New Approaches for Performance Definition
of Composite Materials and Structures
NPL, London 11th March 2010

‘ NDE OF COMPOSITE MARINE STRUCTURES ’

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RNLI

Acknowledgements: TWI Ltd NDT Validation Centre, Wales
& Laser Optical Engineering Ltd, Loughborough

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- BACKGROUND
- AIMS of NDE
- METHODS CONSIDERED
- CASE STUDIES
- CONCLUSIONS
- QUESTIONS

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RNLI Lifeboats

- Over 230 lifeboat stations
- Over 300 boats
- Over 110 Lifeguard units
- 4500 volunteer crew
- Co-ordinated by UK Maritime & Coastguard Agency and Irish Coast Guard
- Funded by voluntary contributions

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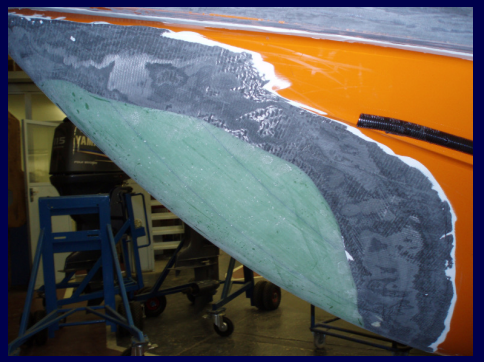
RNLI Aims of NDE

- New build structural verification
- Detect interlaminar shear in monolithic skins
- Through thickness testing of thick cored panels
- Detect failure of secondary bonding externally
- Determine extent of damage
- Verification of repairs
- Structural evaluation for life extension programs



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Practical Considerations

- Working boatyards not clean environments
- Yard heath and safety concerns
- Limited access / confined spaces
- Portability of equipment
- Impact on other maintenance activities
- Post test processing & interpretation
- Type of structure and defect sought
- Cost of inspection

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Methods Considered

- Tap Testing (manual & semi-automated)
- Microwave
- Radiography
- Laser Shearography
- Thermography
- Ultrasonic area scanning

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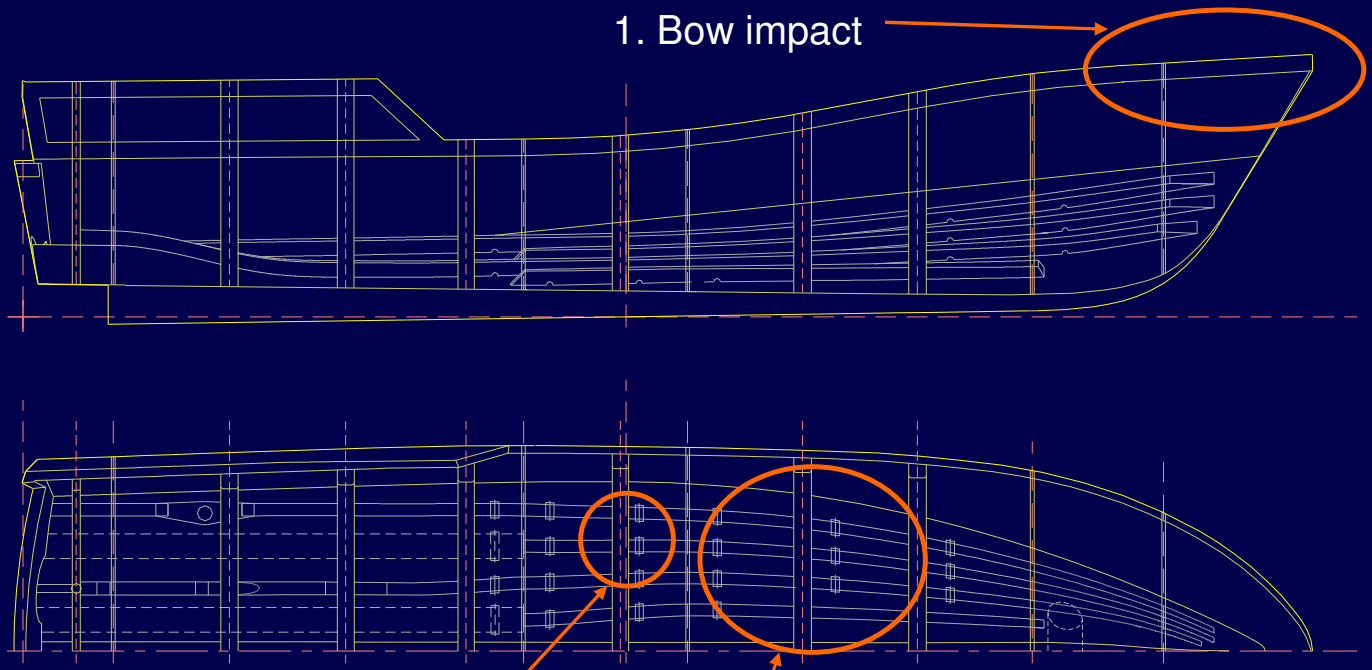
Case Study Areas



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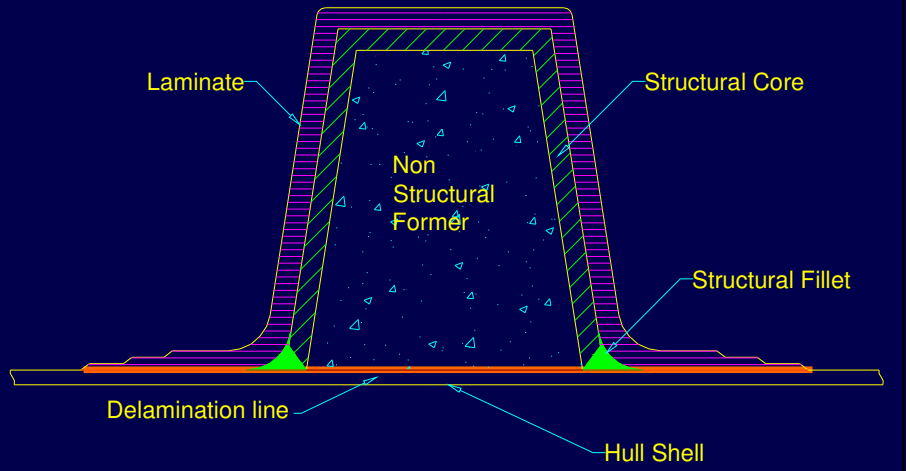
Typical Areas of Damage



- Delamination of monolithic outer hull from internal stiffeners.
- Plotting of subsurface damage in area of visible surface cracking.

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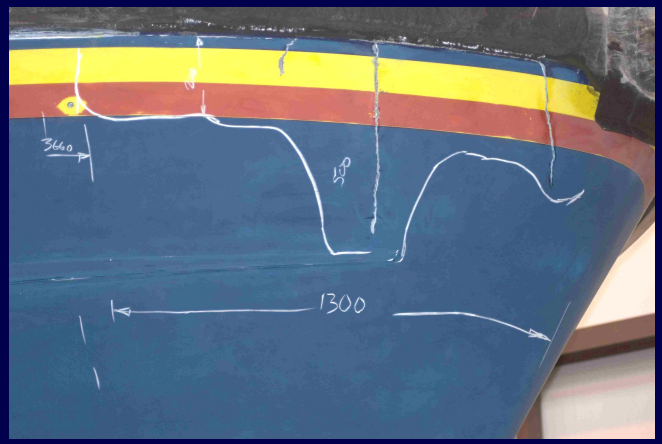
CASE STUDY 1: Bow Damage Assessment

- Aim is to assess extent of damage in order to determine cut lines prior to cutting away damaged structure



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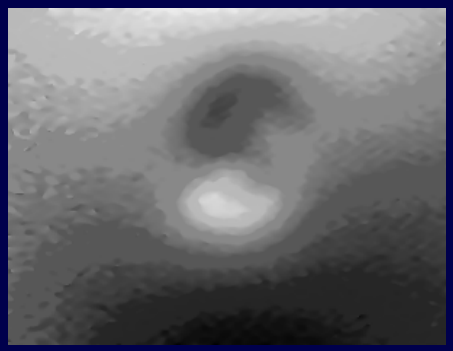
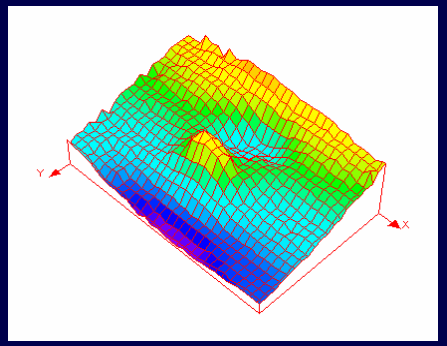
Shearography

- Uses the coherent, monochromatic properties of laser light to generate speckle patterns.
- When illuminated by the laser, the surface reflects the light creating a speckle pattern at the viewing plane.
- This can be processed further by the computer to make the fringe pattern easier to interpret by the operator.





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Shearography 2

- The system digitises and stores a reference speckle pattern, after which the surface is stressed and a new speckle pattern generated, recorded and stored.
- The applied stress must cause the flaw to produce a change in the strain field at the surface
- Very small deformations are required – around the wavelength of the Laser (532ηm)

Typical stressing methods are:

- Vibration
- Heat
- Mechanical
- Vacuum or pressure

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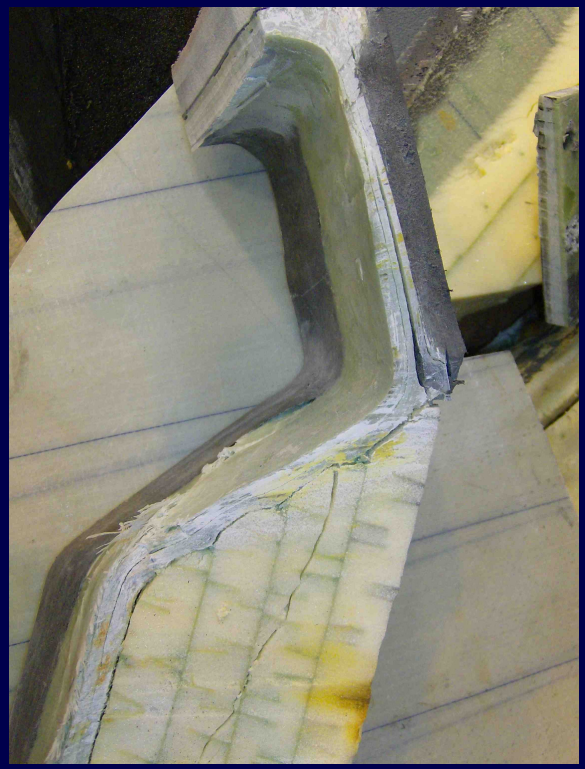
Damage Revealed



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CASE STUDY 2: Impact damage to outer hull

- An impact had produced a crack in the monolithic outer hull.
- An area of delamination could be seen and the surface was removed by drilling.
- Before effecting repairs the extent of the delamination needed to be determined.
- It was suspected that the drilling could have induced more damage.

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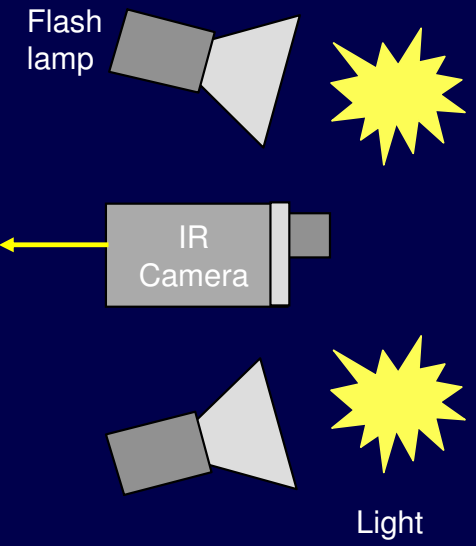
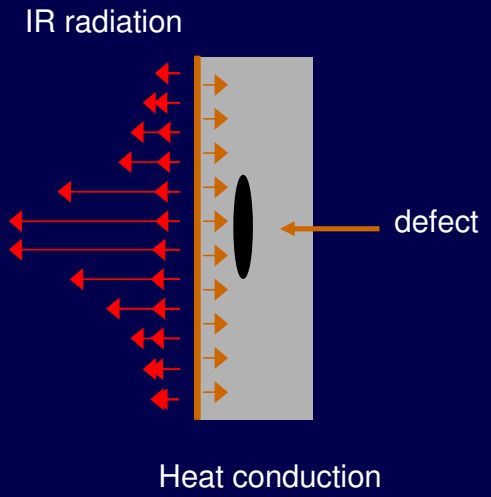
Pulsed Thermography

Sub-surface defects affect the way in which heat is conducted into the material resulting in surface temperature variations that change with time.





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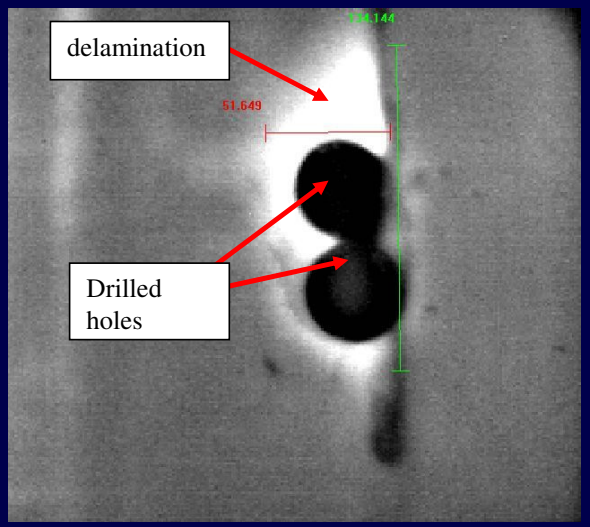
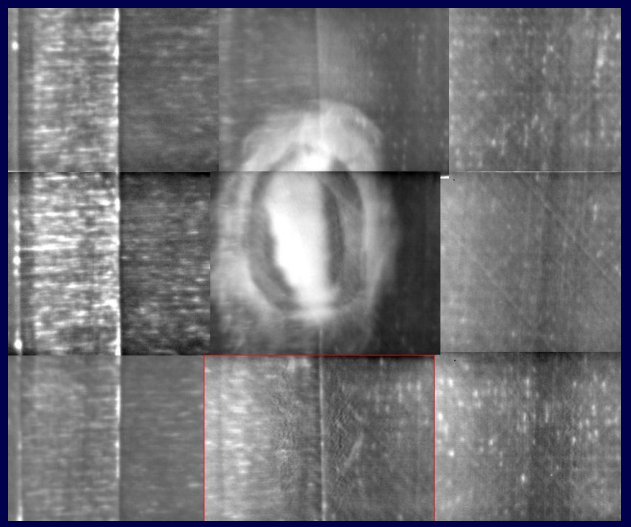
Thermography Results



Pulsed thermography used to define damage area for scarf repair



Composite image of repaired area used for monitoring integrity during service

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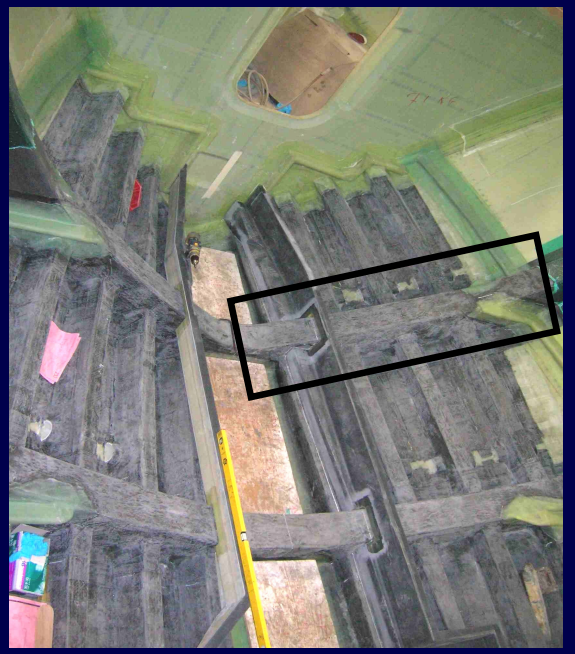
CASE STUDY 3: Debonding of Stiffeners from Hull



- An impact had resulted in debonding of some of the stiffeners from the outer hull

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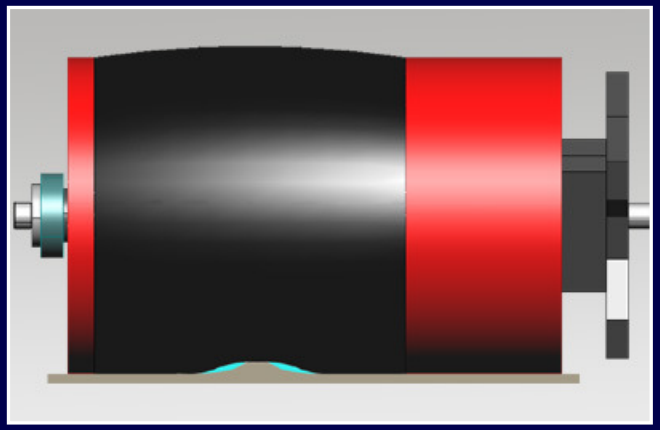
Ultrasonic Area Scanning

- Highly portable ultrasonic scanning system
- Scanning speeds of over 200mm/sec
- No probe wear or surface damage due to rolling tyre design



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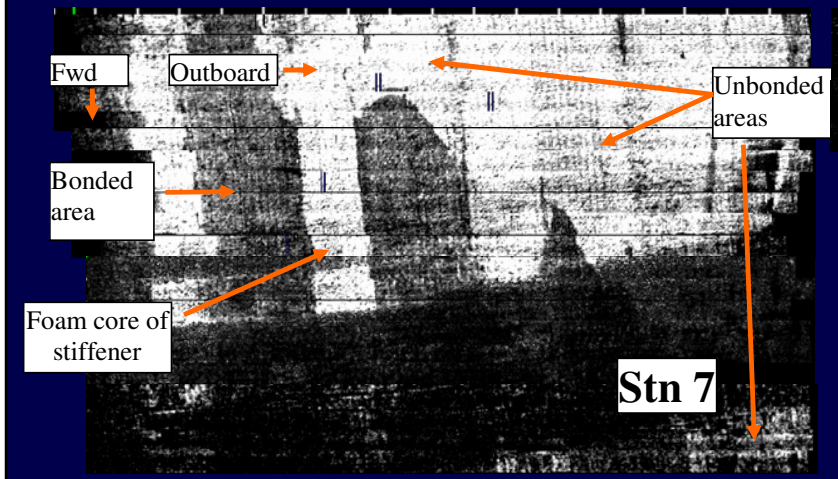
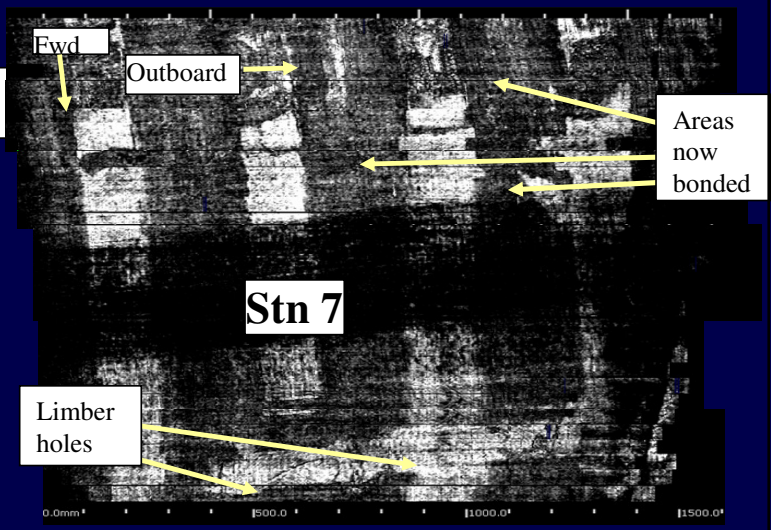
Area Scanning Results





- The damage area was mapped and the disbonded areas show as white
- The area was rescanned after repair

- The newly bonded areas are clearly seen
- Images can be used to monitor structure in service and inform life extension decisions

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Conclusions

- No single solution for all structures / flaws
- Methods must offer rapid area coverage, required sensitivity and the ability to operate in a boatyard environment
- Laser Shearography effective and efficient on cored panels
- UT area scanning can be used successfully on the outer surface to detect delamination of stiffeners from the hull
- Thermography is able to detect flaws in the solid laminate and has shown potential to reveal unbonded structure where the surface coating can be removed to allow penetration of the light into the glass fibre

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Questions ??

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