Mitsubishi Electric Corporation
Tokyo Institute of Technology
Kagoshima University

New Technology Using Predictive Models to Create Highly Tailored Plans for Infrastructure Maintenance Management

Long-term maintenance and management plans can be fine-tuned to administrative objectives

TOKYO, December 2, 2019 – Mitsubishi Electric Corporation (TOKYO: 6503), Tokyo Institute of Technology and Kagoshima University announced today a basic technology that roadway and railway administrators will use to prepare highly tailored long-term maintenance and management plans for infrastructure. The technology is now being refined in cooperation with the city of Satsumasendai, Kagoshima Prefecture, where a verification test began this month targeting bridges managed by the city. Going forward, tests involving a variety of bridges in Satsumasendai will be conducted to improve the accuracy of the technology. Application in other regions of Japan and for other types of infrastructure also is planned.

The technology was announced today at a conference being held by the Japan Society of Civil Engineers in Japan to present research and hold discussions regarding the challenges of construction management.

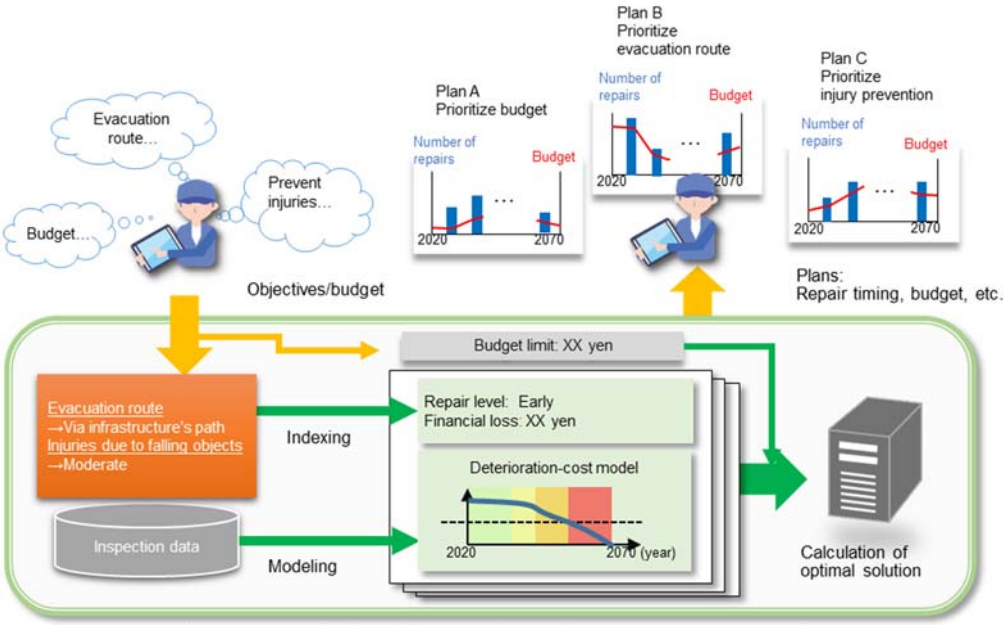

Fig. 1 New technology for preparing maintenance management plans

Key Features

1) Deterioration-rate model focuses on type of damage to predict infrastructure repair needs

Based on data and inspections of 538 bridges in Satsumasendai, a unique model is being refined to predict the rate of deterioration in concrete bridges, focusing on types of damage that have the greatest impact, such as cracks, concrete delamination and rebar exposure. The model identifies infrastructure degradation at an early stage and predicts when infrastructure will need to be repaired (Fig. 2).

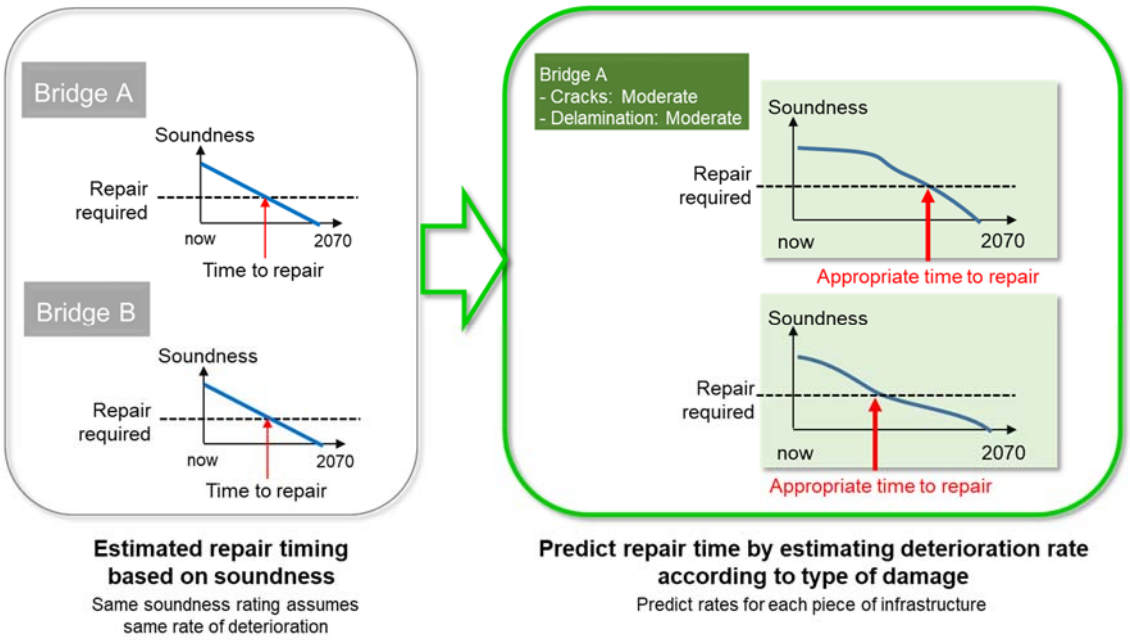

Fig. 2 Prediction repair timing using deterioration-rate model

2) Deterioration-cost model estimates costs of incremental repairs based on rate of deterioration

Repair methods and costs differ according to the type and degree of damage, such as depth of cracks and extent of concrete flaking. The deterioration-cost model estimates costs according to the type and degree of damage. By combining the repair-cost and deterioration-rate models, it will be possible to estimate repair costs according to the estimated rate of deterioration (Fig. 3). The technology, rather than determining standard repair costs, determines costs at the actual time of repair based on the estimated rate of deterioration, allowing for the visualization of costs and repair work aimed at preventing serious damage, including bridge collapses.

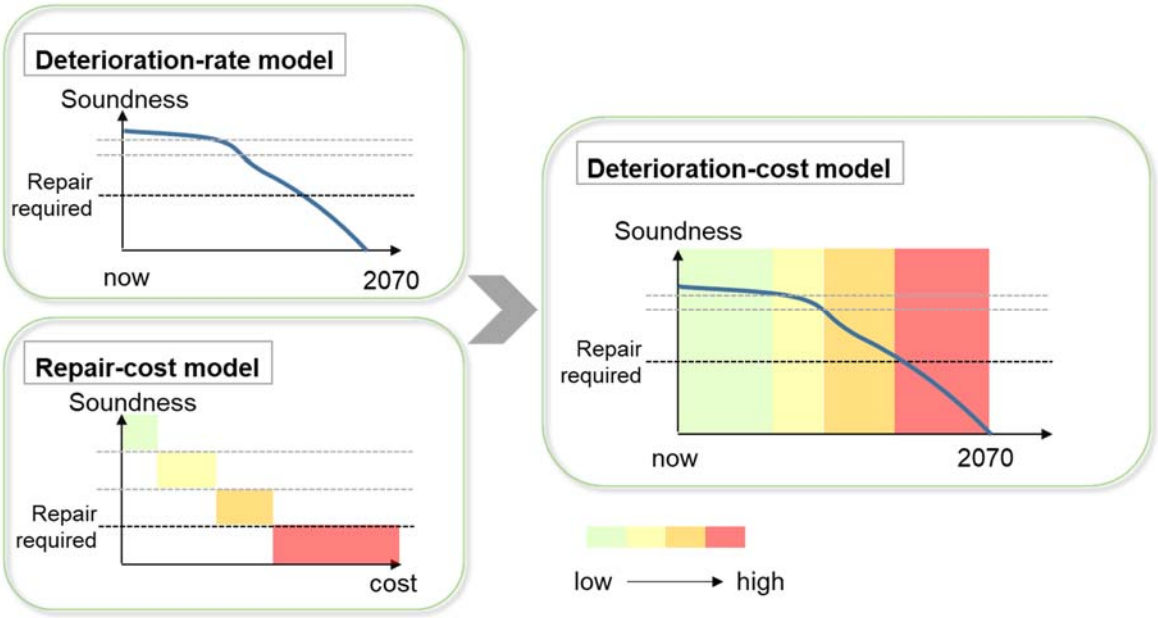

Fig. 3 Repair-cost model that visualizes repair costs according to rate of deterioration

3) Weighted objectives enable administrators to reflect priorities in maintenance plans

Administrators have a variety of infrastructure maintenance objectives, such as securing evacuation routes in disasters or preventing injuries from falling concrete. By expressing these objectives as indicators, such as repair level or financial loss, and then formulating the indicators together with the repair-cost model, it becomes possible to solve problems for optimized solutions. In turn, this will make it easier to create highly diverse plans, and budgets, for comparison purposes. Moreover, it will be possible to make extensive calculations encompassing enormous infrastructure, including rates of deterioration, repair timing and repair costs. The calculations could be used to prepare multiple maintenance plans based on various maintenance objectives, thus enabling an overall plan to be evaluated on a multifaceted basis. In addition, the weights of various indicators could be easily adjusted, such as increasing the level of repair, to create maintenance plans tailored to specific priorities.

Roles in Development Project

Name	Contributions
Mitsubishi Electric	Overall design, systematization, optimization algorithm development and verification summarization
Tokyo Institute of Technology	Overall design, modeling of repair-cost model, and combination of repair-cost and deterioration-rate models in resulting deterioration-cost model
Kagoshima University	Overall design, analysis of infrastructure inspection data and modeling of degradation progress

Background

Extensive infrastructure built during Japan's period of rapid economic growth is now deteriorated and in need of repair en masse. In 2014, the Ministry of Land, Infrastructure, Transport and Tourism mandated that local governments and road companies begin conducting regular visual inspections of bridges and tunnels every five years. The ministry is promoting a shift from post-repair maintenance to preventive maintenance involving frequent repairs aimed at preventing serious problems. Long-term preventive maintenance must be carefully planned, but such planning is very difficult to carry out manually for large-scale infrastructure.

Road bridges in Japan are currently categorized into four levels of soundness based on inspections, making it challenging to determine which infrastructure in the same category of soundness to repair first. Moreover, it is difficult to accurately reflect all priorities in maintenance plans because maintenance and management purposes can vary.

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About Mitsubishi Electric Corporation

With nearly 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Embracing the spirit of its corporate statement, Changes for the Better, and its environmental statement, Eco Changes, Mitsubishi Electric endeavors to be a global, leading green company, enriching society with technology. The company recorded a revenue of 4,519.9 billion yen (US$ 40.7 billion*) in the fiscal year ended March 31, 2019. For more information visit:
www.MitsubishiElectric.com

*At an exchange rate of 111 yen to the US dollar, the rate given by the Tokyo Foreign Exchange Market on March 31, 2019

About Tokyo Institute of Technology

Tokyo Institute of Technology (Tokyo Tech) stands at the forefront of research and higher education as the leading university for science and technology in Japan. Tokyo Tech researchers excel in a variety of fields, such as material science, biology, computer science and physics. Founded in 1881, Tokyo Tech has grown to host 10,000 undergraduate and graduate students who become principled leaders of their fields and some of the most sought-after scientists and engineers at top companies. Embodying the Japanese philosophy of "monotsukuri," meaning technical ingenuity and innovation, the Tokyo Tech community strives to make significant contributions to society through high-impact research.
Website: https://www.titech.ac.jp/english/

About Kagoshima University

Kagoshima University's (KU) origins can be traced back to the Hangaku Zoshikan School, which was established in 1773. After the merger of several higher education institutions, including the Seventh Higher School established during the Meiji period (1868-1912), KU inherited this educational tradition and was newly established in 1949 as a national university.

KU is comprised of nine faculties and nine graduate schools, with approximately 9000 undergraduates and 1600 graduate students.

KU strives to engage in diverse and cutting-edge research. KU encourages academic research pursuits in infection control, biological diversity, the Milky Way Galaxy, and intractable cancer in order to achieve its goals for innovation and solutions for community challenges. Additionally, KU has pursued many interdisciplinary research opportunities, so that it may provide solutions to local issues regarding the islands, environment, food & health, water, and energy. As "the center of intelligence" in the community, KU also promotes the development of quality lifelong learning, cultivation of human resources, joint research projects with the local community, and industry-university-government collaboration.

KU is located in vibrant Kagoshima, considered as a significant gateway into the rest of Japan. KU is surrounded by a diverse selection of natural environments, including volcanic mountains, blue seas, and beautiful islands (such as Yakushima, which has been identified as a world heritage site). The main campus is situated in the center of the city, and provides on-campus facilities such as libraries, museums, botanical gardens, and research farms for public use.
Website: https://www.kagoshima-u.ac.jp/en/