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Full-Scale Crash Testing of Cargo Containers - Experimental Characterization for Transport Airplane Crash Applications

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Abstract

This conference paper presents experimental investigations on crash related failure characteristics of airplane cargo containers, also referred to as ULD containers (Unit Load Device).

Transport airplane crashworthiness has become more relevant in the past decades due to the introduction of non-traditional airplane designs, such as double-deck or composite design; and this trend is expected to continue with the introduction of electric flight technologies involving battery or hydrogen energy storage. In the past, authorities have written special conditions for novel designs to ensure the level of crash protection is equivalent to that provided by traditionally-configured airplanes. So far, demonstration of transport airplane crashworthiness for novel designs is typically accepted by applying a fuselage section that is vertically impacted on the ground. Several impact conditions and loading configurations must be analyzed to demonstrate a robust crash design. Loading configurations consider the cabin and the cargo hold, and specify a range of representative loading scenarios.

Cargo loading can have a significant impact on the airframe crash performance and passenger survivability, due to its mass located on the cargo floor and its stiffness which may become relevant during typical contact interactions with the cabin floor located above for typical airplane configurations. For wide body transport airplanes, and partly also single-aisle airplanes, representative bulk cargo is loaded in ULD containers which consequently have to be considered in crash analyses.

The lack of data for the structural failure behavior of ULD containers under crash related loads is the motivation for DLR to experimentally characterize those ULD containers and to develop validated finite element models that can be used in future crash analyses of airframe designs.

Representative ULD containers for wide body airplanes of type LD3 (IATA: AKE) and for the A320 single-aisle airplane of type LD3-45 (IATA: AKH) were selected for this study. The most representative ULD container design based on differential metallic construction was chosen. In total, 13 in-service ULD containers were purchased which partly show negligible or minor damages and hence well represent the world-wide container fleet in service. Following the building block approach, some of the ULD containers were disassembled for experimental tests at the different test pyramid levels. In total, eight full-scale drop tests were performed on AKE and AKH containers.

The conference presentation will provide an overview on this research program and will discuss experimental results at the full-scale level.

Keywords: air cargo container · experiment · transport airplane · crashworthiness

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