CLAIMS

1. A production method of a hat-shaped steel sheet pile which comprises:

a web;

a pair of flanges;

a pair of arms; and

a pair of joints,

the pair of flanges being formed at both ends of the web, an arm constituting the pair of arms being formed at an end of a flange constituting the pair of flanges, and a joint constituting the pair of joints being provided at a tip of the arm, comprising:

manufacturing a protrusion over an entire length of the steel sheet pile in the web by cold working, the protrusion being formed by being bent to protrude to an inner surface side or an outer surface side of the web and satisfying following expressions (1) and (2),

[Mathematical Expression 1]

$$V \geqq B/16 \quad \cdots\cdots(1)$$

$$1.5 \leqq \frac{4.1}{\left(\left(\frac{B \times (H/B)^{0.1} \times \sqrt{\varepsilon_y}}{t + \frac{W \times V^{0.85} \times n}{B \times (H/B)^{0.1}}} \right)^2 - 0.25 \right)} \leqq 10 \quad \cdots\cdots(2)$$

where V: protrusion height (mm); W: width (mm) between protrusion bases ($W < 5 \times V$); n: number of protrusions; H: steel-sheet-pile cross-section height (mm); B: steel-sheet-pile web width (mm); t: plate thickness (mm) of steel-sheet-pile-web; and ε_y: yield strain of steel sheet pile.

2. A production method of a hat-shaped steel sheet pile which comprises:

a web;

a pair of flanges;

a pair of arms; and

a pair of joints,

the pair of flanges being formed at both ends of the web, an arm constituting the pair of arms being formed at an end of a flange constituting the pair of flanges, and a joint constituting the pair of joints being provided at a tip of the arm, comprising:

manufacturing a protrusion over an entire length of the steel sheet pile in the web by cold working, the protrusion being formed by being bent to protrude to an inner surface side or an outer surface side of the web and satisfying following expressions (1) and (3),

[Mathematical Expression 2]

$$V \geqq B/16 \quad \cdots\cdots(1)$$

$$2 \leqq \frac{4.1}{\left(\frac{B \times (H/B)^{0.1} \times \sqrt{\varepsilon_y}}{t + \frac{W \times V^{0.85} \times n}{B \times (H/B)^{0.1}}} \right)^2 - 0.25} \leqq 10 \quad \cdots\cdots(3)$$

where V: protrusion height (mm); W: width (mm) between protrusion bases ($W < 5 \times V$); n: number of protrusions; H: steel-sheet-pile cross-section height (mm); B: steel-sheet-pile web width (mm); t: plate thickness (mm) of steel-sheet-pile-web; and ε_y: yield strain of steel sheet pile.

3. A production method of a hat-shaped steel sheet pile which comprises:

a web;

a pair of flanges;

a pair of arms; and

a pair of joints,

the pair of flanges being formed at both ends of the web, an arm constituting the pair of arms being formed at an end of a flange constituting the pair of flanges, and a joint constituting the pair of joints being provided at a tip of the arm, comprising:

manufacturing a protrusion over an entire length of the steel sheet pile in the web by cold working, the protrusion being formed by being bent to protrude to an inner surface side or an outer surface side of the web and satisfying following expressions (1) and (4),

[Mathematical Expression 3]

$$V \geqq B/16 \quad \cdots\cdots(1)$$

$$2 \leqq \frac{4.1}{\left(\left(\frac{B \times (H/B)^{0.1} \times \sqrt{\varepsilon_y}}{t + \frac{W \times V^{0.85} \times n}{B \times (H/B)^{0.1}}} \right)^2 - 0.25 \right)} \leqq 4 \quad \cdots\cdots(4)$$

where V: protrusion height (mm); W: width (mm) between protrusion bases (W < 5 × V); n: number of protrusions; H: steel-sheet-pile cross-section height (mm); B: steel-sheet-pile web width (mm); t: plate thickness (mm) of steel-sheet-pile-web; and ε_y: yield strain of steel sheet pile.

4. A method of designing a hat-shaped steel sheet pile which is manufactured by cold working and comprises:

a web;

a pair of flanges;

a pair of arms; and

a pair of joints,

the pair of flanges being formed at both ends of the web, an arm constituting the pair of arms being formed at an end of a flange constituting the pair of flanges, and a joint constituting the pair of joints being provided at a tip of the arm, comprising:

providing a protrusion over an entire length of the steel sheet pile in the web, the protrusion being formed by being bent to protrude to an inner surface side or an outer surface side of the web and

designing the protrusion such that following expressions (1) and (2) are satisfied,

[Mathematical Expression 4]

$$V \geqq B/16 \quad \cdots\cdots(1)$$

$$1.5 \leqq \frac{4.1}{\left(\left(\frac{B \times (H/B)^{0.1} \times \sqrt{\varepsilon_y}}{t + \frac{W \times V^{0.85} \times n}{B \times (H/B)^{0.1}}} \right)^2 - 0.25 \right)} \leqq 10 \quad \cdots\cdots(2)$$

where V: protrusion height (mm); W: width (mm) between protrusion bases (W < 5 × V); n: number of protrusions; H: steel-sheet-pile cross-section height (mm); B:

steel sheet pile web width (mm); t: plate thickness (mm) of steel-sheet-pile web; and ε_y: yield strain of steel sheet pile.

5. A method of designing a hat-shaped steel sheet pile which is manufactured by cold working and comprises:

a web;

a pair of flanges;

a pair of arms; and

a pair of joints,

the pair of flanges being formed at both ends of the web, an arm constituting the pair of arms being formed at an end of a flange constituting the pair of flanges, and a joint constituting the pair of joints being provided at a tip of the arm, comprising:

providing a protrusion over an entire length of the steel sheet pile in the web, the protrusion being formed by being bent to protrude to an inner surface side or an outer surface side of the web and

designing the protrusion such that following expressions (1) and (3) are satisfied;

[Mathematical Expression 5]

$$V \geqq B/16 \quad \cdots\cdots(1)$$

$$2 \leqq \frac{4.1}{\left(\left(\frac{B \times (H/B)^{0.1} \times \sqrt{\varepsilon_y}}{t + \frac{W \times V^{0.85} \times n}{B \times (H/B)^{0.1}}} \right)^2 - 0.25 \right)} \leqq 10 \quad \cdots\cdots(3)$$

where V: protrusion height (mm); W: width (mm) between protrusion bases ($W < 5 \times V$); n: number of protrusions; H: steel-sheet-pile cross-section height (mm); B: steel-sheet pile web width (mm); t: plate thickness (mm) of steel-sheet-pile-web; and ε_y: yield strain of steel sheet pile.

6. A method of designing a hat-shaped steel sheet pile which is manufactured by cold working and comprises:

a web;

a pair of flanges;

a pair of arms; and

a pair of joints,

the pair of flanges being formed at both ends of the web, an arm constituting the pair of arms being formed at an end of a flange constituting the pair of flanges, and a joint constituting the pair of joints being provided at a tip of the arm, comprising:

providing a protrusion over an entire length of the steel sheet pile in the web, the protrusion being formed by being bent to protrude to an inner surface side or an outer surface side of the web and

designing the protrusion such that following expressions (1) and (4) are satisfied.

[Mathematical Expression 6]

$$V \geqq B/16 \quad \cdots\cdots(1)$$

$$2 \leqq \frac{4.1}{\left(\left(\frac{B \times (H/B)^{0.1} \times \sqrt{\varepsilon_y}}{t + \frac{W \times V^{0.85} \times n}{B \times (H/B)^{0.1}}} \right)^2 - 0.25 \right)} \leqq 4 \quad \cdots\cdots(4)$$

where V: protrusion height (mm); W: width (mm) between protrusion bases ($W < 5 \times V$); n: number of protrusions; H: steel-sheet-pile cross-section height (mm); B: steel-sheet-pile web width (mm); t: plate thickness (mm) of steel-sheet-pile-web; and ε_y: yield strain of steel-sheet-pile.