ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 8, Issue 9, September 2021

Review on Extraction of Heat from the Surface of Flexible Pavement by Addition of Graphene

Sheeba Anjum[1], Sivaranjani M[2]
Assistant professor, Department of Civil Engineering, HKBK College of Engineering, Bengaluru, India[1,2]

Abstract: Graphene is considered to be a promising material for the development of the next generation of asphalt binders to be used in road engineering. Nonetheless, in spite of the potential advantages that graphene could add to bitumen, there are currently very few studies able to quantify its real contribution to the performance of existing binders. This research therefore aims to evaluate the mechanical and thermal properties of graphene modified binders. For this purpose, rheological and thermal tests were conducted on binders manufactured with different dosages of graphene flakes. The results indicate that the presence of graphene produces a more elastic response in asphalt binders. In addition, it has been shown that graphene can reduce the thermal susceptibility of these binders, increasing their capacity to be heated and to produce heat transfer.
Keywords – Flexible pavement, Graphene, Extraction of heat.

I. Introduction

Flexible pavement can be defined as the one consisting of a mixture of asphaltic or bituminous material and aggregates placed on a bed of compacted granular material of appropriate quality in layers over the subgrade. Water bound macadam roads and stabilized soil roads with or without asphaltic toppings are examples of flexible pavements. Subgrade Consists of the naturally occurring material on which the road is built, or the imported fill material used to create an embankment on which the road pavement is constructed. Subgrades are also considered layers in the pavement design, with their thickness assumed to be infinite and their material characteristics assumed to be unchanged or unmodified. Prepared subgrade is typically the top 12 inches of subgrade. Sub base is layer of granular material provided above subgrade generally natural gravel. It is usually not provided on subgrade of good quality. It is the layer immediately under the wearing surface. As base course lies close under the pavement surface it is subjected to severe loading. The material in a base course must be of extremely high quality and its construction must be done carefully.

II. MATERIALS DESCRIPTION AND THEIR PRPOERTIES

2.1 Bituminous Macadam:

Consists of combination of mineral aggregate with bituminous binder ranging from inexpensive surface treatment ¼ in or less thick to asphaltic concrete. For good service throughout the full life bituminous pavement must retain following qualities.

- Freedom from cracking or ravelling.
- Resistance to weather including the effect of surface water heat and cold.
- Resistance to internal moisture, particularly to water vapours.
- Tight impermeable surface or porous surface (if either is needed for contained stability of underlying base or subgrade).
- Smooth riding and non-skidding surface.

2.2 Graphene

Graphene is an allotrope (form) of carbon consisting of a single layer of carbon atoms arranged in a

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 8, Issue 9, September 2021

hexagonal lattice. It is the basic structural element of many other allotropes of carbon, such as graphite, charcoal, carbon nanotubes and fullerenes.

2.3 Temperature Sensors

The most commonly used type of all the sensors are those types of sensors which detect Temperature or heat. Temperature Sensors measure the amount of heat energy or even coldness that is generated by an object or system, allowing us to "sense" or detect any physical change to that temperature producing either an analogue or digital output. There are many different types of Temperature Sensor available and all have different characteristics depending upon their actual application. A temperature sensor consists of two basic physical types:

- Contact Temperature Sensor Types – These types of temperature sensor are required to be in physical contact with the object being sensed and use conduction to monitor changes in temperature. They can be used to detect solids, liquids or gases over a wide range of temperatures.
- Non-contact Temperature Sensor Types – These types of temperature sensor use convection and radiation to monitor changes in temperature. They can be used to detect liquids and gases that emit radiant energy as heat rises and cold settles to the bottom in convection currents or detect the radiant energy being transmitted from an object in the form of infra-red radiation (the sun).

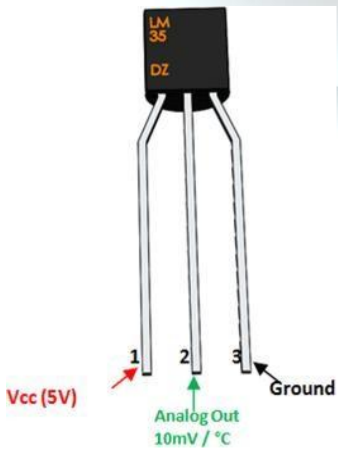

Fig 2.1 LM35 Temperature Sensor Pinout

2.4 LM35 Temperature Sensor Applications

- Measuring temperature of a particular environment.
- Providing thermal shut down for a circuit/component.
- Monitoring Battery Temperature.
- Measuring Temperatures for HVAC applications.

Table 2.1 Temperature Sensor Pinout

Pin Number	Pin Name	Description
1	Vcc	Input voltage is +5V for typical applications
2	Analog Out	There will be increase in 10mV for raise of every 1°C. Can range from -1V(-55°C) to 6V(150°C)
3	Ground	Connected to ground of circuit

III. EXPERIMENTATION AND ANALYSIS:-

3.1 Tests on Aggregates.

3.1.1 Crushing Test

One of the models in which pavement material can fail is by crushing under compressive stress. A test is standardized by IS: 2386 part-IV and used to determine the crushing strength of aggregates. The aggregate crushing value provides a relative measure of resistance to crushing under gradually applied crushing load.

Aggregate crushing value = (W1/W2) *100

A value less than 10 signifies an exceptionally strong aggregate while above 35 would normally be regarded as weak aggregates.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 8, Issue 9, September 2021

Fig. 4.1.1 Crushing Apparatus

3.1.2 Abrasion Test

Abrasion test is carried out to test the hardness property of aggregates and to decide whether they are suitable for different pavement construction works. Los Angeles abrasion test is a preferred one for carrying out the hardness property and has been standardized in India (IS: 2386 part-IV).

Fig 3.1 Los Angeles Abrasion Test Setup

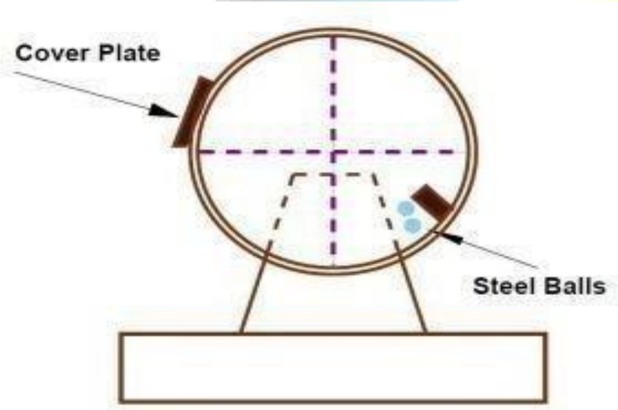

Fig 3.2 Working

3.1.3 Impact Test

Aggregate impact value = (W1/W2) *100

Aggregates to be used for wearing course, the impact value shouldn't exceed 30 percent. For bituminous macadam the maximum permissible value is 35 percent. For Water bound macadam base courses the maximum permissible value defined by IRC is 40 percent.

Fig 3.3 Impact Apparatus

3.2 Shape Tests

3.2.1 Flakiness index

The flakiness index is defined as the percentage by weight of aggregate particles whose least dimension is less than 0.6 times their mean size. Flakiness gauge is used for this test. Test procedure had been standardized in India (IS: 2386 Part-I).

3.2.2 Elongation Index

The elongation index of an aggregate is defined as the percentage by weight of particles whose greatest dimension (length) is 1.8 times their mean dimension. This test is applicable to aggregates larger than 6.3 mm. Elongation gauge (see Fig-5) is used for this test. This test is also specified in (IS: 2386 Part-I). However, there are no recognized limits for the elongation index.

1) 3.3 Tests on Bitumen

3..3.1 Penetration test

It measures the hardness or softness of bitumen by measuring the depth in tenths of a mm to which a standard loaded needle will penetrate vertically in 5 seconds.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 8, Issue 9, September 2021

Fig 3.4 Penetration Test Setup

3.3.2 Ductility test

Ductility is the property of bitumen that permits it to undergo great deformation or elongation. Ductility is defined as the distance in cm, to which a standard sample or briquette of the material will be elongated without breaking. A minimum ductility value of 75 cm has been specified by the BIS.

3.3.3 SOFTENING POINT TEST

Softening point denotes the temperature at which the bitumen attains a particular degree of softening under the specified condition of test.

Generally, higher softening point indicates lower temperature susceptibility and is preferred in hot climates.

3.3.4 Viscosity Test

Viscosity denotes the fluid property of bituminous material and it is a measure of resistance to flow. At the application temperature, this characteristic greatly influences the strength of resulting paving mixes.

Fig 3.5 Viscosity Test Setup

3.3.5 Flash and Fire Point Test

At high temperatures depending upon the grades of bitumen materials leave out volatiles. And these volatiles catch fire which is very hazardous and therefore it is essential to qualify this temperature for each bitumen grade. BIS defined the ash point as the temperature at which the vapour of bitumen momentarily catches fire in the form of ash under specified test conditions. The fire point is defined as the lowest temperature under specified test conditions at which the bituminous material gets ignited and burns.

Fig 3.6 Flash and Fire Point Test Apparatus

IV. MARSHALL MIX DESIGN:

The mix design determines the optimum bitumen content. This is preceded by the dry mix design. The Marshall

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 8, Issue 9, September 2021

Stability and flow test provides the performance prediction measure for the Marshall Mix design method.

Table 4.1 Aggregate Grading and Bitumen Content

Table 500-7 : Aggregate Grading and Bitumen Content

Grading	1	2
Nominal maximum aggregate size*	40 mm	19 mm
Layer thickness	80 -100 mm	50 -75 mm
IS Sieve size (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19	–	90 – 100
13.2	35-61	56 – 88
4.75	13 – 22	16 – 36
2.36	4 – 19	4 – 19
0.3	2 – 10	2 – 10
0.075	0 – 8	0 – 8
Bitumen content ** percent by mass of total mix	3.3**	3.4**

* Nominal maximum aggregate size is the largest specified sieve size upon which any of the aggregate material is retained.

Fig 4.1 Marshall Apparatus

REFERENCES

1. Sources; Patent data: Graphene Patent Landscape dataset Cambridge IP (January 2013); Journal article data, Global Research Report, Material Science and Technology, Thompson Reuters (2011).

2. P. K. Dehdezi, M. R. Hall, and A. Dawson, "Thermophysical Optimization of Specialized Concrete Pavement Materials for Collection of Surface Heat Energy and Applications for Shallow Heat Storage," Transportation Research Record, pp. 96-106, 2011.

3. A. R. Dawson, P. K. Dehdezi, M. R. Hall, J. Z. Wang, and R. Isola, "Enhancing thermal properties of asphalt materials for heat storage and transfer applications," Road Materials and Pavement Design, vol. 13, pp. 784-803, 2012.

4. J. T.-W. Wang, J. M. Ball, E. M. Barea, A. Abate, J. A. Alexander-Webber, J. Huang, et al., "Low-Temperature Processed Electron Collection Layers of Graphene/TiO2 Nanocomposites in Thin Film Perovskite Solar Cells," Nano Letters, 2013.