PYRO DYNAMICS

TECHNICAL NOTE

Correlated Solutions Inc VIC-3D , 3D - Digital Image Correlation

For Non Contact Full Field Displacement and Strain Measurement

And Modal Analysis.

A Brief Application Note on the Tests Carried out by Pyrodynamics

At Various Organizations in India using VIC-3D, 3D DIC System.

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Instagram:- pyrodynamics_india

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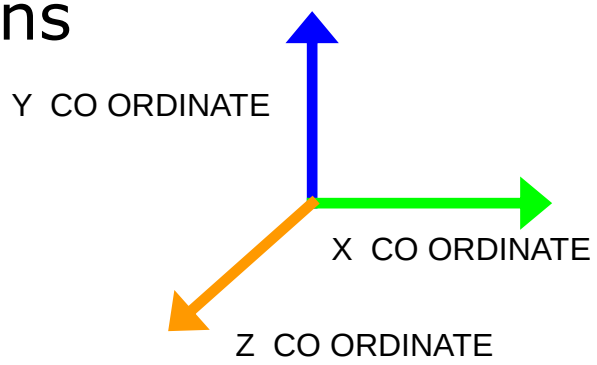
Strain Computation

DIC Measures Displacements.

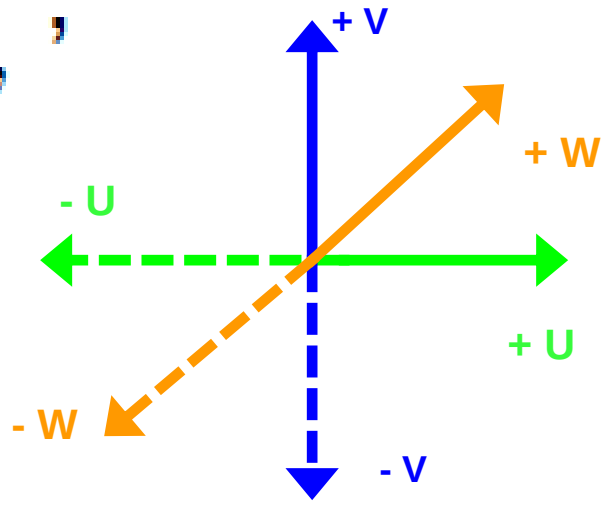
Strain is a Derivative of Displacement. Lagrange Strain tensor is used for calculation of Strains

Calculation of strains:



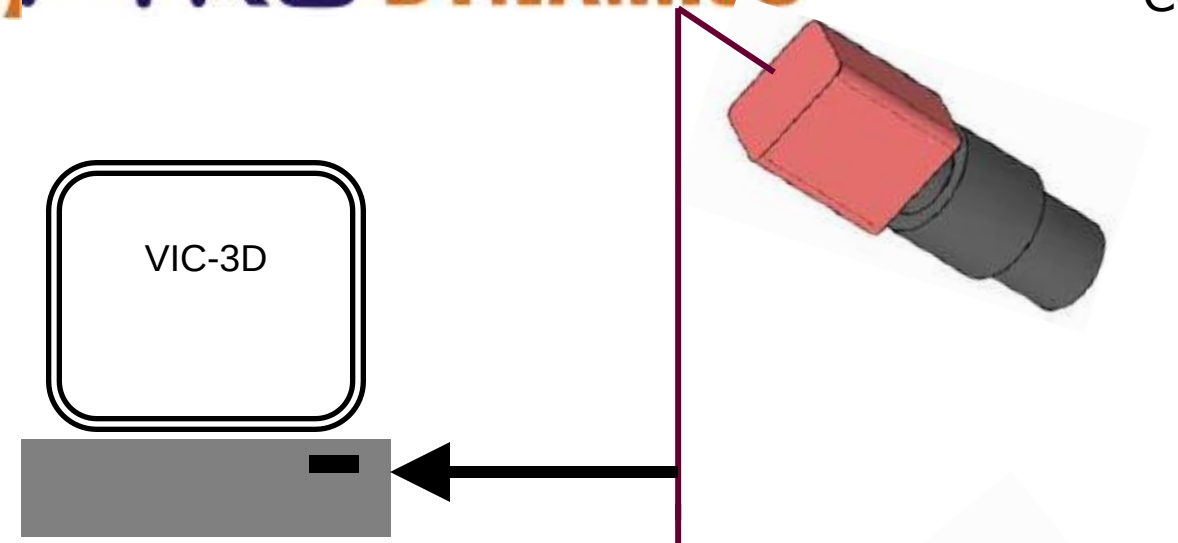
$$\varepsilon_x = \frac{\partial u}{\partial x}, \qquad \varepsilon_y = \frac{\partial v}{\partial y},$$

$$\gamma_{xy} = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}$$

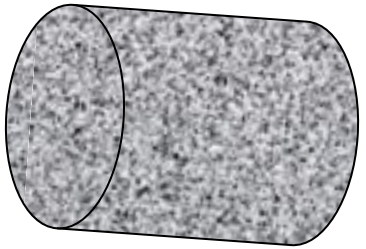


PYRO DYNAMICS

VIC- 3D, 3D Digital Image Correlation System.



Two USB 3.0 Cameras interfaced to the USB Ports of the PC.



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

Contour Co Ordinates:- X, Y and Z ; Displacement:- u, v and w.

Strains:- ε_{xx} , ε_{yy} , ε_{xy} , ε_{1} , ε_{2} , Von Mises, Tresca

and Directions of Principal Strains

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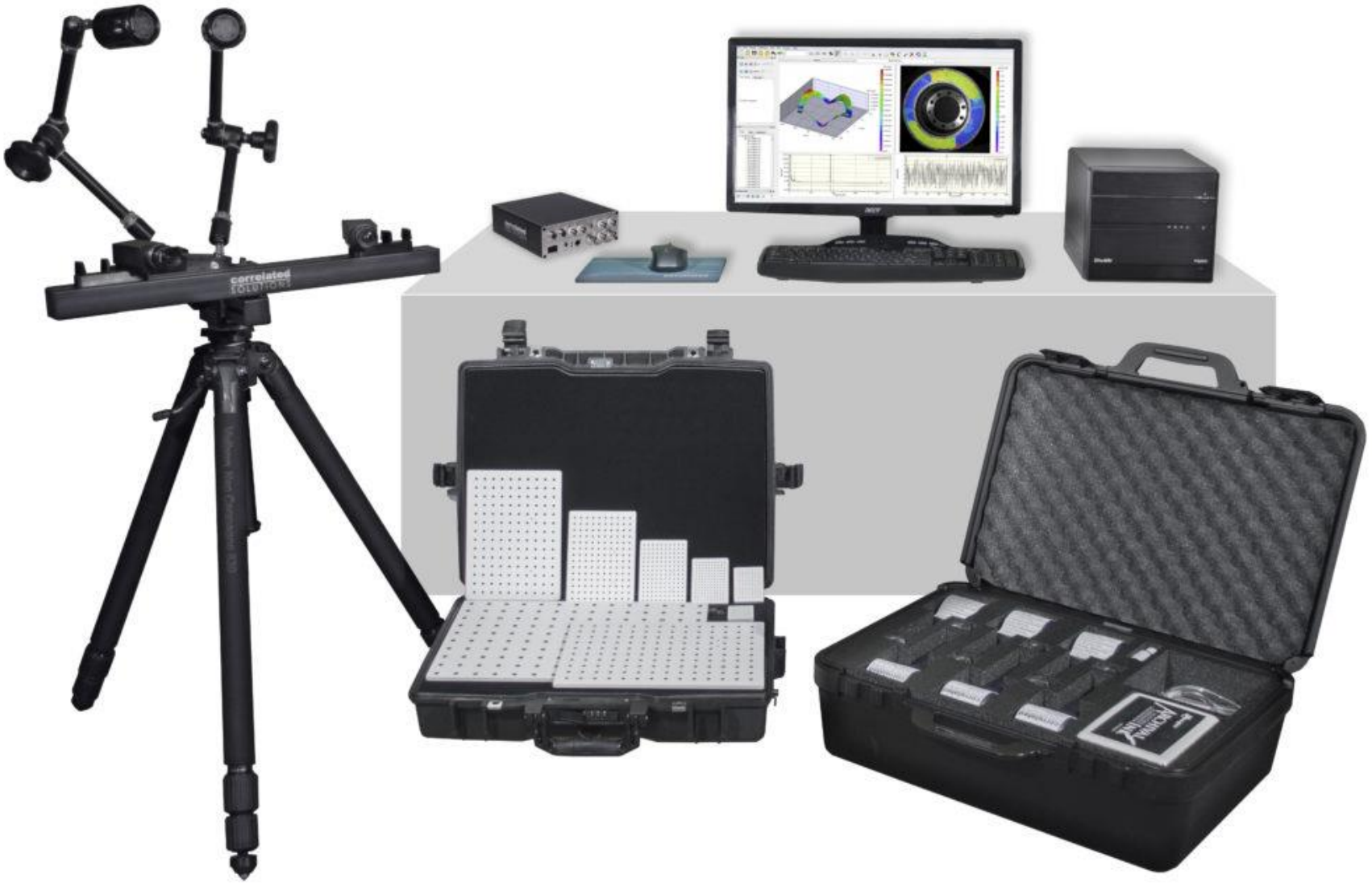
VIC-3D System



PYRO DYNAMICS

Experiment	Validation of DIC Measurements – Comparison of Displacement Data obtained from DIC with the Micrometer Readings.
Organisation	Pyrodynamics – Bengaluru
System Used	VIC-3D, 3D Digital Image Correlation System.
Loading Conditions	Static Load
Camera Used	Point Grey Research Grasshopper 5MP Camera, 15fps
Image Frame Capture	One Image at every discrete load step.

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A Speckle Pattern was applied On a Test Specimen of 100 x 100 mm using an Air Brush with a 0.2mm nozzle.

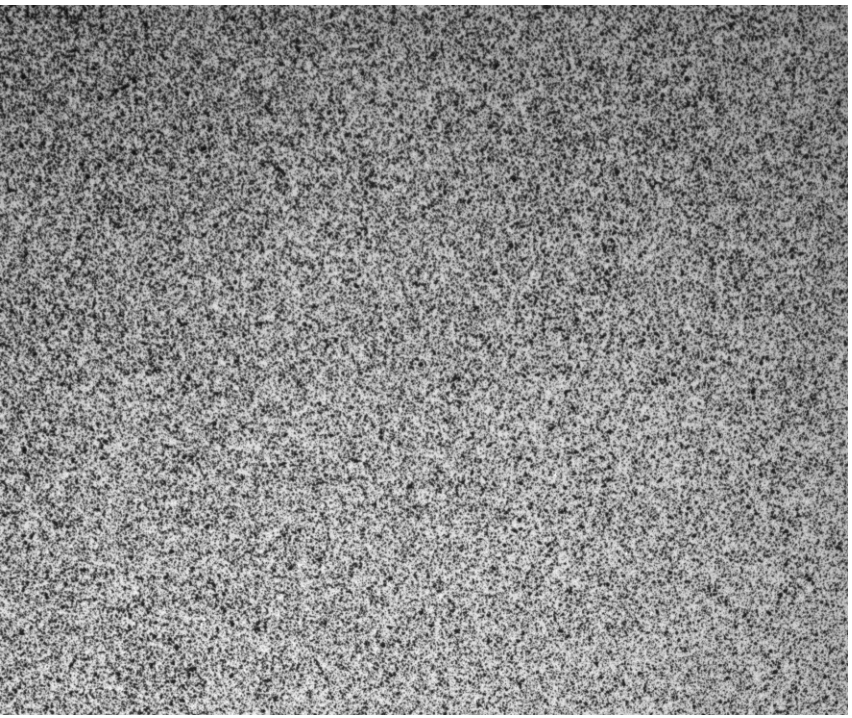
A displacement was provided by a micrometer in the V(Y) Direction

Each rotation of the micrometer provides 500 microns of displacement.

The displacements field showed very little gradients.

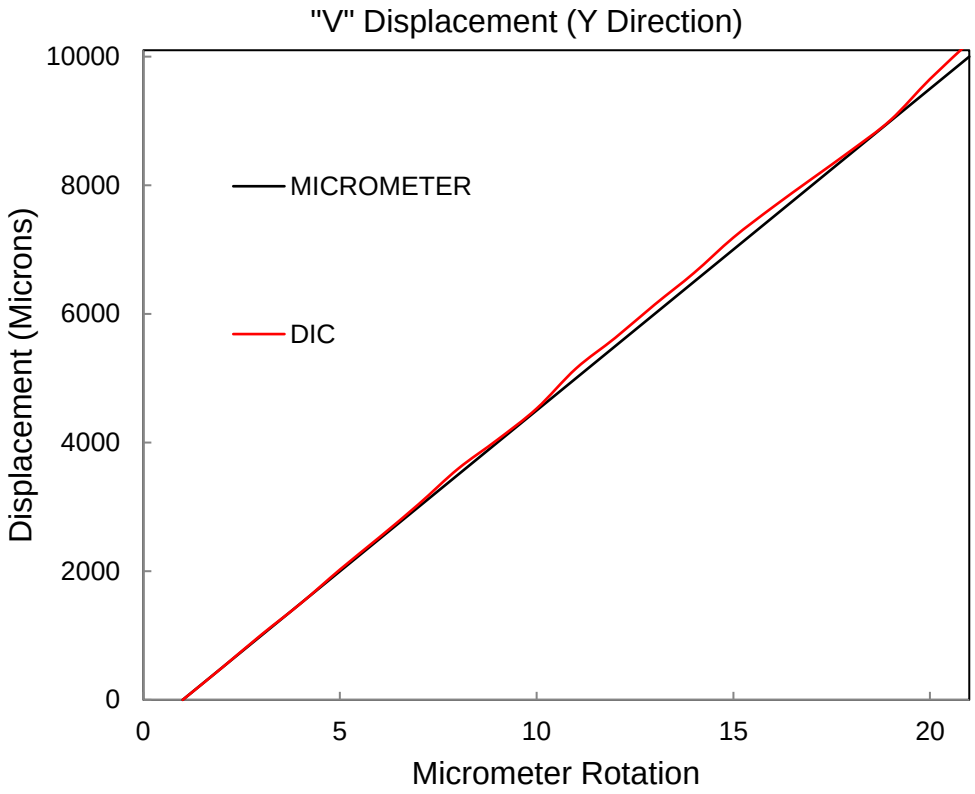
The mean of the DIC plot was taken for comparison with the micrometer readings

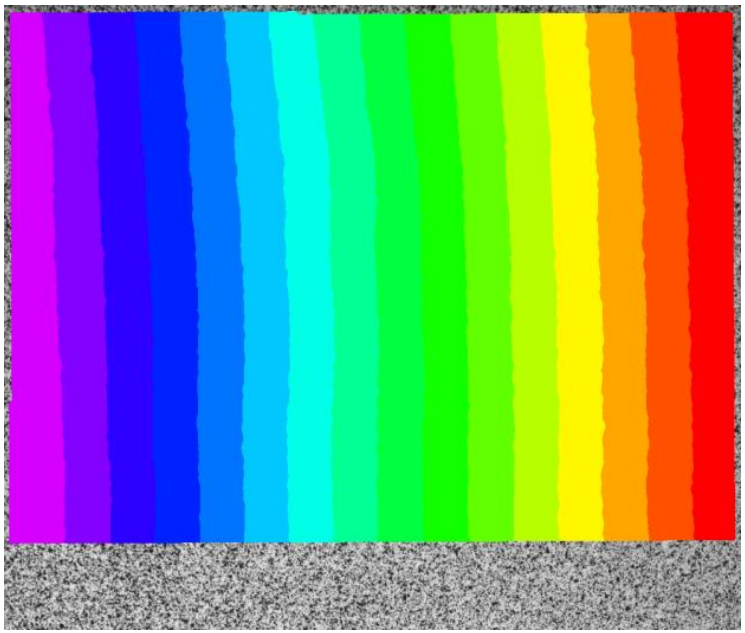
Displacement of the micrometer and DIC measurements matched perfectly.



STEP	MICRO METER	DIC
1	0	0
2	500	499.478
3	1000	1012.85
4	1500	1498.42
5	2000	2026.53
6	2500	2526.42
7	3000	3041.88
8	3500	3591.2
9	4000	4042.12
10	4500	4528.45
11	5000	5150.81
12	5500	5628.6
13	6000	6144
14	6500	6636.06
15	7000	7185.48
16	7500	7657.25
17	8000	8101.41
18	8500	8542.16
19	9000	9014.19
20	9500	9649.69
21	10000	10222.9

PYRO DYNAMICS





PYRO DYNAMICS

Experiment	Validation of DIC Measurements – Comparison of DIC Measurements with Photoelastic Fringe Pattern and Strain Gage.
Organisation	Pyrodynamics – Bengaluru
System Used	VIC-3D, 3D Digital Image Correlation System.
Loading Conditions	Static Load
Camera Used	Point Grey Research Grasshopper 5MP Camera, 15fps
Image Frame Capture	One Image at every discrete load step.

PYRO DYNAMICS

The Test Specimen is a Typical Photo elastic Model and is made out of Acrylic Sheet of 0.5 mm thick.

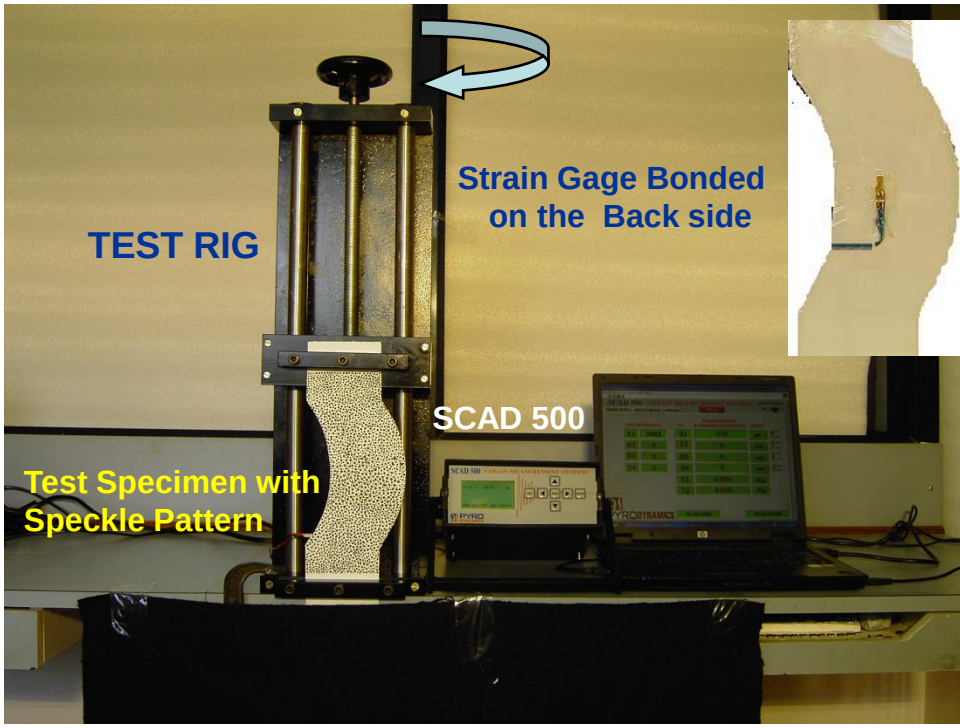
A speckle Pattern is Applied on the Test Specimen on the front side..

A strain Gage (350 Ohms, Quarter Bridge) is bonded at the centre of on the back side of the specimen.

The Specimen is mounted on a test Rig (Designed By Pyrodynamics)

The Strain Gage output is connected to SCAD 500 – Strain Measurement System.

The strain data is viewed on the Front Panel LCD of SCAD 500 and on the Host PC via RS 232 Interface.



The Test Rig has a Thumb wheel and rotation of the wheel in clockwise direction introduces tensile strain and anticlockwise rotation introduces compressive strain.

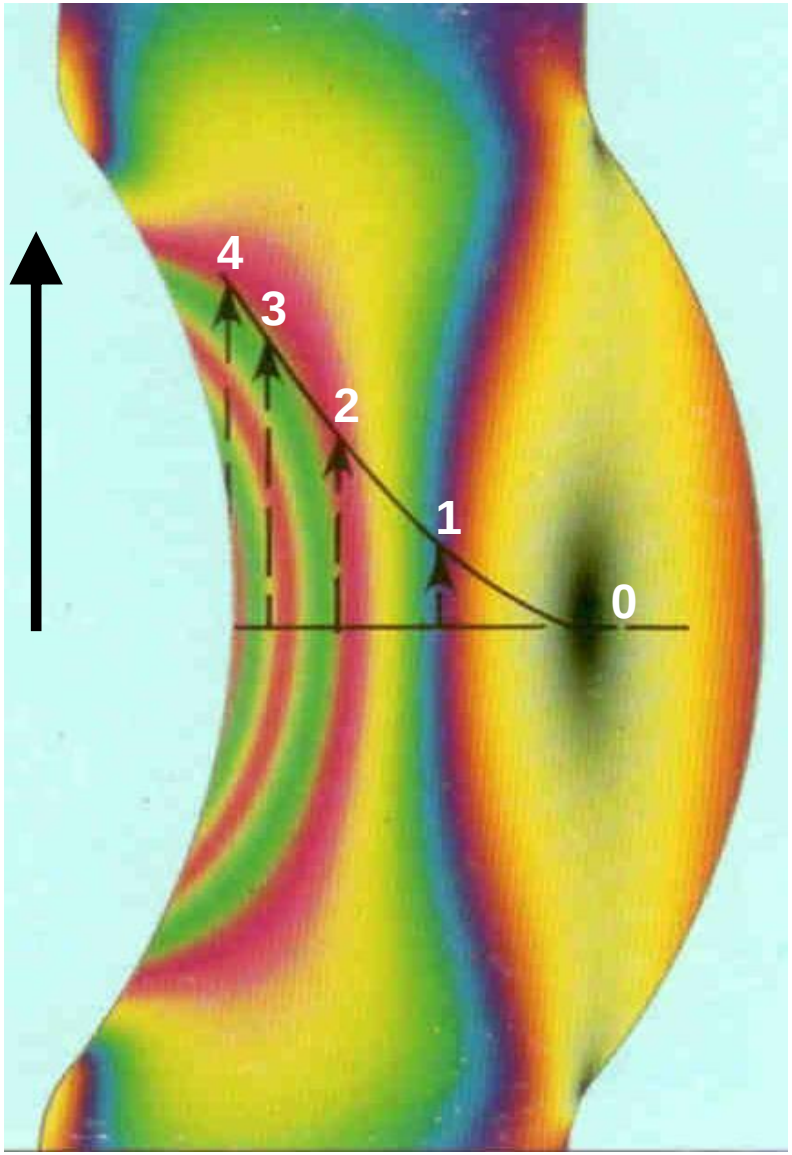
Loading Pattern:- The Test Specimen is mounted in the Test Rig.

A Tensile Load is applied by rotating the Thumb Wheel till the SCAD 500 shows a strain value of 2000 με. At this stage an image is captured. Subsequently images are captured in increments of 2000 με up to failure of the test specimen.

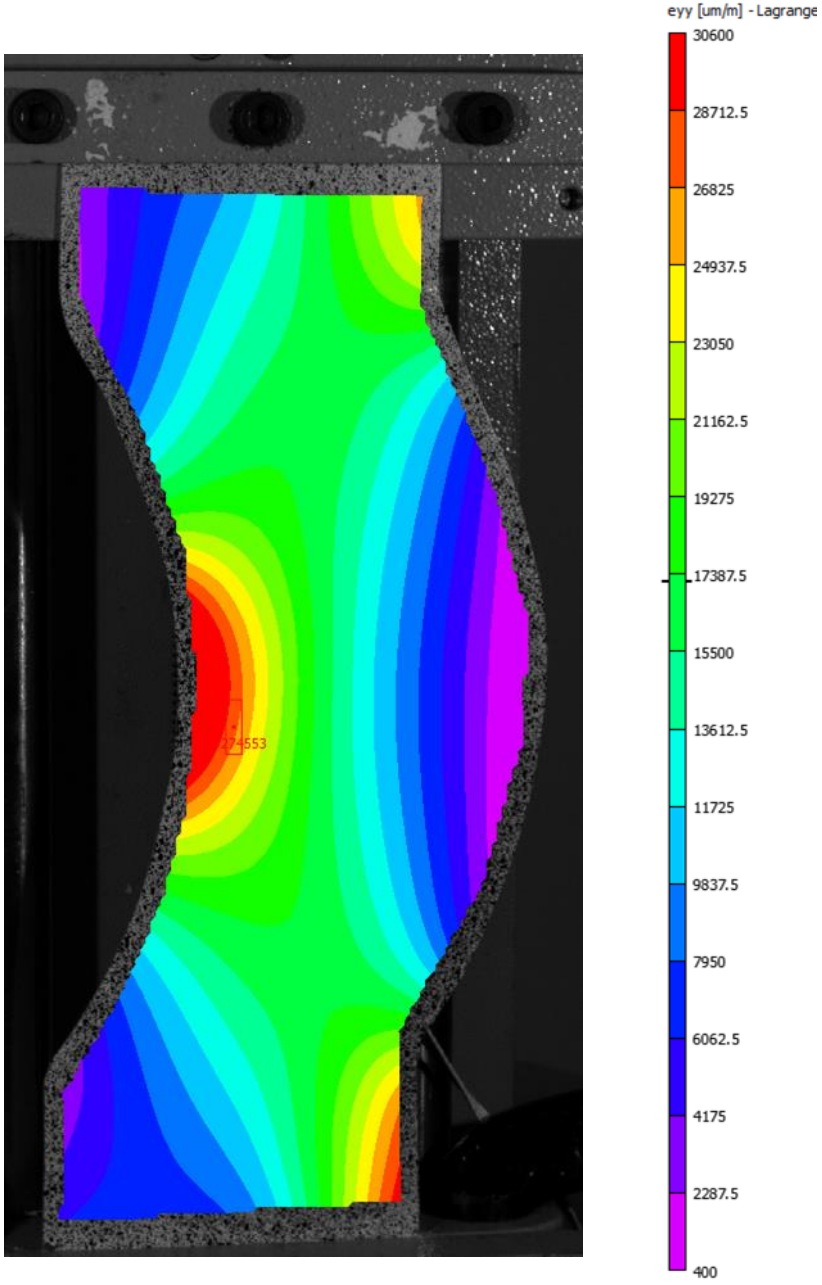
THE DIC MEASUREMENTS COMPARED EXTREMELY WELL WITH THE PHOTO ELASTIC FRINGE PATTERN AND STRAIN GAGE MEASUREMENTS. DIC RESULTS ALSO SHOWED EXCELLENT LINEARITY.

PYRO DYNAMICS

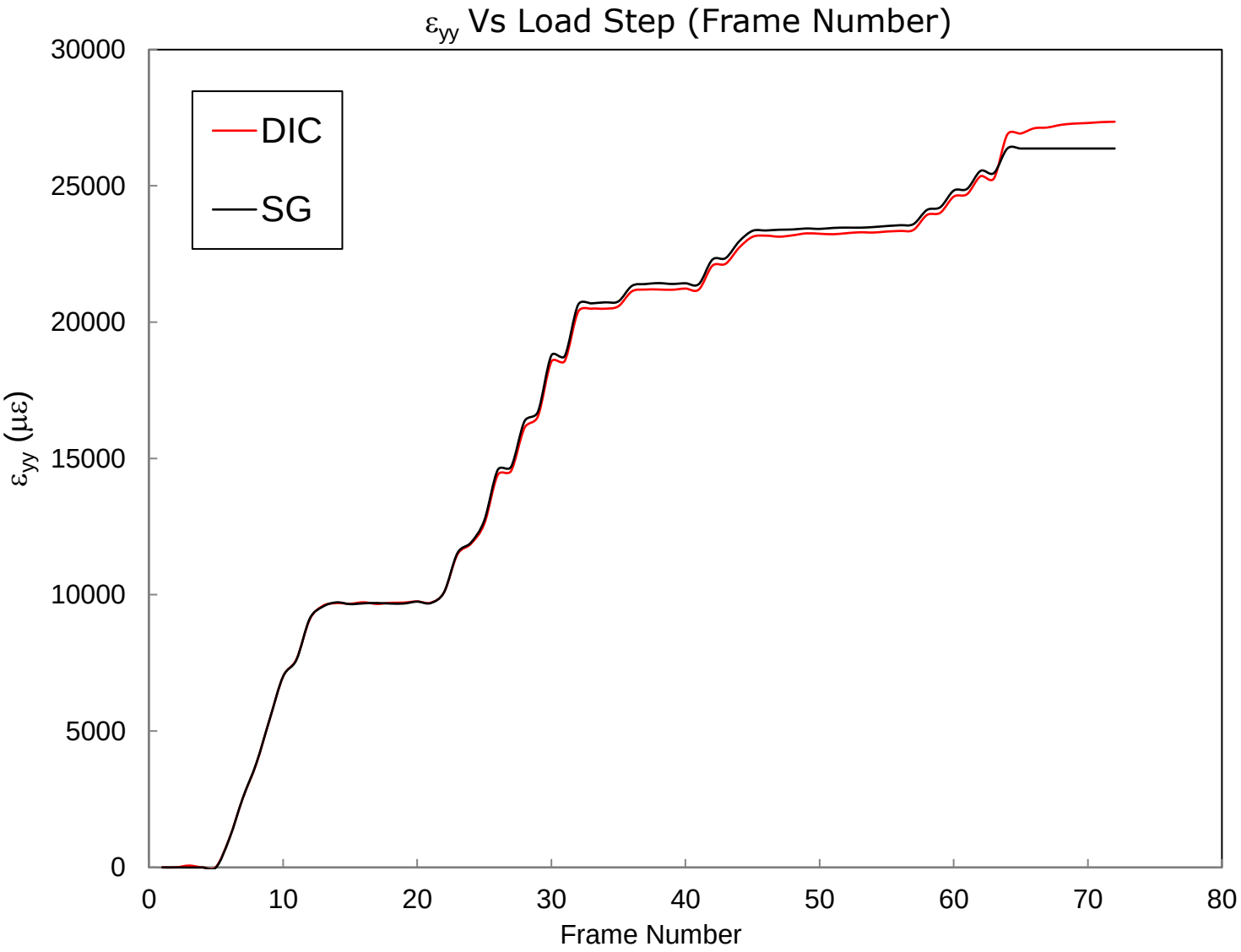
Photoelastic Fringe Pattern



ε_{yy} obtained from VIC-3D.At the final load



PYRO DYNAMICS



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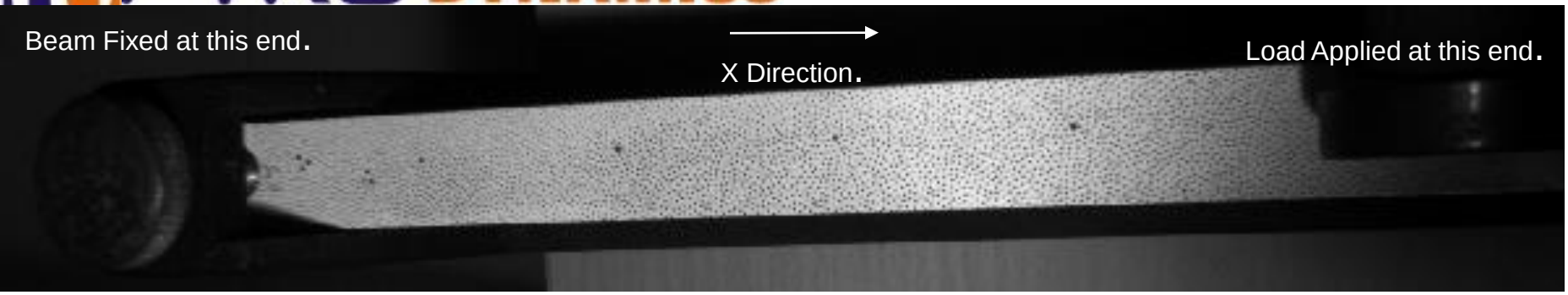
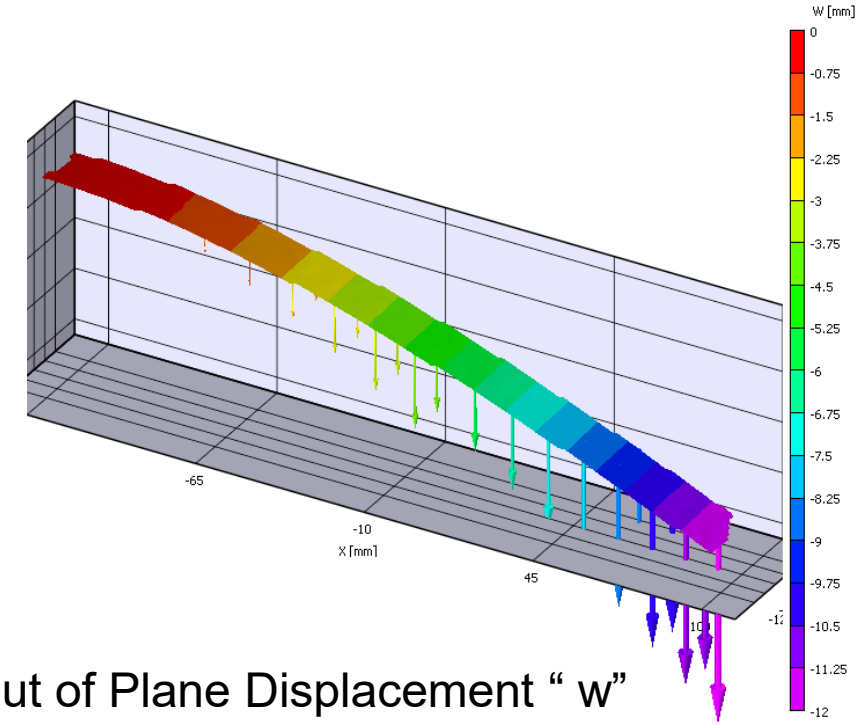
Experiment	Full Field Displacement and Strain Measurement on a Beam under Bending
Organisation	Indian Institute of Technology Department of Applied Mechanics Chennai.
System Used	VIC-3D, 3D Digital Image Correlation System.
Loading Conditions	Static Load
Camera Used	Point Grey Research Grasshopper 5MP Camera, 15fps
Image Frame Capture	One Image at every discrete load step.

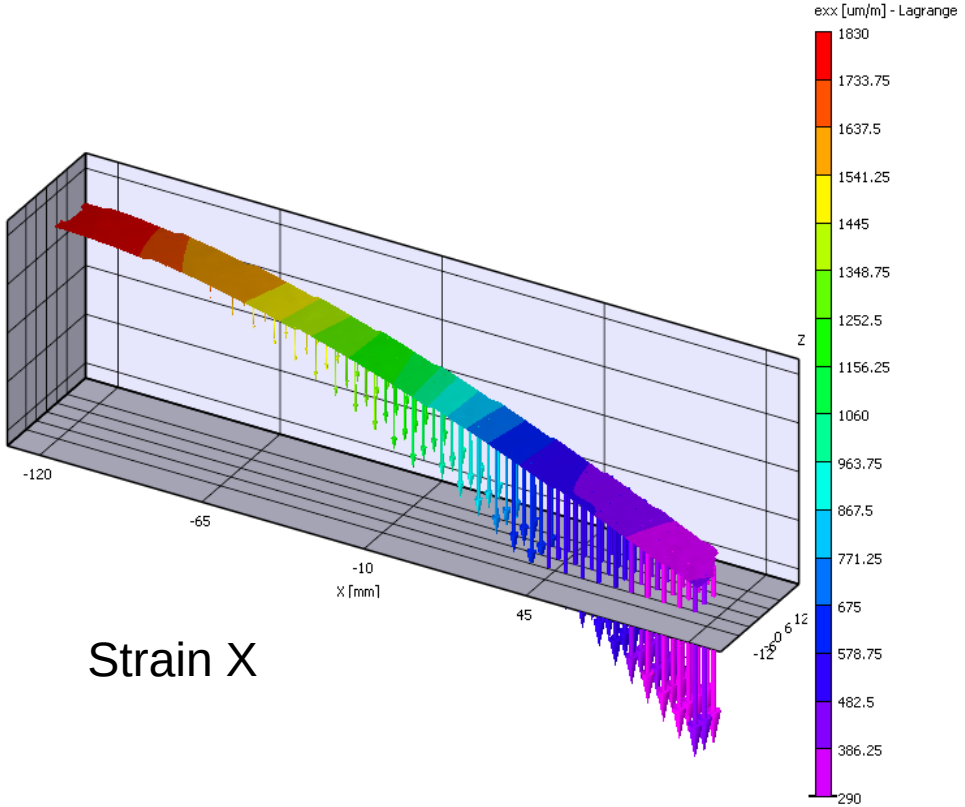
3D DIC Measurements on a Beam under Bending.



A speckle pattern was screen printed on the Test Specimen The beam was firmly fixed at one end and the beam was subject to a bending of 12mm at the other end. The fixed end will have a high strain and a low strain at the free end. This is clearly seen in the ε_{xx} plot.. At the point of loading the displacement is the highest as seen in the "w" plot.



Out of Plane Displacement " w"



Strain X

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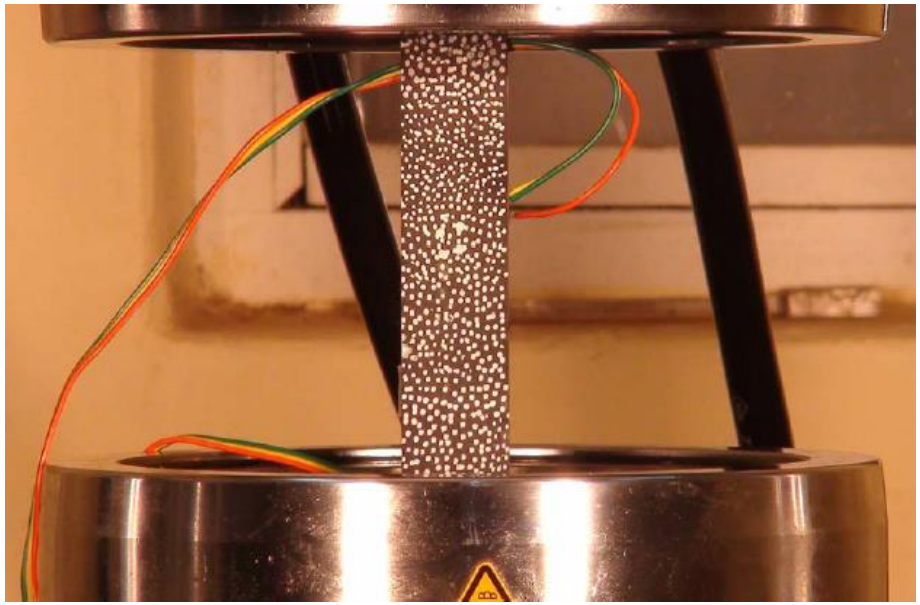
Experiment	Full Field Displacement and Strain Measurement on a Tensile Composite Specimen
Organisation	Indian Institute of Science Structures Laboratory Department of Aerospace Engineering Bengaluru.
System Used	VIC-3D, 3D Digital Image Correlation System.
Loading Conditions	Static Load
Camera Used	Point Grey Research Grasshopper 5MP Camera, 15fps
Image Frame Capture	One Image at every discrete load step.

PYRO DYNAMICS

Experimental Set Up



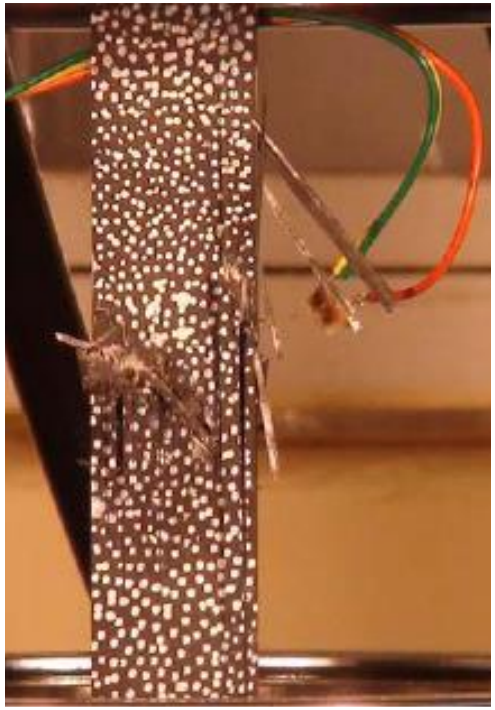
Test Specimen:- Composite Material.

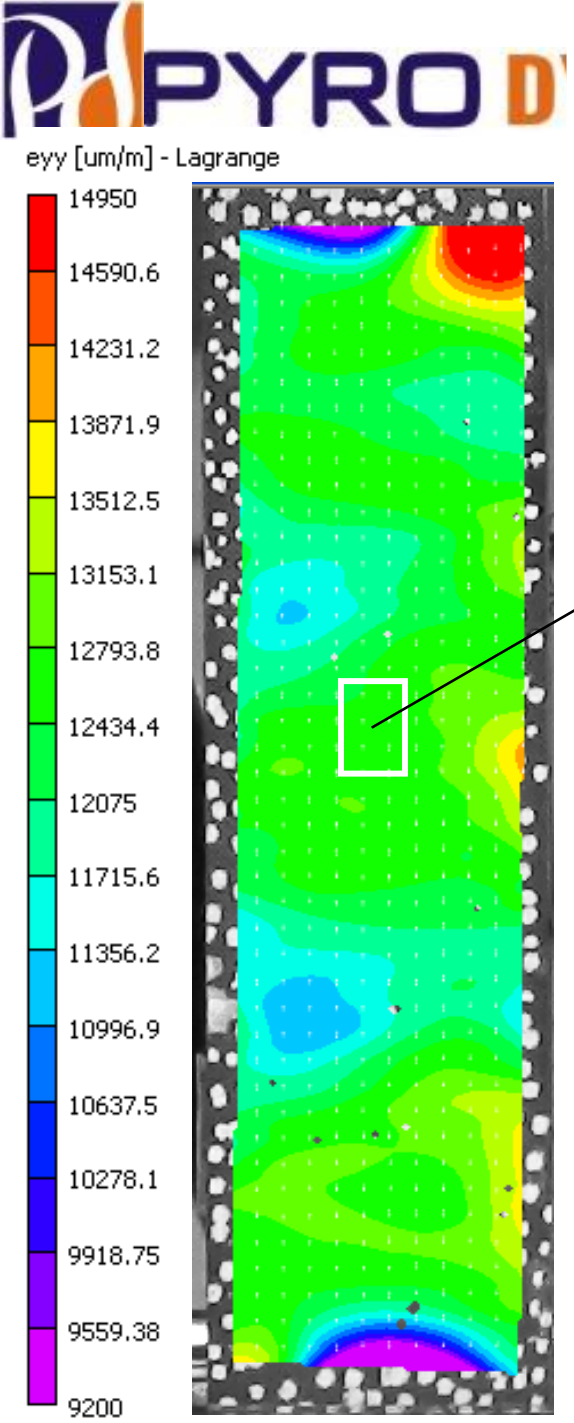
A speckle pattern was applied on the Composite Tensile Specimen.

Strain Gages were mounted on the back side of the specimen in the X and Y direction and the strain gages were interfaced to SCAD 500 Strain Measurement System.

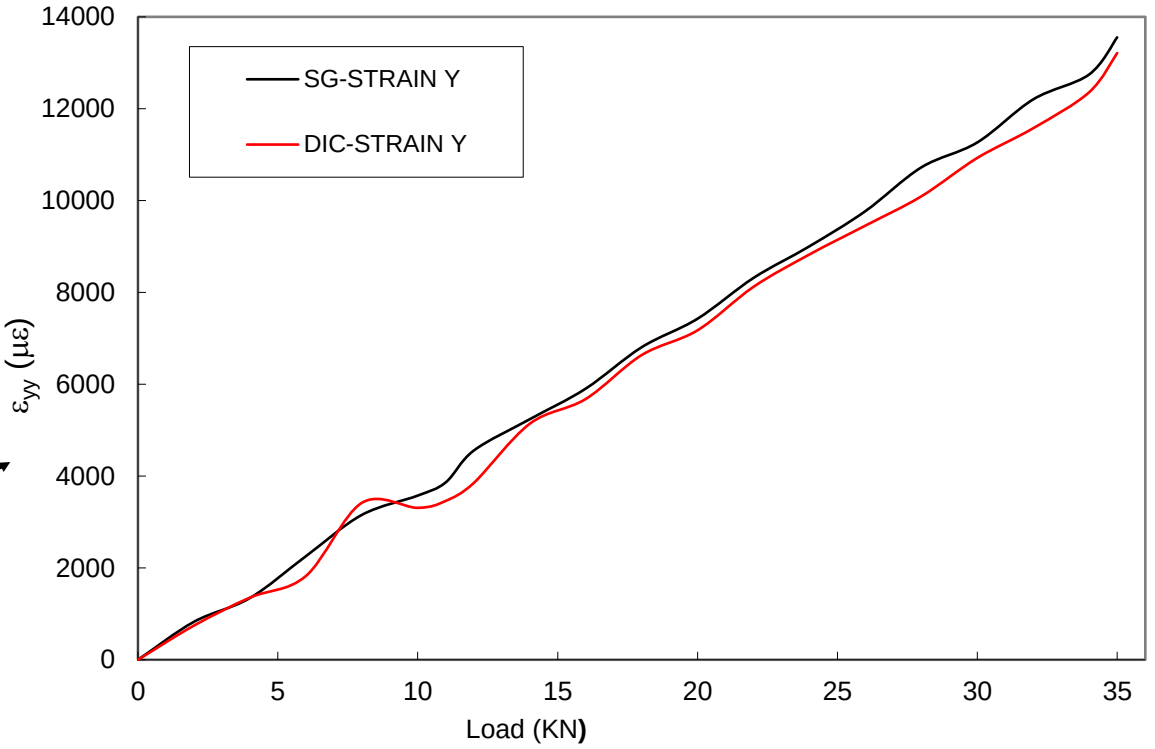
The load was applied in a UTM and images captured in steps of 2KN.

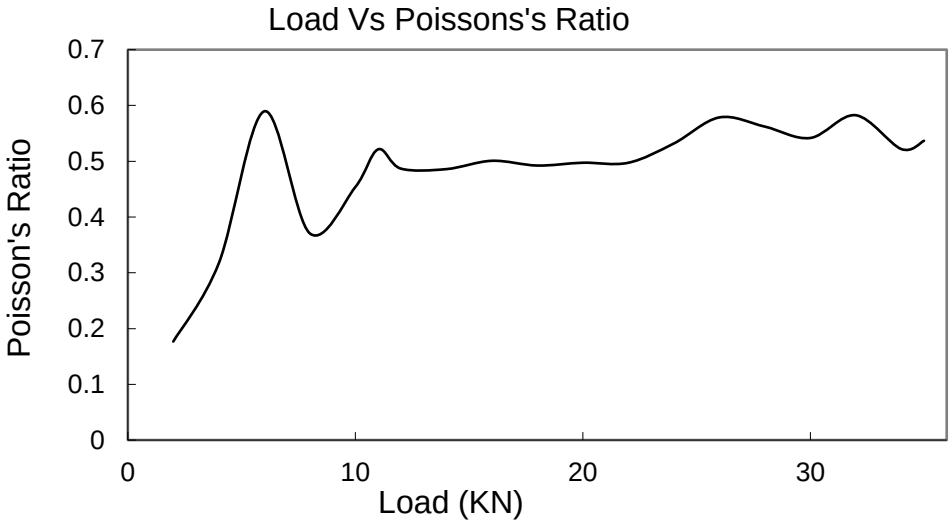
The Specimen failed at 36 KN.





Plot of ε_{yy} At 34KN

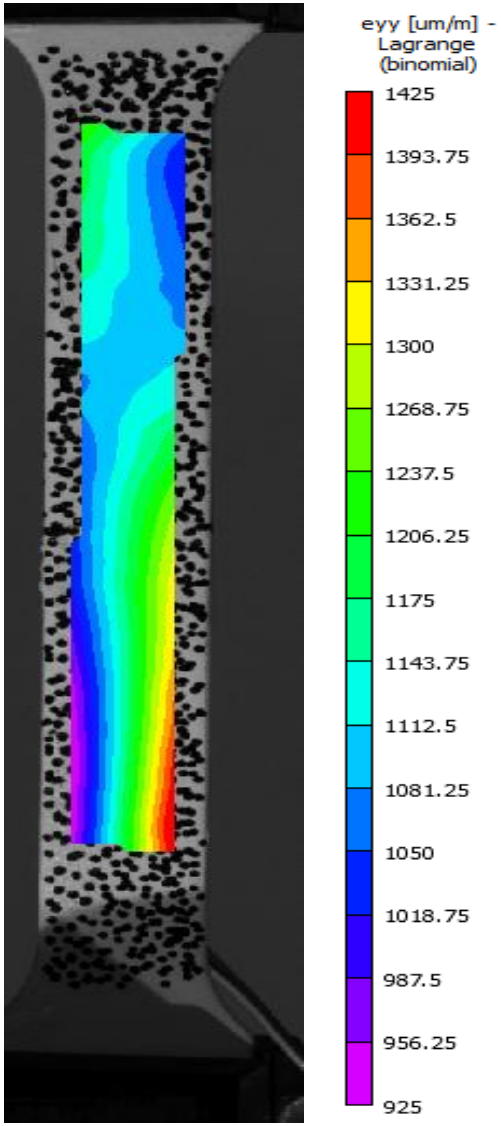




PYRO DYNAMICS

Experiment	Full Field Displacement and Strain Measurement on a Tensile Aluminum Specimen
Organisation	Research Laboratory (Unable to disclose due to contractual obligations)
System Used	VIC-3D, 3D Digital Image Correlation System.
Loading Conditions	Static Load
Camera Used	Point Grey Research Grasshopper 2MP Camera, 15fps
Image Frame Capture	One Image at every discrete load step.

PYRO DYNAMICS



Raw Image

Plot of ε_{yy} at final load

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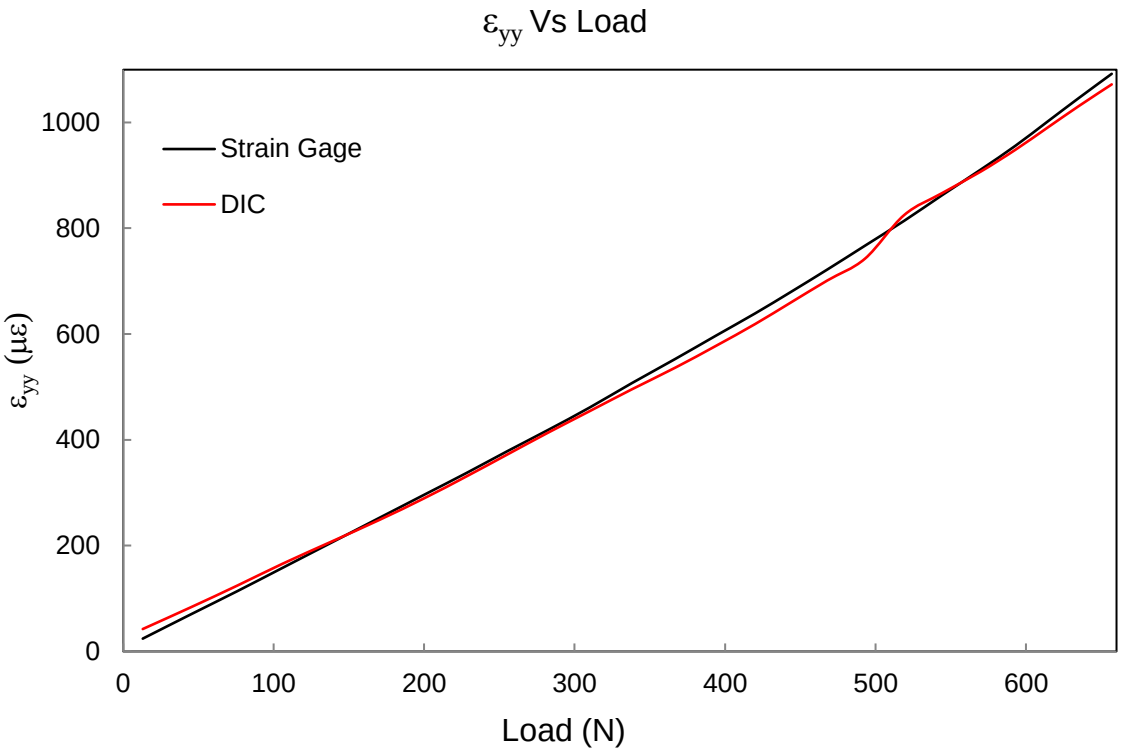
LOAD	Strain Gage (με)	DIC (με)	Difference (με)
13	24	42	-18
45	70	83	-13
76	114	125	-11
106	158	166	-8
138	205	207	-2
170	252	248	4
200	296	289	7
228	337	330	7
255	378	372	6
282	418	413	5
310	461	454	7
338	507	495	12
367	553	536	17
394	597	578	19
420	639	619	20
444	680	660	20
468	722	701	21
493	767	742	25
519	814	825	-11
544	862	866	-4
570	911	907	4
593	956	948	8
614	1001	990	11
635	1046	1031	15
657	1092	1072	20

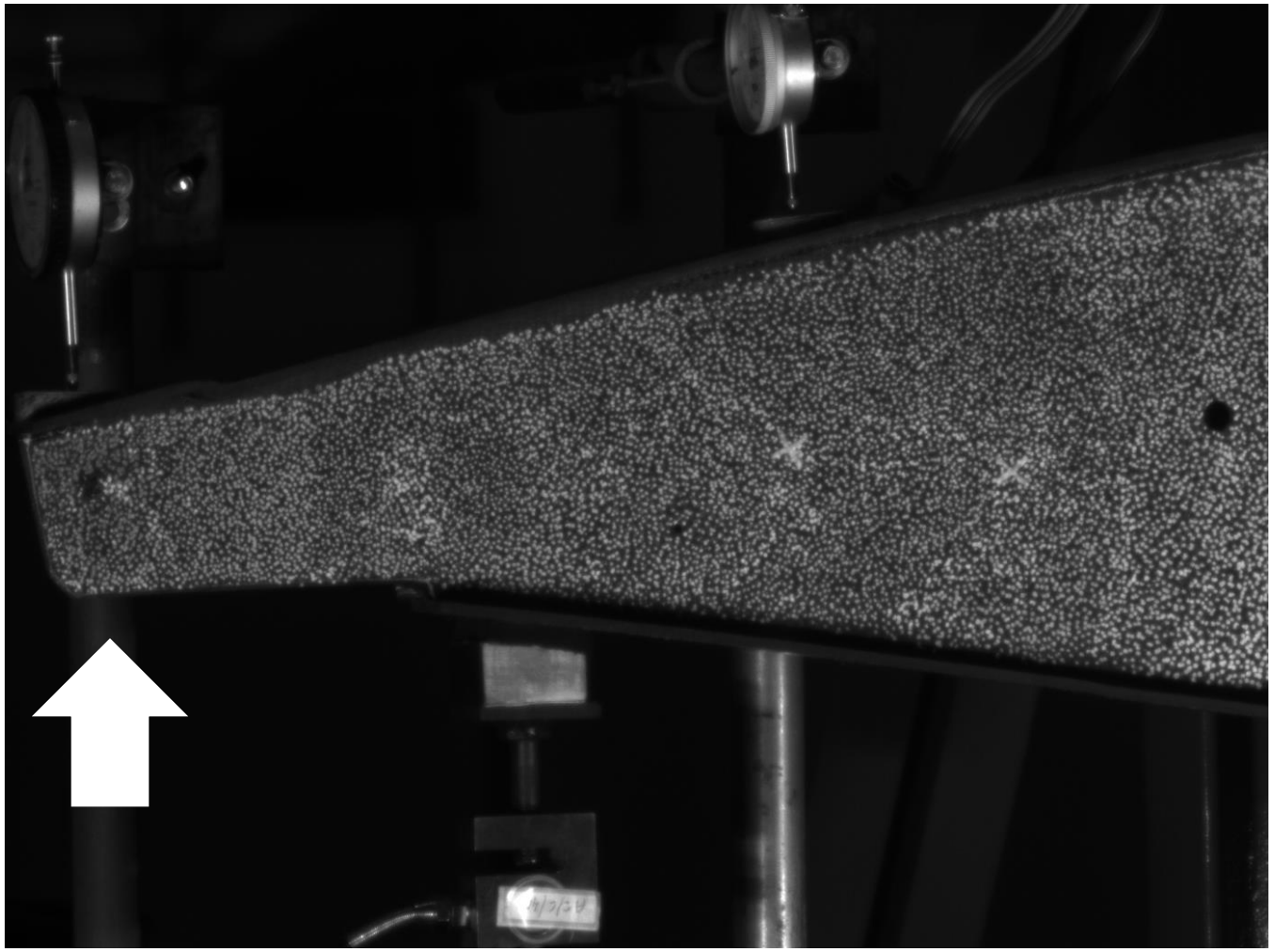


PYRO DYNAMICS

Experiment	Full Field Displacement and Strain Measurement on the AFT Rib of a Wing of a Plane.
Organisation	National Aerospace Laboratories Bengaluru.
System Used	VIC-3D, 3D Digital Image Correlation System.
Loading Conditions	Static Load
Camera Used	Point Grey Research Grasshopper 5MP Camera, 15fps
Image Frame Capture	One Image at every discrete load step.

PYRO DYNAMICS

STRAIN MEASUREMENT ON AFT RIB



The Specimen was fixed at one end and load applied at the other end. Load was applied in steps of 100 Kgs upto 500 Kgs. 2 Dial Gages were mounted to record the displacements. Strain Gages were mounted at the back of the specimen and interfaced to SCAD 500 System. The locations are marked **X**

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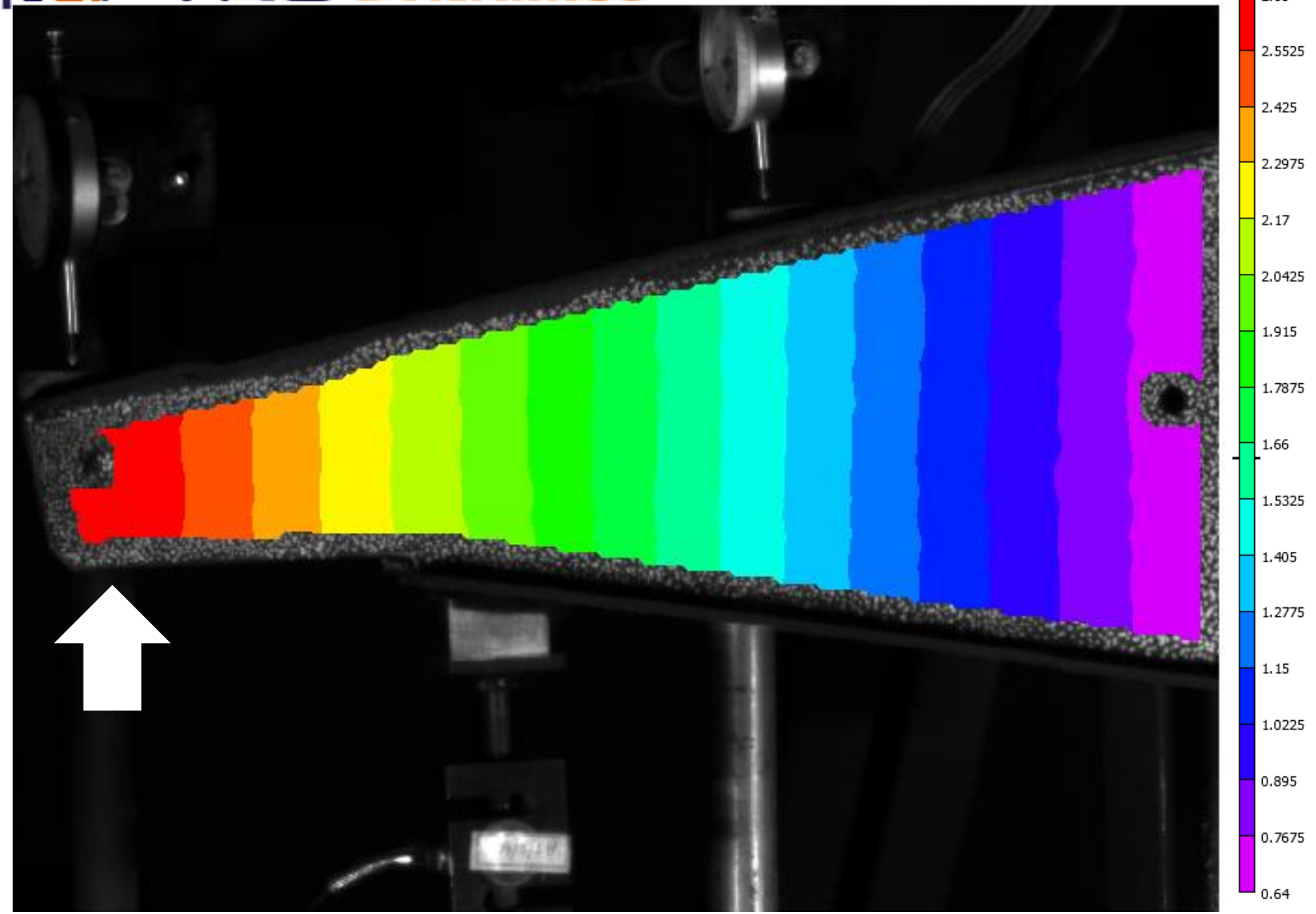
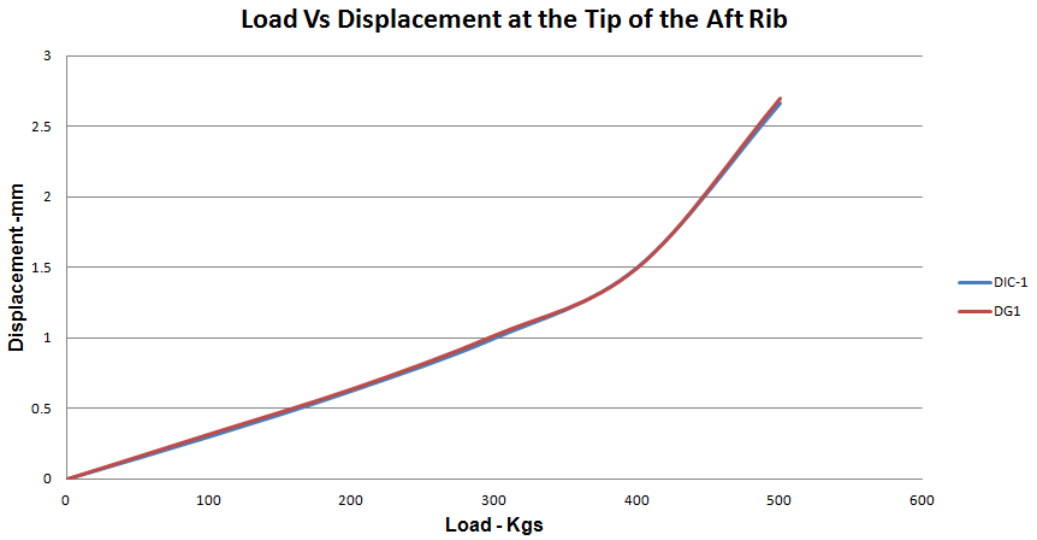
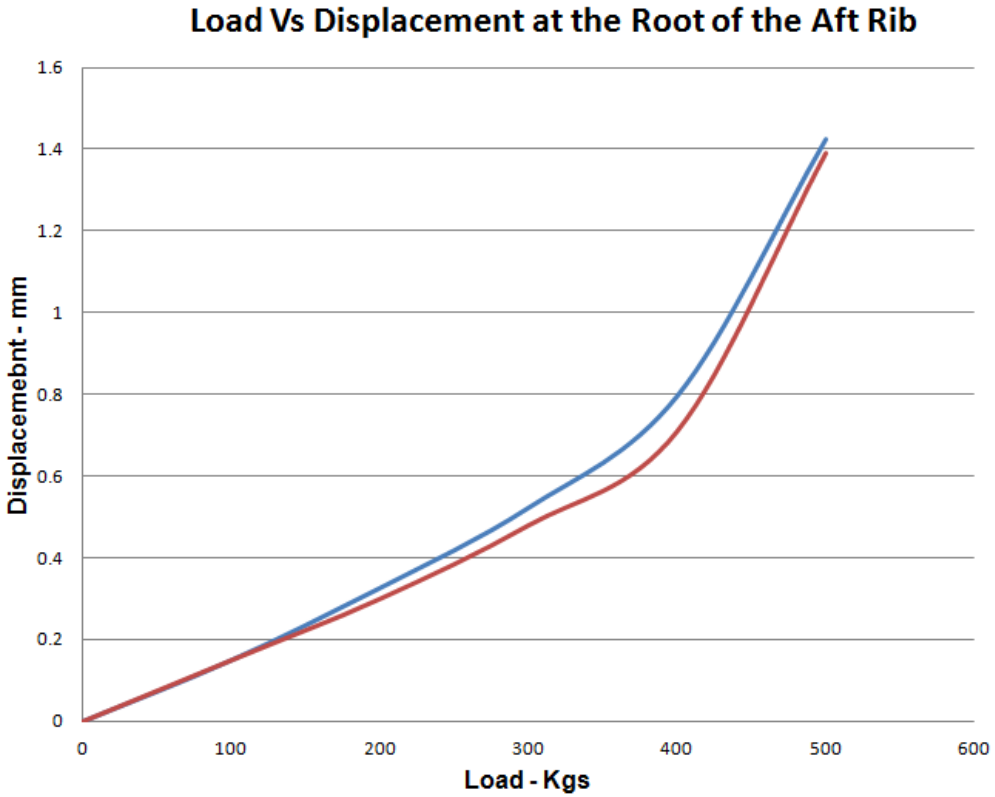
V Displacement



PYRO DYNAMIC

Displacement Data of Dial Gage 1 and "V" Displacement obtained from VIC-3D.

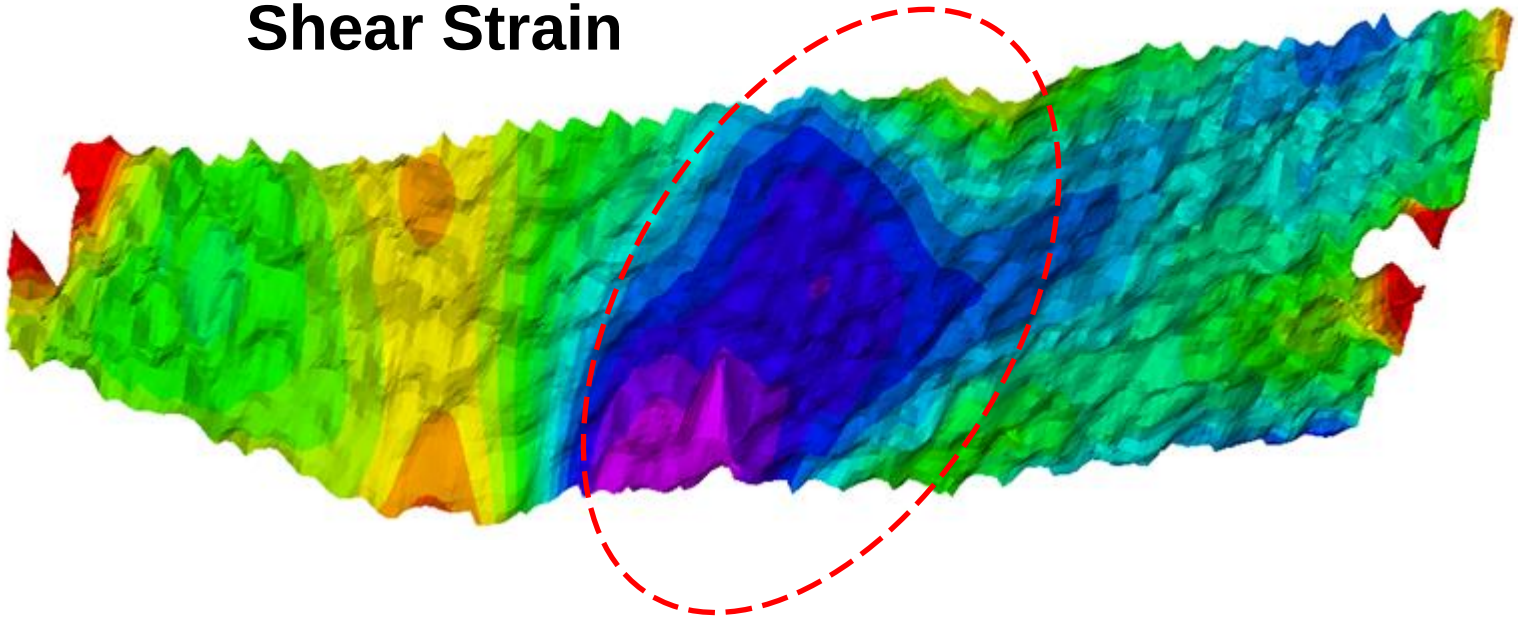




Displacement Data of Dial Gage 2 and "V" Displacement obtained from VIC-3D.

PYRO DYNAMICS

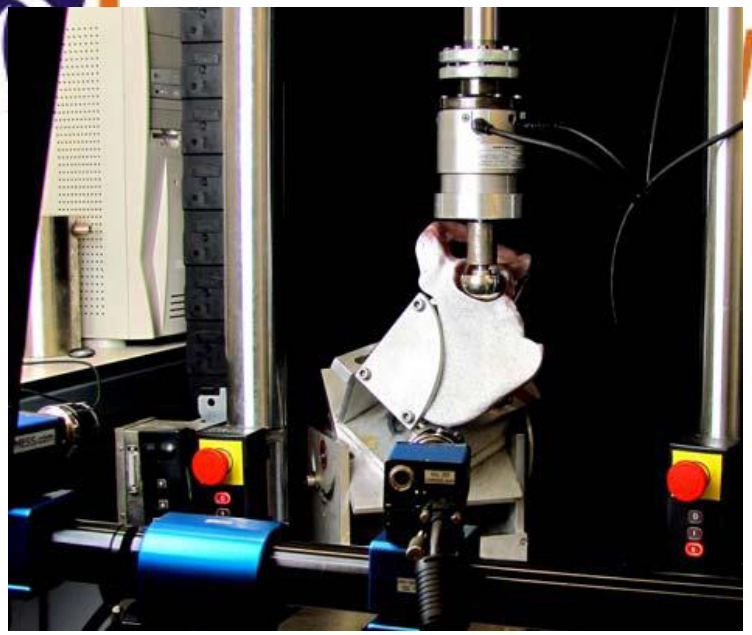
Shear Strain



The Shear Strain Pattern Shows a Significant Strain Concentration.

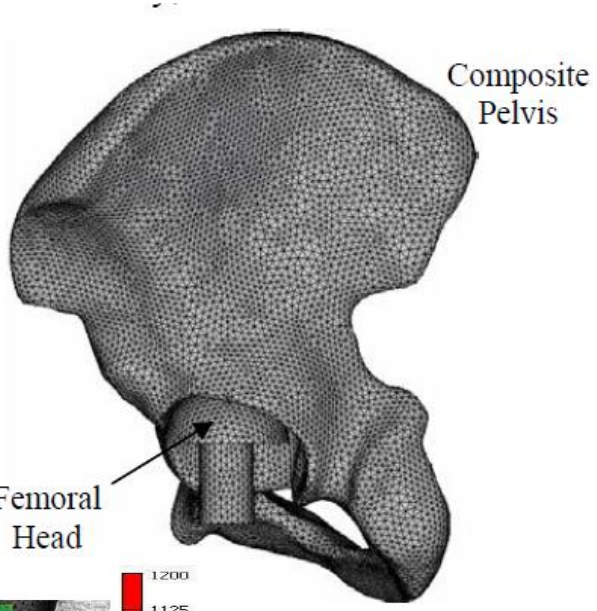
The full scale strain measured was -222 με. Low Strain measurement is very much possible with the VIC-3D system with a resolution of 20 με.

EXPERIMENTAL VALIDATION OF A FINITE ELEMENT MODEL OF THE COMPOSITE PELVIS USING DIGITAL IMAGE CORRELATION



Experimental setup for DIC measurement

FE Model of the Composite Pelvis.



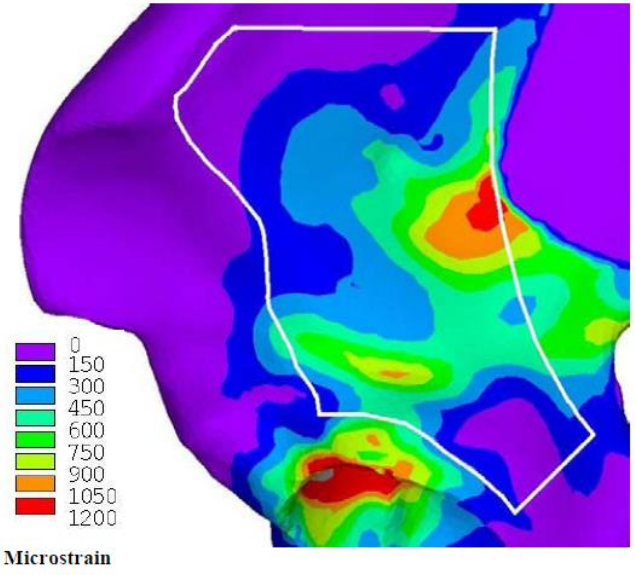


Figure 4. Distribution of von Mises strain in the equivalent FE model of the composite pelvis.

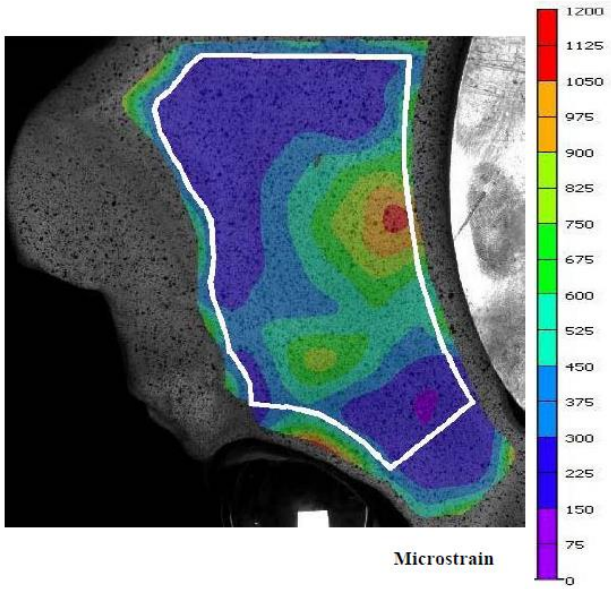


Figure 3. Experimental measurement of von Mises strain pattern using DIC technique.

EXPERIMENTAL VALIDATION OF A FINITE ELEMENT MODEL OF THE COMPOSITE PELVIS USING DIGITAL IMAGE CORRELATION

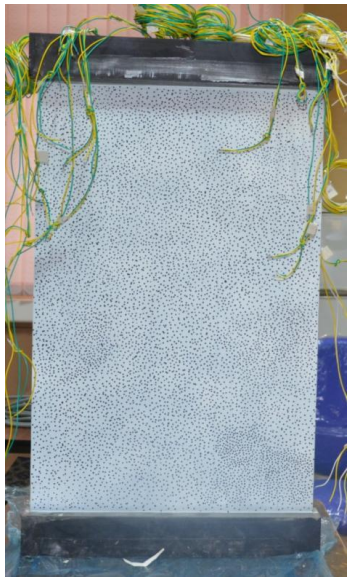
Rajesh Ghosh, Sanjay Gupta,

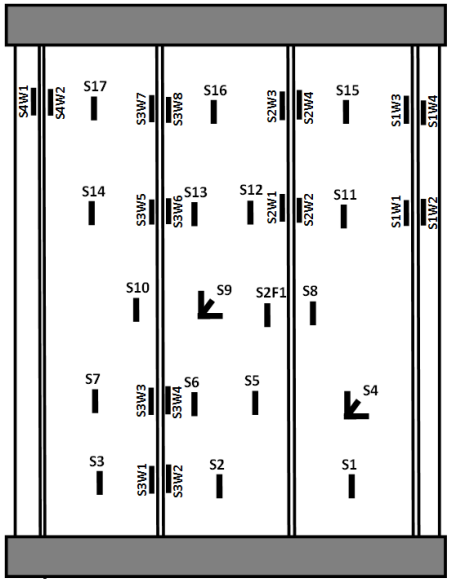
Department of Mechanical Engineering, Indian Institute of Technology Kharagpur, West Bengal, India

Buckling & Post-buckling Behaviour of Thin Composite Panels

National Aerospace Laboratories - Bengaluru

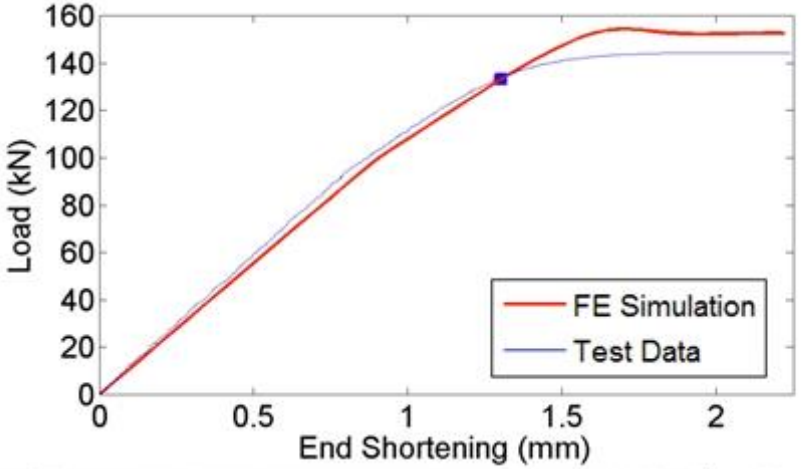
Ref:- Dr.S.R.Viswamurthy - International Digital Image Correlation Conference & Workshop, September 15-18, Dublin

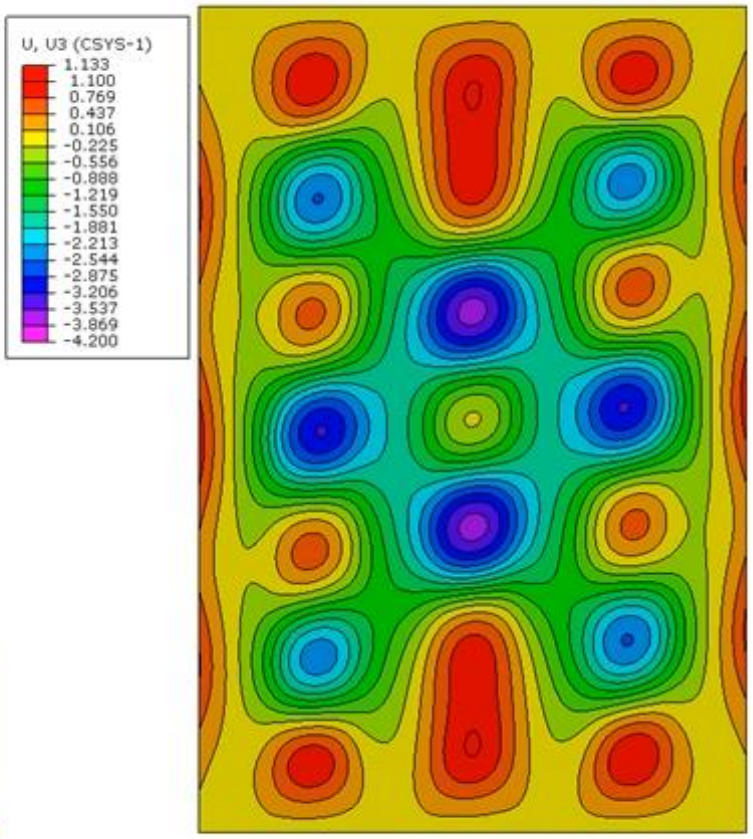




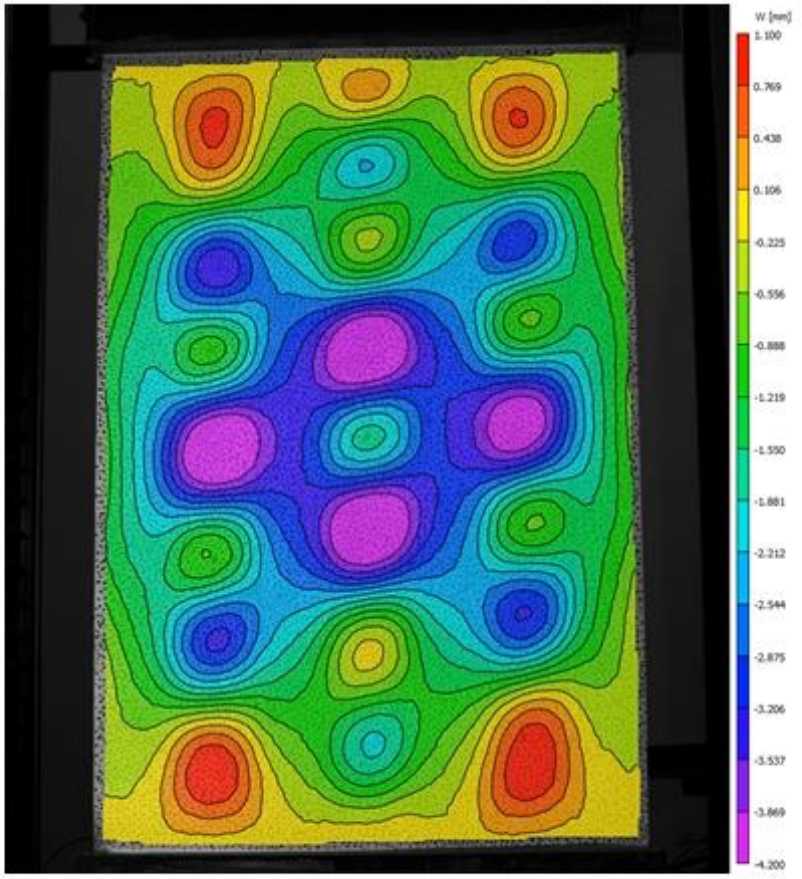
OUT OF PLANE DISPLACEMENT 'W'

LOAD (FE)	= 132.81 kN
LOAD (Test)	= 133.13 kN
END SHORTENING	= 1.3 mm

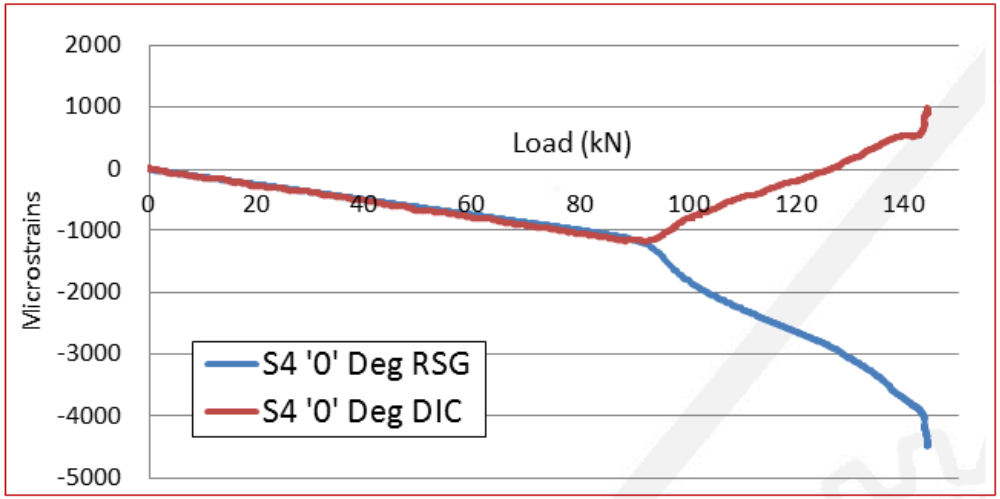


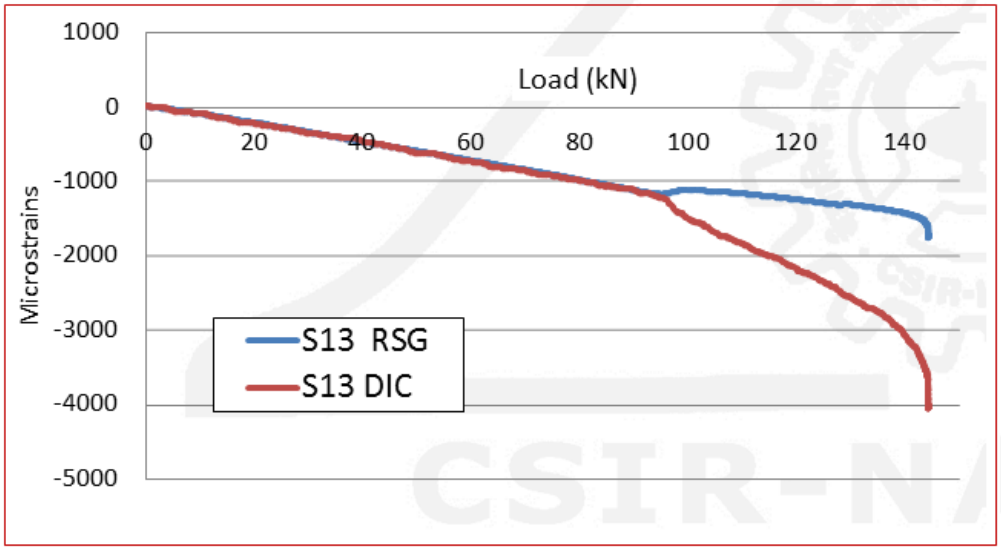


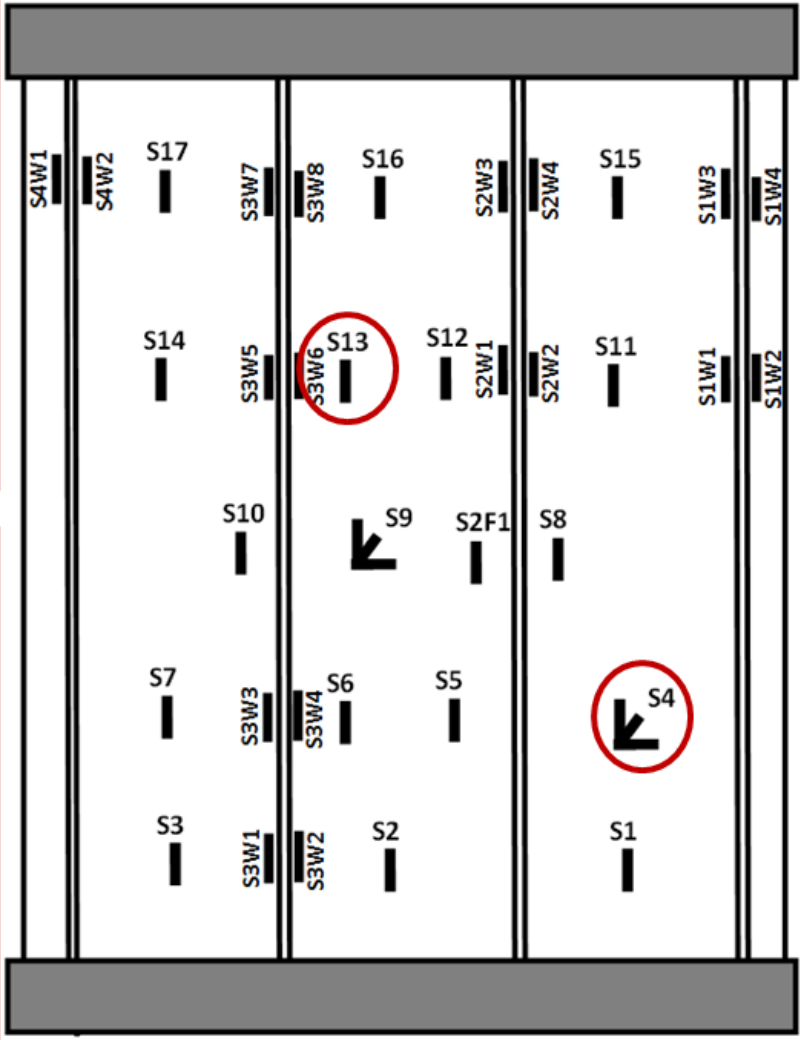
Numerical Simulation



Test-DIC


2000
1000
0
-1000
-2000
-3000
-4000
-5000
Microstrains
Load (kN)
0
20
40
60
80
100
120
140
S4 '0' Deg RSG
S4 '0' Deg DIC

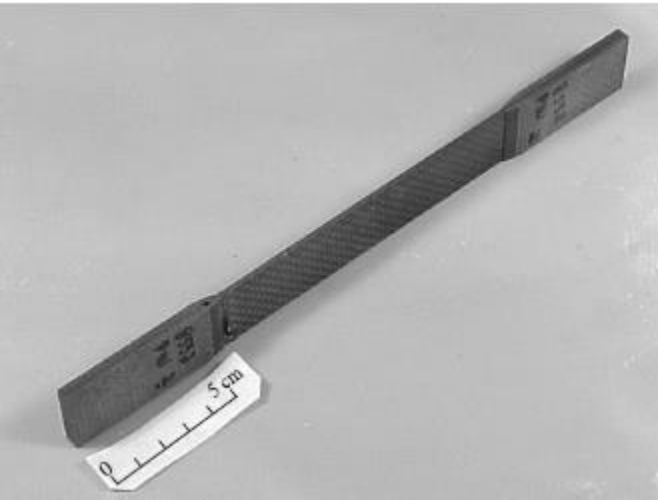

1000
0
-1000
-2000
-3000
-4000
-5000
Microstrains
Load (kN)
0
20
40
60
80
100
120
140
S13 RSG
S13 DIC


S4W1
S4W2
S17
S3W7
S3W8
S16
S2W3
S2W4
S15
S1W3
S1W4
S14
S3W5
S3W6
S13
S12
S2W1
S2W2
S11
S1W1
S1W2
S10
S9
S2F1
S8
S7
S3W3
S3W4
S6
S5
S4
S3
S3W1
S3W2
S2
S1

PYRO DYNAMICS

Experiment	Fatigue Measurements of a Composite Specimen
Organisation	Indian Institute of Technology. Department of Aerospace Engineering. Chennai.
System Used	VIC-2D, 2D Digital Image Correlation System.
Loading Conditions	1 Hz Cyclic Loading upto failure. Measurements carried out in the front and back of the specimen using Two VIC-2D Systems.
Camera Used	Prosilica 2MP Camera, 63fps
Image Frame Capture	60 images in one second and a hold period of 100 seconds. This image capture is looped.

PYRO DYNAMICS



A speckle Pattern was applied on the Composite Specimen. Measurements are made on the width of the specimen.

To study the failure measurements were made both on the front and back side of the specimen.

The failure mode is different in the front and back of the specimen

Image of the Front of the Specimen

At No Load and After Failure.

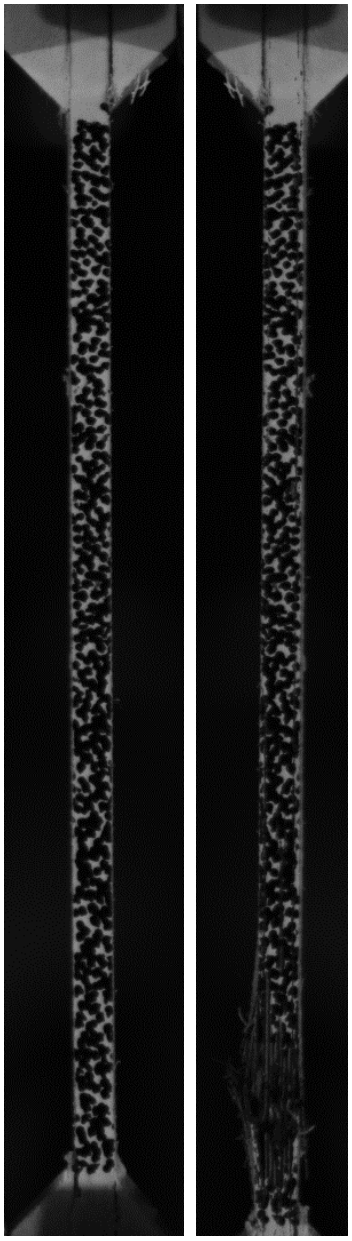


Image of the Back of the Specimen

At No Load and After Failure.

PYRO DYNAMICS

System Set Up.

Two Prosilica GX Series were used for Measurements.

These cameras are interfaced to the GigE Dual Port of the PC.

Each camera can capture images at 63 fps simultaneously.

The analog output of the Load cell from the UTM was interfaced to the Daq.

So whenever an image was captured the analog output was also recorded.

The specimen was subject to a cyclic load from 24 to 48KN. Frequency – 1 Hz

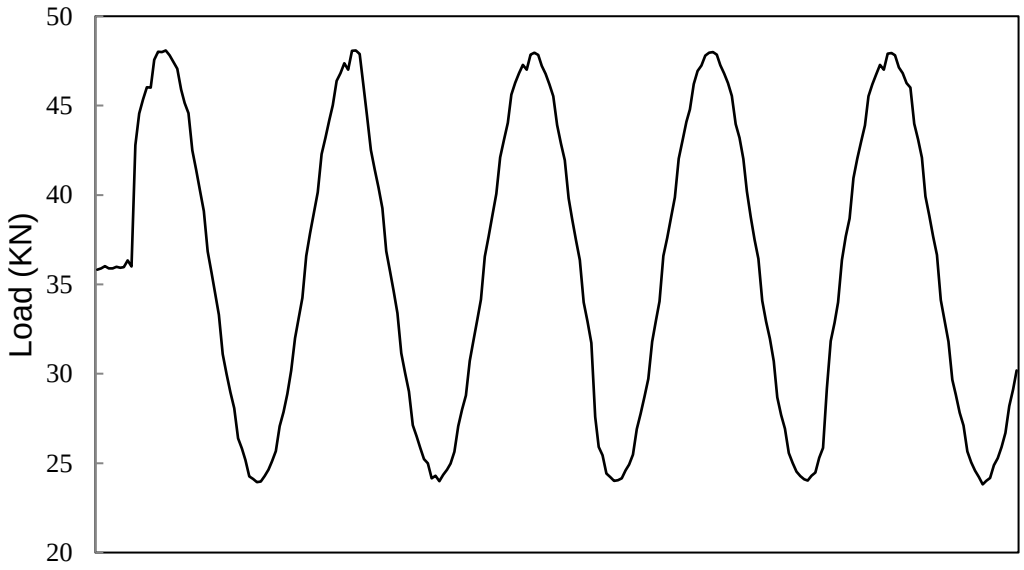
The specimen failed after 8558 cycles.

The VIC-SNAP software was programmed to capture 60 images in one second and a hold period of 100 seconds.

This cycle of image capture was looped until failure.

Duration of the Test:- 3 Hours.

Loading Cycle

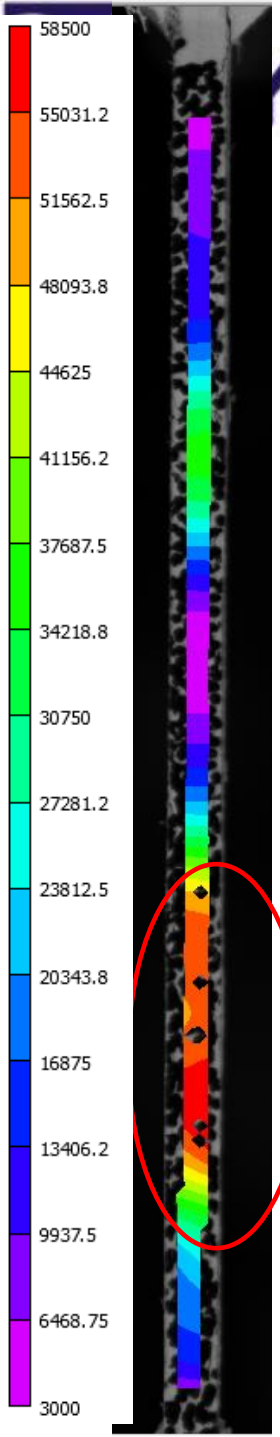


Measurements were made on the Front and Back of the Specimen Simultaneously. So the setup Included 2 Simultaneous Measurements in 2D DIC.

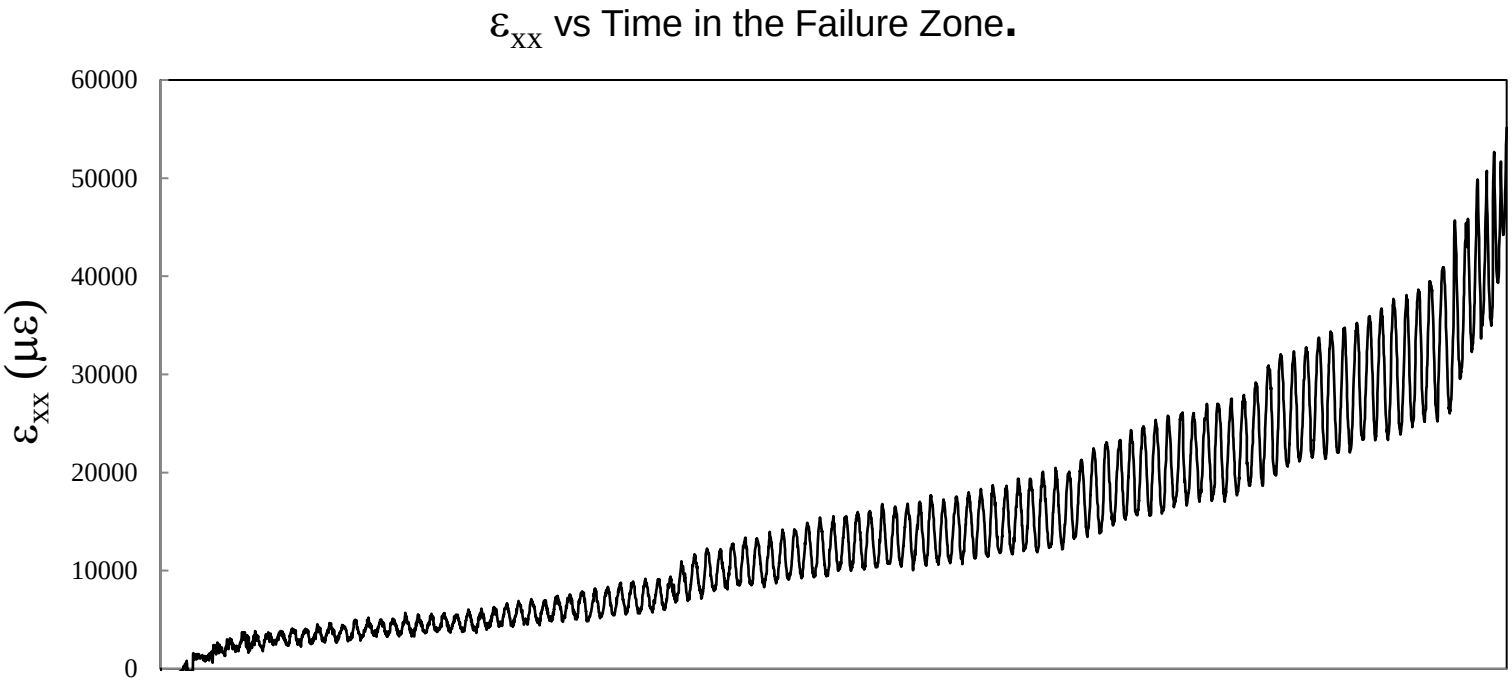
VIC-2D Software was used for Analysis.

YRO DYNAMICS

Strain Plots – Front of the Specimen - Strain - X

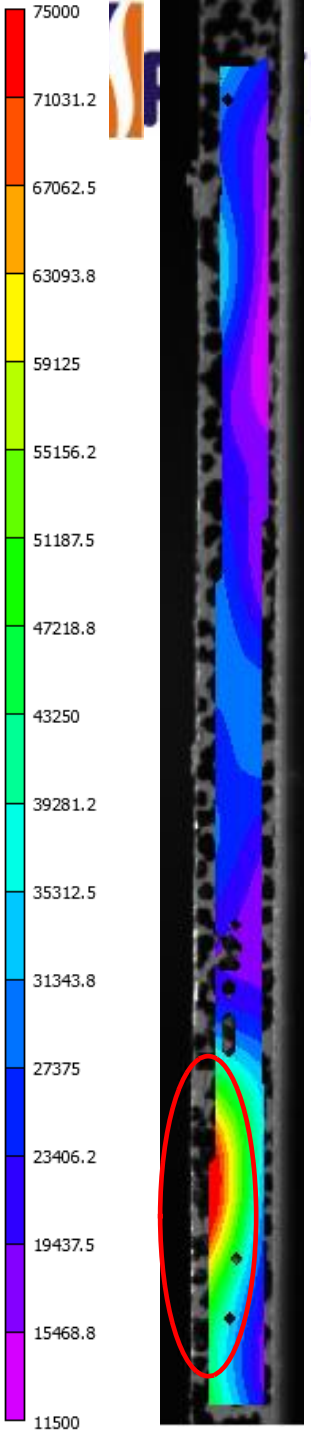


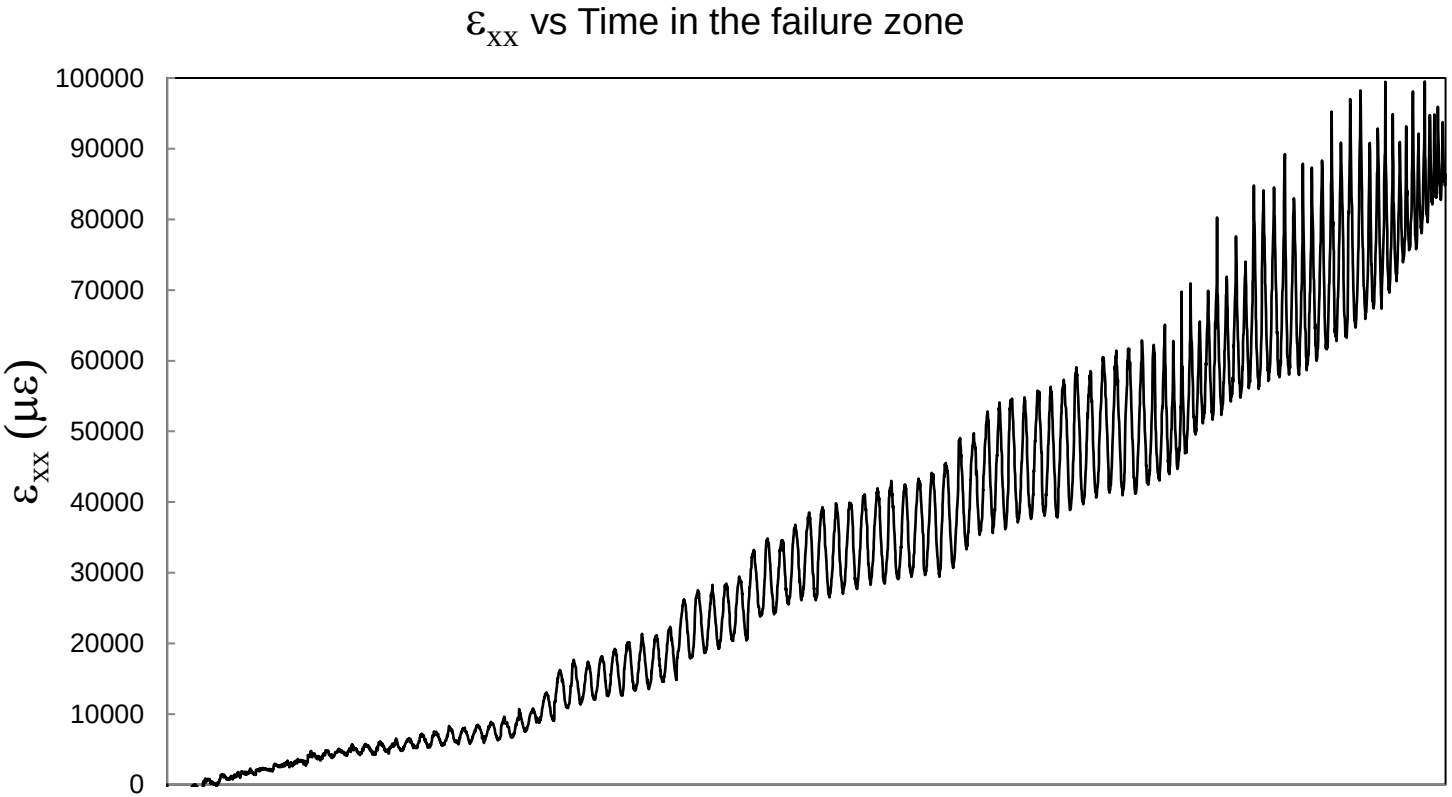
Failure Zone



RO DYNAMICS

Strain Plots – Back of the Specimen – Strain X.





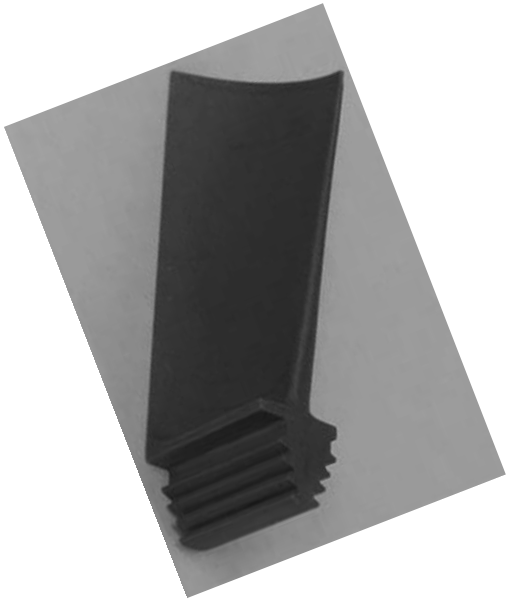
Failure Zone

From the plots its clear the failure mode and the strain profile are different on the back and front of the specimen.

PYRO DYNAMICS

Experiment	Dynamic Strain Measurements on a Gas Turbine Blade.
Organisation	Gas Turbine Research Establishment. Bengaluru.
System Used	VIC-3D, 3D Digital Image Correlation System.
Loading Conditions	Steady State Vibration In a Shaker.
Camera Used	Point Grey Grass Hopper 5MP Camera.
Image Frame Capture	Correlated Solutions Fulcrum Software was used to Capture Steady State Dynamic Signals.

PYRO DYNAMICS



Images of the Turbine Blade from Literature (for description purpose only) and not from The test site.

DIC Measurements were carried on 3 components under steady state vibration:-

1. Flat Plate.

2. Turbine Blade.

3. Cracked Turbine Blade.

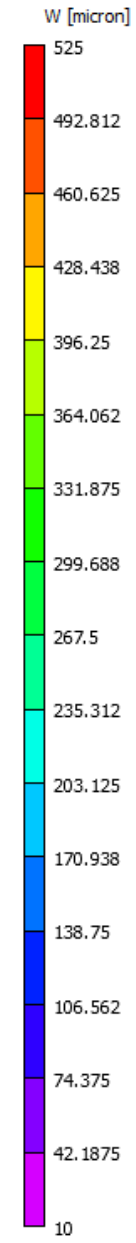
Mode Shapes of these components were obtained at different frequencies.

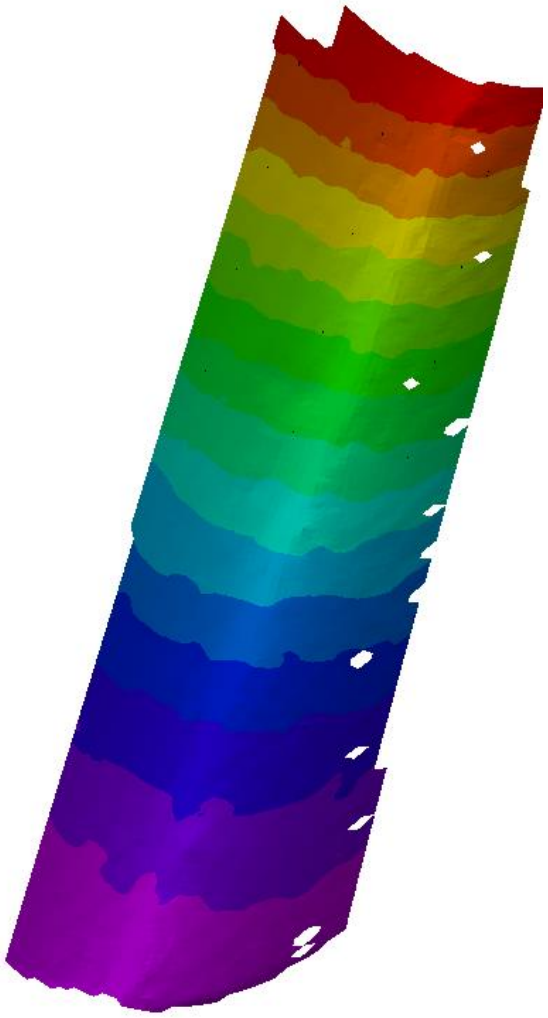
The Turbine blade is very stiff and the levels of Displacement and Strain are very low. VIC-3D captured these low levels of displacements and strain,

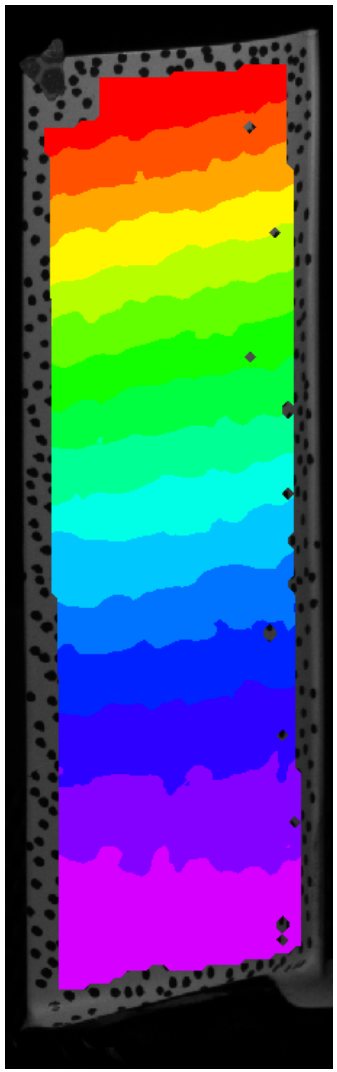
PYRO DYNAMICS

Turbine Blade
Out of Plane Displacement "w"
1st Bending Mode - 438.6 HZ

The Highest Displacement of 525 Microns is seen at the tip of the blade (free end) and the root of the blade (fixed end) had a very low displacement of 10 Microns

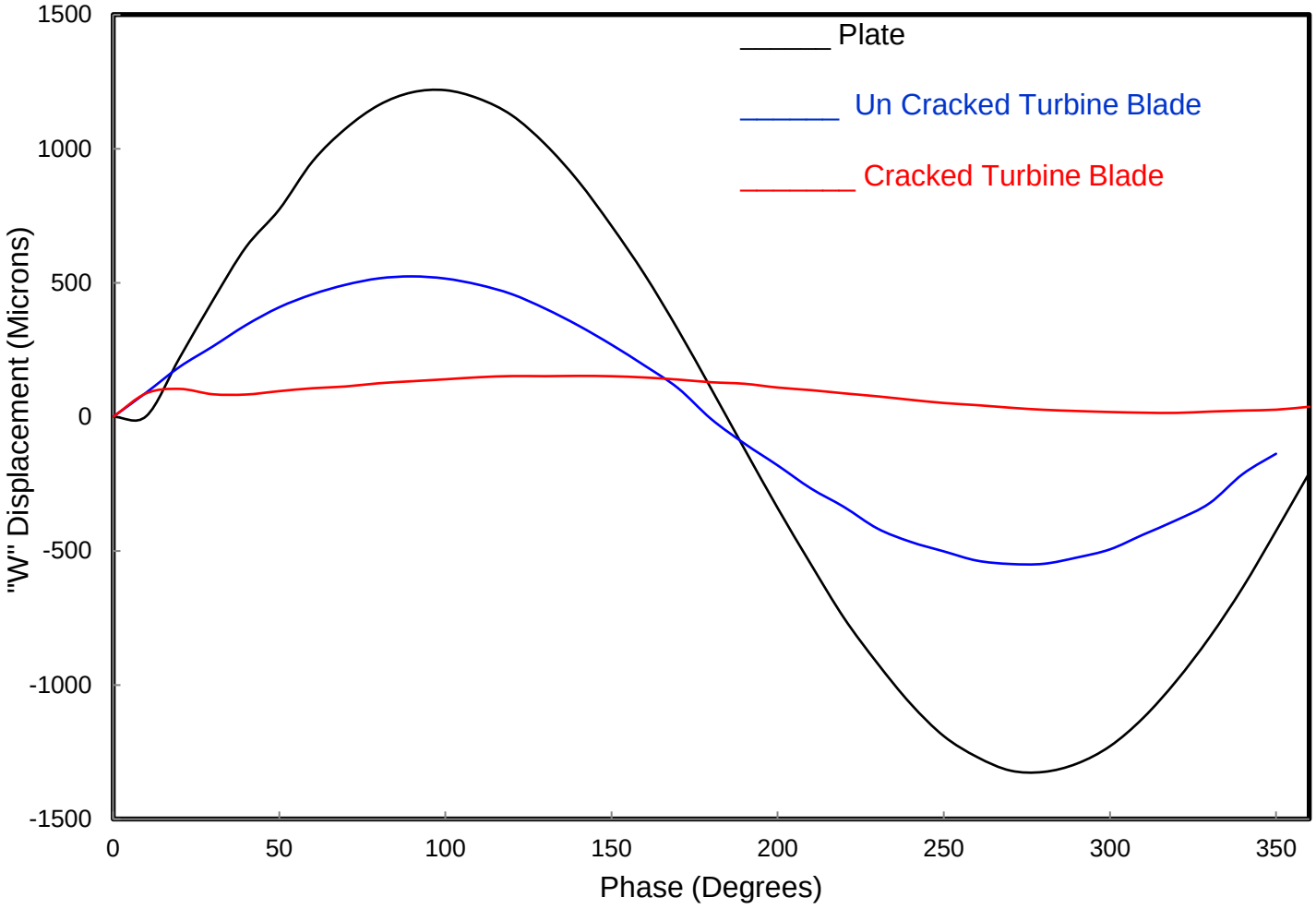


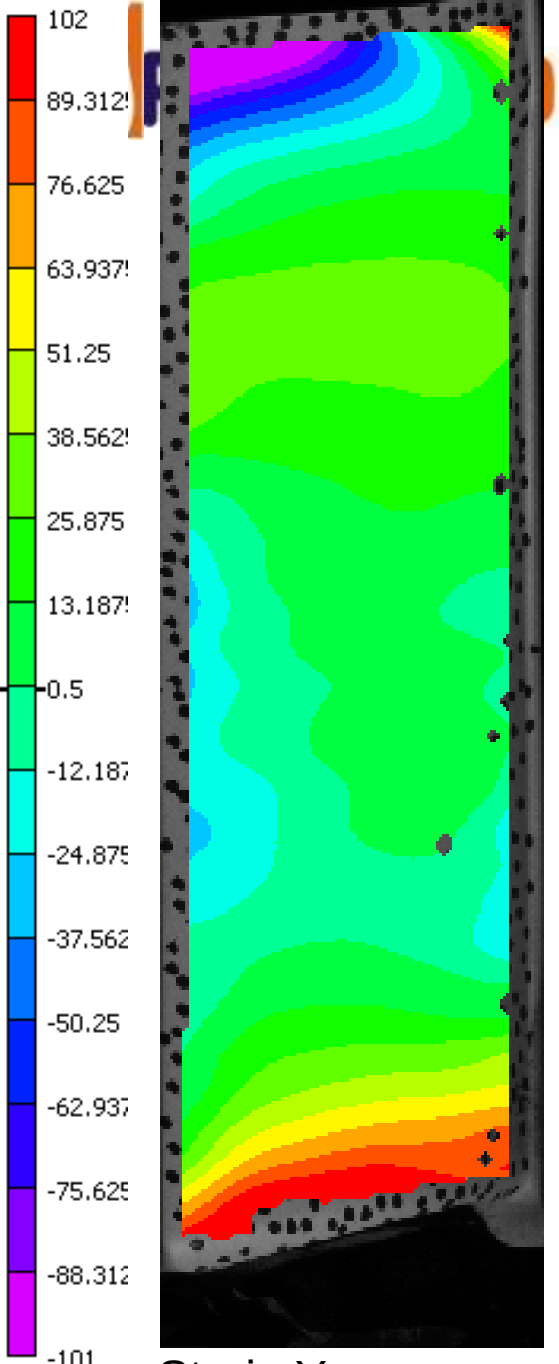




PYRO DYNAMICS

"W" Out Of Plane Displacement





Strain Y - ε_{yy}

The Strain Plot shows a high strain field of 102 με at the root of the blade. The other regions show a uniform strain field except at the tip.

VIC-3D was able to measure such low levels of strains with a resolution of 15 με.

PYRO DYNAMICS

Experiment	Dynamic Strain Measurements on a Charpy Test Specimen in a Drop Testing Machine.
Organisation	Indira Gandhi Centre For Atomic Research. Kalpakkam
System Used	VIC-2D, 2D Digital Image Correlation System.
Loading Conditions	Impact.
Camera Used	Phantom V7, High Speed Camera
Image Frame Capture	20,000 fps.

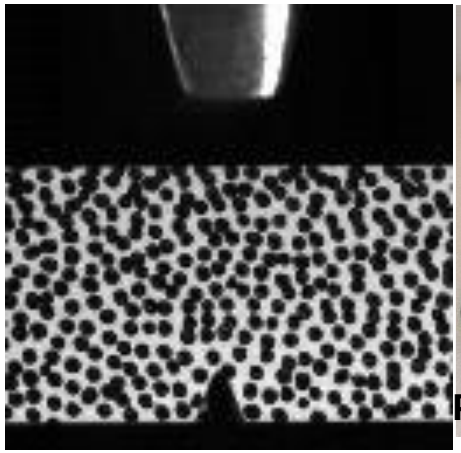
CHARPY TEST

A speckle pattern was applied on the charpy test specimen.

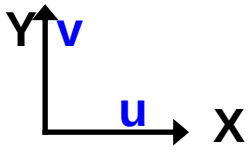
The specimen was first spray painted by a white paint. The speckles was marked using a marker pen.

Images were captured at 20,000 fps using a Phantom Camera.

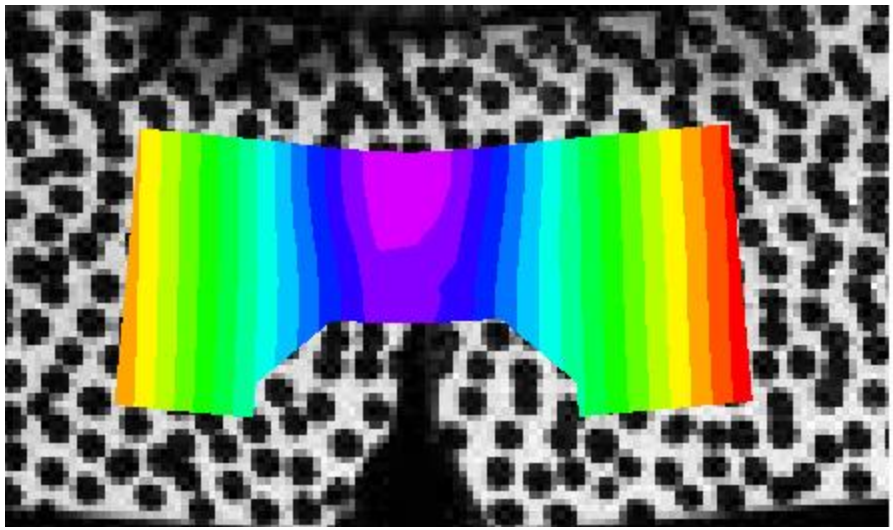
Image Resolution was 128 x 624 pixels. A subset of 25 pixels Was used for correlation.



Phantom V7 High Speed Camera



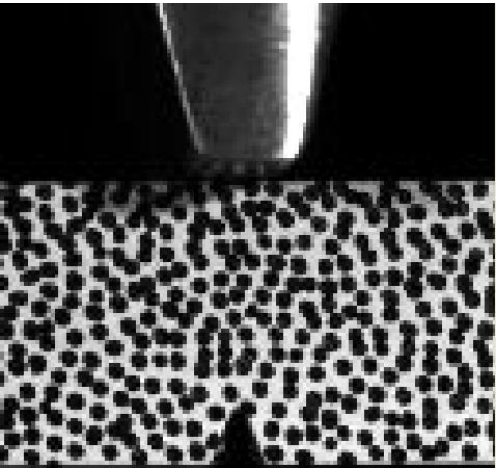
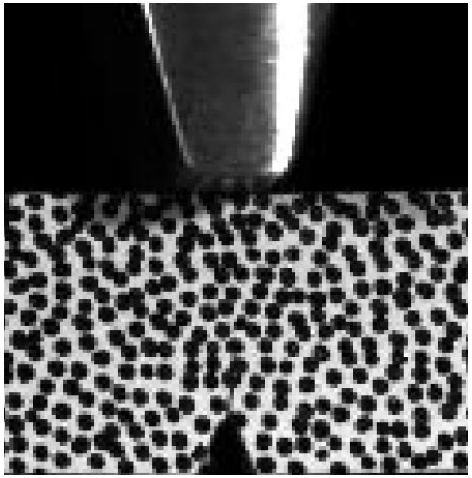
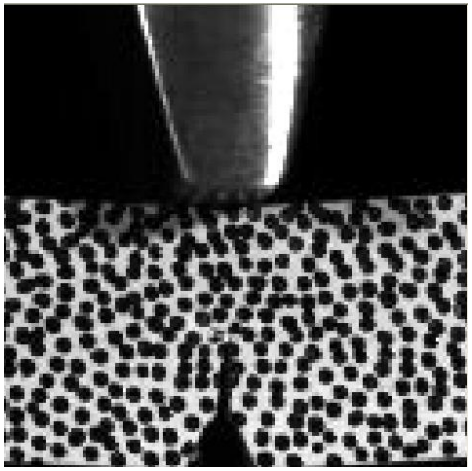
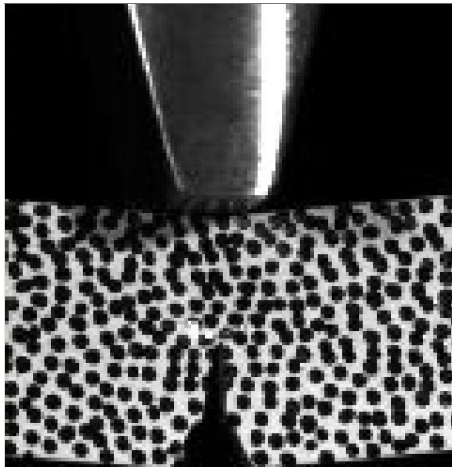
U Displacement
Time = **2100** µs



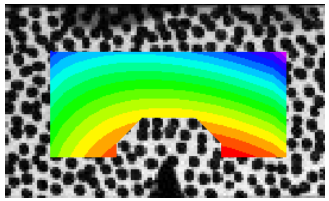
V Displacement
Time = **2100** µs

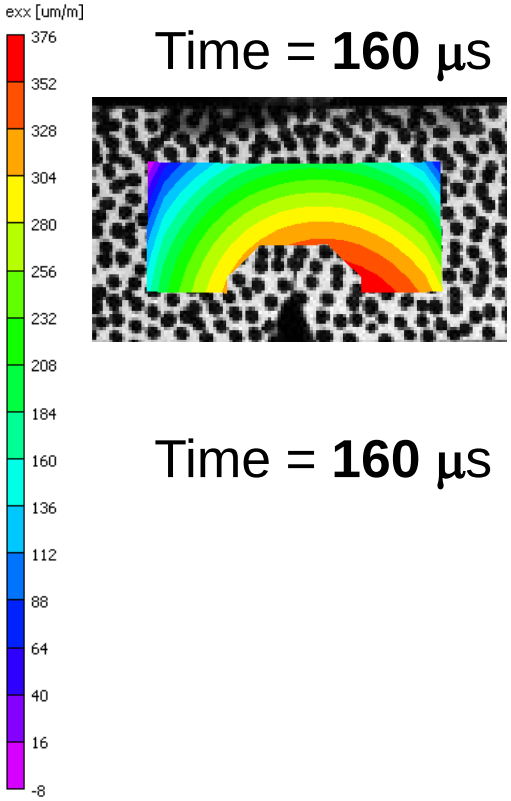
PYRO DYNAMICS

Strain x - ε_{xx}

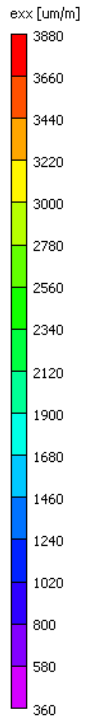
Time = **0** μs





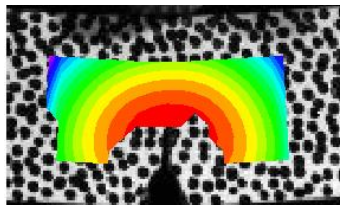
Time = **0** μs

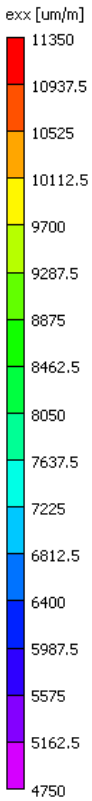
Time = **160** μs



Time = **160** μs

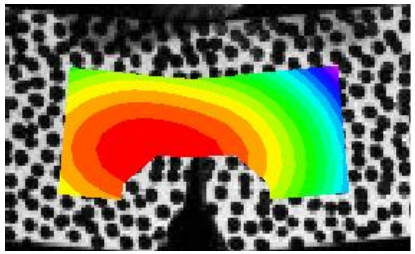
Time = **750** μs

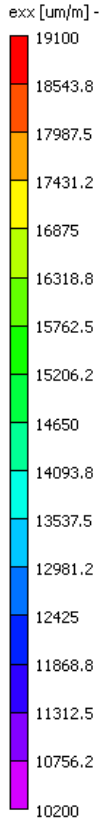




Time = **750** μs

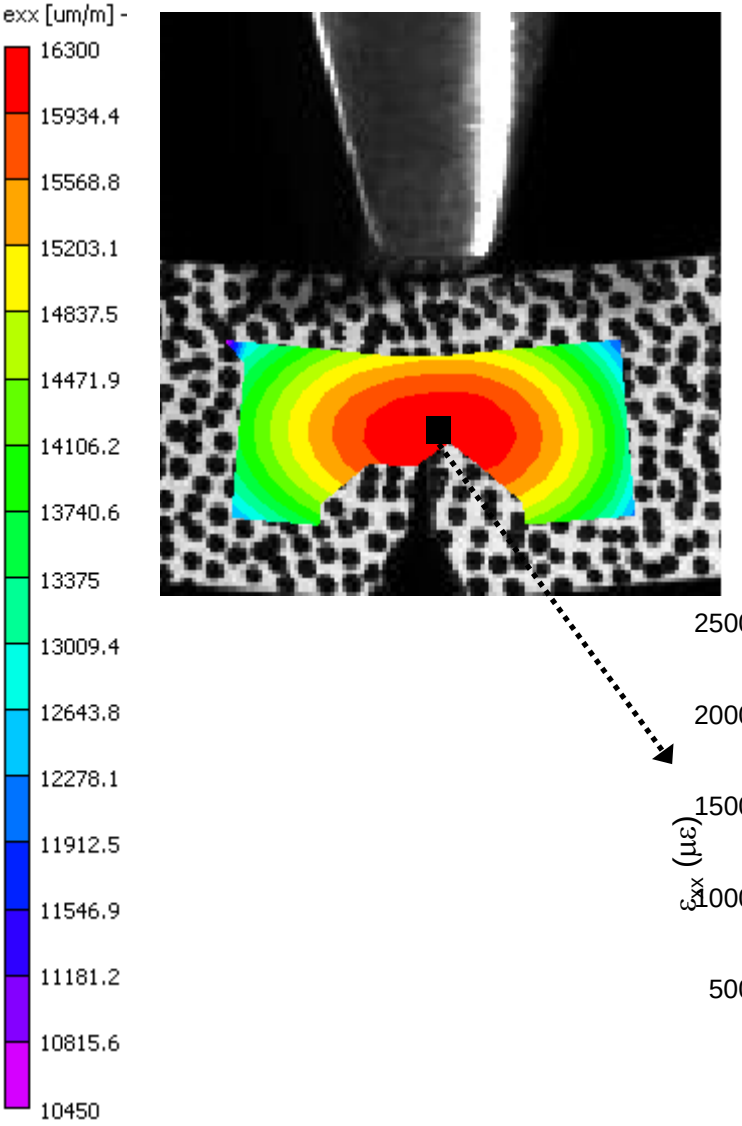
Time = **2100** μs

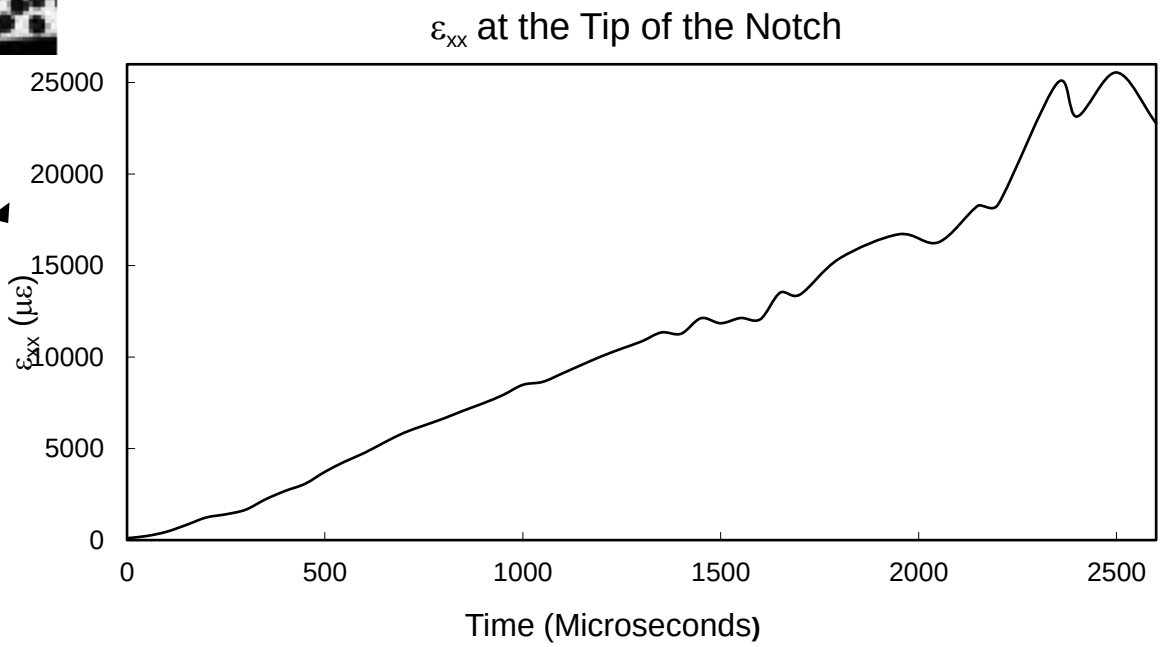




Time = **2100** μs

PYRO DYNAMICS





PYRO DYNAMICS

Experiment	Impact Measurements on a Composite Specimen in a Drop testing Machine
Organisation	Department of Applied Mechanics. Indian Institute of Technology. New Delhi
System Used	VIC-3D, 3D Digital Image Correlation System with Modal Analysis.
Loading Conditions	Impact.
Camera Used	Photron SA5 Cameras.
Image Frame Capture	30,000 fps.

Impact Measurements on a Composite Specimen in a Drop Testing Machine

A speckle pattern was applied on a Composite Specimen.

The specimen was fixed in the fixture of a Dynatup Impact Tester (Drop Testing Machine)

The plunger strikes the specimen at 2 meters/sec.

The ideal condition would be to mount the cameras below the specimen.

However there is no space and due to safety reasons the cameras are mounted outside the machine.

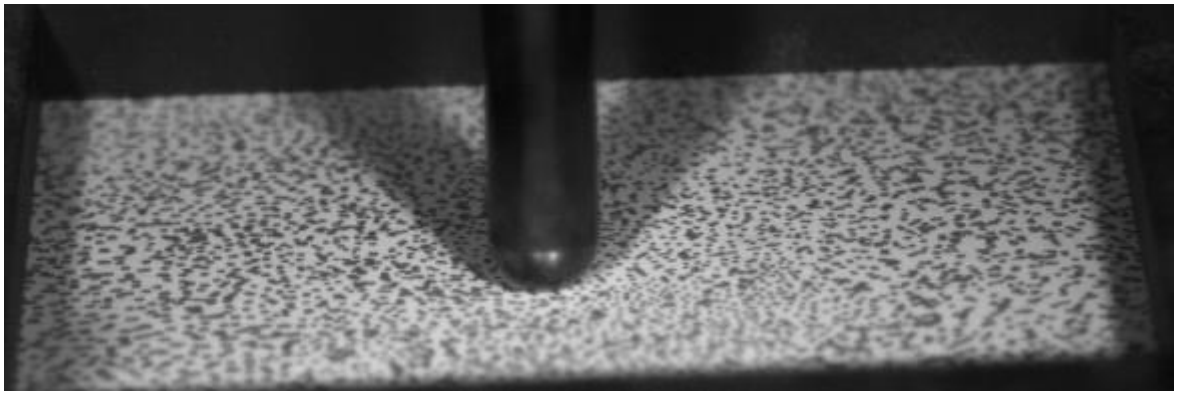
The cameras are mounted at an angle as shown and the specimen is viewed through a glass door.

3D stereo calibration is done using a 12X9X6 Calibration Grid with 6mm spacing.

During calibration, the gris is placed ont he specimen and calibration images captured with the door closed.

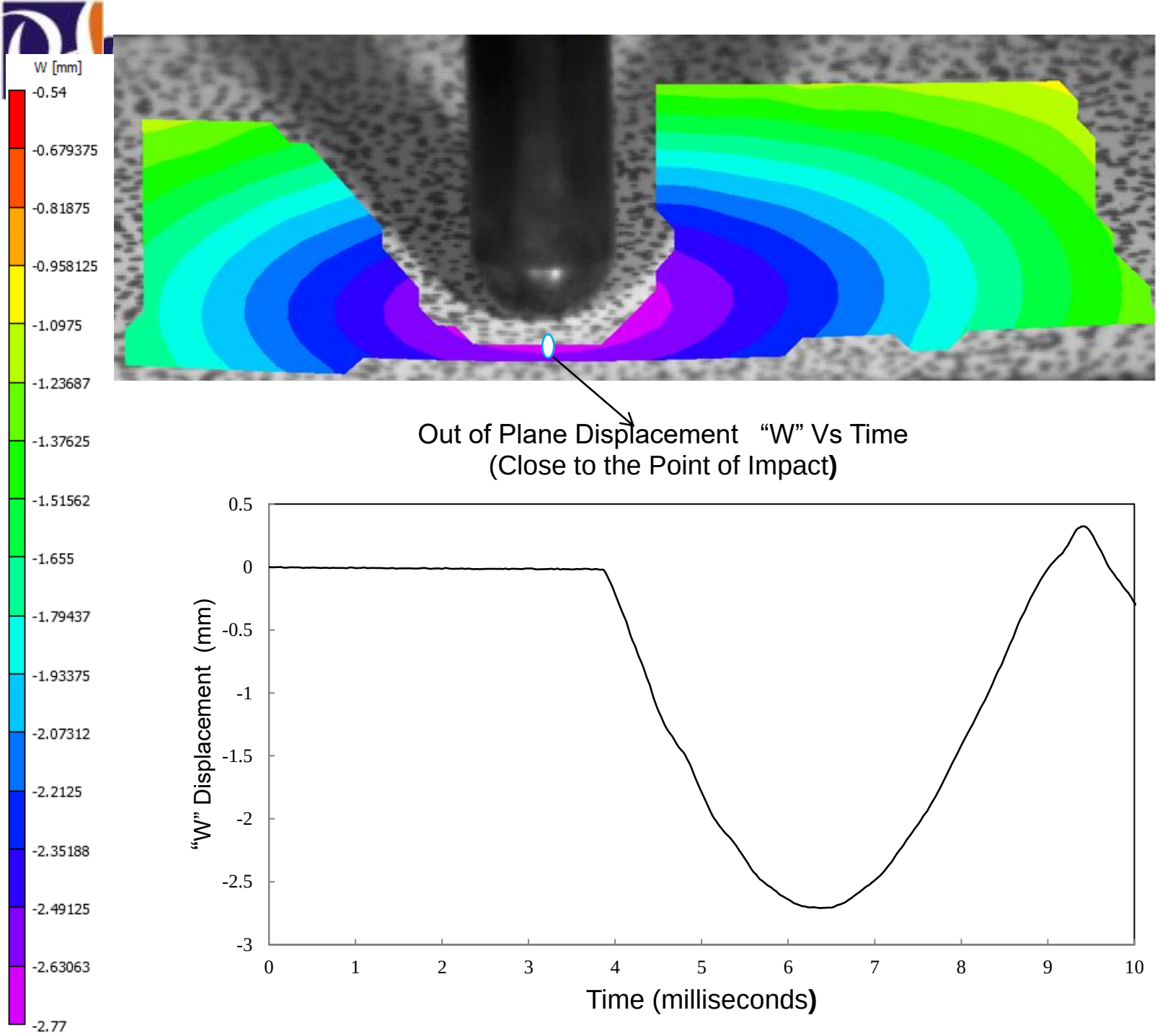
Test Images were captured at 30,000 fps

Image Resolution:- 640 X 376 Pixels



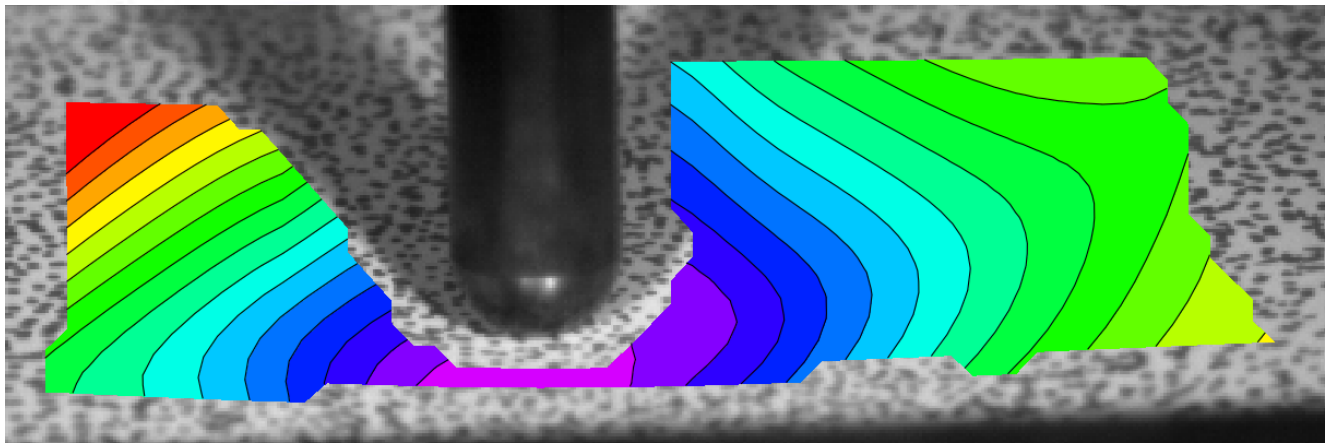
Plunger striking the specimen (Image captured by the camera)

Since the plunger is in the view of the camera, correlation around the plunger is not possible.

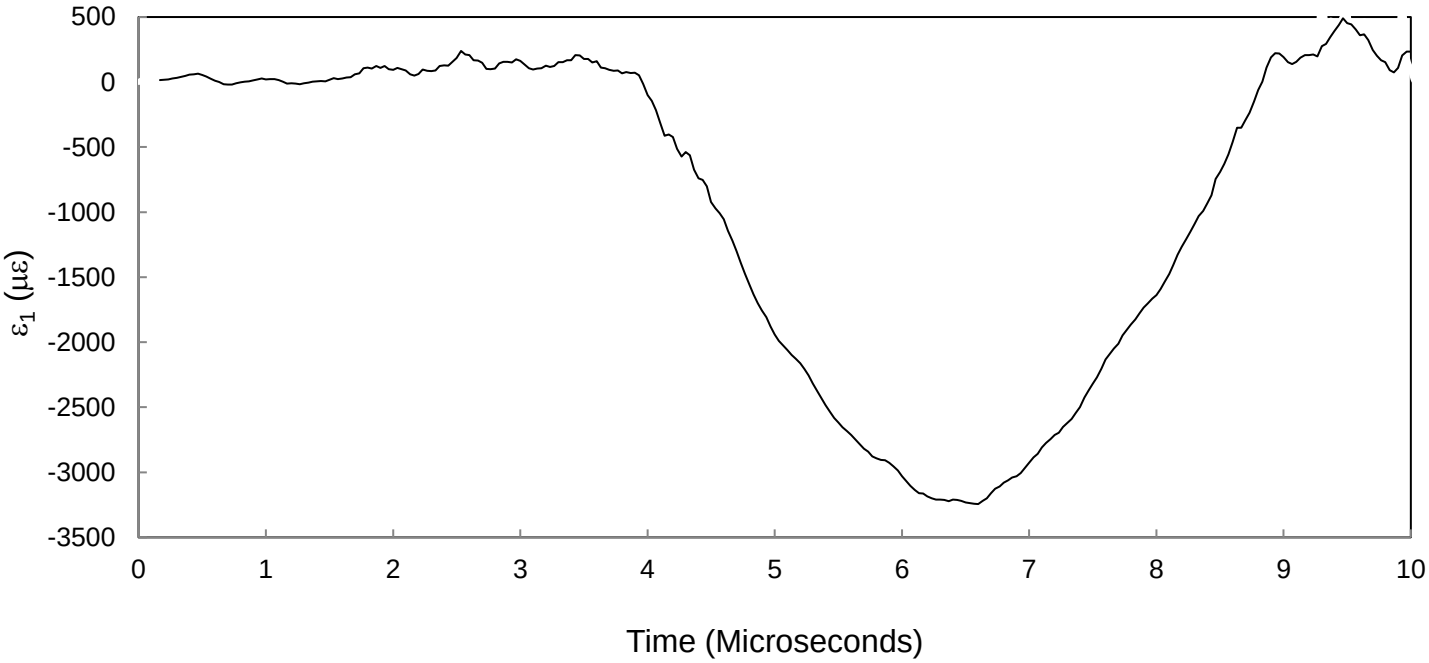


Out of Plane Displacement "W" Vs Time
(Close to the Point of Impact)

PYRO DYNAMICS

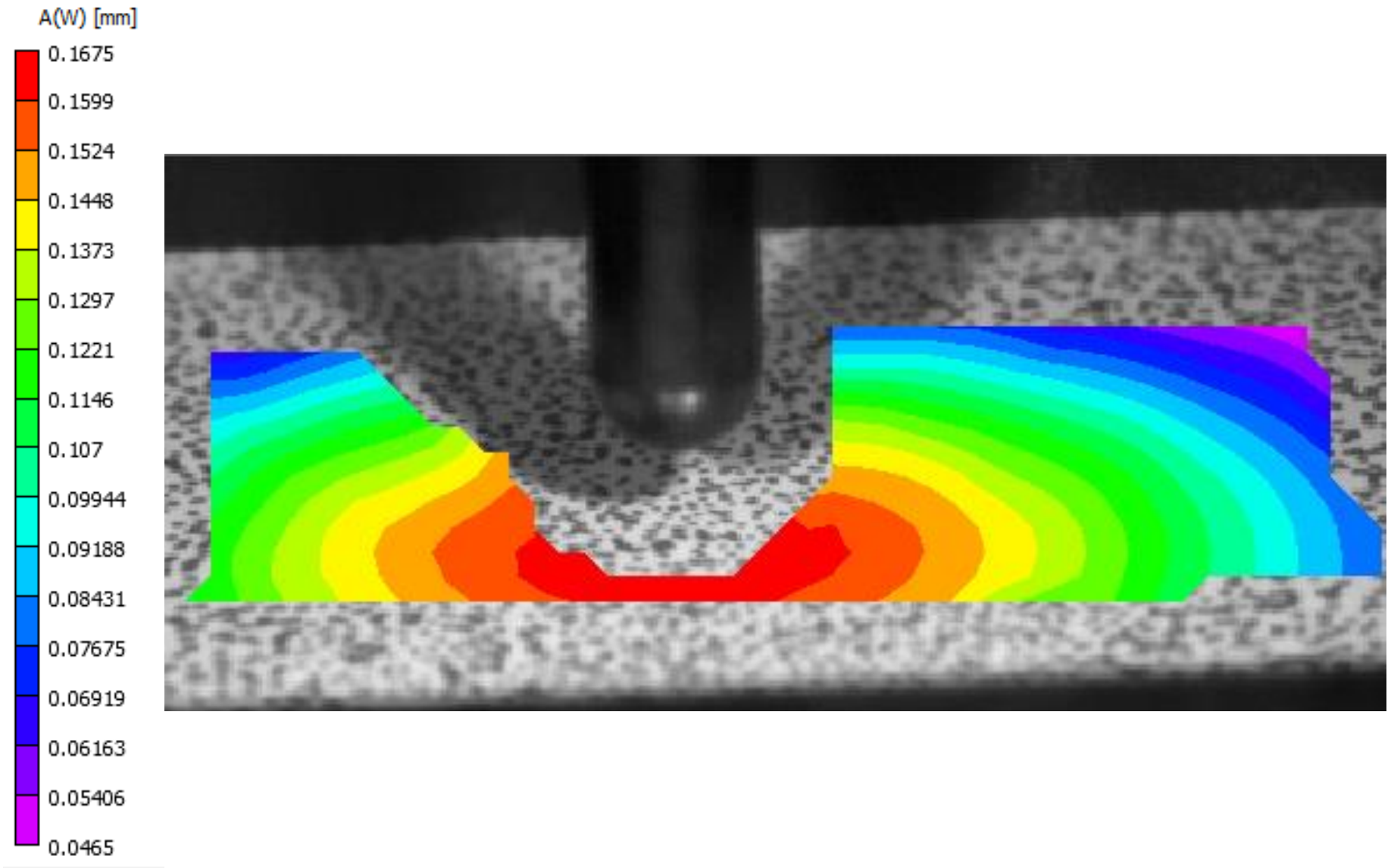


Principal Strain 1 Vs Time
(Close to the Point of Impact)



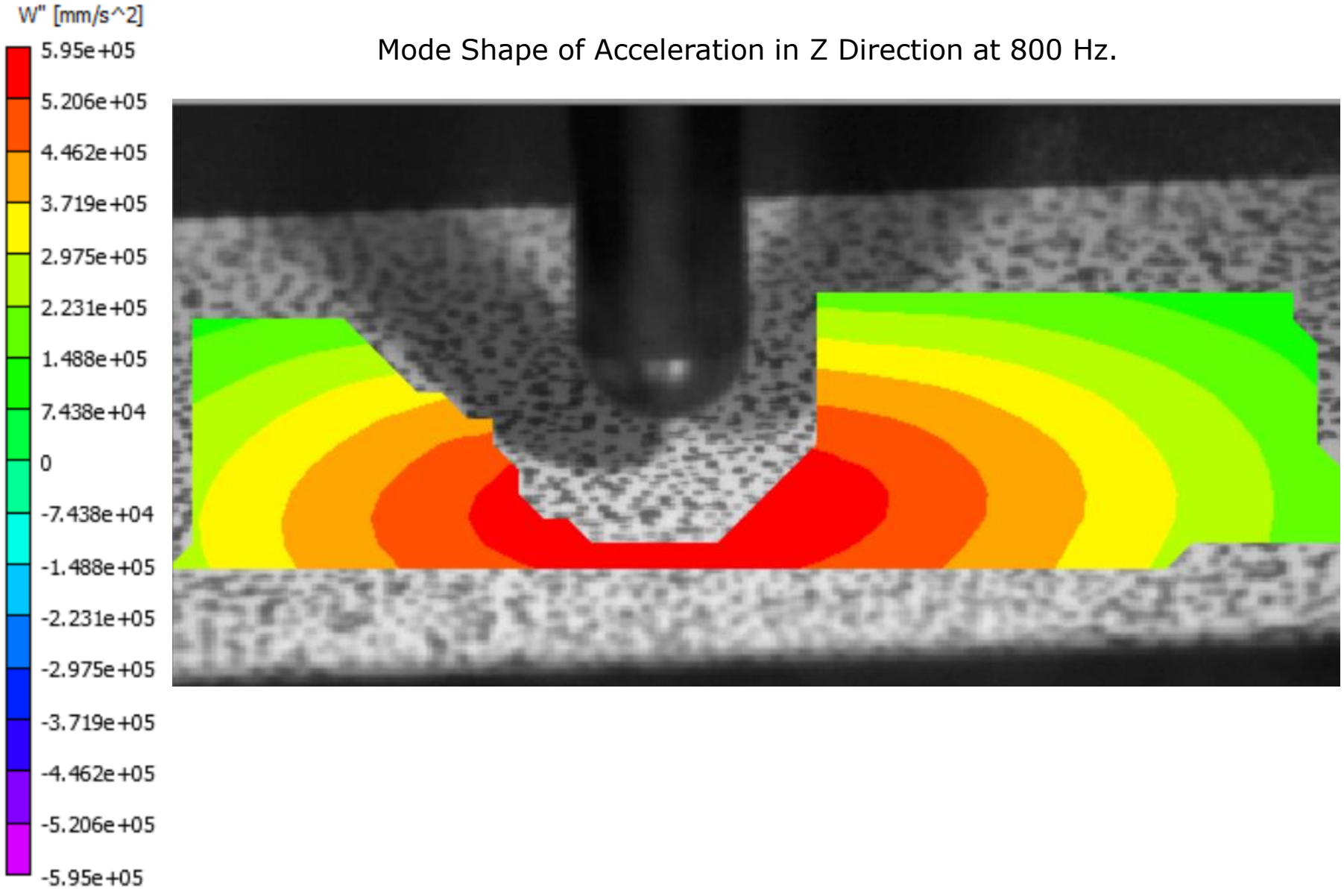
PYRO DYNAMICS

Mode Shape of "W' Displacement at 381Hz.



PYRO DYNAMICS

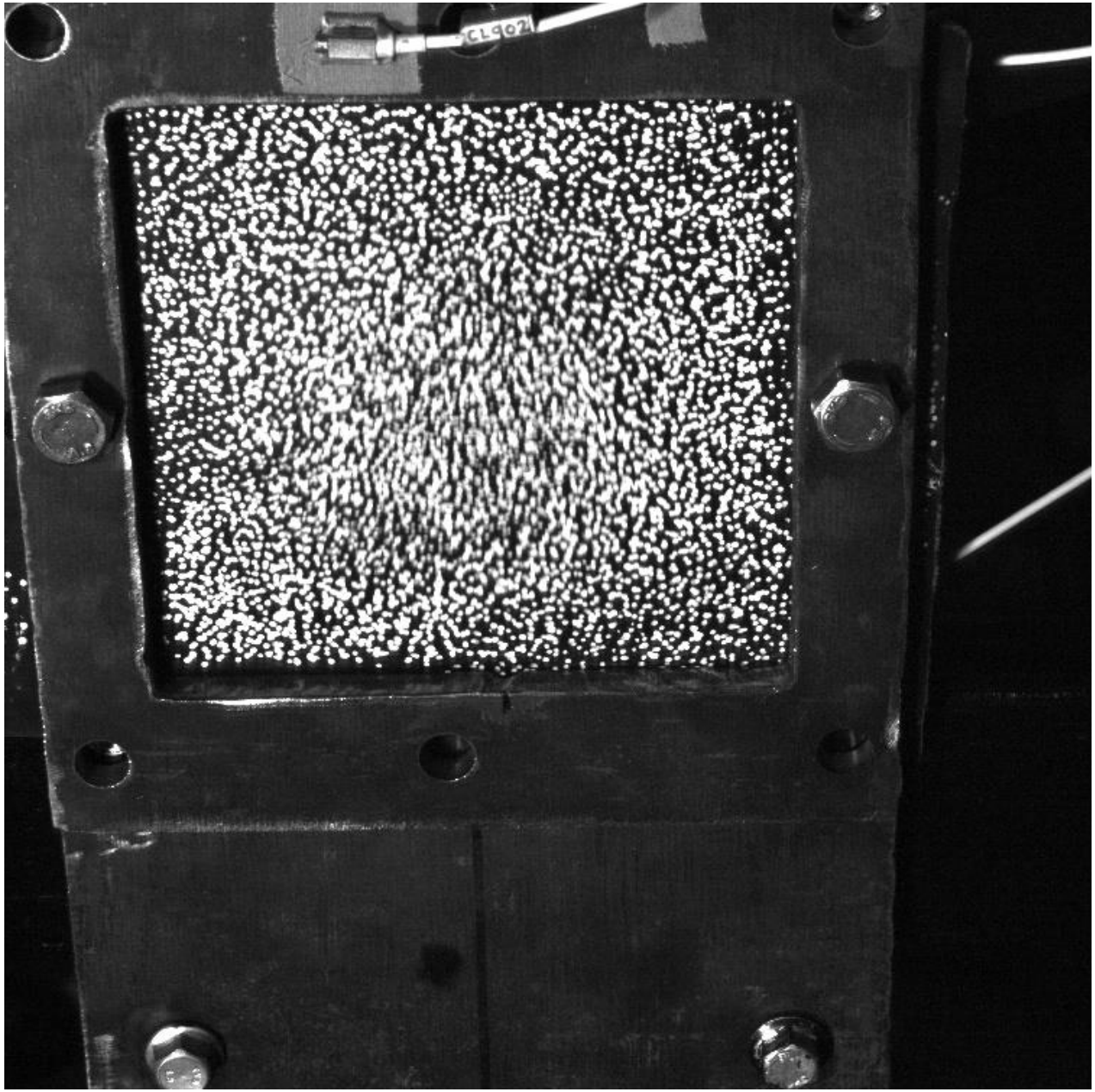
Mode Shape of Acceleration in Z Direction at 800 Hz.



PYRO DYNAMICS

Experiment	Dash Board of a Car in a Shock Tube
Organisation	Tata Motors Limited Research and Development
System Used	VIC-3D, 3D Digital Image Correlation System with Modal Analysis.
Loading Conditions	Shock Tube
Camera Used	Redlake Cameras.
Image Frame Capture	1,500 fps.

Measurements in a Shock Tube



The Test Component is a plastic specimen of 150mm X 150mm.

The specimen was fixed a shock tube and the pressure applied was 6 Bar.

Frame Rate:- 1500 fps

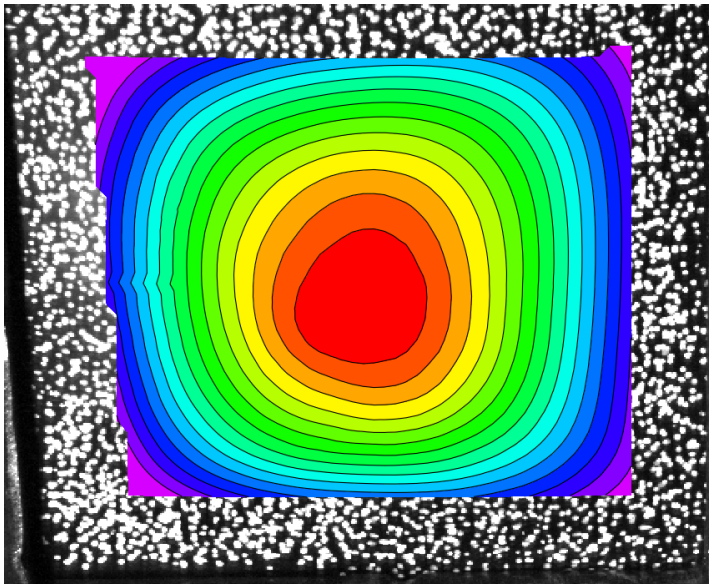
The Test Component was fixed in frame and set close to the exit of the pipe of the shock tube.

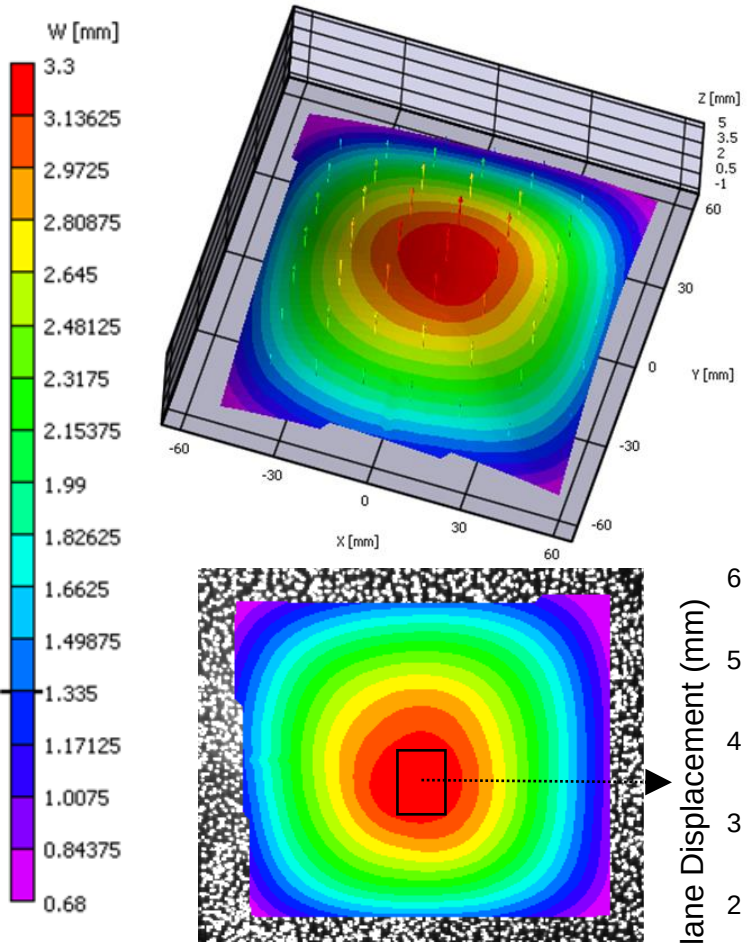
When the pressure was applied the rig moved and there by created a rigid body motion.

The VIC-3D is capable of calculating the Rigid Body Motions.

PYRO DYNAMICS

“W” With Rigid Body Motion Removed. Time:- 0.66 ms



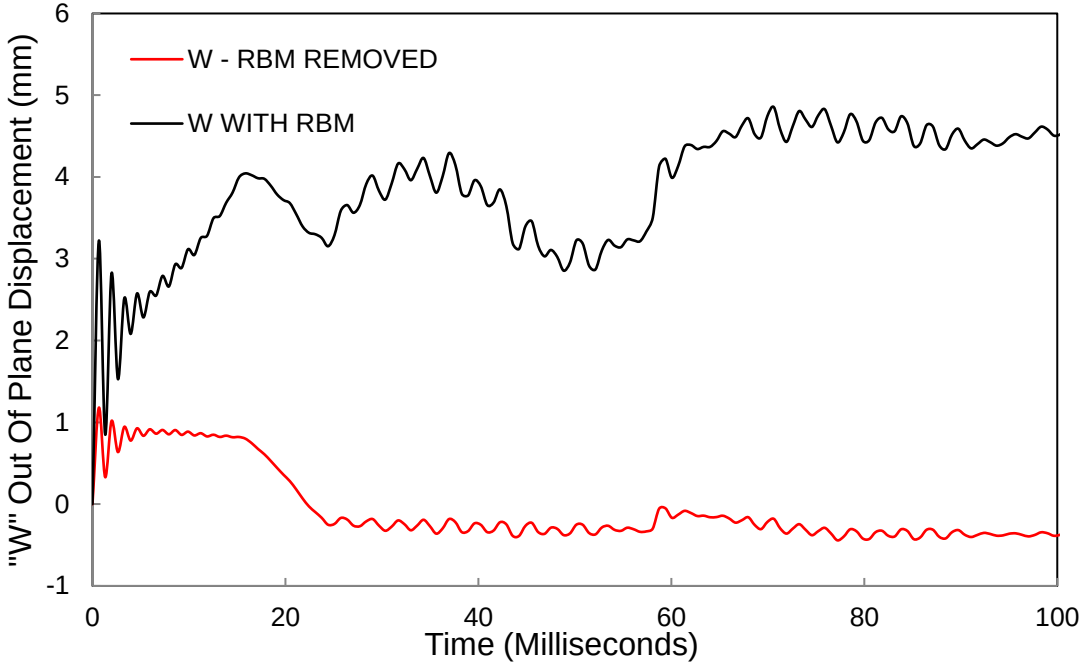


Out of Plane Displacement “W”

With Rigid Body Motion.

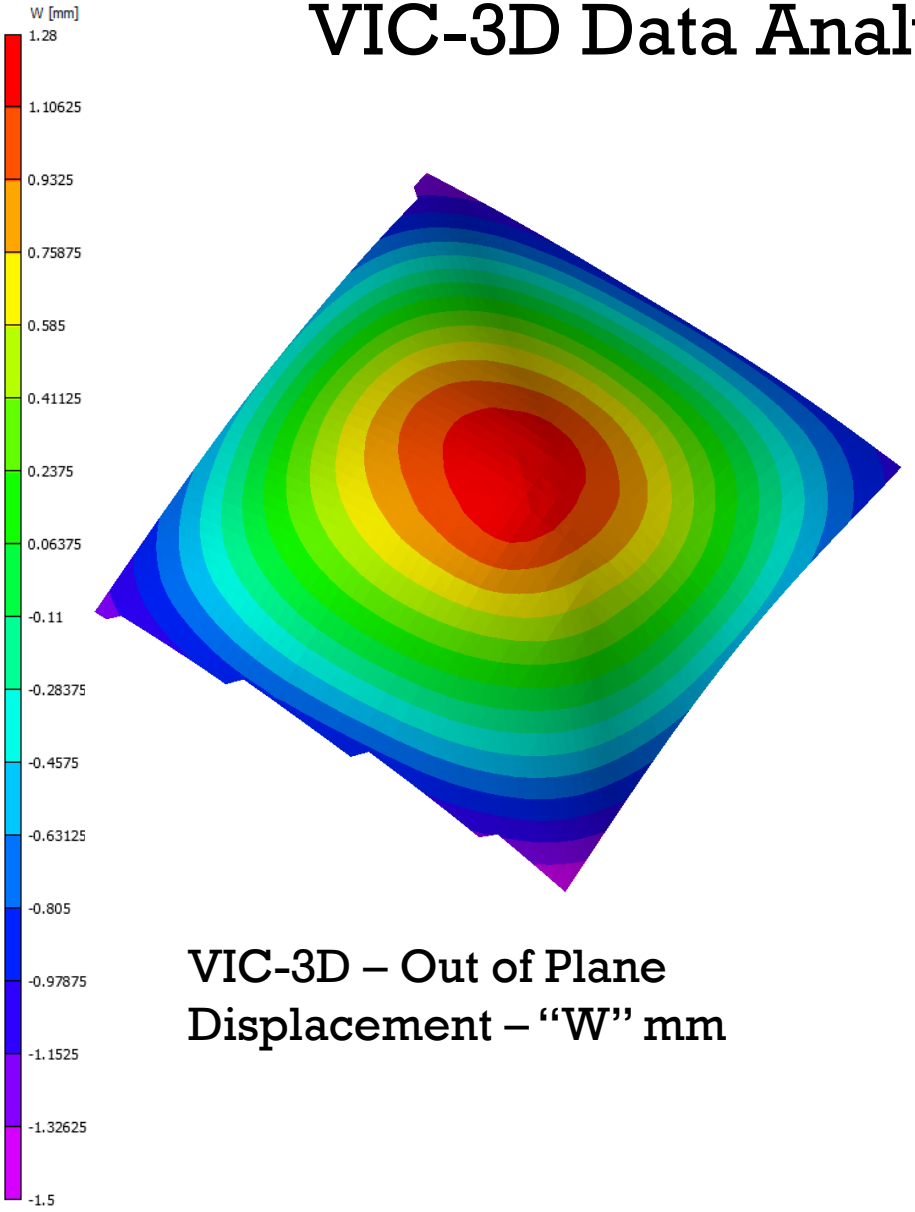
Time:- 0.66 ms

Out of Plane Displacement Vs Time

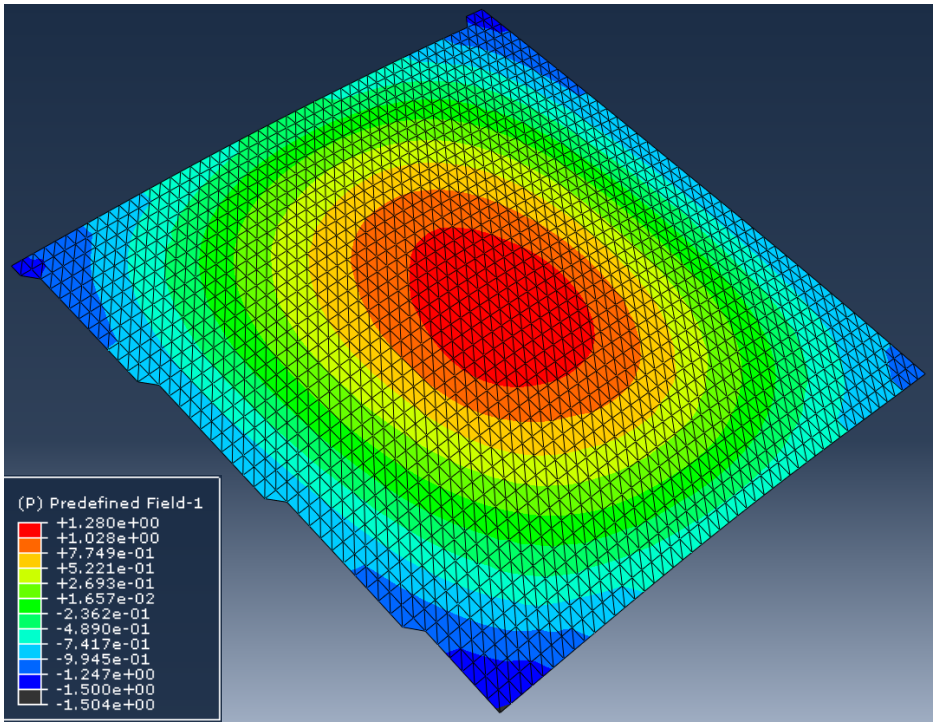


PYRO DYNAMICS

VIC-3D Data Analyzed in FEM - ABAQUS



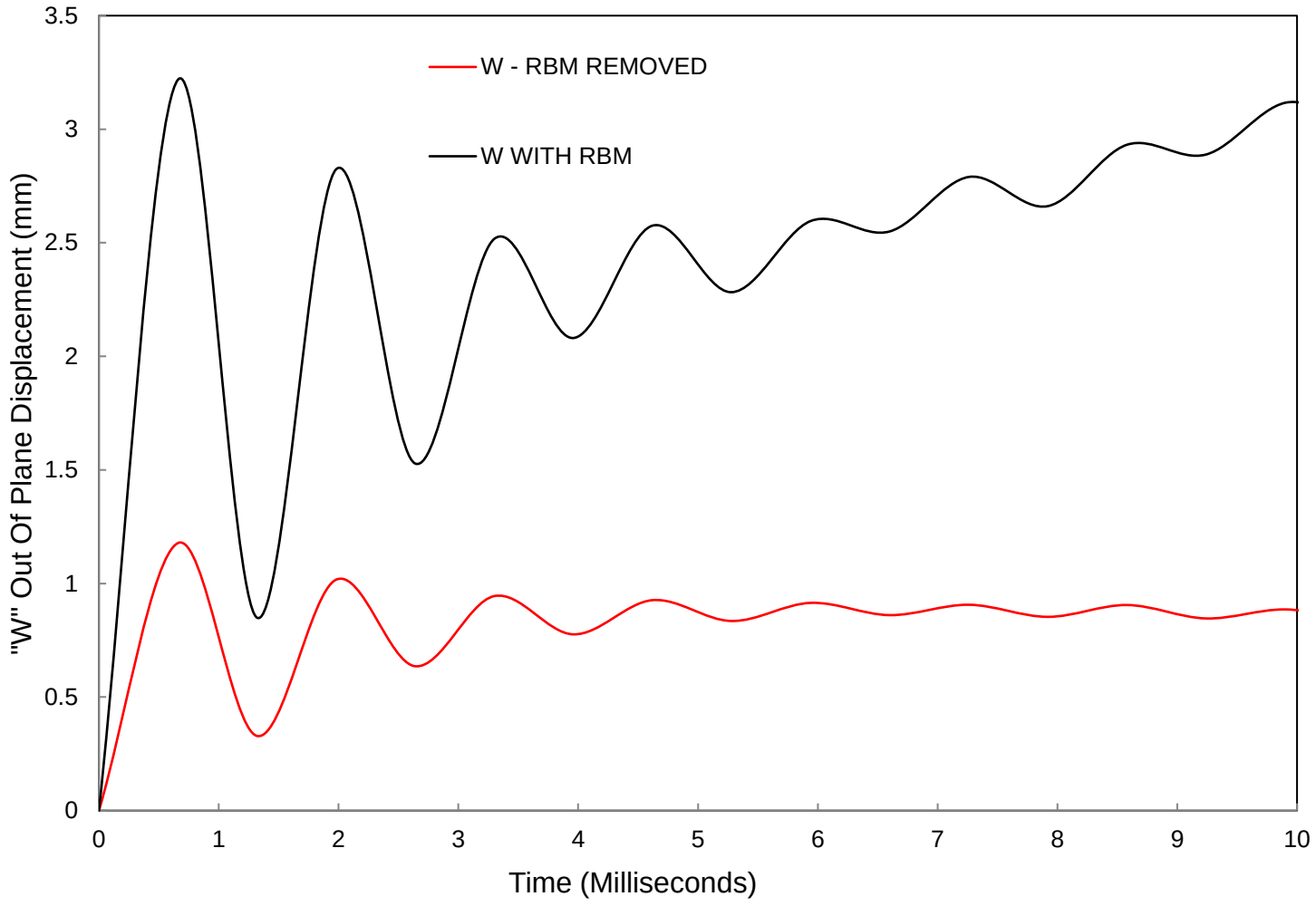
VIC-3D – Out of Plane Displacement – "W" mm



VIC-3D Data exported and analyzed in ABAQUS

PYRO DYNAMICS

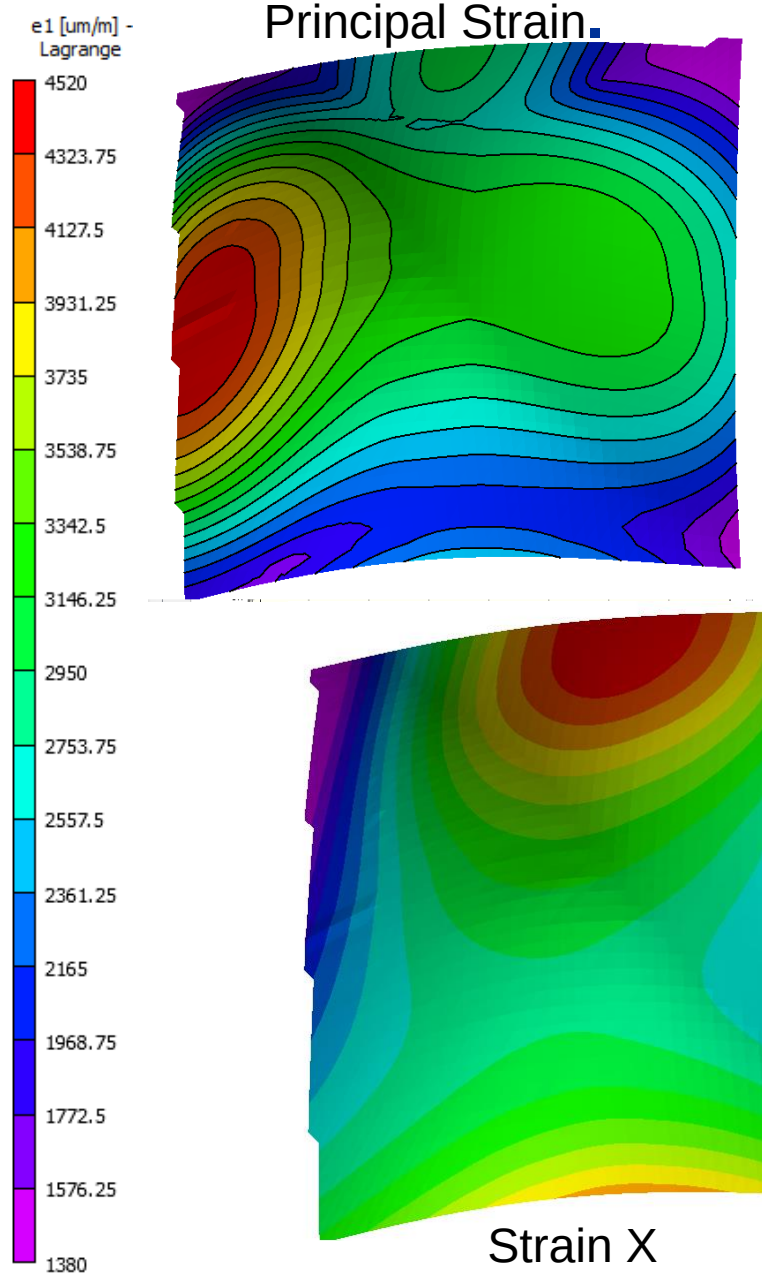
Out of Plane Displacement Vs Time



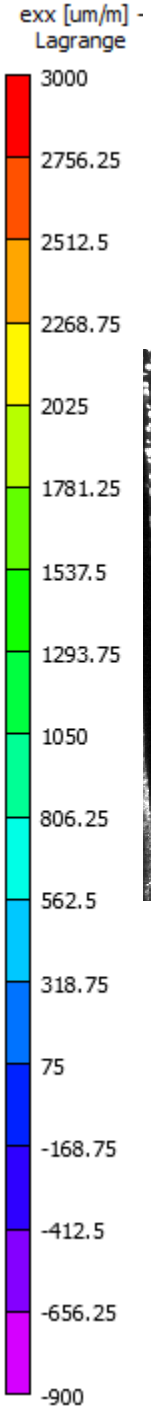
PYRO DYNAMICS

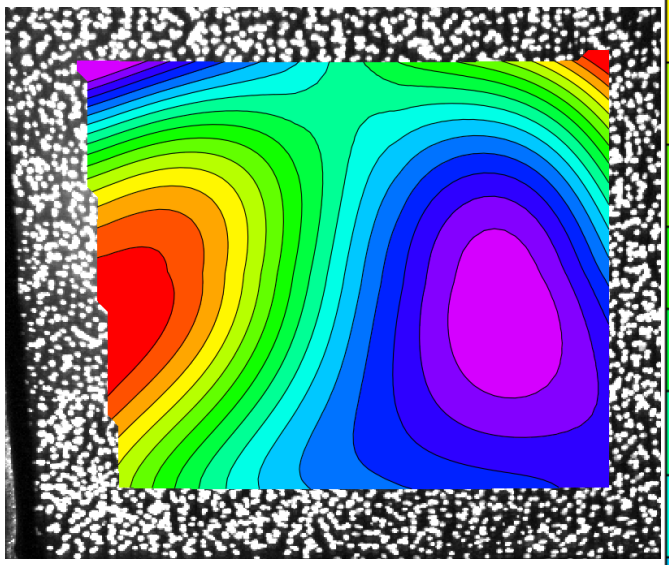
Strain Plots at 0.66 ms.

Principal Strain.

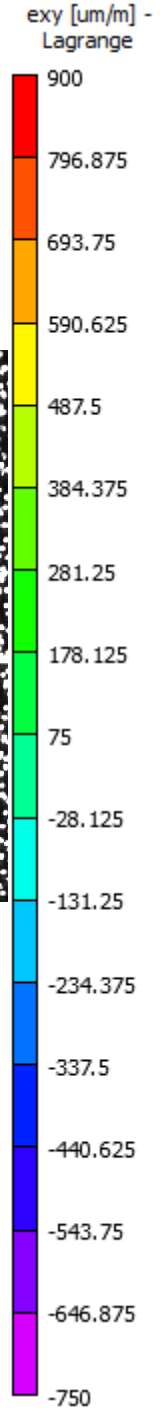


Strain X

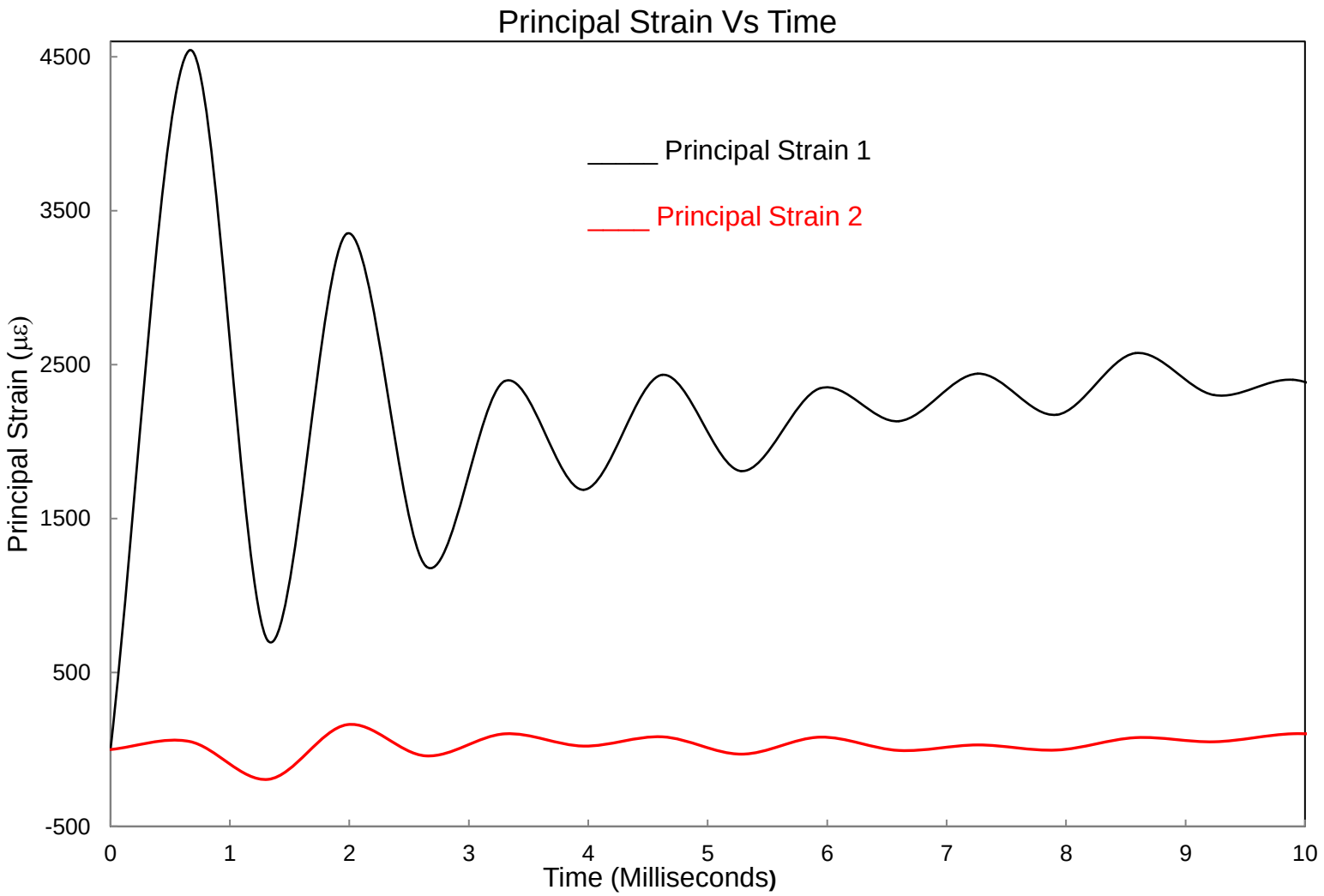




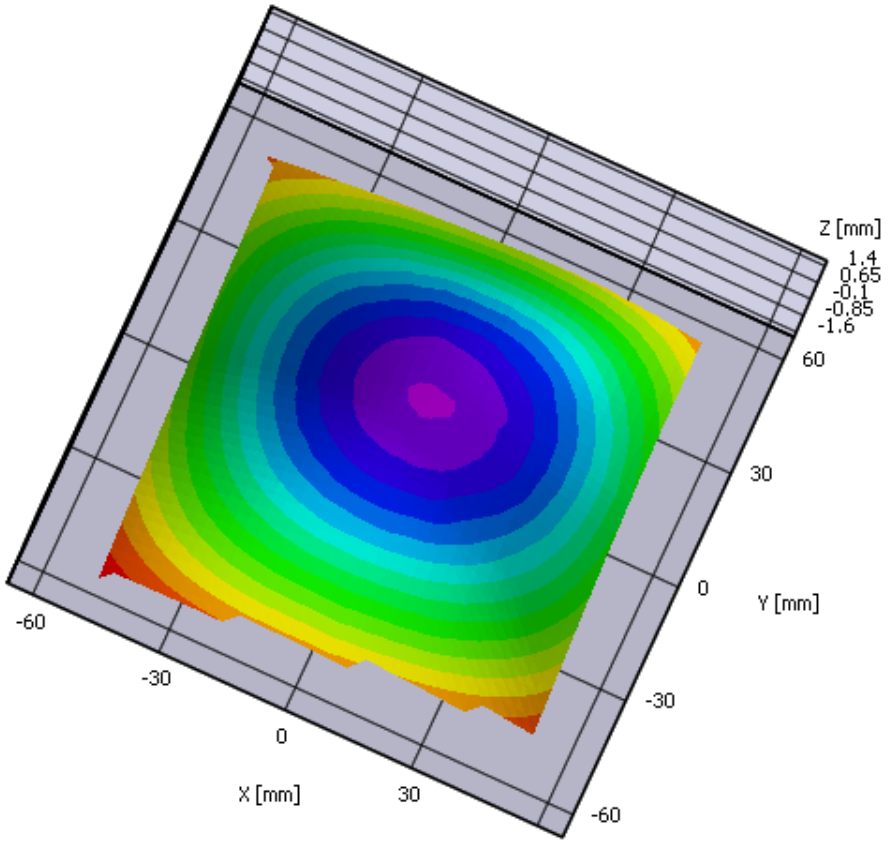
Shear Strain.

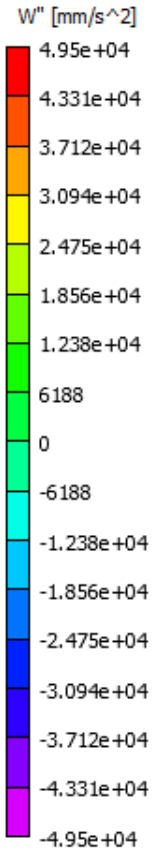


PYRO DYNAMICS

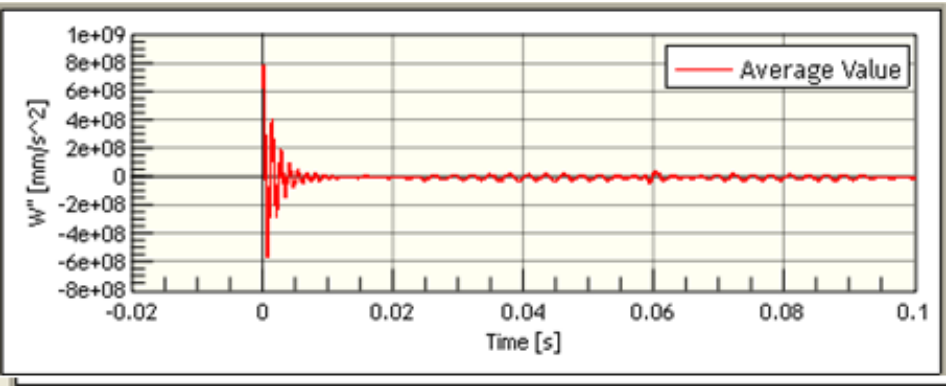


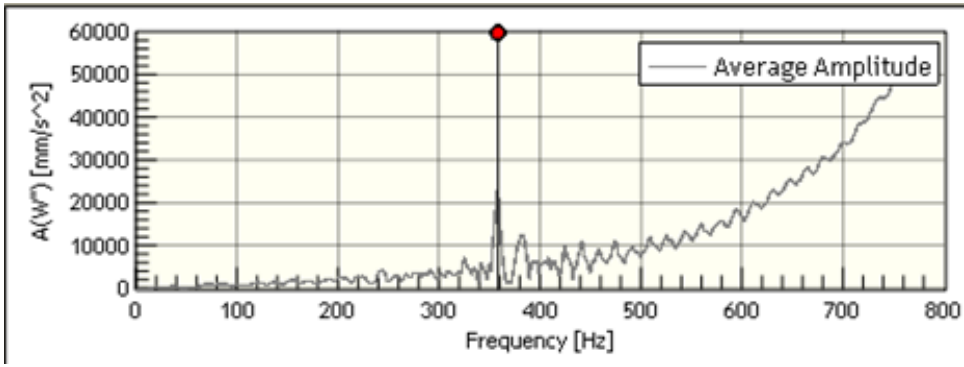
PYRO DYNAMICS





"W" Acceleration
357.531 Hz



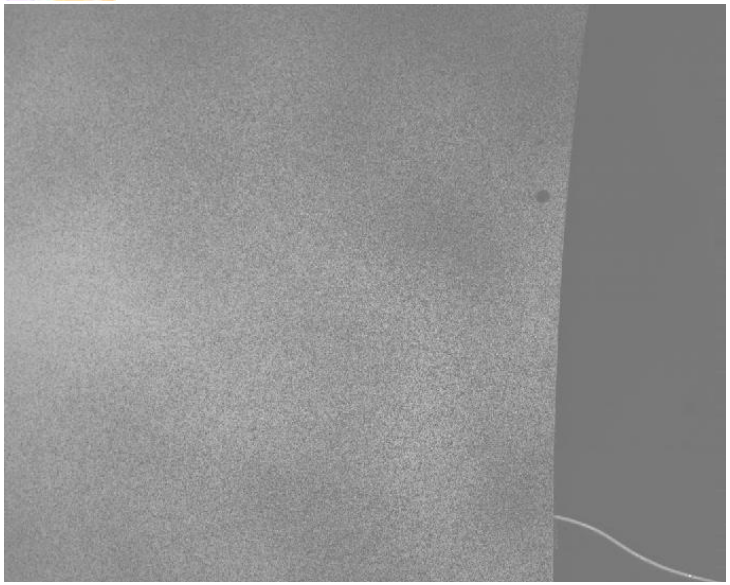


PYRO DYNAMICS

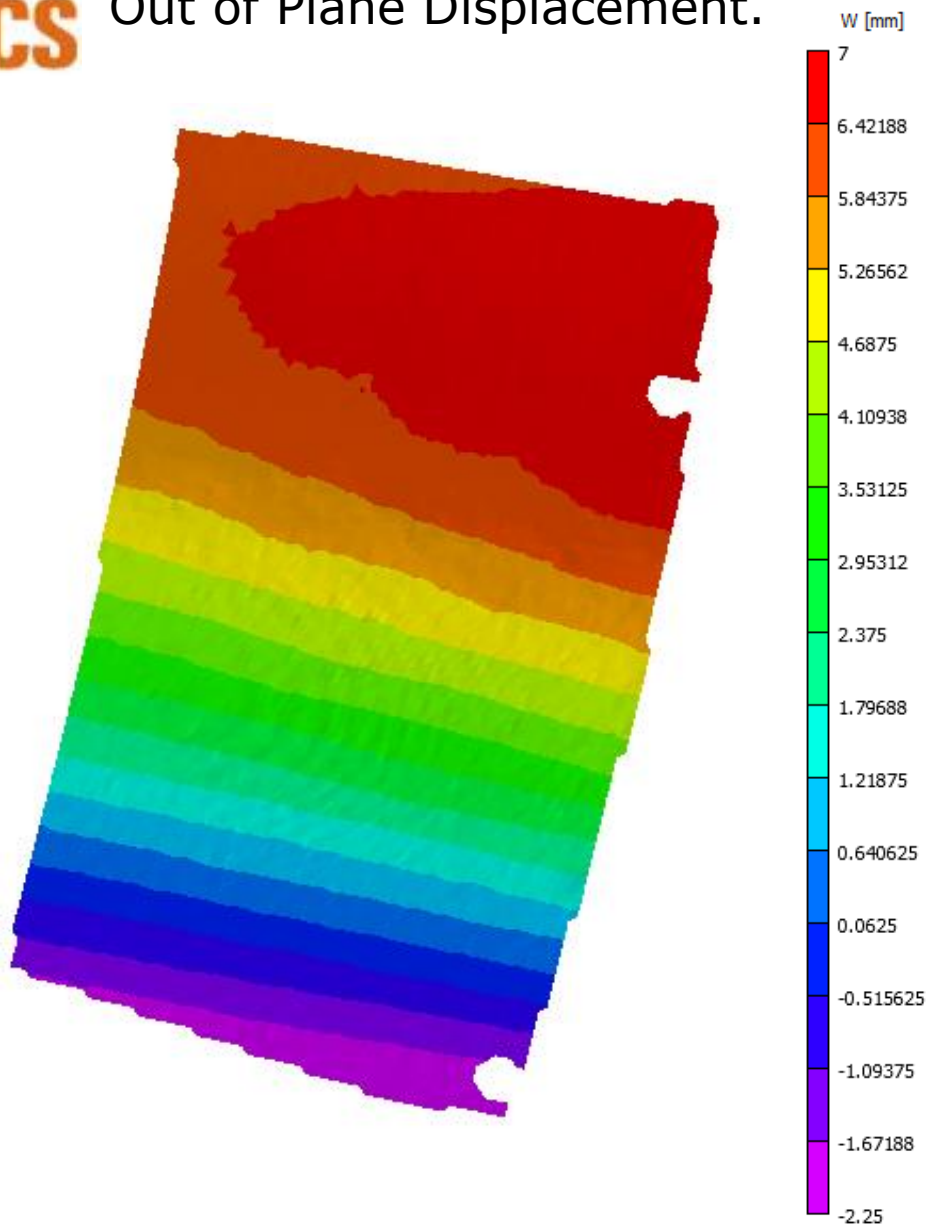
Experiment	Modal Analysis of a 0.5mm Shell at 29 Hz.
Organisation	Department of Applied Mechanics. Indian Institute of Technology. New Delhi
System Used	VIC-3D-MODAL, 3D Digital Image Correlation System with Modal Analysis.
Loading Conditions	Steady State Vibration. The Shell was subject to vibration in a Shaker
Camera Used	Photron SA5 Cameras.
Image Frame Capture	7,500 fps.

PYRO DYNAMICS

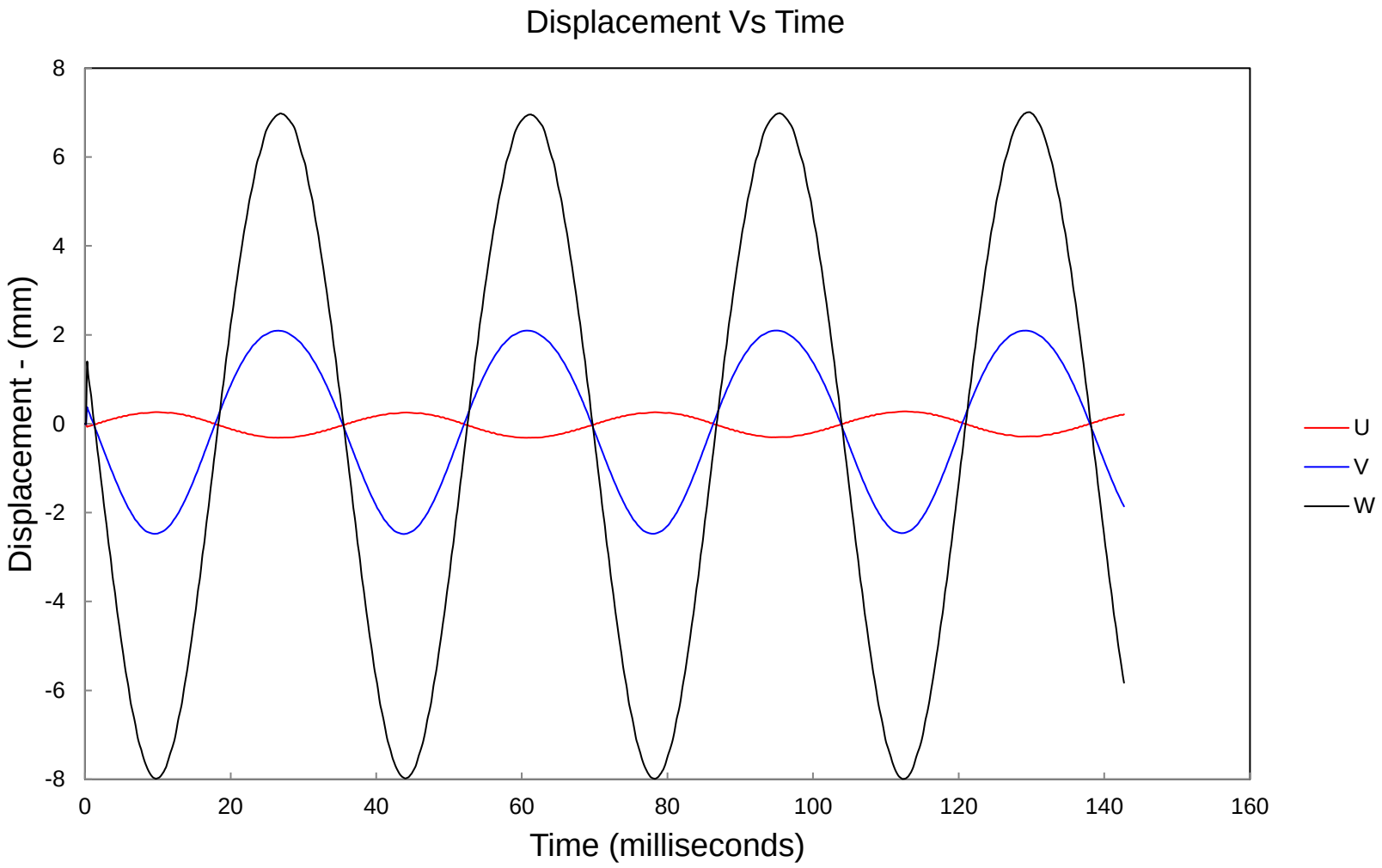
Out of Plane Displacement.



A Shell of 0.5mm thickness was subject to vibration at 29 Hz in a shaker. A speckle pattern was applied on the shell using a Air Brush, Images were captured using Photron SA5 Cameras at 7500 fps

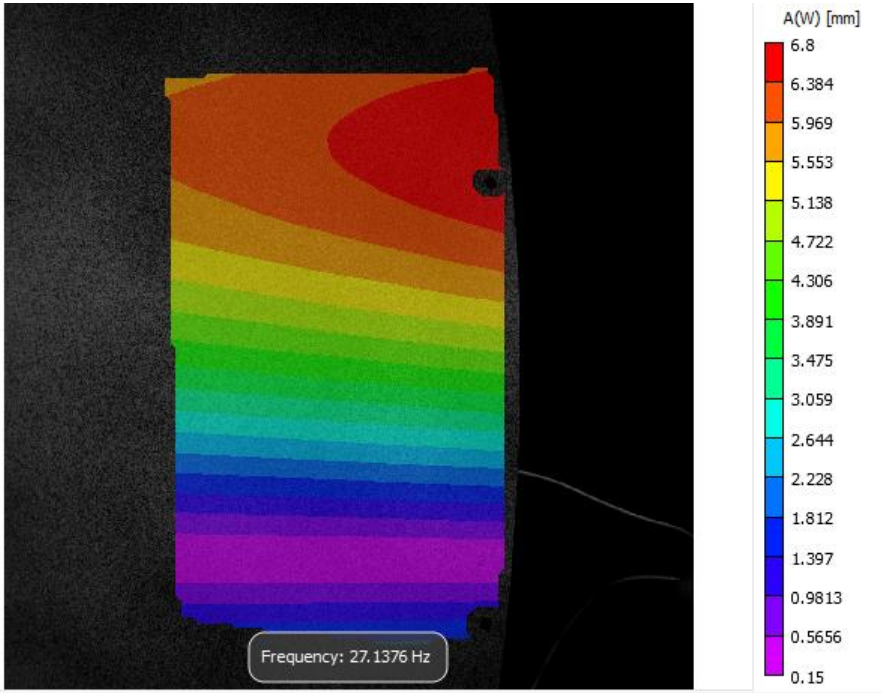


PYRO DYNAMICS

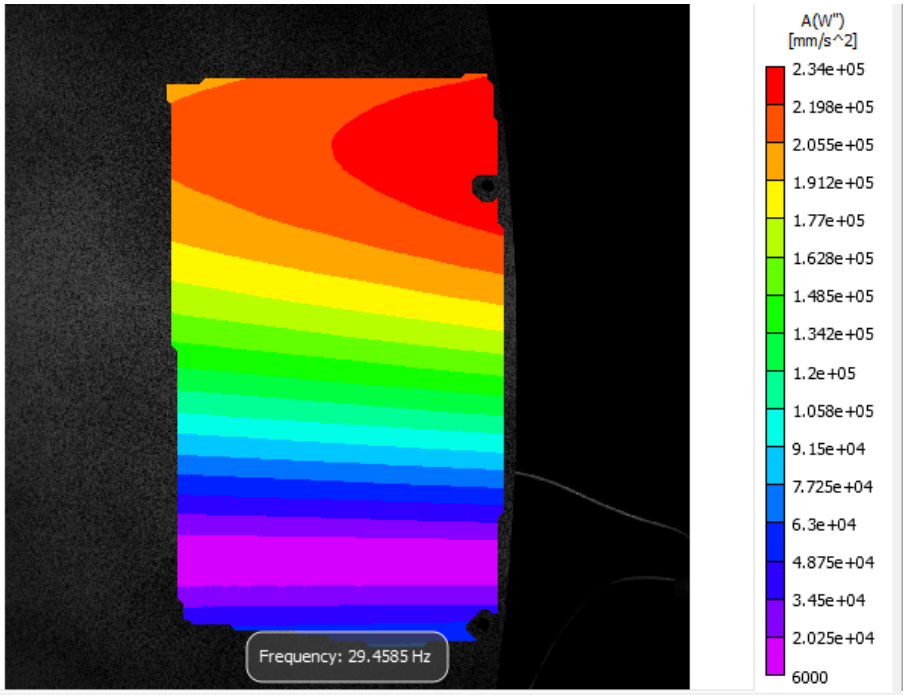


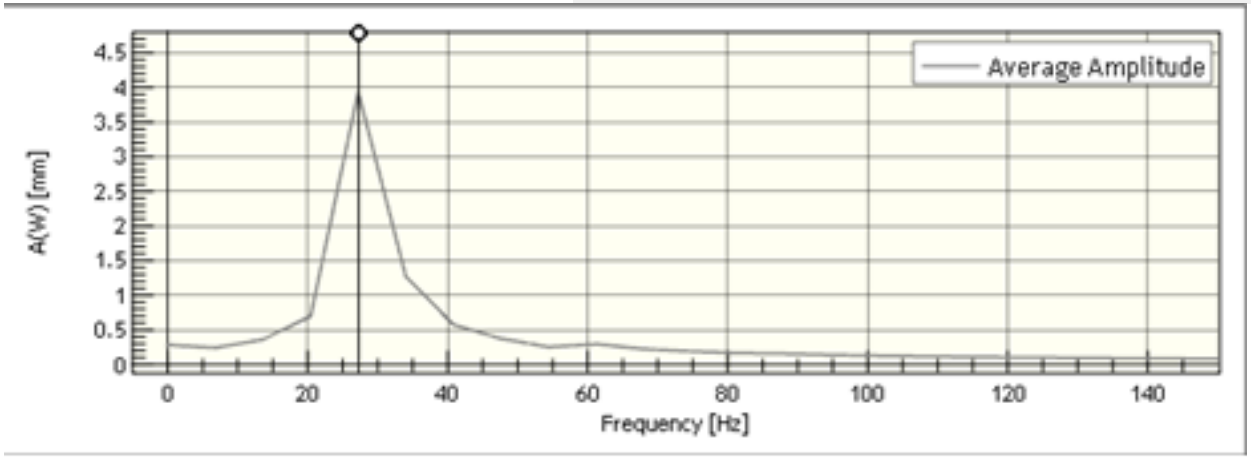
PYRO DYNAMICS

Mode Shape and FFT
Out of Plane Displacement “W”.



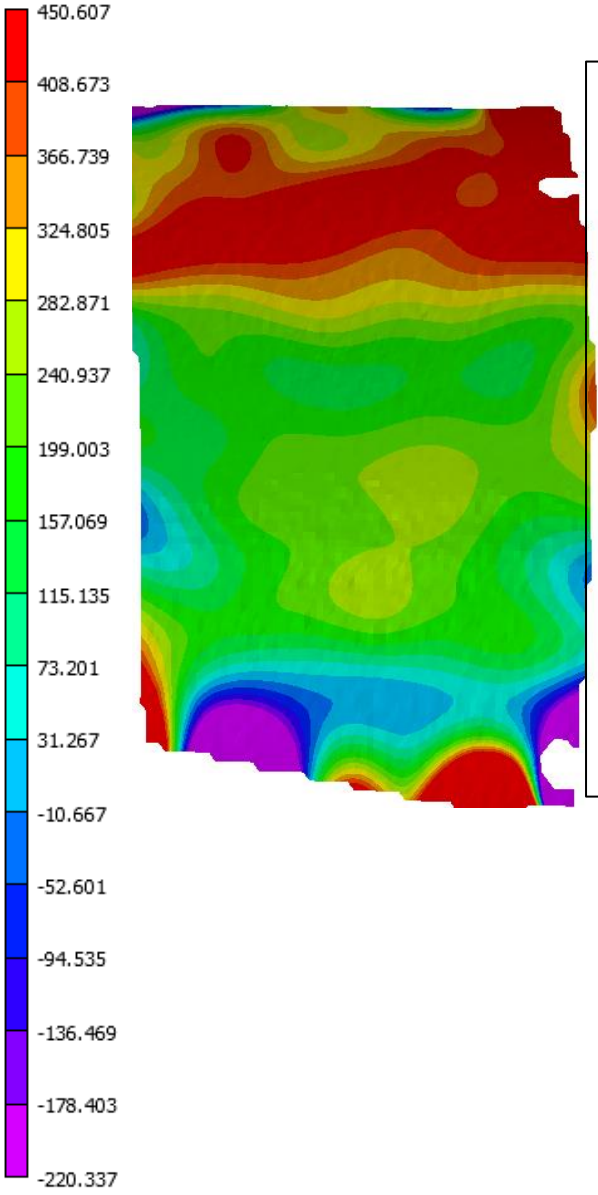
Mode Shape and FFT
Acceleration in “Z” Direction

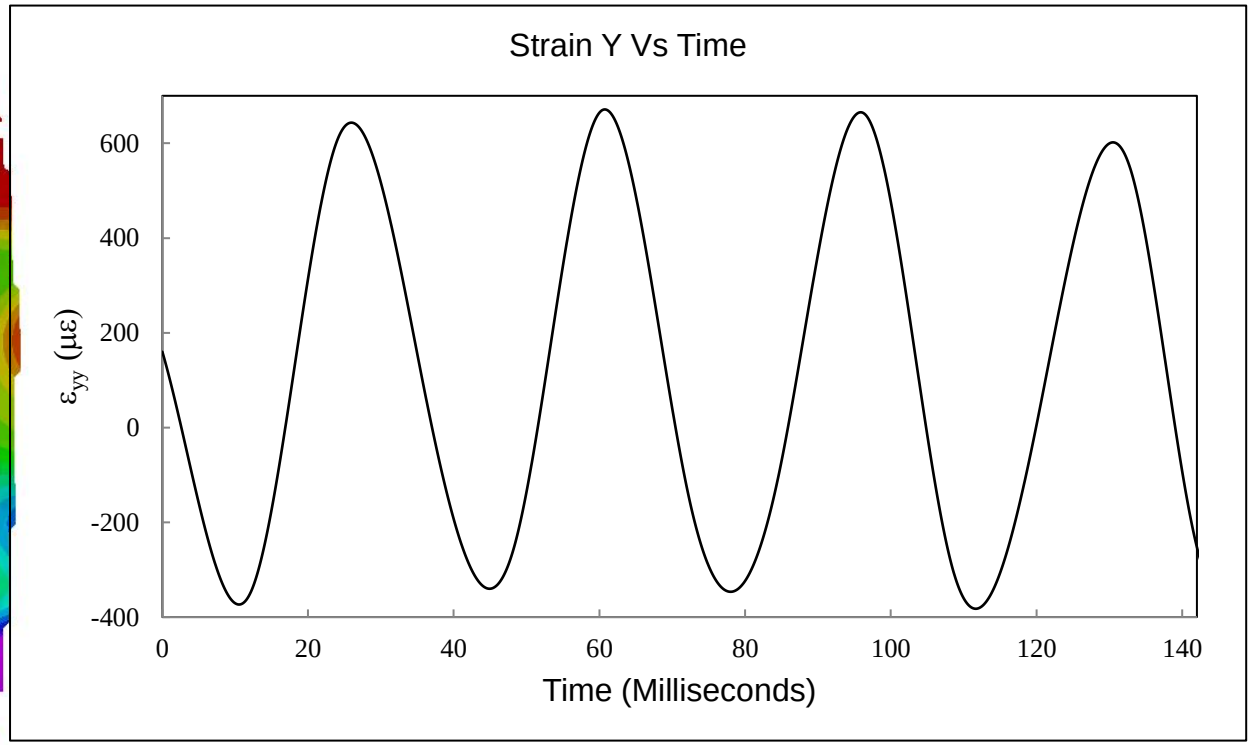




PYRO DYNAMICS

ε_{yy} of 0.5mm thin shell at 29 Hz.





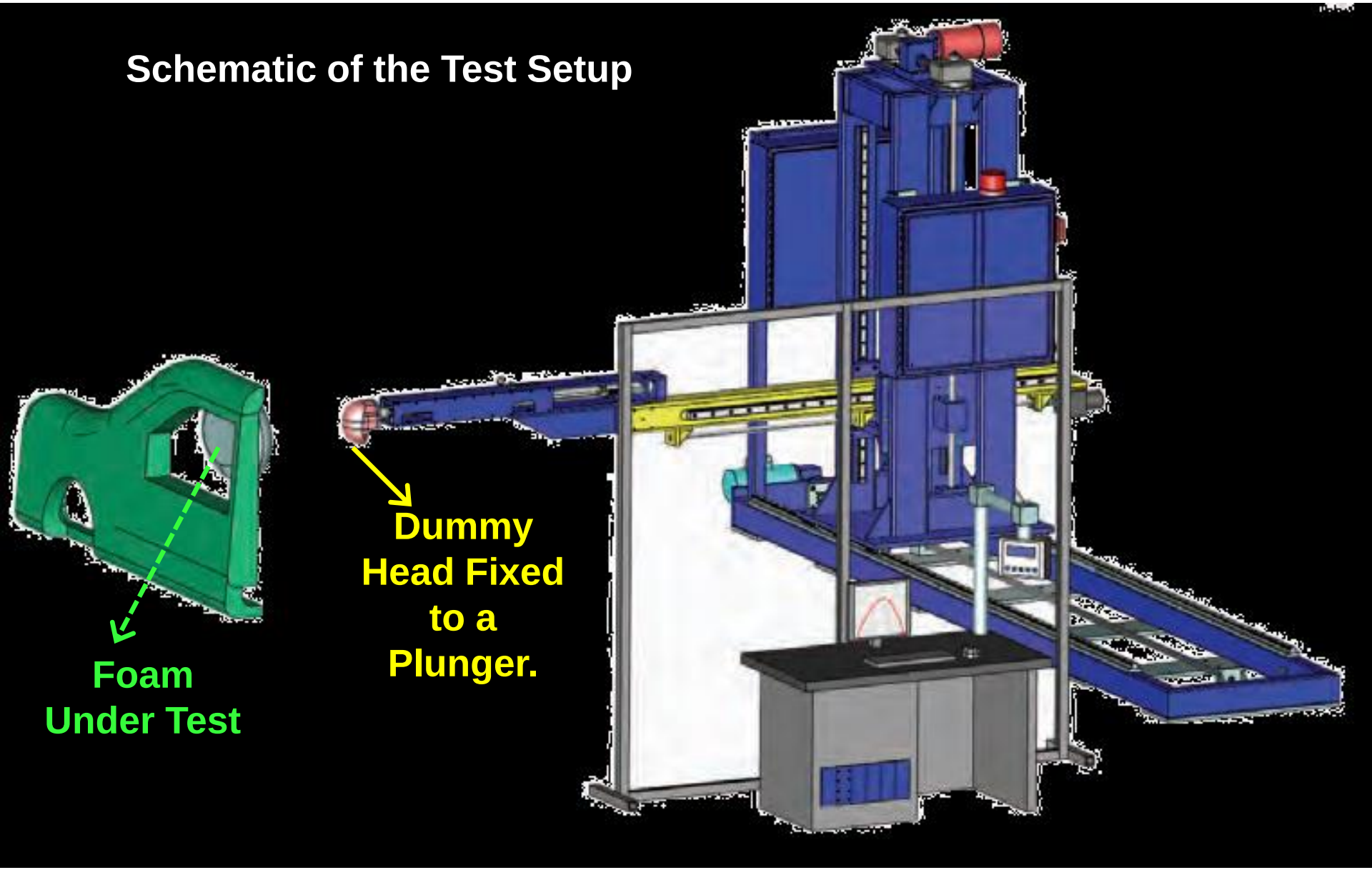
PYRO DYNAMICS

Experiment	Crash Test of a Foam used in Car Interiors
Organisation	General Motors Research and Development Centre.
System Used	VIC-3D, 3D Digital Image Correlation System with Modal Analysis.
Loading Conditions	Crash Test
Camera Used	Photron SA3 Cameras.
Image Frame Capture	2,500 fps.

PYRO DYNAMICS

Crash Test of a Foam used in Car Interiors

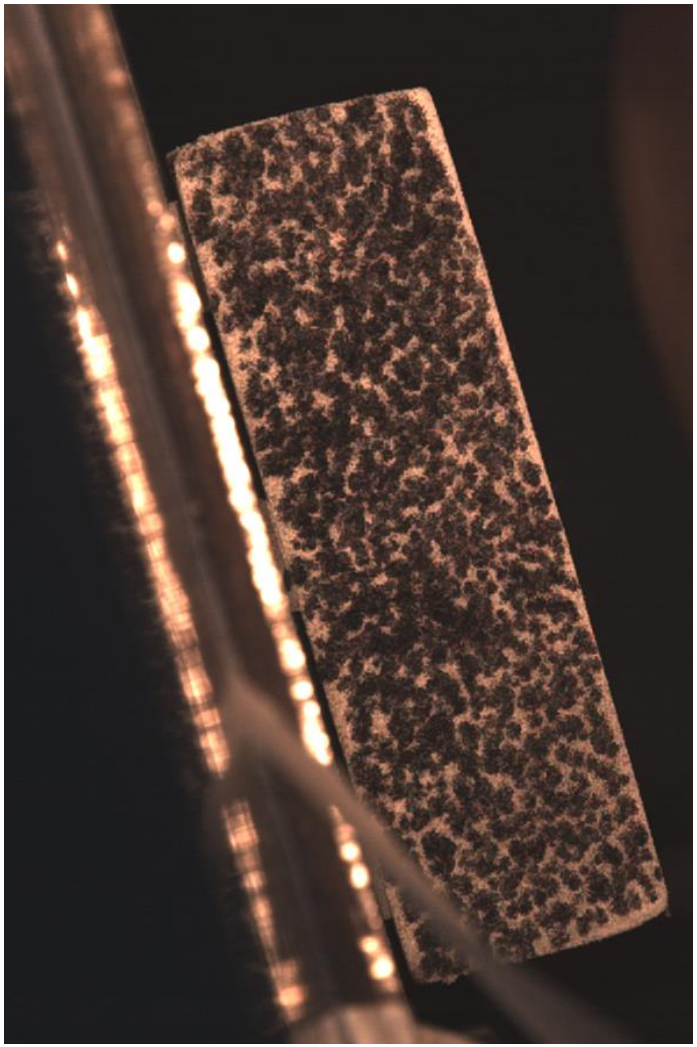
Schematic of the Test Setup



PYRO DYNAMICS

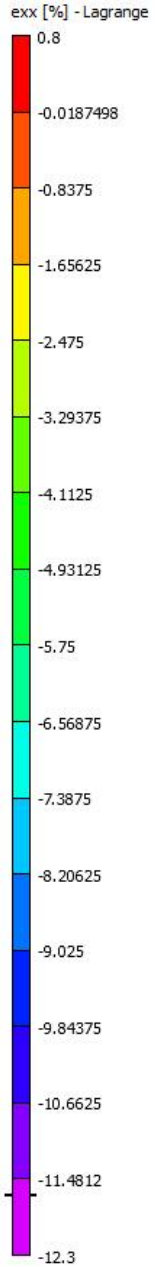
Crash Test of a Foam used in Car Interiors

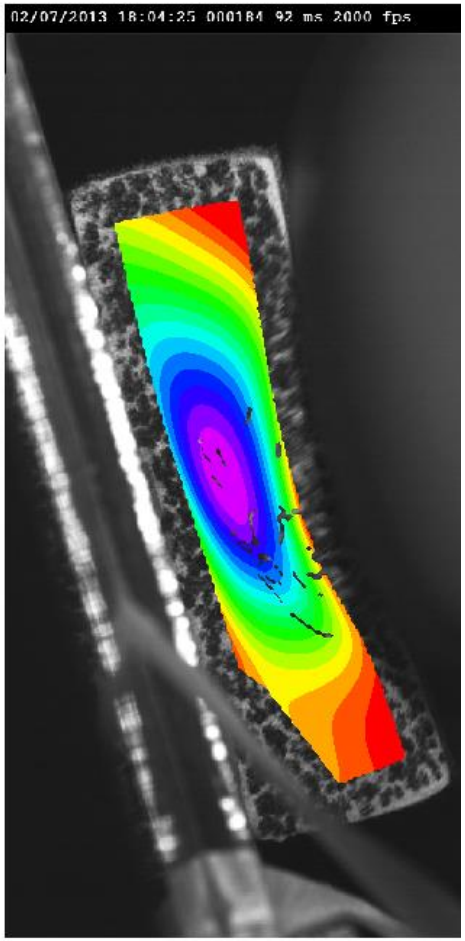
Test Sample at beginning and end of event
FPS = 2000 fps.



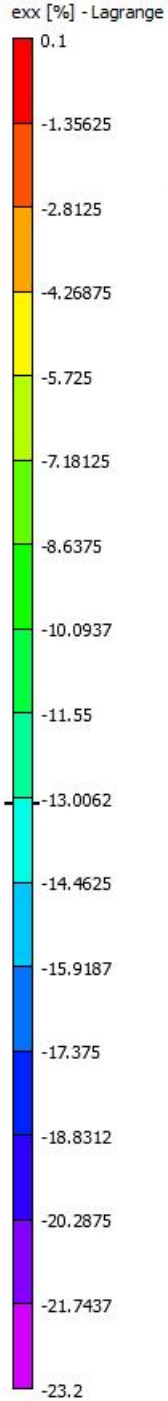
Foam Subject to an Impact by a Dummy Head at 15KmpH

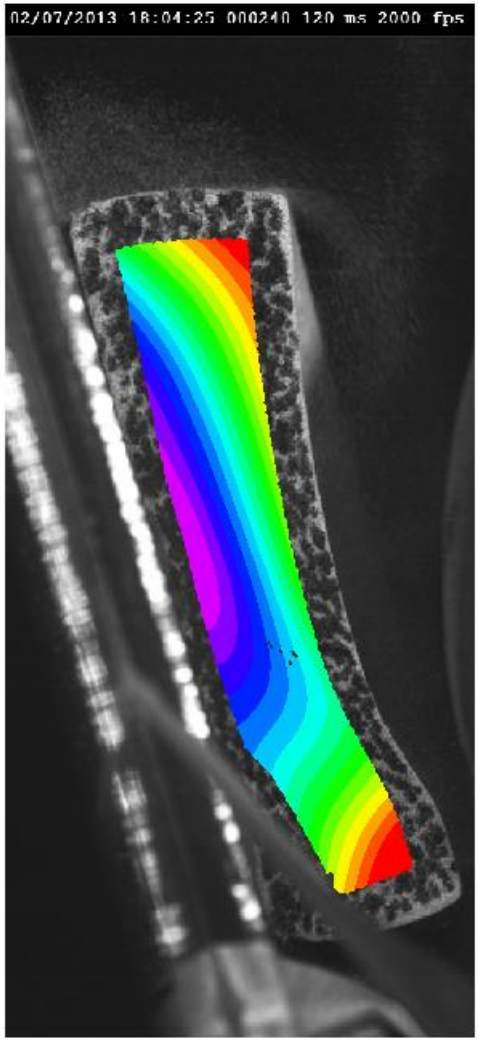
PYRO DYNAMICS





Strain Pattern ε_{xx} (% Strain) at The Middle and End Of the Event





ε_{xx} (% Strain) at The End Of the Event

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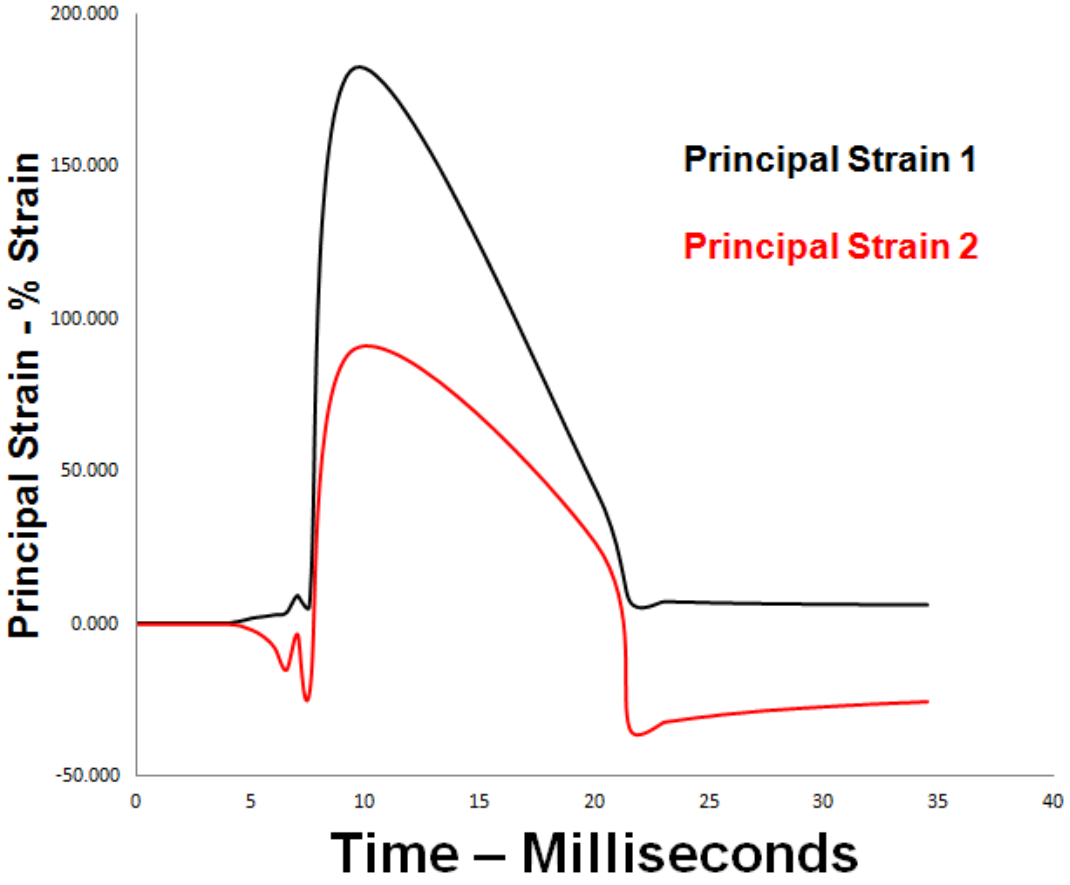
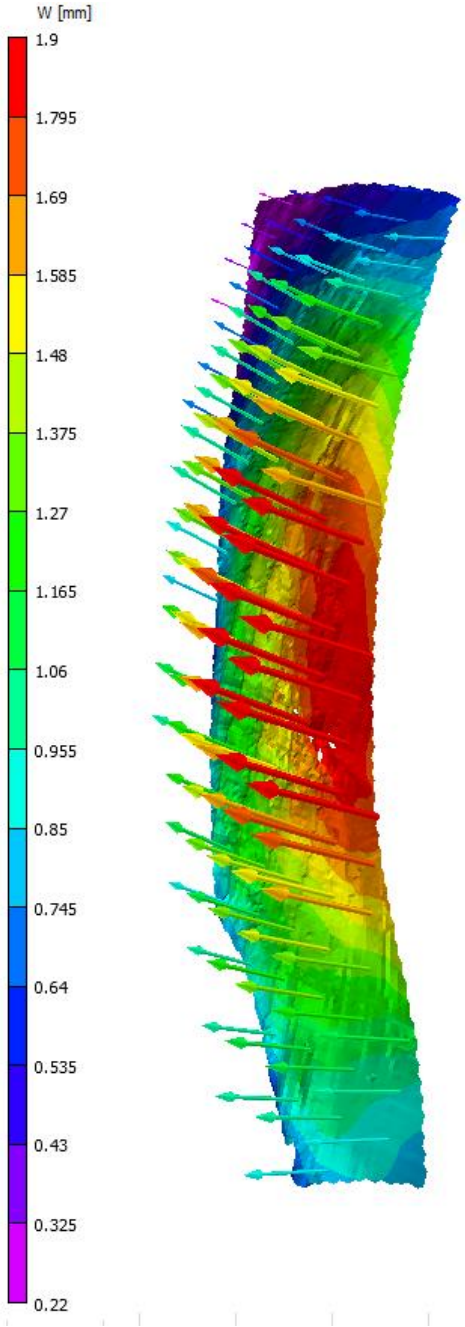
Principal Strain Vs Time at the Point of Impact.





Out of Plane Displacement “w”

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Advantages of Digital Image Correlation

- ✓ Non Contact and Full Field.
- ✓ Setup time is less.
- ✓ Easy to use.
- ✓ Provides Full Field Displacement & Strain Fields.
- ✓ Full Field Modal analysis and Full Field Acceleration Measurement.
- ✓ Strain Resolution of 25 to 50 με or better.
- ✓ Displacement Resolution:- A few Microns to Sub Microns depending on the Field of View.

In Plane Displacement Resolution = 1/100000 of the Field of View.

Out of Plane Displacement Resolution = 1/50000 of the Field of View.

Field of View is defined as the Diagonal Distance of the Area of Interest.

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- ✓ DIC Measurements can be made on any material:- Concrete, Metal, Plastics, Composites, Rubber, Human Skin…etc
- ✓ Validation of FEM Data can be done easily.
- ✓ Direct interface to Matlab to Compare DIC and FEM Data.
- ✓ High Speed DIC and Modal Analysis.
- ✓ Area of Measurement:- mm^2 to a few m^2
- ✓ Strain Range:- Upto 100's of % Strain.
- ✓ High Strain Zones easily identified.
- ✓ Generally 5MP USB cameras with 75fps are used for DIC Measurements.
- ✓ However the recent trend is to use Cameras with a resolution of 8.9 to 12.3 Mega Pixels to carry out Strain Measurements on Large Structures Like Wind Turbine Blades, Wing of Air Craft, Space Craft Shells…etc. This way DIC Measurements are carried out with a good displacement and strain resolutions.

PYRO DYNAMICS

✓ Cameras with 2 MP Resolution and frame rates of 162 fps are Available for Dynamic Measurements.

✓ Recent Trend is to use High Speed Cameras (10,000 fps upwards with 1 MP Resolution) to carry out High Strain Rate, Impact Measurements, Shock Tube Applications, Hopkinson Bar Tests…etc

✓ Recent Trend is that DIC has been successfully used for Non Contact Full Field Modal Analysis

✓ Recent Trend is DIC has been successfully used for measurements of Microscopic Images (In AFM or SEM), MEMS…etc.

✓ The future is to use Volumetric Digital Image Correlation. VDIC has the promise and capability to carry out DIC Measurements insitu of the structure (Something that was carried out so far only through Fiber Optic Sensors).

This technique is still in the University Research and will be commercially available soon.

Limitations of DIC

× Optical Access of The Test Object is a must.

PYRO DYNAMICS

Lets Think Collectively

Thank You

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"A Company of Value Rather than a Company of Success"