Aircraft Crashworthiness Research Program

Structural deformation and the resultant induced impact force experienced by a passenger in a crash depends on the safety design of the integrated airframe and seat systems.

The forces transmitted to a passenger are determined by the manner in which the fuselage deforms and dissipates energy during crash impacts. The airframe structure must maintain a habitable space for the occupants and be able to reduce impact induced forces to human tolerance levels throughout the crash sequence. The key element for this capability is the energy absorption characteristics of the airframe structure, specifically the fuselage. The responses of the cabin interior furnishings (e.g., overhead bins and seats) are directly related to the forces induced by the airframe structure during the impact.

The cabin interior must be able to provide sufficient integrity for occupant protection during the crash sequence. Accident reports indicate that in many survivable accidents, occupants were injured from loose seat attachments, overhead bins, and falling ceiling panels. Behavior of the cabin interior furnishings is critical to occupant survival, particularly in a postcrash environment where rapid, unhindered evacuation is essential.

For many years emphasis in aircraft accident investigation was placed on determining the cause, not the survival aspects, of the accident. Now, through detailed studies of accident investigation reports it is clear that improvements to the aircraft structure could be made which would influence occupant survivability.

Crashworthy seat design involves two major considerations. First, under high longitudinal crash loads, the seat must not break loose from the floor. Second, under vertical crash loads, the seat must absorb force so that the probability of passenger spinal damage is minimized.

The photograph shows the interior of a commuter type airplane after a drop test. The seat in the rear middle is an experimental seat with special energy absorption characteristics developed by the FAA Civil Aeromedical Institute (CAMI), Oklahoma City, Oklahoma. The seats on the left and right are typical production seats for small aircraft. During the drop test, the CAMI seat reduced the vertical load on the simulated occupant, which in turn would reduce the possibility of spinal injury.

Safety

The crashworthiness research program has two specific technical goals: (1) the elimination of structural design, manufacturing, or maintenance faults that could lead to an accident and (2) the improvement of crash design features to provide better protection for passengers and crew in an accident. In order to improve the structural airworthiness of aircraft as well as the likelihood of occupant survivability in an accident, a more comprehensive knowledge of key structural safety issues for establishing certification and continuing airworthiness criteria in all types of aircraft including general aviation are being developed.

This research program is comprised of four task areas: aircraft dynamic testing, aircraft water impact and flotation, transport fuel containment, and aircraft cabin interior safety. Both testing and analysis efforts are performed. For testing, a vertical drop tower and its supporting facility are located at the William J. Hughes Technical Center at the Atlantic City International Airport, New Jersey (see photo on left). For analytical modeling, the FAA has developed computer programs that predict crash damage to aircraft, crash gravity loads sustained by the aircraft structure, gravity loads transmitted to seats, and the resultant forces experienced by seated occupants. One example is the analysis of airframe crash effects using the KRASH computer code, which was developed by the FAA. This code has been modified and improved to accommodate light aircraft, rotorcraft, and transport aircraft. Complementing the KRASH code for airframe loads and damage are two computer programs for seated passengers. One is a Seat Occupant Model for Light Aircraft (SOMLA) and the other is for Seat Occupant Model for Transport Aircraft (SOMTA). Use of these computer programs with the KRASH code provides a basis for estimating the effects on seat occupants from crash loads transmitted from the airframe to the seats. The FAA is also participating in the development of an analytical tool in partnership with the United Kingdom Ministry of Defense and the Air Accident Investigation Board (AAIB) at the Cranfield Impact Centre.

To find out more about the Aircraft Crashworthiness Program, contact:

Airport and Aircraft Safety Research
and Development Division
Airworthiness Assurance Research
and Development Branch
Airframe Structures Section, AAR-431

Federal Aviation Administration
William J. Hughes Technical Center
Atlantic City International Airport, NJ 08405
Phone: (609) 485-5781
Fax: (609) 485-4569