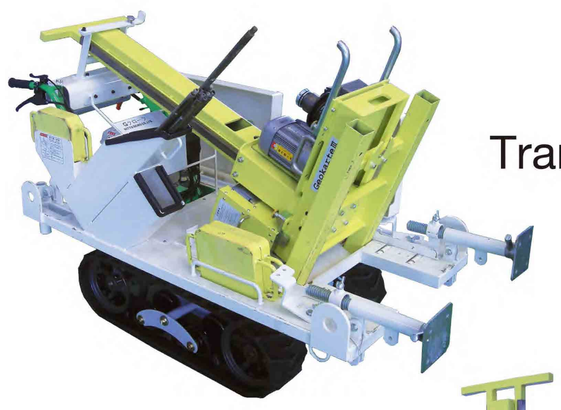
# 01 Screw Driving Sounding Test

The Screw Driving Sounding Test, (hereinafter referred to as the SDS), is the ground investigation method which has been developed using a Swedish Weight Sounding Test (the SWS) machine.
The SWS, which has been generally adopted for ground investigation in residential areas in Japan, is not suitable for the evaluation of a liquefaction risk of ground since it is not able to classify types of soil.
The SDS, on the other hand, is capable of evaluating it because the essential factors such as a load, torque and penetration length are able to be measured by the SDS.

## GeoKarte

### New Technology Machine for SDS Test

- Easy operation
- High performance
- High accuracy
- Compact design



Transfer mode

Test mode

Geokarte with Crawlere

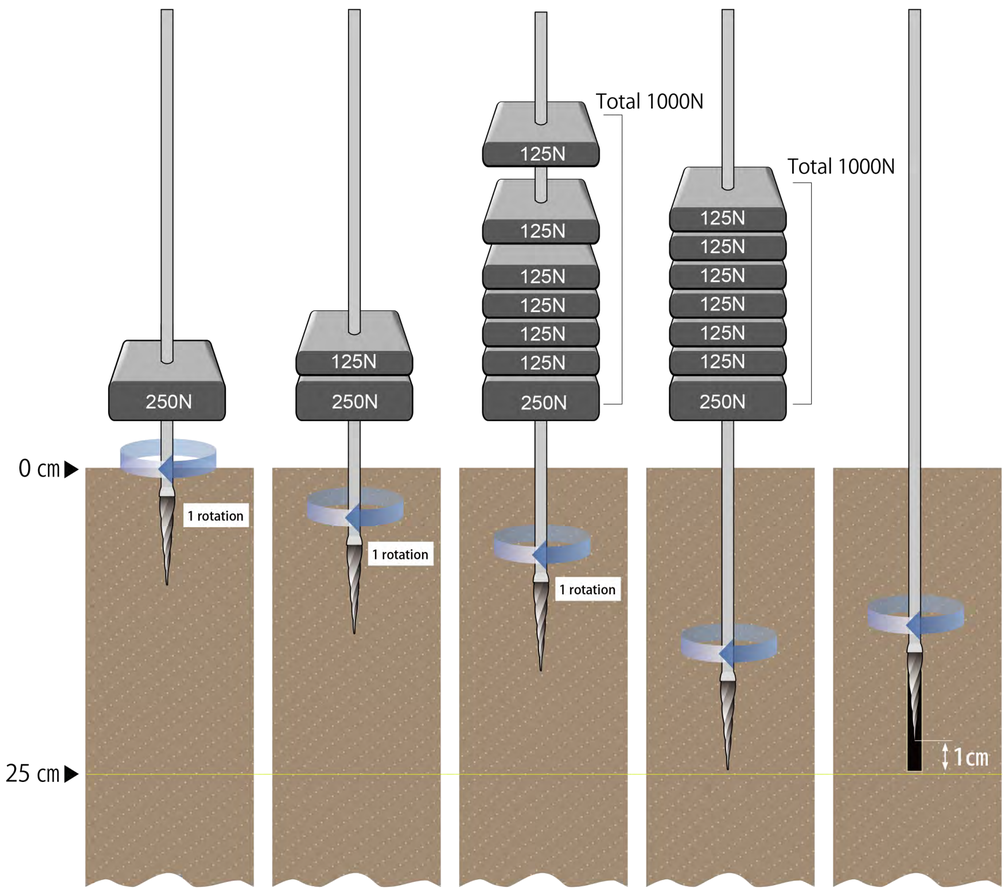
### Geokarte Main Specifications

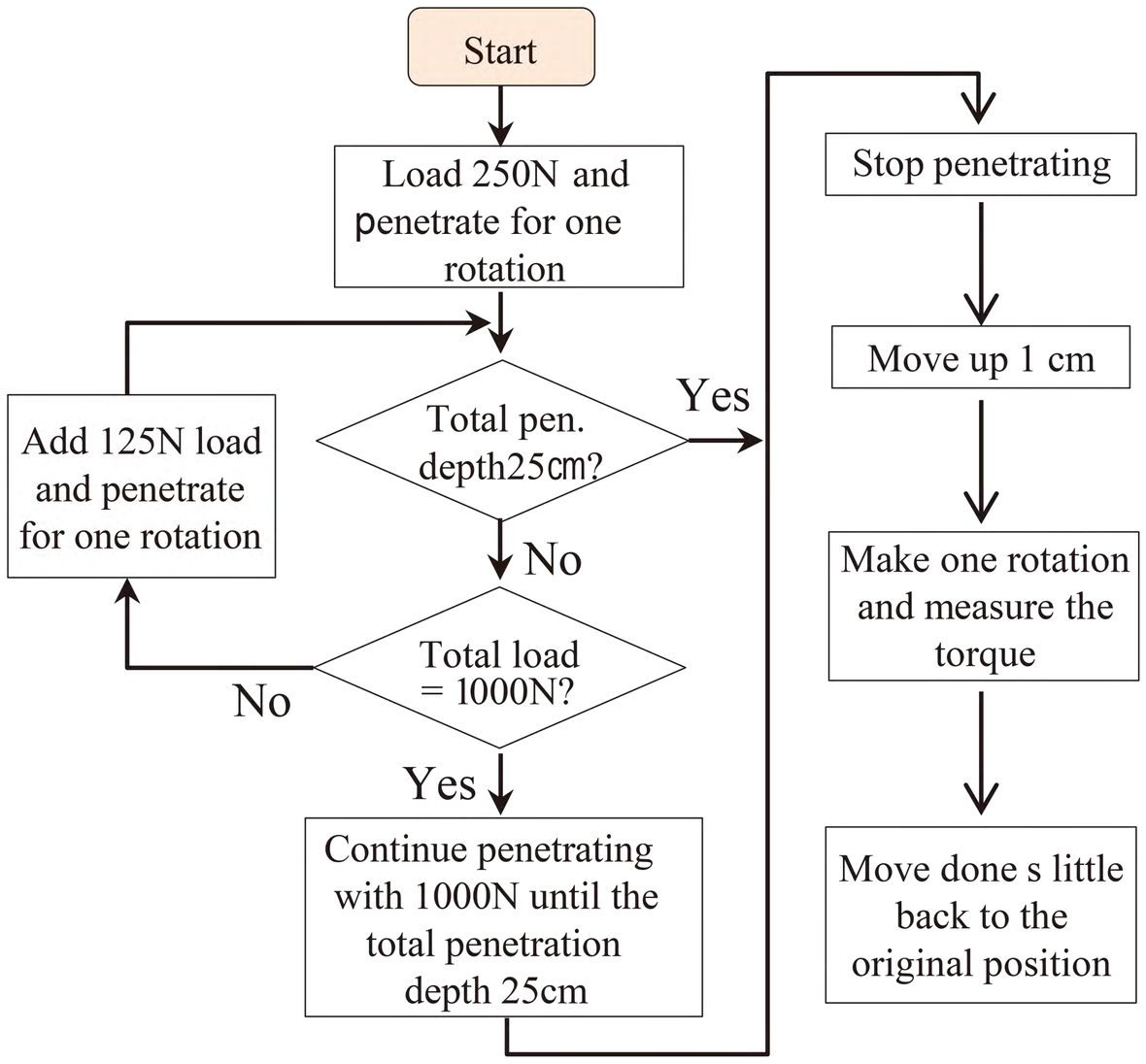
| | | |
|---|---|---|
| Changing of test load | | 7 levels (250,375,500,625,750,875,1000N) |
| Torque detection | | 0～100Nm (±2Nm) |
| Test data recording | | Information：Date, Number of point, etc.<br>Data：Penetration length, Load, Torqe, etc. |
| Machine | Dimenssions | W630×D1100(in test)×H1290 |
| | Weight | 110kg (no weights) ,154kg (with weights) |
| Contorol unit | Dimenssions | W448×D349.5×H459 |
| | Weight | 24.5kg |

The SDS investigates the stiffness and types of soil using a SDS machine whose rod and screw point are the same as those of the SWS (Accorded with JIS). The target soil of investigation is the soft ground from surface to 10m depth and measured items are mainly torque, penetration length and a vertical load at every rotation of rod.

# 02 Characteristics of the SDS

## Test Process




1 A 250N load (the initial weighted load) is weighted and the data is measured immediately after a rod rotates once and penetrates.

2 A monotonic loading system is adopted for the SDS. The loading is constantly increased by 125N up to the maximum load 1000N at every rotation of rod until the total penetration length becomes 25cm.The data such as torque is recorded every time the load is weighted.

3 Torque and the rod friction caused between the surface of the rod and the wall of the borehole are measured immediately after the rod is lifted up a little and rotates at every 25cm penetration.
In order to obtain more precise values directly applied to a screw point, it is necessary to remove the rod friction from the torque and the load measured in the process of 2 .

**Torques and loads are defined with following formulas.**

$$T_a = T_f + T \qquad W_a = W_f + W$$

A maximum shear stress is expressed as follows.

$$\tau = \frac{T}{2\pi r^2 \cdot L}$$

$T$: measured torque, r:19mm,
$L$:penetration length

Assuming the direction of combined speed and that of maximum shear stress are same, the following formulas are given.

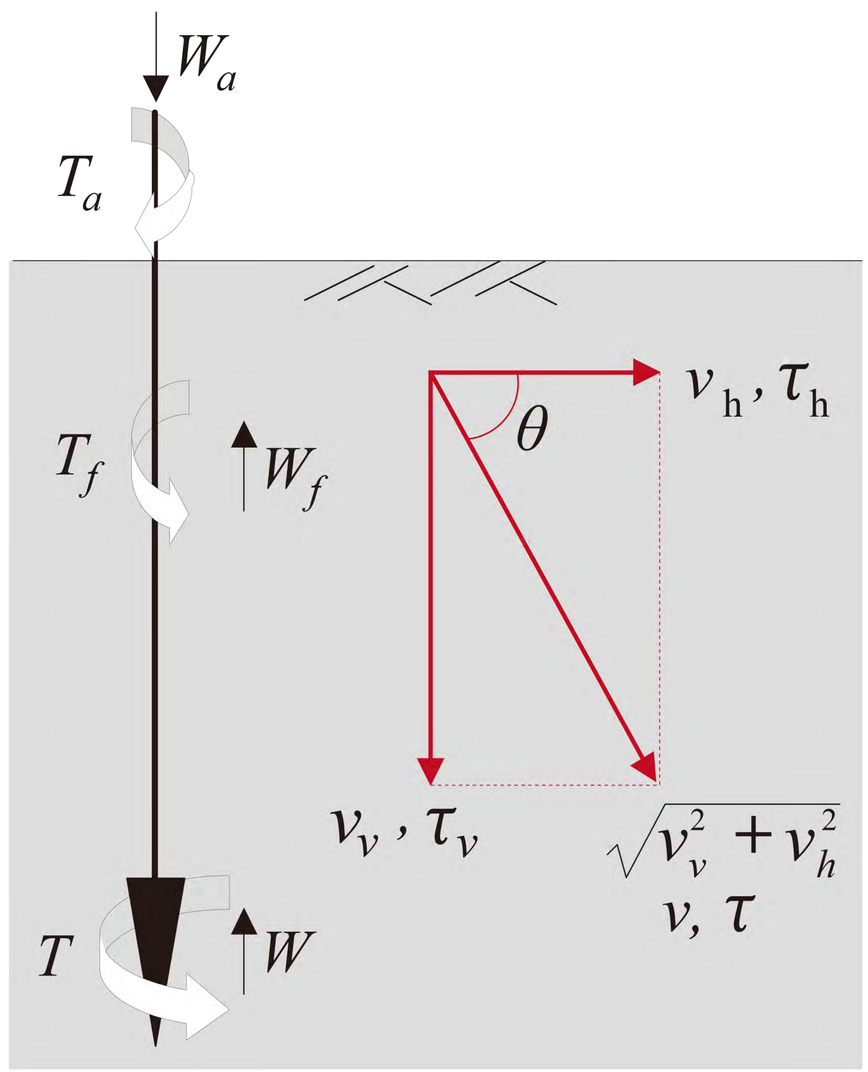
$$\tau_h = \tau \cos\theta \qquad \tau_v = \tau \sin\theta$$

A friction torque of rod rotation and a friction force of penetration are expressed as follows.

$$T_f = 2\pi r^2 \cdot L \cdot \tau_h \qquad W_f = 2\pi r \cdot L \cdot \tau_v$$

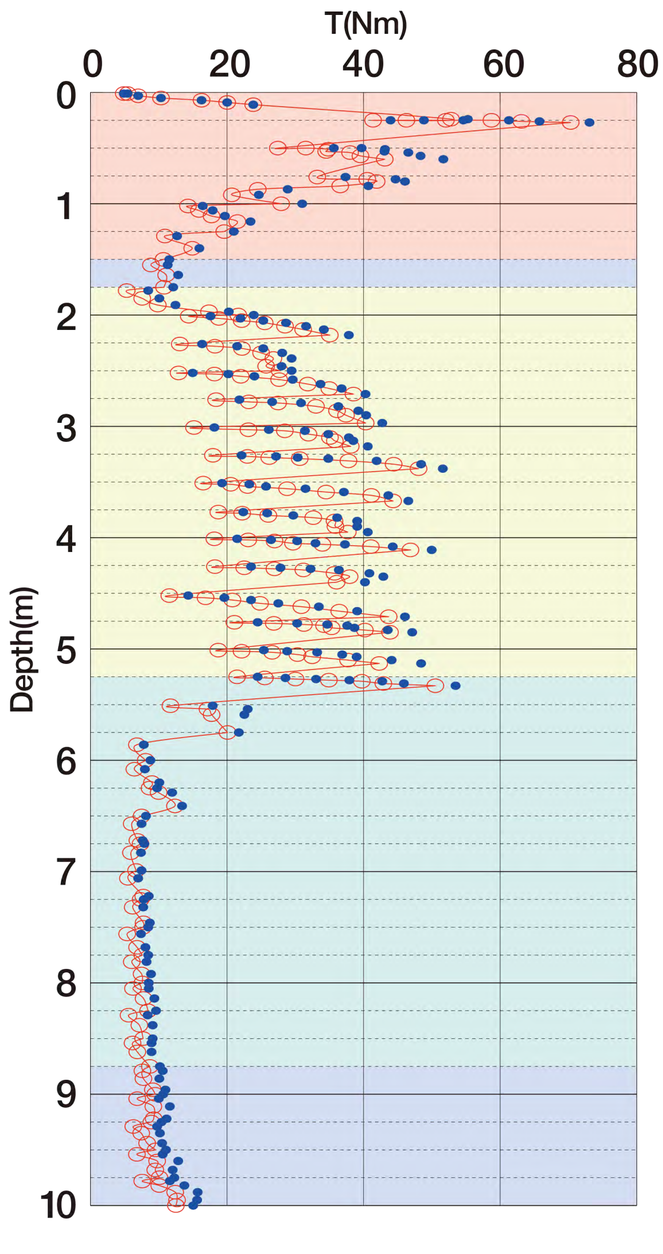
Therefore, a corrected load and a corrected torque are obtained using the following formulas.

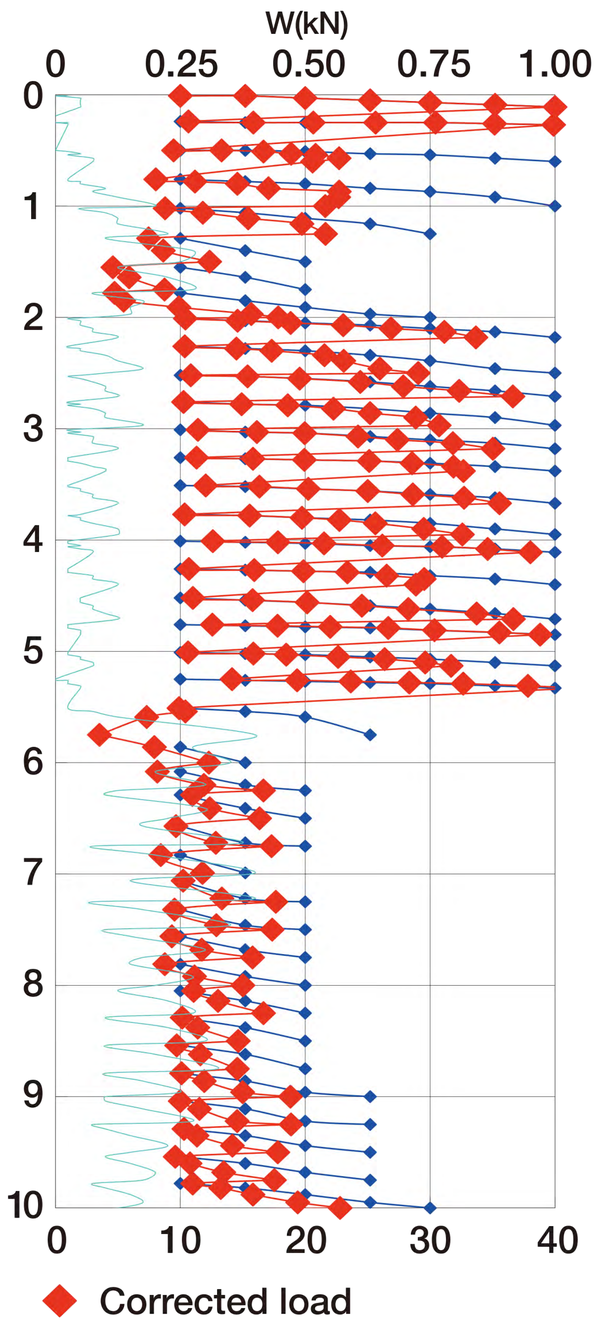
$$T = T_a - T_f = T_a - 2\pi r^2 \cdot L \cdot \tau_h \qquad W = W_a - W_f = W_a - 2\pi r \cdot L \cdot \tau_v$$

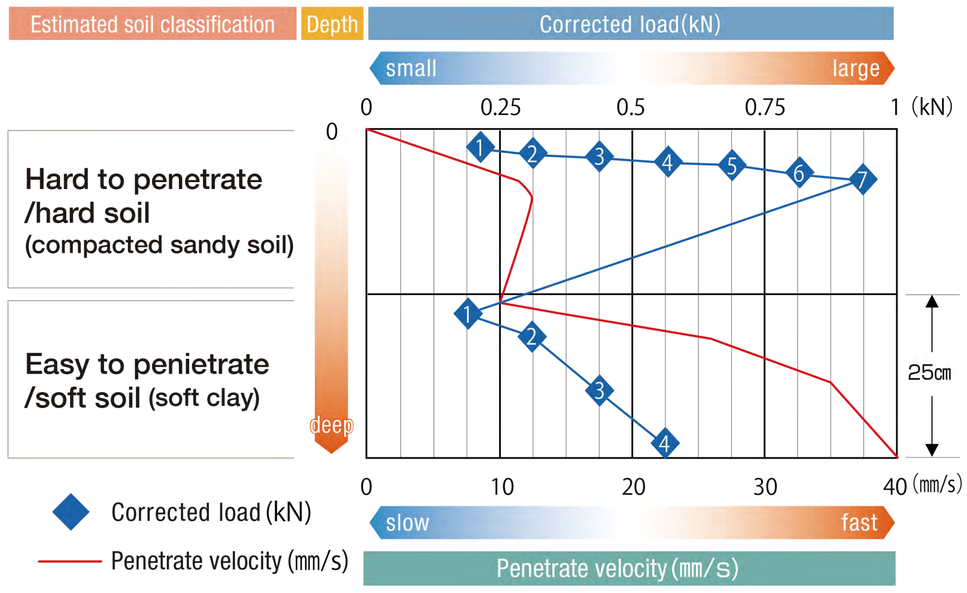


# 03.1 Soil types and SDS data

## SDS primary data



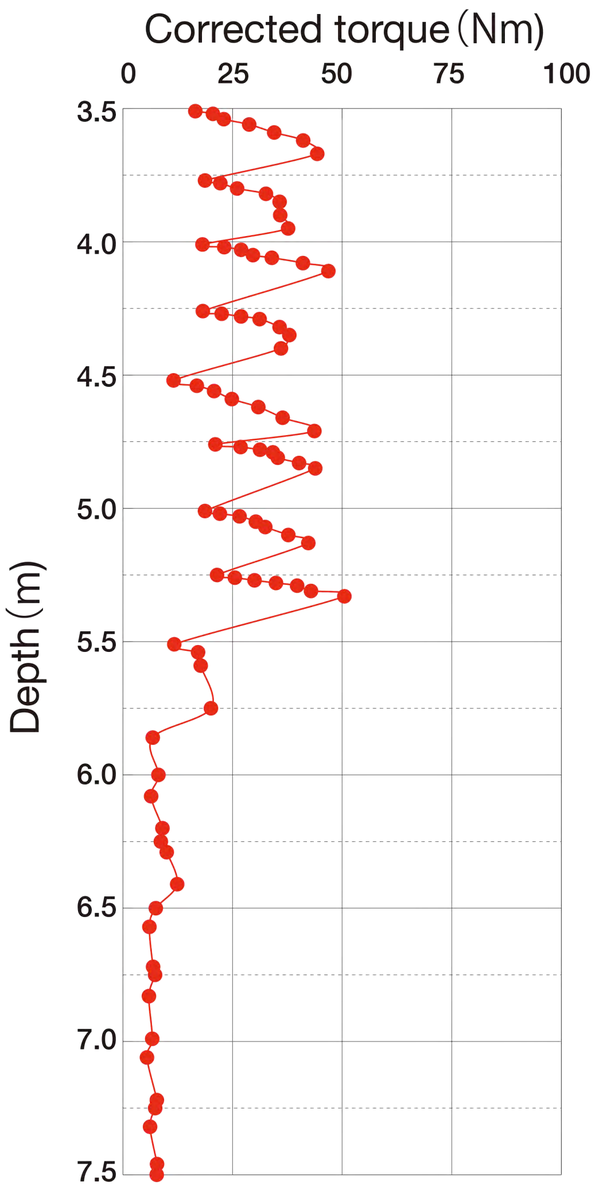



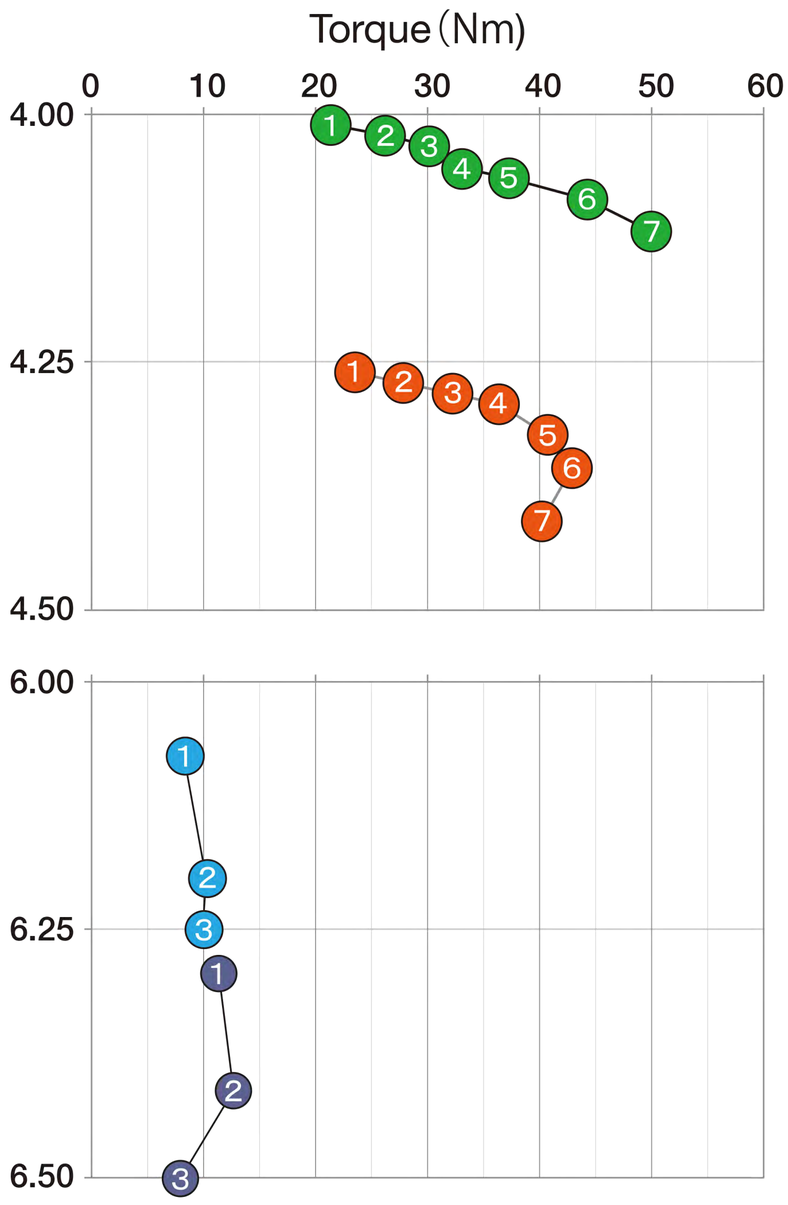

## Borehole

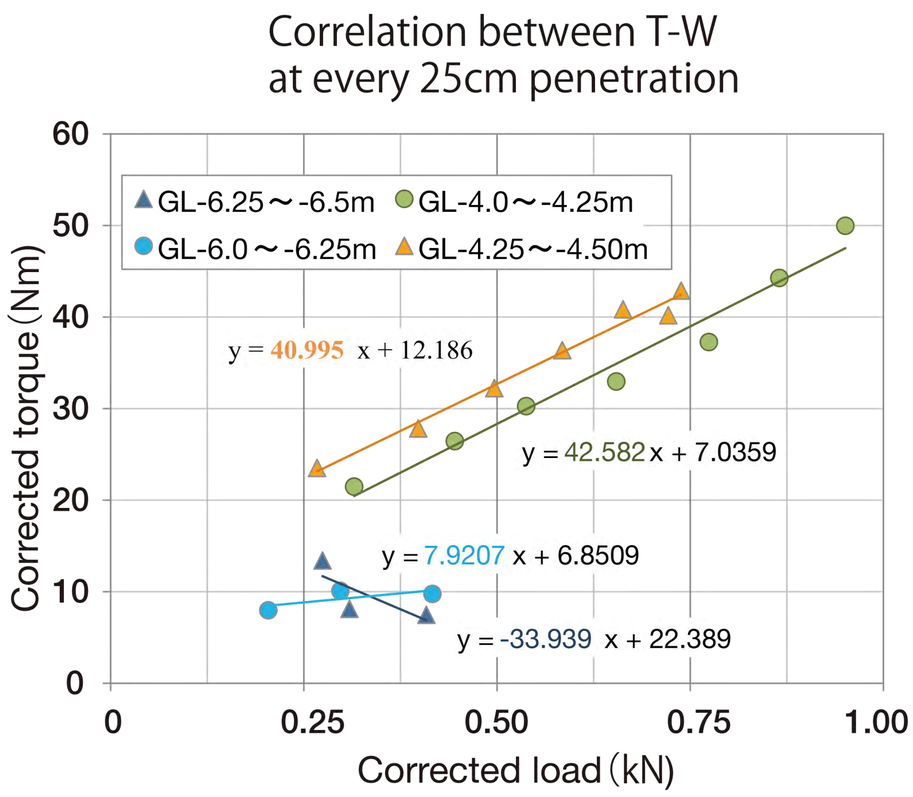
| | |
|---|---|
| Earth Fill | (GL±0 ~ -1.5) |
| Organic clay | (GL -1.5 ~ -1.8) |
| Sand | (GL -1.8 ~ -5.3) |
| Silt | (GL -5.3 ~ -8.7) |
| Organic clay | (GL -8.7 ~) |

## SDS key parameters for soil classification

### Tendency of soil characteristics （dT/dW）



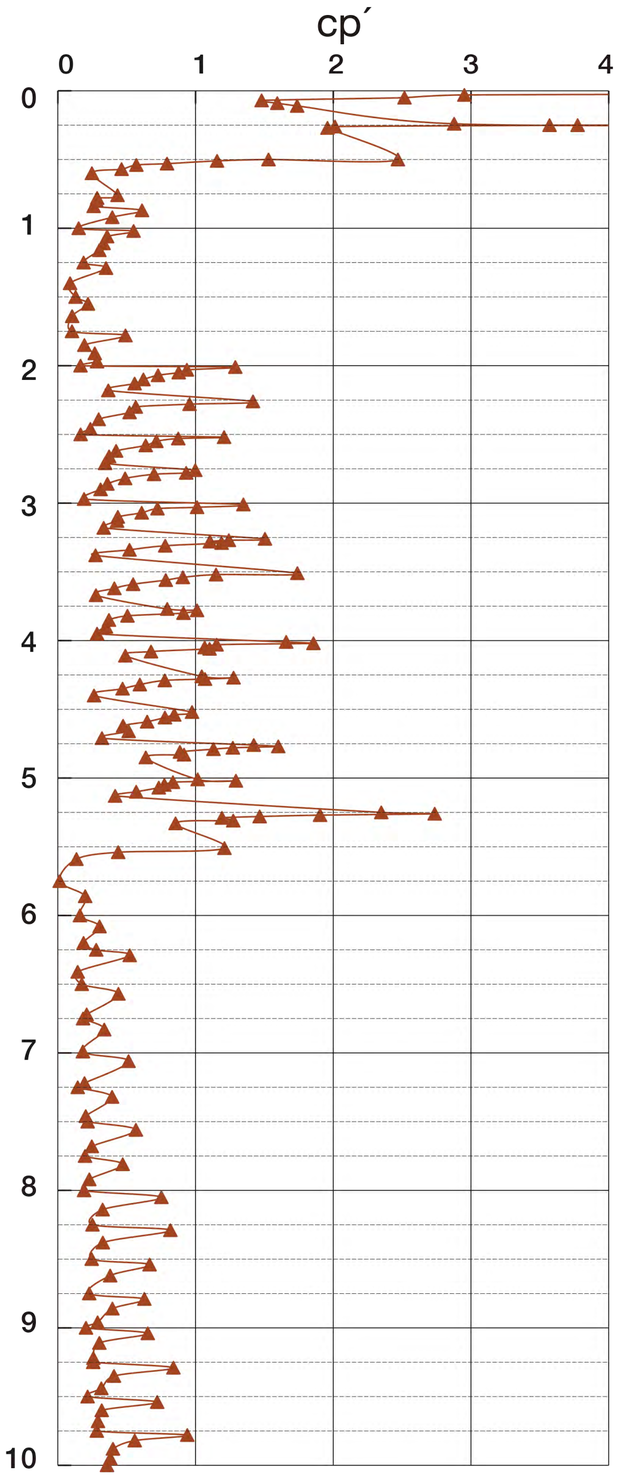




**If the soil has internal frictional force, Torque increases with increasing load**

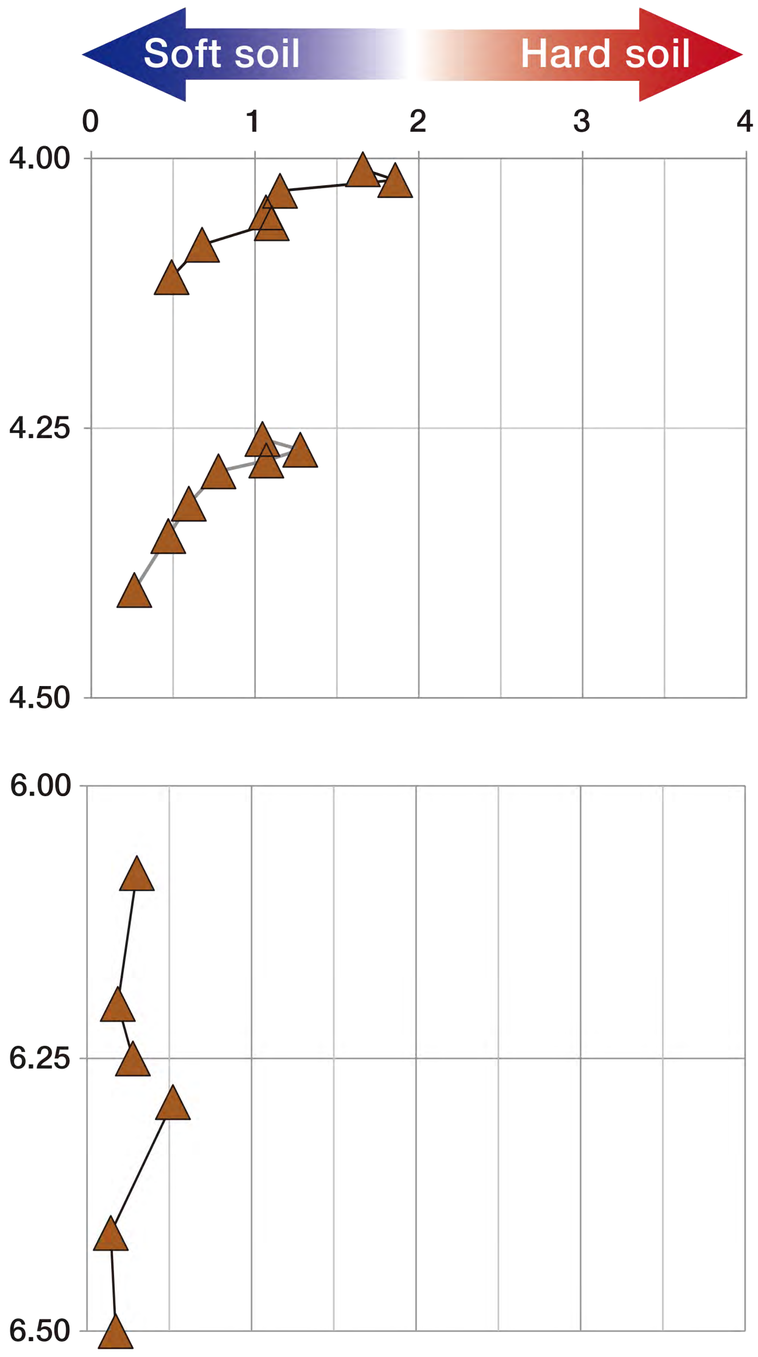
※These indicated data was obtained in the low level ground of a coastal area located in Chiba prefecture in Japan.

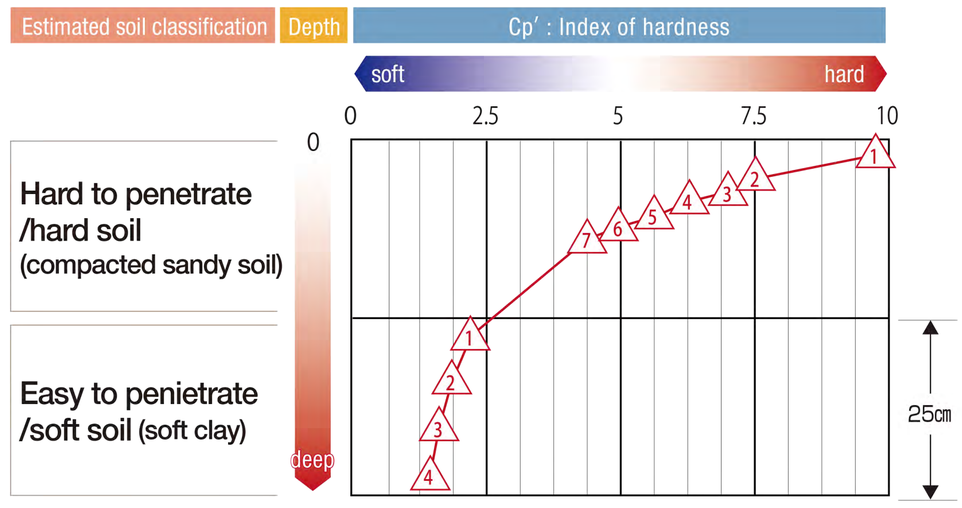
# 03.2 Soil types and SDS data

## SDS key parameters for soil characteristics




cp´ : Parameters indicating the hardness of soils

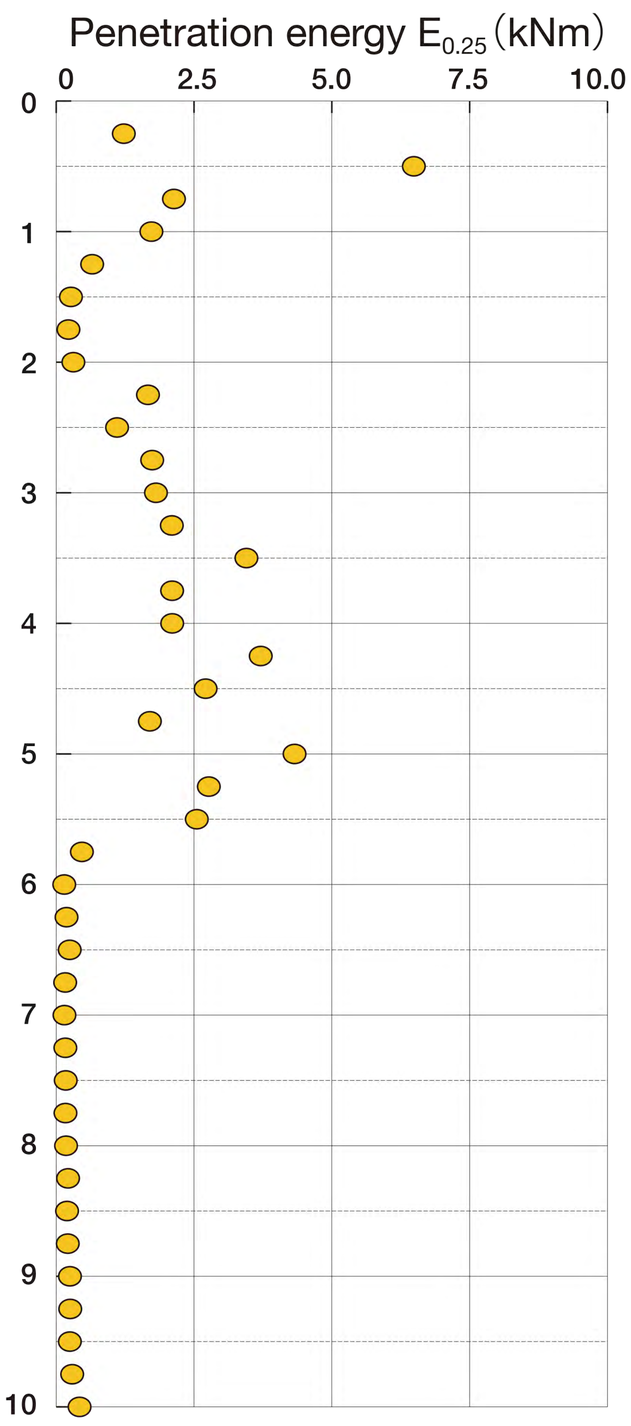


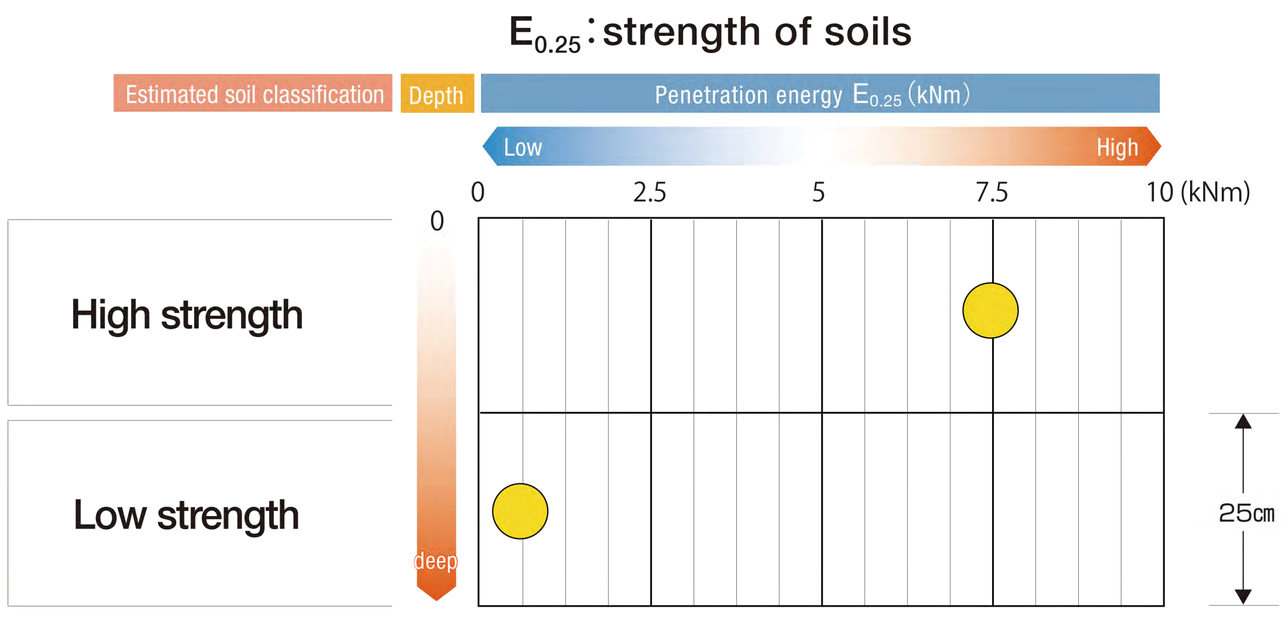

$$c_p' = \frac{N_{SD} D}{\pi T / WD}$$

$N_{SD}D$：a half rotation rate needed for the total penetration length of 1m

πT/WD：a ratio of torque to load D is a maximum diameter of a screw point and used to be dimensionless.




$E_{0.25}$：strength of soils

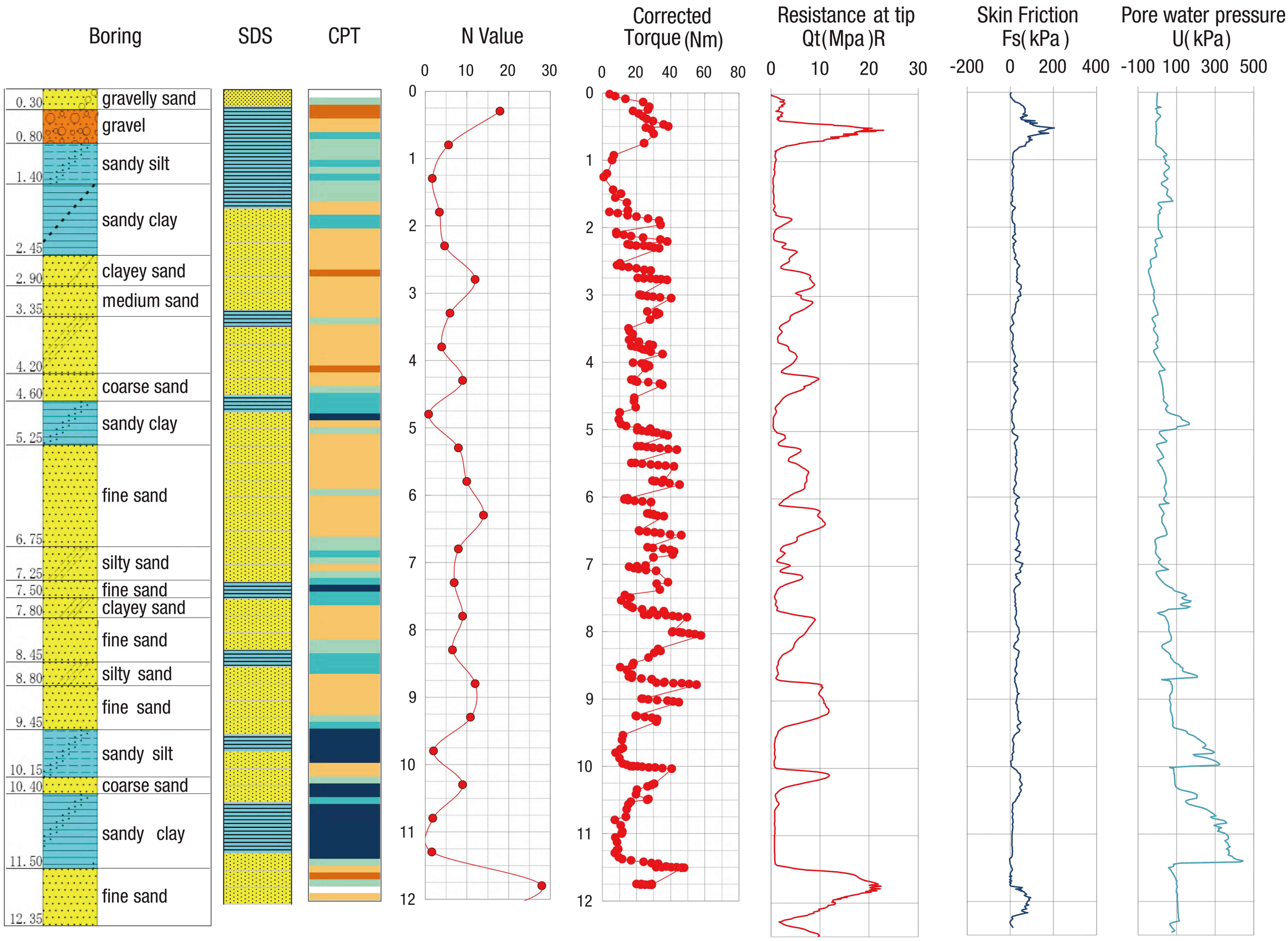



$$dE = \pi T dn_{ht} + W ds_t$$

dE :a penetration energy at every loading
T :corrected torque
$dn_{ht}$ :a half rotation rate
W :a corrected load
$ds_t$ :a penetration amount

The combined energy of torque and a load acting to a screw point(workload）.The energy needed for 0.25m penetration is defined as $E_{0.25}$ according to the relationship between $\Sigma dE$ and $\Sigma ds_t$ at every 0.25m.

# 04 Comparison to other sounding test methods (SDS-CPT-SPT)




**Robertson (1990) Soil Properties**

- sensitive fine grained
- organic material
- clay to silty clay
- clayey silt to silty clay
- silty sand to sandy silt
- clean sand to silty sands
- gravelly sand to sand
- very stiff sand to clayey sand
- very stiff fine grained

※These indicated data was obtained in a delta located in Shiga prefecture in Japan

It is possible to classify soils into ‘sand’ or ‘not sand’ using both a statistical measure ‘the Mahalanobis distance’ and the data obtained from the SDS results.

【SDS parameter used for statistics】

- dT/dWD : correlation between rate of torque and a weighted load
- $W_{0.25}$ : a load needed for 25cm penetration
- 828 samples from 40 bowling test points were used for soil classification.

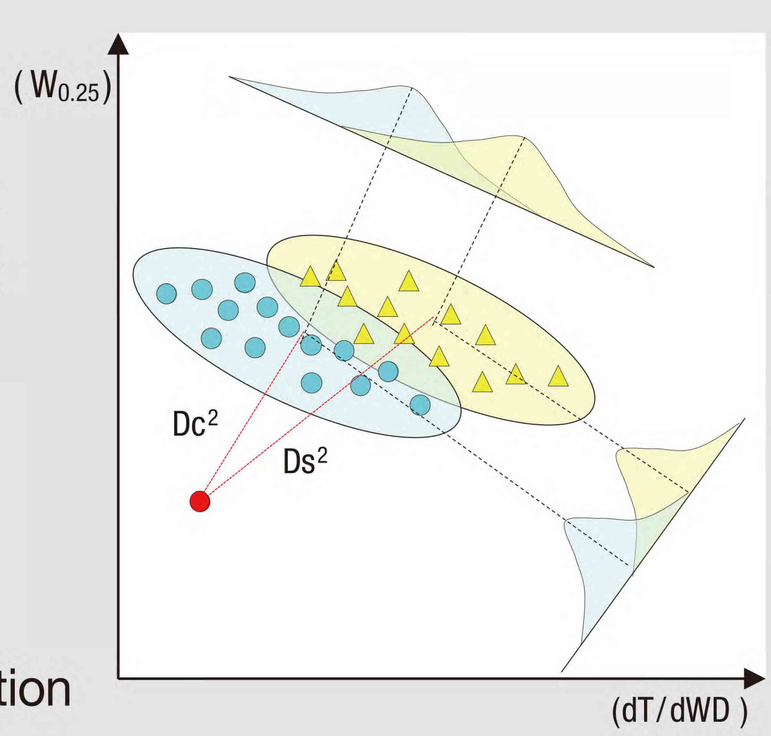
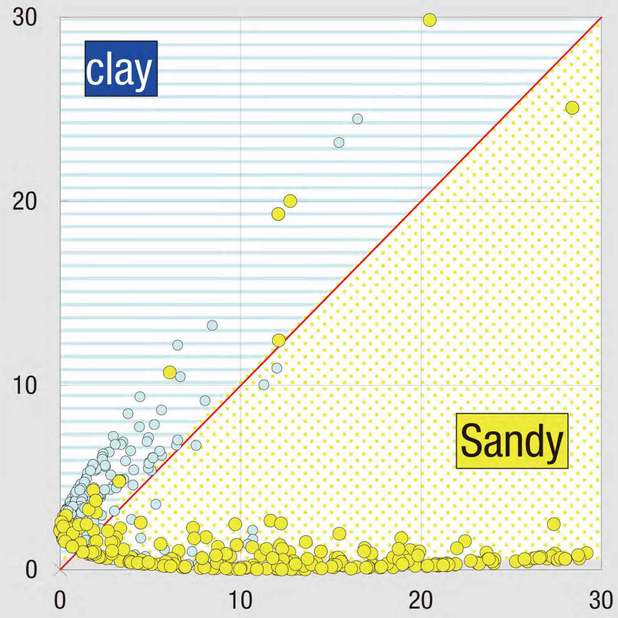


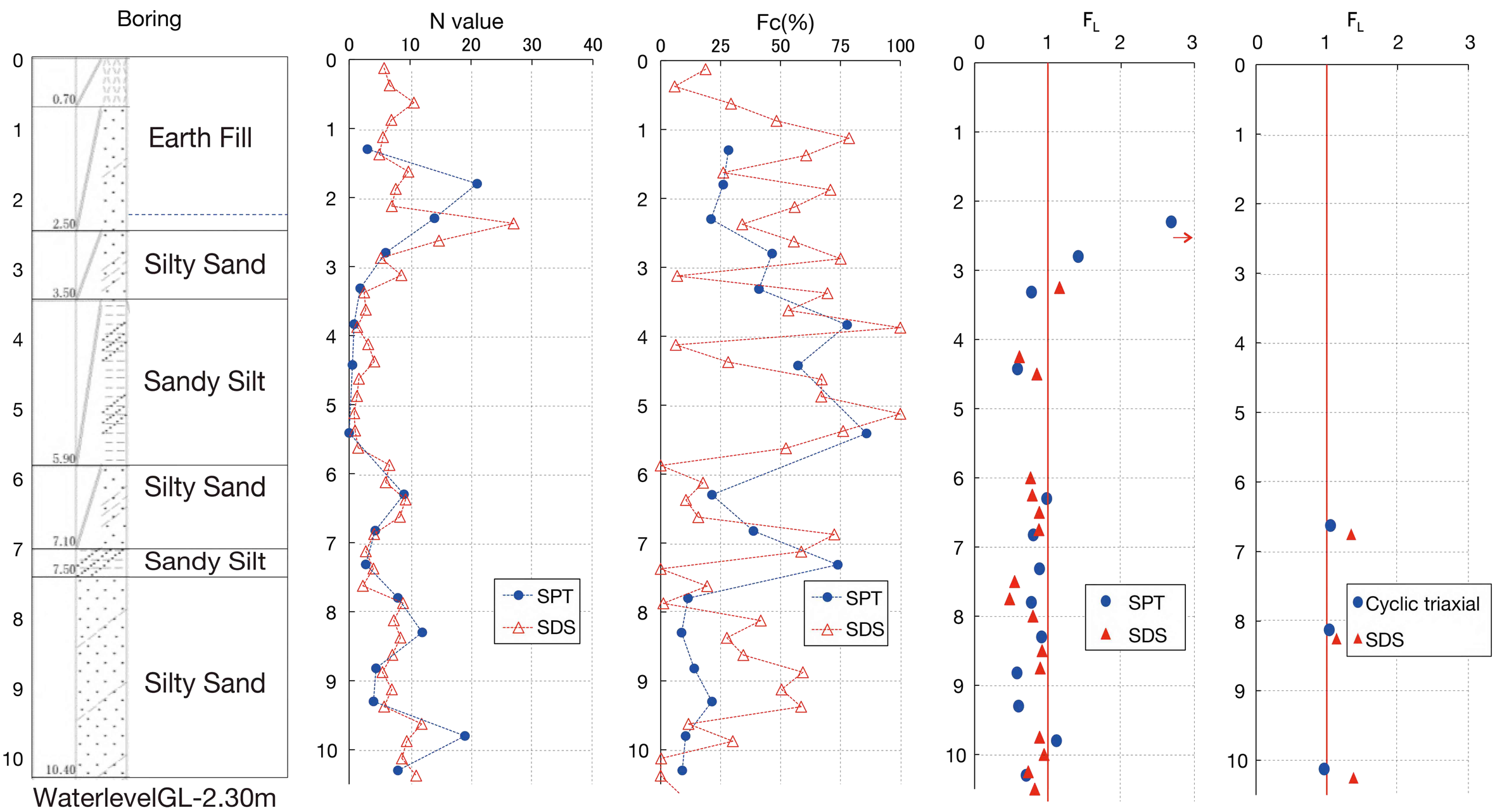

Image of the Mahalanobis distance




| | Match rate (%) |
|---|---|
| Sandy | 86.3 |
| clay | 88.3 |

# 05 Study of the SDS

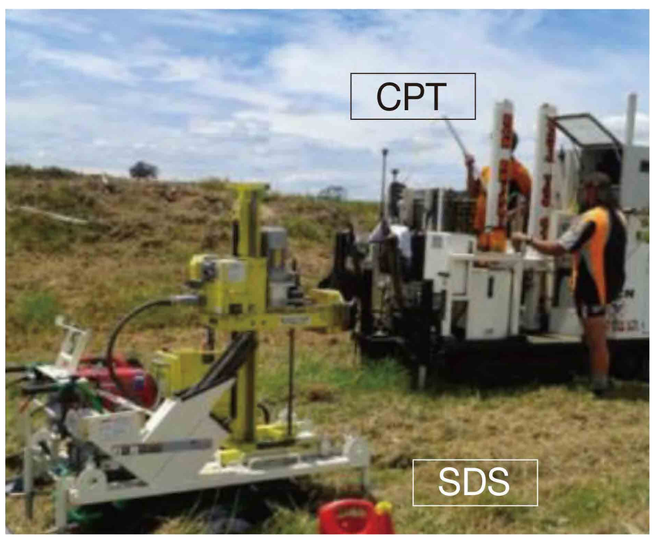
## Estimation of liquefaction risk in Japan

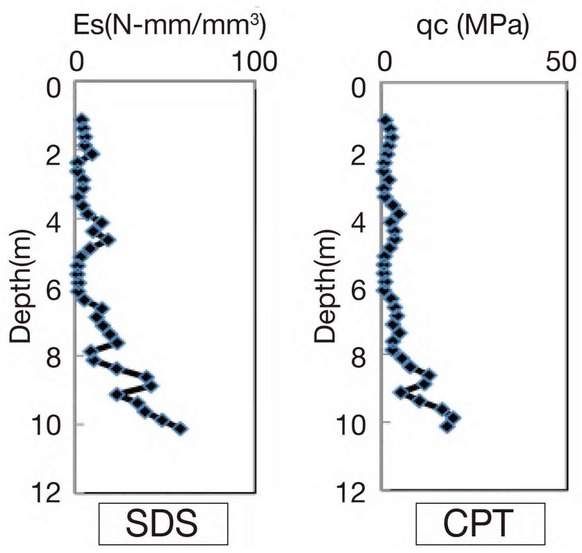


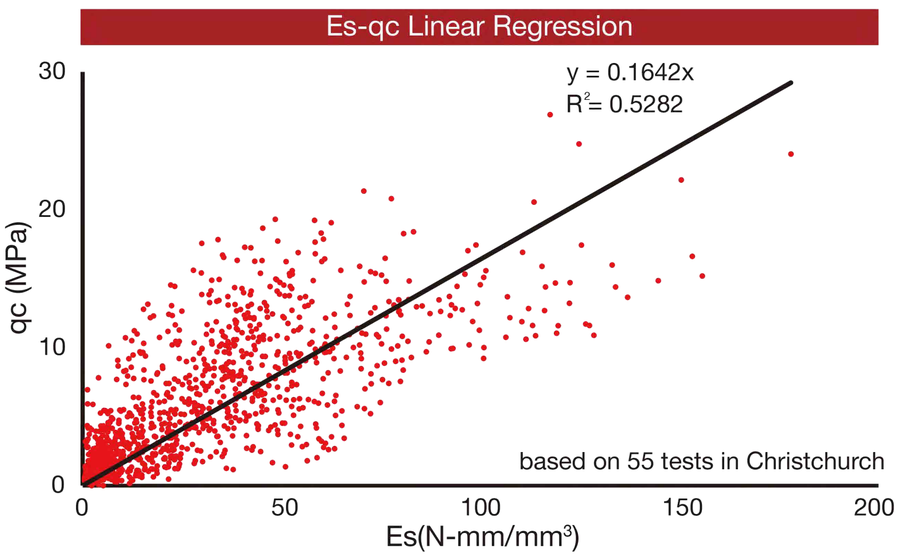

A simple method where the soil strength against liquefaction is examined by the N value and Fc from boring survey which mainly is currently used in Japan. These figures show the comparison between the results of the SDS and those of boring survey.

## Examination of the SDS and the CPT by University of Auckland

### Correlation between CPT and SDS parameters




### 69 SDS points in Christchurch

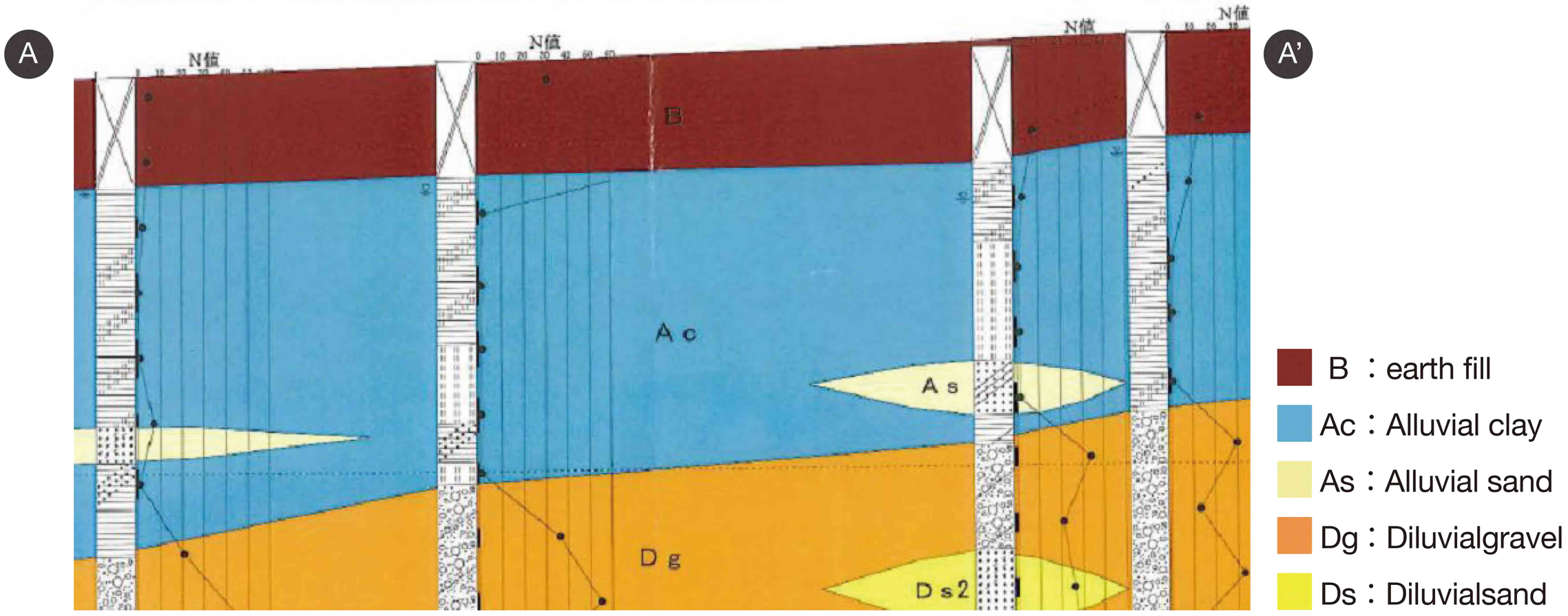

36 SDS test points in Wellington
56 SDS test points in Auckland

Mirjafari, S. Y., Orense. R., Suemasa, N. (2013) “Comparison between CPT and SDS data for soil classification in Christchurch”. 10th International Conference on Urban Earthquake Engineering, March 1-2, 2013, Tokyo Institute of Technology, Tokyo, Japan. 561-566.

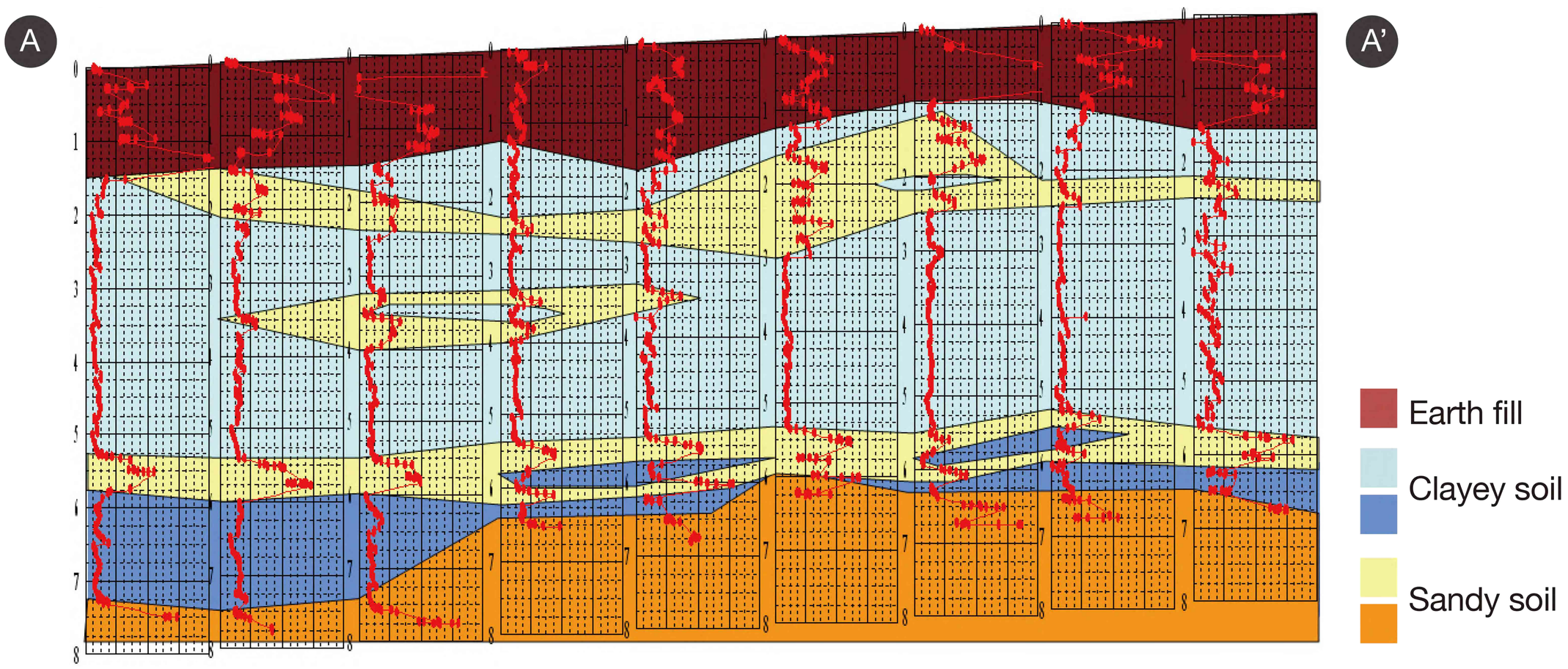
# Interpolation case of boring survey

## Investigated points


## geologic profile estimated by standard penetration test




## geologic profile estimated by the SDS




※The survey data was obtained in a delta located in Shiga prefecture in Japan.