



Time Based Performance Evaluation of Extracted Pavement Bitumen

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ABSTRACT

Deterioration or failure of the road pavements before its expected life period is the major concern, which may results in inconvenience to the passersby& risk to their safety too. Purpose of the research is to evaluate the effect of ageing on bitumen used for construction of roads in India, under different climatic conditions. The paper discusses the changes in the properties of bitumen over a period of time, which is caused mainly by external condition such as climatic, mechanical conditions to which bituminous roads are ordinarily subjected.

The work is carried out on selected road, taken core samples. With the help of extraction bitumen machine, bitumen was extracted and tested for penetration, ductility, flash point, specific gravity and softening point tests in laboratory. The results were compared before ageing and after ageing of sample.

Keywords: Bitumen, Ageing, Hardening, Softening, Ductility

INTRODUCTION

Road transport is vital to the country's economy; better the transport facility & infrastructure available better will be the economy as it's not necessary that better economy will have a better infrastructure. India has the 2nd largest road network in the world at 5.4 million kms after USA⁽¹⁾. This network transports more than 60% of all goods in the country & it contributes 85% of India's total passenger traffic. Road transport has gained its attention over the years compared to railways & air.

In India, large percentage of pavement surfaces are made of macadamized bitumen based. These types of roads are made with the combination of asphalt & bitumen, where asphalt takes load of the pavement & bitumen used to hold them by acting as a binder. Bitumen consists of 85% waterproofing agent by its weight. Indian government uses to spend 3 to 7 crore for construction of bituminous roads per km. However, some of them fail before its expected life period due to mainly ageing. The ageing occurs due to the climatic condition such as rise/decrease in the temperature, rainfall intensity, photo oxidation, etc as well as mechanical condition pertains to wear & tear of the wearing course due to passing of vehicles, excessive loads, etc.; followed by other miscellaneous causes such as the emission of polluted matter from vehicles, improper construction, etc.



DEFINITION

Bitumen: It is a combination of dark, sticky, highly viscous organic liquids composed largely of aromatic hydrocarbons. It is generally black or dark brown in colour Bitumen found in nature is known as crude bitumen, and that obtained by the distillation of crude oil is called refined bitumen.

Viscosity grade of Bitumen: The new method of grading the product has now rested on the viscosity of the bitumen. Various types of characteristics of bitumen are given as follows in the below table.

Characteristics	Paving Grades or Viscosity Grade Bitumen Requirements			
	VG-10	VG-20	VG-30	VG-40
Absolute viscosity at 60 ⁰ C, Poises, Min	800	1600	2400	3200
Kinematic viscosity at 135 ⁰ C, St, Min	250	300	350	400
Flash point, (Cleveland open cup), ⁰ C, Min	220	220	220	220
Solubility in trichloroethylene, %, min	99.0	99.0	99.0	99.0
Penetration at 25 ⁰ C	80-100	60-80	50-70	40-60
Softening point, ⁰ C, Min	40	45	47	50
Tests on residue from thin film oven test/RTFOT				
Viscosity ratio at 60 ⁰ C, Max	4.0	4.0	4.0	4.0
Ductility at 25 ⁰ C, cm, Min, after thin film oven test	75	50	40	25

Table no 1: Characteristics of various VG grades (source: civilblog.org)

Ageing: The ageing of bituminous binders is one of the key factors determining the lifetime of an asphalt pavement. The process of ageing involves chemical and/or physical property changes that usually make bituminous materials harder and more brittle, thus increasing risk of pavement failure. The ageing-related pavement failure



modes include cracking (thermal or traffic induced) and raveling. Cracks on pavement surface may increase ageing of the binder because of increased exposure area to atmospheric oxygen.

In general, bitumen ageing takes place in two stages, namely short-term ageing at high temperature during asphalt mixing, storage and laying, and long-term ageing at ambient temperature during in-service. The mechanisms of ageing include oxidation, evaporation and physical hardening. Physical hardening is a reversible process, which changes the rheological properties of bitumen without altering its chemical composition. At ambient temperatures, physical hardening normally is very slow, but it can speed up at low temperatures. For bituminous binders, loss of volatile components (evaporation) is also considered as an ageing mechanism. However, today's penetration grade of bitumen are relatively in volatile, thus during pavement in-service this type of ageing is negligible.

Bitumen, like any organic matter, is affected by factors like presence of oxygen, ultraviolet rays and changes in temperature, which are responsible for hardening of bitumen. Hardening results in decrease in penetration increase in softening point and increase in penetration index (PI). For increased life of bituminous pavement, it is essential that excessive hardness does not take place.

Bitumen is most important in pavement construction and act as binder. Bitumen is generally obtained from petroleum industry. Properties of bitumen are also depends on its source. Adding modifiers can sufficiently improve the ageing resistance of bitumen sample. Ageing is the main reason behind bituminous wearing course failure. The bituminous pavement fails due to various reasons such as UV radiation, temperature changes, and weather condition and depends upon the grade of bitumen. In India various bituminous pavement fail before its full life and get deteriorated within few months of its laying. Bituminous pavement may also fail due to material property, method of construction during its laying operation and sub-grade strata.

EXPERIMENTAL WORK

Road was identified and a core of the pavement surface was taken with the help of PWD officials. The location of the core was a village Uppalwadi having Longitude: 79.1179 and Latitude: 21.1766. The road under consideration was laid before about 18 to 24 months time.

From the available record, few properties of the virgin bitumen could be obtained and they are:

- Penetration value 65, 67
- Ductility 89cm, 90cm
- Softening point 54⁰ C

The sample was taken to the laboratory for the extraction of the bitumen using bitumen extraction machine. The bitumen so extracted was tested for softening point test at room temperature 34°C, ductility test at room temperature 32°C, penetration value test at room temperature 29°C. Similarly, tests were performed for specific gravity, flash and fire point at respective room temperature.

RESULTS AND DISCUSSIONS

The results so obtained were plotted on a graph for comparing the ageing effect on bitumen over a period.

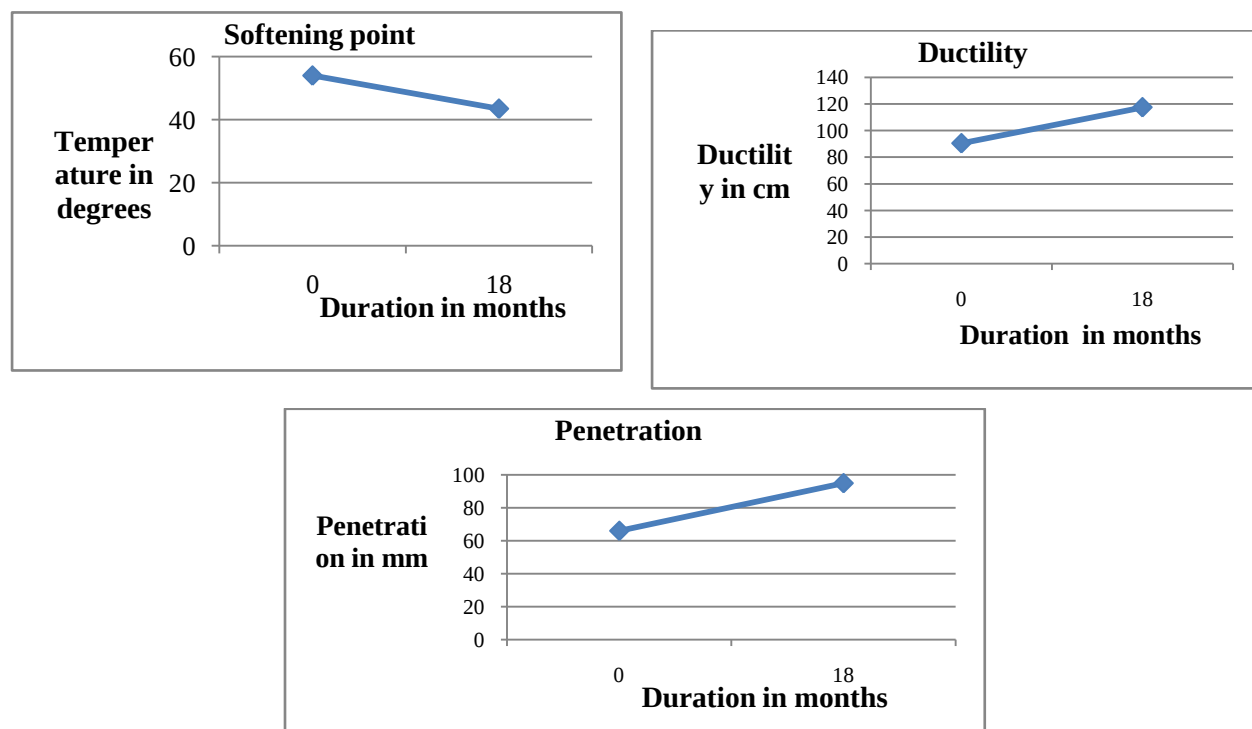


Fig. 1(a), 1(b) & 1(c) graph showing softening point, ductility & penetration values of the test sample (extracted bitumen)

The softening point before ageing was 54°C and after ageing was obtained to be 43.5°C . The softening point of bitumen was found to be 43.5°C . The change in softening point is due to ageing and temperature effect.

The ductility before ageing was 90.5cm and after ageing was 117.5 cm. The ductility of bitumen sample was found to 117.5cm. This happens mostly due to ageing of bitumen but second reason may be the temperature. The ductility as per BIS should be more than 75cm.

The grade of the bitumen sample was S-65 before ageing and it is S-90 after ageing. The penetration values are obtained are 94, 96, 97 this values lies in the range of 80-100 so the grade of bitumen is S-90 grade. For every specific purpose, there is specified grade of bitumen. If its value changing, then it is not suitable for specific purpose for which it is designed earlier.

The specific gravity after ageing was found to be 1.44. The specific gravity generally lies in range 0.97 to 1.02. The flash point after ageing was found to be at 180°C . The standard value of flash point is 175°C .

CONCLUSION:

Experimental result concluded that the ageing of bitumen ought to occur. It will happen and the properties will get change over a period.

The effect of ageing was observed on various properties of bitumen such as penetration, ductility, softening point, specific gravity and flash point of bitumen.

This change in properties of bitumen is happen due to UV radiation, temperature changes, loading due to traffic, day and night cycle. Therefore, it is recommended that before laying of bitumen on road it should be mixed with some chemicals for eg: LDH, OEVM, imidazoline, SBS, elastomer, lignin etc. After mixing of chemicals with bitumen, it will impart resistance to ageing of bitumen. Adding of elastomer can increase softening point. Increasing in proportion of SBS decreases breaking point i.e. Ductility. The lignin modified asphalt binders proved lower penetration values than conventional one.

Nomenclature

LDH- layered double hydroxides

OEVM – Organic expanded vermiculite

OMMT- Organic Montmorillonite

SBS – Styrene butadiene styrene

UV – Ultraviolet

VG-Viscosity grade

VMT- vermiculite

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