NIPPON STEEL

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STEEL PIPE PILES
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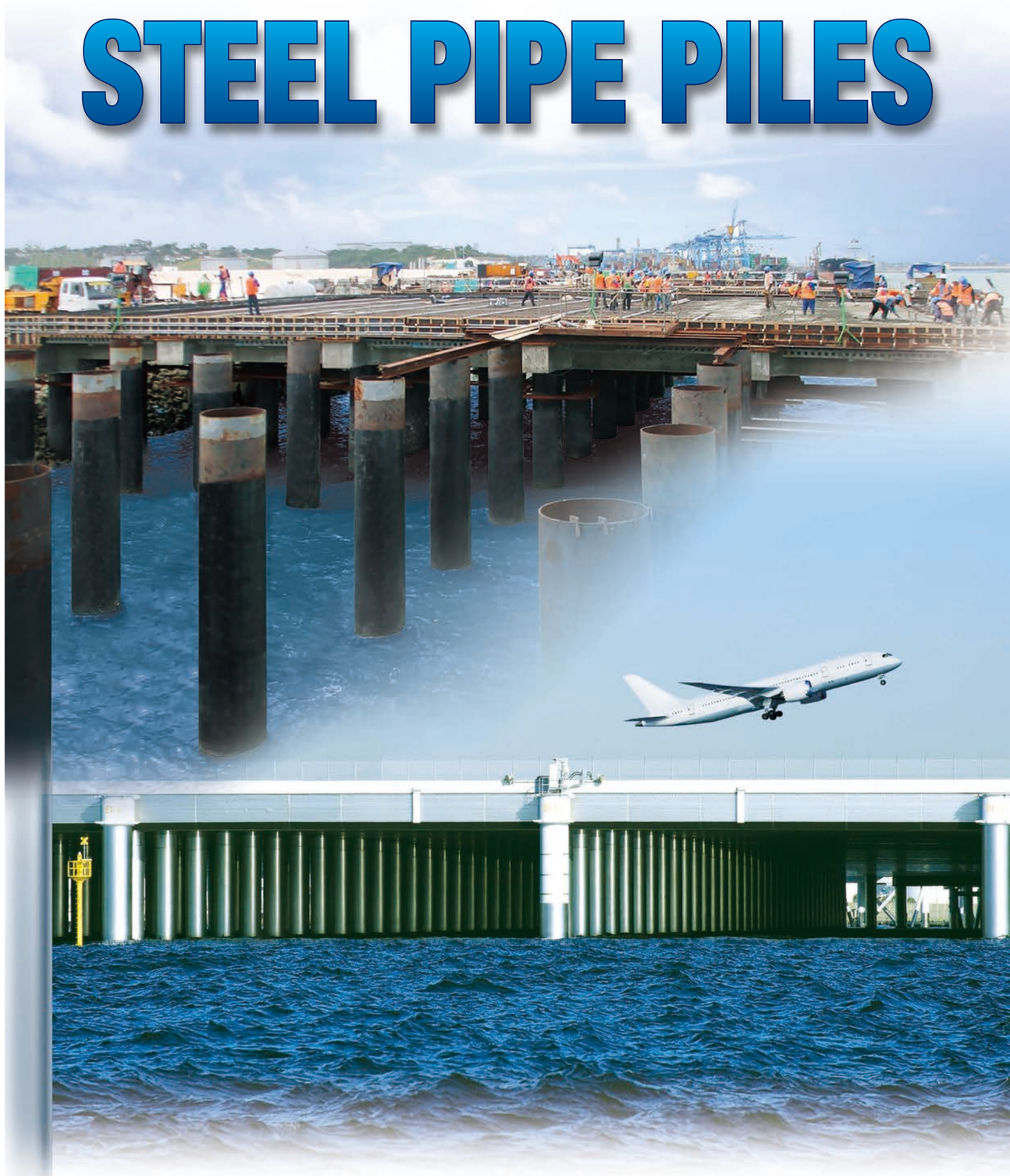
STEEL PIPE PILES



NIPPON STEEL

THE INSPIRING NEW STEEL FOUNDATION SOLUTIONS

Design proposal

Based on the design conditions obtained from the customers and our numerous design records, we can provide an optimum design plan.

Proposal of construction method

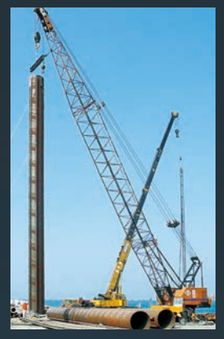
Based on past achievements, we can provide various recommendations, including those regarding the selection of the most-optimum construction machine according to soil conditions.

Proposal of method to prevent corrosion

With long-standing experience, we are able to provide various kinds of recommendations.

Instruction for fabrication

We have prepared manuals for fabrication and can provide instruction at the site.



NIPPON STEEL

We can provide
— steel foundation solu tions from global offices
— steel pipe piles from global factories

NIPPON STEEL's Solution Proposal for Steel Foundations

Q *We want to drive piles into hard ground. Is a good solution available?*

Yes
- **The Gyropress method™**, in which steel pipe piles with cutting bits installed at the tip of the steel pipes are rotationally pressed in, allows the piles to penetrate hard ground and obstacles (e.g., reinforced concrete), being appropriate for hard ground, as well.
- **The RS plus™ method**, in which vibratory hammers equipped with high-pressure water jets are used, features excellent performance in excavating the ground, thus being appropriate for hard ground areas.

Q *Is a pile method available that is appropriate for soft ground?*

Yes
- **The NS ECO-PILE™ method**, in which the bearing capacity at the tip of piles is large, is appropriate for soft ground where skin friction cannot be substantially expected.
- **Steel Pipe Sheet Pile Foundations** involve a method in which steel pipe sheet piles are combined and installed in the shape of an enclosure so that behavior of the sheet piles is unified, from which high horizontal resistance and high vertical-bearing capacity are generated, applicable even for soft ground.
- **The TNX™ method**, in which expanded foot protection sections constructed at the tip of piles are unified with steel pipes, provides high vertical-bearing capacity, being appropriate for soft ground.
- **The Slip Layer Pipe Piles** (piles resistant to negative friction) ensures a reduction of negative friction in soft ground.

Q *We want to drive piles into a deep bearing layer or ground areas without a distinct bearing layer. Can you suggest a good solution?*

Yes
- **The Steel Pipe Pile and Steel Pipe Sheet Pile methods**, which are easy to be joined by welding, are appropriate for ground areas with deeper support layers.
- **Gantetsu pile™** is a composite pile that feature low steel pipe deformability along with excellent soil cement frictional resistance. They can be designed as friction piles.

Q *We want to employ an environmentally friendly method. What is your recommendation?*

Yes
- **The NS ECO-PILE™ and Gyropress method™** have realized construction without producing waste soil by introducing the rotatory press-in method.
- **The NS ECO-PILE™, Gyropress method™, TNX™ method, and Gantetsu pile™** are environmentally friendly methods that enable low-noise and low-vibration construction.

Q *We require pile construction in a narrow ground area. Is an applicable method available?*

Yes
- **The NS ECO-PILE™ and Gyropress method™** require only small workspaces for construction. These methods enable construction in narrow ground areas, such as areas next to existing structures. They are also applicable for construction sites with restricted overhead clearance, such as sites under elevated bridges and overhead lines.

Q *We are seeking a method that has functions featuring bearing piles and retaining walls. What do you propose?*

Yes
- **Steel Pipe Sheet Pile Foundations** utilize a method in which steel pipe sheet piles are combined and installed in the shape of an enclosure, which functions as a temporary cofferdam or retaining wall simultaneously with bearing piles.
- **The Combined Wall method**, in which steel sheet piles and steel pipe sheet piles are combined, performs the function of a retaining wall and the bearing function of vertical force, thanks to steel pipe sheet piles.

Q *We are seeking a method appropriate for improving quay walls and aseismic retrofitting. What are your proposals?*

Yes
- **The Submerged Strut method** was developed to satisfy needs for aseismic retrofitting or the deepening of existing quay walls. The method reduces the size of workspaces and the length of construction periods, which contributes to economical construction.

Q *We want to save labor at construction sites and to speed up construction. Can you suggest a good solution?*

Yes
- **The Sat-in Pile Foundation**, in which the pillars, etc., of superstructures are directly connected to the foundation piles and in which concrete footing can thus be omitted, can reduce costs and construction periods at actual sites.
- **The Jacket technology** is used for marine structures in which steel pipe truss foundations are combined with superstructures made from steel. The method makes construction speedy thanks to prefabrication.
- **Mechanical Joints** utilize a method that takes the place of on-site welding of steel pipe piles and steel pipe sheet piles. Simplified jointing work and construction management ensures joint quality, reduces construction periods and workloads, and makes all-weather construction possible.

	Page	Needs								Application			
		Hard ground	Soft ground	Deep underground	Environmentally friendly	Narrow ground area	Soil retainers serving as bearing piles	Quay wall renovation	Saving labor at actual sites	Railways & roads	Ports/Harbors & rivers	Building foundations	Plant foundations
Steel Pipe Piles	Pages 8		✓	✓						✓	✓	✓	✓
Steel Pipe Sheet Piles	Pages 8		✓				✓			✓	✓		
NS ECO-PILE™	Pages 14		✓	✓	✓	✓				✓	✓	✓	✓
TNX™ method	Pages 16		✓		✓							✓	
Gantetsu pile™	Pages 17			✓	✓					✓	✓		
Gyropress method™	Pages 18	✓			✓	✓				✓	✓	✓	
Submerged Strut method	Pages 20							✓	✓		✓		
RS plus™	Pages 22	✓			✓						✓		
Jacket technology	Pages 23							✓	✓		✓		
Steel Pipe Sheet Pile Foundation	Pages 24		✓	✓			✓				✓		
Sat-in Pile Foundation	Pages 26				✓				✓				✓
Combined Wall	Pages 28						✓	✓			✓		
Slip Layer Pipe Pile	Pages 31		✓							✓	✓	✓	✓
Mechanical Joint	Pages 31								✓	✓	✓	✓	✓
Anticorrosion System	Pages 32									✓	✓	✓	✓

Leading the New Era on Steel Pipe Pile with Pioneer Spirits

The steel pipe piles of NIPPON STEEL are used in many fields and have acquired high market acceptance due to their excellent product quality and construction efficiencies that derive from their use.

NIPPON STEEL, drawing a wealth of rolling, fabrication and construction methods in this fields, which have also won for the company a high reputation.

Based on an accumulation of technical expertise, NIPPON STEEL has developed and placed on the market solution proposal using all our available products at a maximum.

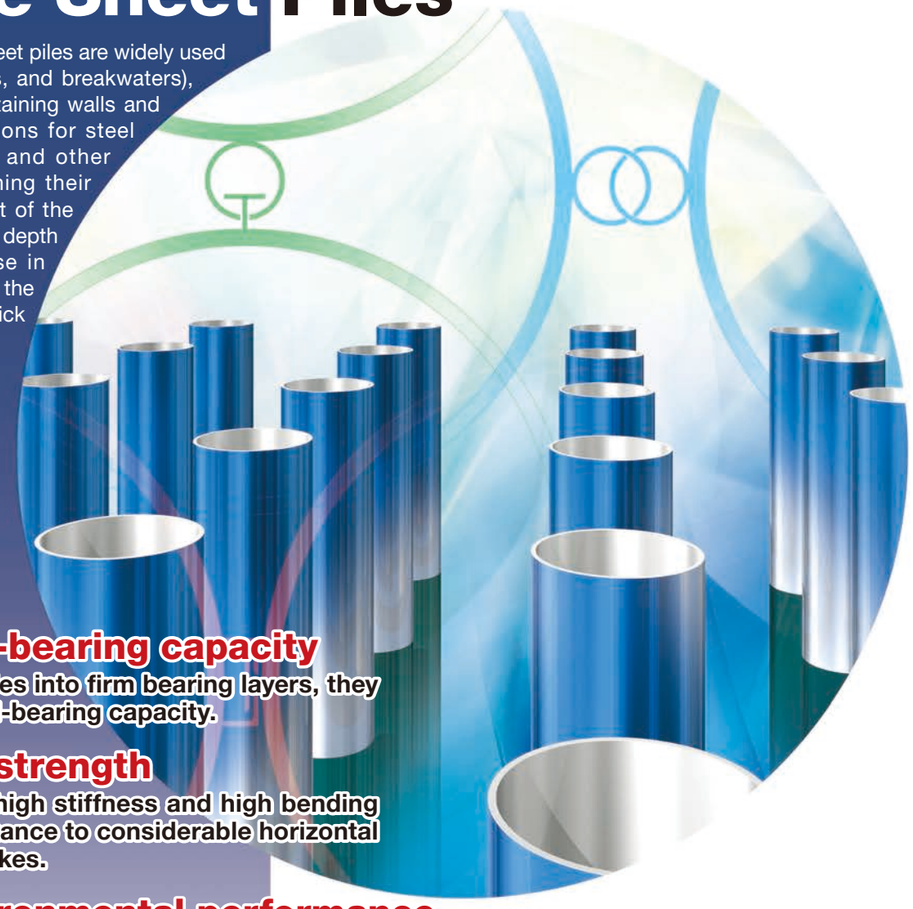
NIPPON STEEL will continue its efforts to develop novel products that bring the properties of pipe piles into full play and to respond to more stringent and diversifying user needs in the future.

Contents

Steel Pipe Piles

Steel Pipe Sheet Piles

Steel pipe piles and steel pipe sheet piles are widely used in ports/harbors (piers, seawalls, and breakwaters), urban civil engineering (earth-retaining walls and cofferdams), bridges (foundations for steel pipe sheet pile foundations), and other applications, along with widening their applications due to enlargement of the structures sizes, growth of water depth for the structures and increase in construction work at sites where the bearing strata are deep under thick soft ground.



■Features

① Large vertical-bearing capacity

By driving the pipe piles into firm bearing layers, they exhibit a large vertical-bearing capacity.

② High bending strength

Steel pipe piles with high stiffness and high bending strength enable resistance to considerable horizontal force during earthquakes.

③ Excellent environmental performance

Piles with small section areas realize less earth removal and low vibration and noise.

④ Custom fit for each structure

Various pile lengths, diameters, and thicknesses contribute to economical design.

⑤ Easy production of longer piles and jointing piles

Longer products can be manufactured, and, as joining piles by welding is also easy, it is possible to apply these to deep water and deep underground structures.

⑥ Easy jointing with superstructures

Jointing with upper concrete structures is easy, using reinforcing steel bars at the top of piles.

⑦ Easy handling

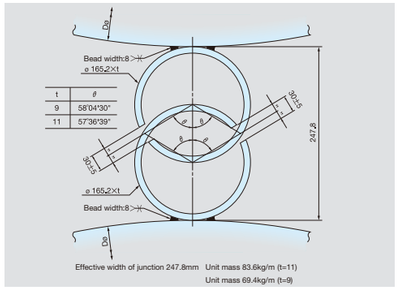
Steel that's light and tough contributes to easy handling and transport.

	Percussion method	Vibratory hammer method	Inner excavation method	Steel pipe and soil-cement hybrid pile method	Rotating pile method	Cast-in-place pile method
Reduction in construction waste soil	◎	◎	○	○	◎	×
Effect on groundwater and soil	◎	◎	○	○	◎	△
Recyclability	◎	◎	○	○	◎	×
Low vibration and noise	×	△	◎	◎	◎	◎
Durability and earthquake resistance	◎	◎	◎	◎	◎	○

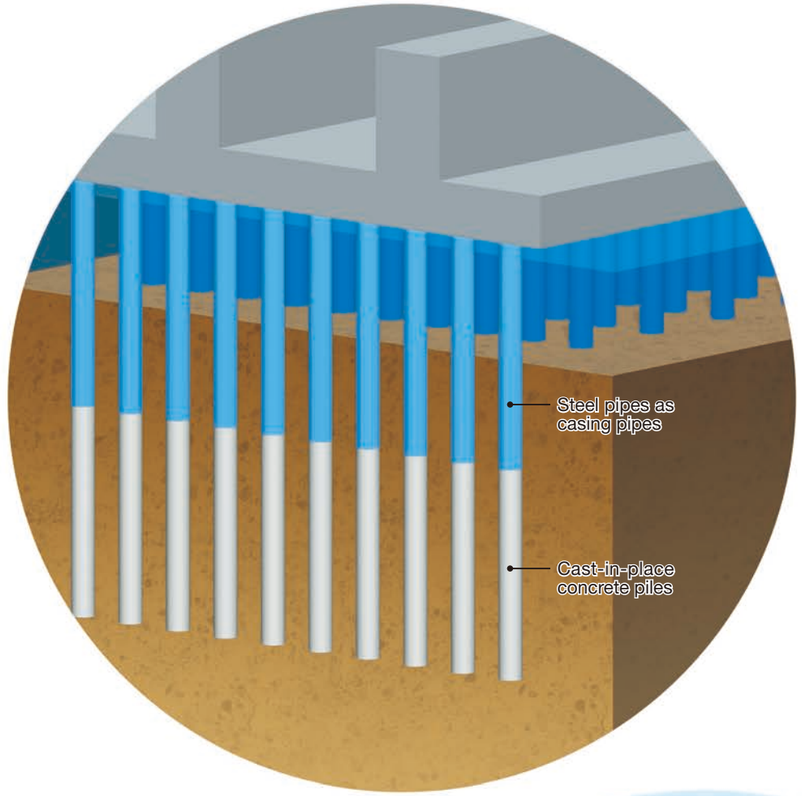
◎:optimum, ○:highly suitable, △:suitable, ×:less suitable

■Application of steel pipe piles

■Application of steel pipe sheet piles

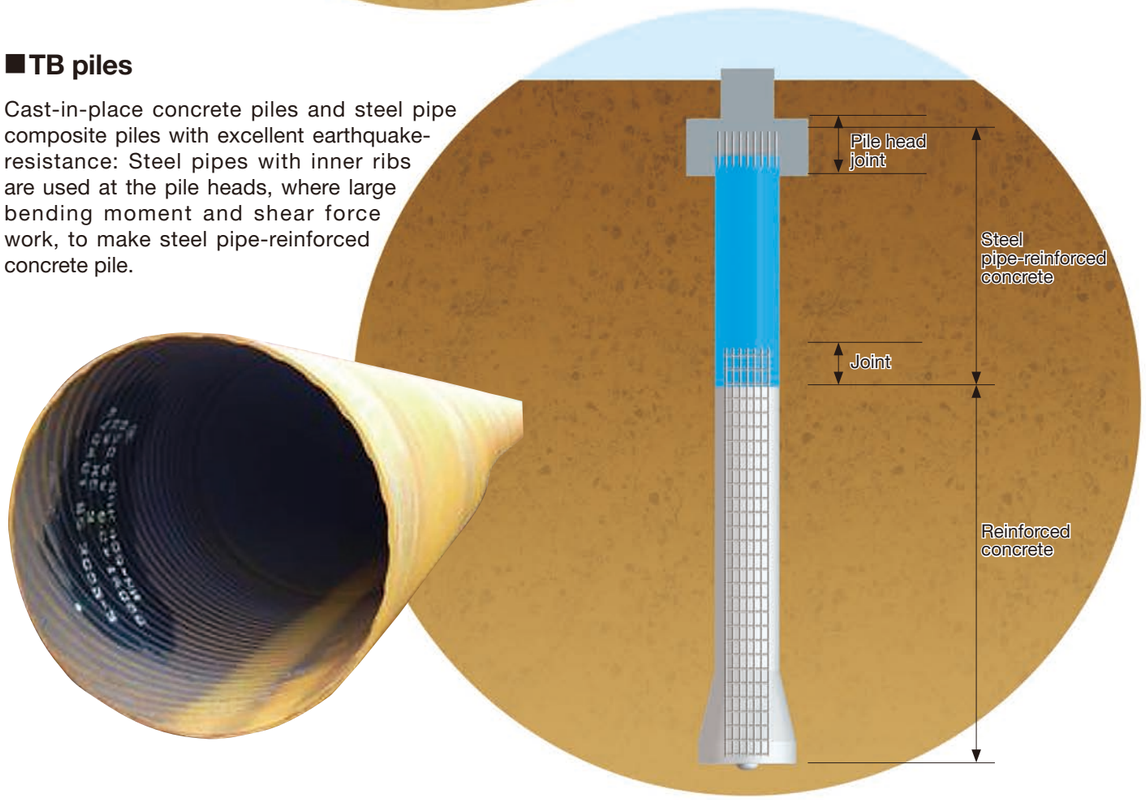


■Application of pipe piles to reinforce the head of cast-in place concrete pile.



■TB piles

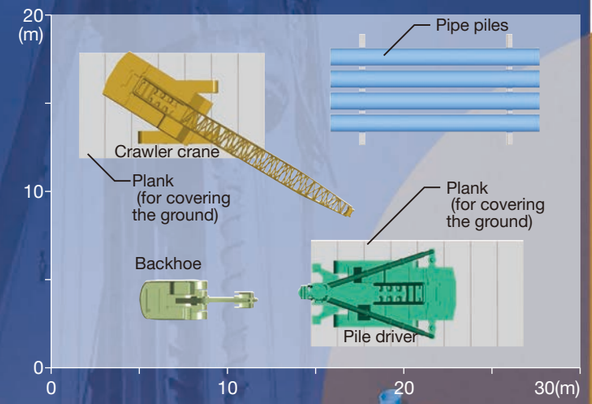
Cast-in-place concrete piles and steel pipe composite piles with excellent earthquake-resistance: Steel pipes with inner ribs are used at the pile heads, where large bending moment and shear force work, to make steel pipe-reinforced concrete pile.

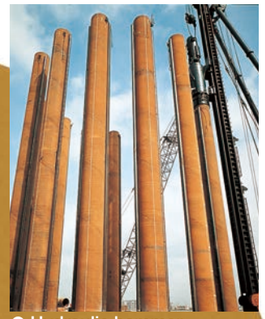


A construction method that utilizes hydraulic hammers or diesel hammers

Impact hammer method

● Example of a layout of construction machines





● Hydraulic hammer

■Features

1. **A conventional method used with many track records**
2. **Bearing capacity can be checked during installation work**
3. **Excellent workabilities and high economical efficiency**
4. **No earth removal during installation**

■Example of construction using the percussion method

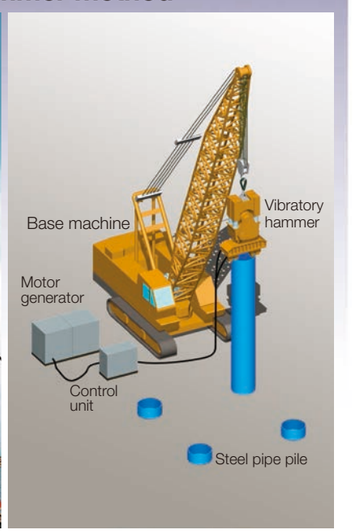
A construction method in which vibratory hammers are used to forcibly apply vibration to piles to temporality reduce pile shaft friction and edge indentation resistance during installation.

Vibratory hammer method

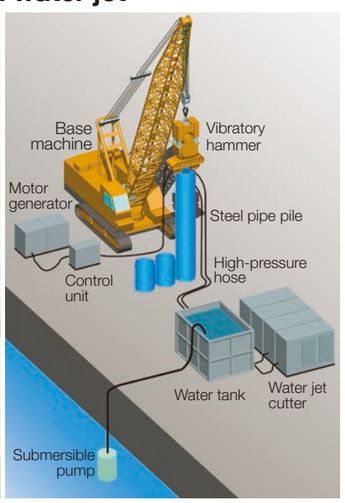
■Features

1. **High driving speed, excellent workability and economical efficiency**
2. **Crane work possible both on the ground and on the vessel**
3. **Combined with water jet, applicable for hard ground**
4. **No earth removal during construction work**

■Example of construction using the vibratory hammer method



■Example of construction using the vibratory hammer method combined with a water jet



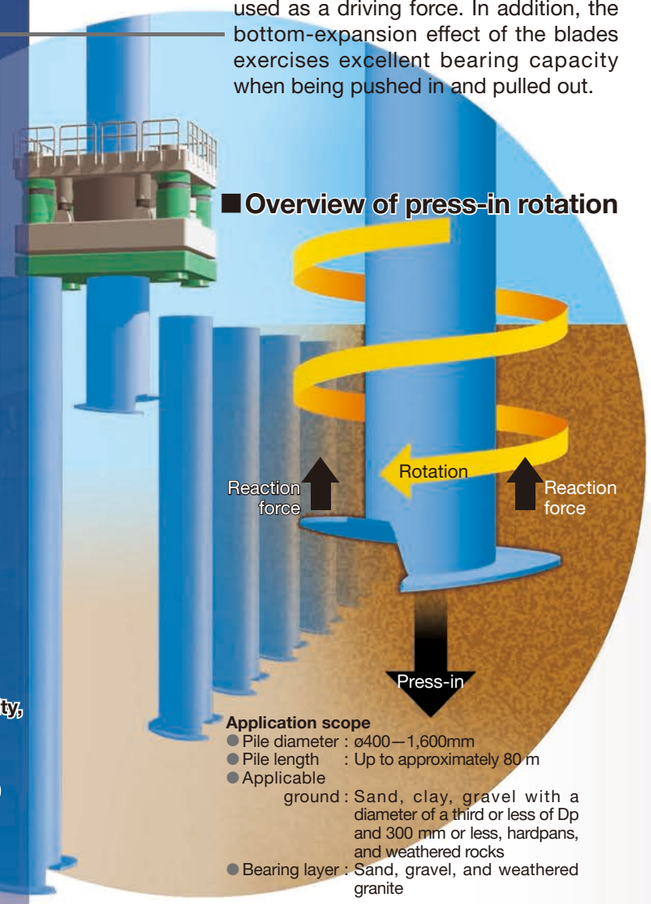
The NS ECO-PILE™ is a method in which steel pipes with helical blades installed at the tips are rotated and pressed in.

NS ECO-PILE™

Smooth penetration into the ground is possible by wedging the blades working to push up the soil and its reaction force used as a driving force. In addition, the bottom-expansion effect of the blades exercises excellent bearing capacity when being pushed in and pulled out.

■Design method

■Overview of press-in rotation



Application scope

- Pile diameter : ø400—1,600mm
- Pile length : Up to approximately 80 m
- Applicable ground : Sand, clay, gravel with a diameter of a third or less of Dp and 300 mm or less, hardpans, and weathered rocks
- Bearing layer : Sand, gravel, and weathered granite

■Features

1 Eco-friendly piling method

Low noise and low vibration, no waste soil, no ground pollution

2 High reliability and quality

Large bearing capacity and pulling resistance capacity, thanks to the helical blade

3 Highly applicable to severe construction conditions

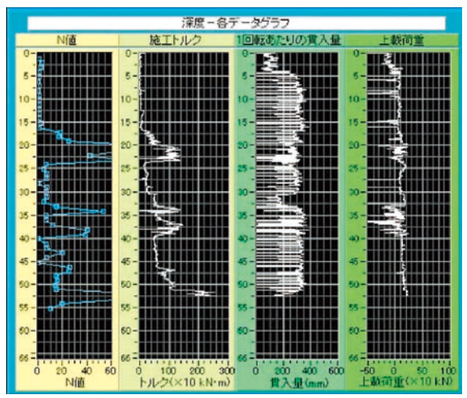
Small area, nearby existing structure, requirement for small foundations

■Construction method

In NS ECO-PILE™ construction, casing rotator, etc., are used. In construction management, the arrival of all piles to the bearing layer is checked based on construction torque. Construction torque is measured on a real-time basis using a construction management system.

● Example of construction

● Construction management system

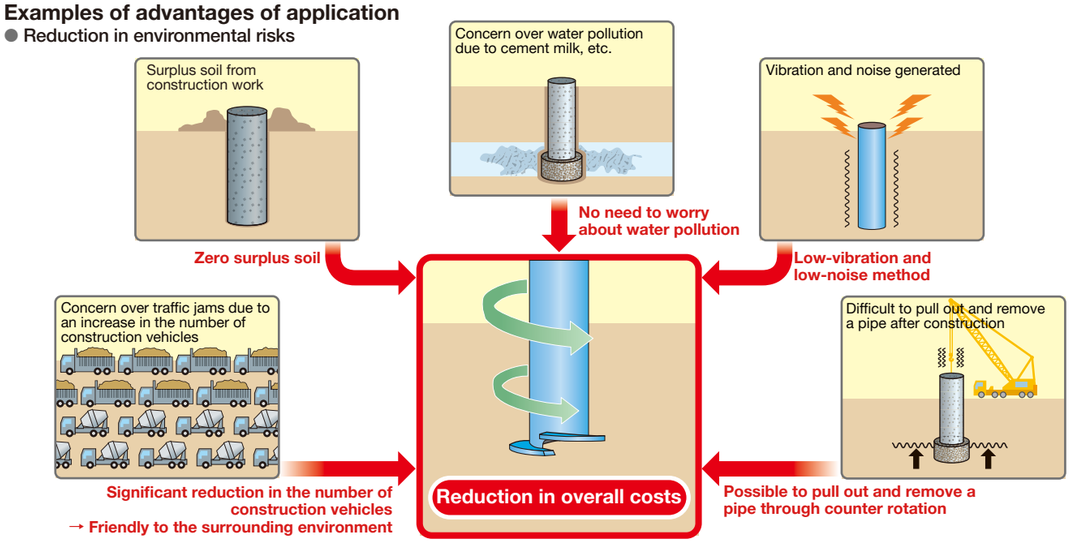


SPT-N | Torque | Installation time | Axial force

■Featuares

Examples of advantages of application

● Reduction in environmental risks



■Examples of applications

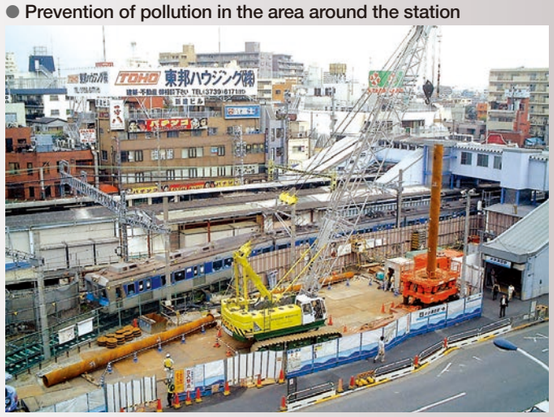
Possibility of work in a narrow area

● Construction close to road foundations

● Construction close to railway tracks

Prevention of pollution in the surrounding area

● Prevention of pollution in the area around the station



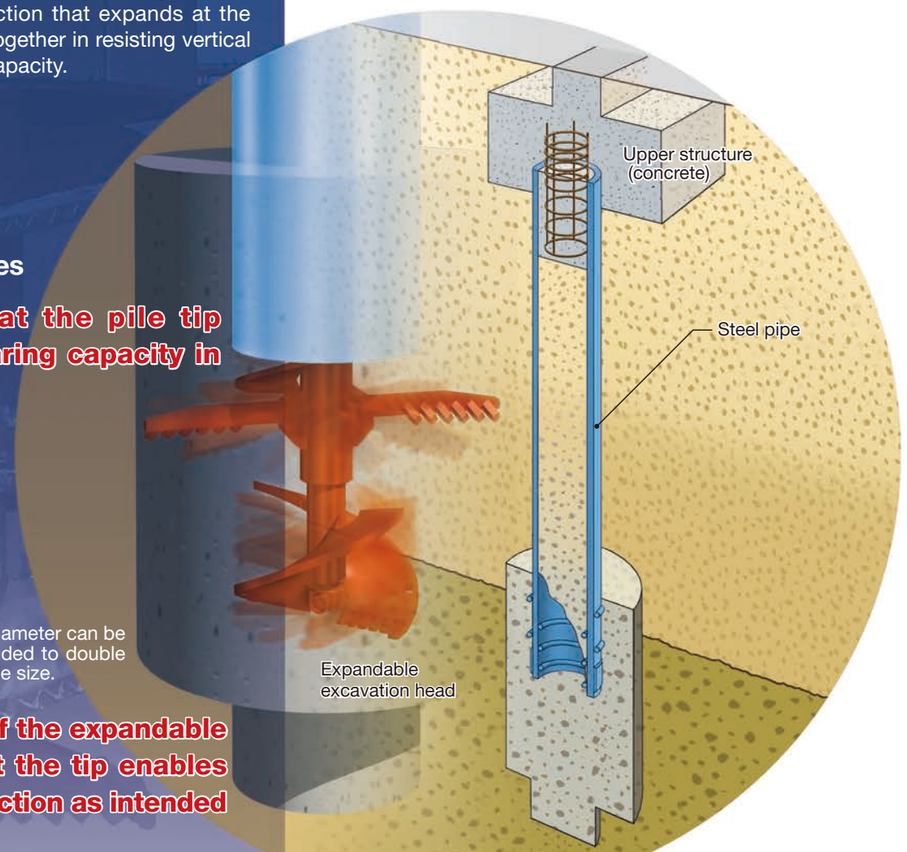
Cost reduction by using a batter pile

● Batter pile construction

Expanded foot protection steel pile method

TNX™ method

The TNX™ method is an environmentally friendly method in which a foot protection section that expands at the pile tip and a steel pipe work together in resisting vertical load, exercising high bearing capacity.



■Features & Advantages

1 Foot protection at the pile tip exercises high bearing capacity in a stable way.

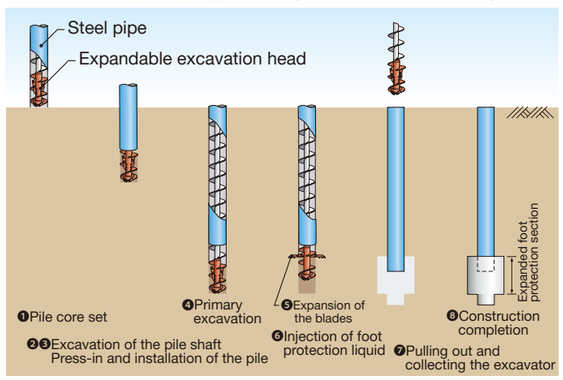
The diameter can be expanded to double the pile size.

2 Hydraulic control of the expandable excavation head at the tip enables a foot protection section as intended in the design.

3 A method of a steel pipe pile with expanded foot protection at the tip with low noise, low vibration, and less earth removal.

● Installation procedures

Simultaneous installation method (inner excavation method)

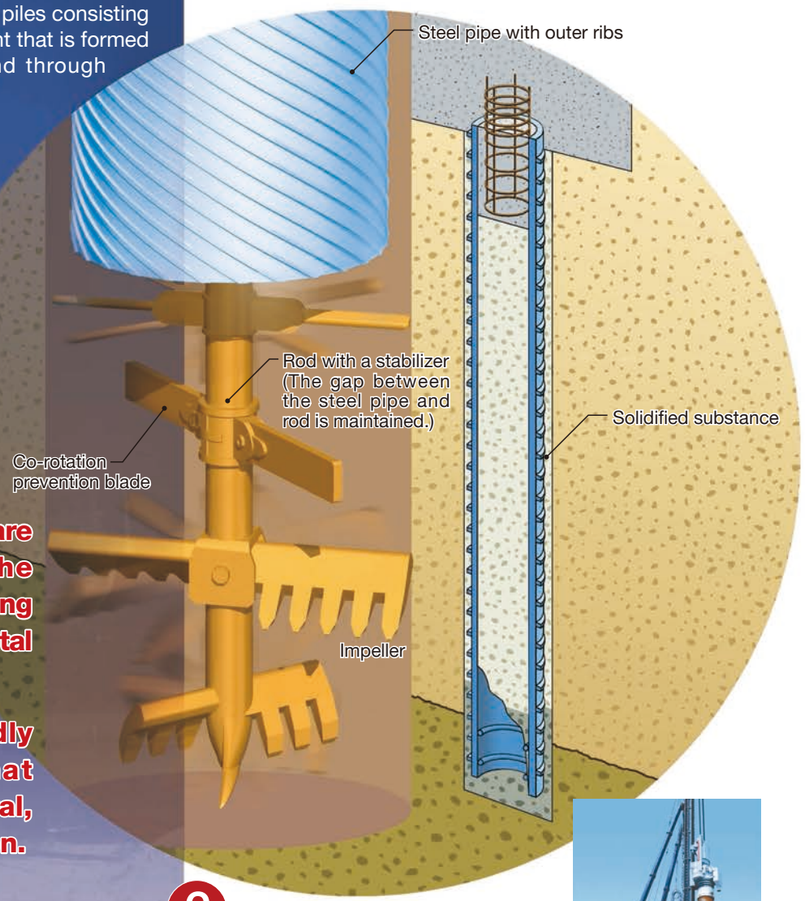


The composite piles that can be designed as friction piles

Gantetsu pile™

The Gantetsu pile™ (steel pipe-reinforced soil cement composite pile) method involves composite piles consisting of steel pipes with outer ribs and soil cement that is formed by pouring cement milk into ground and through mixing & agitation.

Example of formation at the tip of a pile
(A turned-up cut sample with a pile diameter of 1,400 mm and a steel pipe diameter of 1,000 mm)



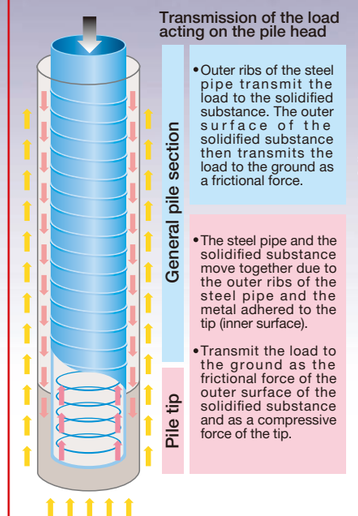
■Features & Advantages

1 Steel pipes with outer ribs are durably combined with the solidified substance, exercising excellent vertical and horizontal bearing capacity.

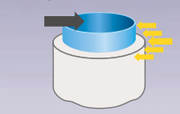
2 An environmentally friendly construction method that produces less earth removal, less noise, and less vibration.

1

● Vertical bearing capacity

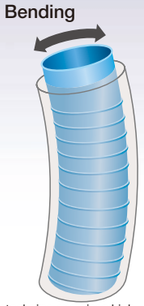


● Lateral resistance of pile



The horizontal load is transmitted to the ground via the solidified substance in the diameter range of the solidified substance.

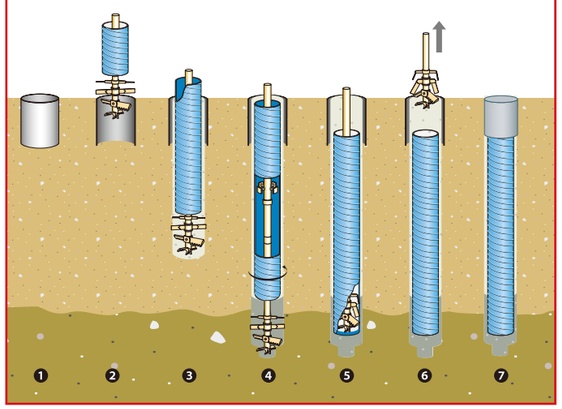
● Bending



A steel pipe exercises high toughness during an earthquake.

2

❶Mouth pipe set
❷Pile core set
❸Forming a solidified substance Embedding a steel pipe
❹Forming the tip
❺Fixing the steel pipe
❻Pulling out the rod and head.
❼Construction completion (Pulling out the mouth pipe.)

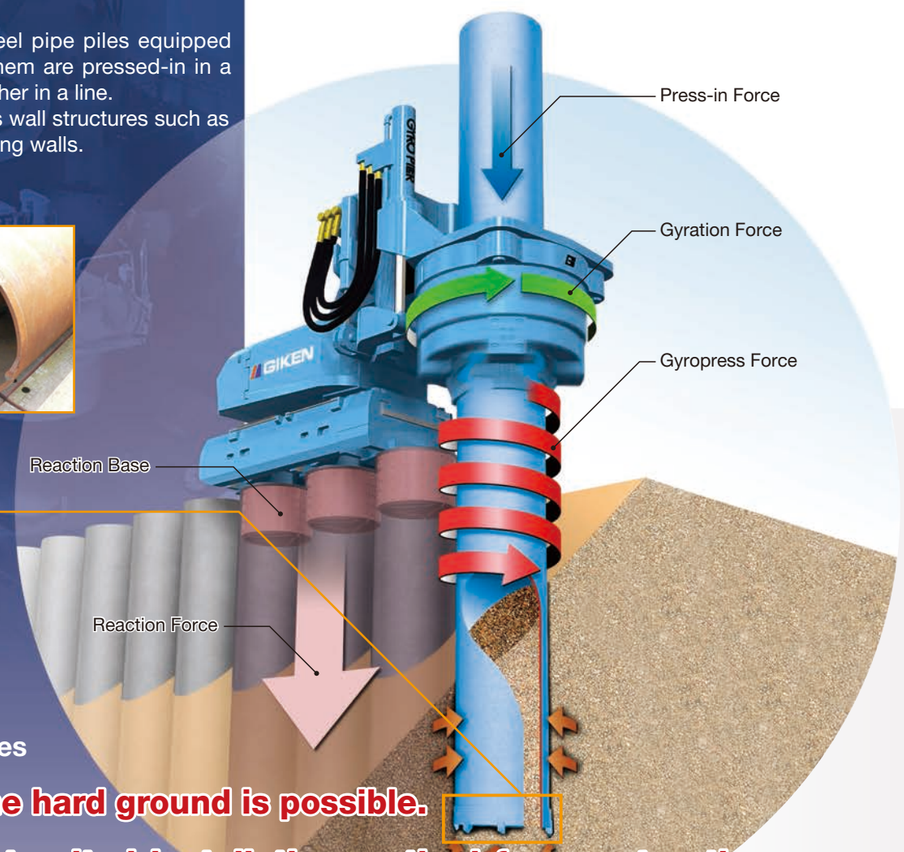


Railways & roads | Ports/ Harbors & rivers | Building foundations | Plant foundations

Self-walking rotary press-in method for tubular piles with tip bits

Gyropress method™

In the Gyropress method™, steel pipe piles equipped with cutting bits at the tip of them are pressed-in in a rotational manner one after another in a line.
This way, the method constructs wall structures such as river revetments and road retaining walls.



■Features & Advantages

1 A press fit to the hard ground is possible.

2 This is the best-suited installation method for construction sites without ample space, such as narrow ground areas and workspaces with limited overhead clearance.

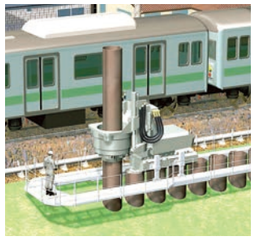
3 Rotary press-in is appropriate for construction under conditions in which vibration or noise needs to be suppressed.

1 A press-in to the hard ground is possible

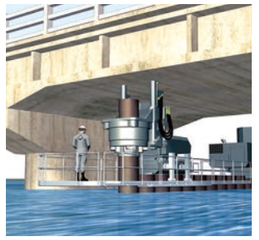
GYRO PILER

The bit attached at the tip can cut and penetrate the reinforcing steel bars of an existing reinforced concrete structure through rotationally press-in.

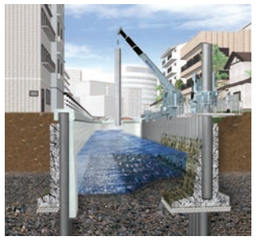
2 This is the best-suited installation method for construction sites without ample space, such as narrow ground areas and workspaces with limited overhead clearance.



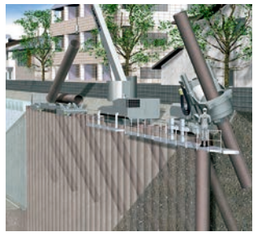
Safe installation method without the risk of toppling, etc.; installation close to existing structures is possible.



Easy installation at a place with limitation in overhead clearance.



Installation in a narrow area is possible because the machine is small in size.



A batter pile can be installed.

■Examples of applications

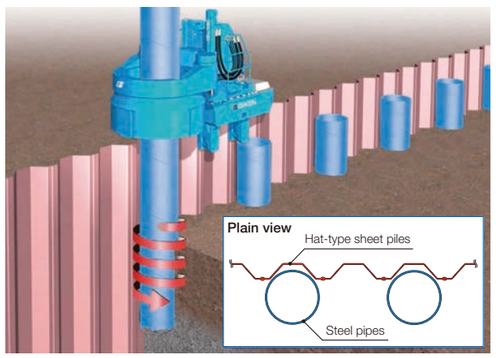
During the Press-in Work

After the Press-in Work

After Completion

■Combi Gyro

In the Combi Gyro method, the excellent workability of Gyropress method™ and Hat-type steel sheet piles with excellent water-shielding performance are combined, providing rational and highly economical wall structures.



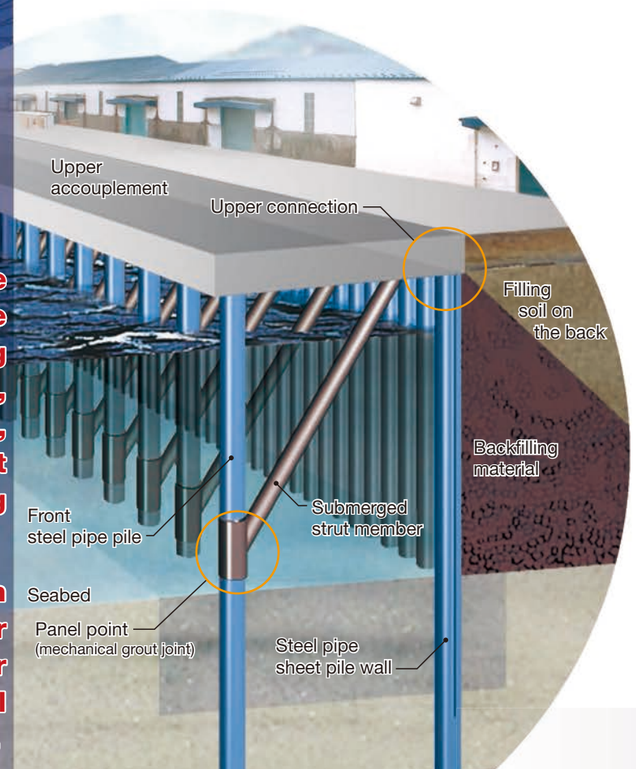
For Hat-type steel sheet piles, see our steel sheet piles brochure.

Gyropress method™ and Combi Gyro method have been developed by NIPPON STEEL and Giken Seisakusho Co.,Ltd.

The economical construction method using submerged strut members in the seawater

Submerged Strut method

In the submerged strut method, a foot protection-type rigid-frame structure consisting of steel pipe piles and steel pipe sheet piles is reinforced with submerged strut members in the seawater. The method can be applied to river revetments, quay walls, and breakwaters, etc.

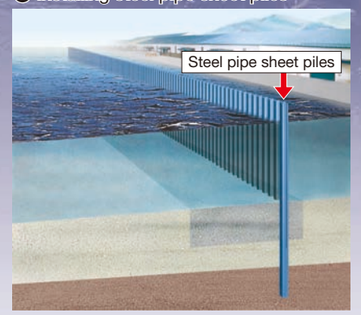


■Features

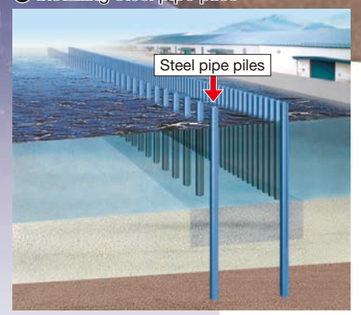
1 The improved performance of the structure makes it possible to reduce the number of piles used. Further, using the prefabricated structural members, reduced structure occupancy width, and reduction in the soil improvement area, speedy and space-saving construction is possible.

2 Applicable to construction in which quay walls are to be deepened or reinforced while facilities behind river revetments are left untouched, as well as to aseismic retrofitting of quay walls.

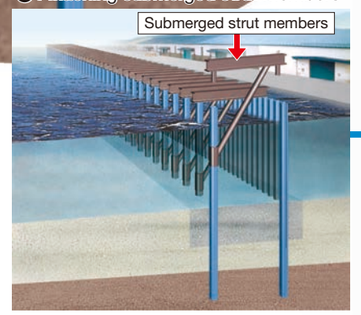
❶ Installing steel pipe sheet piles



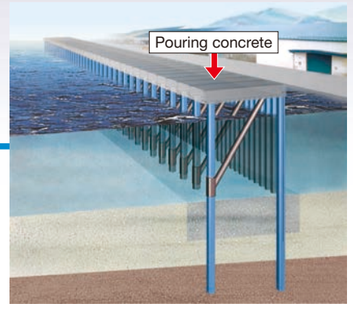
❷ Installing steel pipe piles



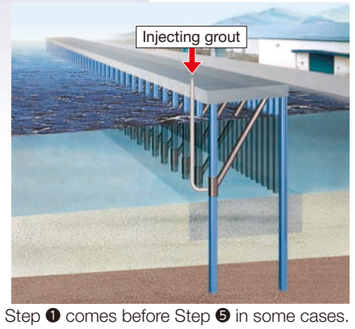
❸ Attaching submerged strut members



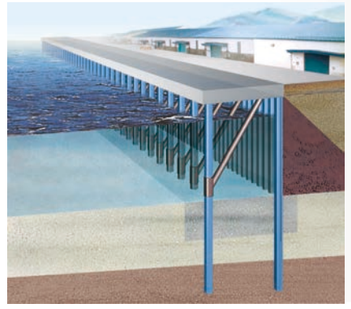
❹ Pouring concrete



❺ Injecting grout into panel points



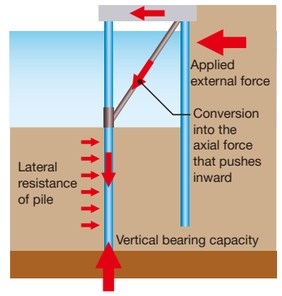
❻ Landfill and completion



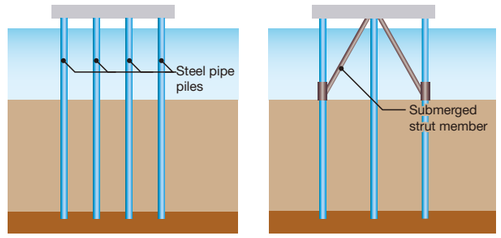
Step ❶ comes before Step ❺ in some cases.

1 Improved structure performance

- The placed diagonal member converts the horizontal external force into axial force.
- A rational structure that uses the ground's vertical and horizontal bearing capacity in an effective way.

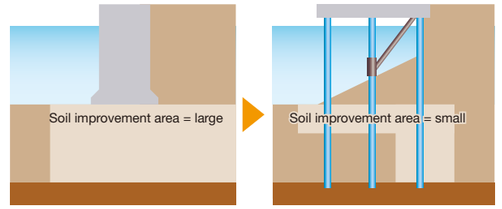


- Increase in earthquake-resistance enables applications in deep-water structures.
- The number of piles and the cross-sectional area of piles can be reduced.



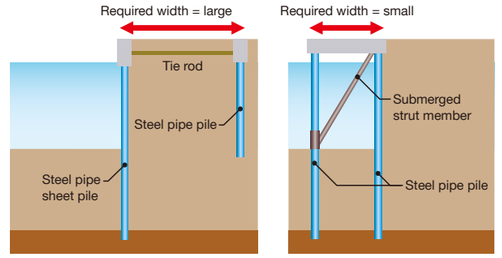
2 Speedy construction is possible

- A reduction in the number of piles and cross-sectional area improves construction efficiency.
- The use of members manufactured at factories simplifies construction work.
- Soil improvement can be omitted, or reduced.



Space-saving construction is possible

- Back retaining pile is not required, which reduces the structure occupancy width.



■Examples of applications

Improvement work of the quay wall in the central quay area of H port

-8m quay wall of M port

The method using vibratory hammers equipped with high-pressure water jets

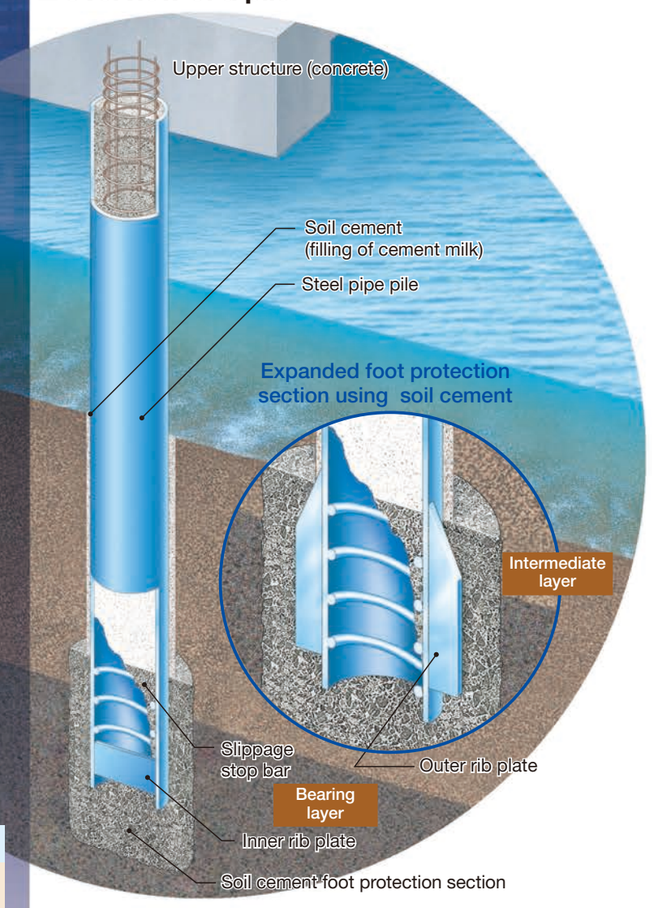
RS plus™

In the RS plus method, vibratory hammers equipped with high-pressure water jets are used. The method features excellent performance in excavating the ground and assists in driving piles securely into the bearing layer.

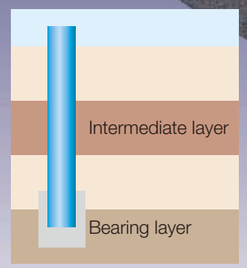
■Features

1. **Without supplementary construction methods, penetration through a hard intermediate layer and embedding in a hard bearing layer are possible, which can reduce construction costs and periods.**
2. **Bulbs constructed by cement milk injection at the pile tips can realize high bearing capacity. In addition, filling cement milk onto the sidewall of piles can realize stable horizontal resistance.**

■Overview of a pile




Example of an attached inner rib plate




Example of attached outer rib plates


Expanded foot protection bulb using the outer rib plates

■Examples of applications


Quay wall of the Port of Karatsu


Elevator tower of the Shinminato Ohashi of the Port of Fushiki-Toyama


Harbor line of the Port of Iwakuni

RS plus method has been developed by Independent Administrative Institution Port and Airport Research Institute(PARI), NIPPON STEEL and Chowa Kogyo Co.,Ltd.

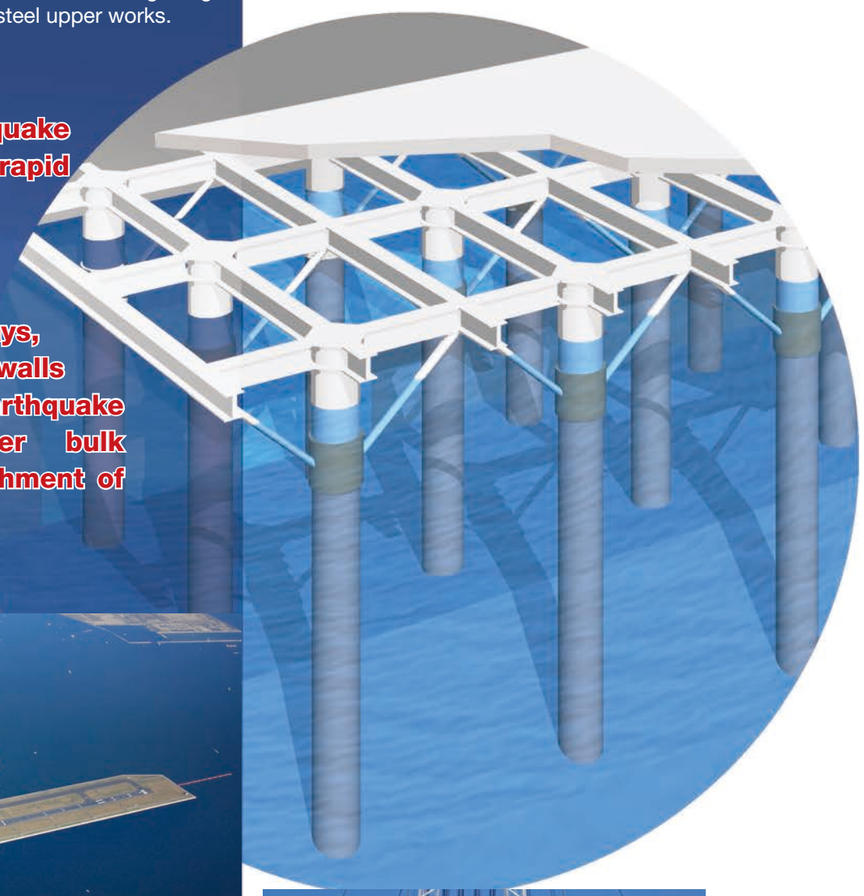
The method to make construction speedy

Jacket technology

Jacket piers and seawalls are offshore structures integrating pipe and tube truss foundations and steel upper works.

■Features

1. **Have superior earthquake resistance and enable rapid construction with prefabrication.**
2. **Applicable to artificial ground bases for runways, container wharves, seawalls designed to improve earthquake resistance, deep-water bulk piers, and the refurbishment of deteriorating piers.**



■Examples of applications


View of Haneda Airport


Jacket for taxiway of Runway D at Haneda Airport


Seawall(-16m) jacket at Tobishima Warf, Nagoya port

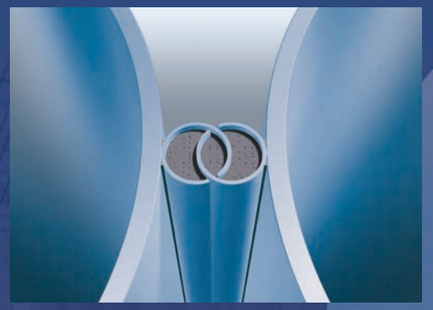

Jacket for pier at Runway D of Haneda Airport


Beakwater at Uramoto fishing port

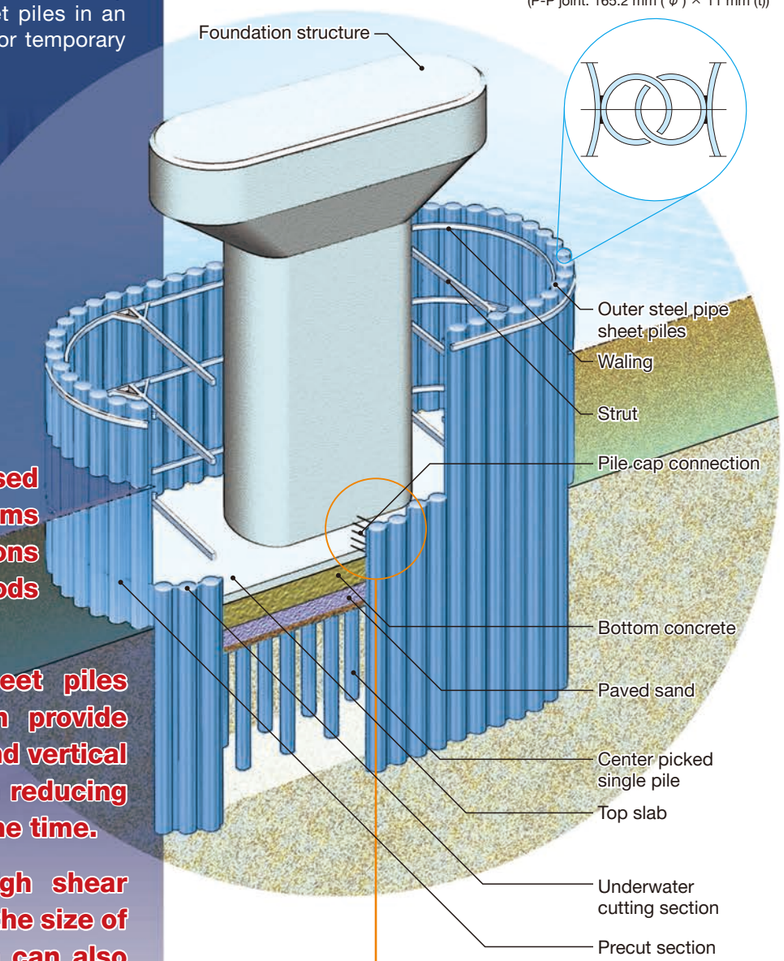
Foundations can be used both for temporary cofferdams and for permanent foundations

Steel Pipe Sheet Pile Foundation

A steel pipe sheet pile foundation is constructed by combining and installing steel pipe sheet piles in an enclosure shape. This can also be used for temporary cofferdams.



Example of the shape of a steel pipe sheet pile joint
(P-P joint: 165.2 mm (ϕ) × 11 mm (t))



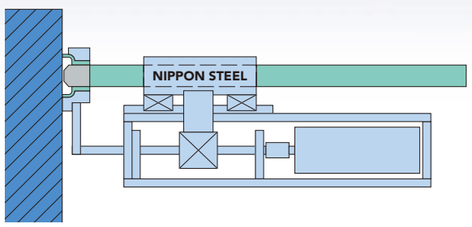
■Features

1. **Foundations possible to be used both for temporary cofferdams and for permanent foundations can reduce construction periods and costs.**
2. **A group of steel pipe sheet piles moves together, which can provide high horizontal resistance and vertical bearing capacity, along with reducing the occupied area at the same time.**
3. **Using the interlocks of high shear strength can further reduce the size of foundations. The foundation can also be used for aseismic retrofitting of bridges.**

■Connection between Top Slab and Steel Pipe Sheet Pile

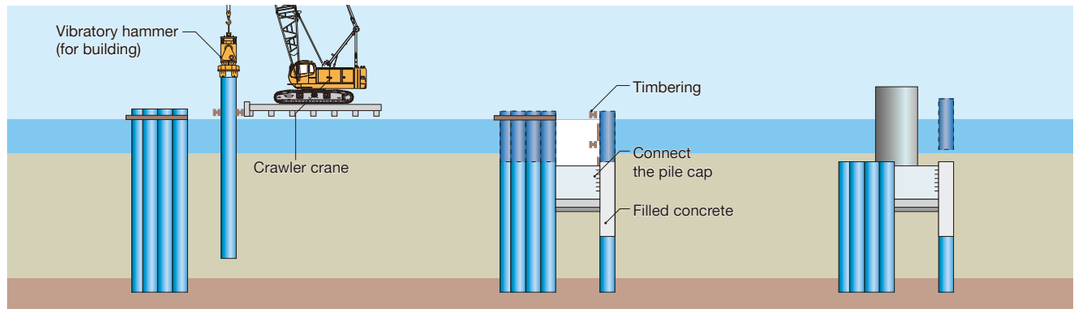
●NS Studs

NS stud method has achieved full penetration welding of long and large-diameter deformed rebar to steel tubes with automatic welding. This was previously assumed to be impossible with conventional stud installation.



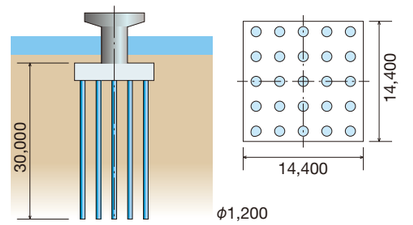
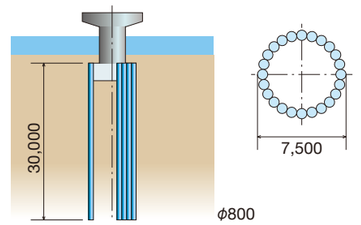
1 Foundations can be used both for temporary cofferdams and for permanent foundations

①Installing steel pipe sheet piles using various methods, such as vibratory hammering and inner excavation　②Constructing the pile cap and inner excavation　③Removing the temporary cofferdam



2 Reduction in the occupied area

Steel pipe sheet pile foundations are more rigid than pile foundations. The size of foundations can be reduced, which in turn reduces earth removal by construction and construction period.

	Cast-in-place pile	Steel pipe sheet pile foundation
Shape drawing		
Foundation area	207.4m^2	44.2m^2
Occupancy area	Foundation area + temporary cofferdam area	Foundation area

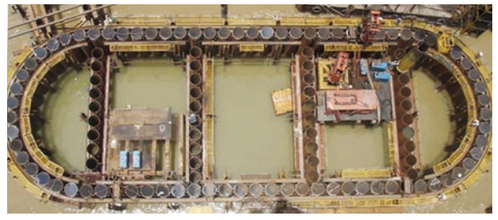
※ Trial calculation by us.

3 Using interlocks of high shear strength can reduce the size of foundations

If the shape of foundations is determined depending on displacement, using interlocks with high shear capacity can reduce the size of planes.

Item	Conventional interlock	High-stress-resistant interlock made from steel pipes with lattice pattern projections
		

■Examples of applications



Nhat Tan Bridge in Vietnam
Photo provided by Sumitomo Mitsui Construction Co., Ltd

Appling this junction realize steel weight 35% less compared to normal-type junctions in Tokyo gate bridge project

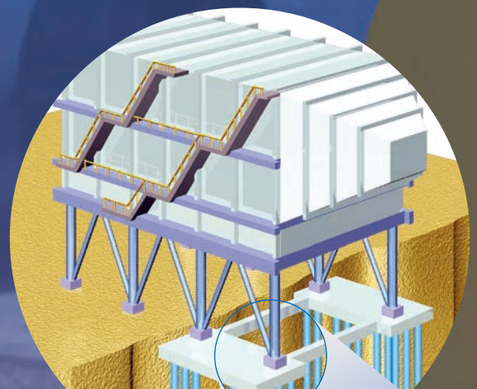
Perspective of Tokyo Gate Bridge
©Bureau of Port and Harbor, Tokyo Metropolitan Government

The method that upper structures are directly connected to the foundations.

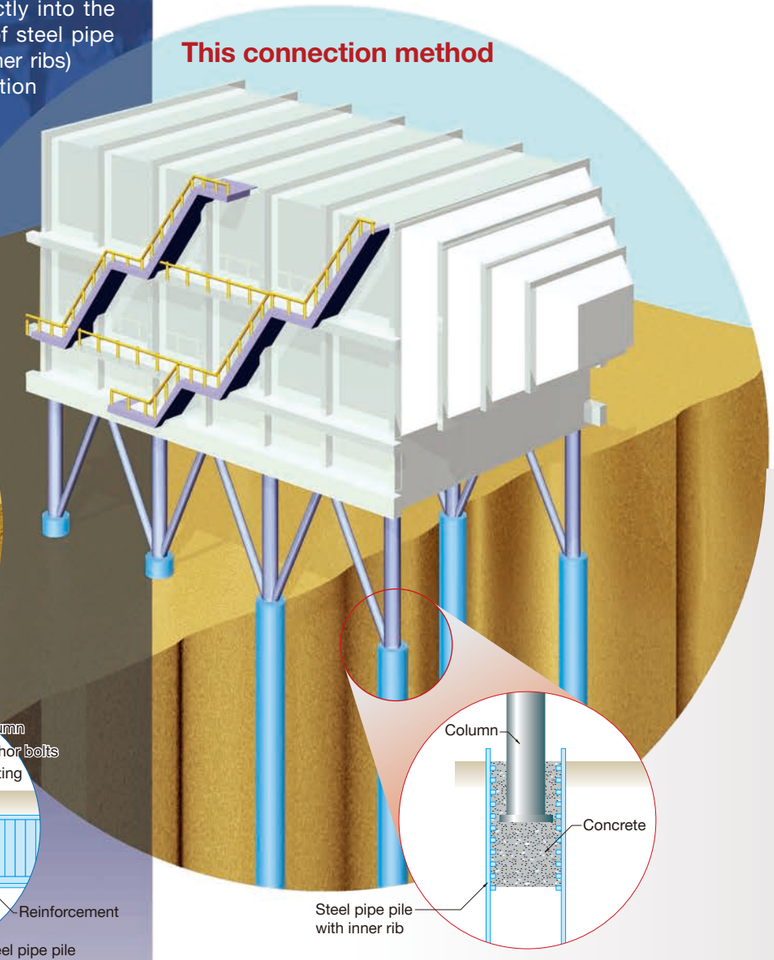
Sat-in Pile Foundation

A sat-in pile foundation involves a method in which the pillars of the buildings are driven directly into the foundation piles for which a special type of steel pipe pile with projections in the inner surface (inner ribs) is used, sothat the pillars and the foundation piles are connected.

This connection method

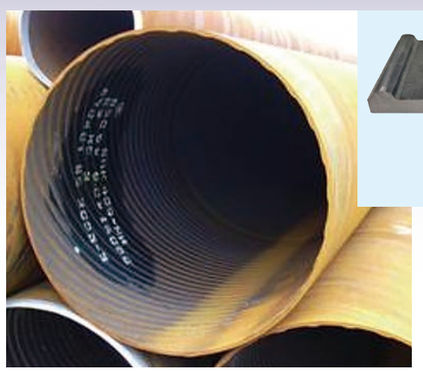


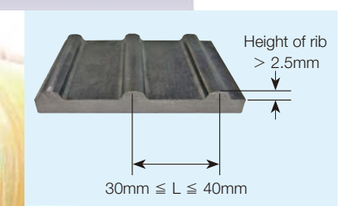
Conventional method



1

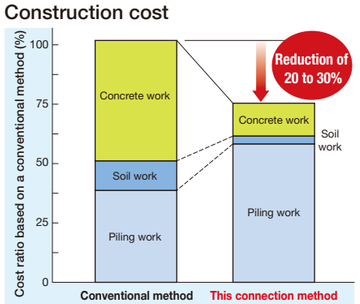
This connecting method can eliminate the need to make a footing and reduces earth removal by utilizing a small number of large-diameter piles using rib pipes.





Comparison to a conventional footing

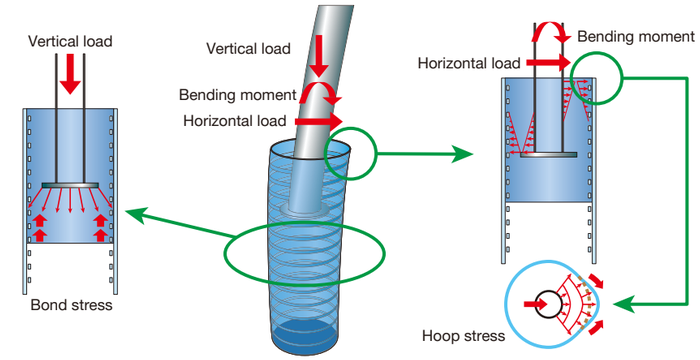
- Construction period
  Reduction of around 30 to 40% (less concrete work)
- Construction cost

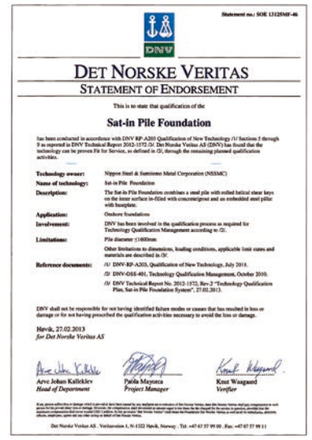


※ Trial calculation by us.

2

A design method has been established in which the load transmitted from the upper pedestal is transmitted to the pile via projections inside the steel pipe. Certification has been obtained both in Japan and overseas.





DET NORSKE VERITAS
STATEMENT OF ENDORSEMENT

This is to state that qualification of the

Sat-in Pile Foundation

has been conducted in accordance with DNV RP-A203 Qualification of New Technology (1/ Sections 1 through 9 as reported in DNV Technical Report 2012-1372 /2/. Det Norske Veritas AS (DNV) has found that the technology can be proven Fit for Service, as defined in /2/, through the remaining planned qualification activities.

Technology owner:	Nippon Steel & Sumitomo Metal Corporation (NSSMC)
Name of technology:	Sat-in Pile Foundation
Description:	The Sat-in Pile Foundation combines a steel pile with rolled helical shear keys on the inner surface in-filled with concrete/grout and an embedded steel pillar with baseplate.
Application:	Onshore foundations
Involvement:	DNV has been involved in the qualification process as required for Technology Qualification Management according to /2/.
Limitations:	Pile diameter ≤1600mm Other limitations to dimensions, loading conditions, applicable limit states and materials are described in /2/.
Reference documents:	/1/ DNV RP-A203, Qualification of New Technology, July 2010. /2/ DNV-OSS-401, Technology Qualification Management, October 2010. /3/ DNV Technical Report No. 2012-1372, Rev.2 "Technology Qualification Plan, Sat-in Pile Foundation System", 27.02.2013.

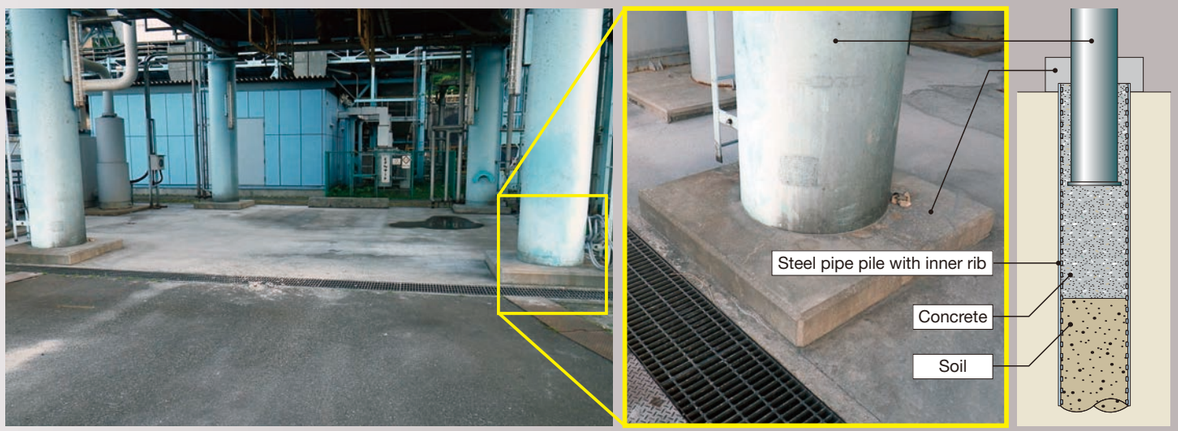
DNV shall not be responsible for not having identified failure modes or causes that has resulted in loss or damage or for not having prescribed the qualification activities necessary to avoid the loss or damage.

Høvik, 27.02.2013
for Det Norske Veritas AS

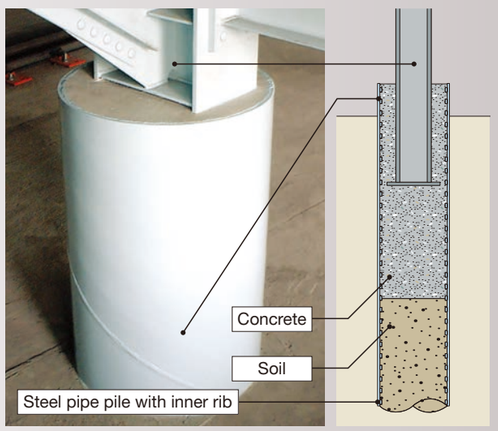
Arve Johan Kallekleiv, *Head of Department* — Paola Mayorca, *Project Manager* — Knut Wangsnes, *Verifier*

DNV Technology Qualification

■Examples of applications



NIPPON STEEL Kamaishi Works



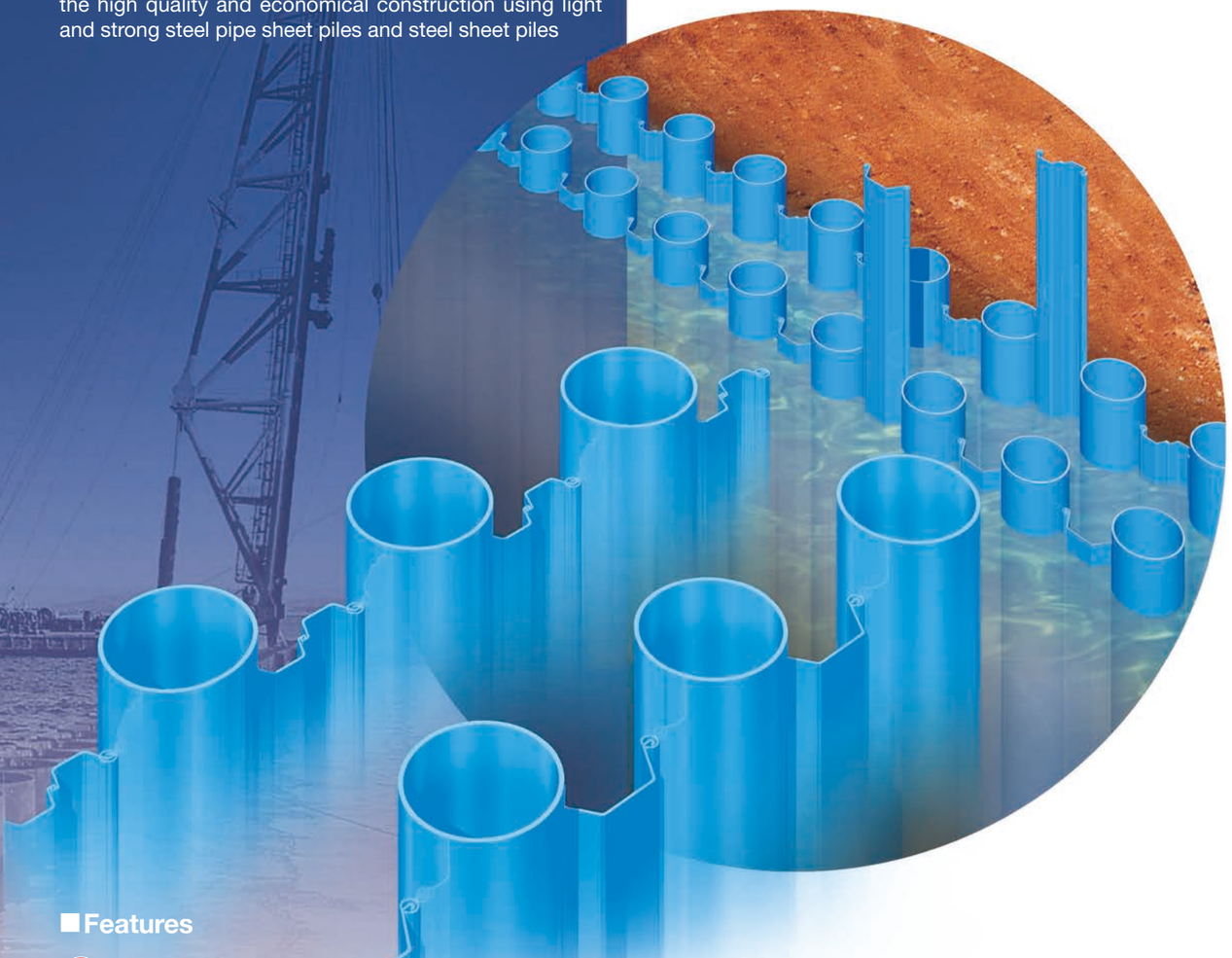
NIPPON STEEL Nagoya Works

ICHTHYS LNG PROJECT in Australia

Steel pipe sheet piles function both as supporting piles for vertical load and retaining walls.

Combined Wall

Our combined wall for large quay wall etc is able to realize the high quality and economical construction using light and strong steel pipe sheet piles and steel sheet piles



Features

1 Excellent cost-effectiveness

Combined walls come in combination of U-type/Hat-type sheet piles which have seven types and steel pipe sheet piles which have many types. Eventually they provide more than 74 types of economical properties.
(Section modulus per meter of wall : over 20,000 cm^3/m)

2 High drivability

Easy threading of large interlocks realizes quick and high-quality construction.

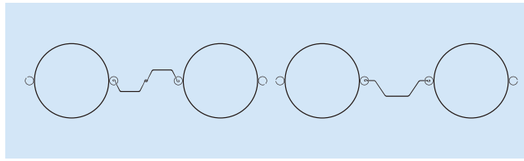
3 High quality

Using NIPPON STEEL's piles ensures high quality, high strength and high stiffness.

4 Function to support vertical loads

Steel pipe sheet piles function both as supporting piles for vertical load and as retaining walls.

Shapes

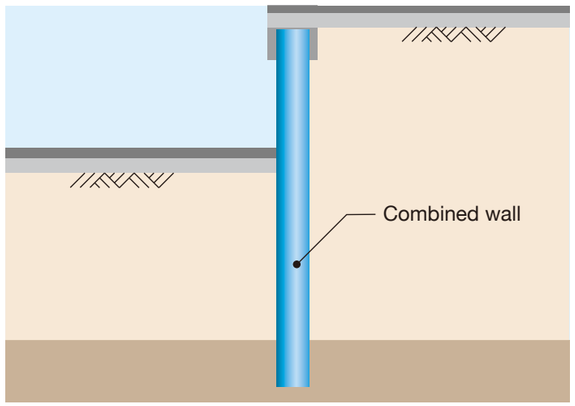


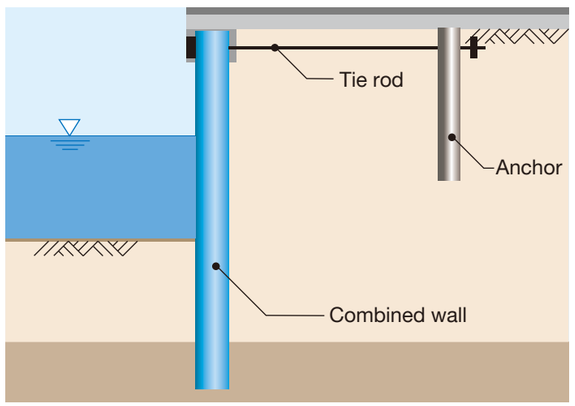
Steel pipe sheet piles	+	Sheet piles
(ϕ 800 to ϕ 2,000)		NS-SP- Ⅱw (2pieces)
		NS-SP- Ⅲw (2pieces)
		NS-SP- Ⅳw (2pieces)
		NS-SP-10H (1piece)
		NS-SP-25H (1piece)
		NS-SP-45H (1piece)
		NS-SP-50H (1piece)

- Joint thickness is 9mm or 11mm.
- Please contact us for material quality of steel pipe sheet pile.

Examples of application

- Quay walls of port facilities and shipyard dock walls
- Earth-retaining walls for high embankments



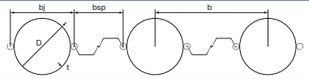


Installation method

- Vibratory hammer and hydraulic hammer are also available for installation.

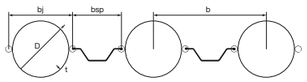
Sectional properties

Other sizes are available upon request.



■Steel pipe sheet pile + NS-SP-Ⅲw (2pieces)

Steel pipe sheet pile						Steel sheet pile					Combined wall			
Diameter	Thickness	Interval of joint	Moment of inertia	Pipe weight	Joint weight	Type	Number of sheet piles	Width	Moment of inertia	Pile weight	Width	Moment of inertia	Section modulus	Unit mass
D(mm)	t(mm)	bj(mm)	(cm⁴/pile)	(kg/m/pile)	kg/m/2piles			bsp(mm)	(cm⁴/bsp)	(kg/m/2piles)	(mm)	(cm⁴/m)	(cm³/m)	(kg/m/m)
800	9.0	965	174,940	176	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,165	98,753	2,469	189
813	9.0	978	183,707	178	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,178	102,188	2,514	189
864	10.0	1,029	244,621	211	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,229	127,176	2,944	199
900	10.0	1,065	276,876	219	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,265	139,394	3,098	200
914	11.0	1,079	318,112	245	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,279	156,630	3,427	210
965	11.0	1,130	375,107	259	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,330	177,662	3,682	211
1,000	11.0	1,165	417,922	268	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,365	193,135	3,863	212
1,016	12.0	1,181	476,985	297	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,381	216,641	4,265	222
1,067	12.0	1,232	553,420	312	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,432	243,524	4,565	224
1,100	13.0	1,265	655,774	348	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,465	281,784	5,123	236
1,118	13.0	1,283	688,890	354	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,483	293,078	5,243	236
1,168	13.0	1,333	786,691	370	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,533	325,900	5,580	238
1,200	14.0	1,365	917,281	409	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,565	372,743	6,212	250
1,219	14.0	1,384	962,072	416	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,584	387,335	6,355	251
1,270	14.0	1,435	1,089,459	434	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,635	428,180	6,743	253
1,300	15.0	1,465	1,250,028	475	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,665	483,606	7,440	266
1,321	15.0	1,486	1,312,315	483	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,686	503,013	7,616	266
1,372	16.0	1,537	1,566,821	535	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,737	586,622	8,551	280
1,400	16.0	1,565	1,665,889	546	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,765	616,509	8,807	282
1,422	16.0	1,587	1,746,594	555	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,787	640,598	9,010	283
1,473	17.0	1,638	2,060,877	610	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,838	739,820	10,045	297
1,500	17.0	1,665	2,177,656	622	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,865	773,606	10,315	298
1,524	17.0	1,689	2,285,093	632	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,889	804,365	10,556	299
1,575	18.0	1,740	2,668,433	691	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,940	920,792	11,693	314
1,600	18.0	1,765	2,799,033	702	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,965	957,073	11,963	315
1,626	18.0	1,791	2,939,307	714	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	2,991	995,650	12,247	316
1,676	19.0	1,841	3,394,987	776	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,041	1,129,116	13,474	332
1,700	19.0	1,865	3,544,640	788	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,065	1,169,098	13,754	333
1,727	19.0	1,892	3,718,184	800	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,092	1,215,013	14,071	334
1,778	20.0	1,943	4,267,787	867	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,143	1,370,154	15,412	350
1,800	20.0	1,965	4,430,010	878	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,165	1,411,882	15,688	351
1,829	21.0	1,994	4,874,533	936	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,194	1,538,230	16,820	366
1,880	21.0	2,045	5,298,742	963	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,245	1,644,774	17,498	368
1,900	21.0	2,065	5,471,593	973	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,265	1,687,637	17,765	369
1,930	22.0	2,095	6,001,716	1,035	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,295	1,833,150	18,996	385
1,981	22.0	2,146	6,495,920	1,063	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,346	1,952,902	19,716	387
2,000	22.0	2,165	6,686,751	1,073	69.4	NS-SP-Ⅲw	2	1,200	38,880	163	3,365	1,998,583	19,986	388



■Steel pipe sheet pile + NS-SP-10H (1piece)

Steel pipe sheet pile						Steel sheet pile					Combined wall			
Diameter	Thickness	Interval of joint	Moment of inertia	Pipe weight	Joint weight	Type	Number of sheet piles	Width	Moment of inertia	Pile weight	Width	Moment of inertia	Section modulus	Unit mass
D(mm)	t(mm)	bj(mm)	(cm⁴/pile)	(kg/m/pile)	kg/m/2piles			bsp(mm)	(cm⁴/bsp)	(kg/m/pile)	(mm)	(cm⁴/m)	(cm³/m)	(kg/m/m)
800	9.0	965	174,940	176	69.4	NS-SP-10H	1	900	9,450	86	1,865	98,858	2,471	178
813	9.0	978	183,707	178	69.4	NS-SP-10H	1	900	9,450	86	1,878	102,841	2,530	178
864	10.0	1,029	244,621	211	69.4	NS-SP-10H	1	900	9,450	86	1,929	131,697	3,049	190
900	10.0	1,065	276,876	219	69.4	NS-SP-10H	1	900	9,450	86	1,965	145,698	3,238	191
914	11.0	1,079	318,112	245	69.4	NS-SP-10H	1	900	9,450	86	1,979	165,502	3,621	202
965	11.0	1,130	375,107	259	69.4	NS-SP-10H	1	900	9,450	86	2,030	189,418	3,926	204
1,000	11.0	1,165	417,922	268	69.4	NS-SP-10H	1	900	9,450	86	2,065	206,940	4,139	205
1,016	12.0	1,181	476,985	297	69.4	NS-SP-10H	1	900	9,450	86	2,081	233,728	4,601	218
1,067	12.0	1,232	553,420	312	69.4	NS-SP-10H	1	900	9,450	86	2,132	263,985	4,948	219
1,100	13.0	1,265	655,774	348	69.4	NS-SP-10H	1	900	9,450	86	2,165	307,234	5,586	233
1,118	13.0	1,283	688,890	354	69.4	NS-SP-10H	1	900	9,450	86	2,183	319,870	5,722	234
1,168	13.0	1,333	786,691	370	69.4	NS-SP-10H	1	900	9,450	86	2,233	356,502	6,104	236
1,200	14.0	1,365	917,281	409	69.4	NS-SP-10H	1	900	9,450	86	2,265	409,117	6,819	250
1,219	14.0	1,384	962,072	416	69.4	NS-SP-10H	1	900	9,450	86	2,284	425,323	6,978	250
1,270	14.0	1,435	1,089,459	434	69.4	NS-SP-10H	1	900	9,450	86	2,335	470,584	7,411	252
1,300	15.0	1,465	1,250,028	475	69.4	NS-SP-10H	1	900	9,450	86	2,365	532,504	8,192	267
1,321	15.0	1,486	1,312,315	483	69.4	NS-SP-10H	1	900	9,450	86	2,386	553,920	8,386	268
1,372	16.0	1,537	1,566,821	535	69.4	NS-SP-10H	1	900	9,450	86	2,437	646,755	9,428	283
1,400	16.0	1,565	1,665,889	546	69.4	NS-SP-10H	1	900	9,450	86	2,465	679,596	9,709	285
1,422	16.0	1,587	1,746,594	555	69.4	NS-SP-10H	1	900	9,450	86	2,487	706,033	9,930	286
1,473	17.0	1,638	2,060,877	610	69.4	NS-SP-10H	1	900	9,450	86	2,538	815,668	11,075	302
1,500	17.0	1,665	2,177,656	622	69.4	NS-SP-10H	1	900	9,450	86	2,565	852,607	11,368	303
1,524	17.0	1,689	2,285,093	632	69.4	NS-SP-10H	1	900	9,450	86	2,589	886,198	11,630	304
1,575	18.0	1,740	2,668,433	691	69.4	NS-SP-10H	1	900	9,450	86	2,640	1,014,273	12,880	321
1,600	18.0	1,765	2,799,033	702	69.4	NS-SP-10H	1	900	9,450	86	2,665	1,053,761	13,172	322
1,626	18.0	1,791	2,939,307	714	69.4	NS-SP-10H	1	900	9,450	86	2,691	1,095,703	13,477	323
1,676	19.0	1,841	3,394,987	776	69.4	NS-SP-10H	1	900	9,450	86	2,741	1,241,951	14,820	340
1,700	19.0	1,865	3,544,640	788	69.4	NS-SP-10H	1	900	9,450	86	2,765	1,285,292	15,121	341
1,727	19.0	1,892	3,718,184	800	69.4	NS-SP-10H	1	900	9,450	86	2,792	1,335,017	15,461	342
1,778	20.0	1,943	4,267,787	867	69.4	NS-SP-10H	1	900	9,450	86	2,843	1,504,374	16,922	360
1,800	20.0	1,965	4,430,010	878	69.4	NS-SP-10H	1	900	9,450	86	2,865	1,549,442	17,216	361
1,829	21.0	1,994	4,874,533	936	69.4	NS-SP-10H	1	900	9,450	86	2,894	1,687,507	18,453	377
1,880	21.0	2,045	5,298,742	963	69.4	NS-SP-10H	1	900	9,450	86	2,945	1,802,320	19,174	380
1,900	21.0	2,065	5,471,593	973	69.4	NS-SP-10H	1	900	9,450	86	2,965	1,848,456	19,457	381
1,930	22.0	2,095	6,001,716	1,035	69.4	NS-SP-10H	1	900	9,450	86	2,995	2,006,933	20,797	398
1,981	22.0	2,146	6,495,920	1,063	69.4	NS-SP-10H	1	900	9,450	86	3,046	2,135,569	21,561	400
2,000	22.0	2,165	6,686,751	1,073	69.4	NS-SP-10H	1	900	9,450	86	3,065	2,184,589	21,846	401

※Please contact us for sectional properties after corrosion. ※In this case, length of steel pipe sheet pile and sheet pile are same.

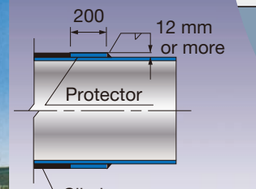
Railways & roads | Ports/ Harbors & rivers | Building foundations | Plant foundations

Ensure a reduction of negative friction in soft ground.

Slip Layer Pipe Pile

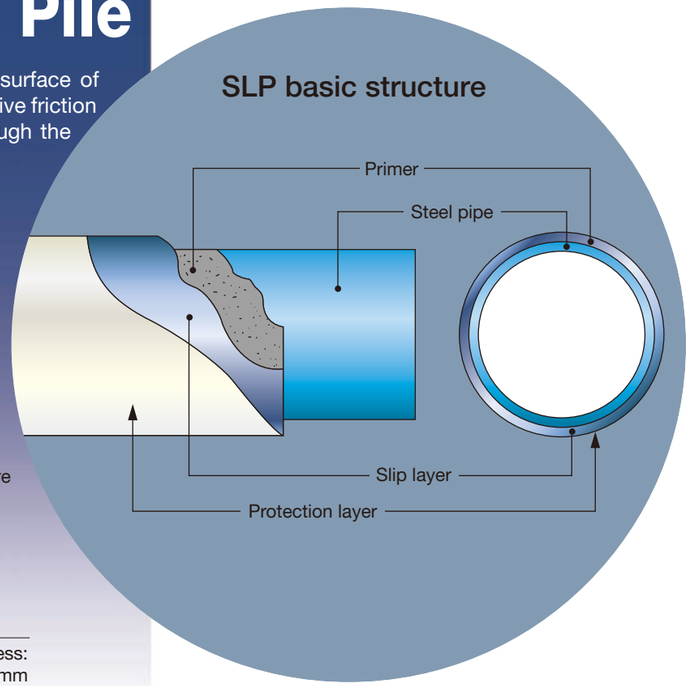
Special bitumen materials are applied to the surface of steel pipe piles to significantly reduce the negative friction that is transmitted to the steel pipe piles through the shearing deformation of slip layers.

Detail drawing of a protector



application thickness: approximately 6 mm

SLP basic structure



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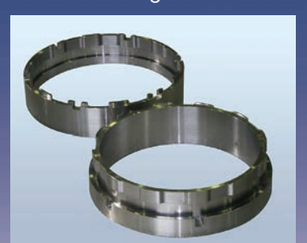
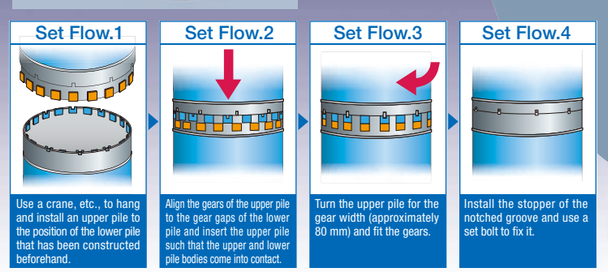
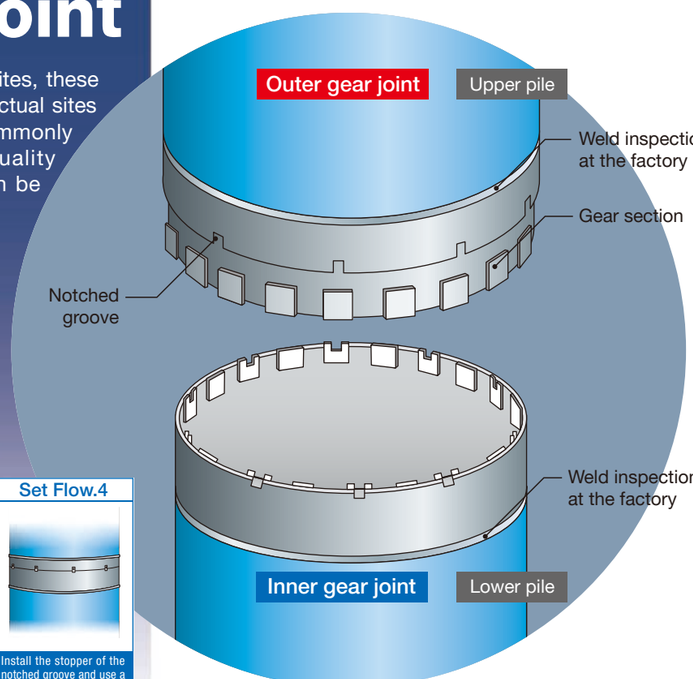
Ensure joint quality, reduces construction period and workloads, and makes all-weather construction possible.

Mechanical Joint

For the vertical joint of piles at construction sites, these joints can reduce the construction period at actual sites compared to that of weld joint, which is commonly used. In addition, products with stable quality are ensured by factory production. They can be constructed regardless of weather.

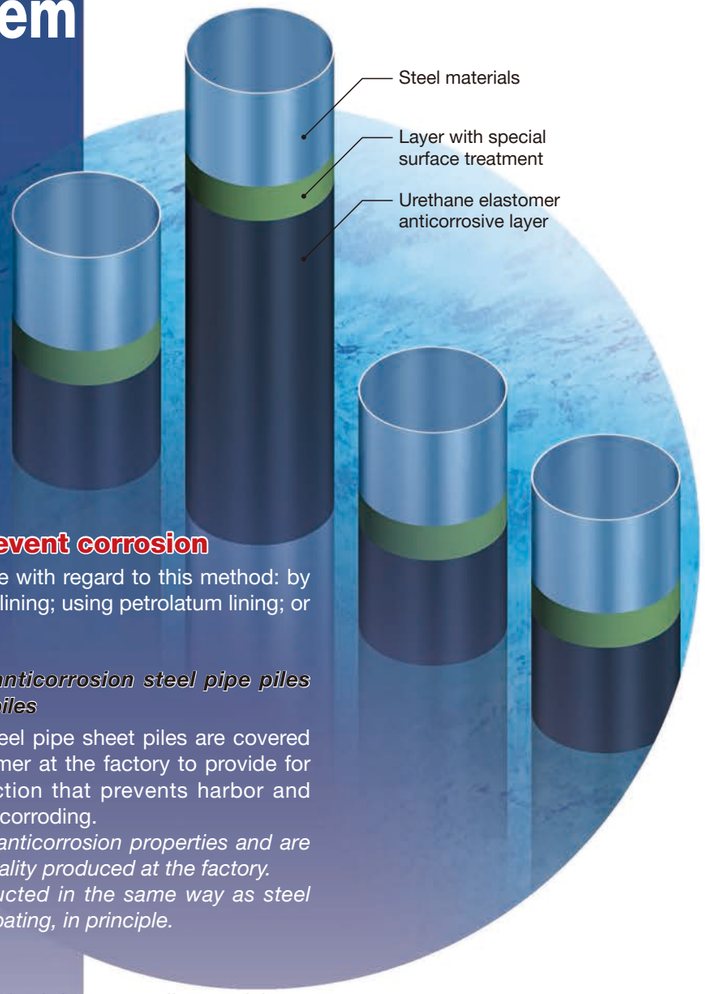






Anticorrosion System

The following methods are available to prevent the corrosion of steel pipe piles



1 Designing the steel pipe pile considering corrosion allowance

A method in which thickness equal to the allowable quantity of the corrosion in steel materials during the service life of structures as a corrosion margin.

2 Cladding concrete to prevent corrosion

A method in which concrete or mortar is cladded around the surface of steel materials.

3 Coating the steel pipe piles to prevent corrosion

Four types are available with regard to this method: by painting; using organic lining; using petrolatum lining; or using inorganic lining

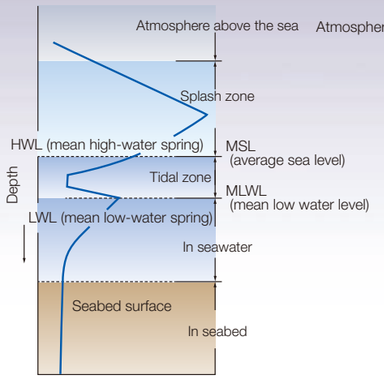
Examples of heavy anticorrosion steel pipe piles and steel pipe sheet piles

Steel pipe piles and steel pipe sheet piles are covered with a urethane elastomer at the factory to provide for an anti-corrosive function that prevents harbor and marine structures from corroding.

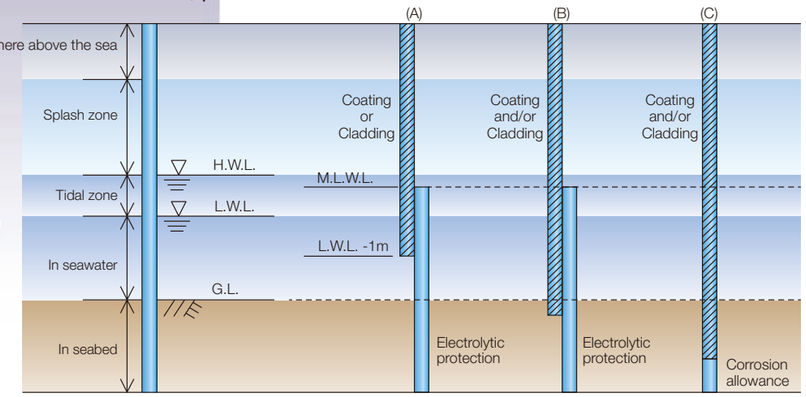
- *They have excellent anticorrosion properties and are products of stable quality produced at the factory.*
- *They can be constructed in the same way as steel materials without a coating, in principle.*

4 Electrolytic protection method

Two types are available with regard to this method: by externally supplying a protection power source to prevent corrosion (external power method) or by attaching alloy such as aluminum and magnesium to the steel material as a sacrificial anode (galvanic anode method).
It is necessary to select the most-optimum corrosion prevention method according to the design and site condition. For details, please contact us.



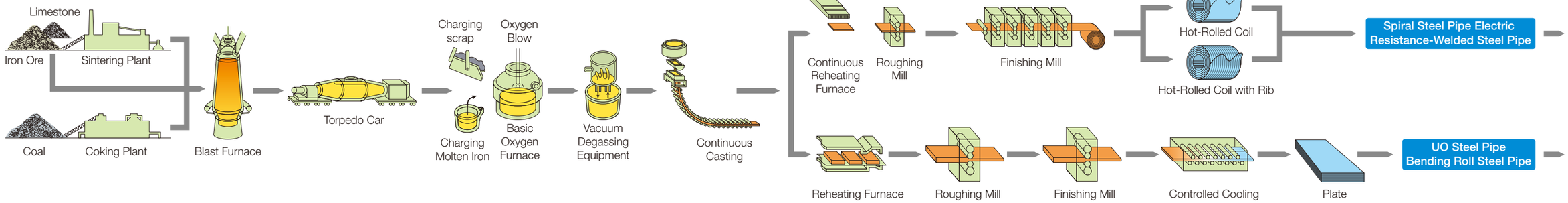
Corrosion condition at the sea area

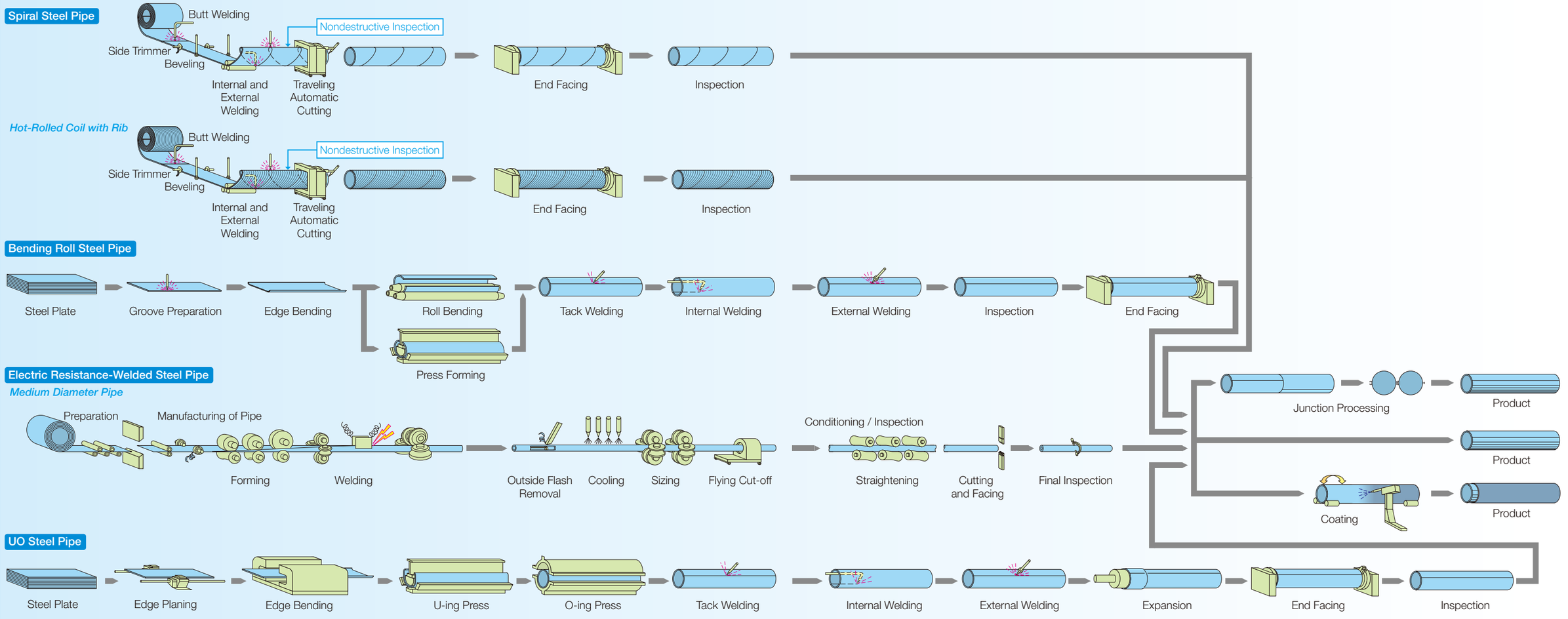


Example of the corrosion classification of port structures and the applied corrosion protection method

Production Process

※It is one example of a typical manufacturing process.





Spiral Welded Steel Pipe

Available Specification *1, *2

JIS A5525 & A5530

Grade	Chemical Component (%)													Mechanical Properties		
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	N	Ceq	Minimum Tensile Strength (Mpa)	Minimum Yield Stress (Mpa)	Minimum Elongation (%) (Gauge Length 50mm)
	max	max	max	max	max	max	max	max	max	max	max	max	max			
SKK400 SKY400	0.25	—	—	0.040	0.040	—	—	—	—	—	—	—	—	400	235 *3	18
SKK490 SKY490	0.18	0.55	1.65	0.035	0.035	—	—	—	—	—	—	—	—	490	315 *3	18

JIS G 3106

Grade	Chemical Component (%)													Mechanical Properties					
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	N	Ceq	Minimum Tensile Strength (Mpa)	Minimum Yield Stress (Mpa)		Minimum Elongation (%) (Gauge Length 50mm)		Minimum Impact Energy (J)	
															Thickness (mm)		Thickness (mm)		0 ℃	20 ℃
	max	max	max	max	max	max	max	max	max	max	max	max	max		≦16	>16 ≦40	>5 ≦16	>16 ≦50		
SM 490YA	0.20	0.55	1.65	0.035	0.035	—	—	—	—	—	—	—	—	490 *4	365	355	15	19	—	—
SM 490YB	0.20	0.55	1.65	0.035	0.035	—	—	—	—	—	—	—	—	490 *4	365	355	15	19	27	—

AS/NZS 3678

Grade	Chemical Component (%)													Mechanical Properties				
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	N	Ceq *5	Minimum Tensile Strength (Mpa)	Minimum Yield Stress (Mpa)			Minimum Elongation (%) (Gauge Length $5.65\sqrt{S_o}$mm)
															Thickness (mm)			
	max	max	max	max	max	max	max	max	max	max	max	max	max		≦8	>8 ≦12	>12 ≦20	>20 ≦32	
250	0.22	0.55	1.70	0.040	0.030	0.25	0.50	0.40	0.10	0.100	0.040	—	0.44	410	280	260	250	250	22
300	0.22	0.55	1.70	0.040	0.030	0.25	0.50	0.40	0.10	0.100	0.040	—	0.44	430	320	310	300	280	21
350	0.22	0.55	1.70	0.040	0.030	0.25	0.50	0.40	0.35	0.100	0.040	—	0.48	450	360	360	350	340	20

* Cr + Ni + Cu + Mo = 1.00% maximum apply.
* Limits specified are for both acid soluble and total aluminium.
* Niobium plus vanadium: 0.030% maximum.
* Vanadium: 0.10% maximum. Niobium plus vanadium plus titanium: 0.15% maximum.

ASTM A252

Grade	Chemical Component (%)													Mechanical Properties		
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	N	Ceq	Minimum Tensile Strength (Mpa)	Minimum Yield Stress (Mpa)	Minimum Elongation (%) (Gauge Length 50.8mm)
	max	max	max	max	max	max	max	max	max	max	max	max	max			
Grade 1	—	—	—	0.050	—	—	—	—	—	—	—	—	—	345	205	30
Grade 2	—	—	—	0.050	—	—	—	—	—	—	—	—	—	415	240	25
Grade 3	—	—	—	0.050	—	—	—	—	—	—	—	—	—	455	310	20

EN 10025-2 & 10219-1

Grade	Chemical Component (%)													Mechanical Properties				
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	N	Ceq *5	Minimum Tensile Strength (Mpa)	Minimum Yield Stress (Mpa)		Minimum Elongation (%) (Gauge Length $5.65\sqrt{S_o}$mm)	Minimum Impact Energy (J)	
															Thickness (mm)			0 ℃	20 ℃
	max	max	max	max	max	max	max	max	max	max	max	max	max		≦16	>16 ≦40			
S235JR	0.17	—	1.40	0.035	0.035	—	—	0.55	—	—	—	0.012	0.35	360 *4	235	225	26	—	27
S275JR	0.21	—	1.50	0.035	0.035	—	—	0.55	—	—	—	0.012	0.40	410 *4	275	265	23	—	27
S355JR	0.24	0.55	1.60	0.035	0.035	—	—	0.55	—	—	—	0.012	0.45	470 *4	355	345	22	—	27
S235JRH	0.17	—	1.40	0.040	0.040	—	—	—	—	—	—	0.009	0.35	360 *4	235	225	24	—	27
S275JOH	0.20	—	1.50	0.035	0.035	—	—	—	—	—	—	0.009	0.40	410 *4	275	265	20	27	—
S355JOH	0.22	0.55	1.60	0.035	0.035	—	—	—	—	—	—	0.009	0.45	470 *4	355	345	20	27	—

*1 All requirements not stipulated herein are subject to discussions.
*2 Don't hesitate to ask if a standard is not listed or mentioned.
*3 You can modify Minimum yield stress of JIS with discussions.
*4 No cap (or limitation) on the maximum TS values.
*5 Ceq = C + Mn/6 +(Cr+Mo+V)/5+(Ni+Cu)/15

Production Range

Yield Stress 235MPa

*For other yield stresses, please contact us detail in advance to order.

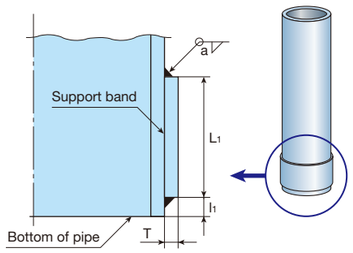
Diameter (mm)	Thickness (mm)																				Diameter (mm)
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
400																					400
500																					500
600																					600
700																					700
800																					800
900																					900
1,000																					1,000
1,100																					1,100
1,200																					1,200
1,300																					1,300
1,400																					1,400
1,500																					1,500
1,600																					1,600
1,700																					1,700
1,800																					1,800
1,900																					1,900
2,000																					2,000
2,100																					2,100
2,200																					2,200
2,300																					2,300
2,400																					2,400
2,500																					2,500
2,600																					2,600
2,700																					2,700
2,800																					2,800
2,900																					2,900
3,000																					3,000

: Please contact us detail in advance to order.

Accessories

Reinforcing Band

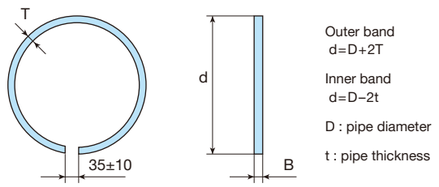
For strengthening pile on the top or bottom



Unit: mm

Diameter D	Band length L_1	Thickness T	Attachment position l_1	Leg length a
D ≦ 609.6	200	9	18	6
609.6 < D	300	9	18	6

Band



Outer band
d=D+2T

Inner band
d=D−2t

D : pipe diameter

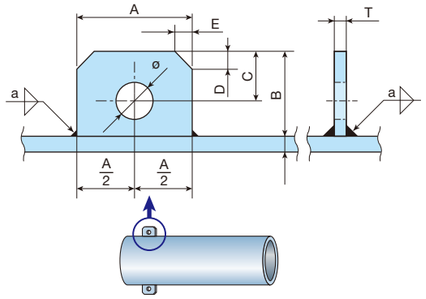
t : pipe thickness

Unit: mm

Diameter D	Band thickness T	Band width B
D < 800	9	25
800 ≦ D < 1200	12	25
1200 ≦ D < 1500	16	32

Lifting Lug

For easy handling of pile transport



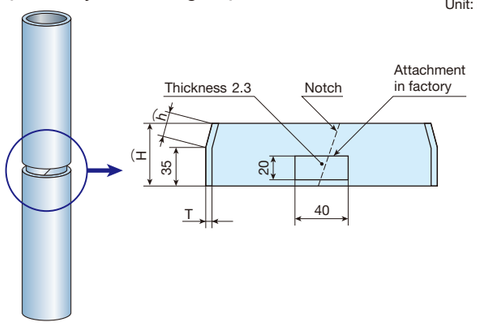
Unit: mm

Maximum lifting load (ton)	Width A	Height B	Location C	Chamfer dimension D	Chamfer dimension E	Thickness T	Diameter ø	Leg length a
W ≦ 3	120	100	55	25	25	12	40	6
3 < W ≦ 5	120	100	55	25	25	16	40	9
5 < W ≦ 10	200	150	90	30	30	22	65	15

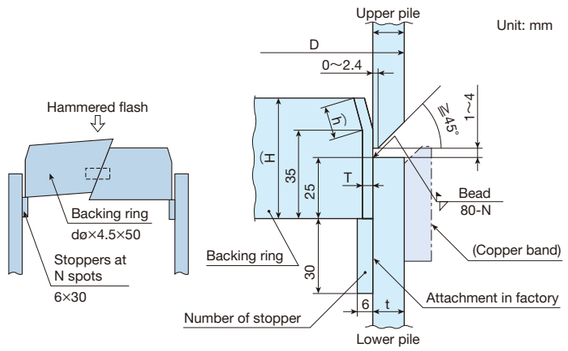
Backing Ring for Weld

Simple weld joint to elongate pile

Unit: mm



Unit: mm



Thickness and height of backing ring

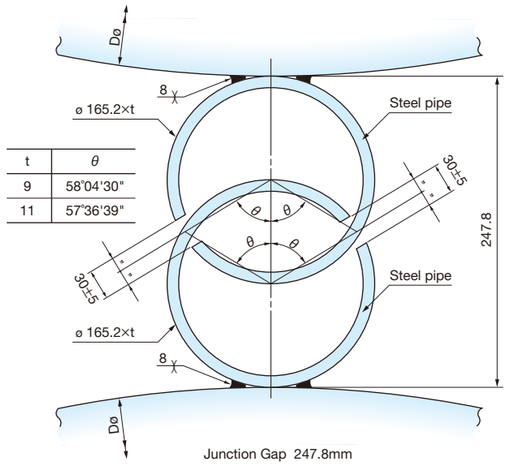
Pipe diameter D (mm)	T	$\widehat{H}$	$\widehat{h}$
D ≦ 1,016	4.5	$\widehat{50}$	15 ($\widehat{H}$=50)
1,016 < D	6.0	$\widehat{70}$, $\widehat{50}$	35 ($\widehat{H}$=70)

Number of stopper

Pipe diameter D (mm)	Number N
D ≦ 609.6	4
609.6 < D ≦ 1,016	6
1,016 < D	8

Junction Types for Steel Pipe Sheet Piles

P-P Type (Pipe Type)



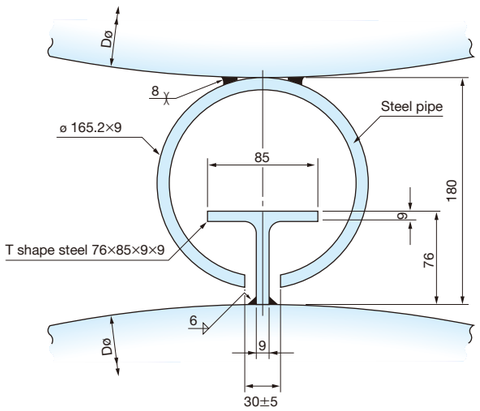
t	θ
9	58°04'30"
11	57°36'39"

Junction Gap 247.8mm

Unit weight 83.6kg/m (t=11)

Unit weight 69.4kg/m (t=9)

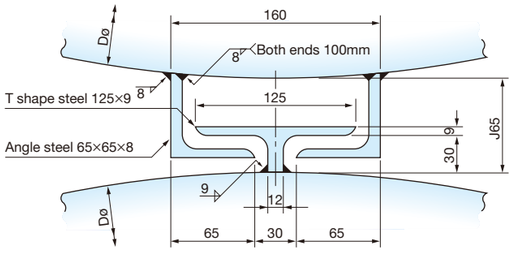
P-T Type (Pipe T Type)



Junction Gap 180.0mm

Unit weight 45.6kg/m { T =10.9kg/m, P =34.7kg/m }

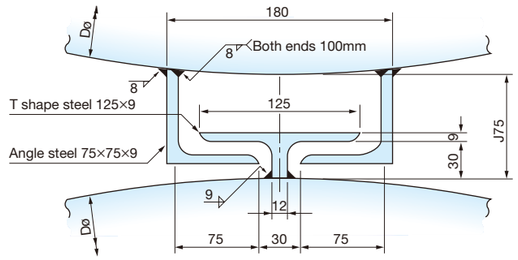
L-T Type (Type 65)



Junction Gap $J_{65} = \left(\frac{D}{2} + 76 + \sqrt{\left(\frac{D}{2}\right)^2 - 80^2}\right) - D$

Unit weight 28.0kg/m { T =12.7kg/m, L =15.3kg/m }

L-T Type (Type 75)



Junction Gap $J_{75} = \left(\frac{D}{2} + 85.5 + \sqrt{\left(\frac{D}{2}\right)^2 - 90^2}\right) - D$

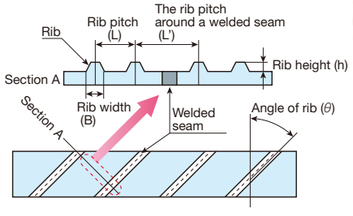
Unit weight 32.6kg/m { T =12.7kg/m, L =19.9kg/m }

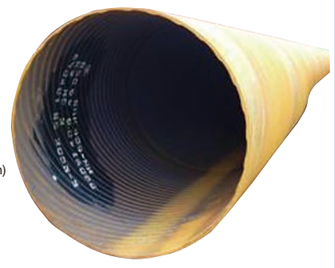
The ribbed piles

The ribbed piles have spiral shape ribs. The ribs work efficiently for improving the bond strength between the pipe and concrete or the pipe and soil cements, so it can used for steel-concrete composite piles or as the core of soil cements.

Rib specifications

Item	Tolerances
Rib height (h)	2.5mm or more
Rib width (B)	4.0mm ≦ B ≦ 20mm
Rib pitch (L)	30mm ≦ L ≦ 40mm The rib pitch around a welded (L') seam shall be not more than 230mm.
Angle of rib (θ)	40 degrees or less





There are two types of ribbed piles, pipe with inner ribs and pipe with outer ribs.
The mechanical properties and chemical composition of the ribbed piles are based on JIS A5525.

Sectional Properties

※Moment of Inertia and Section Modulus are the same as (P – P type) t = 9mm

		Steel Pipe Piles								Steel Pipe Sheet Piles																	
		Corrosion allowance (0mm)					Corrosion allowance (1mm)			Per 1m of pile wall width (L – T type) L65 × 65 × 8					Per 1m of pile wall width (L – T type) L75 × 75 × 9					Per 1m of pile wall width (P – T type)				Per 1m of pile wall width (P – P type) t = 9mm				Per 1m of pile wall width (P – P type) t = 11mm ※	
Diameter	Thickness	Sectional area	Unit weight	Moment of inertia	Section modulus	Radius of gyration	Sectional area	Moment of inertia	Section modulus	Junction gap J65	Sectional area	Unit weight	Moment of inertia	Section modulus	Junction gap J75	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight
mm	mm	cm^2	kg/m	cm^4	cm^3	cm	cm^2	cm^4	cm^3	mm	cm^2/m	kg/m	cm^4	cm^3	mm	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m
400	9	110.6	86.8	211×10^2	106×10	13.8	98.0	186×10^2	93.7×10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	10	122.5	96.2	233×10^2	117×10	13.8	110.0	208×10^2	105×10																				
	11	134.4	106	254×10^2	127×10	13.8	121.9	230×10^2	115×10																				
	12	146.3	115	276×10^2	138×10	13.7	133.7	251×10^2	126×10																				
	13	158.1	124	296×10^2	148×10	13.7	145.5	271×10^2	136×10																				
	14	169.8	133	317×10^2	158×10	13.7	157.2	292×10^2	147×10																				
	15	181.4	142	337×10^2	168×10	13.6	168.9	312×10^2	157×10																				
	16	193.0	152	356×10^2	178×10	13.6	180.5	331×10^2	167×10																				
	17	204.5	161	376×10^2	188×10	13.6	192.0	351×10^2	176×10																				
500	9	138.8	109	418×10^2	167×10	17.4	123.2	370×10^2	148×10	62.9	310.1	243	744×10^2	297×10	68.7	317.2	249	736×10^2	294×10	289.6	227	615×10^2	246×10	303.9	239	559×10^2	223×10	328.1	258
	10	153.9	121	462×10^2	185×10	17.3	138.3	413×10^2	166×10		336.9	264	821×10^2	328×10		343.8	270	813×10^2	325×10	311.8	245	680×10^2	272×10	324.1	254	618×10^2	247×10	348.3	273
	11	169.0	133	505×10^2	202×10	17.3	153.3	457×10^2	183×10		363.7	285	898×10^2	359×10		370.2	291	889×10^2	355×10	334.0	262	743×10^2	297×10	344.2	270	675×10^2	270×10	368.4	289
	12	184.0	144	548×10^2	219×10	17.3	168.3	499×10^2	200×10		390.3	306	974×10^2	389×10		396.6	311	964×10^2	385×10	356.0	280	806×10^2	322×10	364.2	286	733×10^2	293×10	388.4	305
	13	198.9	156	590×10^2	236×10	17.2	183.2	541×10^2	217×10		416.8	327	105×10^3	419×10		422.8	332	104×10^3	415×10	377.9	297	868×10^2	347×10	384.2	302	789×10^2	316×10	408.4	321
	14	213.8	168	632×10^2	253×10	17.2	198.1	583×10^2	234×10		443.2	348	112×10^3	449×10		448.9	352	111×10^3	444×10	399.8	314	929×10^2	372×10	404.1	317	845×10^2	338×10	428.3	336
	15	228.6	179	673×10^2	269×10	17.2	212.9	624×10^2	251×10		469.5	369	120×10^3	478×10		474.9	373	118×10^3	473×10	421.7	331	989×10^2	396×10	423.7	333	900×10^2	360×10	448.0	352
	16	243.3	191	713×10^2	285×10	17.1	227.6	664×10^2	267×10		495.7	389	127×10^3	507×10		500.9	393	125×10^3	502×10	443.4	348	105×10^3	420×10	443.4	348	954×10^2	381×10	467.8	367
	17	258.0	203	753×10^2	301×10	17.1	242.3	704×10^2	283×10		521.7	410	134×10^3	535×10		526.6	413	132×10^3	530×10	464.9	365	111×10^3	443×10	463.1	364	101×10^3	403×10	487.4	383
	18	272.6	214	793×10^2	317×10	17.1	256.9	744×10^2	299×10		547.7	430	141×10^3	563×10		552.3	434	139×10^3	557×10	486.4	382	117×10^3	466×10	482.6	379	106×10^3	424×10	506.9	398
	19	287.1	225	832×10^2	333×10	17.0	271.4	783×10^2	314×10		573.5	450	148×10^3	591×10		577.9	454	146×10^3	585×10	507.8	399	122×10^3	489×10	502.0	394	111×10^3	445×10	526.4	413
600	9	167.1	131	730×10^2	243×10	20.9	148.3	645×10^2	216×10	65.1	304.9	239	110×10^3	366×10	71.7	310.7	244	109×10^3	362×10	288.7	227	936×10^2	312×10	301.4	237	861×10^2	287×10	322.7	253
	10	185.4	145	807×10^2	269×10	20.9	166.5	722×10^2	242×10		332.4	261	121×10^3	404×10		337.8	265	120×10^3	400×10	312.1	245	103×10^3	345×10	322.9	253	952×10^2	317×10	344.2	270
	11	203.5	160	883×10^2	294×10	20.8	184.7	799×10^2	267×10		359.7	282	133×10^3	443×10		364.9	286	131×10^3	438×10	335.4	263	113×10^3	377×10	344.4	270	104×10^3	347×10	365.7	287
	12	221.7	174	958×10^2	319×10	20.8	202.9	874×10^2	292×10		387.0	304	144×10^3	480×10		391.9	308	143×10^3	476×10	358.7	282	123×10^3	410×10	365.7	287	113×10^3	376×10	387.1	304
	13	239.7	188	103×10^3	344×10	20.8	220.9	949×10^2	317×10		414.1	325	155×10^3	518×10		418.8	329	154×10^3	513×10	381.8	300	132×10^3	441×10	387.1	304	121×10^3	406×10	408.4	321
	14	257.7	202	111×10^3	369×10	20.7	238.9	102×10^3	342×10		441.2	346	166×10^3	555×10		445.6	350	165×10^3	549×10	404.9	318	142×10^3	473×10	408.3	320	131×10^3	435×10	429.6	337
	15	275.7	216	118×10^3	393×10	20.7	256.9	110×10^3	366×10		468.2	367	177×10^3	591×10		472.3	371	176×10^3	586×10	427.9	336	151×10^3	504×10	429.4	337	139×10^3	464×10	450.8	354
	16	293.6	230	125×10^3	417×10	20.7	274.7	117×10^3	391×10		495.0	389	188×10^3	628×10		498.9	392	186×10^3	622×10	450.8	354	161×10^3	535×10	450.5	354	147×10^3	492×10	471.9	370
	17	311.4	244	132×10^3	441×10	20.6	292.5	124×10^3	415×10		521.8	410	199×10^3	664×10		525.4	412	197×10^3	657×10	473.8	372	170×10^3	566×10	471.4	370	156×10^3	521×10	492.9	387
	18	329.1	258	139×10^3	465×10	20.6	310.3	131×10^3	438×10		548.5	431	210×10^3	699×10		551.9	433	208×10^3	692×10	496.6	390	179×10^3	596×10	492.4	387	165×10^3	548×10	513.8	403
	19	346.8	272	146×10^3	488×10	20.6	328.0	138×10^3	462×10		575.1	451	220×10^3	734×10		578.2	454	218×10^3	727×10	519.2	408	188×10^3	626×10	513.2	403	173×10^3	576×10	534.7	420
	20	364.4	286	153×10^3	511×10	20.5	345.6	145×10^3	485×10		601.6	472	231×10^3	769×10		604.4	474	228×10^3	761×10	541.8	425	197×10^3	656×10	534.0	419	181×10^3	603×10	555.5	436

Formulas used in the sectional properties table for steel pipe piles and steel pipe sheet piles

D : Diameter (cm)
T : Thickness (cm)
S : Corrosion allowance (cm)
A_0 : Sectional area per pipe proper (cm^2)
W_0 : Unit weight per pipe proper (kg/m)
I_0 : Moment of inertia per pipe proper (cm^4)
Z_0 : Section modulus per pipe proper (cm^3)
B : Junction gap (cm)
A' : Sectional area of a set of junctions (cm^2)
W' : Unit weight of per 1m of a set of junctions (kg/m)

Unit weight $W = 0.02466T\ (D-T)$ (kg/m)

Sectional area $A = \frac{\pi}{4}\{(D-2S)^2-(D-2T)^2\}$ (cm^2)

Moment of inertia $I = \frac{\pi}{64}\{(D-2S)^4-(D-2T)^4\}$ (cm^4)

Section modulus $Z = \frac{\pi}{32}\frac{(D-2S)^4-(D-2T)^4}{D-2S}$ (cm^3)

Radius of gyration $R = \frac{1}{4}\sqrt{D^2+(D-2T)^2}$ (cm)

【Per 1m of steel pipe sheet pile wall】

Sectional area $A = (A_0+A') \times \frac{100}{D+B}$ (cm^2/m)

Unit weight $D = (W_0+W') \times \frac{100}{D+B}$ (kg/m^2)

Moment of inertia $I = I_0 \times \frac{100}{D+B}$ (cm^4/m)

Section modulus $Z = Z_0 \times \frac{100}{D+B}$ (cm^3/m)

● Junction types on the sectional properties list are the 3 types as shown below.
(Please see page 39 for more details on junction geometry.)

1) L–T Type

i)	Junction type	L–65×65×8 T–125×9
	Sectional area of junction	35.71cm^2
ii)	Junction type	L–75×75×9 T–125×9
	Sectional area of junction	41.57cm^2

2) P–T Type (Pipe–T Type)

Junction type	φ165.2×9 CT–76×85×9×9
Sectional area of junction	58.11cm^2

3) P–P Type (Pipe Type)

Junction type	φ165.2×11
Sectional area of junction	106.5cm^2

※ An increase in moment of inertia and section modulus by junction was disregarded because its influence was assumed small.

Sectional Properties

※Moment of Inertia and Section Modulus are the same as (P – P type) t = 9mm

		Steel Pipe Piles								Steel Pipe Sheet Piles																	
		Corrosion allowance (0mm)					Corrosion allowance (1mm)			Per 1m of pile wall width (L – T type) L65 × 65 × 8					Per 1m of pile wall width (L – T type) L75 × 75 × 9					Per 1m of pile wall width (P – T type)				Per 1m of pile wall width (P – P type) t = 9mm				Per 1m of pile wall width (P – P type) t = 11mm ※	
Diameter	Thickness	Sectional area	Unit weight	Moment of inertia	Section modulus	Radius of gyration	Sectional area	Moment of inertia	Section modulus	Junction gap J65	Sectional area	Unit weight	Moment of inertia	Section modulus	Junction gap J75	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight
mm	mm	cm^2	kg/m	cm^4	cm^3	cm	cm^2	cm^4	cm^3	mm	cm^2/m	kg/m	cm^4	cm^3	mm	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m
700	9	195.4	153	117×10^3	333×10	24.4	173.4	103×10^3	296×10	66.7	301.4	237	152×10^3	435×10	73.7	306.2	240	151×10^3	431×10	288.1	226	133×10^3	379×10	299.4	235	123×10^3	351×10	318.5	250
	10	216.8	170	129×10^3	369×10	24.4	194.8	116×10^3	331×10		329.3	258	168×10^3	481×10		333.9	262	167×10^3	476×10	312.4	245	147×10^3	419×10	322.0	253	136×10^3	389×10	341.1	268
	11	238.1	187	141×10^3	404×10	24.4	216.1	128×10^3	367×10		357.1	280	184×10^3	527×10		361.5	284	183×10^3	522×10	336.6	264	161×10^3	459×10	344.5	270	149×10^3	426×10	363.6	285
	12	259.4	204	154×10^3	439×10	24.3	237.4	140×10^3	401×10		384.9	302	200×10^3	572×10		388.9	305	198×10^3	567×10	360.8	283	174×10^3	498×10	366.9	288	162×10^3	463×10	386.0	303
	13	280.6	220	166×10^3	473×10	24.3	258.6	152×10^3	436×10		412.5	324	216×10^3	617×10		416.4	327	214×10^3	611×10	384.9	302	188×10^3	538×10	389.3	306	175×10^3	499×10	408.4	321
	14	301.7	237	178×10^3	507×10	24.3	279.8	164×10^3	470×10		440.1	345	232×10^3	662×10		443.7	348	229×10^3	656×10	408.9	321	202×10^3	576×10	411.6	323	188×10^3	535×10	430.7	338
	15	322.8	253	189×10^3	541×10	24.2	300.8	176×10^3	504×10		467.6	367	247×10^3	706×10		470.9	370	245×10^3	699×10	432.9	340	215×10^3	615×10	433.9	341	199×10^3	571×10	452.9	356
	16	343.8	270	201×10^3	575×10	24.2	321.9	188×10^3	538×10		495.0	389	262×10^3	750×10		498.1	391	260×10^3	743×10	456.7	359	229×10^3	653×10	456.0	358	212×10^3	607×10	475.1	373
	17	364.8	286	213×10^3	608×10	24.2	342.8	199×10^3	571×10		522.3	410	278×10^3	793×10		525.2	412	275×10^3	786×10	480.6	377	242×10^3	691×10	478.0	375	225×10^3	642×10	497.2	390
	18	385.7	303	224×10^3	641×10	24.1	363.7	211×10^3	604×10		549.6	431	293×10^3	836×10		552.2	433	290×10^3	829×10	504.4	396	255×10^3	729×10	500.1	393	237×10^3	676×10	519.3	408
	19	406.5	319	236×10^3	674×10	24.1	384.5	222×10^3	637×10		576.7	453	308×10^3	879×10		579.1	455	305×10^3	871×10	528.1	415	268×10^3	766×10	522.1	410	249×10^3	711×10	541.2	425
	20	427.3	335	247×10^3	706×10	24.1	405.3	234×10^3	670×10		603.8	474	322×10^3	921×10		605.9	476	319×10^3	913×10	551.7	433	281×10^3	802×10	544.0	427	261×10^3	745×10	563.2	442
	21	448.0	352	258×10^3	738×10	24.0	426.0	245×10^3	702×10		630.8	495	337×10^3	963×10		632.7	497	334×10^3	954×10	575.2	452	294×10^3	839×10	565.8	444	273×10^3	779×10	585.0	459
	22	468.6	368	270×10^3	770×10	24.0	446.6	256×10^3	734×10		657.7	516	352×10^3	100×10^2		659.4	518	348×10^3	995×10	598.6	470	306×10^3	875×10	587.6	461	284×10^3	813×10	606.8	476
800	9	223.6	176	175×10^3	437×10	28.0	198.5	155×10^3	388×10	67.9	298.8	235	202×10^3	504×10	75.2	303.0	238	200×10^3	500×10	287.5	226	179×10^3	446×10	297.8	234	167×10^3	417×10	315.1	247
	10	248.2	195	194×10^3	484×10	27.9	223.1	174×10^3	435×10		327.1	257	223×10^3	558×10		331.1	260	221×10^3	553×10	312.5	245	198×10^3	494×10	321.2	252	185×10^3	462×10	338.5	266
	11	272.7	214	212×10^3	531×10	27.9	247.6	192×10^3	482×10		355.3	279	245×10^3	611×10		359.0	282	242×10^3	606×10	337.5	265	217×10^3	541×10	344.6	270	202×10^3	507×10	361.9	284
	12	297.1	233	231×10^3	577×10	27.9	272.0	211×10^3	528×10		383.4	301	266×10^3	664×10		386.9	304	264×10^3	659×10	362.4	285	235×10^3	588×10	367.9	289	220×10^3	551×10	385.2	302
	13	321.4	252	249×10^3	622×10	27.8	296.3	229×10^3	574×10		411.5	323	287×10^3	717×10		414.7	326	284×10^3	711×10	387.3	304	254×10^3	635×10	391.1	307	238×10^3	594×10	408.4	321
	14	345.7	271	267×10^3	668×10	27.8	320.6	247×10^3	619×10		439.5	345	308×10^3	769×10		442.5	347	305×10^3	763×10	412.0	324	273×10^3	681×10	414.3	325	255×10^3	638×10	431.6	339
	15	369.9	290	285×10^3	713×10	27.8	344.8	265×10^3	664×10		467.4	367	328×10^3	821×10		470.1	369	326×10^3	814×10	436.8	343	291×10^3	727×10	437.4	343	272×10^3	680×10	454.7	357
	16	394.1	309	303×10^3	757×10	27.7	369.0	283×10^3	709×10		495.2	389	349×10^3	873×10		497.8	391	346×10^3	865×10	461.4	362	309×10^3	773×10	460.5	361	289×10^3	722×10	477.8	375
	17	418.2	328	321×10^3	802×10	27.7	393.1	301×10^3	753×10		523.0	411	369×10^3	924×10		525.3	412	366×10^3	916×10	486.1	382	327×10^3	818×10	483.4	379	306×10^3	765×10	500.7	393
	18	442.2	347	338×10^3	846×10	27.7	417.1	318×10^3	797×10		550.7	432	390×10^3	974×10		552.7	434	386×10^3	966×10	510.6	401	345×10^3	863×10	506.3	397	323×10^3	807×10	523.7	411
	19	466.2	366	356×10^3	889×10	27.6	441.1	336×10^3	841×10		578.3	454	410×10^3	102×10^2		580.1	455	406×10^3	102×10^2	535.1	420	363×10^3	907×10	529.2	415	339×10^3	849×10	546.6	429
	20	490.1	385	373×10^3	932×10	27.6	465.0	353×10^3	885×10		605.8	476	430×10^3	107×10^2		607.4	477	426×10^3	107×10^2	559.5	439	381×10^3	951×10	552.0	433	356×10^3	890×10	569.4	447
	21	513.9	403	390×10^3	975×10	27.6	488.8	370×10^3	928×10		633.3	497	449×10^3	112×10^2		634.7	498	446×10^3	111×10^2	583.8	458	398×10^3	995×10	574.8	451	372×10^3	931×10	592.1	465
	22	537.7	422	407×10^3	102×10^2	27.5	512.6	387×10^3	970×10		660.7	519	469×10^3	117×10^2		661.9	520	465×10^3	116×10^2	608.1	477	415×10^3	104×10^2	597.5	469	389×10^3	971×10	614.8	483
	23	561.4	441	424×10^3	106×10^2	27.5	536.3	404×10^3	101×10^2		688.0	540	489×10^3	122×10^2		689.0	541	485×10^3	121×10^2	632.3	496	433×10^3	108×10^2	620.1	487	405×10^3	101×10^2	637.5	500
	24	585.1	459	441×10^3	110×10^2	27.4	560.0	421×10^3	105×10^2		715.3	561	508×10^3	127×10^2		716.0	562	504×10^3	126×10^2	656.4	515	450×10^3	112×10^2	642.7	505	421×10^3	105×10^2	660.0	518
	25	608.7	478	457×10^3	114×10^2	27.4	583.6	437×10^3	110×10^2		742.5	583	527×10^3	132×10^2		742.9	583	523×10^3	131×10^2	680.5	534	467×10^3	117×10^2	665.2	522	437×10^3	109×10^2	682.6	536
900	9	251.9	198	250×10^3	556×10	31.5	223.7	221×10^3	493×10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	10	279.6	219	277×10^3	615×10	31.5	251.4	248×10^3	553×10		325.5	255	286×10^3	635×10		328.9	258	284×10^3	630×10	312.7	246	256×10^3	570×10	320.6	252	241×10^3	536×10	336.4	264
	11	307.2	241	304×10^3	675×10	31.4	279.0	275×10^3	613×10		354.0	278	313×10^3	696×10		357.2	280	311×10^3	691×10	338.3	266	281×10^3	625×10	344.7	271	265×10^3	588×10	360.4	283
	12	334.8	263	330×10^3	733×10	31.4	306.5	302×10^3	671×10		382.4	300	341×10^3	757×10		385.4	303	338×10^3	751×10	363.8	286	306×10^3	679×10	368.7	289	288×10^3	639×10	384.4	302
	13	362.3	284	356×10^3	792×10	31.4	334.0	328×10^3	730×10		410.8	322	368×10^3	817×10		413.6	325	365×10^3	811×10	389.2	306	330×10^3	733×10	392.6	308	310×10^3	690×10	408.4	321
	14	389.7	306	382×10^3	850×10	31.3	361.4	354×10^3	788×10		439.1	345	395×10^3	877×10		441.7	347	392×10^3	870×10	414.6	326	354×10^3	787×10	416.5	327	333×10^3	741×10	432.3	339
	15	417.0	327	408×10^3	908×10	31.3	388.8	380×10^3	846×10		467.3	367	422×10^3	937×10		469.7	369	418×10^3	930×10	440.0	345	378×10^3	840×10	440.4	346	355×10^3	791×10	456.1	358
	16	444.3	349	434×10^3	965×10	31.3	416.1	406×10^3	903×10		495.5	389	448×10^3	996×10		497.7	391	445×10^3	988×10	465.2	365	402×10^3	893×10	464.2	364	378×10^3	841×10	479.9	377
	17	471.6	370	460×10^3	102×10^2	31.2	443.3	431×10^3	960×10		523.6	411	475×10^3	105×10^2		525.6	413	471×10^3	105×10^2	490.5	385	426×10^3	946×10	487.9	383	401×10^3	889×10	503.6	395
	18	498.8	392	485×10^3	108×10^2	31.2	470.5	457×10^3	102×10^2	68.8	551.7	433	501×10^3	111×10^2	76.4	553.4	434	497×10^3	110×10^2	515.6	405	449×10^3	998×10	511.6	402	423×10^3	941×10	527.3	414
	19	525.9	413	510×10^3	113×10^2	31.2	497.6	482×10^3	107×10^2		579.6	455	527×10^3	117×10^2		581.2	456	523×10^3	116×10^2	540.7	425	473×10^3	105×10^2	535.2	420	444×10^3	984×10	550.9	432
	20	552.9	434	536×10^3	119×10^2	31.1	524.7	507×10^3	113×10^2		607.6	477	553×10^3	123×10^2		608.9	478	548×10^3	122×10^2	565.9	444	496×10^3	110×10^2	558.7	439	467×10^3	104×10^2	574.5	451
	21	579.9	455	560×10^3	125×10^2	31.1	551.7	532×10^3	118×10^2		635.4	499	578×10^3	129×10^2		636.5	500	574×10^3	128×10^2	590.8	464	519×10^3	115×10^2	582.2	457	488×10^3	108×10^2	598.0	469
	22	606.8	476	585×10^3	130×10^2	31.1	578.6	557×10^3	124×10^2		663.2	521	604×10^3	134×10^2		664.1	521	599×10^3	133×10^2	615.8	483	542×10^3	120×10^2	605.6	475	510×10^3	113×10^2	621.5	488
	23	633.7	497	610×10^3	135×10^2	31.0	605.4	581×10^3	129×10^2		690.9	542	629×10^3	140×10^2		691.6	543	624×10^3	139×10^2	640.6	503	564×10^3	125×10^2	629.0	494	531×10^3	118×10^2	644.9	506
	24	660.5	519	634×10^3	141×10^2	31.0	632.2	605×10^3	135×10^2		718.6	564	654×10^3	145×10^2		719.0	564	649×10^3	144×10^2	665.5	522	587×10^3	130×10^2	652.4	512	552×10^3	123×10^2	668.2	525
	25	687.2	539	658×10^3	146×10^2	30.9	659.0	630×10^3	140×10^2		746.2	586	679×10^3	151×10^2		746.4	586	674×10^3	150×10^2	690.2	542	609×10^3	135×10^2	675.7	530	573×10^3	127×10^2	691.5	543
1000	10	311.0	244	381×10^3	762×10	35.0	279.6	342×10^3	685×10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	11	341.8	268	418×10^3	836×10	35.0	310.4	379×10^3	759×10		352.9	277	391×10^3	781×10		355.8	279	388×10^3	776×10	338.9	266	354×10^3	708×10	344.8	271	335×10^3	670×10	359.2	282
	12	372.5	292	455×10^3	909×10	34.9	341.1	415×10^3	832×10		381.6	300	425×10^3	850×10		384.3	302	422×10^3	844×10	364.9	286	385×10^3	770×10	369.4	290	365×10^3	728×10	383.8	301
	13	403.1	316	491×10^3	982×10	34.9	371.7	452×10^3	905×10		410.3	322	459×10^3	918×10		412.7	324	456×10^3	911×10	390.9	307	416×10^3	832×10	393.9	309	393×10^3	787×10	408.4	321
	14	433.7	340	527×10^3	105×10^2	34.9	402.3	488×10^3	978×10		438.9	344	493×10^3	986×10		441.1	346	489×10^3	979×10	416.8	327	447×10^3	893×10	418.4	328	422×10^3	841×10	432.9	340
	15	464.2	364	563×10^3	113×10^2	34.8	432.8	524×10^3	105×10^2		467.4	367	526×10^3	105×10^2		469.4	368	523×10^3	105×10^2	442.6	348	477×10^3	954×10	442.8	348	451×10^3	906×10	457.3	359
	16	494.6	388	599×10^3	120×10^2	34.8	463.2	560×10^3	112×10^2		495.8	389	560×10^3	112×10^2		497.7	391	556×10^3	111×10^2	468.4	368	507×10^3	101×10^2	467.2	367	480×10^3	962×10	481.7	378
	17	525.0	412	634×10^3	127×10^2	34.8	493.6	595×10^3	119×10^2		524.2	411	593×10^3	119×10^2		525.9	413	589×10^3	118×10^2	494.2	388	538×10^3	108×10^2	491.6	386	508×10^3	102×10^2	506.1	397
	18	555.3	436	670×10^3	134×10^2	34.7	523.9	630×10^3	126×10^2	69.6	552.6	434	626×10^3	125×10^2	77.3	554.0	435	622×10^3	124×10^2	519.8	408	567×10^3	113×10^2	515.9	405	537×10^3	107×10^2	530.4	416
	19	585.6	460	705×10^3	141×10^2	34.7	554.2	666×10^3	133×10^2		580.9	456	659×10^3	132×10^2		582.1	457	654×10^3	131×10^2	545.5	428	597×10^3	119×10^2	540.1	424	565×10^3	113×10^2	554.6	435
	20	615.8	483	740×10^3	148×10^2	34.7	584.4	700×10^3	140×10^2		609.1	479	691×10^3	138×10^2		610.1	479	686×10^3	137×10^2	571.0	448	627×10^3	125×10^2	564.3	443	593×10^3	119×10^2	578.8	454
	21	645.9	507	774×10^3	155×10^2	34.6	614.5	735×10^3	147×10^2		637.3	500	724×10^3	145×10^2		638.1	501	719×10^3	144×10^2	596.7	468	656×10^3	131×10^2	588.4	462	620×10^3	124×10^2	603.0	473
	22	675.9	531	809×10^3	162×10^2	34.6	644.6	769×10^3	154×10^2		665.4	522	756×10^3	151×10^2		666.0	523	751×10^3	150×10^2	622.2	488	685×10^3	137×10^2	612.5	481	648×10^3	130×10^2	627.1	492
	23	705.9	554	843×10^3	169×10^2	34.6	674.6	804×10^3	161×10^2		693.4	544	788×10^3	158×10^2		693.9	545	782×10^3	156×10^2	647.6	508	714×10^3	143×10^2	636.5	500	675×10^3	135×10^2	651.1	511
	24	735.9	578	877×10^3	175×10^2	34.5	704.5	838×10^3	168×10^2		721.4	566	820×10^3	164×10^2		721.6	566	814×10^3	163×10^2	673.0	528	743×10^3	149×10^2	660.5	519	703×10^3	141×10^2	675.1	530
	25	765.8	601	911×10^3	182×10^2	34.5	734.4	871×10^3	175×10^2		749.4	588	851×10^3	170×10^2		749.4	588	845×10^3	169×10^2	698.3	548	772×10^3	154×10^2	684.5	537	730×10^3	146×10^2	699.0	549

Sectional Properties

※Moment of Inertia and Section Modulus are the same as (P – P type) t = 9mm

		Steel Pipe Piles								Steel Pipe Sheet Piles																	
		Corrosion allowance (0mm)					Corrosion allowance (1mm)			Per 1m of pile wall width (L – T type) L65 × 65 × 8					Per 1m of pile wall width (L – T type) L75 × 75 × 9					Per 1m of pile wall width (P – T type)				Per 1m of pile wall width (P – P type) t = 9mm				Per 1m of pile wall width (P – P type) t = 11mm ※	
Diameter	Thickness	Sectional area	Unit weight	Moment of inertia	Section modulus	Radius of gyration	Sectional area	Moment of inertia	Section modulus	Junction gap J65	Sectional area	Unit weight	Moment of inertia	Section modulus	Junction gap J75	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight
mm	mm	cm^2	kg/m	cm^4	cm^3	cm	cm^2	cm^4	cm^3	mm	cm^2/m	kg/m	cm^4	cm^3	mm	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m
1100	11	376.3	295	558×10^3	101×10^2	38.5	341.8	506×10^3	921×10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	12	410.2	322	607×10^3	110×10^2	38.5	375.6	555×10^3	101×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	13	443.9	348	656×10^3	119×10^2	38.4	409.4	604×10^3	110×10^2		409.9	322	560×10^3	102×10^2		412.1	323	557×10^3	101×10^2	392.2	308	512×10^3	932×10	395.0	310	487×10^3	883×10	408.4	321
	14	477.6	375	704×10^3	128×10^2	38.4	443.1	652×10^3	119×10^2		438.7	344	602×10^3	109×10^2		440.7	346	598×10^3	109×10^2	418.5	329	550×10^3	100×10^2	420.0	330	522×10^3	950×10	433.4	340
	15	511.3	401	753×10^3	137×10^2	38.4	476.8	700×10^3	128×10^2		467.5	367	643×10^3	117×10^2		469.3	368	639×10^3	116×10^2	444.8	349	588×10^3	107×10^2	445.0	349	559×10^3	102×10^2	458.4	360
	16	544.9	428	800×10^3	146×10^2	38.3	510.4	748×10^3	136×10^2		496.2	389	684×10^3	124×10^2		497.8	391	679×10^3	124×10^2	471.0	370	625×10^3	114×10^2	469.9	369	594×10^3	108×10^2	483.3	379
	17	578.4	454	848×10^3	154×10^2	38.3	543.9	796×10^3	145×10^2		524.8	412	725×10^3	132×10^2		526.3	413	720×10^3	131×10^2	497.2	390	663×10^3	120×10^2	494.7	388	629×10^3	114×10^2	508.2	399
	18	611.9	480	896×10^3	163×10^2	38.3	577.3	844×10^3	154×10^2		553.4	434	765×10^3	139×10^2		554.7	435	760×10^3	138×10^2	523.4	411	700×10^3	127×10^2	519.6	408	665×10^3	121×10^2	533.0	418
	19	645.3	506	943×10^3	171×10^2	38.2	610.7	891×10^3	162×10^2	70.2	581.9	457	806×10^3	146×10^2	78.1	583.0	458	800×10^3	146×10^2	549.5	431	737×10^3	134×10^2	544.3	427	700×10^3	127×10^2	557.8	438
	20	678.6	533	990×10^3	180×10^2	38.2	644.1	938×10^3	171×10^2		610.4	479	846×10^3	154×10^2		611.3	480	840×10^3	153×10^2	575.5	452	773×10^3	141×10^2	569.1	447	735×10^3	134×10^2	582.5	457
	21	711.9	559	104×10^4	188×10^2	38.2	677.3	984×10^3	179×10^2		638.9	502	886×10^3	161×10^2		639.5	502	880×10^3	160×10^2	601.6	472	810×10^3	147×10^2	593.7	466	769×10^3	140×10^2	607.2	477
	22	745.1	585	108×10^4	197×10^2	38.1	710.5	103×10^4	188×10^2		667.2	524	925×10^3	168×10^2		667.7	524	919×10^3	167×10^2	627.5	493	846×10^3	154×10^2	618.3	485	803×10^3	146×10^2	631.8	496
	23	778.2	611	113×10^4	205×10^2	38.1	743.7	108×10^4	196×10^2		695.6	546	965×10^3	175×10^2		695.9	546	958×10^3	174×10^2	653.4	513	882×10^3	160×10^2	642.9	505	838×10^3	152×10^2	656.4	515
	24	811.3	637	117×10^4	214×10^2	38.1	776.8	112×10^4	204×10^2		723.8	568	100×10^4	183×10^2		723.9	568	997×10^3	181×10^2	679.3	533	918×10^3	167×10^2	667.5	524	872×10^3	158×10^2	681.0	535
	25	844.3	663	122×10^4	222×10^2	38.0	809.8	117×10^4	213×10^2		752.1	590	104×10^4	190×10^2		752.0	590	104×10^4	188×10^2	705.1	553	953×10^3	173×10^2	692.0	543	905×10^3	165×10^2	705.4	554
1200	12	447.9	352	790×10^3	132×10^2	42.0	410.2	723×10^3	121×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	13	484.8	381	854×10^3	142×10^2	42.0	447.1	786×10^3	131×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	14	521.6	409	917×10^3	153×10^2	41.9	484.0	850×10^3	142×10^2		438.6	344	722×10^3	120×10^2		440.4	346	717×10^3	120×10^2	420.1	330	665×10^3	111×10^2	421.4	331	633×10^3	106×10^2	433.8	341
	15	558.4	438	980×10^3	163×10^2	41.9	520.8	913×10^3	152×10^2		467.6	367	772×10^3	129×10^2		469.2	368	767×10^3	128×10^2	446.7	351	710×10^3	118×10^2	446.8	351	677×10^3	113×10^2	459.3	360
	16	595.1	467	104×10^4	174×10^2	41.9	557.5	975×10^3	163×10^2		496.5	390	821×10^3	137×10^2		497.9	391	816×10^3	136×10^2	473.3	372	756×10^3	126×10^2	472.1	371	718×10^3	120×10^2	484.6	380
	17	631.8	496	111×10^4	184×10^2	41.8	594.1	104×10^4	173×10^2		525.3	412	870×10^3	145×10^2		526.6	413	865×10^3	144×10^2	499.9	392	801×10^3	134×10^2	497.5	390	767×10^3	127×10^2	510.0	400
	18	668.4	525	117×10^4	195×10^2	41.8	630.7	110×10^4	184×10^2		554.1	435	919×10^3	153×10^2		555.2	436	913×10^3	152×10^2	526.4	413	846×10^3	141×10^2	522.7	410	808×10^3	135×10^2	535.2	420
	19	704.9	553	123×10^4	205×10^2	41.8	667.3	116×10^4	194×10^2		582.9	458	968×10^3	161×10^2		583.8	458	961×10^3	160×10^2	552.9	434	891×10^3	148×10^2	548.0	430	850×10^3	142×10^2	560.5	440
	20	741.4	582	129×10^4	215×10^2	41.7	703.7	122×10^4	204×10^2	70.6	611.6	480	102×10^4	169×10^2	78.7	612.3	481	101×10^4	168×10^2	579.3	455	935×10^3	156×10^2	573.2	450	891×10^3	149×10^2	585.7	460
	21	777.8	611	135×10^4	225×10^2	41.7	740.2	128×10^4	214×10^2		640.3	503	106×10^4	177×10^2		640.8	503	106×10^4	176×10^2	605.7	475	980×10^3	163×10^2	598.3	470	932×10^3	155×10^2	610.8	479
	22	814.2	639	141×10^4	235×10^2	41.7	776.5	135×10^4	225×10^2		668.9	525	111×10^4	185×10^2		669.2	525	110×10^4	184×10^2	632.1	496	102×10^4	171×10^2	623.4	489	974×10^3	162×10^2	635.9	499
	23	850.5	668	147×10^4	246×10^2	41.6	812.8	141×10^4	235×10^2		697.4	547	116×10^4	193×10^2		697.6	548	115×10^4	192×10^2	658.4	517	107×10^4	178×10^2	648.4	509	102×10^4	170×10^2	661.0	519
	24	886.7	696	153×10^4	256×10^2	41.6	849.0	147×10^4	245×10^2		725.9	570	121×10^4	201×10^2		725.9	570	120×10^4	200×10^2	684.7	537	111×10^4	185×10^2	673.4	529	106×10^4	177×10^2	686.0	538
	25	922.8	724	159×10^4	266×10^2	41.6	885.2	153×10^4	255×10^2		754.4	592	125×10^4	209×10^2		754.2	592	125×10^4	208×10^2	710.9	558	115×10^4	192×10^2	698.4	548	110×10^4	183×10^2	711.0	558
1300	13	525.6	413	109×10^4	167×10^2	45.5	484.8	100×10^4	154×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	14	565.6	444	117×10^4	180×10^2	45.5	524.8	108×10^4	167×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	15	605.5	475	125×10^4	192×10^2	45.4	564.7	116×10^4	179×10^2		467.7	367	912×10^3	140×10^2		469.2	368	906×10^3	139×10^2	448.4	352	845×10^3	130×10^2	448.3	352	808×10^3	124×10^2	460.0	361
	16	645.4	507	133×10^4	205×10^2	45.4	604.6	124×10^4	192×10^2		496.8	390	970×10^3	149×10^2		498.1	391	965×10^3	148×10^2	475.3	373	899×10^3	138×10^2	474.1	372	859×10^3	132×10^2	485.8	381
	17	685.2	538	141×10^4	217×10^2	45.4	644.4	132×10^4	204×10^2		525.8	413	103×10^4	158×10^2		526.9	414	102×10^4	157×10^2	502.2	394	953×10^4	147×10^2	499.8	392	911×10^3	140×10^2	511.5	402
	18	725.0	569	149×10^4	229×10^2	45.3	684.1	140×10^4	216×10^2		554.8	435	109×10^4	167×10^2		555.8	436	108×10^4	166×10^2	529.1	415	101×10^4	155×10^2	525.5	412	963×10^3	148×10^2	537.2	422
	19	764.6	600	157×10^4	241×10^2	45.3	723.8	148×10^4	228×10^2		583.7	458	114×10^4	176×10^2		584.5	459	114×10^4	175×10^2	555.9	436	106×10^4	163×10^2	551.1	433	101×10^4	156×10^2	562.8	442
	20	804.2	631	165×10^4	253×10^2	45.3	763.4	156×10^4	241×10^2	71.1	612.6	481	120×10^4	185×10^2	79.2	613.2	481	119×10^4	184×10^2	582.7	457	111×10^4	171×10^2	576.7	453	107×10^4	163×10^2	588.4	462
	21	843.8	662	173×10^4	266×10^2	45.2	803.0	164×10^4	253×10^2		641.5	504	126×10^4	194×10^2		641.9	504	125×10^4	193×10^2	609.4	478	117×10^4	179×10^2	602.3	473	112×10^4	172×10^2	614.0	482
	22	883.3	693	180×10^4	278×10^2	45.2	842.5	172×10^4	265×10^2		670.3	526	132×10^4	202×10^2		670.6	526	131×10^4	201×10^2	636.0	499	122×10^4	188×10^2	627.8	493	116×10^4	180×10^2	639.5	502
	23	922.7	724	188×10^4	289×10^2	45.2	881.9	180×10^4	277×10^2		699.0	549	137×10^4	211×10^2		699.1	549	136×10^4	210×10^2	662.7	520	127×10^4	196×10^2	653.3	513	121×10^4	187×10^2	665.0	522
	24	962.1	755	196×10^4	301×10^2	45.1	921.3	187×10^4	289×10^2		727.8	571	143×10^4	220×10^2		727.7	571	142×10^4	218×10^2	689.3	541	132×10^4	204×10^2	678.7	533	127×10^4	194×10^2	690.4	542
	25	1001.4	786	204×10^4	313×10^2	45.1	960.6	195×10^4	300×10^2		756.4	594	148×10^4	228×10^2		756.2	594	148×10^4	227×10^2	715.9	562	138×10^4	212×10^2	704.0	553	132×10^4	202×10^2	715.8	562
1400	14	609.6	478	146×10^4	209×10^2	49.0	565.6	136×10^4	194×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	15	652.7	512	157×10^4	224×10^2	49.0	608.7	146×10^4	209×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	16	695.7	546	167×10^4	238×10^2	48.9	651.7	156×10^4	223×10^2		497.1	390	113×10^4	162×10^2		498.2	391	113×10^4	161×10^2	477.0	375	105×10^4	151×10^2	475.8	374	101×10^4	144×10^2	486.8	382
	17	738.6	580	177×10^4	252×10^2	48.9	694.7	166×10^4	237×10^2		526.3	413	120×10^4	171×10^2		527.3	414	119×10^4	171×10^2	504.2	396	112×10^4	160×10^2	501.9	394	107×10^4	153×10^2	512.9	403
	18	781.5	613	187×10^4	267×10^2	48.9	737.6	176×10^4	252×10^2		555.4	436	127×10^4	181×10^2		556.2	434	126×10^4	180×10^2	531.4	417	118×10^4	169×10^2	527.9	414	113×10^4	162×10^2	538.9	423
	19	824.3	647	197×10^4	281×10^2	48.8	780.4	186×10^4	266×10^2		584.5	459	134×10^4	191×10^2		585.2	459	133×10^4	190×10^2	558.5	438	124×10^4	178×10^2	553.9	435	120×10^4	171×10^2	564.9	443
	20	867.1	681	206×10^4	295×10^2	48.8	823.1	196×10^4	280×10^2	71.5	613.6	482	140×10^4	200×10^2	79.7	614.1	482	140×10^4	199×10^2	585.6	460	131×10^4	187×10^2	579.9	455	125×10^4	179×10^2	590.8	464
	21	909.8	714	216×10^4	309×10^2	48.8	865.8	206×10^4	294×10^2		642.6	504	147×10^4	210×10^2		642.9	505	146×10^4	209×10^2	612.6	481	137×10^4	196×10^2	605.8	476	131×10^4	188×10^2	616.8	484
	22	952.4	748	226×10^4	323×10^2	48.7	908.5	215×10^4	308×10^2		671.5	527	154×10^4	220×10^2		671.7	527	153×10^4	218×10^2	639.6	502	143×10^4	204×10^2	631.6	496	137×10^4	196×10^2	642.6	504
	23	995.0	781	236×10^4	337×10^2	48.7	951.0	225×10^4	322×10^2		700.5	550	160×10^4	229×10^2		700.5	550	159×10^4	228×10^2	666.5	523	149×10^4	213×10^2	657.5	516	143×10^4	205×10^2	668.4	525
	24	1037.5	814	246×10^4	351×10^2	48.7	993.5	235×10^4	336×10^2		729.4	572	167×10^4	238×10^2		729.2	572	166×10^4	237×10^2	693.4	544	155×10^4	222×10^2	683.3	536	149×10^4	213×10^2	694.2	545
	25	1079.9	848	255×10^4	365×10^2	48.6	1036.0	245×10^4	350×10^2		758.2	595	174×10^4	248×10^2		757.9	595	173×10^4	246×10^2	720.3	565	162×10^4	231×10^2	709.0	557	155×10^4	221×10^2	720.0	565
1500	15	699.8	549	193×10^4	257×10^2	52.5	652.7	180×10^4	240×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	16	745.9	586	205×10^4	274×10^2	52.5	698.8	192×10^4	257×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	17	792.0	622	218×10^4	290×10^2	52.4	744.9	205×10^4	273×10^2		526.6	413	139×10^4	185×10^2		527.6	414	138×10^4	184×10^2	506.0	397	130×10^4	173×10^2	503.7	395	125×10^4	166×10^2	514.1	404
	18	838.1	658	230×10^4	307×10^2	52.4	791.0	217×10^4	290×10^2		555.9	436	146×10^4	195×10^2		556.7	437	146×10^4	194×10^2	533.4	419	137×10^4	183×10^2	530.1	416	132×10^4	176×10^2	540.4	424
	19	884.0	694	242×10^4	323×10^2	52.4	836.9	229×10^4	306×10^2		585.2	459	154×10^4	206×10^2		585.8	460	153×10^4	205×10^2	560.8	440	144×10^4	192×10^2	556.4	437	138×10^4	185×10^2	566.7	445
	20	929.9	730	255×10^4	340×10^2	52.3	882.8	241×10^4	322×10^2		614.4	482	162×10^4	216×10^2		614.8	483	161×10^4	215×10^2	588.1	462	152×10^4	202×10^2	582.6	457	146×10^4	195×10^2	593.0	465
	21	975.7	766	267×10^4	356×10^2	52.3	928.7	254×10^4	339×10^2	71.7	643.5	505	170×10^4	226×10^2	80.1	643.8	505	169×10^4	225×10^2	615.4	483	159×10^4	212×10^2	608.9	478	153×10^4	204×10^2	619.2	486
	22	1021.5	802	279×10^4	372×10^2	52.3	974.4	266×10^4	355×10^2		672.7	528	178×10^4	237×10^2		672.8	528	177×10^4	235×10^2	642.6	504	166×10^4	221×10^2	635.0	498	160×10^4	213×10^2	645.4	507
	23	1067.2	838	291×10^4	388×10^2	52.2	1020.1	278×10^4	371×10^2		701.7	551	185×10^4	247×10^2		701.7	551	184×10^4	246×10^2	669.8	526	173×10^4	231×10^2	661.2	519	166×10^4	222×10^2	671.6	527
	24	1112.9	874	303×10^4	404×10^2	52.2	1065.8	290×10^4	387×10^2		730.8	574	193×10^4	257×10^2		730.6	573	192×10^4	256×10^2	697.0	547	180×10^4	241×10^2	687.3	540	173×10^4	231×10^2	697.7	548
	25	1158.5	909	315×10^4	420×10^2	52.2	1111.4	302×10^4	403×10^2		759.8	596	201×10^4	267×10^2		759.5	596	199×10^4	266×10^2	724.1	568	188×10^4	250×10^2	713.4	560	180×10^4	240×10^2	723.8	568

Sectional Properties

※Moment of Inertia and Section Modulus are the same as (P – P type) t = 9mm

		Steel Pipe Piles								Steel Pipe Sheet Piles																	
		Corrosion allowance (0mm)					Corrosion allowance (1mm)			Per 1m of pile wall width (L – T type) L65 × 65 × 8					Per 1m of pile wall width (L – T type) L75 × 75 × 9					Per 1m of pile wall width (P – T type)				Per 1m of pile wall width (P – P type) t = 9mm				Per 1m of pile wall width (P – P type) t = 11mm ※	
Diameter	Thickness	Sectional area	Unit weight	Moment of inertia	Section modulus	Radius of gyration	Sectional area	Moment of inertia	Section modulus	Junction gap J65	Sectional area	Unit weight	Moment of inertia	Section modulus	Junction gap J75	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight	Moment of inertia	Section modulus	Sectional area	Unit weight
mm	mm	cm^2	kg/m	cm^4	cm^3	cm	cm^2	cm^4	cm^3	mm	cm^2/m	kg/m	cm^4	cm^3	mm	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m	cm^4	cm^3	cm^2/m	kg/m
1600	16	796.2	625	250×10^4	312×10^2	56.0	746.0	234×10^4	292×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	17	845.4	664	265×10^4	331×10^2	56.0	795.2	249×10^4	311×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	18	894.6	702	280×10^4	350×10^2	55.9	844.4	264×10^4	330×10^2		556.4	437	167×10^4	209×10^2		557.1	437	167×10^4	208×10^2	535.2	420	157×10^4	197×10^2	532.0	418	152×10^4	189×10^2	541.8	425
	19	943.7	741	295×10^4	369×10^2	55.9	893.5	279×10^4	349×10^2		585.8	460	176×10^4	220×10^2		586.3	460	175×10^4	219×10^2	562.8	442	166×10^4	207×10^2	558.6	438	160×10^4	200×10^2	568.4	446
	20	992.7	779	310×10^4	387×10^2	55.9	942.5	294×10^4	368×10^2		615.1	483	185×10^4	232×10^2		615.5	483	184×10^4	230×10^2	590.3	463	174×10^4	218×10^2	585.1	459	168×10^4	209×10^2	594.9	467
	21	1041.7	818	325×10^4	406×10^2	55.8	991.5	309×10^4	386×10^2		644.4	506	194×10^4	243×10^2		644.7	506	193×10^4	242×10^2	617.9	485	182×10^4	228×10^2	611.6	480	176×10^4	220×10^2	621.4	488
	22	1090.6	856	340×10^4	424×10^2	55.8	1040.4	323×10^4	405×10^2	72.0	673.7	529	203×10^4	254×10^2	80.4	673.8	529	202×10^4	253×10^2	645.4	507	191×10^4	238×10^2	638.1	501	184×10^4	229×10^2	647.9	509
	23	1139.5	894	354×10^4	443×10^2	55.8	1089.3	338×10^4	423×10^2		702.9	552	212×10^4	265×10^2		702.8	552	211×10^4	264×10^2	672.8	528	199×10^4	249×10^2	664.5	522	192×10^4	240×10^2	674.3	529
	24	1188.3	933	369×10^4	461×10^2	55.7	1138.0	353×10^4	442×10^2		732.1	575	221×10^4	276×10^2		731.9	574	220×10^4	274×10^2	700.2	550	207×10^4	259×10^2	690.9	542	200×10^4	249×10^2	700.7	550
	25	1237.0	971	384×10^4	480×10^2	55.7	1186.8	368×10^4	460×10^2		761.2	597	229×10^4	287×10^2		760.9	597	228×10^4	285×10^2	727.6	571	216×10^4	269×10^2	717.3	563	208×10^4	260×10^2	727.1	571
1700	17	898.8	706	318×10^4	374×10^2	59.5	845.5	299×10^4	352×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	18	951.1	747	336×10^4	396×10^2	59.5	897.8	317×10^4	374×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	19	1003.4	788	354×10^4	417×10^2	59.4	950.0	335×10^4	395×10^2		586.3	460	200×10^4	235×10^2		586.8	461	199×10^4	234×10^2	564.7	443	189×10^4	222×10^2	560.5	440	182×10^4	214×10^2	569.8	447
	20	1055.6	829	372×10^4	438×10^2	59.4	1002.2	353×10^4	416×10^2		615.8	483	210×10^4	247×10^2		616.1	484	209×10^4	246×10^2	592.4	465	198×10^4	233×10^2	587.3	461	191×10^4	225×10^2	596.6	468
	21	1107.7	869	390×10^4	459×10^2	59.4	1054.3	371×10^4	437×10^2		645.2	506	220×10^4	259×10^2		645.4	507	219×10^4	258×10^2	620.2	487	208×10^4	244×10^2	614.0	482	200×10^4	236×10^2	623.4	489
	22	1159.8	910	408×10^4	480×10^2	59.3	1106.4	389×10^4	458×10^2		674.6	530	230×10^4	271×10^2		674.6	530	229×10^4	270×10^2	647.8	509	217×10^4	255×10^2	640.8	503	210×10^4	247×10^2	650.1	510
	23	1211.7	951	426×10^4	501×10^2	59.3	1158.4	407×10^4	479×10^2	72.2	703.9	553	240×10^4	283×10^2	80.7	703.8	552	239×10^4	281×10^2	675.5	530	227×10^4	267×10^2	667.5	524	219×10^4	257×10^2	676.8	531
	24	1263.7	992	444×10^4	522×10^2	59.3	1210.3	425×10^4	500×10^2		733.2	576	250×10^4	295×10^2		733.0	575	249×10^4	293×10^2	703.1	552	236×10^4	278×10^2	694.1	545	228×10^4	268×10^2	703.4	552
	25	1315.5	1033	461×10^4	543×10^2	59.2	1262.2	442×10^4	521×10^2		762.5	599	260×10^4	306×10^2		762.1	598	259×10^4	305×10^2	730.7	574	245×10^4	289×10^2	720.7	566	237×10^4	279×10^2	730.1	573
1800	18	1007.7	791	400×10^4	444×10^2	63.0	951.2	377×10^4	420×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	19	1063.1	834	422×10^4	468×10^2	63.0	1006.6	399×10^4	443×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	20	1118.4	878	443×10^4	492×10^2	62.9	1061.9	420×10^4	467×10^2		616.4	484	237×10^4	263×10^2		616.7	484	236×10^4	262×10^2	594.2	466	224×10^4	249×10^2	589.3	463	216×10^4	240×10^2	598.2	470
	21	1173.7	921	464×10^4	516×10^2	62.9	1117.2	442×10^4	491×10^2		645.9	507	248×10^4	276×10^2		646.1	507	247×10^4	274×10^2	622.1	488	235×10^4	261×10^2	616.3	484	227×10^4	252×10^2	625.2	491
	22	1228.9	965	486×10^4	540×10^2	62.9	1172.3	463×10^4	515×10^2		675.4	530	259×10^4	288×10^2		675.4	530	258×10^4	287×10^2	650.0	510	245×10^4	273×10^2	643.3	505	237×10^4	264×10^2	652.1	512
	23	1284.0	1008	507×10^4	563×10^2	62.8	1227.5	484×10^4	538×10^2	72.4	704.8	553	271×10^4	301×10^2	81.0	704.7	553	269×10^4	299×10^2	677.8	532	256×10^4	284×10^2	670.2	526	248×10^4	275×10^2	679.0	533
	24	1339.1	1051	528×10^4	587×10^2	62.8	1282.6	505×10^4	562×10^2		734.2	576	282×10^4	313×10^2		734.0	576	281×10^4	312×10^2	705.6	554	267×10^4	296×10^2	697.1	547	258×10^4	287×10^2	705.9	554
	25	1394.1	1094	549×10^4	610×10^2	62.8	1337.6	526×10^4	585×10^2		763.6	599	293×10^4	326×10^2		763.2	599	292×10^4	324×10^2	733.4	576	277×10^4	308×10^2	723.9	568	268×10^4	298×10^2	732.8	575
1900	19	1122.8	881	497×10^4	523×10^2	66.5	1063.1	470×10^4	495×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	20	1181.2	927	522×10^4	549×10^2	66.5	1121.6	495×10^4	522×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	21	1239.6	973	547×10^4	576×10^2	66.4	1180.0	520×10^4	548×10^2		646.5	508	277×10^4	292×10^2		646.7	508	276×10^4	291×10^2	624.0	490	263×10^4	277×10^2	618.3	485	255×10^4	268×10^2	626.8	492
	22	1298.0	1019	572×10^4	602×10^2	66.4	1238.3	545×10^4	575×10^2		676.1	531	290×10^4	305×10^2		676.1	531	289×10^4	304×10^2	652.0	512	275×10^4	290×10^2	645.5	507	266×10^4	280×10^2	653.9	513
	23	1356.3	1065	597×10^4	629×10^2	66.4	1296.6	570×10^4	601×10^2	72.6	705.6	554	303×10^4	319×10^2	81.2	705.5	554	302×10^4	317×10^2	680.0	534	287×10^4	302×10^2	672.6	528	278×10^4	293×10^2	681.0	535
	24	1414.5	1110	622×10^4	655×10^2	66.3	1354.8	595×10^4	627×10^2		735.2	577	315×10^4	332×10^2		734.9	577	314×10^4	331×10^2	708.0	556	299×10^4	315×10^2	699.7	549	290×10^4	305×10^2	708.2	556
	25	1472.6	1156	647×10^4	681×10^2	66.3	1413.0	620×10^4	654×10^2		764.6	600	328×10^4	345×10^2		764.3	600	327×10^4	344×10^2	736.0	578	311×10^4	328×10^2	726.8	570	301×10^4	317×10^2	735.2	577
2000	20	1244.1	977	610×10^4	610×10^2	70.0	1181.3	578×10^4	579×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	21	1305.6	1025	639×10^4	639×10^2	70.0	1242.8	608×10^4	608×10^2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	22	1367.1	1073	669×10^4	669×10^2	69.9	1304.3	637×10^4	638×10^2		676.8	531	323×10^4	323×10^2		676.8	531	321×10^4	321×10^2	653.8	513	307×10^4	307×10^2	647.5	508	298×10^4	298×10^2	655.6	515
	23	1428.5	1121	698×10^4	698×10^2	69.9	1365.7	667×10^4	667×10^2		706.4	554	337×10^4	337×10^2		706.3	554	335×10^4	335×10^2	681.9	535	320×10^4	320×10^2	674.8	530	311×10^4	311×10^2	682.9	536
	24	1489.9	1169	727×10^4	727×10^2	69.9	1427.1	696×10^4	697×10^2	72.8	736.0	578	351×10^4	351×10^2	81.4	735.8	578	349×10^4	349×10^2	710.1	557	334×10^4	334×10^2	702.1	551	323×10^4	323×10^2	710.2	557
	25	1551.2	1218	756×10^4	756×10^2	69.8	1488.4	725×10^4	726×10^2		765.6	601	365×10^4	365×10^2		765.2	601	363×10^4	363×10^2	738.2	579	347×10^4	347×10^2	729.4	573	336×10^4	336×10^2	737.5	579
2100	21	1371.6	1077	741×10^4	706×10^2	73.5	1305.6	705×10^4	672×10^2																				
	22	1436.2	1127	775×10^4	738×10^2	73.5	1370.3	739×10^4	704×10^2																				
	23	1500.8	1178	809×10^4	771×10^2	73.4	1434.8	773×10^4	737×10^2																				
	24	1565.3	1229	843×10^4	803×10^2	73.4	1499.3	807×10^4	769×10^2																				
	25	1629.7	1279	877×10^4	835×10^2	73.4	1563.8	841×10^4	802×10^2																				
2200	22	1505.3	1182	893×10^4	812×10^2	77.0	1436.2	851×10^4	774×10^2																				
	23	1573.0	1235	932×10^4	847×10^2	77.0	1503.9	890×10^4	810×10^2																				
	24	1640.7	1288	971×10^4	883×10^2	76.9	1571.6	929×10^4	846×10^2																				
	25	1708.2	1341	101×10^5	918×10^2	76.9	1639.2	969×10^4	881×10^2																				
2300	23	1645.3	1291	107×10^5	927×10^2	80.5	1573.1	102×10^5	887×10^2																				
	24	1716.1	1347	111×10^5	966×10^2	80.5	1643.8	106×10^5	926×10^2																				
2400	24	1791.5	1406	126×10^5	105×10^3	84.0	1716.1	121×10^5	101×10																				
	25	1865.3	1464	132×10^5	110×10^3	84.0	1790.0	126×10^5	105×10																				
2500	25	1943.9	1526	149×10^5	119×10^3	87.5	1865.4	143×10^5	114×10																				
2600	25	2022.4	1588	168×10^5	129×10^3	91.0	1940.8	161×10^5	124×10																				
2700	24	2017.7	1584	181×10^5	134×10^3	94.6	1932.9	173×10^5	128×10																				
2800	23	2006.6	1575	193×10^5	138×10^3	98.2	1918.6	185×10^5	132×10																				
2900	23	2078.8	1632	215×10^5	148×10^3	101.7	1987.7	206×10^5	142×10																				
3000	22	2058.2	1616	228×10^5	152×10^3	105.3	1964.0	218×10^5	145×10																				

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