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FRAUNHOFER INSTITUTE FOR NONDESTRUCTIVE TESTING IZFP

CLINCHING

OFFLINE AND ONLINE MEASUREMENT OF THE WALL THICKNESS IN CLINCHED JOINTS

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- Accredited laboratory in line with DIN EN ISO / IEC 17025, to qualify and validate new non-destructive testing (NDT) processes for industrial applications
- Accelerated time-to-market and opportunity for qualified, norm-compliant deployment in industrial applications as well as for complete new in-house developments or custom adaptation of innovative NDT technologies, even in fields where norms have not been established
- Certification of the corresponding quality management system in accordance with DIN EN ISO 9001

TÜV SAAR CERT ISO 9001

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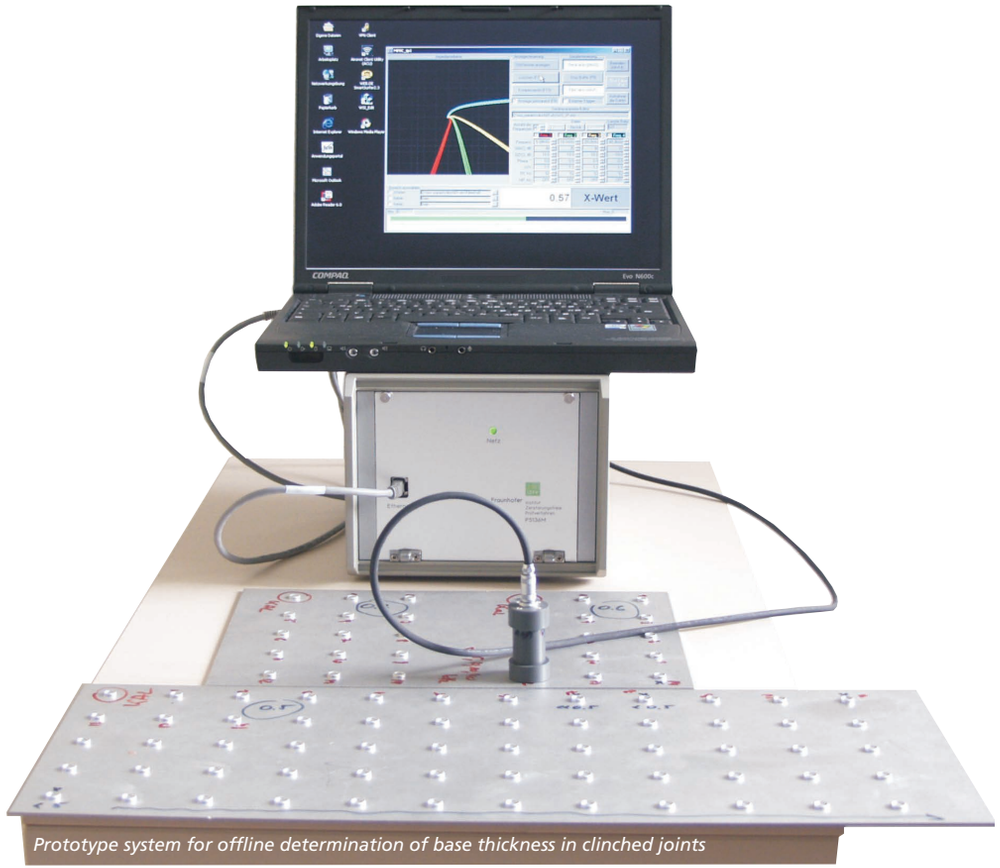

Prototype system for offline determination of base thickness in clinched joints

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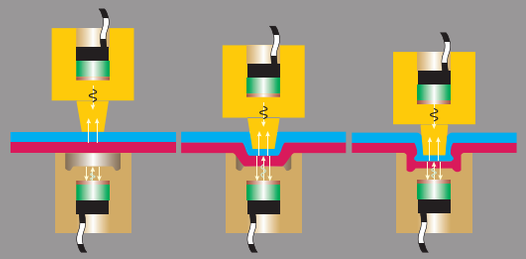
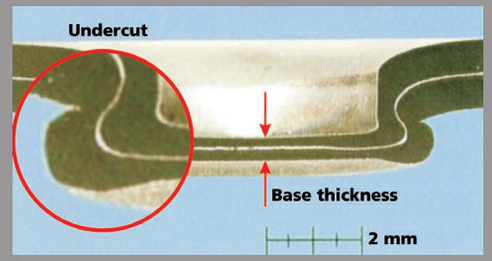


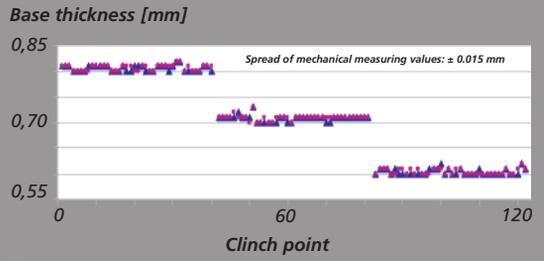
1

Online determination of the base thickness in clinched joints by ultrasonic methods



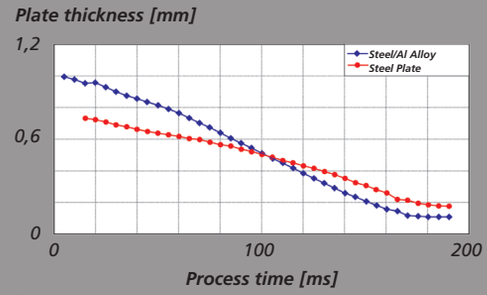
2

Undercut and quality feature "base thickness"



3

Offline determination of base thickness of joint Al plates



4

Decrease of base thickness of die-sided plate during clinching process

Situation

The modern joining process "Clinching" is largely characterized by the positive connection´s material itself being taken from the components´ material. Under pressure the material flows into the actual joining zone, the undercut (figures 1,2). In this process, the original thicknesses of the two adherends reduce differently. The mass portion in the undercut is correlated with the base thickness, thus, with the total thickness of the two adherents in the joining point. The base thickness in the joining point is the decisive quality feature of a clinched joint.

The current state of quality assurance exploits a force/path measurement that compares the joining strength and the tool path during joining with a reference curve representing the parameter changes of an ideal joint. In case of aberrances, the joining force can be reduced or increased to adapt the process corresponding to the force/path course of the reference curve.

Solution

The methods developed at the Fraunhofer IZFP allow the nondestructive determination of the quality feature "base thickness" for each clinched joint.

Offline determination of the base thickness

For a fast quality monitoring of the clinched joints, the eddy current method was refined. An eddy current sensor is placed either on the stamp side or on the die side so that the whole volume of a clinched joint is imbued with the eddy current field.
The electrical conductivity and, in the case of ferritic joining partners, the permeability determine the strength and distribution of the generated eddy currents in the joint zone. In addition, the strength of the eddy currents is determined by the imbued mass-filled volume. Different base thicknesses and inadequately stamped undercuts change the flooded volume and, thus, the electromagnetic feedback on the signal of the eddy current sensor.

The electromagnetic characteristics and the mass-filled volume affect the measurement signal at different test frequencies in different ways. By a suitable combination of several eddy current frequencies, disturbances such as sensor lifting from the surface or changes in conductivity and permeability can be distinguished from the objective criterion "base thickness". The procedure will be calibrated. After the measurement data recording was performed on supposedly good and supposedly bad clinched joints, the joints are characterized destructively. The results of the destructive measurements are compared with the results of the eddy current measurements. By special algorithms measurement reliability and the accuracy of the eddy current method can be adjusted. In figure 3, first results are represented.

Online determination of the base thickness

Ultrasonic sensors that transmit and receive high-frequent ultrasonic waves are implemented in stamp and die of the clinch tool. Figure 1 outlines the situation. Once the stamp exerts pressure on the adherent, the sound wave propagates in the stamp-sided adherent and will be reflected by the interface to the die-sided adherent and, thus, received by the sensors. The time-of-flight of the sound wave is sampled at approx. 100 Hz. Using the known or experimentally determined material-specific sound velocity the thickness of the stamp-sided adherent can be calculated from the time-of-flight. In the same way the thickness of the die-sided adherent is determined.

In preliminary studies the reliance of the sound velocity from the plastic deformation was observed and quantified. This fact can be used to improve the measurement accuracy. Continuously determined during the process base thickness can be used to control the force on stamp and die.

A prototype system verified the basic feasibility of the online determination of base thickness in the clinching process. Thereunto an ultrasonic sensor was mounted into a die. Figure 4 shows the decrease of the base thickness during the clinching process as a function of the ultrasonic time-of-flight.