
Study and characterization of wear and heat phenomena, for metallic and composites aircraft structural materials, during emergency landings

Tovignon Devo*^{1,2}, Arnaud Beaurain¹, Didier Joly², Eric Deletombe², and Yannick Desplanques¹

¹LaMcube - Laboratoire de Mécanique Multiphysique Multiéchelle – Université de Lille, Sciences et Technologies, Ecole Centrale de Lille, Centre National de la Recherche Scientifique : FRE2016 – France

²Onera - The French Aerospace Lab – DMAS ONERA – France

Résumé

Aviation is one of the safest public transport means today. To reach such a performance, aircraft safety mainly relies on experience feedbacks and a set of constantly evolving rules which concern the flying products and operations. This also works for emergency landings or crash situations wherein the aircraft "belly" is directly in contact with the runway. For this purpose, a four years research project (PHYSAFE) funded by the French DGAC started in August 2015. Part of the research aims at experimentally studying and characterizing various phenomena which may have a noticeable influence on aircraft passengers' safety in case of emergency landing or crash. Among these experimental studies, the development of test means and facilities to characterize the dynamic wear behavior of aircraft primary structure materials once in contact with the ground was selected as being of common interest for aircraft and rotorcraft airframes.

The part of the PhD work to be presented is notably focusing on the study and characterization of wear and heat phenomena, for metallic and composites aircraft structural materials (reference materials: Au2024, T700/M21) during emergency landing situations. It aims at estimating (through "pin on disc" tests [1]) the main phenomena and principles to be taken into account for an experimental protocol (test bench, specimens, instrumentation, etc) dedicated to the study of wear and heat of materials in representative conditions, followed by a first comparison of metallic and composite reference materials performances.

The global methodology set up to partially answer the studied problematic, starts with "pin on disc" tests using a concrete pad and discs made of aluminum or composite material. The preliminary experimental design permits to observe the results of interactions between concrete and the materials like in an aircraft fuselage.

A first identification of the tribological systems representing the studied contact, aims at defining the first bodies and the third body produced within the studied contacts. Once the tribological mechanisms identified (by post mortem and in-situ analysis), an estimated dissipated energy may be linked to those mechanisms through the writing of material and energy balances [2,3].

*Intervenant

A future step of the work would concern the study of possible similitude rules (through non-dimensional numbers establishment relying on the Vaschy-Buckingham's theorem [4]), for a selection of identified wear and abrasion mechanisms, to check the possible extrapolation of experiments at a laboratory scale at full-scale level.

References

Y. Desplanques, O. Roussette, G. Degallaix, R. Copin, and Y. Berthier. Analysis of tribological behaviour of pad-disc contact in railway braking. Part 1. Laboratory test development, compromises between actual and simulated tribological triplets. Wear, 262(5-6):582.

Romain Mandard, Yannick Desplanques, Grégory Hauss, Jacky Fabis, Jean-François Witz, Jean Meriaux, Mechanisms of incursion accommodation during interaction between a vibrating blade and an abradable coating, Wear, Volumes 330–331, 2015, Pages 406–41.

Quentin Agrapart, Jean-François Brunel, Yannick Desplanques, Philippe Dufrenoy, Romain Mandard, et al.. An energy balance of blade-casing interaction. 16th International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC 2016), Apr 2016, Honolulu, United States.

E. Buckingham. On physically similar systems: illustrations of the use of dimensional equations, 1914.

Mots-Clés: Wear, heat, emergency landing, friction, tribology, experiments, aircraft