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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

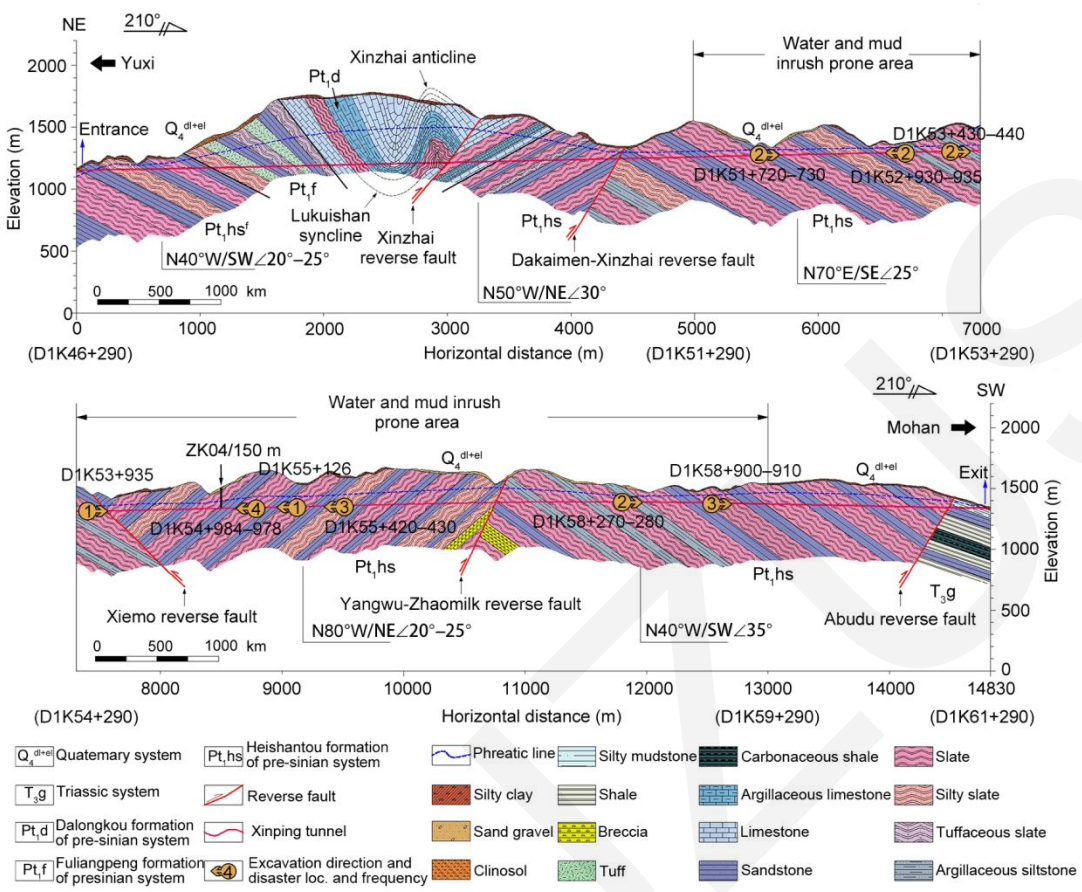

Fig. 3 Longitudinal geological profile of the Xinping Tunnel

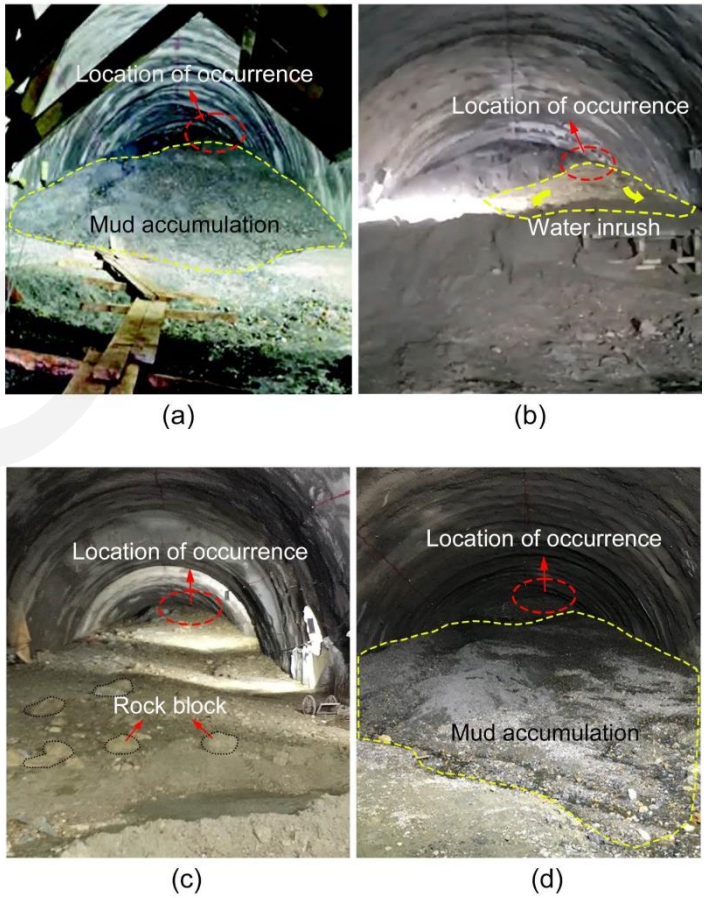

Fig. 6 Scenes from the water-and-mud inrush disasters

- **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 6.7×10^4 m^3.**

Characteristics of geological structure

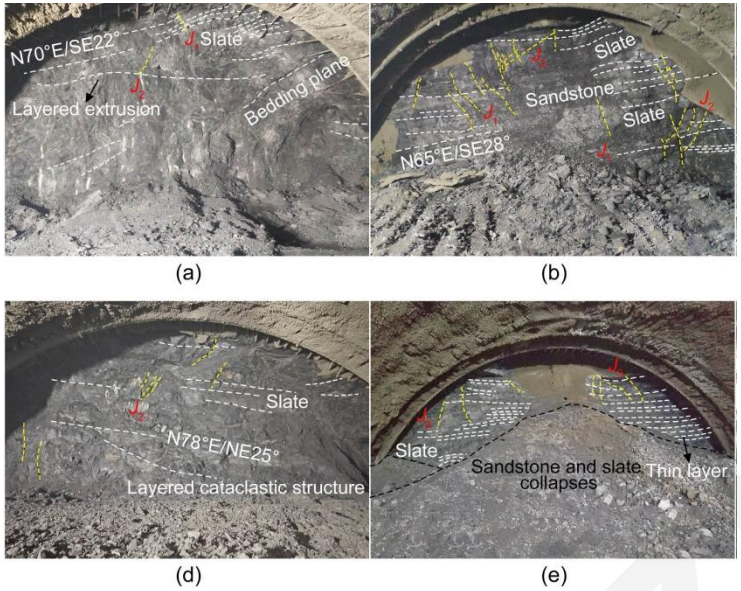

Fig. 4 Geological survey of various tunnel faces

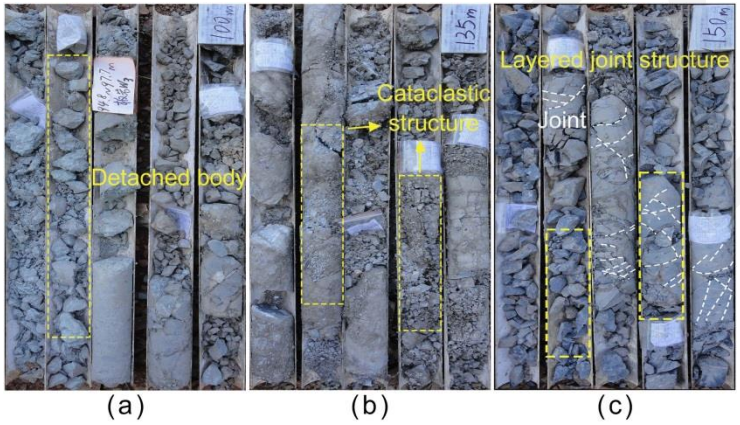

Fig. 5 Core photographs of sandstone and slate inter-bedded Presinian strata

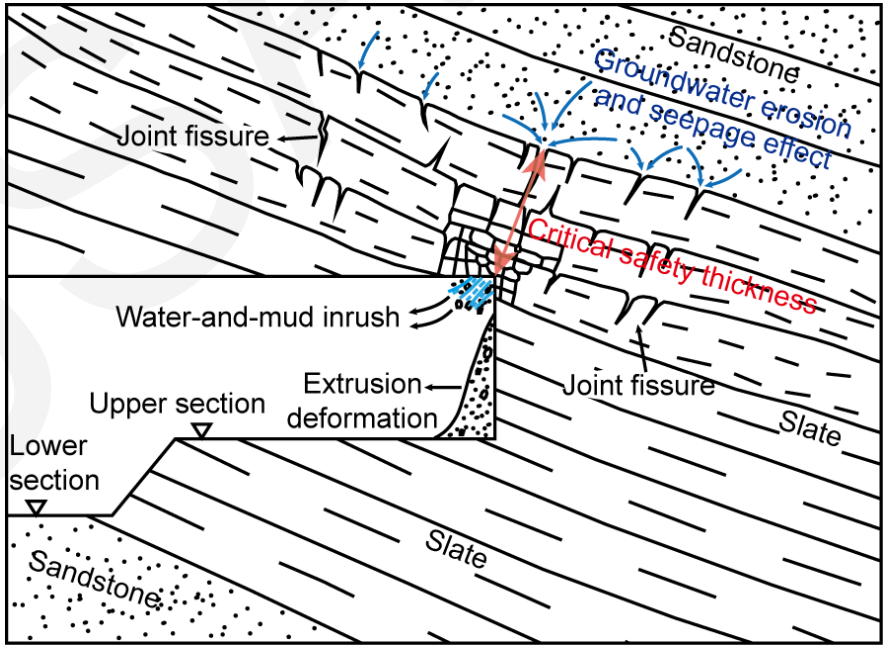

Fig. 7 Engineering geological model of the Xinping Tunnel and water-and-mud inrush

Model Test

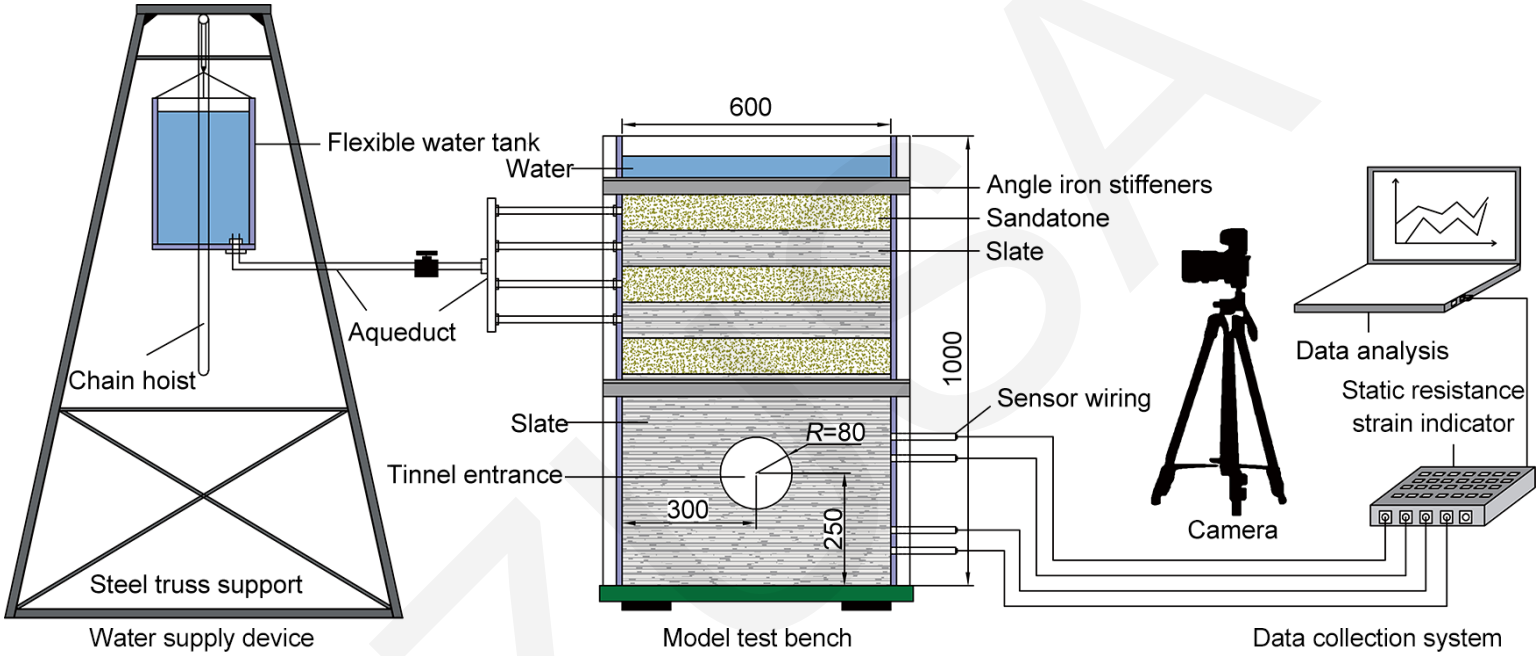

Fig. 8 Design of the model test system of water-and-mud inrush (unit: mm)



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

Characteristic parameter analysis

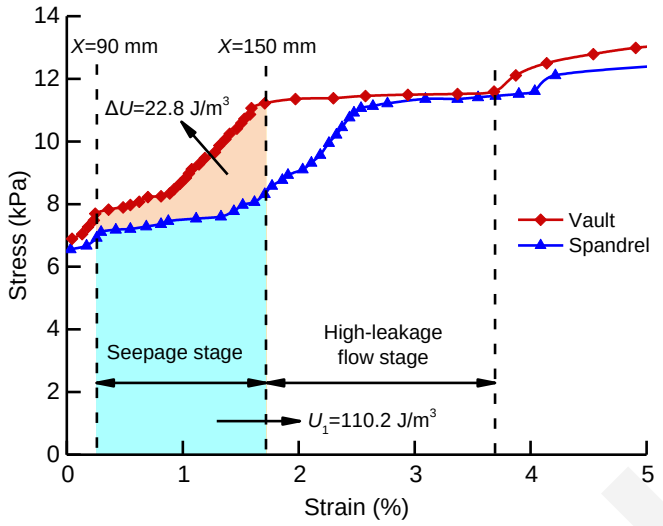

Fig.17 Stress–strain curves during tunnel excavation

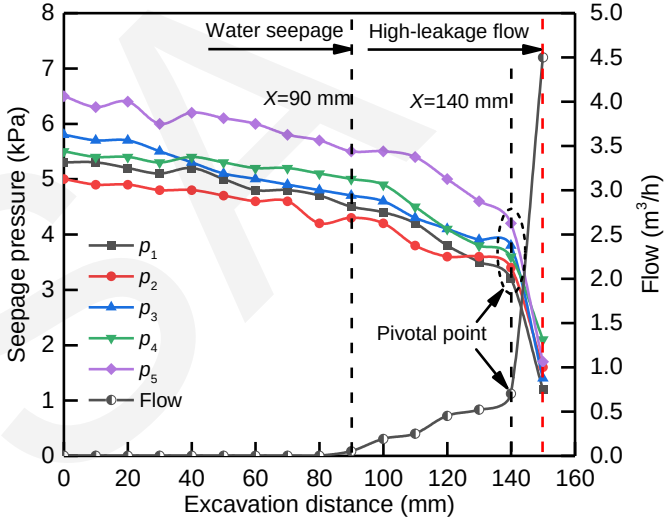

Fig. 18 Characteristic curves of seepage pressure and flow at different excavation distances of monitoring sec-tion I

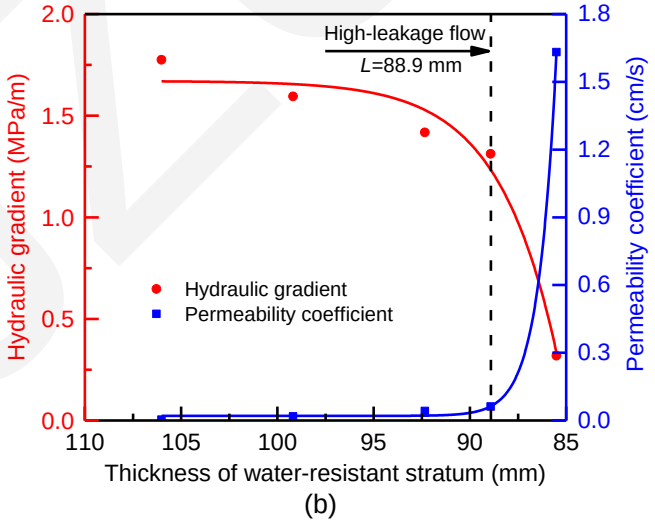

Fig. 22 Change rule of hydraulic gradient and permea-bility coefficient

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**.

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