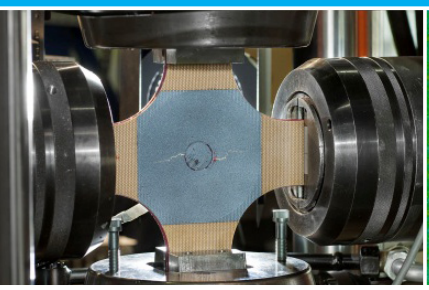
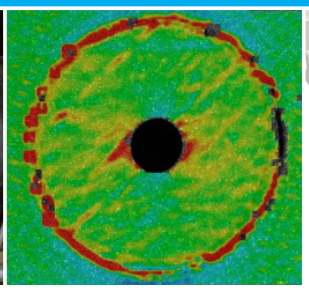
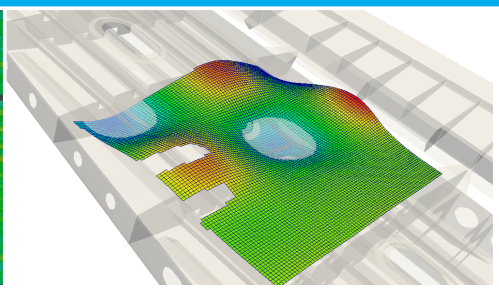
NLR Optical 3D Deformation Analysis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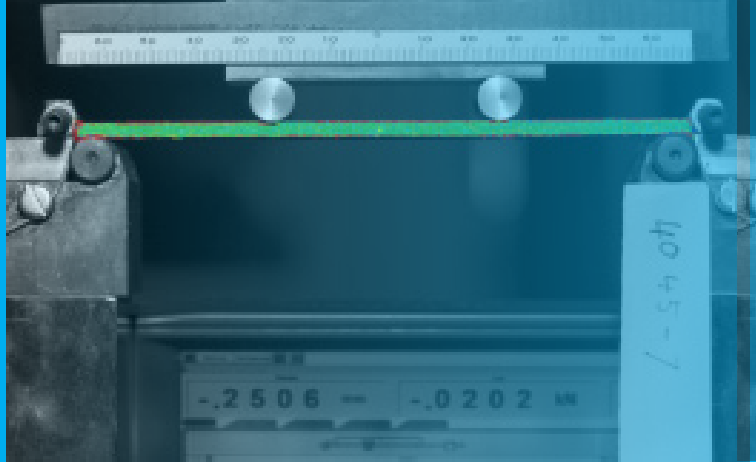
"OPTICAL 3D DEFORMATION ANALYSIS"

Optical 3D deformation analysis for static or dynamically loaded components and structures is an effective non-contact and material independent full-field measurement solution.

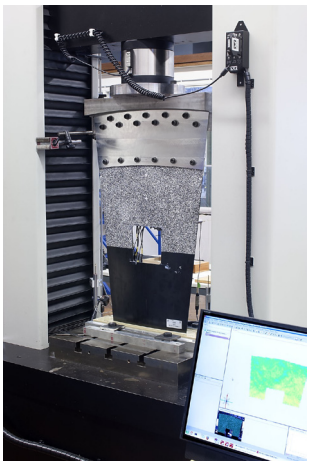
Applications

- Surveying a structure for potential problem sites
- Visualisation of strain gradients and hot spots
- Visualisation of crack growth, crack tip opening and local/global strain fields/distribution
- Measurement of in-plane strains and 3D out-of-plane displacements
- Verification and iteration of Finite Element Models
- Verification of failure behaviour
- Investigation of fracture mechanics
- Design tool validation
- Tracking damage in (composite) materials
- Test of Non-Homogeneous and Anisotropic Materials
- Impact studies and non-stationary responses
- Moving and rotating objects



Optical 3D deformation analysis facility

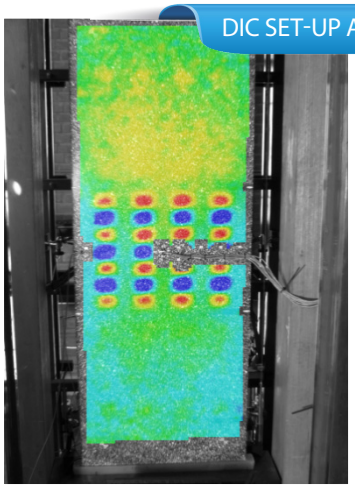
The optical 3D deformation analysis facility uses principles of 3D digital image correlation (DIC) photogrammetry that gives full-field out-of-plane displacement and in-plane strain results of the surface of the component. A random or regular (sprayed) pattern with good contrast is applied to the surface of the test object, which deforms along with the object and is tracked with the stereo metric camera's of the system

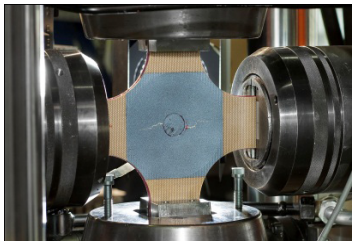


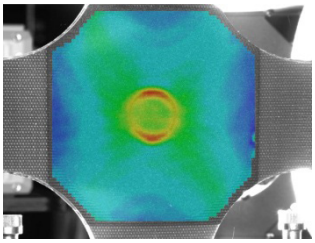
Specifications:

- Full-field analysis of small specimens (mm^2) up to large components (> m^2)
- 4000x3000 pixels camera resolution
- 58 images/sec
- High speed option with 2 high speed camera's (up to 7000 fps at 1024x1024 pixels resolution)
- 3D point/marker target tracking function

DIC SET-UP AND RESULTS



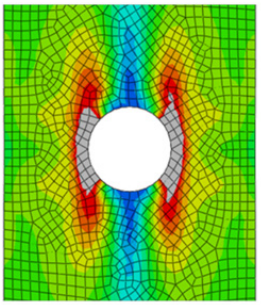




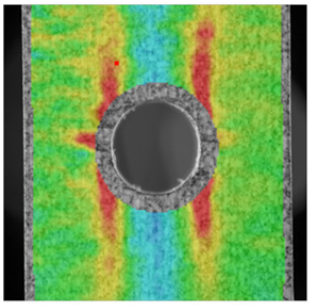
Results

- Full-Field 3D coordinates
- In-plane strains
- 3D out-of-plane displacements
- 3D velocities
- Fine resolution 3D mesh
- Plain strain tensor
- Object contour based visualization

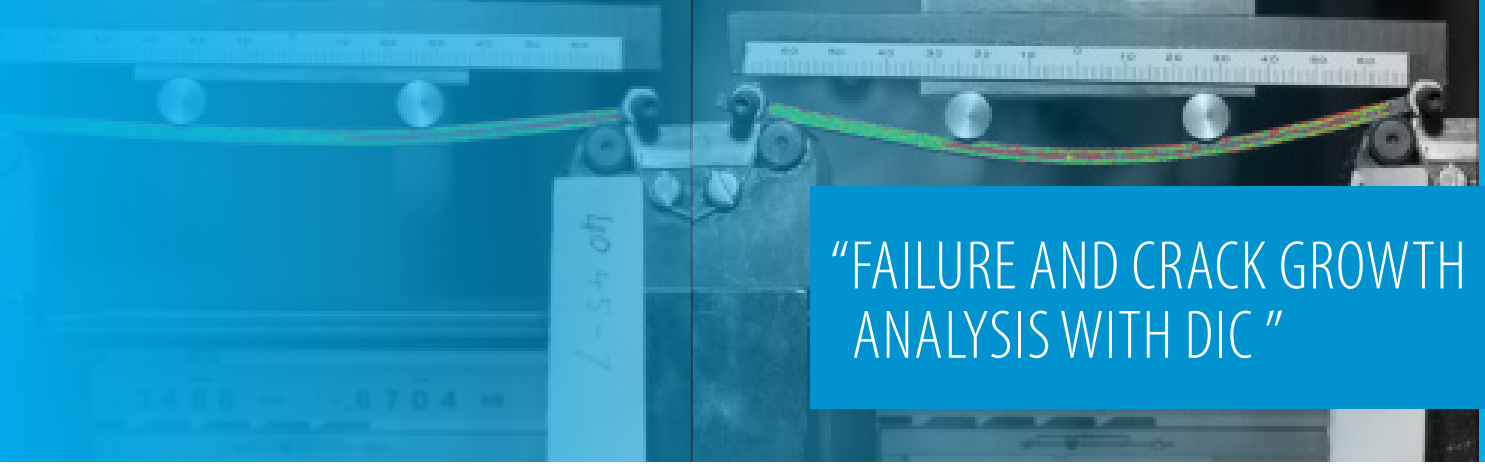
Example of design tool validation by DIC



FEM strain prediction



DIC processed strain results



"FAILURE AND CRACK GROWTH ANALYSIS WITH DIC "

Example of design tool validation by DIC of full-scale sandwich panel

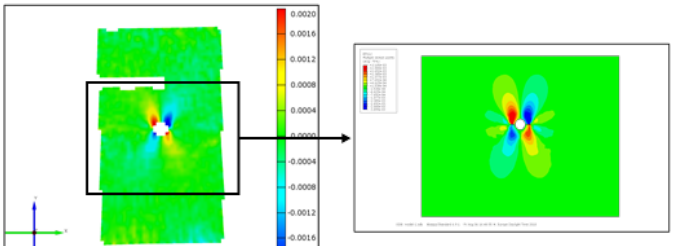
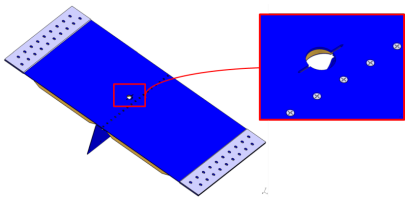
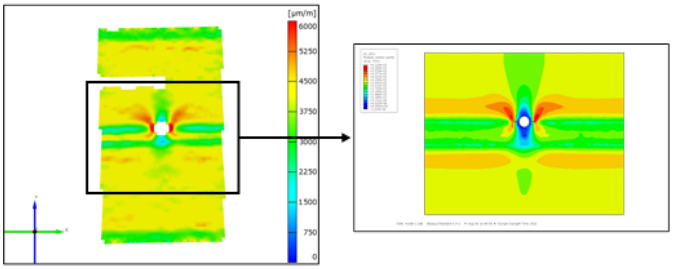


Figure Excellent agreement between DIC result (left) and FEM (right)

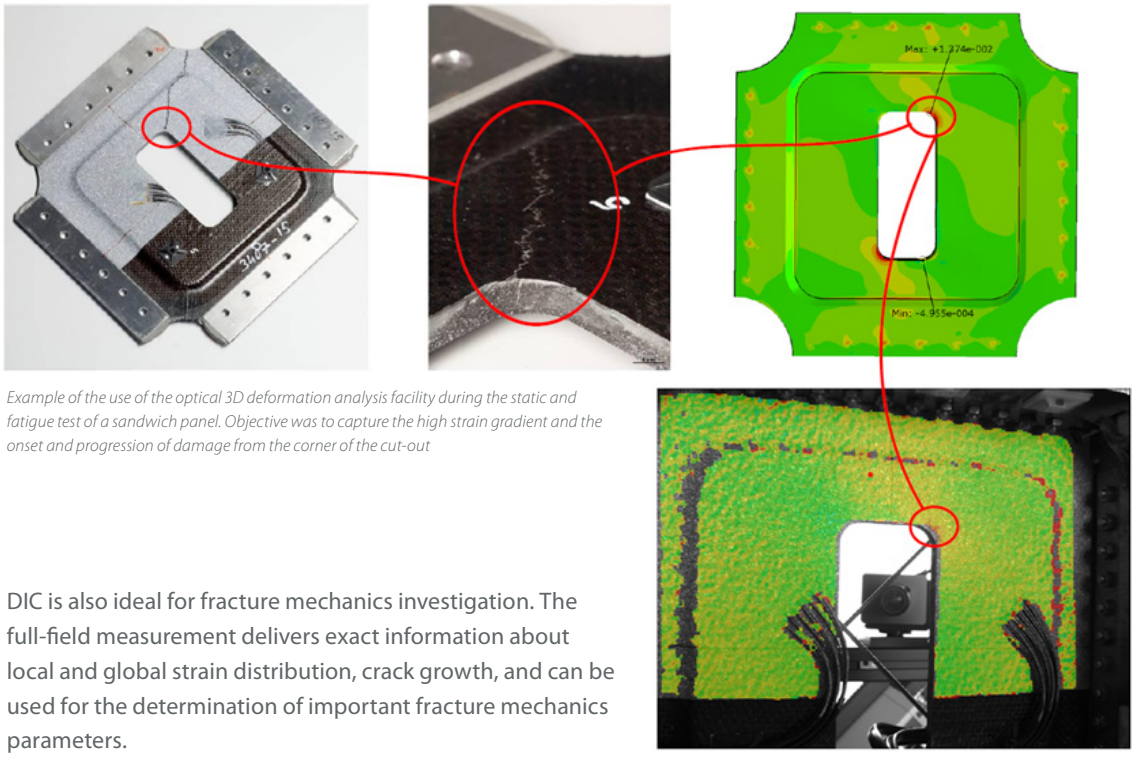


Full-scale sandwich panel with 1 inch hole with 2 inch crack



The optical 3D deformation analysis system is very attractive to look for typical physical phenomena with panel testing:

- Onset of buckling, type of buckling
- Delamination growth
- Failure behaviour (skin rupture, stiffener pop-off)



Example of the use of the optical 3D deformation analysis facility during the static and fatigue test of a sandwich panel. Objective was to capture the high strain gradient and the onset and progression of damage from the corner of the cut-out

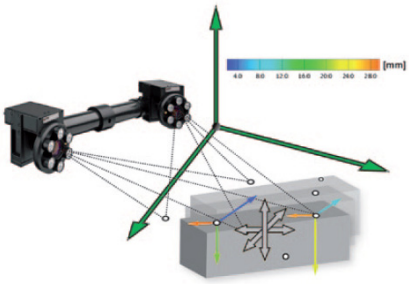
DIC is also ideal for fracture mechanics investigation. The full-field measurement delivers exact information about local and global strain distribution, crack growth, and can be used for the determination of important fracture mechanics parameters.

3D point target tracking function

The additional 3D point target tracking function is based on Stereo Pattern Recognition (SPR) technology (type of Digital Image Correlation). SPR is based on the recognition and tracking of visible reflective markers on the object surface using stereo metric camera's. With the use of high-speed cameras, the system is also suitable for measuring fast processes and motion sequences, e.g. for impact testing.

SPR is ideal for:

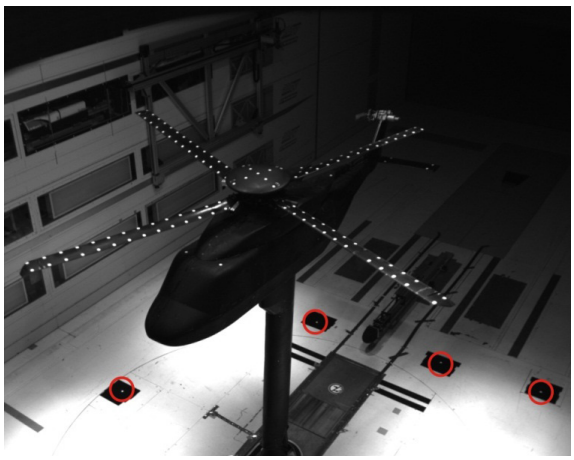
- Full field Structural Monitoring
- Complex motion tracking and analysis
- Component deformation analysis
- Mode shapes and relative motion



Spatial 3D online measurement of positions and displacements of reflective markers, 3D displacement vectors

Advantages

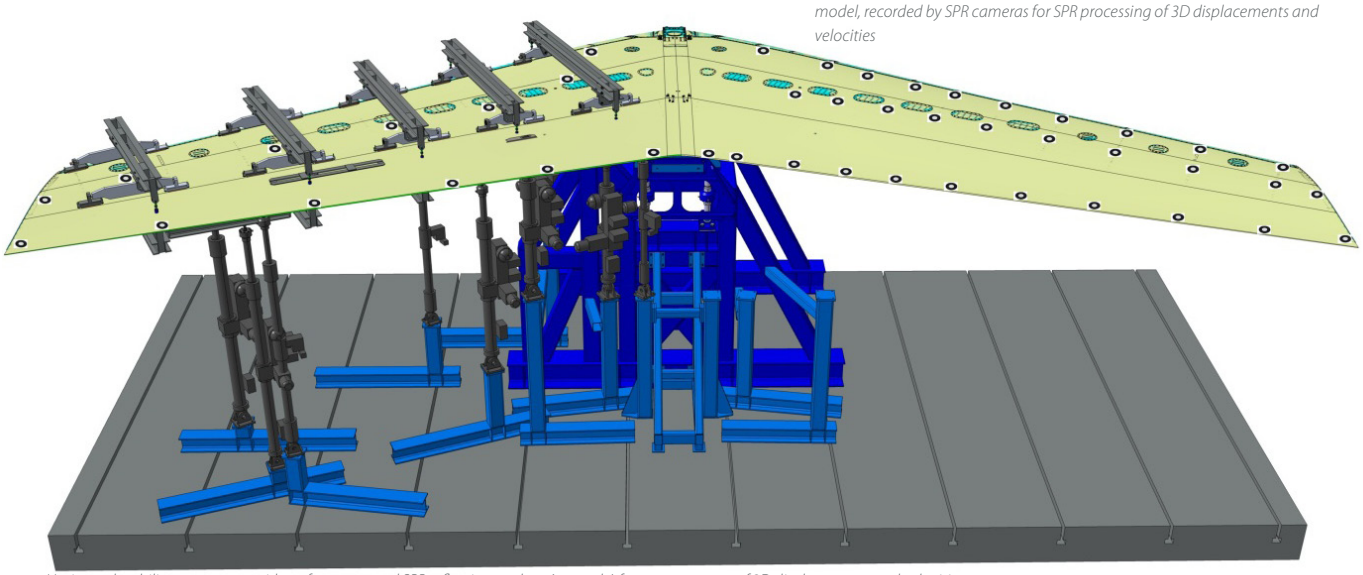
- Simple specimen preparation with ultra-light self-adhesive reflective markers
- Frame rates independent of the number of markers
- Insensitive to ambient conditions, such as vibrations and light changes
- Easy adjustment to different measurement areas and tasks



Reflective markers on the upper rotor blade surface from a helicopter wind tunnel model, recorded by SPR cameras for SPR processing of 3D displacements and velocities

Results

- 3D Coordinates
- 3D in-plane and out of plane displacements
- 3D Velocity and acceleration



Horizontal stabilizer test set-up with surface mounted SPR reflective markers (example) for measurement of 3D displacements and velocities

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