The 2025 World Congress on
Advances in Structural Engineering and Mechanics (ASEM25)
BEXCO, Busan, Korea, August 11-14, 2025

Correlation between temperature distribution and defect progress in urban railway tunnel

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ABSTRACT

Although temperature fluctuations inside tunnels are generally smaller than those observed in above-ground structures, they can still lead to freeze–thaw cycles in cold regions and cause variations in joint leakage in areas with high groundwater levels. This study focused on a section of an urban railway tunnel divided into six stations, where temperatures were monitored over a six-month period using 55 Bluetooth sensors installed in the mainline tracks, ventilation shafts, and station areas. The selected tunnel section had undergone PISD (Precise Inspection for Safety and Diagnosis) 10, 15, and 20 years after its completion. Based on these PISD results, defect quantities were estimated, and relevant maintenance-related influencing factors were incorporated into the analysis. The study examined daily and monthly temperature distributions by section, temperature differences between the mainline and ventilation shafts, and temperature characteristics at various locations within the tunnel to identify correlations with different defect types. The analysis revealed that as the range of temperature variation within the tunnel increased, the incidence of cracks tended to decrease, whereas occurrences of leakage and efflorescence increased. These findings suggest that temperature distribution plays a significant role in the defects, indicating the need for maintenance strategies that incorporate environmental temperature conditions for prediction and mitigation of defects.

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