Compressive properties on the spherical-roof contoured-core with different amounts of diamond-shaped notches

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ABSTRACT

It is a challenging task to develop lightweight materials and novel structures, which offers the better energy-absorbing characteristics. Therefore, it is still a significant issue to obtain secondary processing on available contoured-cores to provide a lightweight structure. This paper is aimed to investigate the effect of compressive properties on the single spherical-roof contoured-core cell with series diamond-shaped notches subjected to quasi-static compressive loading, which is referential concept on second weight reduction. The spherical-roof contoured-core panel was manufactured using the compression moulding process using carbon fibre reinforced laminates, and then cut to every single cell structure with 50×50 mm. The diamond-shaped notch is cut using hand saw with 1 mm thickness followed notch mould. It is concluded that with the number of diamond-shaped notches increasing, compressive strength and modulus generally shows the decreasing trend. Energy absorption, specific energy absorption and peak load are also studied. In addition, the failure types of single cell unit are discussed according to corresponding experimental results. It is highlighted that secondary process such as notch cutting process is a sufficient method to reduce weight reduction parameter of lightweight structure for automotive and aerospace application.

Keywords

Compressive properties, spherical-roof, contoured–core structure, diamond-shaped notch, compressive loading, sandwich structure

1. INTRODUCTION

Sandwich structures offer a wide range of structural applications in the naval, aerospace, automotive and construction industries, which provided superior specific stiffness, thermal and compressive properties compared to common materials such as aluminium, metal, and steel [1-3]. Sandwich panel structure is comprised of a core sheet positioned between two thin skins [4]. The principal feature of this type of structure is to obtain a high strength-to-weight ratio, which is still a changing task to reduce its weight and cost as the energy-absorbing structure. In recent years, various novel core-structure has been explored under quasi-static and dynamic loadings, which involved cellular foams [5, 6], corrugated-cores [7, 8], honeycomb cores [9-11] and lattice truss cores [12-14].

Numerous studies have been undertaken to investigate the effect of different core design on energy absorption in structural sectors, such as contoured-core, egg-box and cellular core [15-19]. For example, Rejab and Cantwell investigated an insight into the failure response of the corrugated-core sandwich panel, which indicated that initial failure was dominated as the cell walls buckled. In contrast, the composite corrugations exhibited zones of fibre fracture, debonding and delamination [20]. Kazemahvazi et al. studied the compressive behaviour of a corrugated system, which exhibited a number of different failure modes as the structural geometry [21]. Chung et al. fabricated composite egg-box as energy absorbing structure, which stated that the parameters of material density, geometric structure, and boundary condition have affected the energy absorption of sandwich panel [22]. Haldar et al. explored that the influence of the core profile and core cell wall thickness on the energy absorbing characteristics on carbon fibre reinforced plastics (CFRP) and glass fibre reinforced and plastics (GFRP). It has been found that the specific energy absorption capability increased nonlinearly with increasing core cell wall thickness [15]. Jin et al. researched the deformation modes and dynamic response of peripherally clamped square monolithic and sandwich panels of localized impulsive loading, which comprises three types of cellular metallic cores [23]. The findings indicated that all the sandwich panels presented mainly large global inelastic deformation, and the dynamic response is sensitive to the applied impulse and its geometrical configurations. Montemurro et al. proposed the multi-scale approach and material optimization with the cellular core of sandwich panels, which was applied to the least-weight design subject to constraints of different nature [19].

Noticeably, there have been studied to develop new and novel core structure in recent years, and it can greatly expand fundamentals in various kind of sandwich structures. Several examples of novel designs in the structural application of sandwich structure have been discussed, which highlights new and non-traditional core concept. For the commercial sandwich structure subjected compressive loading, the main deformation of structure is the cell wall bending, resulting in core structure is limited utilized [24]. In the view of this perspective, the lattice sandwich structure has been studied, which provided many strengths compared to the traditional structure, such as open-hole geometry, relative higher porosity rate, heat transfer, and energy absorption. There are several common lattice sandwich structures included spherical-roof lattice core [25], tetrahedral truss core [26], octet-truss lattice core [27] and Kagome core [28]. For example, Wei et al proposed the compressive response of the lightweight C/SiC spherical-roof core lattice sandwich panel in advance, which demonstrated that the critical relative density affected the failure models under aerodynamic pressure load [29]. Mei et al. developed a novel fabrication method to manufacture

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