Applications and structural types of sheet piles

Leading the New Era on Steel Sheet Pile with Pioneer Spirits

The steel sheet piles of NIPPON STEEL are used in many fields (port and harbor structures, river revetments, retaining walls and cofﬁerdams) 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 these 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 sheet piles into full play and to respond to more stringent and diversifying user needs in the future.

Features

Wide Selection of Shapes and Types

Sheet pile is available in a wide range of section modulus per meter of pile wall, ranging from 874 to 21,846 cm³/m. This allows selection of the most economical type of sheet pile to meet the design requirements and the intended construction method.

Superb Drivability and Watertightness

The clearance between the two threaded interlocks is high stiffness steel sheet piles and reduces the deformation of the wall using robust methods (masonry, RC walls, etc.)

Advantages of steel sheet piles over other methods (masonry, RC walls, etc.)

1. Quick construction: Dramatic reduction in the construction period
2. Reliability for long-term use: Increases the safety factor and reduces the deformation of the wall using robust steel sheet piles
3. Availability of long pile and deep embedment: Up to 38m in length
4. Sustainability: Remove and reuse possible
5. Availability of narrow areas

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Applications

- Quay wall, revetment, artificial island

Hat+H Guam Apra Port refurbishment / USA

Hat-type Sheet pile Quay wall as port reinforcement in Benoa Port / Indonesia

Hat-type Sheet Pile O-Bahn City Access Project / Australia

Steel Sheet Pile Cell (Straight web-type sheet pile)

Hat-type Sheet Pile Hong Kong Macau Artificial Island / Hong Kong

Hat-type Sheet Pile Church point seawall / Australia
Permanent retaining wall

Temporary retaining wall

Hat+H  Pasig-Marikina River Channel Improvement Project(Phase 3) / Philippine

Hat-type Sheet Pile / Singapore

Hat-type Sheet Pile / New Zealand

Hat-type Sheet Pile / China

Hat+H / China

NS-SP-J Pile / Singapore
**Do you have a steel sheet pile that can be easily installed?**

- High stiffness wall
  - Hat-type and H-shape combined high stiffness steel sheet pile

- We want to minimize deflection for safety when the front of a steel sheet pile is excavated. Can you provide a good steel sheet pile?
  - For Small-scale excavation
    - Hat-type sheet pile
  - For Large-scale excavation
    - Hat-type and H-shape combined high stiffness steel sheet pile

- We want to use our land to the utmost. Can you provide a good steel sheet pile?
  - NS-SP-J pile and the dedicated press-in piler can construct an earth-retaining wall without dead space. This enables the full use of the premises to the boundary limits. (Refer to pages 23.)

---

**NIPPON STEEL provides comprehensive solutions.**

We have a team of civil engineers at the head office and the overseas offices. And we can propose the optimum design plan by our products through discussions with our customer in a given time after we obtain the design conditions. This is our complimentary engineering support to our customer. (Our proposal is for reference of our customer. The responsible judgment is up to the customer.) (Refer to pages 15 and 16.)

Various types and sizes of sheet piles are available. The optimum type and size is selected based on the design conditions and the construction method. (874 cm$^3$/m to 21846 cm$^3$/m) (Refer to pages 9 and 10.)

---

**Example of solution**

- Steel sheet pile cell
  - This is a gravitational wall featuring a cylindrical shape assembled with straight web-type sheet piles. Inside is filled with sand. It is excellent in structural stability.
  - A prefabricated sheet pile cell method can provide quick construction. (Refer to pages 29 and 30.)

- Steel sheet pile double wall
  - This is a gravitational wall in which steel sheet piles are installed in two rows. The tops of the sheet piles are connected by tie rods. And the space between the sheet piles is filled with sand. It is excellent in structural stability.
  - By dividing the construction site into multiple zones and by pairing a group of ships, the construction lead time can be reduced.

---

**Can you provide a good method to build a large-scale revetment for reclamation?**

The steel sheet pile is a good method to construct a revetment quickly. The special function required to construct the revetment for reclamation is the stability against waves until the completion of reclamation. The structure must be safe even without back reclamation.

- Applicable to approx. 10-15m depth
  - Steel sheet pile cell
  - Steel sheet pile double wall

- Applicable to less than 10m depth
  - Open cell

---

- In the case of construction of a revetment at a seaside where a week layer exists, the improvement of soil is eliminated by embedding sheet piles into the load-bearing layer—unlike a concrete caisson or stone revetment. This is an environmentally friendly method. (Refer to pages 29 and 30.)
<table>
<thead>
<tr>
<th>Shape Type</th>
<th>Type</th>
<th>Moment of inertia</th>
<th>Section modulus</th>
<th>Unit mass</th>
<th>Maximum length</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hat-type sheet piles</td>
<td>NS-SP-10H</td>
<td>10,500</td>
<td>902</td>
<td>96</td>
<td>30*2</td>
<td>SYW295 SYW390 SYW430 SY295 SY390 SY300 S355GP S430GP ASTM Gr.50 A992 Gr.50</td>
</tr>
<tr>
<td>Hat+H w=900 mm</td>
<td>NS-SP-10H+HY</td>
<td>87,800</td>
<td>902</td>
<td>96</td>
<td>30*2</td>
<td>SYW295 SYW390 SYW430 SY295 SY390 SY300 S355GP S430GP ASTM Gr.50 A992 Gr.50</td>
</tr>
</tbody>
</table>

Please refer to “NS-SP-10H” and “NS-SP-25H”. H-shapes is also available JIS, ASTM and BS.*1

<table>
<thead>
<tr>
<th>Straight web-type sheet piles</th>
<th>Type</th>
<th>Moment of inertia</th>
<th>Section modulus</th>
<th>Unit mass</th>
<th>Maximum length</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-SP-FL</td>
<td>396</td>
<td>89</td>
<td>123</td>
<td>38*2</td>
<td>SYW295 SYW390 SYW430 SY295 SY390 SY300 S355GP S430GP ASTM Gr.50 A992 Gr.50</td>
<td></td>
</tr>
<tr>
<td>NS-SP-FXL</td>
<td>570</td>
<td>121</td>
<td>154</td>
<td>38*2</td>
<td>SYW295 SYW390 SYW430 SY295 SY390 SY300 S355GP S430GP ASTM Gr.50 A992 Gr.50</td>
<td></td>
</tr>
</tbody>
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<tr>
<th>U-type sheet piles</th>
<th>Type</th>
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<th>Section modulus</th>
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<tbody>
<tr>
<td>NS-SP-VL</td>
<td>63,000</td>
<td>3,150</td>
<td>210</td>
<td>30*2</td>
<td>SYW295 SYW390 SYW430 SY295 SY390 SY300 S355GP S430GP ASTM Gr.50 A992 Gr.50</td>
<td></td>
</tr>
<tr>
<td>NS-SP-VL</td>
<td>86,000</td>
<td>3,200</td>
<td>240</td>
<td>30*2</td>
<td>SYW295 SYW390 SYW430 SY295 SY390 SY300 S355GP S430GP ASTM Gr.50 A992 Gr.50</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>U-type w=600 mm</th>
<th>Type</th>
<th>Moment of inertia</th>
<th>Section modulus</th>
<th>Unit mass</th>
<th>Maximum length</th>
<th>Grade</th>
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</thead>
<tbody>
<tr>
<td>NS-SP-Vl</td>
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<td>3,150</td>
<td>210</td>
<td>30*2</td>
<td>SYW295 SYW390 SYW430 SY295 SY390 SY300 S355GP S430GP ASTM Gr.50 A992 Gr.50</td>
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<th>Type</th>
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<thead>
<tr>
<th>U-type w=400 mm</th>
<th>Type</th>
<th>Moment of inertia</th>
<th>Section modulus</th>
<th>Unit mass</th>
<th>Maximum length</th>
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</table>

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*1: Please contact us detail in advance to order
*2: Tolerance of dimension based on JIS standard (refer to page 11)
*3: Mechanical property of elongation based on JIS standard (refer to page 11)
*4: Please contact us availability
# Steel Sheet Piles

## General

### JIS A 5523 : 2012
- Weldable hot-rolled steel sheet piles
- Hot-rolled steel sheet piles

### Chemical composition of the ladle analysis

<table>
<thead>
<tr>
<th>Classification</th>
<th>Grade</th>
<th>Chemical composition(%)</th>
<th>Ceq(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weldable hot rolled steel sheet piles</td>
<td>SYW395</td>
<td>0.18max. 0.55max. 1.50max. 0.040max. 0.040max. 0.0060max. 0.044max.</td>
<td>0.45max.</td>
</tr>
<tr>
<td>Hot rolled steel sheet piles</td>
<td>SY295</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Mechanical properties

#### Standard

<table>
<thead>
<tr>
<th>Classification symbol</th>
<th>Yield point N/mm²</th>
<th>Tensile strength N/mm²</th>
<th>Test Place</th>
<th>Elongation %</th>
<th>Test temperature (C)</th>
<th>Test size Standard piece</th>
<th>Sub-size test specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weldable hot rolled steel sheet piles JIS A 5523</td>
<td>SYW395</td>
<td>295min. 460min.</td>
<td>No.1A</td>
<td>18mm.</td>
<td>0</td>
<td>43mm.</td>
<td>32mm.</td>
</tr>
<tr>
<td>Hot rolled steel sheet piles JIS A 5528</td>
<td>SY295</td>
<td>295min. 460min.</td>
<td>No.1A</td>
<td>18mm.</td>
<td>0</td>
<td>43mm.</td>
<td>32mm.</td>
</tr>
</tbody>
</table>

Note: Chemical composition and mechanical properties conform to JIS A 5523-2012 or JIS A 5528-2012.

### Tolerances

#### Items

<table>
<thead>
<tr>
<th>Item</th>
<th>JIS A 5523, JIS A 5528 straight type</th>
<th>JIS A 5523</th>
<th>JIS A 5523</th>
<th>JIS A 5528</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>± 4 mm</td>
<td>± 10 mm</td>
<td>± 10 mm</td>
<td>± 10 mm</td>
</tr>
<tr>
<td>Height</td>
<td>± 4 %</td>
<td>± 5 mm</td>
<td>± 5 mm</td>
<td>± 5 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>± 1.5 mm</td>
<td>± 12 mm</td>
<td>± 12 mm</td>
<td>± 12 mm</td>
</tr>
<tr>
<td>Straightness</td>
<td>± 10 mm</td>
<td>± 15 mm</td>
<td>± 15 mm</td>
<td>± 15 mm</td>
</tr>
<tr>
<td>Length</td>
<td>Not specified</td>
<td>± 10 mm</td>
<td>± 10 mm</td>
<td>± 10 mm</td>
</tr>
<tr>
<td>Squareness of ends</td>
<td>4%b</td>
<td>4%b</td>
<td>4%b</td>
<td>4%b</td>
</tr>
<tr>
<td>Overall width</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>End deflection</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Appendix

#### ASTM A572M / A572-12
- High-strength low-alloy columbium-vanadium structural steel

### Chemical composition of the ladle analysis

#### Steel name

<table>
<thead>
<tr>
<th>S355GP</th>
<th>S430GP</th>
</tr>
</thead>
<tbody>
<tr>
<td>C Mn Si P S N Ceq.</td>
<td>0.24 1.60 0.55 0.045 0.045 0.009</td>
</tr>
</tbody>
</table>

### Mechanical properties

#### Grade

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum yield strength</th>
<th>Minimum tensile strength</th>
<th>Minimum elongation(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>50Ksi (345MPa)</td>
<td>65Ksi (450MPa)</td>
<td>In 8 in. (200 mm) : 18</td>
</tr>
</tbody>
</table>

* Please contact us in advance.

---

1) See the specific limitation in the standard.

* Please contact us in advance.

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* Please contact us in advance.

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* Please contact us in advance.
NIPPON STEEL is the world’s leading supplier of hot-rolled steel sheet piles. In addition to the supply of products, we provide the complimentary engineering support listed below in response to the request of our customer. The engineering team from NIPPON STEEL and overseas offices can cover the global market.

- Design proposals related to the basic / detailed design of structures (temporary / permanent) using steel sheet pile products.
- Supply of information on the construction method of structures using steel sheet piles.
- Design proposals related to the method to prevent corrosion of steel sheet pile products.
- Instructions on how to manufacture fabricated products, etc.

Note: This is a part of complimentary engineering support for reference of our customer. The responsible judgment is up to the customer.

### Design proposal

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

### Proposal of method to prevent corrosion

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

### 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.

### Map of offices

Through the offices below, we review various techniques, and we hold seminars, exhibitions, and construction demonstrations, etc., all over the world.

### Design and Instruction for fabrication

NIPPON STEEL can provide design proposal of corner section and also can provide instruction of fabrication for Hat+H at site.

### Standardization

We have standardized material specification and design criteria.
Hat-type sheet piles

- **Superb drivability**
  The large sectional area of the Hat-type sheet pile realizes superior drivability.
- **High structural reliability**
  No reduction is required in sectional properties to consider the possible lack of shear force transmission at the interlocks, which is true for U-type steel sheet piles.
- **Excellent cost-effectiveness**
  The amount of steel per unit wall can be reduced, resulting in improved total cost.

### Shapes

- NS-SP-10H
- NS-SP-25H
- NS-SP-45H
- NS-SP-50H

### Deviation angle

Each interlock allows for a certain rotation. The minimum angle of coupling mating joint (the interlock swing) for the combination of the identical versions of Hat-type sheet piles is shown in the figure below.

### Compatibility

- NS-SP-10H
- NS-SP-25H
- NS-SP-45H
- NS-SP-50H

### Sectional properties

<table>
<thead>
<tr>
<th>Type</th>
<th>Effective width W mm</th>
<th>Effective height H mm</th>
<th>Thickness t mm</th>
<th>Sectional area cm²</th>
<th>Moment of inertia cm⁴</th>
<th>Sectional modulus cm³</th>
<th>Unit mass kg/m</th>
<th>Sectional area cm²/m</th>
<th>Moment of inertia cm⁴/m</th>
<th>Sectional modulus cm³/m</th>
<th>Unit mass kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-SP-10H</td>
<td>900</td>
<td>230</td>
<td>10.8</td>
<td>110.0</td>
<td>9,430</td>
<td>812</td>
<td>86.4</td>
<td>122.2</td>
<td>10,500</td>
<td>902</td>
<td>96.0</td>
</tr>
<tr>
<td>NS-SP-25H</td>
<td>900</td>
<td>300</td>
<td>13.2</td>
<td>144.4</td>
<td>22,000</td>
<td>1,450</td>
<td>113</td>
<td>160.4</td>
<td>24,400</td>
<td>1,610</td>
<td>126</td>
</tr>
<tr>
<td>NS-SP-45H</td>
<td>900</td>
<td>368</td>
<td>15.0</td>
<td>187.0</td>
<td>40,500</td>
<td>2,200</td>
<td>147</td>
<td>207.8</td>
<td>45,000</td>
<td>2,450</td>
<td>163</td>
</tr>
<tr>
<td>NS-SP-50H</td>
<td>900</td>
<td>370</td>
<td>17.0</td>
<td>212.7</td>
<td>46,000</td>
<td>2,490</td>
<td>167</td>
<td>236.3</td>
<td>51,100</td>
<td>2,760</td>
<td>186</td>
</tr>
</tbody>
</table>

U-type sheet piles

- **U-type sections** have been widely used for various types of permanent and temporary structures, and are one of the most familiar sheet piles among both designers and users.
- NS-SP-Ⅱ, Ⅲ, Ⅳ, Ⅴ, and Ⅵ. are solidly designed. These sections are especially suitable for repeated use, and have acquired high market acceptance from users.
- U-type sections offer section modulus ranging from 874 cm³/m to 3,820 cm³/m.

### Shapes

- NS-SP-Ⅰ
- NS-SP-Ⅱ
- NS-SP-Ⅲ
- NS-SP-Ⅳ
- NS-SP-ⅤL

### Compatibility

- NS-SP-Ⅰ
- NS-SP-Ⅱ
- NS-SP-Ⅲ
- NS-SP-Ⅳ
- NS-SP-ⅤL

### Deviation angle

Each interlock allows a certain rotation. The minimum angle of deviation (the interlock swing) for the combination of the identical versions of U-type sheet piles is shown in the figure below.

### Sectional properties

<table>
<thead>
<tr>
<th>Type</th>
<th>Effective width W mm</th>
<th>Effective height H mm</th>
<th>Thickness t mm</th>
<th>Sectional area cm²</th>
<th>Moment of inertia cm⁴</th>
<th>Sectional modulus cm³</th>
<th>Unit mass kg/m</th>
<th>Sectional area cm²/m</th>
<th>Moment of inertia cm⁴/m</th>
<th>Sectional modulus cm³/m</th>
<th>Unit mass kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-SP-Ⅰ</td>
<td>400</td>
<td>100</td>
<td>10.5</td>
<td>61.18</td>
<td>1,240</td>
<td>152</td>
<td>48.0</td>
<td>153.0</td>
<td>8,740</td>
<td>120</td>
<td>190</td>
</tr>
<tr>
<td>NS-SP-Ⅱ</td>
<td>400</td>
<td>125</td>
<td>13.0</td>
<td>76.42</td>
<td>2,220</td>
<td>223</td>
<td>60.0</td>
<td>191.0</td>
<td>16,800</td>
<td>1,340</td>
<td>150</td>
</tr>
<tr>
<td>NS-SP-Ⅲ</td>
<td>400</td>
<td>150</td>
<td>13.1</td>
<td>74.40</td>
<td>2,790</td>
<td>250</td>
<td>58.4</td>
<td>186.0</td>
<td>22,800</td>
<td>1,520</td>
<td>146</td>
</tr>
<tr>
<td>NS-SP-Ⅳ</td>
<td>400</td>
<td>170</td>
<td>15.5</td>
<td>96.99</td>
<td>4,670</td>
<td>362</td>
<td>76.1</td>
<td>242.5</td>
<td>38,600</td>
<td>2,770</td>
<td>190</td>
</tr>
<tr>
<td>NS-SP-ⅤL</td>
<td>500</td>
<td>200</td>
<td>15.0</td>
<td>138.3</td>
<td>7,960</td>
<td>520</td>
<td>105</td>
<td>267.6</td>
<td>63,000</td>
<td>3,150</td>
<td>210</td>
</tr>
<tr>
<td>NS-SP-Ⅵ</td>
<td>500</td>
<td>225</td>
<td>27.6</td>
<td>153.0</td>
<td>11,400</td>
<td>680</td>
<td>120</td>
<td>306.0</td>
<td>86,000</td>
<td>3,820</td>
<td>240</td>
</tr>
<tr>
<td>NS-SP-ⅦL</td>
<td>600</td>
<td>300</td>
<td>10.3</td>
<td>78.70</td>
<td>2,110</td>
<td>203</td>
<td>61.8</td>
<td>131.2</td>
<td>13,000</td>
<td>1,000</td>
<td>103</td>
</tr>
<tr>
<td>NS-SP-ⅧL</td>
<td>600</td>
<td>300</td>
<td>13.4</td>
<td>103.9</td>
<td>5,220</td>
<td>376</td>
<td>81.6</td>
<td>173.2</td>
<td>32,400</td>
<td>1,800</td>
<td>136</td>
</tr>
<tr>
<td>NS-SP-ⅨL</td>
<td>600</td>
<td>310</td>
<td>18.0</td>
<td>135.3</td>
<td>8,630</td>
<td>539</td>
<td>106</td>
<td>225.5</td>
<td>56,700</td>
<td>2,700</td>
<td>177</td>
</tr>
</tbody>
</table>
Hat-type and H-shape combined high stiffness steel sheet piles

**Features**

- **Availability of numerous sectional properties**
  Hat-type and H-shape combined high stiffness steel sheet piles come in combination of Hat-type sheet piles which have four types and H-shape sections which have many types. Eventually they provide more than 200 types of economical properties. (Section modulus per meter of wall: Approx. 2,320 to 19,970 cm³/m)

- **Ease of fabrication**
  It is easy to fabricate Hat-type and H-shape combined high stiffness steel sheet piles by combining Hat-type and H-shape with intermittent fillet welding. Welding can be carried out at the site or the nearby yard or shop.

- **Excellent cost-effectiveness**
  From the viewpoint of design for the Hat-type and H-shape combined high stiffness steel sheet pile, Hat-type functions as a continuous wall to sustain soil and water, and H-shape functions as a structural member to bear the bending moment. This makes it possible to use low-cost H-shape up to 50 to 70% of weight as well as avoiding use of expensive connectors to connect a sheet pile and a section.

- **Ease of Installation**
  An ordinary vibratory hammer is directly applicable for driving. The Hat-type and H-shape combined high stiffness steel sheet pile, having higher moment of inertia per pile compared with Z-type and other type piles, is very easy to work with.

**Shape**

Fillet weld: Welding ratio: 40-60%

![Hat-type and H-shape combined high stiffness steel sheet piles](image)

**Examples of application**

- Quay walls of port facilities and shipyard dock walls
- Temporary and permanent earth-retaining wall structures for open-cut tunnels
- Earth-retaining walls for high embankments

**Fabrication method**

Hat-type and H-shape combined high stiffness steel sheet piles can be easily fabricated on construction site or at a nearby yard or shop.

We have prepared manuals for fabrication and can provide on-site instruction.

**Trial calculation example of benefit in the case of the application of Hat-type and H-shape combined high stiffness steel sheet piles compared with existing temporary retaining walls**

The following shows the comparison result between soldier piles, which are generally used as steel material for temporary retaining walls in Southeast Asia, and Hat-type and H-shape combined high stiffness steel sheet piles.

<table>
<thead>
<tr>
<th>Item</th>
<th>Soldier Pile</th>
<th>Hat+H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build-up section</td>
<td>H-shape</td>
<td>Equivalent Z</td>
</tr>
<tr>
<td>Composite section</td>
<td>H-shape</td>
<td>Equivalent I</td>
</tr>
</tbody>
</table>

Outline

- H-shape: UB810×229×243
- U-type steel sheet pile: NS-SP-W
- Section Modulus Z = 6,264 cm³/m
- Moment of Inertia I = 168,000 cm⁴/m

Equivalent Z = 6,770 cm³/m
Equivalent I = 168,000 cm⁴/m

Soldier Pile: NS-SP-W-100x250x12x19
Soldier Pile: NS-SP-100x250x12x19
Soldier Pile: NS-SP-125x300x9x16

Steel weight per 1m of pile wall width (kg/m²)

- Soldier Pile: 342 kg
- Hat+H: 256 kg
- Hat+H: 194 kg

* Trial calculation by NIPPON STEEL
<table>
<thead>
<tr>
<th>Type</th>
<th>Mass per m² of wall</th>
<th>Sectional area</th>
<th>Sectional moment of inertia</th>
<th>Sectional modulus</th>
<th>Moment of inertia</th>
<th>Sectional modulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSHYPER BEAM™</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Other sizes except for the regular size mentioned above also can be available. Please contact us.
NS-SP-J

Close-proximity installation
NS-SP-J piles can be installed in close proximity to existing structures, permitting the construction of retaining walls abutting site boundaries and making maximum use of the site area.

100% interlock integrity
As interlocks are located on the outermost side of the wall, there is no need to consider the reduction of sectional properties due to slip on interlocks, and this permits economical design.

Cost-saving and Work-shortening of Temporary Work
Cost-saving and the shortening of temporary work time
Compared to conventional steel sheet piles for temporary work with an effective width of 400 mm, NS-SP-J has an effective width of 600 mm. This makes it possible to reduce the number of installed piles, with less cost and improved water tightness.

Shapes

Deviation angle

Sectional properties

Straight web-type sheet piles

High joint strength
This type of sheet pile boasts extremely high tensile strength at its interlocking sections, up to 5.88 MN per linear meter of joint length, and is suited for use in cellular-type structures, such as quay walls, manmade island seawalls, cofferdams, and other similar projects.
In addition, we can provide the longest product currently possible: a maximum of 38.0 m.

Large deviation angle
This sheet pile has large deviation angle at interlocks (the interlock swing), the maximum angles for the combination of the identical types of straight web-type sheet piles are respectively 10.0 and 12.5.

Shapes

Deviation angle

Joint strength

Type | Tensile strength (MN/m)
--- | ---
NS-SP-FL | 3.92
NS-SP-FXL | 5.88

Sectional properties

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimension</th>
<th>Per pile</th>
<th>Per 1 m of pile wall width</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effective width</td>
<td>Effective height</td>
<td>Thickness</td>
</tr>
<tr>
<td>W</td>
<td>mm</td>
<td>mm</td>
<td>t</td>
</tr>
<tr>
<td>NS-SP-J</td>
<td>600</td>
<td>200</td>
<td>13.0</td>
</tr>
<tr>
<td>NS-SP-FL</td>
<td>500</td>
<td>44.5</td>
<td>9.5</td>
</tr>
<tr>
<td>NS-SP-FXL</td>
<td>500</td>
<td>47.0</td>
<td>12.7</td>
</tr>
</tbody>
</table>
Corner section sheet piles: As rolls

### High reliability
- Corner-section sheet piles are a newly developed type produced by rolling, to replace the conventional T-shape corner-sheet piles produced by welding. Thus, these eliminate the need for welding and other fabrication processes and are far lighter in weight.
- For assembly, the conventional cast equipment can be used as-is.
- In particular, Larssen sheet piling has been adopted as a base for the shape of corner joints, in order to prevent detachment, and therefore, particularly, joint performance such as fitment and repetition endurance is excellent.

### Shapes

| NS-SP-CB, NS-SP-CW | NS-SP-CBe |

#### Sectional properties

<table>
<thead>
<tr>
<th>Type</th>
<th>Effective width W mm</th>
<th>Effective height h mm</th>
<th>Thickness t mm</th>
<th>Sectional area cm²</th>
<th>Moment of inertia cm⁴</th>
<th>Section modulus cm³</th>
<th>Unit mass kg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-SP-CB</td>
<td>400</td>
<td>125</td>
<td>13.0</td>
<td>79.63</td>
<td>2,330</td>
<td>237</td>
<td>62.5</td>
</tr>
<tr>
<td>NS-SP-CBe</td>
<td>400</td>
<td>125</td>
<td>13.0</td>
<td>76.40</td>
<td>1,930</td>
<td>222</td>
<td>60.0</td>
</tr>
<tr>
<td>NS-SP-CW</td>
<td>400</td>
<td>170</td>
<td>15.5</td>
<td>96.76</td>
<td>4,630</td>
<td>337</td>
<td>76.0</td>
</tr>
</tbody>
</table>

### Compatibility

#### Installation

NS-SP-CB, NS-SP-CW

NS-SP-CBe

#### Sectional properties after corrosion

Steps to calculate sectional properties after corrosion:
1. Assume the corrosion rate and lifetime of the facility, and calculate the corrosion loss of the marine side \( t_1 \) (mm) and that of the land side \( t_2 \) (mm).
2. Calculate the corrosion loss rate \( \alpha = \frac{t_2}{t_1} \).
3. Using the corrosion loss of the marine side \( t_1 \) (mm) and the corrosion loss rate \( \alpha \), obtain the reduction ratio of the sectional properties \( \eta \) from the following graphs.
4. Calculate the sectional properties after corrosion loss, \( Z \) and \( I \), by multiplying the sectional properties before corrosion loss, \( Z_0 \) and \( I_0 \), by the reduction ratio \( \eta \).

\[ Z = Z_0 \times \eta \]
\[ I = I_0 \times \eta \]

\( \eta \): Reduction ratio of sectional properties after corrosion (%)
\( t_1, t_2 \): Corrosion loss of marine side and land side (mm)

\( \alpha \): Corrosion loss rate, \( \alpha = \frac{t_2}{t_1} \)

Note: Only the illustrated ranges are effective in the following graphs.

- \( I_0, Z_0 \): Moment of inertia and section modulus without corrosion loss
- \( \eta \): Reduction ratio after corrosion
- \( I, Z \): Moment of inertia and section modulus after corrosion
In this case, if the shear force doesn’t transmit sufficiently between the adjacent the interlocks slip from each other, and the moment of inertia and section modulus of the wall of the sheet piles are reduced. This can be referred to as “lack of interlock integrity”. And the degree of reduction is expressed by reduction factor. In contrast, for a wall using Hat-type steel sheet piles, the reduction of sectional properties is not required because interlocks are located at the most outer edge of the wall, which means that the shear force does not occur in the interlocks.

Reduction factors of sectional properties from code to code. An example of the Eurocodes is shown below.

<table>
<thead>
<tr>
<th>Reduction factor of sectional properties due to the lack of interlock integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of U-pile unit</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Singles or uncrimped doubles</td>
</tr>
<tr>
<td>&gt;1</td>
</tr>
<tr>
<td>Crimped or welded doubles</td>
</tr>
<tr>
<td>&gt;1</td>
</tr>
</tbody>
</table>

Where, $\beta_u$: Factor accounting for the possible reduction of the section modulus of U-piles due to insufficient shear force transmission in the interlocks.

Interlock integrity in Hat-type steel sheet piles

Bending tests for Hat-type steel sheet piles in the form of a wall as well as in the form of a single pile have been conducted. It is confirmed that the design values of the load-displacement relationship are in agreement with the experimental values. This demonstrates that the reduction of sectional properties is not required.

### Steel-weight comparison between U-type and Hat-type, the sectional properties of which are reduced using by interlock factors

<table>
<thead>
<tr>
<th>Hat-type (NS-SP-25H)</th>
<th>U-type (NS-SP-25H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moment of inertia per 1 m of pile wall</td>
<td>1,500</td>
</tr>
<tr>
<td>Section modulus per 1 m of pile wall</td>
<td>2,500</td>
</tr>
</tbody>
</table>

### Example of a trial design for temporary retaining walls

The reduction factor of U-type steel sheet piles is set as 0.45 for the moment of inertia, with 0.6 for the section modulus, in order to compare U-type and Hat-type using the same design conditions. NS-SP-25H (Hat-type) shows design results that are roughly equivalent to those of NS-SP-IV (U-type), and the number of short strut rows and the length of the steel sheet piles are mostly the same. However, the weight of NS-SP-25H (Hat-type) is 66% that of NS-SP-IV (U-type). When using NS-SP-45H (Hat-type), the working space increases during excavation with only one strut row, and the working efficiency of concrete structure fabrication is greatly improved, enabling a construction cost reduction for the concrete structure. Although the weight increases compared with NS-SP-25H, NS-SP-45H is still 89% that of NS-SP-IV (U-type), and thus a weight reduction benefit can be obtained.
Steel sheet pile cell structure

- **Features**
  - Available for various soil conditions
  - It is widely applicable especially port and harbor structure in deep water because no auxiliary construction method is required and ground resistance at embedded part is utilized unlike concrete structure such as concrete caissons.
  - Various construction method
    - There are various construction method such as prefab, semi-prefab and in-situ type, and it can be chosen optimum construction method according to soil, hydrographic conditions and availability of equipment.
  - High-speed construction
    - The prefabricated sheet pile method can cut construction time remarkably.
  - Environmentally friendly method
    - No soil improvement is needed in the case of sheet piles reaching the supporting layer, as the embedded part of the sheet pile can resist earth pressure.

- **Structural example**

  - **Circular cell**
    - Circular cell is commonly used closed section structure consists of cylindrical and arc part, formed by straight web type sheet piles. This structure is suitable for underwater structure, such as revetment, quay, breakwaters, temporary cofferdam because the cylindrical cell becomes a stable structure after the filling.
    - Application: Seawall, Brekwater, Cofferdam, etc.
    - Applicable depth: 10–15m

  - **Diaphragm cell**
    - Diaphragm cell consists of bulk head and arc part, and usage of steel can be reduced compared with circular cell. This structure is especially suitable for artificially-excavated port on shore and shallow.
    - Application: Seawall, Cofferdam
    - Applicable depth: 15m–

- **Open cell**

  - Open cell consists of front arc part and bulkhead as anchoring function and usage of steel is less than other cell structures because back side of bulkhead is not necessary on this structure.
  - Application: Seawall, Breakwater, Cofferdam

Citation: PND ENGINEERS, INC.
We have conducted performance evaluation for the repeated use of Hat-type steel sheet piles based on the field tests. So far, we have conducted these tests for the cases of different installation methods such as vibratory hammer methods and press-in methods.

### Cases of performance evaluation for the repeated use of Hat-type steel sheet piles

#### Piling test in Japan

Hat-type and U-type

Installing and pulling out was repeated for ten times.

#### Piling test in Singapore

Hat-type

Installing and pulling out was repeated for six times.
Driving method

- **Vibration method**
  Sheet piles are driven into the ground by transferring to them up-and-down vibratory forces generated by a vibratory hammer. As percussion force is not used, the pile head is not damaged, driving efficiency is high, and it is useful for both driving and pulling piles.

- **Percussion method**
  A percussion method is a method in which steel sheet piles are driven into the ground with the percussion force of a hydraulic hammer or diesel hammer. To prevent buckling at the head of the sheet pile, a pile cap is generally attached to the head of the sheet pile. Sheet piles can be easily driven with high percussion force at a location with large joint resistance or ground resistance.

**Press-in method**

Sheet piles are pressed-in using hydraulic mechanism by grasping the middle place of sheet pile while taking reaction by holding driven piles. Driving machine is compact, and need no crane, though it needs crane separately for hanging sheet piles. It is applicable to the driving conditions such as narrow places and low clearance places. It is also possible to drive piles in conditions of low noise and low vibration. When ground is so hard that driving is difficult by using only pressing machine, it is useful to use water jet cutter together.
Detail of tie-rods, wailing, guide frame and coping

- **Tie-rods and waling**

To support a part of the external force applied to the steel sheet pile, sheet pile walls are often provided with waling, tie rods, and tie wires at the upper part of the steel sheet pile. The following figures show an installation example of a tie rod and waling.

- **Hat-type**

  - **elevation view**
  - **plain view**

  Setting waling on back face of the sheet pile

  Setting waling on front face of the sheet pile

- **U-type**

  - **elevation view**
  - **plain view**

  Setting waling on front face of the sheet pile

  Setting waling on back face of the sheet pile

- **Concrete coping**

  To prevent water from entering the joint or to improve joint efficiency of U-type steel sheet pile, it is usually install the concrete coping at the top of steel sheet pile walls. Here, one example shown in below.

  - **Side view**
  - **Plain view**

- **Guide frames**

  In installation of steel sheet piles, it is necessary to install guide frames to ensure correct driving position and the stability of the steel sheet piles during construction. Here, one example is shown in which two rows of guide frames parallel to the normal line are driven at intervals of 2 to 4 m and in which the guide beam is mounted inside.
When steel sheet piles are used, multiple sheet piles are sometimes joined to obtain a specified length. In general, a weld joint is used.

### Weld joint (temporary / permanent installation)

#### (a) U-type sheet pile

- When welding, it's need to choose welding rod as considering base material, thickness of sheet pile, position of weld. Here, shows the examples of welding material of JIS.

#### (b) Hat-type sheet pile

When welding, it's need to choose welding rod as considering base material, thickness of sheet pile, position of weld. Here, shows the examples of welding material of JIS.

### Water tightness

A steel sheet pile consists of continuous steel material and is itself water-impermeable material. However, considering the ease of driving, a slight gap is provided at the joint.

It is known that, generally, the amount of water leaking from the joint is reduced over time by clogging sand. However, if you would like to stop water at an early stage, it is necessary to take measures to stop water at the joint.

The most popular method is when swelling water-stop material is preliminary applied to the joint. Various water-stop materials have been developed for this. For details, please contact us.

### Anticorrosion system

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

1. Designing the sheet pile considering corrosion allowance
2. Cladding using concrete to prevent corrosion
3. Coating the sheet pile to prevent corrosion
   - Four types are available with regard to this method: by painting; using organic lining; using petrolatum lining; or using inorganic lining.
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.