EFFECT OF WASTE PLASTIC AND CRUMB RUBBER ON PROPERTIES OF SEMI DENSE BITUMINOUS CONCRETE MIX

A PROJECT REPORT

submitted in partial fulfillment of the requirements for the award of the

Degree

of

BACHELOR OF TECHNOLOGY
IN
CIVIL ENGINEERING

Under the supervision of

Dr. Tanmay Gupta

Assistant Professor (Grade-II)

by

Pranav Gupta (161659)

Vivek Kashyap 161664)

To

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY
WAKNAGHAT, SOLAN – 173234
HIMACHAL PRADESH, INDIA
May – 2020

STUDENTS' DECLARATION

We hereby declare that the work presented in the project report entitled **"Effect of waste plastic and crumb rubber on properties of Semi Dense Bituminous Concrete mix"** submitted in partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of our work carried out under the supervision of **Dr. Tanmay Gupta.** This work has not been submitted elsewhere for the reward of any other degree/diploma. We are fully responsible for the contents of this project report.

Pranav Gupta
161659

Vivek Kashyap
161664

Department of Civil Engineering
Jaypee University of Information Technology,
Waknaghat, India
May 2020

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Effect of waste plastic and crumb rubber on properties of Semi Dense Bituminous Concrete mix"** submitted in partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology,Waknaghat** is an authentic record of work carried out by **Pranav Gupta (161659)& Vivek Kashyap (161664)** under the supervision of **Dr. Tanmay Gupta, Assistant Professor (Grade-II),**Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.
Date: 29 May 2020

Dr. Tanmay Gupta **Assistant Professor**	**Dr. Ashok Kumar Gupta** **Professor and HOD**	**Sign of External Examiner**
Civil Engineer Department	Civil Engineer Department	
JUIT,Waknaghat	JUIT,Waknaghat	

ACKNOWLEDGEMENT

This project report gives a detailed description of the study work done on the project topic "**Effect of waste plastic and crumb rubber on properties of Semi Dense Bituminous Concrete mix**" for the partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering, under the supervision of Dr. Tanmay Gupta.

We gratefully acknowledge the Management and Administration of Jaypee University of Information Technology, Waknaghat for providing us the opportunity and hence the environment to initiate and complete our project now.

We are very grateful to our Faculty Coordinator Mr. Tanmay Gupta for his help and able guidance regarding the project. We are also very grateful to the support and assistance provided by the team of talented and dedicated technical staff comprising Mr. Jaswinder Singh of department of Civil engineering.

PRANAV GUPTA (161659)

VIVEK KASHYAP (161664)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviations	Full form
CRMB	Crumb rubber modified bitumen
LDPE	Low density polyethylene
VG	Viscosity Grade
VFB	Voids filled with bitumen
VMA	Voids in mineral aggregates

ABSTRACT

Plastic is used in day to day life. So it's a well-known thing that more waste would be generated through plastic. It is discarded either by burning or by burying it in the soil. Due to the non-biodegradability of the plastic its not easy to get rid of it through natural processes prevailing in the environment. So one way in which plastic could be reused is by using it in pavement. An effort of using waste plastic in coating the aggregates is being engrossed in this study. Crumb rubber made from waste tires is also used in this study to modify the bitumen. Earlier studies have proven plastic and crumb rubber effective in increasing the strengths of pavements. So taking this idea plastic coating is done in the aggregates and bitumen is modified with crumb rubber to check the results.

The low density plastic is taken in use. Temperature varying between 120℃ - 160℃ gives the softening point of the plastics being used. They do not produce any toxic gases during heating but they get often edandlaminate the aggregates.

The study focuses on using different percentages of plastic in coating aggregates and different percentages of crumb rubber & study their behaviour. The bitumen VG-30 is used as a binder in the mix.The performance tests including, Marshall Stability tests are to be conducted to find stability, density, optimum binder content and voids. The first phase of investigation focuses in the next study CRUMB RUBBER Modified Bitumen will be used in place of normal VG-30 bitumen.

Further conclusion will be taken out to see the increase in strength of aggregates after coating them with plastic as this can be an efficient way out to use low quality aggregates where desired one are unavailable. Bitumen modified with crumb rubber will be checked for its new properties and check how much replacement is conceivable.

Keywords: - Marshall Stability, crumb rubber, semi dense bituminous mix, low density polyethene.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Generally during rainy days the roads gets deteriorated due to penetration of water in the voids which cause discomfort to people and damage to vehicles. Many accidents are caused by the potholes which usually go wide and deep till the end of rainy season. In our country this is prevailing from many years. Many people lose their life due to such conditions of the roads and have become one of the concerns of Indian people. Road defects can be reduced by using plastic coated aggregate and crumb rubber modified bitumen.

Recent studies have shown that the life span of the roads can be increased by adding plastic in the mix. The aggregates when coated with plastic can improve their properties and sometimes when proper quality aggregates are not available during construction the aggregates can be coated to use the poor quality aggregates. The bitumen when modified by adding crumb rubber has shown improvement in the properties of bitumen which are effective to keep a road safe during rains. The present study is on the combined effect of plastic coated aggregates and crumb rubber modified bitumen. This waste plastic partially replaced the conventional material to improve desired mechanical characteristics for particular road mix.

1.2 SDBC

Semi Dense Bituminous Concrete is a wearing course generally laid in single layer. It is used in rural roads where the traffic density is very less and it is porous because of voids in them. Bitumen used in this layer are VG-30, 40. The bitumen is modified with CRMB and coated aggregates with LDPE. Further few changes were seen in the properties.

Fig 1.1 Construction of SDBC pavement

1.3 PLASTIC

The menace of plastic will not be eradicated until the obvious steps are not implied at the zero level. The main concern is the abuse of plastic. People carelessly throw the plastic after they use it. The polyethylene is taken into the use in this study. Polythene is commonly used in life. The vegetables, fruits or peanuts etc. from shops are given in polythene. After taking out the items from it, plastic is thrown carelessly without even worrying about its aftermath. Polythene that clogs the drain and that causes the water to get stagnant in drain which leads to breeding of mosquitos and all sorts of things not good for our health are caused due to our negligence. Thus our study aims to use them in the pavement design and then see that polythene menace can be reduced to a certain level or not?

Fig 1.2 Plastic

Fig 1.3 Crumb Rubber

1.4 CRUMB RUBBER

Crumb rubber is recycled rubber produced from automotive and truck scrap. Tires are often used and they are worn out thus get collected in scrap in large volume. Accumulation of such a huge amount of scrap can generate huge amount of toxic and chemical which are undesirable and are a threat to environment. In order to eliminate their ill effects recycling is important so that they can be used where their applications are in benefit of environment. From many years a lot of work in done in civil engineering by using this waste. Crumb rubber so made helps control deformation under high pavement temperature and when the load is quite heavy. It increases the life of a pavement under repeated loading. It helps in reduction of maintenance cost and also reduces the percentage of bitumen used. The property of the bitumen gets improved when the proper percentage of crumb rubber is added in bitumen. The rubber modified bitumen can also be helpful in reducing the cracks that arise beneath the surface. As it stops the cracks formation to a certain level, this helps us in keeping check on the capital invested in maintenance of roads. The lifespan of the roads increases even after daily use for a long period of time. Thus this works like an anti-aging effect for the pavement.

1.5 Scope of Thesis

The effect of CRMB and LDPE is to be studied as these are the modifiers which are available easily and are inexpensive. They both as waste are to be put somewhere where they can be used effectively. The study is for semi dense bituminous concrete mix. This type of mix is usually layered in less traffic area for instance a village road. As we know the quality of the roads in our country gets affected badly during the rainy seasons which cause people with discomfort and even cause damage to the vehicles. The study is focusing on improving the quality of the pavement by keeping costs in mind. Water goes in the pavement which deteriorates it, but increasing the ductility and reducing the penetration of bitumen will be useful to stop all the problems. Thus, adding CRMB in the bitumen becomes beneficial to achieve this. So, adding CRMB in bitumen to increase its durability and coating aggregates with LDPE may become beneficial in stopping water and other factors to deteriorate the pavement and increase the life span of the roads and also recycling the wastes of plastic and tyres.

1.6 Organization of Thesis

This study shows how waste materials can be used effectively without affecting our environment. The organization of the thesis is as follows.

Chapter 2 discusses about various research paper study related to our investigation. It is focusing on reviewing other related studies, and shows how our work is different from other works

Chapter 3 provides a description of various materials and method used to complete this report. This includes basic test on material used like bitumen, aggregates, CRMB, LDPE and Marshal Stability tests for modified and unmodified samples.

Chapter 4 shows the result and analysis of various tests with the help of graphs. The variation with different percentages of material is shown. Optimum bitumen, CRMB, LDPE content is drawn here.

Chapter 5 describes the conclusion drawn from all tests and their ability and competency of using CRMB and LDPE in future projects.

CHAPTER 2

LITERTAURE REVIEW

2.1 INTRODUCTION

Subgrade is an inside material on which pavement is constructed. Pavement may be flexible, rigid and composite. Subgrade should have a wide area for the distribution of load. A flexible pavement has a layer of mixture of aggregates and bitumen. The aggregates and bitumen are heated, mixed and compacted. Flexible pavement has surface course, base course, sub-base course and subgrade. Composite pavement are those which utilizes both asphalt and concrete. Load is transferred grain to grain in ground in flexible pavement whereas in rigid pavement load is transferred through beam. As everyone know the condition of Indian Roads and especially in rainy season. Aftermath is also bad because there are potholes and all types of road defects that prevail. So it is tried to make bitumen and aggregates more safe towards this wearing caused during different seasons of India.

This project contains the normal as well as different percentages of waste materials that can bring changes in the SDBC layer of flexible pavement. CRMB and LDPE are used here. The test comprises of 9 combinations of LDPE and CRMB and has to compare results with the bitumen and aggregates give. So linear approach is being followed to deal with comparisons and combinations among bitumen and aggregates.

2.2 REVIEWS

V. Suganpriya S. Omprakash V. Chandralega [2012]

The objective of this study is to use the waste crumb rubber effectively in highway construction in safer manner. From various tests optimum crumb rubber content is selected for further testing it in semi dense bituminous concrete mix. The results in the study shows that modified bitumen gives better results as compared to nominal mix. It leads to better binding between bitumen aggregates. It is also seen that Marshal Stability value is also increasing with increase in crumb rubber content. Hence giving better results,durability and strength to pavement. Upto a limit of 12% crumb rubber is added, after that mixing of bitumen and aggregate is not seen leading to segregation of the mix.

After getting the results of Marshal Stability test it is seen that the sample with modified bitumen is able to resist deformation in better way as compared to nominal sample. Air voids are reduced to some extent which resist water to come inside pavement. Thus preventing potholes formation. Air voids percentage is decreased by 20.75 %. Out of all the percentages of crumb rubber, 6% is found suitable for mix. VMA (Voids in mineral aggregates) is decreased by 5.34 % and VFB (voids filled with bitumen) is increased by 5.72 %.Density of Sdbc mix is also increased by 1.03 %.

SS. Asadi, T. NagaSeshuBabu, B. Harish Kumar, M. Sumanth, G. Sumanth Kumar, S. Harsha vardhan, P. Khasim khan [2013]

In this paper waste tyre rubber are used to improve the binding property between bitumen and aggregate, which is used for constructing a pavement. It is seen that new tyre have better properties than waste tyre but it is not economical as well. Here 10 % crumb rubber passing 600 microns sieve is taken by total weight of bitumen. Crumb rubber is taken as a replacement for bitumen.

Resistance to rutting can be improved by using crumb rubber in pavement. Also making the pavement durable as different test values are enhanced when comparing with

nominal samples. 10% of crumb rubber in bitumen content is considered best for the usage.

Rokade [2013]

In this paper aggregates are coated with plastic. Coating the aggregate with plastic increases the area of contact which will lead to bind the bitumen with aggregates. The voids present in aggregate are also covered by coating. Thus, voids are reduced and also prevent water to go into aggregates.

Coating plastic aggregate would also resist the heavy traffic load and are more durable as compared to normal mixture. Using the waste plastic in such a way will lead a positive impact on environment and also cleans the plastic from landfills and surroundings. This would add value to plastic and as a new invention or technology.

On adding the LDPE and CRMB in bitumen mix, it is seen that Marshal Stability is increased by 25% and other values like VMA, Vv and VFB is also increased. Density of mix is also increased. Water adsorption is reduced and stability, durability is increased in comparative to nominal mix.

Anusha G Krishna [2013]

In this study plastic and crumb rubber are used as a replacement agent for bitumen. This would improve various properties of bituminous mix as compared to normal mix. Both CRMB and LDPE are used simultaneously to know which gives better result. Hence comparison is made for both the materials to modify bitumen for highway construcion giving strength and durability.

Marshal Stability Test is done for various percentages of bitumen by weight of aggregate. Out of these 5% bitumen is considered as optimum bitumen content. After this 5% bitumen content is made constant and different percentages of crumb rubber is added. According to this study marshal stability value of 1963 kg at the rate of 2% LDPE is seen maximum among all. Here LDPE is considered as a best modifier than crumb

rubber. Hence it is concluded from the report that 2% LDPE content by weight of bitumen can give better result.

Rishi Singh Chhabra, Supriya Marik [2013]

Using waste plastic and waste tyre rubber in highway construction gives effective result than nominal mix as better binding property between plastic and tyre waste is seen. Using these material, the contact area in aggregate is increased which binds the mixture properly. The voids present in the mix is reduced which also helps in increasing the bonding strength. Water absorption is also reduced as the voids are also reduced.

Hence, the roads can bear heavy traffic, by making them more durable. The waste tyres can also be used as well sized aggregates in the bitumen mixes if it is identical to the form and shape of aggregate by cutting and can be used as rubber aggregate. This not only decreases the pollution occurred due to waste tires but also reduces the use of stone aggregate which is also decreasing day by day. Rutting of pavement, thermal cracking and deformation in pavement are reduced in hot plane region. Rubber absorbs sound and this also help in reducing the noise pollution coming from wheels in the roads. Waste rubber tires thus can be used as it enhances the quality, maintenance and performance of road. Range between 5 to 20% of optimum content of waste rubber tires is used. Cushioning effect which manages the load perfectly is also seen in case of rubber mix. Flexibility of road is also increased with addition of rubber.

Minakshi Singhal,Yudhvir Yadav,Ranadip Mandal [2015]

The polymer modified bitumen mix is considered to be a better binder as compared to conventional bitumen. The mix increases Softening Point and decreases Penetration Value. When polymer modified bitumen is used for road construction it can bear higher temperature. Hence it is suitable for hot regions. As Penetration Value is reduced, its load carrying capacity is increased. From the study it is seen that Marshall Stability Value is increasing. The bitumen content can be replaced depending upon the % of

polymer added. No harmful gas and pollution is produced. Disposal of waste plastic now can be done in safer and useful manner. The binding property of polymer also provides strength to road. The use of waste plastics on the road helps to provide better place for disposing off the plastic waste without causing pollution. The plastic coated aggregate reduces the porosity, water absorption and improves soundness. The coated aggregate bitumen mix gives better result for constructing flexible pavement as the mix shows increase in Marshall Stability value. The insertion of waste plastic modifies bitumen properties. When comparing the conventional results the modified bitumen shows better result. The optimum content of waste plastic used in this report is within the range of 5 to 10%. Bleeding problem is also resolved in hot temperature region to some extent. Plastic help in reducing the noise pollution of heavy traffic to some extent as plastic has property of absorbing sound. The waste plastics thus can be used to improve the quality and performance of road. Total cost of the project is also reduced by 7.99% in this report.

YashMenaria, RupalSankhla [2015]

In this study use of the plastic in flexible pavements to increase strength an stability and to reduce the construction cost. The low-density plastic softens at 160 ^{0}C and then aggregates were coated. 8% plastic is good to replace 0.4% bitumen by weight. Use of waste plastic improves the properties of mix. The properties of the bitumen being modified showed considerable improvements. The penetration tests and softening point went up. Even plastic roads can be made in areas with temperature as high as 50^{0}C. The whole procedure is not bad for environment and waste plastic can be utilized. Thus, replacement of binder with plastic will help reducing cost of projects.

Amit gawande, G Zamare, VC Renge, SaurabhTayde, G. Bharsakale [2016]

In this paper aggregates are coated with dry and wet process. The properties of the aggregates were improved. In dense bituminous macadam there was 250 % increase in the marshal stability. Triaxial tests were conducted by varying the percentages of plastic and bitumen by weight of aggregates. 10% plastic by weight of bitumen is best for

improvement. The triaxial test also showed the improvement in cohesion property and showed an increase in shear strength. When plastic is added in bitumen by 5-10% by weight of bitumen the stability and strength are increased. Even the process is not harming biosphere. It will actually help in reducing the waste plastics from creating a menace.

Miss Apurva J Chavan [2016]

In this paper aggregates are coated with plastic basically with low density one. The shredded plastic was added in desired percentages to coat the aggregates. Experiments like absorption test, specific gravity test, impact value test, Los Angeles abrasion test, stripping value test were conducted. All were as expected optimistic. Even the adhesive bond between aggregates improve after coating them. The aggregates impact value went down by 10% which means the toughness was improved. Low crushing value indicates the strength of aggregates which was also shown when experiments were conducted. The specific gravity also increased which meant that coated aggregates have an advantage over uncoated. Stripping value also went down meaning that coated ones are more rugged. The water absorption also reduced down which was obvious because plastic doesn't allow water to come in. Los Angeles abrasion value also showed that the hardness was increased.

Alfroz Sultana, SK, KSB Prasad [2015]

In this paper use of plastic as a modifier is studied. If low density plastic, high density plastic in different ratios is used, good results can be obtained. Rheological tests were conducted to see the changes made by plastic in the asphalt. So simple mix and modified mix were taken into consideration. Further by coating aggregates with plastic lead to better quality of aggregates. This means low quality aggregates when coated with plastic will show an improvement. This can be helpful where proper size of aggregates cannot be made available. Adding plastic to normal or unmodified bitumen will improve some of the properties of bitumen. There is increase in softening point and considerable reduction in penetration and values of ductility. Thus, by increasing plastic

binder can be replaced and also reduce the costs of construction. Finally, it shows that flexible pavements show better results than rigid to these modifiers.

2.3 SUMMARY

In general, binder (bitumen) and aggregates are the important materials which are required for performing various tests. In today's world, modification of bitumen or different substitutes to replace bitumen partially or fully was presented and pavement properties are enhanced. This research is focusing on effectively using waste materials in highway construction. In this project, crumb rubber and plastic is used. Crumb rubber is used as a replacing agent of bitumen and aggregates are plastic coated. Crumb rubber is still used in many countries as a substitute of bitumen and even codes are also there to use crumb rubber. After going through various research papers replacement of bitumen with crumb rubber is beneficial for construction of road.

2.4 OBJECTIVES

The primary motive of this project is to study the strength, optimum bitumen content and voids percentages in the SDBC mix. To achieve the motives, following objectives have been set:-

1. Conducting normal experiments on aggregates and bitumen.
2. Performing the Marshall test using normal aggregates and normal bitumen so that later results can be compared.
3. Shredding plastic of size 3-4.5mm low and adding it to coat the aggregates & comparing these coated aggregates results with the normal ones.
4. Adding crumb rubber in the bitumen and comparing with the normal bitumen.
5. Performing Marshall test with modifications both in aggregates and bitumen respectively.

CHAPTER 3

METHODS AND MATERIALS

3.1GENERAL

Present investigation is divided into four phases:

- Determination of properties of VG-30 bitumen
- Determination of properties of plastic coated aggregates with normal bitumen
- Determination of properties of plastic coated aggregates with partially replaced bitumen with crumb rubber.
- Determination of optimum percentage of crumb rubber bitumen required with the plastic coated aggregates.

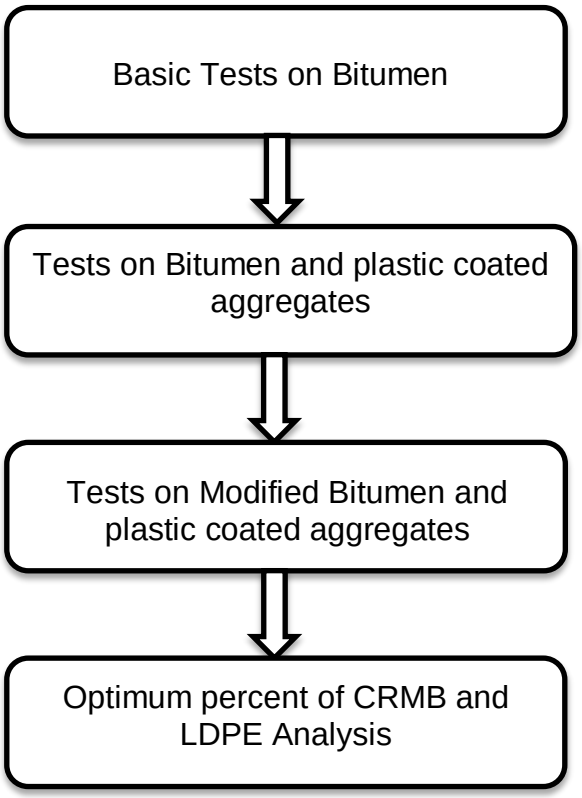


Fig 3.1 Work approach

3.1.1 Work Plan

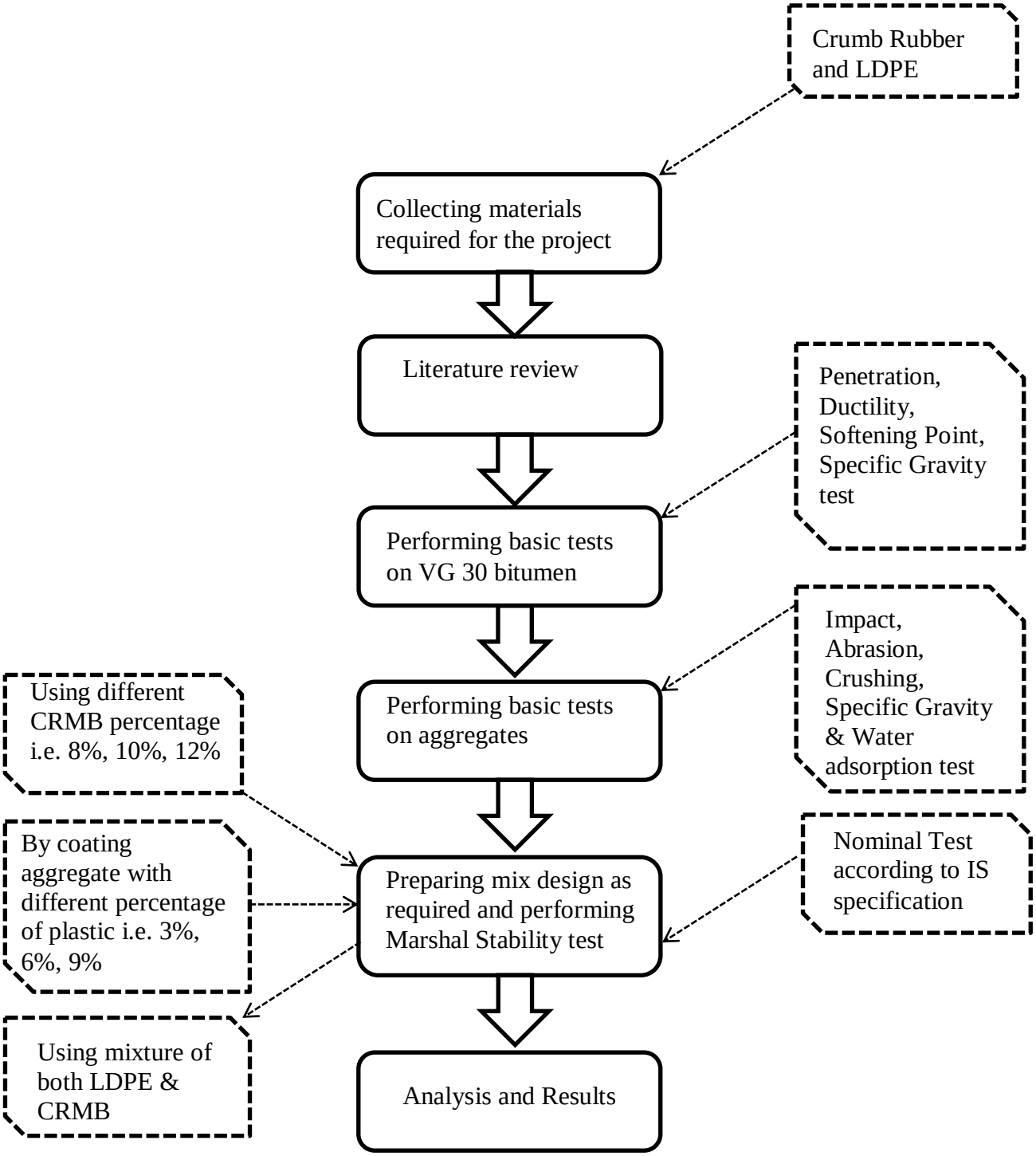


Fig 3.2 Flow chart of work plan

3.2 MATERIAL PROPERTIES

3.2.1 AGGREGATES

Aggregate plays an important role in the construction of pavement. Aggregates main motive is to absorb and transfer the live load from road to ground. Hence, it is important to know different qualities and features of the aggregate. They should resist abrasive action of load coming from wheels. Different types and grades of aggregates are used to make bituminous pavement. To know different properties of the aggregates, following tests are performed in the lab

- Crushing test
- Los angeles abrasion test
- Impact test
- Shape test
- Soundness test
- Specific gravity & water absorption test

3.2.2. BITUMEN

From the fractional distillation of crude petroleum bitumen is obtained. It is a black viscous mix comprising hydrocarbons obtained as residue from petroleum distillation or naturally obtained in liquid, solid semi solid and in gaseous form and can be dissolved in carbon tetrachloride and carbon disulfides. It is commonly used for paving road and roofing. It is used in the road pavement due to its better binding quality and water resisting property. Type of bituminous construction depends upon the different characteristic properties of the bitumen to be used. There are different bitumen grades

according to their viscosity grade. Here bitumen of Viscosity Grade 30 is used in the tests. To find various bitumen properties, following tests are performed -

- Softening Point Test
- Penetration Test
- Ductility Test
- Specific Gravity Test

3.3 TESTS ON AGGREGATES

3.3.1 AGGREGATES CRUSHING TEST

The test is executed according to IS 2386 Part 4. It is defined as the percentage by weight of aggregates (crushed) when submitted to specific load. The test is practiced so as to achieve the resistance value of aggregates when subjected to loads. The result from this test describes aggregates quality. Low Crushing Value is recommended for construction of road as it is durable and provides long life to the pavement. Aggregates which pass through 12.5mm sieve and left over 10mm sieve are taken. Then aggregates are put down in a crushing mould with 115mm diameter and 180mm length in about three coverings and every single covering is tamped. The aggregates are tamped 25 times with the help of tamping rod. Afterwards the aggregate sample is put into test cylinder and tampered again in three coverings or layers. Then the load of 40 tons is applied to the sample at the rate of 4 tons per minute by universal testing machine (compressing machine). Then the crushed aggregate is passed through sieve of 2.36mm and its weight is noted. The result is shown in Annexure A.

$$\text{Aggregates Crushing Value} = \frac{W_1}{W_2} \times 100$$

Where,

W_1=Weight of aggregates passing through 2.36 mm sieve

W_2 =Weight of Aggregates used in total

Figure 3.3- **(a)** Sample under Universal testing machine **(b)** Readings of UTM **(c)** Sample after testing

3.3.2 LOS ANGELES ABRASION TEST

The test is executed according to IS 2386 Part 4. LA test is done to measure the aggregate's hardness value. The main motive of the test is to know the amount of wear and tear due to rubbing and striking of aggregates and steel balls. Here steel balls are used as an abrasive charge. The test consists of a cylinder which is hollow from inside with 70cm diameter and length 50 cm and is arranged to rotate about horizontal axis. Steel balls comprises of 46-48mm diameter and weight of about 340-445g. This abrasive charge is set in the cylinder along with the aggregates. Steel balls are taken depending upon the grade pf aggregate being used. Generally 5 to 10 kg of aggregates are used in this test.

The abrasion cylinder is then closed with the help of steel plate and screws and then rotated for about 500-1000 rotations according to the aggregate grading at the speed of 30-33 rpm. After completing the rotations, aggregates are taken out and passed through

1.7mm sieve. The proportion of aggregates passed from sieve is indicated in percentage and called Los Angeles Abrasion Value.

Table 3.1: Abrasive Charge

Grading	No. of steel balls	Weight of charge in gm
A	12	5000±25
B	11	4584±25
C	8	3330±20
D	6	2500±15
E	12	5000±25
F	12	5000±25
G	12	5000±25

Table 3.2: Grading of Aggregates for Test Samples

Sieve size (square hole)	Weight of test sample in gm							
Passing (mm)	Retained on (mm)	A	B	C	D	E	F	G
80	63					2500*		
63	50					2500*		
50	40					5000*	5000*	
40	25	1250					5000*	5000*
25	20	1250						5000*
20	12.5	1250	2500					
12.5	10	1250	2500					
10	6.3			2500				
6.3	4.75			2500				
4.75	2.30				5000			

Los angelesAbrasionvalue = $\frac{W_1}{W_2} \times 100$

Where,

W_1= Weight of aggregates passing through 1.7 mm sieve

W_2= Weight of Aggregates used in total

Figure 3.4 Los Angeles Abrasion apparatus

3.3.3. IMPACT TEST

Test goes as per IS code 2386 part IV. The test tells us about the extent to which an aggregate can resist to a striking. The one passing through 12.5 mm and retaining on 10 mm sieve are to be used. Then fill them in cup in III layers and tamping XXV times with tamping rod. The dimension of cup is 10.2 cm and a height 5 cm is joined with the testing machine. The gavel weighing 14 kg is dropped from 38 cm height for 15 times. Aggregates are then passed through 2.36 mm size sieve. At last ratio of passed aggregate to total aggregate is taken which is known as Aggregate Impact Value.

Impact value = $\frac{W_1}{W_2} \times 100$

Where,

W_1= Weight of aggregates passing through 1.7 mm sieve

W_2= Weight of Aggregates used in total

(a) (b) (c)

Figure 3.5- **(a)** Sieving of aggregates **(b)** Free fall **(c)** Weighing sample after testing

3.3.4 SOUNDNESS TEST

Test goes in accordance with IS code 2386 part V. This test is performed to check resistance of mineral aggregates to natural weathering action. Aggregates breaks easily due to regular heating and freezing cycles. This test includes submerging sodium sulfate solution for 16 hours to 18 hours & then oven drying at 106^0 C. The loss in weight of aggregates in seen in % by passing from a particular sieve. The loss of aggregates weight should not go beyond 12 % and 18%.

Soundness value = $\frac{W_1}{W_2} \times 100$

W_1=Loss in weight subsequently five cycles

W_2= Weight of Aggregates used in total

3.3.5 SHAPE TEST

This test is done in accordance with IS code 2386-part I. It is done to evaluate the % of flaky and elongated mineral aggregates in the sample. This is so because such aggregates are not considered fir and lack reliability, workability and stability.

3.3.5.1 FLAKINESS INDEX

Flakiness index is mentioned as % by weight of aggregates who have minimum dimension as less than 60% of the mean dimension. This test is not appropriate for aggregates whose size is less than 6.3 mm. The aggregates are then made to pass from the sieves of different sizes. The % of aggregates within specific size limitation which pass through the slots of thickness gauge is Flakiness index.

Flakiness Index= $\frac{W_1}{W_2} \times 100$

Where,

W_1= weight of aggregates passing through the gaps of thickness gauge

W_2= Weight of Aggregates used in total

Figure 3.6 Flakiness Gauge

3.3.5.2 ELONGATION INDEX

The % by weight of particles whose biggest dim is 1.8 X greater than the average size of particles. Above test is not appropriate to small size aggregates i.e. 6.3mm. The aggregates are segregated into different size according to sieves. The % of aggregates of set size range that pass-through length gauge slot are seen and is referred to as elongation index.

$$\text{Elongation Index} = \frac{W_1}{W_2} \times 100$$

W_1= weight of aggregates passing through the gaps of the length gauge

$W_{2=}$ Weight of Aggregates used in total

Figure 3.7 Elongation Gauge

3.3.6. SPECIFIC GRAVITY AND ABSORPTION TEST

This test goes in accordance with IS code 2386 part III. Specific Gravity gives us information about strength of aggregate and water absorption tells us about how much an aggregate is porous. II kgs aggregates are put in the netted basket, then submerged in water tank for 24 hours. Then weight is measured in the water tank itself without taking it out. The aggregate's surface is dried and then weighed again. Next step is oven drying for 1 day at 110^{o} C. After this take the weight. Ratio of weight of aggregate to weight of an equal volume is specific gravity. Water absorption is taken by dividing the weight of water absorbed to the weight of oven dried aggregates.

Water Absorption= $\frac{W_3 - W_4}{W_4} \times 100$

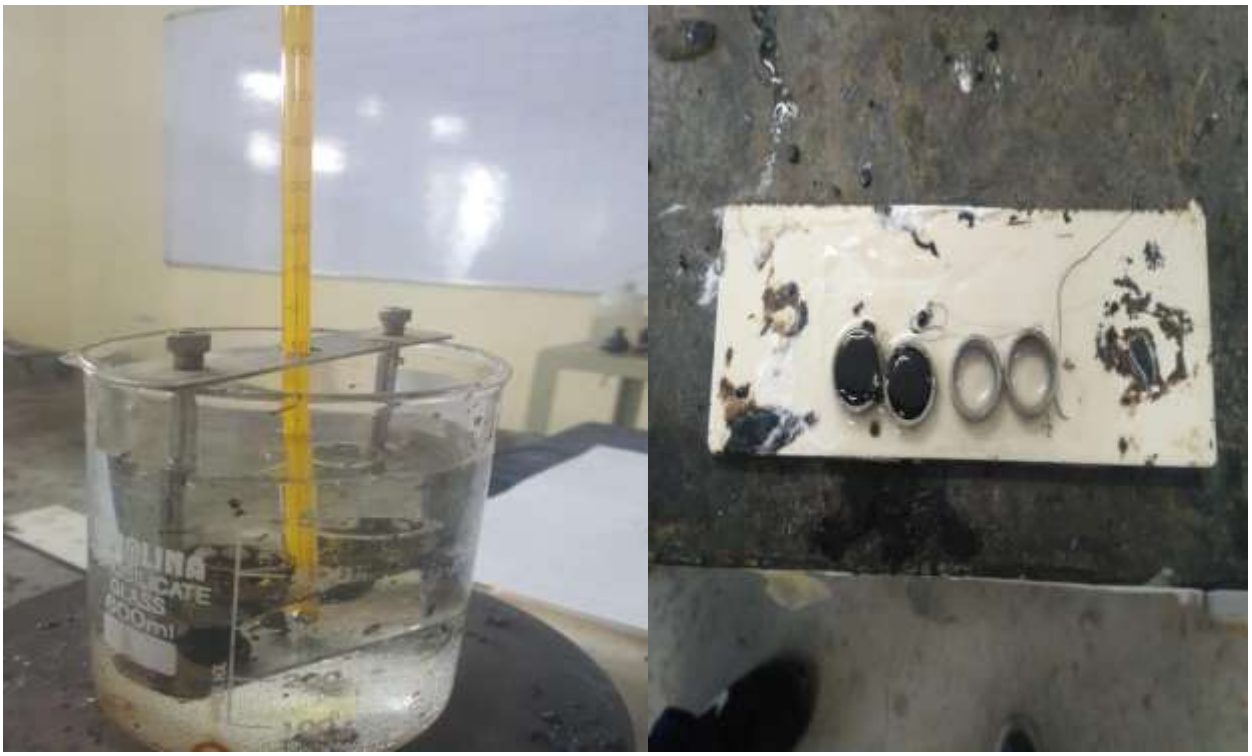
Where,
W_1 = Weight of aggregates immersed in water with Basket
W_2= Weight of Basket immersed in Water
W_3= Weight of Surface Dried Aggregates
W_4= Weight of Aggregates after drying in oven

Figure 3.8- (a) Weighing aggregates in basket in water (b) Weighing of aggregates in basket in air

3.4 TESTS ON BITUMEN

3.4.1. SOFTENING POINT TEST

The test is done in accordance to IS code 1205 1978. Softening point is the temp. at which ball passes through bitumen and falls through a height of 2.5 cm, obviously when heated under water keeping standard conditions. The setup's name is Ring and Ball setup. Steel ball is kept on bitumen test ring and water is heated at 5^{o}C per minute. Temperature is jotted down when the ball touches the metal plate which is at a standard height underneath it. It varies between 35^{o}C – 70^{o}C.



(a) (b)

Figure 3.9- **(a)** Beaker & Thermometer. **(b)** Rings (with & without bitumen)

3.4.2. PENETRATON TEST

The test runs in accordance with IS code 1203 1978. It tells us about consistency of bitumen. The given test is carried out using penetrometer. Initially bitmen is poured into the mould and cooling is done for 30 minutes carried by water bath at 25^{o}C for an hour. It has a needle weighing 100 gm which penetrates into the sample of bitumen for 5 seconds. Three readings are taken and the reading should be taken within 10 mm distance of the first penetration. The measurement is done in 1/10th mm units.

(a)

(b)

Figure 3.10 **(a)** Mould containing bitumen **(b)** Penetrometer with Needle

3.4.3. DUCTILITY TEST

The test runs in accordance with IS code 1208 1978. Ductility is important to prevent and resist cracking of binder(bitumen) under loads of the traffic wheels which may lead to penetration of water in it to cause breaking and failure in pavement. Sample is kept in the room temp. and water bath is given at 25^{o} C for an hour. The briquette mould is placed in ductility test apparatus and pull is started at a rate of 5 cm per minute. The min. ductility value is between 50-75 cm depending upon viscosity grade of bitumen.

Figure 3.11 Ductility Test Apparatus

3.4.4. SPECIFIC GRAVITY TEST

The test is run in accordance to IS code 1202 1978. Specific gravity is ratio of the weight of bitumen (binder) to the weight of water at same volume. Bitumen has impurities in amount that makes it have high specific gravity value. It varies between 1.1-1.25.

Specific gravity of Bitumen $= \frac{(W_2 - W_1)}{(W_3 - W_1) - (W_4 - W_2)}$

W_1= Specific gravity bottle's (empty) weight

W_2= Weight of specific gravity bottle filled with bitumen

W_3= Weight of specific gravity bottle filled with water

W_4= Weight of specific gravity bottle filled with water and bitumen.

Figure 3.12 Specific Gravity Bottle

3.5 MARSHALL STABILITY TEST

Marshal stability is the most important test to determine the optimum bitumen content. The test is performed at the rate of 5.08 cm per minute load. Marshall Stability is the maximum applied force at which the bituminous sample breaks or fails. Along with marshal stability flow value is also measured during the failure of test sample.

3.5.1 SAMPLE PREPARATION

1. 1200 gm of aggregates are taken according to mix design and then sample is heated at 175 to 190°C temperature.
2. Bitumen is warmed up to 120°C to 140°C temperature with different percentage of the weight of the aggregates starting from 4%.
3. Then heated aggregates at 175°C temperature and bitumen are mixed at a temperature of 160 °C.
4. Then mix is poured in a marshal stability test mould and compacted by giving 75 blows on each side with the help of rammer. Oiling of the mould should be done to extract sample easily.

5. Left the mix in the test mould for a day at room temperature and then extract the marshal sample from the mould gently using test extractor.
6. Then sample is weighed in the water as well as in air.
7. Then sample is left submerged in a water bath at 60°C temperature for 30 to 45 minutes.
8. The sample is then placed in Marshall Stability apparatus and apply loading.
9. Change the percentage of bitumen and crumb rubber in case of modified bitumen and again do above steps.

Figure. 3.13 Marshal Stability Test Instrument

3.5.2. MIX PROPERTIES

3.5.2.1. THEREOTICAL SPECIFIC GRAVITY (G_t)

Theoretically Specific Gravity is $G_t = \frac{W_1+W_2+W_3+W_b}{\frac{W_1}{G_1}+\frac{W_2}{G_2}+\frac{W_3}{G_3}+\frac{W_4}{G_4}}$

Where,

W_1 = Weight of coarse Aggregates in the mix,

W_2 = Weight of fine Aggregates in the mix,

W_3 = Weight of filler in the Mix in the mix,

W_4= Weight of the bitumen in the mix,

G_1= Specific Gravity of the Coarse Aggregate,

G_2= Specific Gravity of the Fine aggregates,

G_3= Specific Gravity of the Filler,

G_b= Specific Gravity of the Bitumen.

3.5.2.2 BULK SPECIFIC GRAVITY OF THE MIX (Gm)

Bulk Specific Gravity of the Mix is given by $G_m=\frac{W_m}{W_m-W_w}$

Where,

W_m= Weight of Mix in air,

W_w= Weight of the mix in water.

3.5.2.3 AIR VOID PERCENTAGE (V_v)

Air Void Percent is given by $V_v = \frac{G_t-G_m}{G_t} \times 100$

Where,

G_t= theoretical Specific Gravity of the Mix,

G_m= bulk specific Gravity of the Mix.

3.5.2.4 PERCENT VOLUME OF BITUMEN (Vb)

Percent Volume Bitumen of the mix is given by, $V_b= \frac{\frac{W_b}{G_b}}{\frac{W_1+W_2+W_3+W_4}{G_m}}$

W_2= Fine Aggregates weight

W_3= Filler material weight

W_b= Bitumen weight

G_b= Bitumen's specific gravity

Where,

W_1= Coarse Aggregate weight

G_m = Specific Gravity of whole mix.

3.5.2.5. (VMA) VOIDS IN MINERAL AGGREGATES

Voids present in aggregates VMA = V_{b+} V_v

V_v = Percent of air Voids present in the sample

V_b = Percent of Bitumen Content in the sample

3.5.2.6 (VFB) VOIDS FILLED WITH BITUMEN

, VFB= $\frac{V_b}{VMA} \times 100$

Where,

VMA= Voids in Mineral Aggregates

V_b= Vol. of Bitumen used

3.5.3 MARSHAL STABILITY TEST PICTURES

(a)

(b)

(c) (d)

Figure 3.14- (a) Water bath at 60^0C centigrade (b) Taking out samples (c) Compacting the sample (d) Sample for testing

3.6 PLASTIC COATING METHOD

(a) (b)

Figure 3.15 a) Mixing shredded plasic with aggregate b) Plastic coated aggregates by Shredding Method

After studying the papers discussed above, 8% plastic was added by weight of aggregates. In this case aggregates are heated and sprinkled shredded pieces of

plastic into it. So this was the result after coating aggregates. Further tests will be conducted to see if the aggregates get better values or not.

Since most of the aggregate were stick with each other this idea was dropped and gone for Dipping method of coating aggregate.

Firstly plastic was melted at 130°C and the result didn't come as expected. The plastic layer on aggregate was thick and was easily breakable by hands. The grey colored one aggregate in figure is the plastic after cooling down which has no strength.

Then plastic was melted at 170°C. This time the coating was thin, strong and favorable amount of plastic was covering the aggregates properly.

(a) (b)

(c) (d)

Figure 3.16 (a) Melting of plastic (b) Dipping of aggregates (c) Thick coated aggregates (failure) (d) Fine coated aggregates

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 GENERAL

Basic tests on normal and modified bitumen and aggregates are performed in laboratory. The results of test performed on aggregates and bitumen are shown in Annexure A and the basic test values of plastic coated aggregates and crumb rubber are shown in Annexure B.

4.2 MARSHALL DESIGN MIX

This section is showing the marshal stability values and other related values after conducting marshal test on the SDBC mix according to IS code 111:2009. The table for these graphs is given in Annexure C.

4.2.1 MARSHALL STABILITY FOR BITUMEN CONTENT

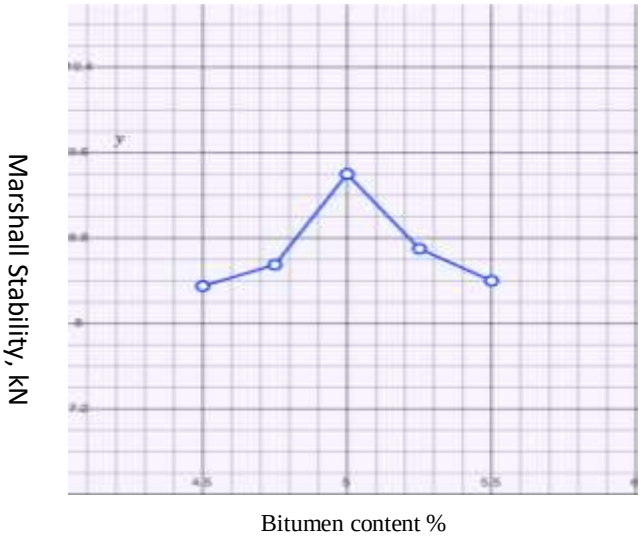


Figure 4.1 Graph between Marshall stability and different bitumen content

As appeared in the above figure with increment of bitumen, the stability first increases and then decreases. This is so because first the bitumen fills the voids but later on the excess bitumen cannot take any load thus decreases the stability. Thus 9.35 kN is the highest stability the sample produced at 5% bitumen content.

4.2.2 FLOW VALUE FOR BITUMEN CONTENT

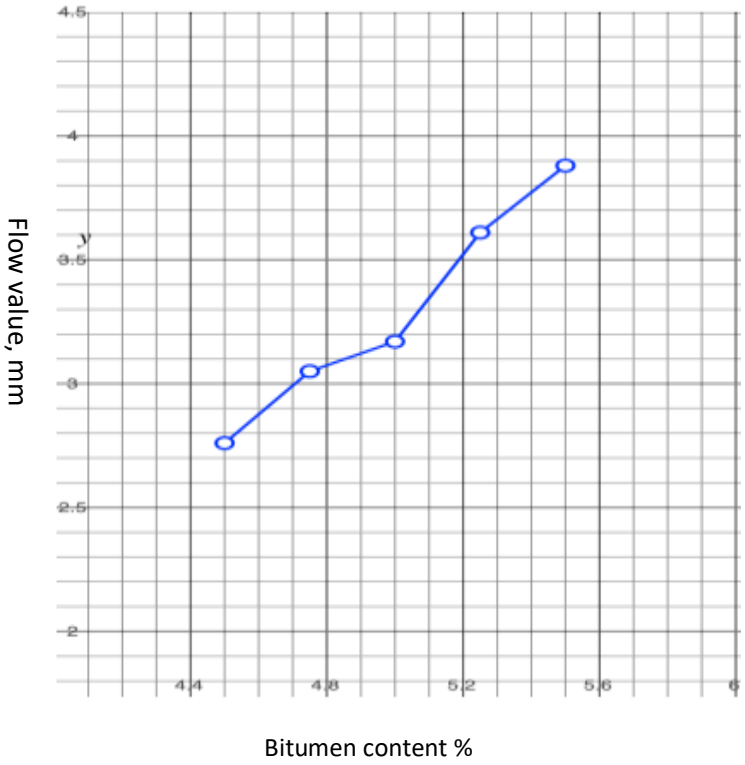


Figure 4.2 Graph between Flow Value vs variable bitumen content %

As it is seen that with increasing bitumen content, the flow value increases which means with increase in bitumen content, the vertical deformation in sample is also increasing.

4.2.3 VOIDS FILLED WITH BITUMEN FOR BITUMEN CONTENT

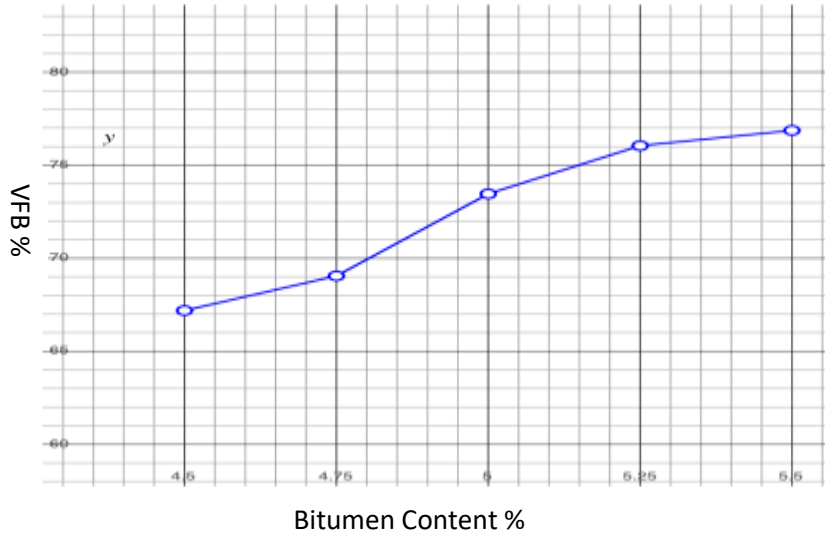


Figure 4.3 Graph between VFB% v/s Binder Content %

As seen in the above graph the increasing % of bitumen leads to increment of VFB and also gets stagnant at the upper percentages of bitumen.

4.2.4 AIR VOIDS FOR BITUMEN CONTENT

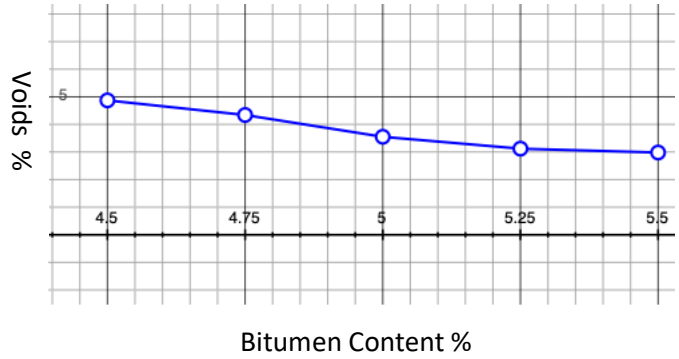


Figure 4.4 Graph between Voids % v/s Binder Content %

As seen from the above graph the increment of bitumen causes decrease in air voids percentages.

4.2.5. BULK UNIT WEIGHT FOR BITUMEN CONTENT

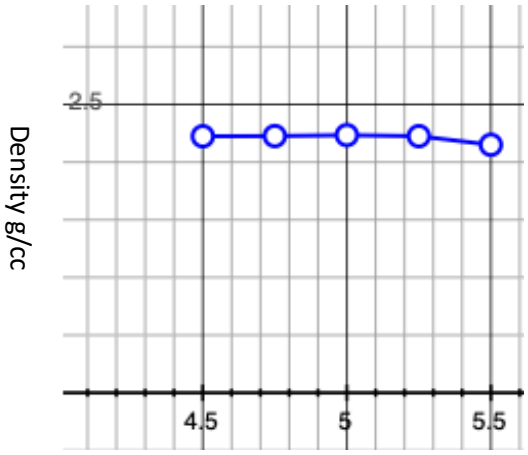


Figure 4.5 Graph between Density v/s Binder Content percent

The values of density are fairly constant if the bitumen content was increased as per the graph.

After all these tests on bitumen, the optimum bitumen content comes out to be 5%.So in all the modified samples 5% of bitumen is taken.

1. 8% Crumb rubber and 3% LDPE
2. 8% Crumb rubber and 6% LDPE
3. 8% Crumb rubber and 9% LDPE
4. 10% Crumb rubber and 3% LDPE
5. 10% Crumb rubber and 6% LDPE
6. 10% Crumb rubber and 9% LDPE
7. 12% Crumb rubber and 3% LDPE
8. 12% Crumb rubber and 6% LDPE
9. 12% Crumb rubber and 9% LDPE

4.2.6 MARSHAL STABILITY FOR DIFFERENT COMBINATIONS

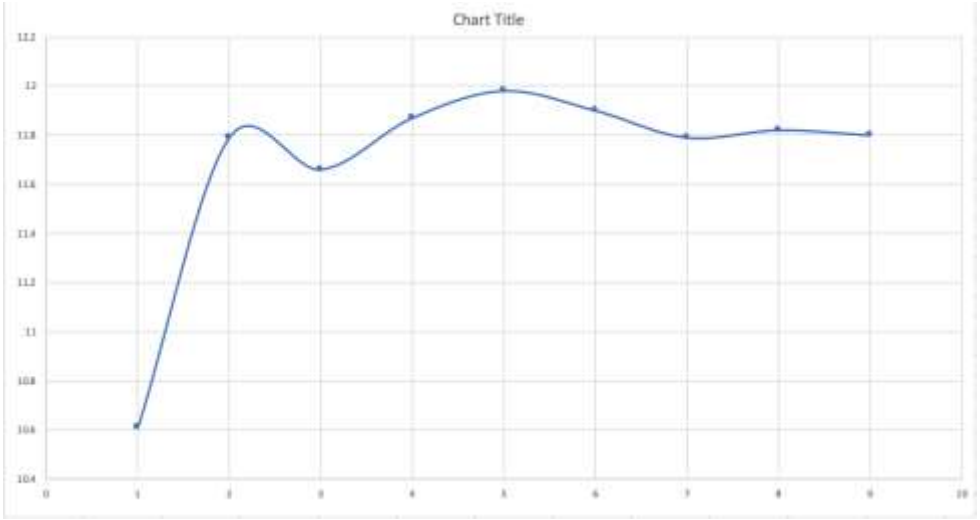


Figure 4.6- Marshal value v/s different combination of LDPE & CRMB

In this graph it was seen that initially with combinations of different percentages of CRMB and LDPE variance in the values of Marshall Values is there but the maximum value is obtained at 10% CRMB and 6% LDPE. So this means that the most desirable combination is this one. In this test the value is more than the standard Marshall test in SDBC mix.

4.2.7 FLOW VALUE FOR DIFFERENT COMBINATIONS

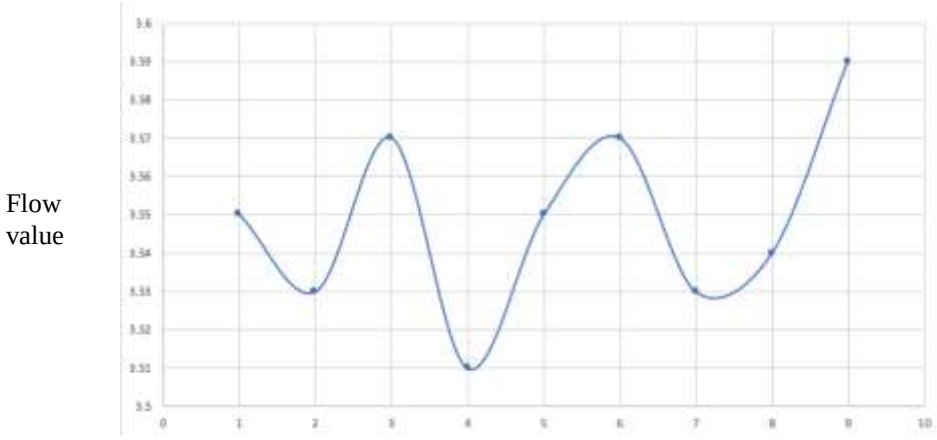


Figure 4.7 – Flow value v/s different combinations of LDPE & CRMB

The deformation at the failure point expressed in units of 0.25 mm is called the flow value of the specimen. Here the flow value at 5th combination has the most desirable marshall value which is 3.55 mm.

4.2.8. BULK DENSITY FOR DIFFERENT COMBINATIONS

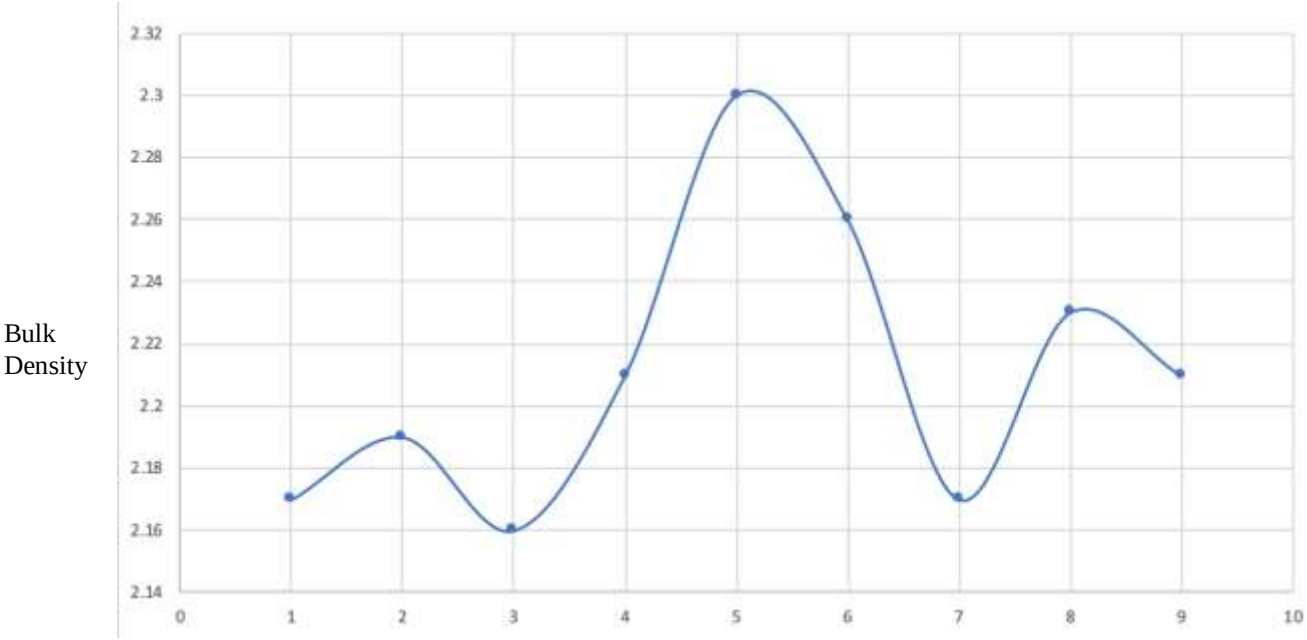


Figure 4.8- Bulk density v/s different combinations of LDPE & CRMB

Here in the above figure the density is maximum at the 5th combination i.e. is 2.30(gm/cc). This means that the max. marshall value also means max. density there.

4.2.9 AIR VOIDS FOR DIFFERENT COMBINATIONS

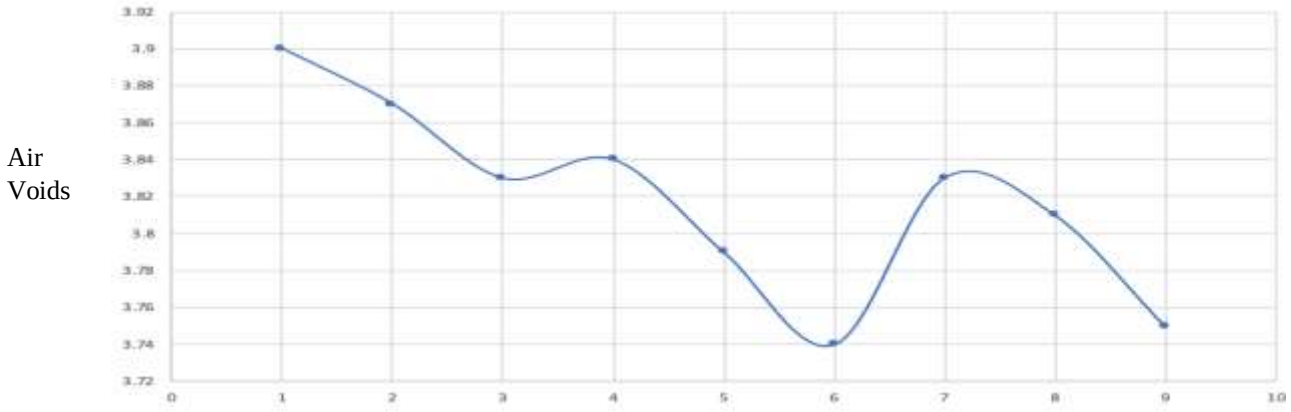


Figure 4.9- Air voids v/s different combinations of LDPE & CRMB

In the above figure it was seen that the air voids reduce at the 5th combination. This means at the point we see the max density the air voids tends to reduce but as seen in the vicinity this trend doesn't follow up for long. The different combination of CRMB and LDPE makes the air voids changes their behavior.

4.2.10 VMA FOR DIFFERENT COMBINATIONS

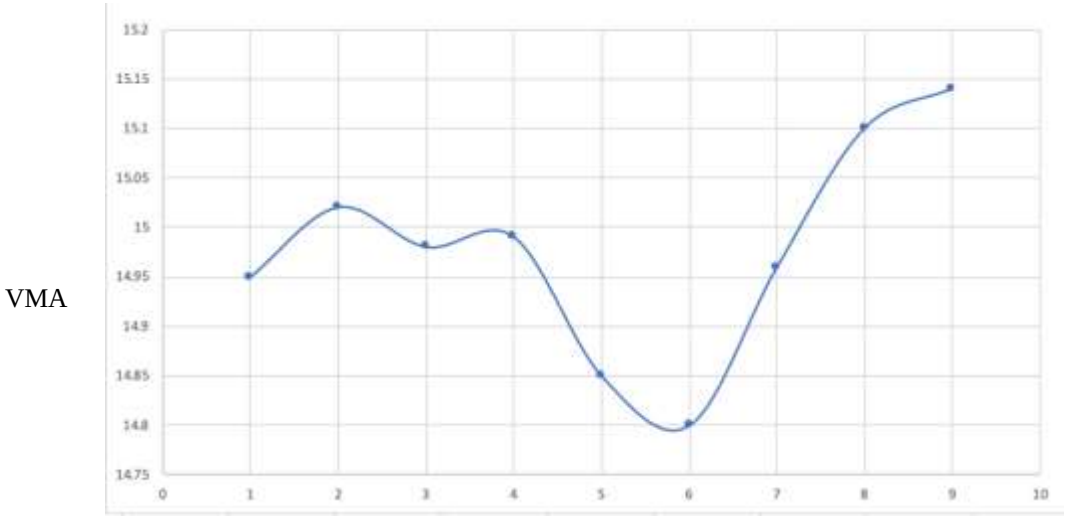


Figure 4.10- VMA v/s different combinations of LDPE & CRMB

The above figure shows the way the VMA shows up in the different combinations. The value tends to reduce near the 5th combination and then it rises.

4.2.11 VFB FOR DIFFERENT COMBINATIONS

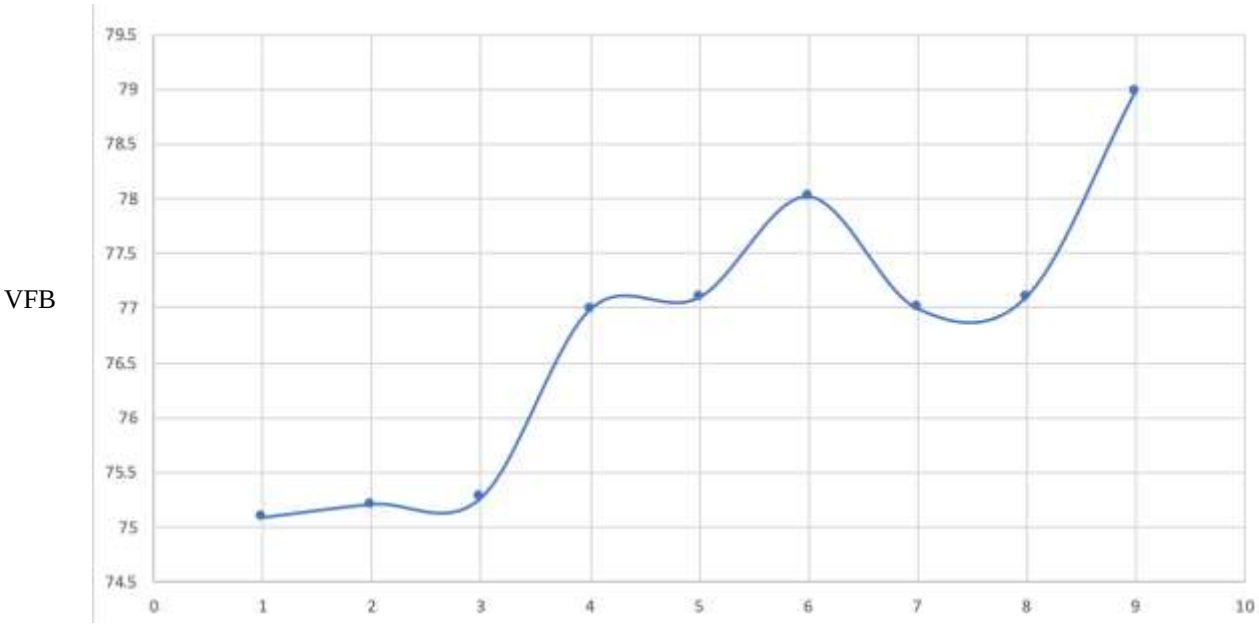


Figure 4.11 – VFB v/s different combinations of LDPE & CRMB

In the above figure the VFB shows an increasing value trend. The value at the fifth combination is 77.10 %.

Chapter 5
CONCLUSION

Adding LDPE and CRMB has increased properties of the mix such as Marshall stability, bulk density and in bitumen we observed positive result in penetration test, ductility test, softening point and flash and fire test. This can help making the SDBC layer last long. It was seen that as one of the content of modifiers keep on increasing the marshal stability keeps falling. This shows us that the strength is not achieved due to excess mixing of the modifiers. Thus, to reach the ideal quantity, nine samples were taken into account until the Marshall Stability curve showed us the best mix.

5.1 CONCLUSION

On the basis of the results obtained following points can be drawn

- Mixing of CRMB and LDPE the marshal stability & bulk density were increased in the mix whereas the individual properties of bitumen and aggregates were also enhanced by proper quantity of modifiers.
- Marshall Stability is at its maxima when 10% CRMB and 6% LDPE is used.
- Flash and Fire, softening point, ductility, penetration are increased due to the use of CRMB.
- Aggregate’s impact value, crushing value, Los Angeles abrasion test value and specific gravity are increased due to the coating of LDPE.
- Aggregates of low quality coated with plastic can be used when on a site the quality of aggregate is not desirable.

5.2 RECOMMENDATIONS

These are the recommendations on the basis of our results-

- CRMB can be recycled by mixing it in bitumen that too yield good results.
- LDPE is also taken into use in coating and that this decreases the waste plastic.
- Coating should be done at 180^0C and below that the coating is brittle.

5.3 FUTURE STUDY

In future, there is always possibility for research in the field of bitumen modifiers. Hence future study may consider the following points-

- Other types of plastic can also be used to coat the aggregates.
- Other grade of CRMB (30 mesh size in this study) can be taken into consideration.
- Road costs analysis should be taken into consideration seeing the optimistic results of our study.

REFERENCES

1. V. Suganpriya,S.Omprakash,V. Chandralega. Study of Behaviour of Bitumen Modified with Crumb Rubber *International Journal of Engineering Research & Technology* (IJERT) ISSN: 2278-0181
2. SS. Asadi, T. NagaSeshuBabu, B. Harish Kumar, M. Sumanth, G. Sumanth Kumar, S. Harsha vardhan, P. Khasimkhan . Crumb Rubber Utilization in Pavements to Improve the Durability:An Experimental Study *. International Journal of Applied Engineering Research* ISSN 0973-4562 Volume 11, Number 9 (2016) pp 6418-6423 .
3. RokadeS . Use of Waste Plastic and Waste Rubber Tyres in Flexible Highway Pavements. *International Conference on Future Environment and Energy* IPCBEE vol.28(2012) © (2012)IACSIT Press, Singapore.
4. Menaria, Y. and Sankhla, R. (2015) Use of Waste Plastic in Flexible Pavements-Green Roads. Open Journal of Civil Engineering, 299-311
5. Dr. V. Vasudevan, Guidelines for the Use of Plastic Waste in Rural Roads Construction TEC, Madurai, and CRRI, New Delhi. National Rural Roads Development, Agency Ministry of Rural Development.
6. Narayan, Priya, 2001, ”Analyzing Plastic Waste Management in India: Case study of Polybags and PET bottles” published by IIIEE, Lund University, Sweden, pp 24-25 accessed at http://www.iiiee.lu.se/information/
7. Miss Apurva J Chavan,Use of plastic in green pavements,International journal of engineering research and technology ISSN:2319-4878

ANNEXURE A

Basic test values of aggregate and bitumen	Various tests- Impact, crushing, specific gravity, water absorption, abrasion, penetration, ductility, softening point, flash and fire point test	**A**

A.1 BASIC TEST VALUES

Table A.1 Basic test values

S.No.	Experiment	Value
1.	Aggregate Impact Value	17.75%
2.	Aggregate Crushing Value	24.04%
3.	Specific Gravity (aggregates)	1.9
4.	Water Absorption (aggregates)	1.18%
5.	Los Angeles Abrasion Test	32.41%
6.	Penetration Test	69
7.	Ductility Test	39cm
8.	Softening Point	49°
9.	Flash and Fire Point Test	Flash-260° Fire-340°

A.2 GRADING OF AGGREGATES FOR MIX DESIGN

Table A.2 Grading of aggregates for mix design

Sieve size (mm)	Percentage retained by weight
19	-
13.2	95
9.5	80
4.75	45
2.36	35
1.18	25
.6	-
.3	15
.15	-
.0075	5

ANNEXURE B

Crumb Rubber, Plastic coated aggregate, properties and tests	Various tests- specific gravity, moisture content, bulk density, sieve analysis, grade, penetration test	**B**

B.1 PROPERTIES OF CRUMB RUBBER

Table B.1 Properties of crumb rubber

S.No.	Experiment	Value
1.	Specific Gravity	1.105
2.	Moisture Content	0.73%
3.	Bulk Density	0.30 - 0.45 gm/cc
4.	Sieve analysis	90%
5.	Grade	30 Mesh

B.2 PENETRATION TEST RESULTS WITH DIFFERENT CRMB PERCENTAGE

Table B.2 Penetration test results with different crumb rubber percentage

S.No.	Percentage of Crumb Rubber	Penetration
1.	0	69
2.	8	51
3.	10	43
4.	12	34
5.	14	26

B.3 MODIFIED AGGREGATES TEST RESULTS

Table B.3 Plastic coated aggregate basic test

S.No.	Experiments	Values
1.	Aggregate impact value	14.53%
2.	Aggregate crushing value	18.37%
3.	Specific gravity	2.3
4.	Water absorption	1.18%
5.	Los Angeles Abrasion test	35.41%

ANNEXURE C

Marshal Mix Design	Marshal Stability Test	**C**

C.1 MARSHAL STABILITY VALUES

Table C.1 Marshal Stability value of nominal mix

Bitumen %	Marshal Stability kn	Flow value mm	Air Voids% Vv	VFB	VMA	Bulk Density Gm/cc
4.5	8.36	2.76	4.83	67.13	14.87	2.224
4.75	8.55	2.98	4.34	69.99	14.95	2.228
5	9.36	3.17	3.53	73.58	14.75	2.235
5.25	8.69	3.60	3.14	76.99	14.88	2.225
5.5	8.38	3.89	2.89	77.89	15.19	2.13

C.2 MARSHAL STABILITY VALUE FOR VARYING PERCENTAGE OF PLASTIC (LOW DENSITY)

Table C.2 Results of SDBC Mix for Varying Percentages of LDPE

S.No.	LDPE %	Bitumen %	Marshall Stability (kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids% V_v	VMA	VFB%
1.	3%	5%	1067	3.00	2.13	3.76	14.88	74.02
2.	6%	5%	1180	3.50	2.14	3.75	15.00	76.20
3.	9%	5%	1170	3.70	2.16	3.90	15.14	77.14

C.3 MARSHAL STABILITY VALUE FOR VARYING PERCENTAGE OF CRUMB RUBBER

Table C.3 Results of SDBC Mix for Varying Percentages of Crumb Rubber

S.No.	Crumb Rubber %	Bitumen %	Marshall stability (kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids% V_v	VMA	VFB%
1.	8%	5	1055	2.99	2.20	3.82	14.87	74.02
2.	10%	5	1184	3.54	2.23	3.84	14.98	74.25
3.	12%	5	1179	3.67	2.27	3.88	15.17	73.16

C.4 MARSHAL STABILITY VALUE FOR VARYING PERCENTAGE OF CRUMB RUBBER AND LDPE

Table C.4 Results of SDBC Mix for varying Percentages of Crumb Rubber and LDPE

S.No.	Crumb Rubber %	LDPE %	Bitumen %	Marshall stability (kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids % V_v	VMA	VFB%
1.	8%	3%	5%	1061	3.55	2.17	3.90	14.95	75.09
2.	8%	6%	5%	1179	3.53	2.19	3.87	15.02	75.21
3.	8%	9%	5%	1166	3.57	2.16	3.83	14.98	75.27
4.	10%	3%	5%	1187	3.51	2.21	3.84	14.99	76.99
5.	10%	6%	5%	1198	3.55	2.30	3.73	14.80	77.10
6.	10%	9%	5%	1190	3.57	2.26	3.76	14.85	78.02
7.	12%	3%	5%	1179	3.53	2.17	3.83	14.96	77.00
8.	12%	6%	5%	1182	3.54	2.23	3.81	15.10	77.10
9.	12%	9%	5%	1180	3.59	2.21	3.75	15.14	78.97

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

PLAGIARISM VERIFICATION REPORT

Date: 29-5-2020

Type of Document (Tick): PhD Thesis | M.Tech Dissertation/ Report | B.Tech Project Report ✓ | Paper

Name: Pranav Gupta & Vivek Kashyap Department: CIVIL Enrolment No 161659,161664

Contact No. 78073-37065,70189-57080 E-mail. pranavgupta6862@gmail.com,vivekkashyap708@gmail.com

Name of the Supervisor: Dr. Tanmay Gupta

Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters):

EFFECT OF WASTE PLASTIC AND CRUMB RUBBER ON PROPERTIES OF SEMI DENSE BITUMINOUS CONCRETE MIX

UNDERTAKING

I undertake that I am aware of the plagiarism related norms/ regulations, if I found guilty of any plagiarism and copyright violations in the above thesis/report even after award of degree, the University reserves the rights to withdraw/revoke my degree/report. Kindly allow me to avail Plagiarism verification report for the document mentioned above.

Complete Thesis/Report Pages Detail:

- Total No. of Pages = 49
- Total No. of Preliminary pages = 11
- Total No. of pages accommodate bibliography/references = 1

(Signature of Student)

FOR DEPARTMENT USE

We have checked the thesis/report as per norms and found **Similarity Index** at 18 (%). Therefore, we are forwarding the complete thesis/report for final plagiarism check. The plagiarism verification report may be handed over to the candidate.

(Signature of Guide/Supervisor) Signature of HOD

FOR LRC USE

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	Excluded	Similarity Index (%)	Generated Plagiarism Report Details (Title, Abstract & Chapters)	
	• All Preliminary Pages • Bibliography/Images/Quotes • 14 Words String		Word Counts	
Report Generated on			Character Counts	
		Submission ID	Total Pages Scanned	
			File Size	

Checked by
Name & Signature Librarian

Please send your complete thesis/report in (PDF) with Title Page, Abstract and Chapters in (Word File) through the supervisor at plagcheck.juit@gmail.com