# **Digital Shearographic Non-destructive Testing Laboratory**

- Digital Shearography is a laser technique which directly measures strain data in real time.
- Digital Shearography is insensitive to environmental disturbances and suited well for real world application, because a rigid body movement produces displacement but not strain.
- Digital Shearography can be used as a non-destructive testing tool to find defects in object surface because they can be represented as strain concentrations.
- Digital Shearography enables quantitative and automatic measurement in real time.

# Capabilities of the lab

The laboratory of Digital Shearographic Non-destructive Testing has various digital shearographic sensors (both research and commercial versions) and software packages developed for different application purposes. The laboratory has capabilities to detect nondestructively delaminations, disbands, microcracks, leak and so on in any materials, especially in composite materials. Also the laboratory has capability to conduct NDT-testing of spot weld for determination of nugget size.

## **Principle:**

Digital Shearography is an interferometric technique. The layout of the setup for shearography is as shown in Fig.1.



Fig. 1 Schematic Layout of the Principal of Digital Shearography

The object to be studied is illuminated by an expanded laser. The light waves reflected from two points on object surface are brought into one point on the image plane of a CCD camera

through a shearing device. Therefore, the two light waves interfere with each other producing a random interference pattern commonly known as "Speckle Pattern", which relates to the relative information between the two points. During measurement, two speckle patterns before and after deformation are compared producing a fringe pattern, i.e. a Shearogram, depicting a relative deformation, thus the first derivative which is related to stain data is produced as shown in the right image. A typical fringes of the shearogram are indicated as butterfly pattern as shown in Fig.2. A comparison between hologram and shearogram are demonstrated in Fig. 3



Fig. 2 Defects are indicated as "Butterfly Pattern"



Hologram depicting deformation



3D representation of Hologram(Deformation)



Shearogram depicting derivative deformation (Strain Data)



3D representation of Shearogram(Strain)



# **Applications:**

- Non Destructive Testing and Quality Assurance
- Design Validation and Optimization
- Full Field Strain/stress Measurement.
- Structural Integrity-Delamination of Composite and Honey Comb Panel
- Thermal Strain Measurement in Real-Time.
- Non-Destructive Evaluation of Spot Welds.

## **Quantification of tests**

- Adapt the sensitivity of the technique by definition of the load level
- Small defects show up at higher load levels
- Realistic load conditions possible



## **Delaminations in composites**



10.99 20.88 30.49 40.52 50.14 60.03 69.64 79.67 89.15 99.18

Delamination in a carbon fiber reinforced plastic honeycomb panel



Two delaminations in a glass fibre reinforced plastic honeycomb panel

#### Shearogram 65.5 65.5 26.3 26.3 7.1 Evaluated Bending strain $(\partial^2 w / \partial x^2)$ -12.9 -12.94 -32.1 shearogram -32.1 -52.1 -52.1 $(\partial W / \partial X)$ -76.78 -58.04 -40.08 -21.34 -3.38 15.36 33.32 52.05 70.01 88.75 -76.78 -58.04 -40.08 -21.34 -3.38 15.36 33.32 52.05 70.01 88.75

Bending strain making small defect visible

Micro-crack on a carbon fibre reinforced plastic panel

## NDT of a rotor vane



Delaminations and microcracks In a glass fiber-reinforced plastic (GFRP) rotor vane (Using an internal pressure of 0.01 Mpa)

## Portable Inspection System

(From Dantec-ettemeyer GmbH, Germany)

# Field inspection of composite fuselages

- Fast inspection of composite materials
- Easy application
- Simple operation
- Vacuum stressing of component
- Ideal for field inspection



# Helicopter Rotor Blade Inspection System (From Dantec-ettemeyer GmbH, Germany)



No preparation and fully automatic inspection of rotor blade: 10 minutes inspection per rotor blade

## **Robotic Inspection System**

(From Dantec-ettemeyer GmbH, Germany)

- Automatic inspection of ARIANE 5 thermal protection parts
- 80m<sup>3</sup> vacuum chamber
- Flexible operation



