



Model test of the mechanism underpinning water-and-mud inrush disasters during tunnel excavation in sandstone and slate interbedded Presinian strata

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Project Overview

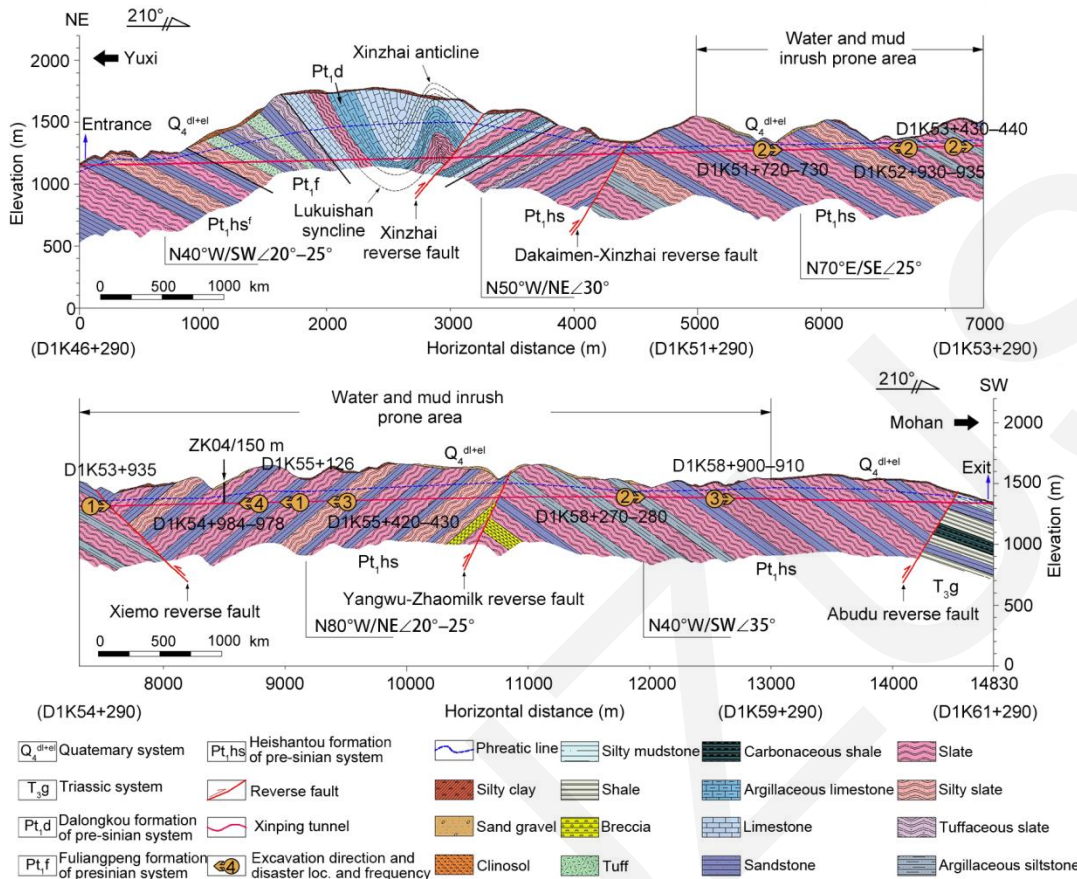
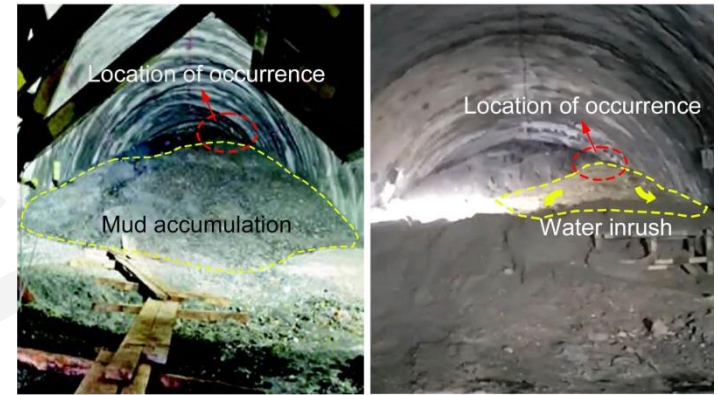


Fig. 3 Longitudinal geological profile of the Xinping Tunnel



(a)

(b)



(c)

(d)

Fig. 6 Scenes from the water-and-mud inrush disasters

- The study is based on the project of Xinping Tunnel, Yunnan, China. Most of the tunnel is located in the sandstone and slate interbedded Presinian strata.
- The Xinping Tunnel has had 41 water-and-mud inrush disasters since its construction, with a total mud inrush of $6.7 \times 10^4 \text{ m}^3$.

Characteristics of geological structure

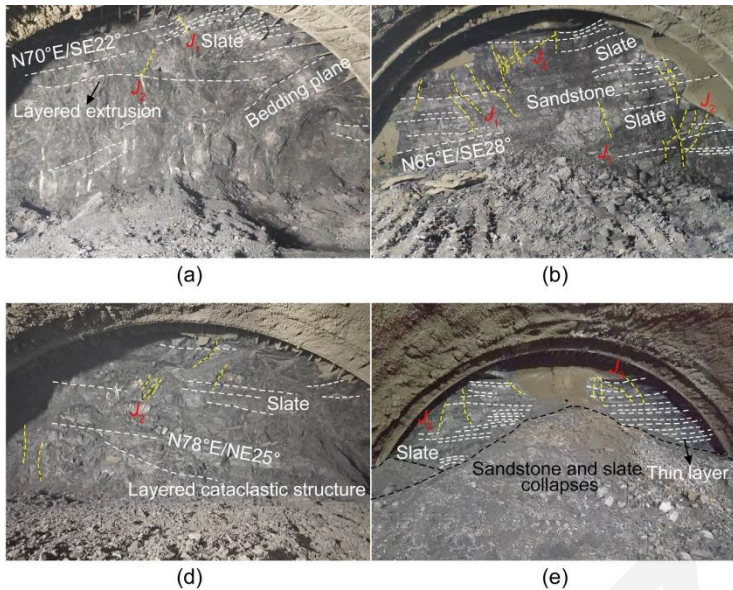


Fig. 4 Geological survey of various tunnel faces

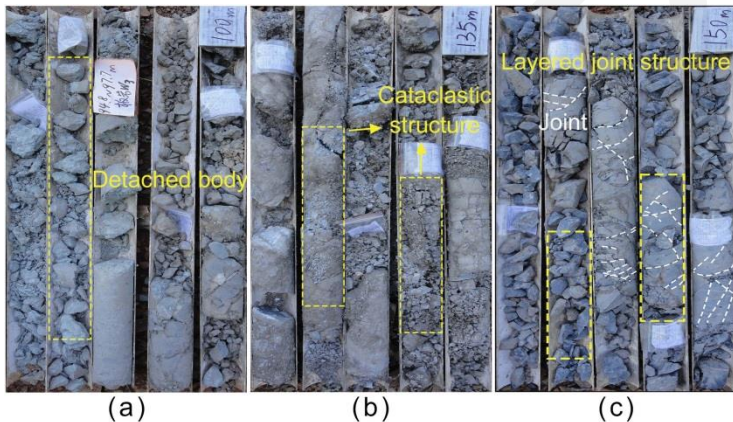


Fig. 5 Core photographs of sandstone and slate inter-bedded Presinian strata

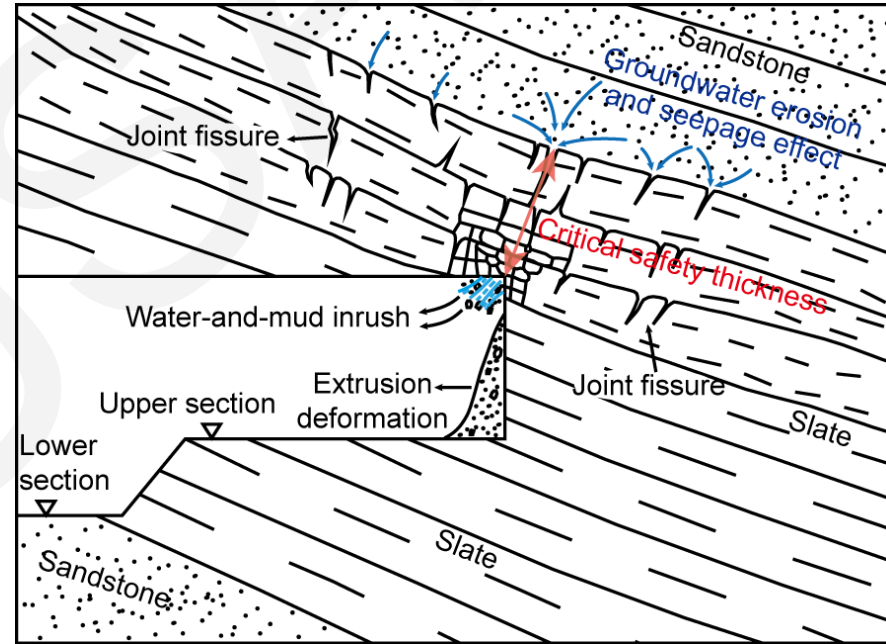


Fig. 7 Engineering geological model of the Xinping Tunnel and water-and-mud inrush

Model Test

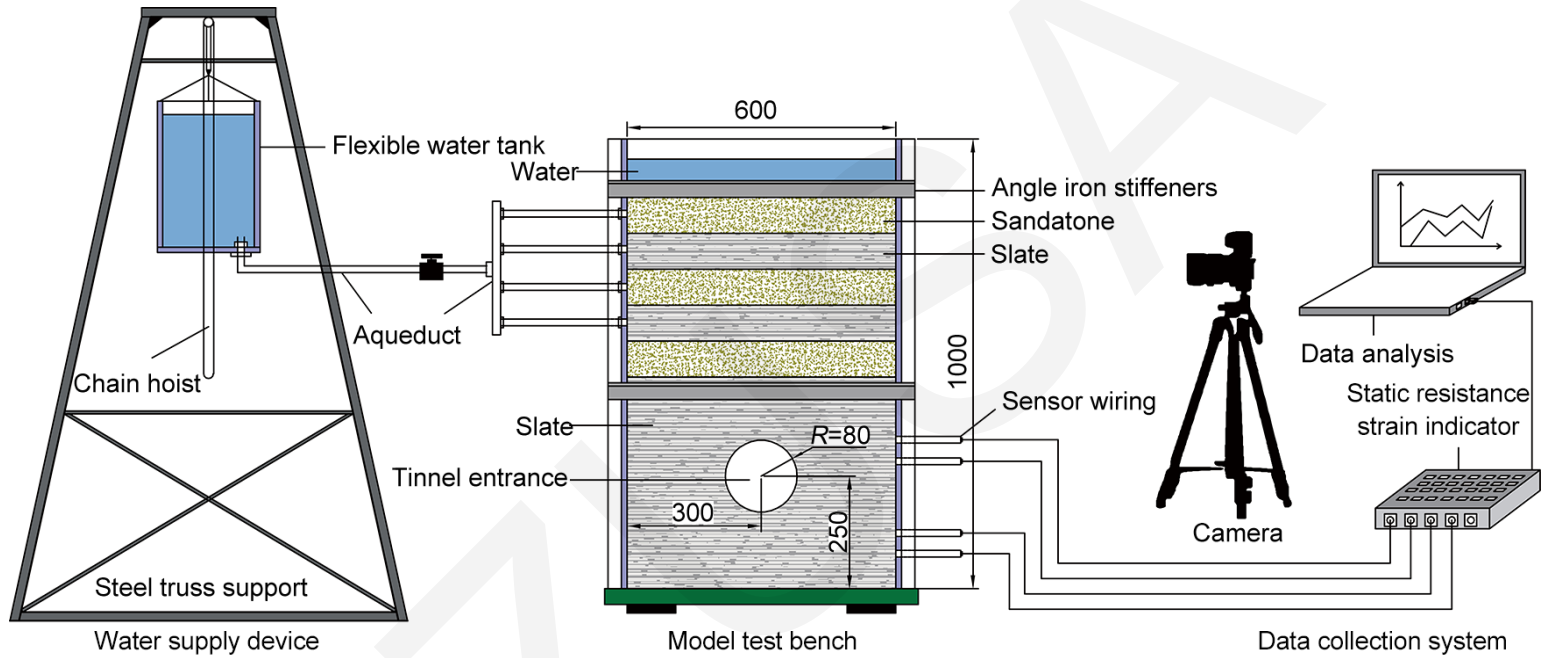


Fig. 8 Design of the model test system of water-and-mud inrush (unit: mm)

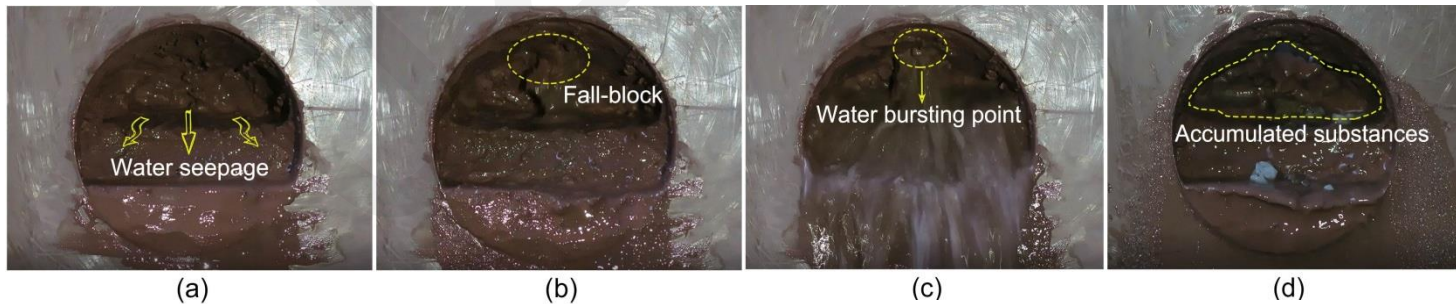


Fig. 16 Catastrophic process of water-and-mud inrush

Characteristic parameter analysis

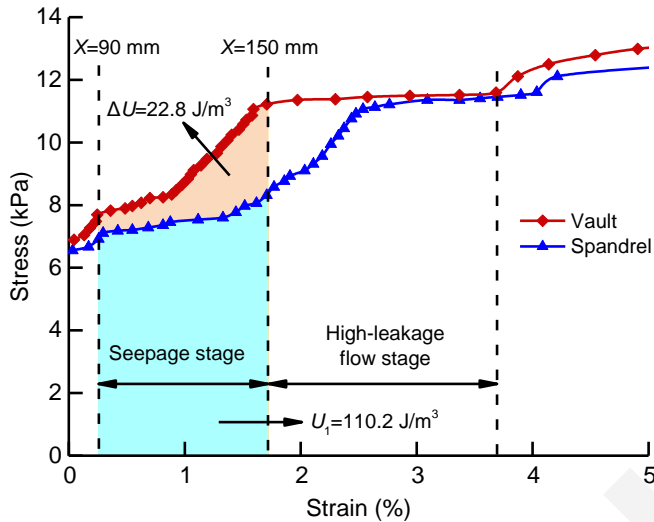


Fig. 17 Stress-strain curves during tunnel excavation

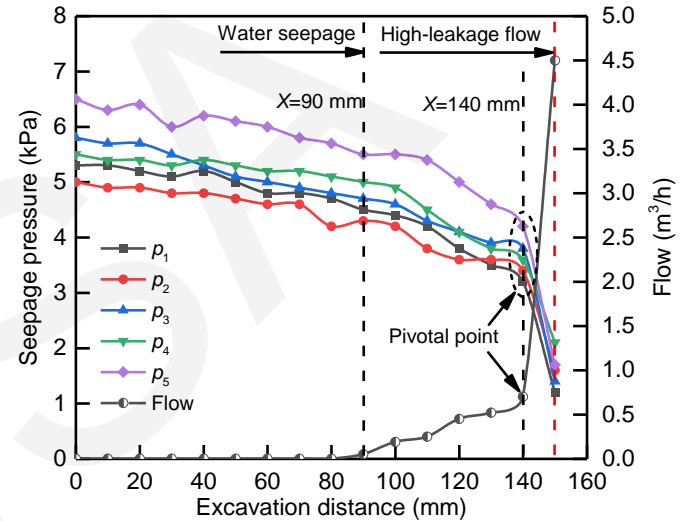


Fig. 18 Characteristic curves of seepage pressure and flow at different excavation distances of monitoring section I

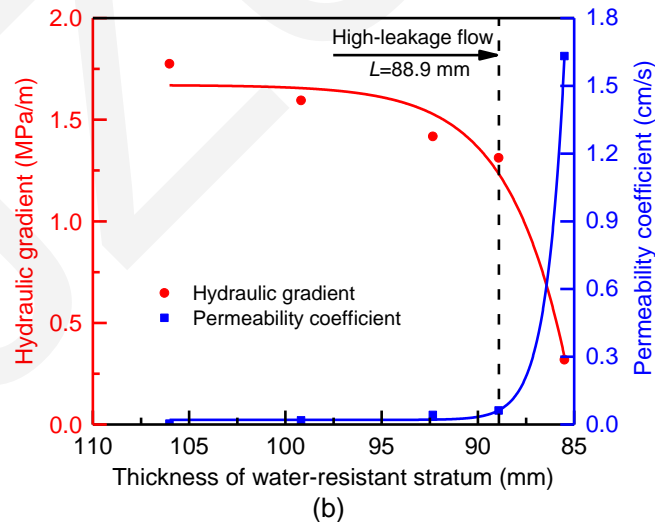


Fig. 22 Change rule of hydraulic gradient and permeability coefficient

Conclusions

- The water-and-mud inrush disaster of a tunnel in sandstone and slate interbedded Presinian strata is a **catastrophic process** induced by the action of excavation unloading and in situ stress–seepage coupling, in which the water-resistant stratum reaches the critical safety thickness, a high-leakage flow channel forms, and the water-resistant stratum gradually fails.
- The process of water-and-mud inrush was divided into three stages: **seepage stage, high-leakage flow stage, and attenuation stage**. In the process of the water-and-mud inrush, parameters such as the stress–strain, seepage pressure, and flow of the surrounding rock had **stage-related characteristics**, which indicated the disaster’s formation, development, and evolution.
- The pivotal point was regarded as **the characteristic point of deterioration of the water-resistant stratum**, and the thickness of the water-resistant stratum corresponding to this point was determined to be **the critical safety thickness**.