ULTRA RS

Ultrasonic stress measurement device

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1 INTRODUCTION

Ultra RS has developed state of the art expertise in stress measurements in metals with application of Ultrasound technology. Our know-how enable us to tailor make solutions to particular client challenges and allow them to reach more accurate stress measurements. This is vital for sensitive industries where better control of stresses is of great importance. Ultra RS have served Nuclear, Aviation, Oil & Gas and many other industries with a long track record of success.

2 METHOD STATMENT

2.1 General Description

The device of measurement is composed by an electronic module (figure 1) and by an ultrasonic sensor (figure 2) **adapted to the shape of a mechanical part**.

The electronic module contains a ultrasonic pulser/receiver (generator of electric impulsions) and a central processing unit in which the oscilloscope card is installed. During the starting of the module, all the material starts, and the « Ultra-sys » software, allowing measurements, is launched **automatically**.

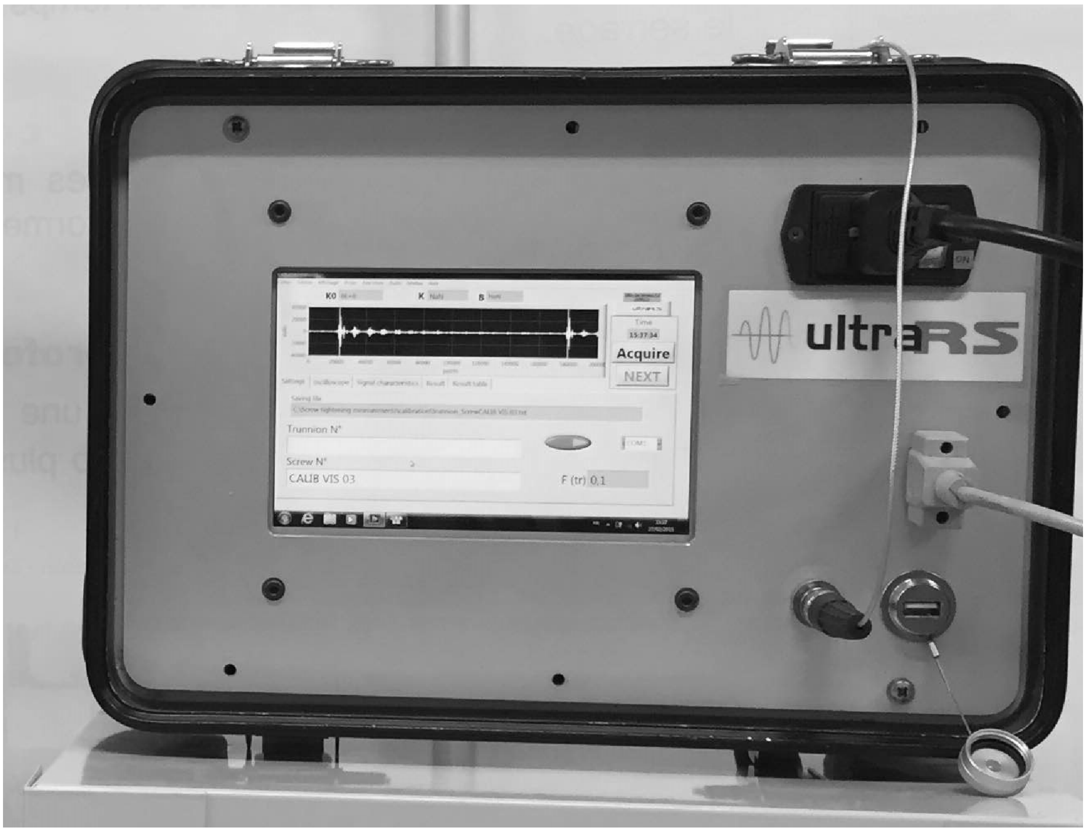

Figure 1: Ultrasonic device

At the beginning of a test, some electric impulsions are emitted by the transmitter. Then, these ones are converted in ultrasounds and sent in the mechanical part. The ultrasonic signals corresponding to the value of stress are **treated and posted on the control screen** of the electronic module. All these steps are done **in real times**, there is no waiting to see the results!

Then, it is possible to save and print a summary of each test to keep a **traceability**.

Figure 2: Ultrasonic transducer

2.2 Longitudinal Subsurfacic Wave

When a medium is subjected to stress, changes in ultrasonic speed (travel time) can be observed due to acoustoelastic effect. Ultrasonic stress measurement is based on variation of wave travel time. The stress is calculated for uniaxial strain field, in the isothermal case, by the following relationship:

$$\sigma = \frac{t - t^{\circ}}{t \, . \, K}$$

The acoustoelastic constant **K** relates the ultrasonic velocity to the stress, and can be given by the ratio of the change in wave travel time **($(t- t_0)/t$)** to the stress, where **t_0** is the wave travel time in an unstressed medium, **t** is the wave travel time in the presence of stress.

The Longitudinal Subsurfacic Wave (LSW) is an acoustic wave that is excited when the angle of incidence (Fig. 3) is slightly greater than the first critical angle of the specimen. Based on Snell's law, an incident beam angle of approximately 27° (in case of steel) from the perpendicular to the boundary surface is required to excite the LSW.

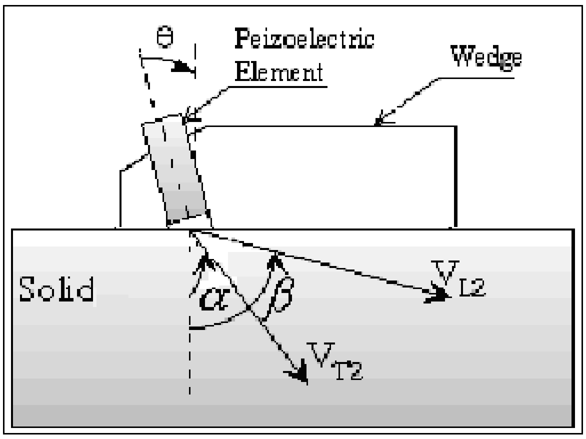

Fig. 3. Excitation of the LSW in steel with an angle transducer

The LSW are of great interest for industrial applications, because the influence of stress is felt especially on the surface of a material. Figure 4 illustrates a basic configuration for determining stress on the surface. Using transducers of the same size, it is possible to produce LSW that travel deeper in the steel pipe. The effective depth of these critically refracted longitudinal waves is estimated to be equal to one wavelength.

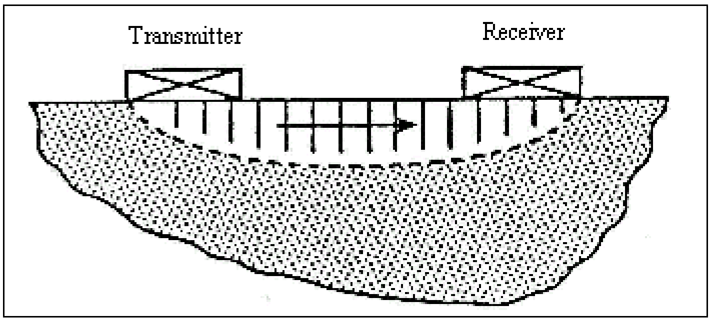

Fig. 4. Schematic view of acoustoelastic measurement.

2.3 Calibration

The measurement technique requires calibration phase in order to determine the absolute stress valid to the considered component material. Two parameters should be identified:

- t_0, the wave travel time in reference zone
- and K, the acoustoelastic coefficient.

Experimental calibration of the acoustoelastic effect is carried out by step-by-step loading and unloading of the steel specimen. The reference signal corresponds to zero stress.

Figure 5 show an example of the calibration curve determined on the rail steel. The slope is corresponding to acoustoelastic coefficient.

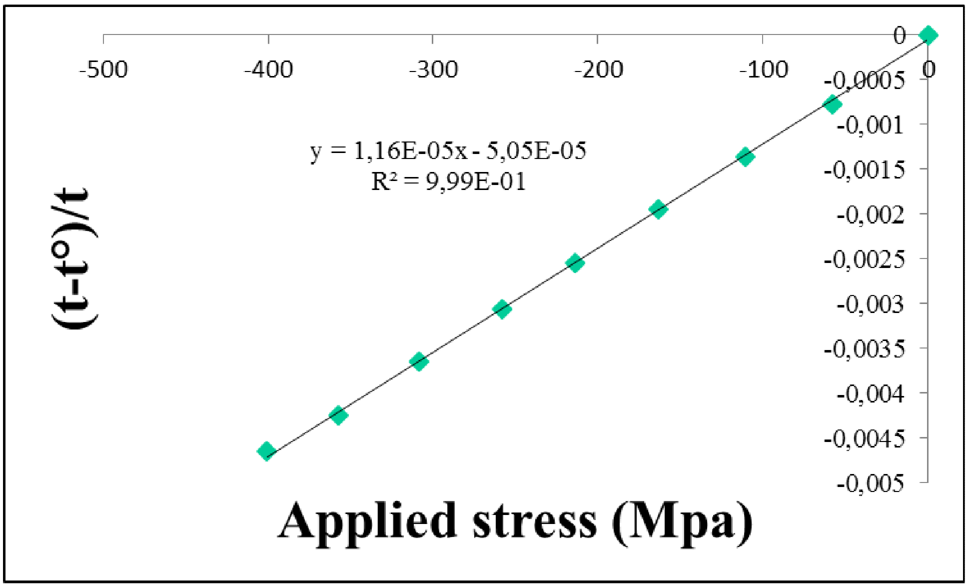

Fig. 5. Calibration curve determined in the rail steel.