EVALUATING THE CHARACTERISTICS OF SANDWICH COMPOSITE STRUCTURES UNDER QUASI-STATIC LOADING

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ABSTRACT

The integrity of composite structures used in aircraft is crucial and is regularly a subject of discussion. Sandwich composite panels with carbon fibre reinforced laminate skin and flax fibre reinforced laminate skin; both with hemp as the core material were subjected static loading test of 10 mm/min indenter speed. The carbon fibre skin panels were more tolerant to the loading, but the flax fibre skin panels although with lower peak load did not show interlaminar failure like delamination in the response.

INTRODUCTION

Engineered structures made of composite materials designed for specific requirements have gained applications in various industries, including the aviation sector. The present awareness to protect the environment has now triggered the consideration of materials that are environmentally friendly, sustainable, and renewable without a compromise on the integrity. Hence, the development of novel hybrid and sandwich structures will help to achieve the balance between a specific strength application and percentage of renewable resources in the content.

The process of hybridisation enables one component to complete what is lacking in the other within the structure. Chitturi et al [1] manufactured layered composite structures using glass fabric and polycarbonate sheet and achieved the reduction in weight compared to glass fibre reinforced composite. Also, the inclusion of the polycarbonate improved the impact strength. Sarwar et al [2] conducted tests on Kevlar/Flax/epoxy hybrid and Flax/epoxy composites and observed that hybridisation improved the strength and stiffness. While Zhua et al [3] presented results about the crushing characteristics of composite tubes made aluminium and carbon fibre reinforced polymer under static and dynamic tests.

The development of solutions leading to better damage management, lighter and with minimal impact on the environment is still a topic of discussion. This study is based on the experimental analysis of sandwich composites made of synthetic and natural fibre as reinforcements. The findings are intended to serve as pointers in practical design applications.

RESULTS AND CONCLUSIONS

Sandwich composite plates made of cured carbon fibre reinforced ([0/30/60/90/30/60/0] and [0/30/60/90]s) and flax fibre reinforced ([0/30/60/90]s and [0/±45/90]s) composite skin and hemp fibre core manufactured by hand lay-up were tested under the quasi-static loading rate of 10 mm/minute using the instrumented Tinus Olsen universal testing machine. The boundaries of the test samples were firmly clamped during the test.

In Fig. 1 is a representative image of the tested sandwich composite with carbon fibre reinforced epoxy composite skin; part of the rear ply can be seen broken. The behaviour of all the four plates tested under the static loading of a 12 mm indentor are presented in Fig. 2; as can be seen the peak loads are from the carbon fibre reinforced plates. The data plotted in Fig. 2 were normalised with the sample thickness. This prImarily is due to the strength of this type of fibre compared to flax. The drops in load is primarily because of failure such as matrix crack, fibre breakage and delamination, but significant here is the very long sharp drop in load from 2160 N/mm to 775 N/mm for [0/30/60/90/30/60/0] skin plate and 2302 N/mm to 1115 N/mm for [0/30/60/90]s skin panel, which happens within the hemp core material. This is very significant and can serve to absorb shock and prevent catastrophic failure; hence the effectiveness of this action can be improve by increasing the core thickness.

Fig. 1 Tested carbon fibre reinfoced skin sandwich plate.

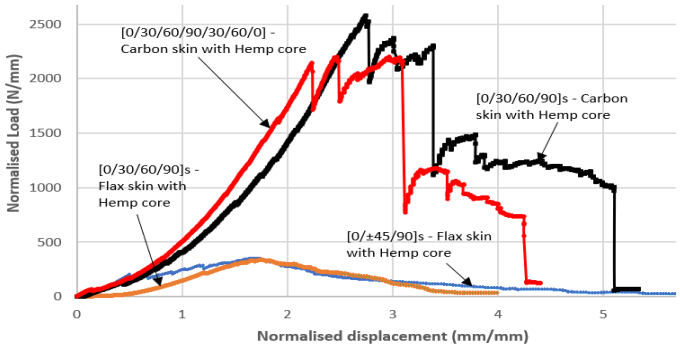

Fig. 2 Normalised load – displacement plots of the tested sandwich composites.

Fig. 3 Tested flax fibre reinfoced skin sandwich plate.

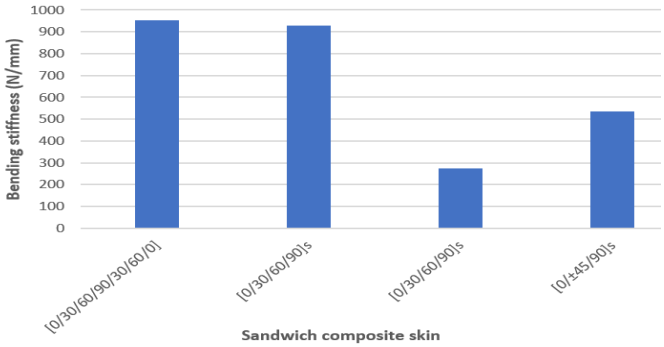

Fig. 4 Comparison of the composite panels bending stiffnesses

In Fig. 3 is a rear end image of tested flax fibre reinforced composite panel, showing the breakage of fibre within the loading zone; but the peak loads are much lower as shown in Fig. 2. Hence, this is recommended for secondary components subjected to low level loads. The bending stiffnesses of the panels are compare in Fig. 4 and as expected the highest values are from the ones with carbon fibre skin reinforcements. The ±45 plies presence in the [0/±45/90]s flax laminate skin induced better bending resistance compared to the spiral arrangement of the [0/30/60/90]s flax laminate skin panel.

REFERENCES

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