6-6 Land Slide

6-6 Land Slide Survey

6-6-1 Boring survey

The drilling survey was executed along the traverse line A-1 for the landslide movement clod in the vicinity of STA14+850. The position and the grinding hole depth are as shown in Table 3-1.

Table 3-1 bore position and grinding hole depth

Hole number	Easting	Northing	Altitude (m)	Grinding hole length (m)
BV-1	394076.984	3031349.836	623.122	23.0
BV-2	394055.112	3031279.277	678.429	30.0
BV-3	394034.910	3031214.992	700.955	17.5

The result of the survey was brought together as a boring log and a core photograph.

① BV-1(L=23m): It is a landslide deposit up to 18.1m in depth, and 18.1-23.0m in depth is a basement rock.

② BV-2(L=30m): It is a landslide deposit up to 15.8m in depth, and 15.8-30.0m in depth is a basement rock.

③ BV-3(L=17m): It is a landslide deposit up to 9.95m in depth, and 9.95-17.0m in depth is a basement rock.

Photo 6-6-1 BV-1 bore core photograph

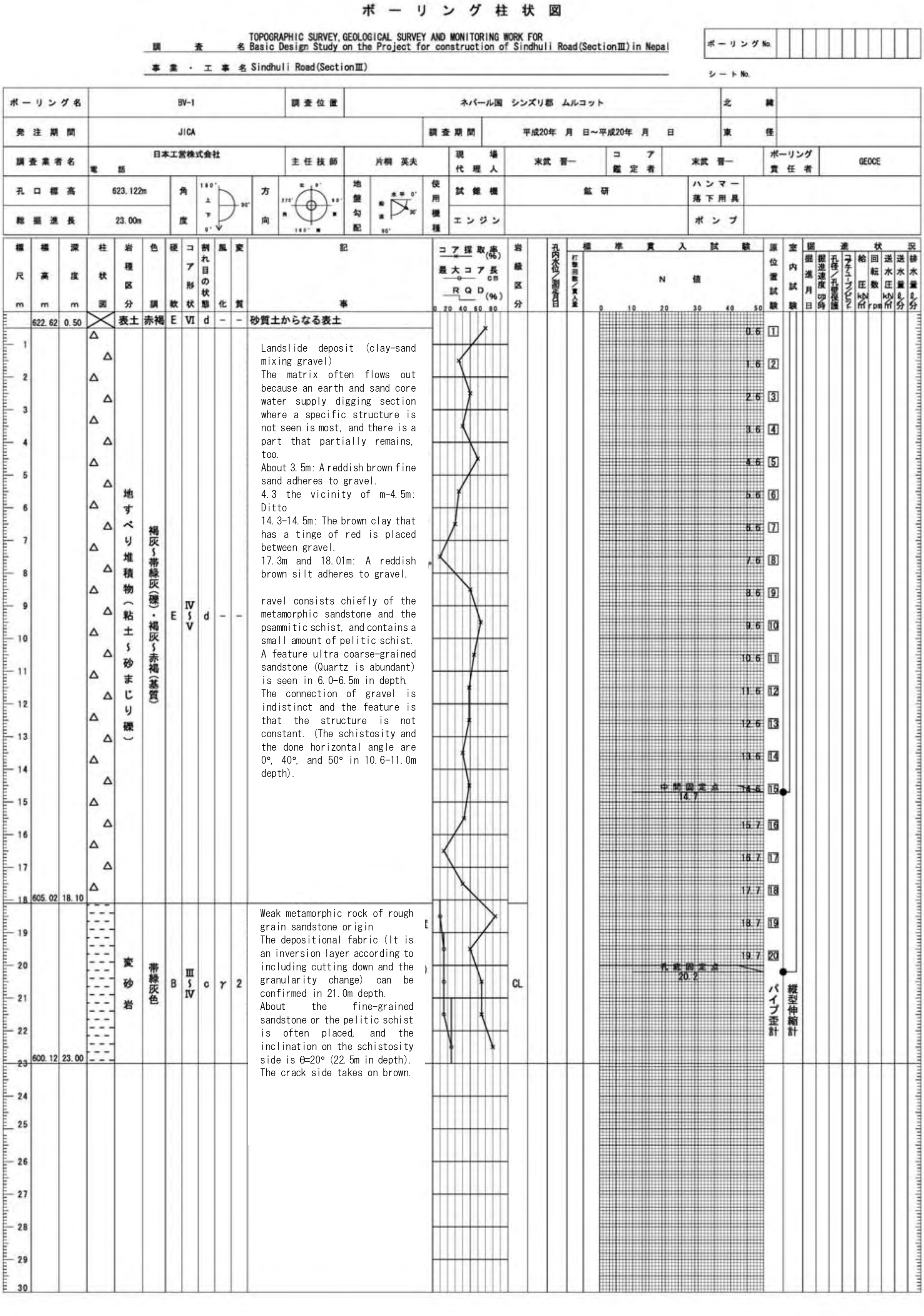


Figure 6-6-1 BV-1 bore pillar-shaped chart

Photo 6-6-2　BV−2 bore core photograph

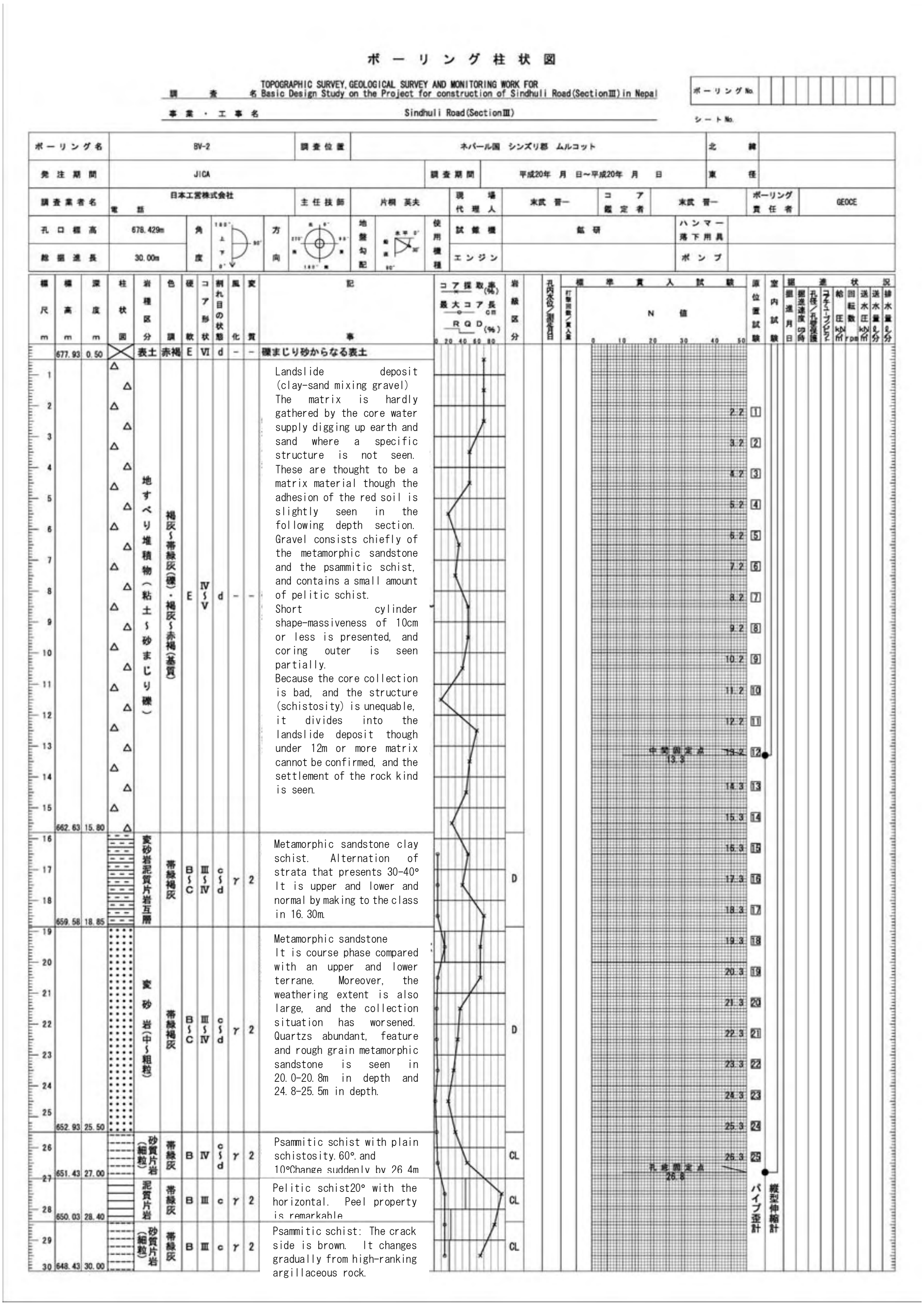


Figure 6-6-2 BV-2 bore pillar-shaped chart

Photo 6-6-3 BV-3 bore core photograph

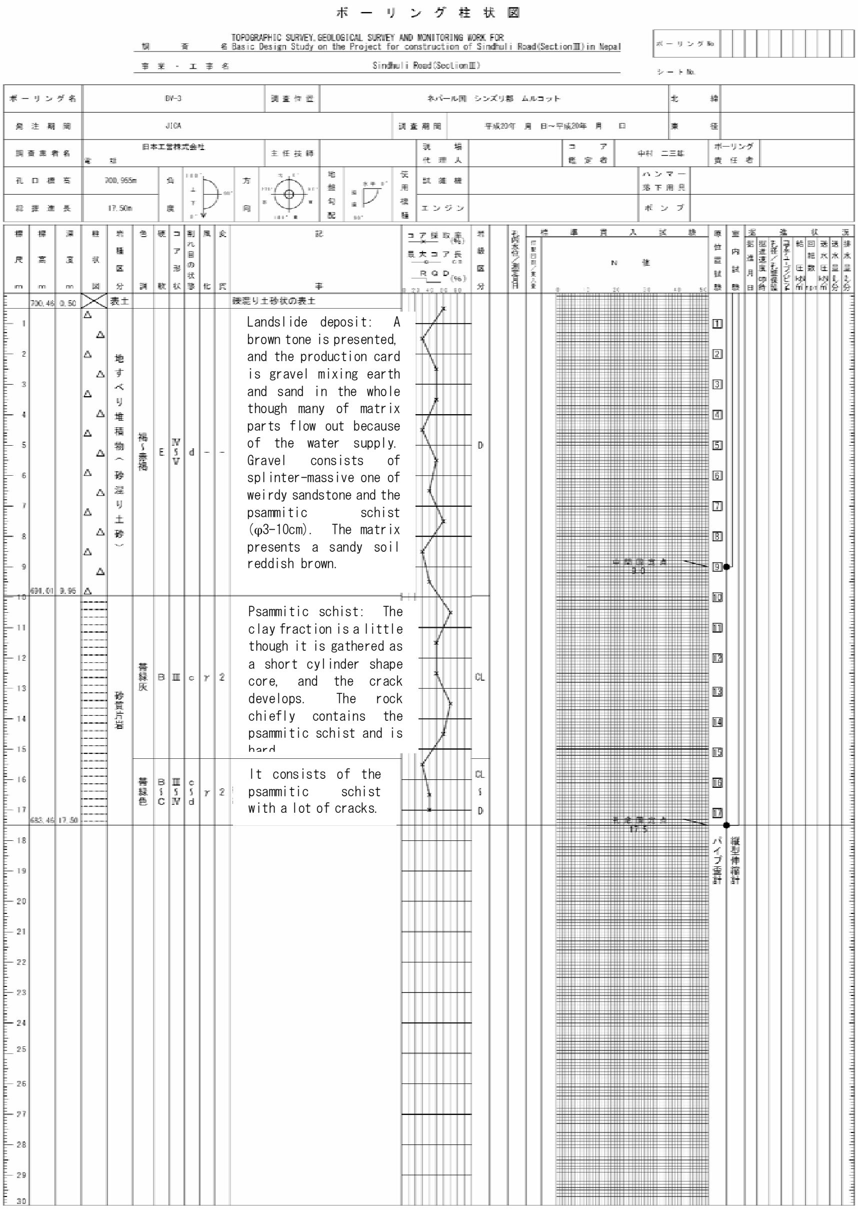


Figure 6-6-3 BV-3 bore pillar-shaped chart

6-6-2 Monitor equipment installation

To investigate the presence of the change of the slope that presented the landslide geographical features, the monitor equipment was set up on the investigation ground of A 'A~E. The monitor equipment consists of the pipe strain meter, the length extensometer, the ground clinometer, and the movement regret. Moreover, to investigate the slope movement and the relation to underground water in the slope of the rainfall, the rain gauge was set up, and the groundwater level measurement in the bore hole was executed.

Table 6-6-1 monitor equipment

Monitor equipment	Unit	Amount	Remarks
Pipe warp meter	Hole	3	62m
Length extensometer	Hole	3	Preliminary measurement of pipe warp meter
The ground clinometer	Part	12	Water pipe type
Movement pile	Part	20	W/t concrete foundation
Rain gauge	Part	1	

1) Pipe strain meter

① Specification

- One direction two gauges (Figure 4-2)
- Gauge interval 1m(The gauge sticking position is the upper side from the bottom of each pipe by about 10cm).
- Porous Pipe: VP-40 vinyl chloride strainer pipe
- Strain measuring instrument: STR-102 (made of Sokusho Giken)

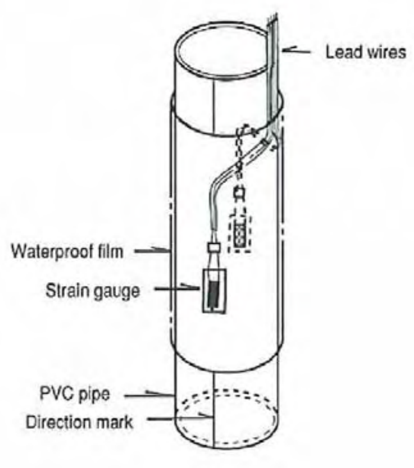


Figure6-6-4. Structure of pipe strain meter

② Installation position

It laid to bore hole (BV-1,2,3) after the hole of grinding. The gauge installation depth in each hole is as shown in Table 4-1.

③ Installation method

The connected vinyl chloride tube was filled bringing 3m together beforehand, and they were made to descend one by one while connecting them, and sand was filled in the place where it was between the porous walls after the hole bottom had reached. When the total length of the installation hole was longer than that of the strain meter, sand was filled to the hole bottom position set up beforehand. The pithead fixed with concrete, and set up the protection box at the same time.

It was confirmed that the swerve was measured on the day before it set it up, and there was no unexpected value about the strain gauge. In addition, it was confirmed that it measured immediately after the installation, and there was no unexpected value.

The mark recorded in the vinyl chloride tube was set to become the valley side of the direction of the traverse line A-1. When the strain is measured, the value at a normal position of the measuring instrument becomes positive when the vinyl chloride tube is convex against the valley side.

Table 6-6-2 Swerve gauge installation depth table (m)

ゲージ番号	BV-1	BV-2	BV-3
1	0.6	2.2	0.9
2	1.6	3.2	1.9
3	2.6	4.2	2.9
4	3.6	5.2	3.9
5	4.6	6.2	4.9
6	5.6	7.2	5.9
7	6.6	8.2	6.9
8	7.6	9.2	7.9
9	8.6	10.2	8.9
10	9.6	11.2	10.0
11	10.6	12.2	11.0
12	11.6	13.2	12.0
13	12.6	14.3	13.0
14	13.6	15.3	14.0
15	14.6	16.3	15.0
16	15.7	17.3	16.0
17	16.7	18.3	17.0
18	17.7	19.3	
19	18.7	20.3	
20	19.7	21.3	
21		22.3	
22		23.3	
23		24.3	
24		25.3	
25		26.3	

② Example of strain meter installation situation (BV-2)

BV-2 . Strain meter measurement.

BV-2 . Installation completion of the protection box

BV-2 . Completion

2) Wire installation for length extensometer measurement

① Specification

It consists of the outer tube of a spiral steel wire that covers the vinyl with the inner wire made of the stainless steel. The inner wire is a structure that can move freely in the outer tube. To connect it with the vinyl chloride pipe of the strain meter, the edge in the earth is processed as shown in the photograph.

Photo 6-6-2 Connection

② Installation position

The assumed slide surface part was placed about bore hole BV-2 and 3 and the fixed end was installed respectively by two places. The purpose of this is to grasp distinguishing the change and other noises by slipping. The depth in each hole at the fixed end is as shown in Table 6-6-3.

Table 6-6-3. Wire fixation edge depth table for length extensometer measurement (m)

固定箇所	BV-1	BV-2	BV-3
中間	14.7	13.3	9.0
孔底	20.2	26.8	17.5

③ Installation method

The fixed end was installed at the same time as setting up the pipe strain meter, and the wire was outside in the vinyl chloride tube along fixing with the tape and laid underground. The edge in the above-ground part was stored in the protection box. It is necessary to connect some measuring instruments with the edge of the ground of the wire to measure the amount of the length expansion and contraction. The measuring instrument installation is not done this business. It is substitution when the strain meter becomes unavailability.

The measurement principle of the length extensometer is as shown in Figure 6-6-5. When the displacement magnitude grows, the amount of the change by the landslide sliding can be grasped though there is no reaction part at first.

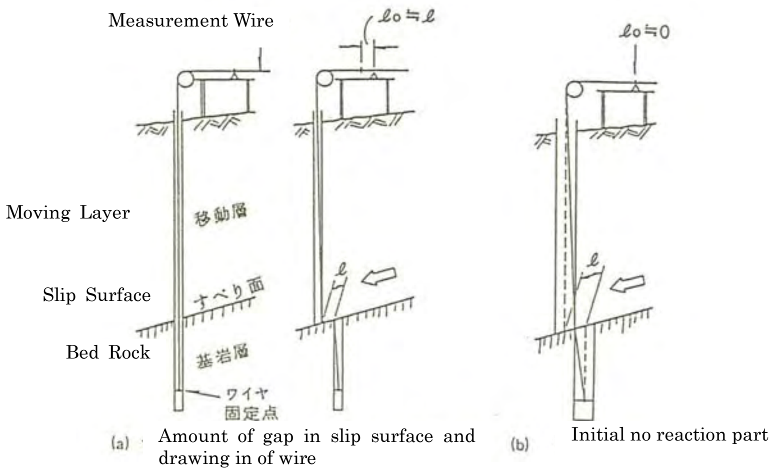


Figure 6-6-5 Measurement principle of length extensometer

3) The ground clinometer

① Specification

Measuring instrument: The water pipe type ground clinometer (made of Nakaasa Sokki).

Measurement accuracy: 1.2 seconds in tilt angle

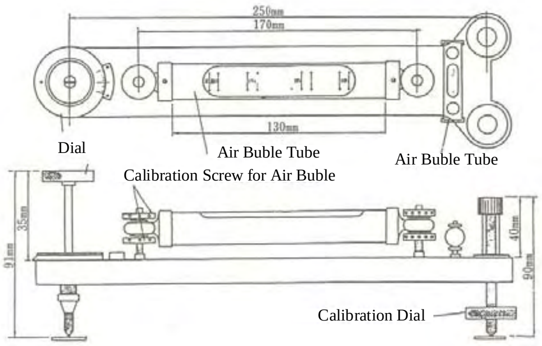


Figure6-6-6 The ground clinometer

② Installation position

It chiefly set it up within the range of distribution of the ancient landslide. Coordinates and the altitude at the installation position are as shown in Table 6-6-4

Table 6-6-4 The ground clinometer installation position

Number	Northing	Easting	Altitude (m)
TA-1	3031271.263	394049.424	684.658
TA-2	3031225.419	394036.871	697.641
TA-3	3031257.653	394193.769	655.119
TA-4	3031586.811	393760.084	628.161
TA-5	3031415.390	393970.313	583.734
TA-6	3031306.167	393961.912	653.584
TC-1	3030578.558	394475.505	660.848
TC-2	3030613.707	394531.221	633.128
TC-3	3030625.242	394568.943	617.665
TD-1	3030323.068	394720.277	679.574
TD-2	3030478.081	394719.922	636.043
TE-1	3030171.339	394982.892	631.972

③ Installation method

The foundation pile of about 1m was driven after the foundation excavation was done as shown in Figure 6-6-6, aggregate was filled to the upper part of the pile, and a concrete basic stand of 30cm in thickness was placed. The glass board was made to stick to this, and the clinometer was set up on this in the place in which it had solidified. In addition, to enclose a concrete basic stand as shown in Figure 6-6-7, the protection box was set up.

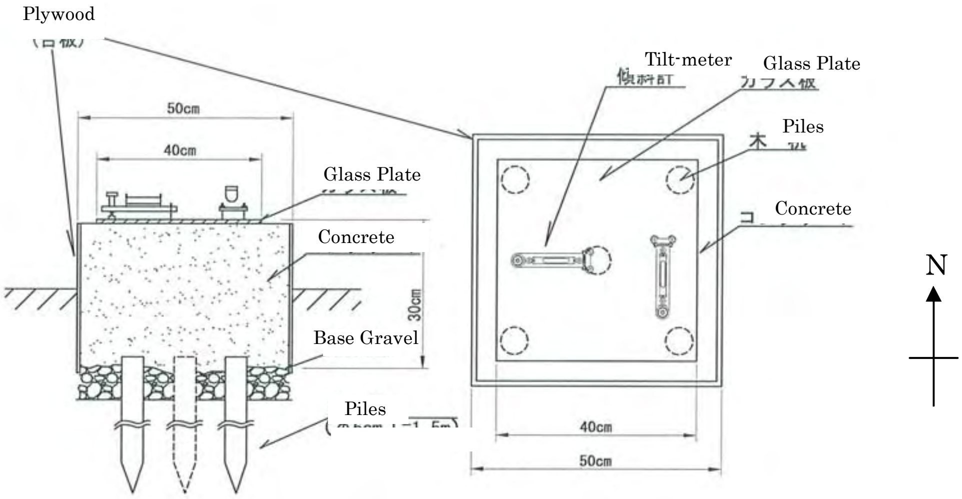


Figure 6-6-6 Concrete tiltmeter base stand installation

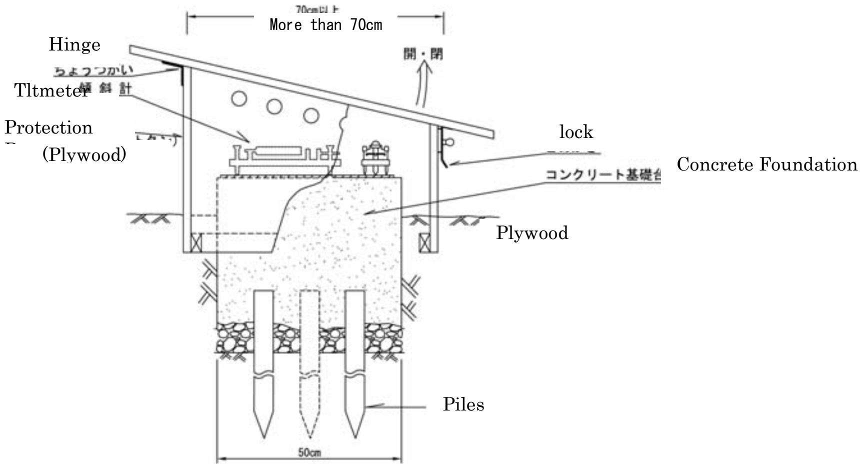


Figure 6-6-7 The Tiltmeter protection box installation

④ Site photograph: No. TA-1

Photo 6-6-3 Foundation Excavation

Photo 6-6-4 Installation situation of the concrete basic stand

Photo 6-6-5 Installation completion of the ground clinometers

3) Movement pile

① Specification

10cm in the above-ground part was left, the vinyl chloride tube of about 10cm in the diameter and 1.5m in length was laid underground, and it made it to the movement pile to grasp the range of the landslide change and the amount of the change. The measurement accuracy depends on the way of measurement accuracy.

② Installation position

It chiefly set it up within the range of distribution of district A ancient landslide. Coordinates and the altitude at the installation position are as shown in Table 6-6-5.

Table 6-6-5 Movement pile installation position

Number	Northing	Easting	Altitude(m)
P-1	3031164.653	394340.414	662.279
P-2	3031214.355	394294.882	659.561
P-3	3031236.251	394251.386	649.704
P-4	3031240.781	394224.484	656.662
P-5	3031254.621	394182.322	659.447
P-6	3031245.656	394149.887	664.231
P-7	3031253.389	394110.222	671.594
P-8	3031265.728	394087.602	672.667
P-9	3031288.642	394067.789	668.578
P-10	3031302.595	394010.420	659.589
P-11	3031303.981	393982.096	654.050
P-12	3031316.682	393949.160	651.243
P-13	3031354.931	393918.812	638.010
P-14	3031400.785	393883.230	629.391
P-15	3031438.440	393858.895	628.660
P-16	3031482.248	393847.849	623.516
P-17	3031517.347	393822.815	618.387
P-18	3031240.188	394034.984	693.275
P-19	3031199.294	394021.734	707.717
P-20	3031337.175	394072.117	631.756

③ Installation method

After the foundation excavation was done, the vinyl chloride tube of about 1.5m was placed as shown in Figure 6-6-6, and it was built, filled aggregate by 1.3m, and the concrete of 10cm in thickness was placed. Concrete was filled to the vinyl chloride jurisdiction, and the nail was set up at the center.

Example of movement pile installation situation (P-4)

Basic digging situation

Installation completion of the movement pile

5) Rain Gauge

①Specification

It digs up about 60cm in depth and hole by about 50cm in the diameter, and a wooden stand is installed on the point of about high 1.0m on the ground. A self-registering rain gauge of the fall mass type is set up on a wooden plinth.

②Installation position

Falling a mass rain gauge was set up in the hotel backyard in the ﾑﾙｺｯﾄ village. Moreover, the record machine was set up on the second floor in this hotel. When the rain gauge was set up, it was confirmed that there was no obstacle that blocked the catchments of the rainfall in neighborhood.

③Installation method

After the foundation excavation of about 60cm in depth was done as shown in the photograph, a wooden plinth was placed, and it was built, filled aggregate by 30cm, and the concrete of 30cm in thickness was placed.

Installation completion of the rain gauge 1

Installation completion of the rain gauge 2

Installation completion of the rain gauge 3

Installation completion of the rain gauge 4

6) Fence

The fence to protect the ground clinometers, the pipe strain meter, and the monitor equipment such as rain gauges from the animal etc. was set up.

①Specification

To take the clearance of about 50cm from the observation equipment, and to enclose the equipment, the fence was set up in the square.

②Installation position

It set it up in each physical instrument.

③Installation method

After the foundation excavation of about 50cm in depth was done as shown in the photograph, a wooden prop was placed, and it was built, filled aggregate by 25cm, and the concrete of 25cm in thickness was placed. The prop is surrounded with the barbed wire on that.

Example of BV-1 fence installation

7) Observation hut

The observation hut that became watch bases such as the monitor equipment of the ground clinometer and the pipe strain meter, etc. was constructed.

①Specification

It was architectural with a traditional style of architecture in a Nepalese country.

②Installation position

It was built on smooth ground in the vicinity of the linden in block D.

Under construction the observation hut 1

Under construction the observation hut 2

Completion of the observation hut 1

Completion of the observation hut 2

8) Landslide monitoring

After the meter had been set up, the following each monitor meters were observed. The observation period is after the rainy season ends from September to October, 2008.

<u>Table 6-6-6 monitor amount</u>

Monitor meter	Unit	Amount	Remarks
Movement pile	Times	3	20 survey points
Strain meter	Times	21	Three holes × seven times
The ground clinometer	Times	84	12× seven times
Groundwater observation	Times	21	Three holes × seven times

① Movement pile

The displacement of about 1-5cm is observed to the standard value. It is necessary to judge the change situation from the result of the observation in the future.

<u>Table 6-6-7 monitoring result of movement pile</u>

peg No.	movement of X direction (m)	movement of Y direction (m)	movement of H direction (m)	accumurate movement by level
P-1	0.012	-0.007	-0.002	0.014
P-2	-0.016	-0.020	-0.009	0.026
P-3	-0.010	-0.017	-0.002	0.020
P-4	-0.007	-0.009	-0.014	0.011
P-5	0.015	0.018	-0.001	0.023
P-6	0.000	-0.009	-0.015	0.009
P-7	0.005	-0.020	-0.010	0.021
P-8	0.000	-0.014	-0.006	0.014
P-9	0.060	-0.001	-0.003	0.060
P-10	0.029	-0.014	-0.002	0.032
P-11	0.014	-0.020	-0.020	0.024
P-12	-0.015	-0.019	-0.011	0.024
P-13	-0.076	-0.015	-0.010	0.077
P-14	0.015	-0.002	0.001	0.015
P-15	-0.003	-0.007	0.001	0.008
P-16	-0.006	0.001	-0.002	0.006
P-17	0.002	-0.004	-0.002	0.004
P-18	-0.024	0.004	-0.011	0.024
P-19	0.004	-0.007	-0.002	0.008
P-20	-0.003	0.100	-0.012	0.100

② Pipe strain meter

The change of the landslide potential is not seen from there is no accumulation though local displacement is seen in all the observation holes.

Table 6-6-8 monitoring result of pipe strain meter

strain meter No.	assumed depth of slide plane(m)	composite accumulate strain (μ strain)
BV-1	18.10	-20(18m)
BV-2	15.80	-240(16m)
BV-3	9.95	16(10m)

③ Ground tiltmeter

It is judged the local one as there is no accumulation in the direction of the change though displacement is observed in all meters. Moreover, the amount of the change is small, and the change of the landslide potential is not seen.

Table 6-6-9 monitoring result of ground tiltmeter

tiltmater No.	tilt direction	movement of accumulate tilt by N-S direction (sec)	movement of accumulate tilt by E-W direction (sec)	composite movement of accumulate tilt (sec)
TA1	S36° W	4.0	3.0	5.0
TA2	S63° W	2.0	4.0	4.5
TA3	S45° E	2.0	-2.0	2.8
TA4	N63° W	-10.0	20.0	22.4
TA5	S45° E	2.0	-2.0	2.8
TA6	N26° E	-2.0	-1.0	2.2
TC1	N71° E	-2.0	-6.0	6.3
TC2	S45° E	-2.0	-2.0	2.8
TC3	N56° E	-2.0	-3.0	3.6
TD1	S45° W	2.0	2.0	2.8
TD2	N45° E	-2.0	-2.0	2.8
TE1	S30° E	5.0	-3.0	5.8

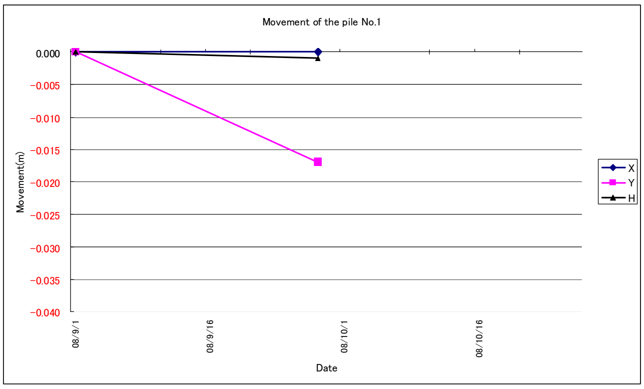
④ Groundwater levels

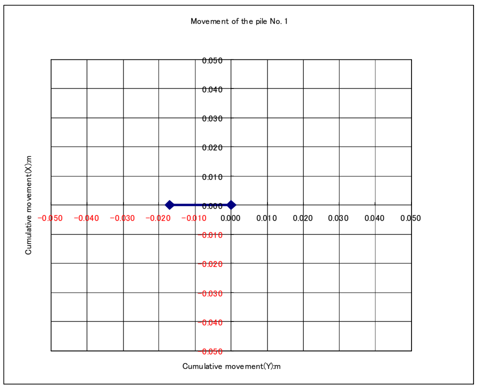
The groundwater level shows the tendency to decrease gradually at the hole BV-3. The groundwater level was seen in the vicinity of the hole bottom as for other holes, and the fluctuation of water level for the observation period was not confirmed.

Table 6-6-10 monitoring result of ground water levels

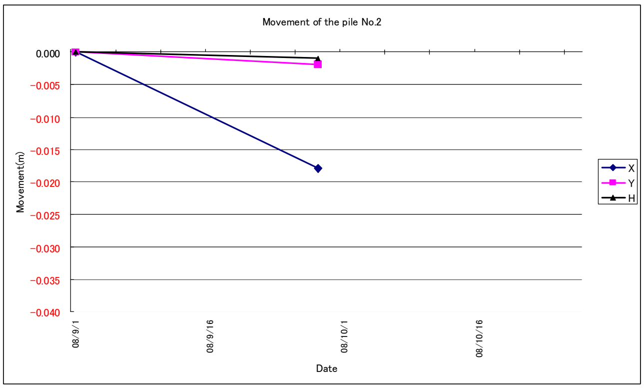
instrument No.	highest ground water level(GL-m)	lowest ground water level(GL-m)	difference of movement water level(m)
BV-1	19.72	19.79	0.07
BV-2	25.56	26.56	1.00
BV-3	15.77	16.99	1.22

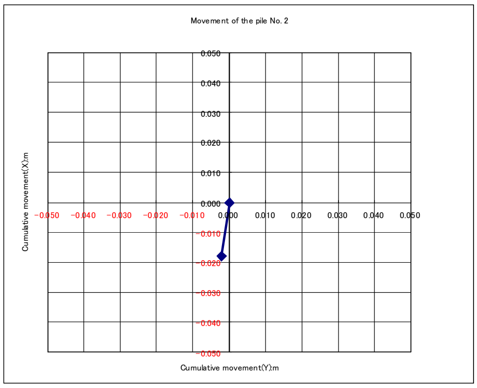
Movement pile P-1



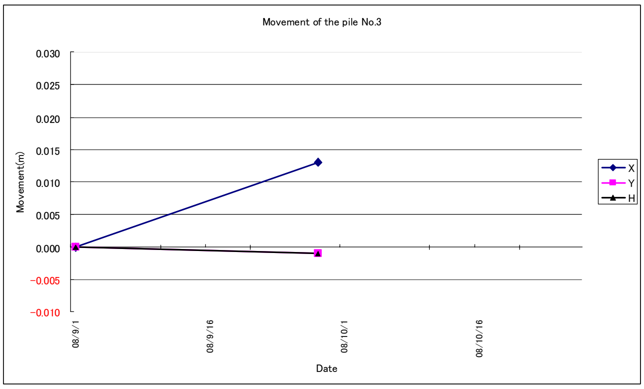


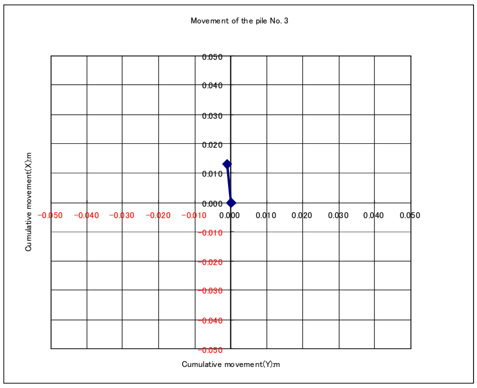
Movement pile P-2



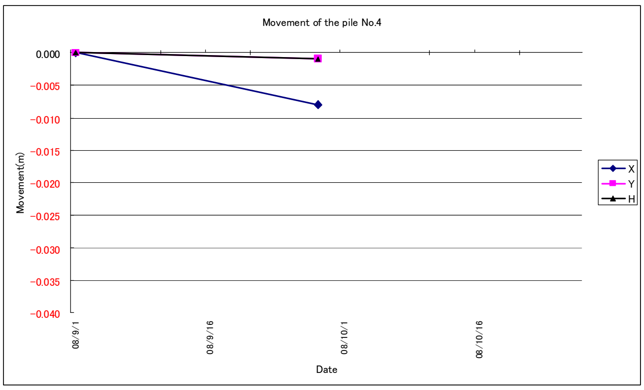


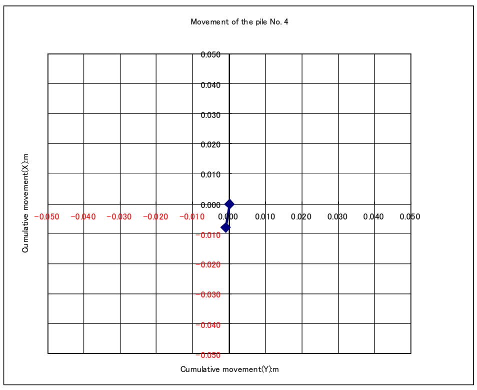
Movement pile P-3



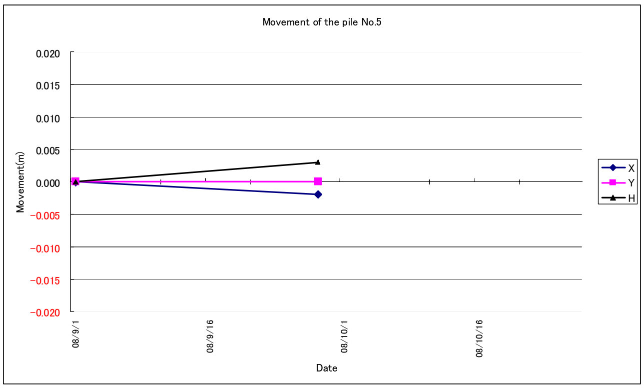


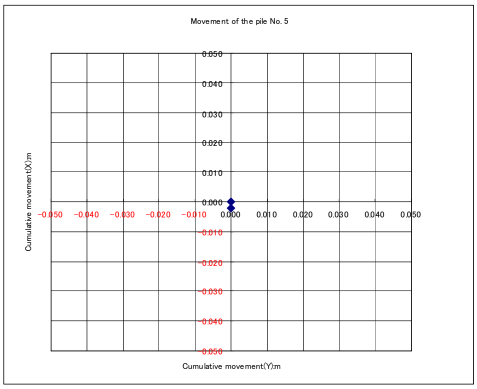
Movement pile P-4



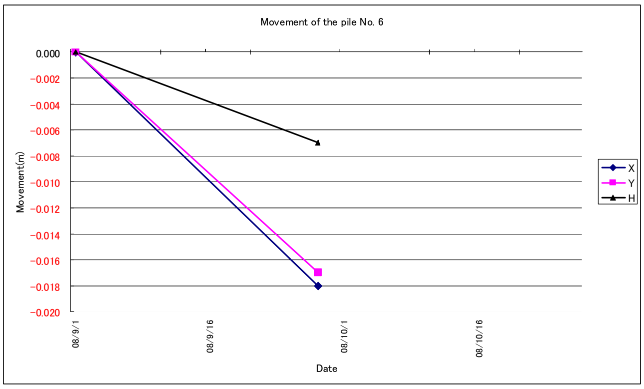


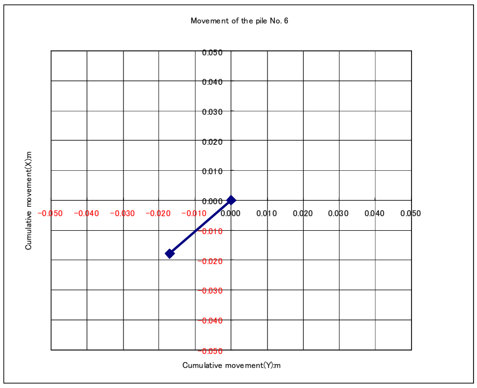
Movement pile P-5



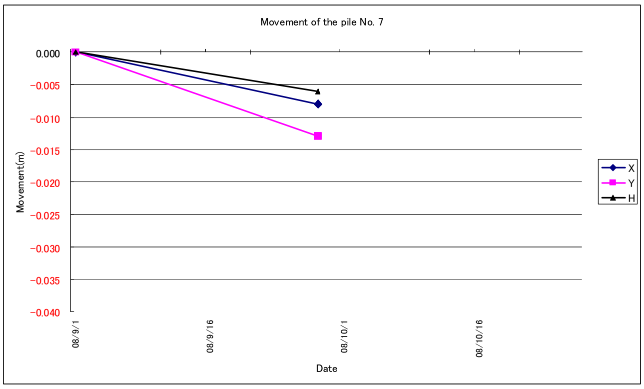


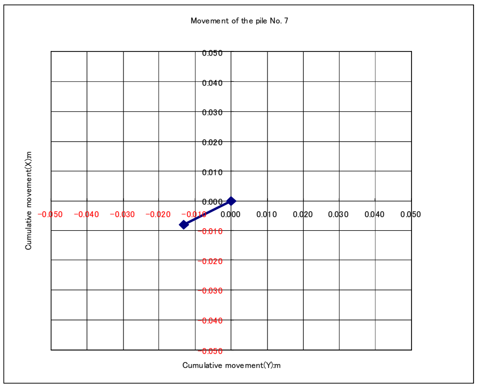
Movement pile P-6



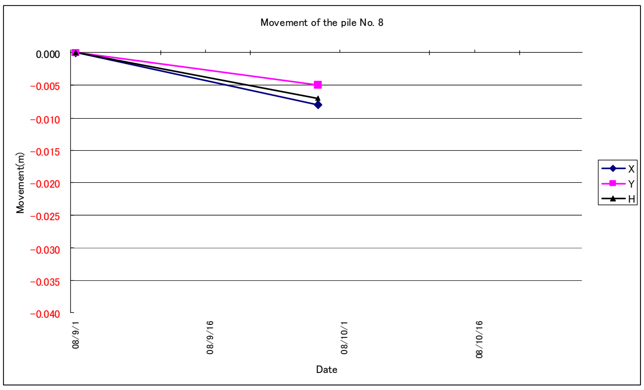


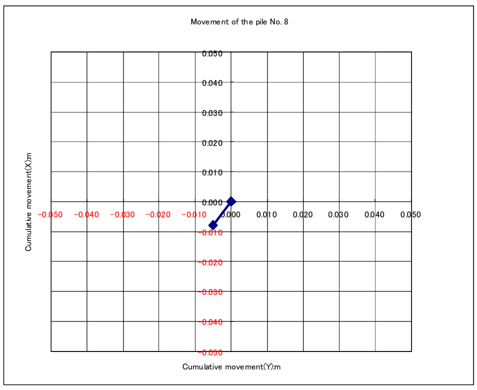
Movement pile P-7



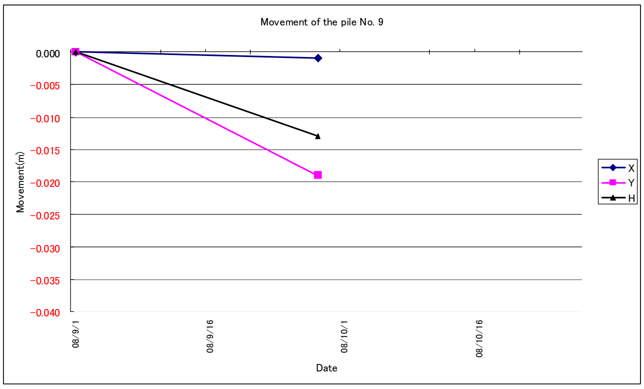


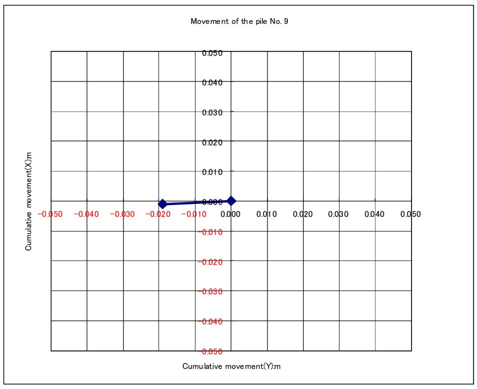
Movement pile P-8



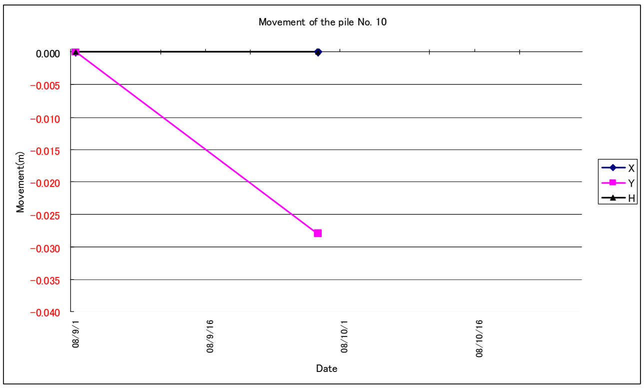


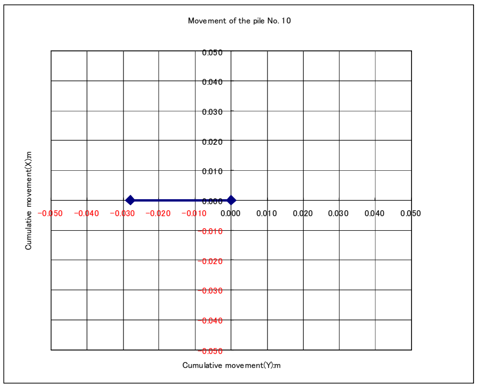
Movement pile P-9



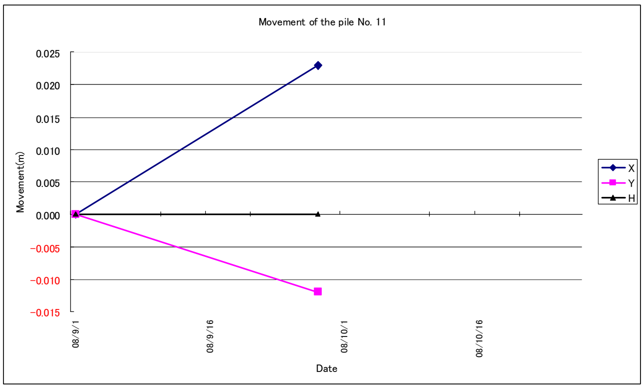


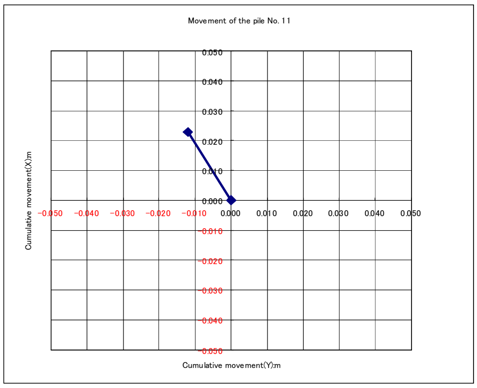
Movement pile P-10



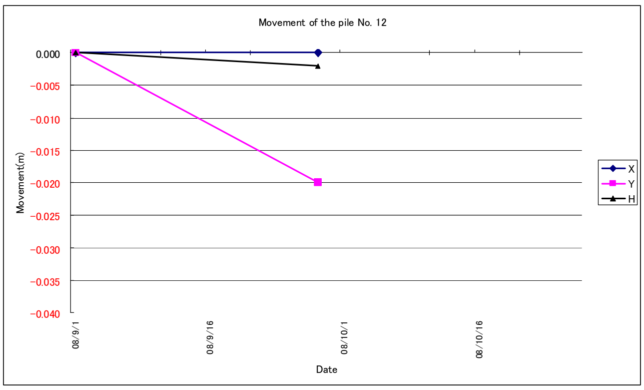


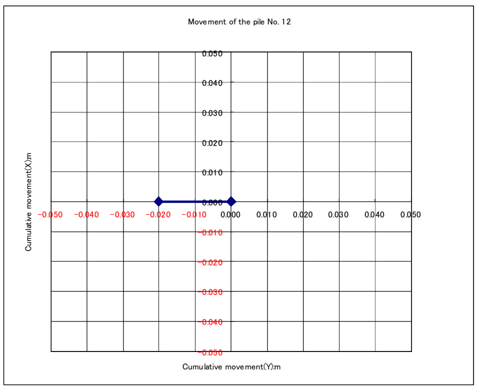
Movement pile P-11



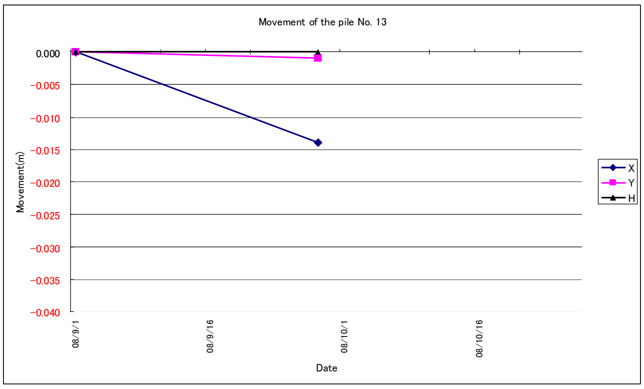


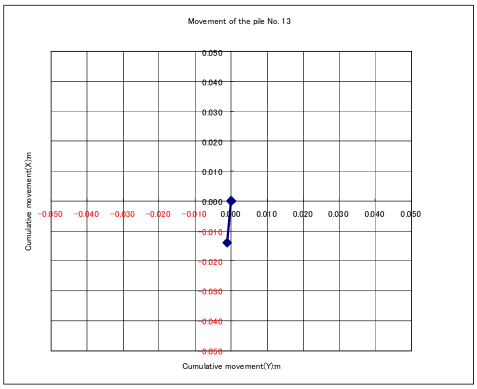
Movement pile P-12



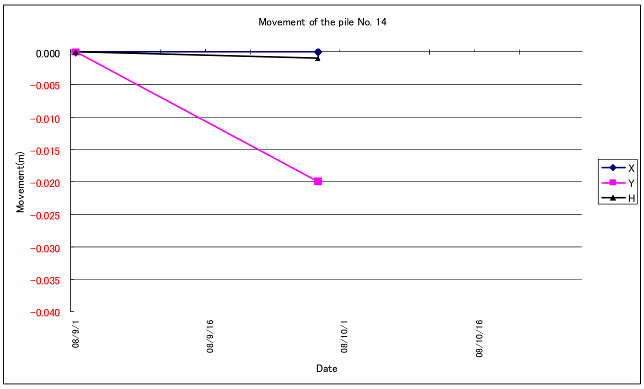


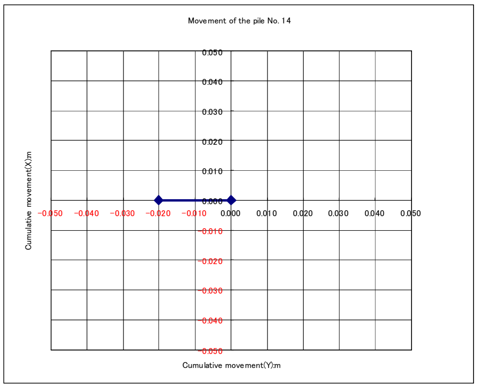
Movement pile P-13



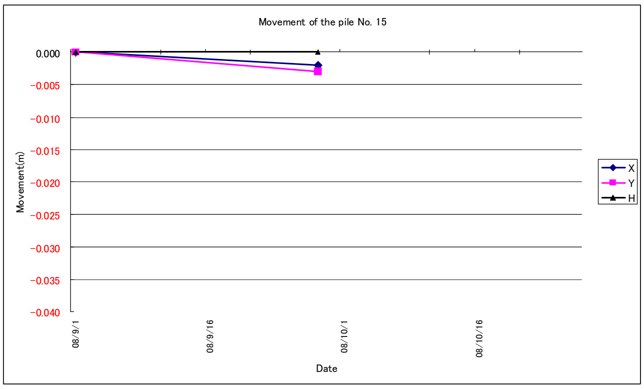


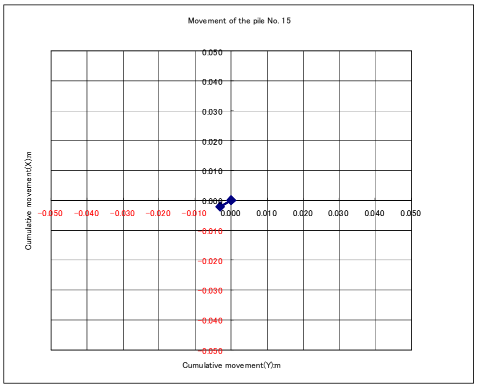
Movement pile P-14



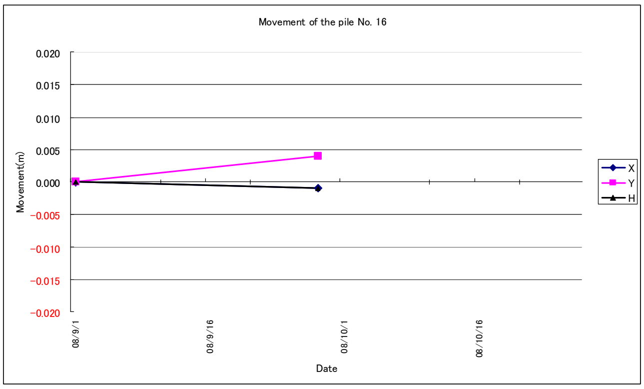


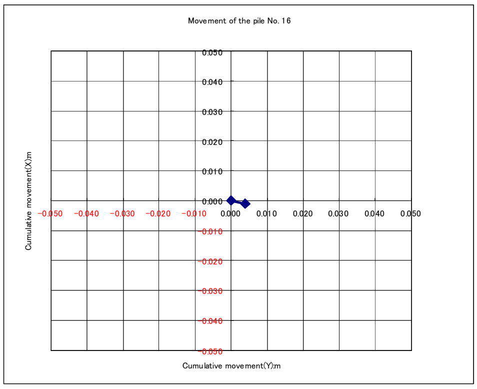
Movement pile P-15



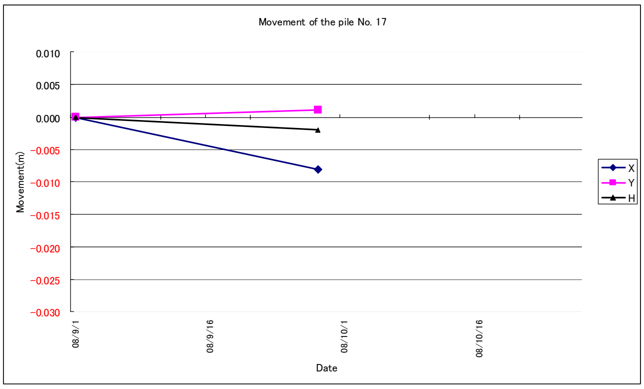


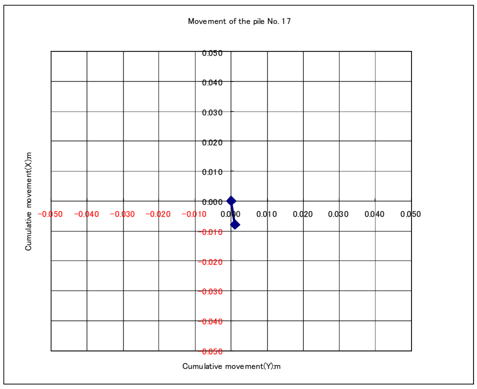
Movement pile P-16



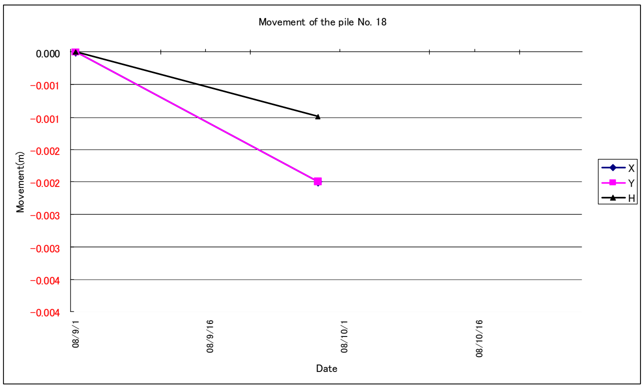


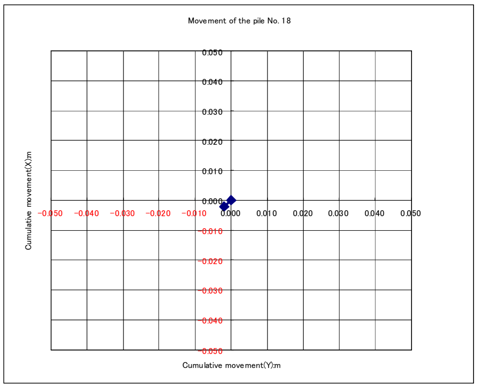
Movement pile P-17



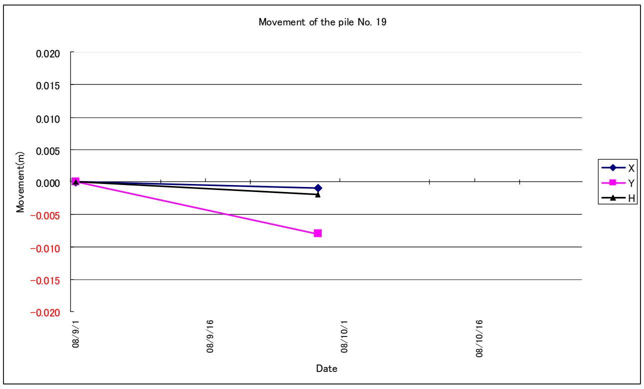


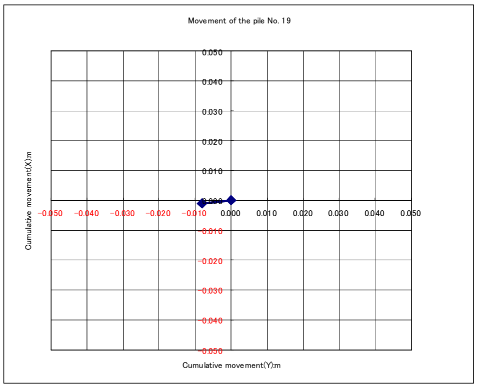
Movement pile P-18



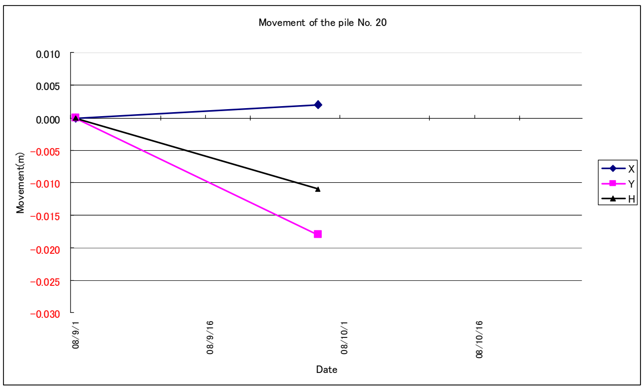


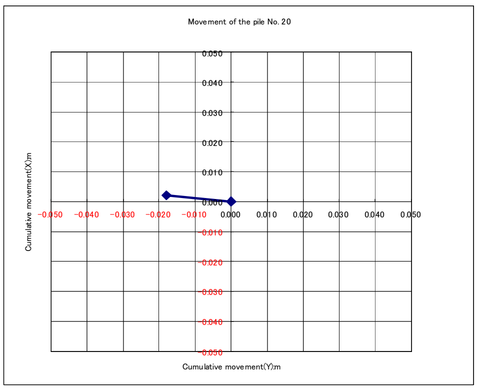
Movement pile P-19



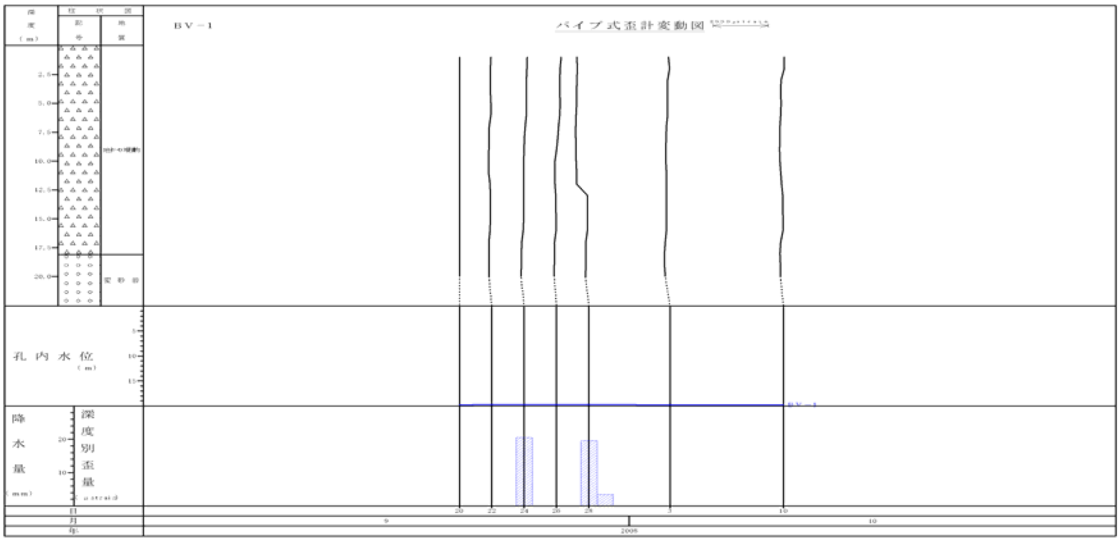


Movement pile P-20

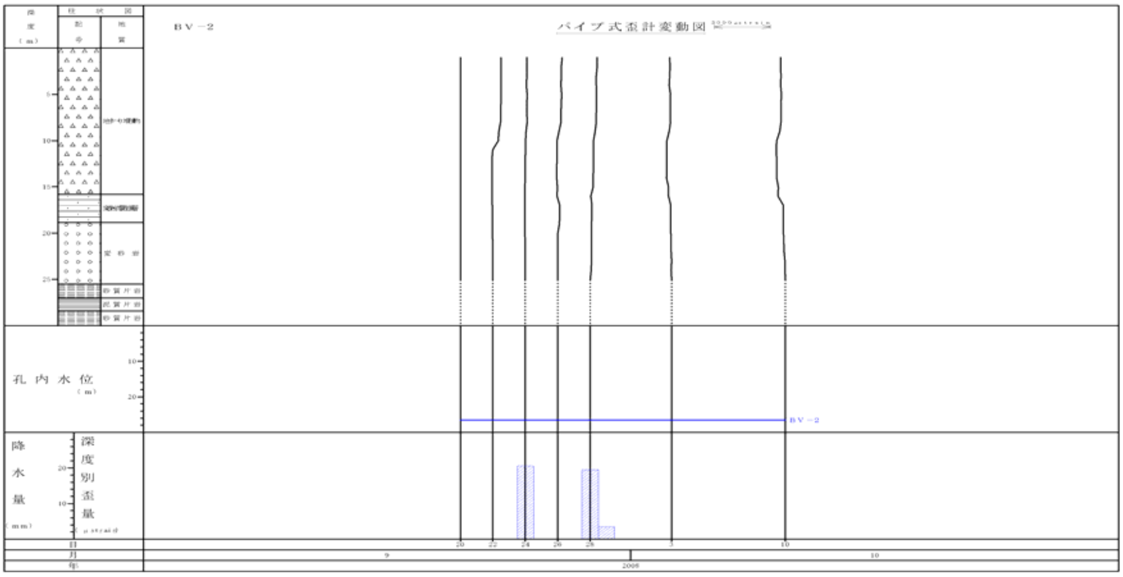




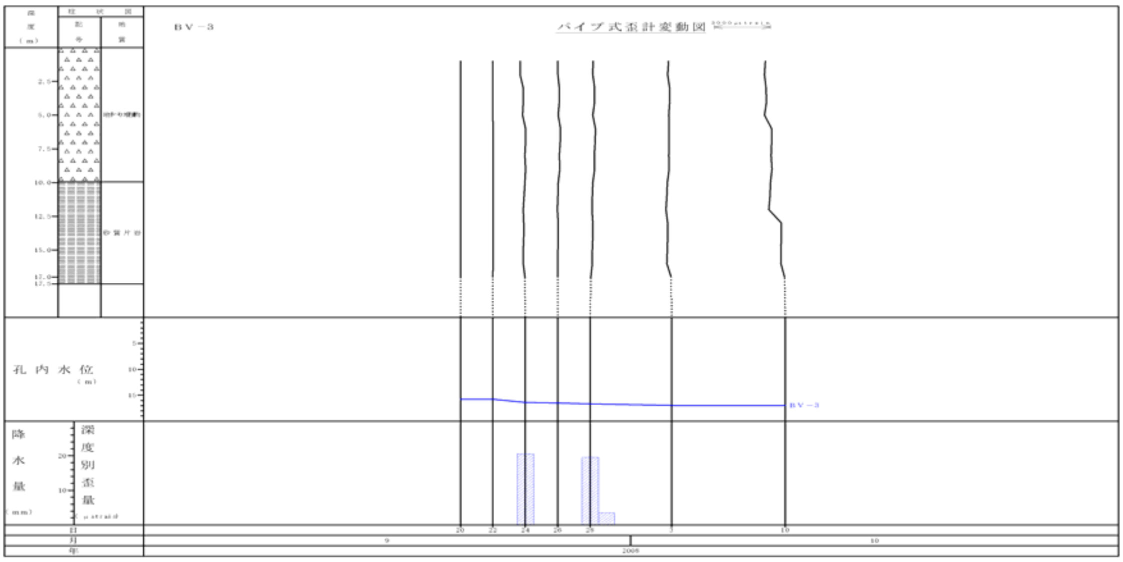
Pipe strain meter BV-1



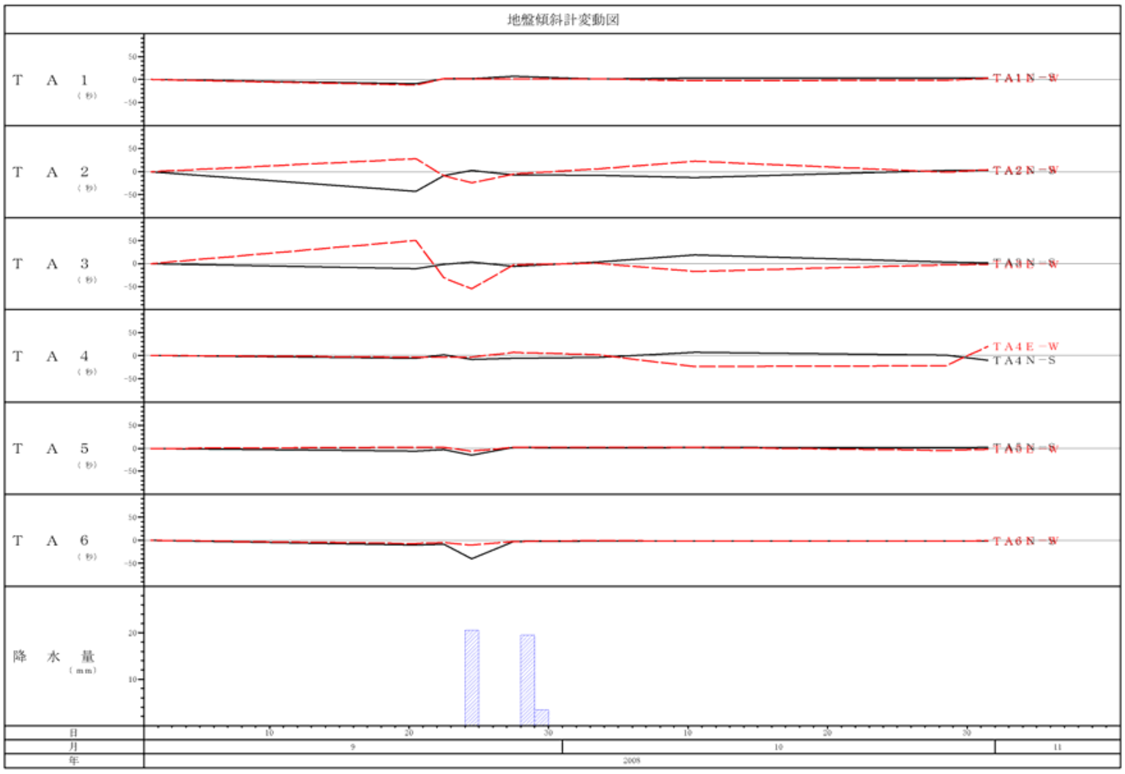
Pipe strain meter BV-2



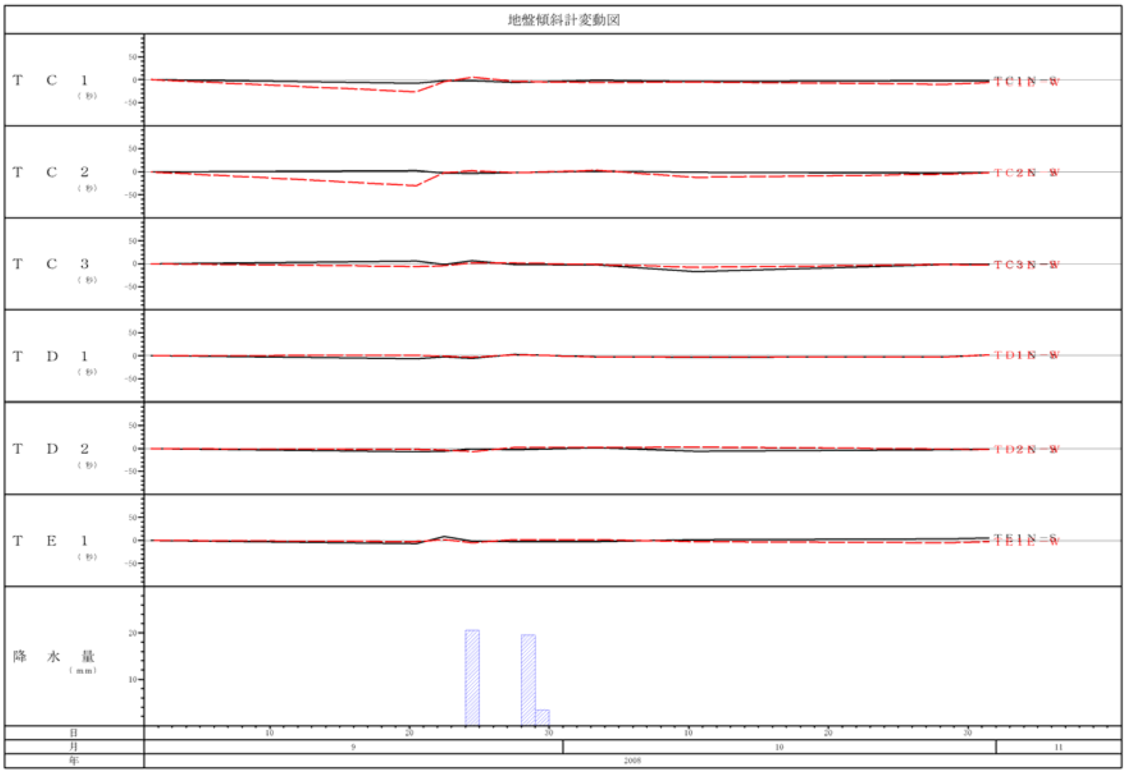
Pipe strain meter BV-3



Ground clinometers (A block) change chart

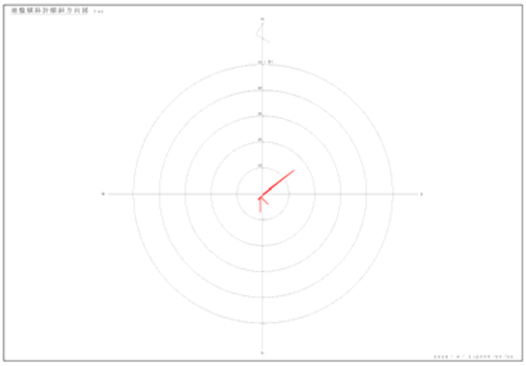


Ground clinometer (C, D, and E block) change chart

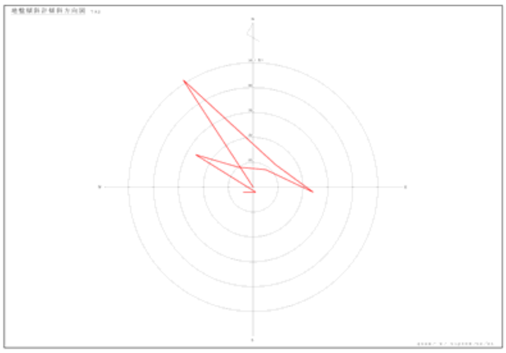


Ground clinometers change direction chart

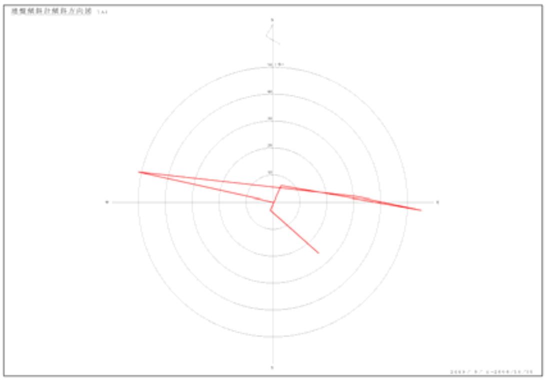
TA-1



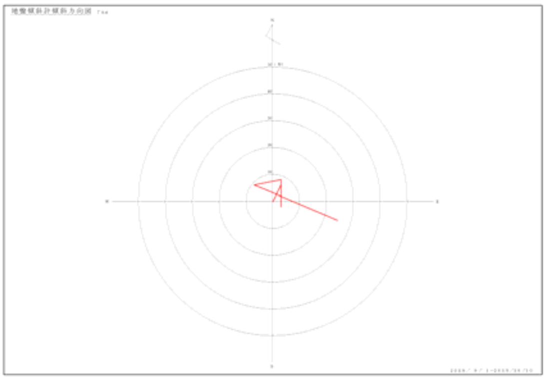
TA-2



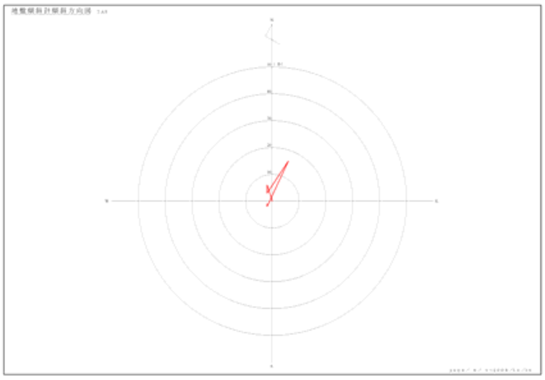
TA-3



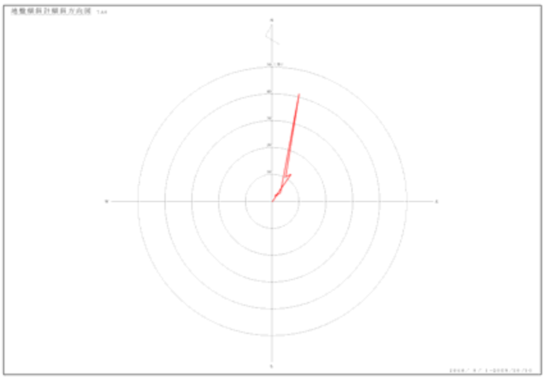
TA-4



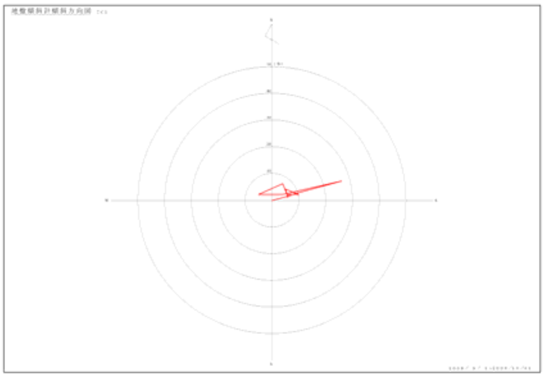
TA-5



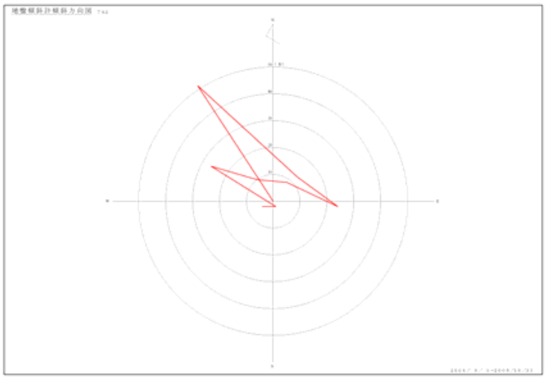
TA-6



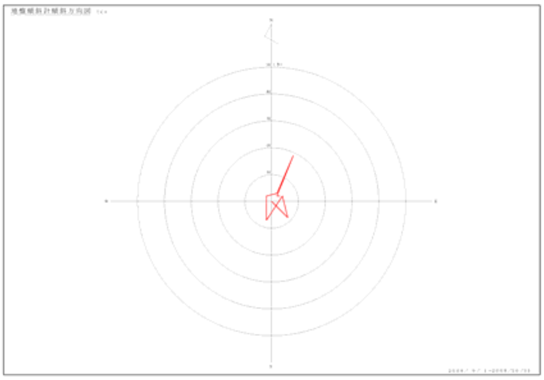
TC-1



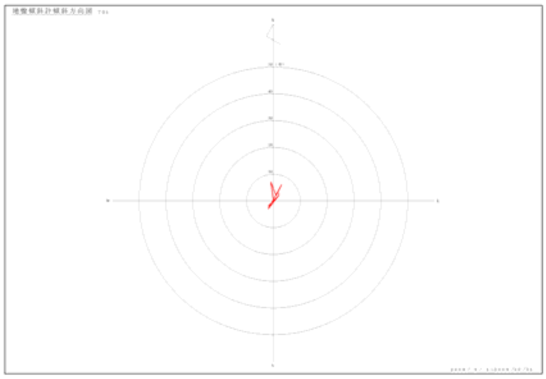
TC-2



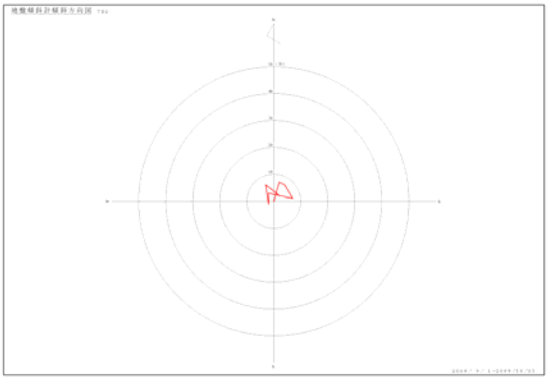
TC-3



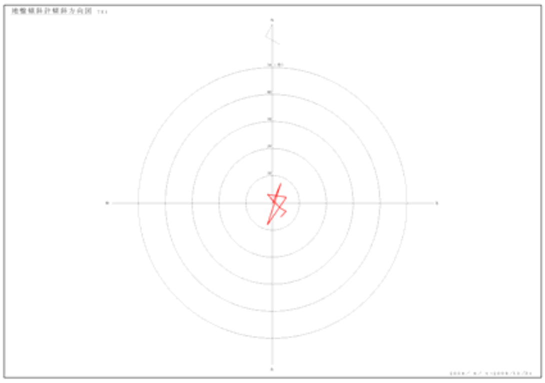
TD-1



TD-2



TE-1



Groundwater level BV-1-3 observation graph