Assessment of efficient BEM/FW-H methodologies for the preliminary design of counter rotating open rotors

A. Visingardi, D. Casalino & M. Barbarino
CIRA, the Italian Aerospace Research Center

P. Caccavale, G. Petrone & C. de Nicola
University of Naples ”Federico II”

Motivations

- In the framework of Green Regional Aircraft ITD of the “Clean Sky” JTI, pre-design architectural studies have to be conducted by AleniaAeronautica (e.g. CROR installation optimization – aerodynamics & aeroacoustics).

- CIRA is supporting this activity through a preliminary method assessment.

- This activity has been started in September, therefore only very preliminary results are presented, the main outcome being the assessment of two BEM codes, one belonging to CIRA (**RAMSYS**) and one to the University of Naples (**PaMS**).

- The aeroaacoustic potentialities of these “low-order” aerodynamic methods have been explored by using the CIRA FW-H code ***Opty∂B.***

Concluding remarks & outlook

- Due to the different wake formulations (vortex lattice / vortons) and the different simulation of the wake/body interactional process, different noise levels have been predicted.
- The noise differences are high at small observation angles with respect to the rotor axis, where the loading noise is dominant, and tend to vanish at observation angles approaching 90 deg, where the thickness noise is dominant.
- A preliminary consistency study have been conducted with RAMSYS, showing that a minimum of 2 deg azimuthal step angle is required for aeroacoustic purposes.
- Surprisingly, up to 13% difference in the CROR thrust prediction has been obtained. Further consistency studies are required (space & time).
- At the present stage it is not possible to establish which code is more accurate, but the vorton model requires a lower time resolution ($\Delta\Psi$=5 deg) than the vortex lattice model ($\Delta\Psi$=2 deg) to obtain qualitatively similar solutions.
- **Even though both codes have potentialities for the optimization of the engine installation, a deeper validation activity is required. Both experimental and URANS data will be used for the validation purposes.**
- The carpet representation of FW-H results is the best way to study the aeroacoustic behaviour of a CROR.
- The RAMSYS code is 99% vectorial and has reached is asymptotic performances, while the PaMS code can be improved using MPI and accelerating techniques (e.g. Fast Multipole Method).