



## From Chairman's Desk ...

Dear Members,

The new executive committee for 2015-2017 has assumed charge at the AGM held on 25<sup>th</sup> July 2015 and I, on behalf of the new committee, thank and greet all our members and solicit the support and very active involvement in furthering the activities of the society. Let's all work together and make a wonderful period ahead.

Since taking over, various activities are happening and the Executive Committee had two formal meetings and several informal sittings to address the emergent requirements. As suggested by the previous committee, we have proposed our interest in hosting NDE 2016 at Thiruvananthapuram during the NGC, ISNT meeting. Committee members visited probable venues and a detailed presentation has been sent to HQ in this regard. If we get the chance, it will be a great opportunity, a huge challenge and a big responsibility. I am sure, with the support of our dynamic members, we can make it a great success which will bring further glory to the chapter.

NDE 2015, Hyderabad is approaching and we have encouraged members to have more participation in terms of technical papers as well as delegates. I once again urge our members to ensure their participation.

Young engineers' forum has organized a technical talk on "Infrared Thermography" by Dr Ravibabu Mulaveesala, IIT Ropar, Punjab on 14<sup>th</sup> October. I hope the talk was very beneficial for community.

All our activities are updated in our website [www.isnttvm.org](http://www.isnttvm.org) and also at HQ website [www.isnt.org.in](http://www.isnt.org.in)

With great expectation on a very eventful period ahead...

With best wishes

**G. Levin**

Chairman, Thiruvananthapuram Chapter

## M. R. Kurup Memorial Lecture, Annual Technical Meet and Annual General Body Meeting 2015

The M R Kurup memorial lecture for the year 2014-2015 was held on 25<sup>th</sup> July 2015 at Hotel Classic Avenue, Thiruvananthapuram. Sri. S. Saratchandran, Chairman (2013-2015), ISNT, Thiruvananthapuram Chapter welcomed the gathering. The lecture was delivered by Shri N. Narayanamoorthy, Senior Advisor, Launch Vehicles, VSSC on "Engineering Risk Analysis and Mitigation"



Welcome address by Sri. S. Saratchandran



**Sri.N. Narayanamoorthy delivering MR Kurup memorial lecture**

*Annual technical meet (ATM) lecture was delivered by Dr. Ajit C. Sekhar (Medical Officer, VSSC) on “Non-communicable Diseases”*



**A view of audience**

*The annual general body meeting of ISNT Thiruvananthapuram chapter for the year 2014-15 was held at Hotel Classic Avenue on 25<sup>th</sup> July 2015.*

*Shri. S. Sarathchandran, Chairman of the chapter welcomed all the members. Shri. L. Mohankumar Returning officer announced the list of office bearers and members of executive committee for the year 2015-2017.*

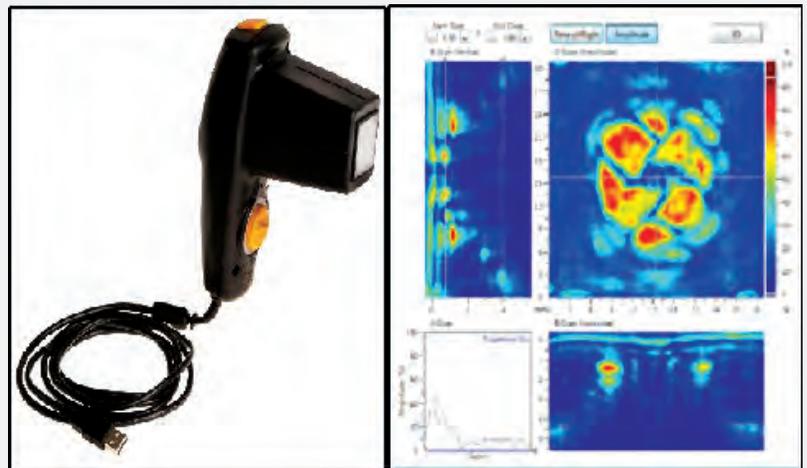


**Dr. Ajit C.Sekhar delivering ATM lecture**

## *What's New.....*

# Dolphi Cam

DolphiCam is a mobile and ergonomic ultrasound camera system designed for NDT inspection of CFRP (Carbon Fiber Reinforced Plastics) creating high-resolution 2D and 3D images of suspected damage areas. Connected to a PC, tablet or laptop via a USB port it displays a high resolution colour palatte representation of any defect within the structure under test, and uniquely can show a variable angle 3D representation of the inspection area. It can be used on carbon composite parts up to 16 mm thick. There are two cameras available viz. The DolphiCam CF08 : for up to 8mm thick CFRP & The DolphiCam CF16 : for up to 16mm thick CFRP





## Secretary's Report

Copies of the minutes of last AGM held on 25<sup>th</sup> July 2015 were circulated to all the members. The first sitting of the new executive committee was held on 11<sup>th</sup> August 2015 and the second sitting was on 7<sup>th</sup> September 2015. Twelve new members were joined.

### Technical Talk

Technical lecture on "Infrared Thermography" by Dr. Ravibabu, Prof. IIT, Rupa, was organized by Young Engineers Forum of ISNT Trivandrum on 14<sup>th</sup> October 2015

### Future Programme

Foundation course on NDT on 30<sup>th</sup> & 31<sup>st</sup> October, 2015 at Hotel Classic Avenue, Trivandrum

### New Members Joined

S. No.	Name	Type of member	Organization
1	Arun Dwivedi	Life member	VSSC
2	Praveen S.N.	Life member	VSSC
3	Syamkumar S.	Life member	VSSC
4	Aiswarya N.	Life member	VSSC
5	Gino Prakash F.	Life member	VSSC
6	Paul Murugan J.	Life member	VSSC
7	Sriranganath Annam	Life member	VSSC
8	Elamurugu S.	Member	VSSC
9	Yogesh	Life member	VSSC
10	YezhilArasu A.	Life member	VSSC
11	Achu Ashokan	Associate Member	Individual
12	Md. Aftab Ahmed	Life member	VSSC

## New Executive committee of Thiruvananthapuram Chapter

### Chairman:

**Shri.G. Levin**, GD, PRG, VSSC  
Phone: 0471-2563854 (O), 9496050075  
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### Vice Chairmen:

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**Shri.Roykuttan K. K**, Manager, QCIG, LPSC  
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### Secretary:

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### Joint Secretary:

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Phone: 0471-2562593(O), 9995198940  
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### Treasurer:

**Shri. P. N. Gopakumar**, QCE, VSSC  
Phone: 0471-2563168(O), 9447458614  
Email: [pn\\_gopakumar@vssc.gov.in](mailto:pn_gopakumar@vssc.gov.in)

### Executive Committee:

**Shri S. Saratchandran**, GD, QRMG, VSSC  
(Immediate Past Chairman)

**Shri S. Ratheesh**, PED, VSSC  
(Immediate Past Secretary)

**Dr. A. Mujeeb**, Director, LBS center for S&T

**Dr.S. Annamala Pillai**, Rtd., VSSC

**Shri. K.S. Narayanan**, GD, QCG, VSSC

**Shri.Murugesan N.**, DH, QNDTD, IPRC

**Shri.Harikrishna S.**, CMSE, VSSC

**Shri.Girish N. Namboodiri**, NDTD, VSSC

# NDT applications in field conditions by dynamic excitation with Shearography

S. Raviprakash<sup>1</sup> and Dr.-Ing. Peter. Mäkel<sup>2</sup>

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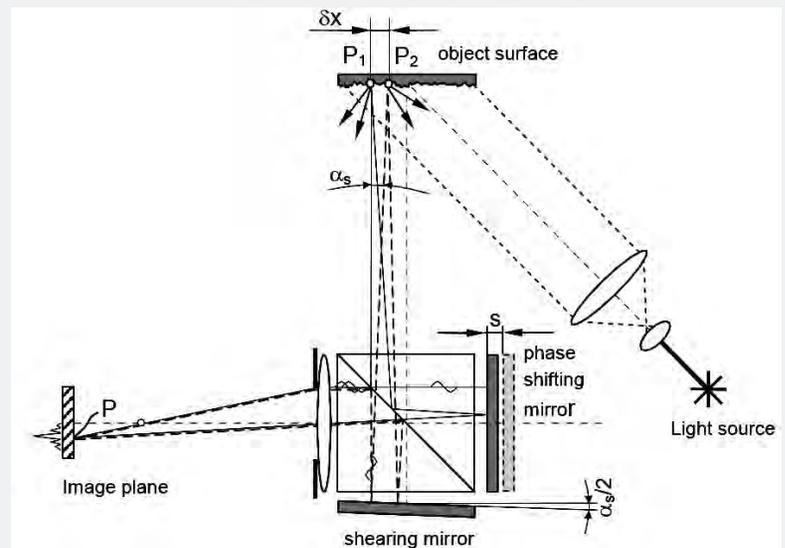
Shearography as an NDT technique has been well known for several years and is in extensive use for NDT of Aerospace and Composite Structures. The demand from industry has been to carry out NDT inspections at site in very short time and to provide full field and immediate results. Using shearography for NDT, defects are identified by their inhomogeneous deformation gradients in response to mechanical or thermal loads. Commonly-used loading principles are slightly variation of pressure for tubes and tanks, vacuum chambers and heat applied by radiation and hot air. Dynamic excitation of structures in combination with shearography/ESPI (Electronic Speckle Pattern Interferometry) is a special technology for NDT especially for delamination detection within composite material as well as for vibration measurements including quantitative evaluation using stroboscopic laser diode arrays up to high frequencies.

## Principle of Shearography

The general principle of shearography is interferometry. Interferometry is the determination of the fractional relative phase differences between light waves traversing different paths. Phenomena which influence the phase of these light beams can be measured. In practice this is e. g. surface deformation or density variation of a fluid. Due to light phase reconstruction methods at fractions of the wavelength the resolution is in the nanometer range and below.

Nevertheless especially shearography works at this maximum sensitivity without need for vibration isolation. This is due to the fact that shearography does not determine the relative light phase against a fixed reference beam such as Holography or ESPI (Electronic Speckle Pattern Interferometry), which would be susceptible to ambient disturbances such as rigid body motion. Instead shearography determines the differences between neighbouring beams. The principle compensates ambient disturbances, which affect both beams to an equal extent.

The differences between neighbouring beams result in differential displacements, if the light is reflected by deformed object surface. The sketch of Fig. 1 shows a principle setup of shearography based on a Michelson Interferometer. The Michelson Interferometer permits to superpose two points of the object on one point of the image plane by tilting one of the mirrors by a small angle, whereas the other mirror allows generating small shifts of the light pass by lateral movements. The translation of phase shifting mirror is usually generated by piezo actuator and the tilt of the other mirror can be adjusted manually or remote controlled.



**Fig. 1 :- Schematic of Shearography Setup**

Sufficient sampling of the intensities on the image plane with different phase shifts allows reconstructing the relative phase distribution of all superposed points across the field of view. Subtraction of the relative phase distribution before and after loading the object surface leads to a phase difference dis-

tribution of the field of view, which corresponds to the differential displacements of the object surface. The sensitivity to the differential displacements is depending on the illumination and observation direction relative to the object surface. A first approximation based on the simplified model shown in Fig. 2 is a proportional ratio between the relative phase difference and the differential displacements between P1 and P2, where the sensitivity of the proportionality is determined by the wave length of the light source, the illumination and observation direction of the light path and the distance between the superposed object points.

The distance between the superposed object points is called the shearing distance, which is commonly used for adjustment of sensitivity corresponding to the application. Thus the shearing distance also influences the spatial resolution concerning the measurement result. The differential displacements between the superposed points can be approximately treated as deformation gradients or strain. The direction of the shearing thus determines the gradient, which would be  $\delta w / \delta x$  corresponding for the case in Fig. 3, as the shearing is in x-direction. The out of plane fraction of the deformation is  $w$  (in z direction) corresponding to the light path sensitivity corresponding to the illumination and observation is perpendicular to the object surface. Shearing in y direction would lead to  $\delta w / \delta y$ . Using sequential illumination (and observation) under inclinations permits to isolate the corresponding in-plane fractions  $\delta u / \delta x$ ,  $\delta v / \delta y$ ,  $\delta u / \delta y$  and  $\delta v / \delta x$ .

However all this approximations requires a uniform (flat or known) surface geometry over the area of interest, so that geometric parameters and thus the proportional evaluation factor is valid.

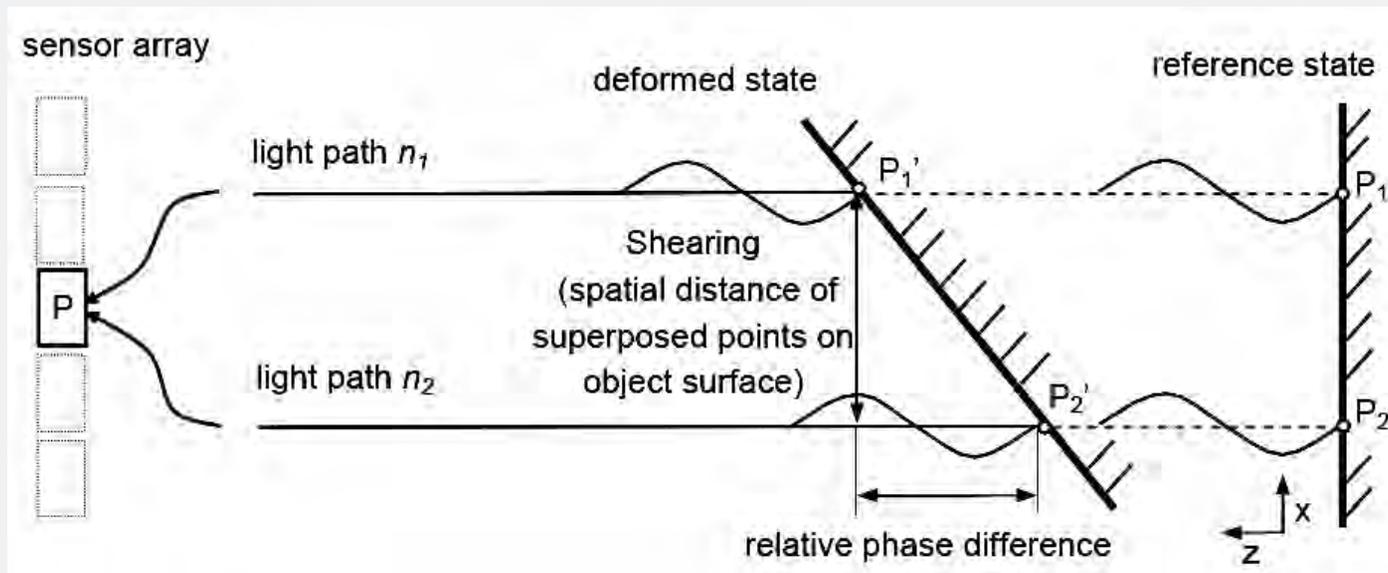


Fig. 2 :- Simplified light path model of the principle setup

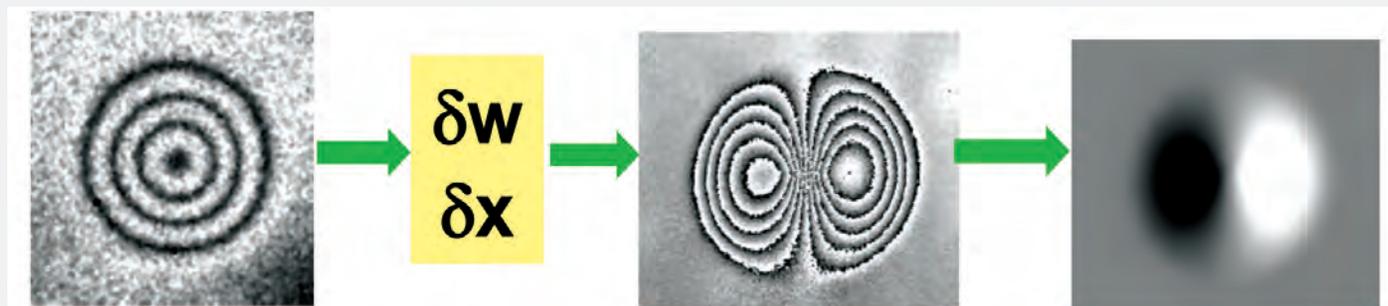


Fig. 3 :- Displacement, displacement gradient and 3D plot of gradient

## SE2 full digital system concept

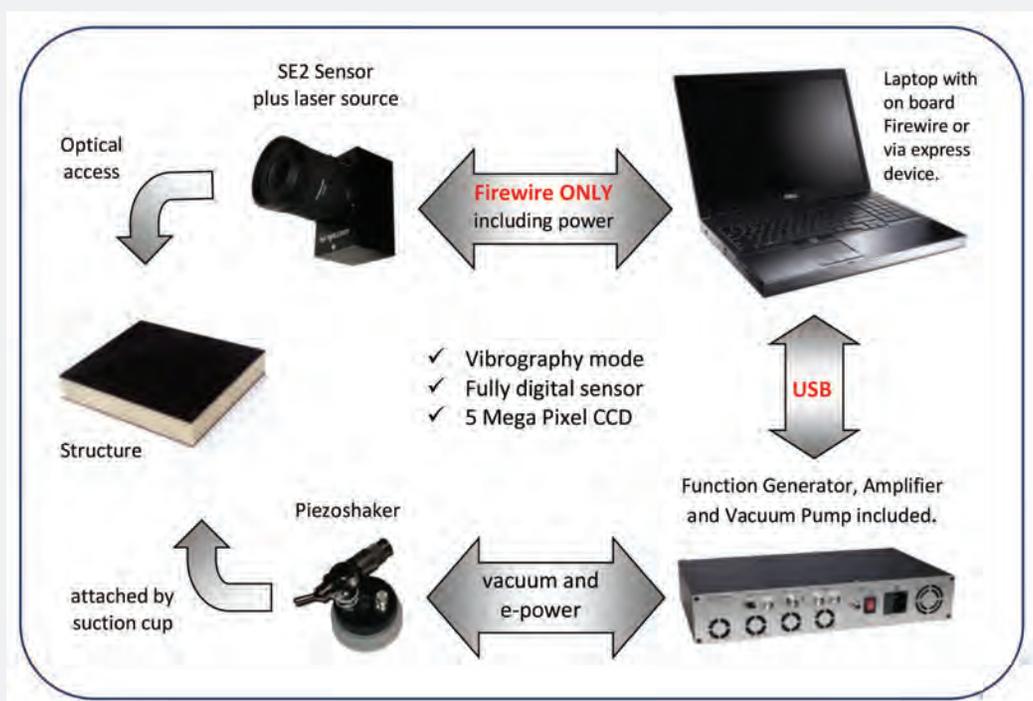
Isi-sys GmbH have designed and developed SE2 Shearography system especially for flexible laboratory use as well for field applications . The system is compact, light weight and can be packed in a carry case and taken to the site for in-service NDT inspection for a lot of composite structures type such as used for aerospace, yachts , automotive ..etc. The SE2 system includes a Shearography Sensor and a direct interface to Laptop. All controls of the sensor are through the digital interface and software.

## SE2 Shearography System for NDT

- One system for thermal, vacuum and dynamic loading
- Operation by Laptop only - no additional devices required
- Laser class 1 and 2M (no additional safety requirements)
- Modular laser power from 0,1-12W per module
- Realtime phase reconstruction with >2-8Hz@5Mpx on Laptops
- Debonding detection in foam or honeycomb structures also on backside by dynamic and vacuum loading
- New vacuum window with special seal for curved surfaces
- For rapid operation without need for sensor calibration
- With flexible suction cup tripod



**Full digital temporal phaseshifting shearography sensors including time average mode for NDT with dynamic excitation.**



## Case Study-1: CFRP tank used for Airbus planes and ATV for space station.

**Task:** Automated non destructive testing on tank

**Loading Method:** Modulation of Internal Pressure .

**Material:** CFRP composite / stainless steel

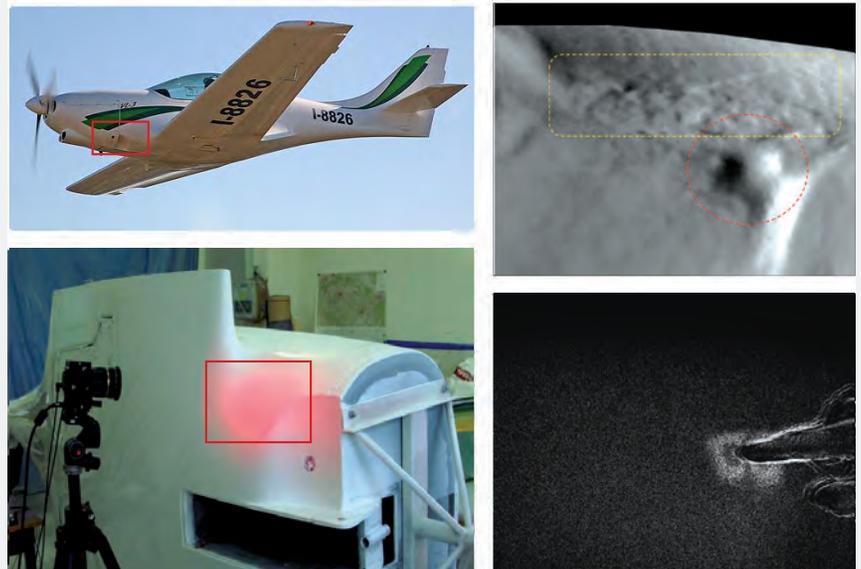
**Result (image right):** De-bond (size 8x8mm<sup>2</sup>).

Field of view is about 200 mm using SE3 sensor



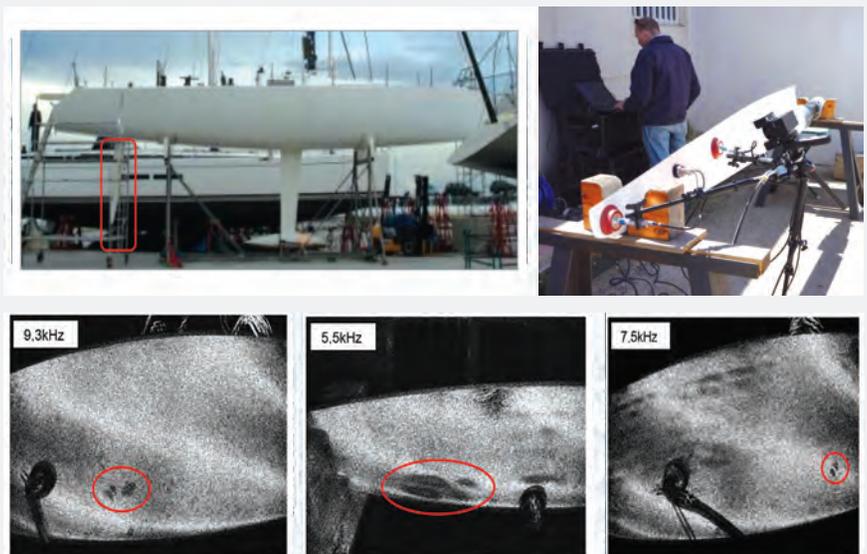
## Case Study-2: NDT of a repaired area of fuselage using SE2 with thermal loading.

The photo bottom left shows the SE2 sensor in front of the fuselage turned by 90°. The field of view is marked with a red line. The measurement results (top right), which is achieved by thermal loading with simple flood light, shows a remaining delamination (red lines) below the repaired area (yellow lines). The delamination can also be confirmed by manual loading (pressed by finger) corresponding to the locally reduced stiffness on the same location (image below, right)



## Case Study-3: Defect detection on marine composites by dynamic loading

The direct rigid mounting of the sensor on the rudder by the suction cups allows outdoor measurement even at strong winds. The high quality interference filters of the sensor permits measurement under day light conditions. Measurement results (time average) showing local vibration modes of defects due to reduced or inhomogeneous stiffness of the material. Even if a big field of view is selected, it is possible to detect small defects as shown in the lower right measurement. Defect size and type as well as the depth of the defect (delamination) determine the normal modes (resonance frequency) of the local defect area. Measurement and images by Marine NDE, Spain

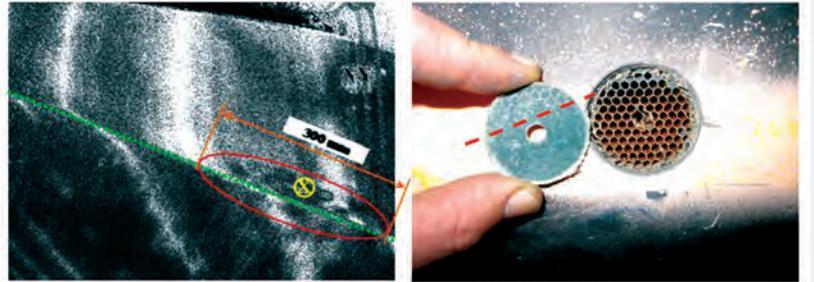


## Case Study-4: Defect detection of carbon yacht hull using SE2 Shearography System with dynamic excitation

The image shows the application of a system on a large yacht hull, made of carbon fiber honeycomb sandwich. The hull has been fully inspected for delamination from inside and outside by Marine NDT, Spain.



The image (below left) shows a time average Shearogram of the port aft chine (marked in green) of a contemporary 72' Mini-Maxi racing yacht. Core bonding defects are encircled in the red oval. Yellow 'X' indicates location of core-sample taken. Core sample taken clearly depicts a never-bond between film adhesive and Kevlar honeycomb in approx. 70% of the area. The image (below right) shows the zone between bonded and non bonded part, which is marked by red. This type of delamination between the honeycomb and surface layer are generally difficult to detect by methods such as Ultrasonic or Infrared Thermography, because of the similar thermal or ultrasound reflection properties between air and the honeycomb, whereas Shearography indicate the structural stiffness differences.



25<sup>th</sup> National Seminar & International Exhibition on  
“NON DESTRUCTIVE EVALUATION” -2015  
Will be held at Hyderabad from: November 26 to 28, 2015  
Theme: NDE FOR MAKE IN INDIA  
[www.nde2015.com](http://www.nde2015.com)

## Foundation course on NDT

30<sup>th</sup> & 31<sup>st</sup> October, 2015

at

Hotel Classic Avenue, Trivandrum

organized by

ISNT Thiruvananthapuram

Chapter

### Fees:

ISNT Member: Rs. 2500

Non- ISNT Member: Rs.3000

Students nominated from educational institutions: Rs. 1000

### Important Dates & Dead lines

- Receipt of Abstract before : 15.10.2015
- Intimation of paper acceptance before : 20.10.2015
- Full paper submission Before : 30.10.2015

### Fees Structure

- ISNT Member : Rs.7000 + 14% ST
- Non-ISNT Member: Rs.8000 + 14% ST



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