

Keeping in shape

A350 structure repairs and kits

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Maintenance and structure repairs are part of the normal upkeep of an aircraft. And this goes of course for the A350, with some slightly different methods due to composite primary structures. Today's aircraft have been designed using the accumulated, past experience from previous passenger and cargo planes, enabling potential repairs to be identified and planned for in advance.

The choice of repair method will depend on the type of damage, level of severity and the material being repaired - be it aluminium, titanium or carbon. In some cases, solutions can be temporary, taking into account customer needs and constraints.

Designed to be maintainable and robust

Designing the A350 structure meant taking into account different criteria:

- **Maintainability**

For customers, this was key to ensure maximum operability of the aircraft and minimum maintenance costs.

- **Robustness**

This can be defined as the ability of the structure to sustain in-service loads with no or minimum maintenance action. Changing from a metallic fuselage to a composite one required Airbus to consider all threats (lightning strikes, mechanical impact, scratches) and to define the associated damage.

Airbus conducted a survey of in-service damage on single-aisle and long-range programmes to define all “prone to damage” areas. Typical damage can be caused by lightning strikes and hailstones. ‘Abnormal events’ damage can occur on the ground from catering trucks, cargo-loading equipment and elevators or during maintenance.

Airbus defined airframe zones based on a probabilistic approach between damage occurrence and mechanical impact energy threshold. Basically, the more prone to damage an area is, the more resistant the structure is in order to reduce maintenance operations and repairs.

The right balance had to be achieved between the structural weight and the impact resistance.

Detecting and assessing damage

In case of visible mechanical impact damage during operations, ultrasonic Non Destructive Testing (NDT) detection is required. (Non-visible damage is covered by design and does not compromise the structure integrity.)

Customers can perform the detection and assessment without an NDT-qualified inspector thanks to the Line Tool and Line Sizing tool to determine the extent and severity of damage.

NDT inspection by non-specialist

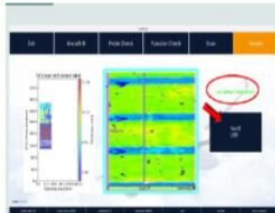
LineTOOL: go/no go composite delamination assessment tool

- Prevent flight delay and cancellation due to lack of Non Destructive Testing expert personnel availability
- Provide quick and reliable statement
- Already available and used by several Operators



LineSIZING: Damage sizing and reporting

- Easy to use device, enable B1 or equivalent mechanics to perform damage sizing on A350 monolithic CFRP.
- Ultrasonic C-scan , automatic damage size measurement.
- Enhanced damage tracking and automatic report creation.



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Picking the right repair type for the job

Repairs can be divided into three main types: non-structural or cosmetic repairs; standard structural repairs, and major structural repairs. Depending on the damage analysis, temporary and permanent options may be available for both the non-structural and standard structural repairs.

Repair solution on A350 monolithic CFRP* structures

	Temporary	Permanent
Non-structural repair	High Speed Tape ASR**	Quick Cosmetic Repair (bonded ECF*** restoration) ASR
Standard structural repair	Aluminium - blind bolted repair ASR	CFRP - doubler bolted repair Permanent out-of-autoclave bonded repair
Major structural repair	NA	Pre-Defined Repair Solution PDRS

Requires highly qualified staff

*Carbon Fibre Reinforced Plastic

**Aircraft Structural Repair (ASR) documentation - part of the line maintenance documentation

***Expanded Copper Foil

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1. Non-structural repair

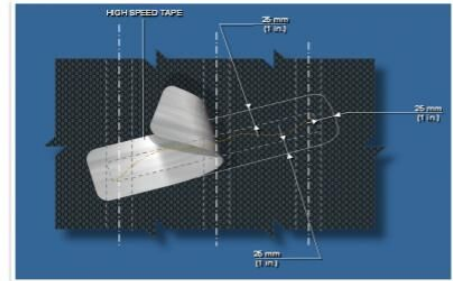
Non-structural damage does not affect the structural strength.

A temporary fix can be done using high-speed tape:

Non-structural repair - temporary



High speed tape



TERMINATING ACTIONS

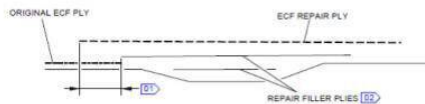
DAMAGE TYPE	REPAIR ACTION	REPAIR CATEGORY	REPAIR REFERENCE	TIME LIMIT BEFORE REPAIR	REPAIR LIFE LIMIT
SCRAPPED PAINT	TEMPORARY	C	SEE ASR 51-77-12-660-00 TEMPORARY SKIN PROTECTION USING HIGH SPEED TAPE	IMMEDIATELY	600 FC (FH NOT RELEVANT)
	TEMPORARY OR PERMANENT	NOT APPLICABLE	REPAIR FOR LIGHTNING STRIKE AS PER SPECIFIC CHAPTER	600 FC (FH NOT RELEVANT)	NOT APPLICABLE
NON SCRAPPED PAINT	TEMPORARY	C	NOT APPLICABLE	IMMEDIATELY	600 FC (FH NOT RELEVANT)
	PERMANENT	A	SEE ASR 51-75-12-660-00 REPAIR OF PAINT COATING - GENERAL	600 FC (FH NOT RELEVANT)	NOT APPLICABLE



A permanent fix is the quick cosmetic repair:

Non-structural repair - permanent

- Goal : **Restoration of Expanded Copper Foil** (ECF = lightning strike protection), filling of small damages, flush result
- New standard practice task: **51-77-11**
- Adhesive paste use for impregnation & bonding : EA9394 (easy to supply)
- Quick cure cycle at 100°C (212°F): total duration ~1h



Example of Cosmetic Permanent repair – restoration of ECF

- Add 30% contingency resin: rationale behind is to impregnate correctly the ECF with a uniform thickness on ECF to ensure good protection and appearance after painting with no pore filler.

Kit with small quantities of materials available:

COMPOSITE Repair KIT LD	(Cosmetic repair)	Airbus Spares Portal	SR5100-50C00000
Adhesive paste gun+Piston - 43ml	13FGC1/13FBC6	HENKEL/3M	EA9394
Expanded Cooper Foil - A3	13VFD1	BENMETAL/ BENDER GMBH	ECF Ae 195 low density zone
Carbon Fabric - A3	13BCB1	HEXCEL FABRICS (EUROPE)	G0904D1070TCT
Breather - 4m²		Cytec	AB10 / CYTEC
Vacuum bag - 2m²	14HCA1	Cytec	HS6262 262LTX
Peel ply - A3	14SFA1	Cytec /AIRTECH	B100 / CYTEC
Non-Perforate Parting film - A3		Cytec	HALAR-NP
Fiber Glass (Bleeder) -A3	13ABC1	Cytec	SAE AMS C 9084 TYPE III CLASS 2
Vacuum Joint - Roll	14JEA1	Cytec /AIRTECH	SM5142/5144-IGS 213
Ruban polyester - 2 Rolls			FT8272/PS10



Cosmetic Repair Box



2. Standard structural repairs

There are several options available for composite which will depend on damage location and operational constraints. So there could be a temporary option with life limitation, or a permanent repair (external or flush; bonded or bolted or mixed).

The temporary option is to do an aluminium blind bolted repair:

Standard structural repair - temporary skin repair

□ Temporary repair

- Life limited:
 - Validity: 3600FC / 15000FH / 36 months
- Material easy to obtain:
 - Aluminium 2024T3 (thickness as per ASR table to restore stiffening ratio)
- Blind bolted repair = No access
 - Fasteners: ABS0257

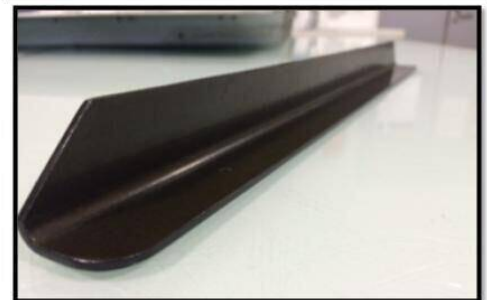
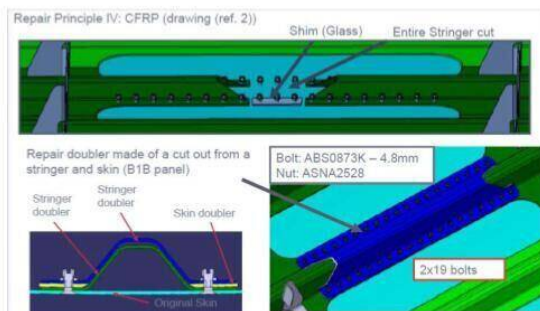


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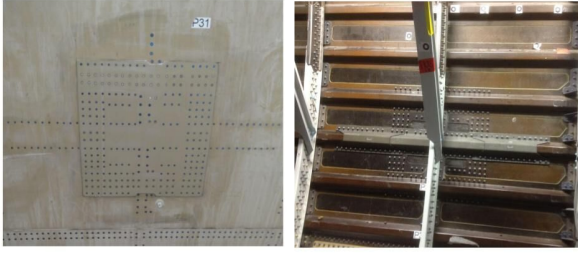
Permanent repairs are done by bolting or bonding or mixed repair types:

Standard structural repair - permanent stringer bolted repair

- Omega stringers repaired by standard CFRP omega repair profile (13 geometries for 4 different lay up)
- L stringers (lower bilge) repaired by standard CFRP L angle repair profile (2 different lay up)
- Standard repair parts also secured for internal structure:
 - Clips, shims.



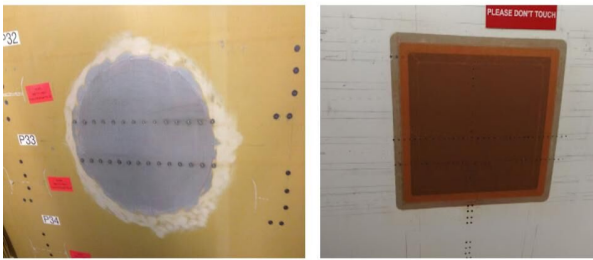
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Example of bolted repair



Example of bonded repair



Examples of mixed bonded/bolted repairs

These repairs require specific composite drilling and bonding competences. They can only be carried out by qualified staff who have followed appropriate training.

Refer to [Airbus Structure Training catalogue](#)

More details on A350 XWB composite bonded repair in [FAST 61](#)

3. Major structural repairs

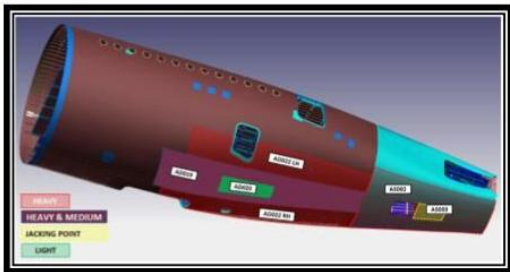
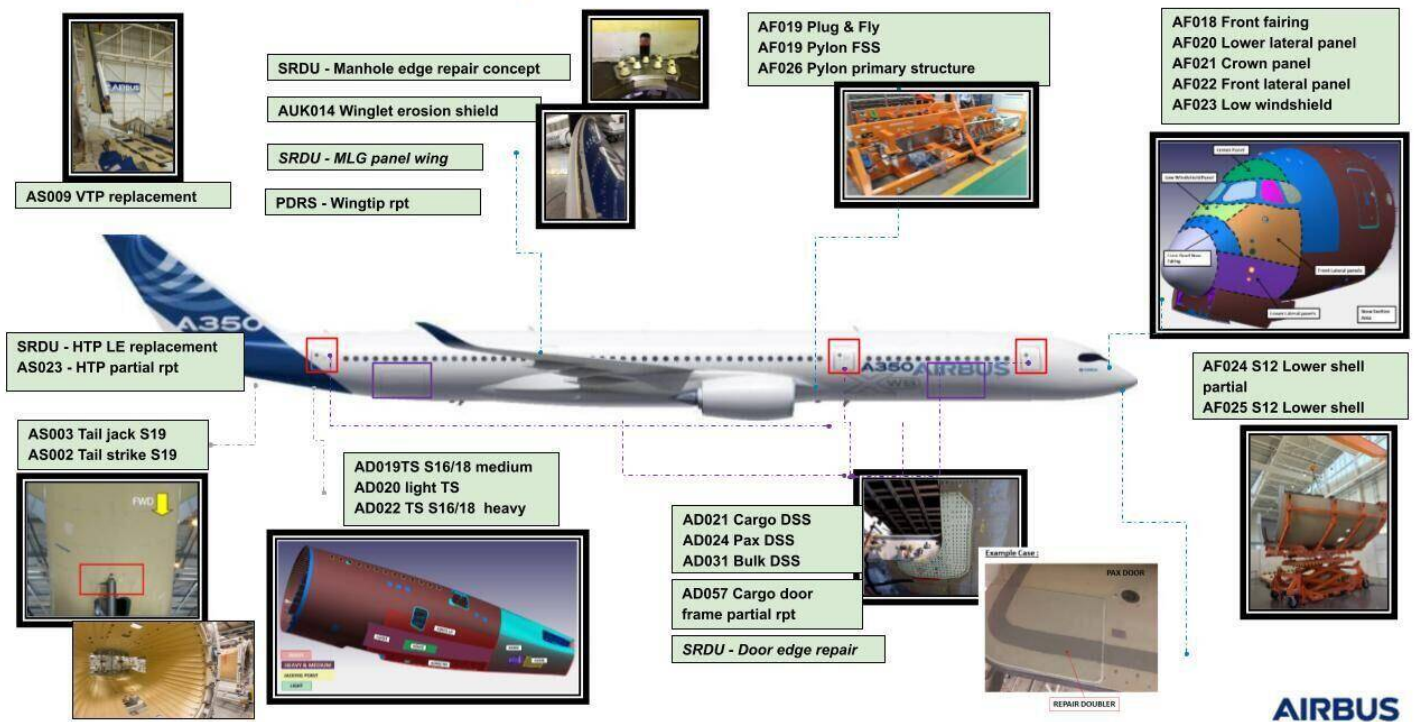
These repairs are used where there is significant damage which requires a permanent solution. As the work can be time-consuming and costly, Airbus has developed Pre-defined Repair Solutions (PDRS) to help speed up the repair process.

Pre-defined Repair Solutions (PDRS)

The solutions are ready-to-dispatch kits, which include repair instructions, access and close-up data, parts, hardware, specific tools and Ground Support Equipment (GSE) if required, and embodiment instructions validated in most cases through trials. They have been developed to anticipate typical recurrent repair needs, based on repair analysis from passenger and cargo aircraft, enabling customers to plan ahead.

Typical key risk areas include the cargo loader area, door surroundings, and panels in the hold. Other damage may be inflicted by bird or tail strikes, nose landing gear collapse, tail jack incidents or truck damage.

Solutions for unscheduled / major event



Detailed PDRS rear lower shell areas

Composite or Carbon Fibre Reinforced Plastic (CFRP) has progressively replaced aluminium in aircraft design over the past years. It helps improve aircraft performance thanks to its lighter weight. It also assists in maintenance and repairs thanks to its increased robustness.

Based on decades of experience in cargo and passenger aircraft with both metallic and composite materials, Airbus has been able to identify areas susceptible to damage during operations and anticipate different structure repair types. This eases the task for operators, helping them to release aircraft back into service as quickly as possible thanks to rapid assessment and temporary or permanent solutions. In the case of major events, the PDRS

catalogue provides ready-to-go solutions to gain time and efficiency for airlines, MROs or Airbus working parties carrying out the repairs.

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