FAA William J. Hughes Technical Center

Aircraft Crashworthiness Research Program

Safety

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.

The crashworthiness research goals are (1) to improve crash design features of aircraft to provide better protection for passengers

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and crew in an accident; (2) to develop a database based on test and accident information on the crash characteristics of aircraft structures, cabin interiors, and occupant seat/restraint systems; (3) to develop analytical methodologies to predict aircraft structural response and occupant survivability under generalized crash impact conditions; and (4) to provide a less costly means of compliance to FAA regulations. The scope of the program encompasses all categories of aircraft, from commercial transport to general aviation, and rotorcraft. The crash environments under study includes land and water impacts, including ditching.

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, including occupant protection. 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 above). For analytical modeling, the FAA is developing 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. Because detailed information of individual components of the test articles as well as general fuselage acceleration information are desired, both finite element models, such as the MSC-DYTRAN code, as well as lumped-mass models, such as the KRASH code, are being developed.

Interagency agreements (IA) and grants are in place for cooperative programs with the National Highway Traffic Administration (NHTSA), the Army, the Navy, NASA, and universities. Work with the Army will enhance and validate crash test analytical models by comparing their predictions with actual tests. Common Navy and FAA interest is in rotorcraft ditching, its characteristics, and analytical modeling. Work with NHTSA will share data on crash effects on the human body and develop new aircraft occupant injury criteria. Systems approach to aircraft crashworthiness is being pursued with Drexel University, Wichita State University (WSU), and the Cranfield Impact Centre (CIC) in the United Kingdom. Drexel is analytically modeling drop tests conducted at the William J. Hughes Technical Center; WSU is developing data for dynamic seat testing protocols; and CIC is developing models for reconstruction of aircraft accidents.

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

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