Architected materials and instabilities: a journey towards uniformity

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Soft matter architected materials exhibit intriguing buckling modes that reside at the unit cell scale and can occur uniformly across the sample. These modes were first observed by Papka &Kyriakides (1999) during bicompaction experiments on polycarbonate honeycombs. They experimentally identified 3 patterns, but without precise measurements of their critical loads. In addition, these patterns did not appear uniformly in the samples. Later experiments by Shan et al. (2014) on silicone rubber honeycombs reported the same patterns, but this time the patterns were uniform across the specimen. Subsequent modelling by Combescure & al. (2020), assuming periodicity and an infinite specimen, also confirmed the existence of these 3 modes, while establishing the theoretical critical loads at which they appear.
In order to take advantage of these patterns, which exhibit interesting and different wave propagation properties, a faithful prediction of the appearance of bifurcated modes in architected materials subjected to mechanical loading requires both the ability to predict the possible buckling patterns, and the critical loads that cause them as well as ensuring the uniformity of the modes in the material.

The present study therefore has a dual role. On the one hand, to carry out numerical simulations of bicompaction tests in order to understand the influence of various experimental parameters on the buckling uniformity: behavior and homogeneity of the specimen material, honeycomb geometry, type of boundary, loading conditions and friction coefficient. Secondly, to carry out better instrumented tests (camera tracking and multiple force measurements) in order to quantify the buckling uniformity actually achieved, and to compare theoretical and experimental critical loads.

Keywords: architected materials, instabilities, experimental, simulation

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