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EDITORIAL

Asphalt Pavement Temperature Fluctuation: Impacts and Solutions

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Solar radiation, temperature, and relative humidity, depending on severity, can cause asphalt structural damage besides inducing the Urban Heat Island (UHI) effect. Such damage is more common in countries with extreme weather conditions. The ultimate failure of asphalt pavements under extreme weather conditions causes significant economic losses [1].

Apart from weather conditions, **pavement thickness, depth and porosity** also play a significant role in influencing the functional and mechanical properties of pavement systems. Air-void and pavement microstructures do not have continuous spatial and transient properties. Whereas minor changes in the thickness and depth of the asphalt pavement considerably change the elastic properties of the pavement. The impacts of both underestimating and overestimating the depth, porosity and thickness of asphalt pavement are economically detrimental and structurally detrimental. An underestimation of the dimensions of the pavement will lead to unnecessary costs and delays in the project schedule. Whereas, an overestimate can lead to a design that is not going to achieving in the desired life in service [2].

Significant **temperature fluctuations** expose pavements to increasingly unfavorable conditions and degrade their performance and strength. The daily temperature fluctuations during Summer can exceed 20 °C, and in some hot climates, asphalt temperature exceeds 70 °C. Fluctuations in the temperature and its associated effects on pavements are known as thermally instigated pressure. When thermally instigated pressure exceeds the rigidity of the asphalt pavement, a transverse split can occur at its surface, and the temperature at which this occurs is known as the crack temperature. These cracks will propagate throughout the asphalt during its maturing phase and the extra low-temperature cycles [3,4].

The impact of asphalt temperature fluctuation

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on pavement structure includes thermal cracking, fatigue cracking, and ageing. While the impact of asphalt pavement temperature on the surrounding environment includes human comfort, the upsurge of energy demand, emissions of greenhouse gases (GHG) and air pollutants, impaired water quality and pavement life. Temperature-related damages can be mitigated by watering when pavements are being laid, using porous materials, mixing multiple additives, using multiple material configurations and increasing the thickness of asphalt pavement.

Asphalt pavement materials having lower heat transfer coefficient, lower heat conductivity and excellent water retention capabilities respond well in harsh weather climatic conditions. These materials prevent heat from reaching the surface and the surrounding area of asphalt pavement due to its lower heat transfer coefficient and lower heat conductivity. Urban Heat Island effect will be also reduced by using such material resulting in lower near-surface air temperatures and daytime pavement temperatures. This further affects human health by decreasing general discomfort, breathing problems, heat cramps and fatigue, non-fatal heat stroke, and heat-related mortality. In addition, building energy consumption will also be reduced throughout the summer, particularly during hot weekday afternoons, as most building ventilation devices, lighting, and other operation equipment required less energy [5-7].

Potential solutions for pavement temperature include micro filling, lower surface temperature and increasing solar reflectance, porosity, albedo and emittance, increasing the thermal conductivity, evaporation cooling and shading, mechanical cooling, convection cooling, and asphalt solar collector. The **asphalt solar collector** (ASC) concept refers to an asphalt pavement with a piping network system embedded below roads that convert solar energy to thermal energy. A heat transfer process occurs between the pavement and the working fluid flowing within the pipes, which decreases the pavement's temperatures and the thermal radiative losses from the asphalt to its surroundings. Besides the cooling benefit for the asphalt pavements that the ASC can provide, the collected heat from the ASC system and stored in a well-insulated small, medium and large-scale heat bank to be used for different applications and heating purposes [2-4,8].

Future research directions can be drawn as follows:

- Further efforts to enhance the thermo-structural characteristics of asphalt pavement are vital to withstand the effect of solar radiation and temperature.
- As heat transfer in asphalt concrete depends on the structure, future models should incorporate heat data and asphalt conditions.
- The thermophysical properties of asphalt blends need to be investigated in the future for detailed structural analysis.
- The impacts of materials on the surface temperature of pavements should be further investigated.
- Compare to other solutions, solar asphalt technology would cool asphalt temperature by absorbing heat through pavement-pipe systems and concurrently utilize it in different heating applications. ASC systems have been designed and implemented in many countries. Further simulation and experimental investigations are still vital to be carried out.

Conflict of Interest

There is no conflict of interest.

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