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An in-situ slurry fracturing test for slurry shield tunneling

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Background

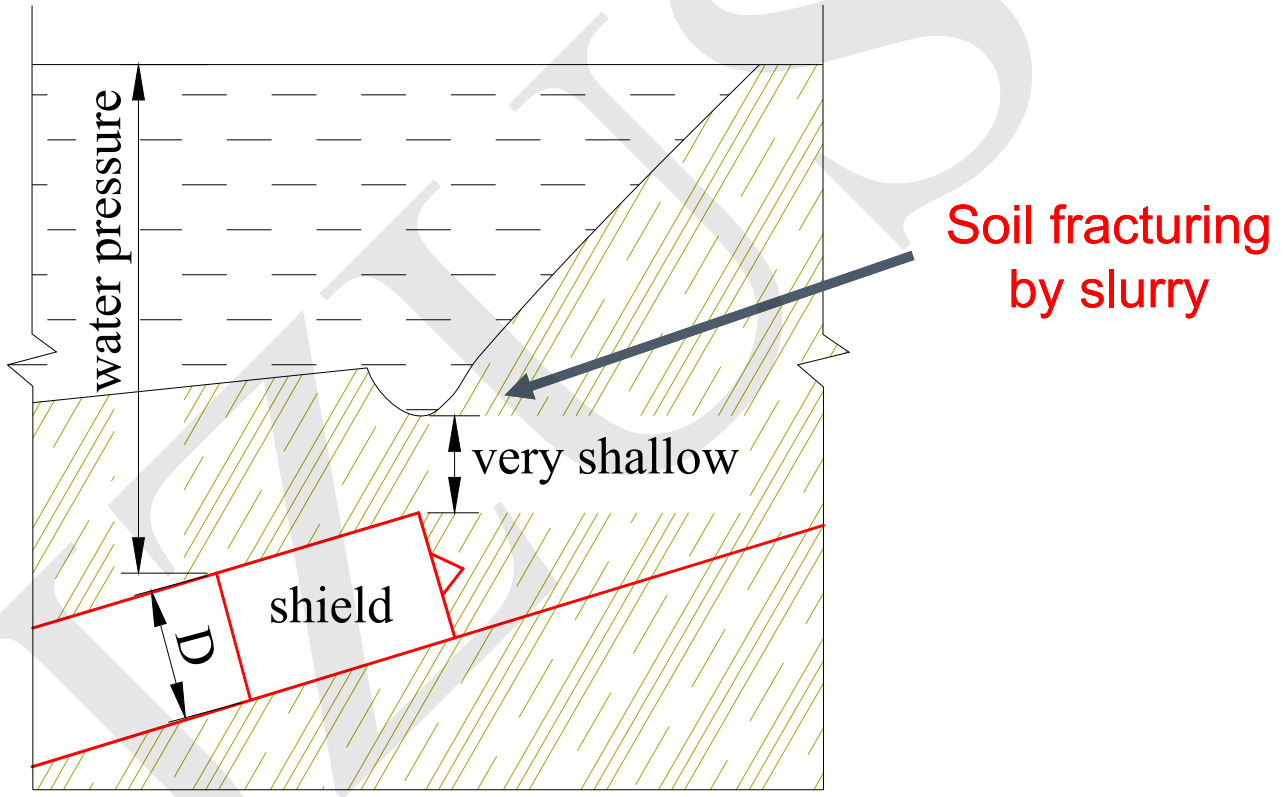
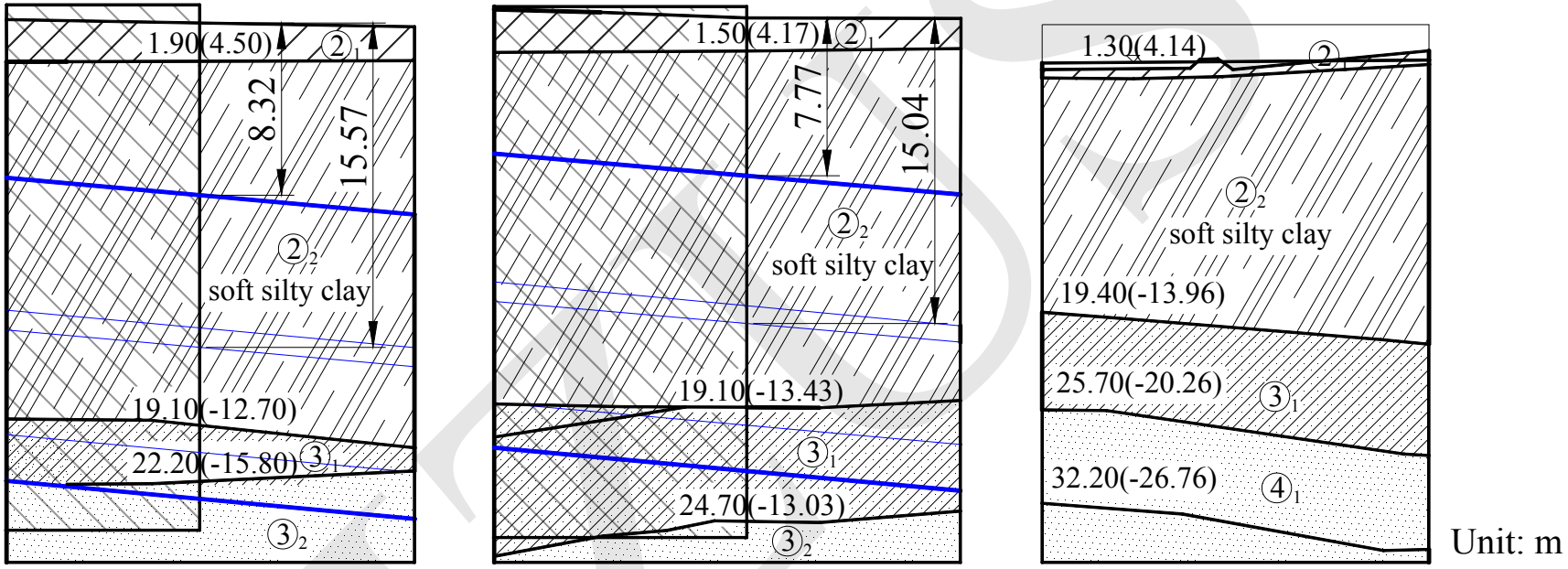


Fig. 1 A dangerous condition for shield tunneling of the Nanjing Yangtze River Tunnel

Site description

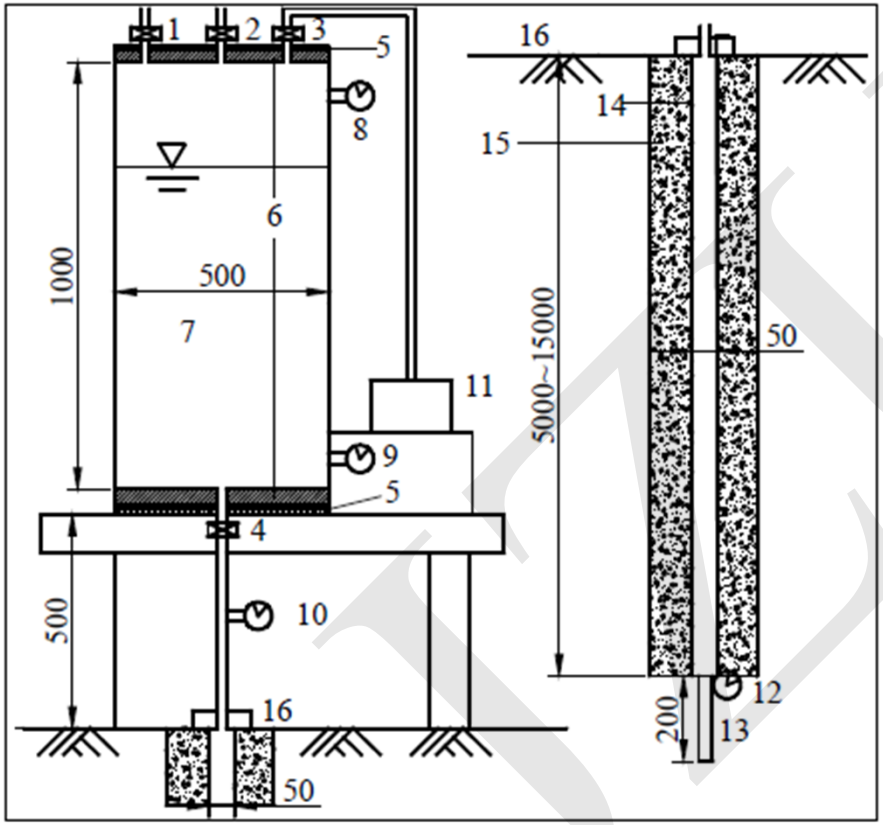


(a) south tube (b) north tube (c) in-situ test field

Unit: m

Fig. 2 Soil properties of the strata for the tunnel and the in situ tests

In-situ test apparatus



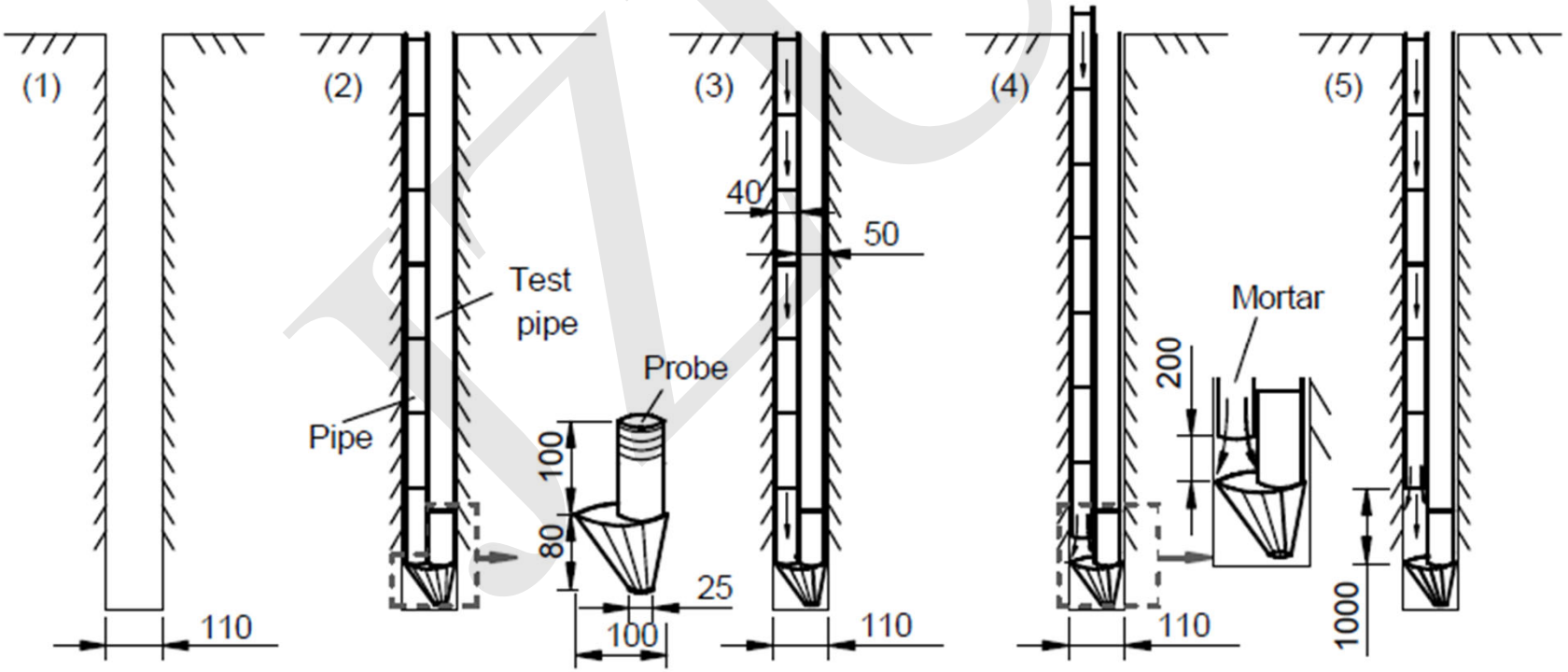
1: exhaust value;
2: slurry addition tube;
3: air addition tube;
4: value; 5: structural panel;
6: combined panel;
7: slurry container;
8: air manometer;
9: pore water; 10: flowmeter;
11: air compressor;
12: pore water; 13: soil hole;
14: steel pipe;
15: cement mortar;
16: ground surface

Fig. 3 General layout of the in-situ slurry fracturing apparatus(unit: mm)

Test procedures(1)

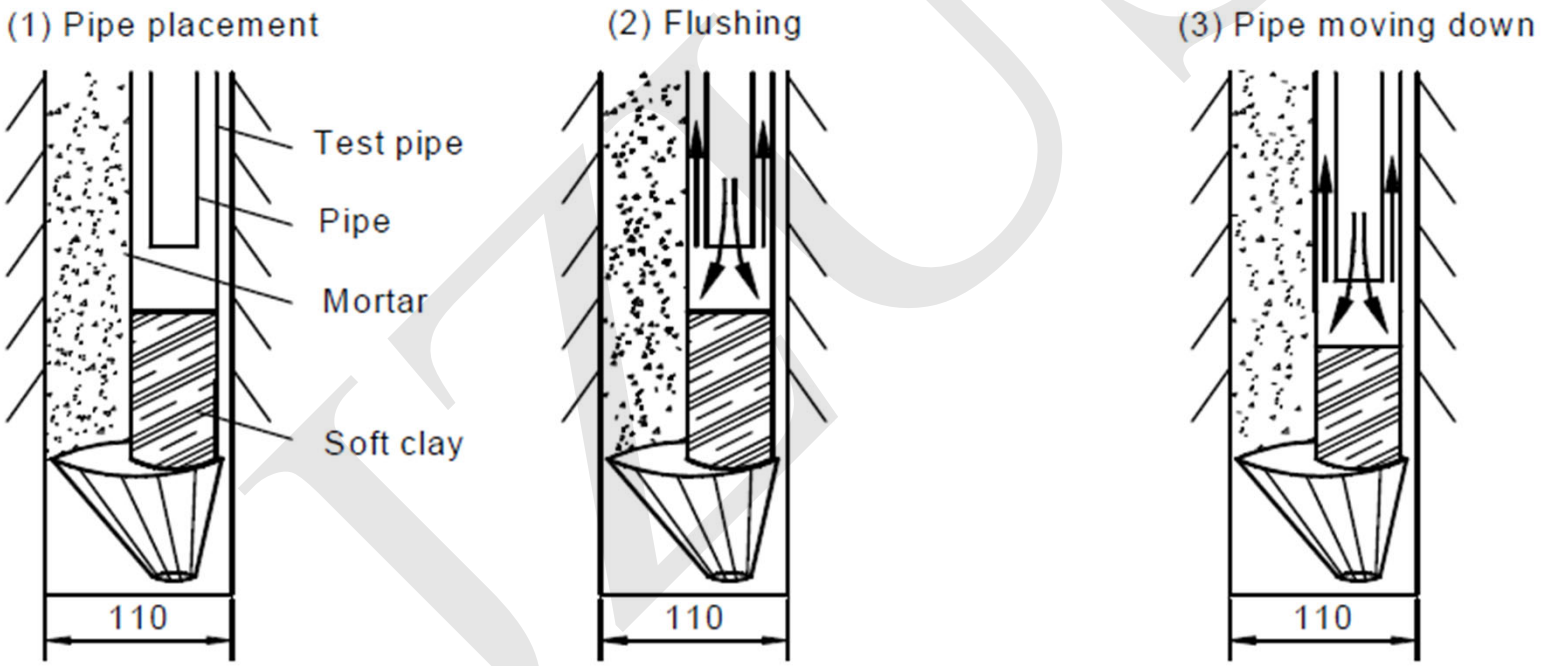
(1)Lateral earth pressure investigation

(2)pipe placement



Test procedures(2)

(3) Pipe flushing and slurry preparation



(4) Slurry fracturing

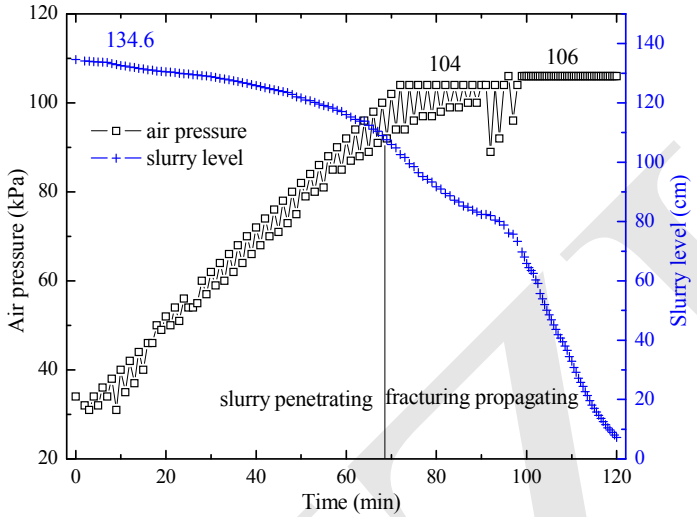
(5) Uncovering the path of fracture

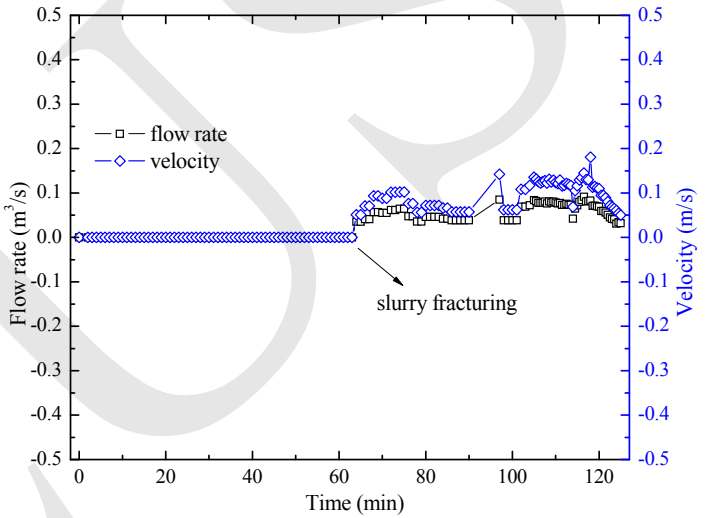
Slurry break-out phenomenon

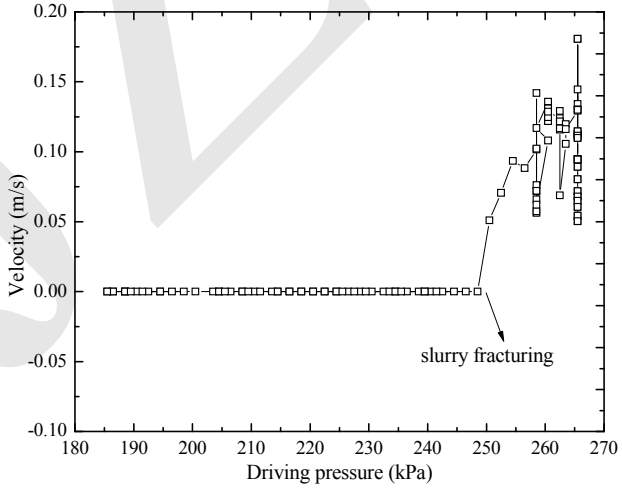


Fig. 4 Slurry breakout phenomenon of the in-situ slurry fracturing tests

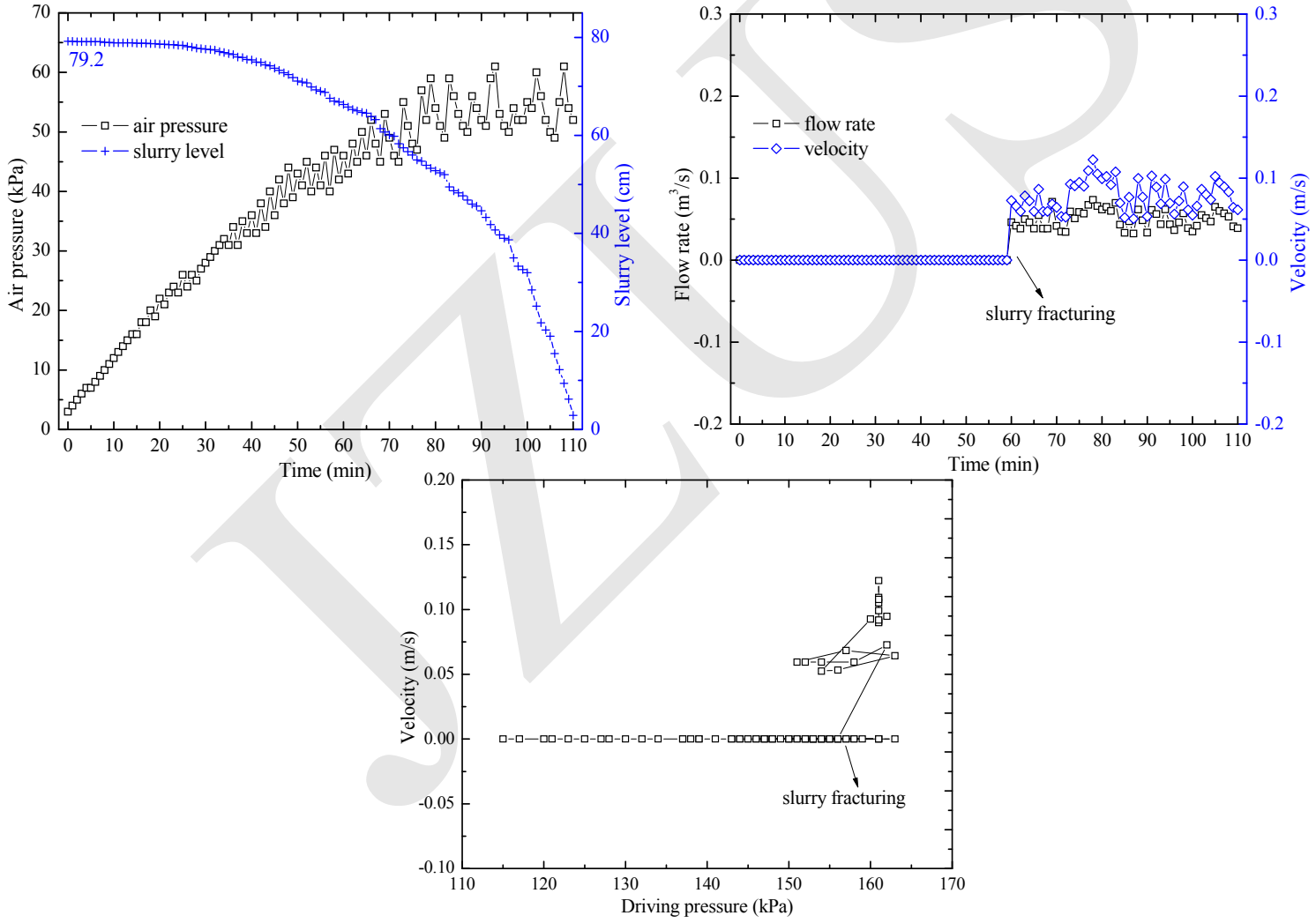
Test results(1)



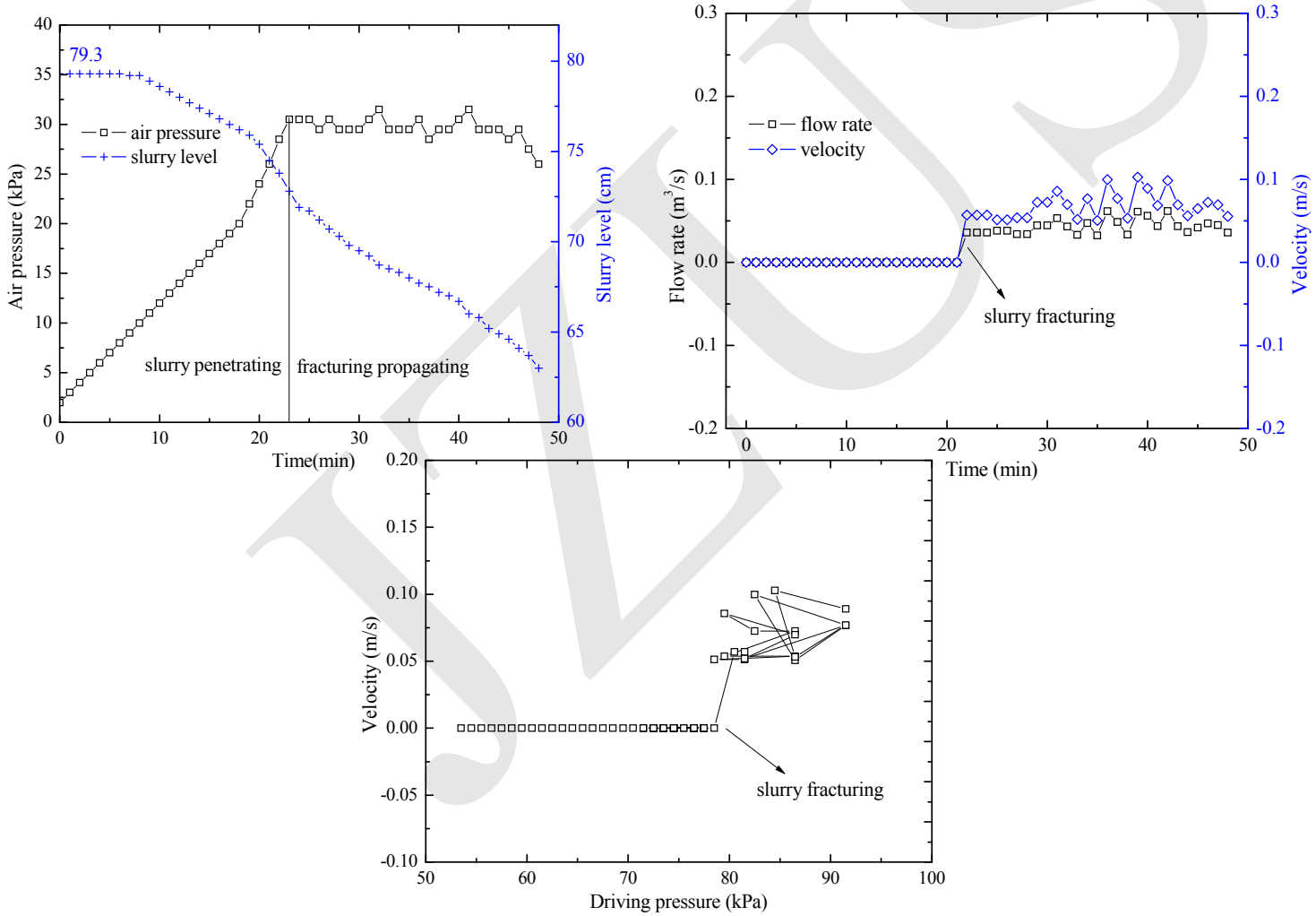




Test results(2)



Test results(3)



Initial fracturing pressure prediction

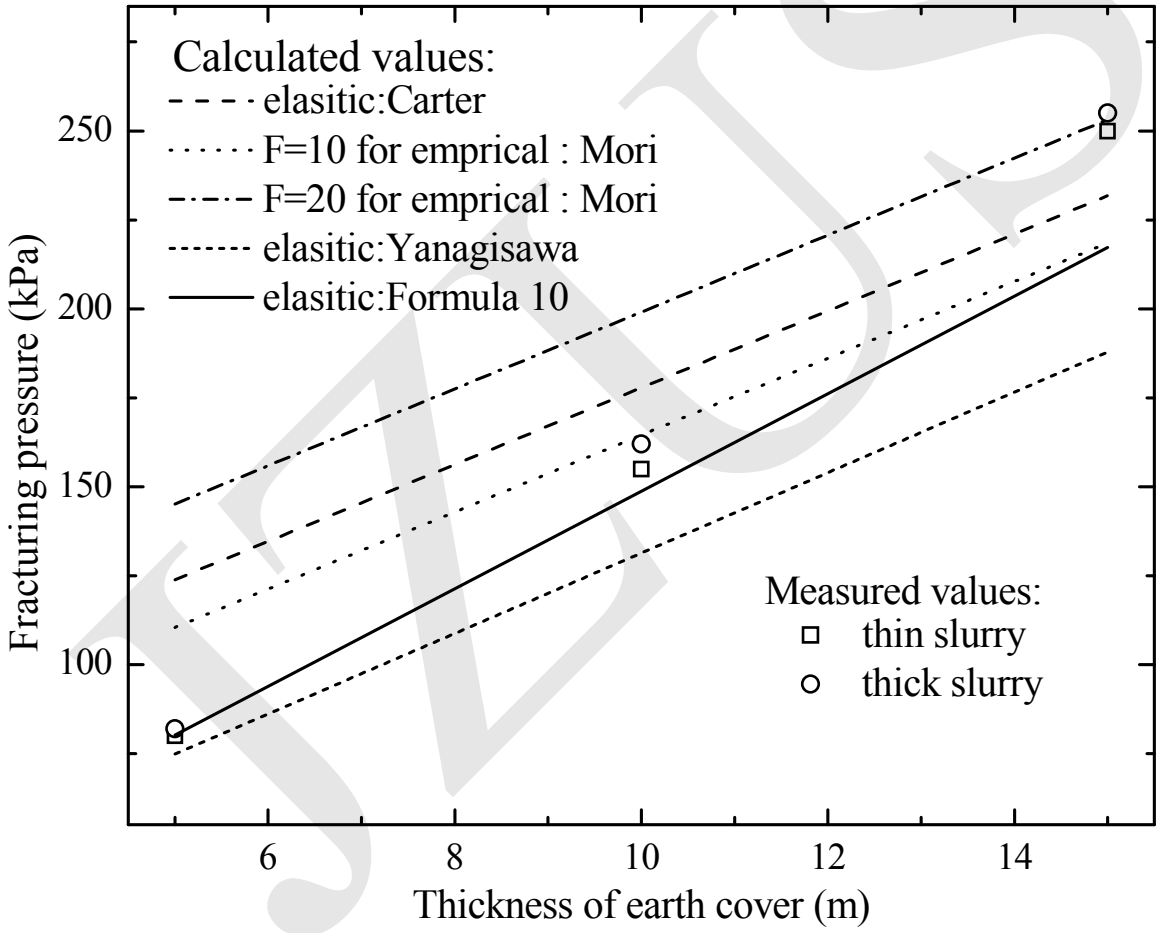


Fig. 5 Measured versus predicted values of the initial fracturing pressures for the in-situ test

Driving pressure prediction

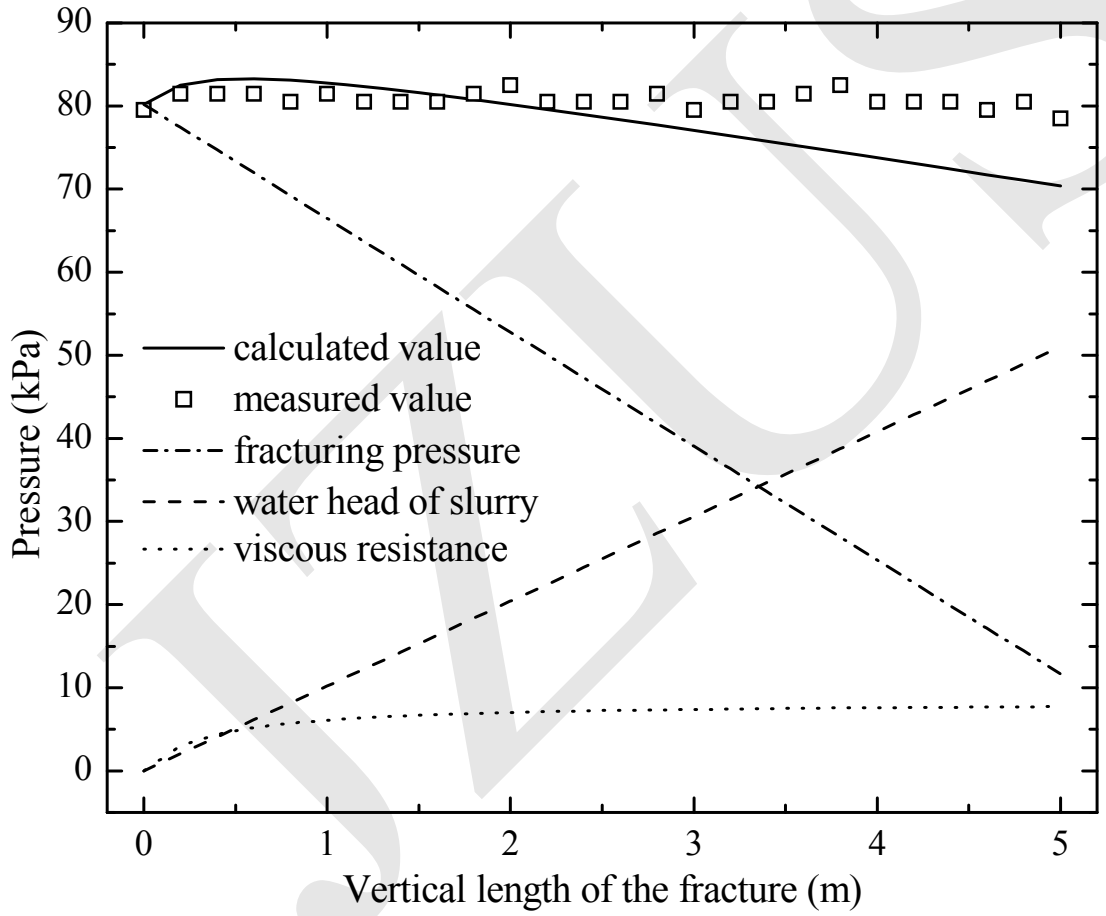


Fig. 6 Comparison of the modified and measured values of the fracturing propagation of the A_3 hole

Sensitivity analysis

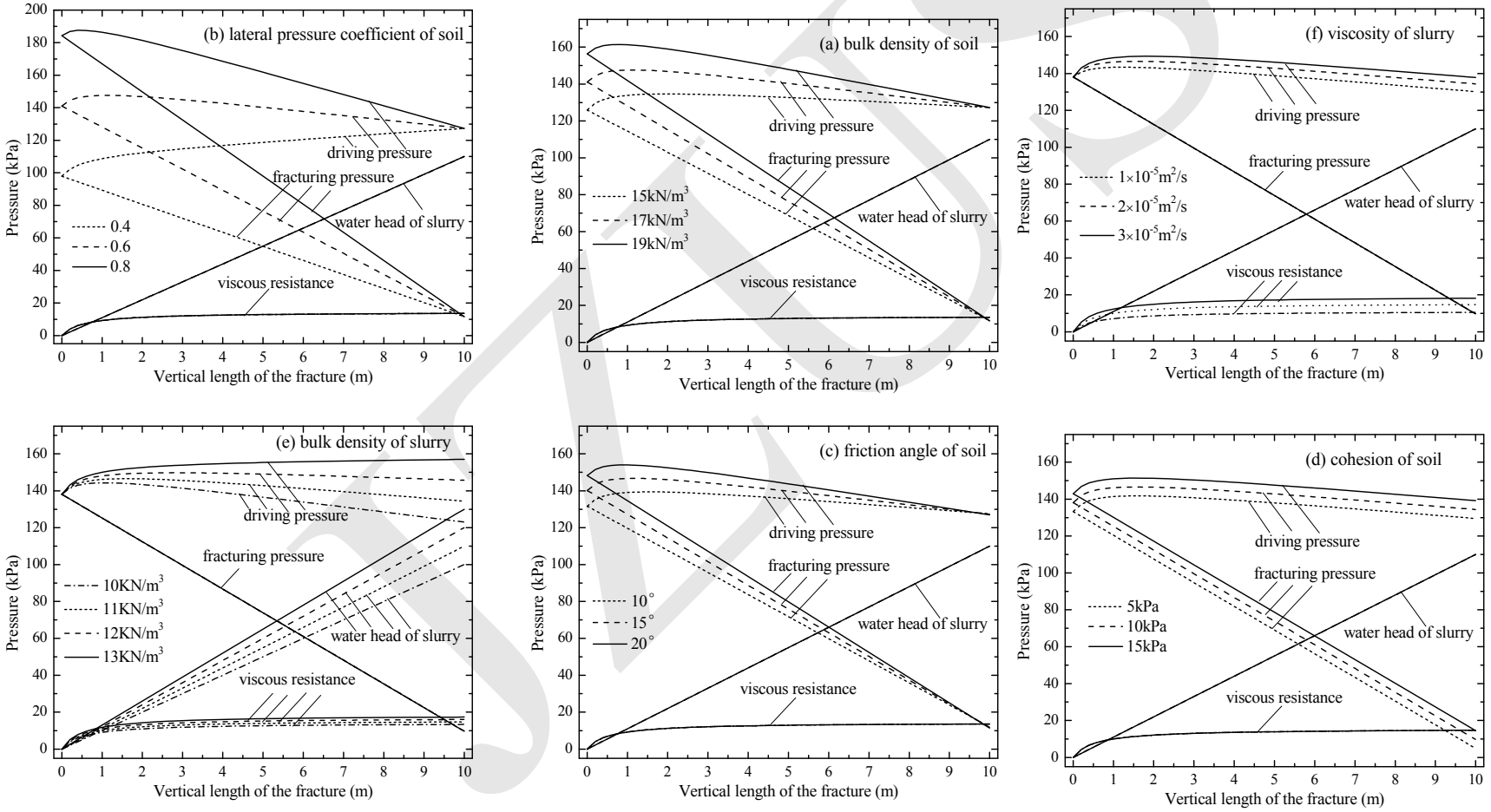


Fig. 7 Sensitivity analysis of parameters for driving pressure

Measures for preventing soil fracturing

(1) Reinforce the soft stratum.

(2) Prepare slurries with high bulk density and viscosity.

(3) Limit the maximum support pressure.

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Conclusions (1)

(1) It is reliable to employ the device described in this paper to measure the anti-fracturing ability of soil.

(2) The model for soil fracturing with parameters in total stress can predict the test results.

(3) The model for fracture propagation with consideration of bulk density and viscosity of slurry make a good prediction of test results.

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Conclusions (2)

(4) The large parameters of bulk density and viscosity of slurry can hold the fracture propagation, however, these can hardly contribute to the initial fracturing pressure.

(5) The fracture propagation can not easily been held on during slurry shield tunneling, thus, it's important to set the up bound value of slurry pressure to prevent soil fracturing by slurry.