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Title:

Numerical Crashworthiness Analysis of ISOFIX and LATCH Automotive Child Restraints in Transport Category Aircraft

Abstract:

Infant passengers aboard public transport aircraft commonly travel unrestrained on the lap of an adult passenger. In countries such as Australia and the United Kingdom, lap-held infants must be restrained by a 'supplemental loop belt' attached to the adult passenger's lap belt. In either case, a lap-held infant is at far greater risk of severe injury or death than an adult passenger in what would otherwise be considered a survivable crash. The regulations of most countries allow for the use of automotive child restraint systems (CRS) in aircraft. However, while research has proven that they provide a significant increase in safety for the infant passenger, their use is not widespread. This is due in part to several interface issues associated with the installation of traditional CRS in aircraft seats. It has been established that new generation CRS utilizing the ISOFIX and LATCH attachment methods have the potential to overcome these issues while affording the infant a level of safety at least equal to that of an adult passenger.

ISOFIX and LATCH type CRS do not make use of the belt on the host seat; instead, they attach to rigid mounting points in the bight of the host seat. The implementation of these restraints in the air transport environment presents some unique issues. It has been identified that the increased rigidity of the CRS-aircraft seat assembly will affect the dynamic behaviour of the aircraft seat, potentially having a negative effect on the safety of a passenger seated directly behind the CRS. Furthermore, the loads exerted on the aircraft seat by the CRS during a crash must be quantified to enable the design and regulation of attachment points compatible with the ISOFIX and LATCH systems.

A numerical model was created to facilitate the study of the dynamic behaviour of a typical economy class seat configuration involving ISOFIX and LATCH child restraints. The model was developed in the MADYMO dynamic finite element/multibody code and validated against data from physical tests conducted by Australia's Civil Aviation Safety Authority (CASA). Parameters such as seat pitch, occupant size, CRS type and CRS lower anchorage stiffness were varied in order to determine their effect on the crashworthiness of the configuration. Results are presented in terms of occupant head and neck injury criteria as well as seat loads; hazardous configurations are identified.