



Realizing reasonable pile driving into bedrock Rock Pile Driving (GANPILE) Method

Former NETIS Registration :Registration No. KT-990499-V

Independent inspection certificate for private developed
construction technique in the field of port and harbor
(Coastal Development Institute of Technology) :Certificate No. 21004号



Rock Pile Driving (GANPILE) Method Research Society

What is GANPILE Method ?

GANPILE is reasonable pile driving method to embed steel pile into bedrock



Specialized vibratory hammer "GANPILER".

Ordinarily in case of pile driving into bedrock, the following two steps are required.

1. Drilling a hole in rock
2. Install a pile into the hole

In contrast GANPILE Method enables a pile to drive directly into hard rock by means of special tough tip metal equipped steel pile.

Piles are driven by specialized vibratory hammer "GANPILER".

("GANPILER" is durable enough to operate for long time in bedrock.)

Low-pressure water jet from pile tip removes crushed powder rock during pile driving to ensure efficient energy transmission.



Special tough metal attached to pile tip prevents damage of pile body.

Strong points

Short construction period and less construction cost

Piles are driven to bedrock directly, so that both construction period and construction cost can be minimized.

Reliable bearing capacity of pile

Calculation formula to estimate bearing capacity of pile embedded in rock is evaluated by Coastal Development Institute of Technology in Japan. In case of steel pipe pile and steel pipe sheet pile, pull-out resistance of pile also can be counted by filling grout into clearance between pile and bedrock.

Less water pollution

A pile is driven with small amount of low-pressure jetted water, so that constructor can minimize amount of polluted water. GANPILE Method doesn't discharge lubricant oil unlike down the hall hammer method.

Simple equipment

Specialized vibratory hammer "GANPILER" is employed for pile driving. Other special equipment are not required.

Easy quality control

Construction step is simple, because pre-drilling is not required unlike ordinary method. Actual depth of bedrock can be confirmed by penetration amount of driven pile directly.

High adaptability

GANPILE Method is applicable to various kind of rock from soft rock to hard rock as well as to various steel piles such as H-shaped pile, sheet pile and pipe pile.

Public certificate

- NETIS Registration : Registration No. KT-990499-V
- Independent inspection certificate for private developed construction technique in the field of port and harbor (Coastal Development Institute of Technology)
: Certificate No. 15005
 - June 14, 2016 (No. 15005)
 - March 31, 2022 (No. 21004) – Content Revised



Three featured technique of GANPILE Method

Specialized vibratory hammer "GANPILER"



"GANPILER" is motor driven vibratory hammer equipped with a water cooling system which enables extra long time operation.

Low-pressure jetted water machine



Small amount of low-pressure jetted water (Approx. 4MPa×40L/minute) removes crushed powder rock to ensure efficient energy transmission.

Special tough metal at pile tip

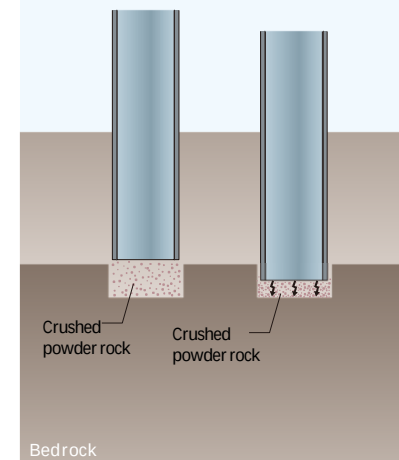


Highly durable tip metal prevents damage of pile body.

Comparison with ordinary water jet vibratory hammer method

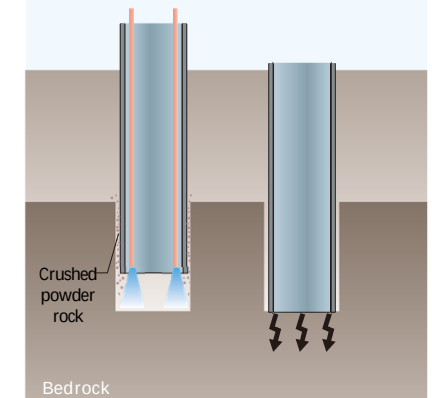
Ordinary method

During pile driving, crushed powder rock that generates while driving takes on a role as cushion material. Impact energy from the hammer can't be transmitted directly to rock.



GANPILE Method

During pile driving, low-pressure jetted water removes crushed powder rock efficiently. Impact energy from the hammer can be transmitted directly to rock. As a result, GANPILE Method makes a pile possible to drive to hard rock.



GANPILE Method Technical Information

Applicable scope

1 Applicable ground

- Hard rock and soft rock (including stiff clay layers) whose unconfined compressive strength (q_u) is $q_u \leq 100 \text{ MN/m}^2$ *1
- Riprap layer, boulder stone, cobble stone layer *2

*1: There are application records to rock whose unconfined compressive strength is $q_u > 100 \text{ MN/m}^2$. Consult us about the application of ground and steel materials other than the above.

*2: The criteria derived from actual performance with a riprap layer of existing seawall are a stone diameter of $\phi 40 \text{ cm}$ or less and a layer thickness of 5m or less.

2 Applicable steel

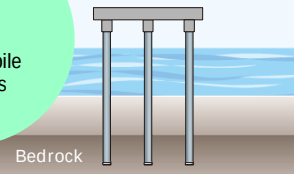
1. Steel pipe pile, steel pipe sheet pile
Good construction results with $\phi 318.5$ to 1500mm and maximum length of 54m.
2. Steel sheet pile
Can be used for steel sheet piles of 400 to 600mm width.
3. H-shaped steel pile
Many good results have been obtained with H-shaped steel piles of H300 x 300 to H400 x 400mm

※For the application of steel materials other than those listed above, please contact us.

Main usages

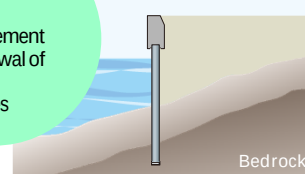
Foundation for port & harbor structure

- Pier pile
- Jacket pile
- Mooring pile
- Coast levee pile
- Coastal roads



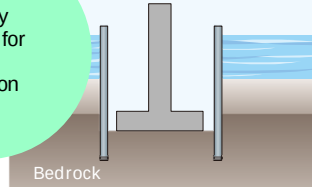
Quay and seawall structure

- Quay
- Seawall
- Reinforcement and renewal of existing structures



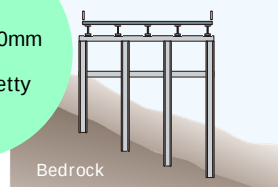
Temporary cofferdam, Earth retaining wall, Temporary jetty Cut off wall

- Temporary cofferdam for main construction

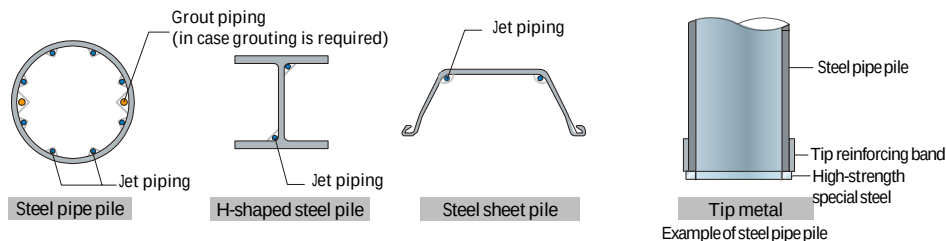


Temporary jetty

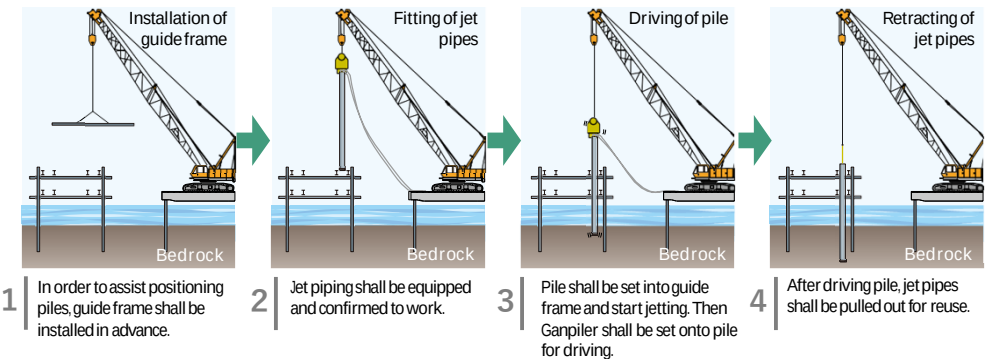
- H300x300 to H400x400mm as piles for temporary jetty



Jet piping, Grout piping, Tip metal



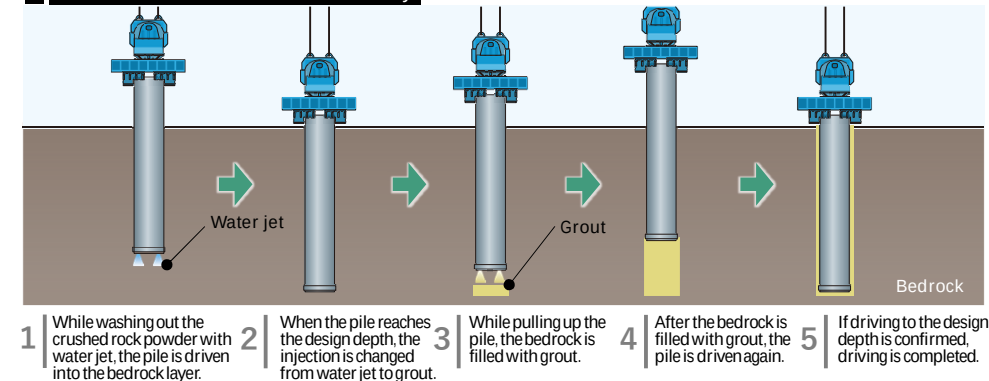
Construction procedure (example of offshore construction)



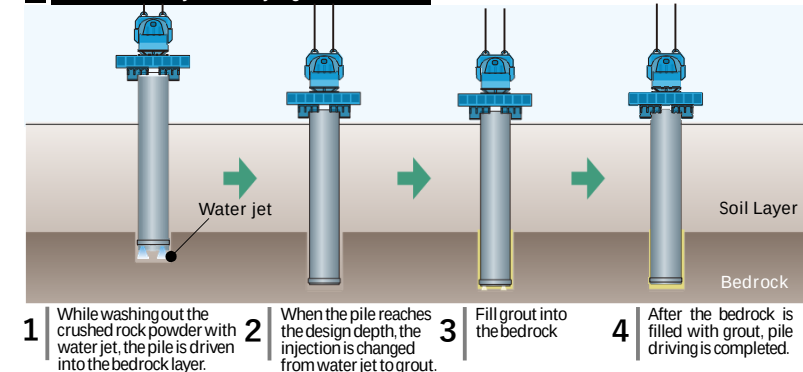
In case grout is filled in bedrock layer

In case frictional resistance is counted in the bedrock layer, grout shall be filled into clearance between pile surface and rock.

1 Case of Pile Embedment in Bedrock Only



2 Case of Soil Layer Overlying Bedrock



Technical information of GANPILE Method

Independent inspection and evaluation
by Coastal Development Institute of Technology in Japan

Summary of evaluation

- (1) After filling grout into clearance between a pile and rock, sufficient amount of grout was observed. (Grout was mixed at specified ratio and filling amount was being controlled.)
- (2) End bearing capacity of a pile at rock could be calculated by net cross-sectional area of a pile tip and parameters of rock mechanics. (Net cross-sectional area: Area of a pile tip except for tip metal and reinforcement band)
- (3) In case of hard rock ($5\text{MN/m}^2 \leq \text{Unconfined compression strength } q_u \leq 100\text{MN/m}^2$), enough frictional resistance was measured. (Specified grout (Target strength $\geq 7\text{MN/m}^2$) was filled and work procedure was being controlled.)
- (4) Compared with ordinary pile driving method for rock utilizing supplementary method, construction efficiency of GANPILE Method was high. Thus, construction period could be shortened.

Equation for Estimating the Characteristic Value of Resistance

※ Consult a member company of the research society in advance to consider the GANPILE Method.

1 End bearing capacity (pushing resistance)

$$R_{pk} = 5 \cdot q_u \cdot A_t$$

R_{pk} : Characteristic value of end bearing capacity (kN)
 q_u : Unconfined compression strength at bedrock (kN/m²)
 A_t : Net cross-sectional area of a pile tip (m²)
 ※ Net cross-sectional area of a pile tip
 (Area of the steel pipe pile only at the pile tip,
 excluding the Tip reinforcing band and Tip metal)

2 Frictional resistance (pushing resistance and pull-out resistance)

Frictional resistance is calculated as sum of average unit frictional resistance times lateral area of pile touching per layer.

$$R_{fk} = \sum \gamma_{fki} \cdot A_{si}$$

R_{fk} : Characteristic value of frictional resistance (kN)
 γ_{fki} : Average frictional resistance per unit area
 (no.i ground) (kN/m²)
 A_{si} : Lateral area of pile touching layer i (m²)
 (=outer circumference length $U \times$ layer thickness L_i)

- 1) Sandy soil ground : $\gamma_{fki} = N_i$ ($\leq 35\text{kN/m}^2$) ※1
- 2) Cohesive soil ground : $\gamma_{fki} = 3N_i$ ($\leq 35\text{kN/m}^2$) ※1

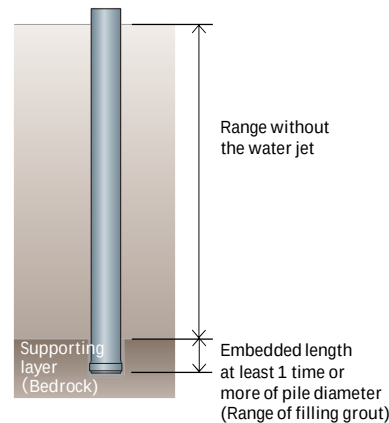
※1 As no bearing capacity estimation formula is available for vibratory hammer methods, pile bearing capacity should be verified by load testing. At the design stage, average unit skin friction resistance may be estimated using available references such as PWRI Technical Memorandum No. 4374. Examples from PWRI Technical Memorandum No. 4374 are shown below.

- 3) Bedrock layer : If grout is placed in the clearance between the pile and the bedrock
 $\gamma_{fki} = 100\text{kN/m}^2$ ※2

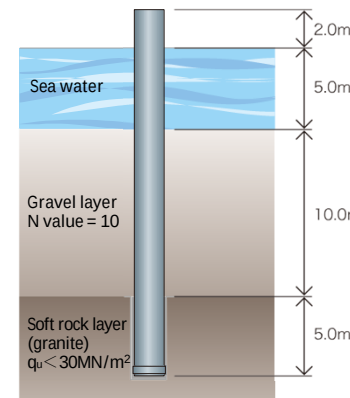
(Unconfined compression strength of rock $q_u \geq 5\text{MN/m}^2$)

※2 Such rocks as highly weathered or cracked need additional consideration, because reliability of filling grout is unclear.

Appropriate safety margins shall be considered when establishing design limits based on these characteristic values.

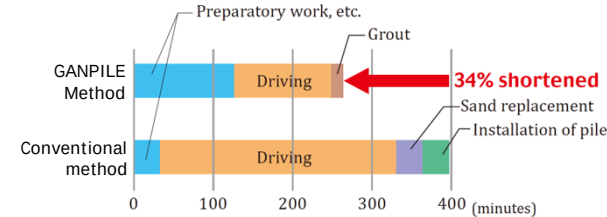


Comparison of the work speed of GANPILE Method and the conventional method



[Preconditions]

- Support layer soft rock layer ($q_u < 30\text{MN/m}^2$)
- Steel pipe pile $\phi 800$, $t=14\text{mm}$, $L=22.0\text{m}$
- Offshore work
- Working hours 6.0 hours/day
- Excluding guide member construction (install, removal)



The construction period is dramatically shortened in comparison with the conventional method*!

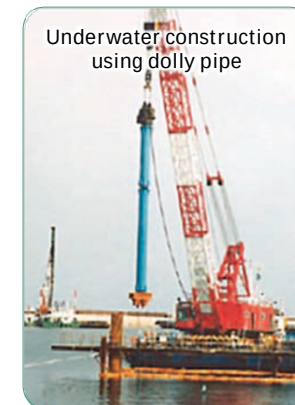
*Pile driving method using the auxiliary method for bedrock drilling.

Construction variation

GANPILE Method can deal with wide variety of construction techniques.



Construction is possible at up to 20°.



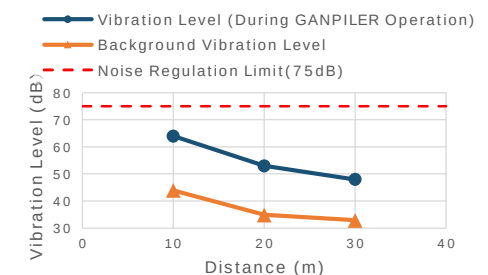
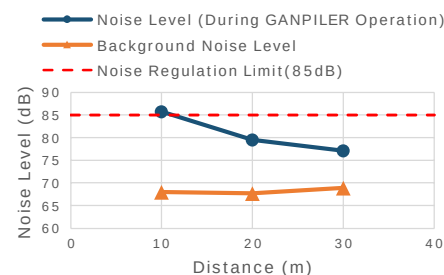
Construction is possible even if The pile head is underwater.



The peripheral noise is reduced.

Noise and Vibration Measurement Results

Measurement Conditions : Steel Pipe Pile / Pile Diameter: 800 mm / Pile Length: 18.4 m / Rock Socket Length: 4.5 m



Main applications



1 Floating pier mooring pile
Construction with maximum pile diameter
Steel pipe pile $\phi 1500\text{mm}$ $L=28$ to 30m
Crushed rock, Unconfined compression strength: $q_u=10\text{MN/m}^2$

2



3

Driving through riprap seawall
Steel pipe pile $\phi 400$ to 500mm $L=16.5$ to 16.7m
Granite, Unconfined compression strength: $q_u=80$ to 130MN/m^2



4

Drinking water reservoir applications

Steel pipe sheet pile $\phi 1000\text{mm}$ $L=8$ to 25m
Andesite, Tuff, Unconfined compression strength: $q_u=70$ to 110MN/m^2



5

Temporary cofferdam construction with the steel pipe sheet pile

Steel pipe sheet pile $\phi 800\text{mm}$ $L=9.5$ to 13.5m
Rhyolite, Unconfined compression strength: $q_u=10$ to 60MN/m^2



Main applications



◀6▶

Driving through riprap seawall

Steel sheet pile III w to VI L=9.5 to 27m
H-shaped steel pile H200 to H300 L=9.2 to 13m
Cobble mixed gravel, Boulder stone, Andesite layer
Unconfined compression strength : $q_u < 50\text{MN/m}^2$



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Renewal of existing seawall

Driving through cobble,
boulder stone layer

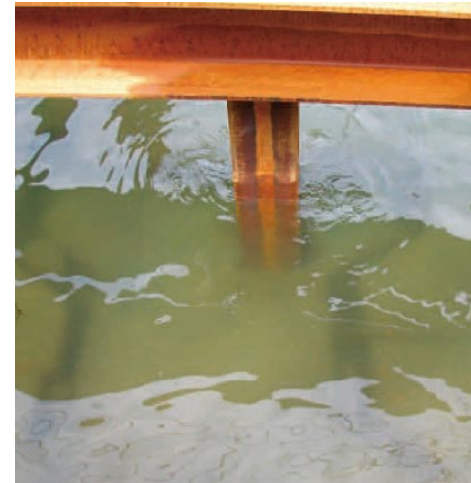
Steel sheet pile II w L=8m
Cobble mixed gravel, Boulder stone layer
Unconfined compression strength : $q_u < 20\text{MN/m}^2$



▶8▶

Direct driving of steel sheet pile to the existing masonry concrete block seawall

Steel sheet pile IV to V L=14 to 16.5m
Tuff angular conglomerate layer,
Unconfined compression strength : $q_u < 20\text{MN/m}^2$



◀9▶

Driving through concrete block at river bed (thickness 1m)

H-shaped steel pile
Cobble mixed gravel, Boulder stone layer, Andesite layer,
Unconfined compression strength: $q_u < 50\text{MN/m}^2$

Driving of H-shaped steel pile into a river where there are boulder stone and cobbles

H-shaped steel pile H300 L=6.0m
Gravel, Tuff

▶10▶



Measures for muddy water

Use of muddy water spread prevention sheet and muddy water pumping disposal system

▶12▶



◀11▶

Sound insulation measures

Sound insulation cover in consideration for neighboring area

