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DYNAMIC RESPONSE OF HONEYCOMB SANDWICH PANELS UNDER IMPACT LOADING

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ABSTRACT

Honeycomb sandwich structures are broadly used in the aerospace and automotive industries, as well as in civil infrastructure, such as highway, bridge and building construction. Due to their high mechanical performance per unit weight and high energy-absorption capability, the sandwich structures show great potential for impact protection, so as to reduce the pressure applied to a protected structure located behind the panel and mitigate damage of structures under various loadings. Obviously, the requirements for materials or structures in considering energy absorption characteristics are not as the same as those in strength and stiffness. For sandwich structures, the cores are designed containing a large amount of space and have a relative low density. They can provide high strength, impact resistance along with reduced weight. All these performances are especially important for aviation, rocket, and space technology.

A large number of experimental, numerical and analytical studies on the behaviour of honeycomb sandwich structures under quasi-static loading have been reported in the past decades. However, for the energy absorption design in automotive and aeronautical applications, impact behaviour of the sandwich structures has gained an increasing research interest. Several groups have examined the dynamic response of sandwich structures to impulse loading [1–5]. In the present study, we will report our investigation on the dynamic behavior of honeycomb sandwich structures subjected to localized, high rate loading.

A sandwich panel considered consists of a pair of solid metal faces and a honeycomb core that is rigidly edge supported and a bird strike on the system. The finite element simulations using fully meshed geometries have been conducted. The properties of LY12 aluminum alloy are described by Johnson-Cook constitutive relation. The core material selected is NOMEX honeycomb with hexagonal cell, modeled by shell elements. The bird, defined as a soft projectile, is modeled by SPH (Smoothed Particle Hydrodynamics). The dynamic analysis of sandwich panel is conducted by using Pam-crash dynamic analysis software. The numerical model of the sandwich panel is shown in Fig. 1.

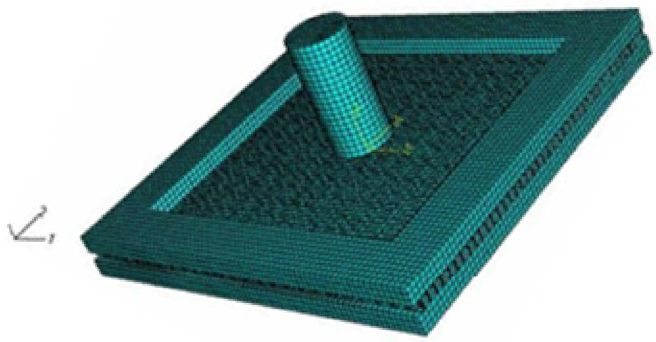

Figure 1 Finite element model of a sandwich panel

The studies indicate a complex dynamic structural response at different impact speed. The advantage of using a sandwich structure with a cellular core has been demonstrated as a good candidate for energy absorption purpose and withstanding impact loads. The energy absorption mechanisms are identified as significant front face bending and progressive cell wall buckling at the center of the panel closest to the impact loading. Cell wall buckling and core densification increased as the impact speed increased. The model also captures many phenomenological details of the core deformation behavior. The honeycomb sandwich panels suffered significantly smaller back face deflections than solid plates of identical mass even though their design was far from optimal for such an application.

REFERENCES

[1] N.A. Fleck, V.S. Deshpande, "The resistance of clamped sandwich beams to shock loading", *J Appl Mech*, Vol. 71, pp386－401, (2004).

[2] Z. Xue, J.W. Hutchinson, "A comparative study of impulse-resistant metal sandwich plates", *Int J Impact Eng*, Vol. 30, pp1283－1305, (2004).

[3] H.J. Rathbun, D.D. Radford, Z. Xue, M.Y. He, J. Yang, V.S. Deshpande, et al. "Performance of metallic honeycomb-core sandwich beams under shock loading", *Int J Solids Struct*, Vol. 43, pp1746－1763, (2006).

[4] P.J.Tan, S.R Reid, J.J. Harrigan, Z.Zou, S.Li, "Dynamic compressive strength properties of aluminum foams, Part I-experimental data and observations", Journal of the Mechanics and Physics of Solids, Vol. 53, pp2174–2205, (2005).

[5] P.J.Tan, S.R Reid, J.J. Harrigan, S.-T. Hong, J. Pan, T. Tyan, P. Prasad, "Dynamic crush behavior of aluminum 5052-H38 honeycomb specimens under out-of-plane inclined loads. In: ASME International Mechanical Engineering Congress, Anaheim, CA. November 13–19, (2004).