

Quasi-static crushing behaviours of folded open-top truncated pyramid structures with interconnected side walls

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Abstract

New type of open-top truncated pyramid kirigami structure is developed in this paper. The vertical sidewalls of the proposed folded structures are connected via triangular interconnections, aiming to increase its crushing resistance and achieve single sheet fabrication as compared to the existing best performing strip kirigami structures [1]. Three base shapes of the truncated pyramid kirigami structures including triangle, square and pentagon are numerically constructed. Geometric parameters of these structures are derived based on top, bottom edge length and height of unit cell. After calibration of the numerical model, the quasi-static crushing behaviours of the structures are simulated. Their structural responses including stress-strain curves, peak and average crushing stress, energy absorption, densification strain and uniformity ratio are calculated and compared with Miura-origami. Superior performance of crushing response is demonstrated for some of the proposed open-top truncated pyramid folded structures with a higher crushing resistance and a lower initial peak stress.

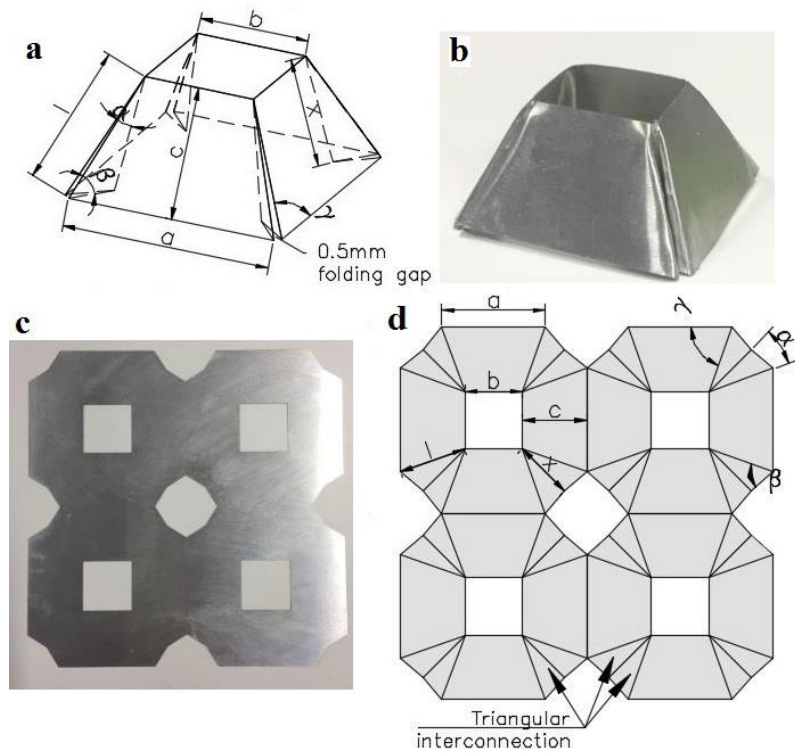


Figure 1: (a) isometric view of a folded open-top square truncated pyramid unit cell; (b) folded sample of a single unit; (c) pre-cut aluminium sheet for four-unit folding; (d) crease patterns and geometry parameters

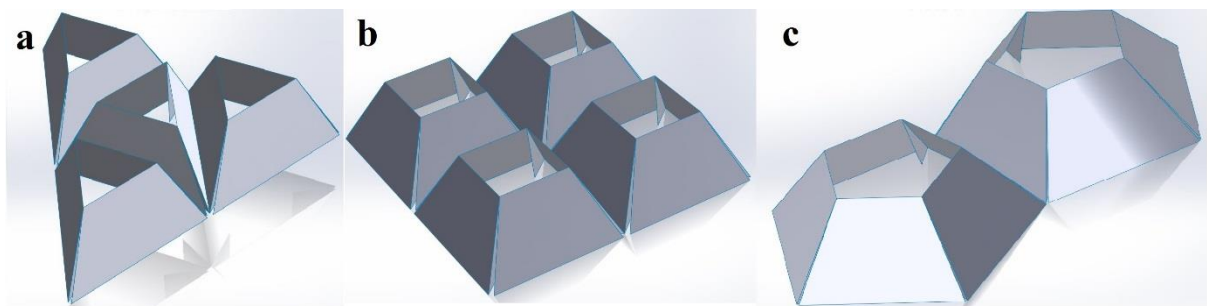


Figure 2: open-top truncated pyramid structures (a) triangular; (b) square; (c) pentagonal

References

- [1] R.K. Fathors, J.M. Gattas, Z. You, Quasi-static crushing of eggbox, cube, and modified cube foldcore sandwich structures, *International Journal of Mechanical Sciences*, 101-102, 2015, 421-428.