2014 Kinki Regional Development Bureau Research Presentation Construction and Safety Management Strategy Division

Investigation at the Bottom of Railway and an Embankment by Sounding Method

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Soil structures such as embankments at road, railway, harbor facilities, river levee, electric power and industrial facilities are expected to be in a state of heterogeneity in terms of strength and soil types in both the transverse and longitudinal directions.

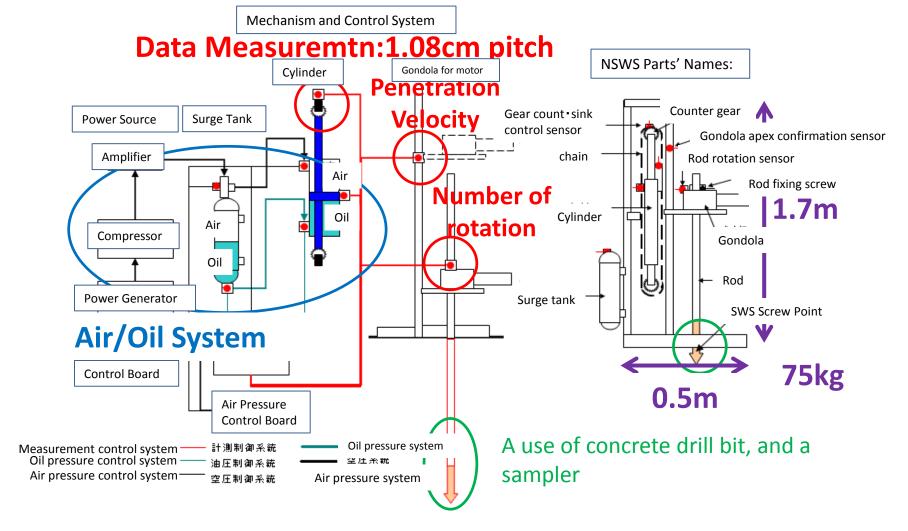
This heterogeneity greatly affects permeability of rain water, endurance against earthquakes, and others.

I'd like to present an investigation result which was carried out with a new sounding testing machine, or NSWS. It was meant to comprehend a soil structure and its strength of a deformed embankment sighted by visual observation in details from operation and maintenance point of view.

- 1. Introduction of Nippon Screw Weight System, or NSWS
- 2. Investigation Result at Embankment Point A
- 3. Investigation Result at Embankment Point B
- 4. Discussion and Conclusion

1. NSWS Testing Machine

NSWS is a machine that complies with the Swedish sounding test in combination with the rotation penetration due to the load.



1 Loading System (Air / Oil system)

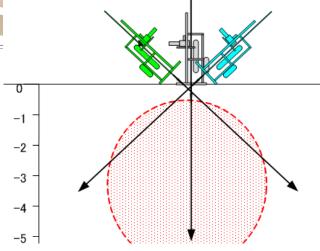
- Applicable Loading Amount: 0~2,500N (variable)
- Direction of measurement : vertical, diagonal, horizontal



vertical measurement at slopes



54 degree diagonal measurement at a slope



Comprehension of a particular ground location in two or three dimension.



40 degree diagonal measurement

2 Measurement(penetration speed, a number of Rotation, 1.08cm measurement resolution)

- Comprehension of compositions of soil layers in details
- An automatic stopping feature at self-scuttling layers and re-starting of a measurement from 0 Newton. This leads to comprehension of a void or a very soft layer in details.

3 A Use of Concrete Drill Bit

- Applicable to various kinds of ground
- Used for calculating soil strength such as converted N-values, etc.
- Data results are mostly the same as results of SWS machines
 Results were examined by soil layer experiment, and in-situ
 experiment.

 Sampling at two spots, 1m interval
- 4 A Use of Soil Sampler

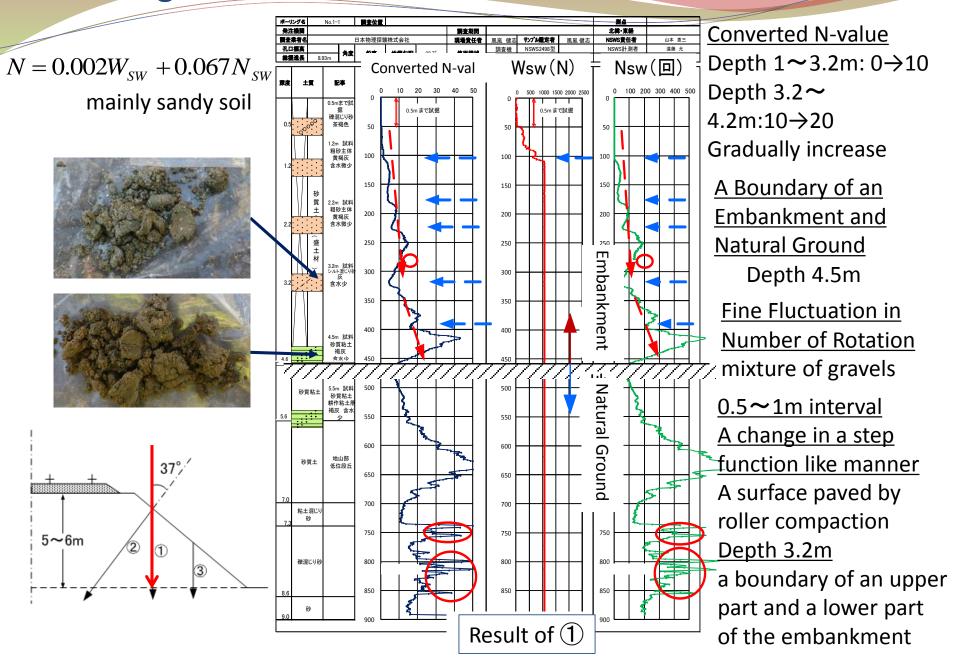
accurately sorting soil layers by penetration sound as well as samplers.

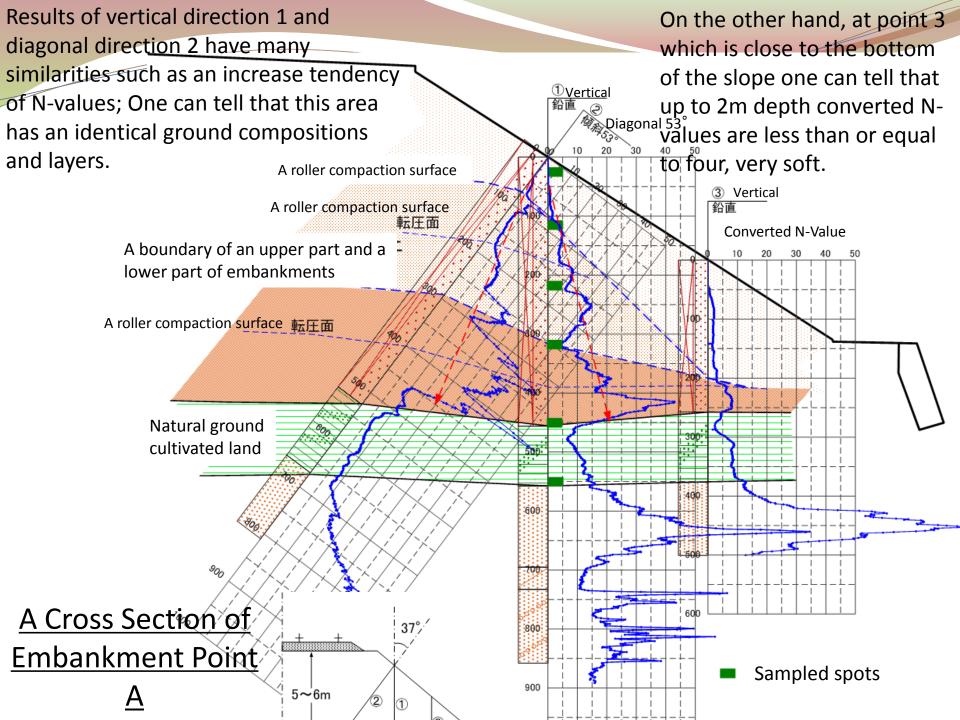
 $(5)1.7m \times 0.5m \times 0.5m, 75kg$

NSWS is applicable at confined area and highly mobile due to its lightweight.



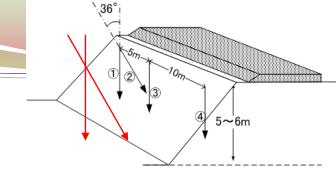
2. Investigation Result at Embankment Point A



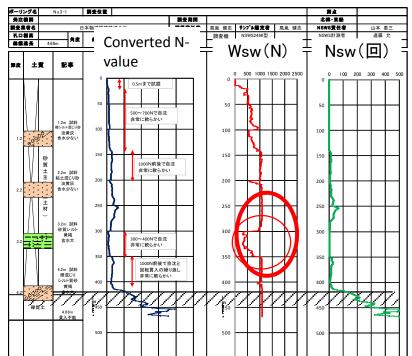


3. Investigation Result at Embankment Point B

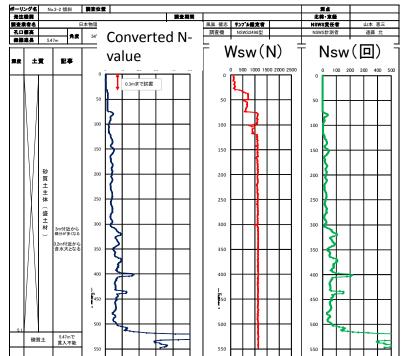
Although embankment A and embankment B have sandy soil as a major component, results were quite different. Vertical hole 1 has converted N-values less than or equal to four, very loose density down to GL-4m, and diagonal hole 2 has converted N-values less than or equal to four, very loose density down to GL-5m.



Especially vertical hole 1 had no rotation down to 1.5m, from GL-3.0m to 3.5m self-scuttled with 300 to 400N of loading, very loose. A sampler confirmed that a great amount of water was contained, very close to saturation.

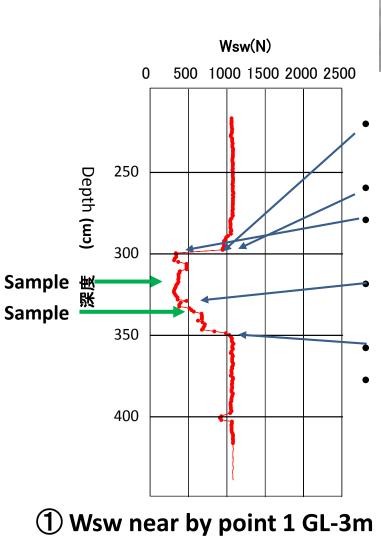


 ${f \textcircled{1}}$ Result of Vertical Measurement



2 Result of Diagonal Measurement

Embankment B Point 1 Collection of a Specimen





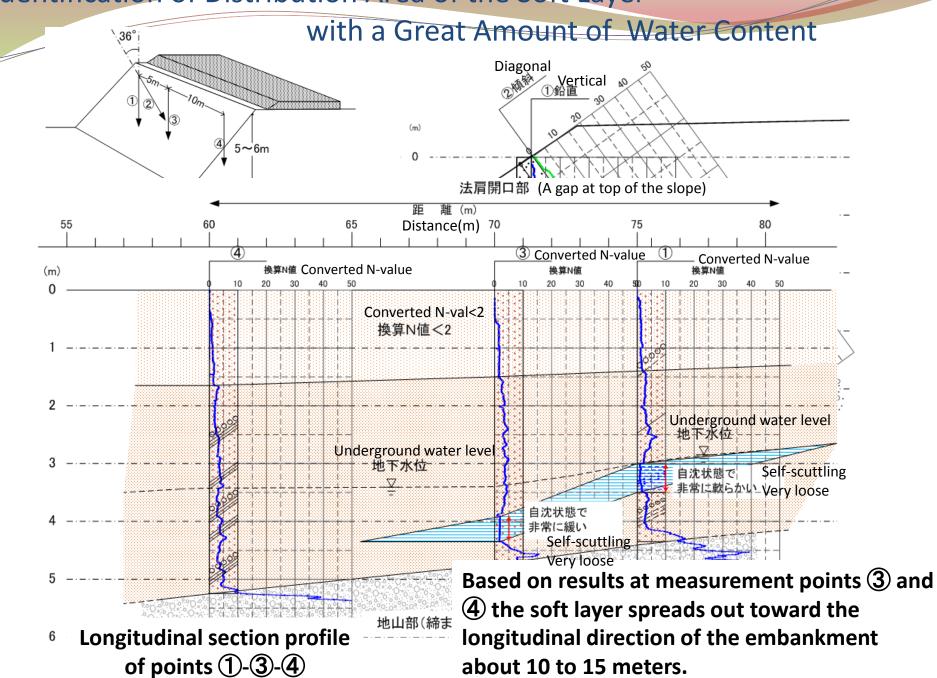
GL-3.2m Sandy silt GL-3.4m gravels mixed silty sand Detection of self-scuttling by abrupt change of penetration speed

Penetration, Automatic stop of rotation Reset a loading amount to 0 Newton, and re-start measuring from 3.0m to 3.3m, self-scuttling with 300 to 400N of loading

from 3.3m to 3.5m, gradual increase up to 1000N start rotation

A extremely soft silt layer with a great amount of water included and 0.5m thickness was confirmed, and it turned out that the probability of the collapse of the embankment could be very high at heavy rainfall depending on a range of the

Identification of Distribution Area of the Soft Layer



4. Discussion and Conclusion

At two locations of railway embankments conducted sounding test.

At embankment A which has natural ground with many gravels, vertical as well as diagonal measurements were conducted down to 9 meters depth. And at an embankment part where soil type was homogeneous, unprecedented results came out:

- Even though a soil type was homogeneous, we could detect fine variations in loading amounts. This means with NSWS tiny variations of soil strength and soil layer boundaries which was created by roller compaction can be detected.
- 2. This embankment has a variation of converted N-values from 1 to 20.

At embankment B vertical measurements at 7 locations and diagonal measurement at one location were extensively conducted within a limited time. The result reveals followings:

- 1. A part of the embankment with 5 to 6 meters high converted N-values are equal to or less than four, very loose state of relative density.
- 2. And within that region a very soft clay layer with saturation state, 0.5 meter thickness, at 3 to 4 meters depth spread out in longitudinal directional direction for 10 to 15 meters.

These results prove the capabilities of NSWS for detecting very soft layers and its usefulness for safety measure of embankments.

Henceforth, we can verify heterogeneity, fine variations of embankments and other soil structures by comparing data which is collected right after rainfall, using the features of NSWS, conducting shear test, or conducting general investigation with in-situ permeability test.

I believe this will contribute to sampling of soil at a site of landslide caused by Guerilla rainstorm or earthquake, stability analysis, and a logical countermeasure against natural disasters

ご清聴ありがとうございました。 Thank you for your participation.