NS ECO-PILE™

Screwed steel pile/
Foundation Structure
**Overview of NS ECO-PILE**

**What is NS ECO-PILE?**
Most of the major cities in Japan are built on alluvial plains at the lower reaches of the rivers. Since alluvium is typically soft ground, structures such as high-rise buildings or expressways need to be supported by piles long enough to reach the hard ground base. Industrial waste such as waste soil or slurry as well as noise and vibration arising during the conventional pile construction method create environmental and social problems. NIPPON STEEL’s NS ECO-PILE solves all these problems and realizes high bearing capacity, excellent earthquake resistance, cost effectiveness and shorter construction period. This is the piling method of the future.

**Structure of NS ECO-PILE**
NS ECO-PILE is a steel pile with a helical blade welded to the edge. During construction, a pile driver or casing rotator, for example, rotates the pile, and the blade on the edge performs the digging that drives the pile into the ground like a wood-screw.

**Many Advantages**
- **Large bearing capacity**
  A large vertical bearing capacity is generated by the consolidation effect of the ground as the pile is driven down into the ground and the base bearing effect of the blade as the blade rotates to stir the ground.
- **Large pulling resistance capacity**
  A large pulling resistance capacity is maintained as the passive soil resistance, which acts on the blade part as propulsive force as the pile penetrates into the ground, is wholly turned into pulling resistance.
- **Excellent earthquake resistance**
  The steel pile foundation is highly resistant to deformation and earthquakes.
- **High quality**
  At the final embankment stage, the bearing layer can be confirmed by the torque, thus constructing a pile foundation of excellent quality and reliability.

**Environmental friendly**
- **Low noise and low vibration**
  The screw-piling method with a pile driver or casing rotator causes no impact when driving a pile into the ground, minimizing noise and vibration during construction.
- **No waste soil**
  By screw-driving the pile without excavating the ground, no waste soil is produced.
- **Congestion reduction**
  Construction vehicles such as dump trucks, concrete mixer trucks are not required. Therefore, pile-driving can be performed without affecting the foundation or incurred piles of an existing structure nearby.
- **Small area or under height restrictions**
  The equipment for pile driving is small and so the method can be used in small area such as sites adjacent to existing structures. For example, piles can be driven by a casing rotator at a site with limited overhead clearance such as under an elevated bridge or aerial wires.

**Applicability on various conditions**
- **Batter piles**
  Unlike soil-boring piling, the method drives piles without excavating the ground and so there is no risk of collapse of the bored hole wall. In the field of structural design, batter piles can reduce the number of piles more economically than vertically straight piles.

**Construction compared with conventional pile method**

**NS ECO-PILE** is good for environmental conservation and contributes to save overall construction cost and term under working restrictions.

**Characteristics**

**Structure of NS ECO-PILE**

**Many Advantages**

**Environmental friendly**

**Applicability on various conditions**

**Construction compared with conventional pile method**

**Major construction machines used with NS ECO-PILE Method**

<table>
<thead>
<tr>
<th>Type</th>
<th>Machine</th>
<th>Specifications, standard, etc</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction machine 1</td>
<td>Casing rotator, 1500 class</td>
<td>Maximum torque: 1150 kN · m (117 t · m)</td>
<td>p500 to p600 mm in dia. (standard outside pile diameter)</td>
</tr>
<tr>
<td></td>
<td>Casing rotator, 2000 class</td>
<td>Maximum torque: 2070 kN · m (211 t · m)</td>
<td>p700 to p1200 mm in dia. (standard outside pile diameter)</td>
</tr>
<tr>
<td></td>
<td>Casing rotator, 2800 class</td>
<td>Maximum torque: 5100 kN · m (520 t · m)</td>
<td>p1300 to p1600 mm in dia. (standard outside pile diameter)</td>
</tr>
<tr>
<td>Construction machine 2</td>
<td>Compact size pile driver DH425</td>
<td>Maximum torque: 276 kN · m (28.1 t · m)</td>
<td>p400 or less in dia. (standard outside pile diameter)</td>
</tr>
<tr>
<td></td>
<td>Compact size pile driver DH445</td>
<td>Maximum torque: 548 kN · m (55.4 t · m)</td>
<td>p600 or less in dia. (standard outside pile diameter)</td>
</tr>
<tr>
<td>Type of crane</td>
<td>Crawler crane</td>
<td>Capacity selectable as required</td>
<td>Used for pile installation or heavy machinery relocation</td>
</tr>
<tr>
<td>Backhoe</td>
<td></td>
<td></td>
<td>Used for backfilling a vacant hole (after removing the temporary pile)</td>
</tr>
</tbody>
</table>
Construction

1. Construction Procedure

NS ECO-PILE procedures

- Setting of casing rotator
- Installation of lower pile
- Driving of lower pile (screw piling)
- Installation of middle/upper pile and site circumferential welding
- Driving of upper pile (screw piling)
- Installation of a lower pile, checking and adjustment of verticality
- Setting of deflection stopper and adjustment of verticality
- Driving of dummy pile and piling completion

Note: If it is difficult to penetrate the pile due to hard intermediate layer, the soil inside the pile may be excavated with a hammer grab etc. as an auxiliary method.

2. Example of Machine Layout

Example of layout when casing rotator is used

- For pile outside diameter of 1,200mm or less and casing rotator with boring diameter of φ2,000 class

Diagram of the necessary distance during proximity construction

- For pile outside diameter of 1,200mm or less and casing rotator with boring diameter of φ2,000 class

Example of layout when Compact size pile driver (DH45) is used

- A dummy pile is used when the pile head is lower than the working ground level.

3. Special Jigs for NS ECO-PILE

For driving NS ECO-PILE, the following jigs are used in addition to the major machines:

- Dummy pile
- Temporary piece
- Temporary pieces for dummy pile

Spiral collar
(for casing rotator)

This is used to insert an NS ECO-PILE from above the machinery (patent no. 3484653)
### Flow of Construction Management

Fluctuation of working torque is used for all piles to check whether a pile has reached the bearing layer. A test pile is driven at each site to determine the management method to confirm arrival at the bearing layer, and the basic criterion for completion of piling is when the pile is embedded into the bearing layer to a depth equivalent to the pile diameter (1 Dp) or more.

#### A: Driving of test pile

Test piles are driven to confirm the degree of workability of the actual ground condition at the work site, adequacy of machines selected, and the status of torque generation. By comparing the status of torque generation and the results of boring data, the torque fluctuation which confirms arrival at the bearing layer is determined. The number and location of test piles are determined to suit the position of the boring exploration point and the scale of the number of piles. Some initial permanent piles may be used as test piles in the vicinity of the boring exploration point.

#### B: Site circumferential weld

Piles are generally connected with welded joints. The backing ring should be that of a standard joint specified by the Japanese Industrial Standard (JIS A 5525).

#### C: Management of the piling completion

In the standard procedure, a pile is screwed to the design depth and piling is completed when the pile is embedded into the bearing layer to a depth of 1 Dp or more. But when there is a difference between the depth of the bearing layer determined by a fluctuation of working torque and the depth of the bearing layer determined at the time of design or when the bearing layer is a very hard stratum, the piling can be completed at a depth shallower or greater than the design depth.

The bearing layer is generally confirmed by the fluctuation of working torque for judging the bearing layer determined by the test pile, but if the bearing layer is shallower than expected, it may be difficult to penetrate the pile to the design depth. In such cases, piling is sometimes completed at a depth shallower than the design depth if it can be confirmed that the pile has penetrated the bearing layer to a sufficient depth (1 Dp or more) and that torque has been generated.

If the bearing layer is too hard to drive a pile to a depth of 1 Dp or more, piling can be completed at an embedment depth of less than 1 Dp providing it can be confirmed that torque has been generated.