Contribution ID : **155** Type : **Oral**

Permeability changes when using waste materials to generate acid resistant mortars, neutron investigations.

Thursday, 6 September 2018 10:00 (20)

Cements (mortars and concrete) are, despite their wide spread use, susceptible to chemical attack and weathering. Cements are particularly susceptible to acid attack, which leaches Ca and Al from the cement paste and lowers paste pH, thereby weakening the cement matrix. Similarly, sulfate in waters can also interact with the cement matrix [1,2], where several reactions occur. Firstly, sulfate reacts with Ca in the system to precipitate gypsum, which removes the Ca from the primary role of forming Calcium-aluminates, and -silicates that provide the cement strength. Secondly, sulfate may interact with the aluminate in the cement to form a Calcium-alumino-sulfate (ettringite) [1,2]. Ettringite, is a low-density mineral (1.8 g/cm3), hence when higher-density cement minerals (2.2 g/cm3) are mobilised to form a low-density ettringite, cement expansion and cracking occurs. Therefore, ettringite formation weakens the cement paste, and rapidly deteriorates cement (mortar and concrete) performance and life expectancy. Consequently, in sulfate-rich areas such as acid sulfate soils, seawaters, and many saline soil environments, specialist cements are often required that circumvent the sulfate attack [1,2].

However, waste materials like coal fly-ashes, high-pH bauxite refinery residues, blast furnace slags, have been suggested for incorporation often substituting cementing (pozzolanic) materials, or have been suggested as pore fillers, such as meta-kaolin, to prevent sulfate penetration [2]. We looked at two large volume waste materials, seawater neutralised bauxite refinery residues (Bauxsol™) and high temperature co-generation sugar cane bagasse ash (SCBA), in mortars. Both waste materials when used as sand replacements in the mortar, improved the acid resistance, including strength retention, and decreased spalling. However, neutron imaging indicates that while Bauxsol™ decreased permeability, SCBA increased permeability consistent with chloride ingress testing [3]. Laser ablation inductively coupled plasma mass spectrometry showed limited sulfate penetration to mortars containing Bauxsol™, while XRD and visual inspections showed surface depositions of acidic sulfato-salt (e.g., alunogen, Jarosite-like minerals, and iron hydroxy sulfates [green-rusts]) [1,2]. Data collected would therefore suggest that Bauxsol™ incorporations within the mortars actively worked to decrease sulfate ingress, restricting gypsum and/or ettringite formation through pore-blocking, which may or may not have been accompanied by shifts in cement paste chemistry. Whereas, SCBA inclusion within mortar mixes, although increasing permeability, increased sulfate resistance most likely through a shift in cement chemistry away from Ca-aluminates (e.g., tricalcium aluminate; C3A) toward Ca-silicates (e.g., di-calcium silicate; C2S), despite the deactivation of silica within the SCBA from the high burn temperatures [3,4]. Unfortunately, for both SCBA and Bauxsol™ the XRD evidence on cement chemistry shifts remain inconclusive.

[1] Tamsin, (2018) MSc by Research Thesis, Southern Cross University; 191pp.

[2] Barbhuiya, et al. (2011) Pro. Instit. Civil Engs. Constr. Mats., 164(5), 241-250.

[3] Arif, et al. (2016) Constr. Build. Mats., 128, 287-297.

[4] Clark, et al., (2017) Helyion, WM-16-2446, 04/04/2017

Primary author(s) : Prof. CLARK, Malcolm (Southern Cross Geoscience)

Co-author(s) : Mrs TAMSIM, Rumia (School of Environment, Science & Engineering, Souther Cross University); Ms ARIF, Elisabeth (Wet-Seal); Dr GARBE, Ulf (ANSTO); Dr LAKE, Neal (Australian Road Research Board)

Presenter(s) : Prof. CLARK, Malcolm (Southern Cross Geoscience)

Session Classification : Speaker Sessions and Seminars

Track Classification : Material Science