Seismic behavior of model embankment affected by seepage water and frozen surface

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INTRODUCTION

Ground water level and earthquake are critical factors with regard to embankment instability.

Damage case of embankment in the 2004 Niigata-kenChuetsu Earthquake

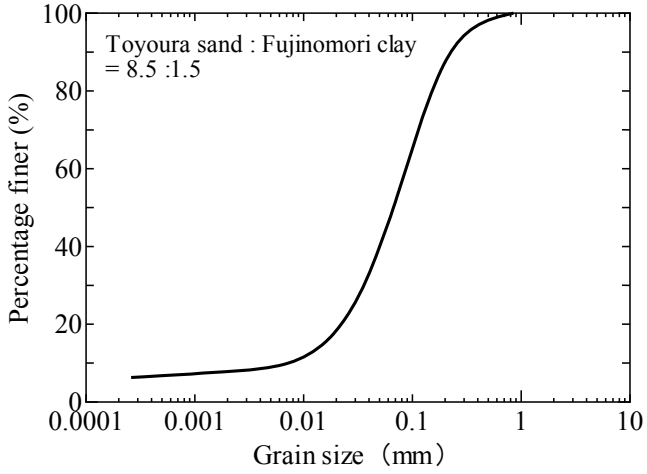
Decrease in earthquake resistance would be expected by the raised water level in the embankment due to **the increased snowmelt water.**

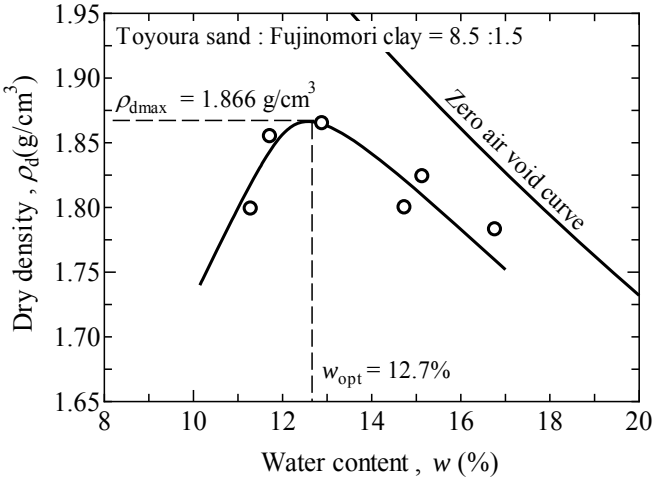
Effect of seepage water and frozen surface of embankment on the model embankment was examined under earthquake by using shaking table.

TEST PROCEDURE

✓Test geomaterial

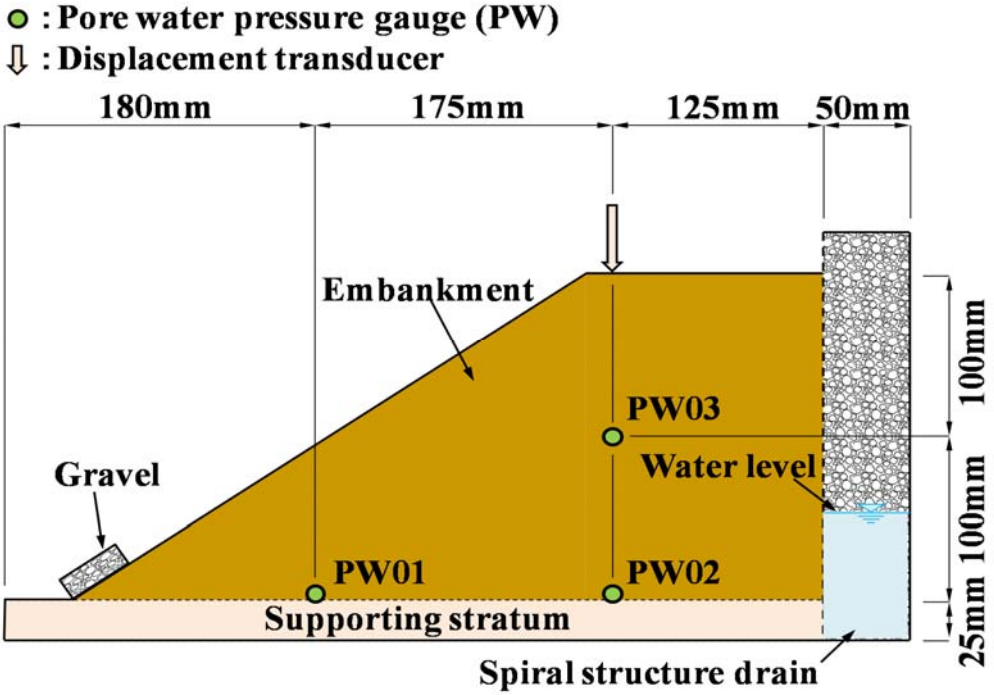
Toyoura sand + Fujinomori clay (8.5 : 1.5)





TEST PROCEDURE

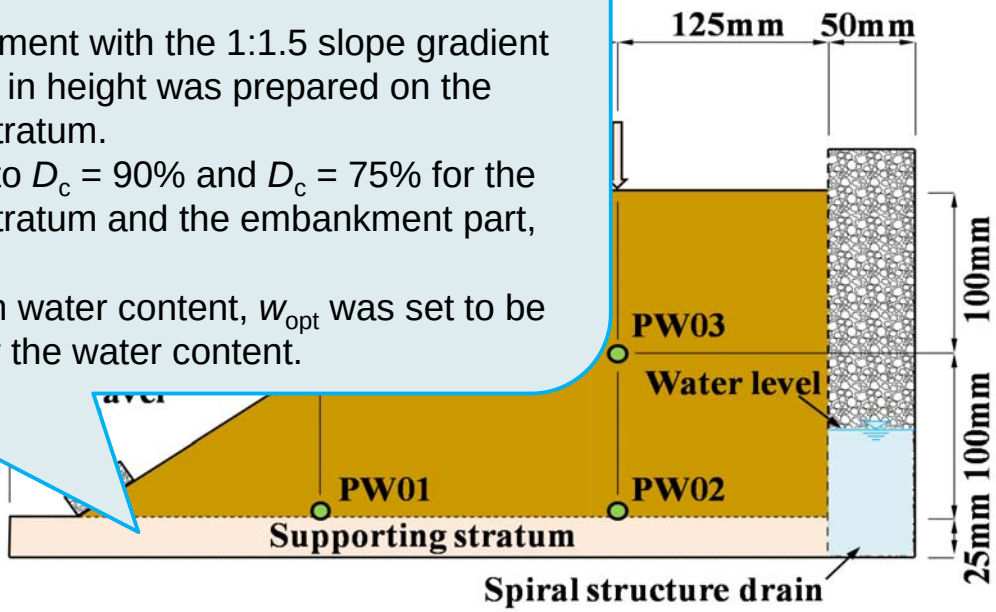
✓Model embankment



TEST PROCEDURE

✓Model embankment

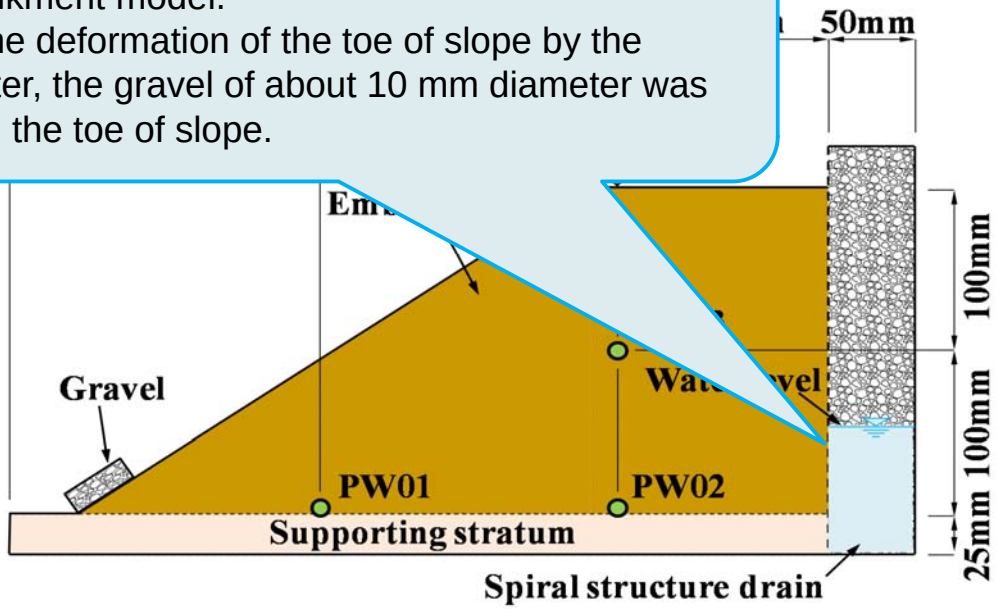
- The supporting stratum of 25 mm in height was prepared.
- The embankment with the 1:1.5 slope gradient and 200 mm in height was prepared on the supporting stratum.
- D_c were set to D_c = 90% and D_c = 75% for the supporting stratum and the embankment part, respectively.
- The optimum water content, w_{opt} was set to be the target for the water content.



TEST PROCEDURE

✓Model embankment

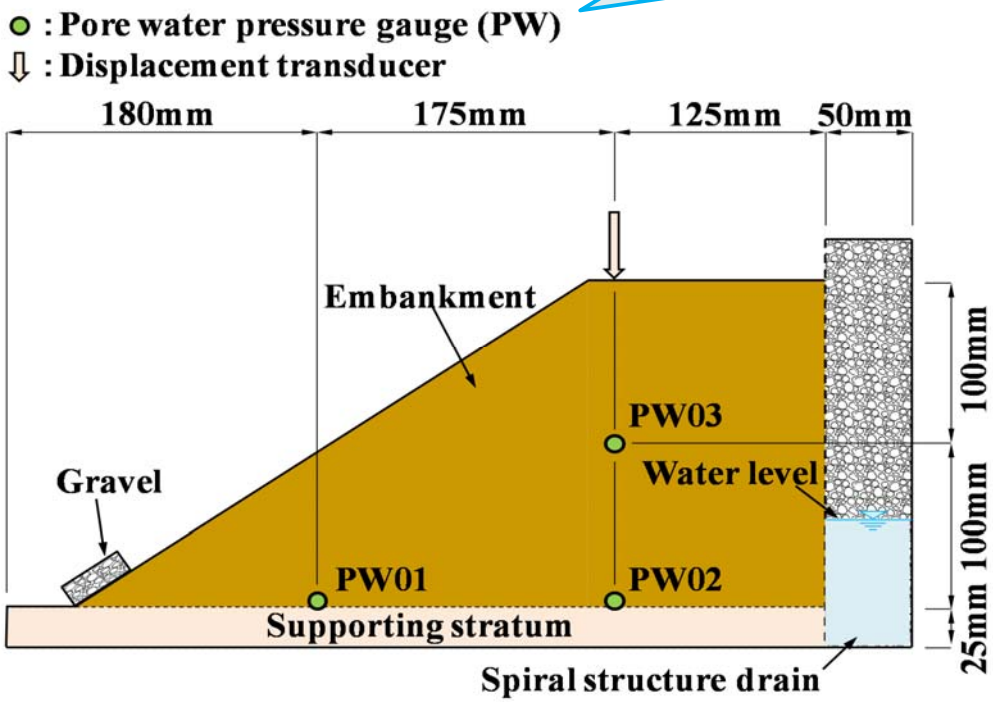
- Water was poured to maintain the water level, h_w of 50 mm in the embankment model.
- To prevent the deformation of the toe of slope by the seepage water, the gravel of about 10 mm diameter was placed along the toe of slope.



TEST PROCE

- The measurement items were set for the pore water pressure in the embankment and the vertical displacement at the top of slope.

✓Model embankment



TEST PROCEDURE

✓Test conditions

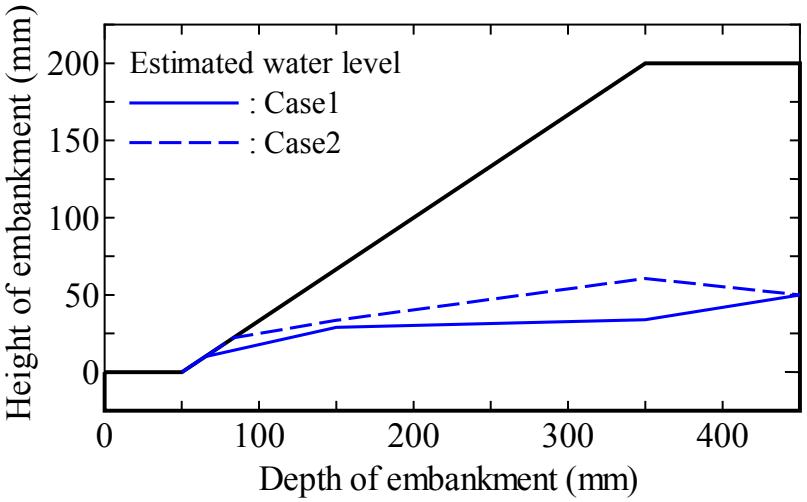
Case	Seepage	Frozen
Case1	○	×
Case2	○	○

Shaking of the sinusoidal wave of 5Hz, 20 waves was applied with the inputted acceleration which was increased in 100 gal incremental steps from 300 gal.

TEST PROCEDURE

✓Water level

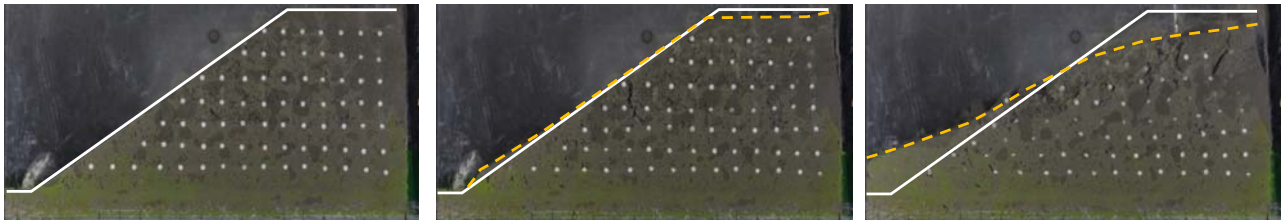
- The difference of the water level condition between Case 1 and Case 2 was small.
- It is considered that the effect to the behavior of the excess pore water pressure during shaking is slight.



RESULT AND DISCUSSION

✓CASE1(Not Frozen)

500gal	**No deformation.**
600gal	• **Cracking occurred in the vicinity of the center of the face of slope.** • **Deformation of the circular slip type from the toe of slope to the top of slope occurred.**
700gal	**Deformation from the toe of slope part was extended, and a large-scale collapse occurred.**



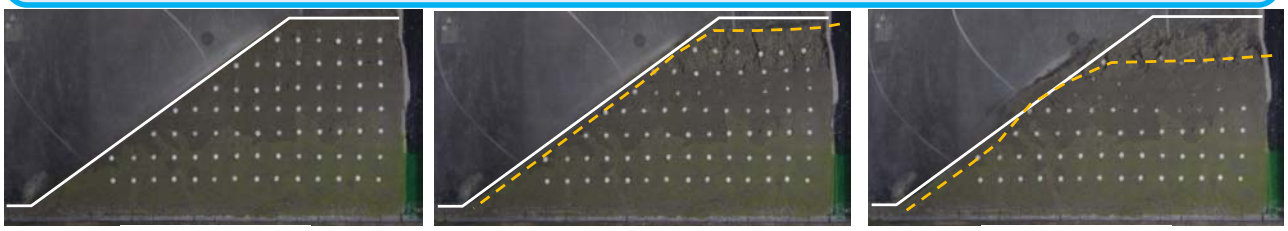
500gal → 600gal → 700gal

RESULT AND DISCUSSION

✓CASE2(Frozen of surface)

500gal	**Small sliding failure occurred at the top of slope**
600gal	**Deformation of the embankment progressed in the part above the embankment height, *H* of about 100 mm**
700gal	**Large collapse occurred**

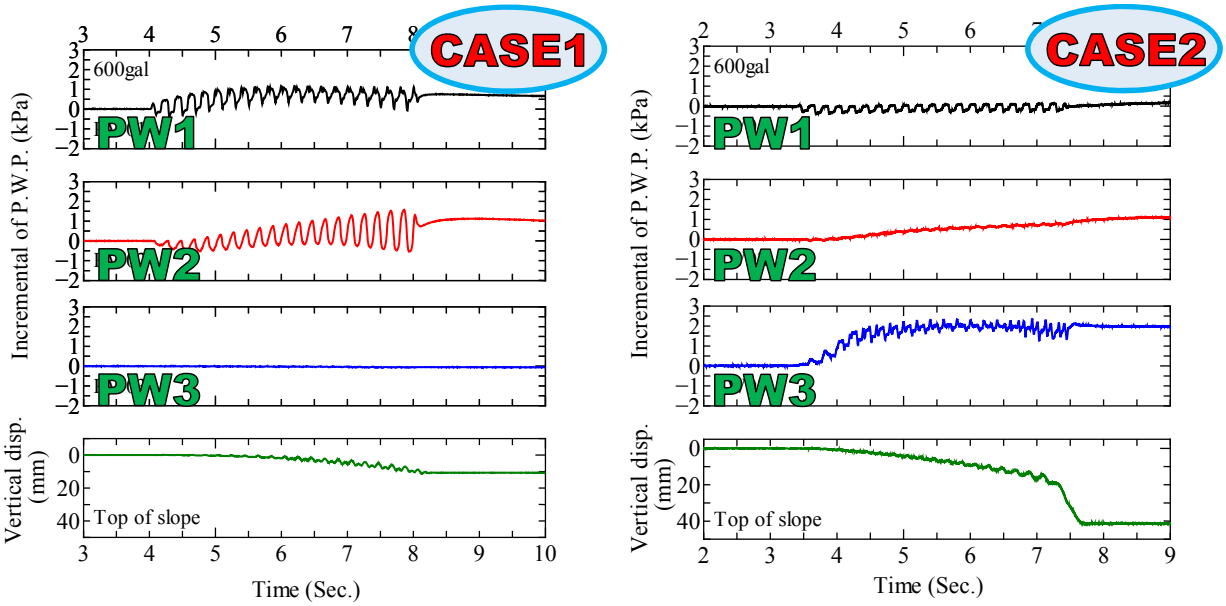
Deformation and collapse behaviors when the shaking is applied varies considerably depending on freezing condition of embankment surface.



500gal → 600gal → 700gal

✓Behavior of P.W.P at 600gal

In Case1, P.W.P. increased clearly at the bottom of the embankment. In Case2, the increase in P.W.P. at the bottom of the embankment was small, P.W.P. increased greatly in the upper embankment.



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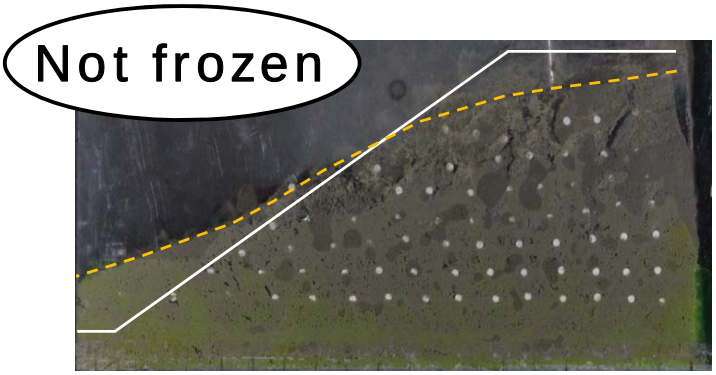
Based on test results …

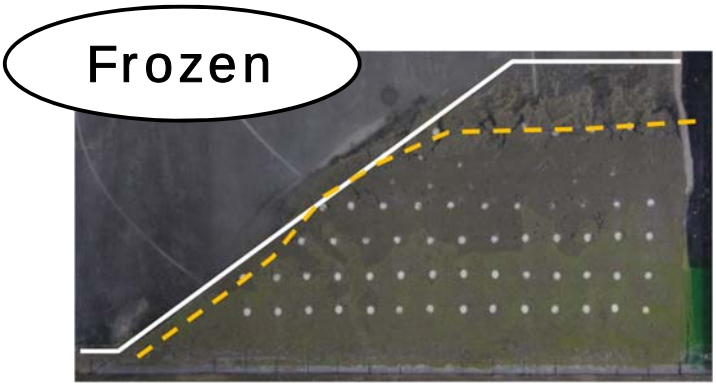
- ✓ It is thought that the freezing condition of the embankment surface would have an effect on the deformation and the collapse modes associated with the **strength characteristic change**.
- ✓ Pore water pressure behaviors due to **the changes in boundary conditions such as ventilation and passing water characteristics** in embankment surface.

CONCLUSIONS

The Difference of Not frozen and frozen

- Deformation and Collapse mode
- Increasing of Pore water pressure location
- Boundary condition for permeability of water / air





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Thank you for your kind attention