Non-destructive Testing
Using New Impact Acoustic Method

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■ Impact Acoustic Method

Test method to judge the existence of the defects on the subject by tapping and hearing the differences is called acoustic method, and it has been widely adopted in diverse fields for many years.

According to a commonly known theory, people can hear the sound with audio frequency between 20 Hz and 20 kHz. But in our actual life, bandwidth that we can distinguish is said to be between 100 Hz and 15 kHz, much narrower than a theory.

In our everyday lives, we unconsciously perceive a sound as high, low, dull (having wide range of frequency), clean (having narrow range of frequency) by hearing a sound wave.

As practice to use computer increases, it is becoming more common to analyze the sound by frequency such as the fast fourier transform (FFT) analysis, which is similar to that of how people judge sound.

But, because sound wave is synthesized with amplitude (scale of the sound) and frequency (high/low), it is more difficult for a computer to analyze the sound precisely unlike the hearing capability of a mankind.

■ Method of Evaluation by New Impact Acoustic Method

A method to analyze the frequency with conventional impact acoustic technique needs to collect entire sound (wave attenuation shape) generated and it analyzes the frequency elements of each sound wave by chronological order (up to 10 ms).

Figure 1 for example, a sound wave attenuation of an impact sound is shown below.

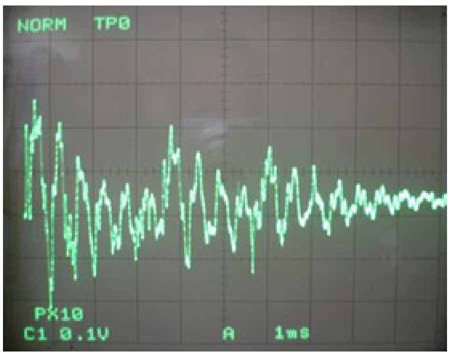

Figure 1: Sound wave attenuation of an impact

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While observing said attenuation in several sound waves precisely upon enlarging the scale, we have noticed that there exist quit differences in frequency shape on the first wave among measurement points as shown below.

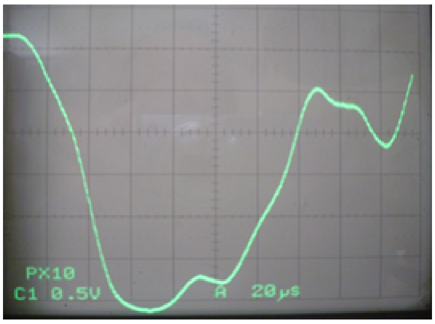

Figure 2: 1/2-wave of the first sound with low frequency (enlarging time scale of 50 times from Figure 1: X axis shows time and Y axis shows strengths of the wave)

From Figure 2, measured frequency is about 110 micro when we specify setting a threshold value at the center of the oscilloscope, which obviously is different from Figure 3 below.

Note: Examined test piece was a clean resin (CFRP).

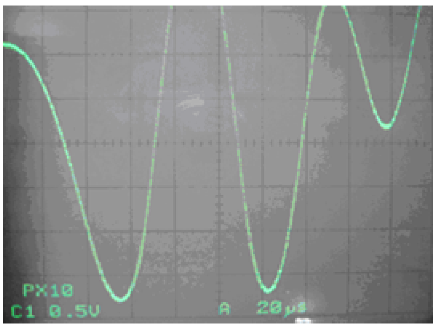

Figure 3: 1/2-wave of the first sound with high frequency

In Figure 3, measured frequency is about 40 micro- setting which is less than half that of Figure 2.

Note: Examined test piece in this case was a resin test piece (CFRP) with cavity.

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Principle theory of appearance of above distinguished characteristic on the first half-wave is explained as below:

Sound wave is generated when testing a subject by tapping hammer. Wave form of the sound is a mixture of various sounds having diverse pitches from high to low. In general, a wave form makes complex shape when you tap any subject as, except in case of a tuning fork which generates steady shape by a simple frequency. However, even the sound wave having various frequency components, each frequency starts simultaneously at the first moment when tapping started (i.e., each frequency component have the same phase).

As time progresses, a sound wave of the high-pitch sound drops sooner than that of a sound wave of the low-pitch sound (topology occurs).

Under the circumstances, characteristics of the sound wave will appear simply on the first 1/2 wave at very first sound wave.

The above is the principle of the new impact acoustic method which enables to judge the condition of the test subject by watching the half cycle of the first wave form.

In the new impact acoustic method, only 1/2 length of the first sound wave is observed and a frequency between 25 kHz and 500 Hz is measured, which realizing ease and quantitative detection of the internal defects of testing subject (Patent #3922459).

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