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Brunel Innovation Centre

Evaluation of NDT techniques for the detection of kissing bond defects in composite joints

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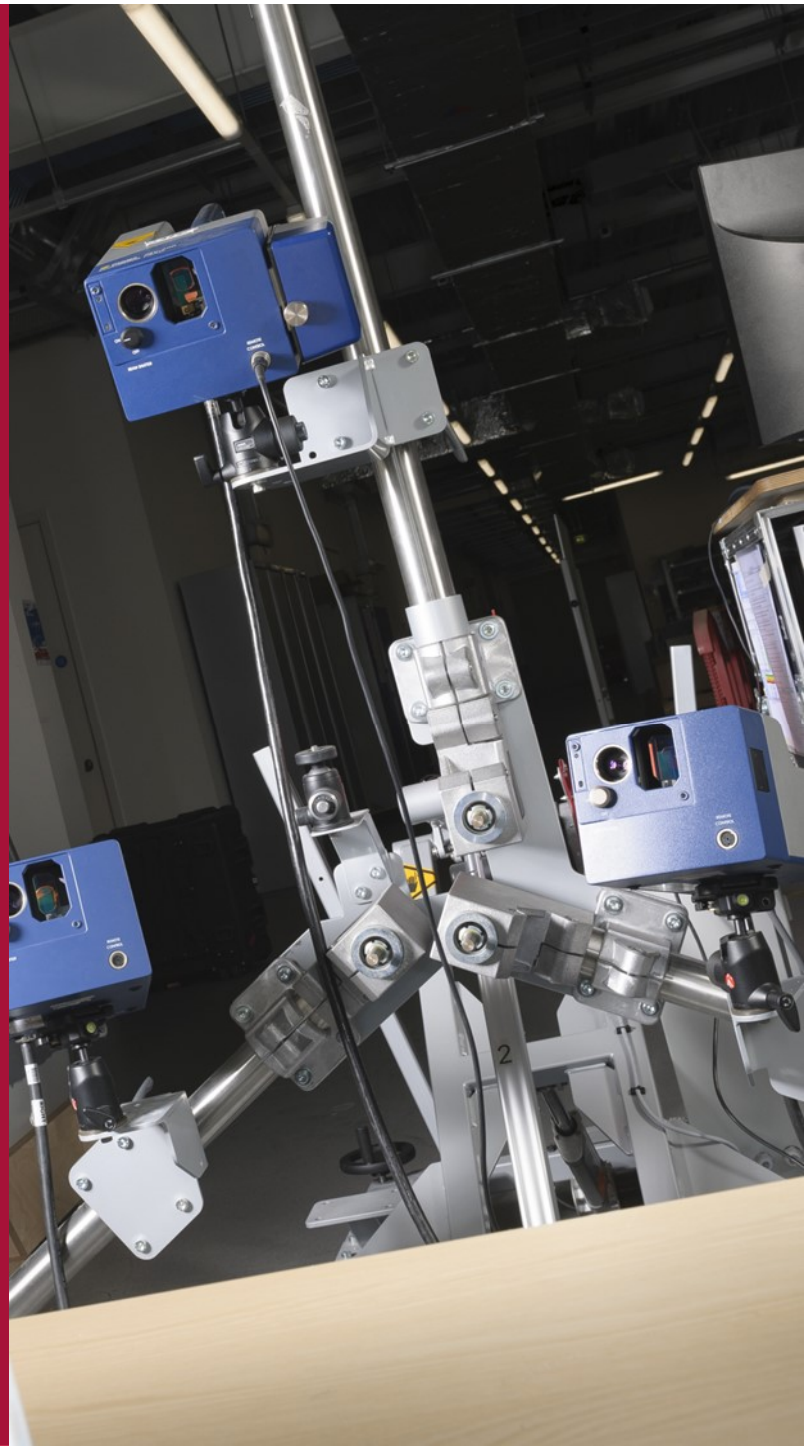


Contents

1. Introduction

- Detection of kissing bond defects in bonded joints is difficult
- The defects are zero volume disbands, offer zero shear strength
- Impossible to detect using classical NDT techniques
- Only method is the destructive testing (not suitable for industry)
- Advanced NDT techniques have shown some degree of detection
- A protocol is made to create bonded joints with kissing bonds. It is confirmed using mechanical testing.
- Advanced NDT methods namely (i) Guided waves (ii) Laser shock (iii) High freq C-scan (iv) CT scan are used in this work

2. Kissing bond manufacturing procedure

Material Used

twenty (20) plies of the HexPly M21/IMA prepreg

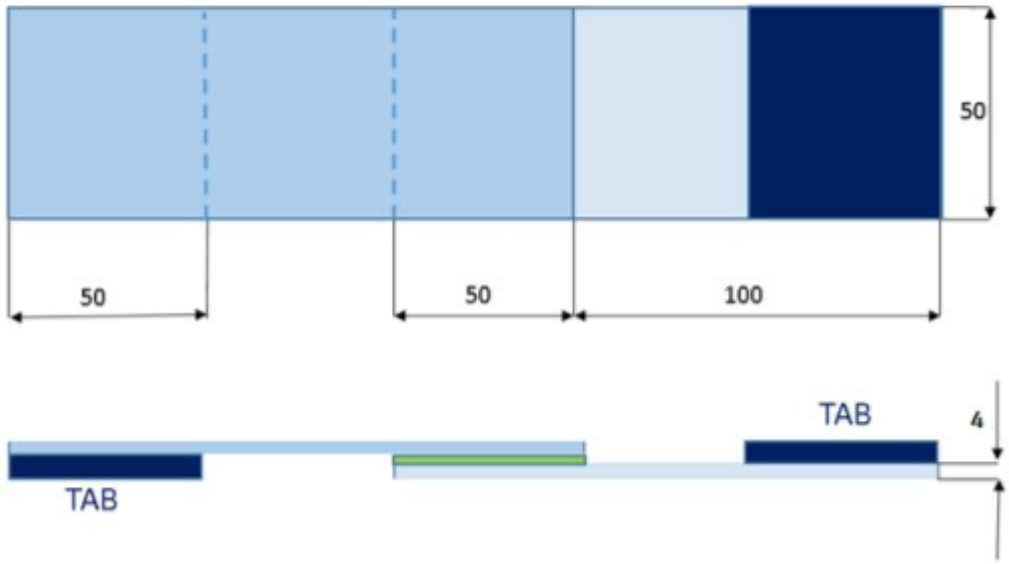
1	M21EV/IMA	0°	
2	M21EV/IMA	+45°	
3	M21EV/IMA	0°	
4	M21EV/IMA	-45°	
5	M21EV/IMA	0°	
6	M21EV/IMA	90°	
7	M21EV/IMA	0°	
8	M21EV/IMA	+45°	
9	M21EV/IMA	0°	
10	M21EV/IMA	-45°	
11	M21EV/IMA	-45°	
12	M21EV/IMA	0°	
13	M21EV/IMA	+45°	
14	M21EV/IMA	0°	
15	M21EV/IMA	90°	
16	M21EV/IMA	0°	
17	M21EV/IMA	-45°	
18	M21EV/IMA	0°	
19	M21EV/IMA	+45°	
20	M21EV/IMA	0°	

Nbr. Of plies	Orientation
10	0°
2	90°
4	+45°
4	-45°

2. Kissing bond manufacturing procedure

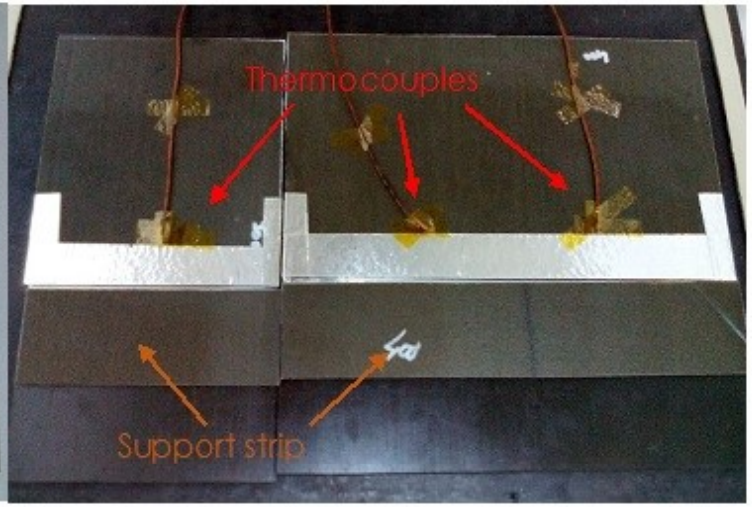
Test sample: Lap joint

- ISO 4587 standard is followed to create test samples
- 2 reference samples and 4 samples with defects are created.
- Sample dimensions are given below



2. Kissing bond manufacturing procedure

Bonded joint preparation:



2. Kissing bond manufacturing procedure

Bonded joint preparation:

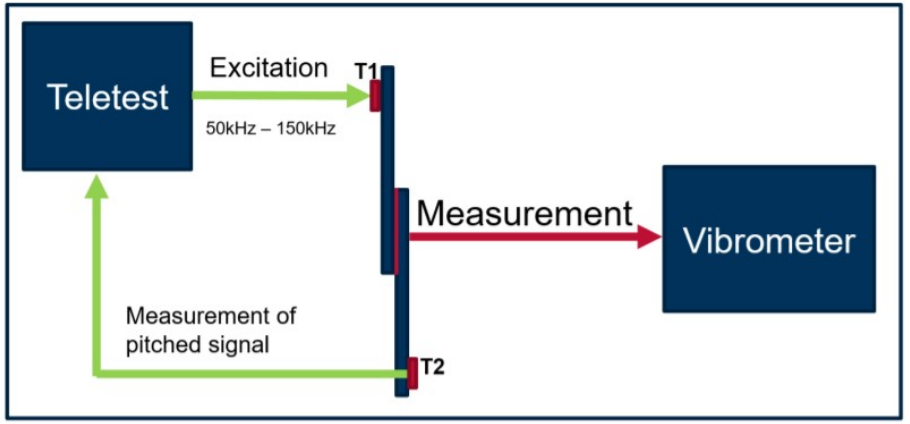
- composite plates are bonded together using an adhesive film and by applying pressure and heat in autoclave oven
- bonding is done using aeronautical grade adhesive film FM 300M
- cure cycle is 177°C for 60 min

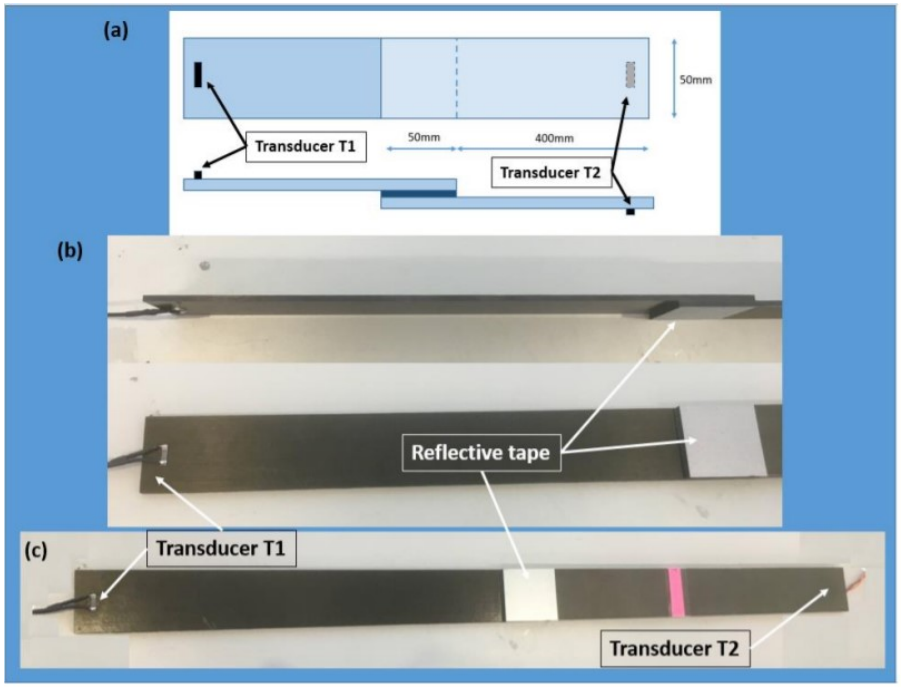
- Defective samples are created by contaminating the bonded area using Lithium Grease (WD40 or similar) as contamination.

3. NDT techniques

Guided waves NDT:

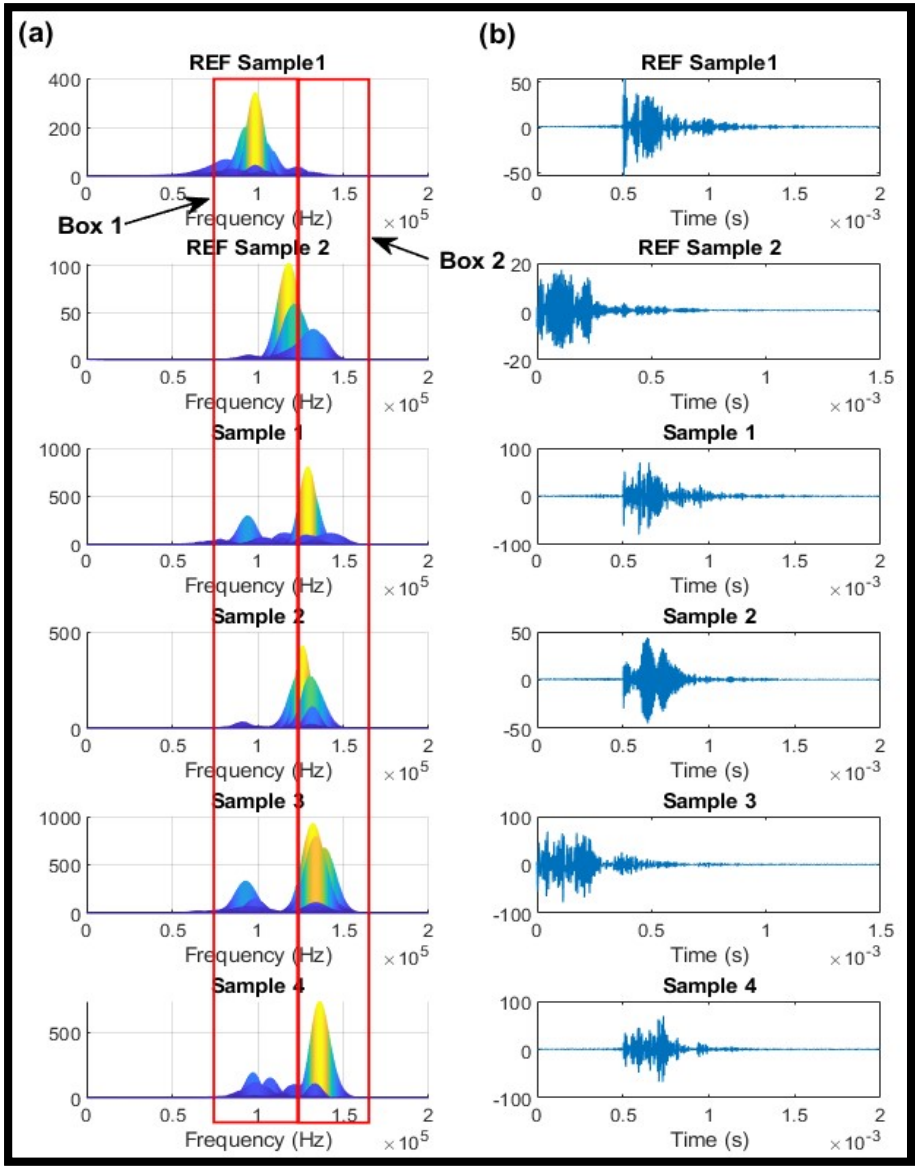
- Test samples in the picture
- Transducer: ASS-3000-0070-B Fuzz Button Piezo Element & Bonded Face Plate
- Equipment: TELETEST Mk4, Laser vibrometer of 2MHz
- I/P frequency: 50kHz to 150kHz





3. NDT techniques

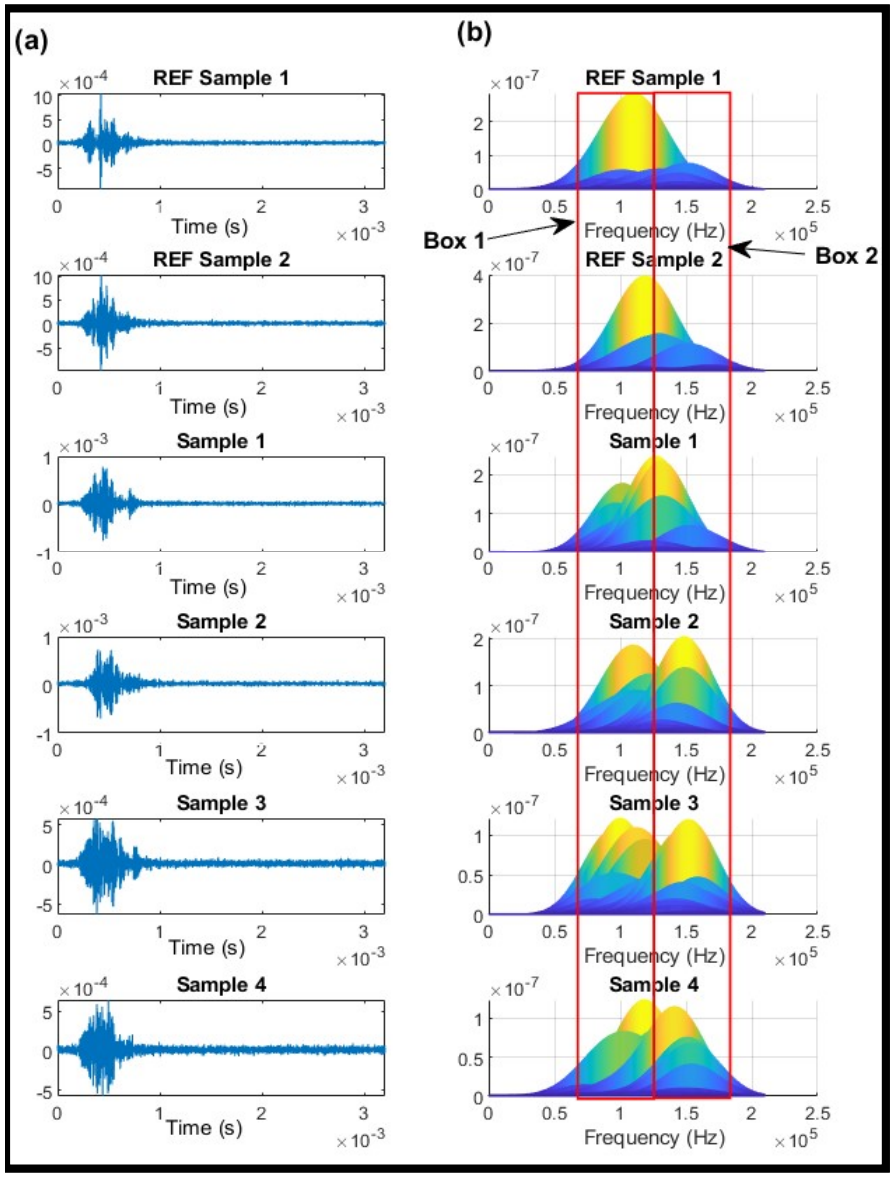
Teletest results



- There is a frequency shift
- Freq of max amplitudes lie below 125kHz for ref samples
- Freq of max amplitudes lie above 125kHz for samples with defects
- The defects can be identified using guided waves

3. NDT techniques

Vobrometer results

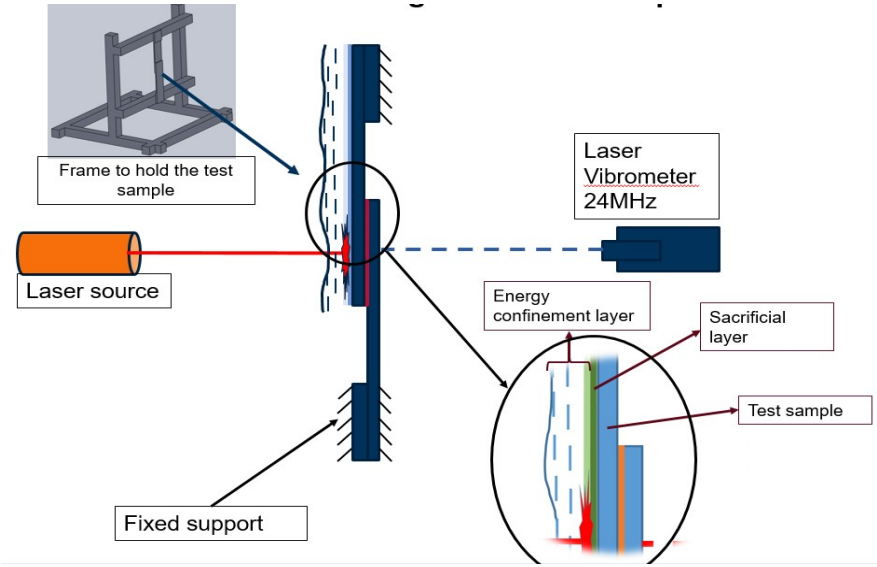


- There is a frequency shift
- Freq of max amplitudes lie below 125kHz for ref samples
- Freq of max amplitudes lie above 125kHz for samples with defects
- The defects can be identified using guided waves
- This is a validation of guided wave results

3. NDT techniques

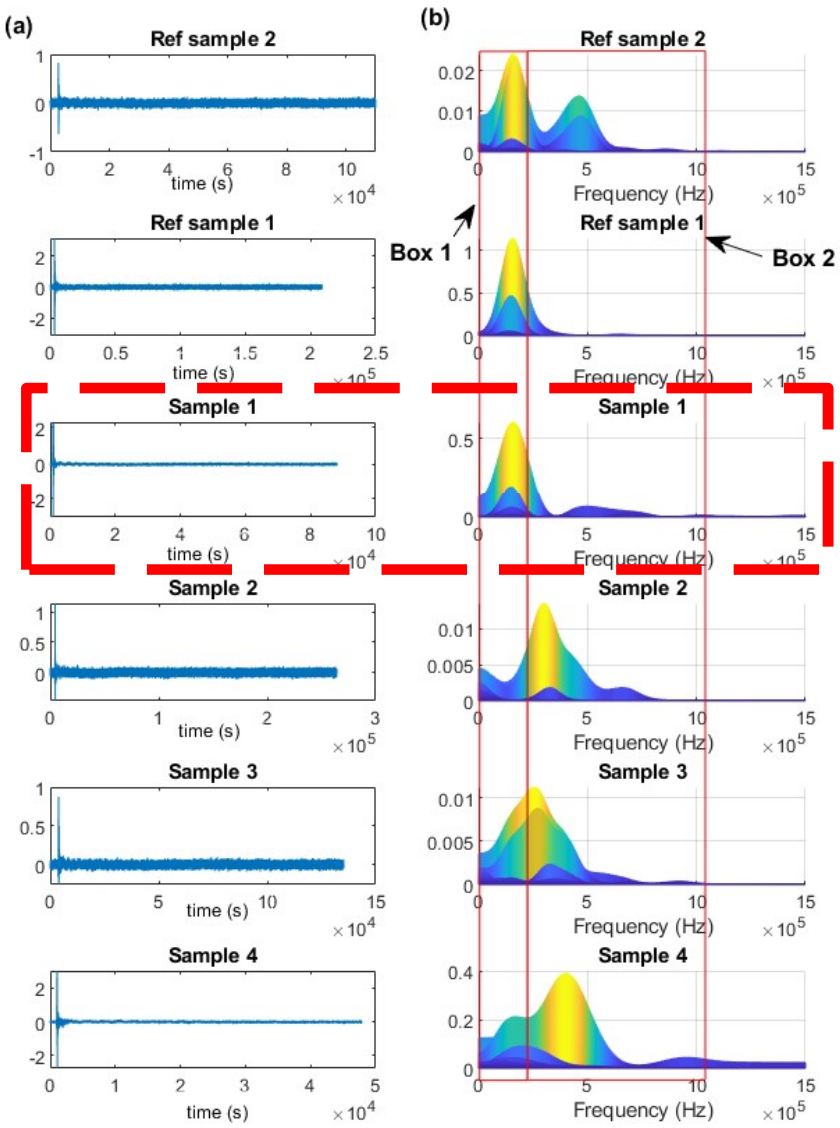
Laser shock tests:

- Laser type: pulsed Nd:Yag laser of 1064nm, 2.7J energy, 10ns
- Laser vibrometer of 24MHz is used
- Each samples is subjected to a single laser pulse for measurement
- Back surface velocity is measured for defect detection



3. NDT techniques

Laser shock tests:

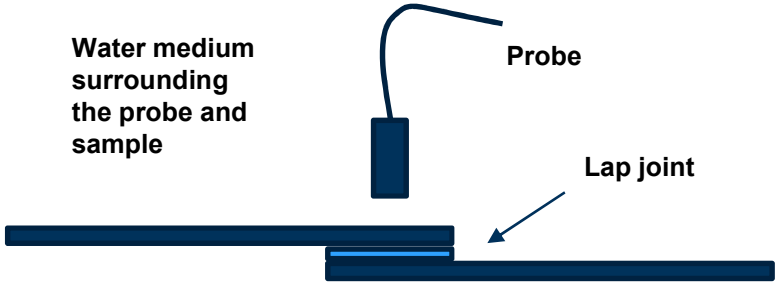


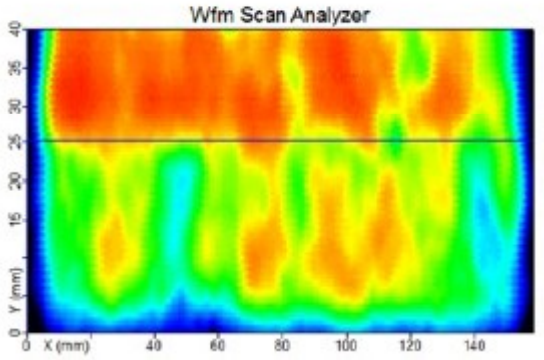
- There is a frequency shift
- Freq of max amplitudes lie below 250kHz for ref samples
- Freq of max amplitudes lie above 250kHz for samples with defects
- The defects can be identified using laser shock
- There is a degree of failure to detect (see Sample 1)

3. NDT techniques

High freq C-scan:

- Probes of 5MHz, 10MHz and 15MHz are used in Pulse-echo mode.
- Various configuration are under testing for successful detection of defects

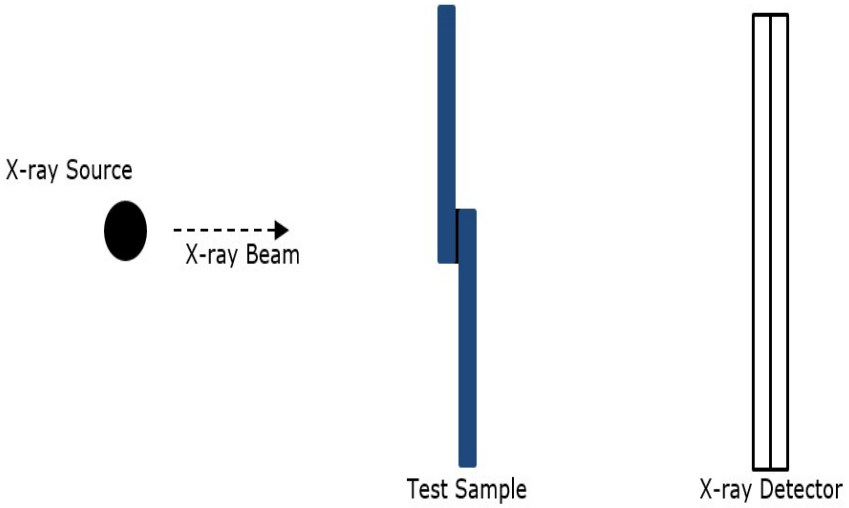


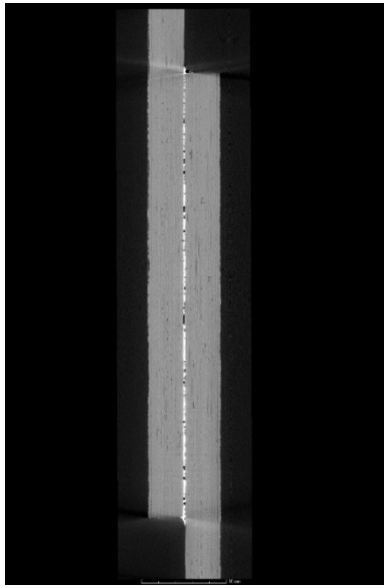


3. NDT techniques

Computed Tomography:

- Results of CT-scan are shown in the pictures below.
- There is a sign of detection of defects.
- Results need validation.





4. Conclusions

- Bonded joints with kissing bond defect have been successfully created and a protocol for the same is made
- Both guided wave NDT and laser shock test are conducted and the results are promising.
- A consistent frequency shift is observed which differentiates a bonded joint with kissing bonds and without kissing bonds
- High frequency C-scan and CT-scan are under trials
- CT-scan has shown some signs of defect detection which has to be validated

Thank you