GARTEUR GROUP FOR AERONAUTICAL RESEARCH AND TECHNOLOGY IN EUROPE

FRANCE GERMANY ITALY THE NETHERLANDS SPAIN SWEDEN UNITED KINGDOM

HC/AG-22: Forces on Obstacles in Rotor Wake

Action Group Chairman: Antonio Visingardi (a.visingardi@cira.it)

Background

Helicopters are largely employed in missions within “confined areas”, regions where the flight of the helicopter is limited in some direction by terrain or by the presence of obstructions, natural or manmade. Rescue operations, emergency medical services, ship-based rotorcraft operations are some examples of near-ground and near-obstacle operations. A helicopter sling load is another, yet particular, case of obstacle subjected to forces produced by its interaction with the rotor wake. Once airborne a sling load comes under the influence of aerodynamic forces and moments associated with its size, shape, mass, and transport speed.

The wind conditions, the distance of the helicopter from the obstacles, the space between the obstacle and the height of the helicopter from the ground are the main factors due to which the wake generated by the obstacle may result in: (a) high compensatory workload for the pilot and degradation of the handling qualities and performance of the aircraft; (b) unsteady forces on the structure of the surrounding obstacles.

These forces are of aerodynamic nature and arise from the interaction between the wake induced by the rotor and the airflow around the obstacles. The intensity of the interaction increases with the proximity of the rotor to the ground and/or the obstacles.

A bibliographic research, performed during the Exploratory Group HC/EG-32 “Forces on Obstacles in Rotor Wake”, highlighted that there is a general lack of:

- experimental databases including the evaluation of the forces acting on obstacles when immersed in rotor wakes;
- both numerical and experimental investigations of the rotor downwash effect at medium-to-high separation distances from the rotor, in presence or without sling load.

Programme/Objectives

Objectives

The principal objective of HC-AG22 is then to promote activities which could contribute to fill these gaps. This will be accomplished by investigating, both numerically and experimentally:

- primarily, the effects of the confined area geometry on a hovering helicopter rotor from the standpoints of both the phenomenological understanding of the interactional process and the evaluation of the forces acting on surrounding obstacles;
- secondarily, the downwash and its influence on the forces acting on a load, loose or sling, at low to high separation distances from the rotor disc.

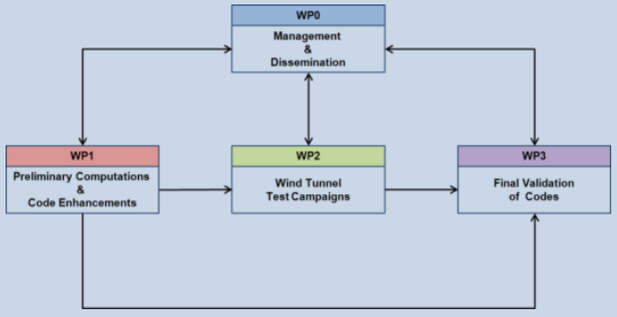
The timescale for the project is three years during which the following activities are planned:

- application and possible improvement of computational tools for the study of helicopter rotor wake interactions with obstacles;
- set-up and performance of cost-effective wind tunnel test campaigns aimed at producing a valuable experimental database for the validation of the numerical methodologies applied;
- final validation of the numerical methodologies.

The know-how acquired by the HC/AG-17 about the wake modelling in the presence of ground obstacles, would be capitalized and would set-up the basis for this new research activity.

The work programme is structured in four work packages:

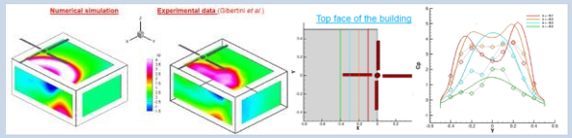
- WP0 – Management & Dissemination: is aimed at the fulfilment of all the obligations concerning the project management and the dissemination of the results;
- WP1 – Preliminary Computations & Code Enhancements: deals with a preparation phase during which partners are involved in literature review and preliminary computational activities;
- WP2 – Wind Tunnel Test Campaigns: concerns the performance of the following four wind tunnel test campaigns:
  1. HOGE/HIGE rotor with a loose/sling load (CIRA);
  2. HIGE rotor in proximity to a well-shaped obstacle (ONERA);
  3. HIGE rotor in proximity to an obstacle in windy conditions (PoliMi);
  4. HIGE rotor in proximity to an obstacle without wind (Univ. Glasgow).
- WP3 – Final Validation of Codes: is aimed at the final validation of the numerical tools proposed by partners.

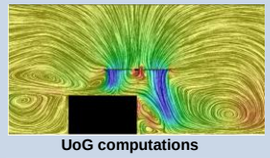


Results

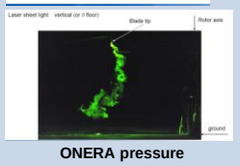
The action group started the activities in November 2014.

Improvements of the computational codes are on-going at CIRA, DLR and NTUA. Univ. Glasgow has performed first calculations in hover conditions providing an overall good correlation with PoliMi existing database of a rotor hovering in proximity to a cubic obstacle.

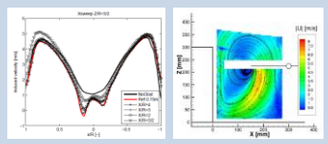




UoG computations



ONERA pressure measurements & visualizations



UoG LDA & SPIV measurements

The Univ. Glasgow and ONERA wind tunnel test campaigns have been almost completed. The PoliMi wind tunnel test campaign is on-going, while the CIRA wind tunnel test campaign is in the preparation phase.

Members of the HC/AG-22 group are:

A. Visingardi	CIRA
F. De Gregorio	CIRA
T. Schwarz	DLR
R. Bakker	NLR
S. Voutsinas	NTUA
J.B. Paquet	ONERA
G. Gibertini	Politecnico di Milano
G. Barakos	University of Glasgow
R. Green	University of Glasgow

GARTEUR Responsable:

K. Pahlke	DLR

CIRA Centro Italiano Ricerche Aerospaziali · DLR · NLR · ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ · ONERA THE FRENCH AEROSPACE LAB · POLITECNICO MILANO · University of Glasgow