Sept 2015: FAA/Bombardier Composite Transport DT & Maintenance Workshop

Airbus Bonded Repairs Applications to Composite Pressurized fuselage.
A350XWB – Composite Materials overview

Most of the External structure of the Airframe are with Composite materials

- Al/Al-Li: 19%
- Steel: 6%
- Titanium: 14%
- Misc.: 8%
- Composite: 53%

A350-900 Material Breakdown (%)
Including Landing Gear

CFRP
- Wings
- Centre wing box and keel beam
- Empennage & Tail cone
- Fuselage Skin panels
- Frames, stringers and doublers
- Doors (Passenger & Cargo)
A350XWB – Composite Parts: large structural parts
A350 XWB: Primary Structure Composite Repairs

Extensive experience to repair regardless whether it’s metal or composite

- Majority of events involved secondary structure like belly fairing panels, nacelles...

- Primary structure
  - Empennages (since A300), ATR72 Wing, A380 Rear Fuselage
  - Example on Recent event of tail cone damage
    - Tail cone cut by winglet of passing aircraft
    - Repaired in situ

Repair definition, production and embodiment in same time as for metallic structure
A350XWB: Primary Structural Bonded Repairs
Part of a solution set for the SRM

Repairs solutions to Wing, Fuselage, Empennage CFRP structures

Non-structural repair

- Permanent Bonded Repair (incl. ECF* restoration)
- ECF: Expanded Copper Foil

Structural repair

- Temporary bolted repair
- Permanent bolted repair
- **Permanent bonded Repair.**
A350XWB: Primary Structural Bonded Repairs – Concept

- **Flush Bonded repair** (permanent, no inspection) bonded repair on **Principal Structural Elements**.

- Current focus on most likely damage scenarios & locations:
  - **Fuselage skin** delamination and perforation.
  - **Fuselage stringer** delamination & disbond.

- **Selected repair material set**
  - **M20/IM7** tape prepreg, low and medium grades (Hexcel) and **FM300-2M** adhesive (Cytec).
  - Material selection & Qualification in the framework of the CACRC (Civil Aircraft Composite Repair Committee).
A350XWB: Primary Structural Bonded Repairs – Embodiment process

- **Environment conditions.** A/C in hangar. Preparation of prepreg plies in a humidity & temperature controlled environment.

- **Stepping** *either* by hand *or* with portable automated machining GSE

- **Curing.** Conventional hot bonder & heating blanket and single vacuum bag cover most damage scenarios & locations.

- **Checks & inspection:**
  - Water break test.
  - Conventional ultrasonic method.
  - Destructive tests on specimen made on the spot may be required.
A350XWB: Extensive Validation process

Large used of physical demonstrators to trial repair procedures and support analysis validation

Development of out-of-autoclave bonded repairs standard

- Extend coverage of bolted repairs → Large bolted repair, stacked doubler
- Installation of “fast” bonded repairs

Assess Structural validation combining:

- Complex design feature: Door surround
- Damages prone area: Bonded door corner repair with impacts:
  → Excellent behavior demonstrated

In progress:

→ Bonded repairs application in SRM
→ Simplify approach for repair justification
Conclusion

- Prioritization of bonded repair as alternative to Bolted repairs
  - In Fuselage structures, at damage prone area
  - In service application ready
  - Development of standard practice in SRM chap. 51
  - Training, specific GSE & materials available for MROs to enable start of MRO preparation activity

- Extensive test program develop to assess structural capability for fuselage :
  - Extend applicability to other components & configurations.
Thank you for your attention
A350 XWB: OoA bonded repairs Fuselage Test demonstrator

- Complex design feature: details on door corner.

Key? Fine tuning of repair procedures for adequate quality level.
A350 XWB: OoA bonded repairs Fuselage Test demonstrator

- out-of-autoclave bonded repair on door corner.

Stepping

Damage diameter 50 mm

4,4 mm deep (24 plies medium grade) on 12,5 mm skin (68 plies)

Curing

Cured patch

Smoothing of surface, re-drilling, fasteners re-installation

* See list of assumptions + Assuming 35 hours for preliminary thermal behaviour.