AIRBUS

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Executive Expert Composite Airframe

EASA Sandwich structure Workshop Oct 2016

SANDWICH STRUCTURE DESIGN PRINCIPLE at AIRBUS

.

Content

1. Why sandwich structure

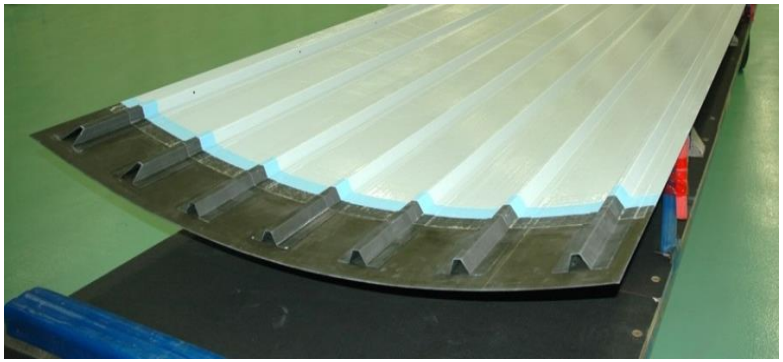
2. Typical design validation principle, from manufacturing feasibility to structural tests validation

3. In service maintenance approach, with few in service experience.

Why Composite?

Integration of functions

- Bonding replaces riveting
- Reduction of number of parts



Fiber orientation to fit structural needs

- Better weight optimization
- Better stiffness control (wing& movables shape)

Reduced maintenance cost

- No need for specific corrosion (re-)protection
- No fatigue behavior

	1990	Today
Flight cycles	48.000	60.000
Scheduled Maintenance Tasks	4 years	12 years
Design Service Goal	20 years	30 years

Higher residual value on 2nd hand market

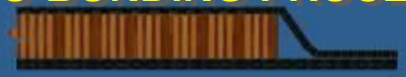
- Major airlines renew fleets every 6-8 years
- Composite repairs / re-build without patches

Manufacturing principles for Sandwich Structures

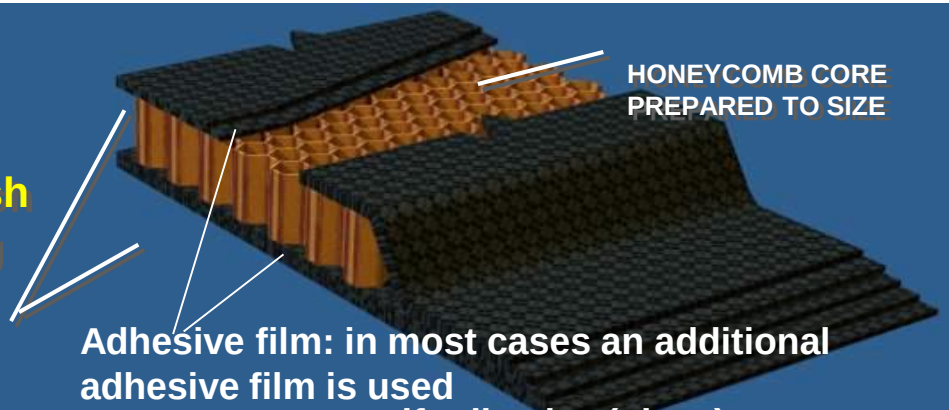
SINGLE SHOT PROCESS

Outer skin fresh
Inner skin fresh
Bonding to the core while curing

CO-BONDING PROCESS



Outer skin cured / Inner skin fresh
Bonding to the core while curing

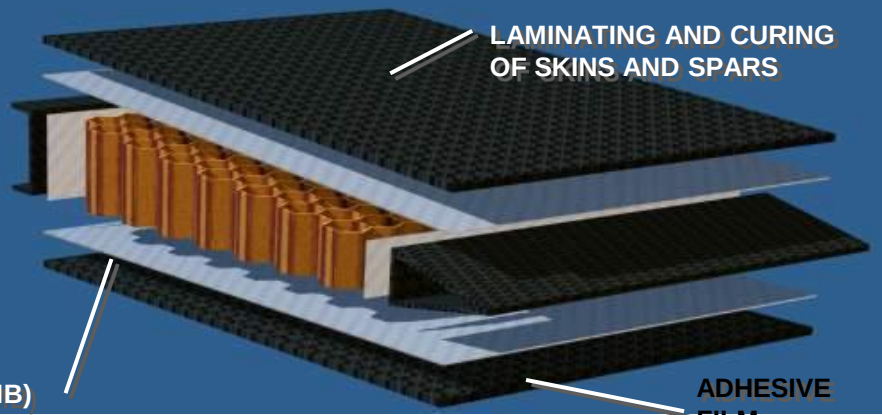


SKIN MADE WITH LAYERS OF FABRIC OR TAPE (CARBON, ARAMID OR GLASS)

Adhesive film: in most cases an additional adhesive film is used
alternative=> self-adhesive (glass) prepreg between skin and core (one layer)

MULTIPHASE PROCESS

Inner skin cured
Outer skin cured
Bonding to the core



MACHINING TO SIZE AND PREPARATION OF HONEYCOMB)

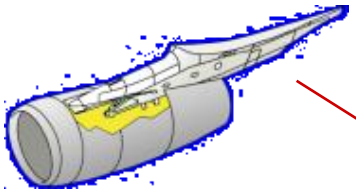
Manufacturing principles for Sandwich Structures

- **Single Shot advantages**
  - Best bonding behaviour
  - Reduction of part count
  - One cycle
  - Lighter (weight optimised)
- **Co-bonding advantages**
  - Good structural behaviour
  - Less complex tooling
  - Possibility of supply cured parts; simplify work.
  - Easy manufacture
- **Multiphase advantages**
  - Good structural behaviour
  - Allows storage of parts
  - Optimised lay-up
  - Avoid water ingress

- **Single Shot disadvantages**
  - Limited pressure for core, risk of porosities
  - Water ingress
- **Co-bonding disadvantages**
  - Two cycles
  - Additional quality control required
  - Use of consumables & set up time
  - Addition of adhesive plies increases the weight and quality control of bonding
  - Water ingress “limited” on one side
- **Multiphase disadvantages**
  - Manufacturing tolerance
  - Two cycles
  - Control of form required between component interface

Sandwich Structures Applications example on A380 –

- ✓ Large used on Movables, Fairings, Landing gear doors, radome, nacelle



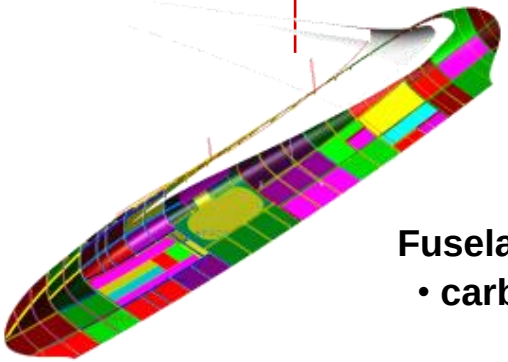
Nacelles &Pylon Aft Secondary Structure Access Panels
- **carbon fiber/epoxy skins**

Empennage Leading Edges

Floor panels
- **carbon fiber/epoxy skins**

Spoilers/ Ailerons

Nose Gear Doors:
- **carbon fiber/epoxy skins**

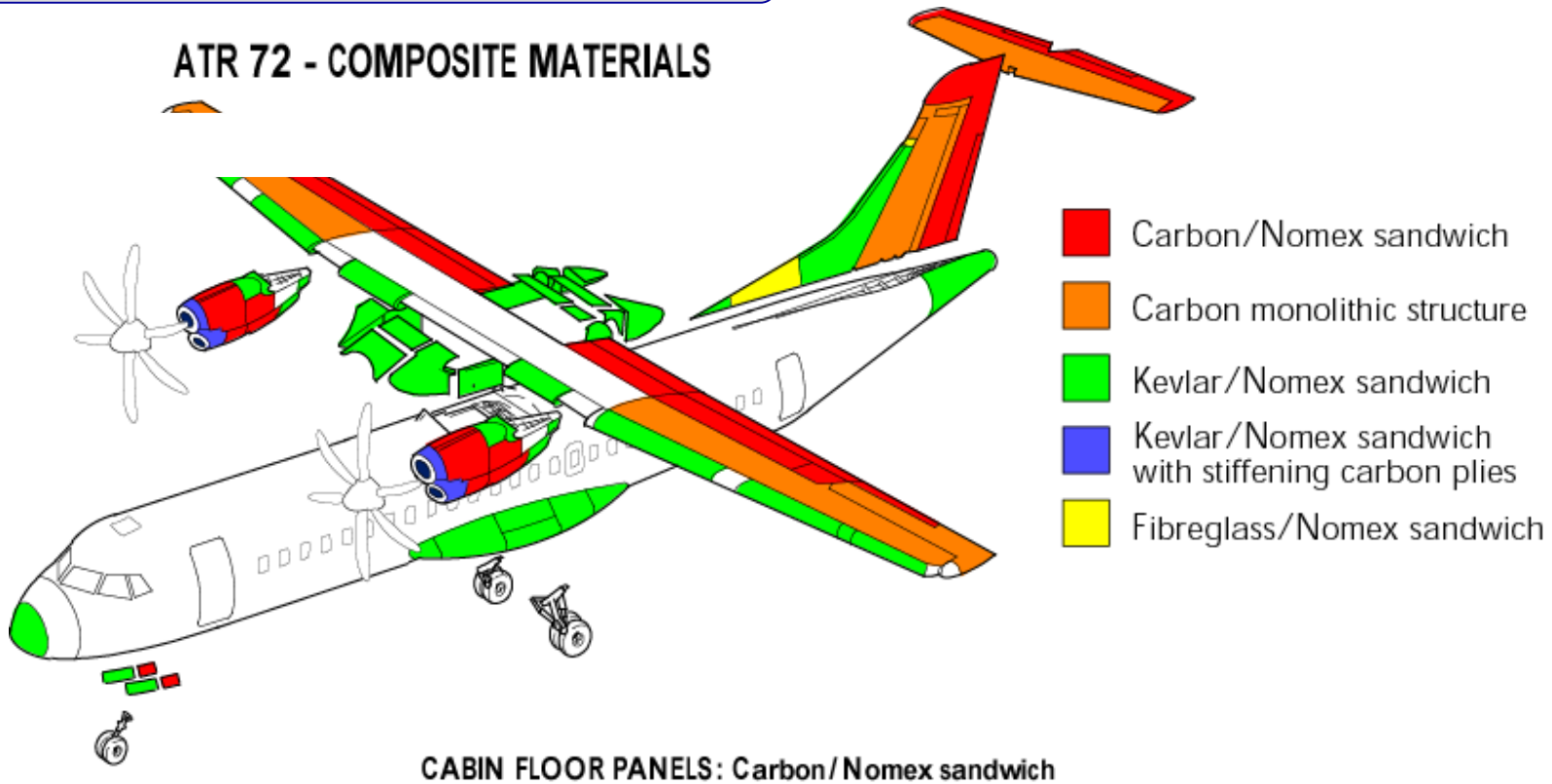


Flap Track Fairings
- **carbon-glass fibers/epoxy skins**

Fuselage Belly Fairing
- **carbon fiber/epoxy skins**

Sandwich Structures Applications example on ATR –

ATR72 Composite applications

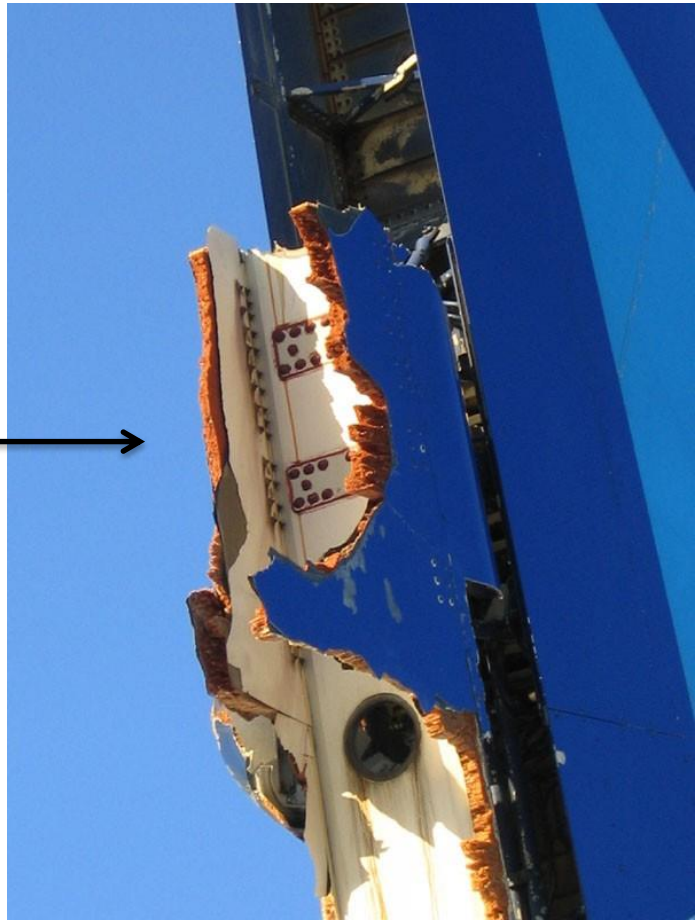


Successful implementation since 1988, on Movables

In Service Experience

Sandwich Rudder (2005)

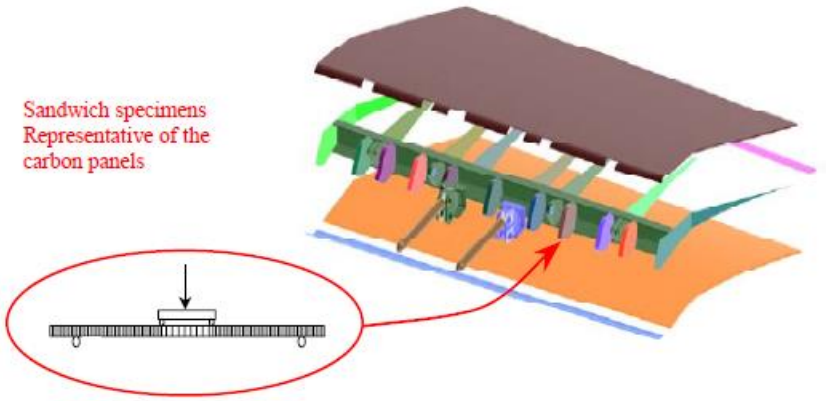
Bonded joint failure



➔ Key to establish design /manufacturing standards

Sandwich structure
Typical design validation (1/3)

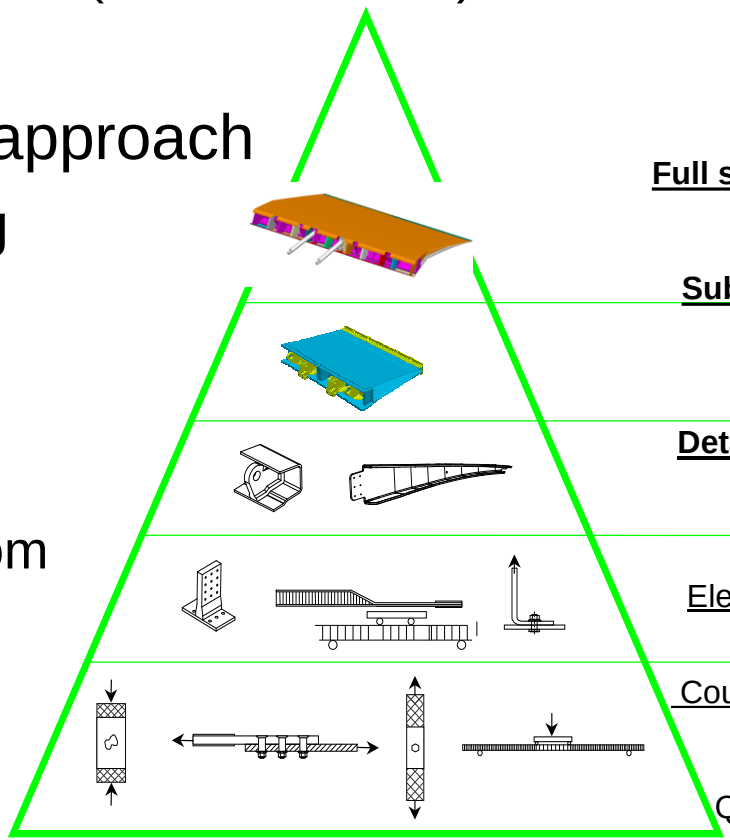
- Sandwich structures (PSE) compile with CS 25.603, 25.605 and AMC 20.29 for Manufacturing process validation
- Design values:
  - Check of design allowable for change of curing cycles (pressure),
  - Influence of telegraphing, wrinkling,(co-cured face sheets)…
  - Honeycomb core buckling, shear…
- Bonding quality
  - Compatibility tests, adherence tests flatwise tension or climbing drum peeling test
  - Tightness test by immersion in hot water (potentially for new technologies)



Sandwich structure
Typical design validation (2/3)

- Sandwich structures (PSE) compile with CS 25.603, 25.605 and AMC 20.29 for Manufacturing process validation
- Quality control plan :
  - Process control specimen time limited for new technologies, check on process robustness. (adherence test)
- Typical building block approach
  - Static&fatigue loading
  - Wet aging at details
  - Impact damage
    - Lightning, hail strike
    - Impact calibrated from

    In service survey



Full scale test : static and fatigue

Sub Component : partial box demonstrator

Details : Weak stitched hinge, thermoplastic box ribs

Elements : Angles, stitched T specimens, sandwich

Coupons :

Allowable : HTS, HTA,

Qualification : HTS, HTA,

Sandwich structure
Typical design validation (3/3)

- Typical building block approach
  - Large scale test to support compliance to CS25.307
  - Good correlation of FEM analysis
  - Static & fatigue loading
  - No EKDF at Full scale level

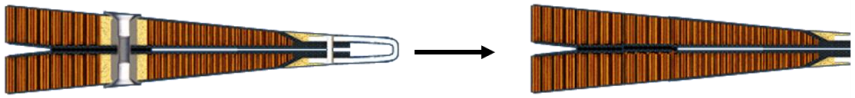
A380 Landing gear door

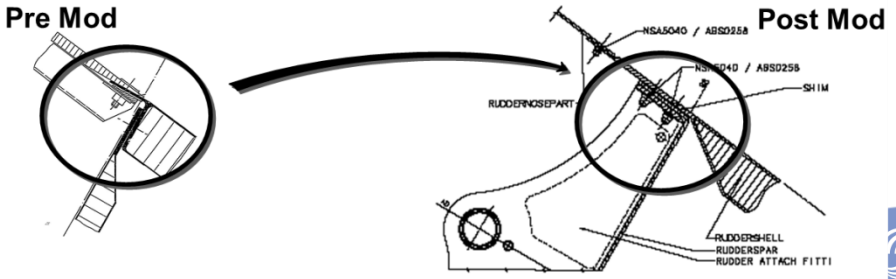
Pre-test case PR2 (Closed door - ΔP=130mbar) – 19/05/2006

Sandwich structure
In service experience /maturity

- Wide use of sandwich technologies on PSE parts since 30 years with more than 185 million flight hours reached with very good in-service behaviour (on A320 spoilers, LR Ailerons..)

- Experience with sandwich structures has revealed some weak points, most notably a lack of water tightness.
  - Mainly due to design (elevators, rudder).
  - Design improvements
    - External Surfacer: two layers of adhesive
    - Remove Lightning strap replaced by Bronze mesh
    - Remove the TE Insert, fastening in core
  - SRM improvements





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