THE POSICOSS PROJECT

Reduction of weight by about 20 % in 10 years without prejudice to costs and structural life is one main objective for the design of the next generation of aircraft structures. A possible contribution to cope with that demand for fuselage structures is to use CFRP material and - for components subjected to compression or shear - to permit postbuckling until ultimate load at the same time. Of course, only local buckling and postbuckling with small deformations will be permitted. To go into the postbuckling regime requires improved, fast and reliable procedures for analysis and design of stiffened fibre composite panels.

The European Commission was funding within its 5th Framework Programme the project POSICOSS, which copes with the above mentioned demand to design fibre composite fuselage structures for postbuckling under ultimate load. POSICOSS means 'Improved POstbuckling SImulation for Design of Fibre COmposite Stiffened Fuselage Structures'. The project started on January 1st, 2000, and run until the end of September 2004. It merged knowledge and capabilities of seven partners from industry and research: The German Aerospace Center (DLR) - which also acted as co-ordinator, AGUSTA from Italy, IAI from Israel, the Politecnico di Milano (PTM) from Italy, the Technical University of Riga (RTU) from Latvia, the Technical University RWTH Aachen (RWTH) from Germany, and the TECHNION from Israel.

The main objective of the work done was the development of improved, fast and reliable procedures for postbuckling analysis and design of fibre composite stiffened panels of future fuselage structures. They are unconditionally needed, because so far postbuckling calculations were extremely time consuming and as such not applicable for design. Another substantial objective was the creation of comprehensive experimental data bases for the purpose of validation.

The partners co-operated in six technical work packages:

- Benchmarking for postbuckling and collapse analysis: This work was performed in order to collect existing benchmarks for software evaluation purposes, as well as to identify in detail the abilities and deficiencies of the tools available.

- Design of stiffened, fibre composite verification structures: The objectives and constraints were mainly defined in view of the requirements from benchmarking according to the shortcomings of existing tools and benchmarks. For designing, material properties have to be known. Hence the required properties were characterized by coupon testing for the fibre composite materials used.
- Manufacturing and testing of verification structures: The objective was to extend the data base for evaluation of improved software tools by results of buckling tests until collapse. A total of 32 verification structures were manufactured and inspected non-destructively. The tests were carried out with shortening control, thus enabling control of how far to go into the postbuckling regime. Different loading conditions were applied (compression, torsion or shear, and critical combinations of them). In general, a basic problem in testing as reference to computations is, that the material properties realized in the structure may vary from those found by coupon testing. Thus efforts were taken to identify material properties as they had been realized in the verification structures.
- Development of improved simulation procedures and preliminary design guidelines: New tools for postbuckling simulation were developed and existing ones for metallic structures were modified. These tools as well as general purpose Finite Element tools then were used for parametric studies in order to derive preliminary design guidelines for stringer stiffened fibre composite panels.
- Design, analysis, manufacture, inspection and testing of fibre composite industrial panels: The industrial panels were designed in regard to pure industrial aspects, to being best for application as part of real industrial structures, thus taking full advantage of experience of the industrial partners. At the end, 19 test structures were manufactured, inspected and tested here.
- Design guidelines for stiffened fibre composite panels: Existing experience and practice of industry, as well as the lessons learned from the project work, were combined in order to carry out final design guidelines.

The project comprises four essential technical results: Material properties, test results for buckling and postbuckling of stiffened CFRP panels and cylinders, improved simulation procedures for buckling and postbuckling of stiffened fibre composite panels, and design guidelines for stiffened fibre composite panels. More details on the POSICOSS project can be found at the website http://www.posicoss.de/.

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 behavior. However, it has to be found out, how far loading can go into the postbuckling regime, because - in order to get the objective of substantial weight reduction - collapse load has to be shifted as close as possible to ultimate load. Structural degradation might have happened before collapse, and consequently not only the geometrical nonlinearity as primarily dealt with in POSICOSS has to be considered, but also the onset of degradation and its effect on postbuckling. Prediction of this by fast and precise simulation procedures will be the main topic of the POSICOSS follower project COCOMAT, http://www.cocomat.de/, which started in January 2004 and will run until the end of the year 2007.