

EFFECTIVENESS OF BITUMEN WITH THERMOCOL GLUE

Submitted in practical fulfillment of the requirements for the awards of
bachelor of engineering degree in civil engineering

By

V.S.RAAMNATH (Reg.No.38200028)

R.NARESH (Reg.No.38200042)



**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT
SATHYABAMA**

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC
JEPPIAAR NAGAR, RAJIVGANDHI SALAI,
CHENNAI-600119**

APRIL 2022



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with "A" grade by NAAC

JeppiaarNagar, Rajiv Gandhi Salai, Chennai-600119

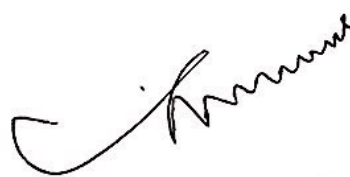
www.sathyabama.ac.in



DEPARTMENT OF CIVIL ENGINEERING

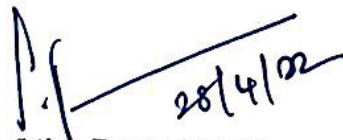
BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of **V.S.RAAMNATH (Reg.no.38200028)** and **R.NARESH (Reg.no.38200042)** who carried out the project entitled **"EFFECTIVENESS OF BITUMEN WITH THERMOCOL GLUE"** under our supervision from November 2021 to April 2022.

 28/4/22

Internal Guide

Dr.V.SAMPATHKUMAR M.E., Ph.D., M.A., M.Sc., LLB., Dip in IRT Delhi

 28/4/22

Head of the Department

(Dr. S. PACKIALAKSHMI)

Submitted for Viva Voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

We **V.S.RAAMNATH (Reg.no.38200028)** and **R.NARESH (Reg.no.38200042)** hereby declare that the project report entitled **"EFFECTIVENESS OF BITUMEN WITH THEROMCOL GLUE"** Done by us under the guidance of **Dr.V.SAMPATH KUMAR M.E., Ph.D., M.A., M.Sc., D.IRT Delhi** is submitted in practical fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil engineering

DATE:

1.



PLACE:

2.



SIGNATURE OF CANDIDATE

ACKNOWLEDEMENT

We are pleased to acknowledge our sincere thanks to the board of management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. Devyani Gangopadhyay, B.Arch., M.T.P., Ph.D.**, deanschool of building and Environment and **Dr. S. Packialakshmi, M.E, Ph.D.**, and **Dr. R. Padmapriya, M.E., Ph.D.**, head of the department, depth of civil engineering for providing necessary support and detail at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our project guide **Dr. V. SAMPATH KUMAR M.E., Ph.D., M.A., M.Sc., LLB., Dip in IRT Delhi** for his valuable guidance, suggestions, and constant encouragement that paved way for the successful completion of my project work.

We wish to express our thanks to all teaching and non-teaching staff members of the department of Civil Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

Disposal of different waste produced from different industries is a main problem to the society. These materials also pose environmental pollution in the nearby locality because many of them are non-biodegradable, Thermocol is one among them. Natural materials are limited in quantity which leads to increasing cost. Thermocol is widely used due to its varied and highly desirable qualities, as well as the convenience and low cost of manufacture. Recycling thermocol to prepare a strong adhesive that could even stick two bricks, plywood or metals together; using discarded plastic to make roads that are durable and environment friendly. Concerned about this, engineers are looking for alternative materials for highways construction, by which the quality of road is increased with low cost. Given the importance of making large-scale use of these solid wastes in India, it is believed necessary to evaluate these materials and develop criteria to improve the use of waste materials in road construction, where larger economic returns may be feasible. This project will conduct a study on recycling plastic (Thermocol glue) and blending it with bitumen to lay roads in India and compare with economic conditions. In this project, Thermocol glue pieces are partially mixed with bitumen in different percentage to check their replacing ability by conducting few standard tests.

Keywords: Thermocol glue, Bitumen, Partial replacement, low cost road, standard tests.

TABLE OF CONTENT

CHAPTER NO.	TITLE	PAGE NO.
	ABSTRACT	v
	LIST OF FIGURES	viii
	LIST OF TABLES	ix
1.	INTRODUCTION	1
	1.1 THERMOCOL GLUE	1
	1.1.1 Amount of thermocol waste produced in India	1
	1.1.2 What is Thermocol glue?	1
	1.1.3 Recycling of plastic waste	1
	1.1.4 Waste Thermocol and its Management	2
	1.2 BITUMEN	3
	1.3 BENEFITS OF MODIFIED BINDER	4
2.	LITERATURE STUDY & METHODOLOGY	5
	2.1 LITERATURE REVIEW	5
	2.2 METHODOLOGY	9
3.	OBJECTIVES	10
	3.1 OBJECTIVES	10
4.	MATERIALS USED	11
	4.1 THERMOCOL GLUE	11
	4.2 BITUMEN-AVISCO-ELASTIC MATERIALS	12
	4.3 ADHESION PROPERTIES OF BITUMEN	13
	4.4 AGGREGATES	13
5.	TEST FOR THERMOCOL MODIFIED BITUMEN	14
	5.1 VISCOSITY TEST	14
	5.1.1 Results & Observations	14
	5.2 SOFTENING POINT TEST	15
	5.2.1 Results & Observations	15
	5.3 DETERMINATION OF PENETRATION VALUE	16
	5.3.1 Results & Observations	16

5.4	LOSS ON HEATING TEST	17
5.4.1	Results & Observations	17
5.5	DUCTILITY TEST	18
5.5.1	Results & Observations	18
5.6	DETERMINATION OF FLASH AND FIRE POINTS	19
5.6.1	Results & Observations	20
5.7	SPECIFIC GRAVITY	20
5.7.1	Results & Observations	21
5.8	Water Content Test	21
5.8.1	Results & Observations	22
5.9	EXPLANATION OF RESULTS OBTAINED	22
5.10	MARSHALL STABILITY TEST- FLOW TEST ON BITUMEN	23
5.10.1	Apparatus used	24
5.10.2	Results & Observations	25
6.	CONCLUSION	26
	REFERENCES	27

LIST OF FIGURES

TABLE NO	TITLE	PAGE
1.1	Thermocol glue sticks	2
1.2	Bitumen	3
4.1	Small pieces of Thermocol sticks	11
4.2	Resultant adhesive reaching melting point	12
5.1	Viscosity Testing Machine	14
5.2	Softening Point Testing Apparatus	15
5.3	Softening Point Testing Machine	15
5.4	Bitumen Penetration test Apparatus	16
5.5	Testing for loss of heat	17
5.6	Ductility Test	18
5.7	Flash and Fire Point	20
5.8	Specific Gravity	20
5.10	Water content Test	21
	Marshall compaction mold	24
	Water bath	24

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
5.1	RESULTS- Viscosity Test	15
5.2	RESULTS- Softening Point Test	16
5.3	RESULTS- Bitumen Penetration Test	17
5.4	RESULTS- Loss of Heat	18
5.5	RESULTS- Ductility Test	19
5.6	RESULTS- Flash and Fire Point	21
5.7	RESULTS- Specific Gravity	22
5.8	RESULTS- Water Content Test	23
5.10	RESULTS- Marshall Stability Test	26

LIST OF SYMBOLS& ABBREVIATIONS

Acronyms	Expansions
%	Percentage
Kg	Kilogram
Cm	Centimeter square
Mm	Millimeter
° C	Degree Celsius

CHAPTER – 1

INTRODUCTION

1.1 THERMOCOL GLUE

1.1.1 Amount of thermocol waste produced in India

Each person uses 5gm of plastics bags in a week, and all over India it is equal to 52,000 tons per year. On assuming just 50% of this if available for roads **1.5 tons plastics** will go into average of 1km road. So, resurfacing just 35,000km of roads a year will absorb all the littered waste and this is just 3.5% of Indians 1 million km surface roads (1.1 million km more roads are un-surface)

1.1.2 What is Thermocol glue?

Thermocol is a kind of polystyrene which is utilized for packing. After use it is thrown away as a “waste plastic”. Thermocol is a packing material used to protect expensive products like Refrigerators, television and computers. After being used they are thrown away without recycling. Thermocol is a plastic and Plastic is very harmful to the environment as they respond very slow to bacterial decomposition in the soil and the fertility of the soil gets deteriorated, on burning the same will release harmful gases which is a threat to human and animals when inhaled causing respiratory problems or even death. Thus, it is seen that thermocol is harmful for environment and the same can be used as an adhesive in bitumen.

1.1.3 Recycling of plastic waste

An unwanted or undesired material or substance is considered as the Waste or trash, junk, garbage, depending on the type of materials or the local terminology. It may consist of manufacturing leftovers (industrial and commercial) or from community of people and their household activities. Before recycling these materials are dismantled and then collected, stored later treated (physically, chemically, or biologically), before being recycled. They are wastes which are used inappropriately. Plastic is a synthetic material which is made up of polymerizing molecular of monomer, materials which are derived from coal, petroleum or natural

gas. Proper way of handling plastic waste is to recycle them which is more desirable because it would avoid their accumulation in landfills.



Fig:1.1: Thermocol Glue sticks

1.1.4 Waste Thermocol and Its Management

- Benefit of use of Thermocol waste in bitumen has been found both eco-friendly and economical.
- Thermocol waste material may replace the costly imported additives like SBS and EVA and also reduce the amount of bitumen used in making construction of bituminous layers more economical.
- Disposal of Thermocol waste will be reduced in future since it can be used in hot bituminous mixes. This directly relates to environment friendly by disposing waste material judiciously and reducing the concept of importing materials at higher cost. This benefits in the saving of public money. The benefit accrued by adding Thermocol waste is to enhance the quality of such mixes in the performance and design life of asphaltic roads. Also, it will be contributing to a cleaner and greener environment by using of plastic wastes in the road construction.

1.2 BITUMEN ROAD

Bitumen is defined as "A viscous, or a solid, comprising primarily of hydrocarbons and their derivatives, which is soluble in trichloro-ethylene, is substantially nonvolatile, and softens gradually when heated," according to the definition of bitumen. It's a dark brown or black color. Bitumen is known for its property of waterproofing and adhesion. The refining process produces bitumen from petroleum. Bitumen occurs naturally or as a component of naturally occurring asphalt and is associated with mineral components. Bitumen is manufactured from crude oil by distillation, blowing and degassing. After these processes, the high molecular weight and chemical complexity components of crude oil are concentrated in bitumen. The world's major oil producing regions include the United States, the Middle East, Caribbean countries and Russia. Crude oil from different sources has different physical and chemical properties thus bitumen may contain hydrogen and carbon primarily but may also contain the sulphur or oxygen influencing the properties of the bitumen.



Fig:1.2: Bitumen

1.3 BENEFITS OF MODIFIED BINDER

- High binder content improves resistance to cracks on the surface.
- Improved resistance to aging and oxidation
- Improved resistance to fatigue and reflective cracks
- Improved resistance to rutting due to increased viscosity and softening points
- The contact between the pavement and the cut improves visibility at night.
- Increases binder film thickness and opening structure, reducing noise.
- Reduced on-site construction time.
- Improves road quality and reduces road maintenance costs
- Helps manage hazardous waste
- Eco-friendly design helps maintain the balance of the environment.

CHAPTER – 2

LITERATURE STUDY & METHODOLOGY

2.1 REVIEW OF LITERATURE

First of all, various books and journals were collected for reference and were studied before starting the project work for having an idea about how the project should be. In this project n Thermocol waste and plastic waste in road are introduced.

Use of plastic waste in bituminous pavement

R.Manju; S.Sathya; K.Sheema; (2017)

Plastic, which is a mixture of asphalt and aggregate, is used to improve the quality of road. The polymer coated on the aggregate will reduce voids and moisture absorption to considerable extent. This will reduce ruts and prevent holes. Plastic pavement is more durable than tar pavement. The use of synthetic mixtures reduces bitumen content by 10% and improves road strength and performance. These new technology materials (titanium dioxide) can even reduce vehicle pollution in the air and land pollution with a polymer content of 10%.

Use of waste plastic in road construction

Ahmed Trimbakwala

This article examines that the use of plastic in road construction is not new. Already used as a PVC or HDPE pipe mat intersection, it is built by wiring Polyvinyl Chloride or High Density Polyethylene Pipes together into a plastic mat. Plastic waste is crushed into powder. Bitumen contains 3-4% plastic. Durability of bitumen roads. Roads laid with shredded plastic waste are much more durable than roads with asphalt with regular mixtures.

Waste thermocol to adhesive for better environment

B.Narendra, V.Chaitanya, G.chetan, Kumar

Plastics are now an integral part of everyday life and the disadvantages of plastics cannot be ruled out, but certain tips on how to dispose of plastic waste can reduce some of the disadvantages. Thermocol is basically a polystyrene $[\text{CH}(\text{C}_6\text{H}_5\text{CH}_2)]_n$ structure. Experiments have shown that gasoline and toluene show better adhesion quality than other solvents. It's easy and you only need a beaker, a glass rod and a scale. Therefore, this method is economical. Again, no additives, catalysts, or intermediates are used and no gaseous or residual products are formed during the process. hence this technique is ecofriendly.

Use of plastic waste inflexible pavements

J.Apurva

The plastic coating of aggregate is used to improve road performance. This helps to use bitumen better with wasteful coated aggregate of plastic by increasing the bond and contact area between the polymer and bitumen. Polymer coating of bitumen in the cavity. This reduces fraying and there is no cave exploration. Roads have a lot of traffic and are durable.

Study of bitumen characteristics with use of waste plastic

G.Agandeep, Amanpreet, Jatin Anand

In our country, plenteously of industrial surplus is produced by industrial activities due to industries, refines and coal fields.in further by adding industrial waste products municipal solid surplus of garbage comprising nonbiodegradable ingredients is to create inside the municipal limits. this is a main basics of ecological pollution effects and also suitable disposal in major difficulty in order to save the environment. The usage of surplus plastics in the formation of road was main concern taken in this route. usage of surplus plastics in the formation of road was main concern taken in this route. usage of appropriate road waste solid in the building of roads not only make available substantial equivalent on road materials cost, but italso helps in to solve the situation of king of waste materials. India lacks much in road construction on national, state and village roads

Compared rough aggregate concrete polystyrene beads with regular concrete blocks

Patidar et al 2019

The result is that the number of polystyrene beads embedded in the concrete affects the structure of the hardened concrete, and the tensile strength, compressive strength and bending strength of M30 and M40 are also 5%, 10%, 15%, 20% and 25%. , And 30% replacement coarse aggregate. Low water / cement ratio and very high mixing performance

Utilization of plastic waste in bitumen mixes for flexible pavement

S.L.Hake, Dr.M.Damgir, Dr.R.Awsarmani

In this research, we are investigating how to recycle plastic waste in order to promote the development of asphalt that can be backed up. Bitumen is used as a foil in normal road construction. Such bitumen can be adjusted with waste parts of plastic, producing a bitumen mixture that can be used as the best layer of compatible asphalt. The plastic from the PET jug can be used as a mixture for testing work. 5%, 7.5%, 10%, 12.5%, 15% plastic measurements were used instead of Bitumen

A study on acting behavior of paving grade bitumen using filler material

MD.jamshed, B.shashikant

Bitumen aging hardening has long been recognized as one of the main factors that can have a significant impact on the durability of bitumen pavement materials. As the bitumen hardens, the asphalt mixture becomes brittle and can significantly reduce its ability to withstand traffic-related stresses and loads. Deterioration of the pavement due to easily induced cracks can continue, and excessive hardening weakens the adhesion between the aggregate and the bitumen, resulting in material loss on the surface and weakening of the asphalt mixture.

States that addition percentage by weight of processed plastic is desirable
C.E.justo

Adding 8% by weight of treated plastic will save 0.4% by weight of bitumen in the mixture. Using recycled plastic, this enhances the stability, strength, durability, and other desirable features of bitumen-proof bitumen macadam. Low density polyethylene (LDPE) replaces 30% of 2.365mm aggregate, reduces mixing density by 16%, and enhances Marshall Stability by a factor of 250%. Bitumen and aggregate are also increased compared to traditional flexible surface finishes.

Proves that the addition of plastic in the innovative technology which is strong then the road construction

B.sasaneneha, 2015

According to Marshall stability tests, flexible rubber with added plastic gives good results. Optimal use of plastic was investigated to be up to 10% easier to dispose of plastic waste

Use of waste plastics coated aggregate

DR.vasudevan, 2013

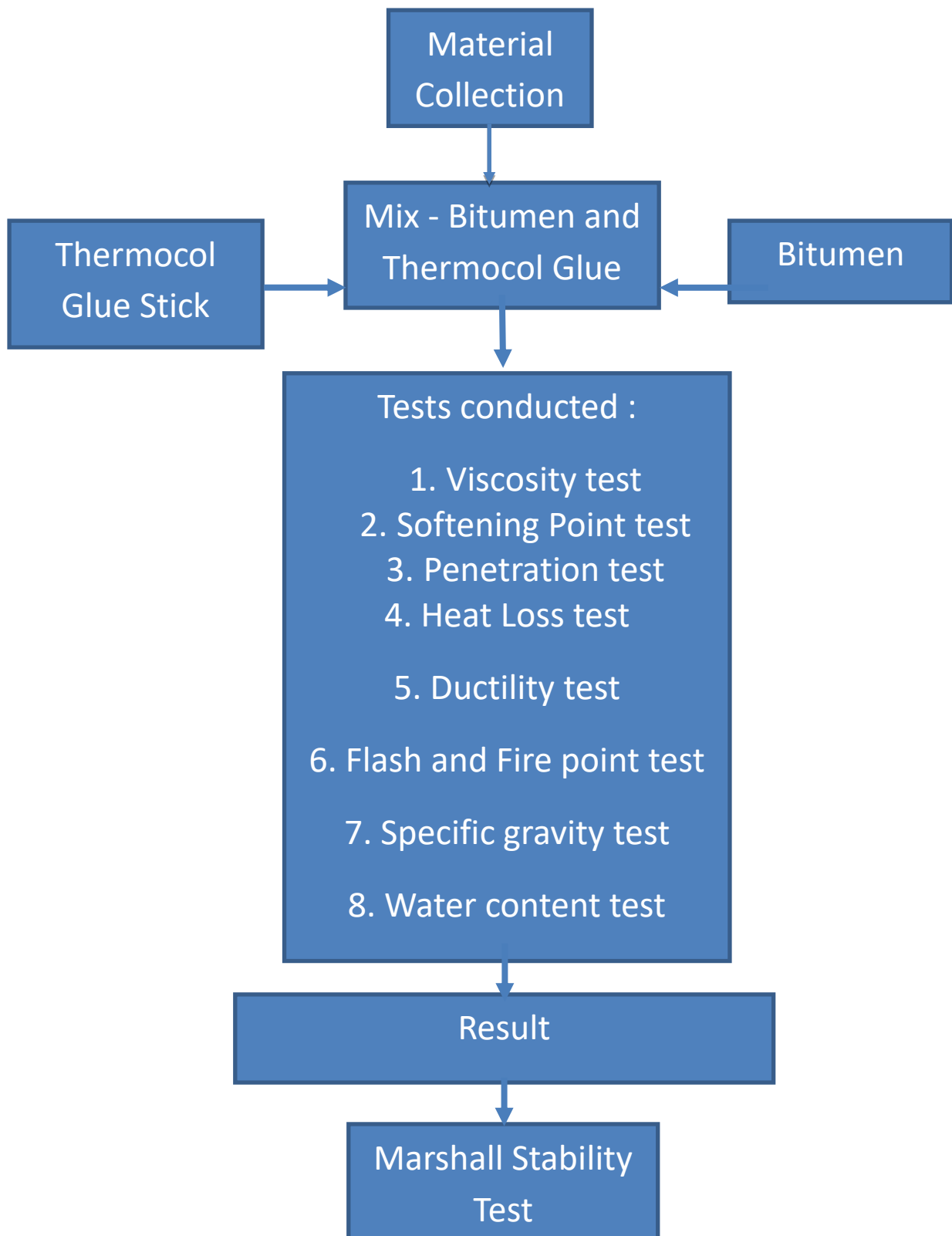
A case study was conducted in Madurai. Total waste and consumption of plastic for road construction is about 10,000 tons so far, which prevents the emission of carbon dioxide. 30,000 tones of waste have been prevented

Comparison of bitumen roads with plastics bitumen roads

K.P Manjusha, 2019

In this paper the rapidly reducing global methods and increasing the amount of plastic waste in urban solid waste is studied.

2.2 METHODOLOGY



CHAPTER 3

OBJECTIVES

3.1 OBJECTIVE

- To mix the various percentage of thermocol glue stick with bitumen.
- To test the effect of thermocol glue sticks with bitumen.
- To find the optimum quantity of thermocol glue stick mixed with bitumen.
- To find the Marshall test of bitumen with optimum percentage of thermocol glue.

CHAPTER 4

MATERIALS USED

4.1 THERMOCOL GLUE STICK

- Initially, Hot Melt Adhesives (HMAs) were primarily developed for industrial use. Thermocol is a kind of polystyrene that are used for packaging such as bookbinding, woodworking, lamination and craft gluing, etc.
- It will available in all stationery shops, Size: 11 mm x 20 cm
- Both thermocol and bitumen are good binders, so we used this product for road construction.
- “Waste plastic” is thrown away after use. Plastic reacts very slowly to the breakdown of bacteria in the soil. It affects soil fertility, releases toxic gases when burned, and can cause respiratory problems and even human and animal death when inhaled. Therefore, it used as an adhesive in bitumen.



Fig: 4.1: Small pieces of thermocol sticks

4.2 BITUMEN- A VISCO ELASTIC MATERIALS

The properties of bitumen can be defined as well as the elasticity of the solid material formed.

- Bitumen is a dark or brown material made from crude oil after it has been distilled and is known for its water repellency and stickiness.
- Bitumen is commonly used in the industry to help bond materials.

Today, this material is most commonly used for road pavement. Since it behaves like a liquid at high temperatures, it exhibits the characteristics of liquid flow such as viscosity. Bitumen, on the other hand, behaves like a solid at low temperatures; hence solid qualities such as stress and strain are involved. Similarly, bitumen behaves like a solid when the load time is short and like a liquid when the load time is long.



Fig: 4.2:Bitumen



Fig: 4.2: Thermocol glue mixed with bitumen

4.3 ADHESION PROPERTIES OF BITUMEN

Under good conditions, bitumen has excellent adhesion. However, adhesion causes some problems in the presence of water. Most aggregates used in road construction have a weak negative charge on their surface. On the other hand, the binding of bitumen aggregate derives from its weak dispersion force. Due to the high polarity of water, water is strongly attached to the aggregate and replaces the bituminous coating. Factors that affect the adhesion of aggregate to bitumen.

4.4 AGGREGATE

- An aggregate of non-metallic mineral obtained in particular form.
- They are used in construction to provide fill, voids, protect pipes and to provide hard surface.
- 1200 grams of aggregate, blended in the required proportions, is measured and heated to the mixing temperature in the oven.
- Aggregate materials help to make concrete mixes more compact.

CHAPTER 5

TEST ON BITUMEN AND THERMOCOL GLUE MIX

5.1 VISCOSITY TEST

Test Method – IS: 1206 – 1978

Viscosity measures the degree of liquidity of the bitumen sample. By giving a degree of liquidity at a temperature, it guarantees the quality of the bitumen used as a binder. The viscosity of the bitumen at 135 degrees Celsius is a strong measure of its capacity to cover the aggregate correctly. Because bitumen tends to be blessed, the viscosity must be appropriate for viscous bitumen in order to produce the best covering, it tends to be blessed, so it tends to be blessed with a very low viscosity properly and heterogeneous Bring a coating. Thus, a viscosity of 135 ° C. is true reflection of binding quality, which may be formed of aggregates. Viscosity can be tested using a variety of testing equipment such as capillary viscometers, cup viscometers and tar viscometers.



Fig:5.1: Viscosity testing machine

The experimental result on bitumen modified by the addition of thermocol glue at 10%,20%,30%,40%of the weight of the bitumen. It is observed that viscosity decreases gradually as the thermocol glue content increases.

Table 5.1: Viscosity Test Results and observation

S. NO.	DESCRIPTION	BITUMEN 100%+ THERMOCOL GLUESTICK 0%	BITUMEN 90%+ THERMOCOL GLUESTICK 10%	BITUMEN 80%+ THERMOCOL GLUESTICK 20%	BITUMEN 70%+ THERMOCOL GLUESTICK 30%	BITUMEN 60%+ THERMOCOL GLUESTICK 40%
1	Viscosity test	2.3min	6 min	7 min	9 min	11 min

5.2 SOFTENING POINT OF BITUMEN

Test Method – IS: 1205 - 1978

The average temperature at which the bitumen disc softens and sags 25 mm under the weight of the steel ball is known as the softening point. This method helps determine the consistency of the bitumen. This test provides information about the temperature at which the bitumen reaches a certain viscosity.



Fig: 5.2: Softening Point Testing Machine



Fig: 5.2: Softening Point Testing Apparatus

Thermocol glue percentage is varied as 10%,20%,30%,40%, at blinder content of at blinder content 7.5% maximum results are obtained at 7.5% thermocol glue modified bituminous mix.

Table 5.2: Softening point test results

S. NO	DESCRIPTION	BITUMEN 100%+ THERMOCOL GLUESTICK 0%	BITUMEN 90%+ THERMOCOL GLUESTICK 10%	BITUMEN 80%+ THERMOCOL GLUESTICK 20%	BITUMEN 70%+ THERMOCOL GLUESTICK 30%	BITUMEN 80%+ THERMOCOL GLUESTICK 40%
1	Softening point	47.3°C	62°C	65°C	58°C	60°C

5.3 PENETRATION VALUE TEST

Test Method – IS: 1203 – 1978

Assess the elasticity or vulnerability of a bitumen by measuring the distance that a standard attack needle penetrates vertically in 5 seconds at a tenth of a millimeter. BIS has organized a test frame. The needle entry metre comes with a 100-gram needle and a system for releasing and fixing any position.



Fig: 5.3: Penetration test Apparatus

Bitumen has an injectable viscosity, is fully mixed, and fills containers with a height of 15 mm or more with normal aisle filling. The test should be run at a given temperature of 25 ° C. It can be seen that penetration quality is affected by virtually all errors in injection temperature, needle size, weight applied to the needle, and test temperature. A 40/50 bitumen rating indicates a penetration quality of 40-50 grade under standard test conditions in high temperature environments, with a lower penetration rating being desirable.

The consistency of the bitumen is also measured by penetration testing. This test applies almost exclusively to bitumen. Other consistency tests are used for cutbacks, emulsions and tars.

Table 5.3: Penetration test results

S. NO	DESCRIPTION	BITUMEN 100%+ THERMOCOL GLUESTICK 0%	BITUMEN 90%+ THERMOCOL GLUESTICKS 10%	BITUMEN 80%+ THERMOCOL GLUESTICKS 20%	BITUMEN 70%+ THERMOCOL GLUESTICKS 30%	BITUMEN 60%+ THERMOCOL GLUESTICKS 40%
1	Penetration Test	34mm	65mm	40mm	37.5mm	43.7mm

5.4 LOSS ON HEATING TEST

Test Method - IS: 1212-1978

The loss on heating test measures the mass of volatile content in bitumen. This amount is important in the industry, especially in the paving industry. A bitumen with a high amount of loss on heating will be hardened as a result it becomes less flexible and brittle. Thus, if such a bitumen binder is used in pavement, the asphalt cannot endure load and temperature change as a result asphalt quality is reduced.

The loss on heating test determines the volatile component of bitumen. To perform this test, 50g of bitumen sample is heated in the oven at 163 degree Celsius. Then the amount of bitumen mass loss is determined.





Fig: 5.4: Loss on heating test machine

Table 5.4: Loss on Heating test results

S. NO	DESCRIPTION	BITUMEN 100%+ THERMOCOL GLUESTICK 0%	BITUMEN 90%+ THERMOCOL GLUESTICK 10%	BITUMEN 80%+ THERMOCOL GLUESTICK 20%	BITUMEN 70%+ THERMOCOL GLUESTICK 30%	BITUMEN 60%+ THERMOCOL GLUESTICK 40%
1	Heat loss	0.015%	0.043%	0.055%	0.045%	0.085%

5.5 DUCTILITY TEST

Test Method –IS: 1208-1978

The ductility test of bitumen is an important test of bitumen essential before using it for road construction purposes. The ductility test of bitumen is used to measure the adhesive and elastic properties of any bitumen sample.

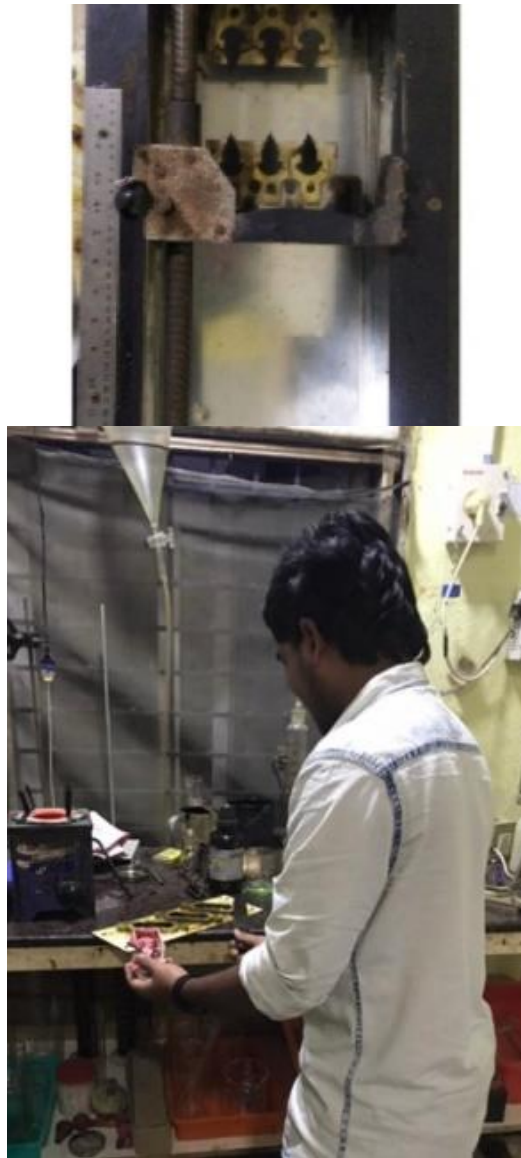


Fig: 5.5: Ductility test

Table 5.5: Ductility Test Results

S. NO	DESCRIPTION	BITUMEN 100%+ THERMOCOL GLUESTICK 0%	BITUMEN 90%+ THERMOCOL GLUESTICK 10%	BITUMEN 80%+ THERMOCOL GLUESTICK 20%	BITUMEN 70%+ THERMOCOL GLUESTICK 30%	BITUMEN 60%+ THERMOCOL GLUESTICK 40%
1	Ductility test	100cm	26.2cm	14cm	8.1cm	2.3cm

5.6 FLASH AND FIRE POINT TEST

Test Method – IS: 1209-1978

- Flash and firepoint tests are performed on the bitumen to determine safe mixing and applicable temperature ratings for a particular grade of bitumen.
- Bituminous materials release volatiles at high temperatures. These fugitives' smoke contains hydrocarbons that can ignite at any time if exposed to heat, and if left exposed to heat, the substance can ignite and burn. When mixing bitumen, especially during application, it is extremely dangerous to ignite. As a result, a safe bitumen grade temperature value for mixing must be identified. In addition, the application of temperature limits can be determined by the following test on bitumen.

FLASH POINT: The flash point of a material is the lowest temperature at which a substance's vapor ignites in the form of a flash under specified test conditions.

FIRE POINT: The lowest temperature at which a substance catches fire and burns under specific test conditions is known as its fire point.



Fig: 5.6:Flash and fire point

Table 5.6: Flash and Fire pointtest results

S. NO	DESCRIPTION	BITUMEN 100%+ THERMOCOL GLUESTICK 0%	BITUMEN 90%+ THERMOCOL GLUESTICK 10%	BITUMEN 80%+ THERMOCOL GLUESTICK 20%	BITUMEN 70%+ THERMOCOL GLUESTICK 30%	BITUMEN 60%+ THERMOCOL GLUESTICK 40%
1	Flash point	316°C	318°C	317°C	307°C	300°C
2	Fire point	320°C	310°C	307°C	315°C	315°C

5.6.1 SPECIFIC GRAVITY

Test Method – IS: 1202-1978

The specific gravity of bituminous materials, such as half-soil, asphalt cement, and soft tar pitch, is calculated by dividing the mass of a particular volume of material at 25 ° C by the mass of the same volume of material at the same temperature. Therefore, it can be used to classify bitumen binders for road construction. It also helps identify the source of the bitumen binder.



Fig:5.7:Specific gravity

Table 5.7: Specific gravity test results

S. NO	DESCRIPTION	BITUMEN 100%+ THERMOCOL GLUESTICK 0%	BITUMEN 90%+ THERMOCOL GLUESTICK 10%	BITUMEN 80%+ THERMOCOL GLUESTICK 20%	BITUMEN 70%+ THERMOCOL GLUESTICK 30%	BITUMEN 60% + THERMOCOL GLUESTICK 40%
1	Specific gravity	1.026	1.035	1.012	0.976	0.958

5.7 WATER CONTENT TEST

Test Method – IS: 1211-1978

When bitumen is heated to a temperature above its boiling point, foaming of bitumen may take place. To prevent this foaming, minimum water content is desirable in bitumen. Hence the water content test for bitumen is performed to know this amount water.

Water in bitumen can be measured by mixing a sample of known weight with a pure anhydrous petroleum distillate and heating and distilling the water. The weight of condensed and collected water is represented as a percentage of the original sample weight. The maximum moisture content should be less than 0.2 percent of the total weight.



Fig: 5.8: Water content test

Table 5.8: Water Content test results

S. NO	DESCRIPTION	BITUMEN 100% + THERMOCOL GLUESTICK 0%	BITUMEN 90%+ THERMOCOL GLUESTICK 10%	BITUMEN 80%+ THERMOCOL GLUESTICK 20%	BITUMEN 70%+ THERMOCOL GLUESTICK 30%	BITUMEN 60%+ THERMOCOL GLUESTICK 40%
1	Water content	0.00%	0.00%	0.00%	0.00%	0.00%

5.9 EXPLANATION OF RESULTS OBTAINED

Thus, on conducting preliminary tests it was found that the specimen with 60% of bitumen and 40% of thermocol glue had convincing results when investigating with different percentages under various trials. And hence it was determined as the optimal ratio for replacement to proceed with Marshall Stability test. Marshall Stability test is a flow test on bitumen that can be used to create a hot mix of bitumen and aggregates with a maximum size of 2.5 cm. Marshall Method is often used to create bituminous concrete mixes. This exam is commonly utilized in paving job routine testing programmes. The resistance of bituminous materials to deformation, displacement, rutting, and shearing pressures is referred to as Marshall Stability. Internal friction and cohesiveness are the fundamental sources of stability. Internal friction is the interlocking and frictional resistance of aggregates, whereas cohesion is the binding force of the binder material. Because bituminous pavement is occasionally subjected to high traffic loads, it is vital to use a bituminous material with adequate stability and flow.

5.10 MARSHALL STABILITY TEST

This mixed design structure determines the optimal bitumen content and how good an asphalt mixture's performance and the maximum load it can support. Marshall's stability and flow testing provides a predictive performance measurement of Marshall's mixed design approach. At a load rate of 50.8 mm/min, the stable section of the test evaluates the maximum load that the test piece can withstand. The sample is loaded until it breaks, at which point it is referred to as stable. The linked dial gauge monitors the sample's plastic flow (deformation) when it is loaded. At the same time as the maximum load, the flow rate is measured in 0.25 mm (0.01 inch) increments.

5.10.1 Apparatus required

- Sample mold assembly including a height of 63.5 cm in shape of shaped cylinder 10.16 cm, base plate, extension binder. Sample extractors for extracting compressed samples from mold. A suitable rod is a flat circular tamping surface with a load from extended collar to upper reworking ring. You need to accommodate the load from the upper reworking ring to the upper reworking ring. Buildup 45 cm.
- Compressed socket consisting of compressed sockets consists of 30 x 30 x 2.5 cm MS plates to hold the model assembly in position during compression. The mold holder consists of a spring voltage device filled on a compression basis with a compression mold.
- Upper and lower cylindrical segments or test heads with a 5 cm inner diameter curvature make form the breaking head. Long segments are fixed on a base with two vertical guide rods that allow the holes in the upper test segment to be inserted more easily.
- Loading machine: Upwards-lifting gear system. The top of the machine block in the test head is coupled to a pre-calibrated test ring with a capacity of 5 tones. It's sandwiched between the test ring and the foundation. The load lifter generates a 5 cm per minute stable vertical moment. The machine can reverse that moment and also allow sample

space to place the test head system after the test piece has been tested.

- The flowmeter consists of a guide, strainer and dial gauge, and the dial gauge actuation pin slides into the guide sleeve with almost no frictional resistance. A minimum of 0.025 mm is sufficient. The full vertical upward movement from the beginning position is referred to as the flow value. The entire vertical upward moment for eating without a load is exactly described by this equation. The following general equipment is also necessary in addition to the above.
- Oven or hot plate
- Water bath
- Range of Thermometer up to 200 ° C, sensitivity 2.5 ° C
- Other Miscellaneous equipmentsuch as containers, mixing and handling tools etc.



Fig: 5.10: Compaction Mould



Fig5.10: Marshall stability machine



Fig; 5.10: Water Bath

5.10.4 Observation & Results

Table 5.10: Marshall Test of Bitumen mixed with 40% Thermocol Glue

SINO.	CHARACTERISTICS	SPECIFICATIONS	TEST RESULTS
1	Stability(kg)	900(minimum)	1180.50
2	Density(g/cc)	2 to 3	2.25
3	Flow(mm)	5 to 4	3.658
4	Volume Of Voids (%)	3 to 6	3.58
5	Voids Filled Bitumen (%)	65 to 75	85.60
6	Voids in Mineral Aggregates (%)	>15	19.25

CHAPTER- 6

CONCLUSION

In this study the effect of thermocol glue modified with bitumen samples as a flexible pavement material was investigated, and the following test results were conducted. Penetration, viscosity, softening and ductility tests etc., The replacement of bitumen with various percentages of thermocol glue (10%,20%,30%,40%) has been investigation to obtained the tests results. The properties of thermocol glue as a bituminous material has been observed. Laboratory tests indicate that bitumen materials 40% replacement of thermocol glue provides better outcomes than other bitumen ratio. These findings are discussed in this project. The use of (thermocol glue) polystyrene in the construction of flexible pavement will improve the mix's qualities. This research helps in analyzing economic aspects of recycling plastic waste (polystyrene beads or thermocol glue) and combining it with bitumen to create roads in India. This directly relates to environment friendly by disposing waste materials at higher cost. This benefits in the saving of public money. Also, it will be contributing to a cleaner and greener environment and use of waste materials in road construction.

REFERENCES

- **Ahmed Trimbakwala [2017]** Plastic roads use of waste plastic in roads construction international journal of scientific and research publication, volume7, issue4, april 2017 137 ISSN 2250-3153
- **Azmat Shaikh [2017]** Use of plastic waste in road construction, sheikh Azmat International journal of Advance Research and development © 2017, www.IJARND.com
- **Dr.R.Vasudevan[2013]** A patent has been obtained from the government of India for the plastic tar roads laying process- patent no.A-H871;198254 and guidelines published by IRC-2013 IRC-SP:98-2013 for the use of waste plastic coated aggregate for flexible pavement and easy disposal of waste plastics.
- **Felice Giuliana [2019] Expanded polystyrene (EPS) in road construction: Twenty years of Italian experiences** www.sciencedirect.com Transportation research produced in India 45(2020) 410-417
- **Huda Shafiq [2016]** plastic roads: A recent Advancement in waste management international journal of engineering research & technology (IJERT) <http://www.ijert.org> ISSN: 2278-0181.
- **K.P manjusha[2019]**comparative study between bitumen roads and plastic bitumen roads, international research journal of engineering and technology (IRJET) e-ISSN:2395-0056
- **Lakshya Singh Solanki [2020]** International Journal of Engineering Research and Management (IJERM) Special Issue, November 2020, Feasibility of Using Plastic Waste in Road Construction, ISSN:2349-2058

- **M.Nassar [2012]** Evaluation of the effect of waste polystyrene on performance of asphalt binder, **ARPJ** Journal of science and technology©2011-2012
- **Prof.C.E. G Justo** states that addition of 8% by weight of processed plastic to save 0.4 percent bitumen by weight of mix is desired since it enhances bitumen's strength, stability, longevity, and other desirable attributes. Dense bituminous macadam with recycled plastics, primarily Low density polyethylene (LDPE), replacing 30% of 2.36-5mm aggregates lowered mix density by 16% and increased marshal stability by 250 percent.
- **Sasane Neha Betal (2015)** The addition of plastic is a new technology that strengthens road construction while also increasing road life since the plastic content boosts bitumen and aggregate properties. When compared to standard flexible pavement, flexible pavement with added plastic produces good results. The best use of plastic, according to marshal stability tests, is up to 10%.
- **Shweta N.Rokdey [2015] Use of plastic waste in road construction** international journal of computer application (0975-8887)international conference on quality upgradation in engineering science and technology (ICQUEST2015)
- **Surendra Kumar Saini [2018]** Feasibility study of plastic waste use in road construction positive and negative aspects conference on innovation trends in civil engineering (NCITCE2018)

Conference Certificate

