PYRO DYNAMICS

Additive Manufacturing / 3D Printing Technology

Expertise and Facility at Pyrodynamics

Abhishek G
Assistant Manager – DIC & 3DP
PYRODYNAMICS
Plot No 272, Road No 2
KIADB Industrial Area Phase 2
Harohalli ; Taluka Kanakapura
Dist. Ramanagaram
Bengaluru Rural - 562 112
Karnataka State – India

Tel:- +91 9686478833
Email:- pddic.ag@gmail.com

Web:- www.pyrodynamics-india.com
Facebook:- Pyrodynamics
Instagram:- pyrodynamics_india

- Additive Manufacturing or 3D Printing is a process of making three dimensional solid objects from a digital file (CAD File).
- The creation of a 3D printed object is achieved using additive processes.
- Additive process is a process where successive layers of material are deposited down layer by layer to create unique shapes and sizes.
- Objects can be modelled of almost any shape, size or geometry and are produced from a CAD Modelling Software such as AutoCAD, Solid Edge, Solid Works, etc.
- The CAD model is then sliced in the CAD Software and converted to an STL/3MF/OBJ File that is ready for 3D Printing.

There are three major ways which is used in Additive Manufacturing:-

1. Fused Deposition Modeling (FDM)

2. Stereo Lithography (SLA)

3. Selective Laser Sintering (SLS)

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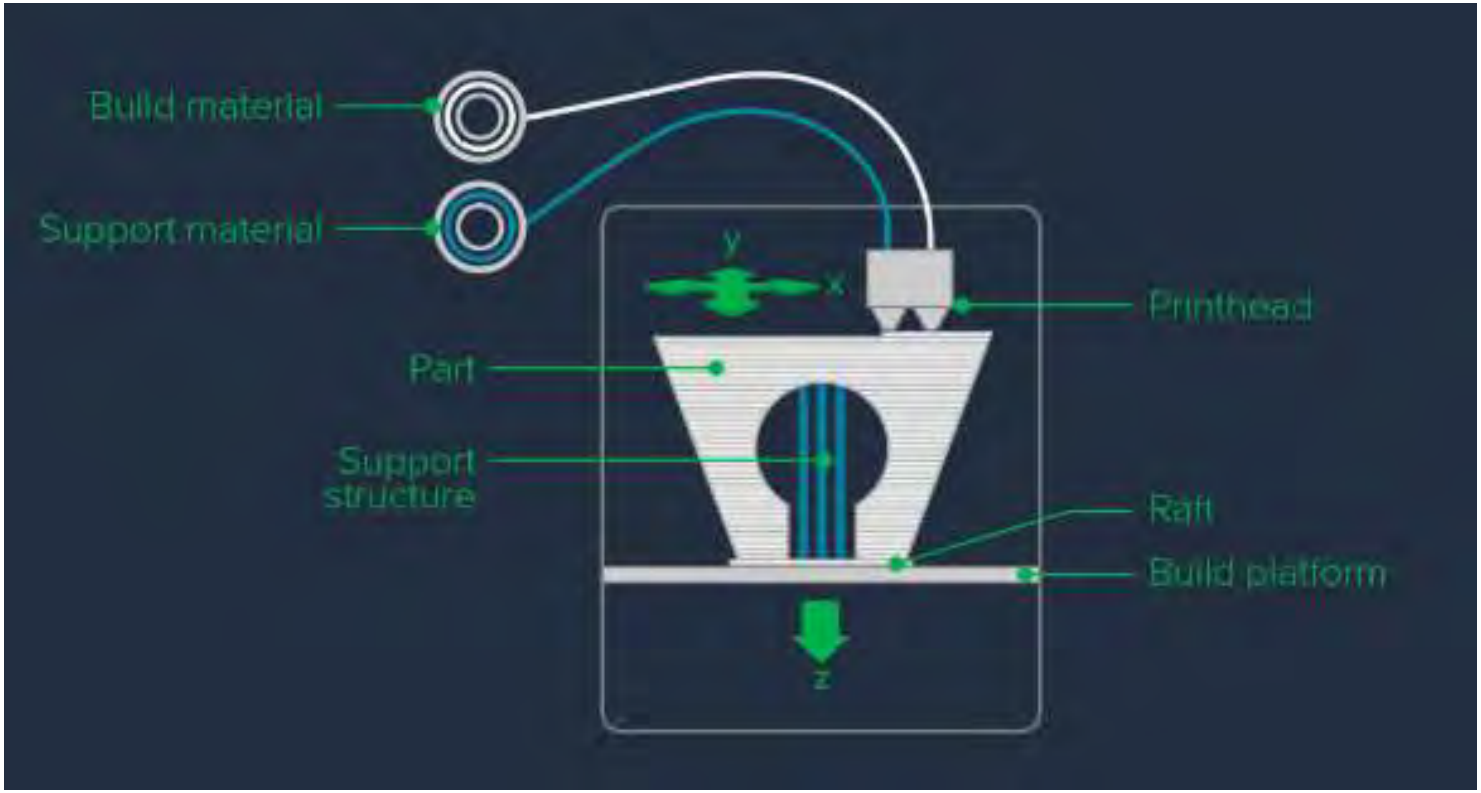
Fused Deposition Modeling (FDM)



Fused Deposition Modeling (FDM) uses a filament (spool) as the input material which is fed to an extrusion nozzle. The nozzle is heated to a certain temperature and this melts the filament, and the nozzle moves in horizontal and/or vertical directions as per the geometry of the CAD Model. The filament is then deposited layer by layer upon which the initial layer hardens immediately after extrusion from the nozzle. This process of layer-by-layer deposition is repeated to achieve the 3D Model.

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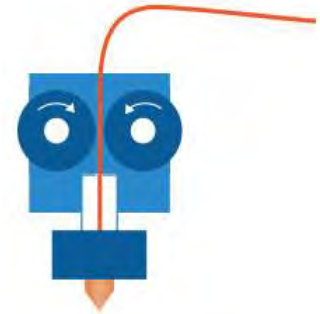
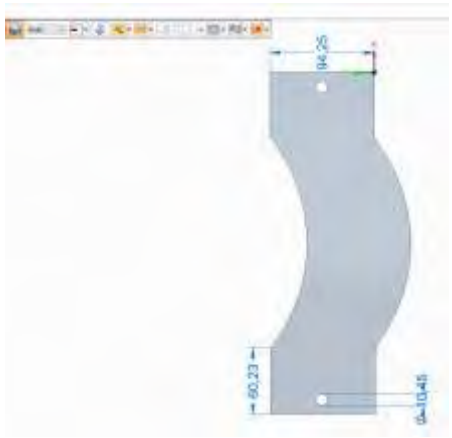
How does it work?





1. **2.** **3.**

1 A 3D Model of an object is created using a computer-aided design (CAD) software program.

2 The CAD File is sliced, and an STL file is generated which is programmed to the printer.

3 The printer deposits the material layer by layer, starting from the bottom layer, onto a build platform. This process is repeated to achieve the final 3D Model.

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Materials that can be Printed

1. PLA (Polylactic Acid)
2. Tough PLA (Tough Polylactic Acid)
3. ABS (Acrylonitrile Butadiene Styrene)
4. Nylon
5. CPE (Co-Polyester)
6. CPE+ (Tough Co-Polyester)
7. PC (Polycarbonate)
8. PP (Polypropylene)
9. TPU
10. PVA (Poly Vinyl Alcohol)
11. Glass Fibre
12. Carbon Fibre

Dimension of the specimen that can be printed:-
Maximum– 330 x 240 x 300 mm
Minimum – 0.5 x 0.5 x 0.5 mm

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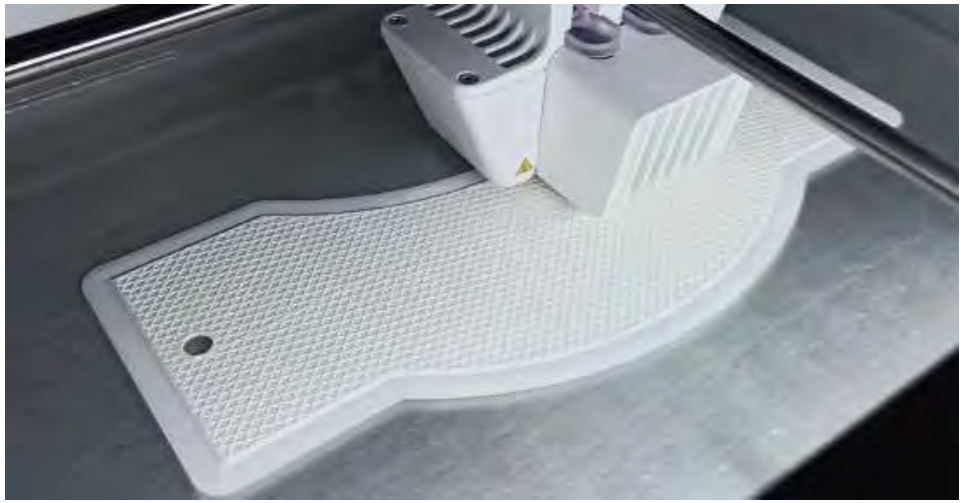
3D Printer Settings Used

Technology	Fused Deposition Modeling (FDM)
Filament Used	PLA White
Filament Diameter	2.85 mm
Nozzle Diameter	0.4 mm
Printing Speed	50 mm/sec
Layer Resolution	0.2 mm
Infill	50% Infill



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DIC Measurement on a 3D Printed Specimen – 50% Infill

A Test Specimen who Photoelastic Fringe Pattern (Stress Pattern) is available from literature was 3D Printed.

The tool path is clearly seen on the test specimen and was not smoothened out

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VIC-3D, 3D DIC Setup

DIC Measurement on a 3D Printed Specimen – 50% Infill

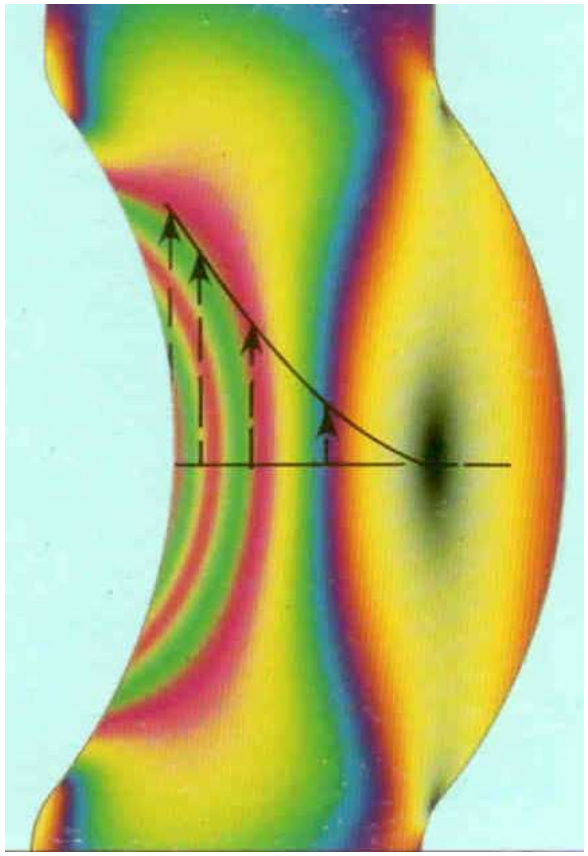
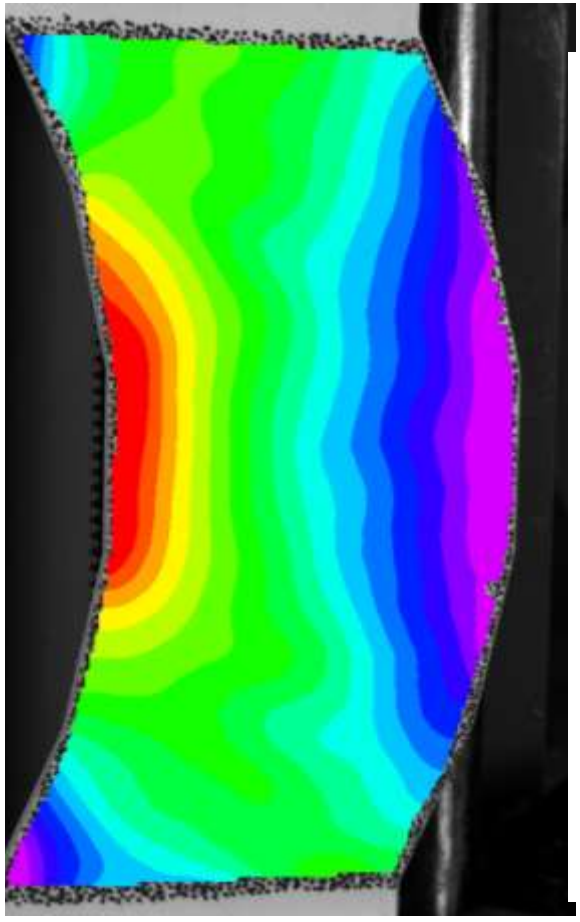
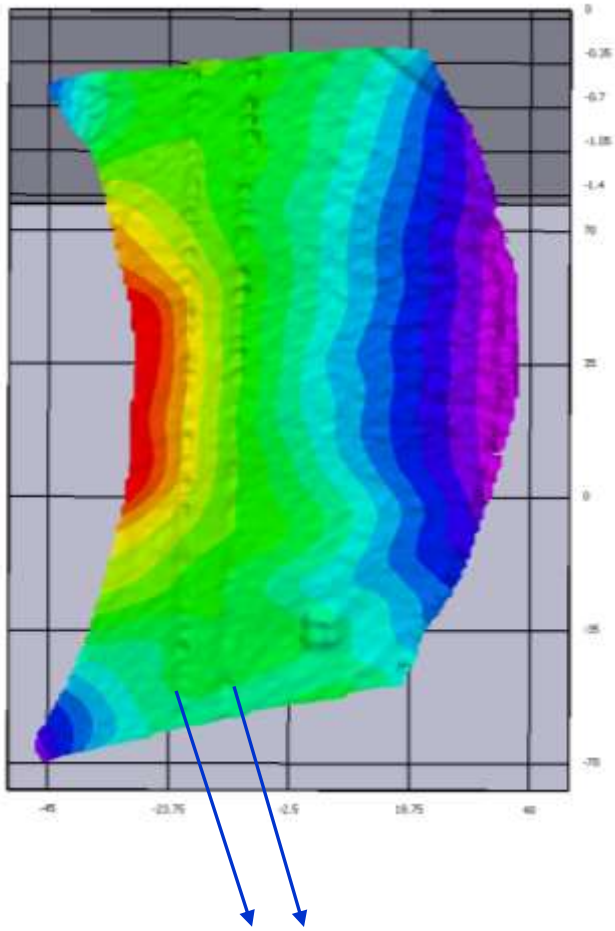


Photo Elastic Fringe Pattern

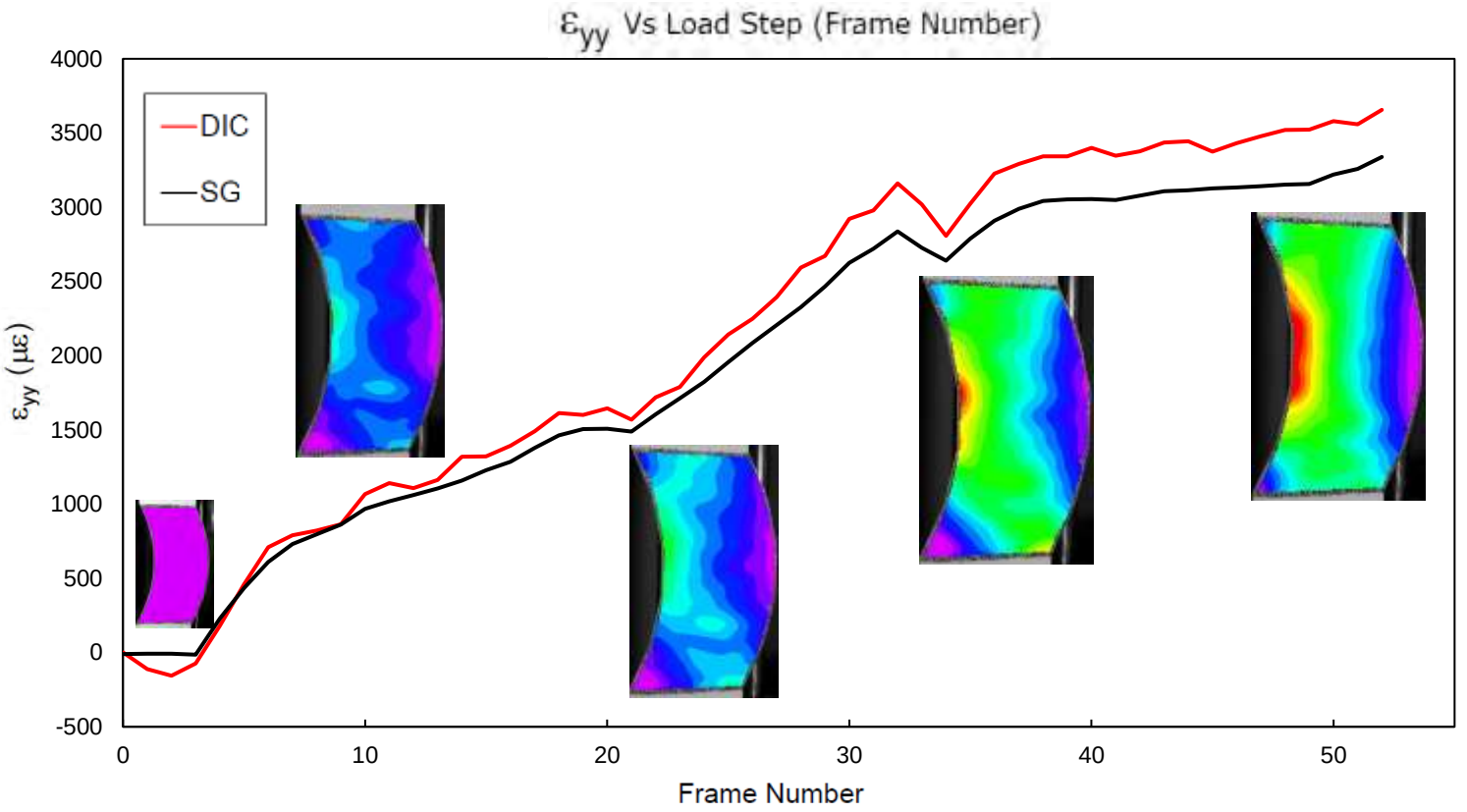


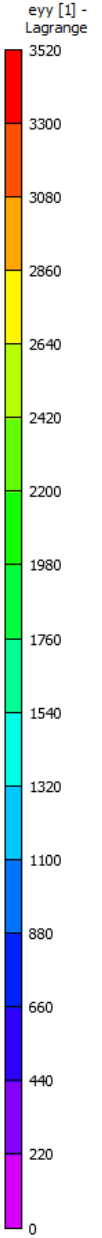
Plot of ε_{yy} obtained from VIC-3D



The tool path of the nozzle is clearly visible in the DIC Plot. The tool path has not created any strain gradient. The data over the tool path can be smoothened using the SMOOTH option of VIC-3D.

DIC Measurement on a 3D Printed Specimen – 50% Infill





A strain gage was bonded on the back of the specimen. There is approximately a 10% difference in the data obtained from DIC and Strain Gage. The 3D Printed Test Specimen has only 50% infill, due to which the material properties in the from and back are not the same. So they behave differently under load.

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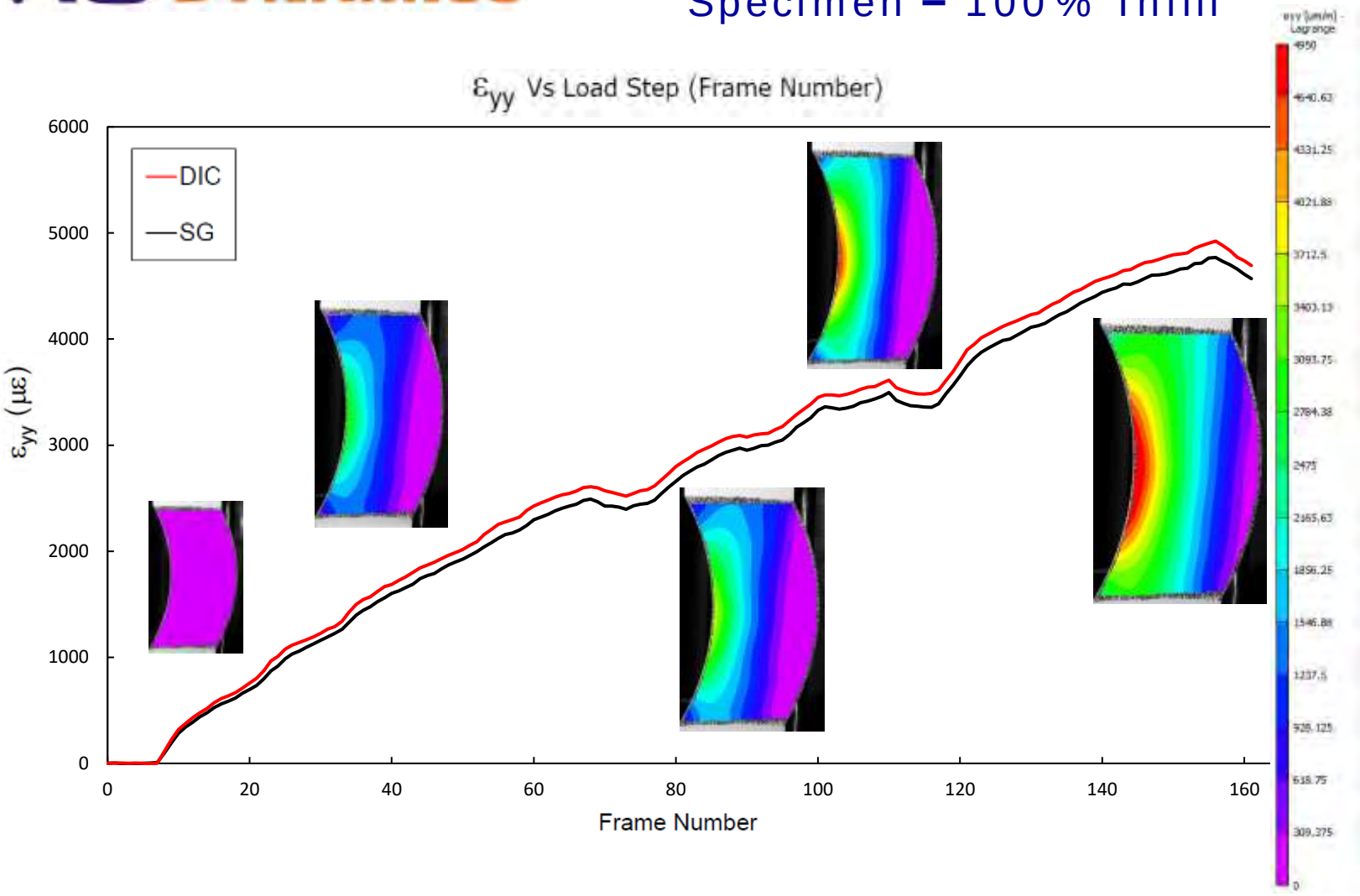
DIC Measurement on a 3D Printed Specimen – 100% Infill

DIC Measurement on a 3D Printed Specimen – 100% Infill



A strain gage was bonded on the back of the specimen. There is a close match of the data obtained from DIC and Strain Gage.

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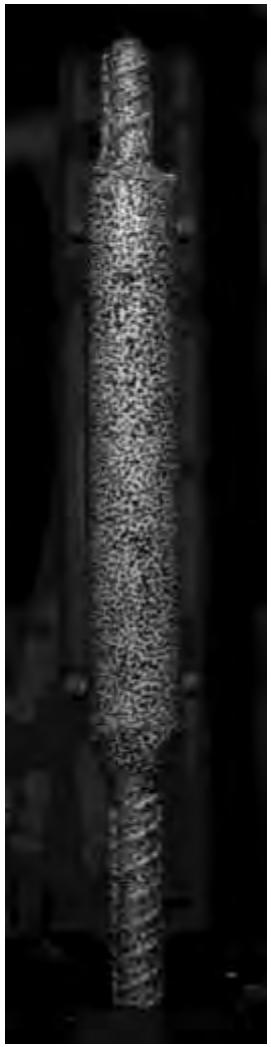
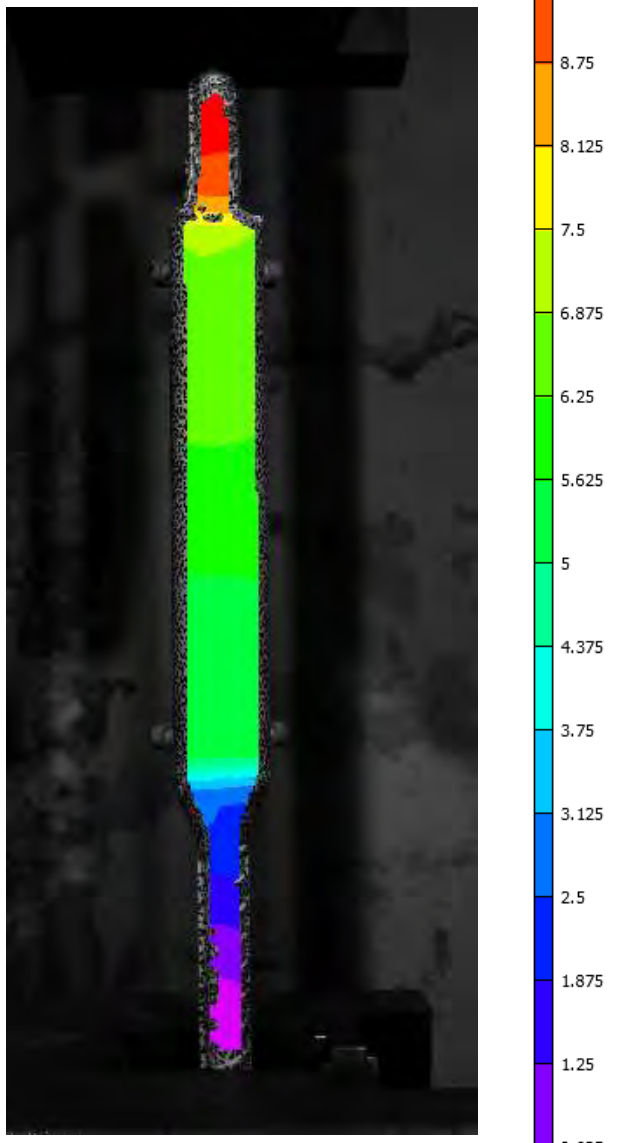
3D Printed Coupler – For IIT Roorkee – Department of Earthquake Engineering.

3D Printed Coupler



Speckle image

An Actual Coupler under test – At IIT-Roorkee – Department of Earthquake Engineering.



V - Displacement Data

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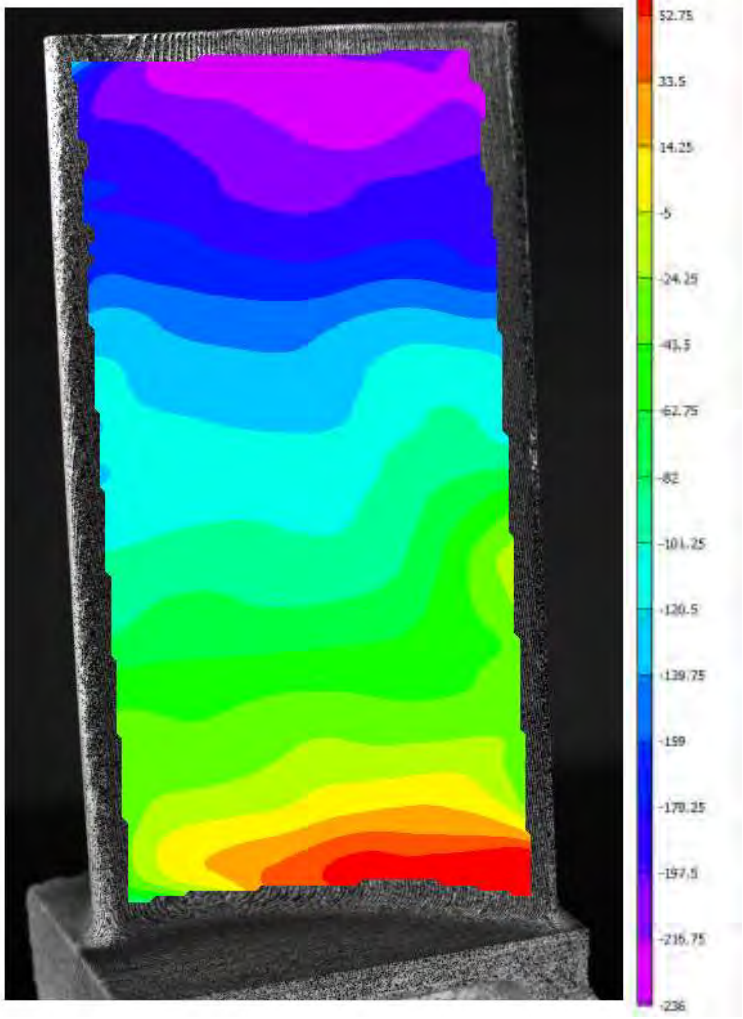
3D Printed Gas Turbine Blade Measurements using VIC-3D

3D Printed
Gas Turbine Blade

Speckle pattern applied on the Gas Turbine Blade using an Air Brush.



Strain Plot ε_{yy} obtained from VIC-3D. The specimen was fixed on a Machine Vice and tapped from behind. We can observe a high strain zone at the fixed end of the turbine blade.

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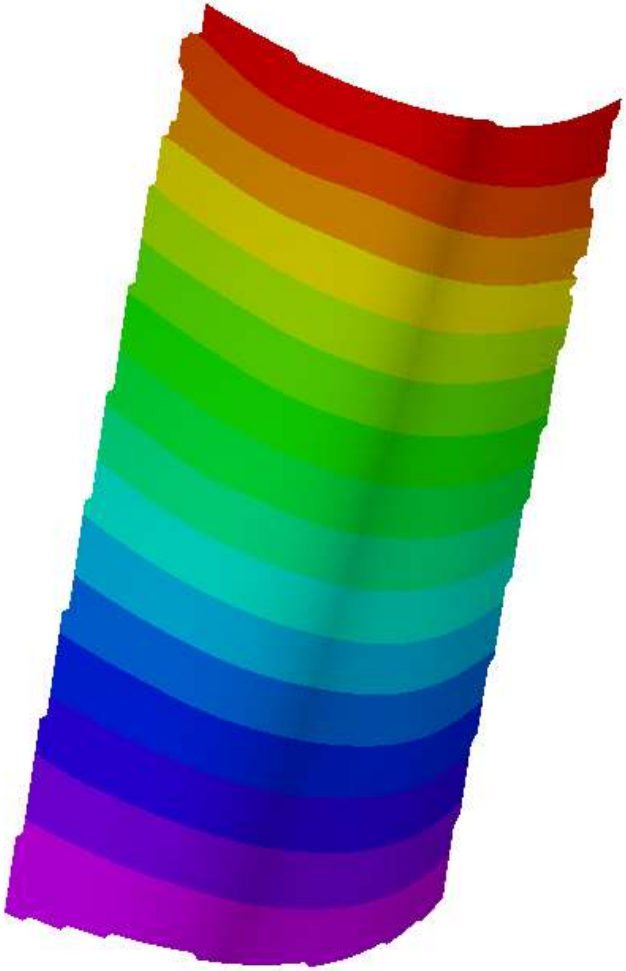
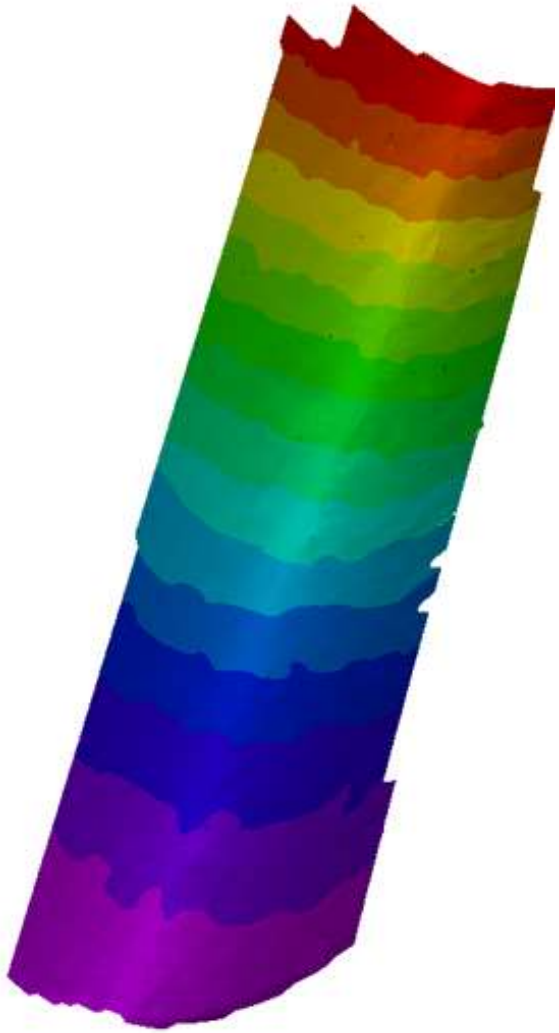
3D Printed Gas Turbine Blade Measurements using VIC-3D



Plot of "W" displacement obtained from 3D Printed Gas Turbine Blade. The specimen was fixed on a Machine Vice and tapped from behind.



3D DIC Measurements done on an actual Turbine Blade – Subjected to vibration in a Shaker.
Out of Plane Displacement "W"
1st Bending Mode - 438.6 HZ

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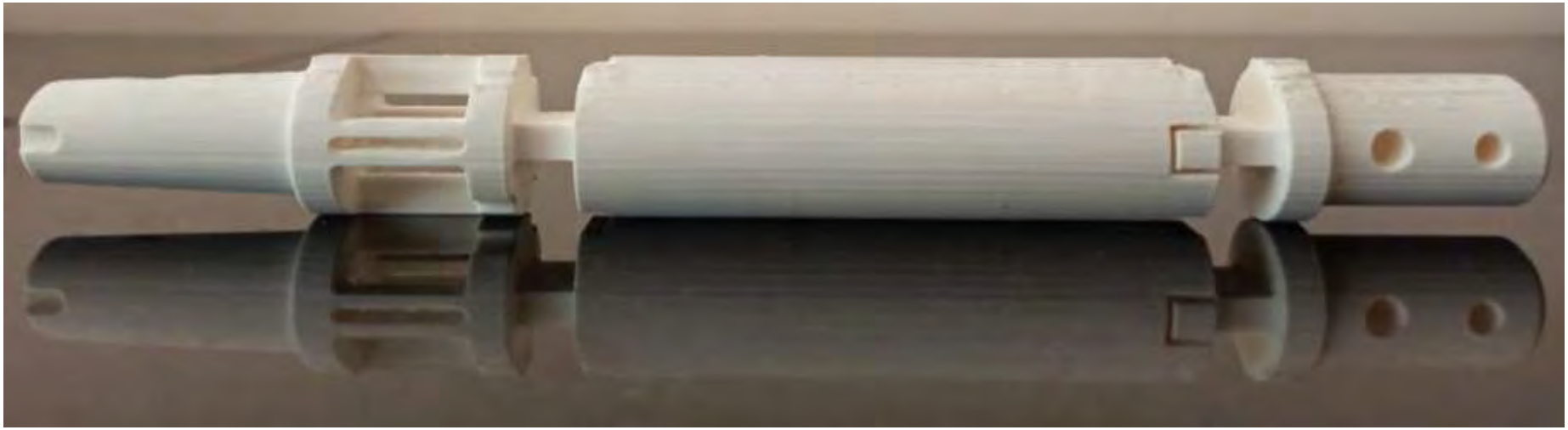
3D Printed Wind Tunnel Balance For Hitech Engineering Equipments - Bengaluru



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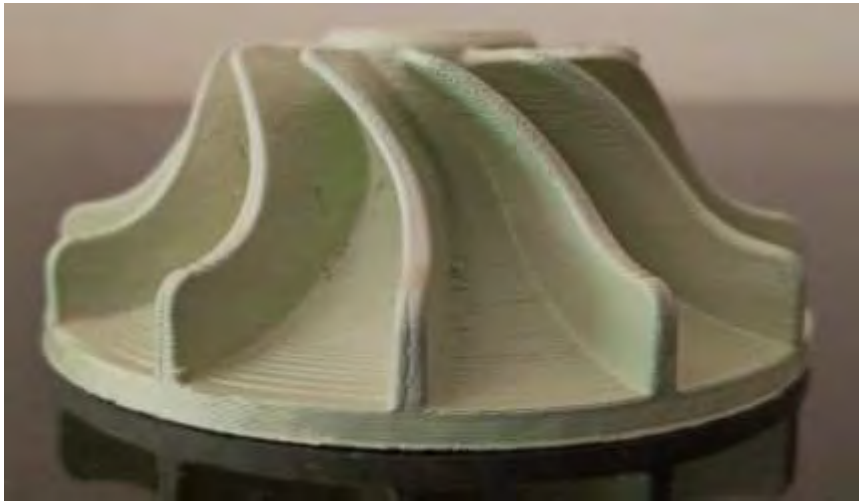
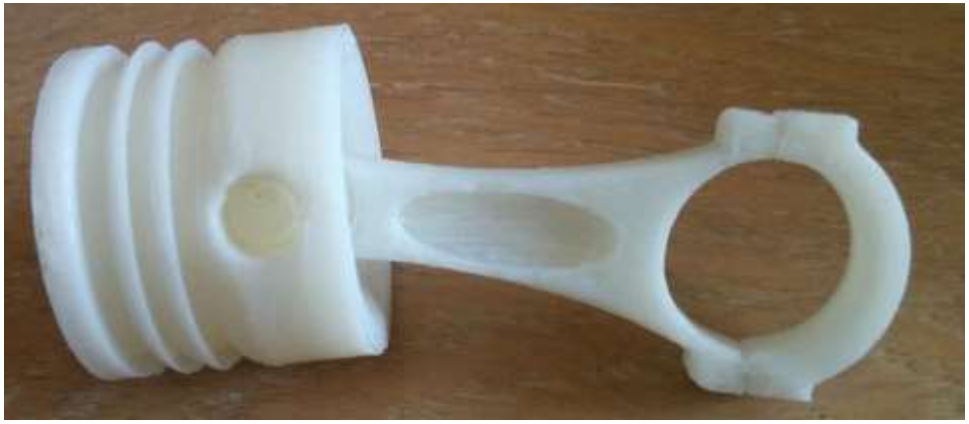
3D Printed Components





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Let's Think Collectively

Thank You

For More Detailed Information or Demonstration of the SCAD 508 Systems Digital Image Correlation and 3D Printing

Please Feel Free to Contact us:-
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