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# Study on the Non-contact Acoustic Imaging Method for Concrete Structures after the Asphalt Pavement

アスファルト舗装後のコンクリート構造物に対する非接触音響探査法に関する研究

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## 1. Introduction

Now the hammering testing is used as a method to inspect the concrete structure inside. But this method has difficulty in inspecting at the place where the person cannot reach. Thus, We examined of Nondestructive inspection method by the non-contact used a LRAD (Long Range Acoustic Device) and a SLDV (Scanning Laser Doppler Vibrometer)[1-5].

By this experiment, the test specimen which simulated the damage, deterioration to occur in RC (Reinforced Concrete) slab using the steel reinforced concrete was used. The RC slab may have the damage and deterioration that separating, embrittlement and horizontal detachment. Liveload and detachment of a floor version and the pavement by the invasion of the rainwater are main causes of the separating and embrittlement. The main cause of the horizontal detachment is reinforcing rod corrosion caused by the penetration of the cryoprotectant.

This time, an experiment was conducted for the purpose of detecting defect in the concrete which was not recognizable in the surface. In addition, as for the RC slab printing block offering open, asphalt pavement is generally considered to be it. Therefore, the detection was carried out this time from the asphalt paving.

## 2. Asphalt Specimen

An asphalt test specimen used in this experiment is the concrete test specimen which is in condition that asphalt pavement of thickness 75mm was given. Show a test specimen example in **Fig. 1**. In the test specimen inside, a thing in imitation of the defect that may occur in RC slab is buried horizontally. Show the summary of the defect in **Table I**. The size of a buried filter paper is 400×400×1 mm$^3$. The fine aggregate and the coarse aggregate were buried in the center of the test specimen by the range of 400×400 mm$^2$.

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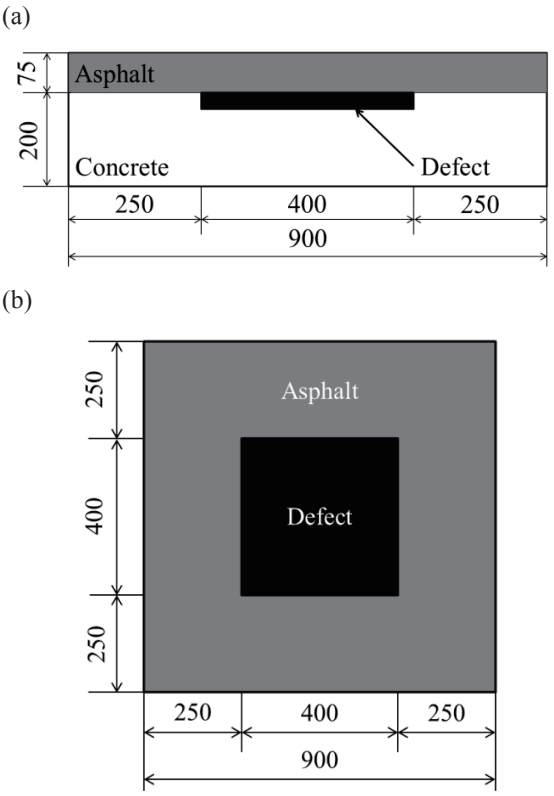


**Fig. 1.** An example of the asphalt test specimen. (a) A side view, (b) A top view.

**Table I**. Defect summary.

| Defect type | Depth (mm) | Material |
|---|---|---|
| Separating | 75 | Filter paper |
| Horizontal detachment | 105 | Filter paper<br>Vinyl |
| | 155 | Filter paper<br>Vinyl |
| Embrittlement | 75-105 | Fine aggregate<br>Coarse aggregate |

## 3. Experiment

### 3.1. Flow

First, a test specimen was made to vibrate by a hammer, and vibration velocity measurement was carried out by SLDV. Next, the resonance frequency of the defect part was

identified by the vibration waveform. Then, a burst wave of the resonance frequency was emitted by LRAD, and non-contact acoustic imaging method was carried out. Finally, two-dimensional brightness imaging was performed using the measured vibration velocity spectrum.

### 3.2. Methodology

Flexural resonance occurs on the concrete surface which there is a defect by emitting the sound wave of the resonance frequency of the defect part from LRAD. The vibration speed of the concrete surface at that time was measured in SLDV. Because the vibration speed is different from a defect part in the healthy part, the position of the defect part can be pinpointed.

### 3.3. Setup

LRAD which was a sound source was established 1m apart on a test specimen. SLDV was set up 1.2m apart by a test specimen. In this state, the non-contact sound exploration law was carried out. **Figure 2** is an experiment setup figure of the non-contact acoustic imaging method. The measurement range was set in the range of central 500×500 $mm^2$ of the test specimen. The number of measurement point was 121 (11×11) points.

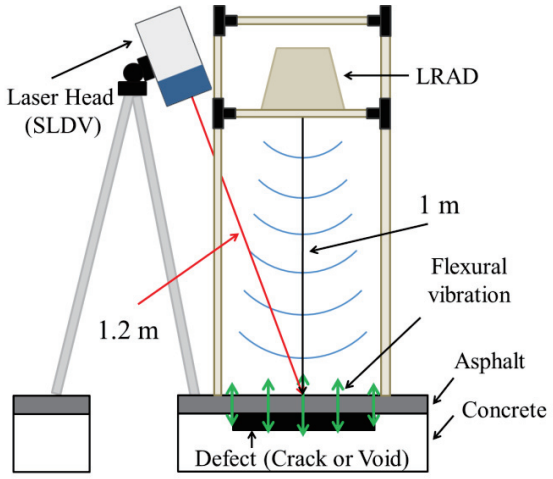


**Fig. 2.** Experimental setup.

## 4. Result

**Figure 3** is the result that made the vibration speed distribution of four kinds of asphalt test specimens a brightness picture. The range of the defect part is shown an inside black frame, and the range that the outside black frame measured is shown. The red shows that vibration speed is high. It was confirmed that vibration speed increased in all results at the defect part center. From these results, we can confirm that the flexural vibration of the defect part can be measured by SLDV.

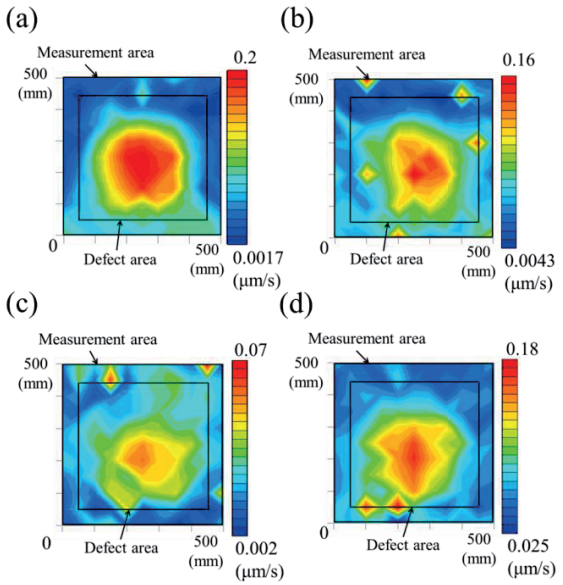


**Fig. 3**. Vibration velocity distribution
(a) Separating (depth: 75 mm) 1536 Hz, (b) Horizontal detachment (depth: 105 mm) 1466 Hz, (c) Horizontal detachment (depth: 155 mm) 2296 Hz, (d) Embrittlement (depth: 75-105 mm) 1080 Hz.

## 5. Conclusions

This time, applicable examination of the non-contact acoustic imaging method for the existing concrete defect was performed under an asphalt side. From the experimental result, it was confirmed that the defect inside concrete can be detected even from on asphalt pavement. We are going to study about the practical use of the non-contact acoustic imaging method.

**Acknowledgment**
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