Investigating the mechanical properties of geopolymer concrete with incorporated micro-encapsulated phase change materials

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Purpose of adding Micro-encapsulated Phase Change Material to building materials

- Heat is released
- Heat is absorbed

Concrete wall with incorporated microcapsules

Saving excess solar energy during the day by melting
Releasing the stored heat into the environment at night by solidifying
Concrete with incorporated micro-encapsulated phase change materials

**Advantage**
- Increasing the heat storage capacity of concrete
  - control energy saving

**Disadvantage**
- Reducing mechanical properties such as compressive strength
Two different types of micro-encapsulated phase change materials

Polymers as shell

Paraffin wax as core

A1

A2
Geopolymer concrete mixture

- Alkaline Solution: NaOH and Na$_2$SiO$_3$
- Fly ash class F
- Slag
- Sand
- gravel
- Extra water
- Superplasticizer
- 2 different MPCMs (A1 and A2)
Experimental procedure

Mixing

Curing at 20 °C and 40 °C for 28 days

Measuring compressive strength

Slump test

GPC

PCC
Compressive Strength of Geopolymer concrete and Portland Cement concrete

GPC and PCC with incorporated 20% MPCM at 20 °C

GPC and PCC with incorporated 20% MPCM at 40 °C
SEM images of GPC with incorporated MPCM

Unreacted FA

MPCM A2

MPCM A1
Hypotheses for the strength reduction of concrete after adding microcapsules

- Low stiffness and difference in PSD of MPCM compared to sand
- Breaking the MPCM during mixing or measurement
- Microscale effects of MPCM on the concrete matrix
Some reasons of the strength reduction in microscale

- Agglomeration of MPCM
- Poor bond and gap between GPC matrix and MPCM
- Broken shell of MPCM and leakage of paraffin into the GPC matrix after mixing
- Acting like porosity
Thank you for attention