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Durability variations in reinforced autoclaved aerated concrete (RAAC) – extended abstract

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Abstract. Reinforced Autoclaved Aerated Concrete (RAAC) was a very common form of construction in the UK and elsewhere in the 1970s, and many of the buildings are now coming to the end of their design life. Although much is known regarding new RAAC (and AAC), many concerns exist regarding their durability, hence the current structural integrity of 40-50 year old RAAC panels, many of which are in use in critical infrastructure such as hospitals, schools and government buildings. Anecdotal evidence and preliminary site observations suggests that there is considerable variation in material properties between different RAAC panels, within the same structure, and across different structures, locations and ages. The aim of this research therefore was to investigate and understand the variability in surface resistivity, sorptivity, permeability, compressive strength, and density of RAAC across a single 2400mm panel, amongst panels from the same structure, and amongst different structures, locations and ages. The research is expected to demonstrate considerable variability in properties and performance, which will have significant implications for the repair, monitoring and management of these critical infrastructure.

1 Background

Reinforced Autoclaved Aerated Concrete (RAAC) is an aerated lightweight cementitious material with no coarse aggregate; the material properties and structural behaviour therefore differ significantly from 'traditional' reinforced concrete (Figure 1 and 2).

Fig. 1. Sawn cross-sections of typical RAAC structural panel.

RAAC has been used in building structures in the UK and Europe since the mid-1960's, mainly as horizontal roof panels, but also as pitched roofs, floors and wall panels.

Significant structural and maintenance problems began to be observed in the 1990s, and initial research and testing was conducted by the BRE [1, 2]. The UK Standing Committee on Structural Safety (SCOSS) also recently issued guidance via the IStructE [3] (2022), which followed on from 2019 [4].

Research on the durability of aged RAAC funded by the UK's NHS is also currently underway by Loughborough University, Corrosion Preservation Technologies Ltd (CPT), Leeds Beckett University, Lucideon Ltd and AIConnects Ltd; the project is in its early stages and full reporting of the data and recommendations will be at a later point in 2022.

2 Material properties

The AAC material is aerated, hence is considerably lighter than traditional concrete, with a typical density of 600-800kg/m³ (compared to ~2400kg/m³ for traditional concrete). Compressive strength is significantly lower than traditional concrete at 2-5N/mm², as are related flexural, shear, and tensile strengths. Elasticity and creep are substantially inferior to traditional concrete due to the aerated nature and lack of coarse aggregate, which are reflected in large observed long-term deflections. Although the voids are not well connected, the aerated material is highly permeable. The (welded) steel reinforcement therefore has a cementitious coating to protect it against corrosion. Reinforcement anchorage is primarily provided via transverse reinforcement bars welded to the ends of the longitudinal reinforcement.

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3 Methodology

This research reports on empirical material testing conducted at Loughborough University 2021-22. 99No 75mm dia cores were extracted from three 2400x600x100mm RAAC panels, cored in a grid-like matrix to allow for a three-dimensional analysis of the variability of durability parameters such as surface resistivity, sorptivity, mass flow rate of water, compressive strength, and density.

4 Findings

The unique manufacturing process creates 'teardrop' shaped voids to one side of the longitudinal reinforcement (Figure 2), increasing material variability and creating poorer areas of durability. The casting orientation defect results in slight variability in durability across each panel.

The average density of panels A, B and C was 606, 606 and 618 kg/m3, with lower standard deviations (2.5, 4.5 and 7.8) and lower Coefficient of Variation's (0.4, 0.7 and 1.3) than expected, suggesting a more consistent material than was expected, but with variation between panels.

Surface resistivity, sorptivity and compressive strength varied slightly across the three panels, suggesting that this (aerated) casting defect was not uniform across all the RAAC panels. The surface resistivity testing was variable and inconclusive as the reinforcement caused interference with the probe, as was expected. The piloted mass flow rate permeability test provided a different interpretation of water transportation through the RAAC. Unlike sorptivity, it did not examine the absorption but rather the water flow rate once the aerated and matrix pores were saturated, which is not an uncommon situation in flat roofs with very old and often poorly maintained and under-performing waterproofing. A 20-30% decrease in average compressive strength between dry and saturated cores was measured (Figure 3). Little variation between panels was found for the dry compressive strength, with a slightly greater variation when wet.

Fig. 2. Sawn cross-sections of typical RAAC structural panel, showing 'teardrop' shaped voids to the side of the reinforcement.

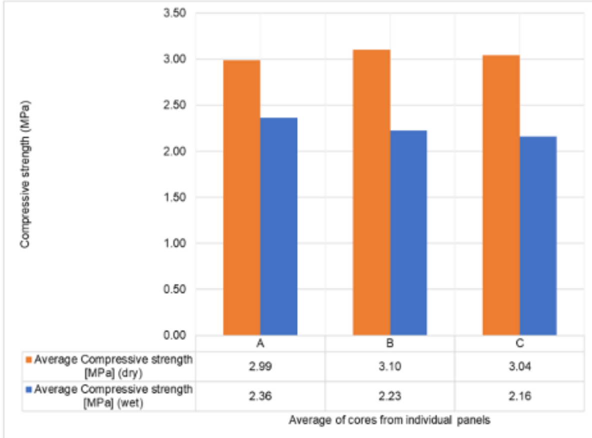

Fig. 3. Compressive strength (MPa) of cores taken from three panels (A, B and C), tested dry (left) and saturated (right)..

5 Conclusions

Only brief preliminary findings are presented here. Full findings will be published later in 2022. Results suggest that saturating the material creates a greater drop in compressive strength than previously thought, particular care must therefore be taken regarding the inspection and assessment of insitu aged RAAC panels.

References

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