Numerical Investigations on the Ballistic Performance of Honeycomb Sandwich Structures Reinforced by Functionally Graded Plates

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Abstract

Sandwich structures are the oldest known form of composite material. It is formed by combining at least two different sheet materials in layer. Presence of sandwich structure in layers allows being formed different composite materials or different materials for each layer. By means of this, sandwich structures can be designed as ballistic armour structures. The purpose of this study is to analyze the ballistic performance of the sandwich structures with aluminum honeycomb core which is reinforced by functionally graded plates. The FG reinforced plate disrupt the edge geometry of the bullet with reducing the ballistic effect by means of the ceramic surface of FGM, while the aluminum honeycomb core material provides the absorption of impact energy which affects the sandwich structure. Honeycomb composite structures are used for high mechanical strength structures which absorb the energy resulting from impact loads. By using the external FGM reinforcement plates and aluminum honeycomb core, the composite structure will have designed as both high mechanical strength and quite lightweight armour material.

In literature, many studies have been performed about mechanical responses of honeycomb sandwich structures under ballistic and impact loads, however, there is no study which is about a sandwich structure reinforced by FGM. Because of the honeycomb sandwich structures reinforced by functionally graded plates can be used for impacted environment under severe conditions as ballistic armour, it is very important to know the ballistic responses of this type structures.

In this study, damage mechanism and deformation of honeycomb sandwich structures reinforced by functionally graded plates under ballistic impact effect was investigated. In order to determine the penetration and perforation threshold energy values which are the most considerable parameters in ballistic performance analysis and ballistic limit of the sandwich structure, the effects of compositional gradient exponent, number of layer, and thickness of FGM reinforcement plates, ballistic impact energy variation, cell size and height variation of aluminum honeycomb core on ballistic performance of sandwich structure was analyzed. For numerical analysis, ANSYS LS-DYNA/Explicit finite element packaged software was used and by means of Ansys Parametric Design Language (APDL) parametric numerical studies were performed. In numerical studies, theoretical models which based on micro structural model of functionally graded materials were used.

Acknowledgement: The authors would like to acknowledge funding from the Scientific and Technological Research Council of Turkey (TUBITAK) under the research Grant No. 112M917.

Keywords: Functionally graded materials, honeycomb, sandwich structure, ballistic performance, finite element method.

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