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PROCEEDINGS

Design of Honeycomb Sandwich Structures with Curved Edge Cores for Optimal Thermal Buckling Strength

Zheng Wu[1], Pai Liu[1], Zhan Kang[1] and Yiqiang Wang[1,*]

[1]State Key Laboratory of Structural Analysis, Optimization and CAE Software for Industrial Equipment, Dalian University of Technology, Dalian, 116024, China

[*]Corresponding Author: Yiqing Wang. Email: wangyq@dlut.edu.cn

ABSTRACT

Honeycomb sandwich structures (HSSs) consist of lightweight cores arranged in periodic polygons [1] between two face sheets. They are widely used in the aerospace industry due to their lightweight but superior strength [2] and energy absorption [3]. As extremely high temperatures might be applied, the sandwich structures may suffer from thermal buckling failure [4] due to thin face walls [5]. This paper designs a new type of HSSs for pursuing optimal thermal buckling strength. The design idea is to replace the vertical straight walls in the honeycomb cores with curved walls. An optimization problem is set up and is solved to determine the best free-form shapes of the curved walls, with the design targets for maximizing the first buckling eigenvalue of the entire HSS. The optimized results show that the curved wall designs can gain over 30% improvement of buckling temperatures under the same weights. Moreover, both buckling of the face sheets and buckling of the entire structure are simultaneously triggered in the curved HSSs. The underlying reasons is that varying the shapes of curved walls is able to improve the buckling strength of the face sheets, and as the buckling strength of the face sheets is equal to that of the entire structure, the optimal thermal buckling strength is reached. Such an optimal design rule is effective for those HSSs with various boundary conditions and core polygons. A nonlinear post-buckling analysis is finally conducted to for further verification.

KEYWORDS

Thermal buckling; honeycomb sandwich structures; structural optimization; free-form shape

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References

1. Wang, A. J., McDowell, D. L. (2004). In-plane stiffness and yield strength of periodic metal honeycombs. *Journal of Engineering Materials and Technology, 126(2),* 137-156.
2. Han, B., Qin, K. K., Bo, Y., Wang, B. et al. (2016). Honeycomb–corrugation hybrid as a novel sandwich core for significantly enhanced compressive performance. *Materials & Design, 93,* 271-282.
3. Zhang, X., Cheng, G., Wang, B., et al. (2008). Optimum design for energy absorption of bitubal hexagonal columns with honeycomb core. *International Journal of Crashworthiness, 13(1),* 99-107.
4. Jeyakrishnan, P. R., Chockalingam, K. K. S. K., Narayanasamy, R. (2013). Studies on buckling behavior of honeycomb sandwich panel. *International Journal of Advanced Manufacturing Technology, 65,* 803-815.

5. Wang, B., Tian, K., Hao, P., et al. (2016). Numerical-based smeared stiffener method for global buckling analysis of grid-stiffened composite cylindrical shells. *Composite Structures, 152,* 807-815.