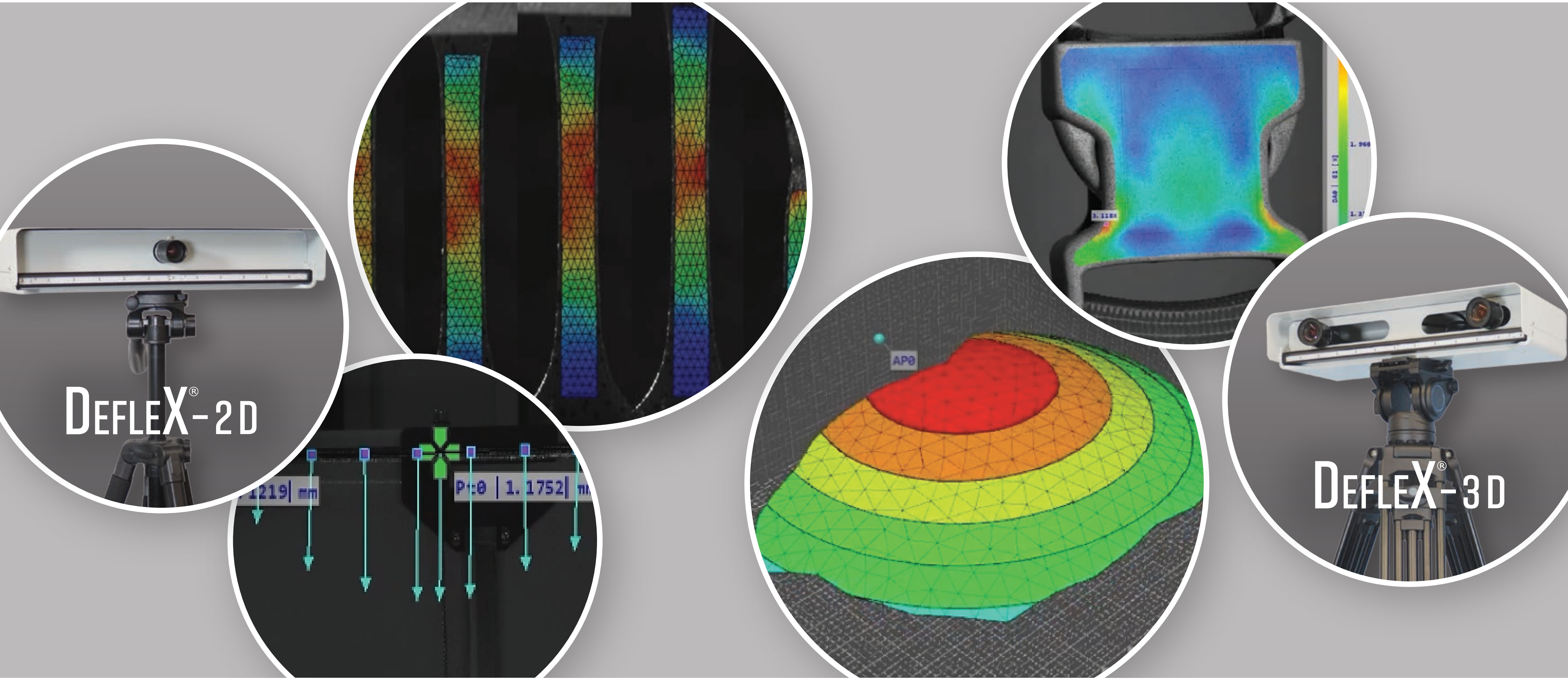
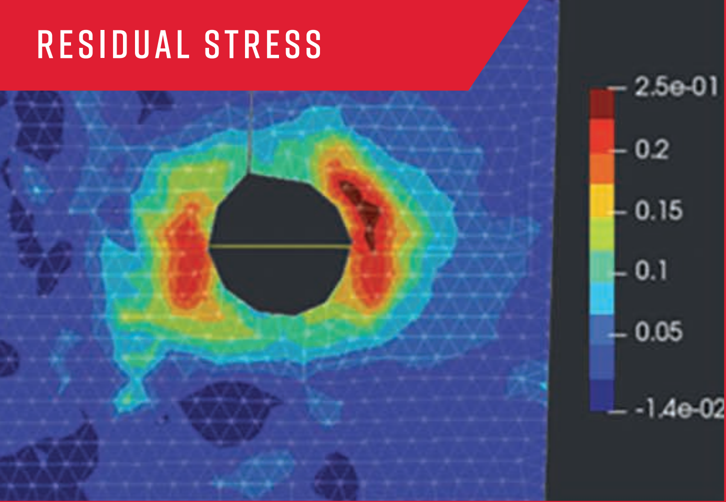
DefleX®

TECQUIPMENT

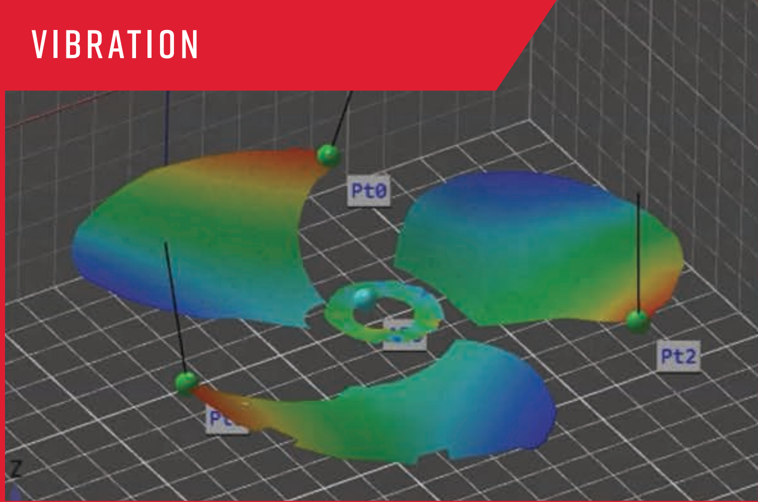
DIGITAL IMAGE CORRELATION



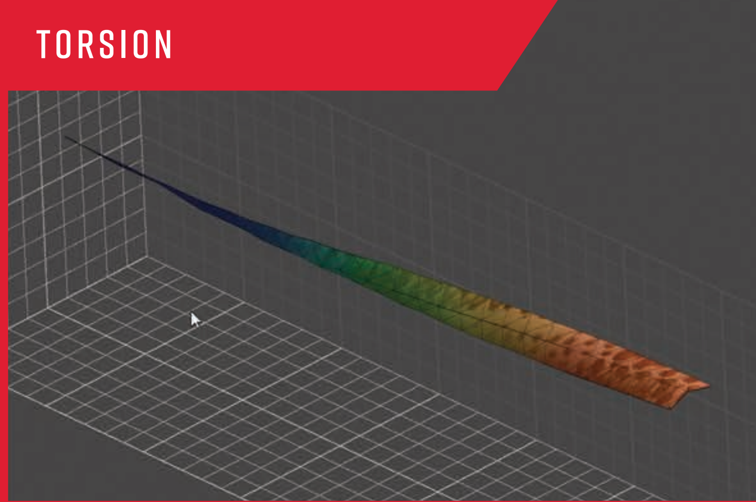
RESIDUAL STRESS



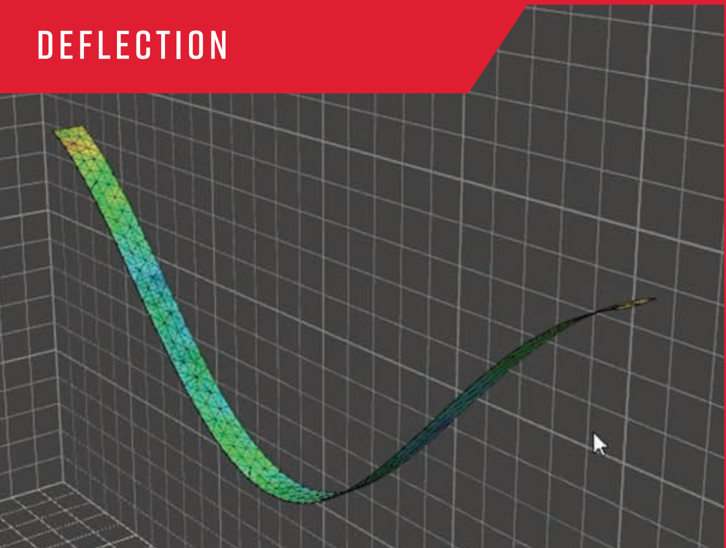
VIBRATION



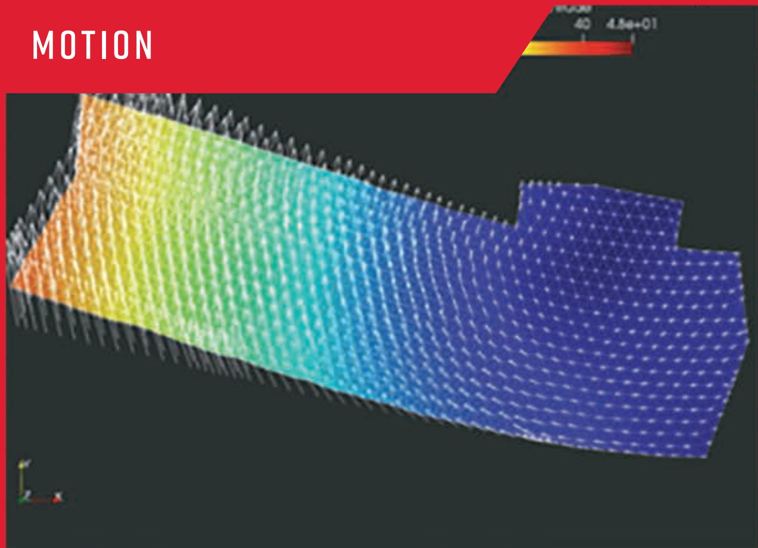
TORSION



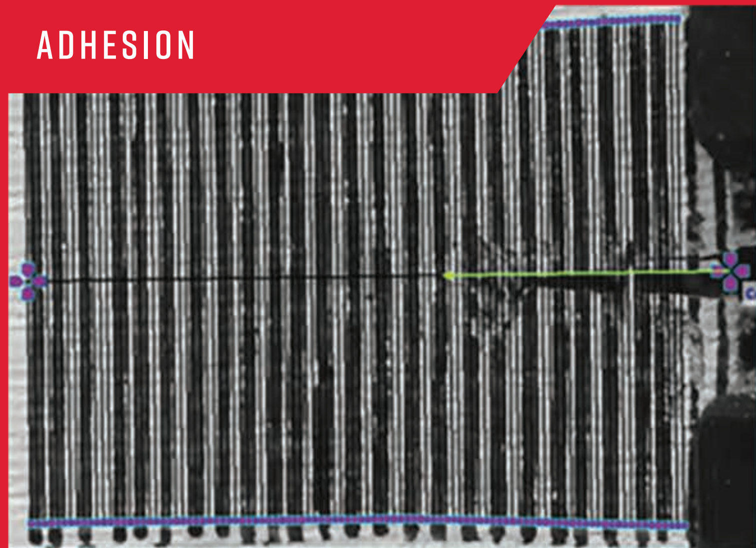
DEFLECTION



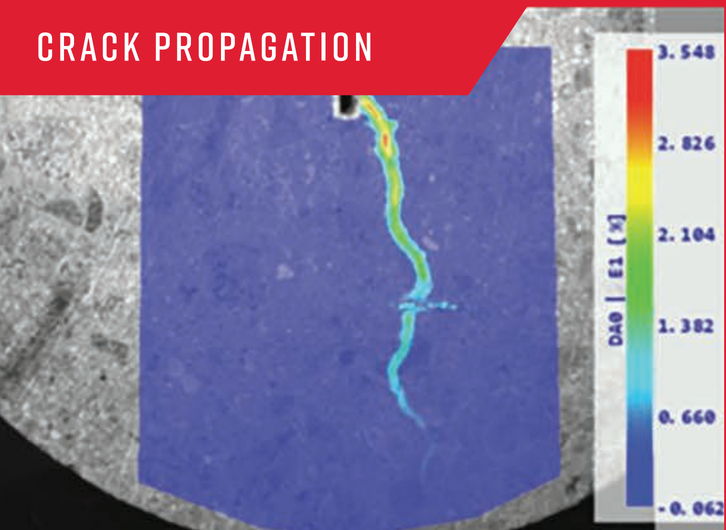
MOTION



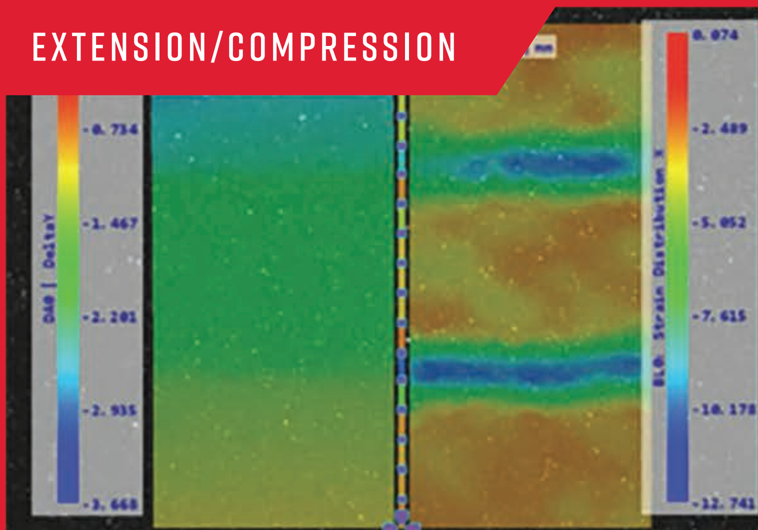
ADHESION



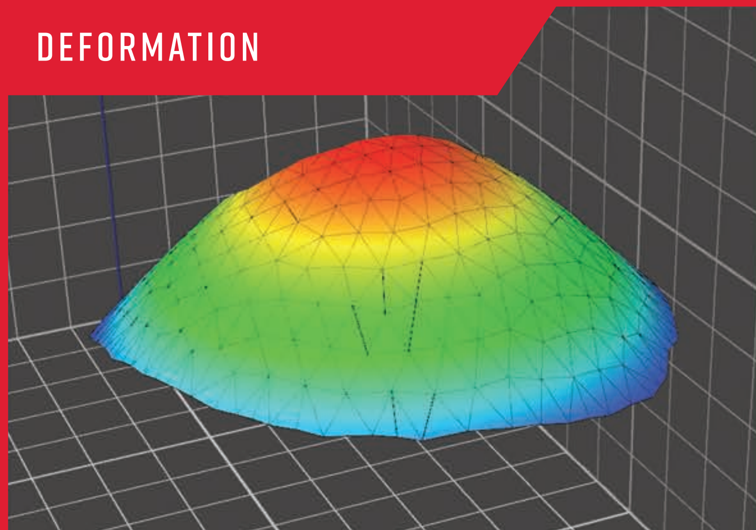
CRACK PROPAGATION



EXTENSION/COMPRESSION



DEFORMATION



INTRODUCING DIGITAL IMAGE CORRELATION

Today digital image correlation (DIC) is used in industry, as well as in research and development, at universities and research facilities. It can be used to aid product and material development, and used to test and validate finite element models (FEA) at a more advanced level.

The skills acquired by learning how to use DIC as part of an engineering curriculum means that students can apply the technique to a variety of fields of engineering. This can help students develop a greater understanding of how different materials, or structures, behave under different loads and in different environments.

WHAT IS DIGITAL IMAGE CORRELATION?

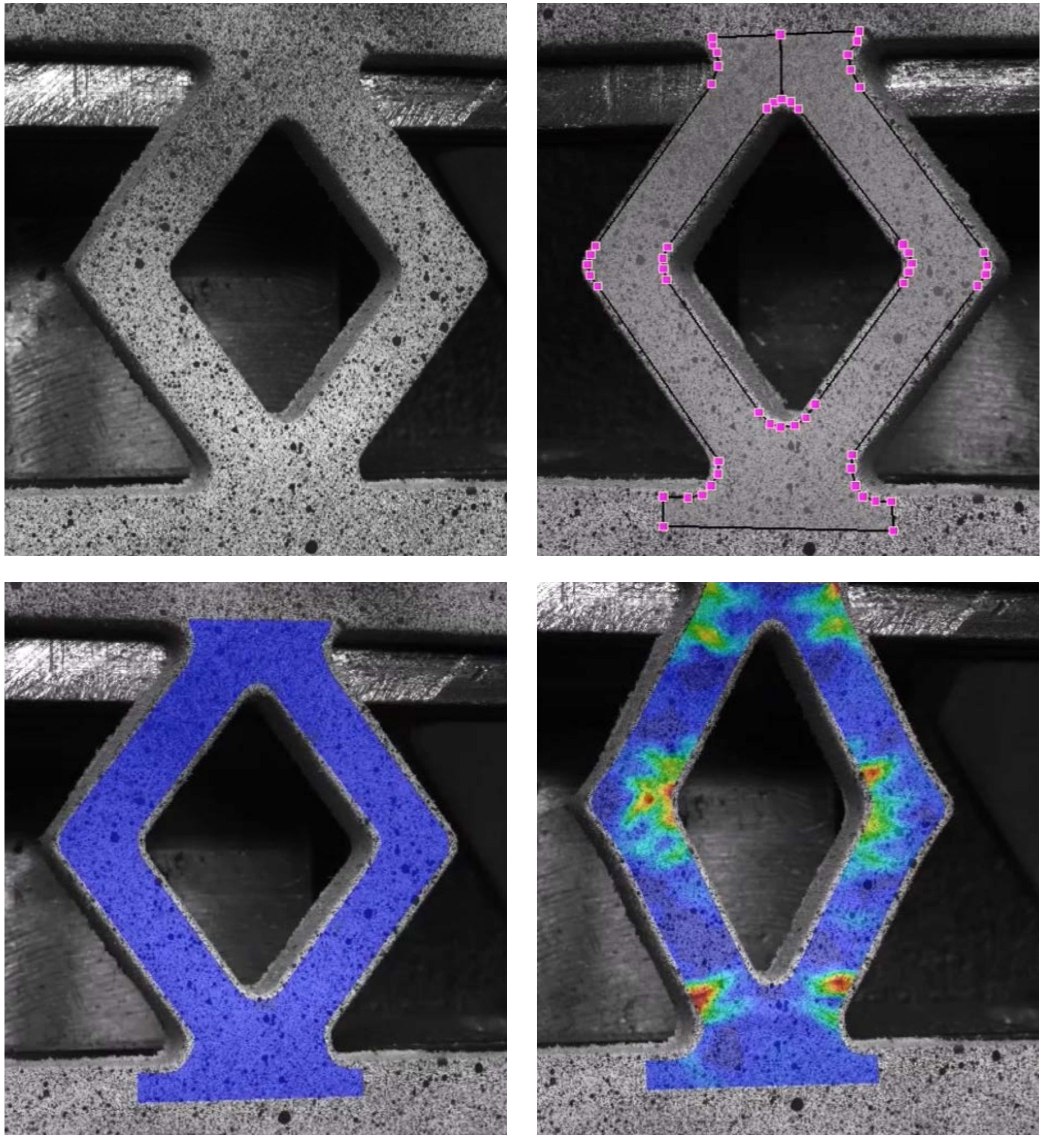
DIC is a non-contact optical technique that offers a highly accurate method of measuring strains, deformations or vibrations of materials as they undergo loading conditions.

It is ideal for students studying materials science, structural engineering and other related disciplines since DIC helps them visualise how materials behave when subject to various loads that would not be apparent to the naked eye.

HOW DOES DIC WORK?

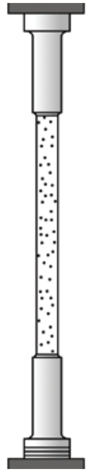
The DIC technique works by taking images of the object before any strains are applied, then continually tracking deformations in the material whilst the load is being applied

DIC uses one or more high-speed video cameras to track the movement of materials during a dynamic event. Images are collected and advanced computer processing is used to reconstruct the images to enhance visualisation. The surface is tracked by using a random surface pattern, either naturally occurring on the material, or applied using a 'speckled' pattern.



2D DIC USED TO MEASURE STRAIN ON A COMPLEX CONCRETE SHAPE

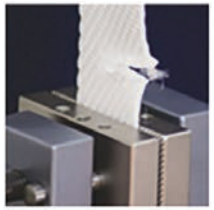
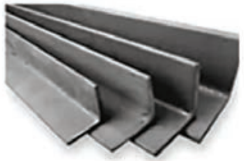
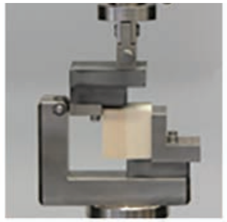
WORKING WITH DIFFERENT MATERIALS AND SURFACES



DIC works by tracking small changes to unique features on the surface of an object. These features can either be natural, such as wood grain, or they can be created artificially using a speckle pattern (a high-contrast series of marks applied to the specimen surface, such as dots or lines, by a pen, stamp or paint).

Some surfaces that don't need "speckling":

- Non-polished metals
- Wood
- Textiles
- Composites
- Concrete


WHEN YOU NEED A SPECKLED PATTERN

The most important thing in DIC measurements is to have a clear, contrasting pattern for the software to track.

Speckled patterns are needed for surfaces featuring smooth and shiny finishes. Generally in DIC this takes the form of a randomly distributed series of dots called a "speckle pattern".

Ideally the target area should be given a black or white undercoat using a thin layer of matt paint. A contrasting pattern of speckles is then applied using, for example, either a rocker stamp, roller or printed directly onto the surface area.

SPECIMEN WITH APPLIED SPECKLED PATTERN

SPECKLING KIT COMING SOON

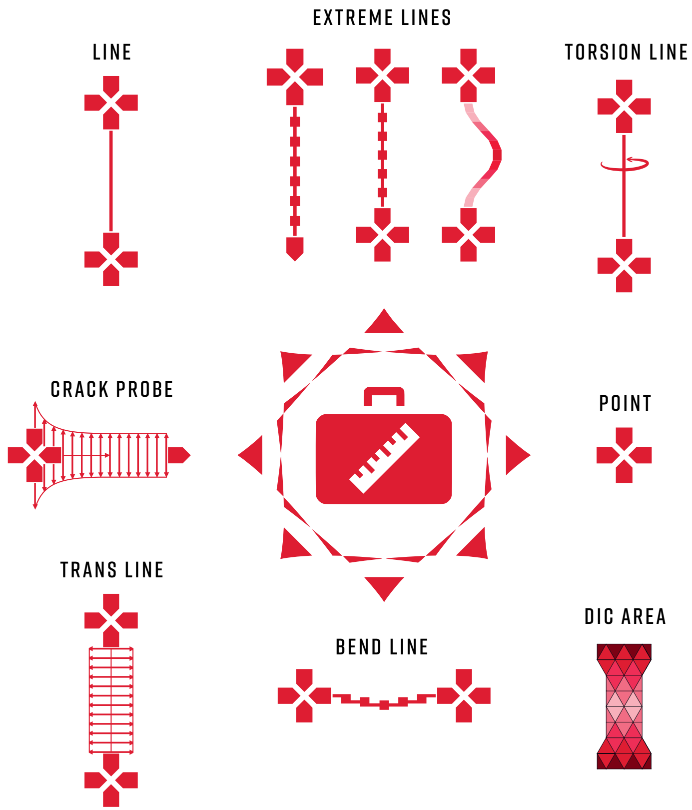
A compact kit designed to teach students how to apply a speckle pattern to a variety of surfaces for DIC measurements. The kit includes a set of rocker stamps and rollers covered in flexible studs.
It allows the user to easily create patterns to cover a range of different surface profiles from flat area, curved surfaces and small intricate areas, helping the DefleX® camera capture and track material deformations.


MEASUREMENT PROBES

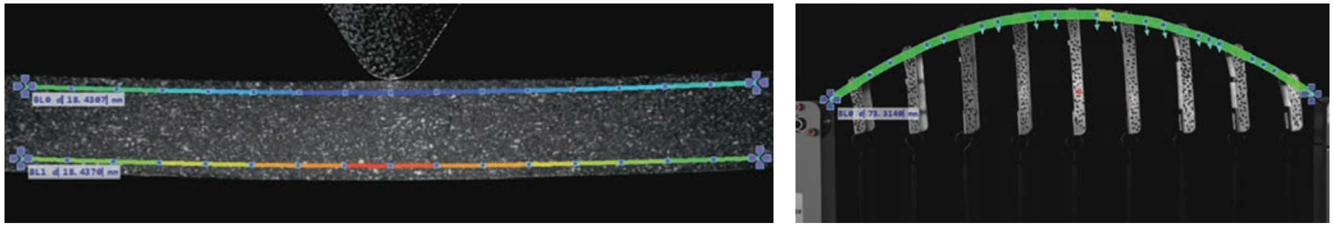
MEASUREMENT AND ANALYTICAL TOOLS

The DefleX® software offers students a number of probes, or sensors, which can be used individually or in combination to customise the measurement of specimens being tested.

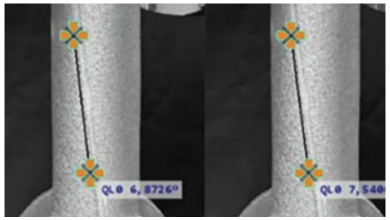
- **Line** is an elementary measuring probe for strain and length determination.
- **Extreme line** is the probe for axial neck detection.
- **Trans line** analyses the change in width along a specimen.
- **Torsion line** enables dual position angular twist and strain measurement.
- **Bend line** is a probe designed for bending tests. Measures strain over a curved shape and enables the visualisation of the real-time strain distribution.
- **Crack probe** measures crack length during static or dynamic tests.
- **DIC area** is the full-field probe for strain and displacement distribution mapping.



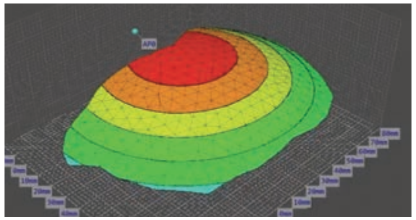
EXAMPLES OF SOME OF THE MEASUREMENT PROBES:



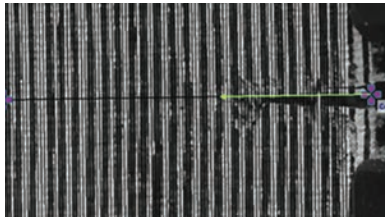
BEND LINE



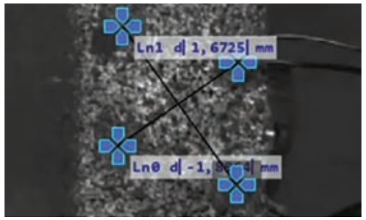
TORSION LINE*



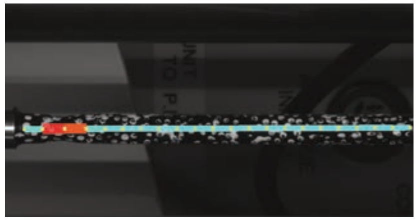
DIC AREA



CRACK PROBE



LINE



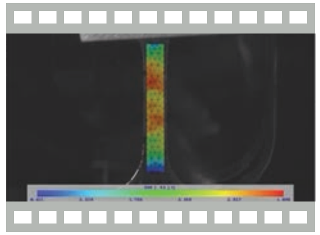
EXTREME LINE*

*Deflex®-2D only

DEFLEX®-2D

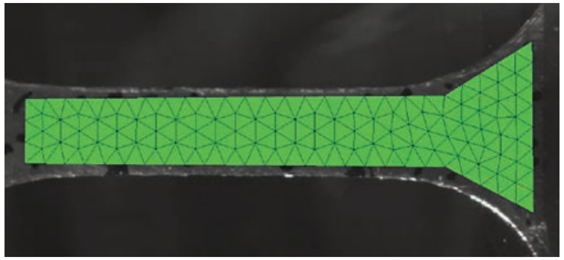
DefleX®-2D is an entry-level system designed to introduce students to the concept and technique of digital image correlation. As a complete and compact system, DefleX®-2D offers students a digital blended learning experience as part of their engineering courses.

DOWNLOAD DATASHEET

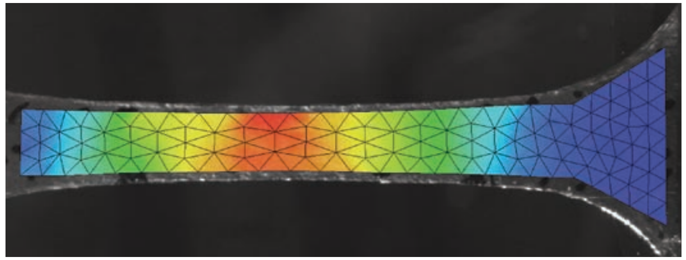


BENEFITS OF DEFLEX®-2D FOR STUDENTS

- Fast and easy to set up
- Great visual learning aid
- Teaches students about the DIC technique
- Encourages learning by experimenting
- Real time concept demonstration
- Deeper scientific understanding of behaviour of materials under strain
- Enhances theory with practical use
- Provides real-time experiment results



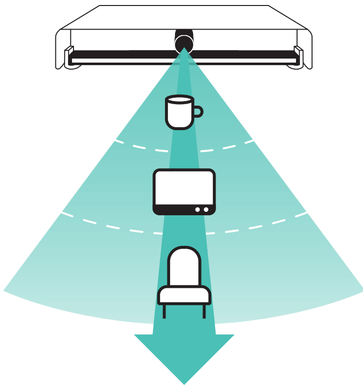
PRE-STRAIN: BEFORE ANY LOADING IS APPLIED TO THE SURFACE MATERIAL



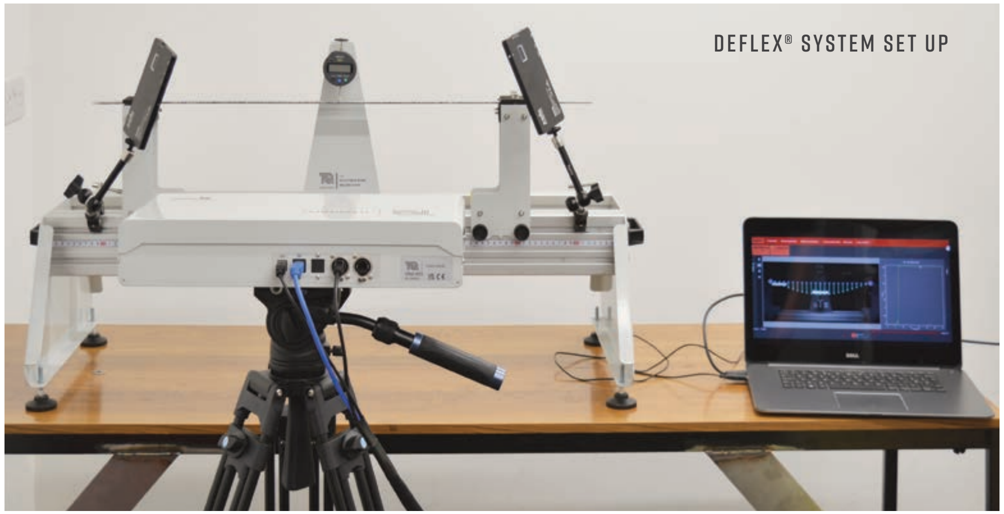
POST-STRAIN: STRAIN DISTRIBUTION ACROSS THE FULL SURFACE OF MATERIAL

SETTING UP THE SYSTEM

The single-lens compact DefleX®-2D camera unit uses an interchangeable set of single lenses offering students the flexibility to measure objects at different distances.



WORKING DISTANCE

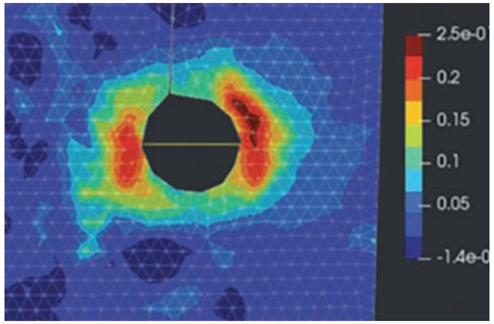


DEFLEX® SYSTEM SET UP

APPLICATIONS OF 2D DIGITAL IMAGE CORRELATION

RESIDUAL STRESS

2D DIC is used to help visualise strain distribution around a drilled hole in the surface of a part containing residual stresses. Combined with finite element simulation, DIC can helps students assess residual stresses in the part.

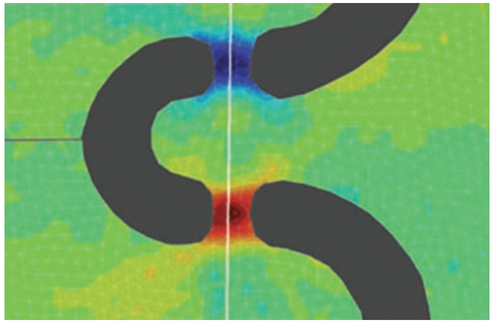


Benefits of DIC:

- Study of residual stresses to understand material performance and structural integrity
- Prevent failures
- Ensure quality control
- Optimise design

STRAIN CONCENTRATION

2D DIC is used to identify strain distribution on a loaded shear-test sample. Identifies strain concentration which can indicate weak points in a component's design. These are potential failure points under static loading or crack initiation sites under cyclic loading.

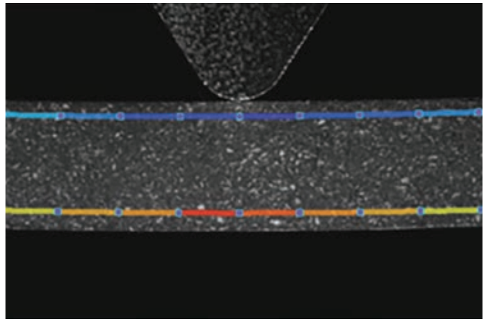


Benefits of DIC:

- Identify weak points, optimise design and manufacturing processes
- Assess structural integrity
- Enhance safety
- Conduct fatigue studies

DEFLECTION

Visualisation of strain distribution during a three-point bending test, showing compression on the top side and tension on the bottom side of the beam. The deflection distribution can also be observed in this setup.



2D DIC can be used to evaluate three/four-point bending tests and visualise fundamental principles of beam bending, which is a critical and potentially dangerous deformation mode.

Benefits of DIC:

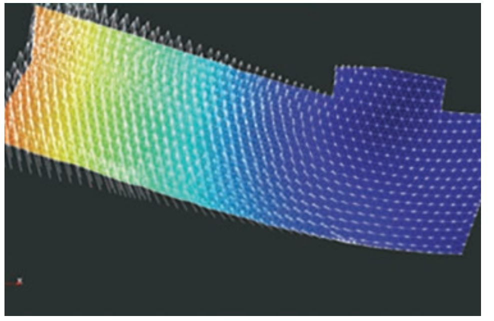
- Material selection
- Component sizing
- Design optimisation
- Component validation
- Assessment and maintenance of existing structures
- Damage prevention
- Ensure compliance with standards

READ OUR BLOG TO FIND OUT MORE

Unlocking the world of digital image correlation (DIC) with the DefleX® solution.

TECQUIPMENT.COM/KNOWLEDGE

MOTION



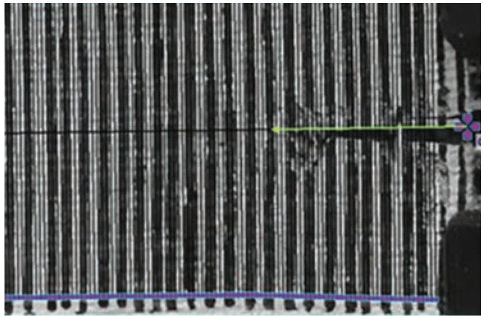
2D DIC provides a comprehensive view and understanding of the behaviour of the component or structure.

Displacement field displayed using both a colour map and a vector field in a motion study of the component.

Benefits of DIC:

- Assess the safety and stability of structures
- Evaluate the performance and functionality of mechanisms
- Analyse and control vibrations
- Predict dynamic responses and noise
- Assess durability
- Optimise or validate design and simulations

ADHESION



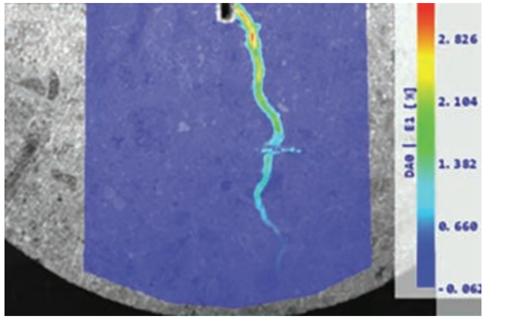
Measures the strength of the bond between two materials and assesses the uniformity and durability of adhesive applications.

2D DIC shows crack length progression during an adhesion test, such as a peel test or a pull-off test.

Benefits of DIC:

- Ensure product performance and reliability
- Test material compatibility and selection
- Quality control and compliance with standards
- Understand and prevent adhesive failures
- Enhance user safety and experience
- Optimise manufacturing processes

CRACK PROPAGATION



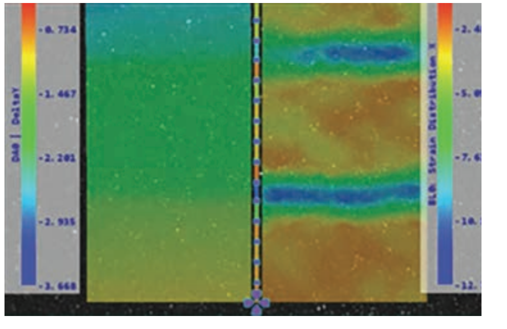
2D DIC is ideal to help students understand the material's fracture behaviour and toughness, characterise anisotropy and heterogeneity in the material, and evaluate stress concentration effects.

An illustration of the principal strain distribution during a notched Brazilian disc test of concrete.

Benefits of DIC:

- Predict and analyse component failure
- Design optimisation
- Select materials with appropriate crack-resistance properties
- Extend the service life of components/structures
- Maintenance planning

EXTENSION/COMPRESSION



2D DIC helps to provide a comprehensive understanding of the deformation of non-standard materials (e.g. composites, foams).

Displacement (left) and strain (right) distribution during the compression test of a foam-like structure.

Benefits of DIC:

- Determine material properties such as elastic modulus, yield strength, ultimate strength, ductility and Poisson's ratio
- Design of structures and components
- Ensure safety and reliability
- Quality control and standard compliance
- Analyse and prevent failures

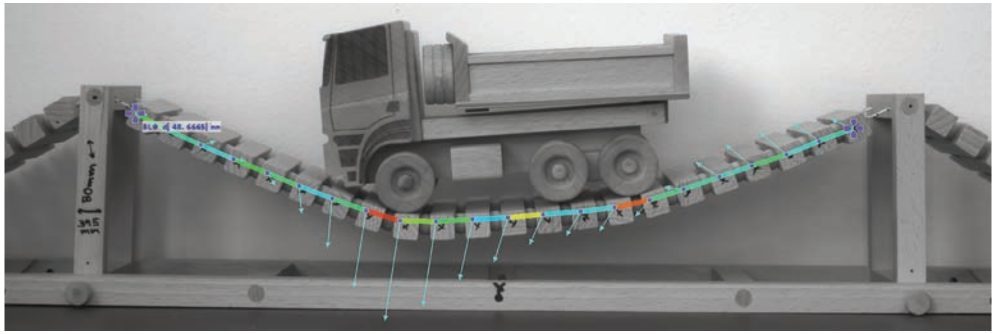
PRACTICAL APPLICATION EXAMPLES OF 2D DIGITAL IMAGE CORRELATION

STRUCTURES AND CIVIL ENGINEERING

MEASUREMENT PROBE WITH BEND LINES

DIC can be used for monitoring the behaviour of large structures. In the image above, using the bend line, the deformation curve is visualised with scaled vectors and shows a deflection of 2 mm caused by the locomotive. The colour coding represents the relative change in the distance between neighbouring points.

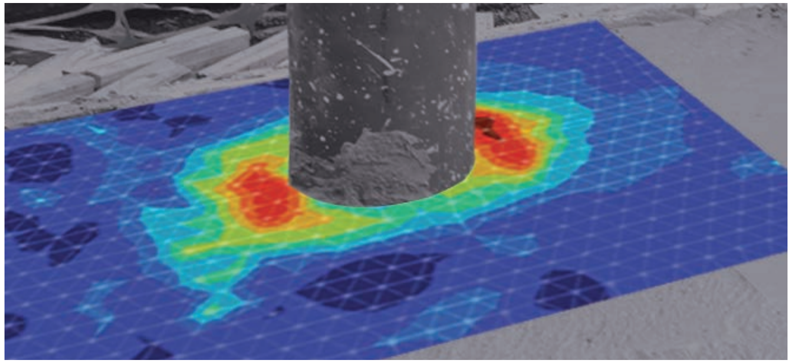
This data can be used to validate the structure's design, confirm compliance with regulations and standards, or enhance structural safety by detecting unexpected responses within the system.



MEASUREMENT PROBE WITH BEND LINES

DIC visualises vectors in real time to show how loading has changed the shape of the original catenary curve, and a colour map shows how much the transverse beams have moved relative to one another.

MATERIALS TESTING AND PROPERTIES



MEASUREMENT PROBE WITH DIC AREA

DIC can be used to examine factors affecting residual stresses around an object in concrete caused by uneven drying. This helps identify crack formation during construction and reduce the risk of failure under anticipated loading conditions. DIC could also be used to quantify concrete shrinkage and settlement.

MEASUREMENT OF TENSILE STRAIN DUE TO WEIGHT OF CLIMBER

This illustrates the practical application of tensile loading on the ropes due to the climber's weight. Visualising tensile loading of equipment in extreme environments is made easier with digital image correlation.

DEFLEX®-3D

DOWNLOAD DATASHEET

An integrated digital image correlation system for measuring full-field displacements and strains over a material's surface in three dimensions. DefleX®-3D is ideal for materials science, structural engineering and general mechanical engineering courses.

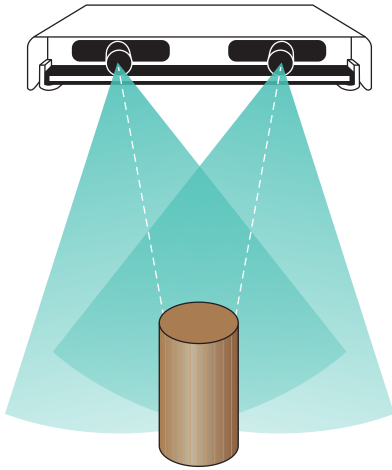
DefleX®-3D is a three-dimensional digital image correlation (DIC) system designed to teach students how to accurately measure full-field 3D surface deformations, strains and displacements in materials and objects. This cutting-edge technology is a powerful tool for gaining insights that are difficult or even impossible to achieve with traditional measurement techniques.

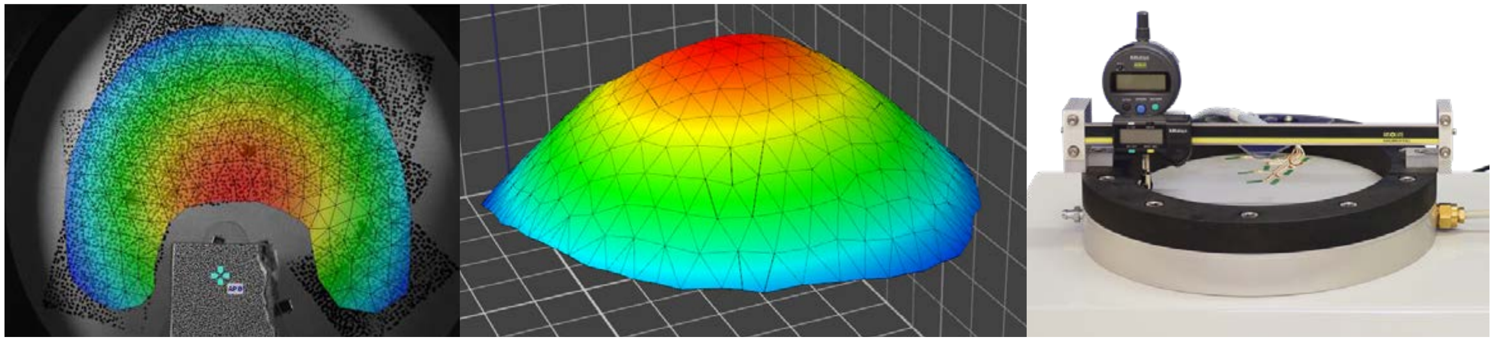
KEY BENEFITS OF 3D DIC

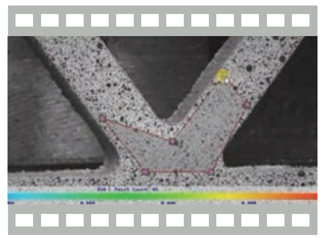
- 3D visualisation of strain measurement and surface deformations
- Non-contact method - no contact between the camera and the object/surface
- Enhances student learning experience
- Fast and easy to set up
- Teaches students principles of digital image correlation
- A non-destructive method to assess the quality of materials and objects by identifying hidden material defects
- Enables precision-driven product development allowing for innovative product design validation and reduced prototype testing
- Great potential in vibration and other structural dynamic tests

THE DEFLEX®-3D SYSTEM

DefleX®-3D features two stereoscopic cameras that simultaneously view the surface of a specimen. The software matches the subset pattern between the two cameras in a process known as stereo-matching. The triangulation of the DIC point between two cameras of known separation and orientation allows deformations and displacements to the surface in the Z-axis (towards and away from the camera) to be calculated.







DEFLEX®-3D VISUALISATION OF THE EFFECT OF PRESSURE ON THE SURFACE PROFILE OF THE DIAPHRAGM (SM1008)

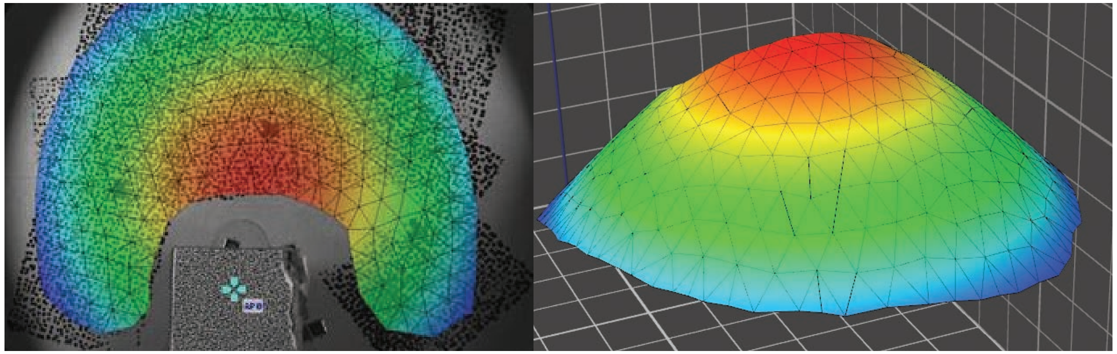
APPLICATIONS OF 3D DIGITAL IMAGE CORRELATION

DEFORMATION OF METAL DIAPHRAGM

3D DIC can be used to visualise the effect of pressure on the surface profile of a diaphragm and measure the distribution of circumferential and radial strains.

DefleX®-3D can be used to show deformation of a metal diaphragm due to increasing pressure of oil reservoir beneath it.

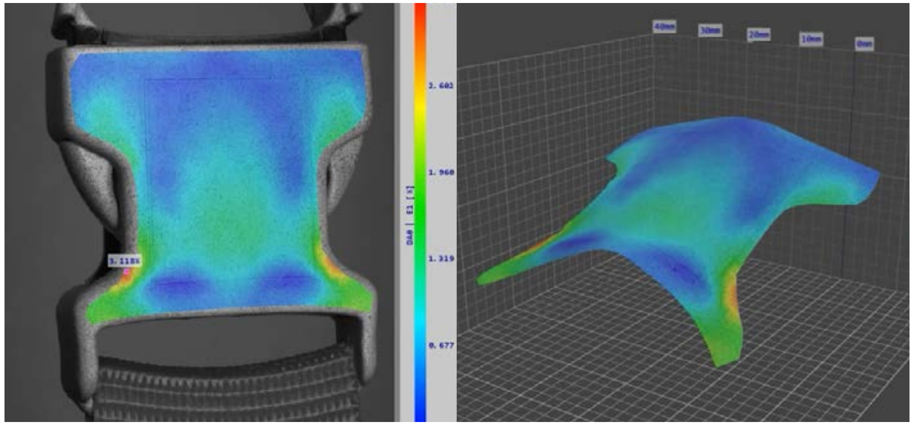
In this instance, using DefleX®-3D is a great way to visualise how digital technology can be used to measure material behaviours under high pressure.



DEFLEX®-3D VISUALISATION OF THE EFFECT OF PRESSURE ON THE SURFACE PROFILE OF A DIAPHRAGM (SMI008)

COMPONENT TESTING

Component testing of a belt buckle subjected to tensile loading in 3D. The distribution of the first principal strain is shown along with the underlying mesh of elements used for its calculation. The red areas indicate potential locations for stiffening to prevent excessive deformation. Additionally, this analysis can serve as a basis for calibrating the Finite Element Model.

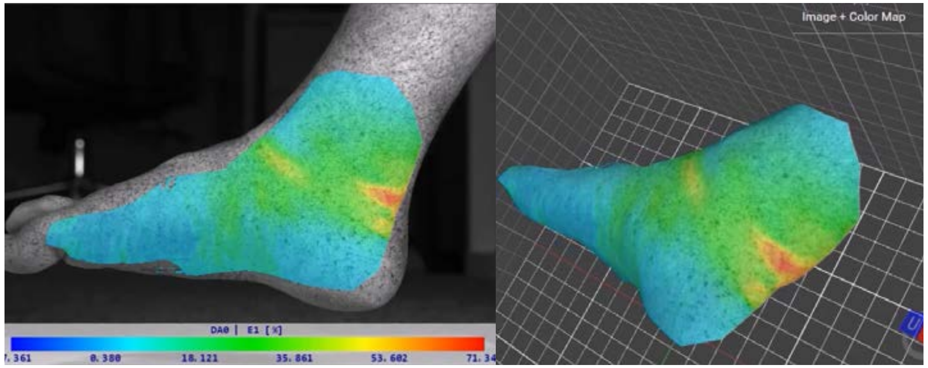


COMPONENT TESTING OF A BELT BUCKLE SUBJECTED TO TENSILE LOADING IN 3D

BIOMECHANICS AND SOFT MATERIALS ANALYSIS

DefleX®-3D delivers precise, full-field deformation measurements for soft materials, such as soft polymers or skin, enabling everything from non-invasive, real-time monitoring to advanced analysis of material behaviour.

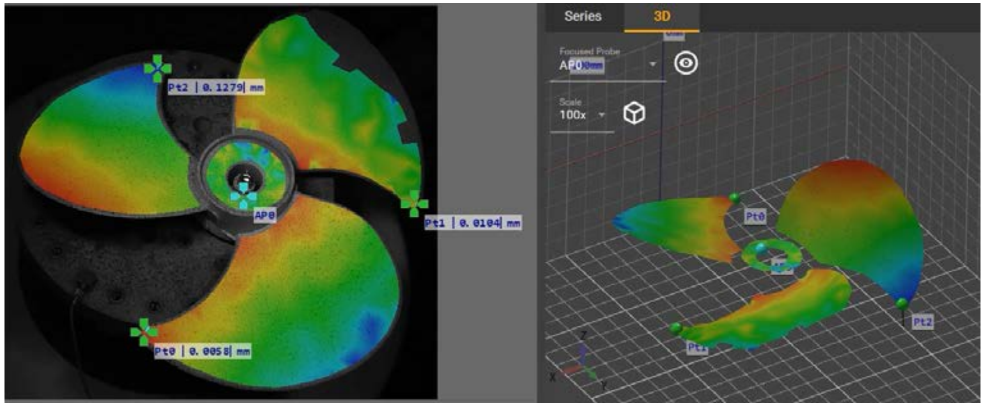
Whether testing biological tissues, soft polymers or other flexible materials, DefleX®-3D provides unparalleled insights with high-resolution imagery.



VISUALISING THE STRAIN FIELD IN SKIN AS IT STRETCHES AND COMPRESSES DURING FOOT MOVEMENT

DEFLECTION OF A FAN BLADE

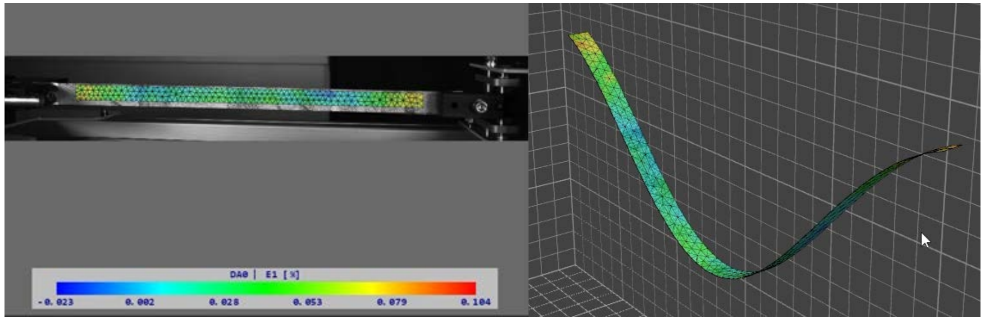
DefleX®-3D can be used to investigate the response of a component to external vibration. This helps to visualise the deflections that describe the mode shapes (vibration patterns) of fan blades under various loading frequencies. With two cameras, DefleX®-3D can measure contour, displacement and vibration of the propeller blades.



VISUALISATION OF VIBRATION OF PROPELLER BLADE

DEFLECTION PROFILES OF STRUTS UNDER EULER BUCKLING

Uniaxial compression of a slender strut with fixed ends. This example illustrates visual representation of bending that has been exaggerated 20x to show the shape of the deformation. This is used whenever columns or struts are under axial compression.

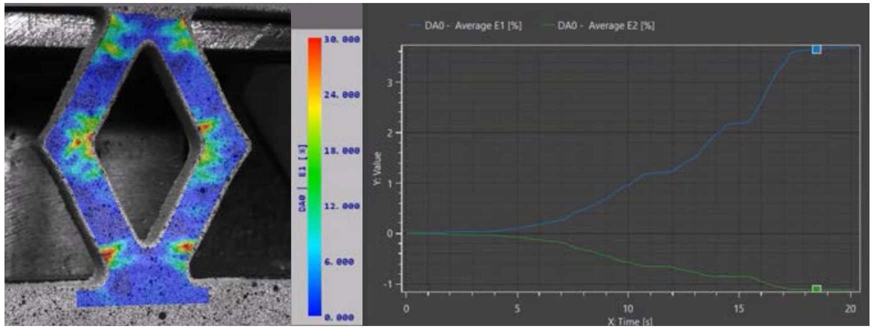


BUCKLING OF A SLENDER STRUT UNDER AXIAL COMPRESSIVE STRAIN USING THE EULER BUCKLING APPARATUS (SM1005)

COMPLEX SHAPE INVESTIGATION

Utilise DefleX®-3D's non-contact measurement capabilities to study complex-shaped components under various loading conditions. Gain deeper insights into their behaviour, identify strain concentration areas and optimise designs for enhanced durability and reliability.

DefleX®-3D shows how a concrete structure will handle tensile strains, which is important for materials design and civil engineering. The heat maps show where the tensile strains are the greatest.



STRAIN DISTRIBUTION IN A COMPLEX CONCRETE STRUCTURE

FIND OUT MORE ABOUT DEFLEX® ON OUR WEBSITE

TECQUIPMENT.COM/OPTICAL-EXTENSOMETRY

COMPATIBLE TECQUIPMENT PRODUCTS

DefleX® can be used as a complementary learning aid to TecQuipment products (the list below is not definitive) and other suitable third-party lab products.

CODE	PRODUCT NAME	EXPERIMENT TYPE
NEXT GENERATION STRUCTURES		
STS4	Deflection of Beams and Cantilevers	Bending
STS7*	Unsymmetrical Bending and Shear Centre	Bending
STS10	Two-Pinned Arch	Bending
STS11	Fixed Arch	Bending
STS12*	Euler Buckling of Struts	Bending
STS14	Curved Bars and Davits	Bending
STS15	Plastic Bending Beams	Bending, Strain
STS16	Plastic Bending of Portals	Bending
STS18	Frame Deflections and Reactions	Bending
STS19	Simple Suspension Bridge	Bending, Strain
MATERIALS TESTING AND PROPERTIES		
MF40 MkII	Materials Laboratory with Data Capture	Tensile
SM110	Hooke's Law and Spring Rate	Tensile
SM1000	Universal Testing Machine	Tensile
SM1001*	Torsion Testing Machine	Torsion
SM1002	Benchtop Tensile Testing Machine	Tensile
SM1003*	Unsymmetrical Cantilever	Bending
SM1004	Beam Apparatus	Bending
SM1005*	Euler Buckling Apparatus	Bending
SM1006	Creep Machine	Strain, Tensile
SM1008*	Diaphragm	Stress, Strain
TE16	Stiffness, Bending and Torsion	Bending

* Only compatible with DefleX®-3D

CODE	PRODUCT NAME	EXPERIMENT TYPE
THEORY OF MACHINES		
TM163*	Centre of Percussion	Vibration
TM164	Free Vibrations of a Mass Spring System	Vibration
TM165	Free Torsional Vibrations	Vibration
TM166	Free Vibrations of a Cantilever	Vibration
TM167	Free Vibrations of a Beam and Spring	Vibration
TM1016V	Free and Forced Vibrations	Vibration

LICENSING

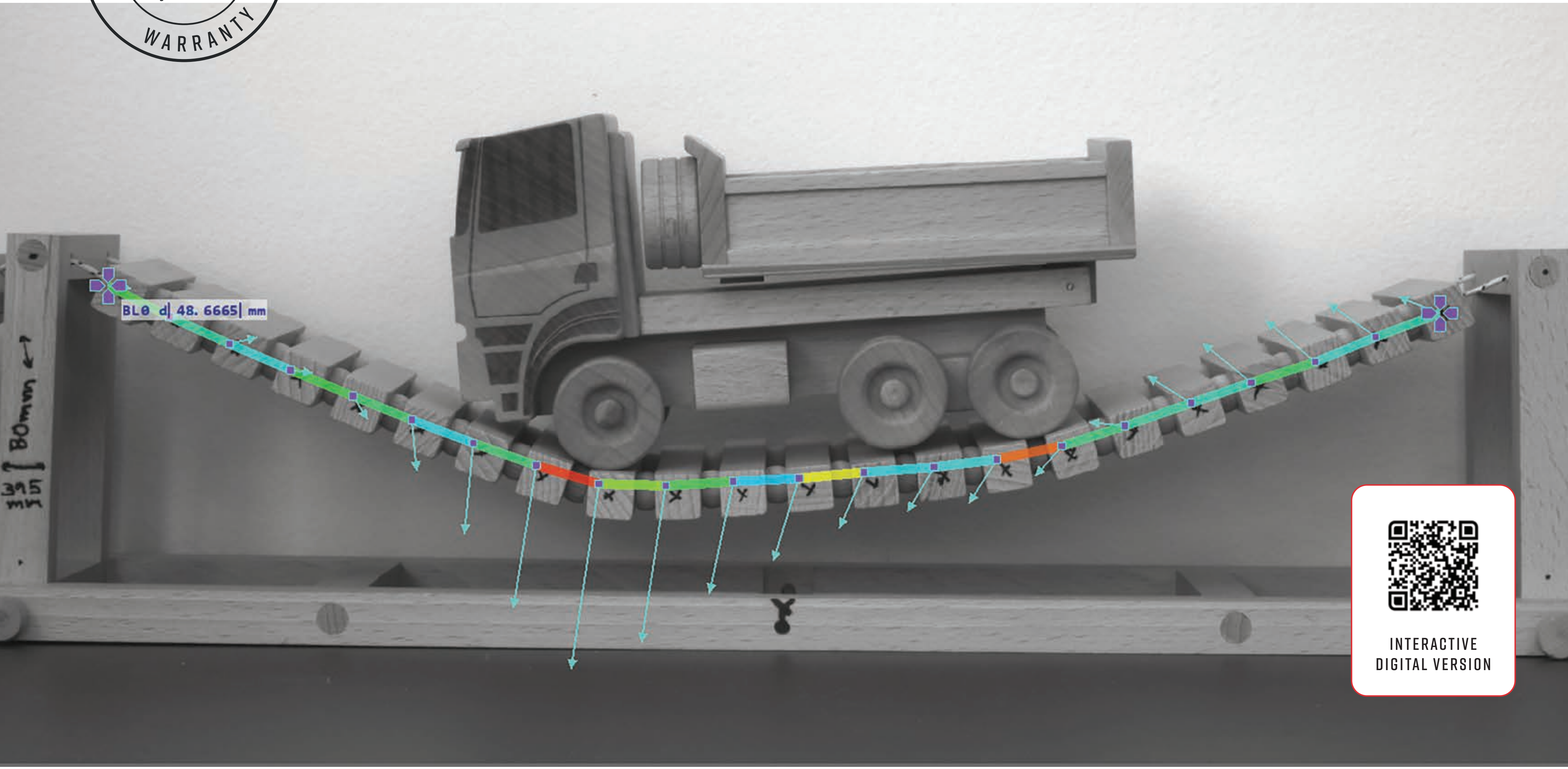
DefleX® comes with a single-user perpetual software licence linked to a USB dongle. The software can be installed on unlimited PCs and operated via the USB licence key.

The DefleX® software can be optionally extended by purchasing an annual network licence (DefleX®-2DNet and DefleX®-3DNet) allowing up to 20 users access to the software on the same network. This enables students to concurrently and independently analyse footage captured by the camera and data recorded in the software. (NOTE: both the network licence and the single-use licence are restricted to educational purposes.)

DefleX® is aimed at education for use in universities, colleges and other specialist training centres, and shall only be installed on equipment owned or used by such institutions.

TECQUIPMENT

FIVE YEAR
QUALITY
TECQUIPMENT
SINCE 1958
WARRANTY



INTERACTIVE
DIGITAL VERSION