

DESCRIPTION

GUIDE FOR STEEL SHEET PILE ROLLING MILL, AND STEEL SHEET PILE MANUFACTURING METHOD

5

Technical Field

[0001]

The present invention relates to a guide for steel
sheet pile rolling mill and a steel sheet pile
10 manufacturing method.

Background Art

[0002]

Steel sheet piles, such as a hat-shaped steel sheet
15 pile, are used as earth retaining members in engineering
works, for example. The hat-shaped steel sheet pile has
characteristics of having an effective width of 900 mm,
right-and-left asymmetric joint shapes, and fitting parts
located at the outermost edges of a wall body, for example.
20 Therefore, the hat-shaped steel sheet pile has an advantage
of shortening the construction period or improving the
rigidity as the wall body, for example, as compared with
a conventional steel sheet pile having a width of 600 mm
(hereinafter also referred to as "600 wide steel sheet
25 pile"), and thus the replacement from the 600 wide steel
sheet pile to the hat-shaped steel sheet pile has been
progressing.

[0003] <Problems of heat scratch, exit posture defect>

However, when hot-rolling the above-described extra-wide and asymmetrical hat-shaped steel sheet pile, a rolling load or a temperature variation in the width direction increase as compared with the conventional steel sheet pile, and therefore an unstable phenomenon, such as heat scratch or an exit posture defect, due to a deterioration of the biting attitude at the front surface of a rolling mill is likely to occur. Herein, the heat scratch refers to a shape defect caused when a rolling material is bitten into a roll while being shifted in the width direction or in the up and down direction, so that a part of the rolling material is peeled off to be pressed and fixed onto the roll, and then the pressed and fixed portion is transferred to the surface of the rolling material. The exit posture defect refers to the fact that the rolling material is bent in the width direction, warped in the up and down direction, curled, or the like, so that the rolling material is out of the line or is unable to proceed to the next pass, resulting in discontinuing of the rolling.

[0004]

To address such problems, PTL 1 discloses a method for stabilizing the biting attitude and the exit posture by arranging a first guide in contact with a web and flanges, a second guide sandwiching the web with the first guide, and a third guide restraining arm parts from above

and below on each of the inlet side and the outlet side of a rolling mill, for example.

Citation List

5 [0005]

Patent Literature

PTL 1: JP 2009-119513 A

Summary of Invention

10 Technical Problem

[0006]

However, the method disclosed in PTL 1 has a possibility of causing guide clogging or a guide flaw because a plurality of friction guides is arranged on each
15 of the inlet side and the outlet side of the rolling mill, excessively restraining a rolling material in the up and down direction. Further, the guides are installed in a large number of places, such as the upper and lower surfaces of the web, the inside of corner parts of the web
20 and the flanges, and the upper and lower surfaces of the arm parts, complicating the guide structure and making maintenance difficult.

[0007]

Thus, the present invention has been made in view of
25 the above-described problems. It is an object of the present invention to provide a guide for steel sheet pile rolling mill and a steel sheet pile manufacturing method

capable of suppressing the occurrence of the guide clogging or the guide flaw and having excellent maintainability.

Solution to Problem

5 [0008]

One aspect of the present invention provides a guide for steel sheet pile rolling mill, the steel sheet pile having, as the cross-sectional shape orthogonal to the longitudinal direction, a web extending in one direction, a pair of flanges connected to both ends in the one direction of the web and extending at an angle with respect to the one direction, and a pair of flat parts connected to the ends on the sides to which the web is not connected of the pair of flanges and having flat places extending in the one direction, the guide being provided on the inlet side of a rolling mill having an upper roll and a lower roll in which a groove corresponding to the shape of the steel sheet pile is formed in the rolling of the steel sheet pile, the guide for steel sheet pile rolling mill including: a web guide restraining a web corresponding part corresponding to the web in a raw material to be rolled from one direction in the up and down direction and guiding the web corresponding part to the groove; and a pair of roller guides having at least one roller rotatable in the rolling direction and restraining flat part corresponding parts corresponding to the flat parts in the raw material from the other direction in the up and down

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direction and guiding the flat part corresponding parts to the groove.

[0009]

One aspect of the present invention provides a steel
5 sheet pile manufacturing method including, in the rolling
of the steel sheet pipe having, as the cross-sectional
shape orthogonal to the longitudinal direction, a web
extending in one direction, a pair of flanges connected to
both sides of the web and extending at an angle with
10 respect to the one direction, and a pair of flat parts
connected to the opposite sides to the web of the pair of
flanges and having flat places extending in the one
direction, a rolling step of providing the above-described
guide for steel sheet pile rolling mill on the inlet side
15 of a rolling mill having a groove corresponding to the
shape of the steel sheet pile and performing rolling in
the rolling mill.

Advantageous Effects of Invention

20 [0010]

One aspect of the present invention can provide a
guide for steel sheet pile rolling mill and a steel sheet
pile manufacturing method capable of suppressing the
occurrence of guide clogging or a guide flaw and having
25 excellent maintainability.

Brief Description of Drawings

[0011]

FIG. 1 is a schematic view illustrating the cross-sectional shape of a hat-shaped steel sheet pile;

FIG. 2 is an explanatory view illustrating the facility configuration of a rolling facility;

5 FIG. 3 is a partial cross-sectional view illustrating a finishing rolling mill;

FIG. 4 is a front view of a guide provided in the finishing rolling mill;

10 FIG. 5 is a cross sectional view along the A-A' line of FIG. 4 as viewed from the direction indicated by the arrow; and

FIG. 6 is a schematic view illustrating the cross-sectional shape of a U-shaped steel sheet pile.

15 Description of Embodiments
[0012]

In the following detailed description, a large number of specific details are described illustrating embodiments of the present invention so as to provide a complete
20 understanding of the present invention. However, it is clear that one or more embodiments can be implemented without such descriptions of the specific details. For simplicity, the drawings illustrate well-known structures and devices in schematic form.

25 [0013] <Rolling facility>

A rolling facility according to one embodiment of the present invention is described with reference to FIGS. 1 to 2. A rolling facility 2 is a facility manufacturing a

steel sheet pile 1 by rolling a rectangular slab or the like which is a raw material in a plurality of rolling mills. As illustrated in FIG. 1, the steel sheet pile 1 to be manufactured is a hat-shaped steel sheet pile 1A having a uniform cross-sectional shape orthogonal to the longitudinal direction of a hat shape in this embodiment. The hat-shaped steel sheet pile 1A has, as the cross-sectional shape, a web 11, a pair of flanges 12, a pair of arm parts 13, and a pair of joint parts 14. The web 11 is a section extending in one direction (which is the right and left direction in FIG. 2 and is also referred to as "right and left direction" below). The pair of flanges 12 is connected to both ends in the right and left direction of the web 11 and extends at an angle with respect to the right and left direction. In the example illustrated in FIG. 1, the pair of flanges 12 extends at an angle such that end parts on the opposite sides to the web 11 are located on the lower side in the up and down direction (which is the up and down direction in FIG. 1 and a direction orthogonal to the right and left direction). The pair of arm parts 13 is a section connected to the side to which the web 11 is not connected of the pair of flanges 12 and extending in the right and left direction. The pair of joint parts 14 is a section connected to the side to which the flange 12 is not connected of the pair of arm parts 13 and has a hooked shape opened upward or downward in the up and down direction. When used as a steel sheet pile, the pair of joint parts 14 is a section

to be used for the connection with the other steel sheet pile by being fitted to a joint part of the other steel sheet pile. In this embodiment, the arm part 13 and the joint part 14 are also collectively referred to as a flat part 15. The flat part 15 is a section having a flat place formed to be connected to the side to which the web 11 is not connected of the flange 12 and extending in the right and left direction in the steel sheet pile 1. In this embodiment, the arm part 13 serves as the flat place in the flat part 15. The distance between the pair of joint parts 14 indicated by W in FIG. 1 is referred to as an effective width. The distance in the up and down direction from the flanges 12 to the arm parts 13 indicated by H in FIG. 1 is referred to as an effective height.

[0014]

As illustrated in FIG. 2, the rolling facility 2 manufactures the hat-shaped steel sheet pile 1A by rolling a rectangular slab which is a raw material heated to a predetermined temperature in a furnace 3 in order in a rough rolling mill (BD) 4, an intermediate rolling mill (SR) 5, and a finishing rolling mill (SF) 6.

The rough rolling mill 4 roughly shapes the rectangular slab heated in the furnace 3 into a roughly shaped billet having a cross section orthogonal to the longitudinal direction of a substantially hat shape. The rough rolling mill 4 has one set of rolls containing an upper roll and a lower roll. In the roll set, a plurality

of grooves (e.g., box groove, K8 groove, and K7 groove) referred to as calibers is formed.

[0015]

The intermediate rolling mill 5 rolls the raw material rolled in the rough rolling mill 4 and has two sets of rolls, each set in which a plurality of grooves is formed. For example, for each roll set in the intermediate rolling mill 5, two grooves are formed, so that four grooves are formed in total (e.g., a K6 groove to a K3 groove). Herein, when the box groove and the K8 groove to the K3 groove are provided in the rough rolling mill 4 and the intermediate rolling mill 5, for example, the box groove has a groove shape of a substantially square shape as viewed from the rolling direction (roll gap shape) and the K8 groove to the K3 groove have a groove shape of a hat shape as viewed from the rolling direction. With respect to the K8 groove to the K3 groove, the sheet thickness of the raw material to be rolled decreases in the grooves to be used in the latter half of the rolling roll gap, and the roll gap and the shape are set such that the cross-sectional shape approaches the shape of the product.

[0016]

The finishing rolling mill 6 rolls the raw material rolled in the intermediate rolling mill 5 and has one set of rolls in which two grooves are formed. More specifically, the finishing rolling mill 6 has the two grooves, which are referred to as a K2 groove and a K1 groove.

The finishing rolling mill 6 is described in detail with reference to FIG. 3. As illustrated in FIG. 3, the finishing rolling mill 6 has an upper roll 61 and a lower roll 62 forming one set of rolls and arranged facing each other in the vertical direction which is the up and down direction. In the upper roll 61 and the lower roll 62, a K2 groove 71 and a K1 groove 72 are formed corresponding to the product shape of the hat-shaped steel sheet pile 1A. The K2 groove 71 is a groove rolling the raw material so that the sheet thickness becomes the product thickness about the cross sectional shape of the raw material rolled by the intermediate rolling mill 5. The K1 groove 72 is a groove bending and forming the joint parts 14 of the material rolled in the K2 groove 71. In the K2 groove 71, a section rolling the web 11 of the hat-shaped steel sheet pile 1A is set to a first section 711, sections rolling the arm parts 13 which are the flat places of the flat parts 15 are set to second sections 712, and sections rolling the flanges 12 are set to third sections 713. More specifically, the K2 groove 71 has the first section 711, the second sections 712, and the third section 713 as the shape of the roll gap (gap between the upper roll 61 and the lower roll 62) as viewed from the rolling direction.

[0017]

On the upstream side (the upstream side in the rolling direction and the inlet side where the raw material enters the finishing rolling mill 6) of the K2 groove 71 of the finishing rolling mill 6, a guide 8 guiding the raw

material to be rolled to the K2 groove 71 is provided. As illustrated in FIG. 4 and FIG. 5, the guide 8 has a pair of roller guides 81, a web guide 82, an upper rest bar 83, and a lower rest bar 84.

5 The pair of roller guides 81 each has a guide frame 811 and two rollers 812. The pair of roller guides 81 is a guide restraining a section corresponding to the arm part which is the flat place of the raw material to be rolled from above and guiding the flat place of the raw material to the K2 groove 71. In order to guide the flat place of the raw material, each of the pair of roller guides 81 is provided above the pair of second sections 712 as viewed from the rolling direction, i.e., on the first section 711 side in a direction orthogonal to the extension direction of the second sections 712.

[0018]

20 The guide frames 811 are members supporting the two rollers 812 and fixed to the upper rest bar 83. As illustrated in FIG. 5, the guide frame 811 has a diagonally cut-out shape in an end part on the upstream side (left side in FIG. 5) in the rolling direction such that the lower end is positioned on the upper side toward the upstream side in the rolling direction. By forming such a shape, the raw material can be guided to the K2 groove 71 even when the tip of the raw material to be rolled is greatly warped upward. The two rollers 812 are fixed to the guide frame 811 in a rotatable state in the rolling

direction of the raw material to be rolled and are arranged side by side in the rolling direction.

[0019]

As illustrated in FIG. 4, each of the pair of roller guides 81 is arranged on the first section 711 side of the second section 712 of the K2 groove 71 as viewed from the rolling direction (on the web side of the hat shape and the upper side in FIG. 4). In the pair of roller guides 81, the lower ends of the two rollers 812 may be located above the roll gaps between the upper roll 61 and the lower roll 62 as viewed from the rolling direction, and predetermined clearances $d2$ are preferably provided between the two rollers 812 and the second sections 712 of the K2 groove 71. As illustrated in FIG. 4, the clearance $d2$ is the distance in the up and down direction between the lower end of the roller 812 and the upper end of the roll gap (lower end of the upper roll 61) of the second section 712 of the K2 groove 71 as viewed from the rolling direction. It is preferable that the clearance $d2$ is the distance of the roll gap in the second section 712 of the K2 groove 71 as a predetermined distance and is substantially the same as the separation distance between the upper roll 61 and the lower roll 62 (distance of the roll gap) in the second section 712 in the final rolling pass in the K2 groove 71. Herein, the final rolling pass is a rolling pass to be performed last when a plurality of rolling passes is performed in the groove. When one rolling pass is performed in the groove, the final rolling

pass is one pass in which the rolling is performed. More specifically, the distance of the roll gap in the final rolling pass is the same as the sheet thickness after rolling of the raw material to be rolled in the groove.

5 The clearance d2 preferably has a distance of 40% or more and 120% or less of the distance of the roll gap in the second section 712 of the K2 groove 71 and preferably has the same distance as the distance of the roll gap in the second section 712 of the K2 groove 71. The roll gaps in

10 the second sections 712 of the K2 groove 71 are equivalent to the sheet thickness in the arm parts 13 of the product of the hat-shaped steel sheet pile 1A to be rolled. When the clearance d2 is less than 40% of the distance of the roll gap in the second section 712 of the K2 groove 71,

15 the clearance d2 is excessively small, and therefore the possibility is high that the clogging of the raw material occurs. On the other hand, when the clearance d2 is larger than 120% of the distance of the roll gap in the second section 712 of the K2 groove 71, the clearance d2 is

20 excessively large, and therefore there is a possibility that the raw material is not guided to the roll gap, resulting in a biting failure.

[0020]

The web guide 82 is a friction guide having a shape

25 following the first section 711 and the third sections 713 of the K2 groove 71 as viewed from the rolling direction, i.e., a shape following the web 11 and the flanges 12 of the hat-shaped steel sheet pile 1A. The web guide 82

restrains sections corresponding to the web and the flanges of the raw material to be rolled from below and guides the sections to the K2 groove 71. As illustrated in FIG. 5, the web guide 82 has a diagonally cut-out shape in an end part on the upstream side in the rolling direction such that the upper end is located on the lower side toward the upstream side in the rolling direction. By forming such a shape, the raw material can be guided to the K2 groove 71 even when the tip of the raw material to be rolled is greatly warped downward.

[0021]

The web guide 82 is arranged below the first section 711 and the third sections 713 of the K2 groove 71, i.e., on the second section 712 sides (the arm part sides of the hat shape, lower side in FIG. 4) in a direction orthogonal to the extension direction of the first section 711, as viewed from the rolling direction.

It is preferable that the upper ends of the web guide 82 each may be located below the roll gap between the upper roll 61 and the lower roll 62 as viewed from the rolling direction and that predetermined clearances d_1 , d_3 are provided between the web guide 82 and the first section 711 and the third section 713, respectively, of the K2 groove 71. As illustrated in FIG. 4, the clearance d_1 is the distance in the up and down direction between the upper end of a section corresponding to the web of the web guide 82 and the lower end of the roll gap of the first section 711 (upper end of the lower roll 62) as viewed from the

rolling direction. The clearance d3 is the distance in the perpendicular direction of the third section 713 between the upper end of the section corresponding to the flange of the web guide 82 (section extending at an angle with respect to the right and left direction as viewed from the rolling direction of the upper end) and the lower end of the roll gap (upper end of the lower roll 62) of the third section 713 of the K2 groove 71. It is preferable that the clearance d1 has a distance of 40% or more and 120% or less of the distance of the roll gap in the first section 711 of the K2 groove 71 and that the clearance d3 has a distance of 60% or more and 180% or less of the distance of the roll gap in the third section 713. The roll gaps in the first section 711 and the third sections 713 of the K2 groove 71 are equivalent to the sheet thicknesses of the web 11 and the flanges 12, respectively, of the product of the hat-shaped steel sheet pile 1A to be rolled. By setting the clearances d1, d3 in the ranges above, the same effects as those in the clearance d2 are obtained.

[0022]

The upper rest bar 83 is a member supporting the pair of roller guides 81 and provided to extend in the right and left direction. The upper rest bar 83 is provided to be fixed to a housing or a chock of the rolling mill in which the guide 8 is provided. The upper rest bar 83 is provided above the K2 groove 71 as viewed from the rolling

direction, and the guide frames 811 of the pair of roller guides 81 are fixed to the upper rest bar 83.

The lower rest bar 84 is a member supporting the web guide 82 and provided to extend in the right and left direction. The lower rest bar 84 is provided to be fixed to a housing or a chock of the rolling mill in which the guide 8 is provided. The lower rest bar 84 is provided below the K2 groove 71 as viewed from the rolling direction, and the web guide 82 is fixed to the lower rest bar 84.

10 [0023] <Method for manufacturing steel sheet pile>

Next, a method for manufacturing the steel sheet pile 1 according to this embodiment is described. In this embodiment, a rectangular slab heated to a predetermined temperature in the furnace 3 is rolled in order in the rough rolling mill 4, the intermediate rolling mill 5, and the finishing rolling mill 6 to manufacture the hat-shaped steel sheet pile 1A having the cross-sectional shape illustrated in FIG. 1. A step of performing the rolling in each rolling mill is also referred to as a rolling step.

20 In the rolling in the rough rolling mill 4 and the intermediate rolling mill 5, the raw material is rolled a plurality of times in each groove in each rolling mill. In the rough rolling mill 4, when the box groove is used as described above, the width reduction of the rectangular slab is performed in the box groove, followed by bending and thickness reduction of the slab in the K9 groove in order.

[0024]

In the rolling in the finishing rolling mill 6, the raw material rolled in the intermediate rolling mill 5 is rolled in the K2 groove 71, and then rolled in the K1 groove 72. In this case, the number of rolling passes in the K2 groove 71 and the K1 groove 72 is set to one pass.

In the rolling in the K2 groove 71, the raw material is bitten into the K2 groove 71 through the guide 8. At this time, the raw material is restrained from above by the pair of roller guides 81 and restrained from below by the web guide 82. This makes it possible to keep the biting attitude of the raw material into the K2 groove 71 within a predetermined range and to cause the tip of the raw material to bite into the K2 groove 71 even when the raw material has a larger upward warp than the clearance $d1$ or a larger downward warp than the clearance $d3$. Further, the raw material is restrained in the right and left direction by the web guide 82, so that the biting attitude into the K2 groove 71 is kept within a predetermined range corresponding to the clearance $d2$. Therefore, even when the raw material is bent in the right and left direction, the tip of the raw material can be caused to bite into the K2 groove.

[0025] <Modification>

The present invention is described above with reference to the specific embodiment but it is not intended that the description thereof limits the present invention. By referring to the description of the present invention, not only the disclosed embodiment but other embodiments of

the present invention including various modifications are apparent to those skilled in the art. Hence, it should be understood that the embodiments of the present invention recited in Claims cover embodiments including
5 modifications thereof described in this specification alone or in combination.

[0026]

For example, in the above-described embodiment, the steel sheet pile 1 is the hat-shaped steel sheet pile 1A,
10 but present invention is not limited to such an example. The steel sheet pile 1 may have another cross-sectional shape insofar as a web, a flange, and a flat part which is a flat section are provided. For example, the steel sheet pile 1 may be a U-shaped steel sheet pile 1B having the
15 cross-sectional shape illustrated in FIG. 6. The U-shaped steel sheet pile 1B is a steel sheet pile having a U-shaped cross-sectional shape and has the web 11, the pair of flanges 12, and the pair of joint parts 14 as illustrated in FIG. 6. The web 11 and the pair of flanges 12 are
20 similar to those of the hat-shaped steel sheet pile 1A. As illustrated in FIG. 6, the pair of joint parts 14 is a section connected to the side to which the web 11 is not connected of the pair of flanges 12 and has a flat part extending in the right and left direction at the lower end.
25 In such a U-shaped steel sheet pile 1B, the joint parts 14 have flat parts (claw bottom parts 142 in FIG. 6) equivalent to the flat parts 15 in the above-described embodiment, and the claw bottom parts 142 are restrained

from above by a pair of roller guides similar to that of the above-described embodiment, thereby stabilizing the biting attitude. In the present invention, in the groove in which the guide is provided, the second section is a section of a roll gap rolling the claw bottom part 142. Therefore, in the case of the U-shaped steel sheet pile 1B, the second section of the groove is a section of the roll gap rolling the claw bottom part 142 extending in the right and left direction of the joint part. The cross-sectional shape of the U-shaped steel sheet pile 1B illustrated by the solid line in FIG. 6 illustrates the cross-sectional shape after the final rolling (rolling in the K1 groove). In rolling after one rolling before the final rolling (rolling in a groove before the K2 groove), claws 141 of the joint parts 14 are rolled into a shape of being opened outward as illustrated by the dashed lines. Therefore, by setting the clearances d2 and providing the rollers 812 as described above, the claw bottom parts 142 are guided to the groove by the rollers 812.

[0027]

In the above-described embodiment, the roller guide 81 is provided with the two rollers 812, but the present invention is not limited to such an example. At least one roller 812 may be provided in one roller guide 81.

In the above-described embodiment, the web guide 82 is the friction guide but the present invention is not limited to such an example. The web guide 82 may be a roller guide provided with a roller in a place in contact

with a web or a flange of a raw material. In this case, the roller may be similar to the roller 812 in the roller guide 81.

[0028]

5 In the above-described embodiment, the orientation of the steel sheet pile 1 to be rolled is set such that the web 11 is located on the vertically upper side and the flat parts 15 are located on the vertically lower side, but the present invention is not limited to such an example.
10 For example, the orientation of the steel sheet pile 1 to be rolled may be reversed in the up and down direction from that of the above-described embodiment. In this case, the direction in which the roller guide 81 and the web guide 82 restrain the raw material is reversed in the up
15 and down direction from the direction in the above-described embodiment.

[0029]

In the above-described embodiment, the guide 8 is provided in the K2 groove 71 of the finishing rolling mill
20 6, but the present invention is not limited to such an example. For example, the guide may be provided in the K1 groove 72 of the finishing rolling mill 6 or in another groove of the rough rolling mill 4 or the intermediate rolling mill 5. In this case, the guide 8 may be provided
25 on each side in a roll set conveying direction in the case of a rolling mill performing reverse rolling in which the rolling direction changes as rolling of a plurality of

passes as in the rough rolling mill 4 or the intermediate rolling mill 5.

[0030] <Effects of embodiments>

(1) The guide 8 for the rolling mill for the steel sheet pile 1 according to one embodiment of the present invention, the steel sheet pile (1) having, as the cross-sectional shape orthogonal to the longitudinal direction, the web 11 extending in one direction, the pair of flanges 12 connected to both ends in the one direction of the web 11 and extending at an angle with respect to the one direction, and the pair of flat parts 15 connected to the ends on the sides to which the web 11 is not connected of the pair of flanges 12 and having flat places extending in the one direction, the guide 8 being provided on the inlet side of a rolling mill (e.g., finishing rolling mill 6) having an upper roll and a lower roll in which a groove (e.g., K2 groove 71) corresponding to the shape of the steel sheet pile (1) is formed in the rolling of the steel sheet pile (1), the guide 8 for the rolling mill for the steel sheet pile (1) including: the web guide 82 restraining a web corresponding part corresponding to the web 11 in a raw material to be rolled from one direction in the up and down direction and guiding the web corresponding part to the groove; and a pair of roller guides 81 having at least one roller 812 rotatable in the rolling direction and restraining flat part corresponding parts corresponding to the flat parts in the raw material

from the other direction in the up and down direction and guiding the flat part corresponding parts to the groove.

[0031]

According to the configuration (1) above, the raw
5 material to be rolled can be restrained in the up and down direction at the inlet side of the rolling mill. Therefore, even when the raw material is warped upward/downward or curled, the raw material is fed into the rolling mill with an appropriate biting attitude, preventing the occurrence
10 of the biting failure. Further, the guide 8 having the configuration (1) above can cause the raw material to bite into the groove by the configuration having only the pair of roller guides 81 restraining the flat places from one direction in the up and down direction and the web guide
15 82 restraining the web 11 from the other direction in the up and down direction on the inlet side of the rolling mill. Therefore, the occurrence of the guide clogging in which the raw material is clogged in the guide or the guide flaw caused by the contact with the guide can be suppressed
20 because the restraint is not excessive as compared with a guide restraining both the inlet side and the outlet side of a rolling mill or a large number of places in the cross section of a raw material as in PTL 1. Further, the configuration (1) above can reduce the configurations
25 restrained by the guide as compared with the guide of PTL 1, achieving excellent maintainability. In the configuration (1) above, a guide mechanism of a system using a roller is used for at least the roller guide 81.

Thus, the configuration (1) above achieves more excellent maintainability as compared with a guide mechanism of a friction system. In addition, due to the guide mechanism using the roller, the occurrence of the guide flaw can be further suppressed as compared with the guide mechanism of a friction system. Further, by stabilizing the biting attitude, the occurrence of the exit posture defect, such as curling or an upward/downward warp, the guide flaw, and the heat scratch during hot rolling can be suppressed.

10 [0032]

(2) In the configuration (1) above, the predetermined clearances d_2 are provided between the rollers 812 and the upper end or the lower end of the groove as viewed from the rolling direction.

15 According to the configuration (2) above, the occurrence of the guide clogging can be further suppressed.

(3) In the configuration (2) above, the clearance d_2 is 40% or more and 120% or less of the distance of the roll gap between the upper roll and the lower roll in a place where the flat part corresponding parts are rolled of the groove.

According to the configuration (3) above, the occurrence of the guide clogging and the biting failure can be further reduced.

25 [0033]

(4) In any one of the configurations (1) to (3) above, the steel sheet pile 1 is the hat-shaped steel sheet pile 1A having, as the pair of flat parts 15, the pair of arm

parts 13 connected to the pair of flanges 12 and extending in the one direction and the joint parts 14 connected to the sides to which the pair of flanges 12 is not connected of the pair of arm parts 13, in which the pair of flat parts 15 is the pair of arm parts 13.

According to the configuration (4) above, the biting attitude can be stabilized in the hat-shaped steel sheet pile in which the biting attitude is likely to deteriorate due to a rolling load or a temperature variation in the width direction due to the extra wide and asymmetrical shape.

[0034]

(5) A method for manufacturing the steel sheet pile 1 of the present invention includes, in the rolling of the steel sheet pile 1 having, as the cross-sectional shape orthogonal to the longitudinal direction, the web 11 extending in one direction, the pair of flanges 12 connected to both sides of the web 11 and extending at an angle with respect to the one direction, and the pair of flat parts 15 connected to the sides to which the web 11 is not connected of the pair of flanges 12 and having flat parts extending in the one direction, the rolling step of providing the guide for the rolling mill for the steel sheet pile 1 described in any one of (1) to (4) above on the inlet side of a rolling mill having the groove corresponding to the shape of the steel sheet pile 1 and performing rolling in the rolling mill.

According to the configuration (5) above, the same effects as those in the configurations (1) to (4) above are obtained.

5 EXAMPLES

[0035]

Next, Example performed by the present inventors is described. In Example, the hat-shaped steel sheet pile 1A having an effective width W of 900 mm and an effective height H of 230 mm was manufactured in the rolling facility 2 illustrated in FIG. 2 in the same manner as in the above-described embodiment. At this time, the guide 8 is provided on the inlet side in the rolling direction in the K2 groove 71 performing the final thickness reduction. In the guide 8, the rollers 812 having a dimension of a diameter of 170 mm and a width of 60 mm were used, and the clearances d1 to d3 were set to the same distances as the roll gaps in the first section 711 to the third section 713, respectively. Then, 10 raw materials were continuously rolled in the rolling facility 2 to confirm whether the guide clogging occurred, whether the exit posture defect occurred, whether the heat scratch occurred, and whether the guide flaw occurred in the K2 groove 71.

[0036]

As a comparison, rolling was also carried out in a rolling facility similar to that in Example under the condition where the rolling was performed without providing the guide 8 (Comparative Example 1) and under

the condition where a guide simulating that of PTL 1 was provided and the rolling was performed (Comparative Example 2) to confirm whether abnormalities occurred in the K2 groove 71 in the same manner as in Example.

5 Table 1 shows the results of Example and Comparative Examples 1, 2. In Table 1, the "rolling order" indicates the ten rolled raw materials. In Table 1, with respect to the abnormality occurrence results, "o" indicates that each of the abnormalities did not occur, "x" indicates that
10 any of the abnormalities occurred, and "-" indicates that it was not able to be confirmed whether the abnormalities occurred. The heat scratch refers to the shape defect caused when the raw material is bitten into the roll while being shifted in the width direction or the up and down
15 direction, so that a part of the raw material is peeled off and pressed and fixed onto the roll, and then the pressed and fixed portion is transferred to the surface of the raw material. The exit posture defect refers to the fact that the raw material is bent in the width direction,
20 warped in the up and down direction, curled, or the like, so that the raw material is out of the line or is unable to proceed to the next pass, resulting in discontinuing of the rolling. The guide flaw refers to a shape defect occurring on the raw material surface caused by strong
25 contact with the guide. In Example, each raw material was inspected for the shape, and then the next raw material was rolled. When the heat scratch was confirmed by the shape inspection, each roll of the intermediate rolling

mill 5 and the finishing rolling mill 6 was checked, and then roll maintenance with a grinder was carried out.

[0037]

[Table 1]

Rolling order	Comparative Example 1					Comparative Example 2					Example				
	Guide clogging	Exit defect	posture	Heat scratch	Guide flaw	Guide clogging	Exit defect	posture	Heat scratch	Guide flaw	Guide clogging	Exit defect	posture	Heat scratch	Guide flaw
1	○	×		-	○	×	-		-	-	○	○		○	○
2	○	×		-	○	○	○		○	×	○	○		○	○
3	○	○		×	○	○	○		○	×	○	○		○	○
4	○	○		×	○	○	○		○	○	○	○		○	○
5	○	○		○	○	○	○		○	○	○	○		○	○
6	○	○		○	○	○	○		○	○	○	○		○	○
7	○	○		○	○	○	○		○	○	○	○		○	○
8	○	○		○	○	○	○		○	○	○	○		○	○
9	○	○		×	○	○	○		○	○	○	○		○	○
10	○	○		○	○	○	○		○	○	○	○		○	○

[0038]

As shown in Table 1, in Comparative Example 1, the exit posture defect and the heat scratch occurred in the early stage of the rolling. The heat scratch sporadically occurred even after rolling adjustment by the roll tilt adjustment or the like. In Comparative Example 2, the guide clogging occurred in the first rolling, but the exit posture defect did not occur. Further, the guide flaw occurred in the early stage of the rolling, but the guide flaw did not occur after the adjustment.

In contrast thereto, in Example, the guide clogging, the exit posture defect, the heat scratch, and the guide flaw did not occur from the first rolling, and thus an improvement effect was able to be confirmed.

The present inventors also performed rolling also in the intermediate rolling mill 5 under the condition where a guide similar to that of the finishing rolling mill 6 was provided. As a result, it was confirmed that the rolling was able to be performed without causing the occurrence of the abnormalities, such as the guide clogging, the exit posture defect, the heat scratch, and the guide flaw, also in the rolling in the intermediate rolling mill 5.

Reference Signs List

[0039]

- 1 steel sheet pile
- 1A Hat-shaped steel sheet pile

	1B	U-shaped steel sheet pile
	11	web
	12	flange
	13	arm part
5	14	joint part
	15	flat part
	2	rolling facility
	3	rolling furnace
	4	rough rolling mill
10	5	intermediate rolling mill
	6	finishing rolling mill
	61	upper roll
	62	lower roll
	71	K2 groove
15	711	first section
	712	second section
	713	third section
	8	guide
	81	roller guide
20	811	guide frame
	812	roller
	82	web guide
	83	upper rest bar
	84	lower rest bar
25		

CLAIMS

1. A guide being provided on a steel sheet pile rolling mill, for the manufacture of a steel sheet pile having, as a cross-sectional shape orthogonal to a longitudinal direction, a web extending in one direction, a pair of flanges connected to both ends in the one direction of the web and extending at an angle with respect to the one direction, and a pair of flat parts connected to ends on sides to which the web is not connected of the pair of flanges and having flat places extending in the one direction,

the guide being provided on an inlet side of the steel sheet pile rolling mill having an upper roll and a lower roll in which a groove corresponding to a shape of the steel sheet pile is formed in rolling of the steel sheet pile,

the guide for the steel sheet pile rolling mill comprising:

a web guide restraining a web corresponding part corresponding to the web in a raw material to be rolled from one direction in an up and down direction and guiding the web corresponding part to the groove; and

a pair of roller guides having at least one roller rotatable in a rolling direction and restraining flat part corresponding parts corresponding to the flat parts in the raw material from another direction in the up and down direction and guiding the flat part corresponding parts to the groove.

2. The guide being provided on a steel sheet pile rolling mill according to claim 1, wherein a predetermined clearance is provided between the at least one roller and an upper end or a lower end of the groove as viewed from
5 the rolling direction.

3. The guide being provided on a steel sheet pile rolling mill according to claim 2, wherein the clearance is 40% or more and 120% or less of a distance of a roll
10 gap between the upper roll and the lower roll in a place of the groove where the flat part corresponding parts are rolled.

4. The guide being provided on a steel sheet pile
15 rolling mill according to any one of claims 1 to 3, wherein the steel sheet pile is a hat-shaped steel sheet pile having, as the pair of flat parts, a pair of arm parts connected to the pair of flanges and extending in the one direction and joint parts connected to sides to which the
20 pair of flanges is not connected of the pair of arm parts, and

the pair of flat parts is the pair of arm parts.

5. A steel sheet pile manufacturing method
25 comprising, in rolling of the steel sheet pipe having, as a cross-sectional shape orthogonal to a longitudinal direction, a web extending in one direction, a pair of flanges connected to both sides of the web and extending at an angle with respect to the one direction, and a pair

of flat parts connected to sides to which the web is not connected of the pair of flanges and having a pair of flat places extending in the one direction,

5 a rolling step of providing the guide for steel sheet pile rolling mill according to any one of claims 1 to 4 on an inlet side of a rolling mill having a groove corresponding to a shape of the steel sheet pile and performing rolling in the rolling mill.