A guidance to derive statistical data for asymmetrical maneuvers on transport operation

Juliana Diniz Mattos [1], Diego Silva Peixoto [1], Frank Machado [1]
[1] *Embraer, São José dos Campos, Brazil*

The airplane fatigue design is based on a load history that shall represent in a reliable way the typical operational usage. To predict airplane operational loads is not an easy task, especially when the airplane design presents innovative features. In such situation, it is possible to derive loads from operational flights of similar airplanes. The flight parameters records obtained from prototype ferry flights are consolidated into a reduced information, which may be applied to an airplane design fatigue analysis. For cyclic loading conditions, such as gusts and maneuvers, the spectrum format is adopted, which consists of curves associating the parameter intensity to the exceedances (accumulated occurrences). The spectrum may be derived for different flight parameters and is treated in the aeronautical industry as an statistical representation of the data records. A good quality of the statistical data is the basis for a realistic fatigue loads, therefore, an assertive analysis and better structural dimensioning.

There are several statistical datasets presented in normative rules, like MIL, and FAA reports comprising flight loads data of commercial operation. These are references frequently adopted in the airplane design development, however there are few published statistical datasets on asymmetrical maneuvers. The loads spectra derived for these maneuvers may be essential for the design of certain components, such as control surfaces and its respective mechanisms.

In order to fill this lack, this work presents a guidance to derive maneuver statistical databank, indicating methods and criteria to process flight data, investigating and suggesting the better flight parameter to represent asymmetrical maneuvers. Moreover, presents normalized flight parameters spectra and discuss if the reduction of the flight data into a multi-parameter statistical data may lead to a generic statistical database that may be representative for different airplanes.

The generation of a statistical databank to represent these maneuvers for airplanes with variable dimensions and structural configurations would enable its re-use for future aeronautical structural designs.

References:
(1) SKINN, D., MIEDLAR, P., KELLY, L. (1996). *Flight Loads Data for a Boeing 737-400 in Commercial Operation," Federal Aviation Administration*. Washington: U.S. Department of Transportation Federal Aviation Administration Office of Aviation Research and Development. (DOT/FAA/AR-95/21).

(2) RUSTENBURG, J. W., *Development of a Rolling Maneuvers Spectrum from Statistical Flight Loads Data*; National Technical Information Service. TECHNICAL REPORT ASD-TR-72-113. U.S. Department of Commerce; Ohio - USA; April 1973.

(3) BROEK, D., *The Practical Use of Fractures Mechanics*, FractuREsearch Inc, Galena, OH, USA, 1988.

(4) van DIJK, G. M. (1972). *Statistical load data processing*. In NASA SP-309. Advanced approaches to fatigue evaluation. 565-598.