

Automatic Detection of Deteriorated Concrete Bridge Deck using 2 GHz Horn Antennae

*Kunio Aoike¹, Shogo Tanaka², Naoto Takase¹, Akio Matsuyama¹, Masaya Yamauchi¹, Yoshinori Uno¹

1. OYO Corporation, 2. Professor Emeritus of Yamaguchi Univ.

In 10 years, about 40% road bridges in Japan will become over 50 years old after the construction. Although many inspections have been conducted to the aged road bridges, the upper part of the bridge deck is impossible to inspect visually because of the asphalt concrete layer covering the bridge decks. It is becoming an important problem that slab deterioration is often generated in the upper part of the aged concrete bridge deck. Thus, it is becoming urgently necessary for the deterioration of the aged concrete bridge deck to be detected and repaired to elongate the life of the bridge. Ground penetrating radar (GPR) mounted on a vehicle is one of the effective non-destructive methods, which enables us to inspect the deterioration under no traffic control. A high pulse resolution is required to the GPR to detect anomalies beneath the asphalt concrete layer of the thickness of about 8cm. Adding to it, both a high scan rate in data acquisition and a safe mounting way of the GPR on vehicle are required to achieve the accurate and high-resolution inspection with a high speed traveling of the inspection cars. We adopted the horn antenna, produced by GSSI, whose central frequency is 2 GHz. The antenna can detect reflection waves from the boundary between the asphalt layer and the concrete bridge deck, and also can distinguish them from the surface reflection wave of the asphalt surface. SIR-30 type radar system having 8 channels enables us to realize 989 scans per second with 512 samples, thus it can realize the inspection under the vehicle speed up to 80km/h. We also mount the GPR antennae to the height of 45cm (i.e., lift off) from the road surface. This mounting is important for safe traveling of the inspection vehicle. 8 antennae are mounted on a boat trailer towed by vehicle and aligned in the transverse line to the moving direction. It allows us to scan about 1.7m width at one time. For the inspection of the deterioration of the concrete bridge deck, we developed an automatic processing system. This method predicts a received signal by using two empirical reflection waveforms. We acquired in advance surface reflection waveform and asphalt bottom reflection waveform from an experiment using a real size physical model. We determined the arrival time and the amplitude for each empirical waveform by matching the linear combination of the two empirical waveforms and the actual received signal. To visualize the anomaly distribution of the concrete bridge deck and to inspect the deterioration, we made three types of 2 dimensional maps on thickness of asphalt layer, relative reflectivity at the asphalt bottom, and the fitness between the received and the predicted waveforms. As the results, we could successfully detect the anomalies and delineate their extents. Fig. 1 shows an example of the processing results on a concrete bridge deck model which simulated slab deterioration. We have a plan to continue to modify and update the proposed method by applying the method to real road bridges as a future work.

Keywords: Ground Penetrating Radar, horn antenna, bridge deck

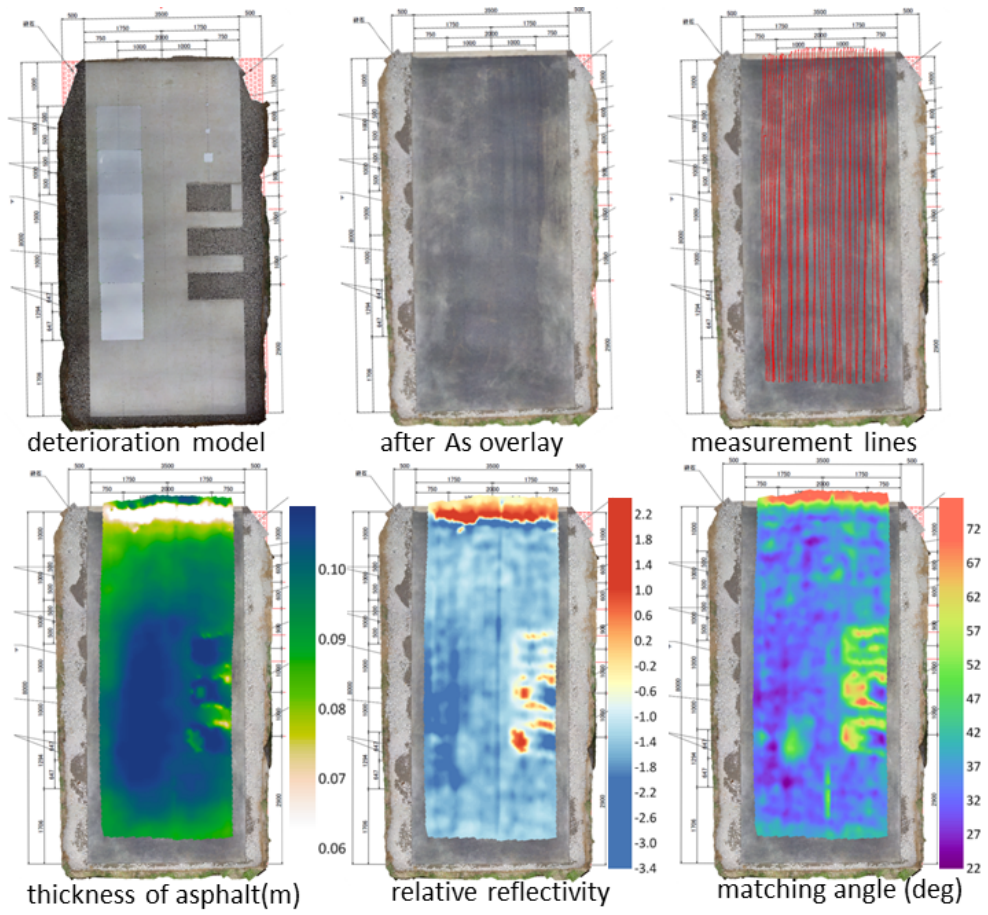


Fig. 1 Simulated deterioration model of concrete bridge deck and the results of automatic processing