iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.54440

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Study on Bitumen Modified with Crumb Rubber and PVC

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Abstract: ***This study investigates the mechanical and rheological properties of bitumen modified with crumb rubber and polyvinyl chloride (PVC). The crumb rubber and PVC were added to bitumen at varying percentages and the resulting modified bitumen was tested for its viscosity, penetration, softening point, and elastic recovery. The results show that the addition of crumb rubber and PVC to bitumen improves its viscosity and elastic recovery properties, while reducing its penetration and softening point. The study also explores the optimal percentage of crumb rubber and PVC for modifying bitumen to achieve the desired mechanical and rheological properties. Overall, the study highlights the potential of using crumb rubber and PVC as sustainable additives for improving the performance of bitumen in road construction.***
Keywords: PVC, crumb rubber, bitumen, mix.

I. INTRODUCTION

Bitumen is a viscous, black, and sticky material that is used as a binder in the construction of roads, pavements, and other asphalt-based structures. Bitumen is derived from crude oil and is typically mixed with various additives to improve its performance and durability. One approach to enhance the performance of bitumen is to modify it with rubber and plastic materials. Crumb rubber, which is produced from recycled tires, is a popular modifier for bitumen. When added to bitumen, crumb rubber can improve its properties such as elasticity, fatigue resistance, and temperature susceptibility. Similarly, polyvinyl chloride (PVC) can also be used as a modifier to improve the viscosity and stability of bitumen. This study focuses on the effects of modifying bitumen with crumb rubber and PVC. The study aims to investigate the rheological, mechanical, and thermal properties of the modified bitumen and to determine the optimal dosage of crumb rubber and PVC for improving bitumen performance. The study also evaluates the potential environmental benefits of using recycled crumb rubber as a modifier for bitumen. The results of this study could provide valuable insights into the use of crumb rubber and PVC as modifiers for bitumen and could help to enhance the durability and sustainability of asphalt-based structures.

A. *Purpose of study*

1) The use of crumb rubber and PVC in bitumen modification can help reduce the amount of waste generated from these materials. This can be an environmentally friendly solution for waste disposal.
2) The use of crumb rubber and PVC in bitumen modification can also be cost-effective. Since these materials are often waste products, their use can be cheaper than other additives used in bitumen modification.
3) Studying the use of crumb rubber and PVC in bitumen modification can also lead to further innovations in the field of materials science and engineering. This can help advance the construction industry and lead to new and improved products and technologies.

B. *Objective of Study*

1) To introduce the concept of modifying bitumen with crumb rubber and PVC and explain the rationale behind this approach.
2) To describe the methods used in the study, including the preparation of the modified bitumen, the testing procedures used to evaluate its properties, and the analytical techniques used to characterize the modified bitumen.
3) To present the results of the study, including the impact of crumb rubber and PVC on the rheological properties, viscosity, adhesion, and aging resistance of the modified bitumen.

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II. LITERATURE REVIEW

A. General

The purpose of a literature review is to gain an understanding of the existing research and debates relevant to a particular topic or area of study, and to present that knowledge in the form of a written report. Conducting a literature review helps you build your knowledge in your field. We'll learn about important concepts, research methods, and experimental techniques that are used in our field. We'll also gain insight into how researchers apply the concepts we're learning in your unit to real world problems. Another great benefit of literature reviews is that as we read, we'll get a better understanding of how research findings are presented and discussed in our particular discipline.

B. Review of Literature

1) V. Suganpriya S. Omprakash V. Chandralega Study of Behaviour of Bitumen Modified with Crumb Rubber . (2016)

The aim of the study was to utilize the waste materials i.e. crumb rubber waste for mass scale utilization such as in highway construction in an environmental safe manner.

As a first part of this study, an attempt was made to assess the stabilization of the bitumen containing crumb rubber waste in shredded form by performing basic tests such as Penetration Test, Ductility Test, Softening Point Test, Viscosity Test and Flash & Fire Point Tests. On the basis of the performance of the modified bitumen, the range of optimum percentages of crumb rubber waste were selected for further investigations related to Bituminous Concrete Mixes such as Semi Dense Bituminous Concrete (SDBC). Marshall Values, namely Marshall Stability Value, Marshall Flow Value, Voids present in air, Voids in Aggregates and Void in Bitumen, determined from Marshall Stability Test, serve as the benchmark values to assess the quality of Bituminous Concrete. The design and performance of Bituminous Concrete mainly depends upon the quality and percentage of binder used.

2) Bapusaheb Shivajirao Deore College of Engineering, Dhule, Maharashtra , Use of waste plastic and crumb rubber in construction of flexible pavement .

Generation of plastic waste and rubber waste is increasing day by day and the necessity to dispose of this waste in a proper way is arising. Nowadays pavements are subjected to various kinds of loading which affects the pavement performance condition that causes various distresses. Use of plastic and rubber in pavement design as an innovative technology not only strengthened the road construction but also increase the road life. In this study, different tests were conducted on aggregates, bitumen, and bituminous mixes. The effect of the addition of waste polyethylene in the form of locally available carry bags had been checked on aggregates as well as on bitumen. As per visual inspection, 5%, 7.5% and 10% plastic coating was made on aggregates and sample were checked for crushing, impact and abrasion values. Effect of addition of waste plastic and crumb rubber on bitumen had been studied by varying concentrations of polyethylene from 0% to 15% i.e. 0%, 5%, 7.5%, 10%, 12.5% and 15% in bitumen. Various tests such as penetration, ductility, softening point, flash and fire point, viscosity and loss on heating were performed on the samples. The optimum percentage was taken from these tests which had shown satisfactory results for all the tests performed. Later, that optimum percentage value was used for preparing bituminous mixes for testing pavement properties such as Marshall Stability, compressive strength, and indirect tensile strength.

3) Athira R Prasad, Dr Sowmya N J2 , Bitumen Modification with Waste Plastic and Crumb Rubber .

Worldwide, sustainability is an important need of the hour in the construction industry and towards this end use of waste material in road construction is being increasingly encouraged so as to reduce environmental impact. In the highway infrastructure, a large number of originate materials and technologies have been invented to determine their suitability for the design, construction and maintenance of the pavements. Plastics and rubbers are one of them. . The plastic waste quantity in municipal solid waste is increasing due to increase in population and changes in life style. . Similarly most tires, especially those fitted to motor vehicles, are manufactured from synthetic rubber. Disposal of both is a serious problem. At the same time, continuous increase in number of vehicles emphasizes on need of roads with better quality and engineering design. This waste plastic and rubber can be used to partially replace the conventional material to improve desired mechanical characteristics for particular road mix. . In the present study, a comparison is carried out between use of different waste plastics like carry bags, PET bottles crumb rubber and all three (3%,4.5%,6%,7.5%,9%by weight of bitumen) in bitumen concrete mixes to analyze which has better ability to modify bitumen so as to use it for road construction.

4) *Arun Kumar , Parveen Berwal Abdullah I. Al-Mansour Mohammad Amir Khan ,Shamshad Alam , Seongkwan Mark Lee Akash Malik and Amjad Iqbal . Impact of crumb rubber concentration and plastic coated aggregate on the rheological performance of modified bitumen asphalt .*

The diminution of natural resource exploration, the retrieval of waste, and the structural modification of polymers by additives are the main contributions to sustainable development. The properties of bitumen are enhanced by the crumb rubber through effective bitumen modification techniques, which have environmental and economic advantages. In this study, plastic waste, plastic-coated aggregate (PCA), and bitumen were blended in order to enhance the engineering properties of the flexible pavement. In order to compute the composition of crumb rubber modified bitumen (CRMB), the adopted materials were subjected to the relevant experiments. PCA was a very effective material when compared to the standard bitumen road pavement. The recycling of waste crumb rubber and plastic was tested by adding them into the hot mix asphalt. The Marshall properties of standard (virgin) bituminous mix, CRMB grade 55, and plastic mix asphalt were studied in detail to explore the solutions for a sustainable environment. The comparison was performed between these two materials with the standard bitumen, which resulted in the CRMB and plastics being found as the most effective additions with robust properties such as low-cost material, high strength, long life usage, and un-harmful to nature. The optimal bitumen content was found to be 6.166%, 6.1%, and 5.833% for standard bitumen, crumb rubber modified bitumen, and plastic-coated aggregate, respectively.

5) *Anusha G Krishna , Waste Plastic and Crumb Rubber in Flexible Pavement .*

Use of waste plastic and natural crumb rubber in road is being increasingly encouraged to reduce environmental influence. The plastic waste measure in of solid waste is increasing due to increase in population and changes in life style. Similarly, tyres those fitted to motor vehicle, are manufactured from synthetic Stinker rubber. Disposal of both natural rubber and vehicle tyres is a serious problem. At the same time, constant increase in the number of vehicles accentuates on need of road with better caliber and production design. Hence, waste plastic and crumb rubber can be used to partially replace the conventional material along with bitumen to improve desired mechanical characteristics for particular road mix. In the present study, a comparison is carried out between use of waste plastic like LDPE and Rubber (1, 1.5,2,2.5%by weight of bitumen) in bitumen concrete mixture to analyze which has better power to modify bitumen to use it for road construction, giving the same strength.

6) *Imran M. Khan, Shahid Kabir, Majed A. Alhussain, Feras F. Almansoor. Asphalt Design Using Recycled Plastic and Crumb-rubber Waste for Sustainable Pavement Construction.*

The seasonal change in temperature and loading nature has a significant effect on asphalt behavior because of its viscoelastic nature. Several types of flexible pavement failure/distress occur due to this behavior of asphalt binder, among which rutting and fatigue cracks are very common. In this study, Low Density and High Density Polyethylene and Crumb rubber were used as additions to base bitumen (PG 64-10). Complex modulus (G*) and phase angle (δ) obtained from Dynamic Shear Rheometer (DSR) are the basic perimeters used to evaluate the behavior of the binder in respect to rutting and fatigue cracking. It was concluded that Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), and Crumb Rubber (CR) modified binder showed significant improvement in rheological properties of the binder. Furthermore, recycling these municipal wastes will contribute to solving environmental problems in the Kingdom of Saudi Arabia caused by the piling up of these wastes in dumpsites.

III. METHODOLOGY

A. Introduction

Methodology is the study of research methods. However, the term can also refer to the methods themselves or to the philosophical discussion of associated background assumptions. A method is a structured procedure for bringing about a certain goal. In the context of research, this goal is usually to discover new knowledge or to verify pre-existing knowledge claims. This normally involves various steps, like choosing a sample, collecting data from this sample, and interpreting this data. The study of methods involves a detailed description and analysis of these processes. It includes evaluative aspects by comparing different methods to assess their advantages and disadvantages relative to different research goals and situations.

1) *Material Used*

a) *Plastic:* Good insulation and low thermal conductivity , good impact resistance and they don't rust , good bear resistance .

b) *Bitumen:* Adhesive , resistance to water , viscosity and flow , durability, ductility.

c) *Aggregate:* Aggregate shows property of Hardness , durability , toughness .

B. *Experiment to be performed are as follows*

1) *Penetration Test:* The penetration test is carried out to know the hardness or softness of bitumen used in road construction by measuring the distance in tenths of a millimeter to which a standard needle will penetrate vertically into a sample of bitumen under the stipulated condition of temperature, time and loading.
2) *Flash and Fire Test:* Flash point of bitumen is the temperature at which, it's vapour will ignite temporarily during heating, when a small flame is brought into contact with the vapour. The knowledge of this point is of interest mainly to the user, since the bitumen must not be heated to this point. The flash point tells the critical temperature at and above which suitable precautions are required to be taken to eliminate the danger of fire during heating.
3) *Softening Point:* The softening point is the temperature at which the substance attains a particular degree of softening under the specified condition of test. The softening point of bitumen is usually determined by the Ring and Ball test .
4) *Crushing Value Test:* The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. With aggregate of aggregate crushing value 30 or higher, the result may be anomalous, and in such cases the ten percent fines value should be determined instead.
5) *Los Angeles Test:* The Los Angeles (L.A.) Abrasion Test is widely used as an indicator of the relative quality of aggregates. It measures the degradation of standard gradings of aggregates when subjected to abrasion and impact in a rotating steel drum with an abrasive charge of steel balls.
6) *Impact Test:* The Aggregates Impact Value (AIV) Apparatus is used to determine the aggregate impact value which provides a relative measure of the resistance of an aggregate to sudden shock or impact. The counter fitted to the machine automatically records the number of blows delivered to the sample.
7) *Flakiness and Elongation Test:* The Flakiness Index of aggregates is the percentage by weight of particles whose least dimension (thickness) is less than 0.6 times their mean dimension. The Elongation Index of aggregates is the percentage by weight of particles whose greatest dimension (length) is greater than 1.8 times their mean dimension.
8) *Marshall Stability Test:* The basic Marshall test consists essentially of crushing a cylinder of bituminous material between two semi-circular test heads and recording the maximum load achieved (i.e. the stability) and the deflection at which the maximum load occurs (i.e. the flow).

This can be easily understood by the following flow chart

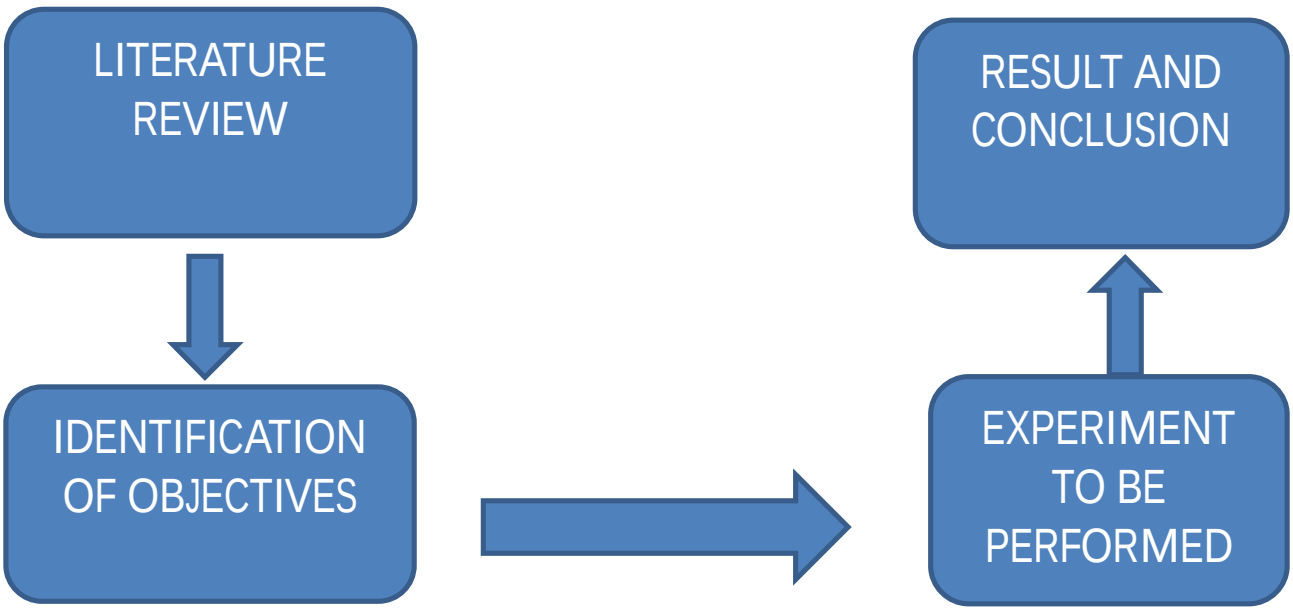

Fig 3.16 Methodology

IV. METHODOLOGY

A. *Introduction*

Methodology is the study of research methods. However, the term can also refer to the methods themselves or to the philosophical discussion of associated background assumptions. A method is a structured procedure for bringing about a certain goal. In the context of research, this goal is usually to discover new knowledge or to verify pre-existing knowledge claims. This normally involves various steps, like choosing a sample, collecting data from this sample, and interpreting this data. The study of methods involves a detailed description and analysis of these processes. It includes evaluative aspects by comparing different methods to assess their advantages and disadvantages relative to different research goals and situations.

1) Material Used

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B. *Experiment to be Performed are as Follows*

1) Penetration Test: The penetration test is carried out to know the hardness or softness of bitumen used in road construction by measuring the distance in tenths of a millimeter to which a standard needle will penetrate vertically into a sample of bitumen under the stipulated condition of temperature, time and loading.

Fig 3.1 Performing Penetration Experiment

2) Ductility Test: Use of ductility test is to measure the adhesive property of bitumen and its ability to stretch. Elastic recovery of any modified bitumen binder is evaluated by the percentage of recoverable strain measured after an elongation during a conventional ductility test. The ductility of

Fig 3.2 Briquette Mould

Fig 3.3 Ductility Testing Machine

3) *Flash and Fire Test:* Flash point of bitumen is the temperature at which, it's vapour will ignite temporarily during heating, when a small flame is brought into contact with the vapour. The knowledge of this point is of interest mainly to the user, since the bitumen must not be heated to this point. The flash point tells the critical temperature at and above which suitable precautions are required to be taken to eliminate the danger of fire during heating. This temperature, however, is well below that at which the bitumen will burn. The latter temperature is called the fire point.

Fig 3.4 Pensky Martin Apparatus

4) *Softening Point:* The softening point is the temperature at which the substance attains a particular degree of softening under the specified condition of test. The softening point of bitumen is usually determined by the Ring and Ball test .

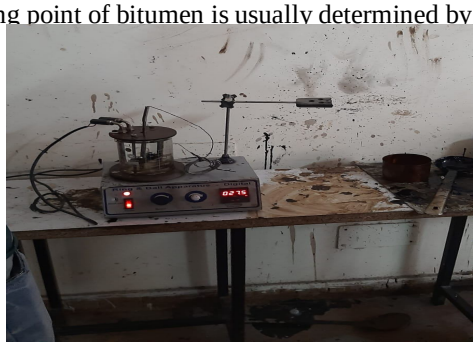


Fig 3.5 Ring And Ball Apparatus

5) *Crushing Value Test:* The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. With aggregate of aggregate crushing value 30 or higher, the result may be anomalous, and in such cases the ten percent fines value should be determined instead.

Fig3.6 Compression Testing Machine Fig3.7 Plunger

6) *Los Angeles Test:* The Los Angeles (L.A.) Abrasion Test is widely used as an indicator of the relative quality of aggregates. It measures the degradation of standard gradings of aggregates when subjected to abrasion and impact in a rotating steel drum with an abrasive charge of steel balls.

Fig 3.8-Abrasion Balls

Fig3.9 Los Angeles Abrasion Testing Machine

7) *Impact Test:* The Aggregates Impact Value (AIV) Apparatus is used to determine the aggregate impact value which provides a relative measure of the resistance of an aggregate to sudden shock or impact. The counter fitted to the machine automatically records the number of blows delivered to the sample.

Fig 3.10 Impact Testing Machine

8) *Flakiness and Elongation Test:* The Flakiness Index of aggregates is the percentage by weight of particles whose least dimension (thickness) is less than 0.6 times their mean dimension. The Elongation Index of aggregates is the percentage by weight of particles whose greatest dimension (length) is greater than 1.8 times their mean dimension.

Fig 3.11 Flakiness Index Apparatus

Fig 3.12 Elongation Index Apparatus

Fig 3.13 Elongation Index Apparatus

9) *Marshall Stability Test:* The basic Marshall test consists essentially of crushing a cylinder of bituminous material between two semi-circular test heads and recording the maximum load achieved (i.e. the stability) and the deflection at which the maximum load occurs (i.e. the flow).

Fig 3.14 Performing Marshall Stability Test

Fig 3.15 Wet Mould Weight

This can be easily understood by the following flow chart

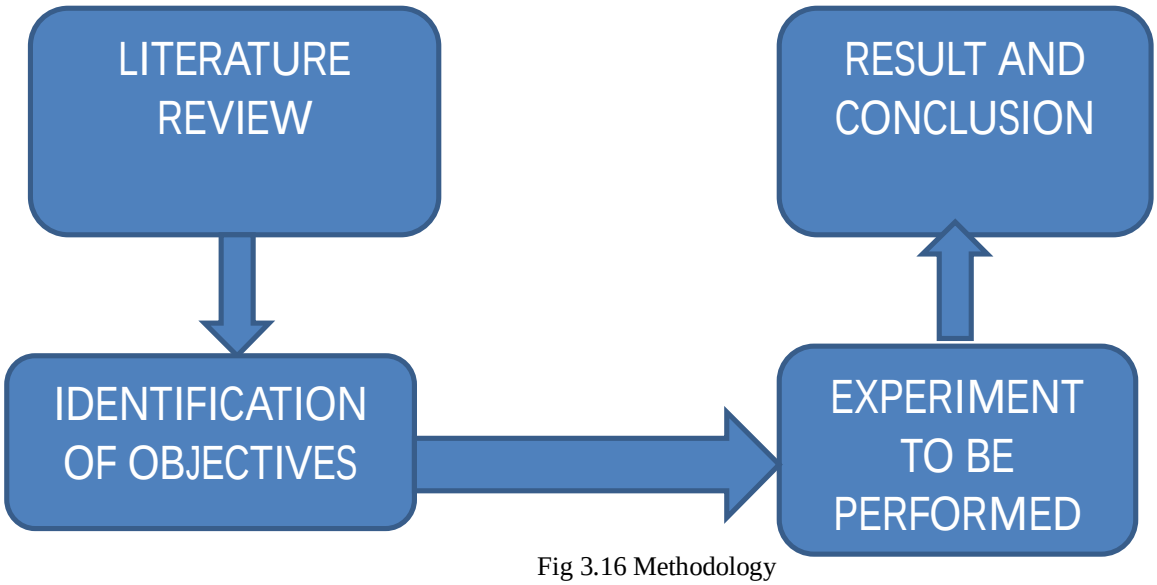


Fig 3.16 Methodology

V. RESULTS AND DISCUSSION

A. *Penetration value of bitumen (IS 73: 2013)*

Bitumen is the residue or by-product obtained by the refining of crude petroleum. A wide variety of refining techniques like straight distillation technique, solvent extraction technique etc are used to produce bitumen of different consistency and other desirable properties. Depending on the origin and other characteristics of the crude oils and property of bitumen required, more than one processing method may be employed. The type of construction decides the type of bitumen needs to be used. But in general good bitumen should have following properties. Temperature susceptibility of bitumen: the bitumen mix should not become too soft or unstable during hot weather, and not become too brittle during cold weather. Viscosity of the bitumen: at the time of mixing and compaction should be adequate. This can be managed by the use of cutbacks or emulsions of suitable grades or heating the bitumen and aggregates prior to mixing. Affinity and adhesion of bitumen: There should be adequate affinity and adhesion between the bitumen and aggregates used in the mix. Penetration is a measure of consistency. It quantifies the hardness or softness of bitumen by measuring the depth in tenths of a millimeter to which a standard loaded needle will penetrate vertically in 5 seconds under specified temperature, load and duration of loading.

1) Observation

a) Pouring temperature, 150°C
b) Period of cooling in atmosphere, 90 -120 minutes
c) Room temperature, 31°C
d) Period of cooling in water bath, 90-120minutes
e) Actual test temperature, 25°C

2) Result

Avg. Penetration of the given bitumen sample is as follow

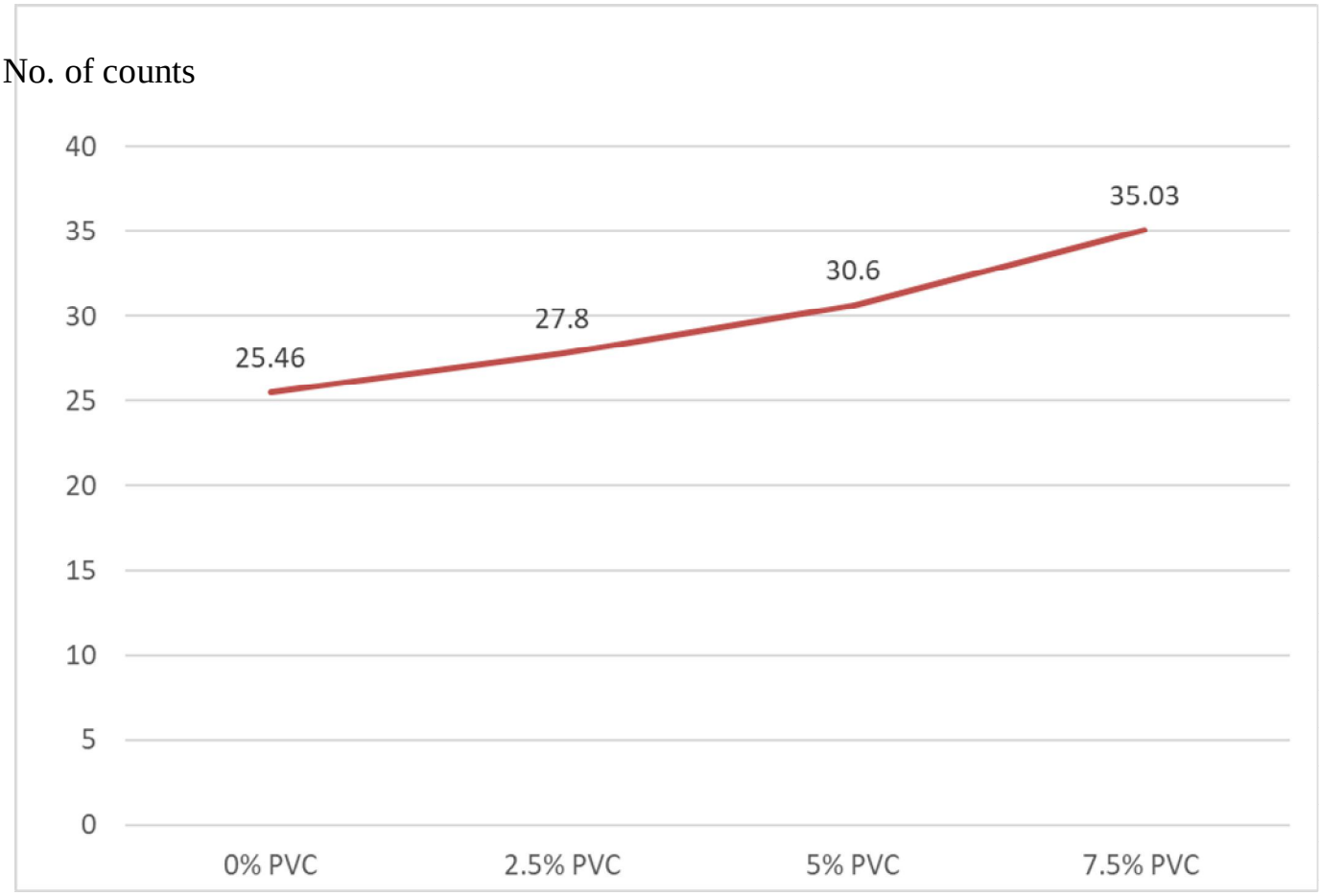
Table 4.1 Table of observation

0% PVC IN BITUMEN		2.5% PVC IN BITUMEN		5% PVC IN BITUMEN		7.5% PVC IN BITUMEN	
INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
20	240	10	252	10	360	10	400
20	230	10	260	10	291	10	344
20	354	10	352	10	297	10	307

Table 4.2 Table of result

% Of PVC IN BITUMEN	MEAN
0%	25.46
2.5%	27.8
5%	30.6
7.5%	35.03

Graph 4.1 Graphical representation of result



B. Ductility Value of Bitumen (IS:1208 -1978)

Ductility is one such property of bitumen which is dependent on the purpose of construction. Ductility is the property that permits the material to undergo great deformation or elongation. Indirectly, ductility measures the adhesive property of bitumen and its ability to stretch. It is necessary that binder should form a thin ductile film around aggregates to improve the interlocking of the aggregates in flexible pavements. It is important in pavement to resist crack due to temperature or traffic stresses to avoid damage the pavement structure. Specifically, the ductility of a bituminous material is defined as the distance in centimeters, to which it will elongate before breaking when two ends of a briquette specimen of the material are pulled apart at a specified speed and a specified temperature. A temperature of 25 ± 0.5 °C and pulling speed of 5 cm/min ± 5.0 % is to be maintained while carrying out the experiment. The ductility of a bitumen specimen mainly gives information about the tensile strength and ductility grade of bitumen.

1) *Observation*

a) Weight of sample 236 gram
b) Test temperature = 25C
c) Grade of bitumen VG40
d) Ductility in cm.

2) *Onservation Table*

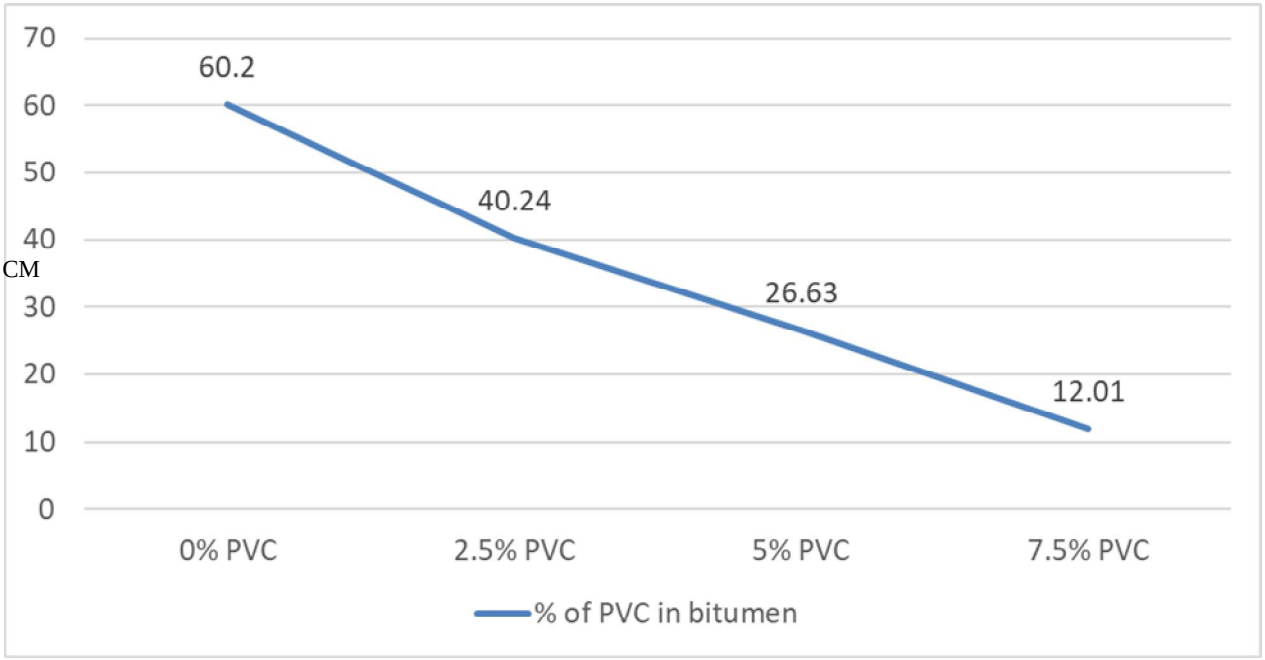
Table 4.3 Table of observation

% OF PVC IN BITUMEN	DUCTILITY IN CM(0%)	DUCTILITY IN CM(2.5%)	DUCTILITY IN CM(5%)	DUCTILITY IN CM(7.5%)
0%	59	40	22	22.69
2.5%	58.7	43.16	24.8	3.64
5%	63.3	37.57	33.1	9.7

Table 4.4 Table of result

% Of PVC IN BITUMEN	MEAN IN CM
0%	60.2
2.5%	40.24
5%	26.63
7.5%	12.01

Graph 4.2 Graphical representation of result



C. Flash and Fire Point of Bitumen (IS: 1209 – 1978)

Flash and Fire point test is conducted on bitumen to know the safe mixing and application temperature values of particular bitumen grade. At higher temperatures bituminous materials leave out volatiles. These volatile vapors contains hydro carbons. So, they can catch the fire easily and will cause flash at one point and if it is further prone to heat the material may ignite and burn.. Catching fire is very dangerous during mixing of bitumen especially during its application. So, it is necessary to recognize the safe temperature values of bitumen grades for mixing as well as for applying. The limited values of temperature can be determined by conducting Flash point and Fire point test on bitumen. The Flash point of a material is the lowest temperature at which vapor of substance quickly catches fire in the form of flash under definite conditions of the test. So, at this point fire will not last longer, just a flash will appear for a fraction of second. The existence of highly volatile and inflammable materials in a particular grade of bitumen can be indicated by the Flash point. The fire point of a material is the lowest temperature at which material catches fire and burns under definite conditions of test. The presence of combustible materials in a bituminous material can be indicated by the Fire point.

1) Observation

a) Bitumen grade /cutback type and grade: VG 40

b) Type of equipment: Closed cup

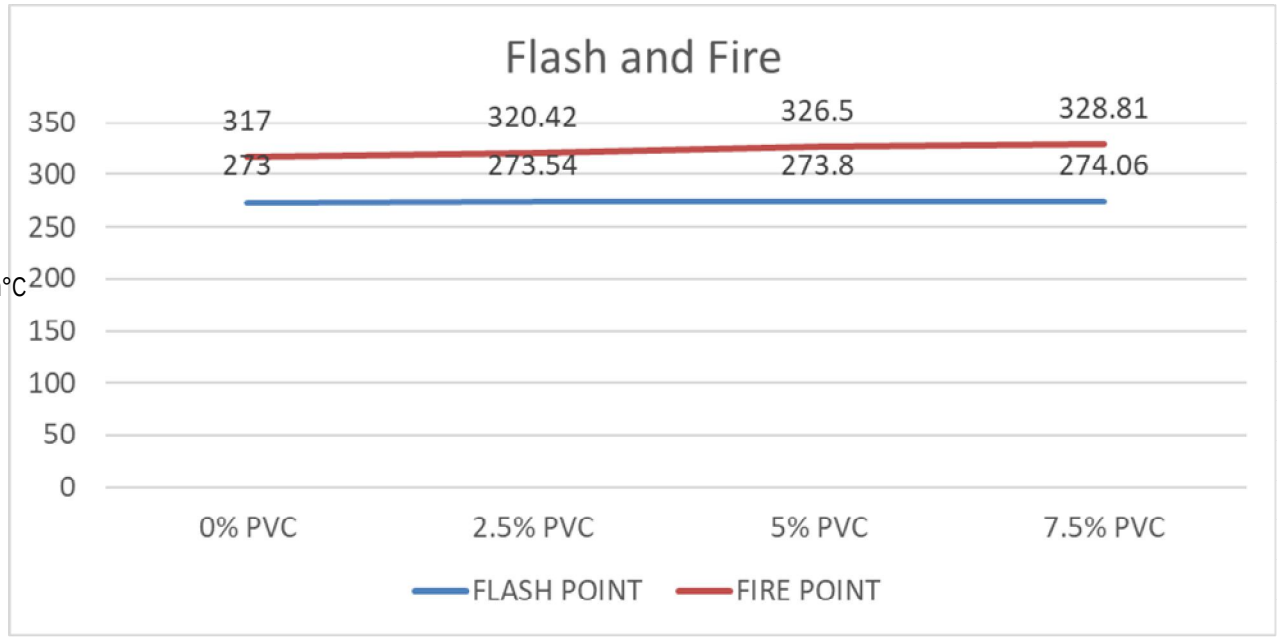
2) Observation Table

Fig 4.5 Table of observation

% Of PVC IN BITUMEN	FLASH POINT (°C)
0%	273°C
2.5%	273.54°C
5%	273.8°C
7.5%	274.06°C

Fig 4.6 Table of result

% Of PVC IN BITUMEN	FIRE POINT (°C)
0%	317°C
2.5%	320.42°C
5%	326.5°C
7.5%	328.81°C



D. Softening point of bitumen by ring and ball apparatus (IS:1205:1978)

Softening point test specified bitumen based on its temperature resistance which indicates the proper bitumen binder in the desired weather conditions when constructing roads.In areas with hot weather, bitumen should be more resistant to high temperatures, so a higher softening point bitumen is used. In other words, the softening point value should be higher than pavement temperature, otherwise, bitumen present in the layer will be soft and sticky. In general, the softening point of penetration grade bitumen and viscosity grade bitumen decreases as penetration increases. In fact, softer bitumen gradually melts at lower temperatures and its thermal resistance is lower. Softening point increases with viscosity as well. This means that viscous bitumen starts to soften at higher temperatures.

As a result, the temperature susceptibility decreases with increasing viscosity.

1) Observation

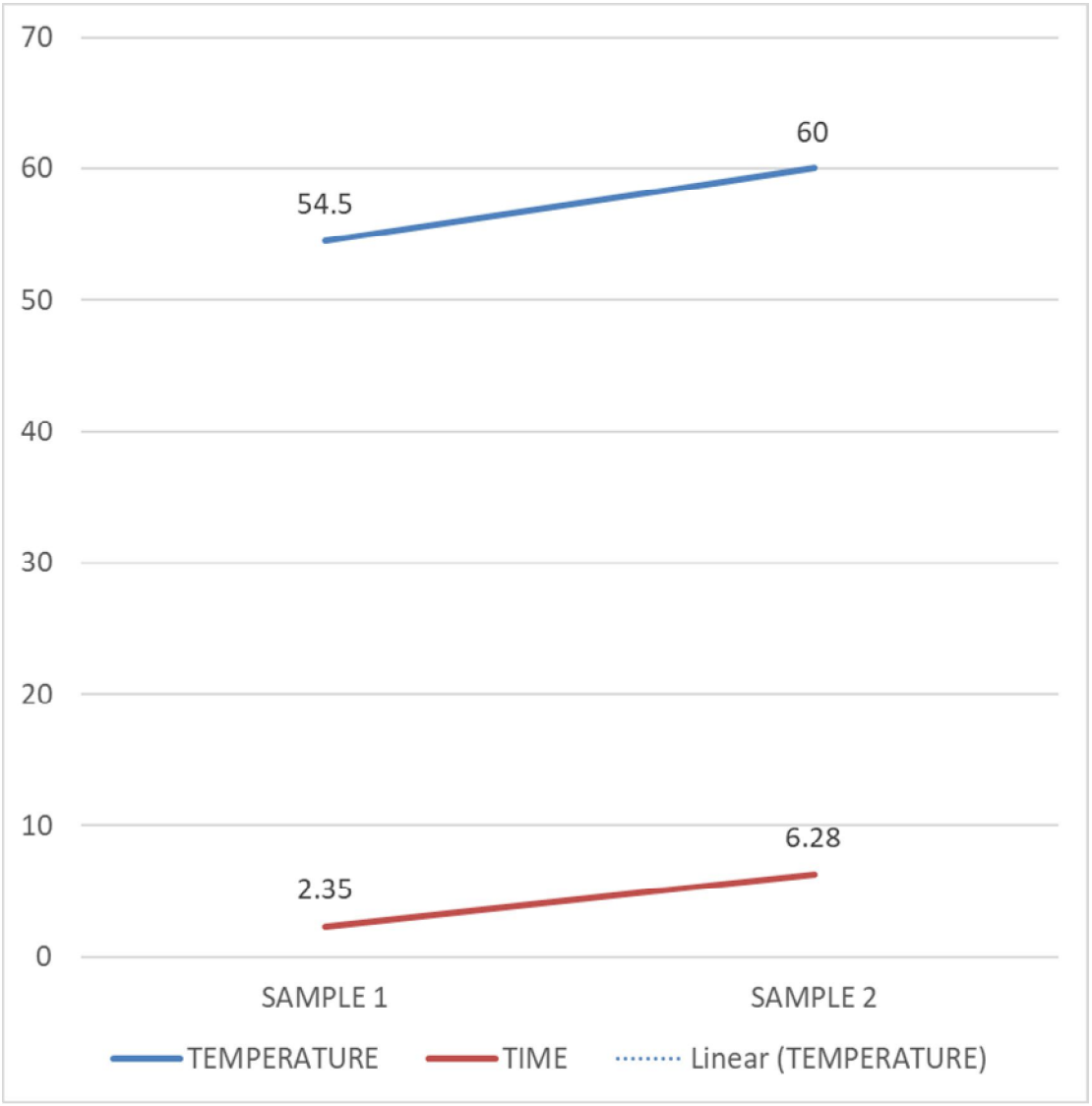
a) Bitumen grade: VG40
b) Approximate softening point:57°C
c) Liquid used in the bath: Water
d) Period fair cooling:30 minutes
e) Period of cooling in water bath = 90-120 minutes

2) Result

Table 4.7 Table of result

TEMPERATURE (°C)	TIME (MINUTES)
54.5°C	2.35
60°C	6.28

Graph 4.4 Graphical representation of result



E. Crushing value of given aggregate (IS 2386 Part IV)

The 'aggregate crushing value test ` gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. Aggregate crushing value is defined as the percentage by weight of the crushed (or finer) material obtained when the test aggregates are subjected to a specified load under standardized conditions, and the strength of the aggregate used in road construction is expressed by numerical index. Aggregate with lower crushing value show a lower crushed fraction under load and would give a longer service life to the road and hence a more economical performance. If we used a weaker would get crushed under traffic loads, would produce smaller pieces not coated with a binder, and these would be easily displaced or loosened out resulting in loss of the surface/layer. Due to this reason, the aggregates used in road construction must be strong enough to withstand crushing under roller and traffic.

1) Observation

W_1 = 6700 , W_2 = W_1-W_1 = 6700-3-839 = 2-865
Aggregate crushing on. W4 X 100 Wa
Average 26.97%
0.780 2-865 X100 =27.22%

2) Observation Table

Table 4.8:- Table of observation

Details	Trail-1	Trail-2
Empty weight of measuring cylinder, W1	3.835	3.835
Weight of measuring cylinder with aggregate, W2	6.700	6.620
weight of aggregate sample filling the 2.865cylindrical measure, Wa= (W1 - W2)g	2.865	2.785
weight of aggregate retained on 2.56 mm sieve after test, W3 g	2.065	2.041
weight of aggregate passingon 2.56 mm sieve after test, W4 = Wa - W3	0.780	0.744
Aggregate crushing value (% fines) W_1/Wa X100g	27.22%	26.71%

F. Los Angles abrasion value of aggregate (AASHTO T96 or ASTM C 131)

Abrasion testing determines the relative quality, toughness, and durability of mineral aggregates subjected to impact and abrasion. Values derived from both the Micro Deval and the L.A. Abrasion tests offer information about the performance of aggregate in use. This testing offers insight into how asphalt and concrete aggregates will stand up to wear and tear over time. It's also a good indicator of changing properties in an aggregate source as part of quality control or quality assurance program.

The Los Angeles (L.A.) Abrasion Test is widely used as an indicator of the relative quality of aggregates. It measures the degradation of standard gradings of aggregates when subjected to abrasion and impact in a rotating steel drum with an abrasive charge of steel balls.

The drum is fitted with an internal shelf that lifts and drops the charge and sample with each revolution, generating impact forces. After the machine has completed the required rpm, contents are removed and percent loss is measured.

1) Observation

a) Type of aggregate Grading Between A and B(Dominating A)

b) Number of spheres used: 500

c) Weight of sample in grams = 5000 ± 25 g.

Table 4.9 Table of observation

Details	Trail-1	Trail-2
Let the original weight of aggregate = W1g	5000	5000
weight of aggregate retained on 1.7 mm IS sieve after test = W_2 g	3955	3862
Loss in weight due to wear and tear (W1-W2)g	1045	1138
Percentage wear = W1-W2/W1*100	20.41	22.76
Mean	21.58%	

G. Impact Value of Road Aggregate (IS 2386 Part-4)

Aggregates undergo significant wear and tear throughout their life. Aggregates must be hard and tough enough to resist crushing, degradation and disintegration and be able to transmit loads from the pavement surface to the underlying layers and eventually the subgrade. Testing the strength of parent rock alone does not exactly indicate the strength of aggregates in concrete. For this reason assessment of strength of the aggregates are made by using a sample bulk aggregates in standardized manner. Several tests are thus performed to assess the stability and quality of roads. The Aggregate Impact Value Test is one such test. The impact test is a type of quality control test for highway pavements that is used to determine the suitability of aggregates for use in highway pavement construction. Aggregates Impact Value gives relative measure of resistance of aggregates to sudden shock or impact, which in some aggregates differs from its resistance to slow compression load. Impact Value should not be less than 45% for aggregates used for concrete other than wearing surface and 30% for concrete used in wearing surface.

2) Observation Table

Table 4.10 Table of result

Details	Trail-1	Trail-2
Weight of measuring cylinder, W1 g	1813	1813
Weight of measuring cylinder. + aggregate W_2 g	2460	2444
Weight of aggregate sample filling cylindrical measure, Wa = W2-W1 g	647	631
Weight of aggregate retained on 2.36mm sieve after test = W3 g	502	541
Weight of aggregate passing through 2.36 mm sieve after test = Wa -W3	145	90
Aggregate impact value-percent fines = Wa-WE/Wa*100	22.41	14.25
Average	18.33%	

H. Elongation Index of Given Aggregate Sample. IS: 2386 (Part 1)-1963.

1) Flakiness Index of Given Aggregate

The flakiness index can be described as the percentage of stones in an aggregate consisting of an ALD (Average Least Dimension) less than 0.6 times the average dimension of stones. In other words, this index value of aggregates gives the percentage by weight of aggregate particles having the least dimension that is less than 0.6 times their mean dimension. The presence of elongated aggregate particles in a mixture can disturb the packing of particles and also creates more space. These aggregate particles consist of a high ratio of surface area to volume, which is useful in reducing the workability of concrete. Moreover, if we use elongated particles for the pavement base course construction, it can cause an easy breakdown of the pavement when a heavy load or stress is applied. Therefore, it is very important to understand the elongation index of a given aggregate mix.

The flakiness index and elongation index are two important types of indices useful in determining the concentration of a given sample by means of the particles that are present in the sample. The key difference between flakiness index and elongation index is that flakiness index determines the concentration of flaky particles in a sample, whereas the elongation index determines the concentration of elongated particles in a sample.

2) Observation Table

Table 4.11 Table of result

Size of Aggregate		**Weight of Fraction Consisting at 200 pieces**	**Thickness, mm**	**Weight of Aggregate**	**Length, mm**
Passing through IS sieve, mm	Retained on IS sieve, mm				
63	50	w1=0	23.90	W1=0	----------
50	40	w2=0.230	27	W2=0.06	81
40	31.5	w3=0.718	19.5	W3=0.218	58.5
31.5	25	w4=0	16.9	W4=0	----------
25	20	w5=0.080	13.5	W5=0.016	40.5
20	16	w6=0.728	10.8	W6=0.464	32.4
16	12.5	w7=0	8.5	W7=0	25.6
12.5	10	w8=0.232	6.75	W8=0.920	20.2
10	6.3	w9=0.206	4.89	W9=0.84	14.7

I. Marshall Stability value) and flexibility (flow value) for given bitumen Mixture (ASTM D6927 – 06).

Marshall stability measures the maximum load sustained by the bituminous material at a loading rate of 50.8 mm/minute. The test load is increased until it reaches a maximum. Beyond that, when the load just starts to decrease, the loading is ended and the maximum load (i.e. Marshall stability) is recorded. During the loading test, dial gauge is attached which measures the specimen's plastic flow owing to the applied load.

Marshall stability is related to the resistance of bituminous materials to distortion, displacement, rutting and shearing stresses. The stability is derived mainly from internal friction and cohesion. Cohesion is the binding force of binder material while internal friction is the interlocking and frictional resistance of aggregates. As bituminous pavement is subjected to severe traffic loads from time to time, it is necessary to adopt bituminous material with good stability and flow.

1) Observations

For 0% PVC in Bitumen:

a) Mass of aggregates in mixing pan 1200 gm
b) Mass of bitumen added 60 gm
c) Bitumen content 5%
d) Heating Temperature Aggregates 250C
Bitumen 150C
Mixing 250C

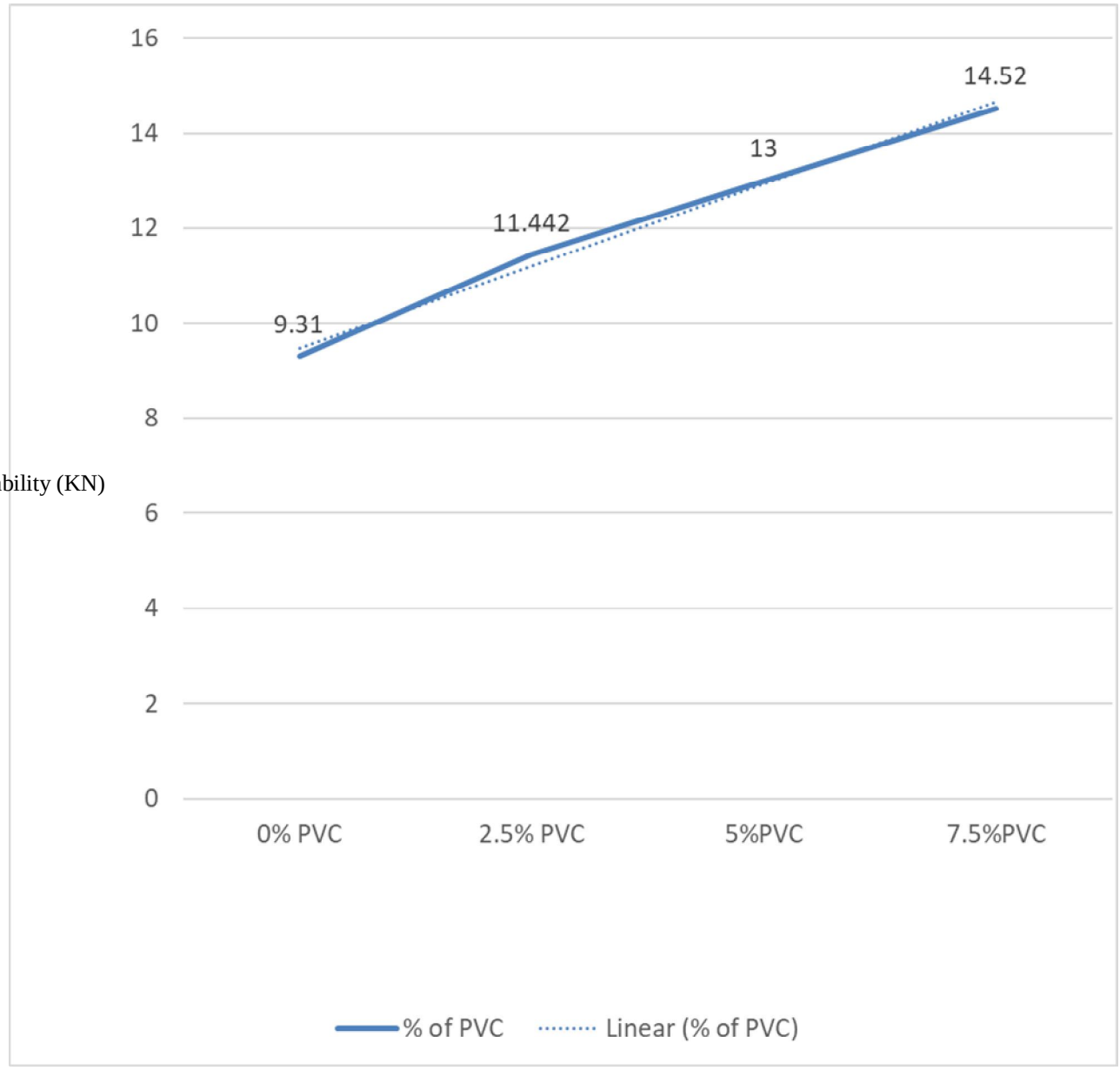
e) Compacting temperature 80C.
f) Number of blows with hammer per face 75
g) Mass of specimen in air 1270gm
h) Mass submerged 760gm
i) Diameter of Specimen 7.5Cm
j) Thickness of specimen 10cm3
k) Volume of specimen 528 cc

2) Observation Table

Table 4.12 Table of result

Details	Trail-1(0%PVC)	Trail-2(2.5% PVC)	Trail-3(5% PVC)	Trail-4(7.5% PVC)
Weight of Compacted Specimen, W, in gm	1270gram	1279gram	1203gram	1268gram
Weight of specimen in water , in gm	760gram	767.4gram	721.8 gram	760.8
Saturated surface dry core weight	1288gram	1296.9gram	1212.14 gram	1285.75gram
Volume of specimen	528cc	529.5cc	483.6 cc	524.95cc
Density of specimen	2.40gm/cc	2.41gm/cc	2.48 gm/cc	2.415gm/cc
Marshall stability (KN)	9.310	11.442	13	14.520
Flow Value	3.10	3.02	2.97	2.89
Marshall qutient	3.00	3.61	3.81	4.23
Bituumen	5%	5%	5%	5%

4.5:- Graphical Representation Of Measured Value



VI. CONCLUSIONS

Based on the present study following conclusion are drawn

1) As per IS CODE 1203-1978 , viscosity grade of ordinary bitumen is VG 30 and by adding 2.5% of crumb rubber and PVC the Grade of Bitumen changes from VG 30 to VG 40. As VG 40 is best suited for HOT CLIMATIC CONDITIONS, it is the preferred percentage.
2) As per IS Code 1208-1978, The ductility value of bitumen usually varies from 5 to over 100 cm's. As we can see at 7.5%, the ductility value is less than 5 cm. Therefore, we can say that , we can add specific percentage of bitumen and crumb rubber. That is less than or equal to 5% .
3) Bitumen modified with crumb rubber and PVC offers potential benefits in terms of improved mechanical properties, durability, and sustainability.
4) Crumb rubber enhances elasticity, viscosity, and resistance to aging and deformation in bitumen.
5) PVC improves stability at high temperatures and reduces temperature susceptibility of bitumen.

6) Modified bitumen shows promise in road construction, pavement rehabilitation, and waterproofing applications.

7) Potential benefits include increased service life, reduced maintenance, enhanced skid resistance, and reduced environmental impact through recycling.

REFERENCES

[1] www.linkspringer.com , Bapusaheb Shivajirao Deore College of Engineering, Dhule, Maharashtra, Use of waste plastic and crumb rubber in construction of flexible pavement , International journal of advanced research ideas and innovation in technology (2019)

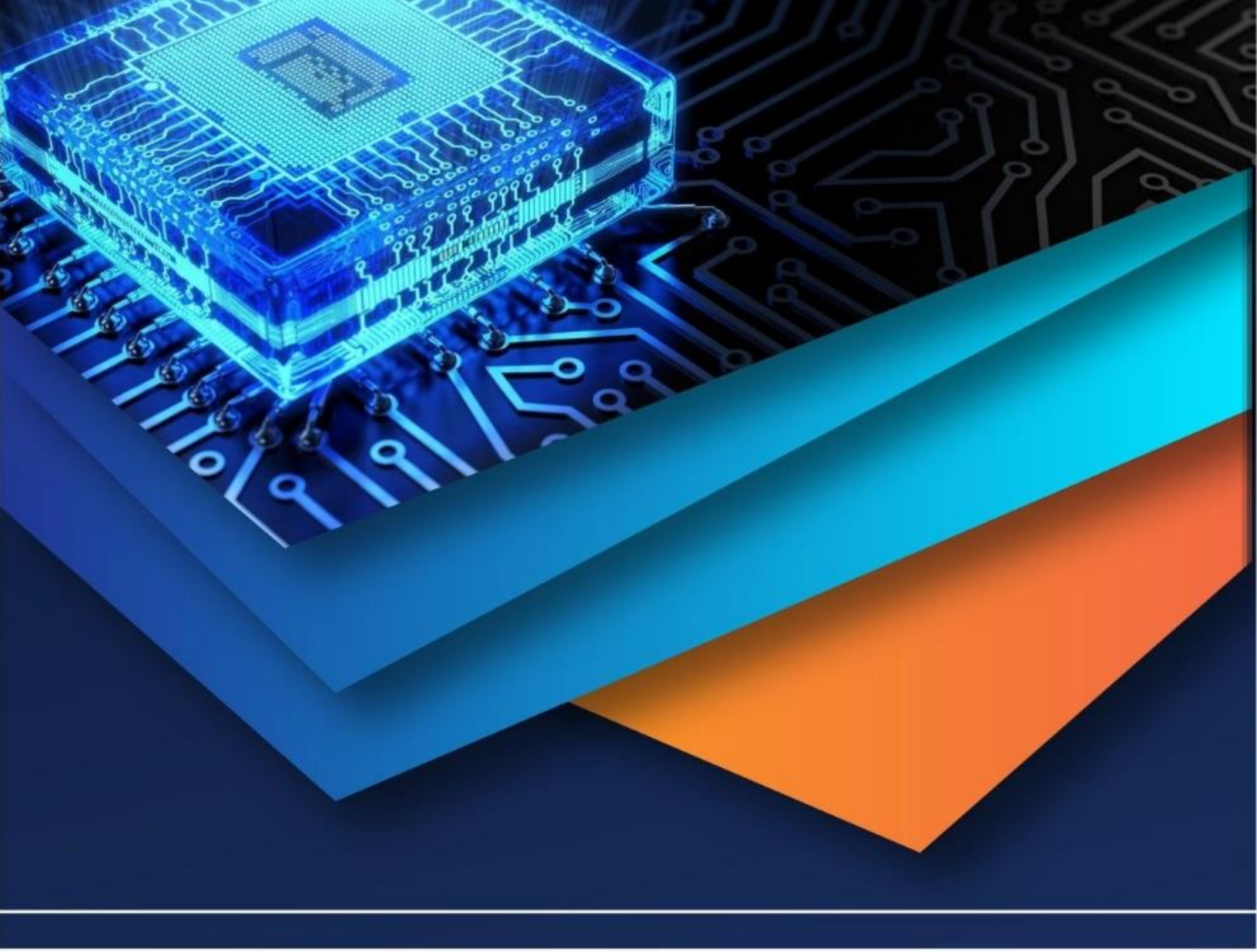
[2] www.ieeexplore.ieee.org , V. Suganpriya S. Omprakash V. Chandralega Study of Behaviour of Bitumen Modified with Crumb Rubber Vel Tech Dr. RR & Dr. SR Technical University (2016)

[3] www.delnet.nic.in , Athira R Prasad, Dr Sowmya N J2 , Bitumen Modification with Waste Plastic and Crumb Rubber . International Journal of Engineering Research & Technology(2015)

[4] www.ieeexplore.ieee.org ,Arun Kumar , Parveen Berwal Abdullah I. Al-Mansour Mohammad Amir Khan , Impact of crumb rubber concentration and plastic coated aggregate on the rheological performance of modified bitumen asphalt . International Journal of ChemTech Research (2022) .

[5] http://www.linkspringer.com ,Anusha G Krishna , Waste Plastic and Crumb Rubber in Flexible Pavement , International Journal of Applied Engineering Research (2018).

[6] www.ieeexplore.ieee.org ,Imran M. Khan, Shahid Kabir, Majed A. Alhussain, Feras F. Almansoor. Asphalt Design Using Recycled Plastic, International Conference on Sustainable Design, Engineering and Construction (2016)



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IMPACT FACTOR: 7.429

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