

# **NAVIGATIONAL DRILLING SYSTEM**





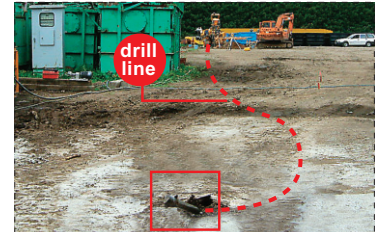
# NAVIGATIONAL DRILLING SYSTEM

Raito Kogyo's 3D Navigational Drilling System has realized three dimensional free curve drilling using dual-wall rod string. This system has been developed to respond to the necessity to drill boreholes in congested urban subsurface conditions. By employing dual-wall rod system, this system is flexibly applied to existing geotechnical and geo-environmental methods that employ borehole drilling, such as chemical grouting and various environmental cleanup methods.

## ADVANTAGES

### Raito Kogyo's 3D Navigational Drilling system:

- 1 Enables ground improvement and soil remediation under or behind existing structures without affecting facility operation or damaging underground structures.
- 2 Is flexibly applied to the conventional methods that employ borehole drilling.
- 3 Drills a sharp-curve borehole (e.g. 20m radius)
- 4 Drills over a long-distance.
- 5 Circumvents underground obstacles.
- 6 Monitors navigation accurately with special bit locator system.



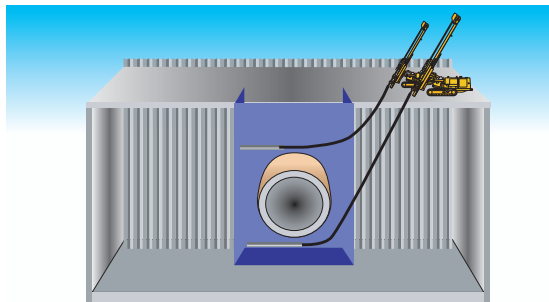
3D drilling performance test (S-shaped curve)



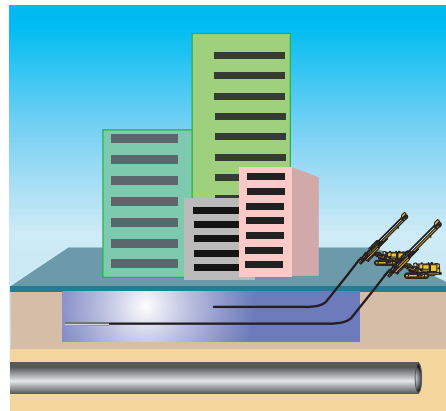
3D drilling performance test (long distance)

## COMPARISON WITH CONVENTIONAL METHODS

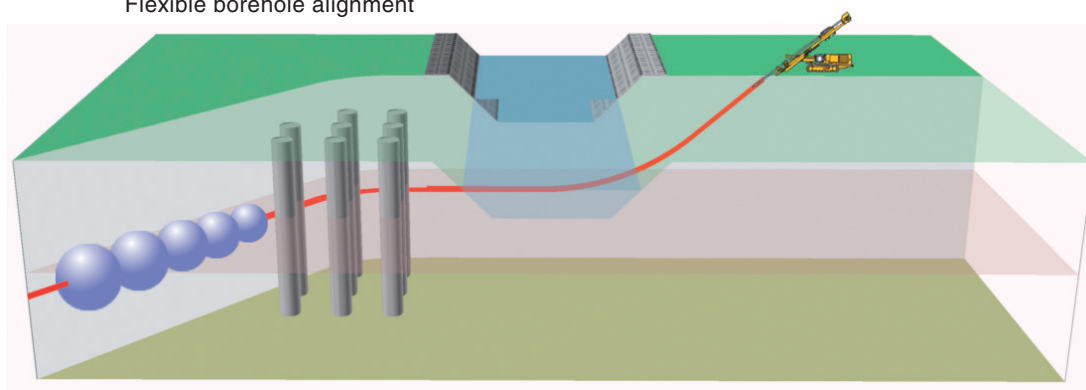
To perform ground improvement under existing structures, two methods have been normally employed: 1) drill inclined grout holes from the ground surface or 2) drill horizontal grout holes from a shaft excavated nearby. By using 3D navigational drilling system, horizontal grout holes can be installed from the surface without excavating a shaft.



Ground improvement to stabilize a sewage main



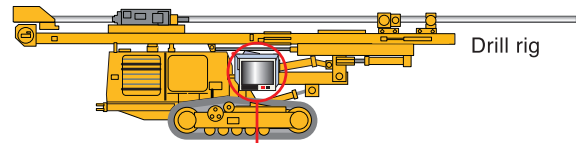
Ground improvement underneath existing buildings



Flexible borehole alignment

## BIT LOCATOR AND STEERING SYSTEM

The bit locator system monitors exact location of the drill bit with special locator sensors free from magnetic disturbance. This enables high-accuracy 3D navigational drilling. The system tells operator in real time such information as direction and inclination of drill bit, tool face orientation, and deviation from preplanned alignment. The operator steers the drill bit and align it to the preplanned course to reach the destination.



Navigation Control



## TYPICAL DRILL SEQUENCE



1. Operator starts drilling while monitoring bit location. The drill bit is rotated for straight drilling. For turning the bit is pushed with the tool face oriented to the directions it turns.
2. Withdraw the inner steel rod
3. Install a grout pipe
4. Withdraw the outer pipe

The drill bit may tow a perforated pipe with check valves. The perforated pipe is left underground to serve as a grout pipe. A PVC pipe may be towed and left as an extraction well.

## APPLICATION

3D navigational drilling system expands the range of remediation options. Injection and extraction wells can be efficiently installed underneath existing facilities, such as operating factory, residential building, and gas station, without damaging structures or hampered by obstructions. Reagents can be injected directly to hot spots to decompose contaminants at source.

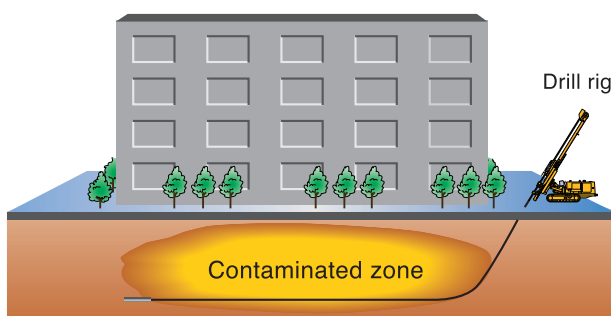
### Ground improvement

underneath sewage treatment facility, oil tank, bridge foundation, runway, factory, and others

### Soil and groundwater cleanup

underneath gas station, operating factory, and others

## Application to Steam Enhanced Extraction



Injection well is installed in the contaminated ground.



Steam is injected to vaporize VOCs, which are collected through extraction well by vapor extraction system.





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