FRACTURE OF 3D PRINTED BRITTLE OPEN-CELL STRUCTURES UNDER COMPRESSION

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We investigated the fracture behavior under compression of well-arranged cubic and tetragonal open-cell structured and notched specimens, all made of brittle plastic and fabricated by 3D printing. The basic material properties were studied by using bulk plastic specimens, the basic properties of cellular-structured specimens by cubic and tetragonal specimens under compression. Notched strip-like specimens were subjected to compressive displacement aimed to study the fracture behavior. The notched specimens were loaded until the columns adjacent to the notch tip collapsed stably by buckling mechanisms, followed by a rapid and unstable sequential collapse mechanisms of the specimens’ columns to a point of failure and load drop. The well-arranged open-cell structured specimens enabled an adequate repeatability of the mechanical properties for valuable analyses and conclusions.

The property that predicts unstable collapse mechanisms of the cellular cell specimens under compression, was evaluated using 3 different approaches: macroscopic and homogenized strip-like specimen using finite element analysis (FEA), J-Integral along the outer surfaces of the specimens, and the energy at the near-tip columns evaluated by digital image correlation (DIC). Most importantly, it is shown that it is not a material property, but is rather dictated by the collapse mechanisms of the columns at the notch tip under Euler buckling.

Fig. 1. Typical open-cell cubic and tetragonal 3D printed brittle specimens used in this investigation (top), the experimental set-up, the collapse mechanisms at the notch tip, and the results obtained for the cleavage energy for 4 types of specimen using three calculations approach (bottom, left to right)