GARTEUR GROUP FOR AERONAUTICAL RESEARCH AND TECHNOLOGY IN EUROPE

FRANCE GERMANY ITALY THE NETHERLANDS SPAIN SWEDEN UNITED KINGDOM

HC/AG-19: Improvement of Structural Dynamic FEM using In-flight Test Data

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Background

The issue of vibration in helicopters is of major concern to operators in terms of the maintenance burden and the impact on whole life costs. Operators are demanding smooth ride vehicles as a discriminator of vehicle quality, which requires close attention to the vehicle dynamics.

Good mathematical models are the starting point for low vibration vehicles. The ability to faithfully simulate and optimize vehicle response, structural modifications, vehicle updates, the addition of stores and equipment is the key to producing a low vibration helicopter. However, there are many issues affecting the creation of an accurate model and it is clear that much research is needed to further that understanding.

A recent GARTEUR Action Group, HC/AG-14, concluded that helicopter dynamic models are still deficient in their capability to predict airframe vibration. The AG looked at the methods for improving the model correlation with modal test data along with the suitability of existing shake test methods.

Among others, the following recommendations were made for continued research:

• Study effects of configuration changes in the structure. How significant are these effects? How can uncertainties be handled in the context of an FE model. What is the influence of flight loads.

• The helicopter structure tested in HC/AG-14 was suspended in the laboratory. However, this is not the operational environment where there are very significant mass, inertia and gyroscopic effects from the rotor systems. Could in-flight measurements be made? What are the benefits?

Other recommendations with respect to ground vibration testing are considered in the closely related GARTEUR Action Group HC/AG-18.

Programme/Objectives

Objectives

The main purpose of this AG is to explore methods and procedures for improving finite element models through the use of in-flight dynamic data. For the foreseeable future it is expected that validated finite element models will be the major tool for improving the dynamic characteristics of the helicopter structural design. It is therefore of great importance to all participants that the procedure of validating and updating helicopter finite element models with such in-flight data is robust, rigorous and effective in delivering the best finite element model.

The members will present further developments of methods used to update the finite element model whether automated, manual or both. Advantages and disadvantages of the approaches should be given and possible future developments of the procedures for localizing the areas of the models causing the discrepancies and for improving the updating process presented.The members will present developments of methods for the prediction of the effect of configuration changes on FRF behaviour. These can be based on a finite element model. Advantages and disadvantages of the approaches should be given and possible future developments of the procedures presented.

Finally the group shall assess the methodology with respect to evaluating vibration measurements from flight tests where effects of aerodynamic and rotating machinery affect the vehicle response. The objective is to extract modal parameters from in-flight measured data. Advantages and disadvantages of the approaches should be given and possible future developments of the procedures presented.

Traditional analysis versus OMA analysis

Available flight test data

Three sources of flight test data are available to the action group:

A flight test programme on an attack helicopter resulted in vibration response measurements on the stub wings for a wide range of manoeuvres and store configurations. A Full Aircraft GVT on RNLAF attack helicopter was conducted by Agusta Westland Ltd (with NLR assistance) on 5-7 March 2012.

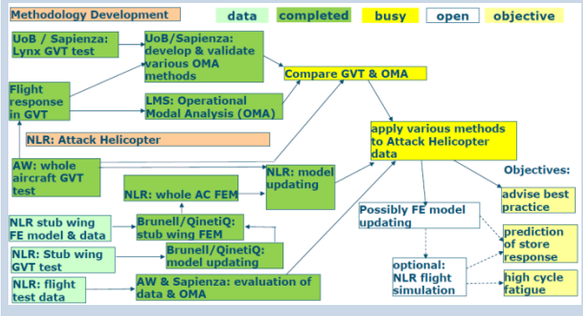
The department of mechanical and aerospace engineering of “La Sapienza” University has a model helicopter at it disposal. Flight tests have been conducted with this helicopter. A finite element model is available. Ground vibration tests have been conducted. The advantage of this helicopter is that it is available for additional ground vibration and flight tests.

The third data set is based on LMS flight test data for Polish Helicopter

Results

The project should result in a review of various methods to process acceleration (or other) time signals. Sine inputs from rotating components in the flying helicopter dominate the response signals and obscure the structural responses related to structural vibration modes. The methods should separate the rotating component contributions from the structural vibration content. The updated finite element models will be used to predict in flight vibration responses of existing and new store configurations. This may reduce the amount of flight testing required to validate new store configurations. This is beneficial to both operators and manufacturers. This could involve coupling the structure model to simulation models that predict the main and tail rotor hub excitation levels.

So far, available experimental flight test data for validation purposes has been analyzed to update the related FE models. For the attack helicopter, model mass and construction of the complete helicopter model is finished. The GVT on a Dutch Attack helicopter was used to update the complete helicopter model. The flight test data will be used to further improve this model.



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