Full Field
Displacement and Strain Measurement

On a Charpy Specimen

Using Digital Image Correlation.
Chapter 1: Introduction to Digital Image Correlation

D.I.C.

The method of 3-D DIGITAL IMAGE CORRELATION - DIC is based on principles similar to human depth perception: (Photogrammetry) by viewing the same object or process from two different viewpoints, the precise shape of the object in three-dimensional space can be resolved. Position resolution in three-dimensions is accomplished by referencing a system-wide coordinate system that is established through a calibration process. The calibration process, conducted prior to the start of each test, establishes the intrinsic camera parameters (focal distance, lens distortion factor, and sensor aspect ratio) and geometric parameters (camera positions relative to each other and to the imaged object), that control the transformation between the system-wide coordinates and the coordinates on each camera’s image plane.

The idea behind the method is to infer the displacement of the material under test by tracking the deformation of a random speckle pattern applied to the component's surface in digital images acquired during the loading.

Mathematically, this is accomplished by finding the region in a deformed image that maximizes the normalized cross-correlation score with regard to a small subset of the image taken while no load was applied. By repeating this process for a large number of subsets, full-field deformation data can be obtained.

The DIC method does not require the use of lasers and the specimen can be illuminated by means of a white-light source. However, the specimen surface must have a fairly uniform random pattern, which can either be naturally occurring or applied to the specimen before the test. Among the many methods for pattern application are self-adhesive, pre-printed patterns, stamps and application of paint speckles with air-brushes, spray cans or brushes.

Images of the Test Component in un deformed and Deformed State are captured using 2 CCD Cameras .

The two cameras are mounted on a rigid bar to avoid relative motion of the cameras.

A speckle pattern is applied on the Test Component as shown.

A series of images are captured while the specimen surface is deformed (in-plane, out of plane, rotation, elongation and compression) due to loading. In each captured image, a specific pattern matching algorithm determines the shift, rotation and distortion of each point with respect to the reference image.

DIC measures displacement by tracking the gray value pattern in small neighborhoods called subsets (indicated in red in the figure) during movement,

A subset is defined as a group of pixels, usually between 20×20 and 30×30 pixels. As the surface deformation is measured point wise, displacement of individual surface points and subsequently surface strains can be evaluated.
Results Obtained from 2D Digital Image Correlation

Displacement: \(-u\) and \(v\).

Strains: \(\varepsilon_{xx}, \varepsilon_{yy}, \varepsilon_{xy}\), Von Mises, Tresca

Principal Strains: \(\varepsilon_1, \varepsilon_2\)

And Directions of Principal Strains
Two Fire Wire Cameras interfaced to the Fire Wire Ports of the PC.

DIGITAL IMAGE CORRELATION

3D, DIC SYSTEM.

Displacement and Strain Measurement In-Plane Direction (X and Y Direction) And Out of Plane Direction (Z Direction)

Results Obtained from 3D Digital Image Correlation

Displacement:- u, v and w.

Strains:- $\varepsilon_{xx}$, $\varepsilon_{yy}$, $\varepsilon_{xy}$, $\varepsilon_1$, $\varepsilon_2$, Von Mises, Tresca

And Directions of Principal Strains
A speckle pattern was applied on the charpy test specimen.

The specimen was first spray painted by a white paint. The speckles was marked using a marker pen.

Images were captured at 20000 fps using a Phantom Camera.

Image Resolution was 128 x 624 pixels. A subset of 25 pixels was used for correlation.

CHARPY TEST RESULTS

U Displacement
Time = 2100 µS

V Displacement
Time = 2100 µS
Strain – $\varepsilon_{xx}$

Time = 0 µS

Time = 160 µS

Time = 750 µS

Time = 2100 µS
Click on the Image to open the Video

**STRAIN X - AT TIP OF THE NOTCH**

- Strain X - Microstrain
- Time - Microseconds

**DISPLACEMENT AT THE TIP OF THE NOTCH**

- Displacement - mm
- Time - Micro Seconds

**U DISPLACEMENT**

**V DISPLACEMENT**
Strain – $\varepsilon_{yy}$

Time = 2100 $\mu$S
For More Detailed Information Please contact us at

PYRODYNAMICS
No 632 ; 22 Main ;
4th T Block Jayanagar
BANGALORE - 560 041

TEL:- 011-91-80-26538731
FAX:- 011-91-80-2 66 55 333

E-Mail:- pyrodynamics@bsnl.in
Web:- www.pyrodynamics-india.com

Thank You