HEAVY TRANSPORT TURBOPROP AIRCRAFT (HTTA) IN FIREFIGHTER CONFIGURATION. GUST LOADS ALLEVIATION FUNCTION EFFECTIVENESS AND 1P LOADS MODELIZATION.

Guillermo PASTOR[1], Mercedes OLIVER[1], Ricardo NAVARRO[2] and Félix ARÉVALO[1]

[1]AIRBUS DEFENCE AND SPACE

Calle Aviocar, 2, 28906 Getafe, Spain

[2]AIRBUS OPERATIONS

Paseo John Lennon, s/n, 28906 Getafe, Spain

guillermo.pastor@airbus.com, mercedes.oliver-herrero@airbus.com, ricardo.navarro@airbus.com, felix.arevalo@airbus.com

ABSTRACT

The present paper introduces a couple of details found during a Heavy Transport Turboprop Aircraft (HTTA) gust analyses in firefighter configuration. Both are particularly relevant during low-speed operations demanding high manoeuvrability and gust encounter. Due to its nature, the phenomenon could be found in the typical firefighter mission or even during contour flying low level missions.

The first technical aspect is associated to the Gust Loads Alleviation (GLA) function, and the limited effectiveness in reducing the wing root bending moment for these kinds of operations. During GLA activation, aileron deflection is used to decrease the outer wing lift, then decreasing the wing root bending moment. However, and due to aileron capabilities, once the limit command is reached because of available deflection, the effectiveness is completely reduced. An example is presented where, due to gust encounter during a high g manoeuvre, incremental dynamic wing root bending moment increases with respect to a less demanding manoeuvre for the same gust intensity level. This could lead to a dramatic increase in the wing root bending moment during firefighter operations, especially in abrupt mountain terrain scenarios or scenarios with limited visibility where escape manoeuvring could be necessary.

The second technical detail, is associated to the incremental 1P loads for high induced angles of attack, and the fidelity of simple linear models in the representation of this physical phenomenon. Linear 1P propeller aerodynamic loads models are extensively used in the dynamic loads' models of propeller-driven aircraft to simulate the vertical/lateral forces/moments when propellers blades are subjected to certain angle of attack or sideslip. These 1P models are defined as linear aerodynamic derivatives that are function of the propeller hub degrees of freedom motion, the local induced aerodynamic angles of attack due to external disturbances (e.g., due to gust), and the downwash aerodynamical effects due to the interaction with the rest of the aircraft aerodynamic model. These linearized models, are conservative and representative enough for the vast majority of cases. However, and for particular applications, higher-order 1P models including non-linear effects are needed.

This paper introduces a non-linear 1P propeller model proposal. In a firefighting scenario, high demanding manoeuvres at low speed are expected to be combined with a gust encounter. Under these conditions, high induced angles of attack in the propeller hub are particularly relevant, leading to extremely high 1P loads. To clear those cases, a new methodology including aerodynamic-stall non-linear corrections is proposed, to improve the accuracy of the engines loads prediction in the propeller's hubs. The methodology leverages the DYNRESP Airbus Defence and Space in-house code capability to introduce non-linear elements in the load calculation process.

Details about the implementation are given and a scheme is proposed to treat these non-linearities within the new model. The implications in the computation time associated to it are discussed. In particular, when using impulse response functions and the convolution theory for the treatment of non-linearities.