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Acoustical Birefringence for Experimental stress Analysis in Casting Iron Using Ultrasonic Techniques

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1. Abstract

Casting irons are widely applied in a lot of fields. It includes the machine tool industry. The manufacture of machine's tool is one of the Private Brand in Taiwan. Therefore, the quality of the machine tool that is the important competitive conditions. All of the machine tool's bases are made of the casting iron. The residual stresses are produced when Casting iron fabricate processing. It's an elastic force that is static equilibrium in solid. The material properties and structure components will be considerably influenced by residual stress. It has many disadvantage that is being worst mechanical properties.

In this paper, a non-destructive method of ultrasonic technique is simulation that release the residual stress when the casting iron is used of a period of time. Using the ultrasonic technique with tensile testing to execute this research.

2. Theoretical background

It's using ultrasonic shear waves to measure stress in two different direction. The two different direction are particle motion perpendicular to load direction and .Comparing the velocity change that is particle motion perpendicular to load direction and particle motion in load direction. In reference, It measure steel and aluminum using ultrasonic technique with compressive stress. And the research result is the velocity of particle motion in load direction that will be going up. Another direction will be going down.

3. Experimental technique

3.1 Experimental system

This technique in which the same transducer is used for transmitting and receiving of ultrasonic waves is often called the pulse-echo method. The measurement of the ultrasonic velocities was accomplished using a transverse wave transducer. To measure the velocities of transverse waves, it was used a normal incidence transducer of 2.25 MHz and coupling, and for the transverse waves was used a transducer of 2.25 MHz and coupling. Then, using the computational algorithm based on echoes overlapping, the waves' time of flight between two echoes was computed. After obtaining the time of the wave propagation and knowing the sample's thickness, it was determined the velocity of the wave propagation in the associated material. The specimens was using MTS to execute the tensile testing, and data was recorded in different force. The experimental apparatus is presented in Fig. 1, consisting of the following components:
(1) Shear waves transducer 2.25Mhz
(2) Panametrics 5058PR pulser/receiver
(3) LeCory waverunner Oscilloscope 44Xi
(4) PC
(5) MTS

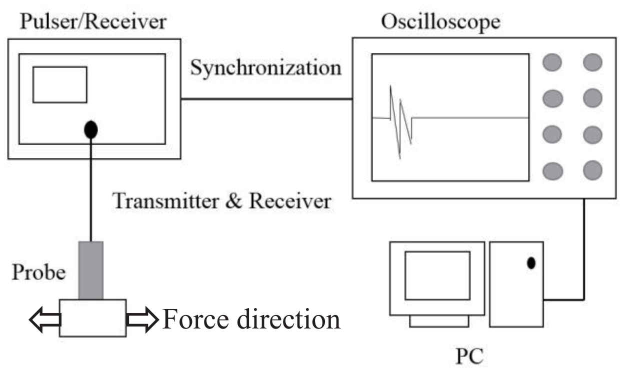

Fig.1 Schematic drawing of the set-up used for the ultrasonic method.

3.2 Specimens

In this experiments, the specimens made of casting iron with different graphite size and microstructure, the cast iron's type are used to FC300 and FC350. It's divided into large, medium

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and small size of graphite for a group. Each group has five different microstructure specimens that is divided into as cast, pearlite matrix, ferrite matrix, annealing and quenching. The sample of pearlite matrix was heated to 900 °C and cooled in air one hour. The sample of ferrite matrix was heated to 900 °C and cooled in oven one hour. The sample of annealing was heated to 500 °C and cooled in oven two hours. Finally, the sample of quenching was heated to 900 °C and cooled in water one hour. The specimens of the central thick is 10 mm, and it diameter are 15 mm.

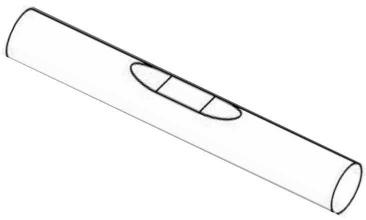

Fig.2 Specimen diagram

4. Result

The experimental results for the longitudinal and transverse wave velocity of all specimens, as shown in Fig. 4-6.

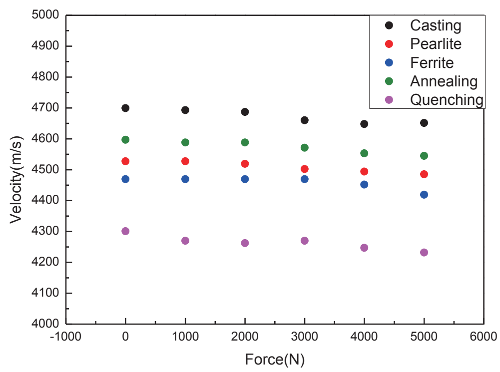

Fig.3 FC300 Large size graphite cast iron in Longtudial wave

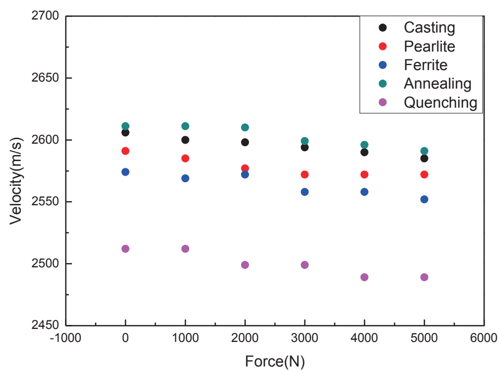

Fig.4 FC300 Large size graphite cast iron that particle motion perpendicular to load direction.

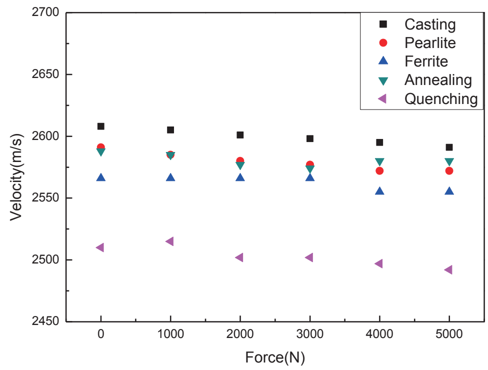

Fig.5 FC300 Large size graphite cast iron that particle motion in load direction.

5. Conclusions

The experimental results for the different microstructures and graphite sizes both have changed on the mechanical properties in cast iron. The longitudinal wave, shear wave in load direction or shear wave perpendicular to load direction. The velocities will be presented a downward trend in the rules. As shown Fig.3-4. It show up not only the different microstructure but also graphite size. All of the specimens presented a downward trend in the rules.

Acknowledgment

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