Use of Phase Change Materials for delaying Low Temperature Cracking and rutting in Asphalt Pavements

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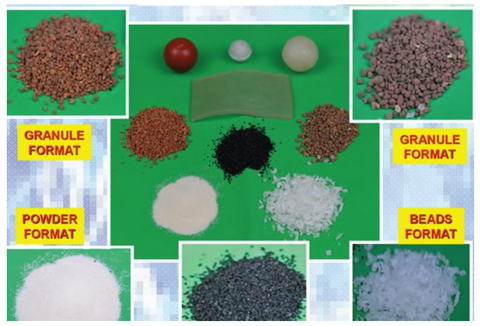
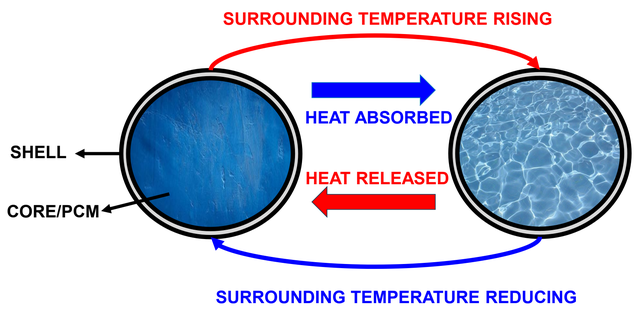
Background

- Asphalt pavements confront distresses such as low temperature cracking and rutting due to rapid temperature fluctuations and heavy traffic loading.
- In general, additives such as polymers , fibers etc are used to control the distresses by improving mechanical resistance; however, they lack thermoregulation effect.
- Microencapsulated Phase Change Materials (MPCMs) are one of the types which can balance the need for both thermoregulation and mechanical resistance and, there by mitigating temperature dependent distresses.
- MPCMs are less explored in asphalt pavement applications. There is a necessity to understand the influence of MPCMs on performance of asphalt binders and mixtures.



Microencapsulated phase change materials



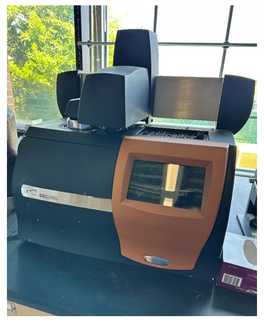
Thermoregulation mechanism of MPCMs

Goal and Objectives

To evaluate the impact of addition of MPCMs with different melting points on asphalt binder and mixture performance.

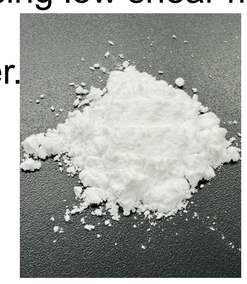
Objectives

- Evaluate the thermoregulation properties of pure MPCMs and MPCMs modified asphalt binders.
- Characterizing the performance of MPCMs modified asphalt binders at low to high temperature ranges.
- Evaluate the rutting, fatigue and low temperature cracking performance of MPCM modified asphalt mixtures.

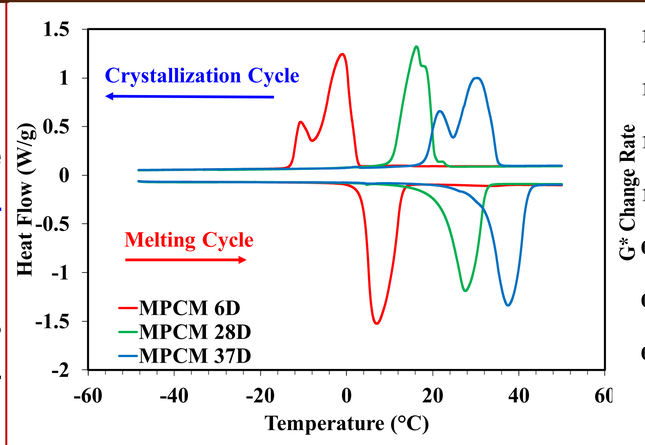


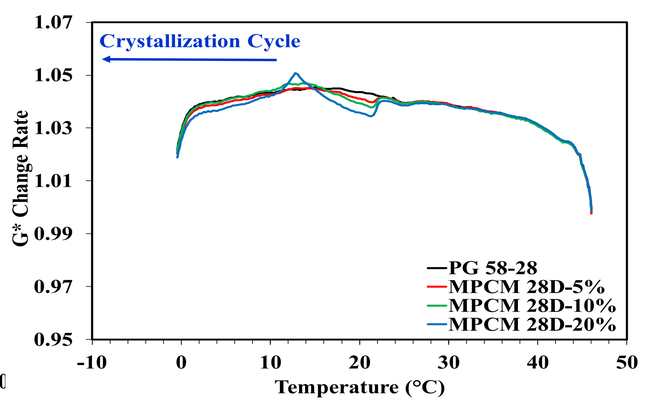
Materials & Blending of MPCMs

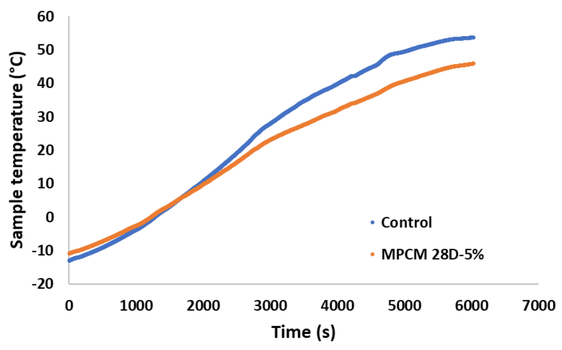
- Three commercially available **MPCM6D , MPCM28D and MPCM37D** were blended with PG 58-28 and PG 64-22 binders using low shear mixture.
- **Dosages:** 5%, 10% and 20% by weight of binder.
- **Temperature**: 125±5°C.
- **Speed & Time:** 1000 RPM & 15-30 minutes.

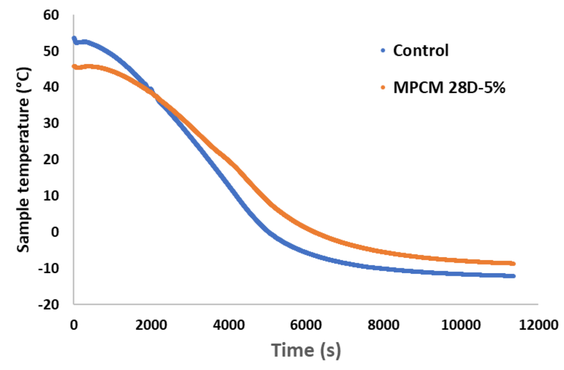


Significant findings of the study









- MPCMs are controlling the asphalt binder properties near melting point due to thermoregulation effect.
- The thermal profiles of MPCM binders different than control binder.

Conclusions

- All the MPCMs have the ***capacity release or absorb heat*** at their specific melting and freezing temperatures.
- MPCMs, within their respective thermoregulation range, can potentially ***improve resistance to low temperature and fatigue cracking.***
- ***Maximum temperature difference of 9 °C*** is observed between MPCM modified asphalt binder and control binder during cooling cycle.

Impact of the research

- ***Delay in the low temperature cracking*** *in asphalt pavements due to thermoregulation effects of phase change materials.*
- ***Higher service life than conventional pavements due to*** delay in cracking and rutting distresses in asphalt pavements.
- ***Reducing Urban Heat Island (UHI) effect and combating heat waves*** due to absorption of heat by phase change materials.

Acknowledgment

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