

RTRI Develops Inspection Support System Using Images of Tunnel Walls

The Railway Technical Research Institute (RTRI) has developed an inspection support system using images of tunnel walls (hereinafter referred to as “this system”) to conduct tunnel inspections efficiently. This system uses AI to extract deteriorations from images of tunnel walls and identify the overall soundness of tunnels, and projects areas that require special attention and intensive investigations on the actual wall surface, thereby supporting the investigation process.

Background of the Development

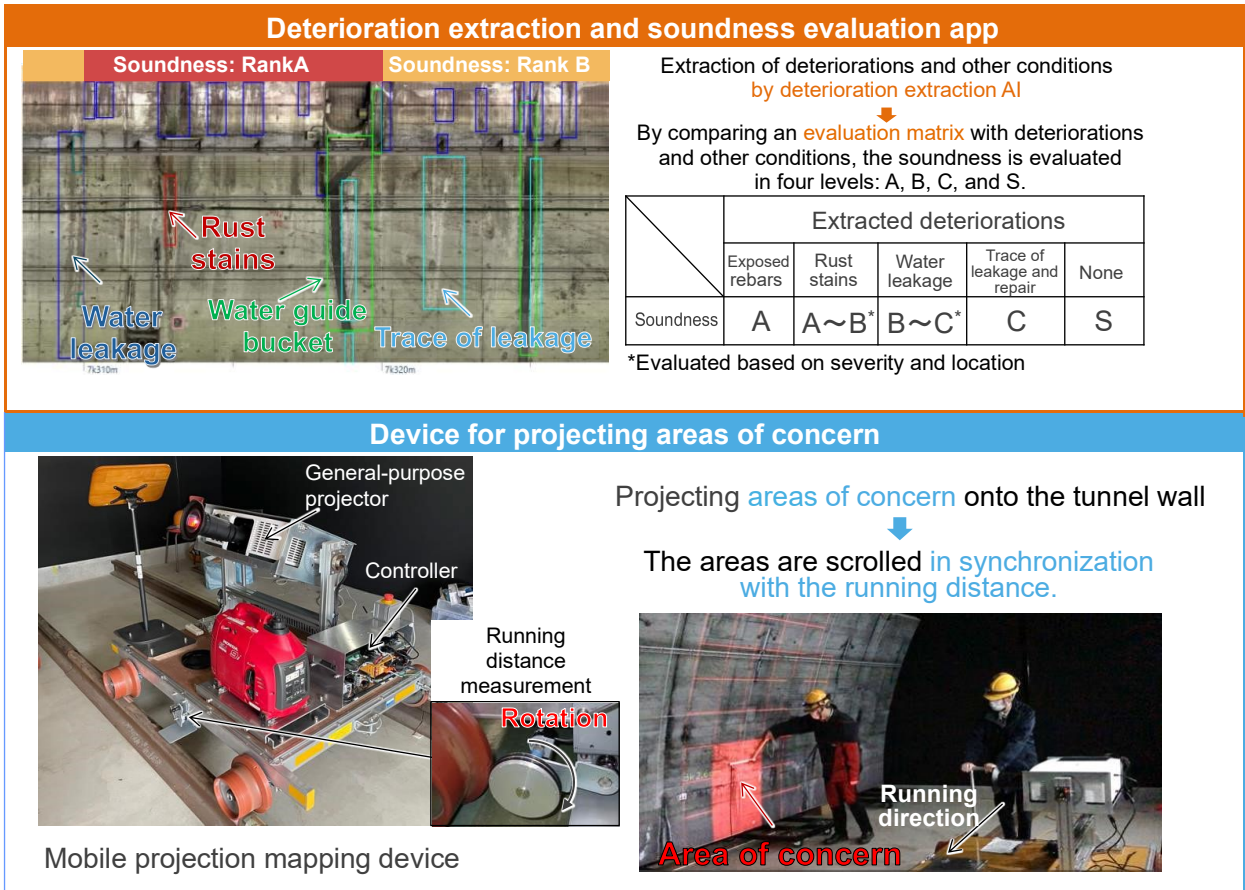
Railway tunnels in Japan include many that were constructed before World War II or during the period of post-war rapid economic growth. These tunnels are regularly inspected and properly maintained by experienced engineers. However, since the total length of Japan's railway tunnels is approximately 4,000 km, inspections and other tasks require a significant amount of time and labor. Additionally, securing the required number of engineers has become a challenge due to factors such as a declining working-age population.

Overview of the System

Tunnel inspections have traditionally involved engineers visually checking for deteriorated areas including locations of water leaks, identifying and recording them, and conducting hammering tests on areas of concern. This process helps determine the need for subsequent maintenance. The results of these investigations were used to evaluate the overall soundness of tunnels based on the Maintenance Standards for Railway Structures.

Recently, the process has shifted from on-site visual inspections to image-based inspections, where engineers took captured images of the tunnel walls to their offices to identify and record deteriorated areas. However, this process required a considerable amount of time and labor. Furthermore, when conducting on-site hammering tests on areas of concern, it was necessary to work while verifying recorded content and identifying investigation locations, which presented challenges in terms of efficiency.

To speed up the investigation process and reduce the required number of engineers with the support of digital technologies, RTRI has developed this system which consists of a deterioration extraction and soundness evaluation app and a device for projecting areas of concern (Fig. 1). The deterioration extraction and soundness evaluation app (upper part of Fig. 1) uses AI to automatically extract and record deteriorated areas from tunnel wall images and evaluates the soundness of the tunnel. The device for projecting areas of concern (lower part of Fig. 1) accurately identifies on-site the areas of concern that require investigations from the deteriorated areas extracted by the app.



by having the mesh scroll in sync with running distance and filling areas of concern with red, it becomes easier to identify the locations of deterioration (Fig. 3).

- The identification of areas of concern becomes more efficient, reducing the time required for hammering tests to less than half (Fig. 4).

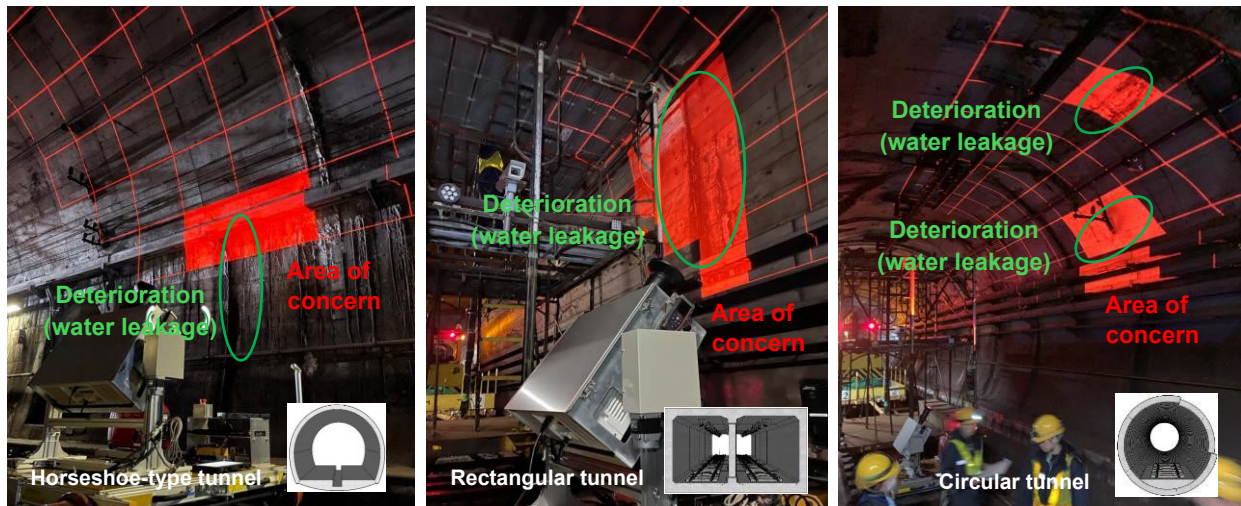


Fig. 3 Projections implemented to match various cross-sectional shapes of actual tunnels

Usage Status of the System

Multiple railway operators are trialing this system.

Moreover, the deterioration extraction and soundness evaluation app of this system has been available since January 2025.

The technologies used for this system have been patented (Japanese Patent No. 7600063).

The research and development of this system were conducted under the Ministry of Land, Infrastructure, Transport, and Tourism's Transportation Technology Development Promotion System (JPJ002223).

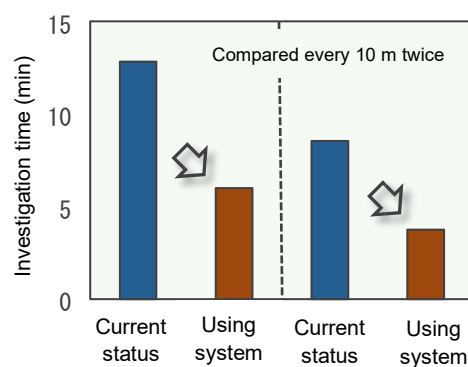


Fig. 4 Example of comparative results for time spent on investigation