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Finite Element Analysis of Multi-Layered Corrugated Panels under Crushing Loading – A Review

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Abstract*: The multi-layered corrugated panels have light weight and higher performances as it has high strength to weight ratio. The sandwich panels are made up of trapezoidal aluminum cores and aluminum alloy sheets. The different configurations of sandwich panels are studied for different layers. Then force-displacement curves and energy absorption characteristics are studied. In this paper a review of various journals which have made studies on the corrugated sandwich panels is done.
Keywords: Multi-layered corrugated sandwich panel, crushing load, energy absorption, quasi-static loading

I. INTRODUCTION

The corrugated sandwich panel has wide applications in nowadays. It has light weight and high strength to weight ratio. The sandwich panel consists of a compressible inner core sandwiched between two stiff facing sheets. The inner core provides shear resistance and holds the facing sheets together. The light weight central core works same as web of I – beam. It is widely applied in building, marine, aerospace and railway industries. The sandwich panels can be used to protect the structures from the high intensity impulsive loads.



Fig 1: corrugated panel

It can be used to make the structure resistant against fire. The trapezoidal aluminium corrugated panels are taken to study. The corrugated panels are studied for single layered and multilayered cores. The base angles and configurations of the core are changed throughout the study. The load carrying and energy absorption capacities are obtained from this study, thus results are compared to find the most effective form.

II. LITERATURE REVIEW

Various literatures reviewed on multi-layered corrugated panels are carried out below.

A. Shujuan Hou et.al. (2015)

This paper investigated the multi-layered corrugated sandwich panels by experimental studies and numerical simulations under the quasi-static crushing loading. The structures are made up of trapezoidal aluminum cores and aluminum alloy sheets. The layers of corrugated sandwich panels vary from two to six. The force-displacement curves of these panels were obtained from the experimental tests and the energy absorption mechanism were studied for each panels. It was found that the sandwich configuration and number of layers of core are played an important role in the failure mechanism and energy absorption. Three different configurations of the multi-layered corrugated sandwich panels were studied and findout that cross arranged panels are better than regular and stagger

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arranged not only in the energy absorption but also in the peak crushing force.

B. M.R.M. Rejab, W.J. Cantwell (2012)

In this journal a series of experimental investigations and numerical analyses are conducted into the compression response, and subsequent failure modes in corrugated-core sandwich panels based on an aluminium alloy, a glass fibre reinforced plastic (GFRP) and a carbon fibre reinforced plastic (CFRP). The initial failure mode in these corrugated systems is found to be the buckling of the cell walls. Then continued loading resulted in the fracture of the cell walls and localised delamination as well as deboning between the skins and the core.

C. R. Biagi, H. Bart-Smith (2012)

This journal conduct the in-plane compressive response of corrugated core sandwich columns by analytically, numerically, and experimentally.Then Failure mechanisms have been identified and include macro buckling, shear buckling, and face wrinkling.

D. Cenk Kılıcaslan et.al.(2014)

The axial crushing response of layered 1050 H14 aluminium zig-zag trapezoidal single and double-layer corrugated core sandwich structures at quasi-static and dynamic loading rates was conducted. The tested single-layer corrugated core at quasi-static strain rate showed comparable specific energy absorption with metal and composite corrugated cores.

E. Hong Su et.al.(2015)

This journal presents a study on the influence of material properties on the energy absorption capabilities of composite sandwich panels. Then they reaches the results that Sandwich panels are a competitive structural member type due to the inherent energy absorption capabilities.The iincreased energy absorption capability is an effective approach to providing blast resistance.

F. Bin Han et. al.(2015)

In this journal combined analytical and numerical approach to exploit the idea of filling core interstices with polymer foam was studied. Then found out that foam-filled corrugated core exhibits radically enhanced transverse shear response.

G. L.L.Yan et. al.(2014)

Sandwich beams with aluminium foam-filled corrugated cores are fabricated and tested under quasi-static three-point bending. Then found out that all-metallic sandwich constructions with foam-filled corrugated cores hold great potential as novel lightweight structural materials for a wide range of structural and crushing/impulsive loading applications.

H. Pan Zhang et.al.(2016)

This paper investigates effective approaches to enhance the blast resistance of sandwich structures with corrugated cores were developed by adopting three different strategies to fill the spaces within cores with polymeric foam. Deformation modes and failure mechanisms of tested panels were investigated. Experimental results demonstrated that the panels with back side filling strategy did not show better blast performance compared with the unfilled panels, even though extra weight was expended due to the addition of foam fillers. The panels with front side filling and fully filling strategies encouragingly appeared to possess desirable blast resistance to prevent severe fracture under high intensity blast loading. This benefit should be attributed to the sufficient crushing deformation of foam fillers and the enhanced buckling resistance of core webs.

I. Seong et. al.(2010)

The bending responses of steel sandwich plates with uni-directionally corrugated cores in the transverse and longitudinal directions have been experimentally and numerically calculated.Then found out that sandwich plates with bi-directionally corrugated cores exhibit quasi-isotopic bending behaviours and structural performances in sandwich plates.

J. Giorgio Bartolozzi et. al.(2015)

In this journal performs an experimental campaign on some available sinusoidal corrugated core panels and found out that the high stiffness-to-mass ratio, especially in bending condition, is mainly influenced by the two faces of the sandwich structure and acoustic or thermal insulation properties are governed by the core.

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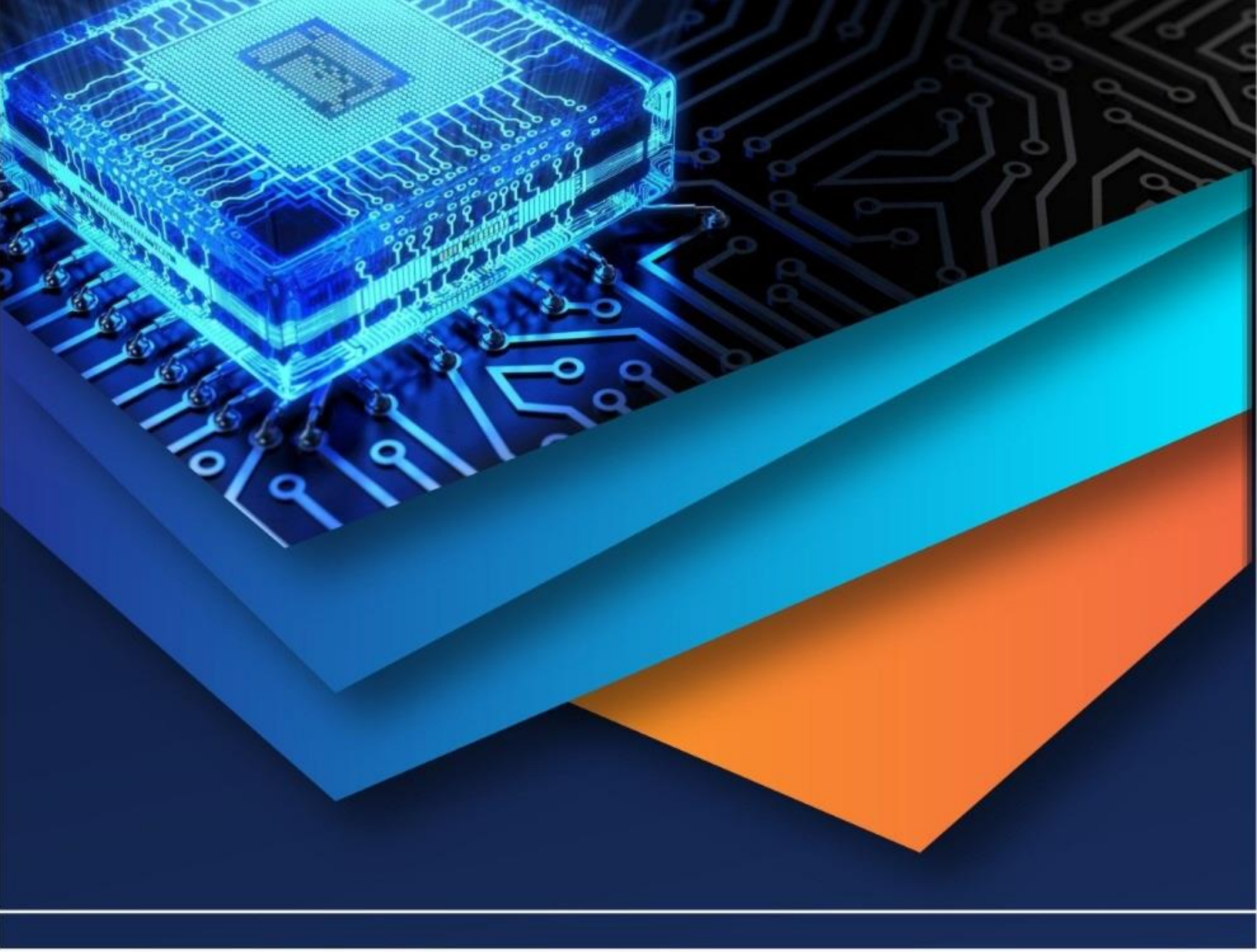
III. CONCLUSION

The study of various literatures about corrugated panels shows that the sandwich panel structures are light weight and load bearing structures. Sandwich panels have high strength to weight ratio, high stiffness to mass ratio and fire resistance. The simplest sandwich panel consists of three layers of materials bonded together to act as a unit. The facings usually consist of thin, stiff, strong sheets of solid materials or composite laminates. The inner core provides shear resistance and holds the facing sheets together. Corrugated panels have high bending resistance. From the study of different configurations of panels it was suggested that the cross arranged panels is better than others.

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