HIGHLY ACCURATE REAL-TIME ESTIMATION OF VOID THICKNESS INSIDE CONCRETE BY SPECTRAL ANALYSIS PATTERN MATCHING OF GPR SIGNAL

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1. INTRODUCTION

Damage caused by aging public infrastructure is a growing problem in Japan, and it is necessary to detect internal damage in concrete structures before it surfaces.

One of the non-destructive inspection methods for concrete is the electromagnetic radar method, which is based on the amplitude and intensity of the received signal, called B-mode (Figure1.)[1]. Since this method is subjective and requires the skill of the person in charge of the inspection, it is desirable to be able to estimate the damage automatically and with high accuracy. Therefore, the objective of this study is to establish an algorithm to estimate the void thickness in concrete accurately and in real time.

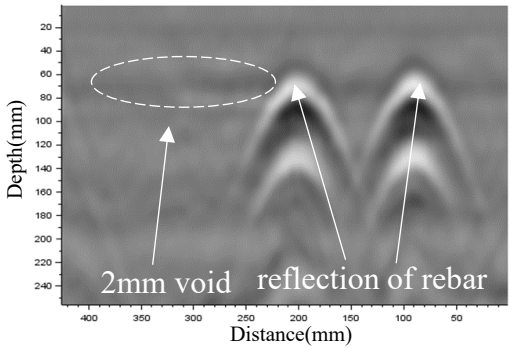

Figure 1. B-mode image by electromagnetic radar

2. ALGORITHM FOR ESTIMATING THICKNESS

As the void thickness decreases, it becomes impossible to distinguish its peak due to the subtractive interference caused by the upper and lower reflected waves. Therefore, we focused on the frequency response because the reflected wave has a frequency dependence depending on the void thickness change[2]. Figure 2. shows the spectrum for different void widths, and since the spectrum also changes as the void thickness changes, we thought that the void thickness could be estimated by performing pattern matching of the frequency spectrum.

Figure 3. shows the results of applying the algorithm to 20mm and 110mm rectangular void. In addition to spectral matching, information on the extreme values of the time waveform and comparison of the spectral centroid of the theoretical value with that of the measured value enable highly accurate estimation of the void thickness at a lower computational cost.

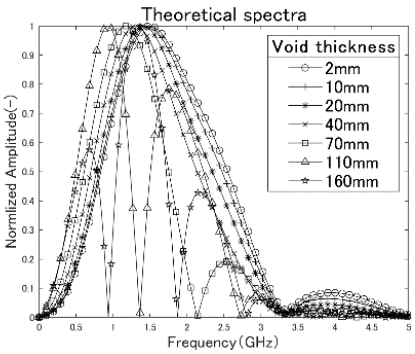

Figure 2. Theoretical spectra for multiple thickness

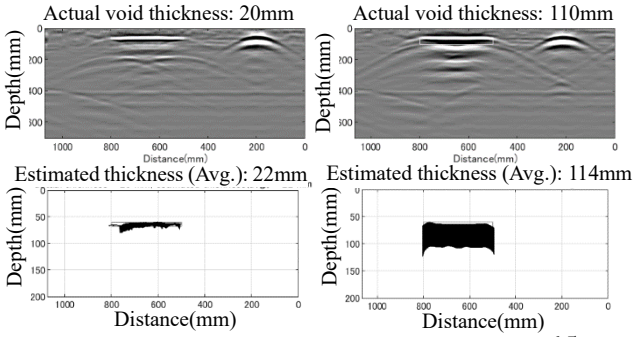

Figure 3. Estimation of rectangular void thickness of 20mm and 110mm by the algorithm

3. CONCLUSIONS

By focusing on both the frequency response and time waveform of the reflected wave, I succeeded in quantitatively estimating the void thickness even with a very weak signal compared to a rebar.

REFERENCES

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