How to determine the safety of medium-sized composite structures submitted to multiaxial loadings?

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Context
The development and certification of aeronautical composite structures is still largely based on the “Pyramid of Tests” in which the number of experimental tests reduces gradually as the size and the complexity of the specimen increases. This approach is extremely costly in terms of number of tests and design loops. Moreover, this is made up of uniaxial tests whereas the real structures are mostly subjected to combined forces. The aim of the collaborative research program VERTEX is to make progress towards “Predictive Virtual Testing” and to significantly reduce the development costs of aeronautical and space programs.

OBJECTIVE
Reduce the number of experimental tests needed to determine the safe domain of composite structures under multiaxial loadings

1 Numerical simulations

Failure loads (red stars) are numerically determined for different combinations of loads (tension/shear and compression/shear).

1 Discrete Ply Model [1]

The “Envelope Curve” is performed with the help of the multiaxial test rig. A coefficient is applied to the failure loads numerically determined (red stars) and an homothetic load curve is applied (green line).

2 Multiaxial test rig

The « Envelope Curve » is performed with the help of the multiaxial test rig. A coefficient is applied to the failure loads numerically determined (red stars) and an homothetic load curve is applied (green line).

References

Conclusion
With the combination of a high fidelity model to predict the composite failure and a multiaxial test rig, it is possible to determine the safe life domain of a medium sized composite structure with a unique test.