RP1020

REDUCING BARRIERS FOR COMMERCIAL ADAPTATION OF CONSTRUCTION MATERIALS WITH LOW-EMBODIED-CARBON

Research Question

Geopolymer (GPC) concrete is prepared with sustainable cementitious materials and therefore, production of GPC can be reduced up to 80% of CO_2 emission from OPC concrete production. Although many investigations have been conducted on the mechanical and durability properties of GPC, the long term durability performance in field condition is a key concern related to application in civil infrastructures.

Figure 1: Field monitoring in Lake king WA

Methodology

The aim of this research project is to investigate the durability performance of GPC concrete structures exposed to the field conditions. Core specimens were collected from fly ash based GPC concrete structure in saline environment for 06 years of period and the durability of GPC concrete was compared to OPC concrete under similar exposed conditions. The core specimens were included into laboratory investigations to determine the combination of carbonation and chloride ingress effect under aggressive exposed conditions.

Results

According to Figure 2, fly ash based GPC concrete structure was much more carbonated than OPC concrete in saline environments. The pH of GPC concrete was dropped to 7.0-7.5, whereas the OPC concrete was still maintained the pH at a high level such as 8.0-10.0.

Figure 2: Carbonation depth measurement

Figure 3 depicts the variation of total chloride measurements with the depth of the concrete.

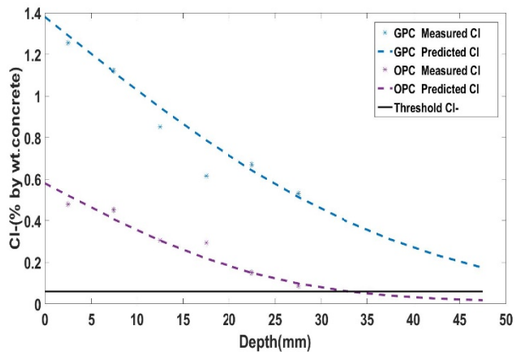

Figure 3: Total chloride variation with depth values

The apparent diffusion coefficient (Da) and surface chloride content (Cs), calculated with Fick's second Law equation are provided in Table 1. According to that, the chloride content in GPC was much higher than the chloride contents in OPC concrete and GPC concrete had greater Da and Cs values compared to OPC concrete.

Table 1: Da and Cs values

Concrete type	(Da) $\times 10^{-12}$ m^2/s	Cs (% by wt. of concrete)
GPC concrete	2.5	1.38
OPC concrete	1.0	0.58

Furthermore, Figure 4 depicts the photograph of the reinforcement bars in the GPC and OPC concrete specimens. The reinforcement bar possesses in GPC concrete was highly corroded whereas not much visible sign of corrosion product was identified in OPC concrete.

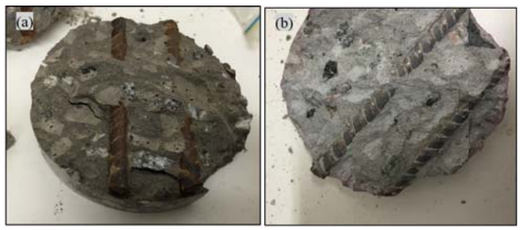

Figure 4: Reinforcement bar in (a) GPC, (b) OPC concrete

Conclusions

Based on this research study, fly ash based GPC concrete exhibited lower durability in aggressive field conditions compared to OPC concrete. In saline environment, fly ash based GPC concrete is more vulnerable to carbonation and chloride ingress and the corrosion effect on the reinforcement bar in GPC concrete was more severe than OPC concrete.

Anticipated impacts

Long term durability data and development of a suitable standard guideline are two main key concerns to the applications of geopolymer materials in the construction field.

The Portland cement consist high embodied energy and the production of OPC concrete has responsible for about 5 - 7% of CO_2 emission in worldwide. The applications of geopolymer materials as a replacement of Portland cement is not only reduced the CO_2 emission, also enhance the utilisation of industrial by products materials such as fly ash and slag.

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