Effect of water level fluctuation on gabion revetment

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Objective of our research

Damage factors

internal

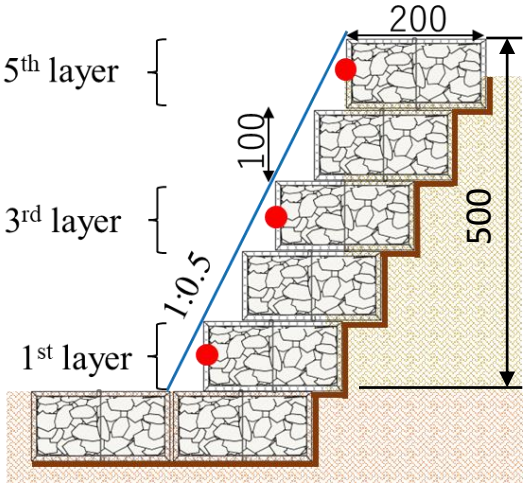
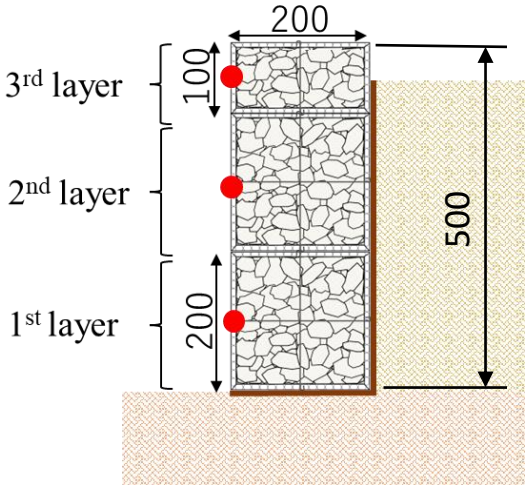
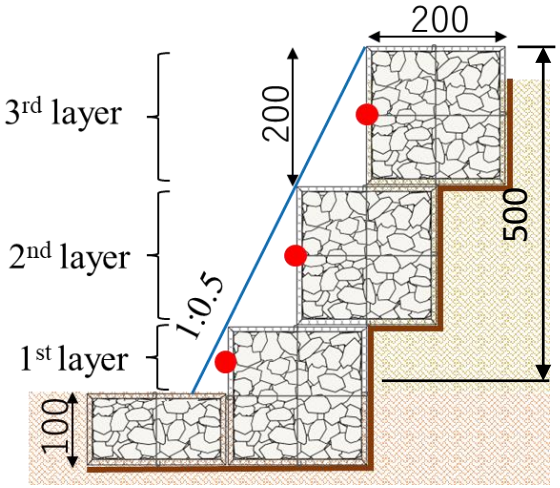
- basket frame
- Filling material
- Structure design

External

- water level fluctuation
- river flow
- overflow
- Erosion
- Back water

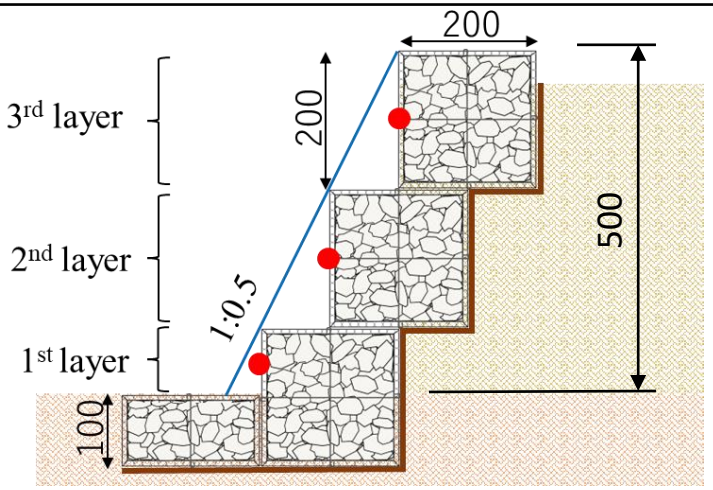
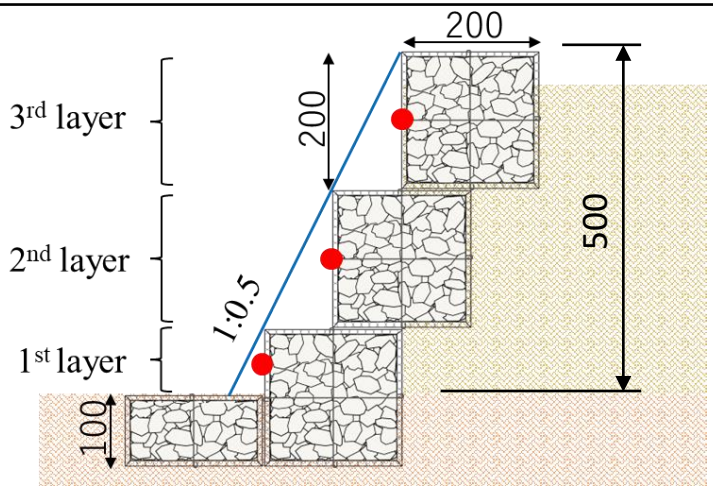
Focused on the differences in the effects of water level fluctuations, overflow, and back water due to the structure of gabion revetment.

Stage①: Focused on structure design

Case1: Slope type	Case2: Straight type	Case3: Mix type (with geotextile)
		
Simulation in the common form used in Japan.	Simulation of gabions confirmed to be damaged in Nepal. Not performed root penetration and root fixing.	Simulation of gabions constructed by JICA. The cubic basket frames are stacked on a slope.

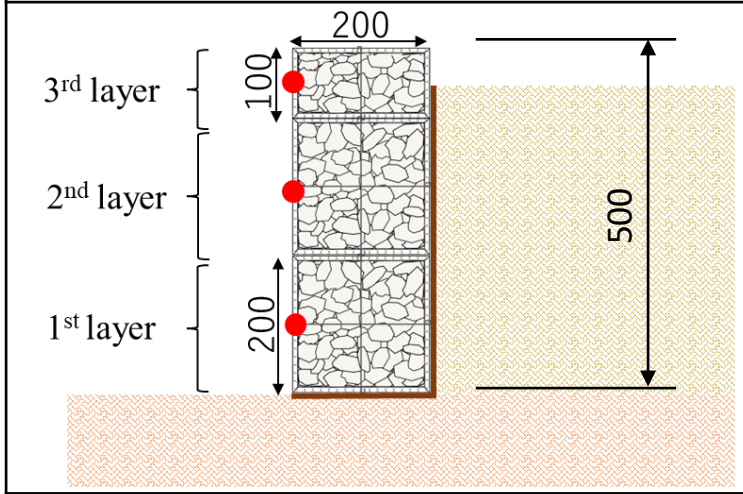
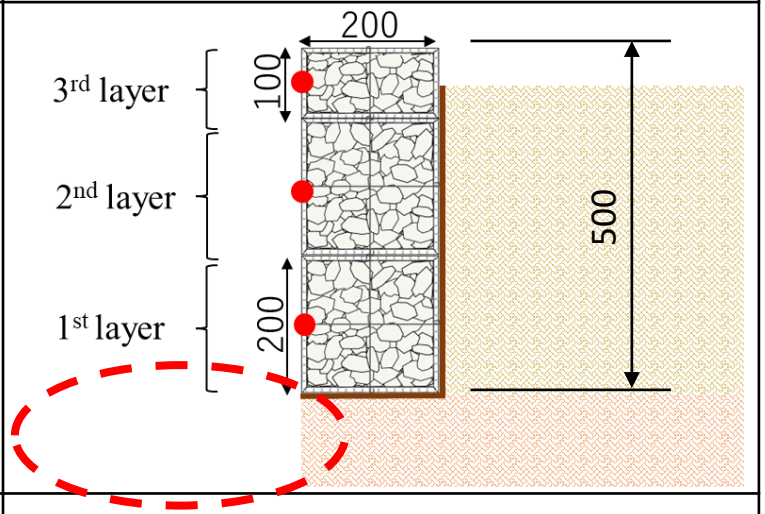
Comparing the effects of water level fluctuations based on different gabion structure design.

Stage②: Focused on geotextile

Case3: Mix type (with geotextile)	Case4: Mix type (without geotextile)
	
Installing geotextile between the gabion and the backside.	Geotextile is not installed between the gabion and the backside.

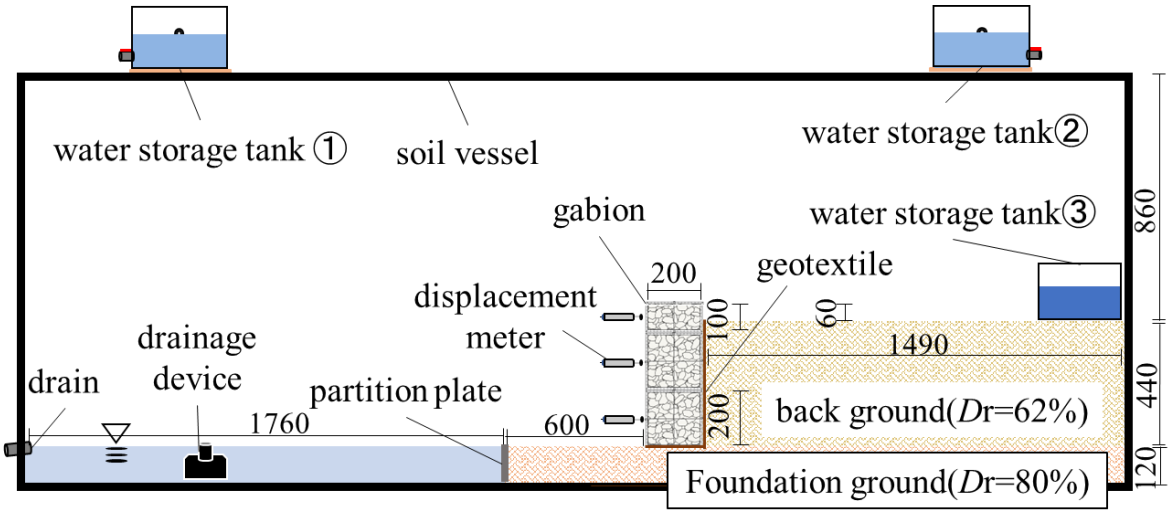
Comparing the effects of the presence and absence of geotextiles on gabion revetments on water level fluctuations

Stage③: Focused on bottom erosion

Case2: Straight type	Case5: Straight type (erosion Ver)
	
Simulation of gabions confirmed to be damaged in Nepal.	Anticipating erosion of the foundation ground. The front side of the foundation ground in Case 2 was removed.

Considering the effects of erosion due to water level fluctuations.

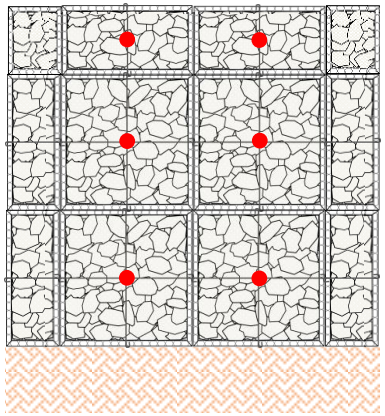
Overview of model experiment



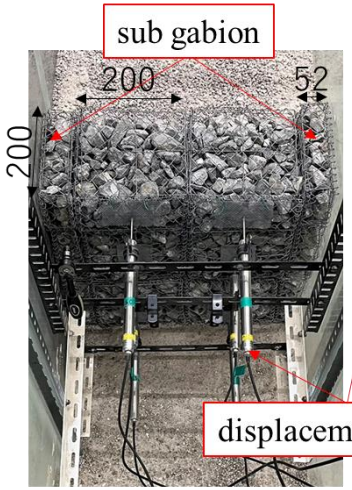
Schematic diagram

1/5 scale model

Soil vessel size
W: 550mm
D: 4100mm
H: 1540mm

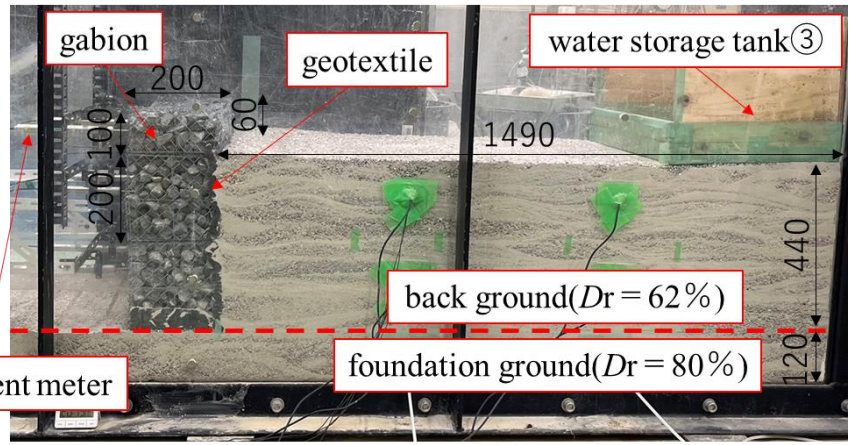


Front view



Plan view

unit : mm

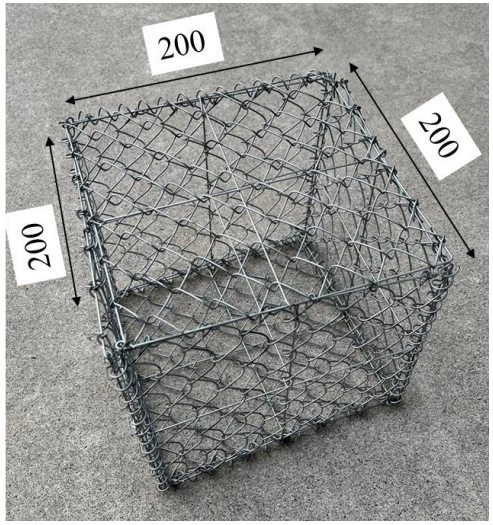


Side view

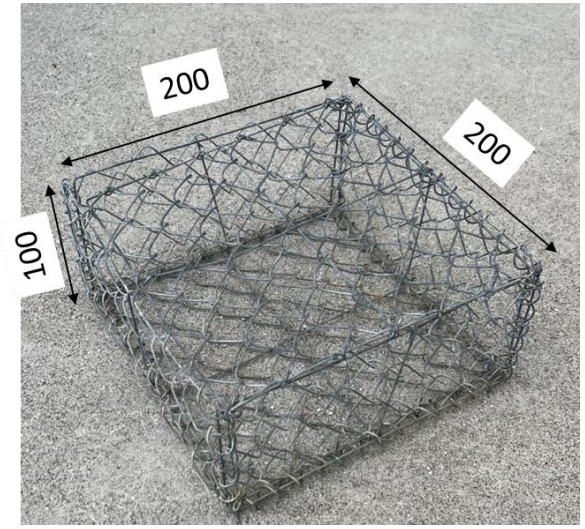
●: Horizontal displacement measurement position

Experimental materials

unit: mm



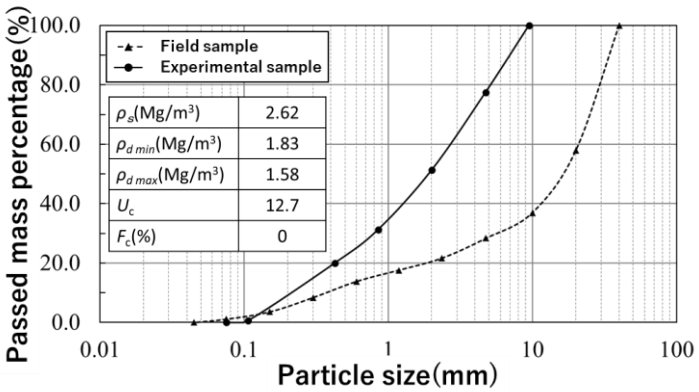
Cubic basket frame



Rectangular basket frame

Filling material

Background materials



Particle size gradation

Important considerations

	Experiment	Field
size	1/5	Actual size
River flow	absent	present
ground condition	At the start: dry	Varies
rain	absent	present
vegetation	absent	present
overflow water	Pure water	Muddy water & driftwood
Bind between gabions	present	Varies

This experiment is just a basic experiment, and the results shown will not be directly reflected in the actual field.

Experimental process: Step1

Simulating river water levels during normal times

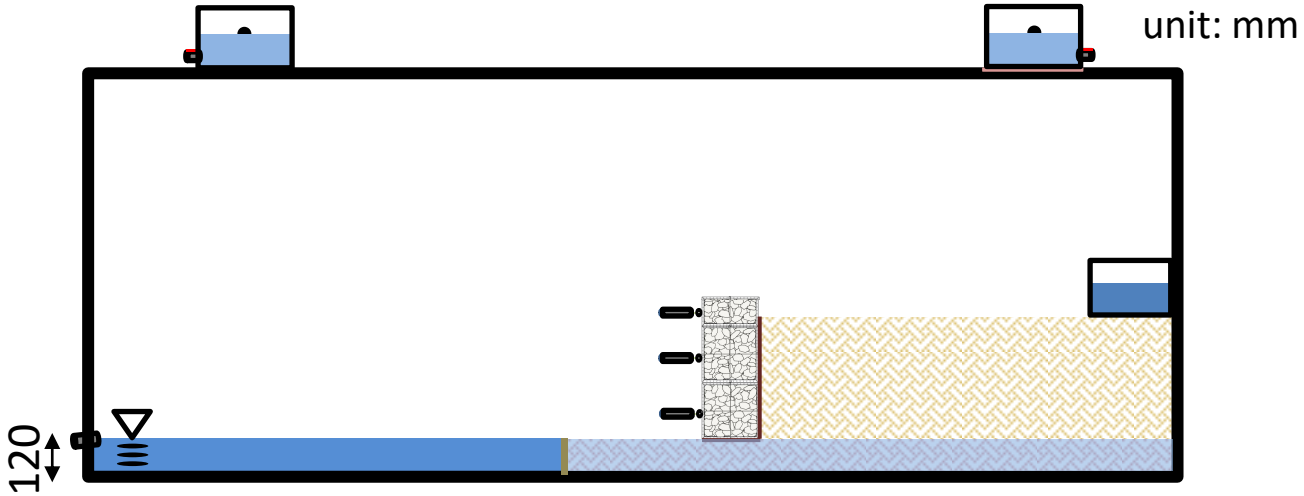
Experimental process

Step1: Penetration of foundation ground

Step2: Rising water level and Overflow

Step3: Lowering water level and Backwater

Repeat 3 times



Experimental process：Step2

Simulating sudden raising water level and overflow

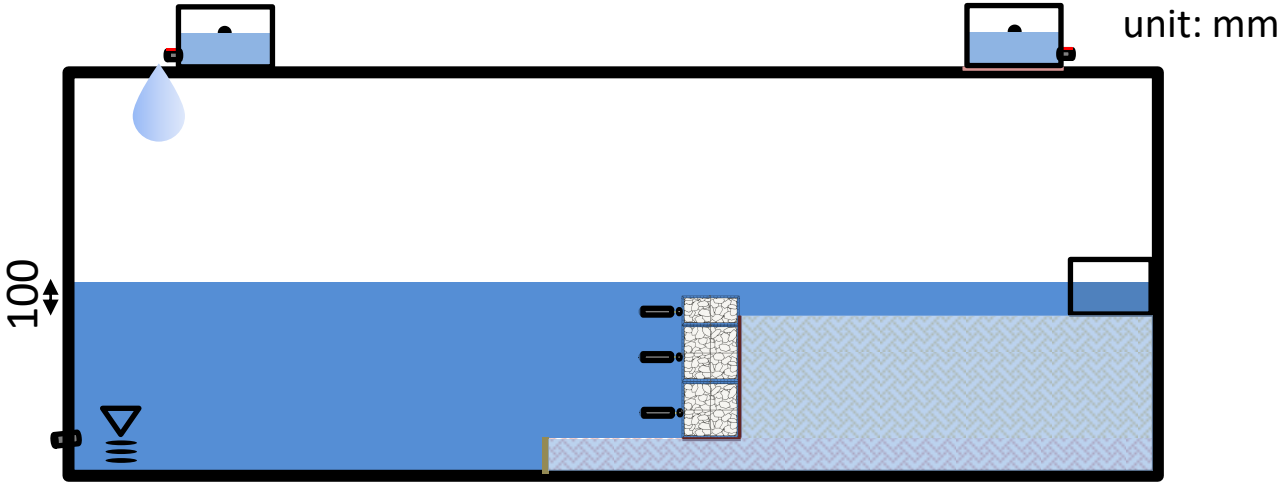
Experimental process

Step1: Penetration of foundation ground

Step2: Rising water level and Overflow

Step3: Lowering water level and Backwater

Repeat 3 times



Experimental process: Step3

Simulating sudden lowering water level and backwater

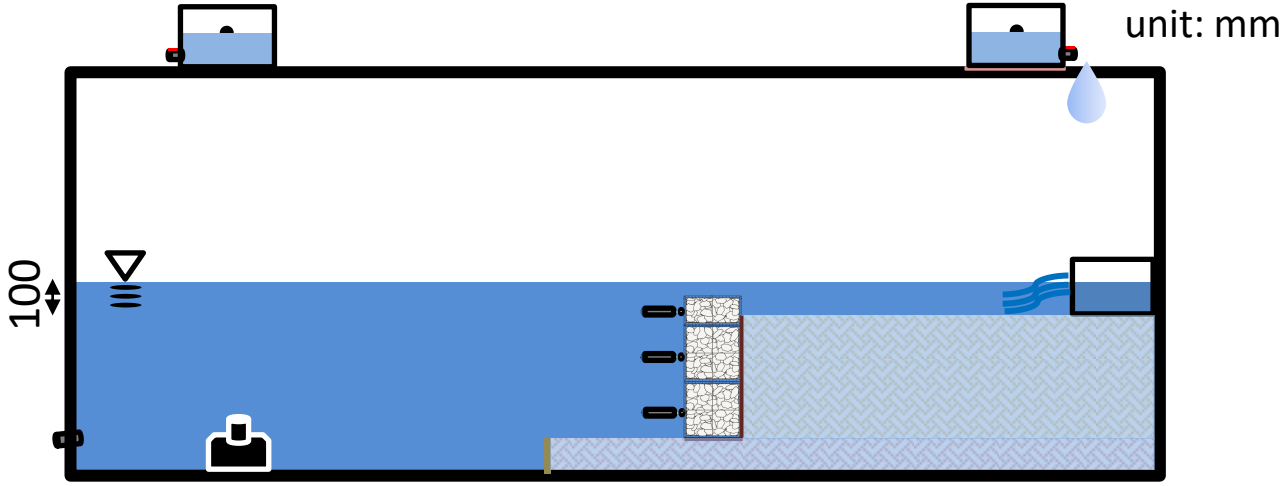
Experimental process

Step1: Penetration of foundation ground

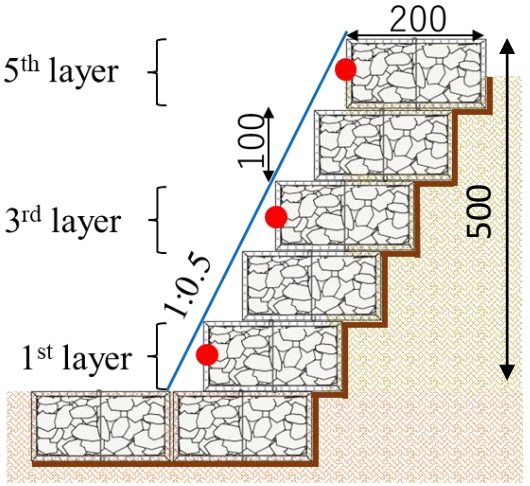
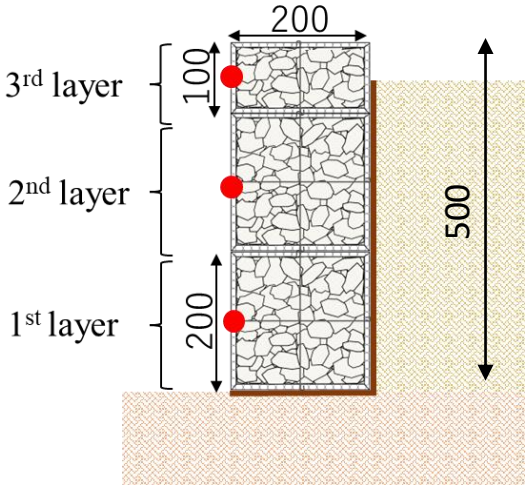
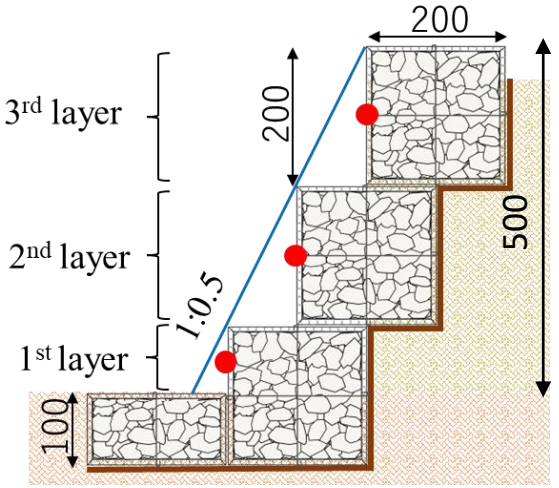
Step2: Rising water level and Overflow

Step3: Lowering water level and Backwater

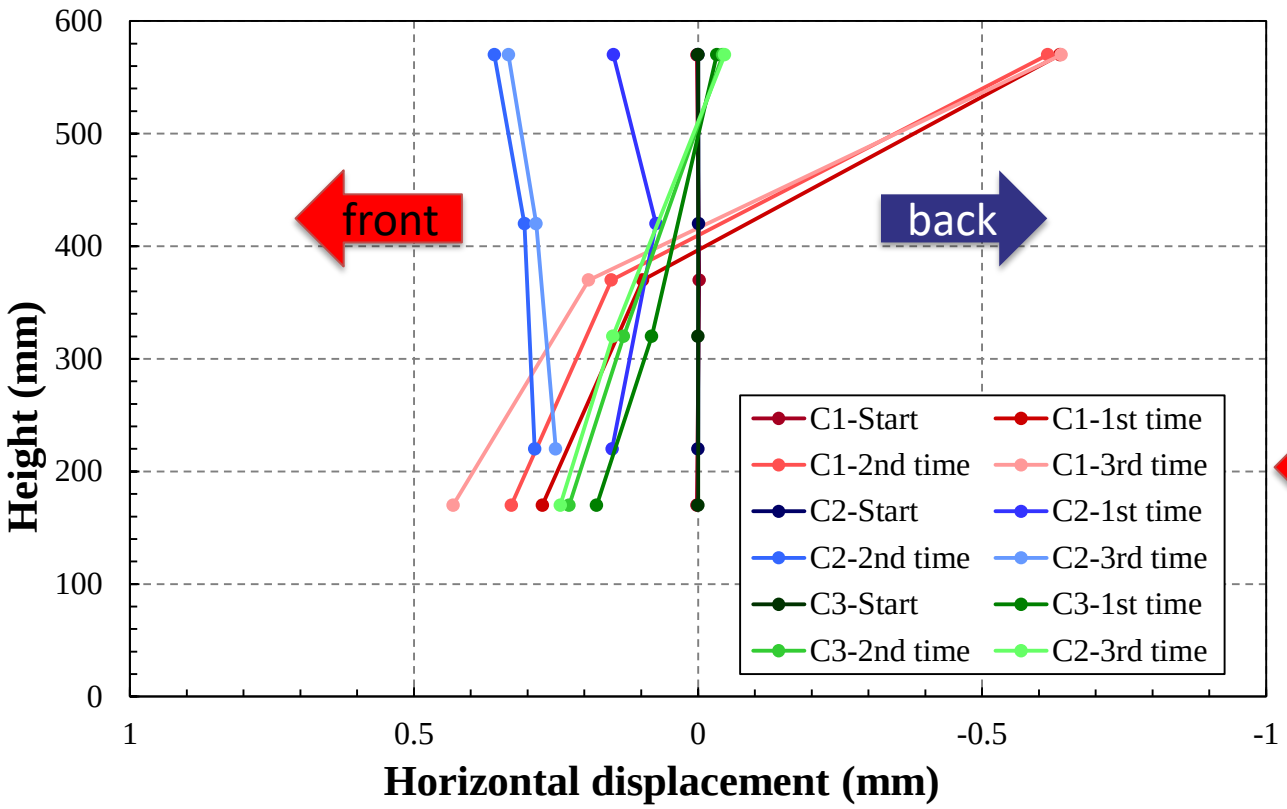
Repeat 3 times

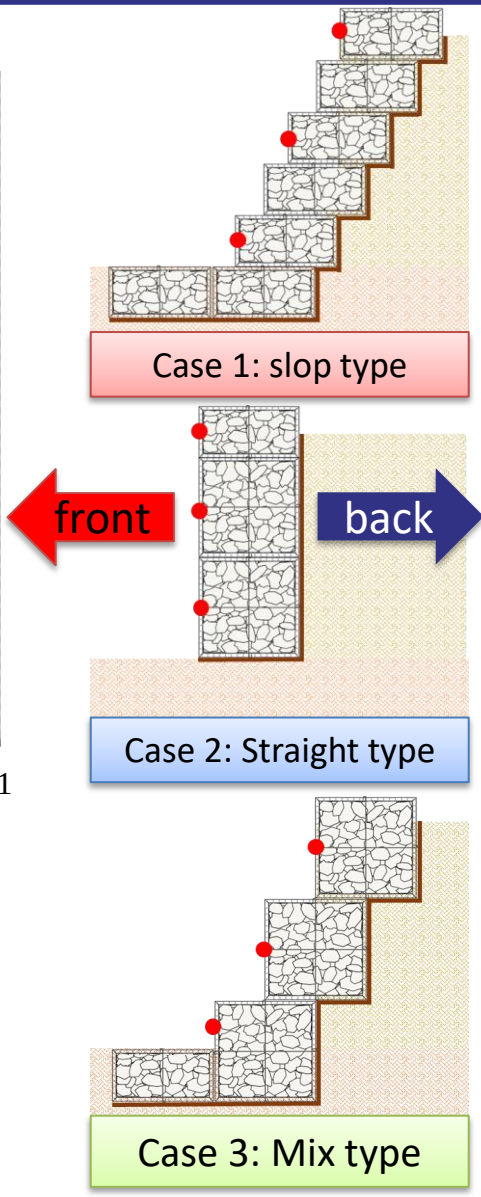


Result and Discussion
Stage①
Focused on structure design

Case1: Slope type	Case2: Straight type	Case3: Mix type (with geotextile)
		

Comparison of horizontal displacement





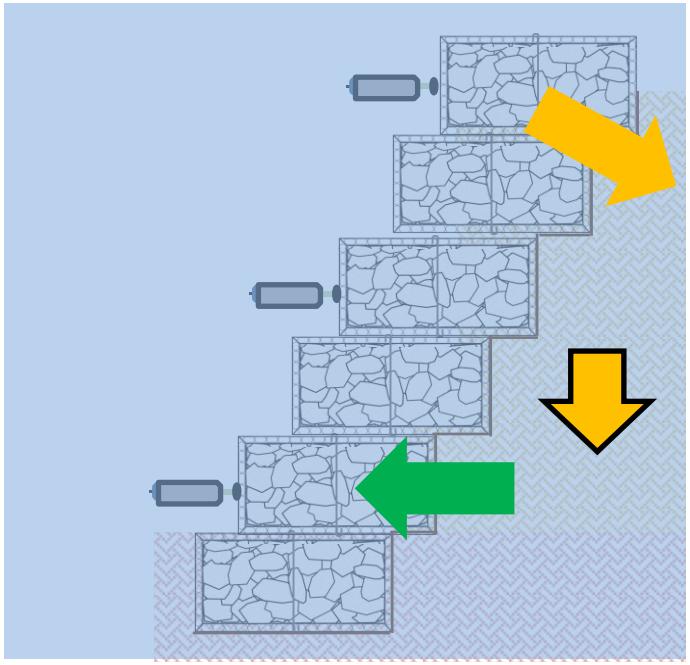
At points other than those in the Straight and Mix types, the top layer indicated front side displacement due to an increase in earth pressure.

Summary1

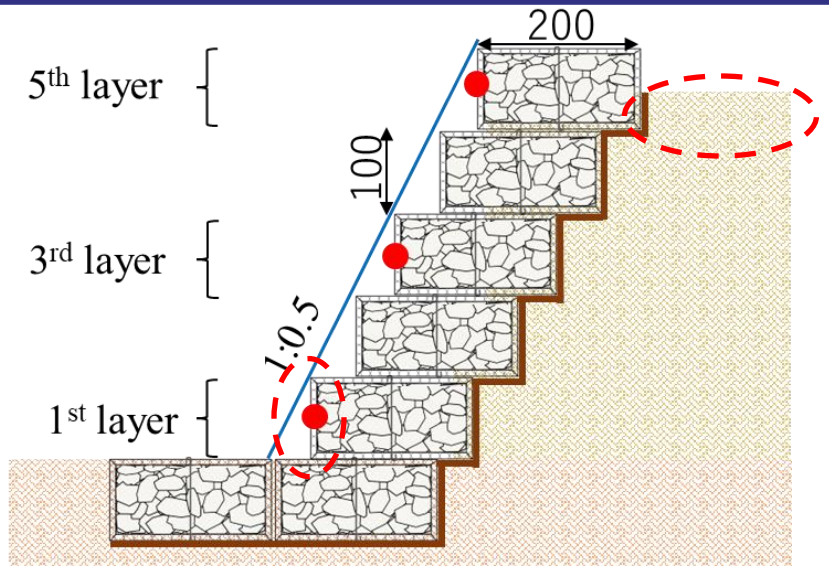
- Slope type and Mix type are displaced to the backside during the first water level change, but there is almost no displacement during the second and third times.

➢ Background experienced saturation, leading to subsidence due to water infiltration. As a result, gabion leaned backside.

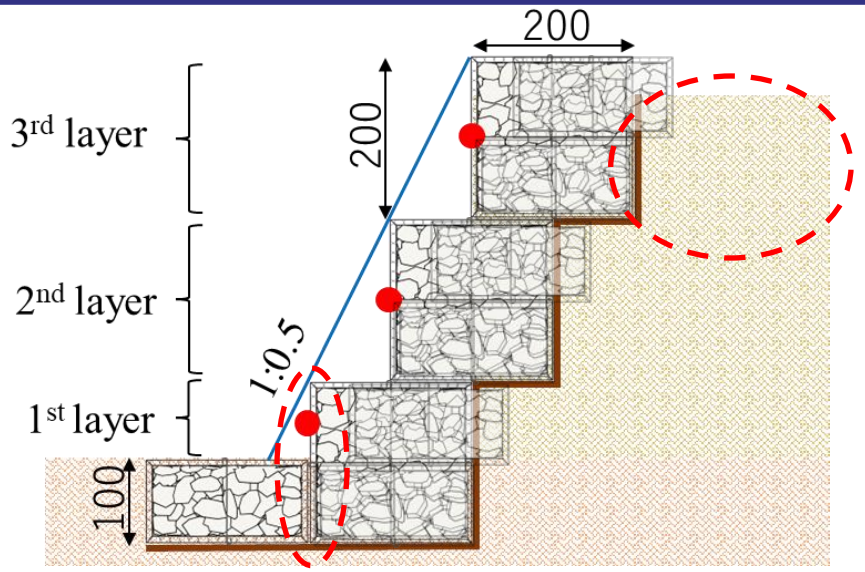
➢ However, When the background stabilizes, it is suggested that there are no further displacement.



Summary2



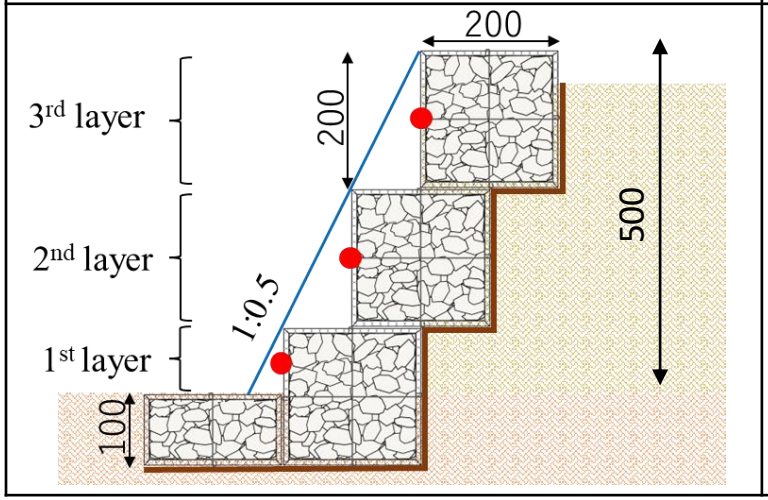
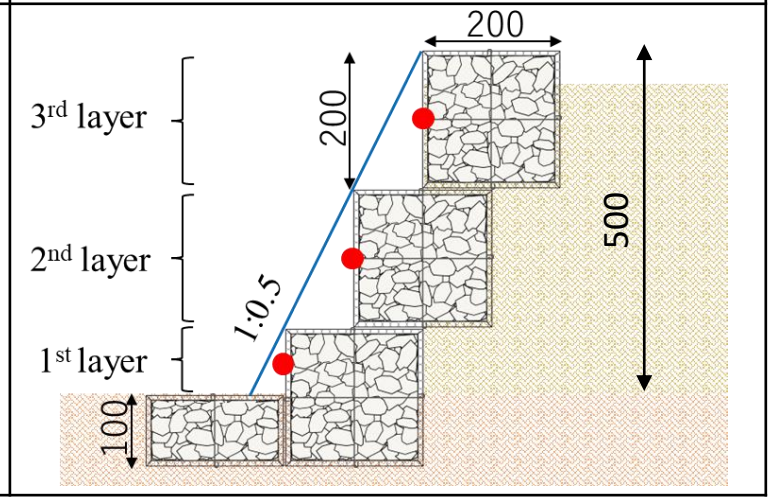
Case1: Straight type



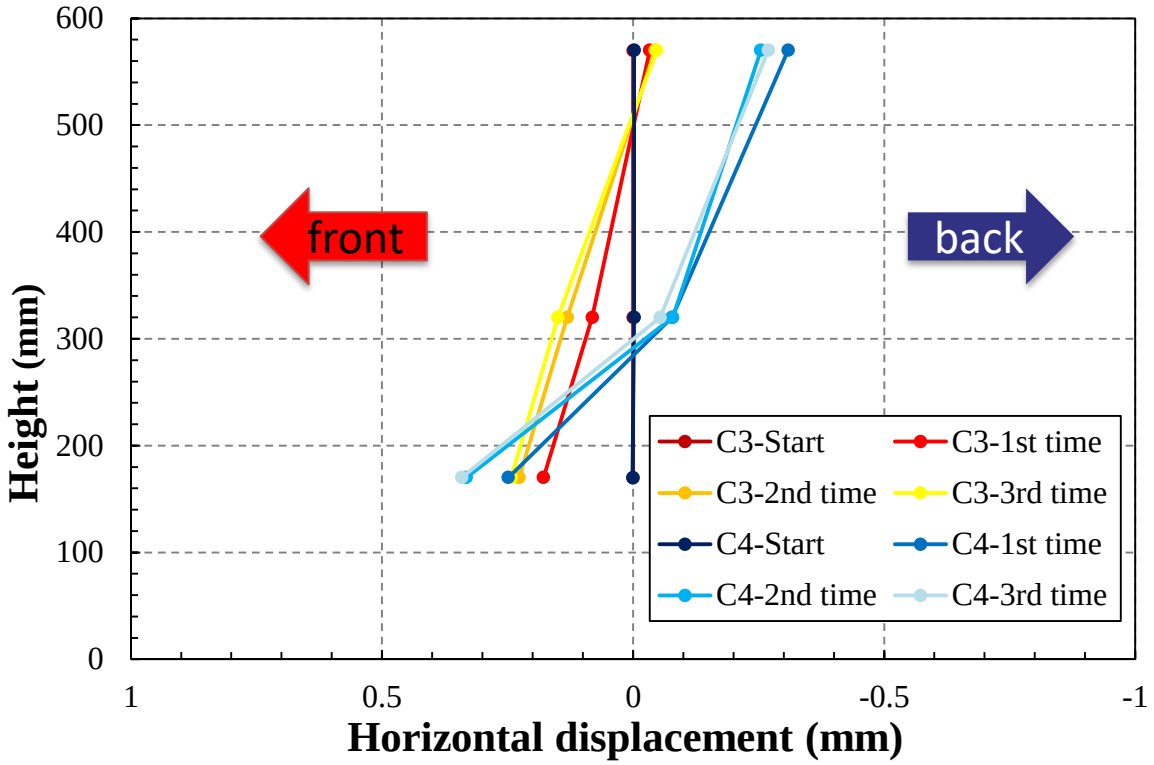
Case3: Mix type

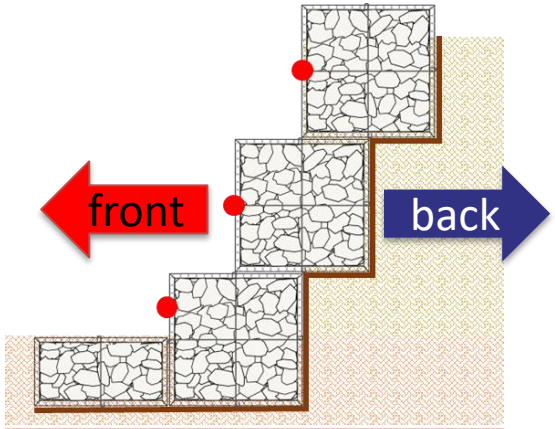
- Japanese type is easy to lean to the back side because the top layer is filled less.
- The revetment slope is the same, it is thought that back side displacement was larger in the Japanese type because it was closer to the background.
- In Mix Type, the displacement of the bottom layer is small because it is suppressed by the rooting.

Stage②
Focused on geotextile

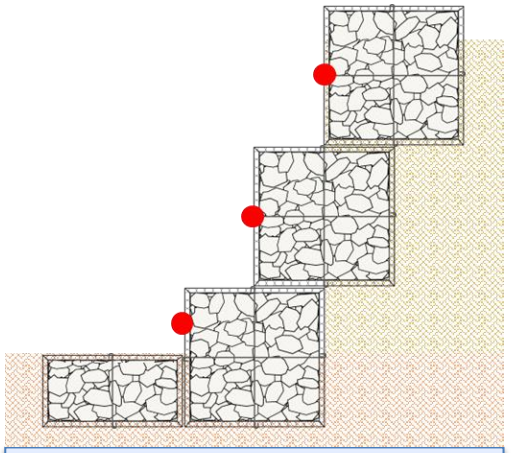
Case3: Mix type (with geotextile)	Case4: Mix type (without geotextile)
	

Comparison of horizontal displacement





Case 3: Mix type with geotextile



Case 4: Mix type without geotextile

- Similar trends were shown, but over all the displacement was smaller than in geotextile.
- In geotextile, the second layer shows a front side displacement, whereas without it, it shows a back side displacement.

Summary3

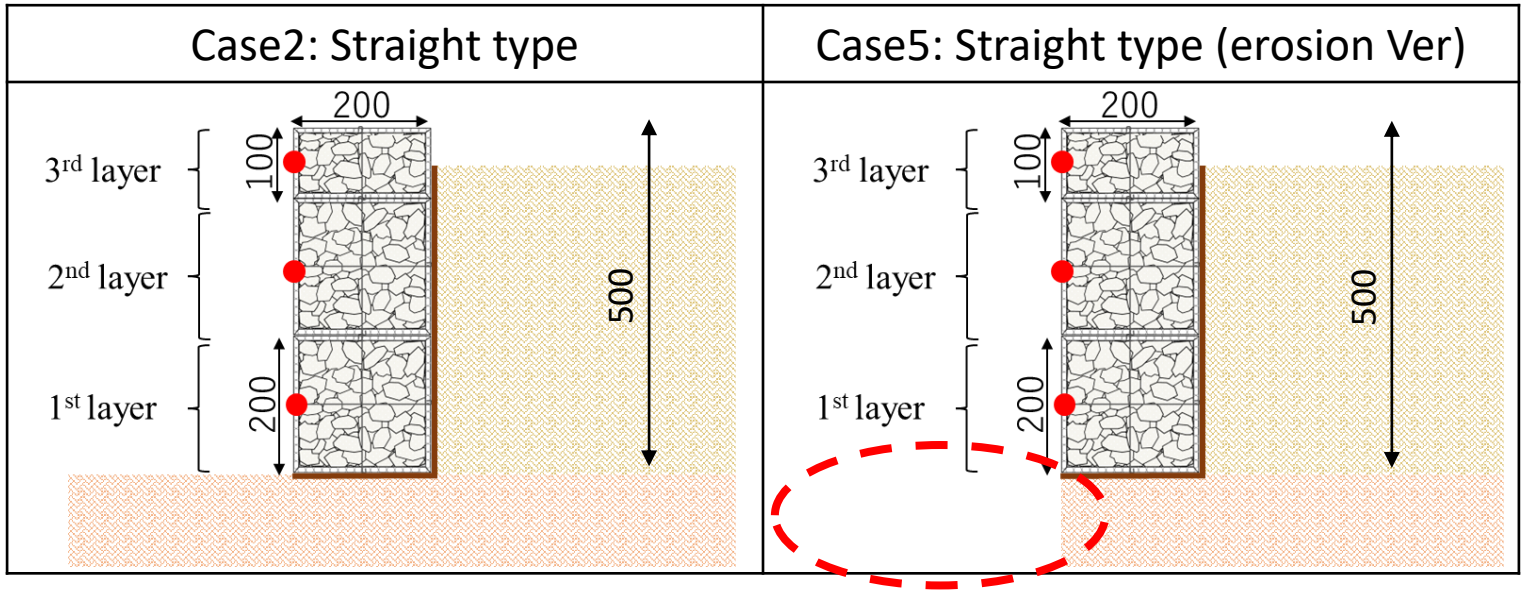
In geotextile

Geotextile less

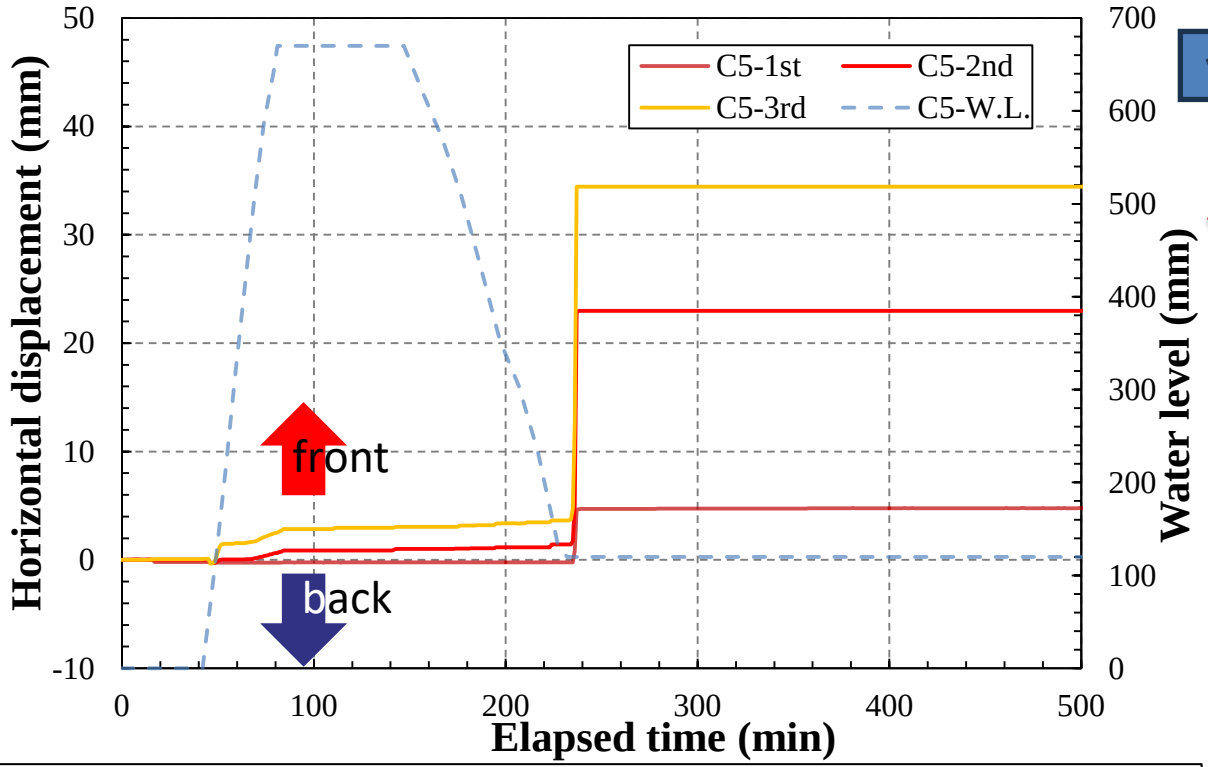
- Without geotextile, outflow of ground material was confirmed.

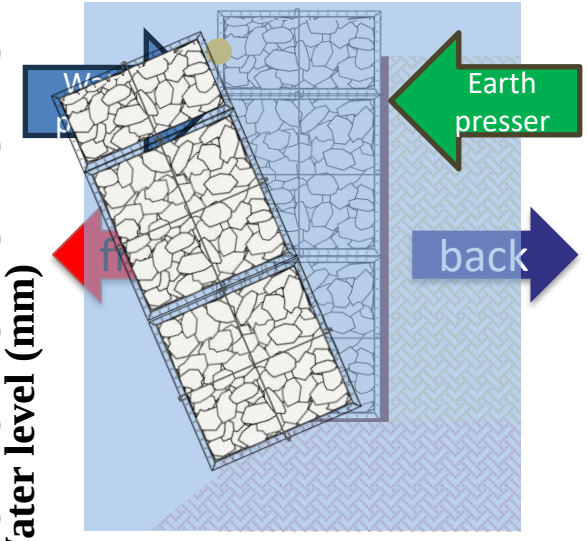
➢ The back ground became destabilized due to missing background materials, it leaned on back side direction.

Stage③
Focused on bottom erosion



Temporal changes



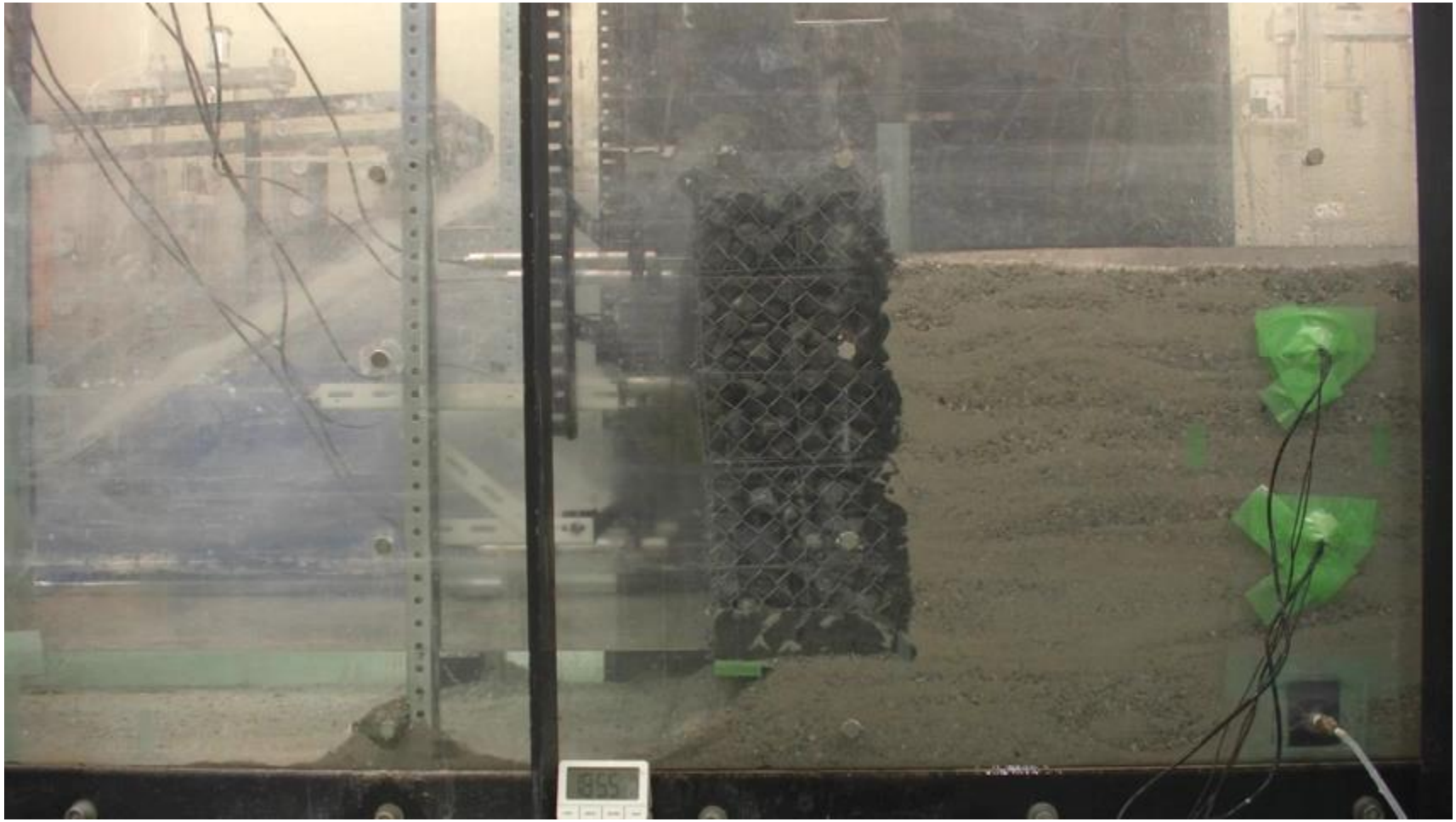


Case 5: Straight type (erosion Ver)

- Displaced in front side direction due to the collapse of the foundation ground when the water level started rising.
- the water level reached the foundation ground level, gabion revetment completely collapsed.

Collapsed foundation ground

Video of the tilting



*Play at 2x speed

Summary4

- It was suggested that erosion of the foundation ground in front of the gabion could lead to additional erosion caused by the weight of the revetment.
- Although gabion revetments have excellent tenacity that follows the ground, it has been suggested that it may displace rapidly if the allowable amount of deformation is exceeded.

Conclusion

- It was found that the gabion revetment was deformed due to water level fluctuations, overflow, and backwater, but it was small at less than 1/500 of the height of the revetment, suggesting that this alone may not cause damage.
- The erosion of the foundation ground becomes a direct cause of the abrupt displacement in gabion revetment.
- This experiment is just a basic experiment, and further research is needed to discuss the stability of gabion revetments in detail by comparing the field level data.