



Failure of a MSE Wall without External Drainage

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1st Failure situation

1. Blocks collapsed forward into the access road.
2. RC walls (x2) fell.
3. 1 car buried.
1 car damaged.



After 1st Failure (16 JUL. 2025)

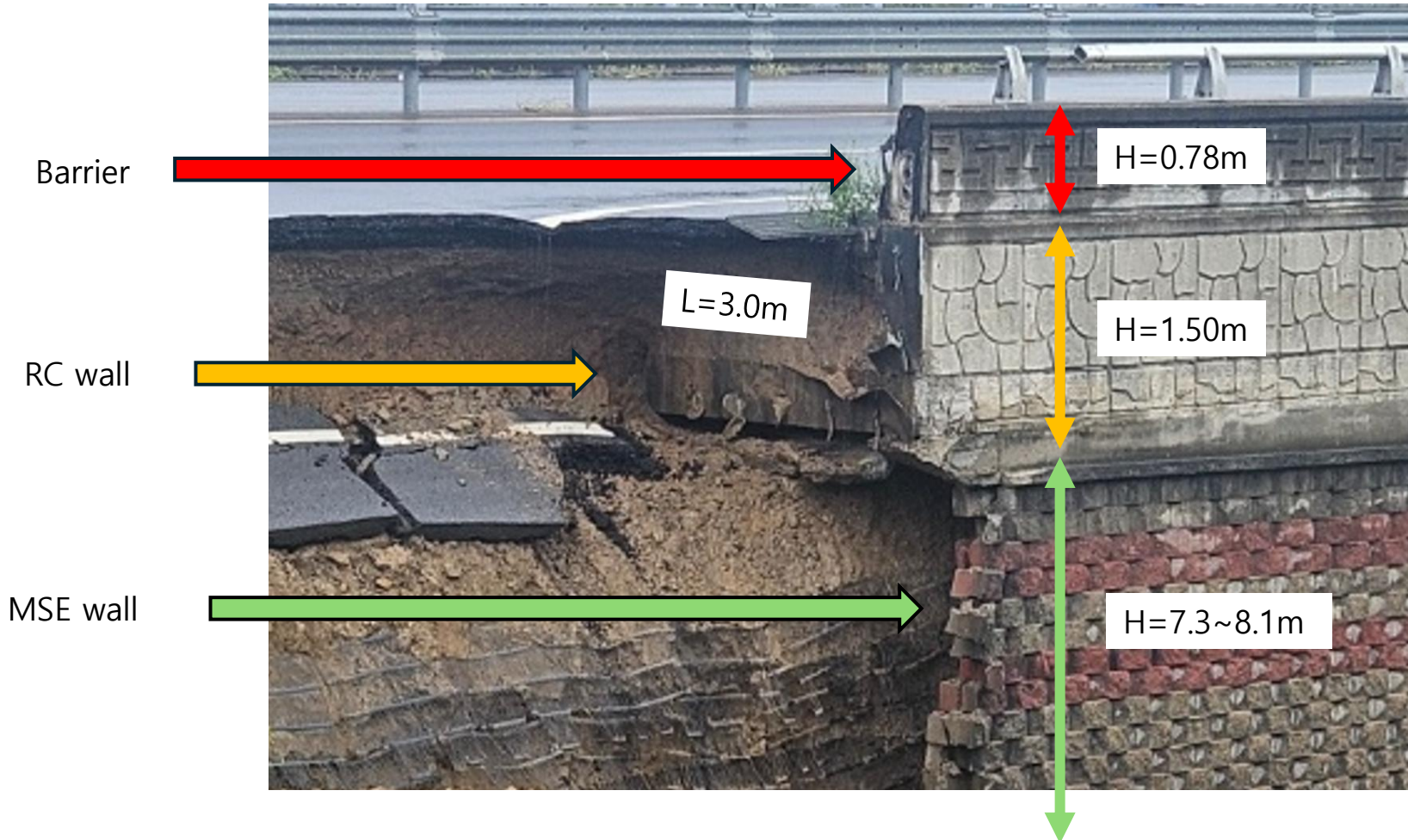
1st Failure of MSE wall (L=40m): MSE wall + Two RC wall segments



Aerial view: 2025-07-29

After 2nd Failure

2nd Failure part of MSE wall (L=20m): MSE wall + RC wall segment



Design spec. from FHWA (2001)



U. S. Department of Transportation
Federal Highway Administration

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NHI Courses No. 132042 and 132043

Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume I

Developed following:

*AASHTO LRFD Bridge Design
Specifications, 4th Edition, 2007,
with 2008 and 2009 Interims.*

and

*AASHTO LRFD Bridge Construction
Specifications, 2nd Edition, 2004, with
2006, 2007, 2008, and 2009 Interims.*

Design spec. for MSE walls came from FHWA (2001), but ignored most of recommendations for internal and external drains



Possible causes of MSE wall failure

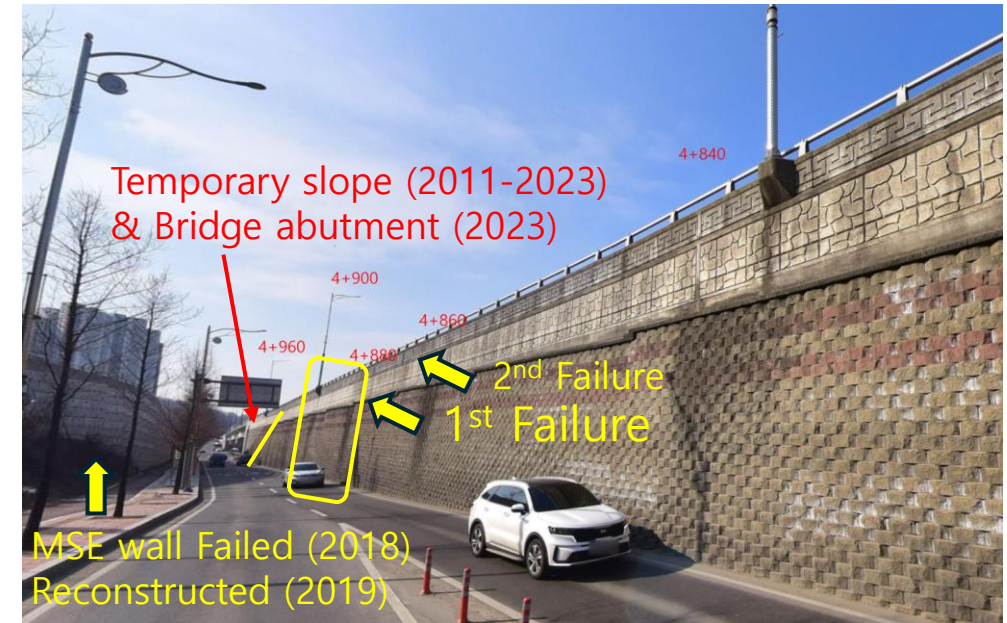
1. Geology of foundation (valley)
2. Lack of Reinforcement dimensions (Design/Construction length and intervals)
3. Lack of Reinforcement strength
4. Reduction of Block dimension (470mm length to 400mm)
5. Railfall (overflow of drainage duct)
6. **No external drainage** (Drainage of inside water to outside)
7. Frequent development of potholes
8. Water inflow from Foundation, Road cracks, Potholes and Drainage duct
9. Lack of maintenance

No drainage

- Long MSE wall (L=350m)
- Low permeability of block wall relative to filter layer
- No internal drainage pipe
- No external drainage pipe/hole
- Strong inflow action of Filter layer behind the blocks

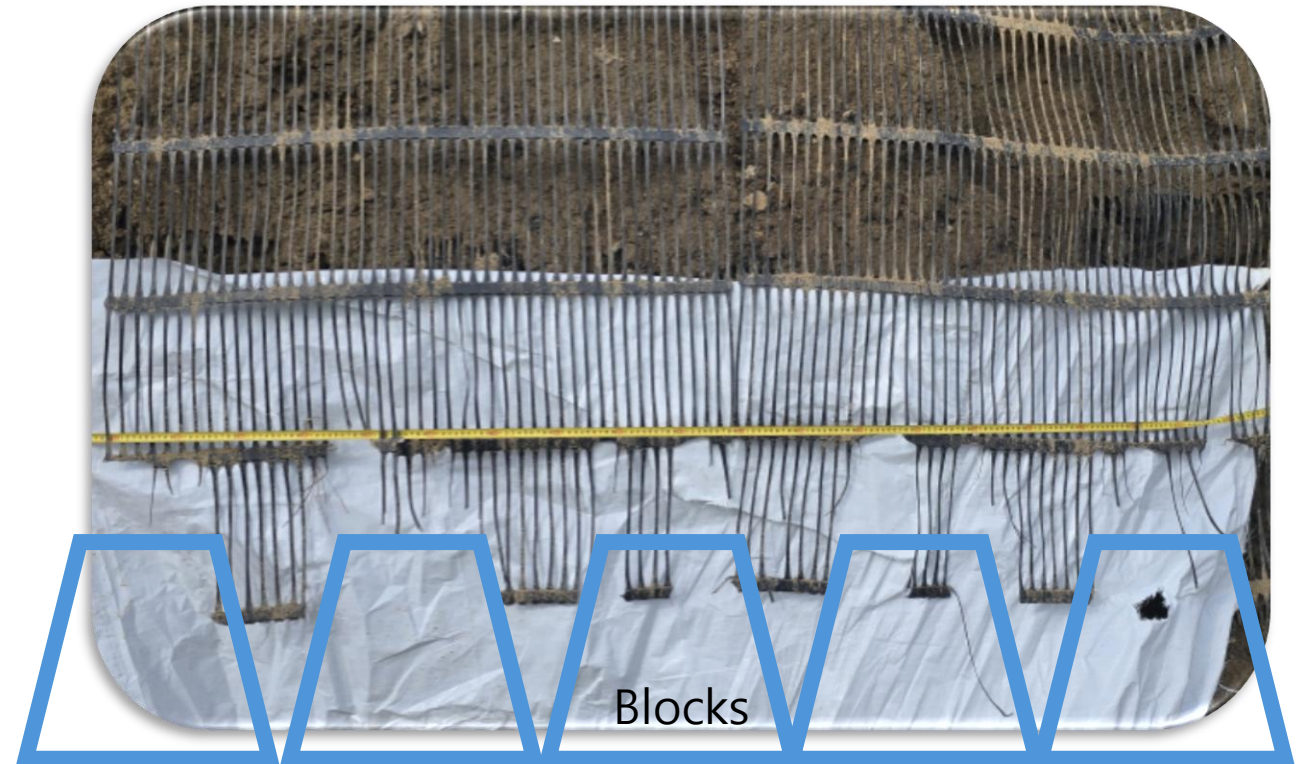


1st Failure
(July 2025)



Reinforcement failure at connection

1. Reinforcement strength: OK
2. Reinforcement length: OK
3. Reinforcement **failed at the connections** with blocks
4. **No sliding** due to active earth pressure



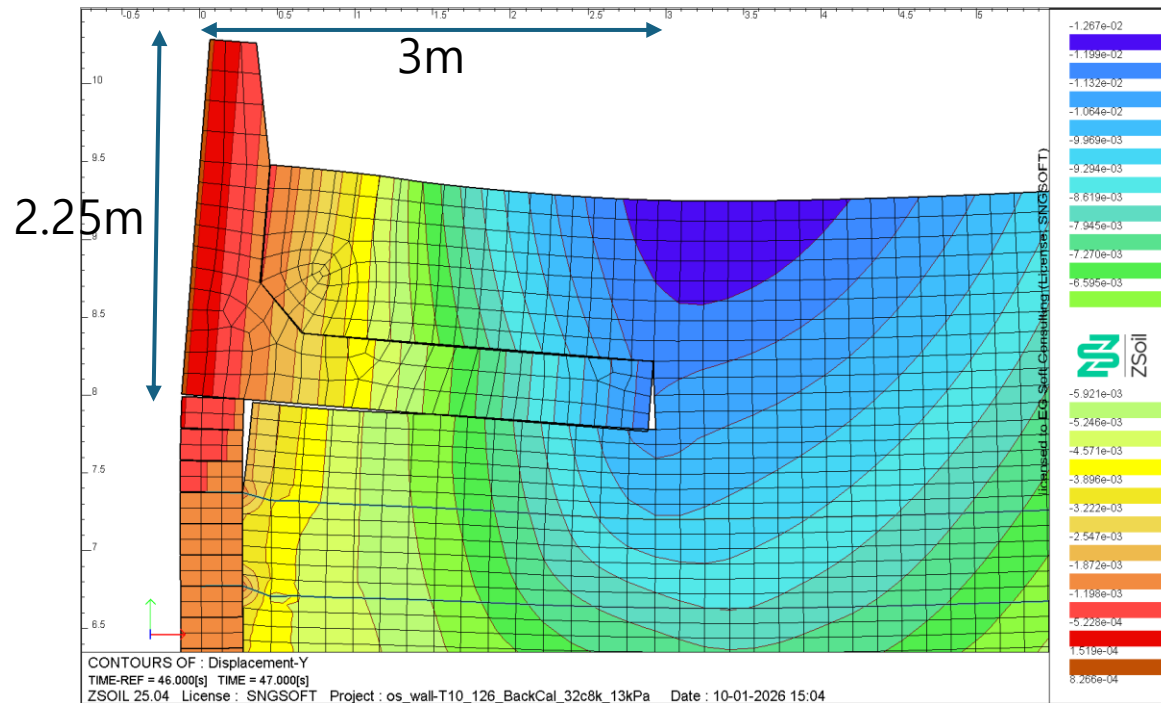
Stability of MSE Wall during construction and water inflow

- Analysis Method: 2D FEA (Zsoil)
- Estimation of c - ϕ : Stability Analysis
(Strength reduction method)
- Software: ZSOIL (developed by GeoDev)
- Sequence: Embankment → Live Load →
Rainwater inflow (main cause of failure)
- Results: Shear strength of backfill in effective stress state

	ϕ'	c'
Back-analysis	30.7°	7.6 kPa
Design	30.0°	0.0 kPa

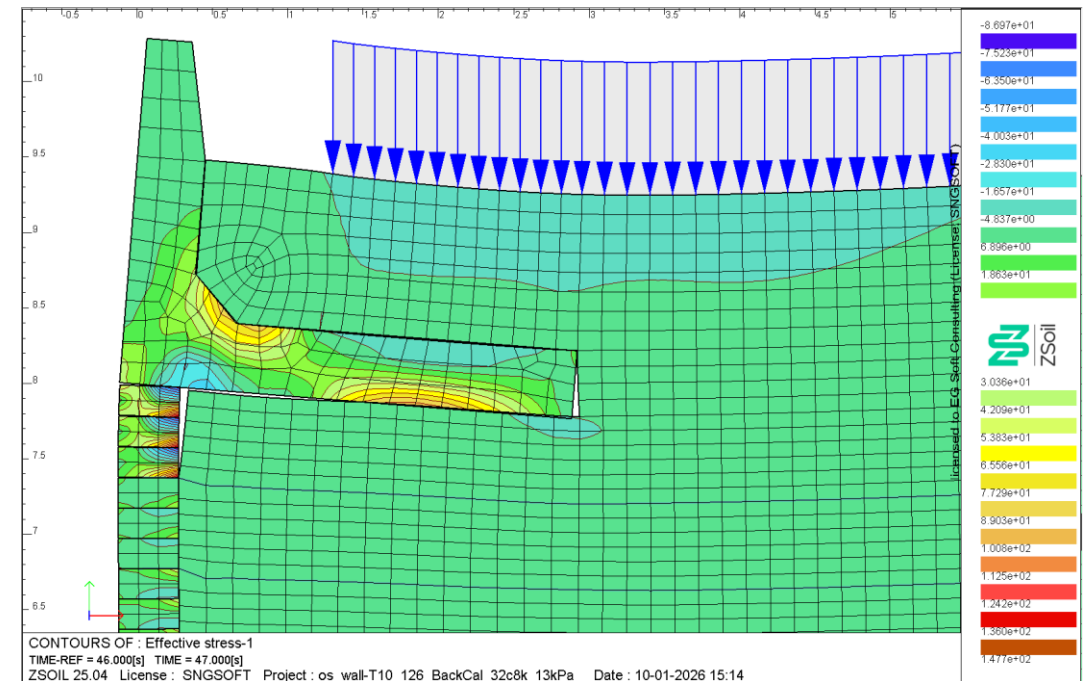


Influence of RC Wall on blocks



- RC Wall: 3m(W), 2.25m(H), 0.45m(thick)
- Block : 0.4(W) x 0.2(H)

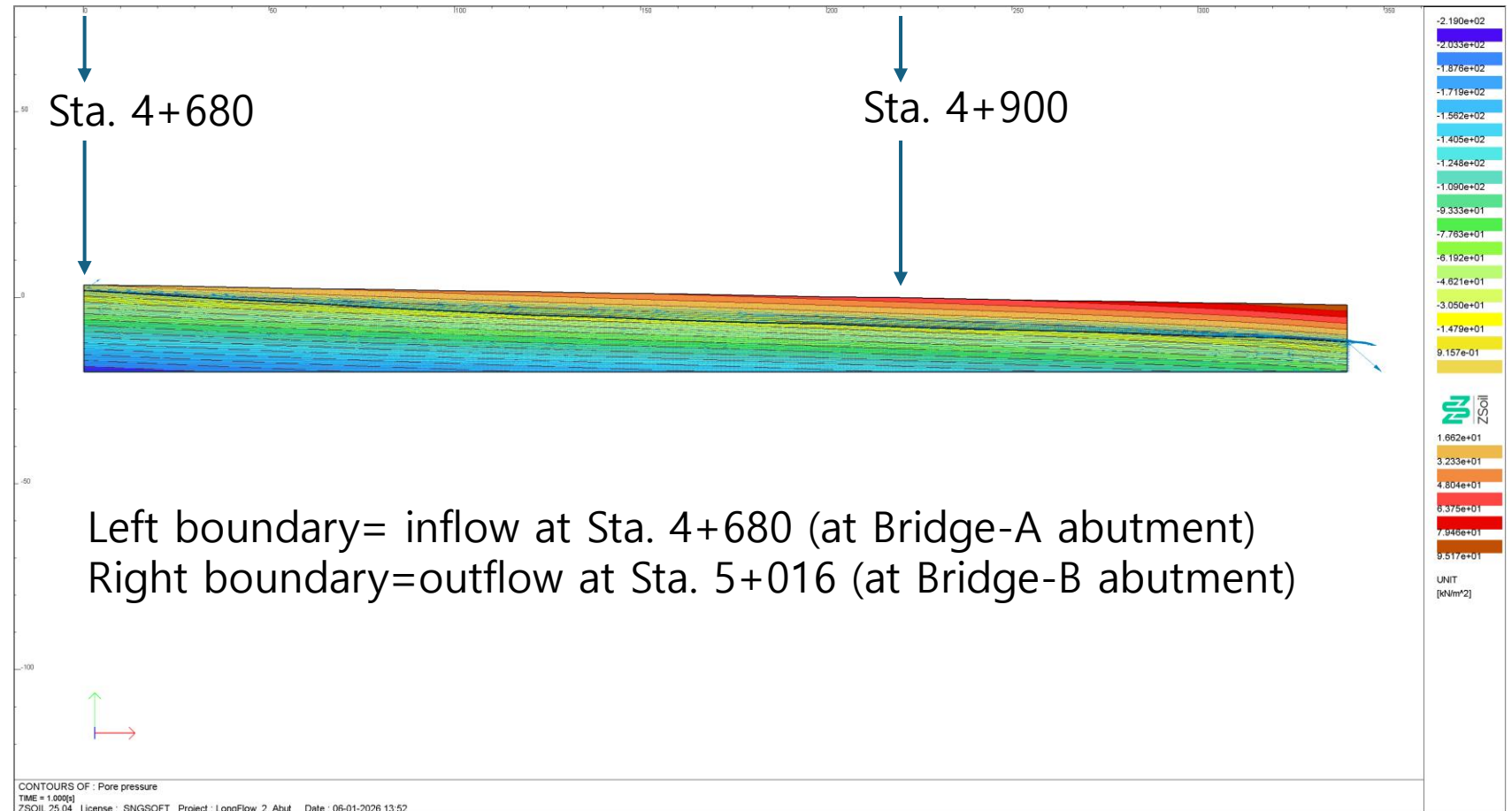
- Additional Earth Pressure
- Rotation of RC wall (differential settlement)
- Voids (=water flow path) developed at heel and bottom of RC wall



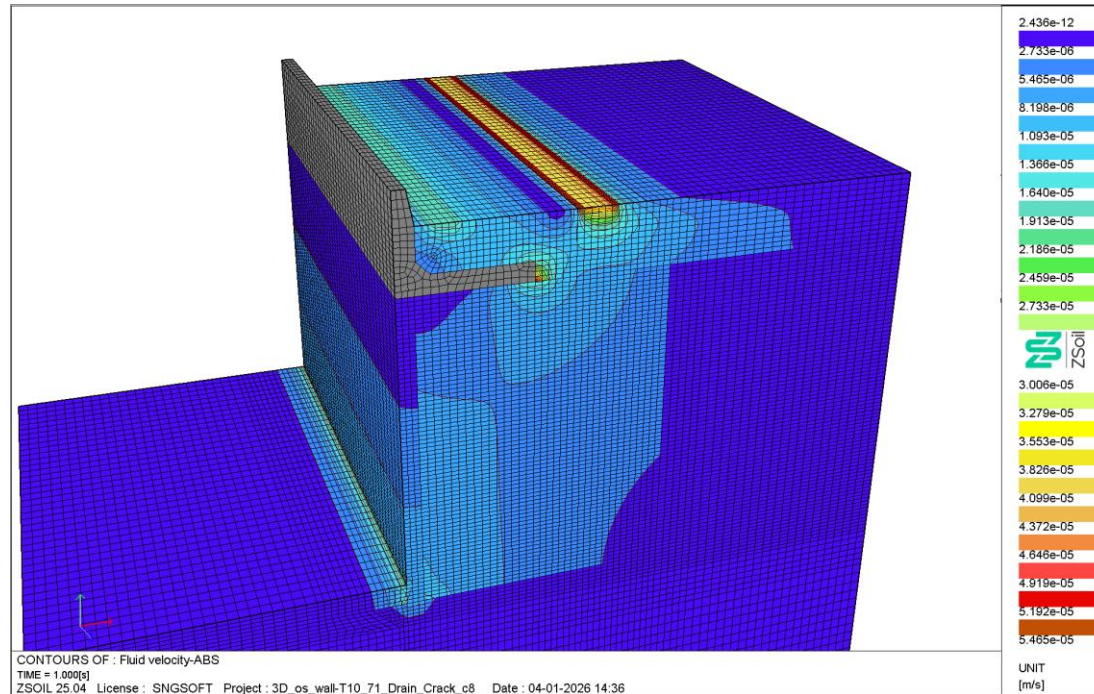
Longitudinal inflow assumed

Bottom slope: 6%~3%
(Sta. 4+680 ~ Sta.
4+900)

Rise of water level:
about 1~2m at Sta.
4+900



Inflow from cracks of duct and road

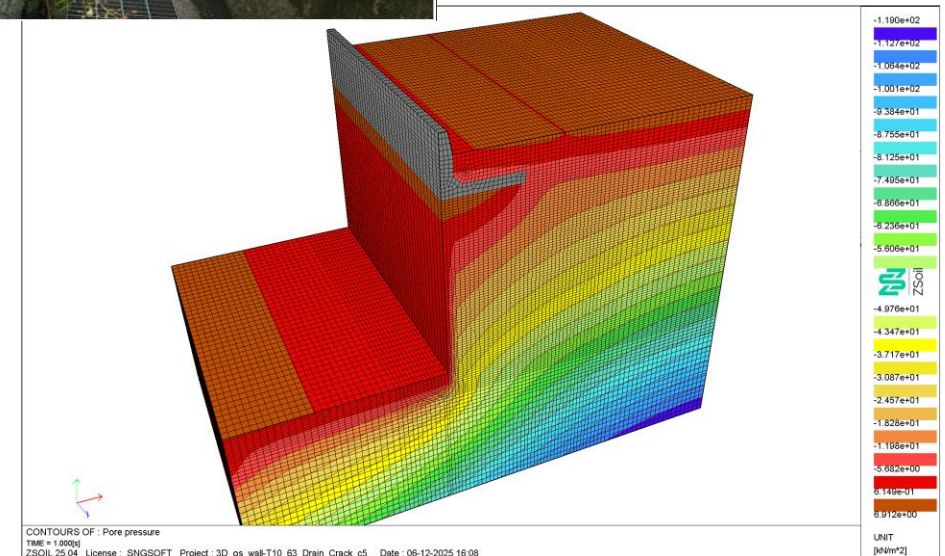


Void possibility due to erosion

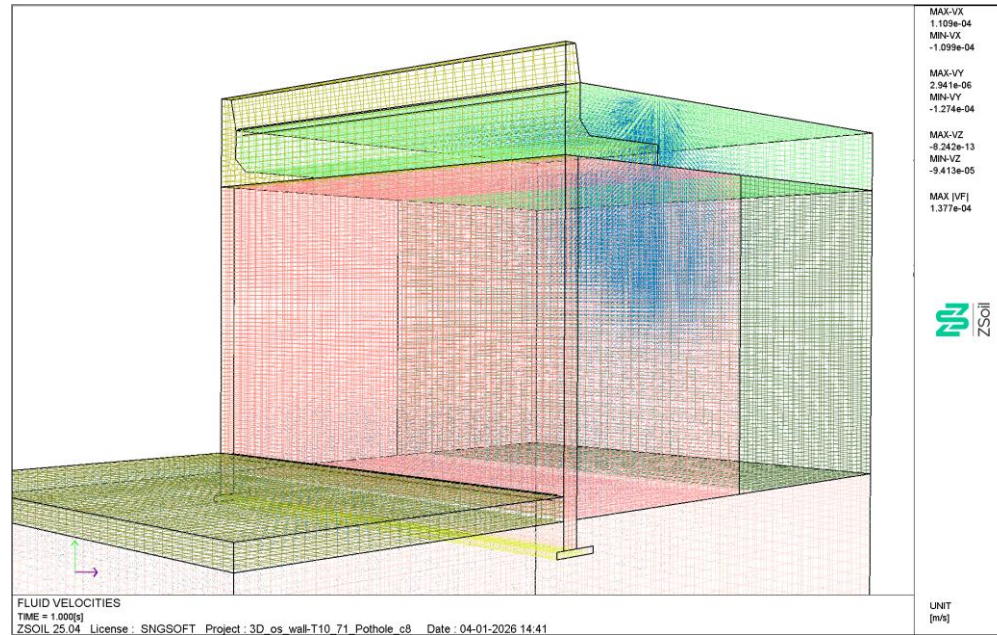
Water pressure increase on wall: about 60kPa



Longitudinal road cracks 1 year before opening (2023)

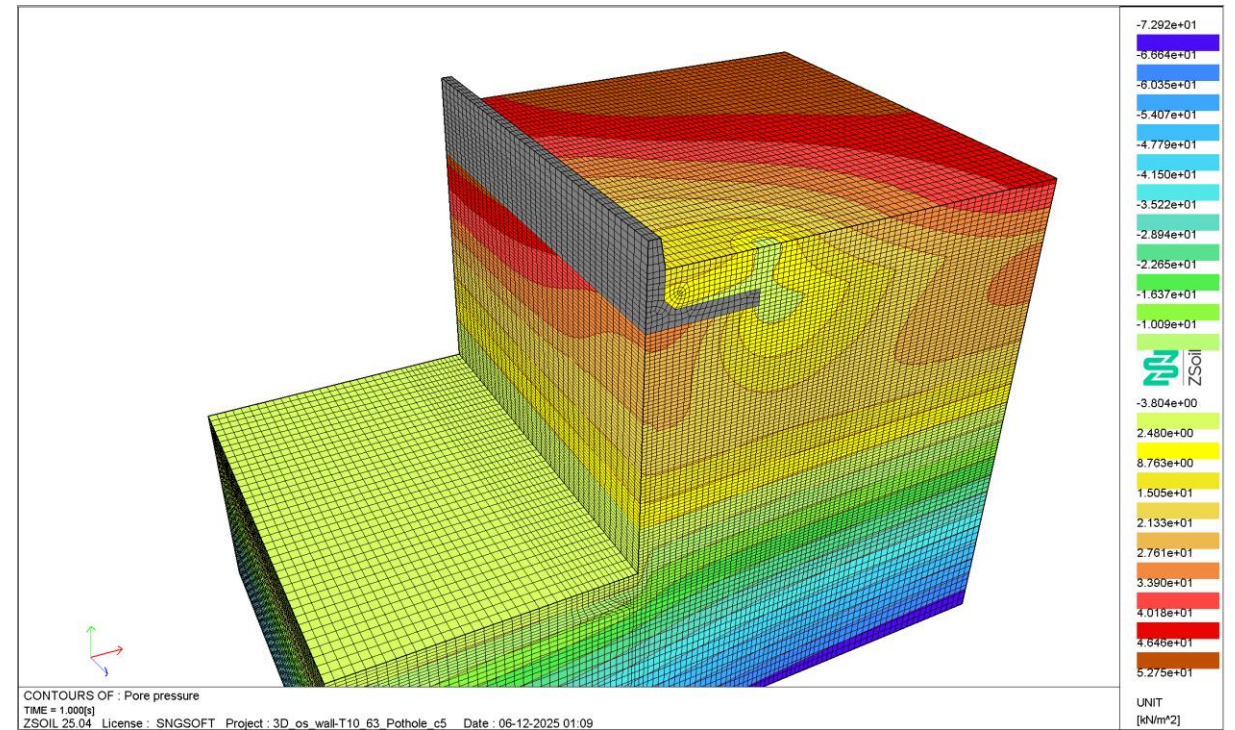


Inflow from pot-hole



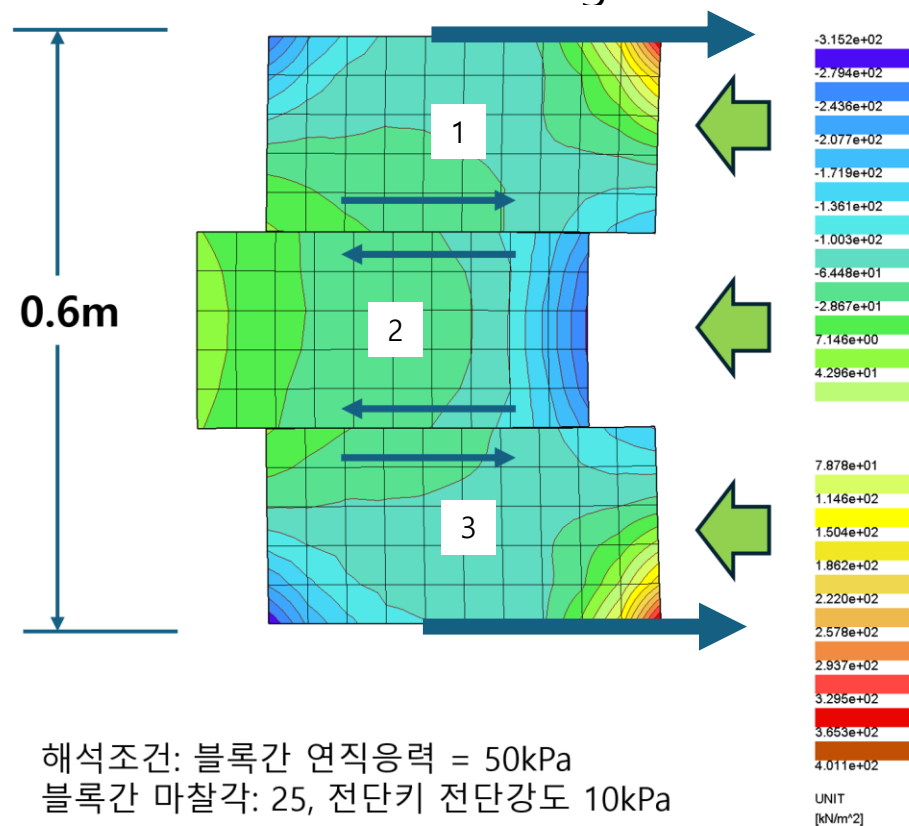
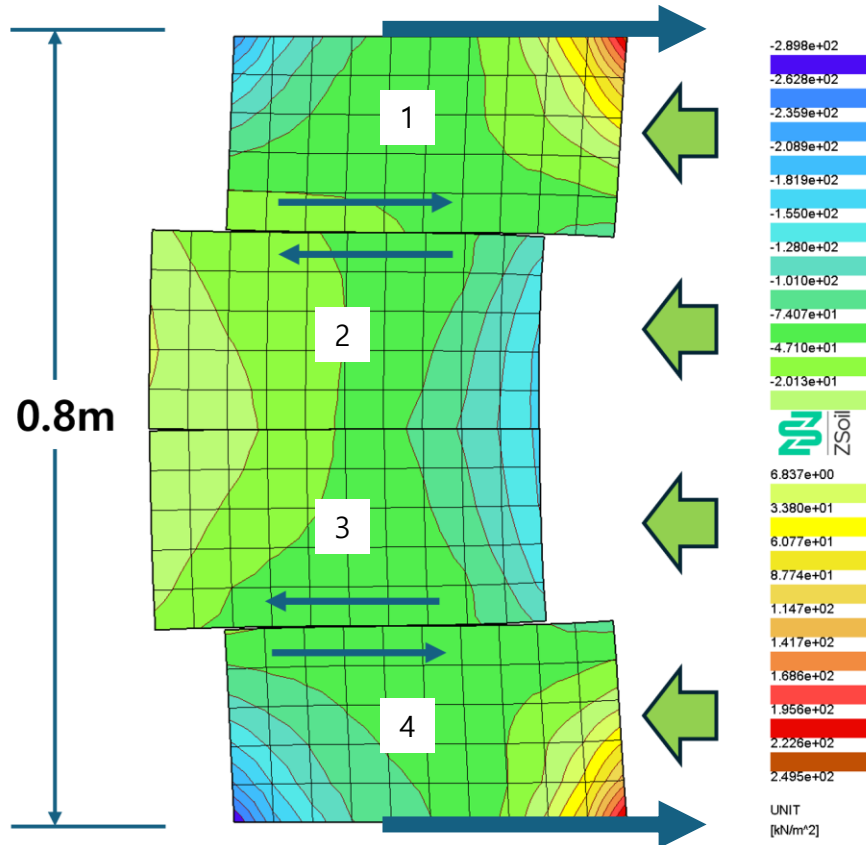
Void due to erosion

Water pressure increase on wall: about 20kPa



Reinforcement interval- 3 blocks vs 4 blocks

4 block and 3 block vertical intervals are mixed along the failed wall.

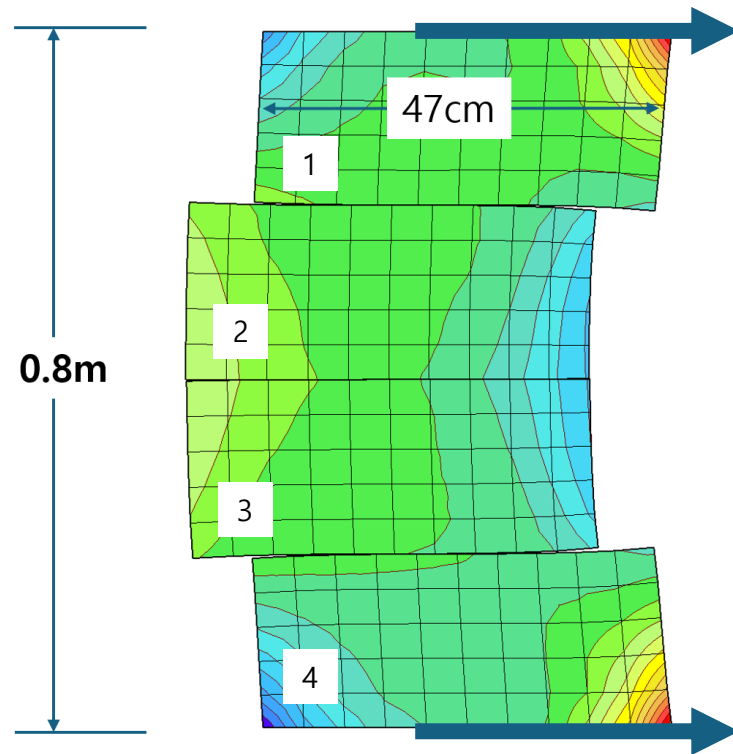


해석조건: 블록간 연직응력 = 50kPa
블록간 마찰각: 25, 전단키 전단강도 10kPa

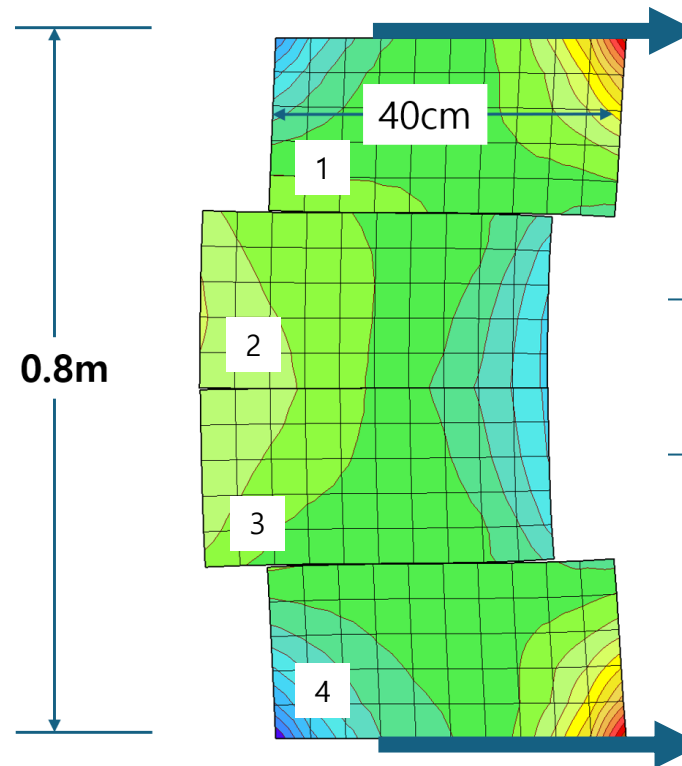
Safety factor comparison: **1.00 : 2.16**

Safety ratio is Arithmetic!!
Ratio of number of blocks unreinforced.

Block size effect on block sliding



Block from design



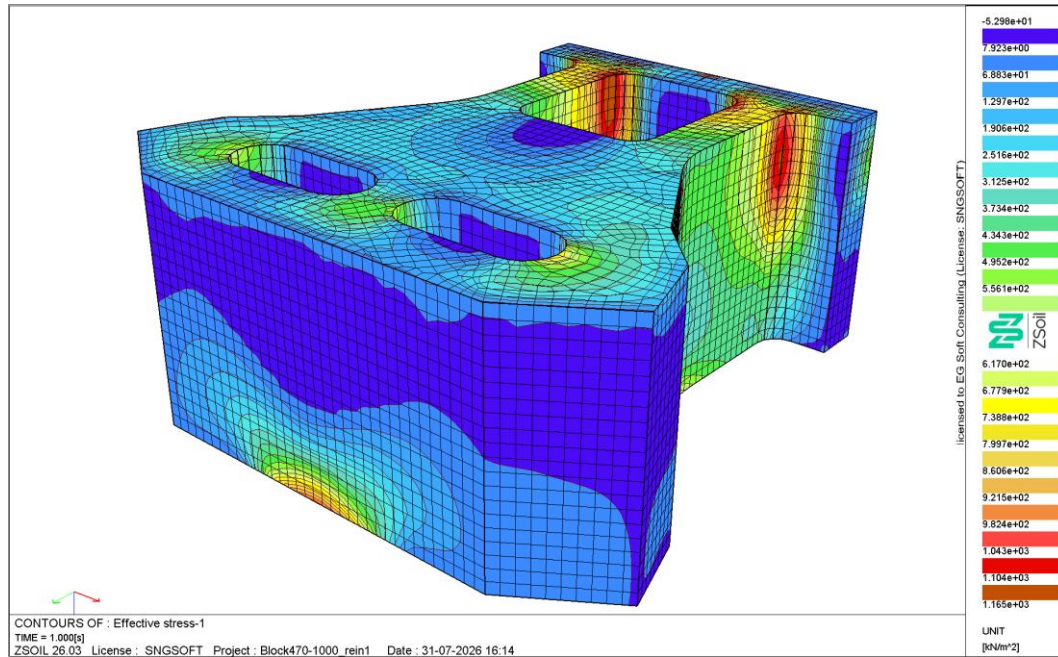
Block used in construction

Safety ratio is Arithmetic!!
=Ratio of friction area.

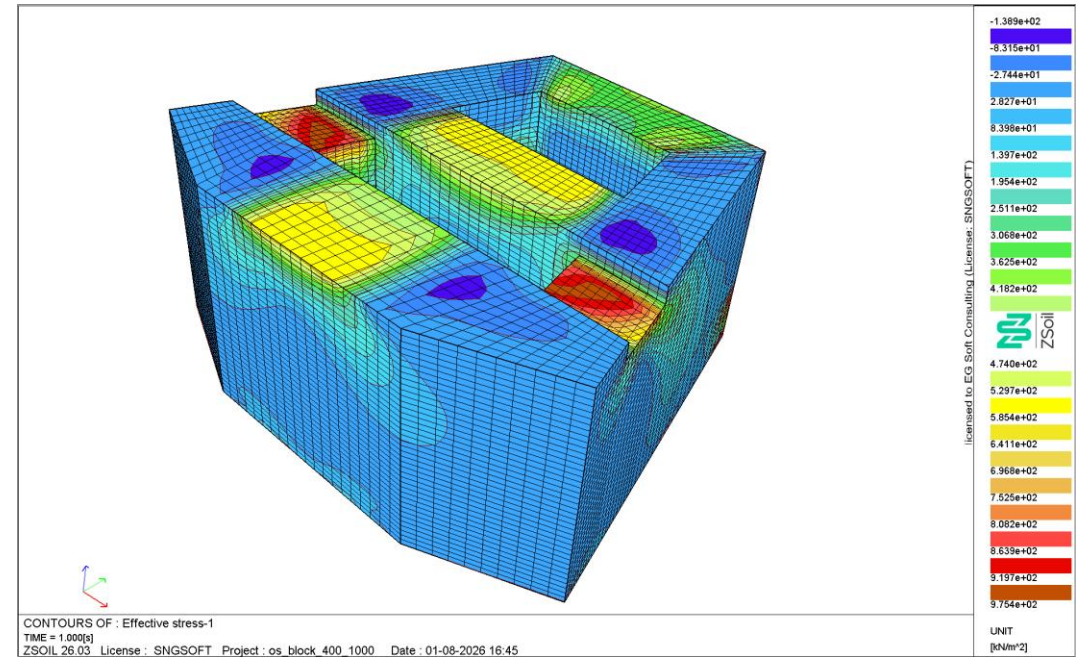
Vertical stress = 50kPa
Contact friction angle = 25 deg.
Shear key strength = 10 kPa

Safety factor comparison: **1.20 : 1.00**

Block size/shape effect on tensile stress



Block in design



Block in construction

Tensile stress safety comparison: **1.00 : 1.19**

Thank you for your listening. Questions?

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