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Structural Compliance for Composite Seats
EASA Rotorcraft Structures Workshop

National Aircraft Certification - TCCA

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Purpose

Present proposed demonstration of compliance for composite seats

Background

- Composite seats have been installed on rotorcraft in the past, with inconsistent demonstrations of compliance
- Composite material and bonded joints in seat structure is relatively new for transport category airplanes
- Material degradation, process defects, and operating environmental effects may lead to seat inability to protect occupant

Focus is on structural elements that carry load from the occupant to the attachment of the seat to the aircraft

Attachments of the seat belt and shoulder harness to a composite laminate / sandwich construction must be included in the assessment

Context

- Composite materials have more intrinsic variability in mechanical properties as compared to traditional metallic structures
  - Composite part strength is directly related to part building parameters
  - Variability in manufacturing is known to affect final part strength
    - inclusions, porosities, matrix inconsistencies, fiber irregularities
    - non-conforming bonds
    - thermal stresses for hybrid elements

Context

- Manufacturing defects and damage due to operational environment may not be detectable and can compromise seat structural integrity
- Goals:
  1. Account for manufacturing variability
  2. Ensure in-service instructions can detect damage

  OR

  2. Demonstrate that seat still performs form, fit, and function in operational environment

Context

CAR 521.28 An applicant for a type certificate in respect of an aeronautical product shall submit to the Minister

(b) a description of the aeronautical product that contains, in addition to its principal design features and its specifications,

(i) in the case of an aircraft, a three-view drawing, the preliminary data respecting the design and performance, and the proposed operating characteristics and limitations

- Current regulations already address these performance expectations, although no guidance exists
- Recall: Simon Waite presentation *Developing Standardization*

AWM 52X.601 General

- Potentially hazardous design feature:

Composite material strength is susceptible to damage that can occur in operating environment

e.g.:

- Seat dropped during storage or installation
- Abuse by passenger / crew (sitting on seat corner)
- Heavy objects (baggage) hitting the seat

AWM 52X.601 General

- Suitability of the selected material must be established by test:

For damage that could degrade the seat's strength, the applicant must:

  - Ensure CMM/ICA are likely to detect that damage and provide repair instructions or ensure design can still meet form, fit, and function
  - For damage that will not be detected by CMM/ICA, include damage, in the material and seat testing

AWM 52X.603 Materials

- Failure of a seat could adversely affect safety
  - Applicant must provide material specification for approval by regulatory authority
- Materials must be selected for appropriate environment
  - Applicant must account for moisture and temperature variation in the cabin
- Experimental data must be provided
  - Applicant must account for environment as well as supplier variability
- Acceptance criteria must be well defined

Reference: FAA AC 20-107B / EASA 20-29 Section 6

AWM 52X.605 Fabrication Methods

- Close control of fabrication process is required
- Statically derived design allowables must account for manufacturing variability
- Fabrication processes must be approved by regulatory authority

Reference: FAA AC 20-107B / EASA 20-29 Section 6

AWM 52X.609 Protection of Structure

- The effect of cabin fluids, e.g. fuels, oils, food, cleaning etc. on composite structure must be considered
- Protection against galvanic corrosion between metallic fasteners and composite (carbon) structure should be addressed.

AWM 52X.613 Material Strength Properties and Material Design Values

- Generate statistically valid strength data
- Variability in materials, fabrication processes and environment must be considered
- Building block approach is recommended
- Generation of load (knockdown) factors to account for environmental effects must be derived
- Robust bonding processes must be developed
  - Bond must be capable of supporting above limit load with maximum disbond possible OR proof tested

Reference: FAA AC 20-107B / EASA 20-29 Section 6

AWM 52X.561 and 52X.562
Emergency Landing Conditions – General

Emergency landing condition tests should include the effects of:

- Processing
- In-service environment
- Material process variability
- Hidden damage

Why?

There is potential for greater scatter in composite seat's ability to pass these criteria, given greater susceptibility to processing variability and operating environment compared to metallic seats

AWM 52X.1529
Instructions for Continued Airworthiness

- Instructions to detect damage that may not be visible by traditional inspection methods for interior components
  - The inspection method, e.g. visible, ultrasonic, tap test etc., for detectable damage must be validated.
- Periodic inspections to ensure damage limits are not exceeded
- CMMs should include inspection of structural load paths following storage, upon installation, and following any known incidents (impacts)

Next Steps

- TCCA, EASA and FAA CARP discussions
  - Safety Emphasis Item review
  - Discuss industry concerns
- Certification memorandum (TCCA), is being considered for new composite seat certifications
  - Service history could be used on a case-by-case basis to show design robustness in consideration of:
    - Actual damage reported in service
    - Design features (thin vs thick laminate, use of fasteners vs bonded joints etc.)

Discussion Topics for CARP: Candidate SEI

1. MOC are appropriate for the selected material.
   a. What is the impact to rotorcraft vs large transport?
   b. Harmonized guidance needed
2. Demonstration by test (52X.561 and 52X.562) challenges:
   a. Cost
   b. Repeatability
   c. Damage location
   d. HIC
   e. …

Discussion Topics for CARP: Candidate SEI

3. Damage tolerance ‘’tied to’’ fracture mechanic demonstrations in AWM 52X.571 and 52X.573. Form, fit and function ‘’tied to’’ maintenance actions. These MOC challenge this distinction.
4. Others?

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