

IMPACT OF CRUMB RUBBER POWDER ON VG-30 BITUMEN

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering Degree in
Civil Engineering

By

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SATHYABAMA

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

Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **GAIKADI VISHNU SAI (Reg. No.38200009)** and **KOTHARU NITHIN SIVA (Reg. No.38200017)** who carried out the project entitled "**Impact of Crumb Rubber Powder on VG-30 Bitumen**" under my supervision from Dec 2021 to May 2022.

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DECLARATION

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ABSTRACT

The goal of these was to determine how bitumen's physical qualities changed after being modified with crumb rubber. To change the bitumen, different percentages of crumb rubber were utilized. To analyse the physical qualities of virgin and modified bitumen, several physical tests were performed. Crumb rubber modified bitumen formulation chemistry is based on the swelling of rubber in hot bitumen and the transfer of components inside crumb rubber. VG30 is a bitumen binder and close-graded premix material for roads with a higher number of heavy commercial vehicles. Roadways are one of the most important parts of the infrastructure and they play a significant role in our everyday lives. The use of crumb rubber in bitumen binder modification is seen as a clever way to promote sustainable development by repurposing waste resources in road construction. This experiment involves employing a binder with 5%, 10%, and 15% content in VG30 bitumen. The following experiments will be carried out using crumb rubber modified bitumen. Test for specific gravity Test for viscosity Test for softening point Test for ductility Test for penetration VG30 bitumen, Crumb rubber, Modification, Physical Properties

Keywords: VG30 bitumen, Crumb rubber, Modification, Physical Properties

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LIST OF SYMBOLS AND ABBREVIATIONS

ACRONYMS	EXPANSIONS
CRMB	Crumb Rubber Modified Bitumen
BIS	Bureau of Indian Standards
VG-30	Viscosity Grade 30
HDPE	High-density polyethylene
PP	Polypropylene
GPPS	General Purpose Polystyrene
HIPS	High Impact Polystyrene
HPS	Polystyrene from Hangers
EOB	Engine Oil Bottoms
OBC	Optimum Bitumen Content
AC-20	Added in Conventional

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CHAPTER 1

INTRODUCTION

1.1. GENERAL

Traditional bituminous binders have several drawbacks when it comes to dealing with excessive overloading and more harsh climatic conditions, which may lead to serious stress-related issues. Binder modification is a breakthrough, and ongoing research in this field aims to develop novel binders with improved rheological and mechanical properties, allowing for the production and use of higher-performing road bituminous mixtures. Disposal of landfills has been a pressing requirement in recent years, not only to reclaim enormous swaths of valuable land formerly held by them, but also to decrease pollution and risks. The benefits of using crumb rubber modified bitumen (CRMB) are extensively established across the globe, with the main drivers being greater fatigue resistance and reduced binder aging. Use of crumb rubber modified bitumen has also been encouraged by attention on the building industry's impact on the environment and measures to minimize and reuse waste material. Bitumen rubber is made out of a mixture of bitumen and rubber fragments. Modification of bitumen with other materials, often known as admixtures, is one of the approaches that has lately attracted increasing attention. When completely mixed with bitumen, several admixtures have been shown to act as modifiers, increasing the binder qualities. These admixtures may be added directly to the bitumen mixture as a bitumen modifier, or they can be mixed with the aggregate. The following are some of the most common admixtures used in bitumen modification: Polymers, for starters (1) Polymer of plastic (2) Polymer fibers Elastomers are a rubber. (2) Blast Furnace Slag, Ground Granulated (3) Ashes of the fly Rubber (4) (1) Rubber crumb (2) Rubber (natural) Modified bitumen, on the other hand, is often manufactured at higher costs, which might contribute to a rise in the cost of the modification process. Permanent deformation (rutting), fatigue cracking, thermal cracking, and water damage occur on bitumen pavements because of a combination of traffic loads and native habitat distress. As a result, bitumen modification is one of the most widely used strategies for

improving execution and comfort in thick asphalt is improved. CRUSHES PVC

To make rubber crumbs, the Tyers of vehicles and trucks are scraped. Steel and Tire wire (fluff)is separated from the rubber crumb during the reprocessing process, and gritty Tire rubber is formed. Due to the fact that waste Tire rubber is not easily biodegradable even after prolonged periods of landfill treatment, municipalities have a challenging time handling the waste Tire rubber. The rubber from old Tyers, on either hand, may be recycled. Discarded Tyers are currently buried in landfills at a rate of 75 to 80 per cent Most of the rest is either used for fuel or as a basic ingredient in the production of a range of rubber goods. Tossing off old Tyers and burying them in landfills wastes resources and money, Composite material is a kind of recycled rubber derived from used Tyres. Recycled rubber is left with a particulate consistency due to the removal of steel and Tyre wire (fluff). The particle size may be further reduced by employing cryogenics or mechanical methods in a mixer or cracker mill. Particles are measured and classified for a number of reasons, one of which being their hue (black only or black and white). Using a screen, the size of the granule is determined by passing it through a quarter-inch-thick or mesh-thick dimension (holes per inch: 10, 20, etc.). Artificial grass padding often includes crumb rubber. Tires, both as standard parts and as spares, have been more in demand in India as the country's automobile fleet has grown in recent years. Two major advantages may be derived from rubber waste: As a result, huge dumping grounds will be cleared from the land. Conserving natural aggregation sources and environmental conservation will also benefit from this. Rubber Tyres are handy, but their non-biodegradability makes them unfriendly to the environment. For the sake of the clean environment and the depletion of landfills, the practice

of burying old Tyres and burning them in open areas is becoming a nuisance.



Fig 1.1 Waste tyres

Mandatory scrapping of end-of-life vehicles in metros by 2010-11 and throughout India by 2012-13 is projected to enable a large-scale supply of scatterers at designated places by promoting organized players. Scrap tire management has been a rising issue in recent years; scrap tires are one of the numerous specific wastes that municipalities find challenging to manage. Because they float to the top, whole tyres are difficult to dump. There are several landfills that prohibit the dumping of tyres because of their size and ability to float above over time. As a result, most landfills require tyres to be shredded before they may be accepted. There are several rubber tyre recycling processes available, depending on the necessity. One of the operations is to turn the rubber from the tyres into crumb rubber and chipped rubber. It is employed in a variety of projects, including road building and mould production. Rubber crumb is marketed as a feedstock for chemical devulcanization or pyrolysis processes, is mixed with asphalt for highway paving and pavement sealers, and is used to make a variety of recycled rubber-based goods.

1.2 Rubber Crumble



Fig 1.2 Rubber crumble

In civil engineering, crumb rubber is used in the following ways:

Garbage tires in India are labelled as either solid trash or hazardous trash. Waste tires (re-treated) account for around 60% of all discarded tires in both cities and rural areas. Waste may produce air pollution, smell, visual effects, and other dangerous substances such as polycyclic compounds, fluorinated gases, and oxides of nitrogen, as well as aesthetic pollution created by scrap tires stockpiles. **Tire buffing (shredded rubber), tire rethreading, and waste tire rubber are the two main feedstocks used to make crumb rubber. Crumb rubber from a single passenger tire weighs 10 and 12 pounds.**

The Benefits of Crumb Rubber Modified Bitumen:

Increased resistance to deformation at higher road temperatures increases driving smoothness. Improved aggregate adhesion and bonding properties, higher softening point, higher flow resistance, and higher impact resistance, withstanding heavy traffic. During vehicle brake application, road grip, and smoothness on the surface decrease road accidents. Elasticity is increased through elongation and tensile strength. Reduced temperature sensitivity, which prevents stress-induced fractures. Reduced rutting increases driving comfort even when axle loads are greater. Because of the high resistance to moisture or water absorption, roadways are not damaged by rain or faulty drainage. Bitumen is a thermoplastic substance

with temperature-dependent stiffness. The temperature-stiffness connection in bitumen is affected by the crude oil source and refining procedure. For the first time in 1950, the Bureau of Indian Standards (BIS) developed paving grade bitumen standards (IS: 73- 1950) and categorized them based on penetration. The specifications were revised twice, in 1962 and 1992. In order to improve bitumen quality, BIS modified IS-73-1992 standards based on viscosity (viscous at 60° C). According to these requirements, there are four levels of quality: 10 to 20; 30 to 40; and 40 to 60 percent. IS: 73-1992 abolished certain qualifying tests, including dry density, water content, flexibility, loss upon heating, and the Fares breaking threshold, since they had no influence on the device's quality or performance. All of Indian Oil's refineries started selling bitumen in compliance with IS 73-1992 Viscous Grade requirements in August 2009. A Viscosity grade of Bitumen has replaced Penetration grades as a consequence. According to the viscosity (degree of flexibility) grading, the higher the grade, the harder the Bitumen. A temperature of 60°C is used for the testing, whereas a temperature of 135°C is used to simulate the mixing temperature in a hot region (such as northern India). As the annual average pavement temperature, the temperature of the penetration is maintained at 25oC.

1.3 Bitumen



Fig 1.3 VG30 Bitumen

Viscosity Grade Bitumen (Asphalt) is a Bitumen grade that is primarily utilised as a Paving Grade and is ideal for road building and asphalt pavement production. In the manufacturing of hot mix asphalt, VG Bitumen is often employed. Viscosity Grade Bitumen is a petroleum-grade bitumen that is made from fractional vacuum bottoms derived from crude oil distillation and may be used and behaves differently depending on the temperature. The thermoplastic property of viscosity grade bitumen leads the substance to soften at elevated temperatures and solidify at low temperatures. When selecting performance factors like as adhesion, rheology, durability, and application temperatures of bitumen, this temperature viscosity relevance is critical. The most essential emphasis in the Viscosity Grade Bitumen requirements is focused on Bitumen ductility.

1.3.1 Indian Oil sells many grades of bitumen:

Spray operations such as exterior and paving in cold areas commonly use **VG-10** in lieu of the older 80/100 Penetration grade. In addition, Bitumen Emulsion and Blended Bitumen goods are also created using this material.

BITUMEN VG-20: In cold climes and high elevations, VG-20 is utilised for pavement. BITUMEN

In the construction of additional Bituminous roads which must endure significant traffic loads, **VG-30** is often utilized. Grade 60/70 Penetration may be substituted.

VG-40 BITUMEN: VG-40 is utilized instead of the traditional 30/40 Penetration grade at high-stress places like crossroads, near toll booths, and truck parking lots. Stiffer Bitumen mixtures may be made because of their increased viscosity, which improves resistance to pushing and other issues connected with higher temperatures and strong traffic loads. Modified Bitumen with Crumb Rubber and Natural Rubber - Crumb rubber and natural rubber are used as modifiers in Bitumen. Polymer Modified Bitumen - Polymer is utilized to alter Bitumen in this form Bitumen. Bitumen Emulsion — Bitumen emulsion is a water-based dispersion of bitumen with various ingredients.

1.3.2 Viscosity Grade Bitumen's Benefits:

Fundamental engineering parameters, not empirical properties, are used to determine the viscosity grade of bitumen. It is a grading system that is based on performance. Bitumen's vulnerability to low and elevated temperatures is taken into account by the viscosity grading system. The viscosity value at two separate temperatures is accessible in viscosity grade bitumen, allowing the user to estimate precise mixing and compaction temperatures. Only seven tests are required to determine the quality of viscosity grade bitumen. This decreases the amount of time and money spent on testing. Pavements composed with VG bitumen will function better since the viscosity value at 135°C provides enough information concerning mixing and compaction temperatures, resulting in increased pavement life. Pavements made with VG bitumen can withstand larger traffic loads in adverse weather conditions

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

In the following lines, a quick overview of several literary methods is offered, along with a few key references:

2.2 LITERATURE REVIEW

By altering the sizes of crumb rubber, **Nabin Rana Magar (2014)** studies the performance of crumb rubber-modified bitumen. The penetration values and softening points of plain bitumen may be greatly enhanced by changing it with the addition of crumb rubber, which is a serious environmental pollutant, according to the findings of typical laboratory tests on plain bitumen and crumb rubber modified bitumen. For commercial CRMB manufacturing, the optimal size to employ for crumb rubber modification is advised to be (0.3-0.15mm).

Crumb Rubber was added to 60/70 grade bitumen in different percentages, according to **Siddharth Rokade (2012)**. The mixture was made using 5% bitumen and various ratios of Crumb Rubber. Crumb Rubber Modified Bitumen is the name given to bitumen that has been combined with Crumb Rubber (CRMB). According to the findings, increasing the Marshal Stability Value from 4% to 12% Crumb Rubber and subsequently decreasing it to 15% Crumb Rubber of the weight of bitumen is the best dosage for improving the mix's strength qualities.

Asfak et al. (2016) investigated the warm mix design of bituminous concrete, using Rediet-organic additive as an adhesion agent and viscosity grade-30 as a binder (VG-30). The Marshall Test will determine

the Optimum Bitumen Content (OBC) using a binder. After that, the optimum Rediet dosage and temperature, i.e., the temperature at which Rediet performs effectively, are discovered. In addition, comparison research is being conducted to determine the stability of Rediet with Binder. The Warm mix with VG -30 fulfilled all the Marshall Stability test of bituminous mixes and is suitable for building of road with high traffic. VG-30 with and without Rediet is also subjected to laboratory testing to determine the physical qualities of aggregate and a bitumen test.

Sara Bressi et al. (2019) reported on the present state, direction, and pace of advancement of scientific research on tyre rubber reuse and recycling throughout the globe. In addition, manufacturing parameters, standard qualities, high and low-temperature performance, and rheological features of Crumb Rubber Modified Asphalt have all been thoroughly investigated. Statistics from a sample of chosen articles have been provided in order to better understand the primary techniques used, rubber particle size, temperatures, and potential further changes to crumb rubber modified binder.

Fernandes et al. (2018) to establish their appropriateness as a partial or total replacement for bitumen in elastic pavement construction using oil and waste oil and engines oil bottoms (EOB) coupled with polymers (i.e., waste polyolefin, crumb rubber, and monomer butadiene). Rheological tests, such as viscous and dynamic shear dynamometer tests, were used to assess flow, while penetrating and softness breakpoint tests, and also rolling thin-film oven exams, were used to evaluate physical attributes. Plasma spectroscopy predicts the quantified and heavy metals contained in motor oil. As a consequence, ten percent EO or fifteen percent RB and six percent HDPE, ten percent

EO or twelve percent RB and five percent SBS, and ten percent EO or fifteen percent RB and twenty percent CR may partly replace bitumen.

Cortavitate et al. (2018) It was discovered that crystal polystyrene, also known as general-purpose polystyrene (GPPS), might be used to replace bitumen in lieu of more harmful high impact polystyrene (HIPS) and hanger polystyrene (HPS). It was determined that a size of the nanoparticles of fewer than 75 millimetres was maintained using sieve analysis. Due to its reduced cohesiveness properties, using PS to substitute 1% of the bituminous mixtures produced the best results, while using PS to substitute 2% yielded unsatisfactory results.

Mashaan et al. (2011) As the amount of crumb rubber in the mixture grows, the hardness or hardness of the bitumen binder diminishes, and this is known as penetration. Penetration values decrease with increasing rubber content in rubberized bitumen binder mixes, implying that the binder becomes stiffer and more violent. The degree at which bitumen softens is known as the softening point. By adding more crumb rubber, we may enhance the melting point and fluidity of our bitumen.

According to **Becker et al. (2001)**, the quantity of crumb rubber added to the bitumen affects the mix qualities. Higher levels showed that the blend's qualities had changed significantly. Rubber content rises with temperature, resulting in increased viscosity, resilience, softening point, and penetration at 25°C.

According to **Abedlrahman and Carpenter et al. (1999)**, the distinctive characteristics of CRMB fluctuate with blending temperature and blending time. For making high-quality CRMB, the ideal blending temperature and duration were determined to be 175oC and 45 minutes, respectively.

Rahman et al. (2017) For the main purpose of this research, we investigated the use of waste goods such tyre rubber powder, palm oil fuel ash, and waste cooking oil. This project was using a bituminous with a penetration rate of 60/70. A sieve analysis was performed, and a particle size of less than 75 mm was maintained. At a temperature of 170°C, reflux was done for 5 hours. Penetration and softening point tests, as well as rolling thin film oven tests, were used to determine physical qualities, while rheological tests, such as viscosity and dynamic shear rheometer tests, were used to determine flow. Methods of mixing were chosen wisely. As a consequence, it was determined that a blend containing 5% bitumen cooking oil is the best of all the mixtures. The modifiers were successful in completing up to 15% of the replacement work. When tyre rubber and POFA were added, the viscosity rose as a consequence.

CHAPTER 3

AIM AND SCOPE OF THE INVESTIGATION

3.1 AIM

- In VG30 Bitumen, recycle crumb rubber powder should be used at a percentage of 0%, 5%, 10%, 15%, and 20%.
- To perform specific gravity, viscosity, softening point, ductility, and penetration tests for each of the five proportions.
- Through laboratory testing, compare the performance of modified bitumen containing crumb rubber as an additive to that of virgin bitumen.

3.2 SCOPE

- To include crumb rubber derived from tire scrap into bitumen to address the environmental issue of waste rubber dumping and to improve the qualities of bitumen.
- The goal is to use bitumen in the most efficient and cost-effective way possible.
- The study also encourages the wide use of such potentially dangerous wastes without damaging the environment, farming, or the lives of humans and animals.

CHAPTER 4

METHODOLOGY AND METHODS USED

4.1 GENERAL

The purpose of this study is to compare the performance of crumb rubber-modified bitumen to that of virgin bitumen.

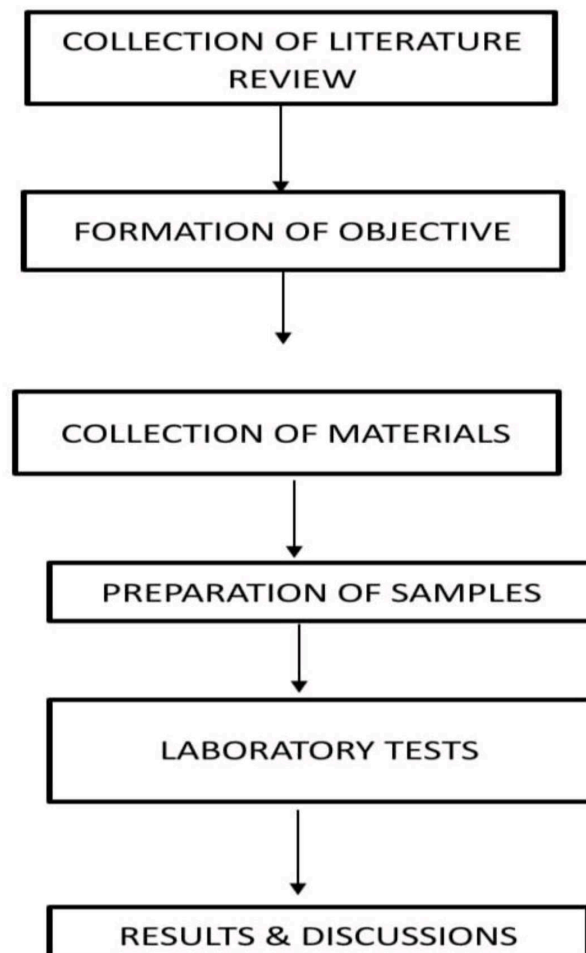


Fig 4.1 Flow chart

4.3 PREPARATION OF BITUMEN AND ITS MIXING WITH RUBBER WASTE

The bitumen was made to meet the Bureau of Indian Standards' minimal standards, which range from IS1201 to IS1220:1978. As the amount of crumb rubber in the bitumen grew, the bitumen got denser. There is a wide range of qualities in this kind of bitumen. Consequently, the amount of crumb rubber used is adjusted to provide the best outcomes. As a result, the VG30 grade of bitumen is further changed by creating multiple samples in accordance with the requirements of the tests that were conducted. To acquire the required findings, the specified method of numerous tests according to Indian norms was followed.



Fig 4.2 Bitumen heating



FIG 4.3 Sample with 20% Rubber Powder



4.4 FIG Collection of Sample

Using a 5-liter metal container, 4 kilos of semi-solid asphalt is warmed to 160°C until it transforms into a liquid with really no bubbles, enabling it to be easily extracted. The powdered waste from burned tire rabbitries is then added, gradually replacing bitumen with 0-20 percent of its weight. For around 4-5 minutes, the mix was continuously mixed. After that, the mixture was heated to 160°C and mechanically stirred for around 20 minutes. The temperature must be always maintained at around 160°C and 170°C. In preparation for the tests, the bitumen was recorded at room temperature and appropriately stored.

Table 4.1 Weight crumb rubber

Crumb rubber (%)	Bitumen (ml)	Crumb rubber (grams)
0	500	0
5	500	25
10	500	50
15	500	75
20	500	100

4.4 BITUMEN AND MODIFIED BITUMEN TESTS

4.4.1 Penetration Examination

The tests were conducted in compliance with the Indian standard code IS 1203 1978. The degree of stability is determined by a bituminous material penetration test. Under governed loading and temperature, the permeability is the spacing a metal needle penetrates the bitumen. The viscosity of bitumen may be determined by conducting a pen test. This same cannula is permitted to permeate the bitumen sample for five seconds at a time. At a distance of 10 millimetres apart, three samples were taken to measure penetration. The needle used weighed 100 grams. Afterward, the sample is refrigerated for 30 min at temperatures up to between 15°C to 30°C before being placed in a heated water tub for Sixty minutes with the keep warm of roughly 25° 0.1°C to preserve the test piece from dirt.

Apparatus

- Device for Penetration
- Needed (Pointer)
- Vessel
- Tub filled with water
- Water Bath Thermometer
- Stop using your wristwatch.

Procedure

- To begin with, the dial gauge's pointer is positioned to read zero.
- The needle is correctly inserted for 5 seconds at a time.
- The penetration device may be regulated to measure the depth.
- The specimen's surface is marked with at least three separate places that are at least 10 mm from the cup's edge. The final measurement is then derived by averaging the values from each sample.

3.4.2 Indian Standard IS: 1205 1978 was used to conduct this softening point test. A climate where the bitumen starts to lighten was indeed the subject of this research, which was utilized to decide the melting temperature.

The point at which the bitumen softens in line with the test standards as a result of temperature fluctuations. The instrument used in this test is a ring and a ball. The samples for bitumen testing were put in brass rings that were then immersed in a liquid at a certain temperature (glycerine or water). After heating the liquid containing the test sample to a temperature of 5 degrees Centigrade per min, a ball was placed on top of the bitumen sample. The weakening temperature at which bitumen becomes pliable and steel balls strike the metallic frame's bottom at a specific distance after the requisite warming. The material with a higher softening point is said to be less susceptible to temperature changes and is preferred for use in hot weather. This test aids in determining the temperature at which bitumen should be heated before being used as a road pavement construction material. The softening point of bitumen varies between 35°C and 70°C.

Apparatus

- Device with ring and ball
- Low Range: -2 to 80°C, Graduation 0.2°C; High Range: 30 to 200°C, Graduation 0.2°C
- 0.5°C scaling

Procedure

- Equipment such as a lab temperature, steel balls, or brass rings must be procured before the testing can be carried out.
- The glassware should be refilled every minute with 5 0.5 C hot refined liquid.
- A stirrer should be used to keep the liquid at a level of 5 0.5 C and stir it every minute.
- The bitumen sample should be heated to the point when steel balls may pass through brass rings due to softening of the test samples. The scenario is shown in Figure 3.2 (b)
- The melting point of a substance may be determined by comparing its melting point to a metal plate's melting point.
- A tub of water
- Thermometer for water baths.
- Stop checking your watch.
- To begin with, the dial gauge's pointer is positioned to read zero.
- The needle is correctly inserted for 5 seconds each time.
- The penetration device may be regulated to measure the penetration depth.
- The specimen's surface is marked with at least three unusual places that are at least 10 mm from of the cup's edge. The final measurement is then derived by averaging the values from each sample.

4.4.3 Ductility Examination

The Indian standard code IS: 1208 1978 was used to perform this test. The ductility of bitumen is a feature that allows pavements to outspread under strong traffic loads. This test on bitumen samples determines the length to which the bitumen elongates

before failing. The ductility test determines the amount of bonding or adhesive nature of the bitumen's expansion ability. To improve aggregate bonding, the binder used in construction must have the ability to retain a thin ductile layer in a flexible pavement plan over the aggregates. Material employed as a binder with insufficient ductility detaches when exposed to regularly moving loads, such as traffic, resulting in a porous highway surface. When two samples of bituminous material are pulled apart at a certain speed and temperature, the ductility is measured in centimetres, which is the distance in cm well before material splits. From zero to 150 ductility is possible based on the type of bitumen.

Apparatus

- Briquette maker
- Scales
- Tub filled with water
- Water Bath Thermometer
- Ductility machine in accordance with IS 1208.

Procedure

- Afterwards, the sample of bitumen is warmed to a liquid state and dispersed among the brass plates.
- Open-air cooling is used to cool down the lump charcoal and metal plates in the assemblage.
- Putting the complete system in a 27°C hot water tub for 80 to 90 min is the maximum time limit.
- Bitumen's ductility ranges from 5 to 100 cm. The sample's ductility should be at a minimum of 50 cm in order to meet the performance standards.

4.4.4 Viscosity test

The inverse of fluidity, viscosity is a measurement of flow resistance. Efflux disconnectors are used to assess the viscosity of liquid bitumen. The bitumen binder lubricates the aggregate particles rather than acting as a binder at a low viscosity.

It will resist compacting effort if the viscosity is high, yet the mixture is heterogeneous.

- Maintain a temperature of 60 ± 0.1 °C in the test bath. With the use of a holder, position the charged viscometer vertically in the test bath so that the highest timing mark is at least 2 cm below the bath liquid's surface.
- In the vacuum system, create a vacuum of 30 ± 0.05 cm of mercury and connect to the viscometer with the valve closed. Open the valve and allow the bitumen to flow into the viscometer after the viscometer has been in the bath for 30 ± 5 minutes.
- Measure the time it takes the leading edge of the meniscus to pass between successive pairs of timing marks (to within ± 0.5 sec).
- Report the first flow time between a pair of timing marks that exceeds 60 seconds, along with the pair's identification.

4.4.5 Test for Specific Gravity

This gravity test is carried out using the Indian reference implementation IS: 1202 1978. Asphalt cement, soft tar pitches, and semi-solid bituminous material at 25°C are represented as a ratio of the water mass of the same volume at the same temperature.

Apparatus

- Bottles with a 50-milliliter specific gravity, 6-millimeter standard containers, and wide-mouthed bottles with a width of 25 millimetres were used for the experimentation.
- The weighing machine with the lowest count of 1g.
- Thermometer
- Tub filled with water

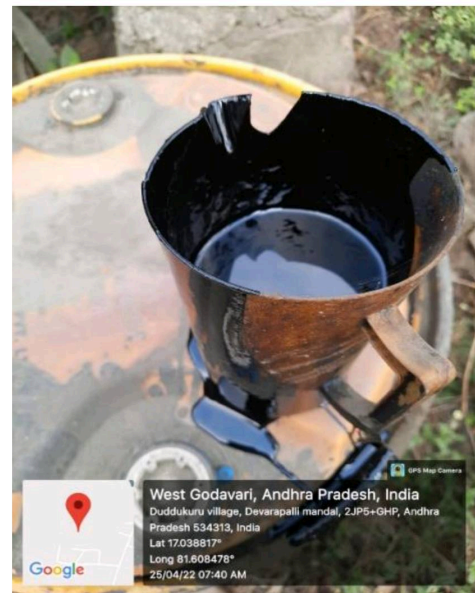
Procedure

1. Before weighing, the specific gravity bottle is cleaned and dried. ('A' weight.)
2. To weigh, distilled water is put into the specific gravity container, which is then sealed with an immovable top. (It is a 'B' weight.)
3. The bitumen is then half-filled into a specific gravity container and weighed (Weight 'C').

FIG 4.5 Bitumen Industry



FIG 4.6 Molten Bitumen



4. Bitumen and water are added to a specific gravity container, and the weight is recorded. Density D To put it another way, In terms of density



FIG 4.7 & 4.8 Testing the Sample

CHAPTER 5

DISCUSSION AND RESULTS

5.1 GENERAL

In this chapter, the findings of many experiments on bituminous samples are reported. A variety of tests were carried out on both raw and modified bitumen to determine its porosity, penetration, softening point, ductility, viscosity, and density. Crumb rubber is used as a substitute for bitumen in order to minimise the amount of bitumen used.

5.2 PENETRATION TEST

The penetration test for bitumen products was performed on samples made with partial replacement of 5-20 percent waste rubber tires respectively. Three experiments were carried out, with the average results being shown

i. 0 % of crumb rubber

Trail	Penetration (0.1mm (about 0 in)	Mean	Requirements as per IS 73-2013(RA 2018) VG-30
1	50	50.1	Min 45
2	50.2		
3	50.1		

ii. 5 % of crumb rubber

Trail	Penetration (0.1mm)	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	48	48	Min 45
2	48.1		
3	47.8		

iii. 10 % of crumb rubber

Trail	Penetration (0.1mm (about 0 in))	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	49.7	50	Min 45
2	50.2		
3	50.2		

iv. 15 % of crumb rubber

Trail	Penetration (0.1mm (about 0 in))	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	45.8	46	Min 45
2	45.8		
3	46.2		

v. 20 % of crumb rubber

Trail	Penetration (0.1mm)	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	43	43	Min 45
2	43.2		
3	42.8		

Table 5.2: Penetration Vs % of crumb rubber

% Of crumb rubber	Penetration (0.1mm (about 0 in))	Requirements as per IS: 73-2013(RA 2018) VG-30
0%	50.1	Min 45
5%	48	
10%	50	
15%	46	
20%	43	

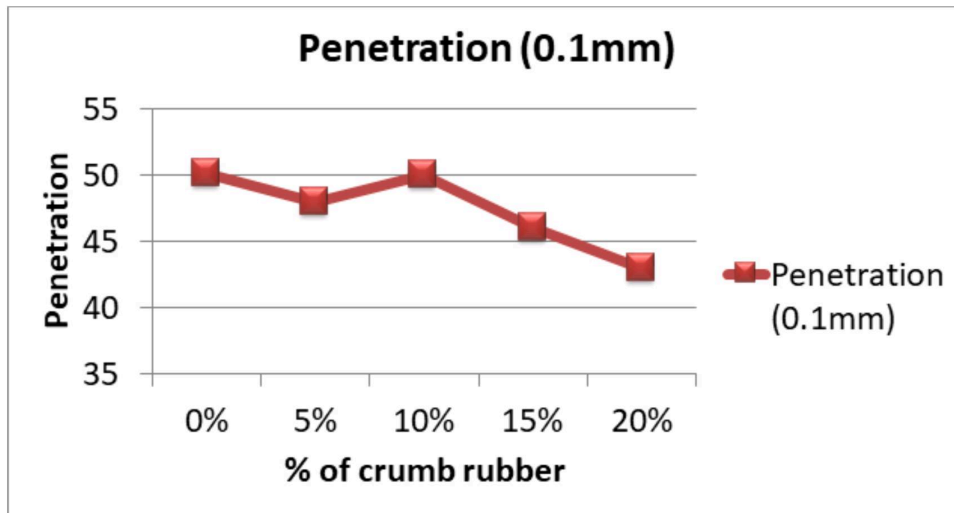


Fig 5.1 Penetration Vs % of crumb rubber



Fig 5.1.1 Penetration Test

There was a comparison done between ordinary asphalt with bitumen products comprising zero, 5, 10, 15, or 20% tire waste from tires. There was a significant

difference in the penetration values of conventional bitumen and bitumen products, according to the data shown in Fig 5 and Table 5.1. An improved bitumen strength results in a tougher quality of asphalt, which in turn increases the road construction's durability. When the percentage of crumb rubber in a product increase, its penetration value falls (fig. 5.1). When crumb rubber is added, the penetration value decreases due to the increased elasticity of the crumb rubber bitumen binder, making it more suitable for colder climates.

5.2 SOFTENING POINT TEST

The findings of the elastic modulus test establish the temperatures during which traditional bitumen should soften.

i. 0 % of crumb rubber

Trail	Softening Point ($^{\circ}\text{C}$)	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	50.8	51	Min 47°C
2	51		
3	51		

ii. 5 % of crumb rubber

Trail	Softening Point (°C)	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	49.7	49.9	Min 47 ⁰ C
2	50.1		
3	49.9		

iii. 10 % of crumb rubber

Trail	Softening Point (°C)	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	50.1	50.1	Min 47 ⁰ C
2	50.2		
3	50		

iv. 15 % of crumb rubber

Trail	Softening Point (°C)	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	49.5	49.5	Min 47 ⁰ C
2	49.6		
3	49.5		

v. 20 % of crumb rubber

Trail	Softening Point (°C)	Mean	Requirements as per IS: 73-2013(RA 2018) VG-30
1	47.3	47.5	Min 47 ⁰ C
2	47.7		
3	47.6		

Table 5.2 Softening Point Vs % of crumb rubber

% Of crumb rubber	Softening Point (°C)	Requirements as per IS: 73-2013(RA 2018) VG-30
0%	51	Min 47° C
5%	49.9	
10%	50.1	
15%	49.5	
20%	47.4	

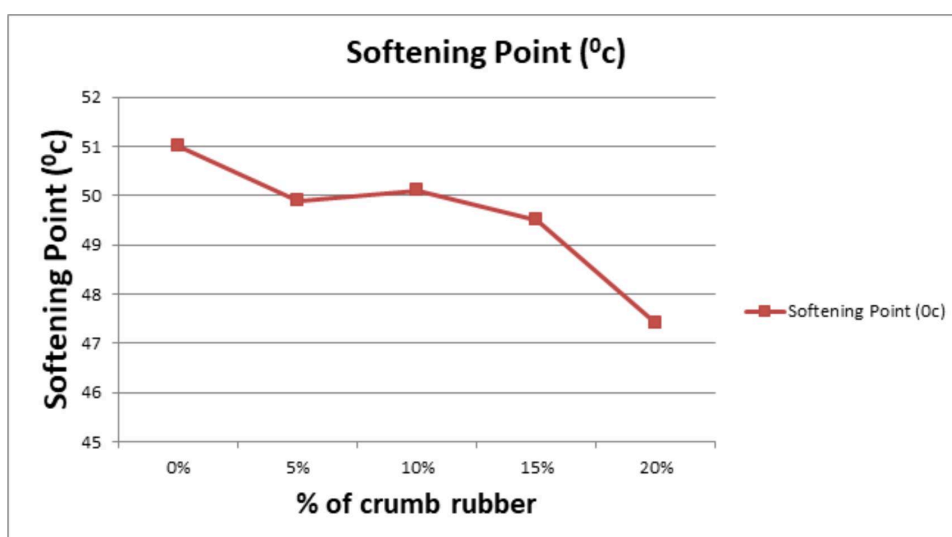


Fig 5.2 Softening Point (°C) Vs % Of crumb rubber



FIG 5.2.1 Softening Point

Table 5.2 reveals that the softening point for conventional bitumen is 51oC, however, the addition of tire rubber waste had a negative effect on the temperature by lowering the softening point. The value of the softening point drops as the amount of waste crumb rubber in bitumen decreases, indicating that modified bitumen with bitumen can only be utilized at sub-zero temperatures.

5.3 DUCTILITY TEST

I. 0% Crumb rubber

Trial	Ductility at 25°C, cm	Mean	Range (IS 1208)
1	47	46.3	Min 40
2	47		
3	45		

ii. 5% Crumb rubber

Trial	Ductility at 25°C, cm	Mean	Range (IS 1208)
1	42	42.6	Min 40
2	44		
3	42		

iii. 10% of Crum rubber

Trial	Ductility at 25°C, cm	Mean	Range (IS 1208)
1	36	35	Min 40
2	34		
3	35		

iv. 15% of Crumb rubber

Trial	Ductility at 25°C, cm	Mean	Range (IS 1208)
1	31	31.3	Min 40
2	31		
3	32		

vi. 20% Crumb rubber

Trial	Ductility at 25°C, cm	Mean	Range (IS 1208)
1	28	28	Min 40
2	28.3		
3	27.7		

Table 5.3.1 Ductility Vs % of Crumb Rubber

% Of crumb rubber	Ductility at 25°C, cm	Range (IS 1208) VG-30
0%	46.3	Min 40
5%	42.6	
10%	35	
15%	31.3	
20%	28.0	

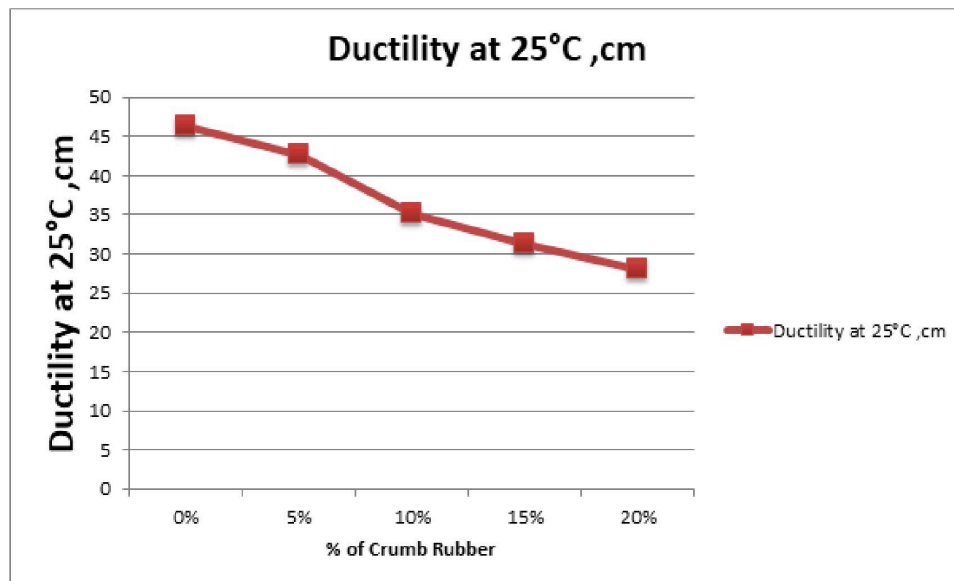


Fig 5.3 Ductility Vs % of Crumb rubber

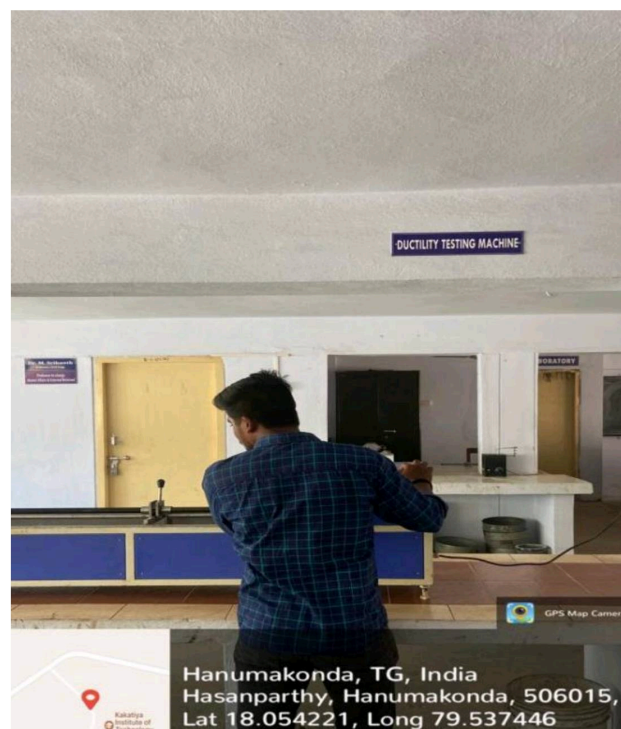


FIG 5.3.1 Ductility Test

5.4 VISCOSITY TEST

i. 0% of crumb rubber

Trail	Absolute viscosity at 60°C, Poises	Mean °c	Range 1206 (Part 2)
1	2660	2660	2 400-3 600
2	2700		
3	2620		

ii. 5% of crumb rubber

Trail	Absolute viscosity at 60°C, Poises	Mean °c	Range 1206 (Part 2)
1	2915	2887	2 400-3 600
2	2883		
3	2865		

i. 10% of crumb rubber

Trial	Absolute viscosity at 60°C, Poises	Mean °C	Range 1206 (Part 2)
1	3219	3202	2 400-3 600
2	3223		
3	3166		

li)15% of crumb rubber

Trial	Absolute viscosity at 60°C, Poises	Mean °C	Range 1206 (Part 2)
1	3422	3425	2 400-3 600
2	3395		
3	3459		

ii. 20% of crumb rubber

Trial	Absolute viscosity at 60°C, Poises	Mean °C	Range 1206 (Part 2)
1	3693	3710	2 400-3 600
2	3712		
3	3725		

Table 5.4 Viscosity Vs % of crumb rubber

% Of crumb rubber	Absolute viscosity at 60°C, seconds
0%	266
5%	288.7
10%	320.2
15%	342.5
20%	371

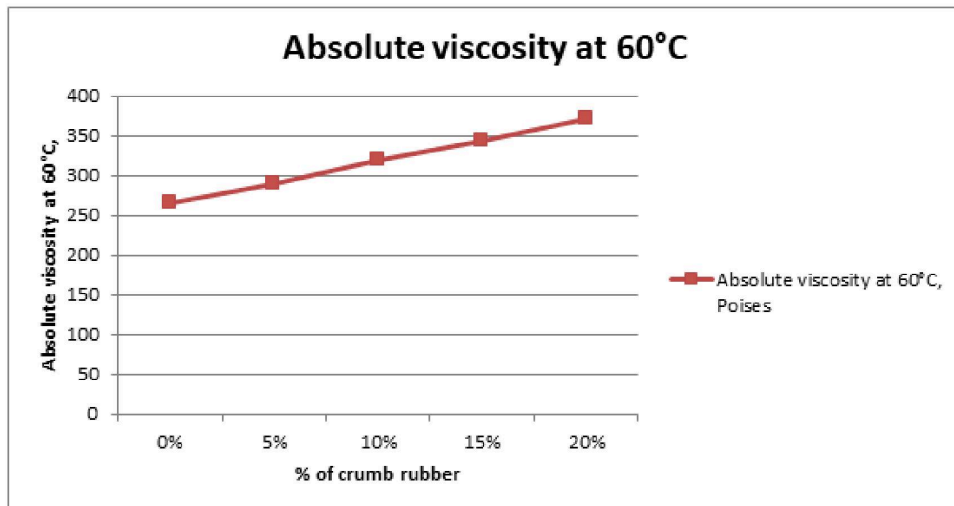


Fig 5.4 Viscosity Vs % of crumb rubber

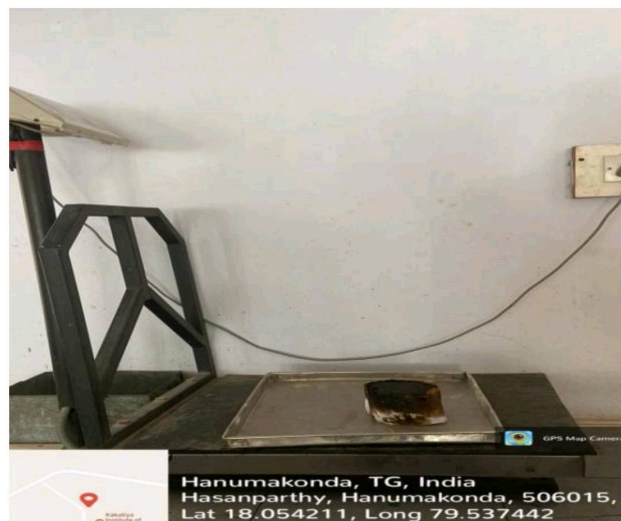


FIG 5.4.1 Weighing Bitumen along with Rubber

In terms of viscosity, the results in Table 5.4 show that ordinary bitumen had a viscosity value of 2660 poises in seconds at 60 °C. By increasing the viscosity of ordinary bitumen, the addition of rubber waste harmed the flow of the bitumen.

5.5 SPECIFIC GRAVITY TEST

i. 0 % of Crumb rubber

Trial	Specific Gravity	Mean
1	1.09	1.08
2	1.08	
3	1.08	

ii. 5 % of Crumb rubber

Trial	Specific Gravity	Mean
1	1.05	1.05
2	1.05	
3	1.05	

ii. 10 % of Crumb rubber

Trial	Specific Gravity	Mean
1	1.02	1.02
2	1.02	
3	1.01	

iii. 15 % of Crumb rubber

Trial	Specific Gravity	Mean
1	1.01	1.01
2	1.01	

iii. 20 % of Crumb rubber

Trial	Specific Gravity	Mean
1	0.95	0.95
2	0.97	
3	0.96	

Table 5.5 Specific gravity Vs % of Crumb rubber

% Of crumb rubber	Specific Gravity	Range
0%	1.08	-
5%	1.05	
10%	1.02	
15%	1.01	
20%	0.95	

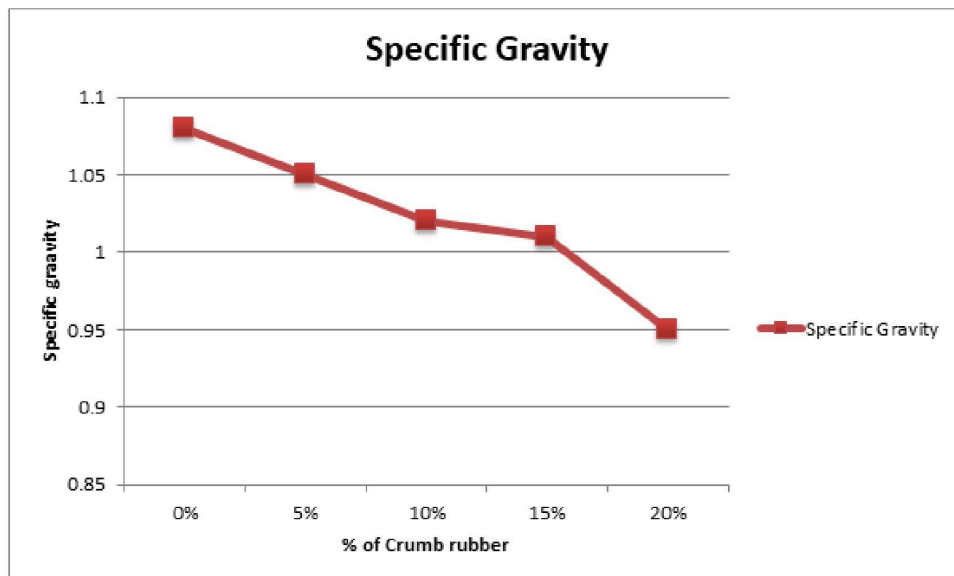


Fig 5.5 Specific gravity Vs % of Crumb rubber

% of crumb rubber	Penetration (0.1mm)	Softening Point (°c)	Ductility at 25°C ,cm	Absolute viscosity at 60°C, Poises	Specific Gravity
0%	50	51	46.3	2660	1.02
5%	48	49.9	42.6	2880	1.02
10%	46	50.1	35	3200	1.0
15%	43	49.5	31.3	3420	0.98
20%	42	47.4	28.0	3710	0.97

Fig 5.6 Table with all calculations

CHAPTER 6

CONCLUSION AND SUMMARY

Based on laboratory results, a new use for recycled aggregate is being explored, in which it is combined with bitumen and used to make the mix. In order to better understand the basic properties of bitumen, this combination was utilized. Several tests are performed on the rubber mixed bitumen, as previously mentioned. Crumb was added to VG30 oil production in increasing ratios, starting at 0-20%. in this experiment. Bitumen-containing rubber particles waste in shredded form was tested for stability using common methods such as the Flexure Test, Penetration Test, Fracture Toughness Test, Viscous Test, and Particular Gravity Test (all of which are based on standard laboratory procedures).

- Experiments have demonstrated that substituting traditional bitumen with 20% crumb rubber did not provide the desired outcomes, but that 5% produced satisfactory results in all tests.
- We concluded from the foregoing findings that crumb rubber's optimal percentages are just 5% and 10% since the majority of the tests were successful at these percentages.

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