CASE STUDY

COMPOSITES IN AEROSPACE – CASE STUDIES

Abstract

A workshop on Living with Composites - Lessons Learnt in the Use of Composites on Aerospace and Marine Structures

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Narendhar Rao S.

Technical Lead Composites and Knowledge Based Engineering Infosys Ltd.

Dr. Ravi Kumar G. V. V.

Group Technical Consultant Product Life Cycle and Engineering Solutions Infosys Ltd.

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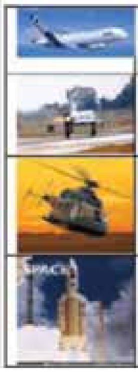
Contents

Composites in Aerospace Industry

- Key factors influencing the usage of composites:



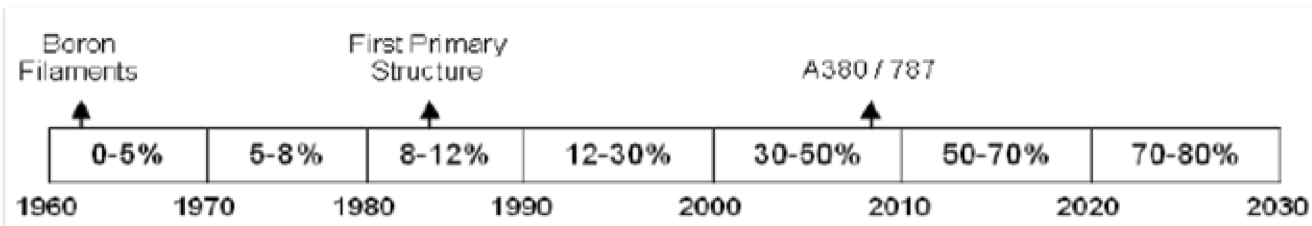
Civil Aircraft	Structural performance, Cost, Safety, Regulation compliance
Military Aircraft	Structural performance, Weight, Assembly and maintenance
Helicopters	Multi function design, superior fatigue properties
Space Application	Light weight design, low response to thermal variations

Composites

Materials for the Present & Future

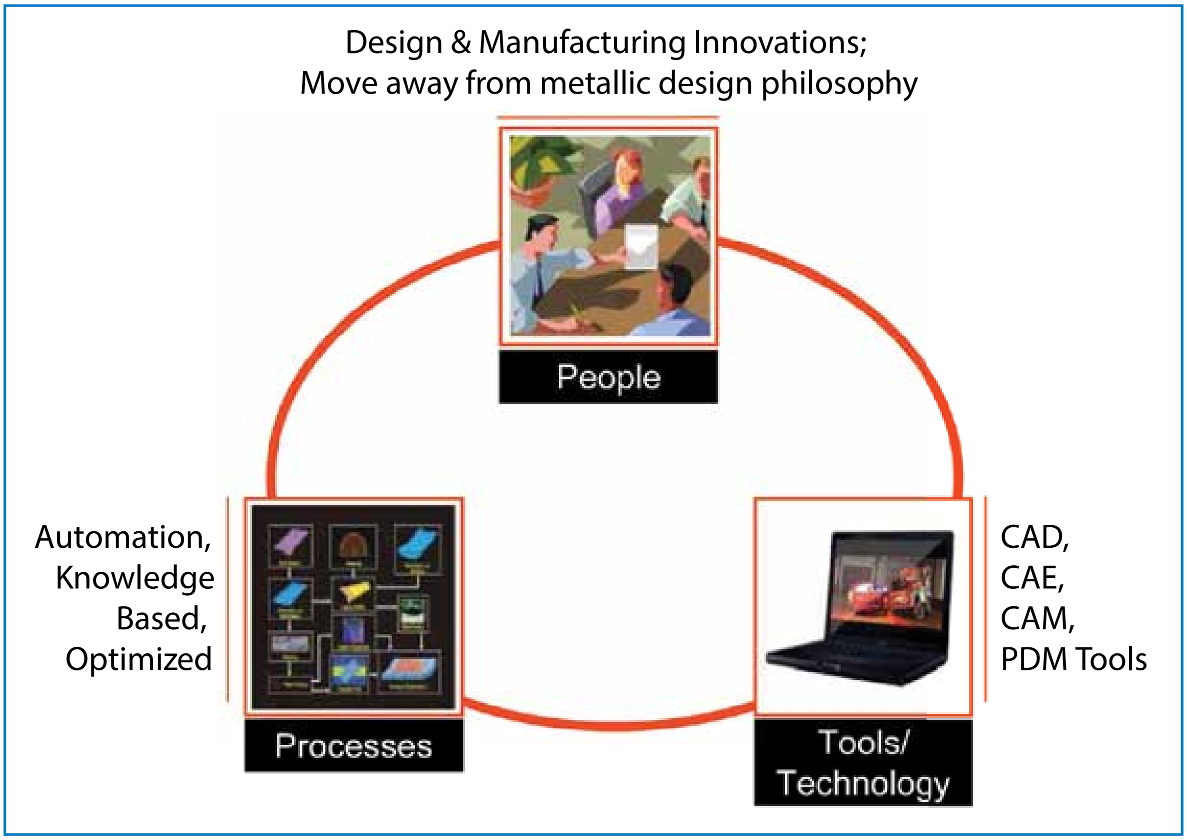
- High Specific Strength & Stiffness
- Directional tailoring capabilities
- Co-cured Co-bonded technology
- Amenable for advanced manufacturing processes
- Superior fatigue properties
- Reduced Cost of Ownership

- Composites usage over the years in Commercial Aircraft Industry



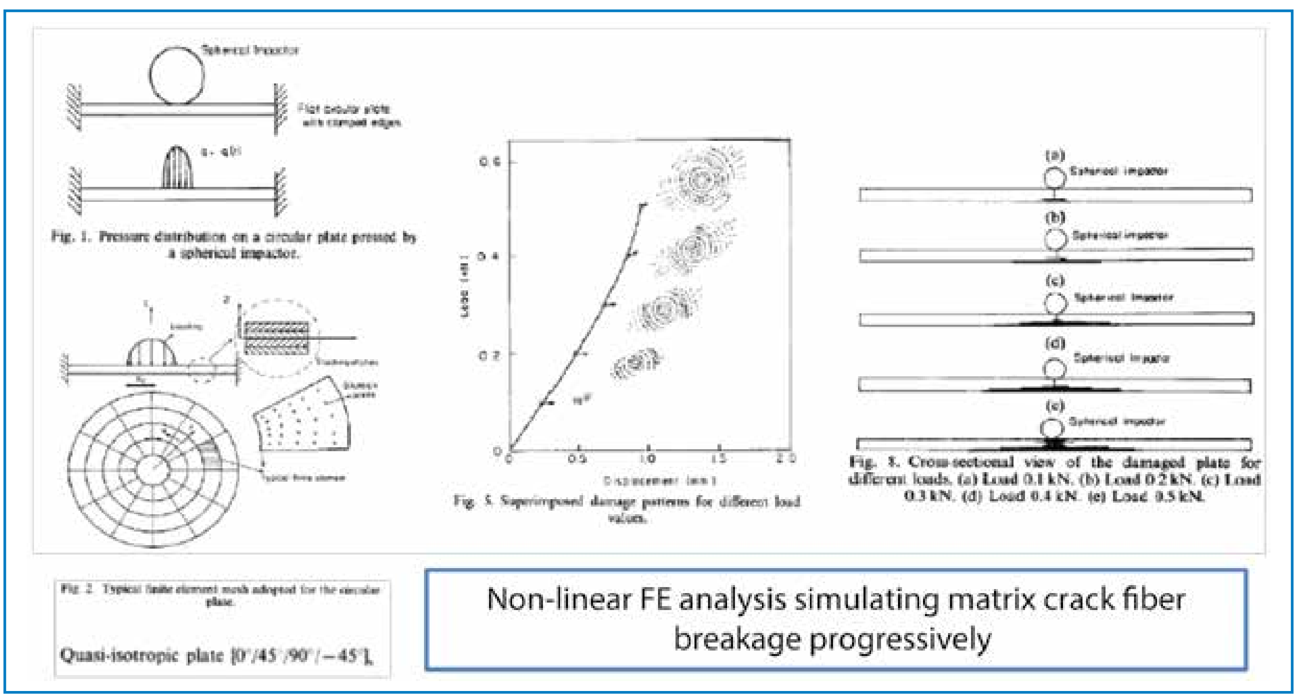
Focus is on Affordability, Safety, Ease of Maintenance and Comfort

Key Enablers for Composites Growth



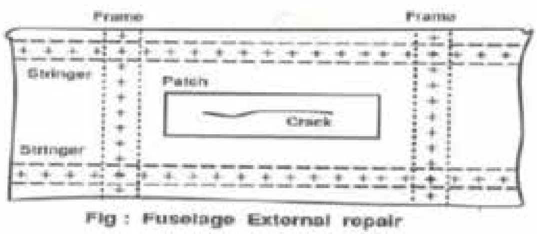
FE analysis to Estimate Damage & its Growth

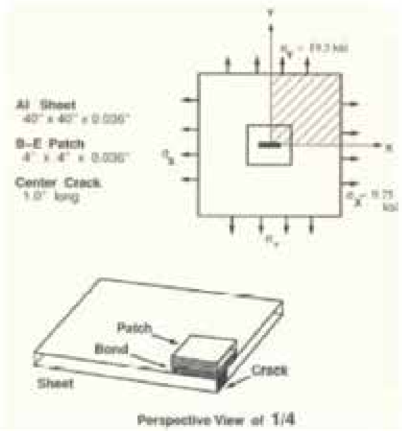
- **Objective**
  - To estimate damage and its growth under low velocity impact – Debris hit or tool drop

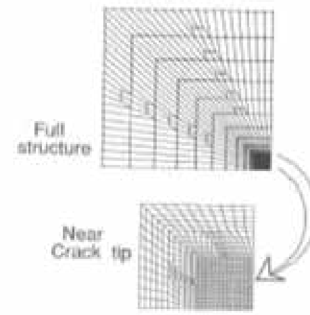


FE analysis to Estimate Damage & its Growth

- **Objective**
  - To assess the effectiveness of the repair through FE analysis

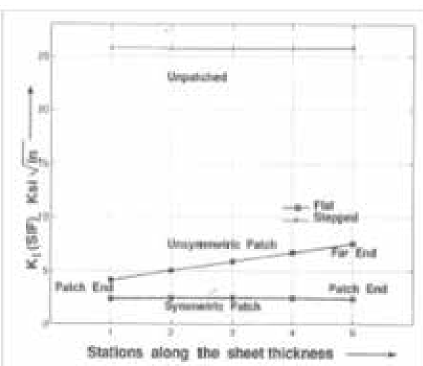


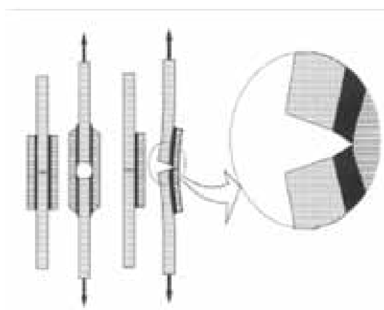




- FE analysis
- 8 Noded 3D bricks - Cracked sheet 4 element layers, Adhesive 3 element layers
- Geometric Non-linearity, Linear material
- SIF by displacement extrapolation computed using modified crack closure integral (MCCI)
- Patch effectiveness is ratio of residual life with patch to residual life without patch

FE Analysis for Computational Repair Assessment (contd..)

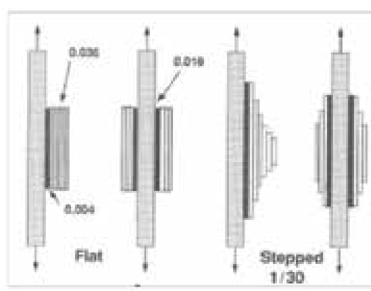




Un-symmetric patch repair causing out of plane bending

- Symmetric stepped configuration gave less SIFs and gave better results

		Stress Intensity Factors (SIF)					
		Ply 1	Ply 2	Ply 3	Ply 4	Ply 5	Ply 6
Configuration I**	Symmetric - Flat	4	4	4			
	Symmetric - Step	4.348	3.988	3.628			
Configuration II**	Unsymmetric - Flat	4	4	4	4	4	4
	Unsymmetric - Step	4.852	4.492	4.132	3.772	3.412	3.052
** Maintaining Same patch volume= 0.576 cubic-inch							



Finite Element Analysis can predict damage & assess repair

Airbus Lateral Wing Box Stringer Development

Project Scope:

Design support for Airbus lateral wing box composite upper cover stringer development; Stringer & Skin – Non-crimped fabric

Challenges:

Co-cured and co-bonded technology

Consideration of maintenance issues during design

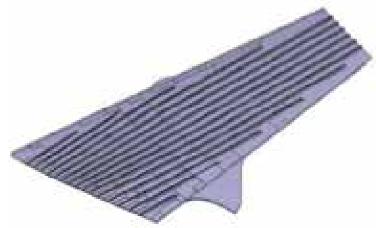
Cost of ownership

Mass production

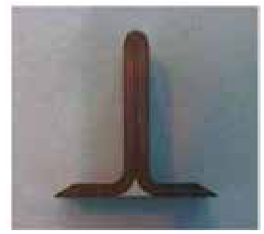
Lessons Learnt:

Need for design automation reducing the development time and improved quality

Bridging the technology gaps between Lab to production



Composite wing cover



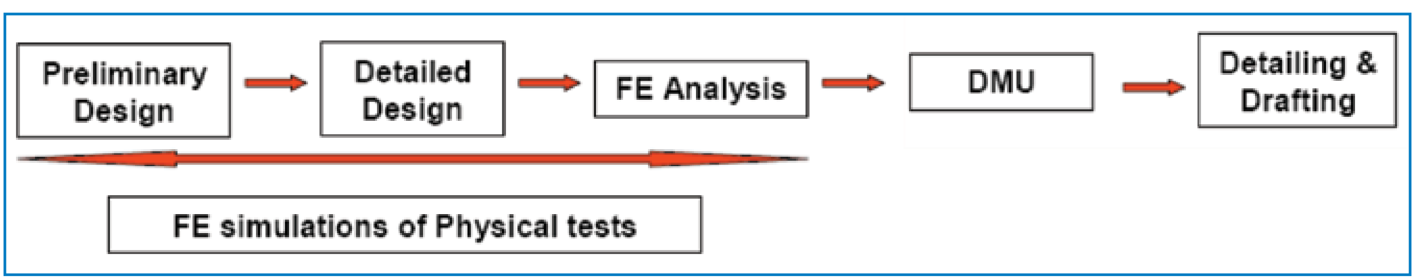
Roll Formed Stringer

Design of composite rib spar interfaces

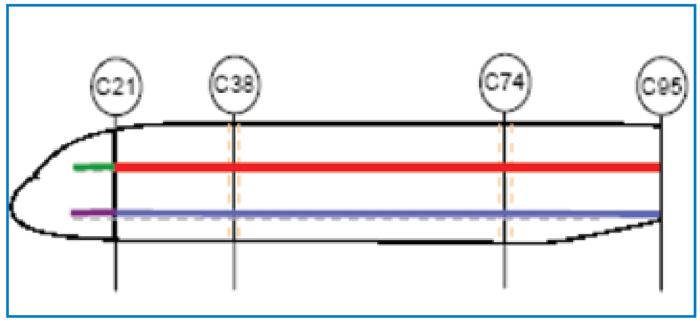
- **Project Scope:**
  - Design support for Airbus lateral wing box composite upper cover stringer development; Stringer & Skin – Non-crimped fabric
- **Challenges:**
  - Co-cured and co-bonded technology
  - Consideration of maintenance issues during design
  - Cost of ownership
  - Mass production
- **Lessons Learnt:**
  - Need for design automation reducing the development time and improved quality
  - Bridging the technology gaps between Lab to production

Composites Sandwich Floor Panel Design for A380F

- **Project Scope:**
  - To provide design and analysis support on composites sandwich floor panels of A380 freighter through US aerospace supplier. This includes design of floor panels and their connecting sheets for both upper and main decks involving:



- **Lessons Learnt:**
  - Conflicting design requirements
  - Stringent weight targets
  - Optimization based on engineering judgment
  - Innovation is the Key
  - Reuse of Knowledge
  - Automation tools and utilities are necessary
  - Mechanisms to handle huge design data
  - FE simulations with limited material data



Design of nose wheel well doors

- **Project Scope:**
  - Design of composite sandwich doors for nose wheel well along with hinges and mechanisms for 787 aircraft through US supplier. The scope includes preliminary design, analysis (FE & Analytical) and detailed design (IDP & FDP).
- **Challenges:**
  - Complex skin and cores configurations
  - Complex loading conditions
  - Many design, stress and manufacturing constraints
  - Complex design procedures and guidelines
  - Stringent time schedules
  - Stringent weight constraints
- **Lessons Learnt:**
  - Company specific design procedures and guidelines
  - Need for automation through state of the art tools and utilities
  - Limited material test data
  - Continuous load and design changes

Knowledge based process improvements in wing skin

Automation in flat pattern and manufacturing data generation

- **Project Scope:**
  - Flat pattern and manufacturing data generation for spars, fin, test boxes, ribs, wing skin, fin skin, fuselage panels, nozzle flaps, air intake ducts of combat aircraft involving:
  - Modeling the manufacturing plies and the tool surface within CADDS-Composites.
  - Generation Flat pattern of tool surface and the manufacturing plies on tool surface.
  - Automatic generation of flat allocation data on all the flattened plies
  - Automatic nesting of all the tape cut-pieces and printing the nested cut-piece information onto a file for manufacturing interface
- **Lessons Learnt:**
  - Need to use composites tools
  - Automation is a key

Tools Used:

- CADDS5, AUTOLAY(CADDS-COMPOSITES)

Infosys Resources/Tools Role in Other Leading Composites programs

Indian LCA

Design & Development
Wing & Fin skins
Fuselage bulkheads
, Fuel tanks
Cockpit, Sandwich floors

HANSA

Design & Development
Composite panels of composite two seat aircraft, complied JAR/VLA requirements

CADDS-COMPOSITES in AIRBUS

A380: Central torsion box, ailerons, floor panels
TANGO: Central torsion box, aileron
A340: Keel beam, fin

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