Polyurethane Adhesive Bond Inspection

Application Note

Industries & Markets

- Automotive (aluminium tub inspection)
- Aerospace
- Military
- Robotics

Typical Parts

- New generation bond assembly
- Aircraft frame
- Automotive structure and body
- Laminate and composite structure

Inspection Techniques

- Back wall monitoring
- Shadow technique
- Echo (A-Scan) signature comparison

Features & Benefits

- Wide band input
- Extra narrow band filters for low damped probes
- High resolution on-screen A-Scan reference
- Quick reference scan buttons
- Alarm options set on singularities
- Built-in inspection interface

RECOMMENDED TOOL PACKAGE

- WAVE
- STP Probe Series
- Starc & T-Starc Series

The technique & the appropriate probe selection

Bond testing is a fairly straight forward task when utilising the **Go / No-Go setup**. However, it can be challenging when dealing with multiple layers of various materials. In an ideal condition, the A-Scan displays the echoes based on individual layer and the reflection from each layer of material is captured from the echoed signal (reflection) for thickness and integrity verification. But this is not always applicable to bond evaluation.

Unlike Aluminium or other homogenised metals, adhesives usually show a high signal attenuation and discrepancies. In this case the polyurethane bond material (area of testing) requires much lower probe frequency since the material composition is not homogenised and grain structure is significantly larger in comparison to aluminium. Beside the ultrasound transmission (foam core for example), the geometries, surface condition and probe access are also contributing factors.

One of the best solutions remains to be the shadow technique, using echo penetration through a pitch and catch probe on opposite sides, although limited to the outer surface. A dual or single element probe could be utilised and, in all cases, Sonatest recommends selecting a low damped piezoelectric AKA narrow band response, due to having the higher sensitivity.

Go/No Go Implementation and Performance; Sonatest WAVE has a specifically designed feature for bond testing. A simple application preset can be programmed in the instrument with shortcuts for an efficient operation. Furthermore, utilising the powerful pulsing capability and the wide band receiver to inspect less homogenised material makes WAVE a versatile tool for difficult inspection scenarios.

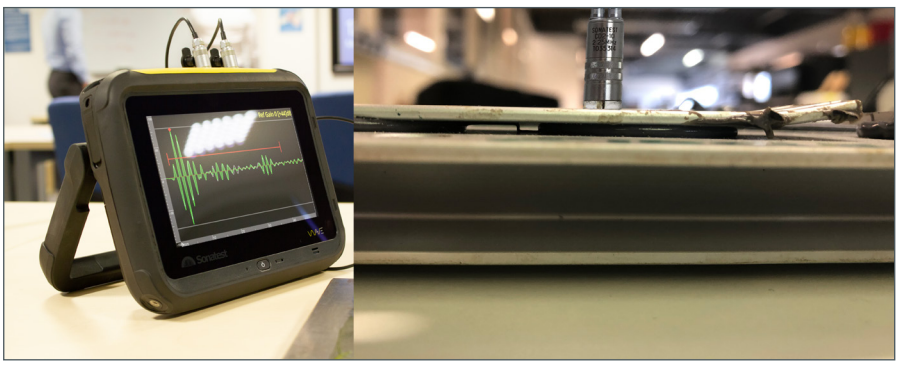

Figure 1: Overview of the inspection

Pitch-Catch probes technique in through transmission

The key to this technique is the shadow effect as per figure 2 set-up. One transducer is transmitting and on the opposite side, the other probe is receiving. This is similar to a vibration hitting a wall, the absorbed or reflected components of the signal are potentially identifying where the air traps are present, as the microphone (receiver) catches the lower pulse energy. The A-scan is typically fully rectified, and a negative alarm gate is used for a go/no-go call.

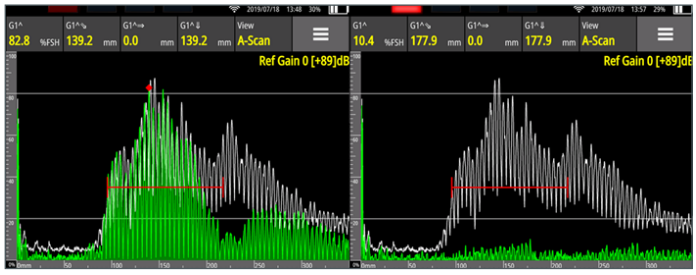

Figure 2: Pitch-Catch Go/No Go identification

On the left, the sound goes through (above its white reference A-Scan) and on the right, a very low sound transmission as the red alarm triggers.

Generic Pulse-Echo transducers approach

It is basically a back-echo attenuation monitoring combined with the bond line signal checking. The unit should be set in RF mode, so the A-Scan shows the full polarity of the signal to spot the acoustic impedance changes. It is also possible to set a negative gate alarm, so the light indicates a defective zone when the signal is dropped. A typical flaw will indicate a low back wall percentage FSH and the bond line echo will increase in parallel.

Pitch-Catch single probe sub family

For difficult applications where the first layer is creating undesired echoes, the dual crystal probe can help. This is especially useful when dealing with thinner layers (less than 2 mm or 0.079 inch), the interface amplitude will improve the signal signature in the adhesive (bond material) to make it an easier go/no-go decision. If the incoming farthest echo is strong enough, it indicates that the signal is going through all the layers (entire specimen) and good bonding between the layers, a fair reference A-Scan and the lack returning waves will be spotted efficiently.

Figure 3 is a series of identified flaws over a polyurethane assembly.

Generic Pulse-Echo transducers approach

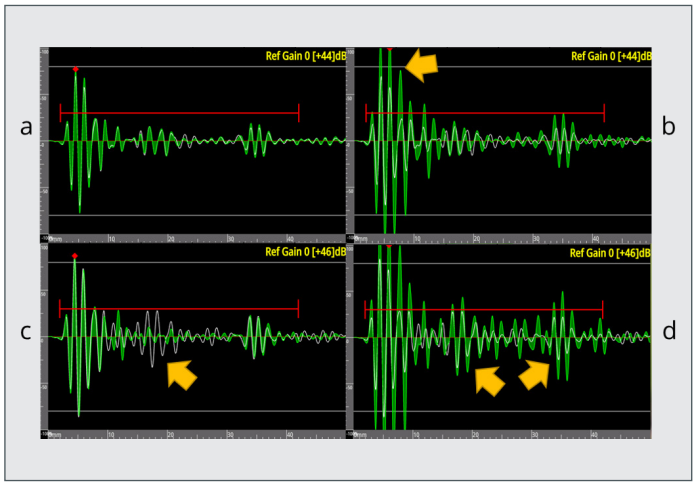

Figure 3: Various A-Scans of Polyurethane adhesive bonding

A-scan over Figure 3 sample

a) Good bonding

b) Thin line

c) First layer been pulled off

d) Absence of glue

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