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Narrow Pipe Driving Method

ACEMOLE

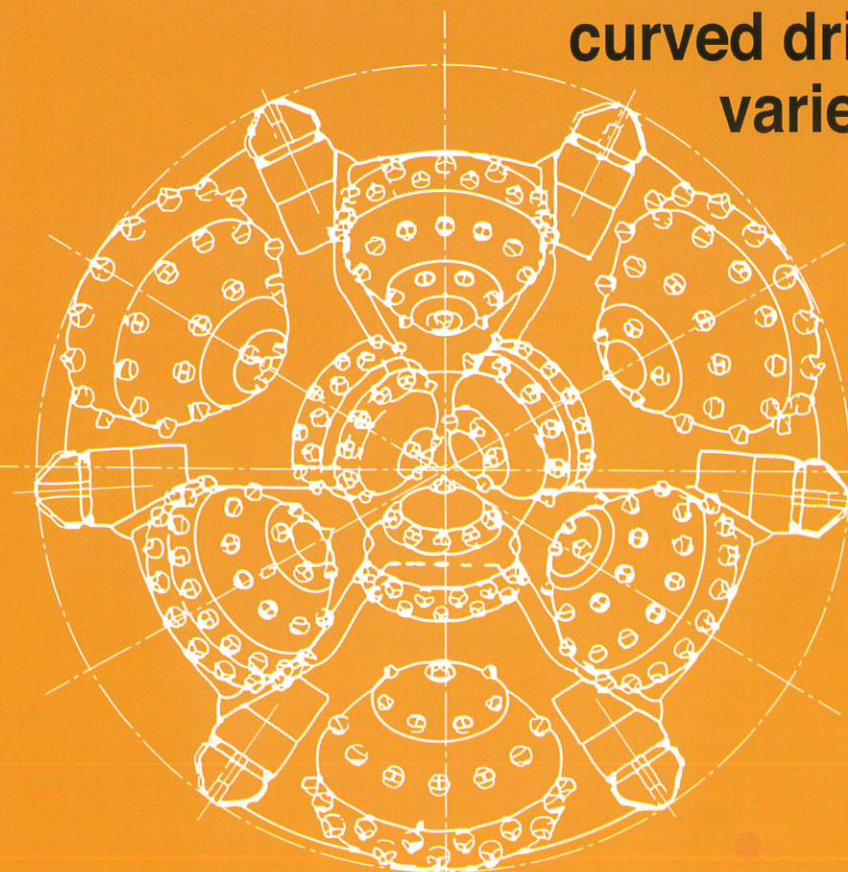
**Slurry Pressure Method /
Single-Process Method
(Pressurized Slurry Removal Method)**

(Nominal Diameter 250-700mm)

DL-C DL-N

ACEMOLE

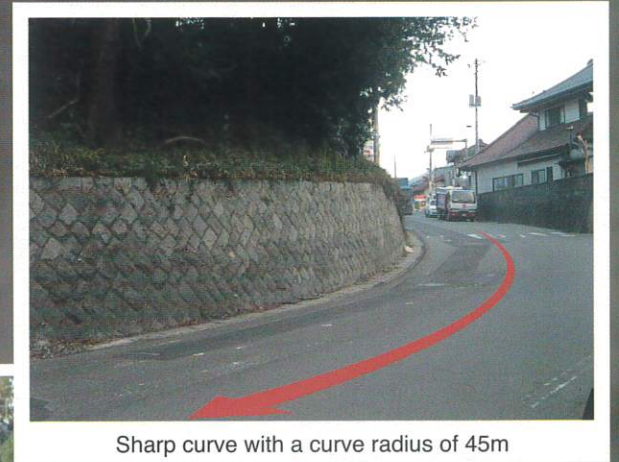
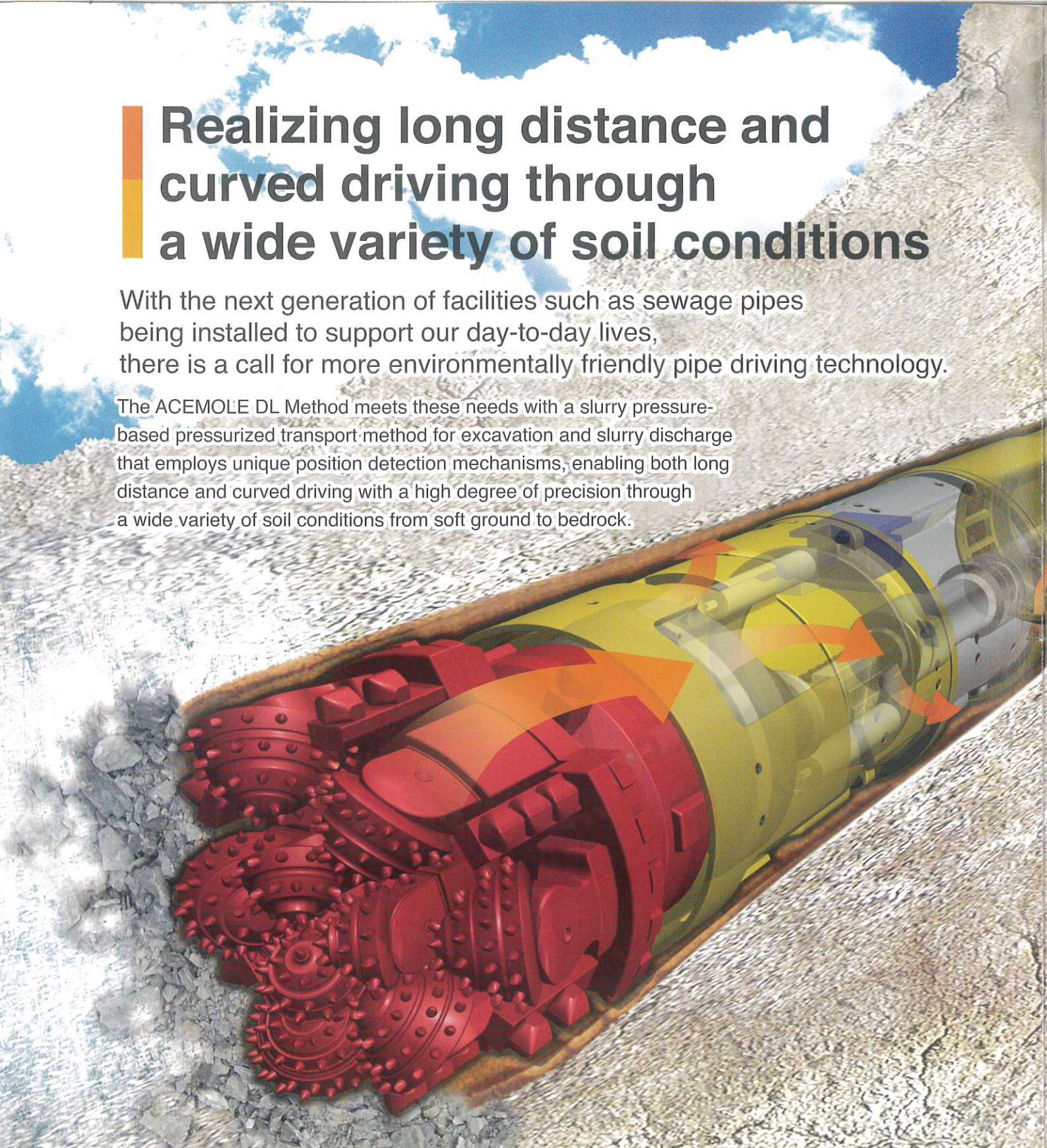
**Realizing long distance and
curved driving through a wide
variety of soil conditions**



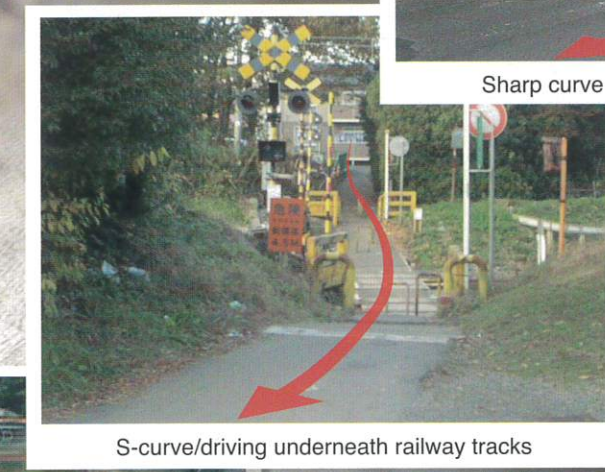
Realizing long distance and curved driving through a wide variety of soil conditions

With the next generation of facilities such as sewage pipes being installed to support our day-to-day lives, there is a call for more environmentally friendly pipe driving technology.

The ACEMOLE DL Method meets these needs with a slurry pressure-based pressurized transport method for excavation and slurry discharge that employs unique position detection mechanisms, enabling both long distance and curved driving with a high degree of precision through a wide variety of soil conditions from soft ground to bedrock.



Sharp curve with a curve radius of 45m



S-curve/driving underneath railway tracks



Driving across a river

ACEMOLE

DL-C DL-N

Excavation and slurry discharge system of ACEMOLE method

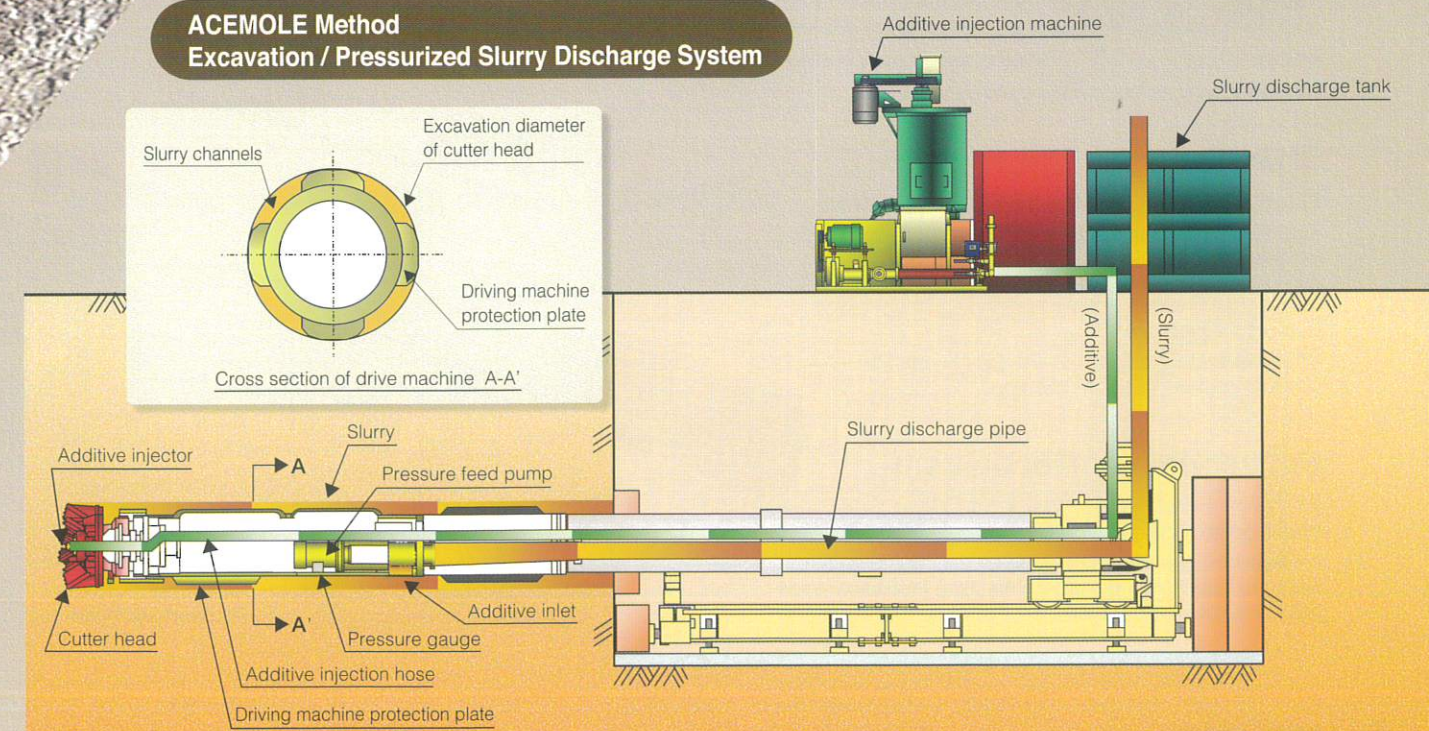
The pressurized discharge system injects additive into the excavation soil, turning it into mud (slurry). The slurry is then pumped to the pit, where it is discharged.

1 Additive is discharged from the end and injected into the working face as the cutter head rotates. Excavated soil is turned into fluid, water-stopping mud (slurry).

2 Soil that has been turned into slurry is sent along the contours of the driving machine to the rear portion, while part of this is removed from the starting pit under pressure by the pressure feed pump via the slurry discharge pipe.

3 The slurry inlet volume is controlled so that some of the slurry is left in the ground. This prevents the working face and shaft wall from collapsing and reduces thrust due to the lubricating effect of the slurry.

ACEMOLE Method Excavation / Pressurized Slurry Discharge System



Range of Application: DL-C (Segmented Driving Type)

Soil Conditions (Segmented Driving Type)

Legend ○: Operation possible
△: TBD (additional construction, etc.)

Soil Quality Range		Soil Conditions			DL35	DL50	DL70	
Classification	Name	N Value	Gravel/Rock Conditions			Application	Cutter Type	
			Max. Gravel/Rock Diameter	Percentage of Gravel Content	Unconfined Compression Strength (qu)			
Standard Soil [A]	Cohesive Soil	N < 1 *1					Spoke Type	
		1 ≤ N < 2 *1				△		
	Sandy Soil	N < 4 *1						△
		2 ≤ N < 50						○
	Sandy Soil	4 ≤ N < 50						○
	Pebble	4 ≤ N < 50	Smaller than 20mm	Smaller than 10%				○
Hard Soil [B]	Soft Rock, Hard Clay	N ≥ 50			Smaller than 10MN/m ²		○	
	Pebbles		Smaller than 75mm	Smaller than 30%			○	
Pebbles [C]	Pebbles		Smaller than 200mm	Smaller than 60%	Smaller than 120MN/m ²		○	
Gravel/Rocky Soil	[D]		Smaller than 400mm	Smaller than 80%	Smaller than 150MN/m ²		○	
	[E]		Smaller than 800mm	Smaller than 90%	Smaller than 250MN/m ²		○ *2	
Bedrock	[G]				10 < qu ≤ 20MN/m ²		Roller Type III	
	[H]				20 < qu ≤ 40MN/m ²			
	[J]				40 < qu ≤ 60MN/m ²			
	[K]				60 < qu ≤ 80MN/m ²			
	[L]				80 < qu ≤ 100MN/m ²			
Special soil not covered by the above conditions		Requires individual research into whether additional construction is necessary and the construction methods that are required.						

*1 Applicable only for straight lines.
*2 Contact us for details on application of the DL35 in gravel/rocky soil [E], as the applicable operation depends on conditions such as the soil conditions and driving length.
*3 The cutter head type is only a guide for application, and may change depending on conditions such as the soil conditions and driving length.

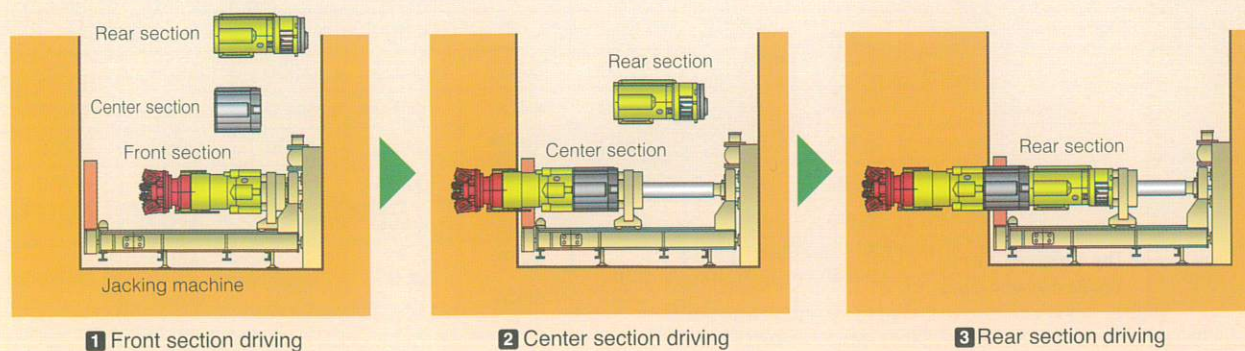
Applicable Driving Length (Segmented Driving Type)

Applicable Driving Length (Orange)
Possible *2 (Yellow)
Maximum recorded driving length *3 (Blue Diamond)

Model	Pipe Diameter	Applicable Soil Condition	Unconfined Compression Strength (MN/m ²)	Driving Length (m)							
				0	50	100	150	200	250	300	400
DL35-C	250 - 350	Standard Soil [A] Hard Soil [B]		[Bar chart showing applicable length up to ~200m]							
		Pebbles [C]	qu ≤ 120	[Bar chart showing applicable length up to ~150m]							
		Gravel/Rocky Soil [D]	qu ≤ 150	[Bar chart showing applicable length up to ~150m]							
		Gravel/Rocky Soil [E]	qu ≤ 150	[Bar chart showing applicable length up to ~150m]							
			qu ≤ 200	[Bar chart showing applicable length up to ~150m]							
		qu ≤ 250	[Bar chart showing applicable length up to ~100m]								
		Bedrock [G]	10 < qu ≤ 20	[Bar chart showing applicable length up to ~150m]							
		Bedrock [H]	20 < qu ≤ 40	[Bar chart showing applicable length up to ~100m]							
		Bedrock [J]	40 < qu ≤ 60	[Bar chart showing applicable length up to ~100m]							
		Bedrock [K]	60 < qu ≤ 80	[Bar chart showing applicable length up to ~100m]							
Bedrock [L]	80 < qu ≤ 100	[Bar chart showing applicable length up to ~100m]									
DL50-C	400 - 500	Standard Soil [A] Hard Soil [B]		[Bar chart showing applicable length up to ~250m]							
		Pebbles [C]	qu ≤ 120	[Bar chart showing applicable length up to ~200m]							
		Gravel/Rocky Soil [D]	qu ≤ 150	[Bar chart showing applicable length up to ~200m]							
DL70-C	600 - 700	Gravel/Rocky Soil [E]	qu ≤ 150	[Bar chart showing applicable length up to ~150m]							
			qu ≤ 200	[Bar chart showing applicable length up to ~150m]							
			qu ≤ 250	[Bar chart showing applicable length up to ~100m]							
		Bedrock [G]	10 < qu ≤ 20	[Bar chart showing applicable length up to ~150m]							
		Bedrock [H]	20 < qu ≤ 40	[Bar chart showing applicable length up to ~100m]							
Bedrock [J]	40 < qu ≤ 60	[Bar chart showing applicable length up to ~100m]									
Bedrock [K]	60 < qu ≤ 80	[Bar chart showing applicable length up to ~100m]									
Bedrock [L]	80 < qu ≤ 100	[Bar chart showing applicable length up to ~100m]									

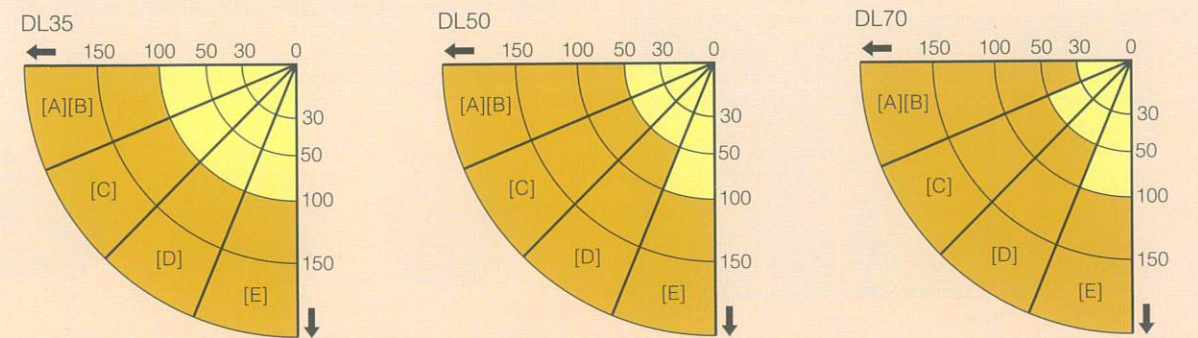
*1 Please note that the driving length differs according to various conditions, even within the standard range. Please contact us for details.
*2 For straight-line driving lengths over 100m, equipment such as oil cooling equipment and suction equipment needs to be used to maintain the precision of position detection by laser targeting.
*3 The figures for maximum recorded driving length are for starting pits with a diameter of φ2,500mm.

Image of Segmented Driving



Applicable Radius of Curvature (Segmented Driving Type)

Suitable (Orange) Possible (Yellow) Unit: mR



*For details on soil conditions, see "Soil Conditions (Segmented Driving Type)" on page 5.

Range of Application: DL-N (Standard Type)

Soil Condition (Standard Type)

Legend ○: Operation possible
△: TBD (additional construction, etc.)

Soil Quality Range		Soil Conditions			DL35	DL50	DL70
Classification	Name	N Value	Gravel/Rock Conditions			Application	Cutter Type
			Max. Gravel/Rock Diameter	Percentage of Gravel Content	Unconfined Compression Strength (qu)		
Standard Soil [A]	Cohesive Soil	N < 1 *1			△		Spoke Type
		1 ≤ N < 2 *1			○		
	Sandy Soil	N < 4 *1			△		
		2 ≤ N < 50			○		
	Sandy Soil	4 ≤ N < 50			○		
	Pebble	4 ≤ N < 50	Smaller than 20mm	Smaller than 10%			
Hard Soil [B]	Soft Rock, Hard Clay	N ≥ 50			○	Smaller than 10MN/m ²	
	Pebbles		Smaller than 75mm	Smaller than 30%			
Pebbles [C]	Pebbles		Smaller than 200mm	Smaller than 60%	○	Smaller than 120MN/m ²	Roller Type II
Gravel/Rocky Soil	[D]		Smaller than 400mm	Smaller than 80%	○	Smaller than 150MN/m ²	
	[E]		Smaller than 800mm	Smaller than 90%	○ *2	Smaller than 250MN/m ²	
Bedrock	[G]					10 < qu ≤ 20MN/m ²	Roller Type III
	[H]					20 < qu ≤ 40MN/m ²	
	[J]					40 < qu ≤ 60MN/m ²	
	[K]					60 < qu ≤ 80MN/m ²	
	[L]					80 < qu ≤ 100MN/m ²	
Special soil not covered by the above conditions		Requires individual research into whether additional construction is necessary and the construction methods that are required.					

*1 Applicable only for straight lines.

*2 Contact us for details on application of the DL35 in gravel/rocky soil [E], as the applicable operation depends on conditions such as the soil conditions and driving length.

*3 The cutter head type is only a guide for application, and may change depending on conditions such as the soil conditions and driving length.

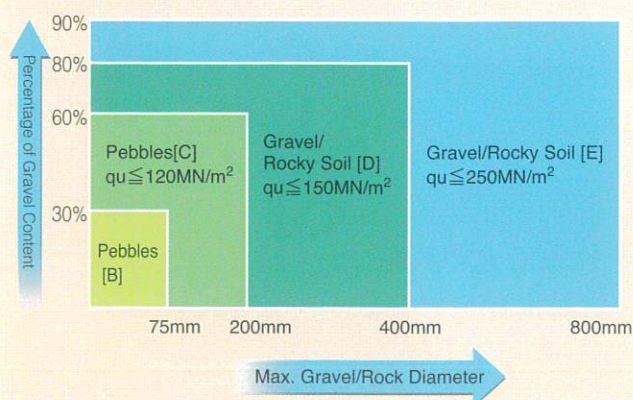
Applicable Driving Length (Standard Type)

Model	Pipe Diameter	Applicable Soil Condition	Unconfined Compression Strength (MN/m ²)	Driving Length (m)								
				0	50	100	150	200	250	300	400	
DL35-N	250 - 350	Standard Soil [A] Hard Soil [B]		[Applicable Driving Length]								
		Pebbles [C]	qu ≤ 120	[Applicable Driving Length]								
		Gravel/Rocky Soil [D]	qu ≤ 150	[Applicable Driving Length]								
			qu ≤ 200	[Applicable Driving Length]								
		Gravel/Rocky Soil [E]	qu ≤ 250	[Applicable Driving Length]								
			qu ≤ 250	[Applicable Driving Length]								
		Bedrock [G]	10 < qu ≤ 20	[Applicable Driving Length]								
		Bedrock [H]	20 < qu ≤ 40	[Applicable Driving Length]								
		Bedrock [J]	40 < qu ≤ 60	[Applicable Driving Length]								
		Bedrock [K]	60 < qu ≤ 80	[Applicable Driving Length]								
Bedrock [L]	80 < qu ≤ 100	[Applicable Driving Length]										
DL50-N	400 - 500	Standard Soil [A] Hard Soil [B]		[Applicable Driving Length]								
		Pebbles [C]	qu ≤ 120	[Applicable Driving Length]								
		Gravel/Rocky Soil [D]	qu ≤ 150	[Applicable Driving Length]								
qu ≤ 200	[Applicable Driving Length]											
DL70-N	600 - 700	Gravel/Rocky Soil [E]	qu ≤ 250	[Applicable Driving Length]								
			qu ≤ 250	[Applicable Driving Length]								
		Bedrock [G]	10 < qu ≤ 20	[Applicable Driving Length]								
		Bedrock [H]	20 < qu ≤ 40	[Applicable Driving Length]								
		Bedrock [J]	40 < qu ≤ 60	[Applicable Driving Length]								
Bedrock [K]	60 < qu ≤ 80	[Applicable Driving Length]										
Bedrock [L]	80 < qu ≤ 100	[Applicable Driving Length]										

*1 Please note that the driving length differs according to various conditions, even within the standard range. Please contact us for details.

*2 For straight-line driving lengths over 100m, equipment such as oil cooling equipment and suction equipment needs to be used to maintain the precision of position detection by laser targeting.

Soil Quality Classification for Gravel and Rocky Soil



Types and Uses of Cutter Heads

The cutter heads have a structure designed for easy replacement. Select the most suitable cutter head according to the soil type.

- Spoke Type
- Roller Type II
- Roller Type III

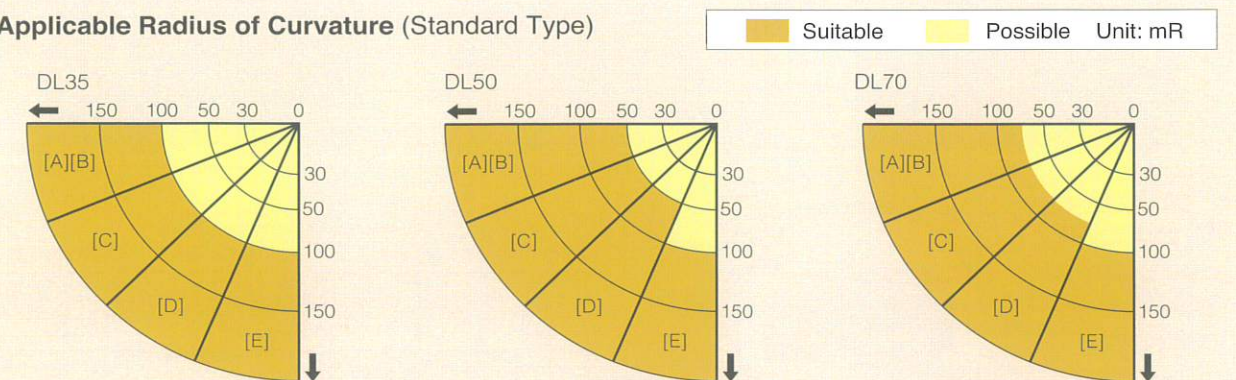


Applicable Soil Conditions: Standard Soil [A], Hard Soil [B]

Applicable Soil Conditions: Pebbles [C], Gravel/Rocky Soil [D]

Applicable Soil Conditions: Gravel/Rocky Soil [E], Bedrock

Applicable Radius of Curvature (Standard Type)



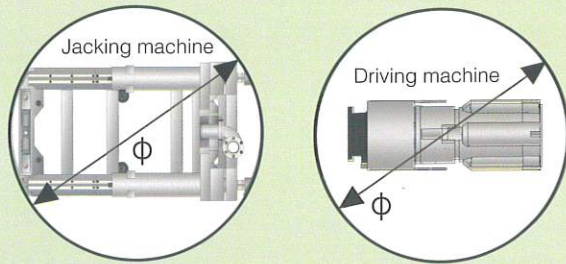
Applicable Soil Conditions: Standard Soil [A], Hard Soil [B], Pebbles [C], Gravel/Rocky Soil [D], Gravel/Rocky Soil [E]

*For details on soil conditions, see 'Soil Conditions (Standard Type)' on page 7.

Pit Dimensions

DL-C

Segmented Driving / Starting pit and Arriving pit



Starting pit dimensions

(dimensions of inner space with water stop installed) (unit: mm)

Nominal diameter	Starting in one direction	Starting in both directions
φ250 - 300	φ2,000	φ2,500
φ350 - 500	φ2,500	φ2,500
φ600 - 700	φ2,500	φ3,000

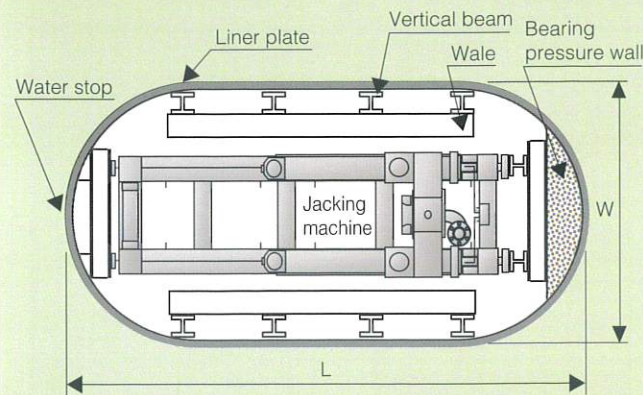
Arriving pit dimensions

(dimensions of inner space with water stop installed) (unit: mm)

Nominal diameter	Arriving in one direction	Arriving in both directions
φ250 - 350	φ1,200	φ1,500
φ400 - 500	φ1,500	φ1,800
φ600 - 700	φ1,800	φ2,200

DL-N

With liner plate



Starting pit dimensions

(unit: mm)

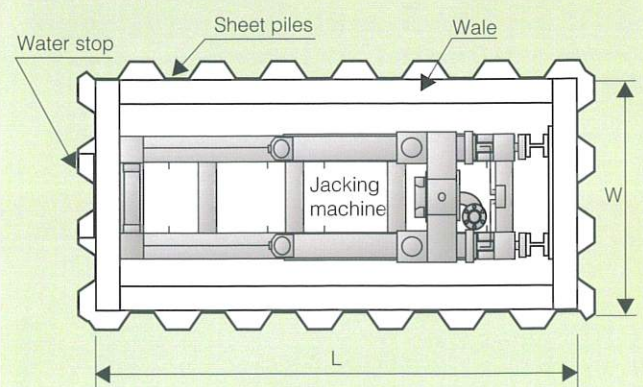
Nominal diameter	Starting in one direction		Starting in both directions	
	L	W	L	W
φ250 - 350	4,070	2,500	4,541	2,500
φ400 - 500	5,797	2,500	5,797	2,500
φ600 - 700	5,826	3,000	5,826	3,000

Arriving pit dimensions

(unit: mm)

Nominal diameter	Arriving in one direction		Arriving in both directions	
	L	W	L	W
φ250 - 350	3,884	2,000	4,198	2,000
φ400 - 500	4,198	2,000	4,512	2,000
φ600 - 700	4,041	2,000	4,355	2,000

With sheet pile steel retaining structure



Starting pit dimensions

(unit: mm)

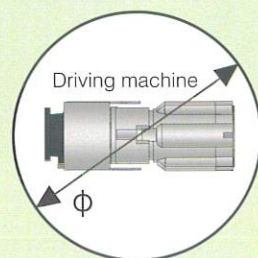
Nominal diameter	Starting in one direction		Starting in both directions	
	L	W	L	W
φ250 - 350	4,800	2,800	4,800	2,800
φ400 - 500	5,600	2,800	5,600	2,800
φ600 - 700	5,600	3,200	5,600	3,200

Arriving pit dimensions

(unit: mm)

Nominal diameter	Arriving in one direction		Arriving in both directions	
	L	W	L	W
φ250 - 350	4,000	2,000	4,400	2,000
φ400 - 500	4,400	2,400	4,800	2,400
φ600 - 700	4,400	2,400	4,800	2,400

Segmented Collectable pit



Segmented Collectable pit dimensions

(dimensions of inner space with water stop installed) (unit: mm)

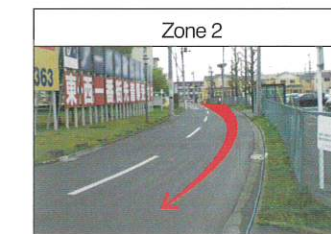
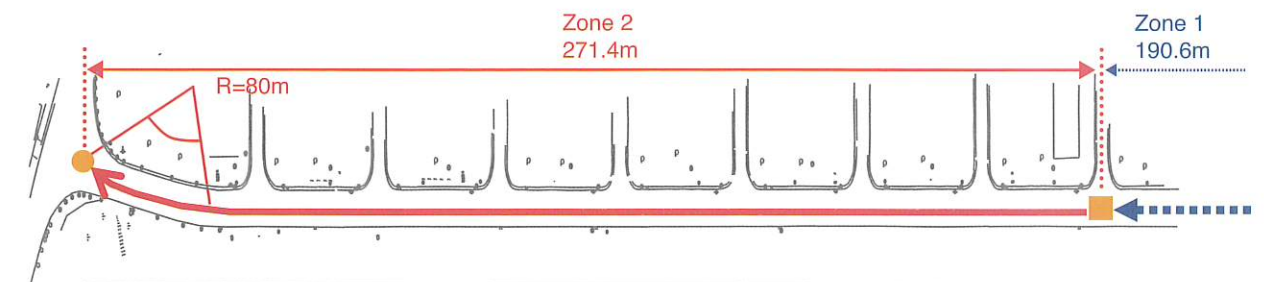
Nominal diameter	Arriving in one direction	Arriving in both directions
φ250 - 350	φ1,800	φ2,000
φ400 - 500	φ2,000	φ2,300
φ600 - 700	φ2,000	φ2,400

* Please note that the pit dimensions differ according to various conditions. Please contact us for details.

Examples of Work

1 Long-distance curved driving across a distance of over 250m

Type & Diameter of pipe	Reinforced concrete pipe for driving (nominal diameter: 450mm)
Driving length	Zone 1: 190.6m (S-curve: R=200m) Zone 2: 271.4m (Single curve: R=80m)
Soil	Cohesive Soil - Sand
Other	As a thrust reduction measure, friction-reducing materials were injected from the pithead and rear pipe and applied to the outside of the pipe to be driven. As a result, driving was completed with less than the designed thrust.



2 Long-distance driving under a river using a PRISM

Type & Diameter of pipe	Reinforced concrete pipe for driving (nominal diameter: 500mm)
Driving length	245.1m
Other	A PRISM was used to drive under the river at a great depth, enabling the driving to be carried out with a high degree of precision.

