Strain Gauges

Digital Image Correlation: A complementary method for DMS measurements.

Today's challenging measurement requirements

Measuring the behavior of complex compo-nents with often anisotropic material behavior, drives the need for full-field optical measurement methods. It is also increasingly the case that economic demands are forcing companies away from labor intensive point focused measurement techniques, into the more efficient and robust optical non-contact technologies. We provide cost efficient solutions for enterprises, who want to explore innovative ways of material testing and structural analysis of complex components in difficult environments.

Figure 1 – Composite Wind Blade Measurement

Figure 2 - Structural Measurement

Figure 3 – Dynamic Measurement

Figure 4 - Bridge Measurement

Optical measurement solution

Dantec Dynamics Digital Image Correlation (DIC) is a 3D, full-field, non-contact optical technique to measure shape, deformation, vibration and strain on almost any material and shape. Its flexible design opens a wide range of applica-tions from microscopic investigations up to large scale civil engineering measurements, with resolutions down to µ-meters.

Save time and money with effective strain gauge positioning

Materials and structures are getting more and more complex, while quality and reliability needs are increasing. For this reason it is important to have efficient methods to determine the exact material behavior when exposed to stress. Traditionally the strain gauge placement is dependent on simulation results and / or experience, but often it turns out that the interesting stress hotspots are not at the predicted positions. In the worst case these critical stress areas are not detected at all.

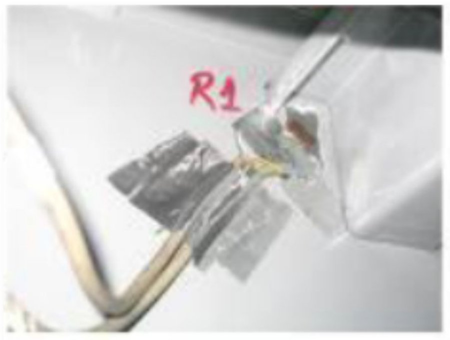


Figure 5 - Attachment of strain gauges to assumed hotspots

DIC provides a full-field view of the displacements and deformations of a component and shows its complex behavior. This easily allows the identification of potential hot spots, where strain gauges can be subsequently attached, e.g. for online strain monitoring of critical areas. Figure 6 shows a typical material test.

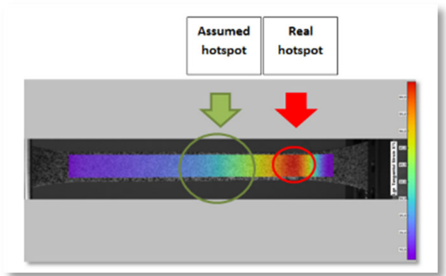


Figure 6 - Tensile test

The determination of strain hotspots is dependent on the clamping of the specimen and the sometimes complex behavior of the material, the consequence of this is that the strain hot spot and subsequent rupture area may not be at the predicted position. The DIC technique can be quickly and easily deployed as a strain hotspot detector, helping with the correct strain gauge positioning which will save valuable time and resources.

Overcome strain measurement constraints

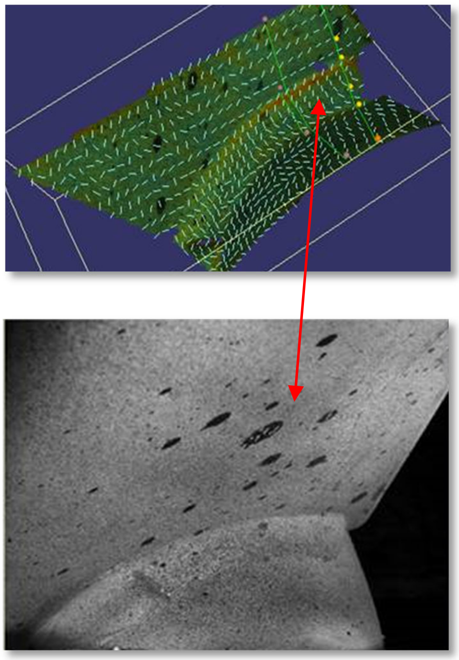


Figure 7 - High strain concentrations had been measured on the edge of the welded area

DIC goes beyond the application limits of strain gauges. For example with DIC it is possible to measure on top of the welded areas in order to derive the exact strain measurement.

High Temperature measurements

It is common knowledge that strain gauges have accuracy limitations when exposed to high temperatures or temperature variations during measurement. DIC on the other hand performs to a very high accuracy independent of temperature change or high temperature conditions.

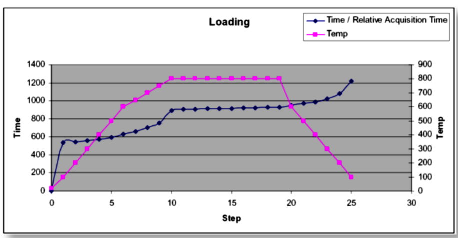


Figure 8 - Deformation under heat load

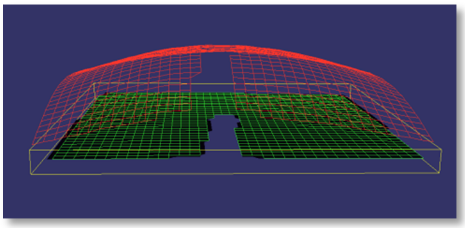
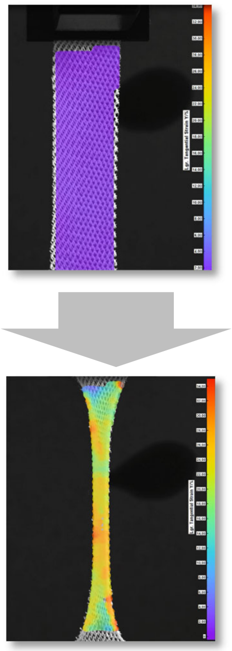


Figure 9 - Red grid= deformation (800°C)
Green grid= reference (20°C)

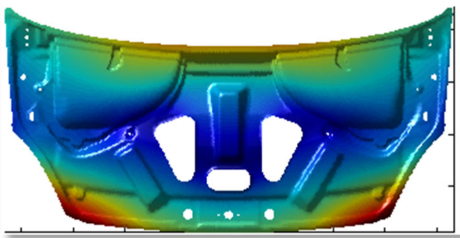
Enlarge strain measurement limits

With DIC it is possible to measure from 0,01% of strain up to several 100% of strain.



FEM comparison

Simulation does not always reflect reality. Sometime parts and components fail in areas where no difficulties had been predicted. Therefore a comparison between simulation and experimental results is vital for the improvement of R&D cycles and the prediction of the reliability of the material / component.



FEM Simulations of components exposed to stress

The ANSYS FEM plugin easily allows FEM simulation and DIC experimental comparisons with just a few clicks directly in the FEM Software.

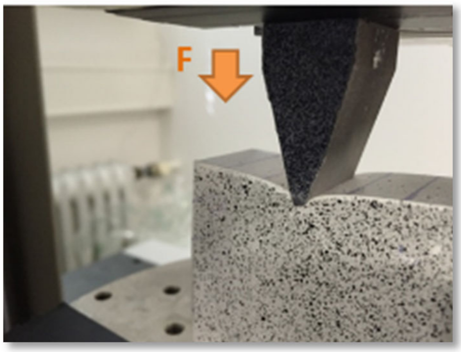


Figure 10 - Component loaded in the indicated direction

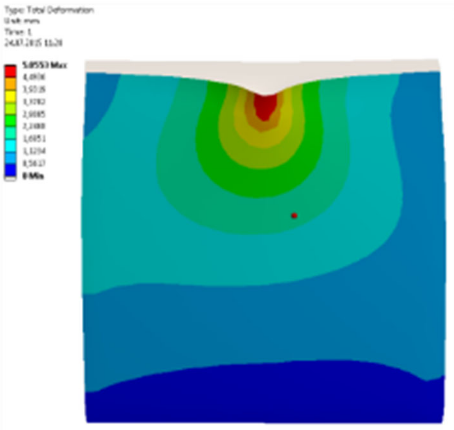


Figure 11 - Imported experimental measurement result

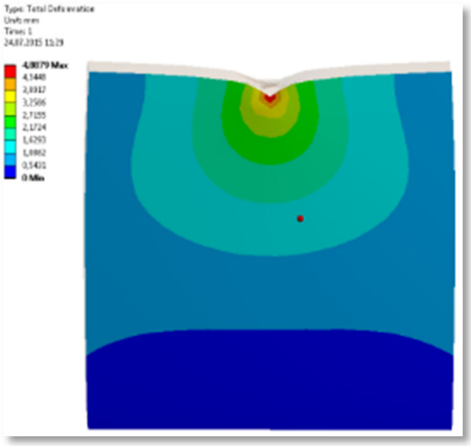


Figure 12 - ANSYS FEM calculation of the component

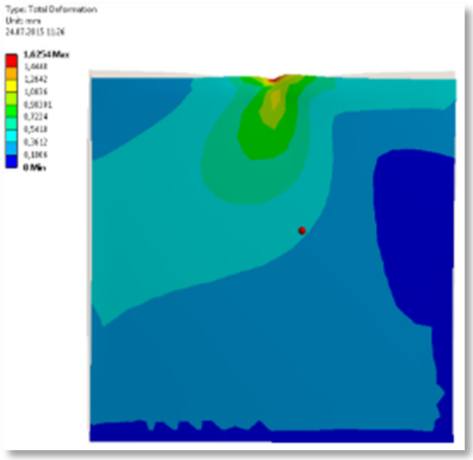
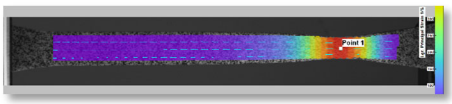


Figure 13 - Comparison experimental results and FEM

Known measurement uncertainty

The DIC does not only provide highly accurate measurement values, but also indicates the measurement precision for each measured value in real-time.



Point 1 - Lgr. Tangential Strain x/%:	-23,18 ± 0,05
Point 1 - Lgr. Tangential Strain y/%:	490,1 ± 0,2
Point 1 - Lgr. Tangential Shear Strain/%:	-6,65 ± 0,13
Point 1 - Lgr. Principal Strain 1/%:	490,1 ± 0,2
Point 1 - Lgr. Principal Strain 2/%:	-23,27 ± 0,05

Easy and quick calibration

Our user friendly and fast calibration procedure, based on holding a calibration target by hand (as shown below), gives a calibration in typically 10 seconds which will significantly reduce the measurement time.

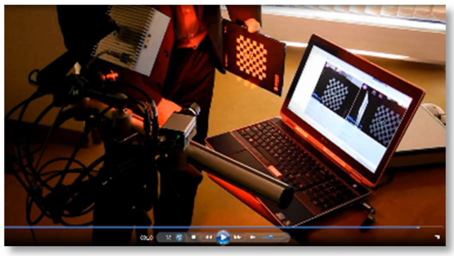


Figure 14 - Calibration done - 10 Seconds

Standardization / Certification

Dantec is a member of all major international standardisation committees for DIC and Shearography. Country and company specific standardisation procedures / certificates similar to strain gauge, video extensometers accuracy classes are available on request (e.g. ISO 9513 / JIS B7741). The DIC calibration targets can be certified according to DAkkS K041B.

Vibration Analysis

With fully integrated medium and high speed cameras, the DIC can easily be extended to vibration and modal shape analysis as shown below.

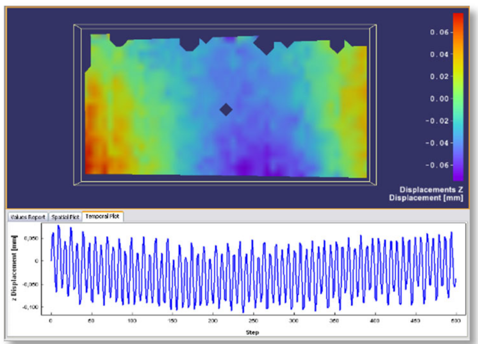


Figure 15 – Out of plane displacement of a composite panel

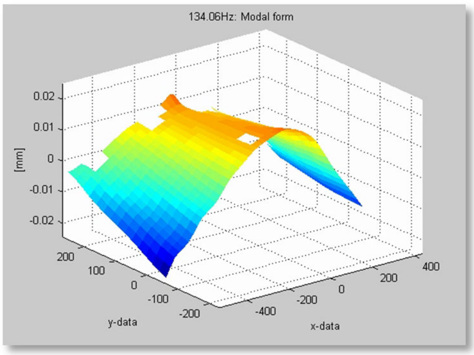


Figure 16 - Modal Shape Analysis of a composite panel

Benefits of Digital Image Correlation measurement solution – Save time/money

- Speed up strain gauge measurement setups with DIC hot spot detection.
- Full-field, 3D quantitative analysis. Unlimited data points.
- Non-contact measurement. Quick and easy setup.
- Easy to use tools are available for test object marking.

Explore innovative measurement techniques

- Measure components / parts which are difficult or impossible to measure with strain gauges.
- Explore advanced materials and structural testing areas with DIC, such as:
  - Strain measurement
  - Fatigue Testing
  - FEM validation
  - Vibration Analysis
- Measure over welded spots or entire welded seams.
- High temperature measurements enabled.
- Stress determination by measurement of sample necking.
- Flexible measurement areas: from mm² to m² dimensions.
- Accuracies down to 1µm displacement for smaller areas.

Easy to use – Built-in "Sensor intelligence"

- Deformation, Displacements (x,y,z), Strains (exx, eyy, exy, e1, e2), etc.
- Material parameters: Poisson ratio and Young's Modulus.
- Vibration analysis and modal shape analysis modules are available.
- Various export formats to support post processing for country specific procedures and standards are provided.
- End user customizable procedures for complex calculations are supported and can be initiated with a single keystroke.

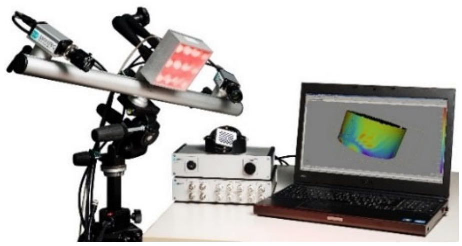


Figure 17 - Q-400 DIC System with two cameras and illumination option

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Turn Measurements into Knowledge