The swelling floor slab problem in Ireland

[a]Azzie B A, [b]Maher M L J, [c]Gray C N

Problems associated with heave in compacted under floor rock fill containing pyrite, most commonly black shales and mudstones, have been recognized for over 40 years [1,2], and have occurred around the world. While the occurrences of these problems have generally been isolated, where they have occurred the consequences have been devastating and costly to repair.

The most recent widespread occurrence of pyrite-induced heave is in Ireland where problems began to be identified in late 2006 during the Celtic Tiger construction boom. The boom was characterized by an increased demand for aggregates for both building and road construction. Whilst strict quality and testing standards were enforced in road-construction, house builders relied on the quarries to supply aggregate fit for purpose. At least four of those quarries in the Dublin and surrounding area supplied low grade crushed mudstones/siltstones containing high concentrations of reactive pyrite.

To date thousands of houses, as well as schools, institutional buildings, and warehouses have experienced progressive structural damage estimated at in excess of a hundred million Euros. Initial signs of damage are in the form of heaving floors, and sticking doors. As pressure builds, the floor slabs crack, along with partition walls and ceilings, and foundation walls ultimately push outwards. Since the damage can take 3 or more years to become apparent, more cases are bound to occur.

Extensive aggregate testing, including geological examination, chemical and physical testing, and petrographic analyses have been performed on underfloor fill sampled from thousands of affected buildings. Rock used to produce construction aggregates generally need to be strong, durable and inert (e.g. limestone). However, it was found that weak calcareous mudstone had been used, possibly with the mistaken belief that it would be good enough for house construction. In a damp environment, the oxidation of fine-grained framboidal pyrite (FeS_2) in the mudstone, releases ferrous sulphates or iron hydroxides and sulphuric acid. Calcite ($CaCO_3$) is then dissolved, and gypsum ($CaSO_4 \cdot 2H_2O$) precipitates from the

oversaturated solution. The gypsum crystallizes both on the surface of particles and more critically within clay-rich laminations in the aggregate particles. As the crystals grow and the solution infiltrates between the natural laminations in the rock, this latter process prises the laminations apart. The resulting bulk volume increase generates pressures capable of lifting load bearing walls and cracking concrete slabs.

The paper will present simple methodologies to identify problematic aggregates prone to pyrite-induced heave prior to their use in buildings.

References

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[a] *Golder Associates Ireland Limited, Co. Kildare, Ireland (bazzie@golder.com)*
[b] *Golder Associates Ltd., Ontario, Canada*
[c] *Golder Associates Ireland Limited, Co. Kildare, Ireland*