SPARE Project Newsletter #3
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"Full scale innovative composite pax and cargo floor grids for regional Aircraft Fuselage barrel on-ground demonstrators"

Dear Reader,
*the **SPARE team** welcome you to the 3rd edition of our **Newsletter** that will be published during the project duration. The main goal of this newsletter is to introduce the project in more details and to provide you with an overview of its progress, as well as to establish a continuous communication with stakeholders and end-users.*
29 months after the official launch, the project is now progressing at full speed to reach its ambitious objectives.
*The full details about the project can be found on the project website at **www.spare-project.eu**.*

Should you have any questions, comments or suggestions on SPARE feel free to contact us at: info@spare-projects.eu.

Thank you for your time and enjoy reading.
The SPARE communication team

SPARE AT GLANCE

SPARE stands for **"Full scale innovative composite pax and cargo floor grids for regional Aircraft Fuselage barrel on-ground demonstrators"**. It is a 38-month Clean Sky 2 funded project started in October 2018.

LEONARDO (founding member of the Clean Sky JTI and member of Clean Sky 2 programme) is the Topic Manager of the project. SPARE is coordinated by OMI Srl in collaboration with CETMA.

SPARE project aims to manufacture full-scale passenger and cargo floor grids made using carbon fibre-reinforced thermoplastic (TP) composites.

The highly automated production comprises progressive roll forming and induction welding for assembly. The objective is to reduce weight and recurring costs compared to traditional metal and thermoset composite solutions.

The composite floor grids will be assembled into the Clean Sky 2 regional aircraft fuselage demonstrators for on-ground testing and will be evaluated for technical and economic impact as well as flame resistance performance per FAR 25.583 regulations.

PROGRESS

SPARE-project addresses the manufacturing of 2 full shipsets of pax and cargo floor grids for regional Aircraft Fuselage barrel on ground demonstrators using thermoplastic resin reinforced with carbon fiber.

Manufacturing technologies (i.e. Progressive Roll Forming, or Continuous Compression Moulding and Induction Welding) with a high potential for automation have been investigated.

Continuous Compression Moulding (CCM) is a process used to fabricate thermoplastics composites of various shapes and sizes in a semi-continuous manner. In this manufacturing process, a “strip” of prepreg moves in a rectangular duct and is heated by ceramic infrared heaters. At the end, the duct opens up in a greater cavity in which pressure is applied by two heating rotating metallic rollers. The limits of CCM process are: i. the unknown temperature on material; ii. the weight of the process parameters on the temperature; the uncertainty about product quality.

Thanks to **numerical simulation**, monitoring via **infrared thermography**, and **induction welding**, the CCM process was upgraded, ensuring savings in terms of production costs, reduction of waste and a higher level of automation.

CMM process simulation

To simulate the process, a numerical model has been set up to reproduce the thermal field inside the prepreg during the heating phase up to the point where pressure is applied to induce consolidation on the material. Physics phenomena involved in the heating of the prepreg strip are included in the numerical model. The numerical simulation was used to analyze the heating process and verify its uniformity in order to identify the best configuration to obtain uniform heating. The model could be further improved after the installation of an on-line system for the monitoring of the process.

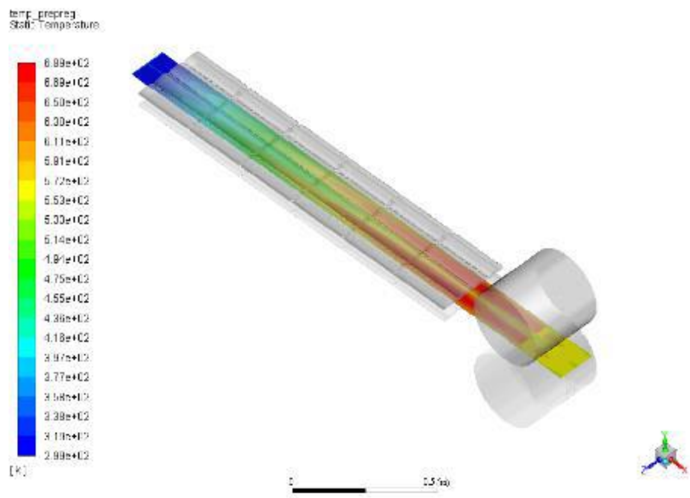

Figure 1 CFD model results - Temperature on prepreg

Real time monitoring of process temperature by InfraRed Thermography (IRT)

Process temperature monitoring can improve process knowledge and increase product quality. IRT was used to continuously monitor the temperate of the laminate at the entrance and exit of the compaction zone and to measure the process temperature and its degree of uniformity.

A thermographic procedure for monitoring the process temperature to be used during the continuous forming process on thermoplastic matrix composites was developed. The procedure developed, which can be integrated into the production process itself, is able to monitor the process temperature allowing to act on the production parameters, so as to guarantee a constant and adequate temperature during the process. The results of the experimental tests conducted have allowed us to evaluate the influence of some process parameters such as: temperature set by thermocouples, drag speed and compaction force on the average temperature trend on the belt being processed.

- **Induction Welding (IW) tools**

In order to create the pax and cargo floors, object of the project, it is necessary to build the beams with H and T section in thermoplastic composite. IW of thermoplastic composites for the manufacturing of H-Shapes can ensure high mechanical properties, high efficiency and reliability together with high flexibility and good applicability at an industrial level.

In the IW process, the material is heated by means of a high-frequency alternate magnetic field generated by an induction coil. The main disadvantage of the IW technique applied to composite materials is the difficulty to optimize the temperature distribution through the thickness of the joint and to avoid, for example, too high temperatures on the surface directly exposed to the induction coil and near the edges of the joint (due to current concentration by “point effect”). CETMA developed and patented a new machine for continuous welding of advanced composite materials with the integration of a new control and tuning system to allow optimized temperature distribution for different materials and geometries to be welded.
In addition, the cooling process is adjusted by a software unit and the temperature on the upper surface of the joint is controlled by means of a thermo-camera. Moreover, the full automation of the welding process is possible because the surface temperature and the cooling velocity are controlled by the software.

The setup of the IW process has been completed, the optimized IW process parameters have been identified and a specific tool has been created for welding beams with different cross sections using a high degree of automation.

Figure 2 View of the induction welding equipment developed by CETMA

PROJECT NEXT STEPS

The **validation of the temperature monitoring system**, already tested, will be used to monitor a continuous extended process to identify the operating temperatures once the production parameters have been optimized.

Induction Welding will be performed on the components for the construction of the beams for the two floors using the parameters already identified and the **assembly of the two floors** will take place by the topic leader of the project.

Finally, a **technical-economic analysis will be performed.** The new solutions developed in the project will be compared with existing baseline technologies in order to point out advantages and disadvantages in terms of cost and performance. For this reason, all recurring and non-recurring costs, associated to a business case, will be investigated both for manufacturing and assembly phase.

NEWS

OPEN ACCESS PUBLICATION

You may read our paper "*SPARE project – improvement of continuous compression moulding process for the production of thermoplastic composite beams*" on the journal's website (LINK).

CLUSTERING ACTIVITIES

SPARE and TOD projects at 10th EASN Virtual International Conference. The latest research results of SPARE and TOD projects, both funded by Clean Sky Joint Undertaking under the European Union's Horizon 2020 research and innovation programme, have been showcased during the Labor Technical Workshop.

SPARE's website, in clustering section, hosted a new Clean Sky project, DEWTECOMP (DEvelopment of innovative Welding systems for structural joints of ThErmoplastic matrix-based COMPosites). Read more about it HERE.

PAST EVENTS

10th EASN Virtual International Conference - Labor Technical Workshop (3rd September 2020)

The latest research results of SPARE project have been showcased during the Labor Technical Workshop.

The Workshop was a virtual event of the 10th EASN International Conference on "Innovation in Aviation & Space to the Satisfaction of the European Citizens" that was held on September 3rd 2020 and was aimed at presenting some of the most recent technological advances in manufacturing, assembly and inspection of aerostructures.

Below the title of the presentation that has been given during the Workshop by SPARE speaker:

SPARE project – improvement of continuous compression moulding process for the production of thermoplastic composite beams by Riccardo ANGIULI (CETMA). Download the presentation!

The Workshop ended with a final panel discussion involving all stakeholders of the design, manufacturing and assembly processes of the regional aircraft of the future.

You can find a more detailed description of the workshop HERE.

CONSORTIUM PARTNERS & ROLES

OMI is the project coordinator of SPARE and works in Aerospace Industry since over thirty years, by consolidating supply relationships and collaborations with major national industries for production of parts and equipment. Read more…

CETMA is a Research and Technology Organization which carries out applied research, experimental development and technology transfer in the field of advanced materials (composites, polymers, bio-based and recycled), ICT (development of specialized software for engineering, manufacturing and services) and product development. Read more…

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