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loaded structures, degradation models, improved slow and fast computation tools for statically loaded structures as well as design guidelines, which take skin stringer separation and material degradation into account. The experimental data base is indispensable for validation of the analytically developed degradation models, which will be implemented into the new tools, and for verification of the computed results as well. Reliable fast tools will allow for an economic design process, whereas very accurate but necessarily slow tools are required for the final certification.

Although, with respect to loads and characteristic dimensions, this project is oriented towards an application in the fields of fuselage structures, the results will be transferable to other airframe structures as well. With the new design guidelines the European aircraft industry will have a tool at its disposal, which substantially contributes to the objectives of reducing development and operating costs, by 20 % and 50 % in the short and long term, respectively. That provides the chance for decisive improvements in competitiveness of future European aircraft.

The traditional aircraft design can be replaced by an advanced procedure including degradation models for composite structures. One main benefit of the application of the new tools and design guidelines will be a considerably reduced structural weight at safety not impaired. In addition, the developed tools also reduce the design and analysis time by one order of magnitude and thus, they substantially improve response-to-market time of industrial developments.

Table 1 · **Participants**

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Improved MATerial Exploitation at Safe Design of COmposite Airframe Structures by Accurate Simulation of COllapse

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INTRODUCTION

The project COCOMAT (Improved MATerial Exploitation at Safe Design of COmposite Airframe Structures by Accurate Simulation of COllapse) is a Specific Targeted Research Project within the 6th Framework Programme (No. AST3-CT-2003-502723) and will run for 4 years (2004-2007).

European aircraft industry demands for reduced development and operating costs, by 20 % and 50 % in the short and long term, respectively. The COCOMAT project contributes to this aim by reducing structural weight at safe design; it exploits considerable reserves in primary fibre composite fuselage structures by accurate and reliable simulation of collapse. Collapse is specified by that point of the load-shortening curve where a sharp decrease occurs thus limiting the load carrying capacity.

COCOMAT is fully based upon the results of the finished Fifth Framework project POSICOSS (Improved POstbuckling SImulation for Design of Fibre COmposite Stiffened Fuselage Structures) which developed improved, fast and reliable procedures for buckling and postbuckling analysis of fibre composite stiffened panels of future fuselage structures, created experimental data bases (cf. Figure 1) and derived design guidelines (www.posicoss.de).

The COCOMAT project extends the POSICOSS results and goes beyond by accounting for degradation. That requires knowing about degradation due to static as well as low cycle loading in the postbuckling range. It is well-known that thin-walled structures made of carbon fibre reinforced plastics are able to tolerate repeated buckling without any change in their buckling behaviour. However, it has to be found out, how deep into the postbuckling regime one can go without severely damaging the structure, and how this can be predicted by fast and precise simulation procedures. This issue is dealt with by COCOMAT.

PROJECT OBJECTIVES

COCOMAT mainly strives for accomplishing the large step from the current to a future design scenario of stringer stiffened composite panels demonstrated in Figure 2. The left graph illustrates a simplified load-shortening curve and highlights the current industrial design scenario. Three different regions can be specified. Region I covers loads allowed under operating flight conditions and is bounded above by limit load; region II is the safety region and extends up to ultimate load; region III comprises the not allowed area which reaches up to collapse. There is still a large unemployed structural reserve capacity between the current ultimate load and collapse. The right graph of Figure 2 depicts the design scenario aspired in future, where ultimate load is shifted towards collapse as close as possible. Another main difference to the current design scenario is that the onset of degradation is moved from the not allowed region III to the safety region II due to reliable simulation of collapse. This is comparable to metallic structures where plasticity is already permitted in the safety region. However, it must be guaranteed that in any case the onset of degradation must not occur below limit load. Moreover, the extension requires an accurate and reliable simulation of collapse, which means to take into account degradation under static as well as under low cycle loading, in addition to geometrical nonlinearity.

PARTICIPANTS

The COCOMAT consortium (cf. Table 1) merges knowledge from 5 large industrial partners (AGUSTA from Italy, GAMESA from Spain, HAI from Greece, IAI from Israel and PZL from Poland), 2 partners belonging to the category of Small and Medium Enterprises (SAMTECH from Belgium and SMR from Switzerland), 3 research establishments (DLR from Germany, FOI from Sweden and CRC-ACS from Australia) and 5 universities (Politecnico di Milano from Italy, RWTH Aachen and University of Karlsruhe from Germany, TECHNION from Israel and Technical University of Riga from Latvia).

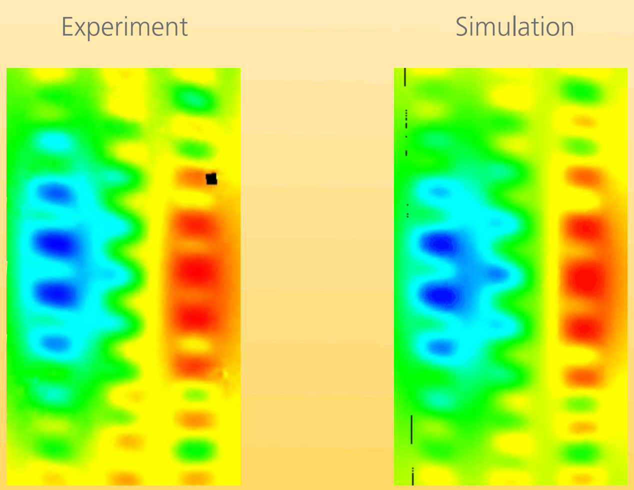

Figure 1 · **Out-of-plane deformations of one tested POSICOSS panel**

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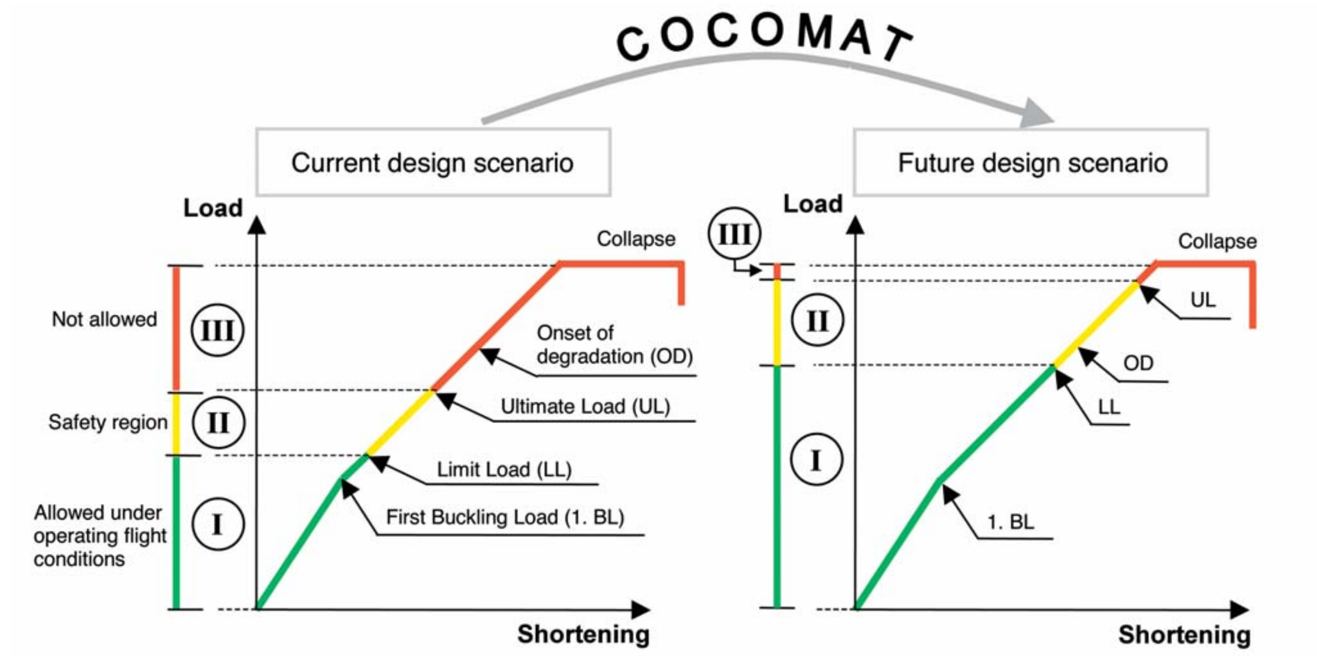

Figure 2 · **Current and future design scenarios for typical stringer stiffened composite panel**

DESCRIPTION OF WORK

The partners co-operate in the following six technical work packages:

- Benchmarking on collapse analysis of undamaged and damaged panels with existing tools: Knowledge of the partners is compared and the deficiencies of existing software are identified.
- Material characterisation, degradation investigation and design of panels for static and cyclic tests: Material properties are characterized, degradation models are developed and test panels are designed as to the requirements of research in order to overcome the deficiencies.
- Development of improved simulation procedures for collapse: Slow certification and fast design tools are developed and validated by the tests.
- Manufacture, inspection and testing by static and cyclic loading of undamaged panels: The experimental data base is extended by testing of undamaged panels.
- Manufacture, inspection and testing by static and cyclic loading of pre-damaged panels: The experimental data base is extended by testing of pre-damaged panels.
- Design guidelines and industrial validation: All project results are assembled and final design guidelines are derived. The tools are validated by the industrial partners.

Industrial partners bring in their experience with design and manufacture of real shells; research partners contribute knowledge on testing and on development of simulation tools. Design guidelines are defined in common, and the developed tools are validated by the industrial partners.

EXPECTED RESULTS AND BENEFITS

The project results will comprise a substantially extended data base on material properties and on collapse of undamaged and pre-damaged statically and cyclically