

# Design Methods and Analysis of the Mechanical Properties of Resch Pattern Foldcores

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## Abstract

The mathematical models of the Resch Pattern foldcores were established according to the constraint equations. In the process of solving these equations, three geometric parameters of the crease pattern can be obtained, which determine the configuration of the 3D Resch Pattern foldcores. If these parameters are changed, the configurations will be distinct from each other. The mechanical properties may be associated with these parameters. This paper presents a parametric analysis of foldcores with different geometric parameters based on the Resch origami structure and its variations, subject to out-of-plane compression and in-plane shear, using the finite element (FE) method. Compression test simulations and in-plane shear test simulations of the flatwise honeycomb and Miura origami structure have also been implemented for comparison with the Resch origami structure. At the same height and the same apparent density, the honeycomb structure exhibits the best properties under compression, but the poorest properties during shearing.

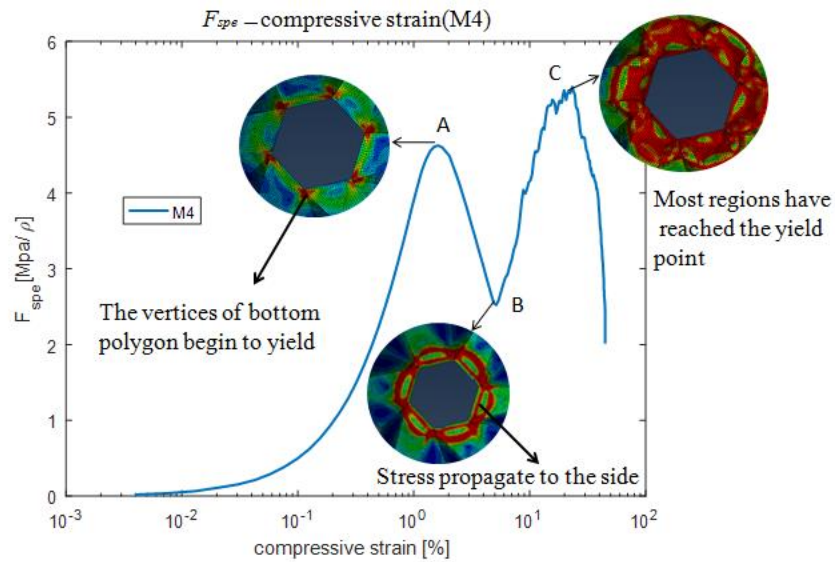
Finite element analysis was performed using the FE solver Abaqus/Explicit (SIMULIA Inc., USA) due to its ability to cope with large nonlinear deformations, post-buckling behaviors and complex contact conditions. As the main purpose of this paper is to study structural influence on the mechanical properties of the foldcores, it is reasonable to also use this technique for the characterization of foldcores.

The material properties are the core simulation parameters which should be input beforehand. Considering the cost of computational time and the experimental samples, we chose polyethylene terephthalate (PET) as the model material. In order to present a parametric study on the mechanical properties of a variety of Resch Pattern foldcores virtually tested under quasi-static compression and shear, three model groups are required, representing the hexagonal pattern, the quadrangular pattern and the triangular pattern, respectively. This was achieved by fixing  $h$  to 20 mm and choosing different combinations of values for the three

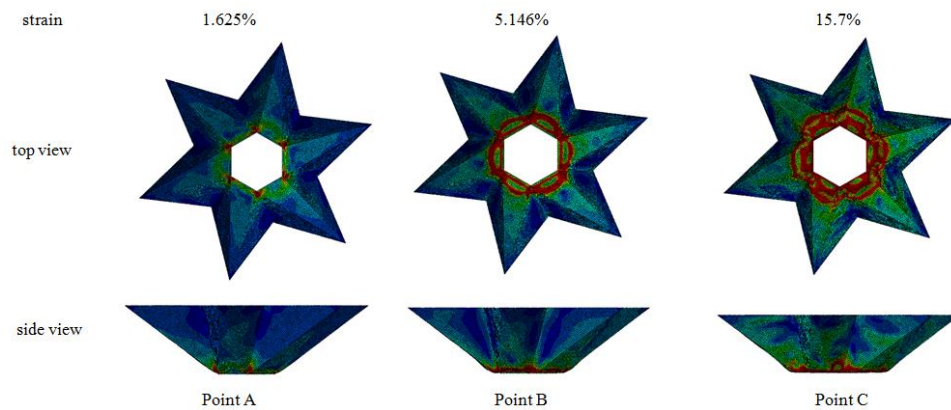
parameters:  $b$ ,  $\gamma$ , and  $\frac{a_1}{a_2}$ .

The results of the virtual testing simulations showed that the hexagonal pattern has better mechanical properties than the quadrangular triangular patterns. It is notable that the compression stress process of the Resch Pattern has a distinctive reversing stage, which results from the fixation of the bottom. We also found that the specific strength of the Resch

Pattern increases with an increase in  $\gamma$  or  $b$  and is more sensitive to changes in  $b$  than in  $\gamma$ . The division point location on the outer polygon has no obvious effect on the specific strength. In addition, it can be concluded that the quadrangular pattern does not have an excellent anti-shear capability.



(a) The compression process of model M4



(b) The compression stress nephogram of the whole unit M4

Figure.1 FE Analysis of Compression Properties of M4.