Experimental Analysis of the Behavioural Change of Temperature on Flexible Pavement

Mrs. Bharathi B[1] Ananya S P[2] Prashanth P[3] Sumanth Uthappa B[4] Manu M[5]
[1]Assistant Professor [2,3,4,5]BE Student
[1,2,3,4,5]Department of Civil Engineering
[1,2,3,4,5]ATMECE, Mysore, India

Abstract — Bituminous road is also known as flexible pavement and is one of the major transportation media. Surface of the bituminous road is always exposed to the atmosphere; the temperature on the surface will be more due to its colour and the exposure. Flexible pavements and climate are interactive. Pavements are climate sensitive infrastructure, where climate can impact their deterioration rate, subsequent maintenance, and life cycle costs. A change in the temperature directly influences the stiffness of the bitumen bound layer, which modifies the stress statues inside the pavement. This alteration in stress can influence the stiffness of the underlying unbound layers since they generally show stress reliance. The changes may impact the pavement life cycle cost and thus their impact on future maintenance requirement should be investigated.

Keywords: Temperature, Flexible Pavement

I. Introduction

Cumulative distress, such as permanent deformation and fatigue cracking, practically define failure of the pavement surface layer. Excessive distress leads to major defects, like potholes. Those distresses may result from many factors, e.g., improper choice of materials and respective proportions, excessive traffic loadings, environmental effects, aging of asphalt layers, among others. Therefore, pavement design methods need to take into account those factors in order to better predict the life of pavements, resulting in more reliable structures.

In deigning durable pavements, many agents are considered and one such primary agent is the climate of the desired highway location that provides a significant influence on pavement performance. The most important climatic agent that significantly influences the mechanical behaviour of all pavement layers and thus the overall performance and life of the pavement is temperature.

Asphalt mixtures are viscoelastic plastic materials where the strength and modulus of these materials clearly change under different temperatures. Thus, the choice of asphalt binder is closely related to the local temperature conditioned to satisfy structural and functional requirements. For instance, at low temperatures, asphalt becomes hard and brittle and the asphalt layers are exposed to thermal and fatigue cracking.

II. Materials

A. Bituminous Macadam

Bituminous macadam is a type of road construction material that consists of aggregate (crushed stone or gravel) bound together with bitumen, a sticky, black, and viscous substance derived from crude oil. It is commonly used in road construction and provides a durable and Water-resistant surface.

B. Cement

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. Of the various ingredients used in concrete, cement is the most energetically and expensive. In the present investigation OPC 43 grade cement is used.

C. Coarse Aggregates

Crushed stone aggregates of 20mm down size obtained from local quarry site were used for the experiment.

D. Temperature Sensors

The most commonly used type of all the sensors is 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.

E. Arduino Sensor

The LM35 uses a solid-state technique to measure the temperature. It makes use of the fact that the voltage drop between the base and emitter (forward voltage – Vbe) of the Diode connected transistor decreases at a known rate as the temperature increases. By precisely amplifying this voltage change, it is easy to generate an analog signal that is directly proportional to temperature. This linear relationship between forward voltage and temperature is the reason why diode-connected transistors are used as temperature measurement devices.

III. Methodology

Tests on Aggregates

Test Name	Permissible Limit	Result	Remark
Impact	<35%	27.31%	Satisfactory
Crushing	<40%	30%	Satisfactory
Abrasion	<30%	28%	Satisfactory
Specific gravity	2.5-3	2.6	Satisfactory

Tests on Bitumen

Test Name	Result	Remark
Penetration	52 mm	Satisfactory
Ductility	82 cm	Satisfactory
Softening Point	56ºC	Satisfactory

IV. RESULTS AND DISCUSSION

SL No	Conventional Temperature	Block Temperature
Day 1		
11.00AM	36°C	65.6°C
12.00PM	35°C	67.5°C
1.00PM	30°C	68.6°C
DAY 2		
11.00AM	38°C	70.2°C
12.00AM	37°C	73.3°C
1.00PM	37°C	78.4°C
DAY 3		
11.00AM	38°C	69.2°C
12.00AM	37°C	72.3°C
1.00PM	37°C	73.4°C
DAY 4		
11.00AM	36°C	70.2°C
12.00AM	35°C	72.3°C
1.00PM	37°C	75.4°C
SL No	Conventional Temperature	Block Temperature
Day 1		
11.00AM	35°C	62.6°C
12.00PM	32°C	63.5°C
1.00PM	30°C	69.6°C
DAY 2		
11.00AM	36°C	71.2°C
12.00AM	32°C	72.3°C
1.00PM	38°C	75.4°C
DAY 3		
11.00AM	38°C	70.2°C
12.00AM	37°C	72.3°C
1.00PM	37°C	75.4°C
DAY 4		
11.00AM	36°C	70.2°C
12.00AM	35°C	73.3°C
1.00PM	37°C	78.4°C

V. CONCLUSION

– Crushing strength less than 45% non-wearing course.
– Abrasion value for the selected aggregates is 23.3% which can be used for surface course of flexible pavement.
– The Impact value of selected aggregate of 32.4% which can be used for construction of flexible pavement.
– Flakiness and Elongation index of the selected sample of aggregate is 12.4% and11.6% respectively hence can be used for Construction of flexible pavement.
– Penetration value of the selected Bitumen of grade VG-30 is 54mm and hence it can be used for surface course.
– Ductility value of the selected Bitumen of grade VG-30 is 77mm and hence it can be used for surface course.
– Softening point of the selected Bitumen of grade VG-30 is 57˚c and therefore it can be used for surface course

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