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Ultrasonic characterization for the influences of microstructure and graphite size in cast irons

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1. Abstract

Cast iron is widely applied in a lot of fields industry. In particular, all of the machine tool's base is made of the cast iron. But residual stress is produced when Cast iron fabricate processing. The mechanical properties and structural components can be considerably influenced by residual stress. It's too much disadvantage of stuff that cause worst situation.

In this paper, a non-destructive method of ultrasonic technique is monitored to detect different microstructure that to evaluate the effect of the matrix change, and then compare it to analysis. And also realize graphite size whether influence on material properties in cast iron or not.

2. Theoretical background

Ultrasonic stress measurement technique is based on the acoustic-elasticity effect, according to which the velocity of elastic wave propagation in solids is dependent on the mechanical stress [1]. The relationships between the changes of the velocities of longitudinal waves in cast iron. For a homogeneous material, the longitudinal wave speed C_L in solids depends on the Young's modulus E, mass density ρ and Poisson ratio ν as [2]:

$$C_L = \sqrt{\frac{1-\nu}{(1+\nu)(1-2\nu)}\frac{E}{\rho}}$$

Use to estimate the difference in velocity of the material changes in property.

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 longitudinal and transverse wave transducer. To measure the velocities of longitudinal and transverse waves, it was used a normal incidence transducer of 1 MHz and coupling, and for the transverse waves was used a transducer of 5 MHz and honey as 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 experimental apparatus is presented in Fig. 1, consisting of the following components:
(1) Probe
(2) Panametrics 5058PR pulser/receiver
(3) LeCory waverunner Oscilloscope 44Xi
(4) PC

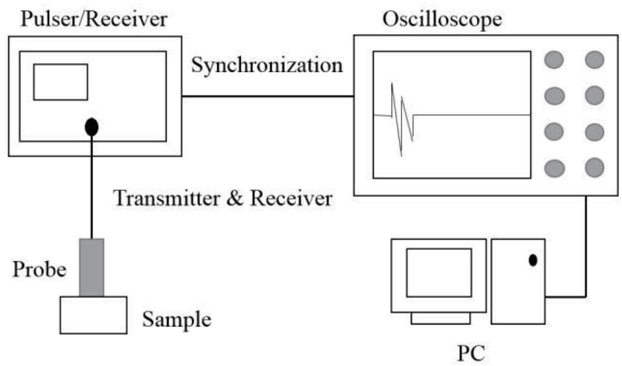

Fig. 1 Schematic drawing of the set-up used for the ultrasonic method.

3.2 Samples

In this experiments, the samples made of cast iron with different graphite size and microstructure, cast iron's type are used to FC250 and FC300.It's divided into large, medium 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

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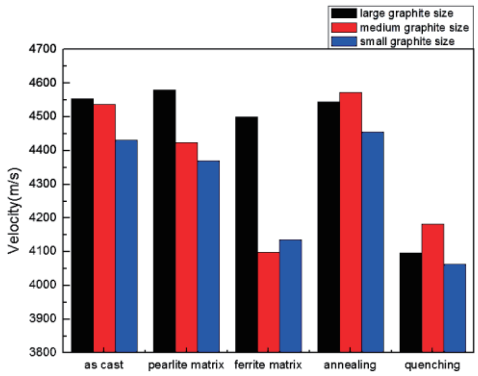
cooled in oven one hour. The sample of annealing was heated to 500 °C and cooled in oven two hours. Finally, the sample of quenching was heated to 900 °C and cooled in water one hour. All samples of thick are 20 mm, and their diameter are 100 mm.

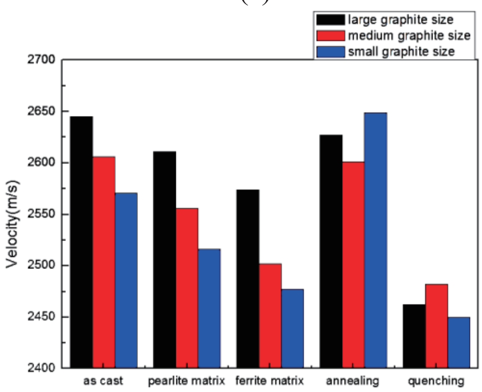
4. Result

The experimental results for the longitudinal and transverse wave velocity of all samples, as shown in Fig. 2. When graphite isn't the same size, it can find as cast, pearlite matrix and ferrite matrix of the longitudinal or transverse wave velocity will be presented a downward trend in the rules. However, the latter two are non-regularity. But this result still be explained that graphite size is influence on cast iron.



Longitudinal wave

(a)

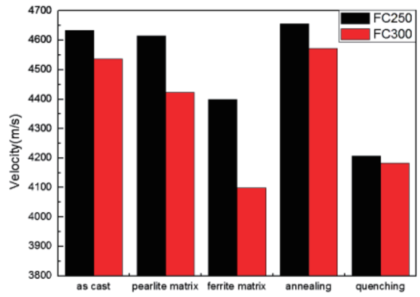


Shear wave

(b)

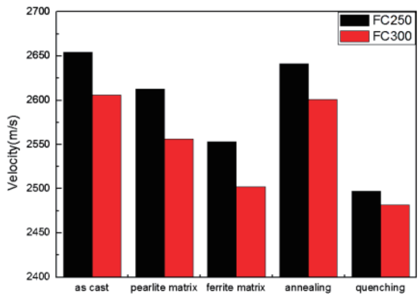
Fig. 2 difference graphite size with kind of matrix in cast iron (a) the result of longitudinal wave velocity, (b) the result of transverse wave velocity

In addition, Fig. 3 Whether FC250 or FC300 will be affected in different matrix. It showed obviously changes in the rules and this result be explained that microstructure is influence on cast iron, too.



Longitudinal wave

(a)



Shear wave

(b)

Fig. 3 F250/FC300 with kind of matrix in cast iron (a) the result of longitudinal wave velocity, (b) the result of transverse wave velocity

5. Conclusions

All of the first, the experimental results for the different microstructures and graphite sizes both have changed on the mechanical properties in cast iron. All of the second, it show up that the different microstructure impact to the mechanical property in cast iron, it's larger than graphite size.

6. Acknowledgment

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References

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