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MODELLING THE MECHANICAL BEHAVIOUR OF LEACHED INTERFACE

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ABSTRACT

Leaching of concrete is a well known phenomenon which takes place as soon as concrete is exposed to water for a significant time. Accelerated leaching processes, such as ammonium nitrate leaching or electric leaching, have been developed in order to obtain enough data in an acceptable time. Wide knowledge has been acquired on the influence of leaching on the mechanical properties and porosity of bulk concrete and mortar (e.g. in [1]). However, little data is available on the influence of leaching on the hydro mechanical behaviour of interfaces. Buzzi et al. [2] have recently performed a series of hydro mechanical shear tests on rock-leached concrete interfaces. Their results suggest that leaching the interface tends to turn the behaviour from contractant/dilatant into fully contractant.

The mechanical behaviour of leached concrete interface has been investigated using the particle flow code PFC3D. The distinct element method has been chosen because it allows one to simulate the evolution of the macro porosity during the leaching process by randomly deleting a fraction of the particles. Moreover, the progressive degradation of the interface asperities during shearing can also be captured. These two features are of major significance to reproduce the mechanical behaviour of leached interface.

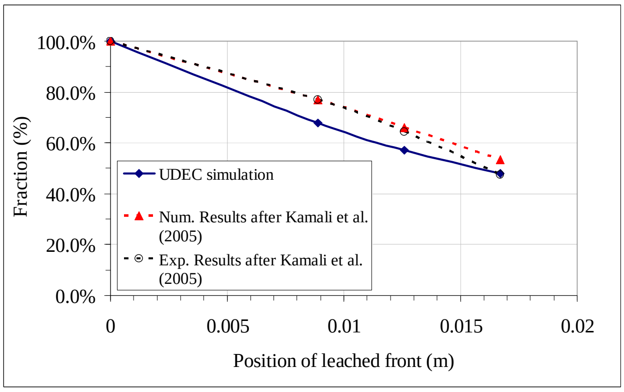

Figure 1. Calibration of the leaching process: decrease of Young's modulus versus thickness of the leached zone.

The increase of macro porosity due to leaching process is firstly calibrated using data after Kamali et al. [3] and more specifically, considering the loss in Young's modulus measured during unconfined compression tests. The cylindrical specimens have a diameter of 70 mm and a height of 140 mm. For the sake of convenience, a unique leaching front is considered whereas Kamali et al [3] have considered five different zones. The increase of macro porosity has been adjusted to 43%, for a front at 0.017 m from the specimen edge (Figure 1), in order to reproduce the experimental result i.e. loss of Young's modulus of about 50 %. Then, the same increase of macro porosity has been applied for a front situated at 0.009 m and 0.0125 m with satisfactory results so that so that the particle removal process is validated.

The three steps of numerical leaching have been applied to a simplified saw-tooth interface and several shear tests have been performed in order to identify qualitative phenomena of the mechanical behaviour. As for the bulk material, a progressive loss of mechanical strength is observed for the interface when the thickness of the leached zone increases (Figure 2 (a)). Logically, the failure criterion of the interface is also reduced. The qualitative change in behaviour mentioned by Buzzi et al. [2] has also been observed during numerical tests (Figure 2 (b)). The interface initially displays a contractant/dilatant behaviour, which turns into a fully contractant response with leaching. This can be explained by the local loss of shear strength within the tooth preventing both surfaces from riding each other and thus dilating.

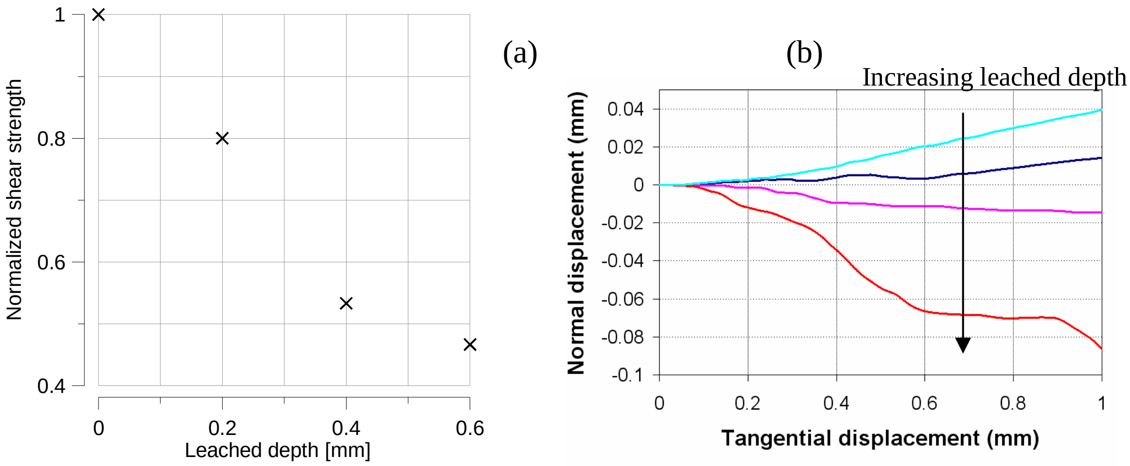

Figure 2. Results of shear tests. (a) Normalized shear strength vs. Leached depth. (b) Normal displacement vs. Tangentiel displacement.

Further work is to be done on the more realistic joint morphology and for longer leaching time or thicker leached zones.

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