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Effect of Asphalt Pavement on Environmental Temperature

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Abstract—*The asphalt pavement is major part of the pavement constructed in world. It consists aggregate as main component and the bitumen as the aggregate binding material. The asphalt pavement is used for providing accessibility to the traffic, which is a part of environment. Prior to the construction of the pavement on the site, the site shows the natural behavior which was pre-observed. After laying the pavement on the site, it affects the natural conditions of the environment. This alteration of the behavior of environment is due to the varying heat conductivity of the material. In this research work, the temperature variation analysis is carried out for the different conditions of the pavement the variation of the temperature with the location and the condition of the site is analyzed. It is observed that the presence of the asphalt pavement and its color directly contribute in heat island formation nearby the road pavement. According to the theory of Black Body, Black color absorbs more heat radiation than white color. If we use white color on the surface of asphalt, road will absorb less amount of heat which can result in different temperature result than the black pavement.*

Keywords*: Temperature effect, environment, Black Body, Heat absorbance, color pavement.*

1. INTRODUCTION

With the growing population, the need for infrastructure is too increased. The road network requirement with better facilities is the most important part of the business and the survival. For the purpose of facilitating the rides on the road, it is needed to be aware of the physical and the chemical conditions nearby the road which can affect the economy of a country. Under the physical conditions, the temperature is more prominent to be investigated. Increase in temperature level nearby the roads causes adverse effects on the human health and reduces the comfort level (Oke T. R. Kalanda B. D. et al. 1981; Narita K. et ai. 1991)

As we all know that artificially prepared land covers such as rigid pavements are accepted as major contributors to heat effect of cities, as they cover a large part of the city settlement land (Swaid H. *et al.,* 1989;). Commonly used pavement material such as Bitumen mixtures, have higher solar energy absorption and possess a higher heat storage capacity that allows them to retain the heat mass and release them at the nighttime (Wu Hao *et al.,* 2018). It also compromises the lifespan of the pavement. In asphalt concrete pavements, continuously raised temperatures in summer could significantly increase the risk of pavement rutting and asphalt aging; whereas in cement concrete pavements, high temperature gradient could increase the probability and severity of damages induced by thermal cracking. The rainfalls could considerably reduce the temperatures in the permeable pavements top and minimize the possibility of thermal impacts caused in impervious pavements. Zhen, Li, (2007) investigated the thermal responses of road surface temperatures and ambient air temperatures of asphalt pavements, cement concrete pavements, brick block pavers, and grass lawns were explored with a comprehensive field investigation; moreover, their 38 influences on the microclimate of the environment were also discussed. The study could be useful for establishing 26 standardized testing method for the thermal related properties and performances of 27 pavement materials under various simulated conditions.

2. METHODOLOGY

Temperature records have been taken from pavement surface, and off street surface. For collecting temperature data, a thermometer of 0 – 300ºC temperature is kept at 4 cm above the chosen surfaces. Another temperature record is collected by placing the thermometer at 2 feet above. The same chosen surface after completion of this mentioned process the same steps have been repeated for collecting temperature variation data on the colored surface of the chosen section. The data collected can be seen in the tables mentioned in the result section.

3. RESULTS AND DISCUSSIONS

The temperature variation data shown in Table 1 is collected at an asphalt road section near Gate of PIET, JAIPUR. The variation in the temperature is mainly due to color and the

location from the middle of the pavement. A column chart is plotted for the graphical representation as shown in Fig. 1.

Table 1: Variation of Temperature with colour and position.

Position of interest	Temperature (^{O}C)	
	Simple Asphalt	Asphalt White Coloured Surface
	(^{O}C)	(^{O}C)
Middle Of Pavement (4 Inches)	37.5	37
Middle Of Pavement (24 Inches)	35	35.5
Side Pavement (4 Inch)	39.2	38
Side Pavement (24 Inches)	36	35
Foot Path (4 Inch)	38	37.5
Foot Path (24 Inches)	37.5	36

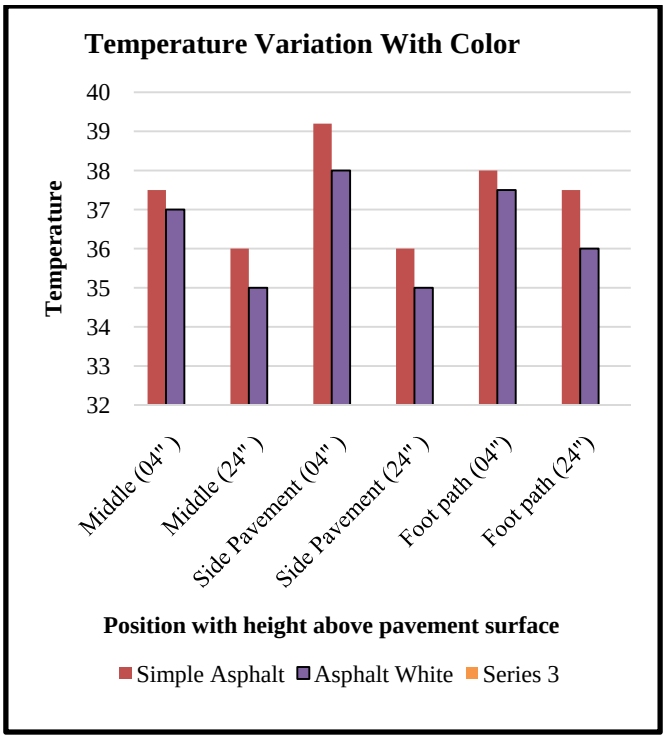

Fig. 1: Variation of temperature with height at mid pavement

The temperature variation with the height at exactly mid of the chosen pavement section is recorded by the thermometer at 2:00 P.M. and the data is given in the Table 2 with the help of the table 2 a graph is plotted to compute the relative intensity of temperature with change of height.

Table 2: Temperature variation with variation of height.

Temperature at mid of the pavement	
Height above pavement	Temperature (^{o}C)
4 inches	40.6
6 inches	39.2
8 inches	38.7
10 inches	38.4

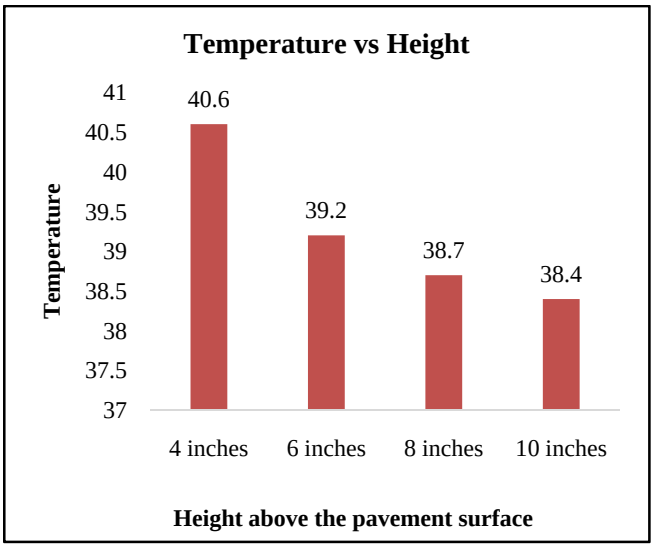

Fig. 2: Variation of temperature with varying height above pavement

Table 3 shows the variation of the air nearby the chosen section of the pavement with radial variation of distance from the middle of the pavement surface. The data is collected and recorded in table.

Table 3: Variation of temp. with height and lateral position (^{o}C).

Moving From Centre Of Pavement				
Displacement from centre of road	Height			
	4 (Inches)	6 (Inches)	8 (Inches)	10 (Inches)
1 Feet	39.8	39.5	39.4	39.1
4 Feet	39.7	39.2	38.9	38.5
7 Feet	39.4	38	38.5	38.2
10 Feet	38	37.6	37.4	37.2
13 Feet	37	37.2	37.1	37

Further, for better understanding, a graph is plotted in Fig. 3, and comparison is to analyze the effect of presence of pavement on air temperature.

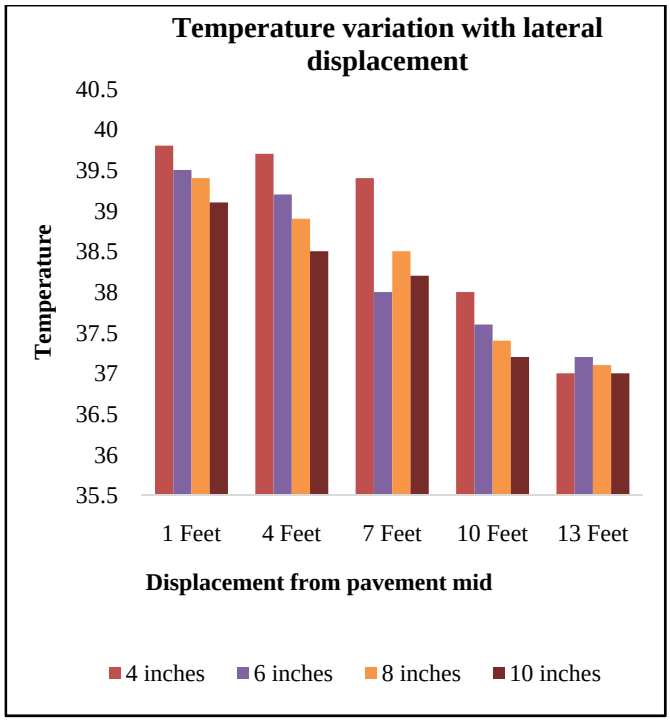

Fig. 3: Temperature variation with Height and Lateral distance from mid pavement

The relationship between heat emission and position of temperature recording on asphalt pavement is given in the Graph. Emission of heat increases with the darker shades of pavement for all materials. This is because of the absorption of heat and emission by the black colored asphalt pavement [1]. The emission rate at night is higher than at daytime. Hence, it is clear that the use of white colored pavement reduces the heat emission. This is because the very low heat absorption rate of white color pigments and hence reduces heat emission. It is also indicated from the graph that as the height increases the temperature is lowered. The results of the test indicate that the heat increases with an increase in darker shades of color pigments. This situation is also same with the building material we use in construction, but it is not possible for us to use only white colored materials for construction purposes.

4. CONCLUSIONS

Among various other materials asphalt pavement surface is heated to considerably higher extent than other materials in days of summer, and it releases a noticeable amount of heat into the atmosphere through sensible heat flux and infrared radiation. This upward infrared emission is absorbed within 200m of the lower part of the atmosphere, within less than 200m of the lower part of atmosphere. The rate of absorption of the infrared radiation emitted exceeds the emission rate. Hence, it increases the temperature of the local surroundings.

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