Industrial Applications of Shearography for Inspection of Aircraft Components

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Abstract
Shearography has been validated as fast and reliable inspection technique for aerospace components. Following several years phase of evaluation of the technique, meanwhile, shearography has entered the industrial production inspection.

The applications basically range from serial inspection in the production line to field inspection in assembly and to applications in the maintenance and repair area. In all applications, the main advantages of shearography, as very fast and full field inspection and high sensitivity even on very complex on composite materials have led to the decision for laser shearography as inspection tool.

In this paper, we present some highlights of industrial shearography inspection. One of the first industrial installations of laser shearography in Europe was a fully automatic inspection system for helicopter rotorblades. Complete rotor blades are inspected within 10 minutes on delaminations and debondings in the composite structure.

In case of more complex components, robotic manipulation of the shearography camera has proven to be the optimal solution. An industry 6-axis robot gives utmost flexibility to position the camera in any angle and distance. Automatic defect marking systems have also been introduced to indicate the exact position of the defect directly on the inspected component.

Other applications are shearography inspection systems for abradable seals in jet engines and portable shearography inspection systems for maintenance and repair inspection in the field. In this paper, recent installations of automatic inspection systems in aerospace industries are presented.

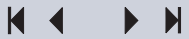

Fig. 1: Helicopter rotorblade inspection system

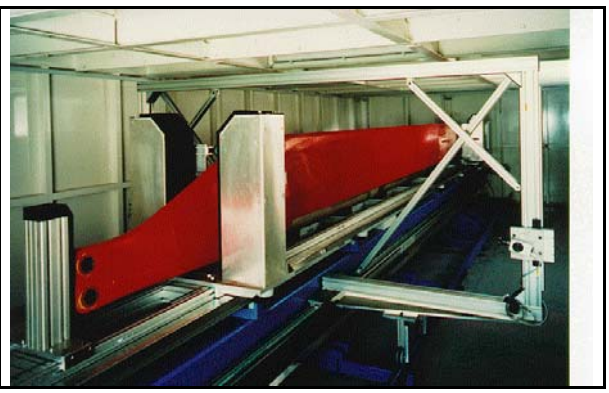

Fig. 2: View inside the vacuum chamber with rotorblade in testing position

The inspection areas are illuminated by a 5 Watt Nd:YAG laser, coupled into two fiber coupling systems. The laser beam expanders are positioned together with the shearography cameras on the guide and provide a homogeneous illumination on the whole measurement field. This allows an inspection of areas up to of 600 x 800 mm² on each side of the rotor blade. After each loading and measurement cycle, the shearography cameras are moved on the linear guide to the next measuring area. Up to 15 measurement steps are required for complete inspection of the largest rotorblades.

The inspection results are fully automatically analyzed, by comparing the measured data with a set of earlier taught master data. This allows to distinguish between structural information and defects. The automatic defect localization is carried out during the test cycle and indicates the defect position on the screen. Sizes and positions of the defects are printed in a test report, which is automatically prepared after every test cycle.

Automatic shearography inspection system for thermal protection parts

In the aerospace industries lightweight sandwich constructions are very common. As example, the thermal protection parts of the European ARIANE 5 launcher are made of carbon reinforced composite materials using honeycomb structure cores and monolithic structures in one part. These thermal protection parts show quite complex shapes, as cylindrical or conical and contain flanges and edges. In an extensive validation process shearography has been chosen as technique for 100 % inspection of all components for its performance and inspection speed. Two different stressing methods are used for the shearography inspection of these components. The honeycomb composite parts are inspected with thermal load, because their structure is, comparing to the monolithic areas, porous and not completely sealed. The sealed monolithic carbon structures are stressed by vacuum. Due