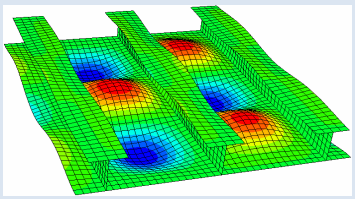
GARTEUR GROUP FOR AERONAUTICAL RESEARCH AND TECHNOLOGY IN EUROPE

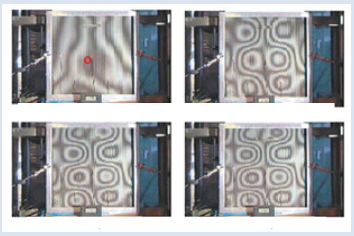
FRANCE GERMANY ITALY THE NETHERLANDS SPAIN SWEDEN UNITED KINGDOM

A GARTEUR SUCCESS STORY
DAMAGE MECHANICS, DAMAGE TOLERANCE, BOLTED JOINTS IN COMPOSITE MATERIALS/STRUCTUES

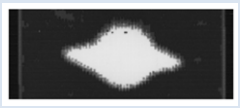
Composite materials, if properly used, offer many advantages over metals. Examples of such advantages are: high strength and high stiffness-to-weight ratio, good fatigue strength, corrosion resistance and low thermal expansion. Nevertheless, conventional composites made of pre-impregnated tape or fabric also have some disadvantages, such as poor transverse properties, inability to yield and sensitivity to moisture and high temperatures, which must be accounted for in the design. Due to the poor transverse properties composite structures are very sensitive to out-of-plane loading such as impact loading, local bending and in bonded and bolted joints. The understanding of and ability to predict damage initiation and damage growth is therefore very important. Improper design of composite structural elements and joints may lead to structural problems or conservative design leading indirectly to overweight structures and high life-cycle cost of the aircraft.



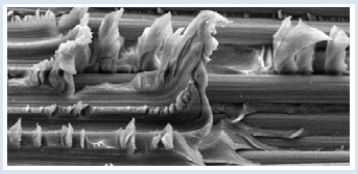
Analysis



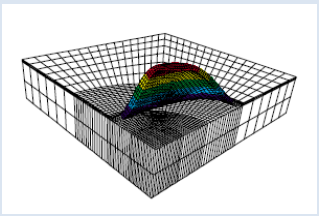
Testing



NDI



Fractography



Damage growth prediction

The pioneering research activities on damage mechanics, damage tolerance and bolted joints in composites started within GARTEUR and were later followed by more application oriented projects within EU FP4 and FP5 as well as within WEAG (Western European Armament Group). The following GARTEUR Action Groups are related to the above subject:

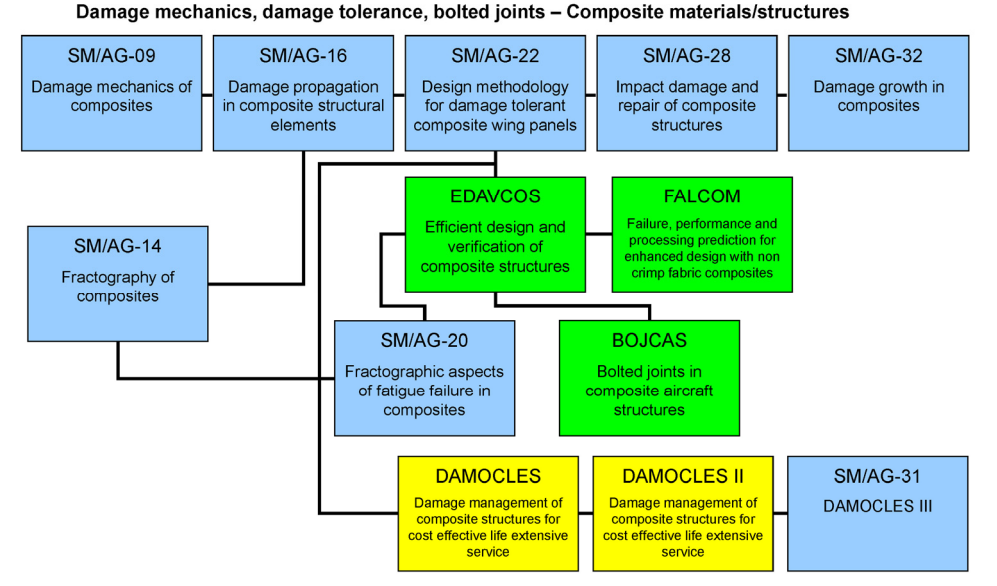
SM/AG-09 Damage mechanics of composites (1986-1994)
SM/AG-14 Fractography of composites (1991-1995)
SM/AG-16 Damage propagation in composite structural elements (1993-1998)
SM/AG-20 Fractographic aspects of fatigue failure in composites (1994-2001)
SM/AG-22 Design methodology for damage tolerant composite wing panels (1997-2001)
SM/AG-28 Impact damage and repair of composite structures (2002-2007)
SM/AG-31 DAMOCLES III (2006-2011)
SM/AG-32 Damage growth in composites (2006-2011)

In combination with the GARTEUR Action Groups noted above three related EU FP4 and FP5 projects were performed as follows:
EDAVCOS - Efficient Design And Verification of COmposite Structures (1998-2001)
BOJCAS - BOlted Joints in Composite Aircraft Structures (2000-2003)
FALCOM - Failure, performance and processing prediction for enhanced design with non crimp fabric composites (2001-2005)

Furthermore two related projects were initiated within the WEAG military framework (predecessor of EDA):

DAMOCLES - Damage management of composite structures for cost effective life extensive service
These projects performed as DAMOCLES I and DAMOCLES II (1999-2005) were followed up by the GARTEUR SM/AG-31 DAMOCLES III (2006-2011).

The figure below illustrates how all these projects are interlinked.



The above activities are documented in numerous technical reports and conference publications. Most of them can be found as references in the open GARTEUR reports available at the “Structures and Materials” part of the GARTEUR website.

In summary it can be stated that the joint European knowledge in Damage Mechanics, Damage Tolerance and Bolted Joints in composites, has largely been built up over the past decades through national efforts coordinated via GARTEUR Action Groups. The GARTEUR activities have led to other European projects within EU Framework and WEAG (predecessor for EDA) programmes. There is no other organisation in Europe where such a collective effort is done for this topic.