Effect of low velocity impact damage on the natural frequency of composite plates

ABSTRACT

Biodegradable natural fibers have been suggested to replace the hazardous synthetic fibers in many aerospace applications. However, this notion has been limited due to their low mechanical properties, which leads to the idea of hybridizing the two materials. Many aircraft components such as radome, aft body and wing are highly susceptible to low velocity impact damage while in-service. The damages degrade the structural integrity of the components and change their dynamic characteristics. In worst case scenario, the changes can lead to resonance, which is an excessive vibration. This research is conducted to study the dynamic characteristic changes of low velocity impact damaged hybrid composites that is designed for aircraft radome applications. Three materials, which are glass fiber, kenaf fiber and kenaf/glass fiber hybrid composites, have been impacted with 3J, 6J and 9J of energy. Cantilevered and also vertically clamped boundary conditions are used and the natural frequencies are extracted for each of the specimens. The obtained results show that natural frequency decreases with increasing impact level. Cantilevered condition is found to induce lower modes due to the gravitational pull. To eliminate mass and geometrical effects, normalized modes are computed. Among the three materials considered, glass fiber composites have displayed the highest normalized frequency that reflects on its higher stiffness compared to the other two materials. As the damage level is increased, glass fiber composites have shown the highest frequency reduction to a maximum of 35% while kenaf composites have the least frequency reduction in the range of 1 – 18%. Thus, kenaf fiber is taken to be helpful in stalling the damage progression and reducing the effect of damage. This has been proven when the percentage frequency decrement shown by kenaf/glass fiber composite lies between glass fiber and kenaf fiber composites.

Keyword: Aerospace; Dynamic characteristic; Natural frequency; Velocity impact; Composite plates