



# EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF BITUMEN WITH CRUMBRUBBER

Tejas D.Jadhav<sup>1</sup>, Ashish R. Gaikwad<sup>2</sup>, Vivek V. Deshpande<sup>3</sup>, HARSHAL. P. Patil<sup>4</sup>

<sup>1,2,3</sup>Student, of Civil Engineering, JSPM's Imperial College Of Engineering & Research, Wagholi Pune, Maharashtra, India

<sup>4</sup>Assistant Professor, Dept. of Civil Engineering, JSPM's Imperial College Of Engineering & Research, Wagholi Pune, Maharashtra, India

**Abstract**— With the ever increasing demand of automobiles in our daily life, rubber waste is also increasing enormously through tyres resulting in disposal of rubber waste in land. Instead of disposing rubber waste into landfills, it can be reused in flexible pavements as crumb rubber as it has elastic properties. So the crumb rubber can be used in road construction works by partially replacing bitumen. Addition of crumb rubber in flexible pavements enhances the properties of the road surfaces as well as it reduces the rubber waste from the lands. In the experimental work, bitumen was partially replaced by crumb rubber with varying percentages i.e. 8%, 10% & 12%, for performing Marshall Stability Test on the prepared samples. Tests were also performed to check the physical properties of the aggregates and bitumen. The optimum percentage of bitumen and crumb rubber for stability value and flow value was found out to be 12.2 KN and 2.7mm respectively.

**Keywords**— Crumb rubber, Flexible pavements, Bitumen, Marshall Stability.

## I. Introduction

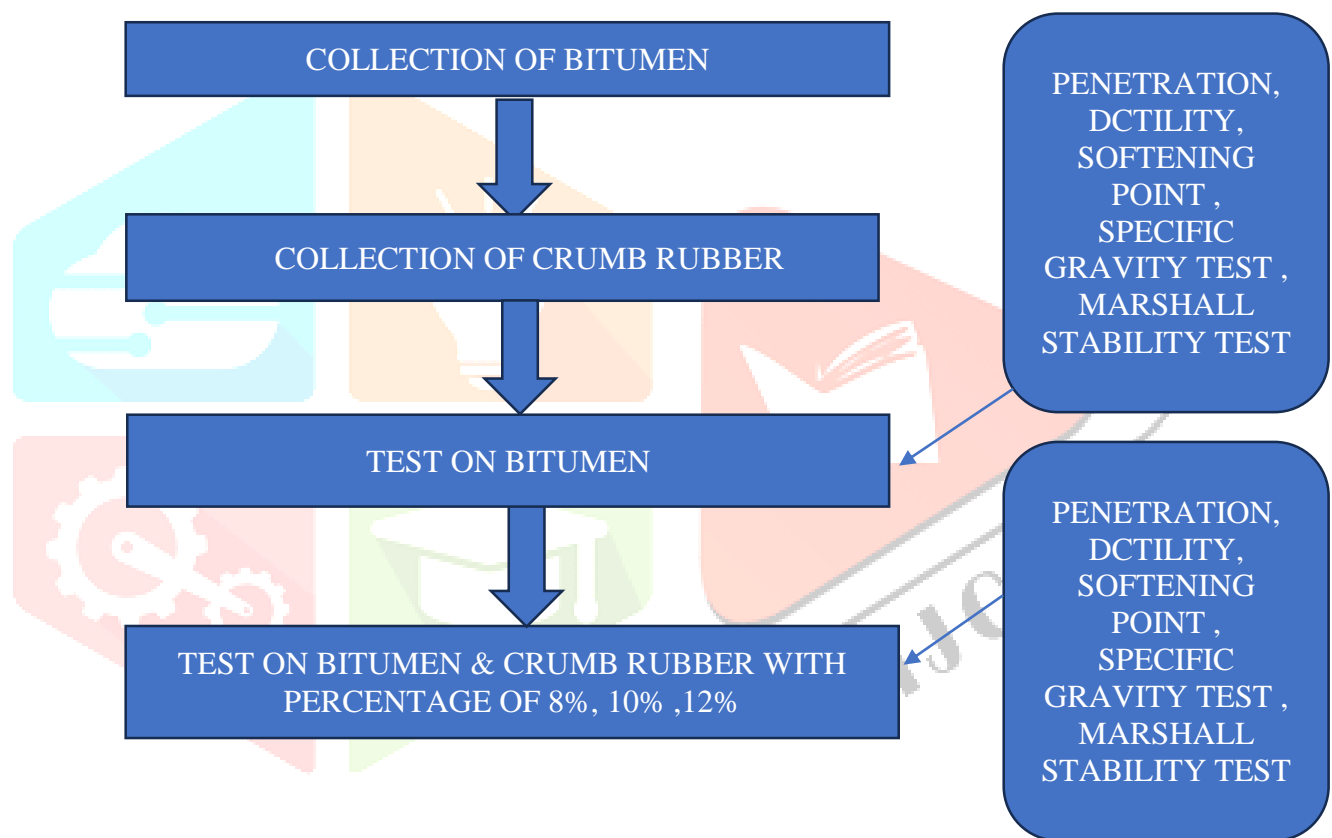
Every country's economy mostly depends upon the industries and trades but it is all possible with the transportation. The most common mode of transport in India is road transport including 90% of passenger and 70% freight vehicles owing on roads. It is very difficult to maintain roads in adverse climatic conditions. So it becomes important to modify the properties of roads surface in order to reduce the increasing maintenance problems. Materials like rubber can help modifying the properties of roads as it is flexible in nature and can be mixed easily with bitumen flexible pavements. Rubber is a non-bio degradable material and the disposal of rubber leads to environmental pollution. Therefore, utilizing waste rubber in roads pavements imparts to the properties of roads and to the environment as well. The cost of natural construction materials is increasing day by day, so it becomes necessary to find alternatives to replace the natural resources which may lead to improved quality of roads and reduced constructional costs. Rubber tyres have been proved user friendly to the people in many ways but are not eco-friendly. So it becomes a matter of utmost importance to reuse waste rubber in any means possible.

## A. OBJECTIVES

- To determine the physical properties of bitumen.
- To study the effects of crumb rubber in bitumen mix.
- To determine the optimum bitumen content.
- To determine the optimum rubber content.
- To determine the Marshall stability and flow value.

## I. METHODOLOGY

Mix design is used to calculate that content of bitumen or any other material that will provide maximum strength and durability as economical as possible. Marshall Mix design was used to determine the optimum percentage of bitumen and crumb rubber. 1200 g of aggregate along with 5% filler (stone dust) by weight of aggregate and various percentages of bitumen were taken to determine the optimum value of bitumen.



### A. TEST CONDUCTED ON BITUMEN

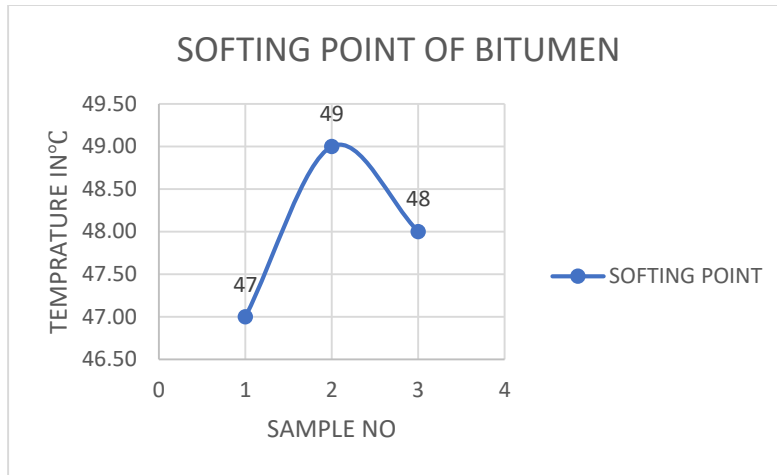
From the fractional distillation of crude petroleum bitumen is obtained. It is a black viscous mix comprising hydrocarbons obtained as residue from petroleum distillation or naturally obtained in liquid, solid semi solid and in gaseous form and can be dissolved in carbon tetrachloride and carbon disulfides. It is commonly used for paving road and roofing. It is used in the road pavement due to its better binding quality and water resisting property. Type of bituminous construction depends upon the different characteristic properties of the bitumen to be used. There are different bitumen grades according to their viscosity grade. Here bitumen of Viscosity Grade 30 is used in the tests. To find various bitumen properties, following tests are performed:-

1. Softening point Test
2. Penetration Test
3. Ductility Test
4. Specific gravity Test
5. Marshall Stability Test

**B. MATERIAL ANALYSIS OF BITUMEN.**

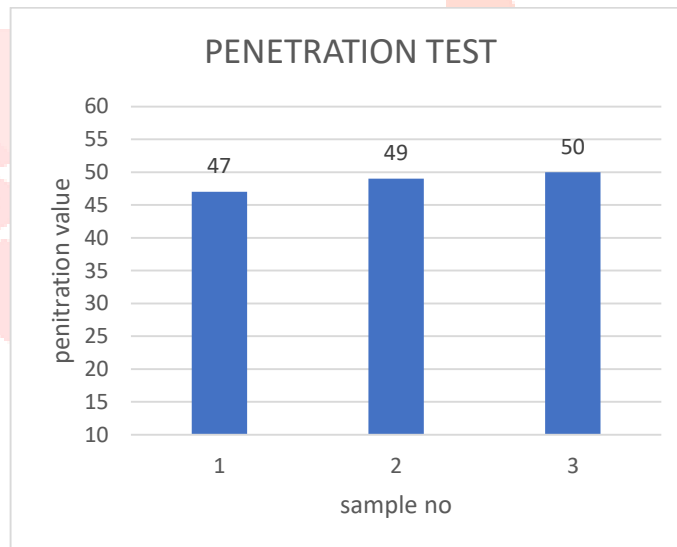
**1. SOFTENING POINT TEST ON BITUMEN :-**

Specific gravity of a material is defined as the ratio of the density of a substance to the density of a standard, usually water for a liquid or solid, and air for a gas.



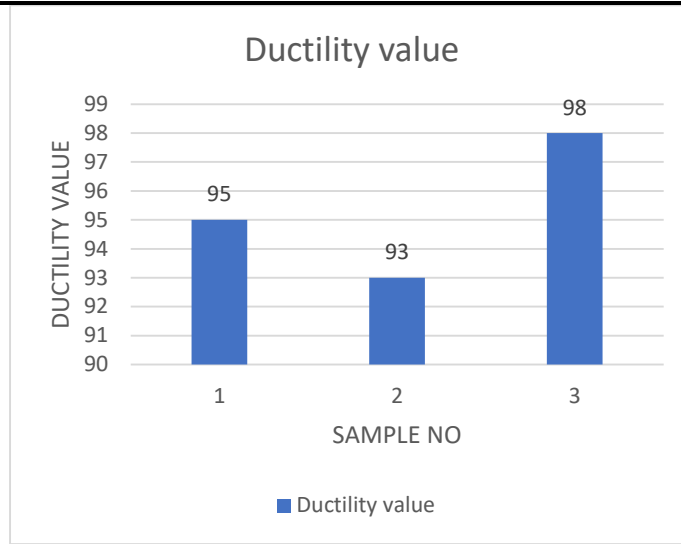
**2. PENETRATON TEST**

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



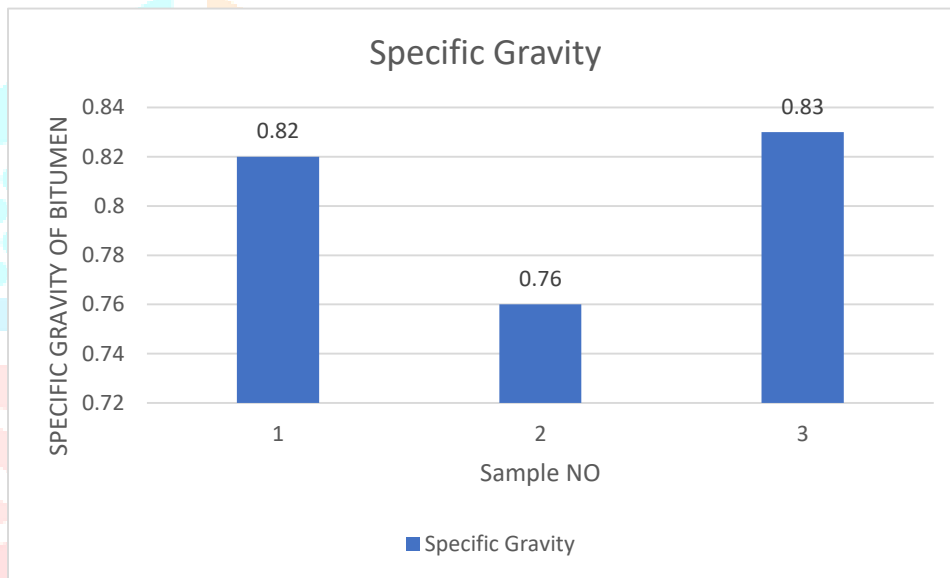
**3. DUCTILITY TEST**

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



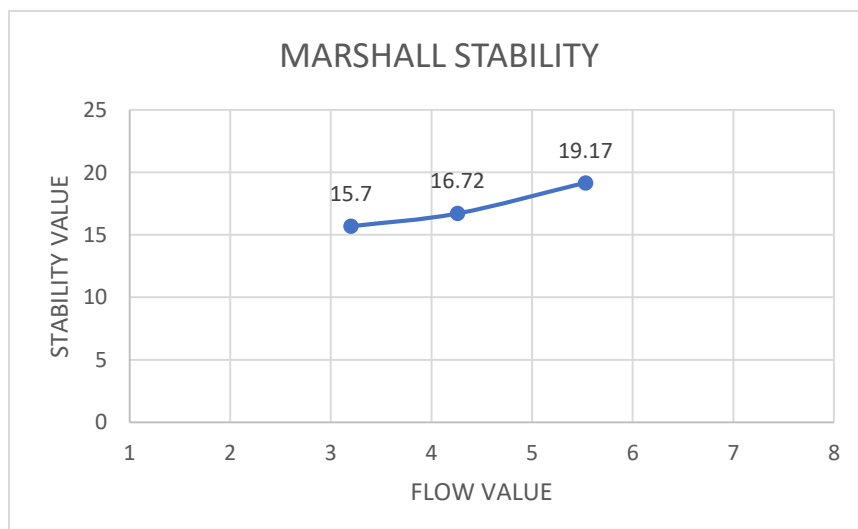
**4. SPECIFIC GRAVITY TEST**

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



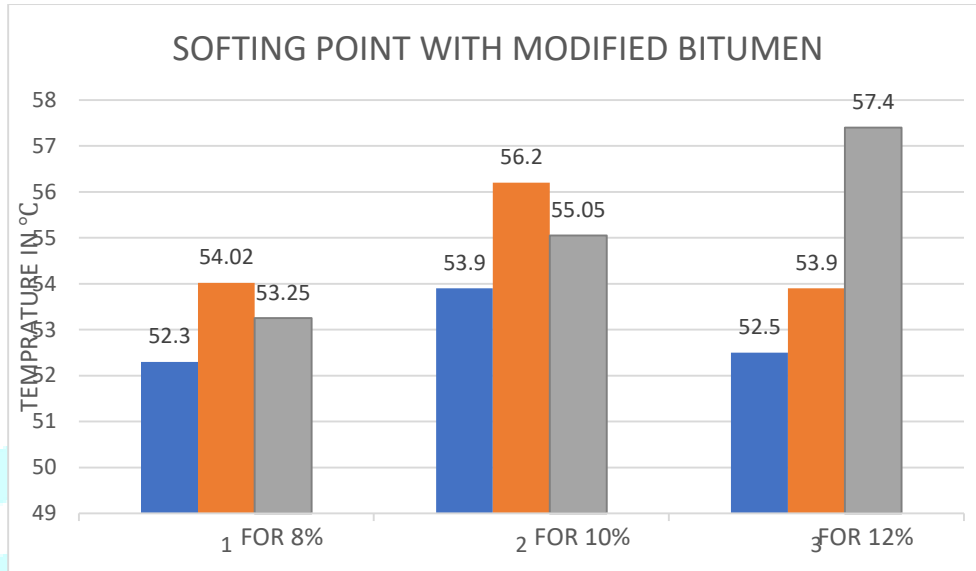
**5. Marshall Stability without crumb rubber**

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

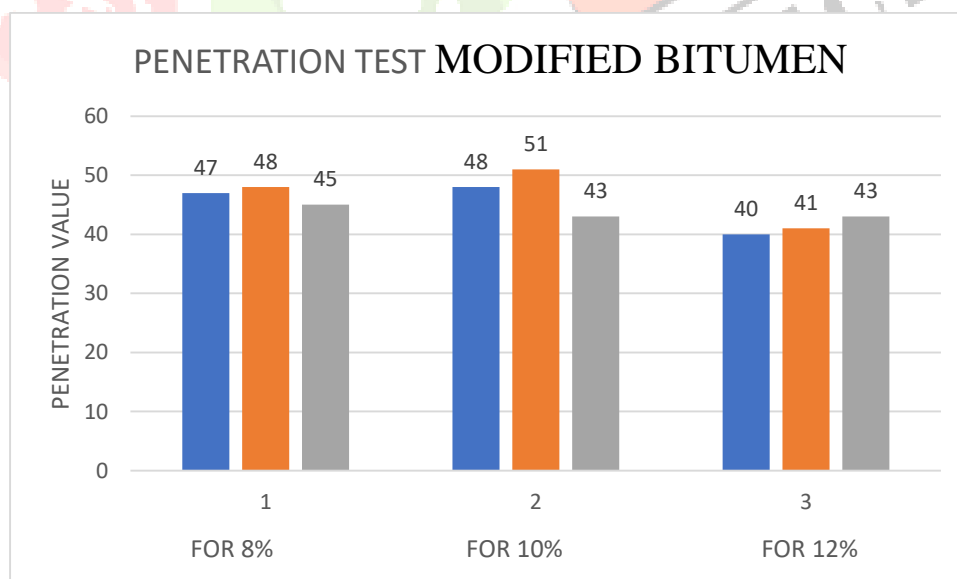


**C. MATERIAL ANALYSIS OF BITUMEN WITH CRUMB RUBBER.****1. SOFTENING POINT TEST ON BITUMEN :-**

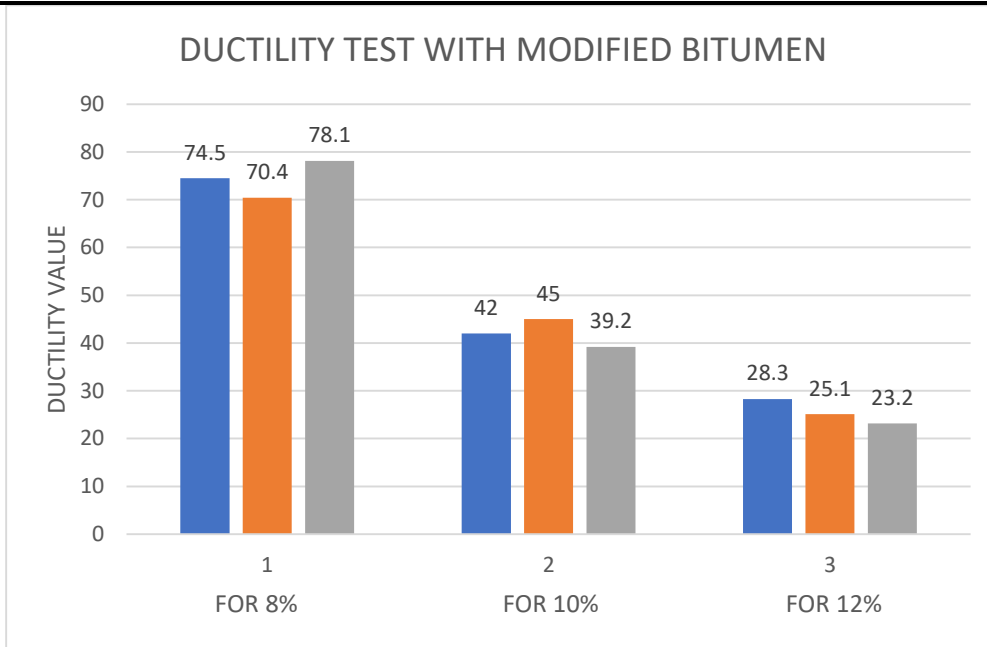
The test is done in accordance to IS code 1205 1978. Softening point is the temp. at which ball passes through bitumen and falls through a height of 2.5 cm, obviously when heated under water keeping standard conditions. The SETUP'S name is Ring and Ball setup. Steel ball is kept on bitumen test ring and water is heated at 5 C per minute. Temperature is jotted down when the ball touches the metal plate which is at a standard height underneath it. It varies between 35 ° C – 70 ° C And we also use the 8%,10% & 12% of crumbrubber to check the properties.

**2. PENETRATION TEST :-**

The test runs in accordance with IS code 1203 1978. It tells us about consistency of bitumen. The given test is carried out using penetrometer. Initially bitumen is poured into the mould and cooling is done for 30 minutes carried by water bath at 25 C for an hour. It has a needle weighing 100 gm which penetrates into the sample of bitumen for 5 seconds. Three readings are taken and thereading should be taken within 10 mm distance of the first penetration. The measurement is done in 1/10 mm units And we also use the 8%,10% & 12% of crumb rubber to check the properties.

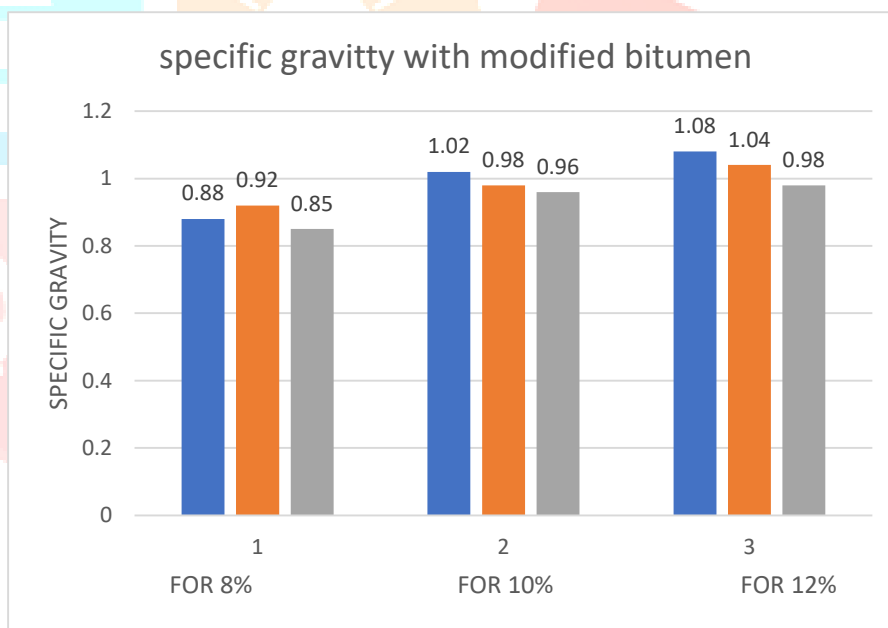
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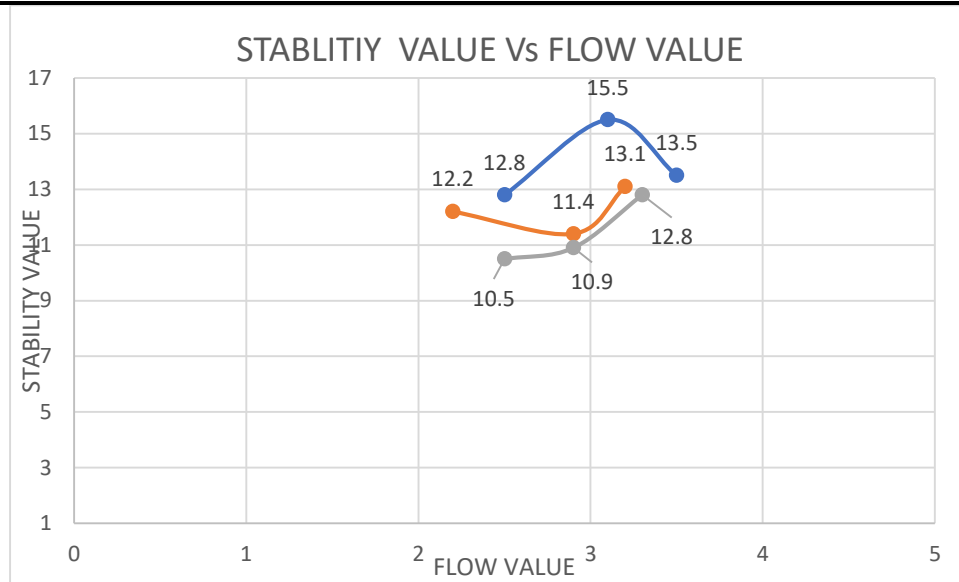
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**5. Marshall Stability with crumb rubber**

Marshall stability is the most important test to determine the optimum bitumen content. The test is performed at the rate of 5.08 cm per minute load. Marshall Stability is the maximum applied force at which the bituminous sample breaks or fails. Along with marshall stability flow value is also measured during the failure of test sample. And we also use the 8%,10% & 12% of crumb rubber to check the Stability and Flow Value of bitumen.



## CONCLUSION

- Penetration value of bitumen is increasing with the increase in percentage of crumb rubber in it. Therefore softening of bitumen is increasing or hardness is decreasing because of elastic property of crumb rubber.
- Softening point of bitumen is increasing till 12% crumb rubber in bitumen. Therefore it increases its temperature bearing capacity.
- Ductility of bitumen is decreasing with the increase in percentage of crumb rubber which reduces its expansion.
- Stability of SDMC is maximum on addition of 12% of crumb rubber in bitumen.
- Flow rate continuously decreasing on increasing of crumb rubber.
- The best percentage of crumb rubber for construction of pavement is 10% as per above result.
- **NOTE :- WE ALSO USE 12% OF CRUMB RUBBER IN PAVEMENT IN O.D.R OR V.L. ROAD'S.**

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