WING BOX TECHNOLOGY EVALUATION

TRADE-OFF STUDY FOR THE RANKING OF NEW TECHNOLOGIES BEST FITTING WING

WINGTECH_EVALUATION

PUBLISHABLE SUMMARY

Clean Sky Research and Technology Development Projects

JTI-CS-2010-1-GRA-01-033

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PUBLISHABLE SUMMARY

The overall strategy of the work plan follows a logical progression, whose objective is to satisfy the call text requests: the projects activities have been divided into ***4 Work Packages*** (WPs) that lead to the production of the expected project results:

- ***WP1*** devoted to the development of a baseline model of the advanced wing box stub, which constitute the necessary reference for the following design activities;
- in ***WP2*** different variants be developed to analyse the impact of the considered structural modifications on the overall performances of the system: the implementation of Multi-Objective Optimization methodologies is here meant to allow the determination of the best suitable system parameters, within the framework of their variability range and of the existing technological constraints (agreed with the Call for Proposal proponent).
- ***WP3*** bring to the completion of the trade-off study, by allowing the individuation of the most promising technical solutions: the usage of Multi Criteria Decision Making techniques support the final evaluation and selection phase.

the completion of the research project also require minor (but still essential) management activities, which have been grouped into ***WP4***: the management of the project allow the project staff to monitor the progression of the research tasks, to efficiently employ the human and economical available resources and to continuously keep in touch with the CfP proponent.

WORK PACKAGE NUMBER 1: BASELINE FE MODEL DEFINITION

A wing box is defined from a general master structure with global configuration reported in **Fig. 1**.

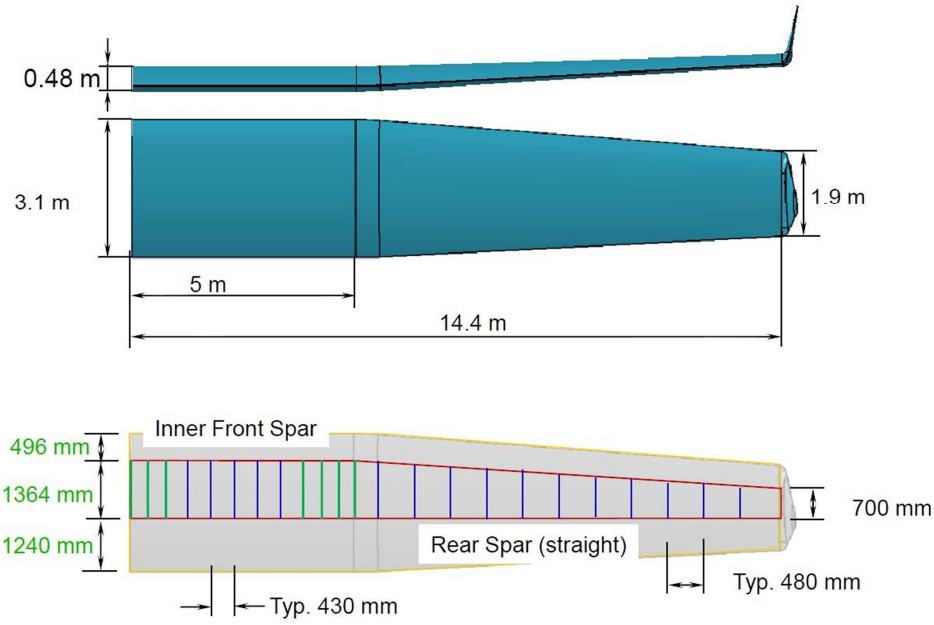

Fig. 1: General wing box configuration

In **Fig. 2** the geometrical model, with removed upper panel, is shown: it is possible to see the result of ribs construction and distribution.

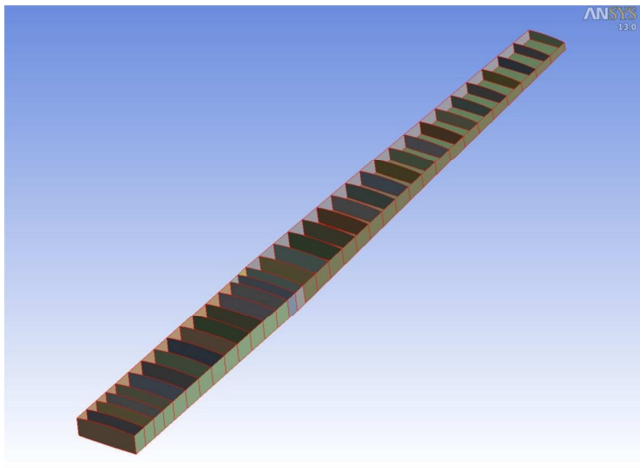

Fig. 2: Rib geometrical reproduction

WORK PACKAGE NUMBER 2: EVALUATION OF THE MODELS VARIANTS

In WP1 different type of possible designs variants were highlighted:

- geometrical variants: rib plan and stringer spacing;
- section definition (typically section of stringer);
- material definition;
- ply definition for composite material;
- applied load.

Variants considered in WP2 are summarized in Tab. 1

	Material	Rib plan (# of bay)	Stringer spacing	Stringer section	Ply definition	Types Load
Baseline	metallic	34	105	J	-	L1 - L7 (1)
Variants	metallic	34 , 31 , 29	105 - 150 (2)	J , T , Z	-	L1 - L7 (1)
	composite	34 , 31 , 29	105 - 150 (2)	J , T , Z	P1 , P2, P3	L1 - L7 (1)

NOTE: (1) To evaluate figures of merits for different designs, governing load conditions can be reduced to two (L1, and L5).
(2) Lower panels have different stringer spacing dependent from spacing in upper panel.

Tab. 1: WP2 Analyzed Variants

WORK PACKAGE NUMBER 3: SELECTION OF THE MOST PROMISING SOLUTION

From the global analyses of the results aimed to the identification of the optimal solution, metal configurations have been discarded due to their high weight.

By the ongoing analyses of failure criteria it has been possible to define modification of bays with critical behavior leading to composite configuration form C15 to C26 (having the ply set-up of type

"P3") that provide the best structural response; the optimal solutions has then been confined to composite designs C15 to C26.

For all the configurations the set of relevant results to be analyzed has been generated(*):

- Weight,
- Deflection at tip(*),
- Axial force graphs
- Maximum and minimum strain contour maps
- Tsai-Wu criteria maps

An example of generated results is attached below (referring to design C15).

> *(*)All generated results together with corresponding FE input files have been uploaded on the project portal (file C15_C26_results.zip).*

From the inspection of the results performed by the Cfd proponent, it has been found that the configuration providing best performances is the C15: it provides the lowest weight and almost lowest tip deflection and satisfy all safety assessments vs. buckling and composite failure.

Configuration C15 is actually undergoing the conversion from Ansys format to Nastran format: this task is covered by the WP3 of the project.

A Linear static analysis of the refined model under the given **load 1** Condition (1.5 times basic loads) is performed with *Nastran* to evaluate maximal displacements at tip.

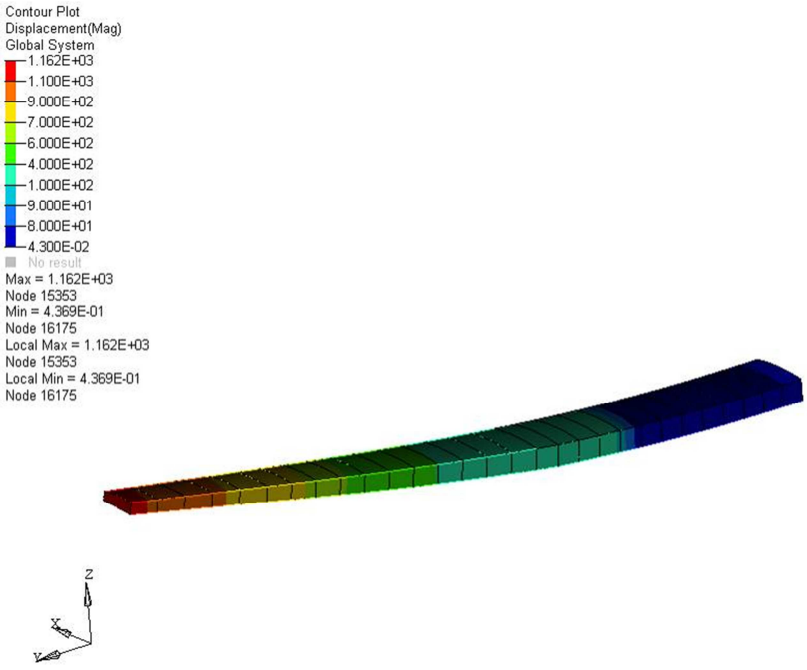

Fig. 3: Tip deflection-load1