

ABSTRACT

The goal of the present work is to investigate and explain failure in concrete under static and erosive loading in terms of the mechanics of interfacial failure between interacting particles. The proposed approach attempts to account for the wide range in aggregate sizes as well as randomness in geometric shape, material properties and loading. The goal is pursued along three lines: a probabilistic formulation, a discrete element implementation and experimental verification. The first step involves identification of the random variables used to characterize the meso geometry and material properties, and development of suitable probabilistic descriptions of these random variables. A particle generation algorithm that allows generation of particles with random size, angularity and flakiness is then developed. This framework is then used to study (i) static failure for deterministic loads (ii) erosive failure due to random wave loading and due to a water jet with known velocity and sediment load. The effect of meso-structure on static failure under deterministic loads is studied using the discrete element code developed. A probabilistic model for erosive mass loss is then developed, that attempts to estimate the probable mass loss from the surface of the concrete structure due to random wave loading. Since it was not possible to experimentally validate the model using random wave loading, an experimental set up was devised wherein concrete slabs were subject to a water jet with controlled sediment content and with constant velocity and constant loading angle. The mass loss obtained experimentally was compared to the predictions of the probabilistic model for this loading. The problem was also solved using the discrete element capability, which was then used to perform a detailed parametric study of the effect of a sediment bearing water jet on the slabs.

Keywords: Concrete behaviour, Meso structure, Aggregate shape, Aggregate size, Size effect, Discrete element method, Erosion, Probabilistic model.