Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: STRMAT
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Type: Oral
Status of corresponding author: Regular
For student corresponding author: student member of one of the following:
3AF / AAAR / AIAE / AIDAA / CzAeS / DGLR / FTF / NVvL / PSAA / RAeS / SVFW / EUROAVIA

Title

Experimental validation of aircraft fuselage sections by testing at the stiffened panel level

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The paper discusses a reliable, high versatility, cost efficient approach for performing full-scale fuselage panel testing and validation of the respective novel materials and stiffening design concepts, as well as the way to confidence enhancement in computational models towards safer and more light-weighted aircraft designs. A methodology to mature low-cost testing technologies for demonstration of the structural integrity of representative aircraft fuselage panels in representative static and fatigue loadings, for the next generation Aircrafts is presented.

In order to mature up to Technology Readiness Level 6 the environmentally friendly manufacturing and surface treatment technologies developed in the metallic materials technological stream of Clean Sky 2 'ecoTECH' project [1], a high versatility, cost efficient approach for performing full-scale fuselage panel testing and validating the respective novel materials and stiffening design concepts are required. The new manufacturing technologies include Friction Stir Welding for the replacement of riveting and mechanical milling for the replacement of chemical milling. The above mentioned methods are combined with new surface treatments like the Chromium free anticorrosive surface treatments, developed and performed by Hellenic Aerospace Industry, Thin film Sulphuric Acid Anodizing and AC131 sol gel developed with a totally free Cr preparatory steps of cleaning and etching, and a totally Cr free post treatment step of Sealing after the anodizing. The basic anticorrosive surface treatments are combined with a new Chromium free primer, developed and industrialized by AKZO NOBEL with the commercial name: Aerolith CF Primer 2210, and water based top coat.

The steps to scale-down the experimentation at the stiffened panel level and provide the opportunity to validate state-of-the-art designs at higher rates than previously attainable are presented in the present paper, as part of Clean Sky 2 project Demonstrate [2]. The proposed methodology comprises the development of a test bench and its application for the execution of static tests on advanced metallic curved integrally stiffened full-scale panels, representative of a business jet fuselage structure; and the execution of an endurance test on an integrally stiffened 4th generation Al-Li curved panel, under a realistic load spectrum representative of the aircraft mission profile. The design of the rig and the experimental process are supported by validated multi-scale simulation models, focusing on the predictions of static, buckling and post buckling deformations, as well as on the crack initiation and damage growth. The virtual testing methodology was used for the definition of the stiffened panels boundary and loading conditions, such that they are fully representative of the

aircraft full-barrel fuselage in-flight loading conditions. It can be concluded from the performed research activities, that the development of the innovative, cost-efficient, and easily adaptable to a wide range of curved panel lengths and curvatures fuselage panel full-scale test bench concept, has been proven capable to introduce the desired representative boundary / loading conditions and successfully validate the novel manufacturing and surface treatment processes.

References

[1] https://www.clean-aviation.eu/material-gain-clean-skys-ecotech-innovative-eco-friendly-airframe
[2] https://www.horizon-demonstrate.eu/

Acknowledgments

This study was funded by the European research program Clean Sky 2, specifically ‘ecoTECH’ and ‘DEMONSTARTE’ projects.
The ecoTECH project has received funding from the European Union Horizon 2020 Clean Sky 2 Joint Undertaking under the AIRFRAME ITD grant agreement 945521.
This research has received funding from the Clean Sky 2 Joint Undertaking under the European Union’s Horizon 2020 research and innovation program under grant agreement No 101007881 (under the call H2020-CS2-CFP11-2020-01): DEMONSTRATE ‘Demonstration of Novel Fuselage Structural Integrity‘