Density Poly-Ethylene):

Generally High density poly-ethylene type of plastic waste is available in the form of carry bags and easily available in the market.

b) Polypropylene:

This plastic may be available in the form of carry bags or solid plastic it’s depend upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

c) Foil covered plastic:

LDPE (Low Density Plastic):

Low density plastic waste available in the form of carry bags generally in stores these plastic bags.

6.5 PREPARATION OF PLASTIC WASTE MATERIAL

6.5.1 Plastic Waste Scenario

The use of plastic materials such as carry bags, cups, etc. is constantly increasing. The consumption of plastics has increased from 4000 tons/annum to 4 million tons/annum and it is expected to rise 8 million tons/annum during the year 2010. Nearly 50 to 60% of the total plastics are consumed for packing.

6.5.2 Waste plastic shredding:

Shredding is the process of cutting the plastic into small sizes between 2.36mm to 4.75mm with the help of the plastic shredding machine viz. Agglomerater and Scrap Grinder. In Agglomerater, thin films of poly-ethylene and polypropylene carry bags are shredded and in Scrap Grinder a solid plastic material are shredded i.e. plastic bottles, drip lines, electric cable lines etc.

6.5.3 Preparation of Plastic-Waste Coated Aggregate

The aggregate are heated to around 170°C; the plastic waste shredded to the size varying between 2.36mm and 4.75mm. This shredded plastic waste is added over hot aggregate with constant mixing to give a uniform distribution. The plastic get softened and coated over the aggregate. The hot plastic waste coated aggregates are mixed with hot bitumen 60/70 or 80/100 grade (160°C).

For shredding of solid plastic waste of poly-propylene 'scrap grinding machine' is used. In this process, a solid plastic waste cut in small pieces with the help of with two rotating and one fixed blades. This whole process gives output in per hour rate.

6.5.4 Characterization of Plastic Waste-Bitumen Blend for Flexible Pavement

The utility of the plastic waste blended bitumen-aggregate mix for flexible pavement construction is characterized by studying Marshall Stability value of the mix for the blends having varying ranges of plastics.

CHAPTER 7

MARSHALL METHOD OF ASPHALT-CONCRETE MIX DESIGN

7.1 APPARATUS

1. Mould Assembly: cylindrical moulds of 10 cm diameter and 7.5 cm height consisting of a base plate and collar extension.
2. Sample Extractor: for extruding the compacted specimen from the mould.
3. Compaction pedestal and hammer.
4. Breaking head.
5. Loading machine.
6. Flow meter, water bath, thermometers.

7.2 INTRODUCTION

Bituminous mixes (some times called asphalt mixes) are used in the surface layer of road and airfield pavements. The mix is composed usually of aggregate and asphalt concrete. Some types of bituminous mixes are also used in base course. The design of asphalt paving mix, as with the design of other engineering materials is largely a matter of selecting and proportioning constituent materials to obtain the desired properties in the finished pavement structure.

The desirable properties of Asphalt mixes are:

1. Resistance to permanent deformation: The mix should not distort or be displaced when subjected to traffic loads. The resistance to permanent deformation is more important at high temperatures.

2. Fatigue resistance: the mix should not crack when subjected to repeated loads over a period of time.

3. Resistance to low temperature cracking. This mix property is important in cold regions.

4. Durability: the mix should contain sufficient asphalt cement to ensure an adequate film thickness around the aggregate particles. The compacted mix should not have very high air voids, which accelerates the aging process.

5. Resistance to moisture-induced damage.

6. Skid resistance.

7. Workability: the mix must be capable of being placed and compacted with reasonable effort.

8. Low noise and good drainage properties: If the mix is to be used for the surface (wearing) layer of the pavement structure.

Marshall Stability and Hveem stabilometer tests are largely used for the routine testing. Criteria for the suitable mix design have been specified by the Asphalt Institute.

7.3 MARSHALL METHOD OF MIX DESIGN

In this method, the resistance to plastic deformation of a compacted cylindrical specimen of bituminous mixture is measured when the specimen is loaded diametrically at a deformation rate 53 of 50 mm per minute.

There are two major features of the Marshall method of mix design.

(i) density-voids analysis and
(ii) Stability-flow tests.

The Marshall stability of the mix is defined as the maximum load carried by the specimen at a standard test temperature of 60°C. The flow value is the deformation that the test specimen undergoes during loading up to the maximum load. Flow is measured in 0.25 mm units. In this test, an attempt is made to obtain optimum binder content for the type of aggregate mix used and the expected traffic intensity.

7.4 STEPS OF DESIGN

1. Select aggregate grading to be used (MORTH´S)
2. Determine the proportion of each aggregate size required to produce the design grading.
3. Determine the specific gravity of the aggregate combination and asphalt cement.
4. Prepare the trial specimens with varying asphalt contents.
5. Determine the specific gravity of each compacted specimen.
6. Perform stability tests on the specimens.
7. Calculate the percentage of voids, and percent voids filled with Bitumen in each specimen.
8. Select the optimum binder content from the data obtained.
9. Evaluate the design with the design requirements.

7.4.1 Aggregate Gradation

Aggregate gradations were selected with a nominal size of 19mm based on The Asphalt Institute Manual Series "Principles of Construction of Hot-Mix Asphalt Pavements "No.22 MS-22 (1983). According to the failure mechanisms (Rutting), the gradations should be limited between upper limit and lower limit based on the 19 mm nominal maximum aggregate size. In this study the gradation range divided into three variations that form a band.

7.5 PROCEDURE

In the Marshall Test method of mix design three compacted samples are prepared for each binder content. At least four binder contents are to be tested to get the optimum binder content. All the compacted specimens are subject to the following tests:

· Bulk density determination.

· Stability and flow test.

· Density and voids analysis.

7.5.1 Preparation of test specimens: - The course aggregate, fine aggregate, and the filler material were proportioned so as to fulfil the requirements of the relevant standards. The required quantity of the mix was taken so as to produce compacted bituminous mix specimens of thickness 63.5 mm approximately. 1200 gm of aggregates and filler are required to produce the desired thickness. The aggregates were heated to a temperature of 175° to 190°C. The bitumen was heated to a temperature of 150°C to 160°C and the required amount of first trial of bitumen was added to the heated aggregate. Bitumen in percentage from 4% to 6% were added for three compacted sample and mixed thoroughly. The mix was placed in a mould and compacted with 75 numbers of blows on either side. The sample was taken out of the mould after few minutes using sample extractor. After the testing of the compacted sample, optimum binder was found out. The obtained optimum binder content was 5.5% of bitumen.

7.5.2 Preparation of test specimens using polyethylene polymer: **-** The course aggregate, fine aggregate, and the filler material should be proportioned so as to fulfil the requirements of the relevant standards. The required quantity of the mix is taken so as to produce compacted bituminous mix specimens of thickness 63.5 mm approximately.

1200 gm of aggregates and filler are required to produce the desired thickness. The aggregates are heated to a temperature of 175° to 190°C. The waste polymer is selected and is shredded into pieces which passes through 4.75 and 2.36 mm and mixed with hot stone with uniform mixing. The selected waste polymer percentage was from 0% to 8%. Each percentage of waste polymer was added to heated aggregate. When heated to around 150°C to 170°C, they melt and in their molten state they spread over the stone as a thin liquid, which acts as a binder. The compaction mould assembly and rammer are cleaned and kept pre-heated to a temperature of 100°C to 145°C. The bitumen was heated to a temperature of 150°C to 160°C and the optimum percentage of 5.5% amount of bitumen was added to the heated aggregate and thoroughly mixed. The mix was placed in a mould and compacted 75 numbers of blows on either side. The sample was taken out of the mould after few minutes using sample extractor. After the test conducted for the sample of particular percentage, the maximum stability was obtained. Three samples were tested for each percentage. When the percentage of waste polymer was varied from 0 to 8%, the maximum stability was obtained for 6% of waste polymer plastic.

7.5.3 Preparation of test specimen using foil covered plastic:-The method of preparation of the specimen for the foil covered plastic is same as the preparation of the specimen using polyethylene. The percentage of foil covered plastic was varied from 0 to 8%. The maximum stability was obtained at 2% addition of foil covered plastics. Three samples were tested for each percentage

7.5.4 Test of Specimen

Bulk density of the compacted specimen the bulk density of the sample is usually determined by weighting the sample in air and in water. It may be necessary to coat samples with paraffin before determining density. The specific gravity Gbcm of the specimen is given by

$$Gbcm = \frac{Wa}{Wa - Ww}$$

Where, Wa = weight of sample in air (g)

Ww = weight of sample in water (g)

7.5.5 Stability test

In conducting the stability test, the specimen is immersed in a bath of water at a temperature of 60° ± 1°C for a period of 30 minutes. It is then placed in the Marshall Stability testing machine and loaded at a constant rate of deformation of 5 mm per minute until failure. The total maximum in KN (that causes failure of the specimen) is taken as Marshall Stability. The stability value so obtained is corrected for volume. The total amount of deformation is units of 0.25 mm that occurs at maximum load is recorded as Flow Value. The total time between removing the specimen from the bath and completion of the test should not exceed 30 seconds.

7.5.6 Percent voids in compacted mineral aggregate (VMA)

The percent voids in mineral aggregate (VMA) is the percentage of void spaces between the granular particles in the compacted paving mixture, including the air voids and the volume occupied by the effective asphalt content

$$VMA = 100 - \frac{Gbcm\ Pta}{Gbam},$$

Where, VMA = percent voids in mineral aggregates.

Gbcm = bulk specific gravity of compacted specimen

Gbam = bulk specific gravity of aggregate.

Pta = aggregate percent by weight of total paving mixture.

7.5.7 Percent air voids in compacted mixture (Vv)

Percent air voids is the ratio (expressed as a percentage) between the volume of the air voids between the coated particles and the total volume of the mixture.

$$Vv = 100 \frac{G_{mp} - G_{bcm}}{G_{mp}}$$

Where, P_{av} = percent air voids in compacted mixture

G_{mp} = maximum specific gravity of the compacted paving mixture

G_{bcm} = bulk specific gravity of the compacted mixtures

CHAPTER 8 - EVALUATIONS AND ADJUSTMENT OF MIX DESIGN

The overall objective of the mix design is to determine an optimum blend of different components that will satisfy the requirements of the given specifications.

This mixture should have:

1. Adequate amount of asphalt to ensure a durable pavement.
2. Adequate mix stability to prevent unacceptable distortion and displacement when traffic load is applied.
3. Adequate voids in the total compacted mixture to permit a small amount of compaction when traffic load is applied without bleeding and loss of stability.
4. Adequate workability to facilitate placement of the mix without segregation.

If the mix design for the optimum binder content does not satisfy all the requirements of specifications it is necessary to adjust the original blend of aggregates. The trial mixes can be adjusted by using the following guidelines.

1. If low voids: The voids can be increased by adding more coarse aggregates.
2. If high voids: Increase the amount of mineral filler in the mix.
3. If low stability: This condition suggests low quality of aggregates. The quality of aggregates should be improved. (Use different aggregate or use cement coated aggregate)

CHAPTER 9 - RESULTS AND DISCUSSIONS

On the basis of above methodology, various aspects regarding the Polymer coated aggregates are being discussed below:

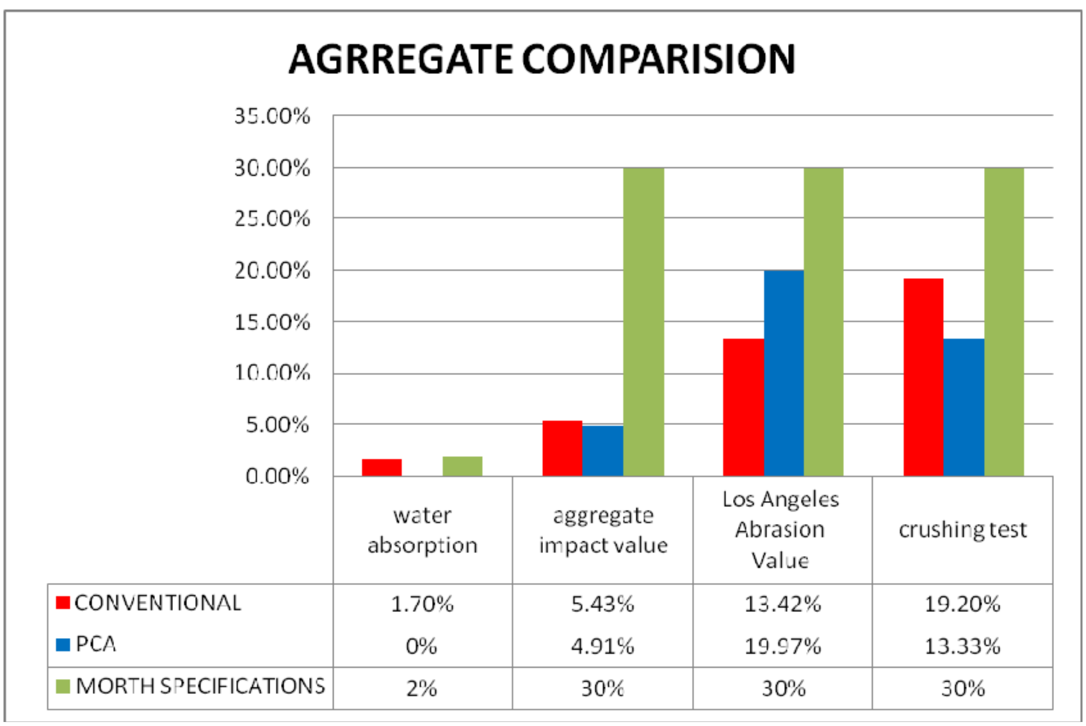
9.1 Results of tests on aggregates:

Based on the tests conducted on the aggregate and bitumen following are the results obtained. The tables are followed by the standard ranges of the respective tests.

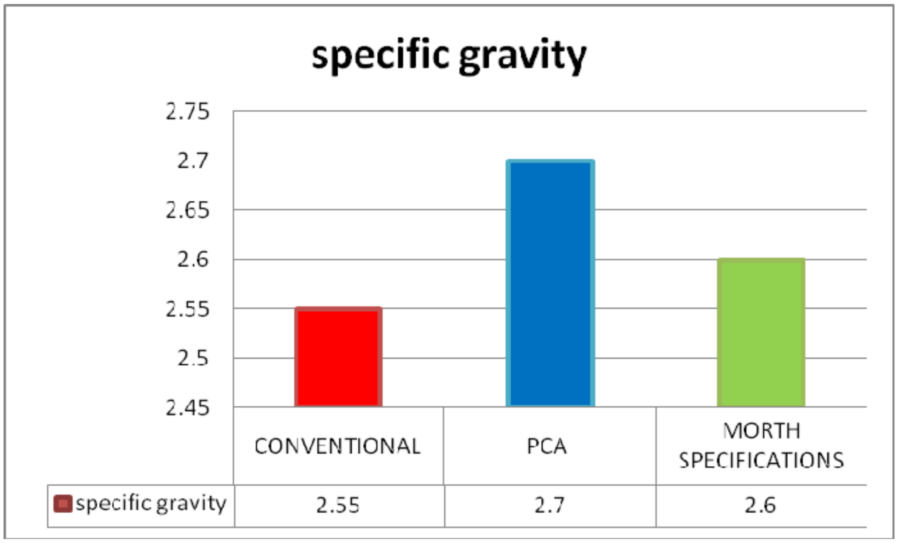
Table 3: Observation Table for Aggregates Test Results

Sl no	TEST	CONVENTIONAL	PCA	MORTH SPECIFICATIONS
1	specific gravity	2.55	2.7	2.6
2	water absorption	1.70%	0%	2%
3	aggregate impact value	5.43%	4.91%	30%
4	Los Angeles Abrasion Value	13.42%	19.97%	30%
5	crushing test	19.20%	13.33%	30%

Graph 1 (a): Representing test results on aggregate



Graph 1 (b): Representing test result on specific gravity of aggregate



9.2 Aggregate Impact Value

The coating of plastics improves Aggregate Impact Value, thus improving the quality of the aggregate. Moreover a poor quality of aggregate can be made useful by coating with polymers. It helps to improve the quality of flexible pavement. This shows that the toughness of the aggregate to face the impacts. Its range should be less than 10%.

9.3 Aggregate Crushing Value

The aggregate with lower crushing value indicate a lower crushed fraction under load and would give a longer service life to the road. Weaker aggregate would get crushed under traffic load. It is clearly seen from Table- that plastic coated aggregates shows the lower crushing value and which can be withstand to traffic load more efficiently than the plain aggregates. The results show that the aggregates are within the range according to ISS. Its range should be less than 30-35%.

9.4 Specific Gravity

The specific gravity of an aggregate is an indirect measure of its strength. The more specific gravity the more is the strength. The value of specific gravity of plain aggregate is less as compare to that of plastic coated aggregate. Since aggregates having low specific gravity are generally weaker than those with higher specific gravity values, the results say that the specific gravity of the aggregates are increased increasing its strength. Its range should be within 2.5-3.0%.

9.5 Water Absorption

The aggregate is chosen also on the basis of the moisture absorption capacity. The aggregate when coated with plastics improved its quality with respect to moisture absorption. The coating of plastic decreases the moisture absorption and helps to improve the quality of the aggregate and its performance in the flexible pavement. The results show that the moisture absorption of the aggregate is within the range of IRC specifications which reduced to nil due to coating. Its range should be less than 10%.

9.6 Los Angeles Abrasion Value

The repeated movement of the vehicle will produce some wear and tear over the surface of pavement. This test gives that wear and tear in percentage. Under this study the percentage of wear and tear values of plastic coated aggregate is found to be in decreasing order with respect to the percentage of plastics. When the Los Angeles abrasion value of plain aggregate value is compared with the plastic coated aggregates the values are less for coated aggregates. The results obtained are within the range hence can be used for the construction. Its range should be less than 35%.

9.7 Results of Tests on Bitumen

Observations for tests conducted on bitumen are given in table 4.

Table 4: Observations for Tests on Bitumen

Test	Result	Ranges
Specific Gravity	0.986	0.97 - 1.02
Penetration value	82	80-100
Softening Point	41ºC	40ºC
Ductility	75 cm	75 cm
Viscosity Test	540	-

Graph 3: Representing test results on bitumen

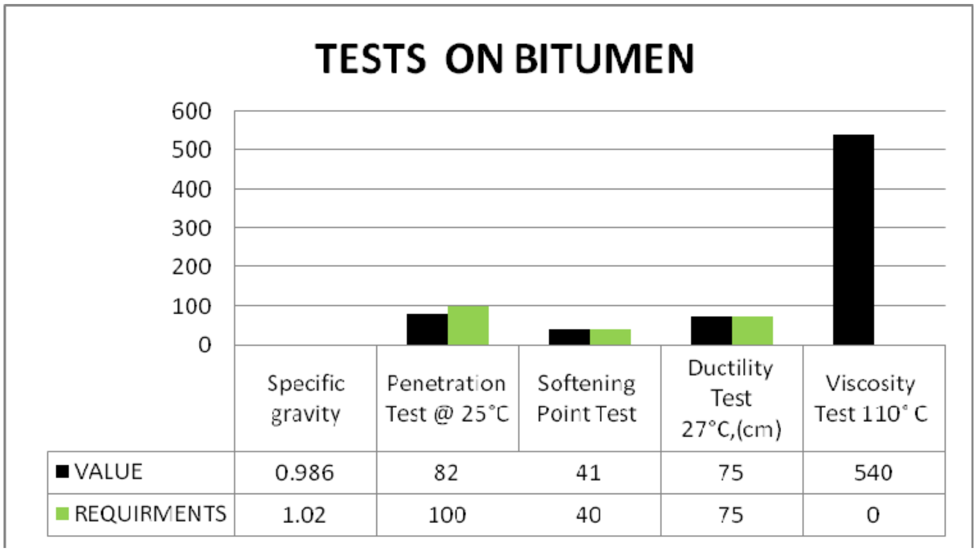


Table 5 Shows the gradation chart for aggregates

Table 5: Observation Table for gradation for aggregate

SIEVE SIZE(mm)	BLEANDING OF AGGREGATE	AGGREGATE			MORTH specification		
	35% - Aggregate- A (20-12.5)	15% - Aggregate- B (12.5-4.75)	55% - Aggregate- C (4.75mm down)	Achieved gradation			
19	87	100	100	100	100	100	100
13.2	48	100	100	89	79	100	89.5
9.5	15	6	100	76	70	88	79
4.75	0	2	100	60	53	71	62
2.36		0.9	95.6	48	42	58	50
1.18			73.7	39	34	48	41
0.6			74.6	29	26	38	32
0.3			7	19	18	28	23
0.15			1.7	13	12	20	16
0.075			10.5	6	4	10	7

Graph 4: graph representing gradation of aggregate

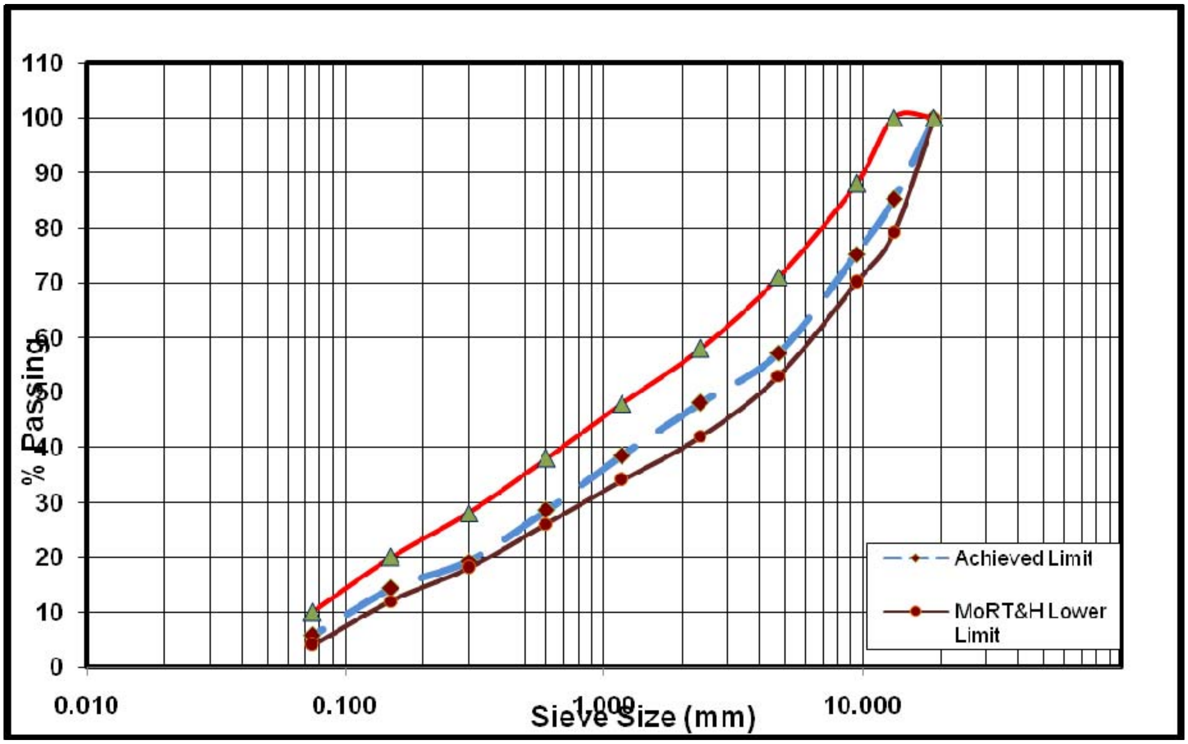
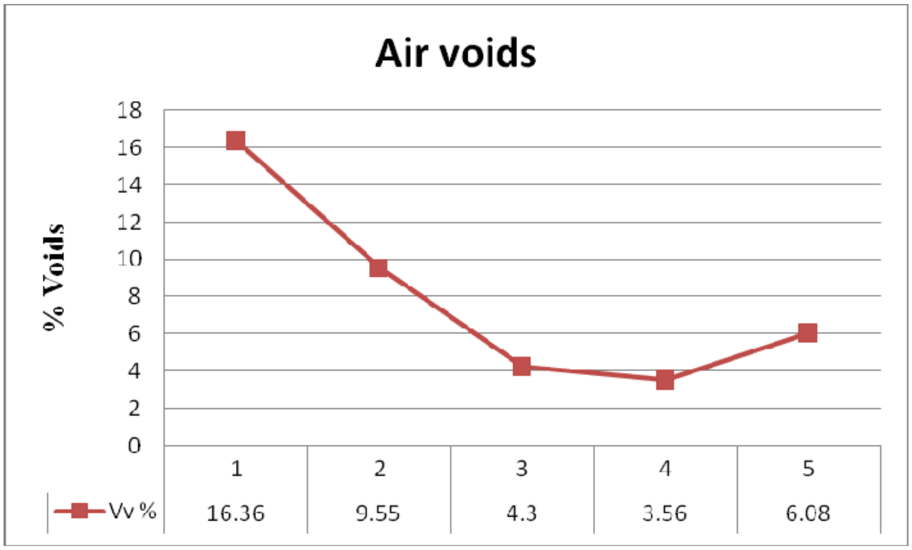


Table 6 Shows the results of marshall stability test for varying percentages of bitumen.

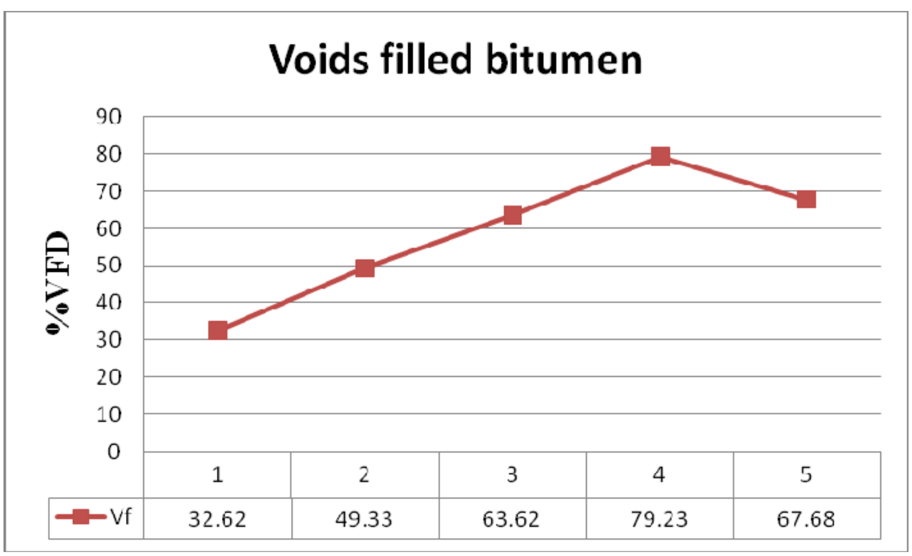
Table 6 Marshall Test results for conventional bituminous mix

SLNO	BITUMEN %	Wt in air (g)	Wt in water (g)	Vv %	VFB	V.M.A	stability	flow
1	4	1238	625	16.36	32.62	24.28	1153.7	4.13
2	4.5	1241	666	9.55	49.33	19.07	1198.2	3.98
3	5	1272	728	4.3	63.62	17.42	1280.5	3.76
4	5.5	1275	735	3.56	79.23	15.36	1355.71	3.41
5	6	1269	732	6.08	67.68	18.81	1295.4	3.88

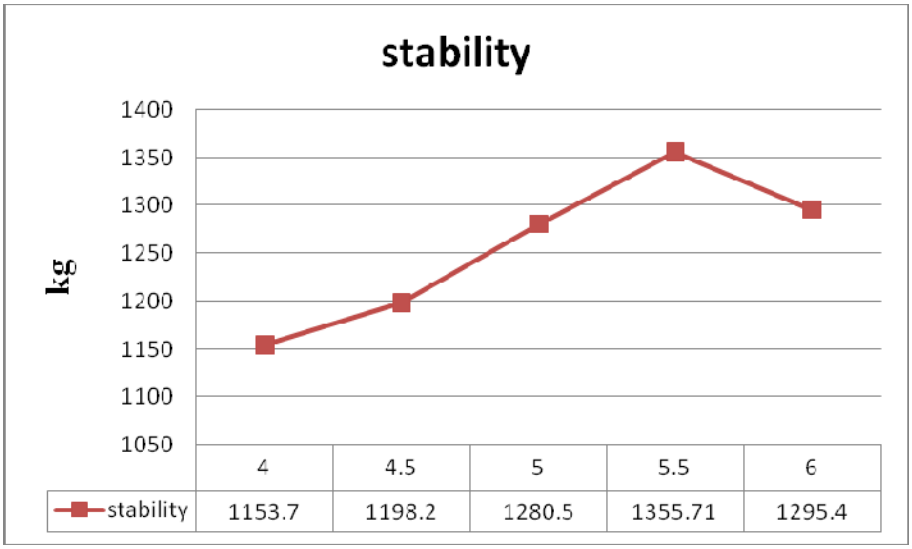
Graph 5: graph representing percentage Air voids Vs % bitumen



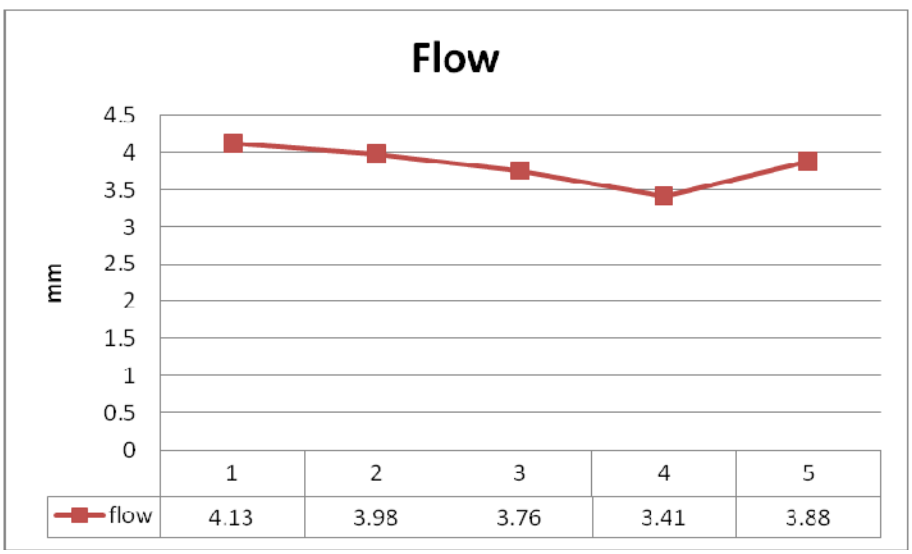
Graph 6: graph representing percentage voids filled bitumen Vs % bitumen



Graph 7: graph representing stability Vs % bitumen



Graph 8: graph representing flow Vs % bitumen

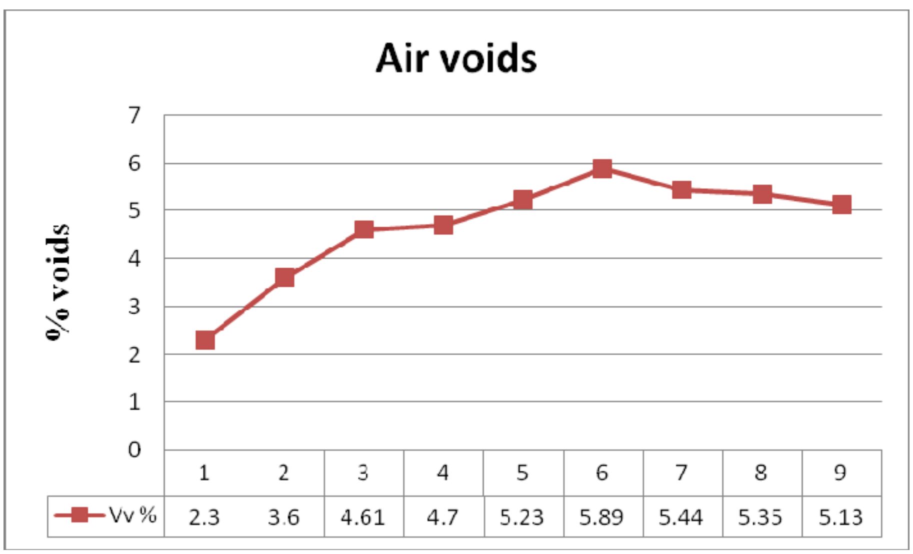


The marshal properties investigated for varying percentages of waste polymer plastic is presented in table 7

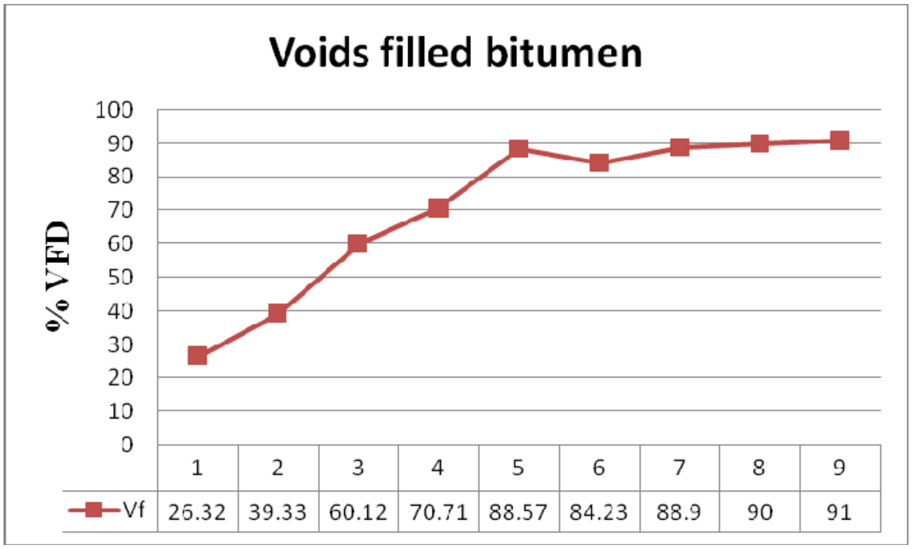
Table 7 Marshall Test results with polyethylene

SLNO	BITUMEN %	waste polymer plastic %	Wt in air (g)	Wt in water (g)	Vv %	VFB	V.M.A	stability	flow
1	5.50%	0	1256	730	2.3	26.32	10.44	1355.71	3.41
2		1	1267	734	3.6	39.33	11.75	1378.51	3.4
3		2	1278	735	4.61	60.12	11.55	1453.08	3.233
4		3	1283	742	4.7	70.71	16.03	1542.14	2.98
5		4	1292	755	5.23	88.57	12.86	1703.5	2.78
6		5	1326	753	5.89	84.23	17.08	1971.71	2.62
7		6	1348	756	5.44	88.9	16.68	1989.97	2.98
8		7	1376	760	5.35	90	16.6	2113.03	3.19
9		8	1388	765	5.13	91	16.41	2186.93	3.21

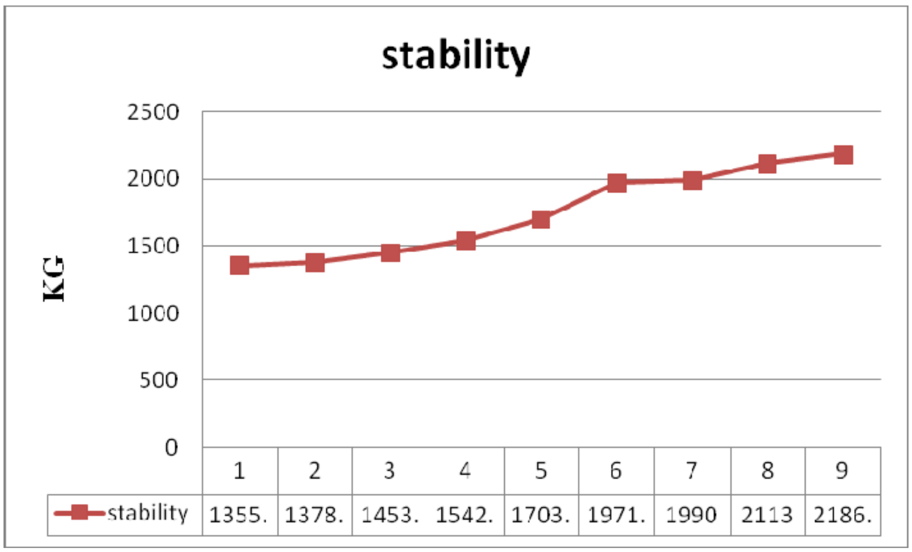
Graph 9: graph representing percentage air voids Vs % bitumen



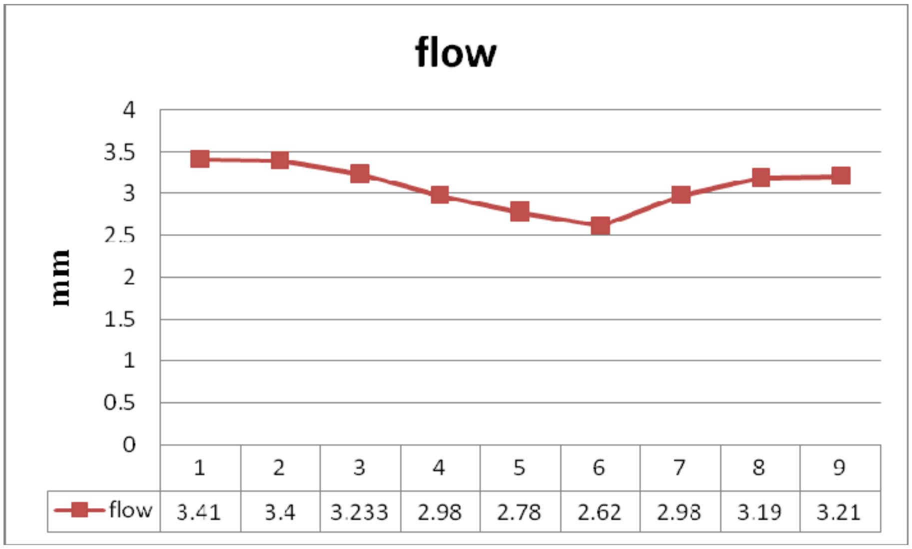
Graph 10: graph representing percentage voids filled bitumen Vs % bitumen



Graph 11: graph representing stability Vs % bitumen



Graph 12: graph representing flow Vs % bitumen

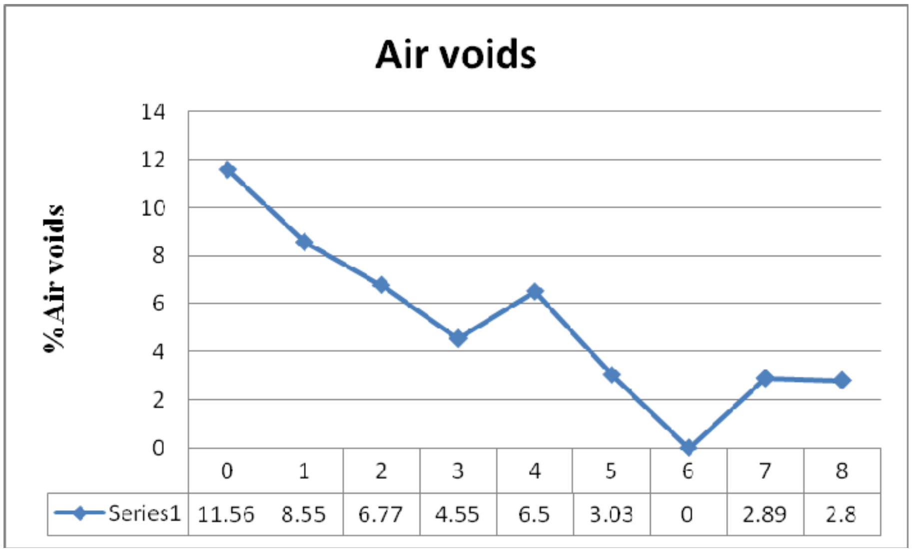


The results of marshal stability test conducted for varying percentages of foil covered plastic is presented in table 8

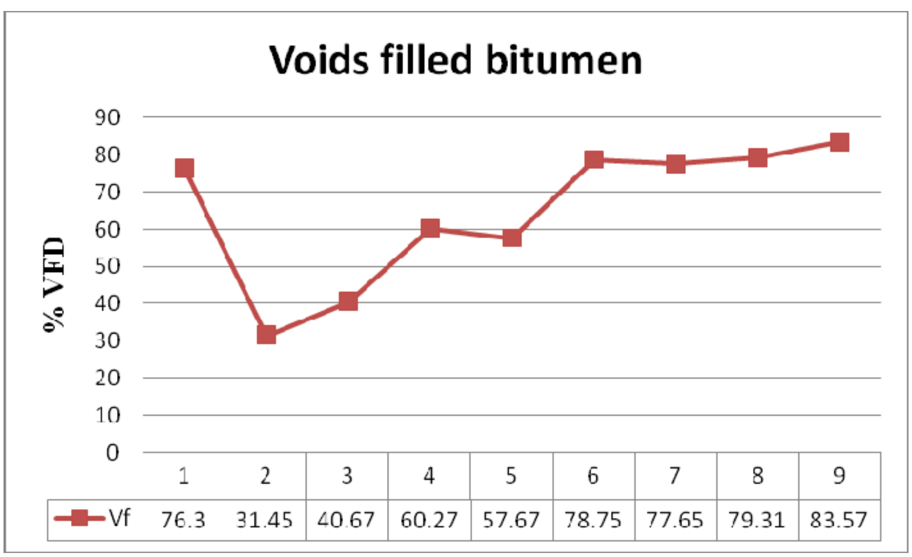
Table 8 Marshal Test results with foil covered plastic

SLNO	Bitumen%	foil covered plastic %	Wt in air (g)	Wt in water (g)	Vv %	VFB	V.M.A	stability	flow
1		0	1275	735	11.56	76.3	11.56	1355.71	3.41
2		1	1254	728	8.55	31.45	10.88	1377.65	3.28
3		2	1274	735	6.77	40.67	11.41	1399.35	3.11
4		3	1279	738	4.55	60.27	11.52	1388.6	3.03
5	5.50%	4	1282	725	6.5	57.67	15.35	1376.87	2.89
6		5	1287	739	3.03	78.75	14.23	1355.23	2.82
7		6	1286	742	3..01	77.65	13.07	1323.25	2.73
8		7	1290	747	2.89	79.31	14.2	1306.89	2.67
9		8	1300	749	2.8	83.57	14.5	1278.34	2.58

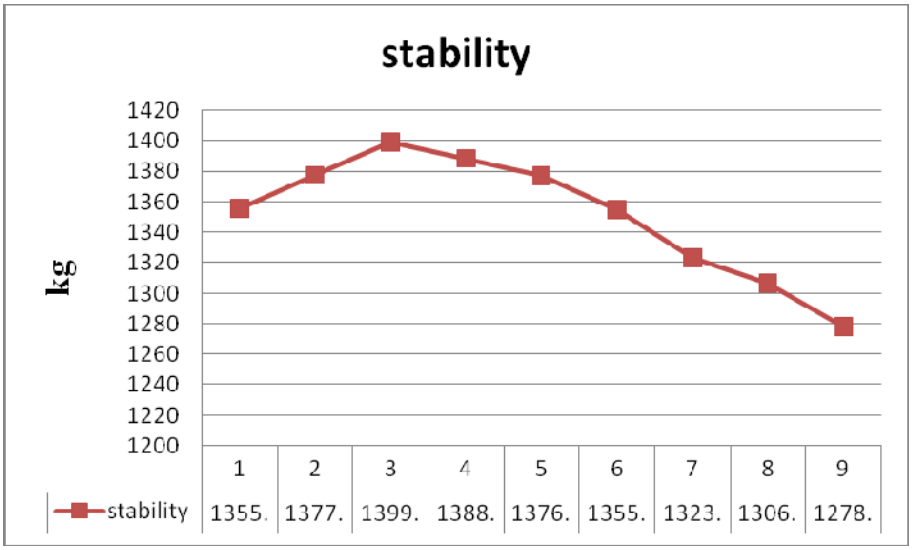
Graph 13: graph representing percentage air voids Vs % bitumen



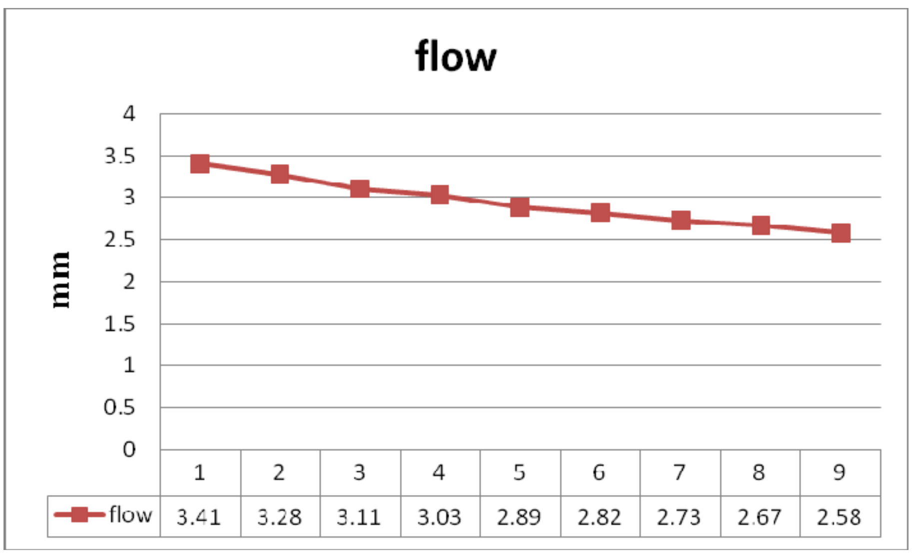
Graph 14: graph representing percentage voids filled bitumen Vs % bitumen



Graph 15: graph representing stability Vs % bitumen



Graph 16: graph representing flow Vs % bitumen



CHAPTER 10 - CONCLUSION

Plastic coating on aggregates is used for the better performance of roads. This helps to have a better binding of bitumen with plastic wasted coated aggregate due to increased bonding and increased area of contact between polymers and bitumen. The polymer coating also reduces the voids. This prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in reducing rutting, raveling and there is no pothole formation. The roads can withstand heavy traffic and show better durability.

Following are some points which are drawn from the study:

1. Aggregate Impact value of conventional aggregate was 5.43%. It reduced to 4.91% for PCA. This shows that the toughness of the aggregate was increased to face the impacts.

2. Crushing Value was reduced from 19.2% to 13.33% PCA respectively. Low aggregate crushing value indicates strong aggregates, as the crushed fraction is low.

3. Specific Gravity of the aggregate increases from 2.55 to 2.7 for PCA due to plastic coating.

4. Water Absorption is reduced to 0% for PCA from 1.7% for conventional aggregates.

6. Los Angeles Abrasion Value of the conventional aggregate was found to be 13.42%. Coating of polymer over aggregate increased abrasion value by 19.97%. This indicates the hardness of the aggregate.

7. Maximum stability value obtained for conventional mix was found to be 1355 kg. For PCA mix, maximum stability was obtained at 6% addition of polymer plastic and value was obtained as 1989 kg.

8. For Foil covered plastic maximum stability was obtained at 2% addition of polymer plastic. The value obtained was 1399kg.

In short we can conclude that, using plastic waste in mix will help reduction in need of bitumen by around 10%, increase the strength and performance of road, avoid use of anti stripping agent, avoid disposal of plastic waste by incineration and land filling and ultimately develop a technology, which is eco friendly. Increased traffic conditions will and are reducing the life span of roads. Plastic roads are means of prevention and ultimately will be the cure. It will save crores of rupees in future and reduce the amount of resources used for construction.

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