B-DASH: Feasibility Study on Practical Application of Screening Technologies: Vehicle-type Ground Penetrating Radar System and AI-based Cavity Detection System

(Research of FY 2020-21)

1. PURPOSE

This study focuses on "dynamic cavities." It aims to develop a screening technology that detects abnormal locations of sewers causing road surface changes and sinking using vehicle-type penetrating radar system data and AI-based image analysis.

This feasibility study was selected for the B-DASH project 2018 and 2019 of the Ministry of Land, Infrastructure, Transportation, and Tourism (MLIT). The research consortium of Kawasaki Geological Engineering Co., Ltd. and JS conducted the study as an entrusted research of the National Institute for Land and Infrastructure Management (NILIM).

2. Study Procedure

① **Vehicle-type penetrating radar system + AI-based image analysis**

As Figure 1 shows, an AI-based system analyzes data from the Ground-Penetrating Radar System to extract abnormal signs that might be cavities. The exploration shall be repeated yearly to identify variability/transition in abnormal signs, including moving to ground surfaces or new cavity occurrences, and study exploration frequency.

② **Cavity Verification**

To verify the existence of cavities, approximately 30 mm-diameter holes shall be made at the road surface where abnormal signs are detected.

③ In-pipe survey

An in-pipe TV camera investigation shall verify in-pipe problems, regardless of whether abnormal signs are detected.

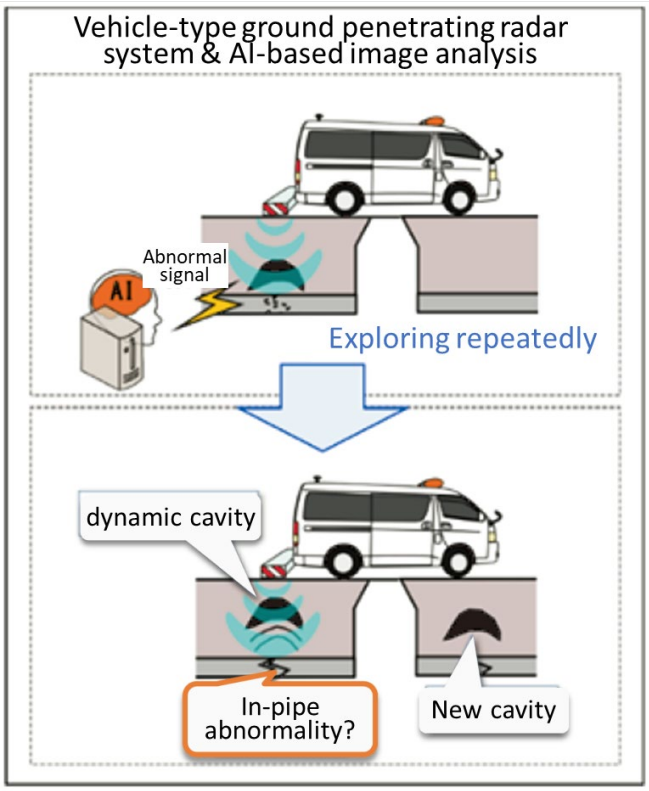

Figure 1. Image of cavity detection by vehicle-type ground penetrating radar system

3. Outcomes of This Year

1) Cavity verification was conducted at 53 locations where abnormal signs were detected, and 44 cavities were confirmed. The abnormal signals moved to shallower depths at an average rate of 0.03 meters per year.

   In contrast, nine locations with abnormal signals that did not confirm cavities showed movement of 0.03 meters per year or less. Thus, it was established that abnormal signals moving more than 0.03 meters per year may indicate the presence of cavities.

2) Dynamic abnormal signals increase during seasons with heavy precipitation. They shift by 0.01 meters each month from the rainy season into summer and then from autumn to winter. However, these signals hardly

move from winter to spring. Thus, the study frequency should be about three times a year: before the rainy season, in summer, and in autumn.

3) An in-pipe survey verified about 90% of abnormalities in sewer facilities near the locations showing dynamic abnormal signals. A high rate of 70% of them was medium to serious sewer and house connection deterioration. Past research indicates that road sinking due to sewer deterioration primarily occurs at house connections. Therefore, analyzing cavity fluctuations to prioritize detailed investigations and confirm severe internal abnormalities may help reduce the risk of road sinking.

4. Summary of the 2-year Study

This technology can effectively screen sewer facilities' abnormalities that may lead to road sinking while monitoring road surface conditions through a vehicle-type penetrating radar system. In addition, its capability of screening data management on GIS enables a practical focus on locations requiring detailed investigations and repairs.
Verifying its utilization and benefits will improve this sewer pipe management technology.

Keywords: **Ground Penetrating Radar, Cavity detection, In-pipe abnormality, Screening, AI**