

SUPPLEMENTAL MATERIALS

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A Model Study of Water Inrush in Underground Roadways

Junhong Yang, Jiwei Li, Hangyu Zhu, Hongbiao Wu, Ziyi Zhou,
and Jianguang Li

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1. Each factor sensitive analysis chart and variance analysis table

1.1 Compressive strength

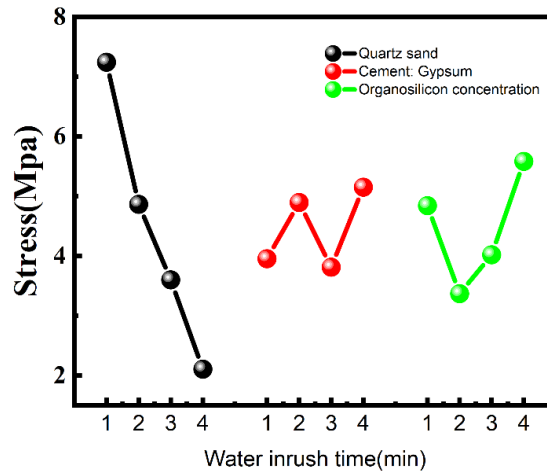


Figure 1. Compressive strength sensitive analysis diagram

factor	Deviation sum of squares	Degree of freedom	F ratio	Fcritical value	Contribution rate /%
Quartz sand content	56.776	3	2.323	3.860	77.44
Cement: gypsum	5.372	3	0.22	3.860	7.33
the concentration of silicone	11.168	3	0.457	3.860	15.23
error	73.316	9			

Table 1. Variance analysis of compressive strength

1.2 Elastic modulus

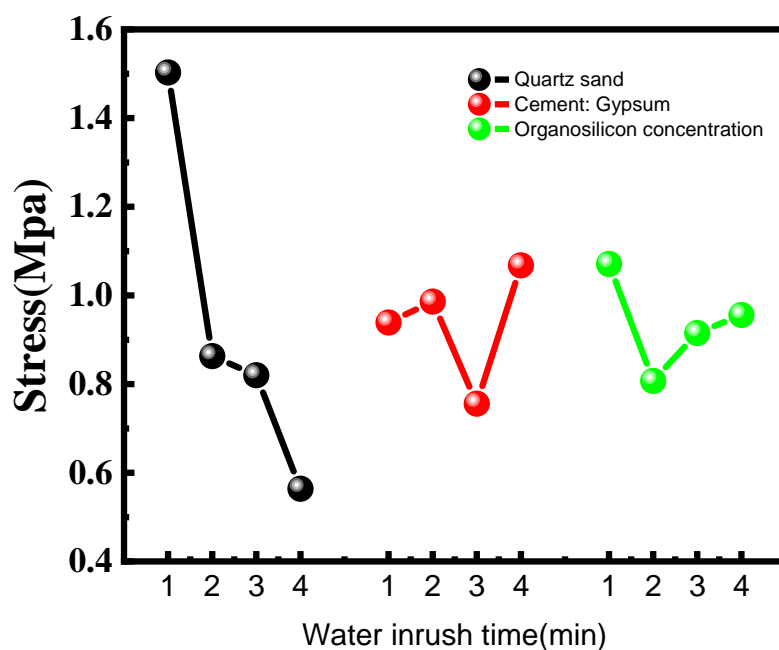


Figure 2. Elastic modulus sensitive analysis diagram

factor	Deviation sum of squares	Degree of freedom	F ratio	F critical value	Contribution rate /%
Quartz sand content	1.918	3	2.533	3.860	84.42
Cement: gypsum	0.21	3	0.277	3.860	9.24
the concentration of silicone	0.144	3	0.19	3.860	6.34
error	2.272	9			

Table 2. Variance analysis of elastic modulus

1.3 Water absorption

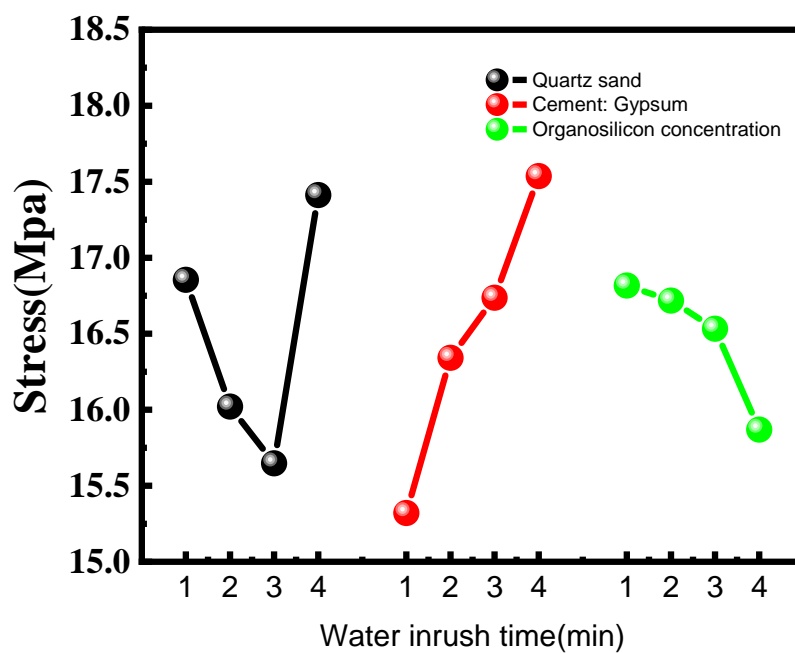


Figure 3. Water absorption sensitive analysis diagram

factor	Deviation sum of squares	Degree of freedom	F ratio	F critical value	Contribution rate /%
Quartz sand content	7.658	3	1.147	3.860	38.25
Cement: gypsum	10.182	3	1.526	3.860	50.85
the concentration of silicone	2.182	3	0.327	3.860	10.90
error	20.022	9			

Table 3. Variance analysis of water absorption

1.4 Softening coefficient

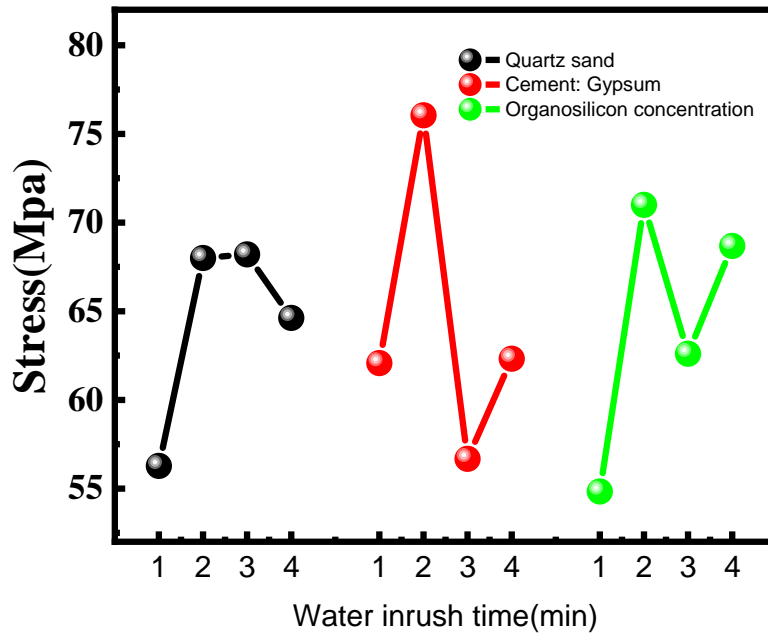


Figure 4. Softening coefficient sensitive analysis diagram

factor	Deviation sum of squares	Degree of freedom	F ratio	F critical value	Contribution rate /%
Quartz sand content	373.367	3	0.616	3.860	20.52
Cement: gypsum	819.712	3	1.352	3.860	45.06
the concentration of silicone	626.027	3	1.032	3.860	34.41
error	1819.106	9			

Table 4. Variance analysis of softening coefficient

1.5 Permeability coefficient

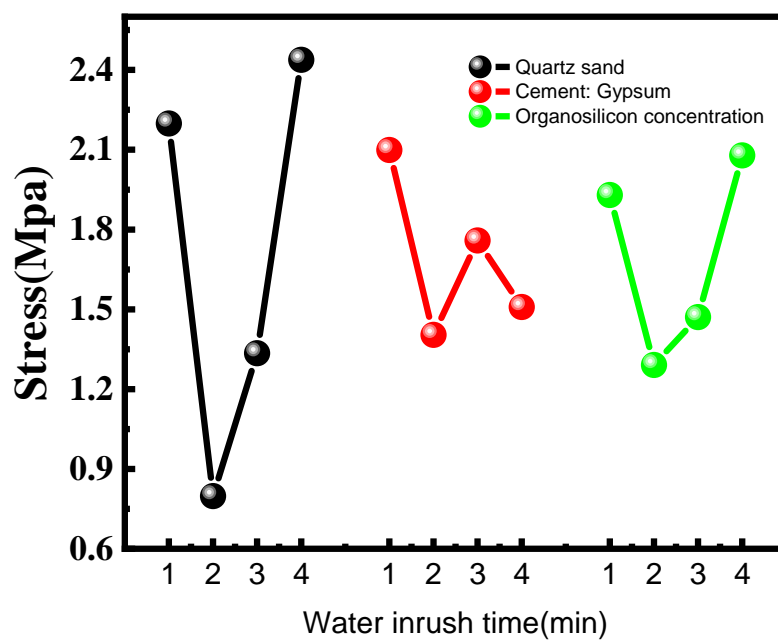


Figure 5. Permeability coefficient sensitive analysis diagram

factor	Deviation sum of squares	Degree of freedom	F ratio	F critical value	Contribution rate /%
Quartz sand content	6.958	3	2.137	3.860	71.24
Cement: gypsum	1.145	3	0.352	3.860	11.72
the concentration of silicone	1.664	3	0.511	3.860	17.04
error	9.767	9			

Table 5. Variance analysis of permeability coefficient

1.6 Tensile strength

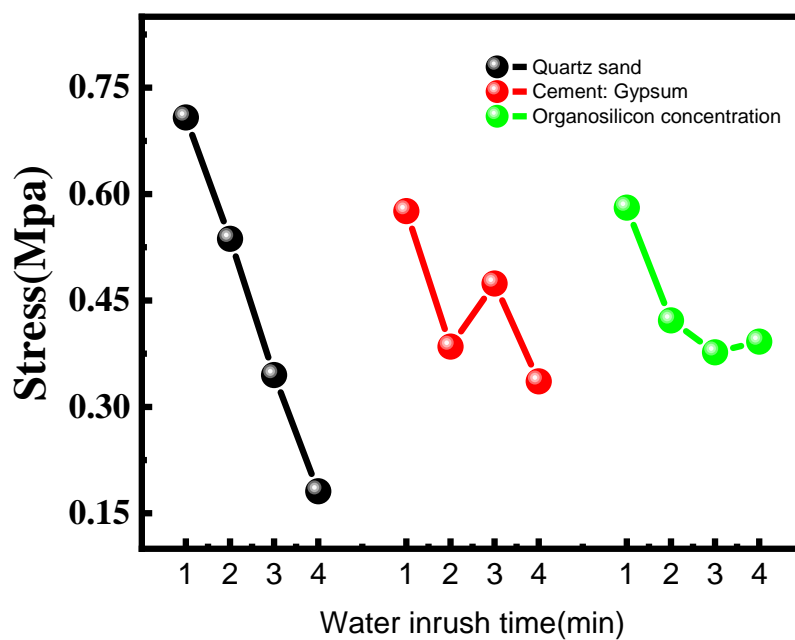


Figure 6. Tensile strength sensitive analysis diagram

factor	Deviation sum of squares	Degree of freedom	F ratio	F critical value	Contribution rate /%
Quartz sand content	0.625	3	2.180	3.860	72.67
Cement: gypsum	0.132	3	0.460	3.860	15.35
the concentration of silicone	0.103	3	0.359	3.860	11.98
error	0.86	9			

Table 6. Variance analysis of tensile strength

1.7 Density

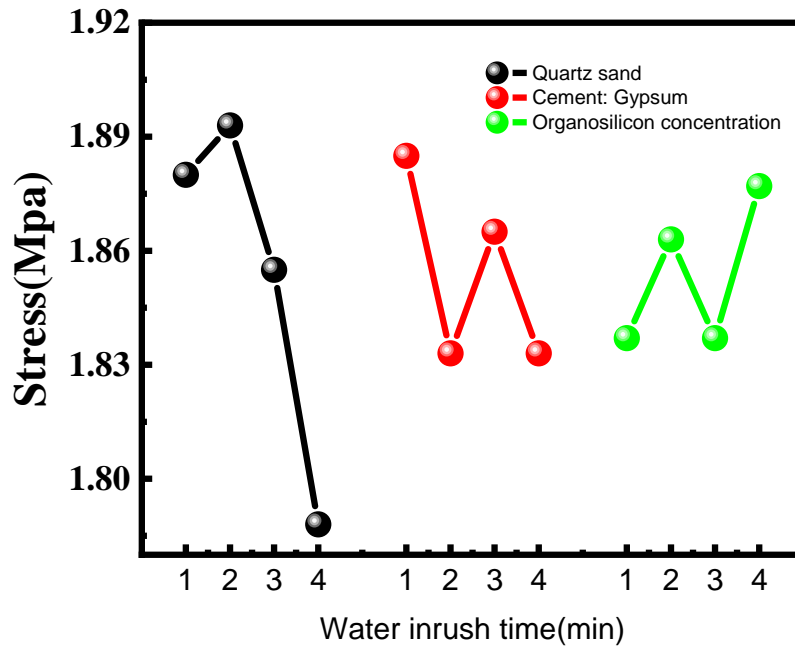
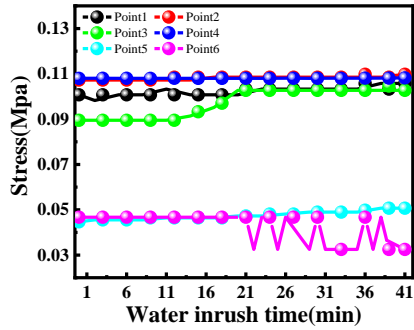


Figure 7. Density sensitive analysis diagram

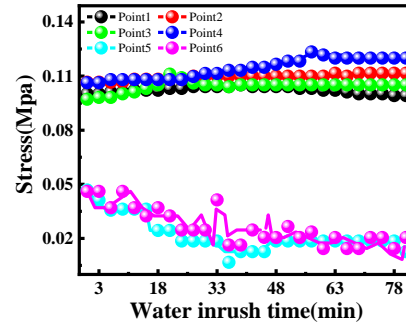
factor	Deviation sum of squares	Degree of freedom	F ratio	F critical value	Contribution rate /%
Quartz sand content	0.026	3	2.000	3.860	66.67
Cement: gypsum	0.008	3	0.615	3.860	20.51
the concentration of silicone	0.005	3	0.385	3.860	12.82
error	0.039	9			

Table 6. Variance analysis of density

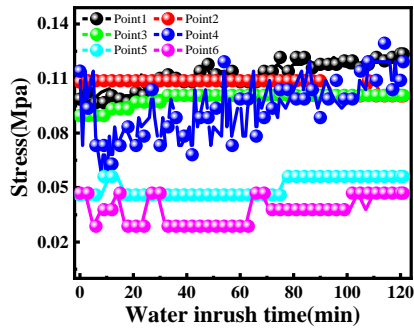
2. Diagram of stress variation with time during water inrush in roadway



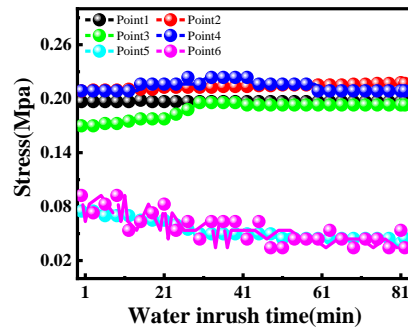
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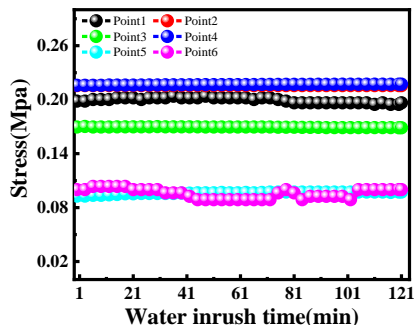
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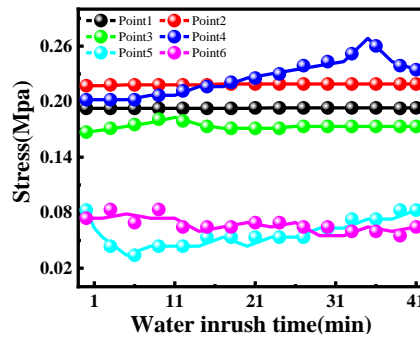
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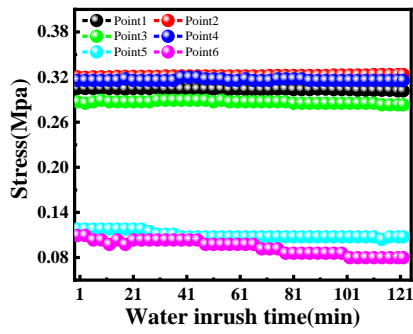
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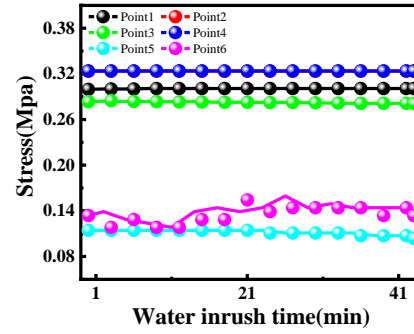
Test-5



Test-6

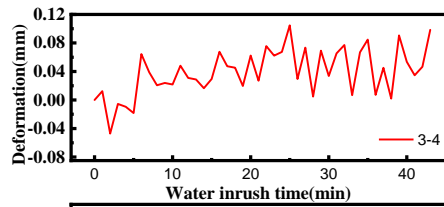


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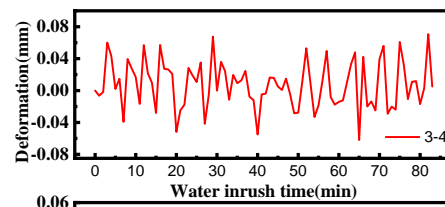


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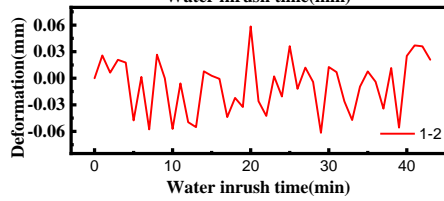
2. Convergence diagram of displacement with time during roadway water inrush.



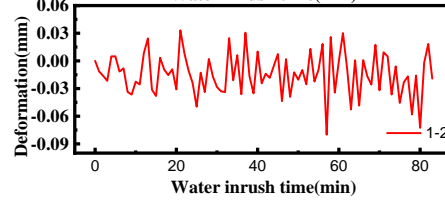
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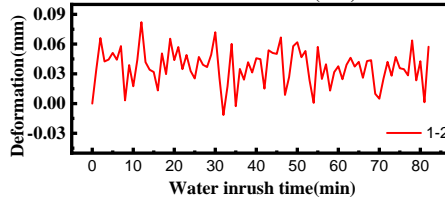
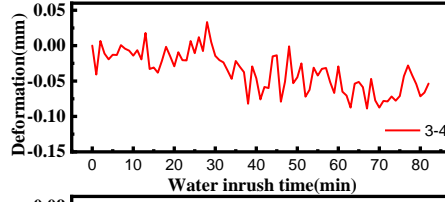
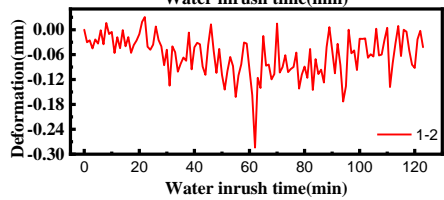
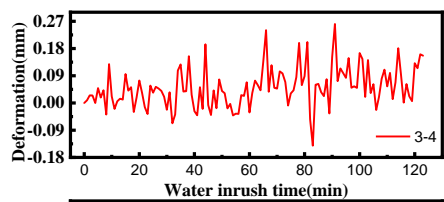
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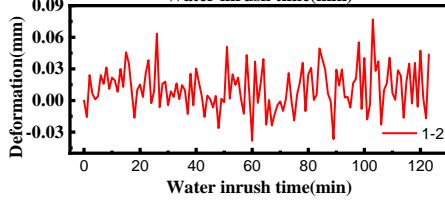
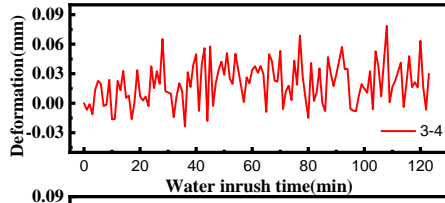


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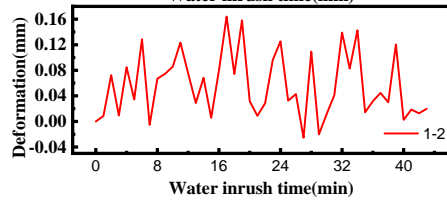
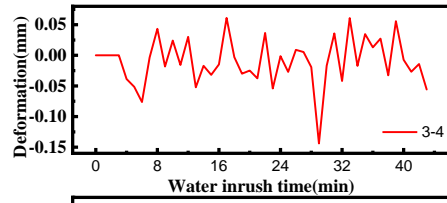


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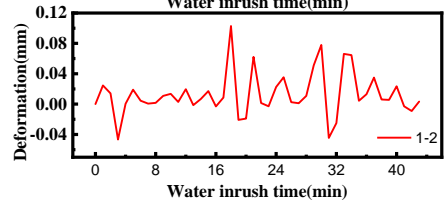
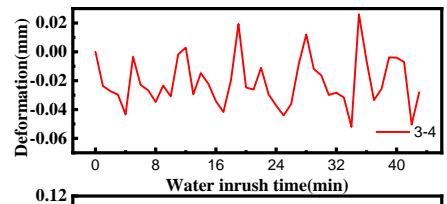
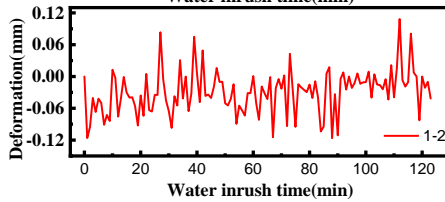
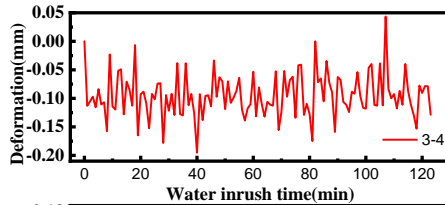




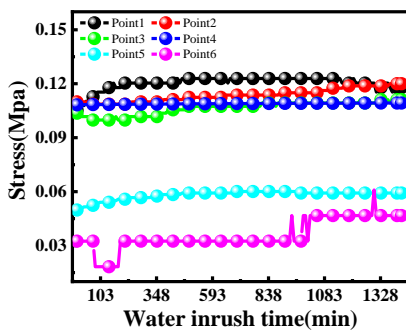
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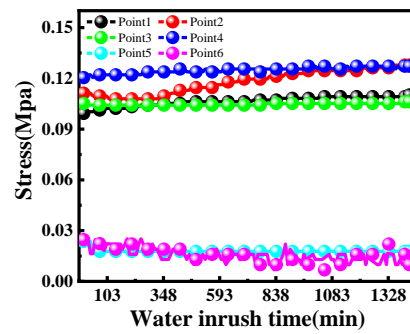
Test-6



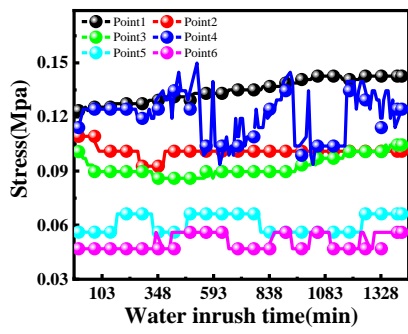
3. Diagram of stress change with time after water inrush in roadway



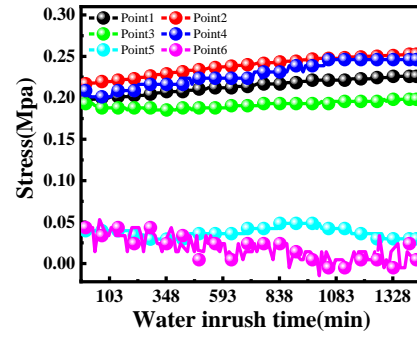
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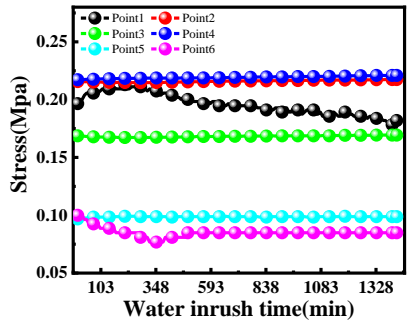
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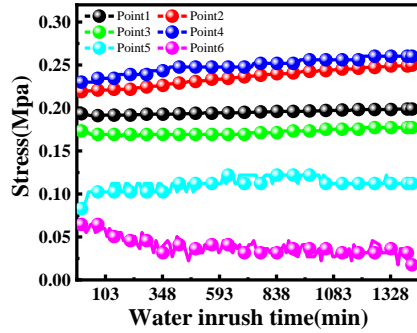
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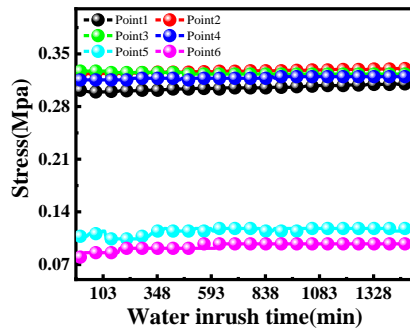
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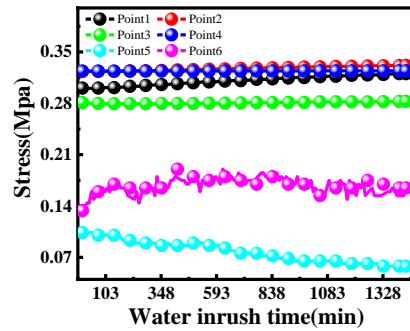
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Test-6

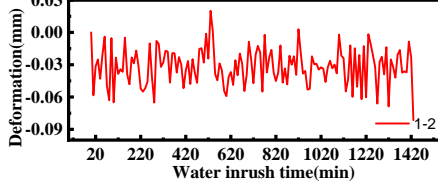
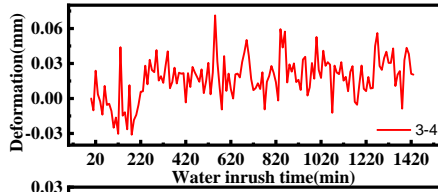


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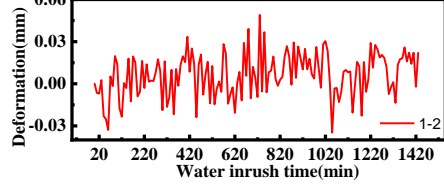
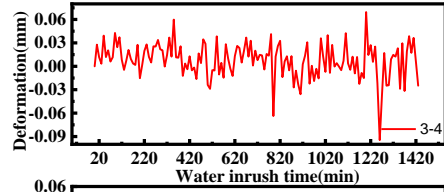


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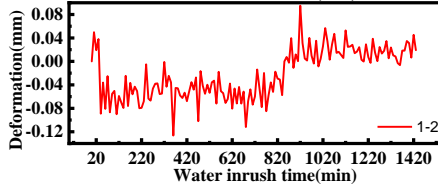
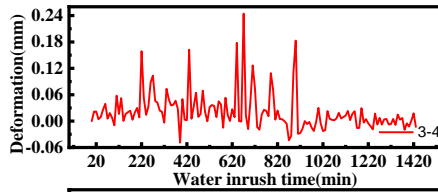
4. Convergence diagram of displacement with time after water inrush in roadway.



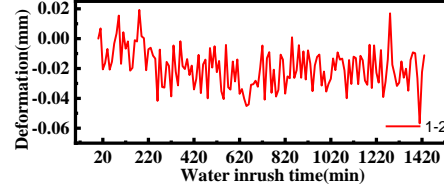
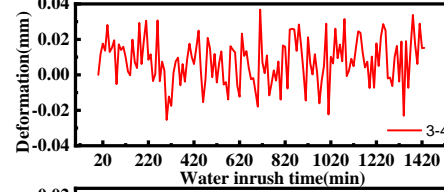
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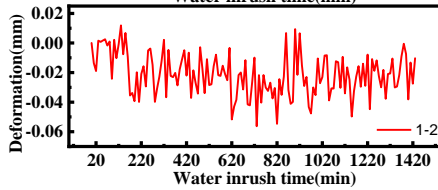
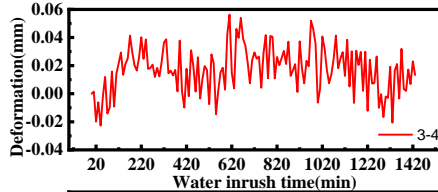
Test-2



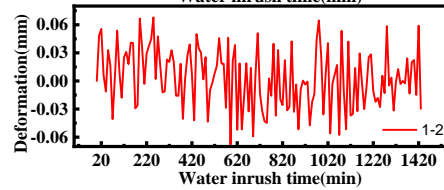
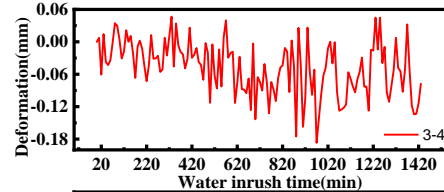
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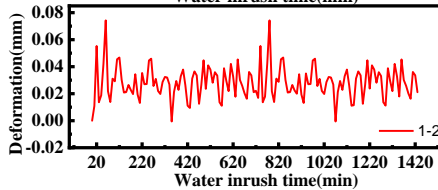
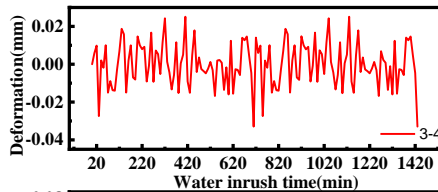
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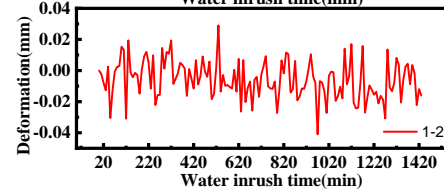
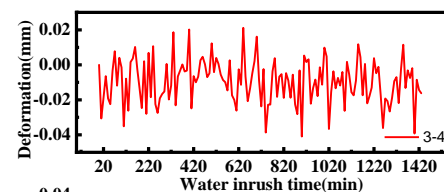
Test-5



Test-6



Test-7



Test-8

5. Numerical simulation of seepage velocity diagram in water inrush process.

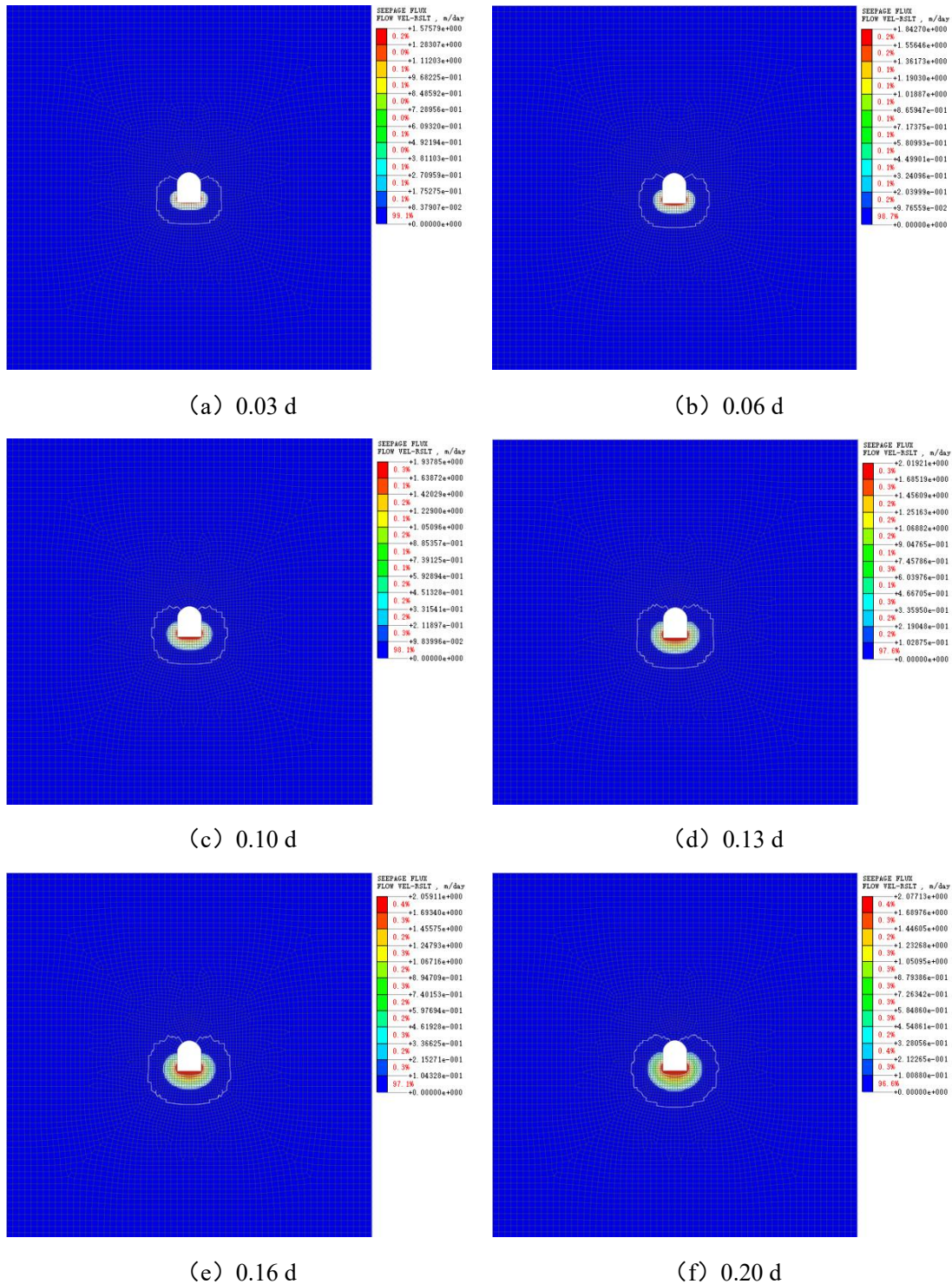
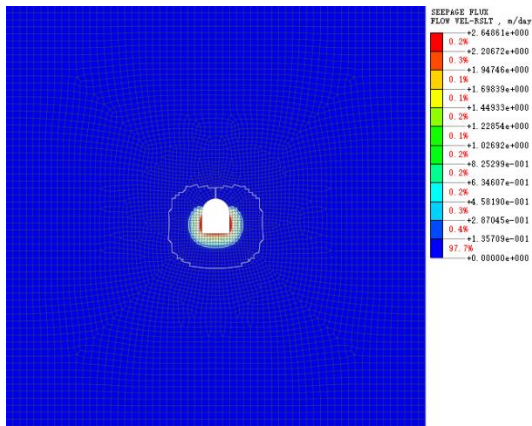
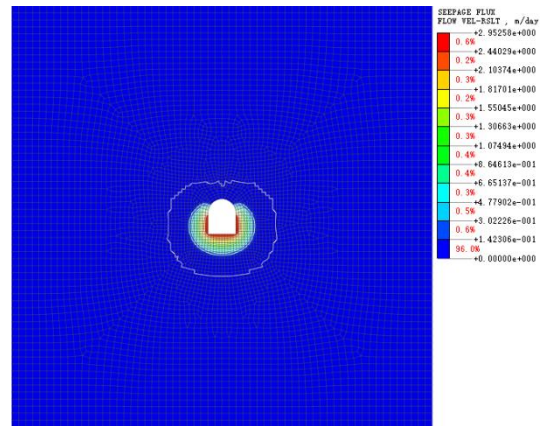


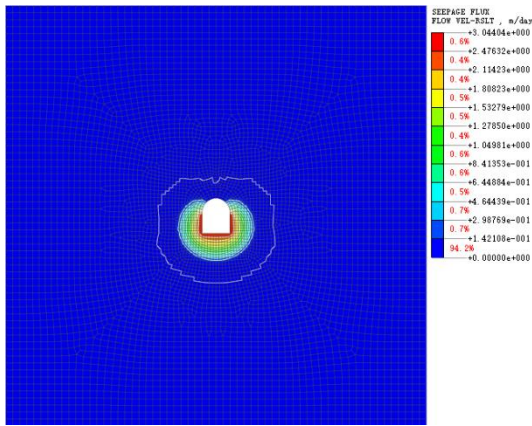
Figure 14. Test-1 Seepage velocity diagram of roadway during water inrush



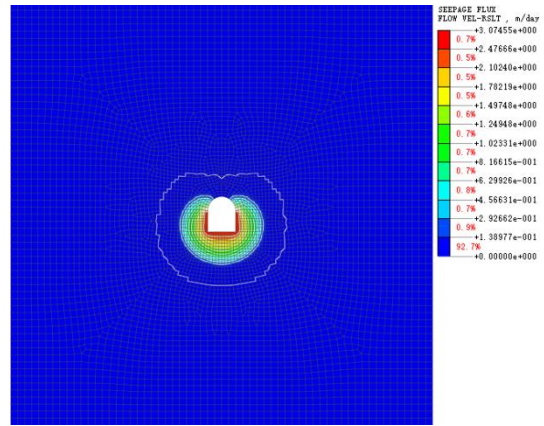
(a) 0.06 d



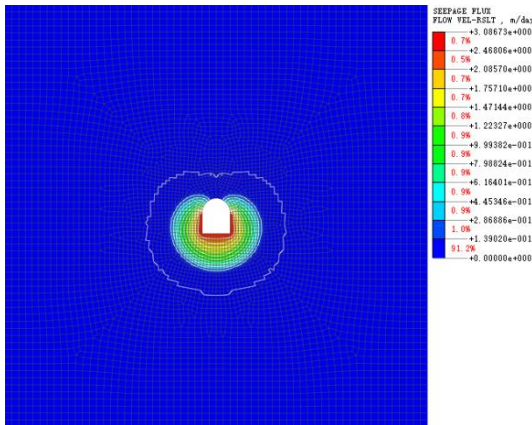
(b) 0.13 d



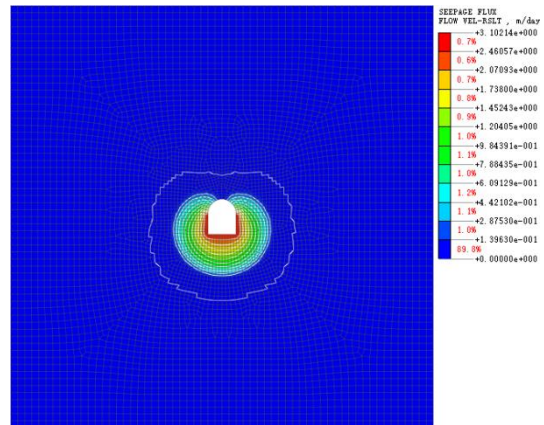
(c) 0.20 d



(d) 0.26 d

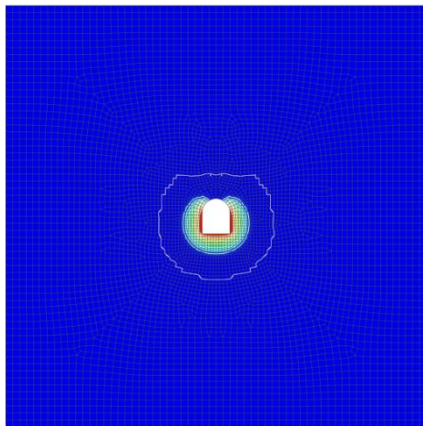


(e) 0.33 d

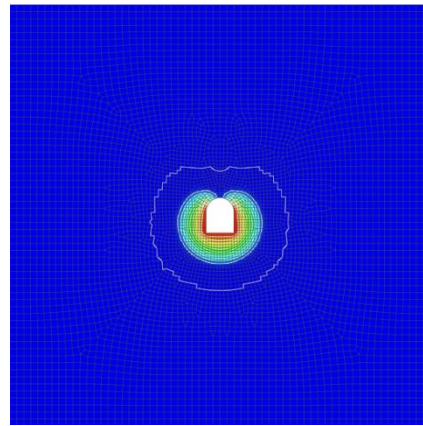


(f) 0.40 d

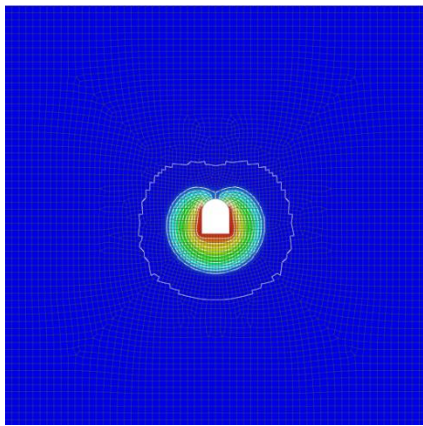
Figure 15. Test-2 Seepage velocity diagram of roadway during water inrush



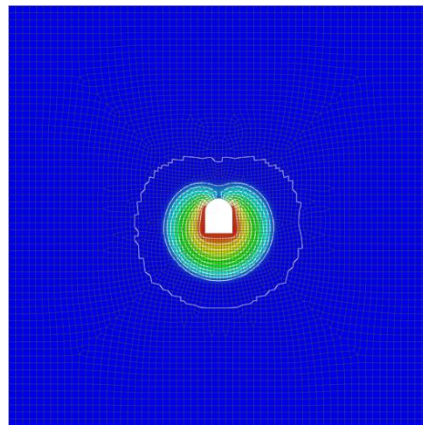
(a) 0.10 d



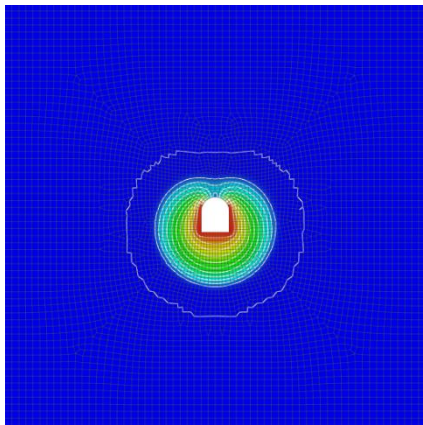
(b) 0.20 d



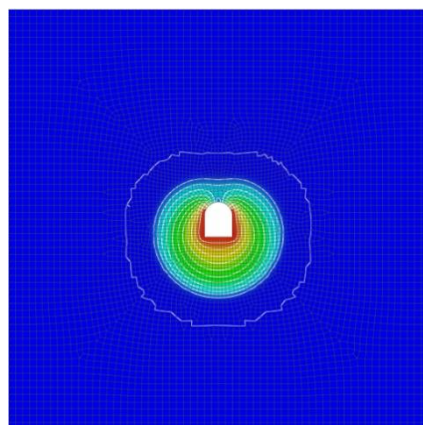
(c) 0.30 d



(d) 0.40 d

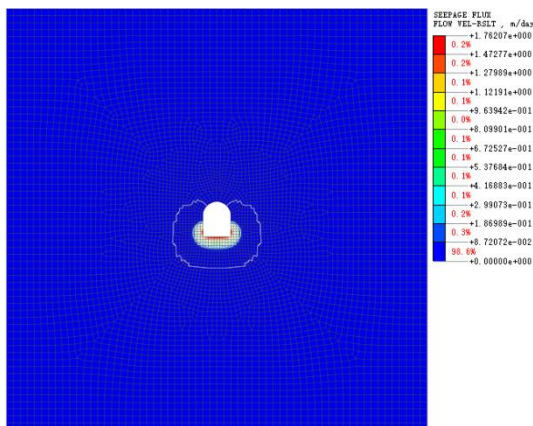


(e) 0.50 d

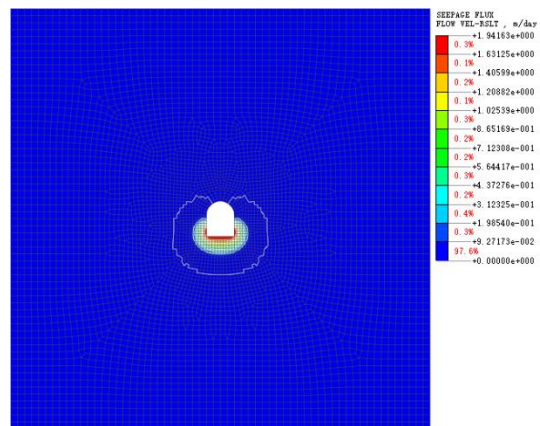


(f) 0.60 d

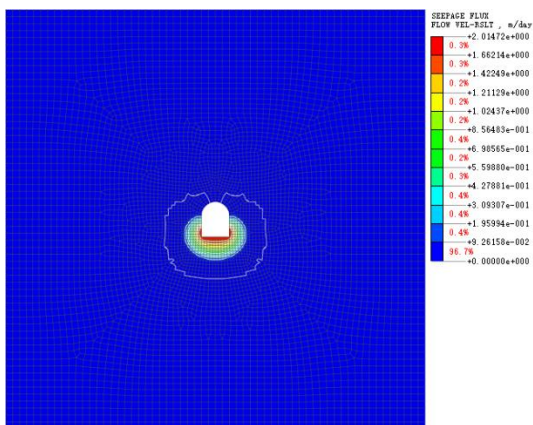
Figure 16. Test-3 Seepage velocity diagram of roadway during water inrush



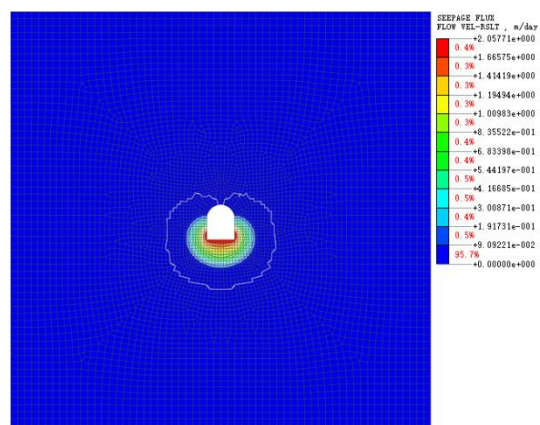
(a) 0.06 d



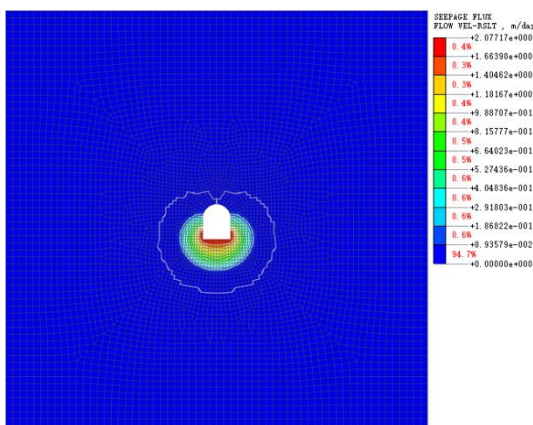
(b) 0.13 d



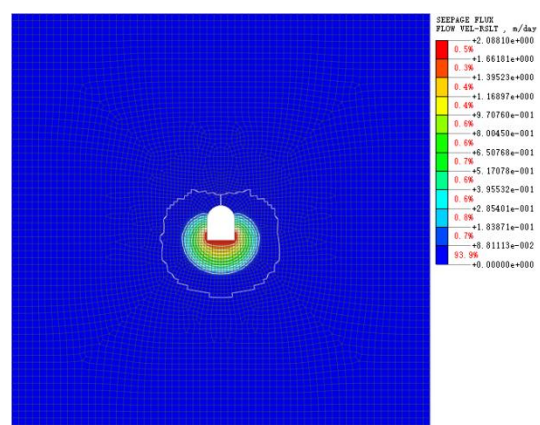
(c) 0.20 d



(d) 0.26 d

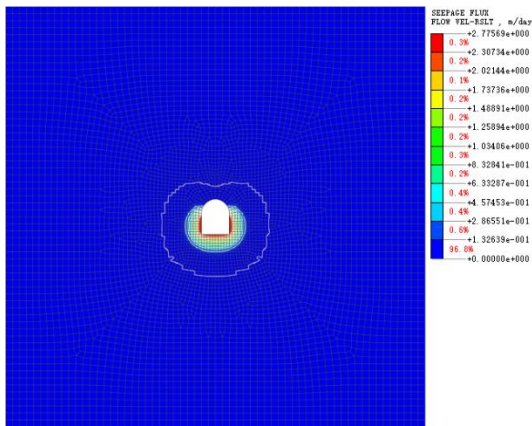


(e) 0.33 d

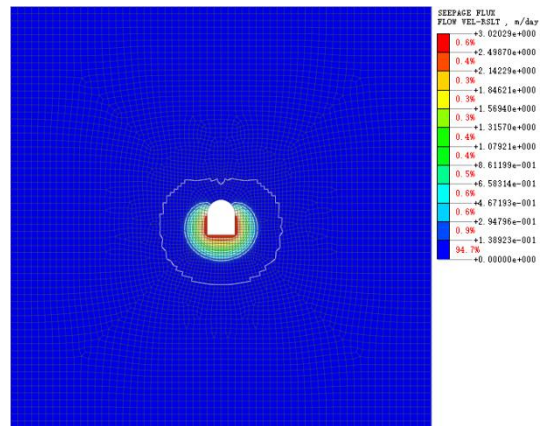


(f) 0.40 d

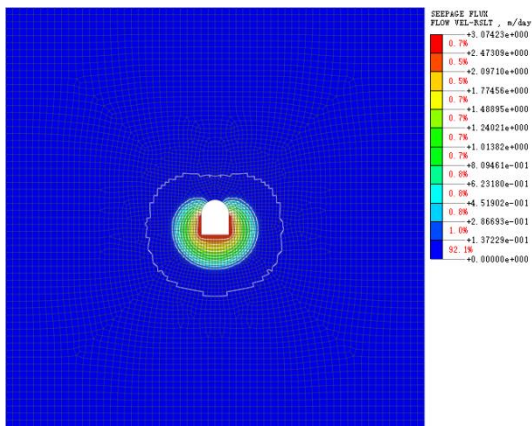
Figure 17. Test-4 Seepage velocity diagram of roadway during water inrush



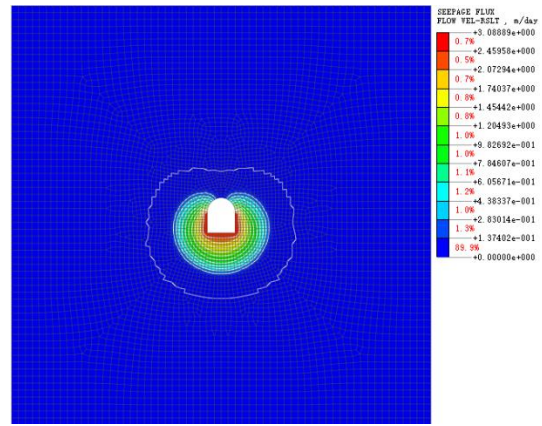
(a) 0.10 d



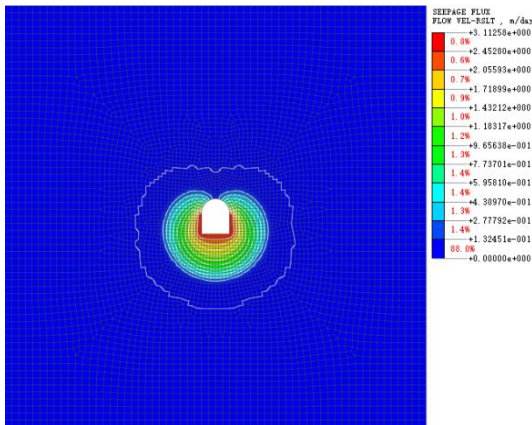
(b) 0.20 d



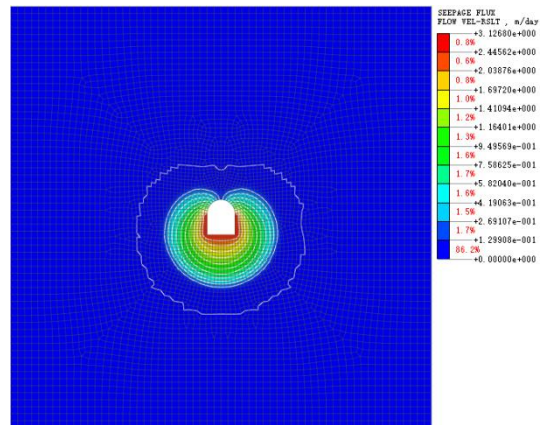
(c) 0.30 d



(d) 0.40 d

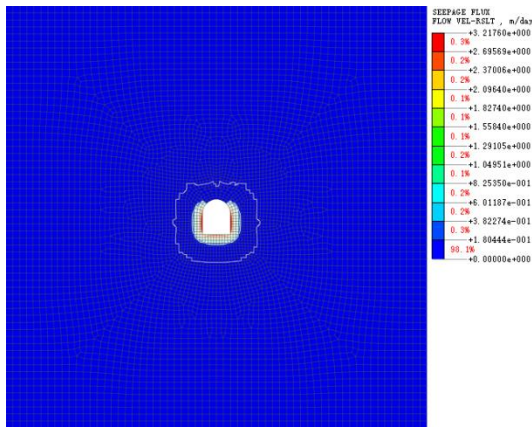


(e) 0.50 d

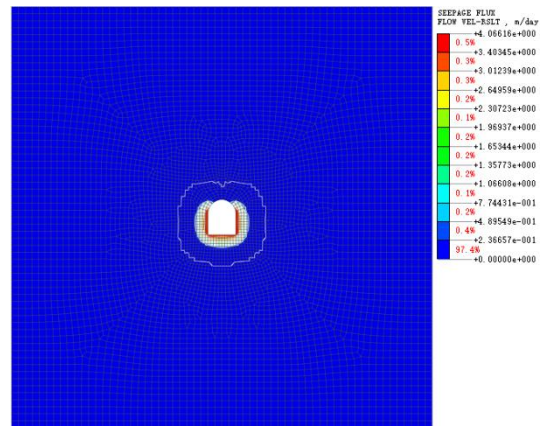


(f) 0.60 d

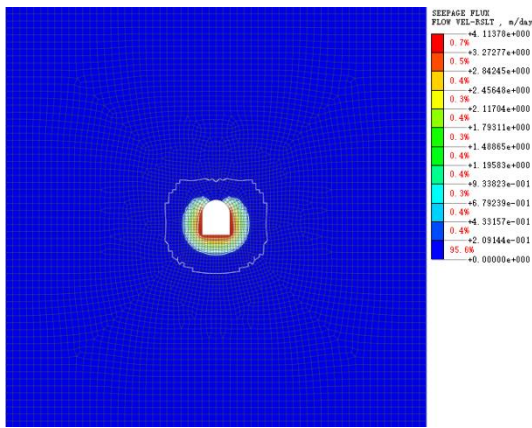
Figure 18. Test-5 Seepage velocity diagram of roadway during water inrush



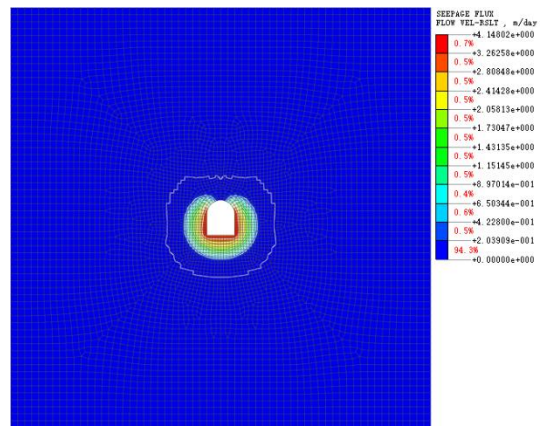
(a) 0.03 d



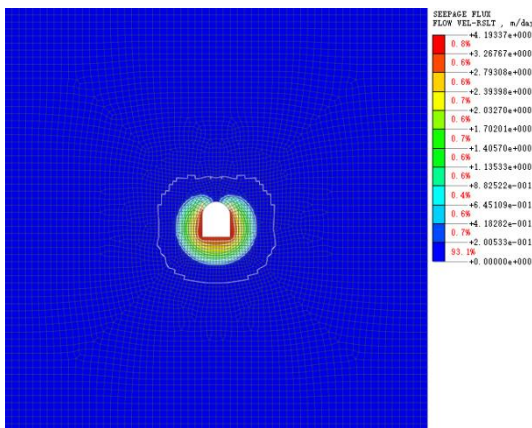
(b) 0.06 d



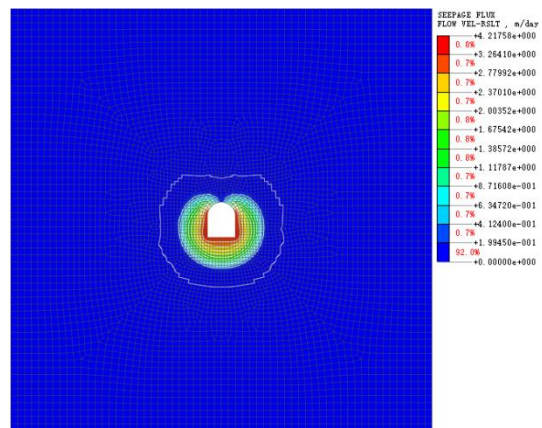
(c) 0.10 d



(d) 0.13 d

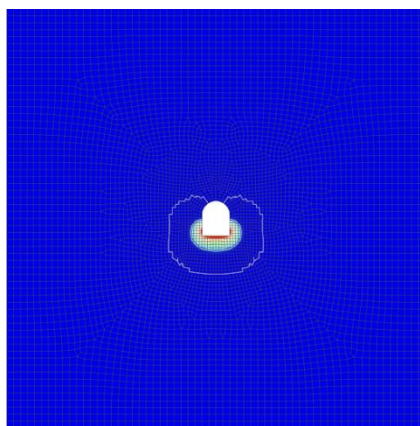


(e) 0.16 d

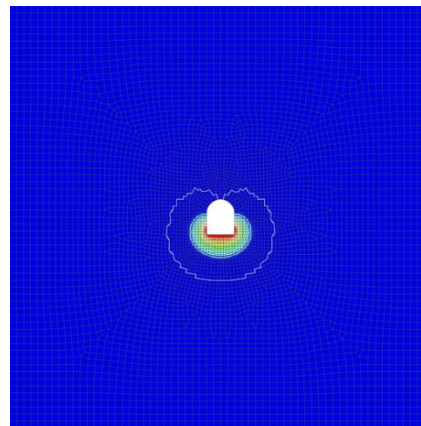


(f) 0.20 d

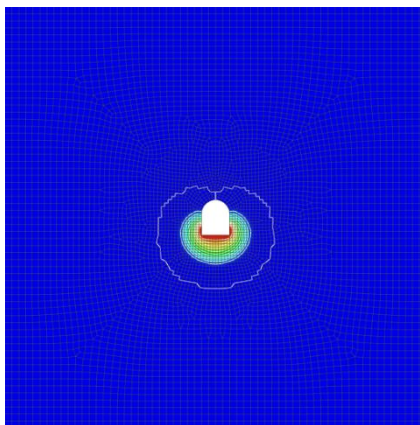
Figure 19. Test-6 Seepage velocity diagram of roadway during water inrush



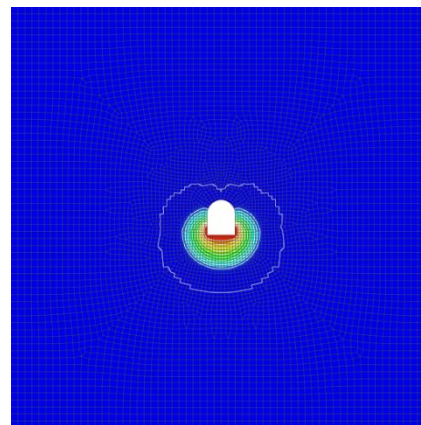
(a) 0.10 d



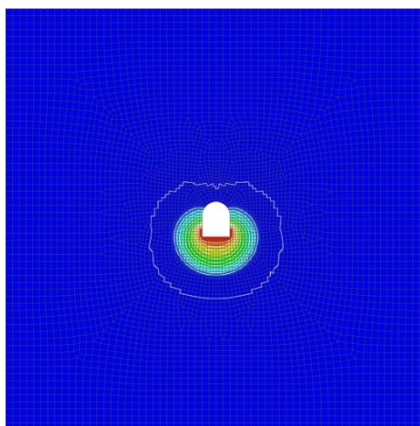
(b) 0.20 d



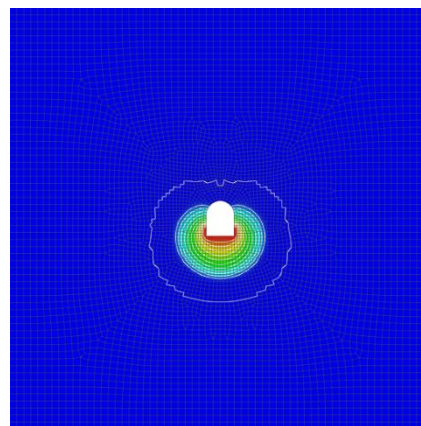
(c) 0.30 d



(d) 0.40 d

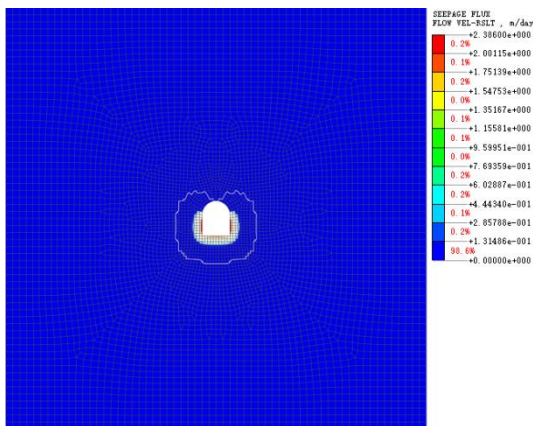


(e) 0.50 d

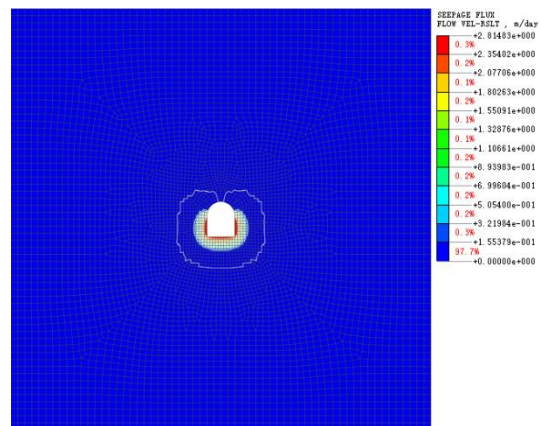


(f) 0.60 d

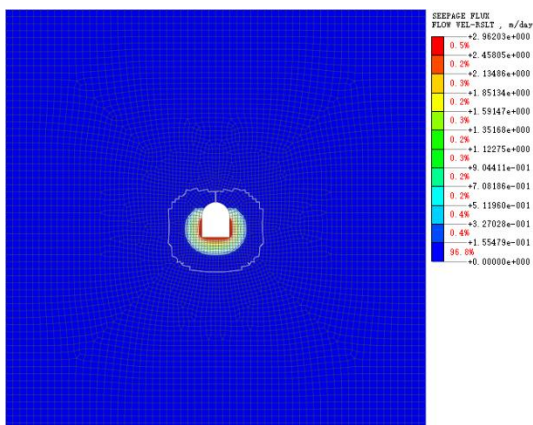
Figure 20. Test-7 Seepage velocity diagram of roadway during water inrush



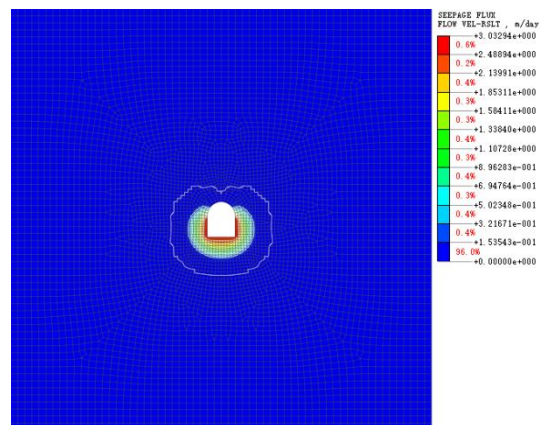
(a) 0.03 d



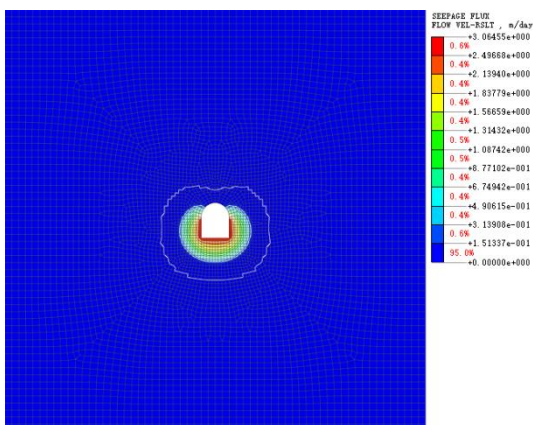
(b) 0.06 d



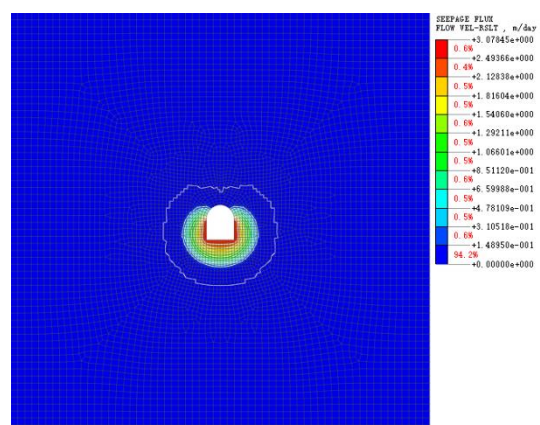
(c) 0.10 d



(d) 0.13 d

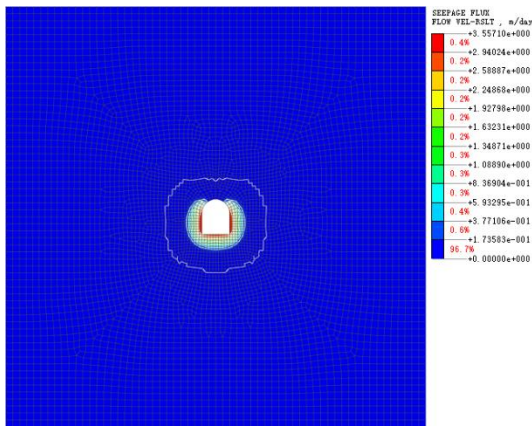


(e) 0.16 d

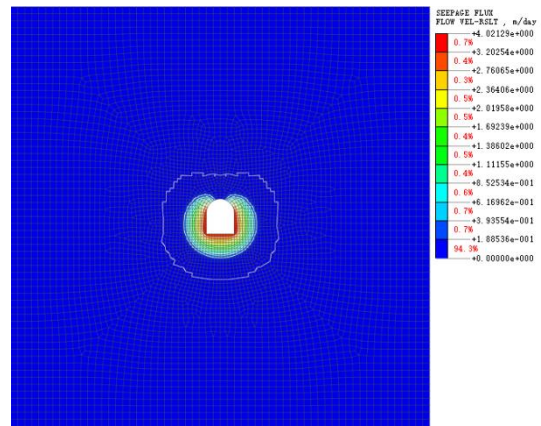


(f) 0.20 d

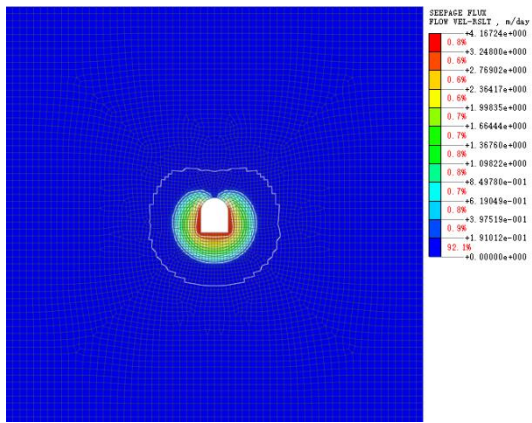
Figure 21. Test-8 Seepage velocity diagram of roadway during water inrush



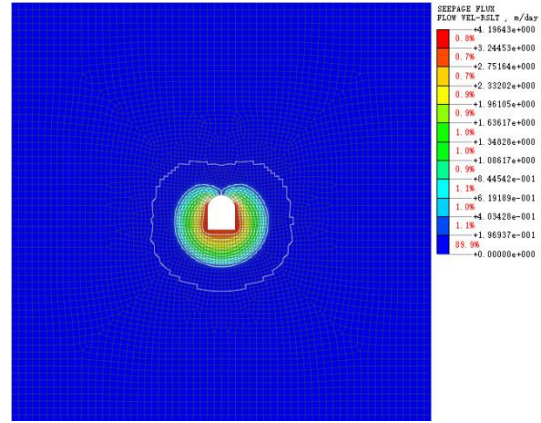
(a) 0.06 d



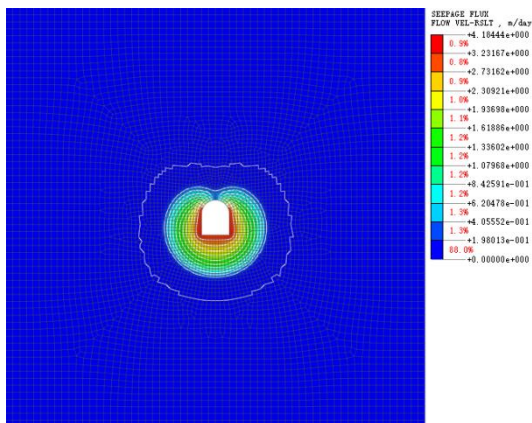
(b) 0.13 d



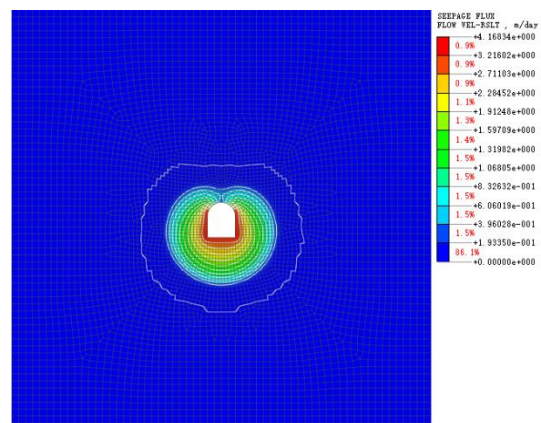
(c) 0.20 d



(d) 0.26 d



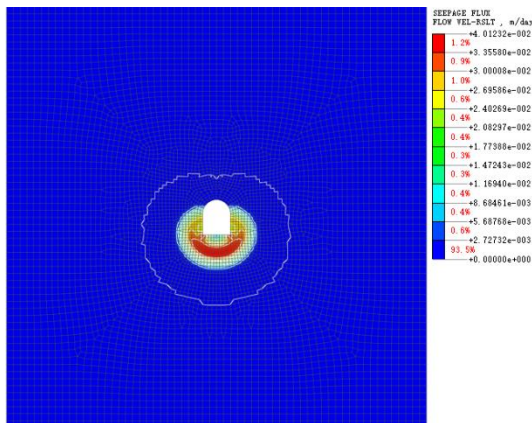
(e) 0.33 d



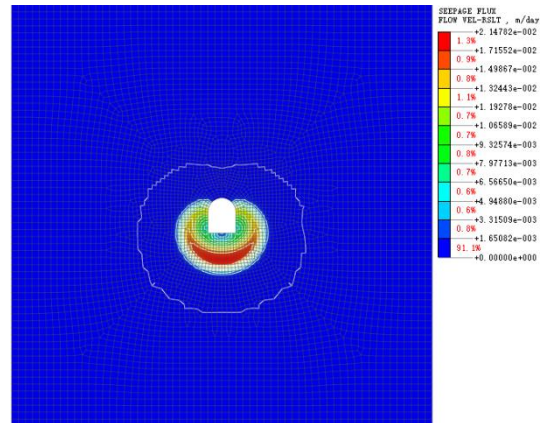
(f) 0.40 d

Figure 21. Test-9 Seepage velocity diagram of roadway during water inrush

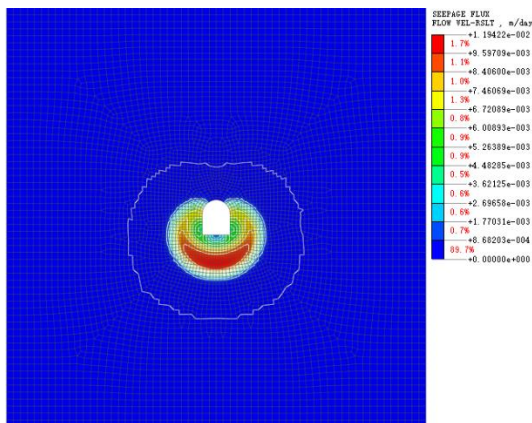
6. Numerical simulation of seepage velocity diagram after water inrush in roadway.



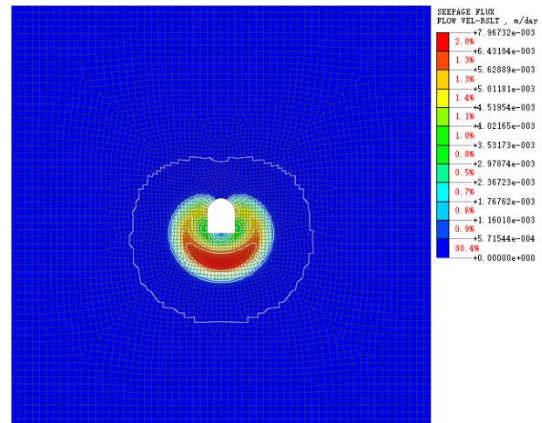
(a) 1 d



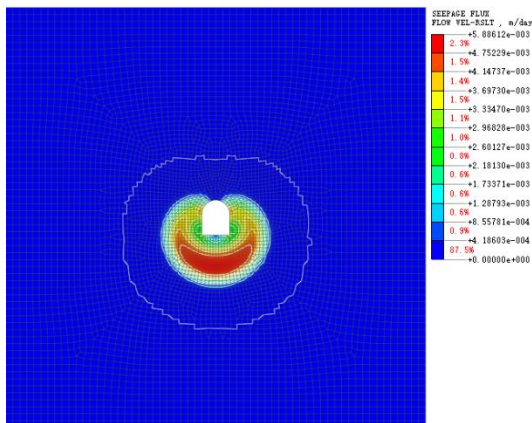
(b) 2 d



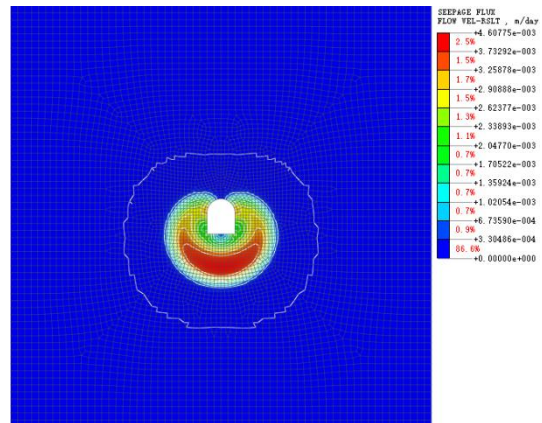
(c) 3 d



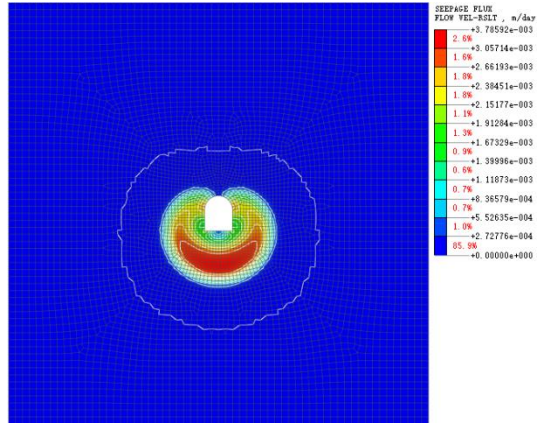
(d) 4 d



(e) 5 d

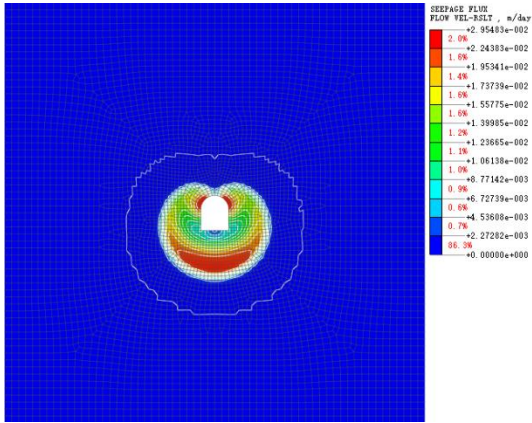


(f) 6 d

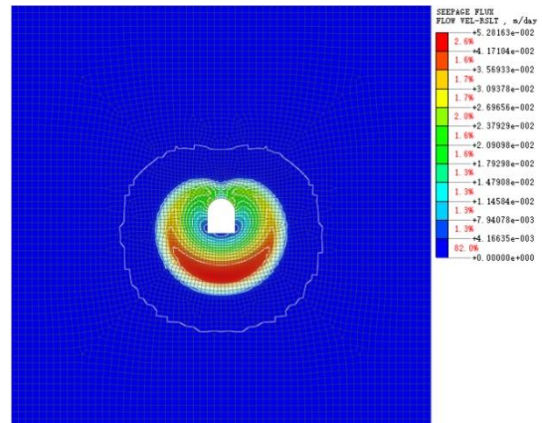


(g) 7 d

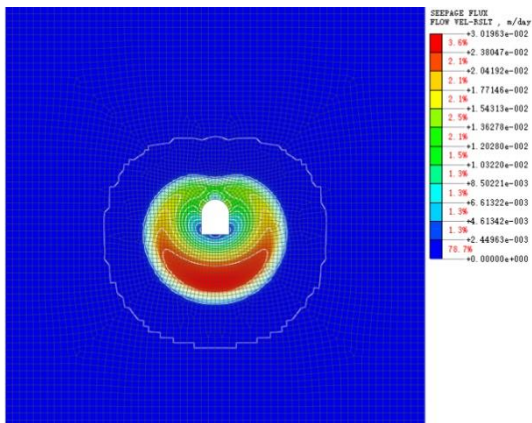
Figure 22. Test-1 Seepage velocity diagram of roadway after water inrush



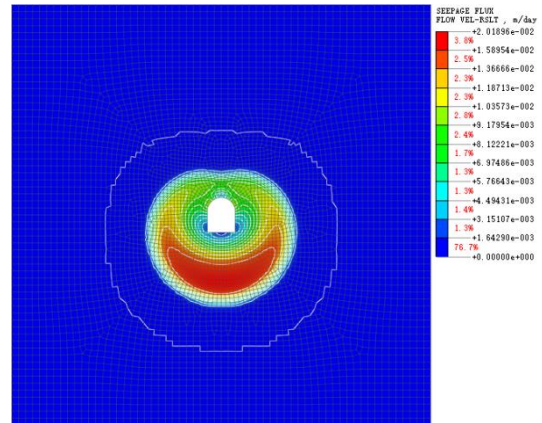
(a) 1 d



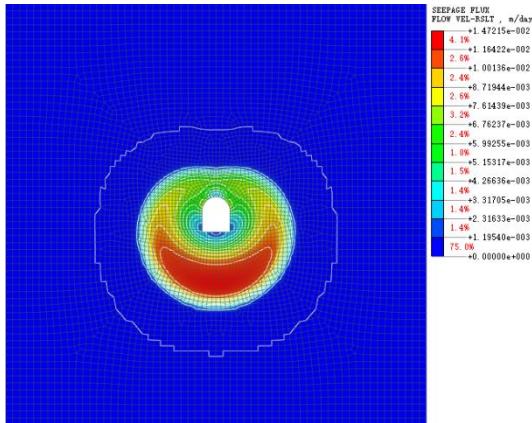
(b) 2 d



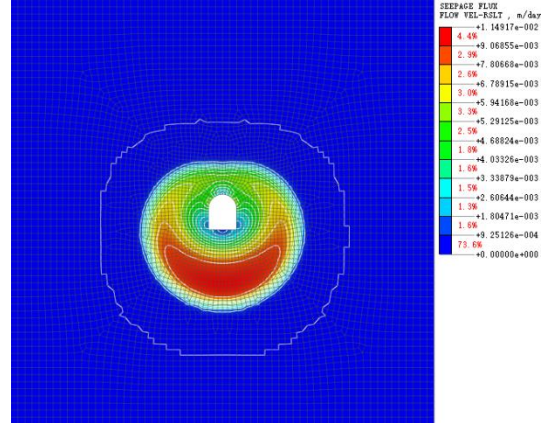
(c) 3 d



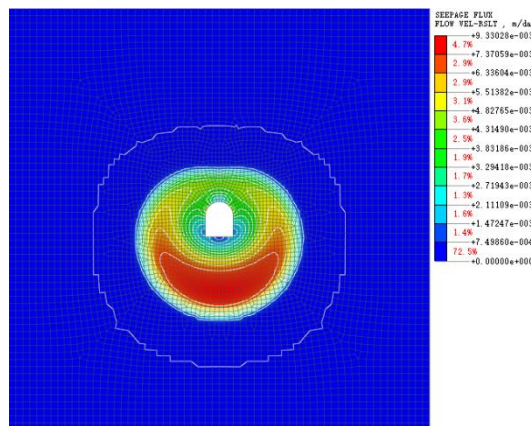
(d) 4 d



(e) 5 d

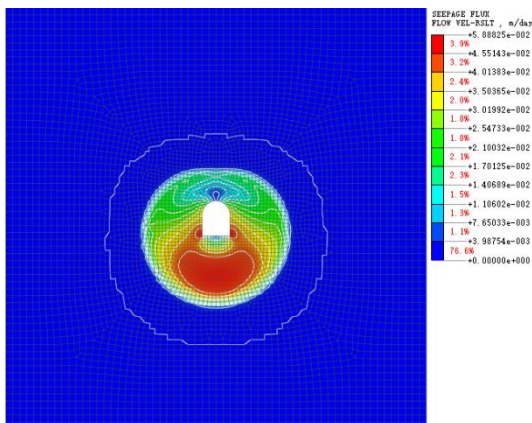


(f) 6 d

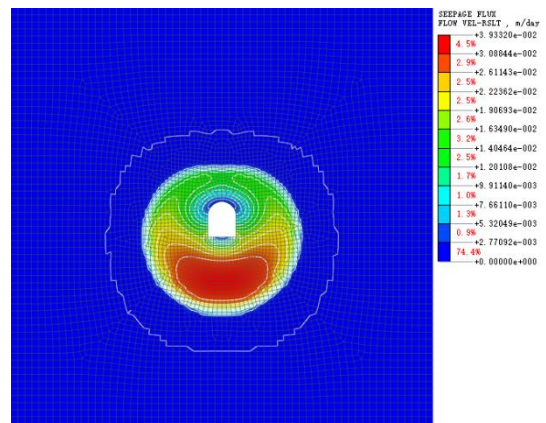


(g) 7 d

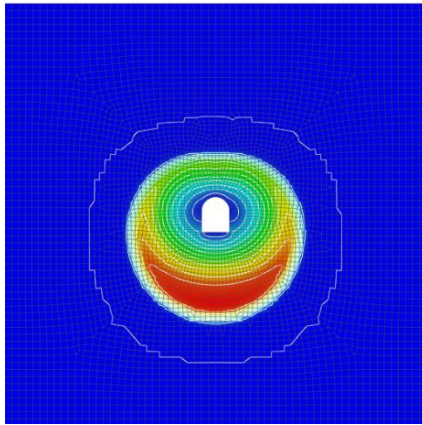
Figure 23. Test-2 Seepage velocity diagram of roadway after water inrush



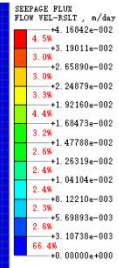
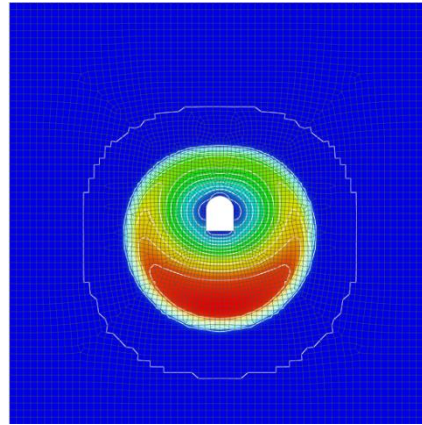
(a) 1 d



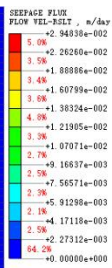
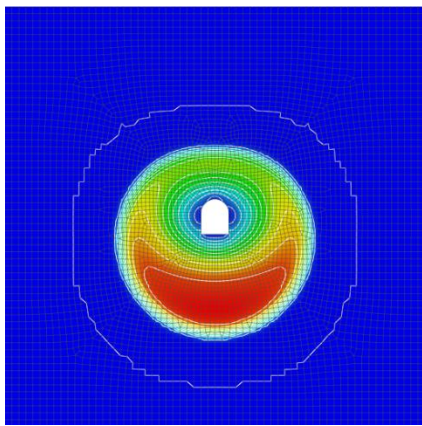
(b) 2 d



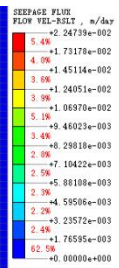
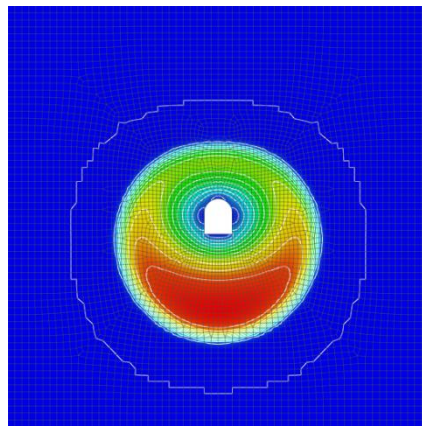
(c) 3 d



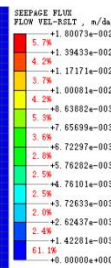
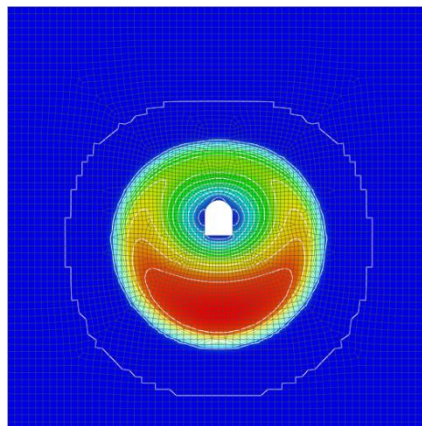
(d) 4 d



(e) 5 d

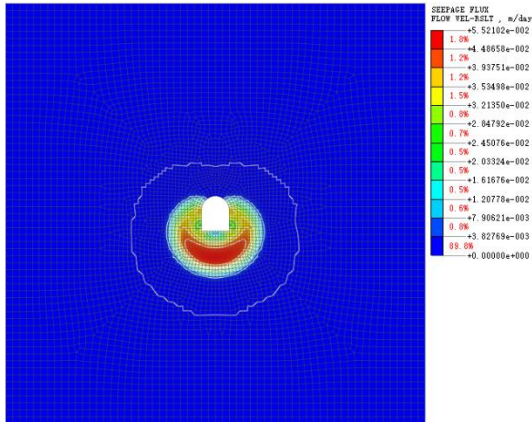


(f) 6 d

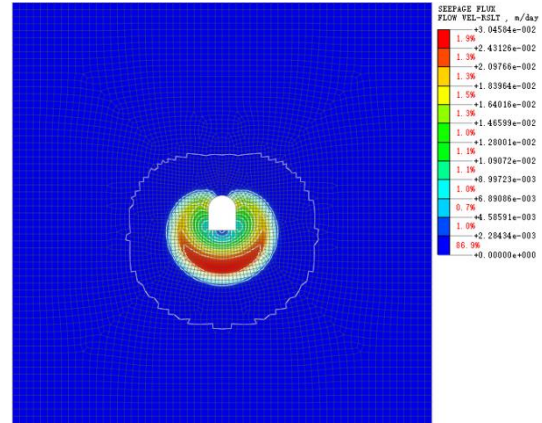


(g) 7 d

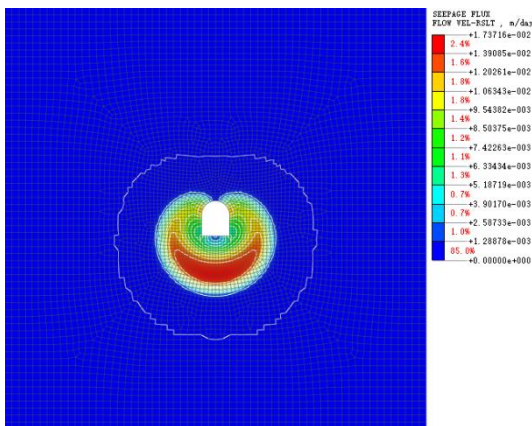
Figure 24. Test-3 Seepage velocity diagram of roadway after water inrush



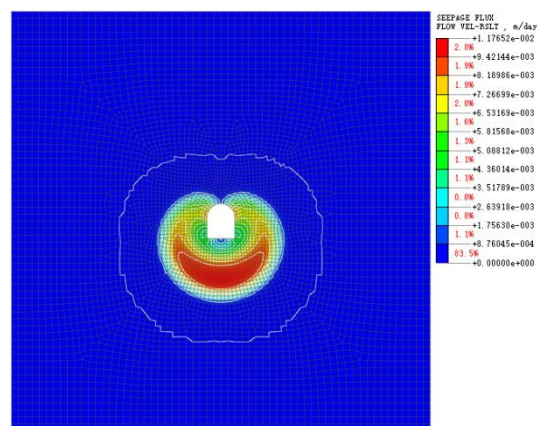
(a) 1 d



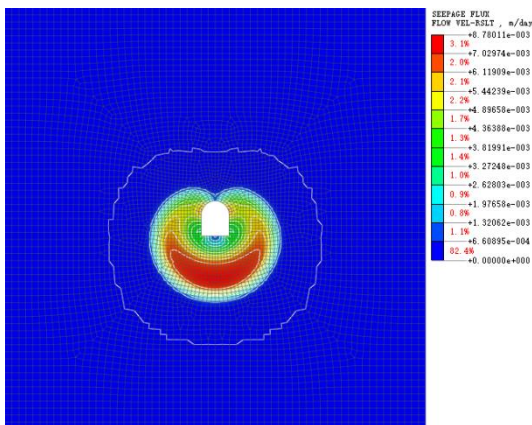
(b) 2 d



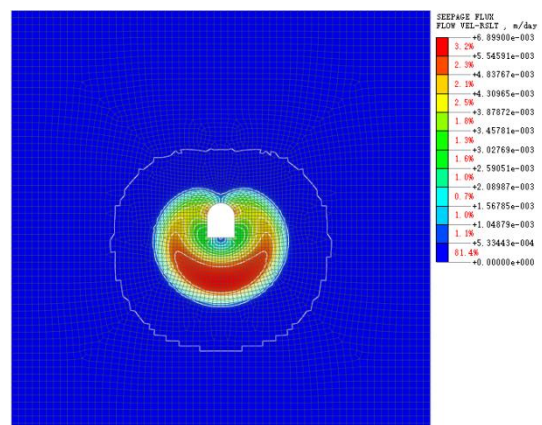
(c) 3 d



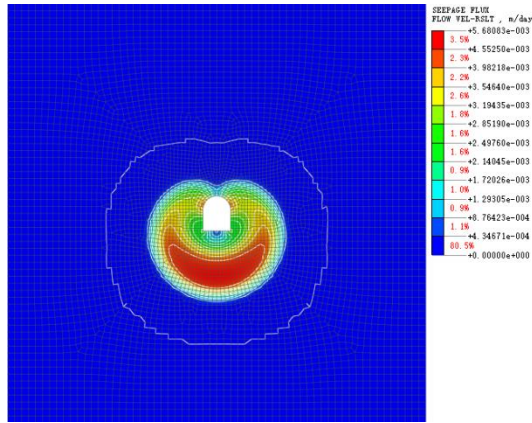
(d) 4 d



(e) 5 d

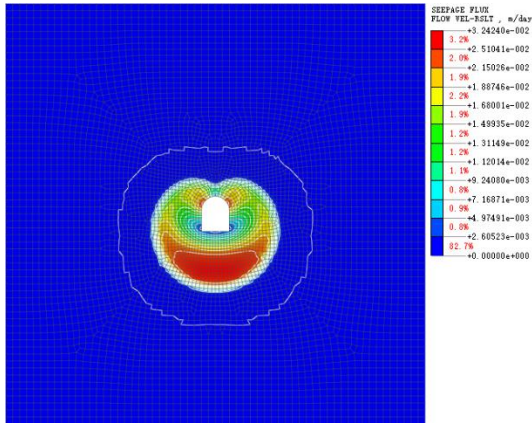


(f) 6 d

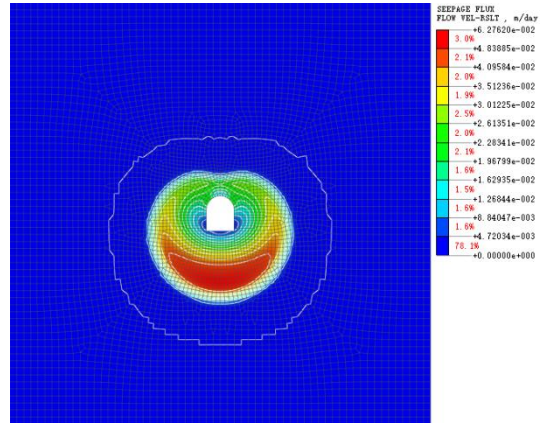


(g) 7 d

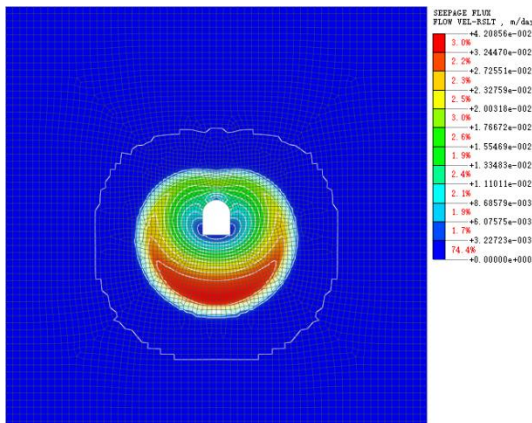
Figure 25. Test-4 Seepage velocity diagram of roadway after water inrush



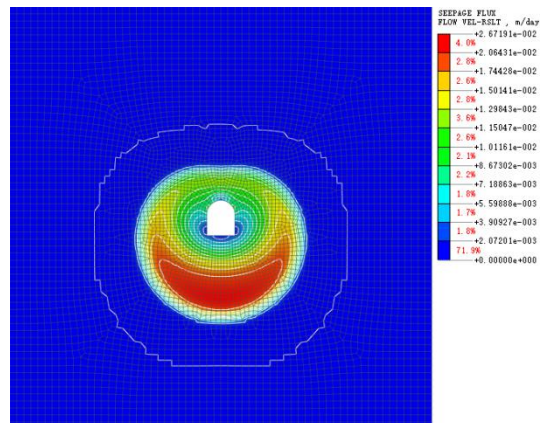
(a) 1 d



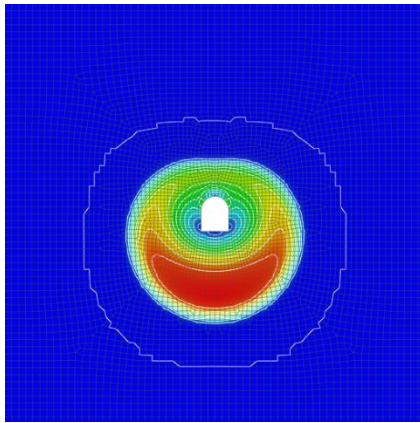
(b) 2 d



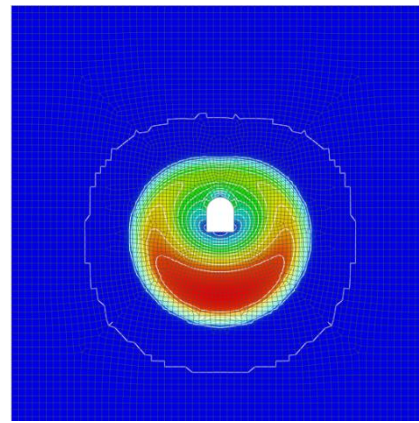
(c) 3 d



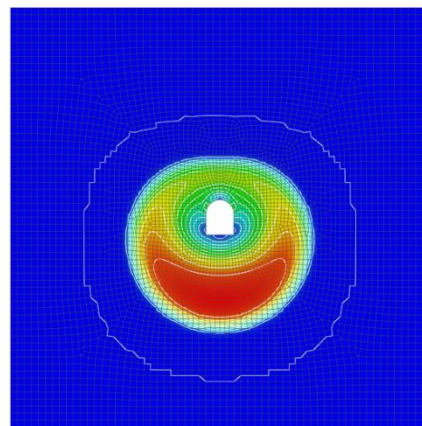
(d) 4 d



(e) 5 d

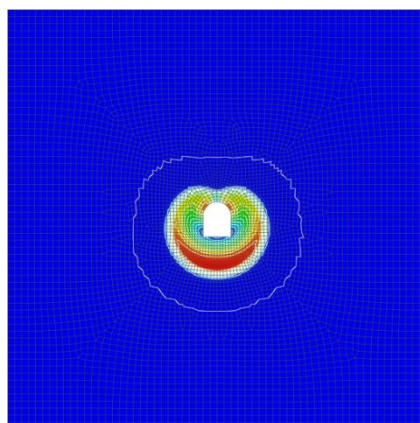


(f) 6 d

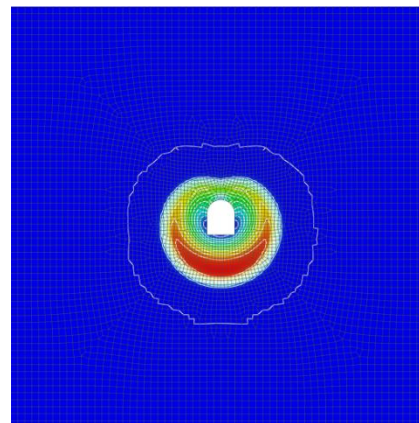


(g) 7 d

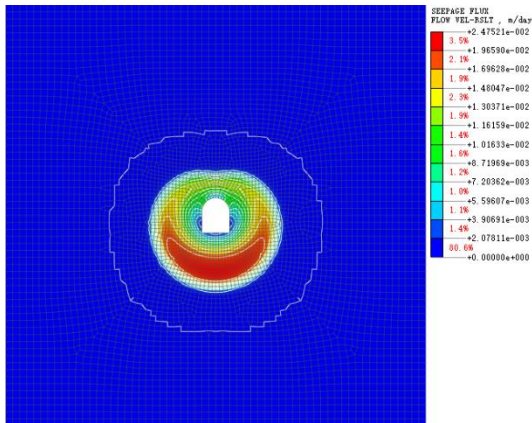
Figure 26. Test-5 Seepage velocity diagram of roadway after water inrush



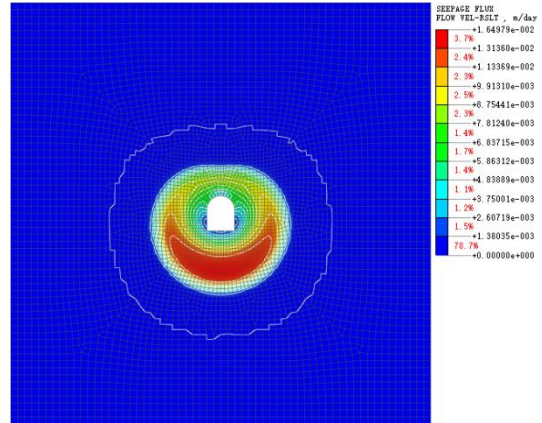
(a) 1 d



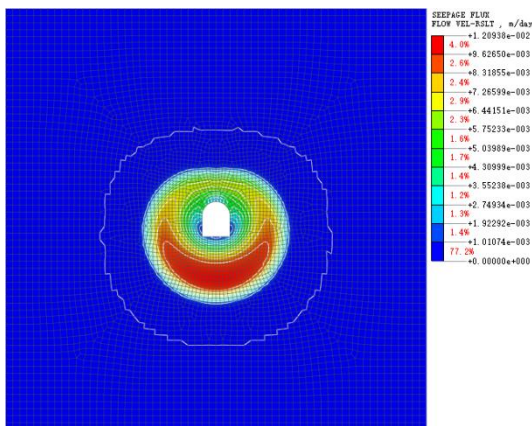
(b) 2 d



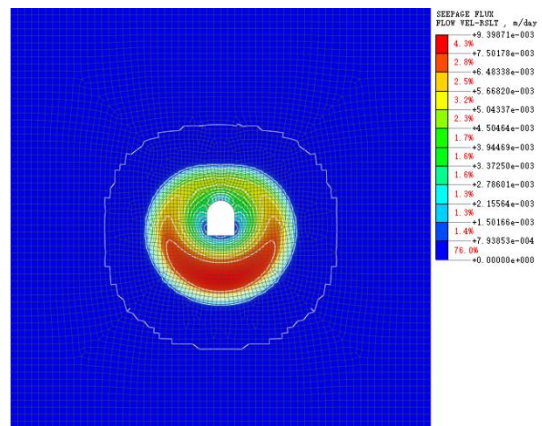
(c) 3 d



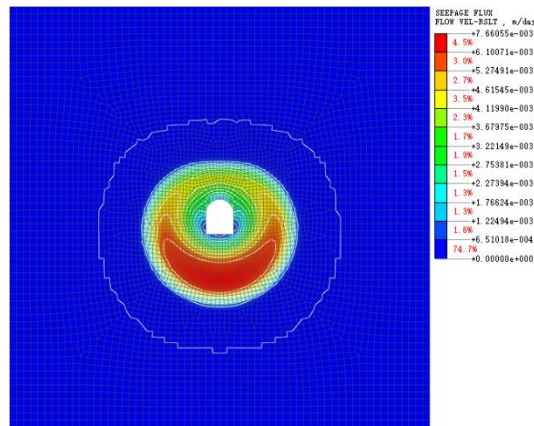
(d) 4 d



(e) 5 d

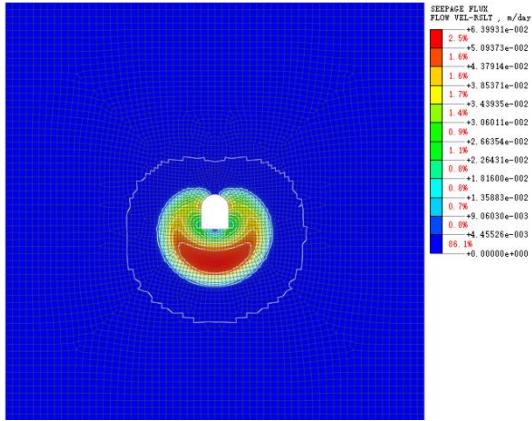


(f) 6 d

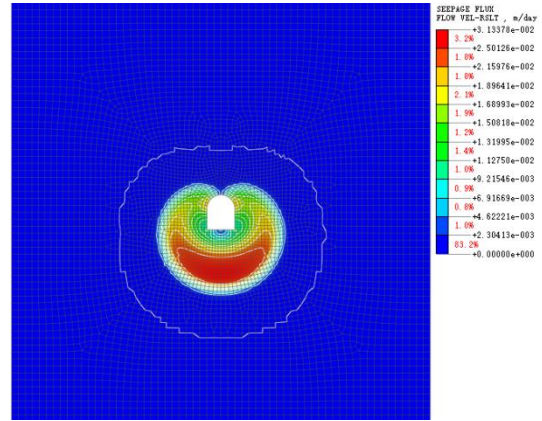


(g) 7 d

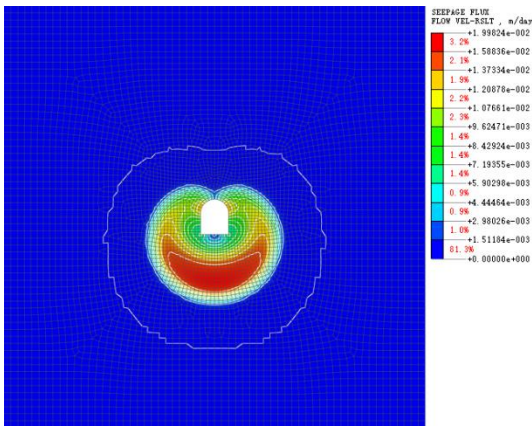
Figure 27. Test-6 Seepage velocity diagram of roadway after water inrush



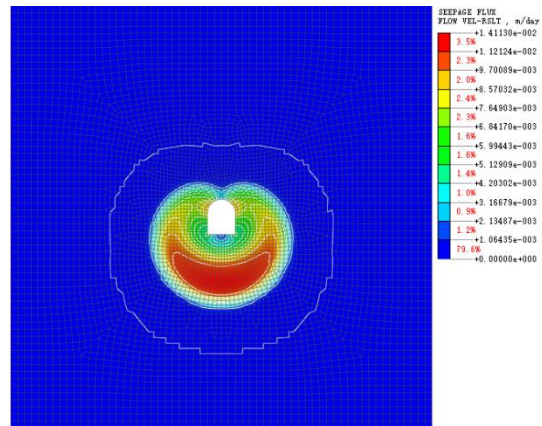
(a) 1 d



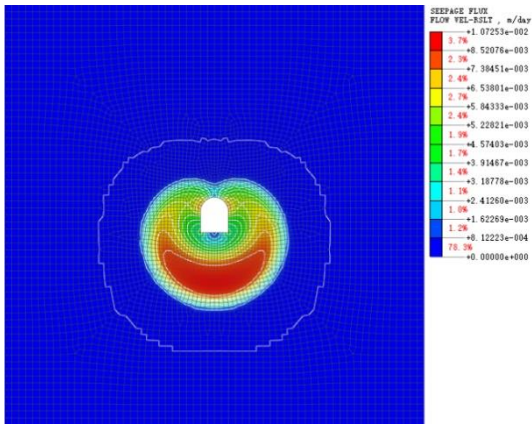
(b) 2 d



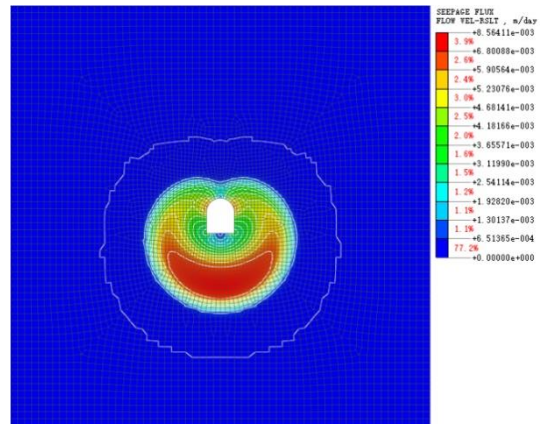
(c) 3 d



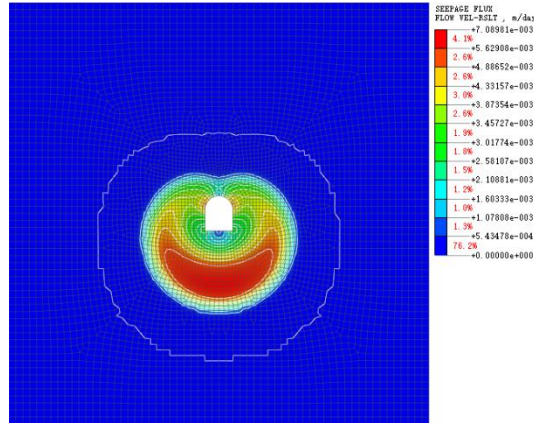
(d) 4 d



(e) 5 d

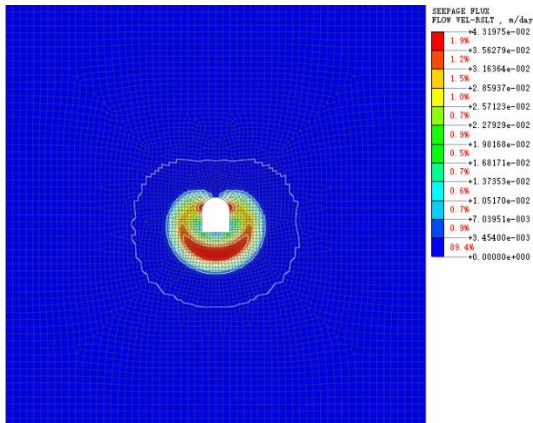


(f) 6 d

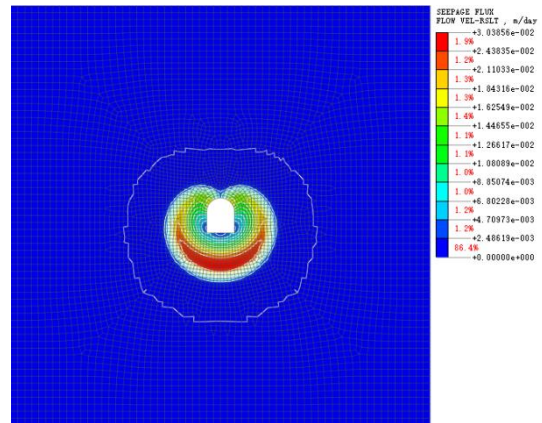


(g) 7 d

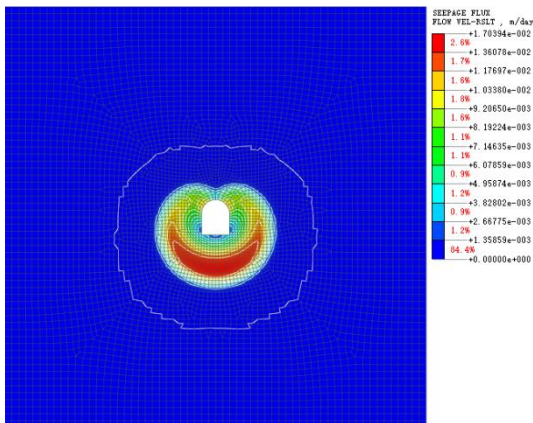
Figure 28. Test-7 Seepage velocity diagram of roadway after water inrush



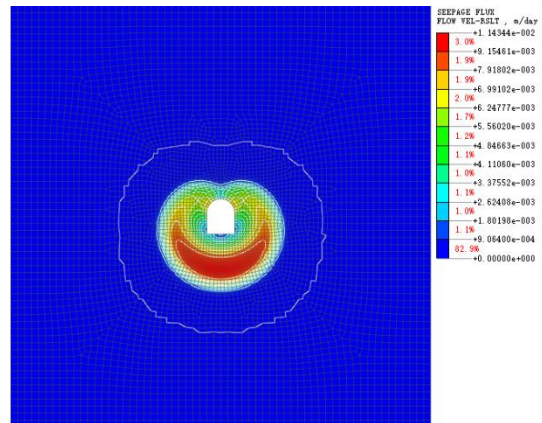
(a) 1 d



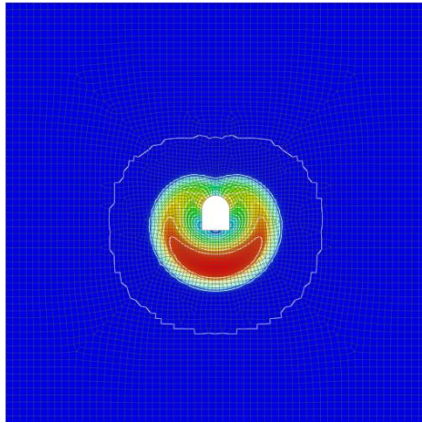
(b) 2 d



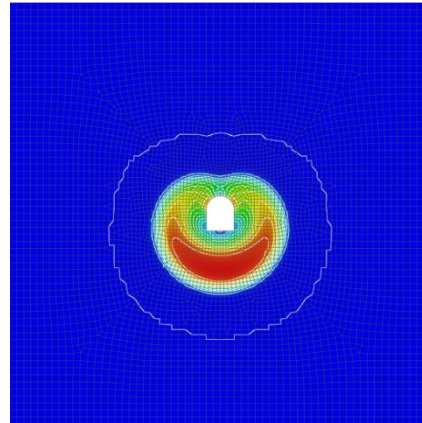
(c) 3 d



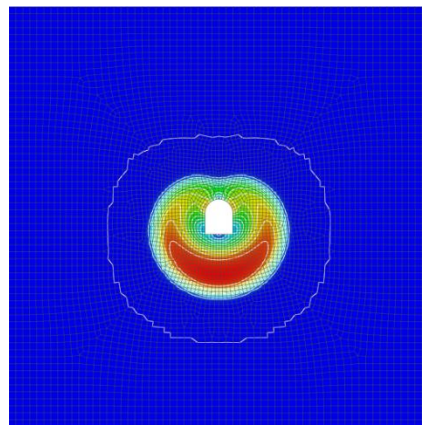
(d) 4 d



(e) 5 d

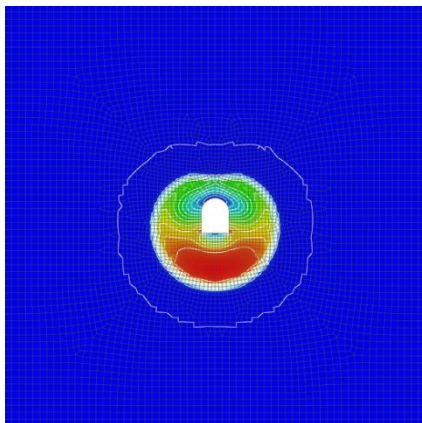


(f) 6 d

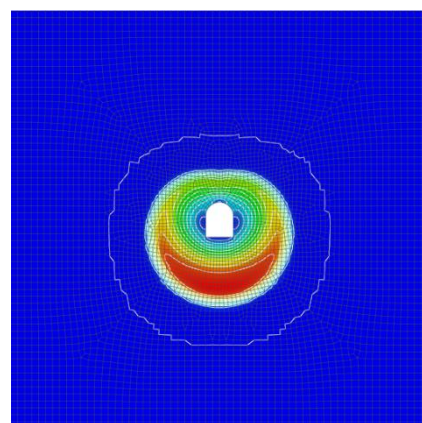


(g) 7 d

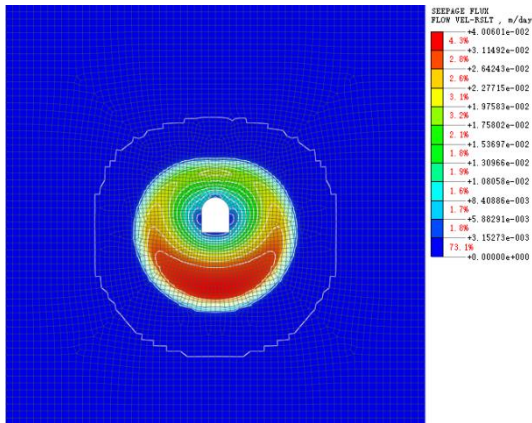
Figure 29. Test-8 Seepage velocity diagram of roadway after water inrush



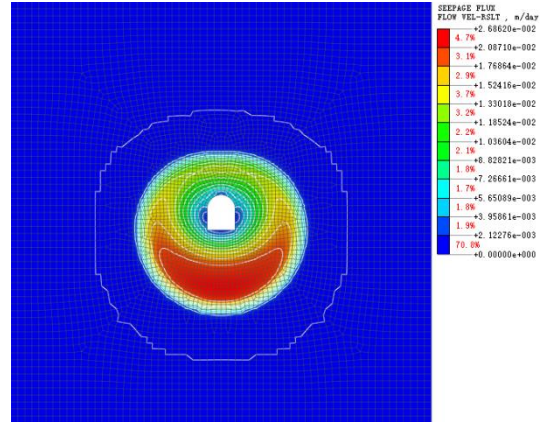
(a) 1 d



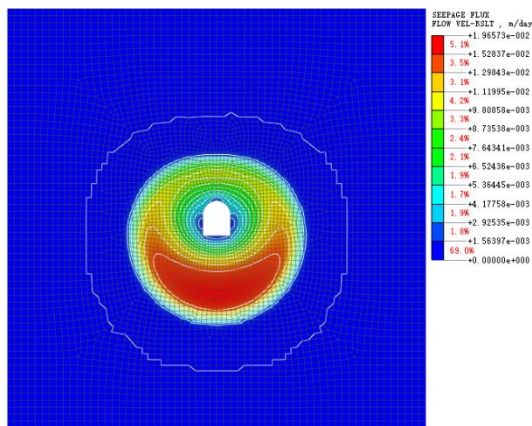
(b) 2 d



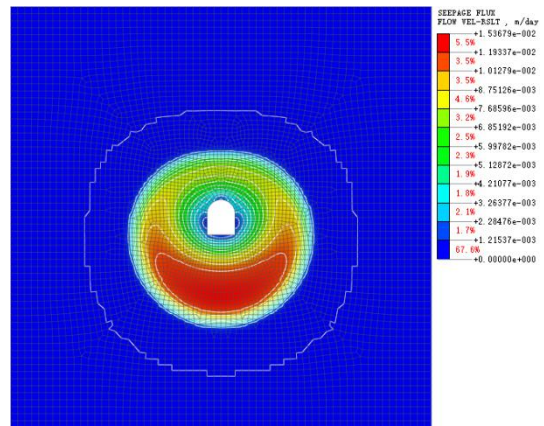
(c) 3 d



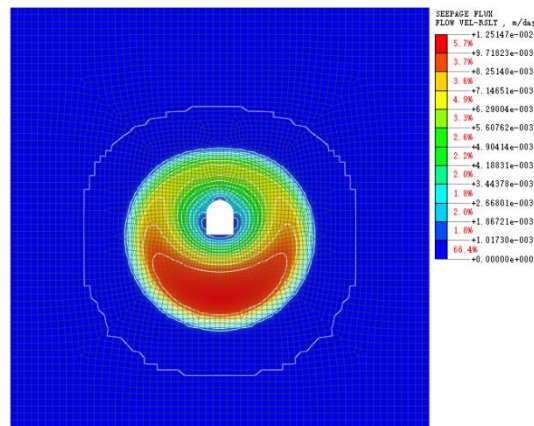
(d) 4 d



(e) 5 d



(f) 6 d



(g) 7 d

Figure 30. Test-9 Seepage velocity diagram of roadway after water inrush