STUDY ON CONSTRUCTION OF ROADS USING PVC WASTE

A PROJECT REPORT

Submitted by

R. UTHRA (17CER192)

K.S. VIHASH KUMAR (17CER202)

R. VISHNU (17CER207)

in partial fulfilment of the requirements

for the award of the degree

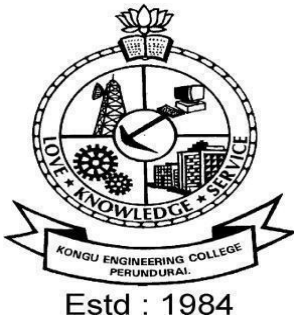
of

BACHELOR OF ENGINEERING

IN

CIVIL ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING



KONGU ENGINEERING COLLEGE

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PERUNDURAI-638060

APRIL 2021

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BONAFIDE CERTIFICATE

This is to certify that the project report entitled **"STUDY ON CONSTRUCTION OF ROADS USING PVC WASTE"** is the bonafide report of project work done by **R. UTHRA (17CER192), K.S. VIHASH KUMAR (17CER202), R. VISHNU (17CER207),** in the fulfilment of the requirements for the award of the Degree of **Bachelor of Engineering** in **Civil Engineering** of Anna University, Chennai during the year 2020 - 2021.

SUPERVISOR **HEAD OF THE DEPARTMENT**

DATE:

Submitted for the end semester viva voce examination held on _____

EXAMINER I **EXAMINER II**

DEPARTMENT OF CIVIL ENGINEERING

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DECEMBER 2020

DECLARATION

We affirm that the project Report titled **STUDY ON CONSTRUCTION OF ROADS USING PVC WASTE** being submitted in partial fulfilment of the requirements for the award of the Bachelor of Engineering is the original work carried by us. It has not formed the part of any other project report or dissertation on the basis of which a degree or award was conferred on the earlier occasion on this or any other candidate.

Date: **Signature of the candidates**

R. UTHRA (17CER192)

K.S. VIHASH KUMAR (17CER202)

R. VISHNU (17CER207)

I certify that the declaration made by the above candidates is true to the best of my knowledge.

Date: **Name and Signature of the Supervisor with Seal**

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ABSTRACT

Roads today are made up of deep strength asphalt, bitumen, crushed rock, chalk rock, compacted sand, as far as rural roads are concentrated, they are made of earth sand, loam, gravel and bituminous spray seal. For years throw-away products made of PVC have been a leading cause of dioxin pollution in incinerators and when burned it fires. Finding proper use of disposed PVC waste is the need of the hour. On the other side road traffic is increasing, hence the need to increase the load bearing capacities of the roads. The use of PVC mixed bitumen or asphalt or PVC coated aggregate in pavement construction allows the reuse of PVC waste. In this study, the different properties of PVC modified bitumen such as softening point, penetration value will be studied.

The results indicate that PVC waste can be used successfully in road construction. Strength and stability of the mix increased after incorporation of PVC waste; it was also observed that addition of PVC wate showed increase resistance to permanent deformation in terms of rutting. On the basis of experimental work, it is concluded that the asphalt mixtures with waste PVC modifier can be used for flexible pavement construction.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF CHARTS

LIST OF TABLES

LIST OF SYMBOLS

%	-	Percentage
mm	-	millimetre
^{o}C	-	Degree centigrade
min	-	Minutes
mec	-	Seconds
kg	-	Kilogram
g	-	Gram
W1	-	Initial weight of aggregate
W2	-	Final weight of aggregate

LIST OF ABREVATIONS

PVC	-	Poly Vinyl Chloride
ASTM	-	American Society for Testing and Materials
ISI	-	Indian Standards Institution
IS	-	Indian Standards

CHAPTER 1

1.INTRODUCTION

1.1 ABOUT THE PROJECT:

Population increases and industrial growth throughout the world result in creation and production of new types of non-biodegradable plastic wastes like PVC waste. Recent studies had shown that plastic waste can stay on earth for 4500 years unchanged and without degradation. In order to reduce pollution due to plastic waste an effective solution for recycling must be found. One such solution is the use of PVC waste materials in flexible pavement mixture. The aim of our project is to compare the strength properties of the PVC modified bitumen with brick powder as filler and the strength properties of unmodified bitumen. In this Project PVC waste used is plastics which is obtained from food wastes such as plastic boxes, covers, etc. The blends were made with different percentages of PVC and the physical properties of bitumen were then measured. The result of the various tests was resulted that the addition of waste PVC increases the softening point, specific gravity and decreases the penetration value, ductility which will prove beneficial in hot climate areas and also helpful to overcome the bleeding problems. The utilization of waste PVC plastic improved so many qualities like strength, fatigue life, reduced low temperature cracking and bituminous surfacing. This makes the material not only to solve the environment problem but also to reduce the overall waste.

1.2 MATERIALS USED

1.2.1 AGGREGATES

Aggregate plays an important role in the performance of bituminous mix. In bituminous mix, aggregates constitute about 90 to 95 percent by weight and comprise 75to 85 percent by Volume. Coarse aggregates offer compressive and shear strength and shows good interlocking properties. Aggregates have to bear stresses occurring due to the wheel loads on the pavement and on the surface course. They also have to resist wear due to abrasive action of traffic. These are used in pavement construction in cement concrete, bituminous concrete and other

bituminous constructions and also as granular base course underlying the superior pavement layers. Therefore, the properties of the aggregates are of considerable significance to the highway engineer. Some of the desired properties of these aggregates are strength, durability, toughness, hardness, etc.

The various tests conducted on aggregates in the laboratory are Los Angeles test, crushing test, impact test, flakiness and elongation index.

1.2.2 BITUMEN

Bituminous materials used in highway construction are broadly classified into bitumen and tar. Bitumen may further be divided into petroleum asphalt or bitumen and native asphalt. There are different forms in which native asphalts are available. These are those which occur in a pure or nearly pure state in nature. The viscosity of bitumen is sometimes reduced by a volatile diluent; this material is called cutback. When bitumen is suspended in a finely divided condition in an aqueous medium and stabilized with an emulsifier, the material is known as emulsion. Tar is the viscous liquid obtained when natural organic materials such as wood and coal are carbonized or destructively distilled in the absence of air.

Bitumen is available in various grades and types. To judge the suitability of these binders' various physical tests have been specified by agencies like ASTM, Asphalt Institute, British Standards Institution and the ISI. These tests include penetration tests, ductility tests, softening test, flash and fire point tests, viscosity tests, etc.

1.2.3 PVC WASTES

Plastic waste may be grouped depending on their physical properties to thermoplastic and thermosetting materials. Thermoplastic materials can be formed into any desired shape under the effect of pressure and heat. Thermoplastic materials become solid when cooled. Plastics can also be classified according to their chemical sources. According to sources of plastic, there are six types: Cellulose Plastics, Synthetic Resin Plastics, Protein Plastics, Natural Resins, Elastomers and Fibres. The essential raw materials for PVC are derived from salt and oil. PVC is manufactured from two starting materials;

- 57% of the molecular weight derived from common salt
- 43% derived from hydrocarbon feedstocks (increasingly ethylene from sugar crops is also being used for PVC production as an alternative to ethylene from oil or natural gas).

CHAPTER 2

2. METHODOLOGY

2.1 PLASTIC WASTE BLENDING

2.1.1 PREPEARATION OF BLEND

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

2.1.2 SEPERATION TEST (IRC-SP: 53-1999)

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

2.1.3 PREPARATION OF PLASTIC-WASTE COATED AGGREGATE

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

2.2 BASIC PROCESSES

- Segregation
- Cleaning process
- Shredding process
- Collection process

2.2.1 SEGREGATION

The plastic waste is separated from the solid waste management, where the solids are being thrown away from the society. The farm where it is kept for waste is chosen to be use in the plastic road.

Figure 2.2.1 Segregation of PVC waste

2.2.2 CLEANING PROCESS

The segregated plastic waste is taken away from the waste and is cleaned with the help of water and kept for dry condition. The dry process can be done by mechanical as well as manual. For big projects it is normally done with the help of machines.

Figure 2.2.2 Cleaning of PVC waste

2.2.3 SHREDDING PROCESS

In this process, plastic waste is shredded or cut into small pieces. Various plastics are mixed together.

Figure 2.2.3 Shredded PVC waste

2.2.4 COLLECTION PROCESS

The plastic waste after shredding i.e. broken pieces of plastic is then formed into the balls and they are kept in the sieves. The sieves of 4.75mm passed and 1mm retained is chosen for the collection of the plastic waste.

2.3 PROCESSES IN PLASTIC ROAD CONSTRUCTION

There are basic two methods

1.Wet Process

2.Dry Process

Basically the dry process is taken in the work as to see the economic and environmental effect.

2.3.1 WET PROCESS

In this procedure, the plastic waste is specifically blended with hot Bitumen at 160 ˚C and this blend is then appropriately blended utilizing a mechanical stirrer. This blend likewise contains extra stabilizers and requires legitimate cooling. This strategy is very little famous in light of the fact that it needs colossal speculations, bigger plants and more hardware than the Dry Process. To begin with the plastic waste is gathered, isolated and put away. The isolation is done in light of the fact that a few sorts of plastic like poly-vinyl chloride (PVC) and flux sheets can't be utilized as a part of street developments for well-being concerns. The following stride includes the cleaning of the plastic. This is vital on the grounds that the vast majority of the plastic waste gathered has been utilized for bundling (55 % in India) and subsequently is probably going to contain leftover substances, for example, little bits of nourishment which must be expelled. After this the plastic experiences the way toward destroying which lessens it to the right thickness of 2 mm – 4 mm. The total is warmed to around 160 ˚C-170 ˚C and afterward the plastic is included and following 30 seconds - 40 seconds, a uniform covering is watched. This covering gives it a slick look. The bitumen is then included and the blend is altogether blended before laying. The bitumen is included at a temperature of around 155 ˚C-163 ˚C. This temperature is deliberately directed to ensure that the coupling is solid

2.3.2 DRY PROCESS

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2.3.3 FLOW CHART OF CONSTRUCTION PROCESS (DRY PROCESS)

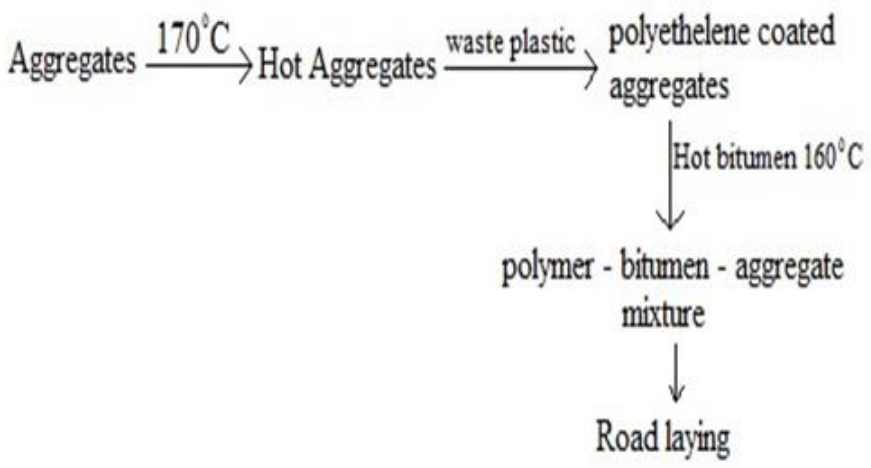

Figure 2.3.3 Flow chart of dry process

CHAPTER 3

3. TESTS

3.1 TEST ON BITUMEN

3.1.1 PENETRATION TEST

Penetration test is to determine the hardness of the bitumen as per IS: 1203 – 1978. The principle is that the penetration of bituminous material is the distance in mm that a standard needle would penetrate vertically, into a sample of the material under standard conditions of temperature, load and time.

Table 3.1.1 Penetration test on bitumen

PVC added	0%	2%	4%	6%
1.	67	66	65	63
2.	67	65	63	63
3.	66	67	65	63
Mean	**67**	**66**	**65**	**63**

Graphical representation:

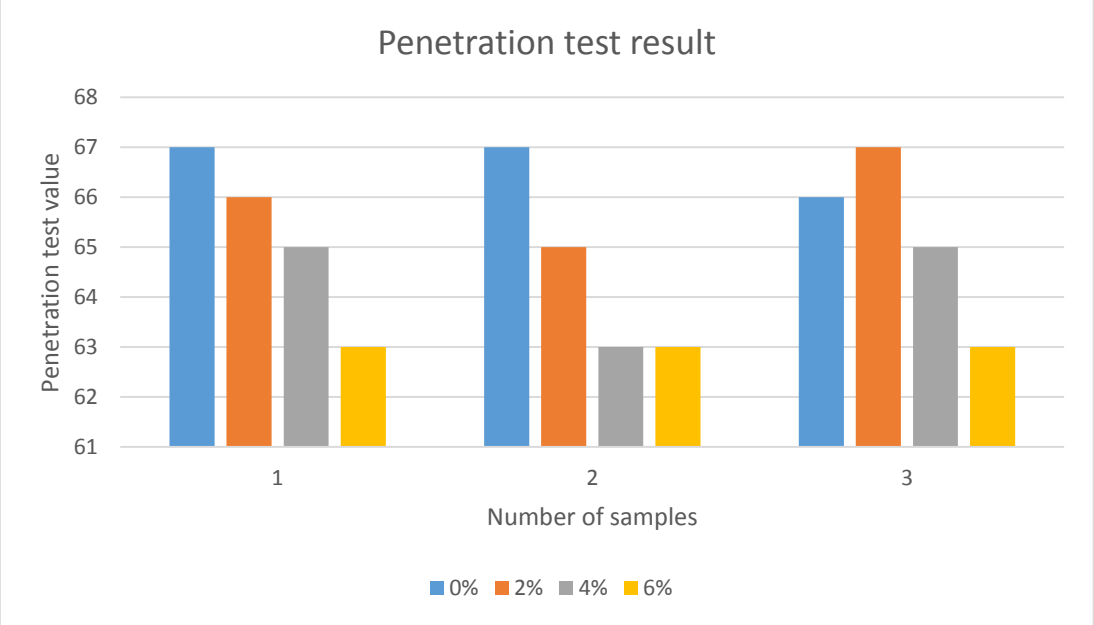

Chart 3.1.1 Penetration test

Inference: The penetration values are decreasing significantly when bitumen is mixed with the modifier. There is a significant decrease in penetration values for modified blends, indicating the improvement in their temperature susceptibility resistant characteristics.

3.1.2 DUCTILITY TEST

This test is done to determine the ductility of distillation residue of cutback bitumen as per IS: 1208 – 1978. The principle is that the ductility of a bituminous material is measured by the distance in cm to which elongate before breaking when a standard briquette specimen of the material is pulled apart at a specified speed and a specified temperature.

Table 3.1.2 Ductility value on bitumen

S.no	%PVC	Ductility value
1	0	105
2	2.5	50
3	5	30
4	7.5	25
5	10	20
6	12	15
7	15	13

Graphical representation:

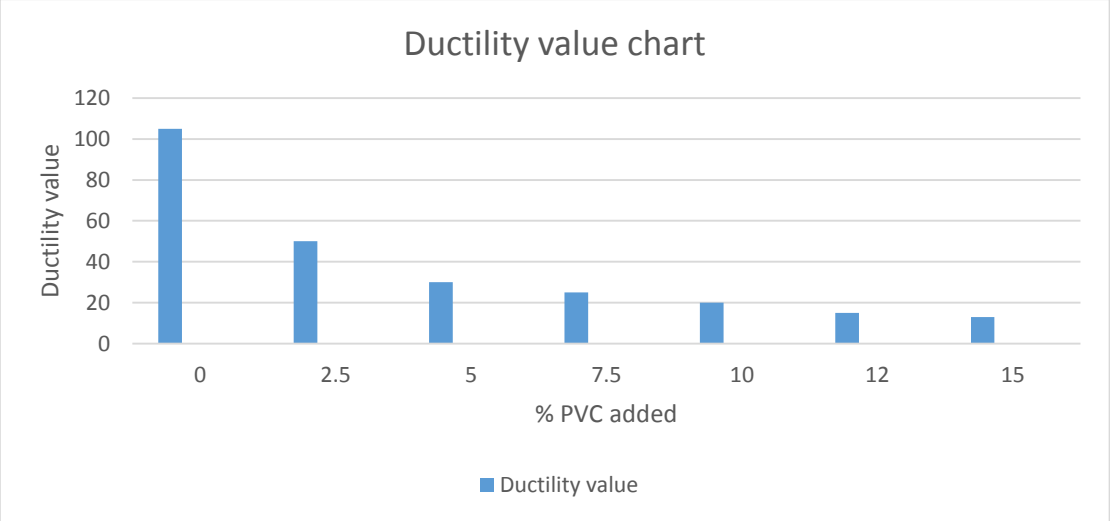

Chart 3.1.2 Ductility test

Inference: It may be seen that the ductility values for bitumen modified with 1%, 2.5%, 5%, 7.5%, 10%, 12% & 15% modifiers are very low compared to original binders. The ductility values decrease with increase in percentage of modifier. The ductility value less than 50cm should not be used in road construction, but may be used as crack and joint filler materials.

3.1.3 MARSHALL STABILITY TEST

This test is done to determine the Marshall stability of bituminous mixture as per ASTM D 1559. The principle of this test is that Marshall Stability is the resistance to plastic flow of cylindrical specimens of a bituminous mixture loaded on the lateral surface. It is the load carrying capacity of the mix at 60°C and is measured in kg.

Table 3.1.3 Marshall stability and flow value

Sample no	Bitumen content (%)	Plastic content (% by weight)	Marshall stability (kg)	Flow value (mm)
1	4	0	950	3.1
2	5	0	1170	3.3
3	6	0	1240	3.6
4	4	5	1560	3.9
5	5	10	1720	4.5
6	6	15	1980	5

Graphical representation:

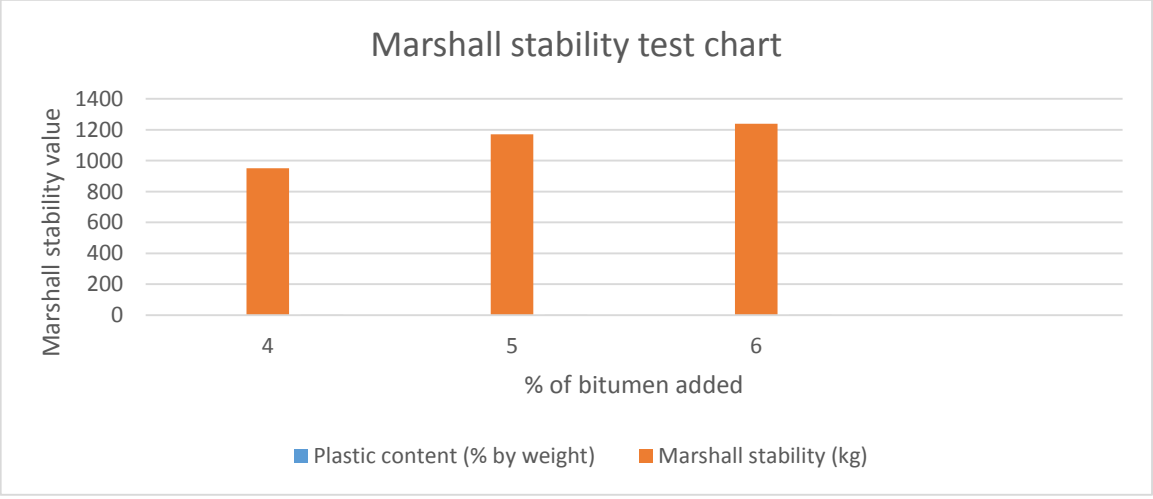

Chart 3.1.3(a) Marshall stability test

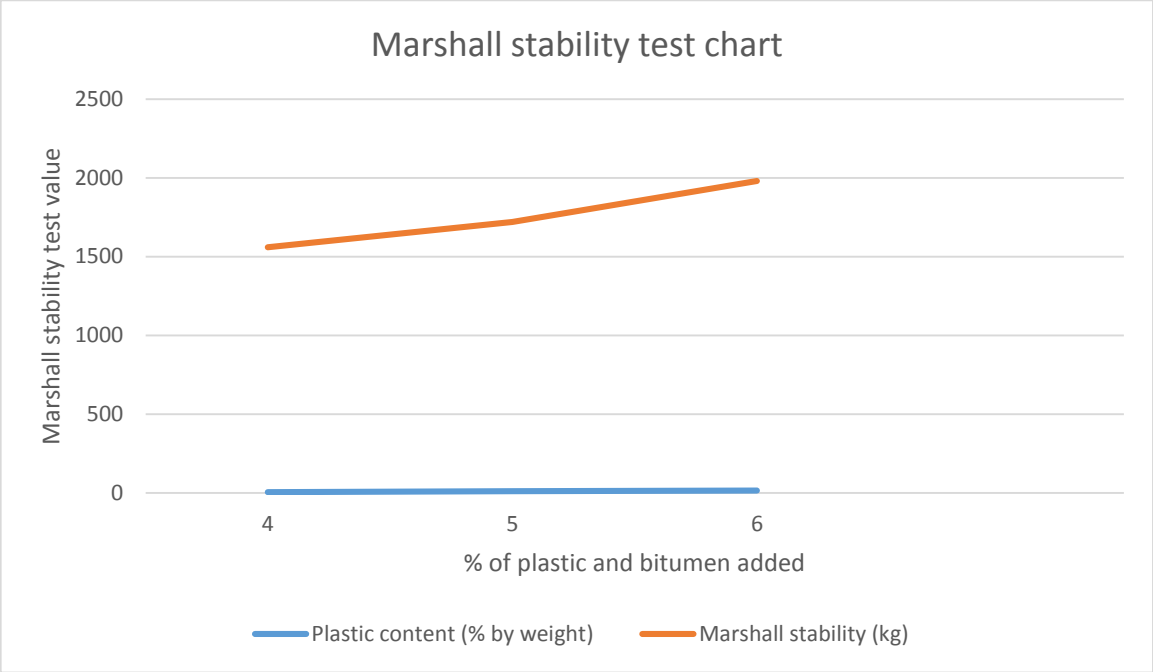

Chart 3.1.3(b) Marshall stability chart with 0% plastic added

3.1.4 VISCOSITY TEST

Viscosity is defined as the inverse of fluidity. Viscosity thus defines the fluid property of bituminous material. Viscosity is the general term for consistency and is the measure of resistance to flow. Many researchers believe that grading of bitumen should be by absolute viscosity units instead of the conventional penetration units.

Figure 3.1.4 Viscosity test on Bitumen

3.1.5 SOFTENING TEST

The principle behind this test is that softening point is the temperature at which the substance attains a particular degree of softening under specified condition of the test. This test is done to determine the softening point of asphaltic bitumen and fluxed native asphalt, road tar, coal tar pitch and blown type bitumen as per IS: 1205 – 1978.

Table 3.1.5 Softening point on bitumen

S.no	%Plastic	Softening point
01	0	46
02	1	48
03	3	49
04	5	51
05	7	52

Graphical representation:

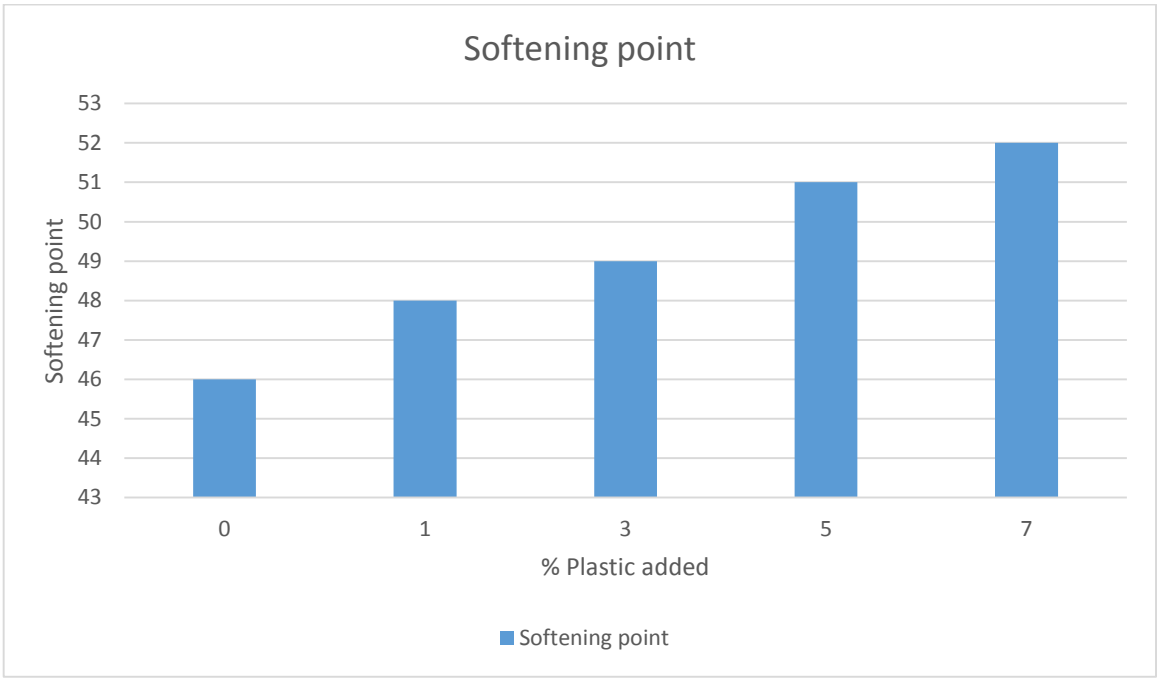

Chart 3.1.5 Softening point

Inference: The softening point increase in percentage of modifiers, the results show that bitumen modified with lower percentage of modifier can be used in road construction, but may be used as a roofing material.

3.2 TEST ON AGGREGATES

3.2.1 IMPACT TEST

The test is used to evaluate the toughness of stone or resistance of aggregates to fracture under repeated impacts is called impact test on aggregates. The aggregate impact value should not normally exceed 30% for aggregate to be used and wearing course of the pavements. The maximum permissible value is 35% for bituminous macadam and 40% for water bound macadam base course.

Figure 3.2.1 Impact test on aggregates

Experimental data:

Table 3.2.1 Impact test value on aggregates

% of plastic	0	2	3	4
W1	400	400	400	400
W2	68	65	63	60
Aggregate impact value	17%	16.25%	15.75%	15%

Observation:

W1 = total weight of the aggregate in g

W2 = weight of the portion of crushed material passing through 2.35mm IS sieve, in g

Formula:

Aggregate impact value = (W2/W1) X100

Graphical representation:

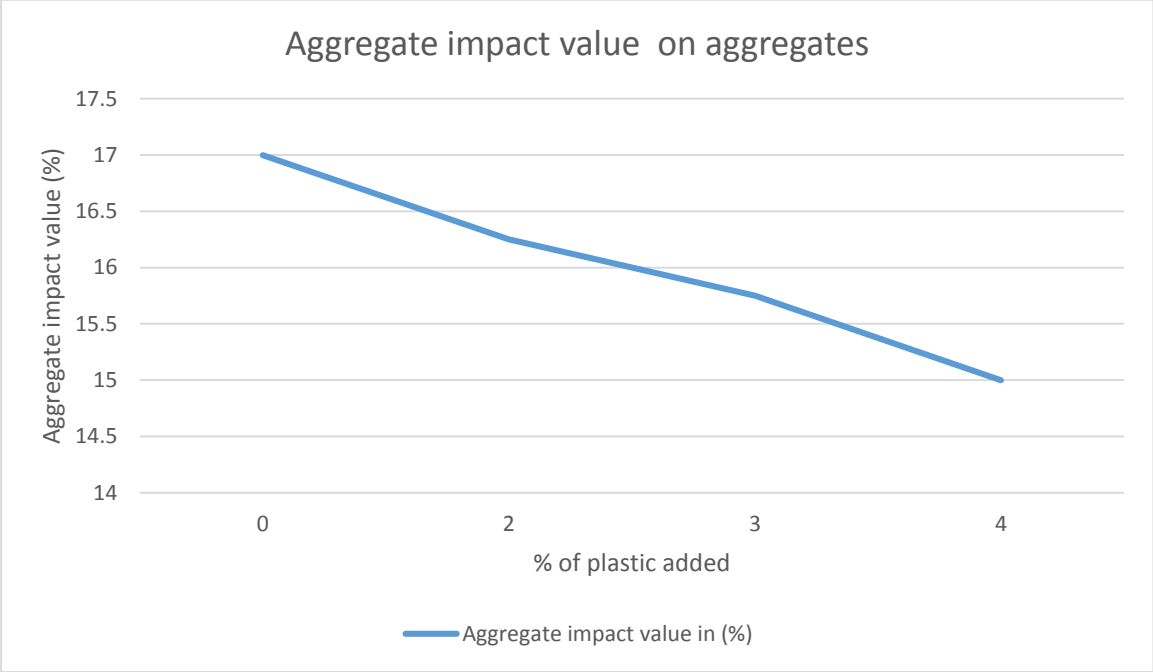

Chart 3.2.1 Aggregate impact value

Inference: The aggregate impact value decreases with increase in plastic percentage. Hence, the impact value of the plastics coated aggregate is lower when compared with the plain aggregate.

3.2.2 ABRASION TEST

The principle of Los Angeles abrasion test is to find the percentage wear due to the relative rubbing action between the aggregate and steel balls used as abrasive charge.

Figure 3.2.2 Abrasion test on aggregates

Experimental data:

Table 3.2.2 Abrasion test on aggregates

% plastic added	0	5	7	9
Original weight of the aggregate (W1) in g	5000	5000	5000	5000
Weight passing 1.75 mm IS sieve (W2) in g	3250	3300	3375	3400
Abrasion value test (%)	35	34	32.5	32

Observation:

W1 = initial weight of the aggregate

W2 = weight of the aggregate after sieving 1.76 mm sieve

Formula:

Abrasion value test = ((W1-W2) / W1) X100

Graphical representation:

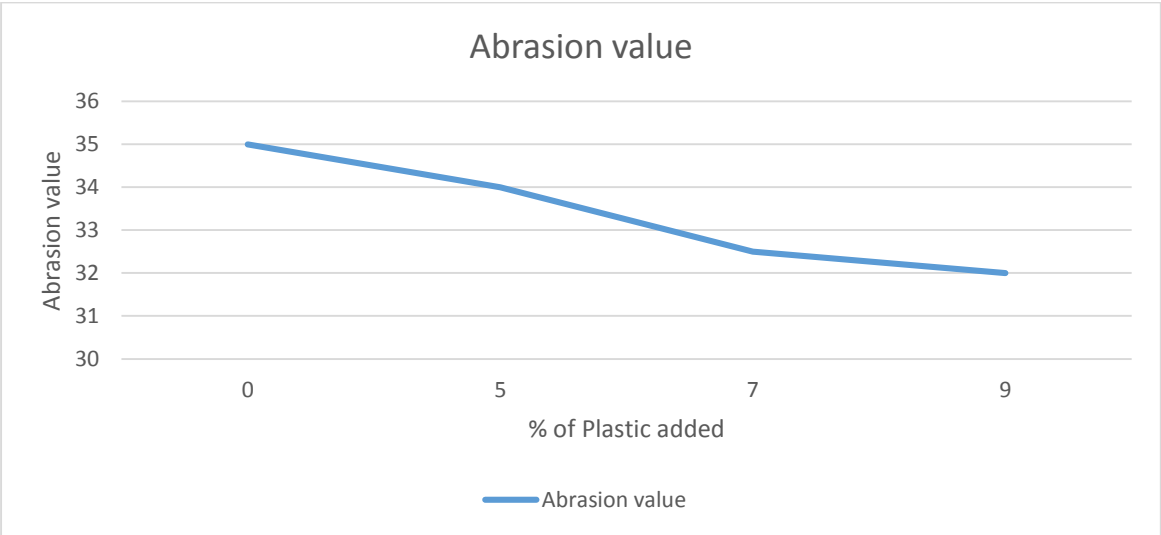

Chart 3.2.2 Abrasion value

Inference: Abrasion value should be less than 30% for pavements.

3.2.3 CRUSHING TEST

The aggregate with lower crushing value demonstrates a lower crushed part under load and would give a more extended administration life span to the road. Normal aggregate would get crushed under traffic load.

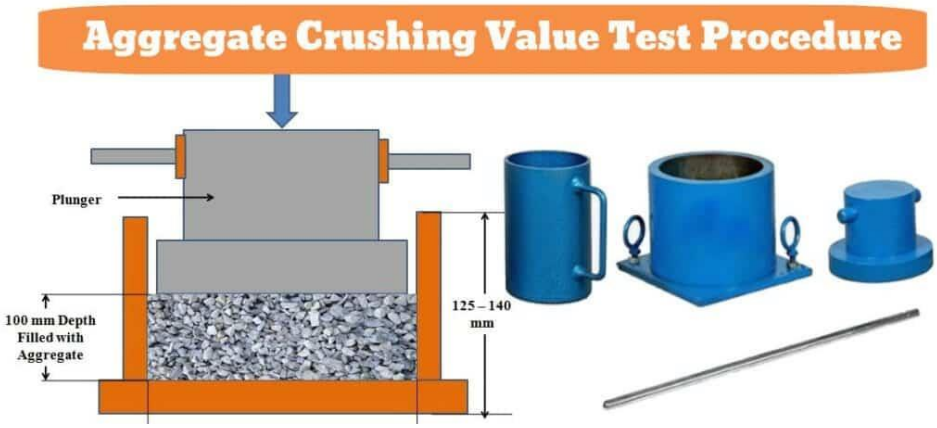

Figure 3.2.3 Crushing test on aggregate

Experimental data:

Table 3.2.3 Crushing test on aggregates

S.no	% of plastic added	Crushing value (%)
01	5	21.46
02	7	19.8
03	9	18.2
04	12	17.4

Observation:

W1 = weight of dry sample

W2 = weight of portion of crushed sample passed through 2.36mm IS sieve

Formula:

Aggregate crushing value = (W2/W1) *100

Graphical representation:

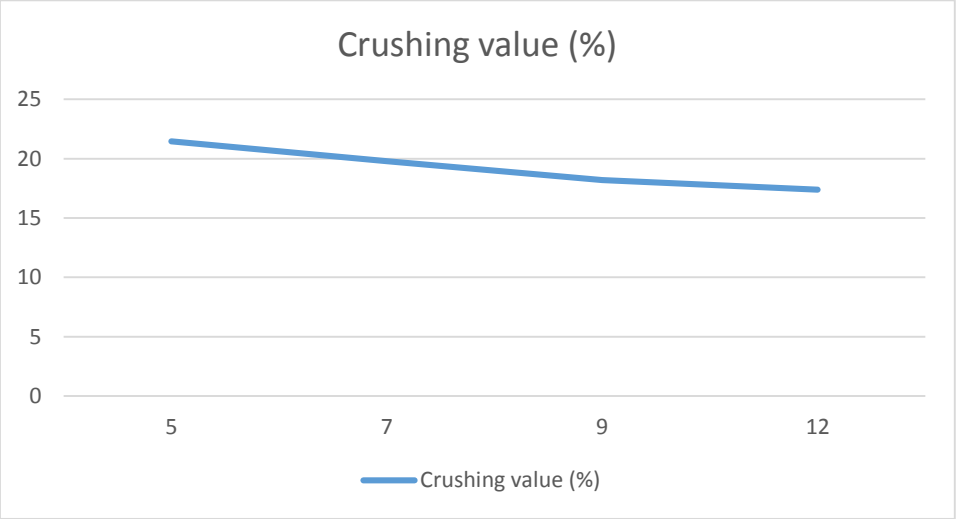

Chart 3.2.3 Aggregate crushing value

Inference: It is clearly observed from Table-that plastic covered aggregates demonstrates the lower crushing value and which can be withstand to traffic load more proficiently than the plain aggregates. The outcomes demonstrate that the aggregates are inside the range as indicated by ISS. Its range ought to be under 30 % - 35 %.

3.3 COMPARISON BETWEEN ORDINARY ROADS AND PLASTIC WASTE ROADS

Table 3.3 Comparison of Ordinary and PVC roads

Sl. No	Properties	Ordinary roads	PVC waste roads
1	Tensile strength	Less	High
2	Softening point	More	Less
3	Binding property	Good	Better
4	Cost of Pavement	Normal	Less
5	Seepage of water	Yes	No
6	Striping (Pot holes)	More	No
7	Durability of road	Good	Better
8	Environment friendly	No	Yes
9	Maintenance cost	More	Almost Nil
10	Marshall Stability value	Less	More

CHAPTER 4

4. ADVANTAGES AND DISADVANTAGES

4.1 ADVANTAGES OF PLASTIC ROADS

- The biggest advantage is that it is environmental friendly.
- The strength is increased twice to the normal roads.
- There is no damage effect of radiation such as ultraviolet rays.
- Binding property is much better than the normal roads.
- There is less chances of rutting in the road.
- The road provides better resistance towards rainwater.
- The Marshall Stability value is increased.
- The cost of road construction is decreased.
- Maintenance cost of such construction is almost zero.
- Disposal of waste plastic will be no longer being a problem to the environment
- For two lanes of 1km × 3.5m road, about 1 ton of plastic is used and 1 ton of bitumen is saved.

4.2 DISADVANTAGES OF PLASTIC ROADS

- The toxics present in the plastic waste may start leaching during cleaning process.
- The presence of chlorine may release harmful gases at the time of road laying
- The road can leach at the time of first rain.

CHAPTER 5

5. CONCLUSION

On the basis of experimental work performed during the project it is concluded that: Waste PVC pipe can be successfully used as modifier with bitumen having conventional mix of 5.5%. The addition of waste PVC increases the softening point, specific gravity and decreases the penetration value, ductility which will prove beneficial in hot climate areas and also helpful to overcome the bleeding problems. By using the waste PVC, the stability and % air voids of the bituminous mixes were improved. Form the test conducted above the PVC is mixed at various % in the bitumen and the stability is checked, as per that the bitumen mix with 6% shows the highest value. Some of the advantages of using PVC in paving applications were listed below;

1) Use higher percentage of plastics waste.
2) Reduce the need of bitumen by around 10%.
3) Increase the strength and performance of the road.
4) Avoid the use of anti-stripping agents.
5) Reduce the cost to around Rs. 30000/ km of single lane road as on date.
6) Carry the process in situ.
7) Avoid industrial involvement.
8) Avoid disposal of plastics waste by incineration and land filling.
9) Generate jobs for rag pickers.
10) Add value to plastics waste.
11) Develop a technology, which is eco-friendly

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