DEVELOPMENT OF LASER SCANNING SYSTEM FOR AGING INSPECTION OF BOX CULVERT

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ABSTRACT: The construction of box culvert for electric power transmission is increasing more and more, and the life extension of it is very important. The development of structural maintenance system in view of structural integrity evaluation is needed and widely discussed. Therefore, Laser Scanning System is developed for the inspection of aging phenomena such as crack, exfoliation, and water leakage of Box Culvert. This system made progress in maintenance technology for box culvert and have various kinds of advantages comparing with conventional method by visual inspection.

Keywords: *Laser Scanning System, Aging Inspection, Concrete, Box Culvert, Structural Integrity*

1. INTRODUCTION

Box culvert for electrical power transmission began to be constructed in the mid-1970s in Korea and is increasing in number recently due to growth of electric power demand and underground construction for transmission line of it. The related maintenance work of box culvert amount also continues to increase because of the increasing usage life of box culvert. The existing structural integrity evaluation method for box culvert, affected by the subjective judgment of the inspector, is not quantitative and has the disadvantage of consuming excessive time and effort. Therefore, for an objective and efficient structural integrity evaluation of box culvert, there is a need to develop a more systematic and accurate maintenance system that quantitatively reflects the structural performance. As such, this study seeks to contribute to establishing a scientific maintenance system by developing a maintenance DB system using a 3D optical scanner and a high-definition camera and integrating these with structural integrity evaluation system.

2. STRUCTURAL INTEGRITY EVALUATION SYSTEM

The system developed in this study is composed of three parts: a diagnostic system using a 3D optical scanner; a maintenance DB system managing the aging and repair history data of box culvert; and a structural integrity evaluation system that executes integrity evaluation utilizing data collected from the diagnostic and maintenance DB system (Fig. 1).

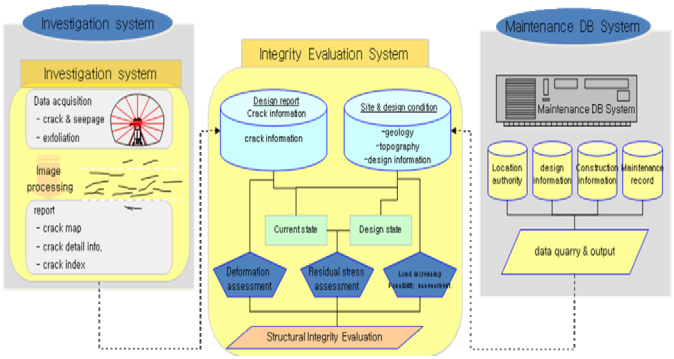

Fig. 1 Outline of Structural Integrity Evaluation System

3. AGING INSPECTION SYSTEM OF BOX CULVERT

When the development of aging inspection system is considered in terms of main units, it can be divided into the

following: obtaining 3D image data, lining up and matching the obtained 3D images, measurement based on actual 3D coordinates, and input/output system related to data management and storage. The development of the 3D image data obtaining system can be divided into scanning system development using a laser slit beam and optical 3D scanning system development. The optical scanner of this system is a 3D scanner based on the space encoding method that uses a pattern beam. Its scan range is 400×300mm, degree of precision less than 0.1mm, and scan cycle time less than 1 second (Fig. 2).

Fig. 2 Aging Inspection System of Box Culvert

Since distortion of 3D image information occurs when a large number of data are matched in the actual coordinates-based measurement and numerical calculation for the box culvert crack information, it is difficult to measure the data for aging such as cracks. To resolve this, the system was developed to enable the restoration of legible digital crack images by expanding the 3D scanning data into the frequency zone and separating the high frequency zone. It was also designed to be capable of measuring crack length and width by using crack data extraction software and verifying the upper and side parts of the 2D information data obtained through planar figure module development.

4. APPLICATION ANALYSIS FOR BOX CULVERT

The results from using the optical scanner showed that fine data verification for the exfoliation area is possible, but the verification of the measurement results for the water leakage area was difficult. Therefore, the function that makes possible identification by visual inspection based on the change in the laser brightness value and on the scanner's projector image response value was supplemented. In addition, since there is no change in the 3D shape information for simple water leakage without surface and height gaps, it was difficult to verify water leakage when the shape measurement was done by using the 3D scanner. Hence the method of using 2D black and white image was applied in the inspection system for water leakage verification.

5. CONCLUSIONS

1) In this study a more precise aging inspection system was developed by combining a slim-beam rotational laser scanner, capable of attaining information on fine cracks of 0.1 mm on box culvert surface, with a pattern-beam based optical scanner. Through applicability testing on box culverts on site, the problems of the system were deduced and its performance supplemented.

2) By substituting the part of the existing inspection that depended on visual observation with this inspection system, objectivity of data has been secured; and through creating a database of the inspected data, the convenience and objectivity of data maintenance have been improved. It is deemed that this system will significantly contribute to improving the efficiency and economic feasibility of the box culvert safety inspection process in the future.

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