※Josei Measurement Technology; Case Study ①-3

Measurement Technology Using Elastic Waves

Concrete diagnostic technology incorporating various elastic wave theories

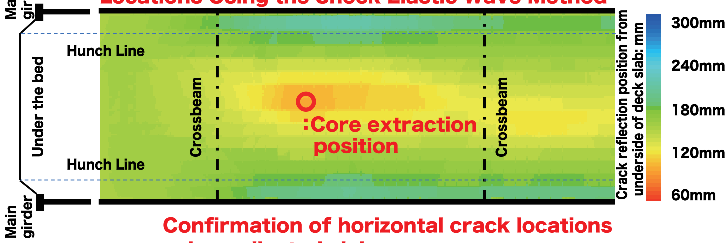
Non-destructive testing using elastic waves primarily includes ultrasonic methods, impact elastic wave methods, and AE methods. These techniques are classified based on differences in how elastic waves are transmitted and received, as well as the frequency range in which they propagate. At Kamiharu, we perform various non-destructive tests using elastic waves to meet the specific objectives of each investigation.

Identification of Fatigue Crack Locations within Slabs Using Impact Elastic Wave Method

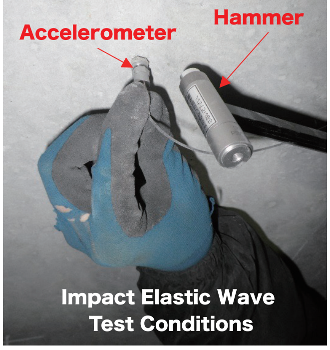
The target slab is one designed under the 1964 Ministry of Public Works guidelines, featuring extremely sparse distribution reinforcement. Having already been in service for 50 years, bidirectional cracking was confirmed on the underside of the slab. Concerns about the presence of horizontal cracks within the concrete led to the question of whether slab replacement was necessary.

Therefore, by applying the impact elastic wave method to the underside of the slab in a grid pattern, we captured reflected waves from horizontal cracks originating beneath the slab. Through data processing for mapping and visualization, we clearly identified the locations of horizontal cracks within the concrete in a manner easily understandable to anyone.

Mapping and Visualization of Horizontal Crack Locations Using the Shock Elastic Wave Method

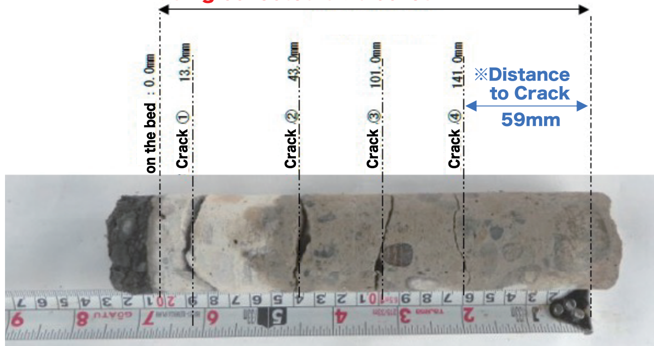


Underside of the deck slab



Impact Elastic Wave Test Conditions

Confirmation of horizontal crack locations using collected slab cores



In this investigation, to verify the validity of the impact elastic wave method, cores were extracted from the darkest areas identified after mapping and visualization. These cores were then compared with the actual crack locations to validate the method. The photo above shows the extracted cores. The distance from the bottom of the deck slab to the horizontal crack location was 59 mm, which was found to correspond with high precision to the 60 mm horizontal crack depth visualized by the impact elastic wave method.

Broadband Ultrasonic Detection of ASR Expansion Behavior in Coarse Aggregate

At Josei, we possess ultrasonic measuring instruments that utilize frequency propagation at 25, 50, and 100 kHz, as well as instruments capable of propagating broadband ultrasonic waves from 0 to 500 kHz simultaneously. Coarse aggregate, a constituent material of concrete, has aggregate diameters of approximately 20 to 50 mm. Generally, the ultrasonic propagation velocity in coarse aggregate is around 5000 m/sec, It can be determined tha the frequency range most easily propagated through coarse aggregate is 100 to 250 kHz.

It can be inferred. The left photograph shows the investigation of propagation energy fluctuations by transmitting broadband ultrasonic waves into a PC girder where coarse aggregate expansion was suspected based on ASR analysis. The left diagram shows the results: a significant decrease in propagation energy within the 100–250 kHz frequency band is clearly observed over time from 1994 to 2018.

Broadband Ultrasonic Spectrum Analysis Results of PC Girders Using the Transmission Method