Research Paper Engineering

Laboratory Study on Fibrous and Non Fibrous Bitumen Using Brookfield Viscometer

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ABSTRACT

Bitumen is available in variety of types and grades. To judge the suitability of these grades various tests are specified by the different agencies like ASTM, ISI, and IRC etc. For classifying bitumen and studying the performance of bituminous pavement, penetration and ductility tests are essential. The other tests like softening point, flash and fire point tests are more important to guide the paving technologists during field operations. In recent years it has been recognized that the above tests are not sufficient to define the temperature susceptibility of bituminous materials .The bitumen from the different sources possessing the same penetration value at the specified temperature may exhibit entirely different viscous characteristics at the application temperatures. These tests therefore may need intensive correlation with fundamental property like viscosity. Viscosity is the resistance offered by the liquids for its motion and it is the general term for consistency. The degree of fluidity of binder at the application temperature greatly influences the strength characteristics of the paving mixes. High or low viscosity during mixing or compaction will result in lower stability values. At low viscosity bituminous binder simply lubricates the aggregates instead of coating a thin film over. At high viscosity resists the compaction effort and mix results in heterogeneous character exhibiting low stability values. Thus measurement of viscosity at the application temperature is very much essential.

The conventional type of measurement of viscosity involves the determination of transpiration time to flow certain quantity of flow under certain test condition. These methods give viscosity in seconds, specifying the apparatus with which it is measured. Brookfield viscometer is one which measures the viscosity directly in centipoises. Test procedure is very simple to conduct. With the Thermosel accessories viscosity can be determined to any desired temperature. Present studies made use of this one. Various types of cracks, like fatigue cracking, low temperature cracking etc. were found to develop on bituminous pavements. In recent years to prevent these cracking in bituminous pavements geosynthesis in the form of fibers are being extensively used. The present investigation envisages laboratory study of different grades of bitumen with and without fibers with respect to change in viscosity measured with Brookfield viscometer.

Keywords :Viscosity, Brookfield Viscometer, Thermosel, Temperature.

INTRODUCTION

All liquids exhibits the property of flowing but it was observed that, thin liquids flow easily than thick liquids. This implies that each liquid has some characteristics property which controls the easiness or the rate of flow. This property which controls the motion or flow of liquid is known as "viscosity". Thus viscosity is defined as the 'resistance to the motion' or it is defined as 'inverse of fluidity'. Bitumen has also got viscosity, here viscosity defines the fluid property of the bituminous material. It is the general term for consistency, and it is the measure of resistance to flow. When the liquid body is subjected to shear force the body undergoes a continuous shear deformation, however, the shear load is small. But the rate at which shear load is small. But the rate at which shear deformation takes place under the action of shear load is dependent on the characteristic property namely, the viscosity. It is the property of fluid which resists the flow, so that when a force is applied to a liquid. It is the measure of flow characteristic of fluids and thus, the higher viscosity slower is the movement of the fluid. And if the viscosity is lower the movement of the fluid is more. Example molasses and bitumen are considered as highly viscous liquids whereas the water and alcohol have very small viscosity. Bitumen is available in different grades, based on conventional penetration units. But, now researchers believe that the grading should be based on absolute viscosity. The degree of fluidity of bitumen at the application temperature greatly influences the strength characteristics of resulting paving mixes. High or low viscosity during mixing or compaction has been observed to result in low stability values. At low viscosity, the bituminous binder simply lubricates the aggregate particles instead providing a uniform film for binding action. Similarly high viscosity also resists the compactive effort and the resulting mix is heterogeneous in character exhibiting in low stability. Here an effort is put to study the viscosity and its variations at different temperatures with varying percentage of fiber. The fiber used is steel wool has got very good flexibility and strength. It is cheaply available in market as steel wool, mostly used for giving furnished surfaces of wood for painting.

The main objectives of present study are as follows

1. To study the temperature- viscosity relationship of 30/40, 60/70, 80/100 and CRMB-55 grade bitumen.
2. To study the temperature- viscosity relationship for the above grades of bitumen with the addition of fiber like steel wool and Glass fibers at different percentages like 1%, 2% and 3%.

BROOKFIELD VISCOMETER

Brookfield viscometer is one of the advanced types of viscometer which measures the viscosity of fluid directly and gives the values in the fundamental units i.e. in mass, length and time. The method of measurement of viscosity is very simple we get the viscosity directly in "centipoises". This viscosity is specified with temperature. The present study involves the use of Brookfield viscometer for the determination of viscosity of different grades of bitumen.

Fig: 1. Brookfield viscometer DV-II version with Thermosel accessory and Temperature controller

Brookfield dial viscometer is a portable one. The complete set of instrument can be separated spare by spare. Very easy to carry and assemble. As far as the function is concerned, the Brookfield viscometer is divided into three parts.

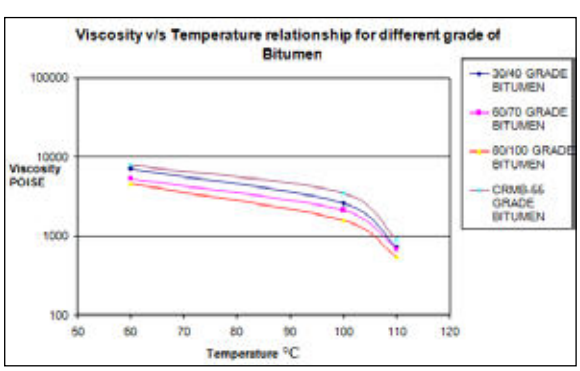
- Digital viscometer with stand
- Thermosel accessory
- Temperature controller

PRINCIPLE OF BROOKFIELD VISCOMETER

The Brookfield viscometer measures the fluid viscosity at a given shear rates. Viscosity is a measure of fluids resistance to flow. The basic principle beyond this Brookfield viscometer and co-axial cylindrical viscometer are same. The viscometer rotates a sensing element in a fluid and measures the torque necessary to overcome the viscous resistance, induced on the sensing element movement. This is accomplished by driving the immersed elements, which is called as spindle, through a beryllium copper spring. The degree to which the spring is wound is proportional to the viscosity of the fluid. For a material of given viscosity, the resistance will be greater as the spindle size and or rotational speed increases. The minimum viscosity range is obtained by using the largest spindle at highest speed and the maximum range by using the smallest spindle at lowest speed. To make the viscosity measurement turn the viscometer switch "ON" which energies the viscometer drive motor. Allow the time to make the indicated reading to stabilize. And note down the viscosity from digital output, when the maximum torque is reached. In the present experiment a spindle number of 1.6 M, samples chamber HT 20 and speed of 2.5rpm is used for measurement of viscosity.

Table No 1: Viscosity of different grade bitumen at different temperatures using Brookfield viscometer.

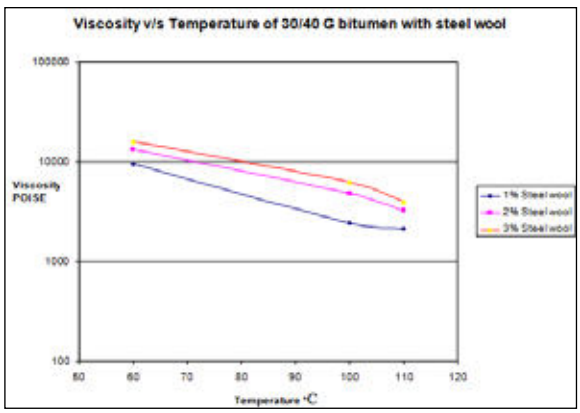
Test Temperature °C	Viscosity (poise)			
	30/40	60/70	80/100	CRMB 55
60	7060	5250	4560	7900
100	2580	2100	1570	3450
110	720	680	540	900



GRAPH NO.1

Table No 2: Viscosity of 30/40 grade bitumen at different temperatures using Brookfield viscometer with steel wool at various percentages.

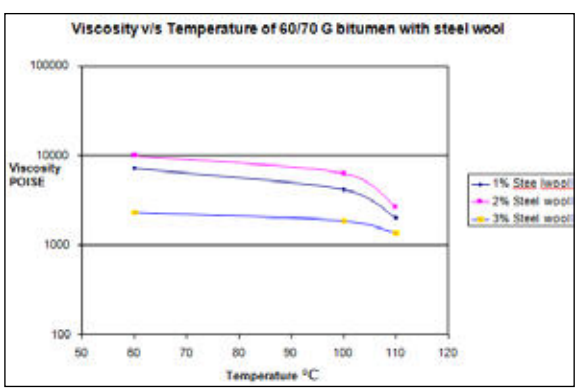
Test Temperature °C	Viscosity (poise)		
	1%	2%	3%
60	9601	13414	15888
100	2420	4840	6292
110	2160	3240	3960



GRAPH NO.2

Table No 3: Viscosity of 60/70 grade bitumen at different temperatures using Brookfield viscometer with steel wool at various percentages.

Test Temperature °C	Viscosity (poise)		
	1%	2%	3%
60	7297.5	9870	2312
100	4200	6300	1860
110	2040	2720	1360



GRAPH NO.3

Table No 4: Viscosity of 80/100 grade bitumen at different temperatures using Brookfield viscometer with steel wool at various percentages.

CONCLUSIONS

- The viscosity of 80/100 Grade bitumen is 4560 poise and 30/40 Grade bitumen is 7060 poise at 60°C. From this we can conclude that 80/100 Grade bitumen will have lesser viscosity and 30/40 Grade bitumen will have greater viscosity at a particular temperature.
- With the inclusions of fiber steel wool to 30/40, 60/70 and 80/100 at 1%, 2% and 3% the viscosity is going to increase subsequently. Viscosity of different grade bitumen will increases with the inclusion of fibers. Steel wool gives good results with respect to increase in viscosity

Acknowledgement

The success associated with the accomplishment of any task

would be incomplete without acknowledging the people who made it possible. I am immensely and sincerely thankful to my thesis guide Dr.L.Manjesh, Associate professor, Department of Civil Engineering, UVCE Bangalore, under whose guidance this paper has been accomplished flawlessly.

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