



The Future of Composite Repairs in the Offshore Industry

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UNDE and Composite Repair Technology Timeline

NDE/NDT Technology Timeline



Early 2000's

Numerous NDE Methods Evaluated (X-Ray, Thermography & Acoustic)



2006

MMS & OTRC Fund Composite Repair of Risers Research



2019

Aerospace Successfully Qualifies UNDE for Orion



2020

ABS Approves Composite Repair Method for Offshore Production Hull Structure



202

ABS Group Commercializing
UNDE for Marine and
Offshore Applications

Engineered Composite Repair (ECR) Technology Timeline



Early 2000's

Use of ECR's in the North Sea becoming more common



2004

Shell internal document on how ECR's should be designed. Working group initiated



2005

ASME PCC-2 include ECR design and qualification 2006
ISO 24817 T/S published



2015

Use of ECR's for structural repair applications steadily increasing



2020 Onwards

Much larger opportunities for ECR's now they have been established and proven

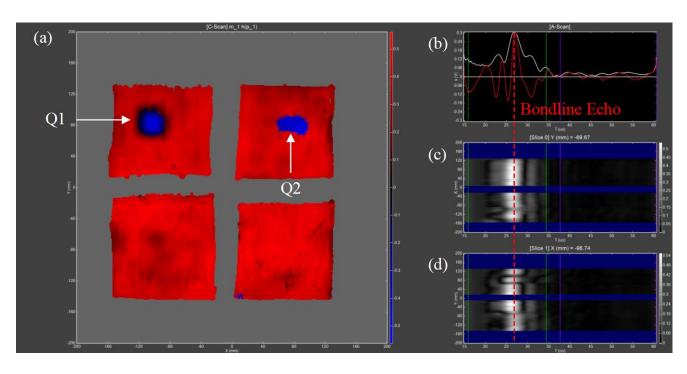


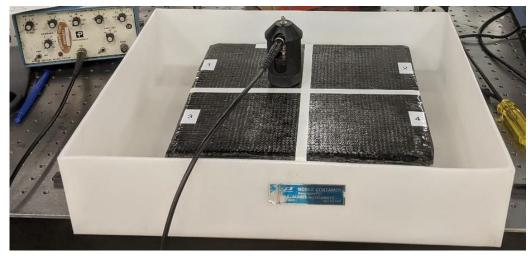


Preliminary Validation Test Results – Multilayer Carbon Fiber

Detailed scans show:

- Size of defect
- Shape of defect
- Depth of defect





Depth of Indications Using 0.5 MHz 1-inch Transducer

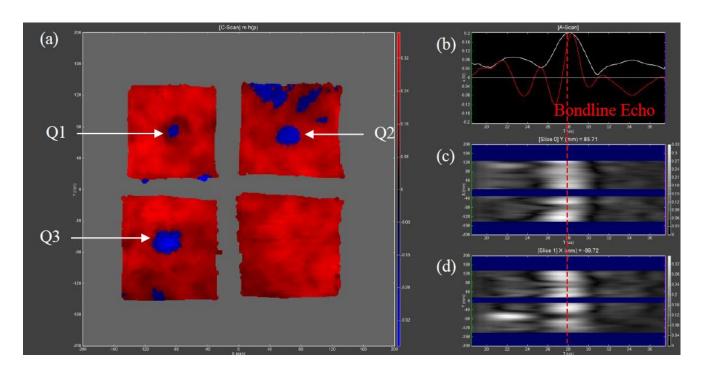
Quadrant	Measured t (μs)	Calculated d (mm)
Q1	26.4	7.50
Q2	25.3	5.81
Q3	-	-

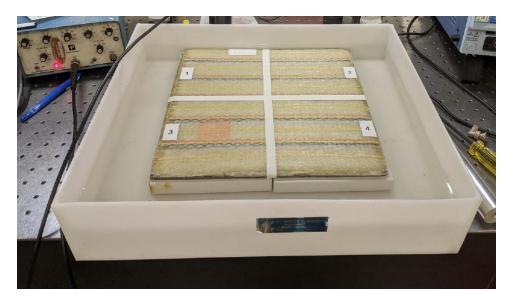




Preliminary Validation Test Results – Multilayer E-Glass

- Technology can identify defects in Real Time
- Location of defects in underlying substrate material
- Detect defects in composite material several inches thick





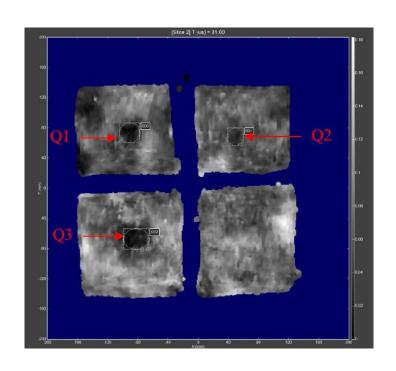
Depth of Indications Using 0.5 MHz 1-inch Transducer

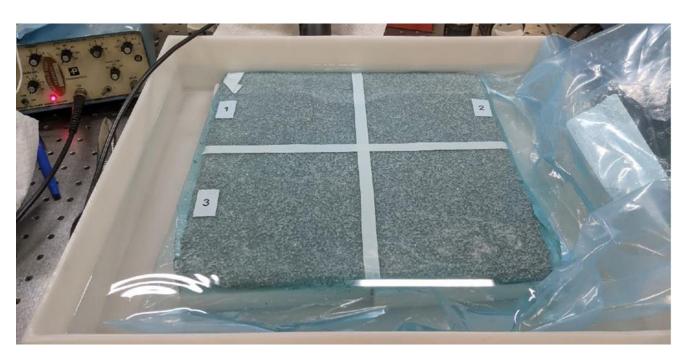
Quadrant	Measured t (μs)	Calculated d (mm)
Q1	27.6	6.4
Q2	26.1	4.8
Q3	22.3	0.8





Preliminary Validation Test Results – Current Limitations





- Specimen consists of 6 layers of DRS on top of steel substrate with a rough aluminum oxide top-coat
- 0.5 MHz, 1 mm brush size used on the previous specimens had difficulty reading through aluminum oxide. A roller probe would be preferable in this instance, which will be calibrated for future tests.



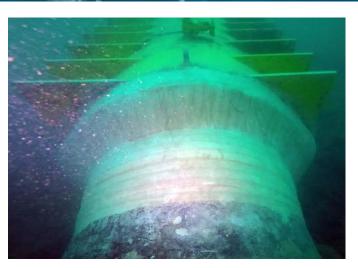


Common Uses of Engineered Composite Repairs



Large OD Cooling Water Lines





Sub-sea Repairs



Structural Repair to Jetty



Deck Repair





Caissons designed for 100 and 1000 year wave loading



Future Use of Engineered Composite Repairs

Greater uptake in the following:

- ✓ Repairs to production critical systems
- ✓ Longer design lives and design life extension
- ✓ Structural repair solutions

A robust, documented inspection procedure leads to verified performance and condition of in service repairs







Thank You

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