

Blunt Impact Damage of Composite Fuselage Structures

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ABSTRACT

Contact with ground and maintenance equipment is the major source of damage to commercial aircraft. Due to their inherent resilience, and the use of co-cured and co-bonded construction methods, advanced composite airframe structures are prone to developing significant internal damage resulting from these impact sources. The effect of impactor bluntness on the development of damage to composite structures was investigated to determine the degree of internal damage that can form with little or no external visually-detectable signs. Softer and larger radius (i.e., blunter) impactor geometry was found to allow development of significant internal damage without penetrating the panel skin.

MAIN BODY

With the increased use of composites in airframe primary structural components (e.g., fuselage and wing), there is a need to understand the damage mechanisms caused by accidental transverse loading, particularly from ground equipment which is a major source of damage [1]. Ground service equipment (GSE) activity surrounding commercial aircraft during the refueling and passenger loading process is an impact threat source that is referred to as high-energy wide area blunt impact. The low velocity, yet large mass involved results in high energy levels in the range of 250 to 1,200 J for typical GSE traveling at speeds of 0.5 to 1 m/s with mass of approximately 2,300 kg to 3,000 kg for belt loaders (several times higher for heavy cargo loaders). The rubber bumper on the GSE distributes the load by increasing the contact area, creating damage to the internal structural components in a manner that is prospectively not externally-visible. This problem has been investigated via indentation tests conducted on specimens representative of a section of wide-body composite aircraft fuselage having stringer-skin

construction. These specimens were indented quasi-statically, at two locations relative to the stringers (hat stiffeners), with rigid impactors of different geometries, as well as with a hard-rubber beltloader bumper, in order to determine how impactor "bluntness" relates to damage formation and visual detectability. Panels indented with a 76.2 mm radius aluminum impactor resulted in penetration through the skin with no debonding of the stringers. Failure occurred at a load of 30.68 kN when indented directly centered over the stringer, and at 26.43 kN when indented between stringers. The panel indented with the rubber bumper developed significant debonding between the stringers and skin, with no visible damage to the exterior surface at much higher load levels, up to 61.65 kN, at which point major stringer debonding occurred. The load progression of the panel indented with the OEM bumper between stringers is shown in Figure 1. The specimen indented with the bumper also experienced more widespread internal damage in structural components away from the location of impact.

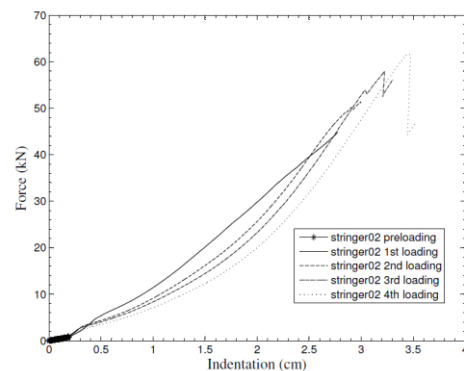


Figure 1: Load vs. displacement of the stiffened panel indented with the OEM rubber bumper

REFERENCES

1. International Air Transportation Association 2005, "Ground Damage Prevention Programme Targets 10% Cost Reduction," Industry Times, Edition 7, September, Article 4.