

Attempt to detect seepage in levees from thermal images

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1. Introduction

River levees are long structures which have, throughout the long history of flood control, been constructed accompanied by repeated reinforcement and repair according to the state of past disasters. So in order to ensure the safety of river levees far into the future, it is important to perform inspections closely coordinated with reinforcement to efficiently and reliably detect locations which impact safety and to monitor their condition¹⁾. An inspection of a river levee is done basically by walking on it to visually examine its condition, and such inspections are performed over the full length of every levee once a year. It is necessary for inspections to be done by limited personnel and restricted budgets, so more efficient methods are needed. And because the results of visual inspections vary in some cases because of differences in the skills of inspectors, it is important to develop methods of using measuring instruments to accurately quantitatively clarify and analyze the state of deformation. So as such a survey method, a method of combining multiple physical exploration methods such as electricity and magnetism to clarify soil quality inside the levee, and a method of measuring the shape of a levee in detail using an automobile equipped with laser measuring instruments and GPS are being studied.

The River Division is conducting research intended to integrate, rationalize, and increase the efficiency of inspections and reinforcement by evaluating the extent that safety is ensured by levee inspections in the same way as reinforcement work. As part of this effort, the Division is studying a method of detecting seepage on the surface of levees using thermal images.

2. Challenges to the application of the infrared inspection method to river levees

The inspection method using infrared radiation is now used to inspect and diagnose concrete structures by measuring the diel variation of the surface temperature caused by sunlight, air temperature change, etc. as thermal images, to detect defects based on temperature differentials caused by differences in thermal capacity etc.

Table Challenges to the Application of the infrared inspection method to river levees

Challenge 1	Does a temperature difference great enough to be distinguished by a thermal image appear at seepage on the slope of the levee?
Challenge 2	The levee slope is covered with vegetation, but is it possible to detect a temperature difference on its surface?
Challenge 3	The soil quality on the levee slope surface is heterogeneous, but to what degree does the soil quality impact temperature differences?
Challenge 4	On a long levee, it is difficult to obtain thermal images under identical weather conditions, but is it possible to detect defects regardless of conditions?
Challenge 5	Is it possible to perform an efficient inspection based on long-distance photography in relation to the above?

The above table shows challenges to its application to river levees.

3. Results and future challenges

Temperature and soil water content sensors were buried in the slope surface of an actual levee and used to measure diel variation at the same time as thermal images were obtained using an infrared thermo-sensor. The results confirmed that if the surface is bare ground unaffected by vegetation, parts with seepage and parts without seepage create temperature differences (Challenge 1). In the future, the results will be further analyzed to clarify weather conditions which are represented by large differences in the temperature. Deepening studies will be conducted concerning other challenges to be resolved to introduce the method: the impact of the degree of vegetation coverage and plant height (Challenge 2), differences in soil material values of the levee (Challenge 3), study of times of day when detection is possible (Challenge 4), and impact of photography distance limit and angles (Challenge 5). The Division wishes to continue studies so that the results of the research will contribute to more efficient and higher quality inspection technologies to be used to inspect river levees.

[Reference]

1) Manual for River Works in Japan, Management (River), MLIT, 2011