Acoustic Visual-Eye

With High Frequency Acoustic Wave

ACOUSTIC TOMOGRAPHY

(HIGH-RESOLUTION GEOLOGICAL SURVEY)

"Visualize!" the underground structure

Useful method in the urban area

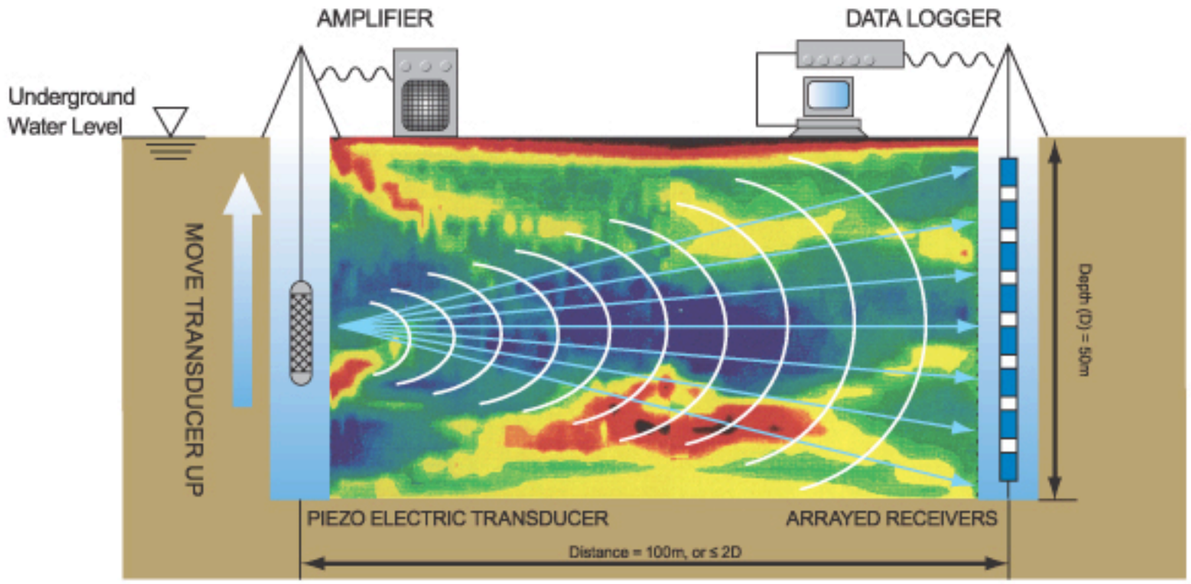
New Technology Information System,accredited by Japanese Ministry of Land,Infrastructure,Transport and Tourism(No.KT-080011-A)

JFE Civil Engineering and Construction Corporation

OUTLINE

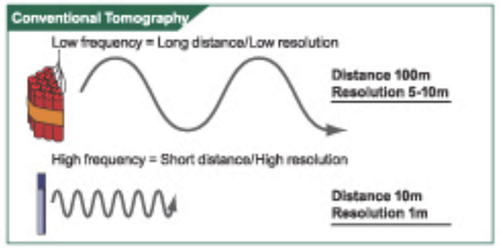
A transducer and arrayed receivers are installed in the two boreholes respectively. Pseudo Random Binary Sequence (PRBS) Wave is utilized and then the arrival time and also the sound pressure level are obtained in this system. Therefore the velocity and the attenuation images are produced simultaneously. The velocity represents the hardness and kinds of the ground, ant the attenuation represents the existence of internal fluid, gas etc and the grain size of the ground.

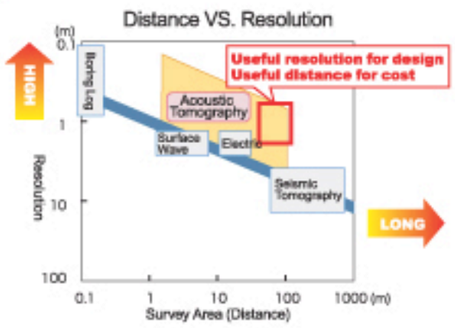
TRANSDUCER
- Piezo type
- OD=44mm,L=270mm
- Weight=4.5kg
- Frequency:100Hz ~ 20kHz



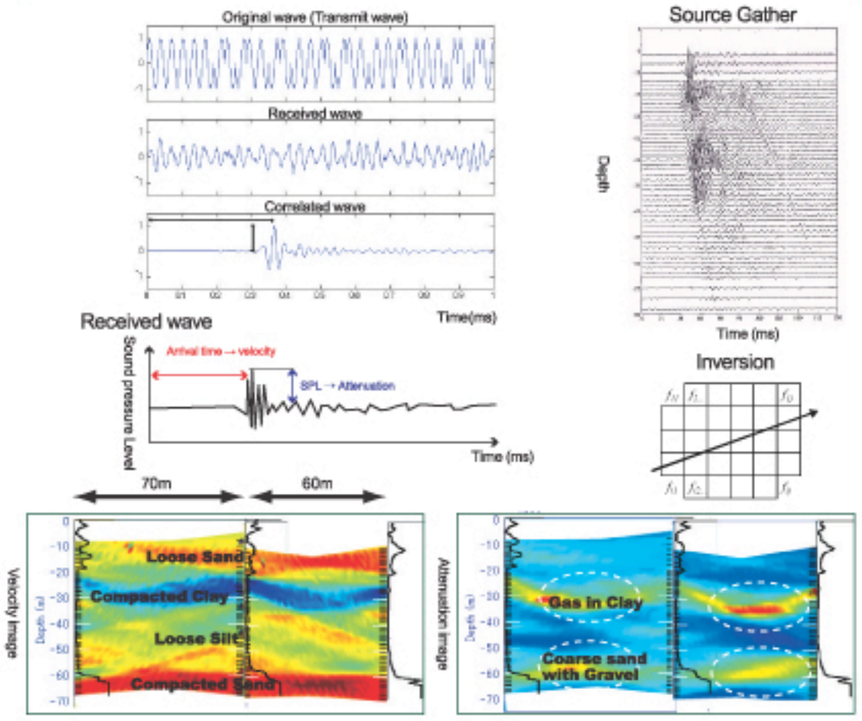
RECEIVER
- Piezo type
- OD=33mm,Weight=11kg
- 24channels@1m-interval
- Frequency:1Hz ~ 20kHz

High Resolution & Long Distance 01





Velocity & Attenuation 02



Noise Proof 03

Quite difficult to gather the clear data by the conventional seismic tomography

Investigation under factory building operated

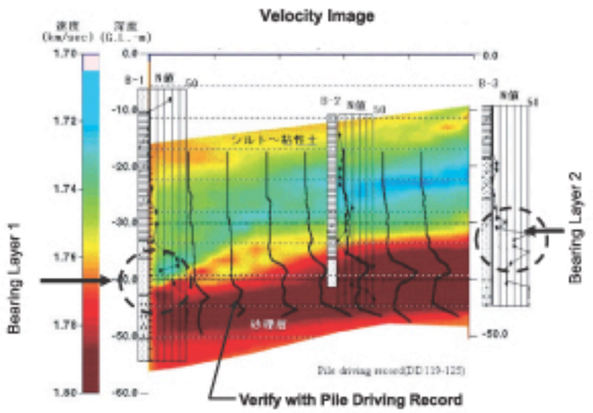
① DATA LOGGER
- Input: 24ch, Resolution: 14bit

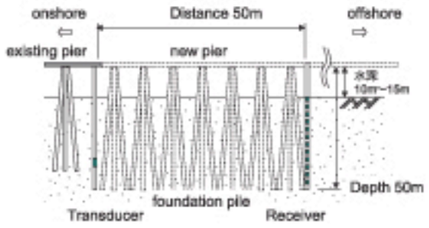
② SIGNAL FILTER
- Input: 24ch, Gain: 100times
- Band Pass Filter (200Hz to 60kHz)
- AC 100V, Weight: 7kg

③ POWER AMPLIFIER
- Output: 120V (<20kHz)
- Frequency: 20Hz ~ 20kHz
- AC 100V, 60W, Weight: 9kg

Port of Manila in Philippines **Past Result**

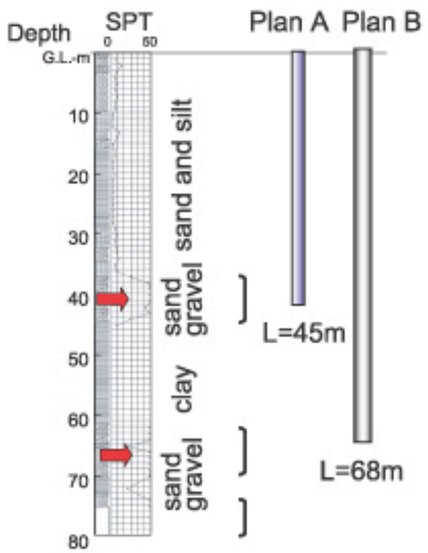
A bearing layer of the piles was different by 8m between two boring results with the distance of 50m. Acoustic tomography was conducted to investigate the bearing layer in between two borings and then successfully minimize the loss of steel pipe pile materials and the construction period.

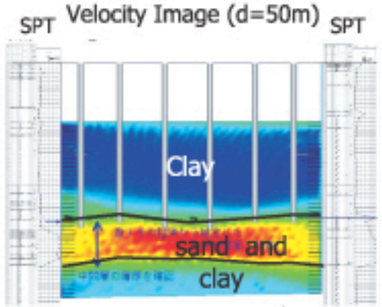




Osaka Bay in Japan **Past Result**

Two bearing layers were found by soil boring test at the new warehouse construction site. Should the minimum thickness of the first bearing layer be kept all over the construction area, Plan A could be applied and it would minimize the construction cost. The thickness of the sand and gravel layer was precisely confirmed by Acoustic Tomography then the Plan A was selected.





Nagoya Bay in Japan **Past Result**

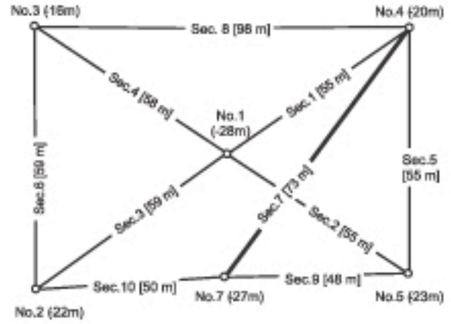
- **Strict limitation of Noise and Vibration by the operation of new airport**
- **Bearing layer is highly fluctuated because of "Old Kiso river systtem"**

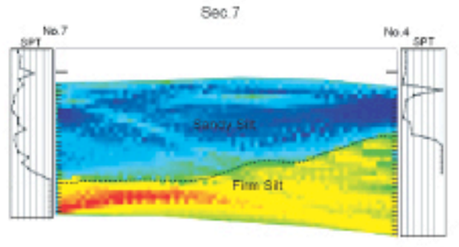
Pre-boring and PC pile installation method
[Advantage]
No vibration or noise
[Disadvantage]
Pile splicing and pile cutting are not allowed.

Precise pile design (length)

Detail investigation by Acoustic Tomography

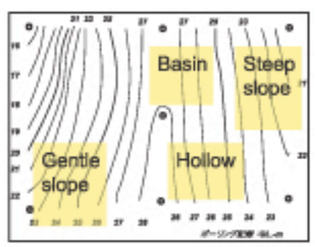
- ✓ No.of Section:10 cross sections
- ✓ Distance:47.6m ~ 97.8m
- ✓ Depth:5m ~ 39m
- ✓ Frequency:2kHz (Resolution:less than 1m)



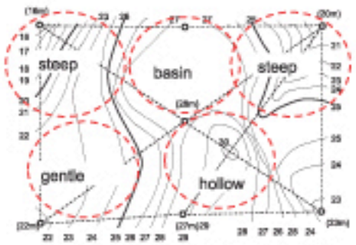


Upper boundary of the bearing layer

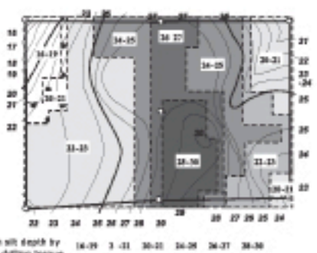
Contour map estimated only from boring logs



Depth contour map made from 10 sections of the tomogram



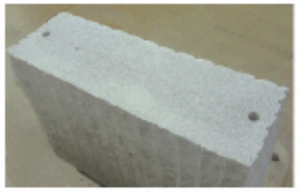
Contour map agreed with the depth obtained by the drilling torque.

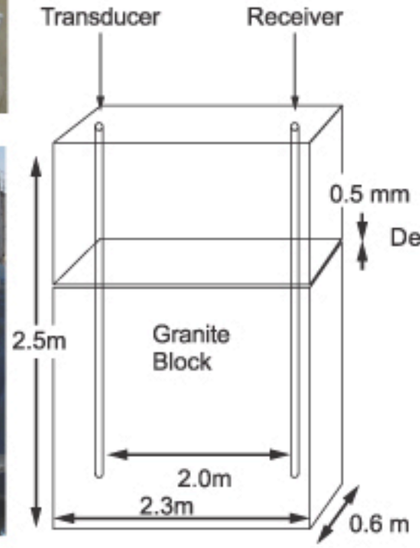


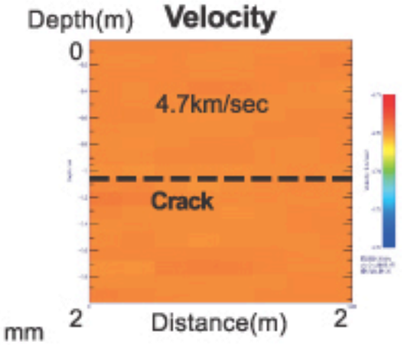
Underground structure estimated only from boring logs became simple, and difficult to reflect the actual complicated underground structure. Thanks to Acoustic Tomography conducted, the pile length was precisely designed. As a result, the multi-story-car-park was constructed on schedule without any adjustment of piles or redo-works.

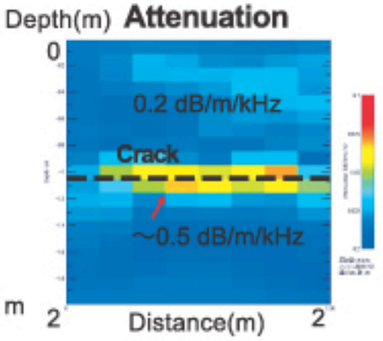
Detecting a thin crack in Granite **Experiment**

One granite block is put on another granite block with 0.5mm spacer which was filled by water. Tomography was conducted between two holes which was drilled in the granite blocks.



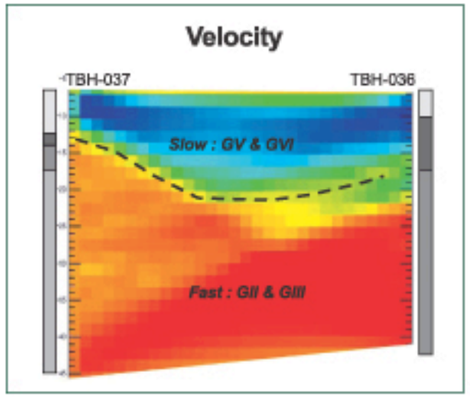


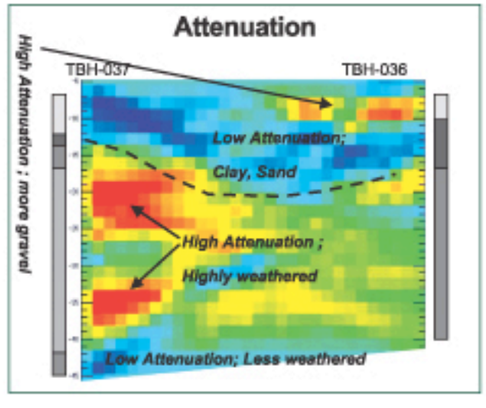




No crack is indicated in velocity image
Crack is indicated as high attenuation area in attenuation image

Granite in Singapore **Past Result**





Weathering grades of Granite are indicated in attenuation image

Detecting an obstacle **Experiment**

Model experiment with a wood block imitating an obstacle

Water tank is filled by Toyoura standard sand with wood block located inside

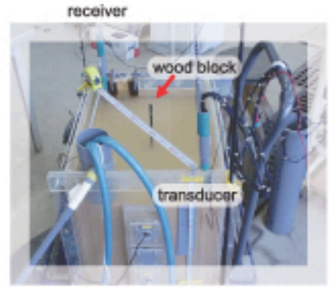
↓

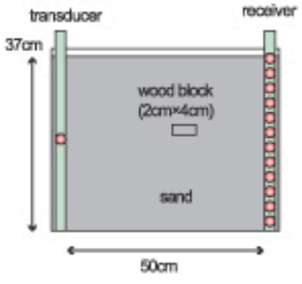
Conduct Tomography with high frequency wave

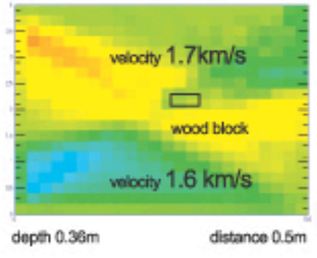
↓

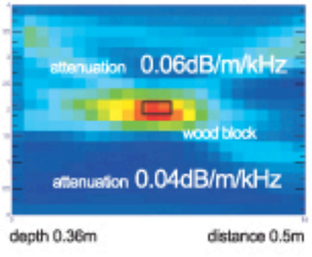
Highly attenuated area agrees with the location of wood block

No change in velocity image

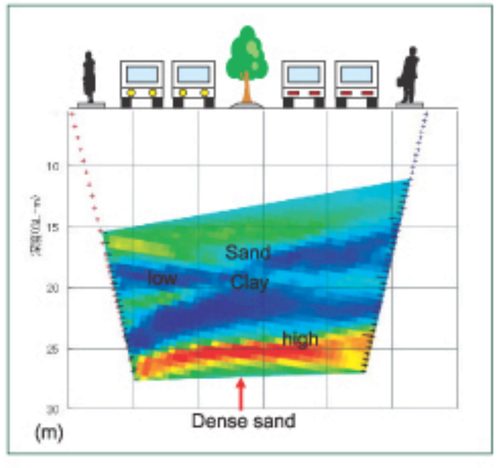


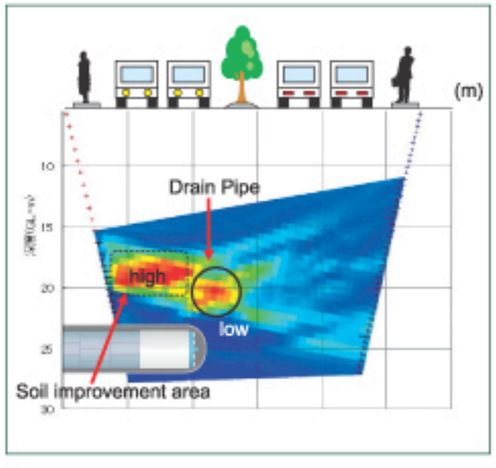






Buried Drain Pipe **Past Result**





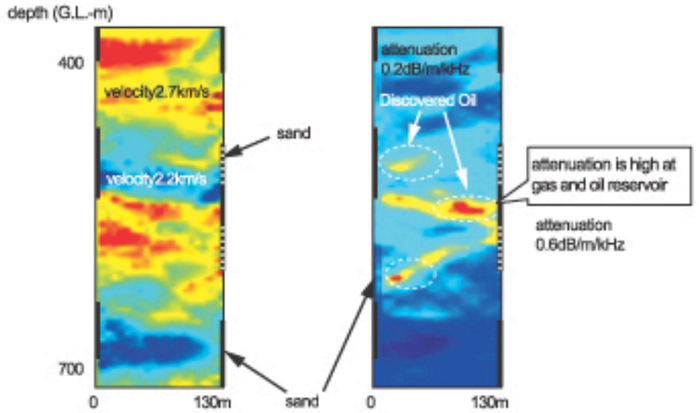
Drain pipe exists at highly attenuated area

Oil Exploration **Past Result**

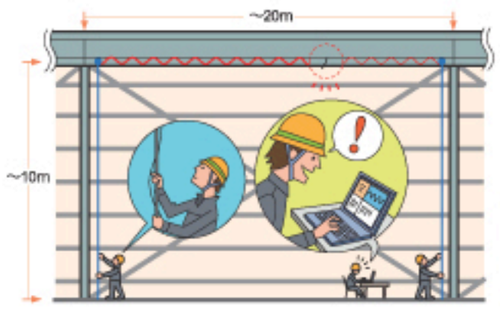
Investigate the layer with crude oil by Velocity, the gas concentrated area by Attenuation

Revive abandoned well

Oil well drilling
newly discovered

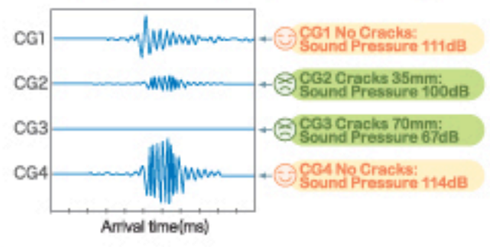


CRACK LOOK **Other Application**



- **Measuring amplitude response of the guided wave**
- **No scaffolding is required, efficient inspection method**

Inspection Results (Example of Wave Patterns)



Specification of Measurement Device

Size: 30 x 60 x 30cm (main unit)
Weight:5kg
Power:DC12V (battery-powered)
Maximum Measurable Height: 10m (actual performance records)

Oscillator | Data logger | Receiver

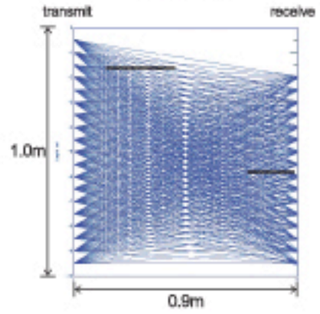
Data analysis unit

Non-destructive Investigation **Other Application**

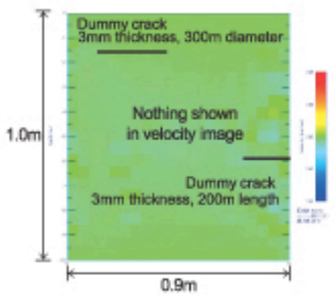
Visualize cracks and openings inside of concrete structure

- **Detect inside cracks or openings as small as some cm without any influence of re-bars.**
- **Possible to apply for the inspection of the pier with traffic due to Noise Proof.**

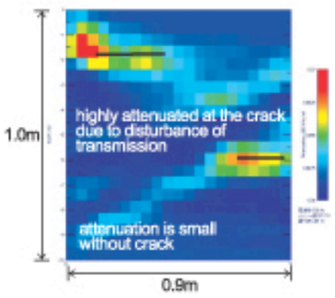
Ray Path



Velocity Image

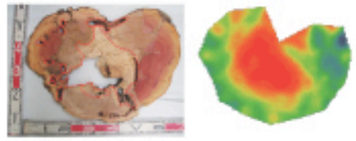


Attenuation Image



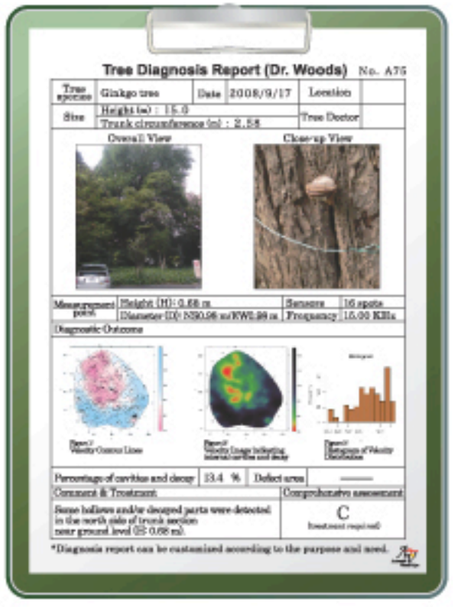
DR. WOODS **Other Application**

Field investigation at Hibiya Park, Tokyo



A Plane Tree : Diameter 62cm

- **Tree Friendly and User Friendly**
- **Real-time analysis**
- **Extensive**

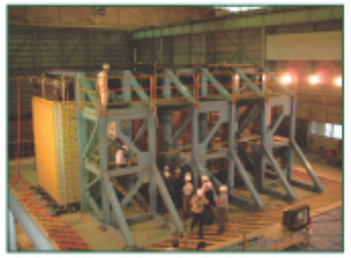


Work Record

Year	Purpose	Location	Distance(m)	Depth(m)
2009	Investigation of bearing layer	Kyushu	80	30
2009	Investigation of bearing layer	Okayama	50	40
2009	Detecting the buried obstacle	East Japan	40	40
2009	Detecting the buried obstacle	East Japan	40	30
2009	Monitoring the soil improvement area	East Japan	20	20
2009	Investigation of fracture in the rock	Europa	4	20
2009	Detecting the weather area at tunnel wall	Hokkaido	3	20
2009	Investigation of fracture in the rock	East Japan	1	400
2008	Detecting the loose area under the basement	Central Japan	10	10
2008	Monitoring the soil improvement area	West Japan	10	10
2008	Investigation of bearing layer	West Japan	50	30
2008	Detecting the weather area at tunnel wall	Hokkaido	2	7
2008	Investigation of bearing layer	West Japan	60	30
2007	Investigation of fracture in the rock	West Japan	80	50
2007	Monitoring the soil improvement area	East Japan	2	2
2007	Investigation of fracture in the rock	East Japan	1	1
2006	Investigation of bearing layer	East Japan	30	60
2006	Monitoring the soil improvement area	West Japan	20	20
2006	Investigation of bearing layer	West Japan	10	10
2006	Detecting the buried obstacle	East Japan	2	2
2005	Investigation of fracture in the rock	Europa	300	500
2005	Investigation of bearing layer	Aichi	70	50
2005	Investigation of bearing layer	Osaka	70	60
2005	Investigation of bearing layer	West Japan	40	70
2005	Detecting the cave in the ground	Fukushima	20	10
2005	Monitoring the soil improvement area	Ibaraki	2	2
2005	Monitoring the soil improvement area	East Japan	2	2
2004	Investigation of fracture in the rock	Europa	100	100
2003	Investigation of bearing layer	Chiba	70	50
2003	Investigation of bearing layer	Chiba	70	50
2003	Investigation of bearing layer	Saitama	70	50
2003	Investigation of fracture in the rock	West Japan	30	30
2003	Investigation of fracture in the rock	Europa	20	10
2003	Monitoring the soil improvement area	Hyogo	10	10
2003	Investigation of fracture in the rock	Europa	2	2
2002	Investigation of bearing layer	Chiba	120	60
2002	Investigation of bearing layer	Chiba	70	50
2002	Investigation of bearing layer	Nigata	50	50
2002	Detecting the cave in the ground	Gifu	35	50
2002	Investigation of fracture in the rock	East Japan	2	2
2002	Liquifaction experiment	Ibaraki	2	2
2002	Investigation of fracture in the rock	Europa	2	2
2002	Investigation of bearing layer	North Japan	1	10
2001	Investigation of bearing layer	Tokyo	50	50
2001	Investigation of bearing layer	Ehime	25	30
2001	Detecting loose sand area in the ground	East Japan	15	50
2001	Liquifaction experiment	Ibaraki	2	2
2000	Investigation of fracture in the rock	Tochigi	50	100
2000	Liquifaction experiment	Ibaraki	2	2
1999	Investigation of fracture in the rock	Central Japan	50	150
1999	Investigation of bearing layer	North Japan	40	150
1997	Oil exploration	Trinidad	150	700
1996	Investigation of bearing layer	Phillipines	50	50
1994	Oil exploration	USA	400	100
1994	Monitoring the reclamation	West Japan	50	30
1993	Goundwater exploration	USA	50	50
1991	Investigation of bearing layer	Chiba	200	50

Typical Application

Investigation in Heavy Traffic Area



Monitoring – Liquefaction Experiment

Oil Exploration at GL-1,000m

Soil Investigation at Reclaimed Land

EDZ Detection

Oil Exploration – Akita, Japan

Soil Investigation for Building Foundation

Cavity Investigation

Underground Water Survey

CONTACT

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