

EXPERIMENTAL ANALYSIS OF COMPOSITE JET ENGINE AIR INLET

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1. Introduction

Aero L-39 light jet trainer is widely used in many countries around the world. One important element of the structure is the air inlet. Fatigue life of the metal air inlet is one of the factors limiting service life of entire aircraft. The new generation L-39NG jet trainer (see Fig. 1) represents deep modernization of the L-39 combining latest engine and aircraft systems technology with traditional advantages of L-39s legacy.



Fig. 1. Light jet trainer Aero L-39NG [1].

The new air inlet design is based on a composite material, with a view to increasing service life and using a new jet engine. The determination of operational loading was necessary to verify numerical model where the aim was to examine the load during the ground engine test run.

2. Air inlet

The complete air inlet (see Fig. 2) is composed of three main composite parts.

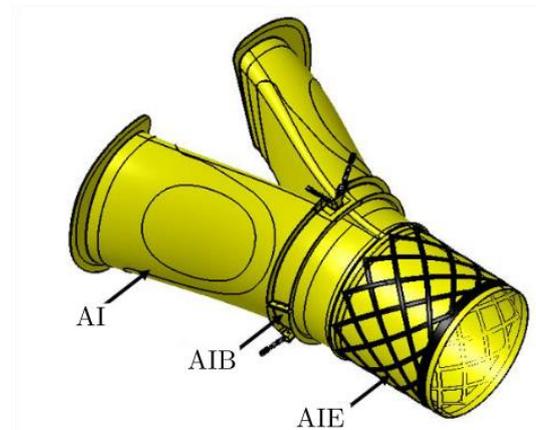


Fig. 2. Composite air inlet (AI – Air Inlet, AIB – Air Inlet Brace, AIE – Air Inlet Extension) [2].

The main material used for the air inlet is pre-impregnated carbon fiber reinforced plastic (CFRP). The minimum used number of CFRP layers is 12, while the maximum number of layers is 24 at the main reinforcement area. Left and right parts of the air inlet are connected by the air inlet brace. The brace is fitted to the fuselage by using four rods, which are main load connections between the fuselage and the air inlet.

3. Air inlet instrumentation

The places for strain measurements were selected on the basis of assumed load peaks obtained by numerical simulations. The 31 places were selected on each inlet arm, with a resistance strain gauge rosettes installed.

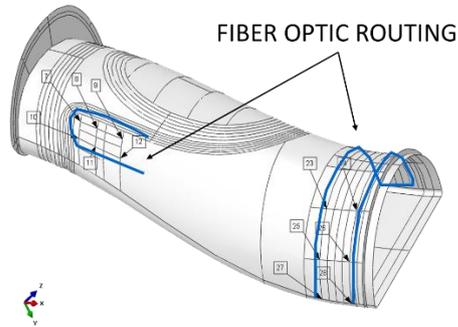


Fig. 3. Left air inlet with places of strain gauge and FBG sensors.

Two optical fibers with twenty FBG (Fiber Bragg Grating) sensors were installed on the surface of each inlet (see Fig. 3). The right inlet with installed sensors can be seen in Fig. 4. The load transmitted by the rods was monitored by strain gauges installed on their surfaces. The instrumented rods were calibrated on a universal testing machine with a conversion between the measured strains and the load forces. The temperature field around the strain gauge sensors was monitored with the six platinum resistance thermometer sensors. The sensors had to be installed before the inlet was assembled into the fuselage. Therefore, solder tabs had to be placed near access or inspection panels and the final cable connection was made after the air inlets were mounted in the fuselage.

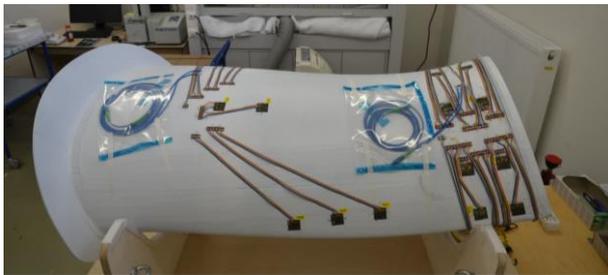


Fig. 4. Right air inlet with installed sensors.

Total number of the installed resistance strain gauges' grids was 186 which represented a large amount of connecting material and working time compared to installing four optical fibers with the 40 FBG sensors.

4. Engine ground run test

The large number of measurement channels was the reason for use of two independent strain gauge measurement systems and the need to perform measurement in parts. The first system contained 56 strain gauge channels with 25 kHz sampling frequency, the second system consisted of 36 channels with 19.2 kHz sampling. The optical interrogator measured at a sampling rate of 11.5 kHz when single fiber was connected. Based on the previous limitations, a test run of the engine has been proposed, where defined power levels have been maintained for some time. This successive loading was repeated after switching a set of other measuring channels. The situation during the test is shown in the Fig. 5.



Fig. 5. Engine ground run test.

5. Conclusions

During the test, a large amount of data was obtained, which will be used to verify numerical models mainly with regard to acoustic fatigue.

Acknowledgements

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