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Modular Joints for Aircraft Composite Structures

March 31st 2011, Madrid

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March the 31st 2011, Madrid
Overview

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- MOJO: Objectives
- MOJO: Strategy
  - Task 1: Preforming
  - Task 2: Infusion & Assembly
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  - Task 4: Simulation
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MOJO: Partners

1. - EADS Deutschland GmbH
   Germany: Ottobrunn, Manching and Augsburg

2. - Biteam AB
   Sweden: Bromma

3. - SECAR Technology GmbH
   Austria: Mürzzuschlag-Hönigsberg

4. - Kungliga Tekniska högskolan Stockholm
   (Royal Institute of Technology)
   Sweden: Stockholm

5. - University of Patras UP
   Greece: Patras

6. - Vyzkumny a Zkusebni Letecky Ustav a.s.
   (Aeronautical Research and Test Institute, Plc.)
   Check Republic: Prag
MOJO: Partners

7.- Dassault Aviation  
France: Saint Cloud

8.- Eurocopter Deutschland GmbH  
Germany: Ottobrunn

9.- EADS - Innovation Works France  
France: Suresnes

10.- Societe Anonyme Belge de Constructions Aeronautiques  
Belgium: Brussels

11.- Deutsches Zentrum für Luft und Raumfahrt (German Aerospace Center)  
Germany: Braunschweig and Stuttgart

12.- Co-operative Research Center for Advanced Composite Structures Limited  
Australia: Melbourne
MOJO: Objectives

Scope of MOJO was to provide synergy between:

- preform technology
- low cost resin infusion, and
- structural adhesive bonding for a specialised composite material design without fasteners

Technical objective was to develop a material driven composite design philosophy, new structural design principles, in order to fully utilise fibre related advantages, thus resulting in weight savings.
MOJO: Strategy

- Introduction of a modular design concept using advanced preforms and textile methods for 3D reinforcement in combination with bonding by means of a demonstrator structure.

- The principle of MOJO laid in the design of CFRP joining elements for pure shear load transfer.

- The activities were complimented with an effects-of-defect research task in order to assess structural consequences of most common manufacturing faults and in-service damages.
MOJO: Strategy

- The mechanical performance of Modular Joints were determined with an extensive testing program according to the Rouchon pyramid (building block approach).

Representative structure testing definition

- to test a structural assembly displaying all the isolated features characterised separately earlier in the test program

Sub element testing definition

- to test an article focused on joint fittings onto other reinforcement elements including bonding methods and profiles tested previously

Assembled panel testing definition

- to produce assembled panels properties with the studied configuration profiles

Individual join element testing definition

- to produce join element properties with woven profiles

Basic material properties testing definition

- to produce basic materials properties of adhesives and composite and evaluate process parameters
Task 1: Preforming
MOJO: Preforming
- Preforming using compacting techniques

Redirection of NCF tapes & Positioning

Compacting

Fixed Preform
MOJO: Preforming & 3D- Reinforcements

- Analysis for different types of connections, 3D-reinforced joints, and design concepts, altering the failure mode - hence improving the mechanical performance.
MOJO: 3D-Woven profiles

- From the scientific point of view the focus is laid on the application of especially 3D-Woven preforms in order to alter the failure mechanism in favour of higher limit loads and overall improved mechanical performance.
Task 2: Infusion & Assembly
MOJO: Infiltration
- RTM, VAP and VARI-process (Vacuum assisted resin infusion)

Pi-profile

Cross section of Pi-profile

L-Profiles
MOJO: Infiltration
- by means of pultrusion
MOJO: Adhesive bonding
- Structures bonded with film adhesive
- Structures bonded with paste adhesive
Task 3: Quality assurance & Effect-of-Defects
MOJO: Quality Assurance

- Basically by means of NDT and Tolerance/Assembly management
MOJO: Effect of Defects

- NDT, mechanical behaviour and simulations
Task 4: Simulation
MOJO: Support adhesive bonding process &
on Woven structures

- Insertion Squeeze flow process optimisation

- 3D-Woven structures
MOJO: Failure analysis on different structure level testing
Task 5: Demonstrators
MOJO: Demonstrator

- One-shot PAX-Door Demonstrator (Fubacomp); 2004

- Reference Structure for MOJO: Quarter Element for Preform-Studies

ALCAS / MOJO Shear concentration profile
MOJO: Industrial Applications and Demonstrator choice
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MOJO: Damage tolerant and structural bonded demonstrator

Disbonding at 7-8mm at many locations
MOJO: Damage tolerant and structural bonded demonstrator

- The demonstrator passed successfully the sequence of tests dealing with limit load, fatigue test until 200000 Cycles, limit load and ultimate load

- The disbonding area in the Pi has propagated and stopped during fatigue testing.
Thank you for your attention

See the Flap Track demonstrator at Booth 18

Thank to all partners and the European Commission