The College of Graduate Studies and the College of Engineering Cordially Invite You to a

Master Thesis Defense

Entitled

USING METAL-ORGANIC FRAMEWORKS (MOFS) IN PRODUCING SELF-CURING CONCRETE

by

Lama Fathi Allan

Faculty Advisor

Prof. Amr El-Diebm, Civil and Environmental Engineering Department

College of Engineering

Date & Venue

30 May 2023

1:00 pm

F1-1117

Abstract:

Curing of concrete is the presence of adequate moisture content in concrete throughout its early stages to produce the desired properties, as it is significant in improving the concrete microstructure and pore structure and hence in developing its performance and durability. However, good curing is not always practical in several cases, such as in hot weather regions and areas of water inadequacy. For that reason, the need to develop self-curing concrete attracted several researchers. The use of self-curing agents minimizes the water evaporation from concrete and consequently increases its water retention capacity compared to conventional concrete. This thesis is concerned with producing sustainable and eco-friendly concrete that integrates metal-organic frameworks (MOFs) to capture H_2O; its capability makes it an ideal candidate to be used as an ingredient in the production of self-curing concrete. The main objective is to synthesize a MOF capable of capturing moisture from the surrounding environment into the concrete and to assess its impact on concrete performance. Different parameters were examined, including the MOF content and curing regimes. The parameters were evaluated through compressive strength, water absorption, permeable pore voids volume, and degree of hydration. The microstructure of MOF-embedded concrete was evaluated using X-ray diffraction analysis (XRD), scanning electron microscope (SEM), and Fourier transform infrared (FTIR) spectroscopy. The study revealed the possibility of incorporating MOFs in concrete to capture moisture without compromising mechanical and durability performance. Up to 6% MOF by cement mass, cured at 70% relative humidity, achieved the highest compressive strength at 39 MPa, with 6.5 and 15.25% water absorption and permeable pores values, respectively, at 7 days. The MOF mix revealed a slight reduction in strength (8%) compared to continuously moist cured concrete without MOF. This reduction can be accepted given the saving of 7 days of water curing. On the other hand, the highest late age strength at 28 days was attained by incorporating 3% MOF, by cement mass, at 50% relative humidity, at 45 MPa, with 5.9 and 15.36% water absorption and permeable pores values, respectively. Similarly, at 90 days, the highest compressive strength was achieved by incorporating 3% MOF, at 50% relative humidity, at 46 MPa, with 5.59% and 14.29% water absorption and permeable pores values, respectively. The microstructure analysis of different mixes highlighted the formation of calcium silicate hydrate, calcium hydroxide, dolomite, and ettringite in the MOF-incorporated mixes. Exceeding 6% MOF addition did not seem to improve the performance of concrete. This study concludes that adding 3% to 6% MOFs to concrete resulted in eco-friendly concrete and helped save water resources by minimizing days of moist-curing. The developed self-curing concrete can be used in construction applications to reduce the need for moist-curing while maintaining concrete properties. Limitations of the study and recommendations for future investigations are also furnished.

Keywords: Curing, metal-organic framework, MOF, relative humidity, moisture uptake, self-curing concrete, performance, microstructure