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Abstract of Doctoral Thesis

Title:A basic study on the collapse behavior of the tunnel face and the slope around tunnel portal zone using SPH simulation

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There is an increasing risk to the lives of citizens because of functional paralysis of road and railroad infrastructures arising from disasters such as concentrated downpours and earthquakes with an epicenter directly below populous areas. Road and rail tunnels, which enable a speedy commute and thereby support livelihoods, often have slopes around their portal zones; these slopes are particularly under threat of collapsing from heavy downpours and earthquakes. Not only is the safe implementation of work during construction important, but implementation of long-term stability measures after completion of construction work is also essential and is therefore a matter of urgency. The inability of the conventional finite element method (FEM) to provide sufficient quantitative understanding of significant deformations or collapsing behaviors has been a problem in studying the stability of the tunnel portal zones, from construction to collapse while in service.

A consistent evaluation for tunnels subjected to external forces arising from factors such as heavy downpours or earthquakes and weathering was attempted by this study using the Smoothed Particle Hydrodynamics (SPH) method. It covered the period of time ranging from tunnel excavation to occurrence of incidents with tunnels. Experimental and analytical examinations were also conducted, using the SPH method, on the stability of the tunnel face at the tunnel portal zone during construction, as well as the stability of the slope around the tunnel portal zone following the completion of the construction work.

This established a method for clarifying and implementing countermeasures against progressive collapsing phenomena. An evaluation method that uses the SPH method was established to study the elastic behavior of tunnels and slopes around the tunnel portal zone, as well as displacements, stress conditions, and stability. A design method that uses the SPH method was also established that examined the stability of the tunnel face as well as the potential for collapse due to deterioration of stability and progressive deterioration of long-term operation and maintenance aspects or application of external forces owing to disasters such as earthquakes.