

SPECIFICATION

Title of Invention

ROLLED H-SECTION STEEL

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Technical Field

[0001]

The present invention relates to a rolled H-section steel that directly supports a floor slab or roof floor slab, and is applied to a small beam that is not directly connected to a pillar, a beam that is used within an elastic design range, and the like.

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Priority is claimed on Japanese Patent Application No. 2009-162402, filed July 09, 2009, the content of which is incorporated herein by reference.

Background Art

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[0002]

Conventionally, as rolled H-section steels, various rolled H-section steels like the following (1) to (5) are known.

[0003]

(1) A rolled H-section steel having excellent earthquake resistance, in which the flange breadth-thickness ratio is less than or equal to 10, the work-hardening exponent in a strain range up to 6% after work-hardening is started is greater than or equal to 0.2, and the rising gradient of plastic deformation stress in a strain range of 6% or more is larger than the moment gradient in the vicinity of a position having a maximum moment, whereby a plastic region generated at a position that causes the maximum moment is enlarged to the perimeter (for example, refer to Patent Document

20
25

1).

[0004]

(2) A rolled H-section steel for a pillar in which the web thickness to flange thickness ratio is 1.2 to 4, and reinforcement by a doubler plate in a pillar-to-beam joint panel, an oblique stiffener, or the like (for example, refer to Patent Document 2) can be omitted.

[0005]

(3) A rolled H-section steel for a pillar in which the web thickness to flange thickness ratio is 1.1 to 2.0, and reinforcement by a horizontal stiffener at a beam flange joining position in a pillar-to-beam joint, a doubler plate in a panel, an oblique stiffener, or the like can be omitted (for example, refer to Patent Document 3).

[0006]

(4) A thin-web rolled H-section steel in which the web thickness to flange thickness ratio is less than or equal to 0.5, and concavo-convex are formed at predetermined intervals in a web in order to prevent a web flapping phenomenon during rolling (for example, refer to Patent Document 4).

[0007]

(5) A thin-web rolled H-section steel in which the web thickness to flange thickness ratio is less than or equal to 0.5, and at least one protrusion reinforcing rib is provided over the longitudinal total length of only one lateral surface of a web in order to prevent a web flapping phenomenon during rolling (for example, refer to Patent Document 5).

[0008]

Additionally, as techniques regarding conventional rolled H-section steels, techniques like the following (A) to (D) are also known.

[0009]

(A) Since it is necessary to secure the plastic deformation capacity of a rolled H-section steel in order to be used as a pillar or beam member having excellent earthquake resistance, as shown in JIS G 3192 or Patent Document 6, the flange
5 breadth-thickness ratio and the web breadth-thickness ratio are specified in a relatively small numerical range (the upper limit of the flange breadth-thickness ratio is set to 10.0 and the upper limit of the web breadth-thickness ratio is set to 56.6, according to JIS, in a case where a major application is a beam and the side-height ratio is in a range of 0.77 or less) that is said to have a deformation capacity.

10 [0010]

(B) In order to improve the cross-sectional secondary moment and the section modulus to weight efficiency, the web thickness to flange thickness ratio of a rolled H-section steel for a beam is specified in a relatively small numerical range (the upper limit of the web thickness to flange thickness ratio is set to 0.75, in a case where a major
15 application is a beam and the side-height ratio is in a range of 0.77 or less) as being specified in JIS G 3192.

[0011]

(C) In order to omit reinforcement by a doubler plate in a pillar-to-beam joint panel, an oblique stiffener, or the like, it is also known that the web thickness to flange
20 thickness ratio of a rolled H-section steel for a pillar is specified in a relatively large numerical range (the lower limit of the web thickness to flange thickness ratio is set to 1.1) (for example, refer to Patent Documents 2 and 3).

[0012]

(D) In order to realize a thin-web rolled H-section steel while preventing the
25 web flapping phenomenon during rolling manufacture, it is also known that the web

thickness to flange thickness ratio is specified in a relatively small numerical range (the upper limit of the web thickness to flange thickness ratio is 0.5) (for example, refer to Patent Documents 4 and 5).

[0013]

- 5 (E) In addition to the above, there are rolled H-section steels that are standardized in ASTM (American Society for Testing and Materials), BS (British Standards), and EN (European Standard) (refer to Non Patent Documents 1 to 3).

Patent Documents

10 [0014]

[Patent Document 1] Japanese Unexamined Patent Application, First Publication No. 2002-88974

[Patent Document 2] Japanese Unexamined Patent Application, First Publication No. 2000-54560

15 [Patent Document 3] Japanese Unexamined Patent Application, First Publication No. 2003-155779

[Patent Document 4] Japanese Unexamined Patent Application, First Publication No. S59-141658

[Patent Document 5] Japanese Unexamined Patent Application, First Publication
20 No. S61-162658

[Patent Document 6] Japanese Unexamined Patent Application, First Publication No. 2002-88974

Non Patent Documents

[0015]

25 [Non Patent Document 1] ASTM (American Society for Testing and

Materials)

[Non Patent Document 2] BS (British Standards)

[Non Patent Document 3] EN (European Standard)

5 Disclosure of Invention

Technical Problem

[0016]

The shape of the rolled H-section steel, as described above, is standardized in respective countries including the U.S., Britain, Europe, and Japan. For example, in
 10 Japan, various rolled H-section steels described in JIS G 3192 (the shape, dimensions, mass, and allowance of a hot rolled steel) are known.

[0017]

As for "the shape, dimension, mass, and its allowance of a hot rolled steel in JIS G 3192", the cross-sectional dimensions in "Appended Table 8: Standard section
 15 dimensions and cross-sectional area, unit mass, and cross-sectional characteristics of H-section steel" published in JIS G 3192 are posted in the following Table 1, and the following (a) to (c) can be seen from a side-height ratio (B/H), a flange breadth-thickness ratio ($B/(2 \times t_2)$), a web breadth-thickness ratio ($(H - 2 \times t_2)/t_1$), and a web thickness and flange thickness ratio (t_1/t_2), which are shown in Table 1.

20 (a) The flange breadth-thickness ratio is in a range of 3.1 to 13.4.

(b) The web breadth-thickness ratio is in a range of 8.0 to 56.6.

(c) The web thickness to flange thickness ratio is in a range of 0.53 to 1.00.

Various conventional rolled H-section steels in which the side-height ratio (B/H) of the various conventional rolled H-section steels in Table 1 is less than or equal to 0.77
 25 are plotted and shown with open circle marks in FIGS. 1 and 4, and various conventional

rolled H-section steels in which the side-height ratio (B/H) in Table 1 exceeds 0.77 are plotted and shown with marks X.

FIGS. 1 and 4 are graphs showing the horizontal axis as the flange breadth-thickness ratio ($B/(2 \times t_2)$) and showing the vertical axis as the web breadth-thickness ratio ($(H-2 \times t_2)/t_1$). Additionally, the various conventional rolled H-section steels shown in Table 1 are plotted and shown in FIGS. 2 and 5 with the horizontal axis as the side-height ratio (B/H) and the vertical axis as the web thickness to flange thickness ratio (t_1/t_2).

[0018]

Here, the major application of rolled H-section steels in which the side-height ratio is in a range (marketed in Japan as a small-breadth series or middle-breadth series of rolled H-section steels regarding the flange breadth of rolled H-section steel) of 0.77 or less can be classified into a beam, and the major application of rolled H-section steels in which the side-height ratio is in a range (marketed as a large-breadth series of rolled H-section steels regarding the flange breadth of rolled H-section steel) exceeding 0.77 can be classified into a pillar or a brace. In addition, in Table 1 Height $\times$ Side ($H \times B$) (unit: mm): 150 $\times$ 100, 200 $\times$ 150, 250 $\times$ 175, 300 $\times$ 200, 350 $\times$ 250, 400 $\times$ 300, 450 $\times$ 300, 500 $\times$ 300, 600 $\times$ 300, 700 $\times$ 300, 800 $\times$ 300, and 900 $\times$ 300 (mm) are middle-breadth series, and the height (H) and the side (B) that has the same dimensions are large-breadth series, and the others are small-breadth series.

[0019]

Thus, if the major application is a beam, and the side-height ratio is limited to a range of 0.77 or less, the following (d) to (f) can be seen.

(d) The flange breadth-thickness ratio is in a range of 3.1 to 10.0,

(e) the web breadth-thickness ratio is in a range of 17.2 to 56.6, and

(f) the web thickness to flange thickness ratio is in a range of 0.53 to 0.75.

[0020]

Being set as in the above (d) to (f) is based on the following reasons (g) and (h).

[0021]

- 5 (g) The reason why the flange breadth-thickness ratio is a relatively small numerical range of 17.2 to 56.6 when the web breadth-thickness ratio is in a range of 3.1 to 10.0 is because, if the ratio of the breadth to thickness of a plate element that constitute a member section is large, local buckling is caused in a portion that receives a compressive force, and the proof stress of the member section declines and a required plastic deformation capacity is no longer obtained.

[0022]

- (h) Moreover, the reason why the web thickness to flange thickness ratio is in a relatively small numerical range of 0.53 to 0.75 is because the cross-sectional secondary moment per unit cross-sectional area and the section modulus are increased by thickening flanges and thinning a web since a beam is a member that receives a bending stress.

[0023]

- Additionally, various rolled H-section steels that are standardized in ASTM (American Society for Testing and Materials), BS (British Standards), and EN (European Standard) are divided into various rolled H-section steels in which the side-height ratio (B/H) is in a range of 0.77 or less and various rolled H-section steels in which the side-height ratio (B/H) exceeds 0.77, and the upper limits of the flange breadth-thickness ratio, web breadth-thickness ratio, and web thickness to flange thickness ratio (t_1/t_2) of the various rolled H-section steels in which the side-height ratio (B/H) is in a range of 0.77 or less are shown in FIGS. 6 to 11 for close study.

- 25 [0024]

Additionally, in FIGS. 6 and 7, as for the various rolled H-section steels that are standardized in ASTM (American Society for Testing and Materials), the various rolled H-section steels (rolled H-section steels belonging to the middle breadth or the small breadth) in which the side-height ratio (B/H) is in a range of 0.77 or less are plotted and shown with open circle marks, and the various rolled H-section steels in which the side-height ratio (B/H) exceeds 0.77 are plotted and shown with X marks. A table of the various rolled H-section steels that are plotted and shown in FIGS. 6 and 7 and are standardized in ASTM (American Society for Testing and Materials) is omitted.

FIG. 6 is a graph plotting and showing the various rolled H-section steels that are standardized in ASTM, with the horizontal axis as the flange breadth-thickness ratio ($B/(2 \times t_2)$) and the vertical axis as the web breadth-thickness ratio ($(H - 2 \times t_2)/t_1$). It can be seen from this drawing that, in the rolled H-section steels that are shown with open circles and belong to the middle breadth or the small breadth, the upper limit of the flange breadth-thickness ratio is 9.4, and the upper limit of the web breadth-thickness ratio is 63.5.

[0025]

Additionally, as for the various rolled H-section steels that are standardized in ASTM, the various rolled H-section steels are plotted and shown in FIG. 7 with the horizontal axis as the side-height ratio (B/H) and the vertical axis as the web thickness to flange thickness ratio (t_1/t_2). It can be seen from this graph that, in the rolled H-section steels that are shown with open circles and belong to the middle breadth or the small breadth, the upper limit of the side-height ratio (B/H) is 0.72, and the upper limit of the web thickness to flange thickness ratio (t_1/t_2) is 0.82.

[0026]

Additionally, in FIGS. 8 and 9, as for the various rolled H-section steels that are

standardized in BS (British Standards), the various rolled H-section steels (rolled H-section steels belonging to the middle breadth or the small breadth) in which the side-height ratio (B/H) is in a range of 0.77 or less are plotted and shown with open circle marks, and the various rolled H-section steels in which the side-height ratio (B/H) exceeds 0.77 are plotted and shown with X marks. A table of the various rolled H-section steels that are plotted and shown in FIGS. 8 and 9 and are standardized in BS (British Standards) is omitted.

FIG. 8 is a graph plotting and showing the various rolled H-section steels that are standardized in BS, with the horizontal axis as the flange breadth-thickness ratio ($B/(2 \times t_2)$) and the vertical axis as the web breadth-thickness ratio ($(H - 2 \times t_2)/t_1$). It can be seen from this drawing that, in the rolled H-section steels belonging to the middle breadth or the small breadth, the upper limit of the flange breadth-thickness ratio is 8.6, and the upper limit of the web breadth-thickness ratio is 63.3.

Additionally, FIG. 9 is a graph shown by plotting the various rolled H-section steels that are standardized in BS (British Standards) with the horizontal axis as the side-height ratio (B/H) and the vertical axis as the web thickness to flange thickness ratio (t_1/t_2). It can be seen from this graph that, in the rolled H-section steels that are shown with open circles and belong to the middle breadth or the small breadth, the upper limit of the side-height ratio (B/H) is 0.66, and the upper limit of the web thickness to flange thickness ratio (t_1/t_2) is 0.86.

[0027]

Additionally, in FIGS. 10 and 11, as for the various rolled H-section steels that are standardized in EN (European Standard), the various rolled H-section steels (rolled H-section steels belonging to the middle breadth or the small breadth) in which the side-height ratio (B/H) is in a range of 0.77 or less are plotted and shown with open circle

marks, and the various rolled H-section steels in which the side-height ratio (B/H) exceeds 0.77 are plotted and shown with X marks. A table of the various rolled H-section steels that are plotted and shown in FIGS. 10 and 11 and are standardized in EN (European Standard) is omitted.

5 FIG. 10 is a graph plotting and showing the various rolled H-section steels that are standardized in EN (European Standard), with the horizontal axis as the flange breadth-thickness ratio ($B/(2 \times t_2)$) and the vertical axis as the web breadth-thickness ratio $((H-2 \times t_2)/t_1)$. It can be seen from this drawing that, in the rolled H-section steels belonging to the middle breadth or the small breadth, the upper limit of the flange
10 breadth-thickness ratio is 11.1, and the upper limit of the web breadth-thickness ratio is 58.0. Additionally, the various rolled H-section steels that are standardized in EN (European Standard) is plotted and shown in FIG. 11 with the horizontal axis as the side-height ratio (B/H) and the vertical axis as the web thickness to flange thickness ratio (t_1/t_2). It can be seen from this graph that, in the rolled H-section steels that are shown
15 with open circles and belong to the middle breadth or the small breadth, the upper limit of the side-height ratio (B/H) is 0.77, and the upper limit of the web thickness and flange thickness ratio (t_1/t_2) is 0.78.

[0028]

20 Meanwhile, since the number of small beams to be used is large compared to the number of large beams, if the weight per beam can be reduced without degrading the required cross-sectional performance, it is possible to greatly contribute to the reduction of the cost of a main body of a structure even if the cost reduction per beam is small.

 For example, if the weight of a small beam or the like can be reduced by 10% or more, without reducing the earthquake-resistant performance of the beam, the unit price
25 of the beam can be reduced by about 10%. Therefore, not only can the cost of the main

body of a structure be reduced markedly, but also the weight of the structure can be reduced, and the burden of a pillar becomes smaller to the extent that the weight of the structure is reduced. This also can contribute to improvement in the earthquake-proof performance of a structure.

- 5 Moreover, compared to rolled H-section steels that are standardized in major advanced nations including the U.S., Britain, Europe, and Japan, a rolled H-section steel is desired which may be made lightweight for a small beam and which does not degrade the cross-sectional performance. The object of the invention is to provide a rolled H-section steel that is advantageous for solving the above problems.

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Solution to Problem

[0029]

The following means is adopted in order to solve the problems advantageously.

- (a) The rolled H-section steel related to one aspect of the invention is a rolled
 15 H-section steel having a web and flanges. The rolled H-section steel satisfies the following Expression (1) when H is the height of the rolled H-section steel, and B is the breadth of the flanges; the tensile strength is 400 to 510 N/mm², the rolled H-section steel satisfies the following Expressions (2) and (3) when t₂ is the plate thickness of the flanges, and the design yield stress of a steel material of the rolled H-section steel is
 20 F(N/mm²).

$$(B/H) \leq 0.77 \quad (1)$$

$$11.1 < B/(2 \times t_2) \leq 215/\sqrt{F} \quad (2)$$

$$235 \leq F \leq 275 \quad (3)$$

[0030]

(b) The rolled H-section steel described in the above (a) may satisfy the following Expression (4) when the plate thickness of the web is t_1 .

$$63.5 < ((H - 2 \times t_2) / t_1) \leq 1100 / \sqrt{F} \quad (4)$$

[0031]

5 (c) In the rolled H-section steel described in the above (a), the plate thickness t_1 of the web and the plate thickness t_2 of the flanges satisfy the following Expression (5).

$$0.75 < (t_1 / t_2) < 1.0 \quad (5)$$

Advantageous Effects of Invention

10 [0032]

According to the rolled H-section steel described in the above (a), even if a material in which the design yield stress F changed in the above range is used, the flange breadth-thickness ratio of the rolled H-section steels belonging to the small breadth or the middle breadth in the major countries can be specified easily and the cross-sectional shape of the rolled H-section steel can be specified.

[0033]

Moreover, the weight of this rolled H-section steel can be reduced more than the conventional rolled H-section steels specified in major countries such as the U.S., Britain, Europe, or Japan. Moreover, the cross-sectional performance of this rolled H-section steel can be kept greater than or equal to that of corresponding rolled H-section steels in the these countries. Accordingly, according to this rolled H-section steel, in all the countries of the world including the major countries, dimensions can be easily set and applied.

25 Additionally, since the flange breadth-thickness ratio ($B / (2 \times t_2)$) with the flange breadth B and the plate thickness t_2 of the flanges in the rolled H-section steel may be set

to the range of the above Expression (2), even if the design yield stress F of a steel material to be used for this rolled H-section steel changes, the flange breadth-thickness ratio ($B/(2 \times t_2)$) of the rolled H-section steel can be set easily.

That is, as for this rolled H-section steel, the dimensions of the H-section steel
5 are easily set from the relationship between the height H of the rolled H-section steel, the breadth B of the flanges, the plate thickness t_2 of the flanges, and the design yield stress F (N/mm^2) of the steel material. Therefore, the cross-sectional area is reduced without reducing the cross-sectional performance compared to conventional rolled H-section steels, and a rolled H-section steel with a new dimension or shape with reduced weight
10 can be provided.

[0034]

Additionally, in the case of the above (2), the web breadth-thickness ratio ($(H-2 \times t_2)/t_1$) of the rolled H-section steel can be set to a predetermined range from the relationship between the height H of the H-section steel, the plate thickness t_1 of the web,
15 the plate thickness t_2 of the flanges, and the design yield stress F (N/mm^2) of the steel material. As a result, the weight of a steel material can be reduced without reducing the cross-sectional performance compared to conventional well-known rolled H-section steels, and a rolled H-section steel with a new dimension or shape can be provided.

For example, in this rolled H-section steel in which dimensions are set as
20 described above, the weight per beam can be reduced more than that of conventional H-section steels by about 10%. As a result, the cost per rolled H-section steel can be reduced, and this can also contribute greatly to reduction of the cost of a structure using this rolled H-section steel. For example, if the weight of a small beam can be reduced by 10% or more, without reducing the earthquake-resistant performance of the beam, the
25 unit price of the small beam can be reduced by about 10%. Therefore, not only can the

construction cost of a structure be markedly reduced, but also the weight of the structure can be reduced due to the weight reduction of the small beam, and the earthquake-proof performance can be improved.

Particularly, when applying to rolled H-section steels for a small beam with high
5 versatility, the cross-sectional area can be reduced by about 10% more than conventional rolled H-section steels, and it is possible to provide a small beam having a cross-sectional performance that is greater than or equal to conventional cross-sectional performance. As a result, it is possible to provide an inexpensive small beam, in which the cross-sectional secondary moment can be improved by 15% or more to a maximum of
10 about 60%, and the section modulus is improved, so that at least the section modulus is the same as before, and the best the section modulus achieves improvement of 15%.

[0035]

Additionally, when the dimensions of the rolled H-section steel are set by a combination of the above (a) to (c), even when the design yield stress F (N/mm^2) is
15 broadened to $235 \leq F \leq 275$ as the specified design strength of the steel material, the weight per rolled H-section steel can be reduced by about at least 5% or more and a maximum of about 15% more than conventional products, and the cost per one rolled H-section steel can be reduced. Hence, it is possible to greatly contribute to the reduction of the construction cost of a structure using this rolled H-section steel. For example, the
20 weight of a small beam can be reduced by about at least 5% or more and a maximum of 15%, without reducing the earthquake-resistant performance of the small beam. Hence, the unit price of the small beam can be reduced by about 5% or more and up to about 15%. Therefore, not only can the cost of a structure be markedly reduced, but also the weight of the structure can be reduced due to the weight reduction of the small beam, and
25 the earthquake-resistant performance can be improved.

[0036]

This rolled H-section steel is optimal to a rolled H-section steel for a small beam with little weight burden, weight can be reduced by about at least 5% or more and about a maximum of 15% more than conventional rolled H-section steels, and a small beam
 5 having the cross-sectional performance that is greater than or equal to conventional cross-sectional performance can be provided. Hence, it is possible to provide an inexpensive small beam in which the cross-sectional secondary moment can be improved by 5% or more and a maximum of about 65%, and the section modulus is improved so that at least the section modulus is the same as before, and the best the section modulus
 10 achieves improvement of 20%.

Brief Description of Drawings

[0037]

FIG. 1 is a graph showing the relationship between a web breadth-thickness ratio
 15 and a flange breadth-thickness ratio in various rolled H-section steels related to one embodiment of the invention and various rolled H-section steels according to JIS.

FIG. 2 is a graph showing the relationship between a web thickness to flange thickness ratio and a side-height ratio in the various rolled H-section steels related to this embodiment and the various rolled H-section steels according to JIS.

20 FIG. 3 is a view showing the representative dimensions of parts of a rolled H-section steel and is an outline view as seen in a cross-section perpendicular to a longitudinal direction of the beam.

FIG. 4 is a graph showing the relationship between a web breadth-thickness ratio and a flange breadth-thickness ratio in the various rolled H-section steels according to
 25 JIS.

FIG. 5 is a graph showing the relationship between a web thickness to flange thickness ratio and a side-height ratio in the various rolled H-section steels according to JIS.

FIG. 6 is a graph showing the relationship between a web breadth-thickness ratio and a flange breadth-thickness ratio in various rolled H-section steels according to ASTM.

FIG. 7 is a graph showing the relationship between a web thickness to flange thickness ratio and a side-height ratio in the various rolled H-section steels according to ASTM.

FIG. 8 is a graph showing the relationship between a web breadth-thickness ratio and a flange breadth-thickness ratio in various rolled H-section steels according to BS.

FIG. 9 is a graph showing the relationship between a web thickness to flange thickness ratio and a side-height ratio in the various rolled H-section steels according to BS.

FIG. 10 is a graph showing the relationship between a web breadth-thickness ratio and a flange breadth-thickness ratio in the various rolled H-section steels according to EN.

FIG. 11 is a graph showing the relationship between a web thickness to flange thickness ratio and a side-height ratio in the various rolled H-section steels according to EN.

Description of Embodiments

[0038]

Next, one embodiment of a rolled H-section steel of the invention will be described in detail.

[0039]

First, the representative dimensions of parts in a rolled H-section steel 1 of the present embodiment and a rolled H-section steel 2 of a conventional example is shown in FIG. 3. Reference sign H represents the height (mm) of an H-section steel 1 (2),
 5 reference sign B represents the length (mm) of a side that is the flange breadth of H-section steel 1 or 2, reference sign t_1 represents the thickness (mm) of a web 3, reference sign t_2 represents the thickness (mm) of flanges 4, and reference sign r represents the curvature radius R (mm) of inner corners between the web 3 and the flanges 4.

10 [0040]

In order to use the rolled H-section steel as a beam is a major application, the relationship between the height H of the H-section steel 1 and the length B (hereinafter, the length of the side is simply referred to as a side) of a side that is the flange breadth in the rolled H-section steel of the present embodiment satisfies the following Expression

15 (1) similarly to the conventional case.

$$(B/H) \leq 0.77 \quad (1)$$

[0041]

As described above, the reason why the relationship between the height H and the length B of the side that is the flange breadth in the rolled H-section steel 1 is

20 specified is the same as the above-described reason in conventional products. That is, whether a side-height ratio B/H that is the ratio of the height H and the length B of the side that is the flange breadth in the rolled H-section steel 1 is either less than 0.77 or greater than or equal to 0.77 depending on the applications of the beam. That is, since the rolled H-section steel is mainly used as a pillar when this side-height ratio B/H
 25 exceeds 0.77, and the rolled H-section steel is mainly used as a beam when the

side-height ratio B/H has a middle breadth or small breadth of 0.77 or less, the present embodiment has also adopted such a practical index.

[0042]

The rolled H-section steel to be targeted in the present embodiment is a rolled H-section steel that is mainly used as a beam in which the side-height ratio B/H falls within 0.77 or less, and the tensile strength of a steel is 400 to 510 N/mm² (the design yield stress F of the steel material is 235 N/mm² to 275 N/mm²). That is, the targeted rolled H-section steel is a rolled H-section steel made of steel materials which are equivalent to SS400 (tensile strength is 400 N/mm² to 510 N/mm²) in JIS G 3101, SM400A, B, C (tensile strength is 400 N/mm² to 510 N/mm²) in JIS G 3106, and SN400A, B, and C (tensile strength is 400 N/mm² to 510 N/mm²) in JIS G 3136.

[0043]

In addition, the rolled H-section steel of the present embodiment is a rolled H-section steel to be used in the elastic range thereof. For example, if the rolled-H-section steel is used as a small beam, the rolled H-section steel remains in use within the elastic range. Therefore, the required plastic deformation capacity of a beam member is zero (plastic modulus 1.0), which is sufficient.

In this way, the targeted rolled H-section steel 1 in the present embodiment is a rolled H-section steel to be used within the elastic range. It is considered that the required plastic deformation capacity is set to zero (plastic modulus 1.0), whereby the flange breadth-thickness ratio $B/(2 \times t_2)$ makes the numerical range shown in JIS G 3192 or JP-A-2002-88974, i.e., the upper limit 10.0 of the flange breadth-thickness ratio $B/(2 \times t_2)$ into a minimum value. However, in addition to this value, the flange breadth-thickness ratio $B/(2 \times t_2)$ is 9.4 in a graph shown by plotting various rolled H-section steels of ASTM shown in FIG. 6, and the upper limit of the flange

breadth-thickness ratio is 11.1 in a graph shown by plotting various rolled H-section steels of EN standard shown in FIG. 10. Therefore, in the present embodiment, the flange breadth-thickness ratio $B/(2 \times t_2)$ is made greater than 11.1.

[0044]

5 Similarly, the web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ is a numerical range shown in JIS G 3192 or Japanese Unexamined Patent Application, First Publication No. JP-A-2002-88974. That is, the upper limit of the web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ is 56.6 in a graph shown by plotting various rolled H-section steels of JIS standard shown in FIGS. 1 and 4, is 63.5 in the various rolled H-section steels of ASTM
10 shown in FIG. 6, and is 63.3 in various rolled H-section steels of BS standard which is shown in FIG. 8. Thereby, since the upper limit 63.5 of the various rolled H-section steels of ASTM standard shown in FIG. 6 is the greatest, in the present embodiment, the upper limit of the web breadth-thickness ratio is made greater than the upper limit 63.5 of the various rolled H-section steels of ASTM standard.

15 [0045]

As upper limits of the flange breadth-thickness ratio $B/(2 \times t_2)$ and web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ of the rolled H-section steel 1 in the present embodiment, the web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ is set to 71.0 or less because the flange breadth-thickness ratio $B/(2 \times t_2)$ becomes 15.5 or less when the tensile strength
20 is 400 to 510 N/mm^2 and the design yield stress F of a steel material is 235 N/mm^2 . Here, the above tensile strength and the design yield strength are the limiting values (similarly specified also in AIJ design criteria) determined in the Building Standard Law (Notification No. 596 by Ministry of Land, Infrastructure and Transport on May 18, 2007).

25 [0046]

As upper limits of the flange breadth-thickness ratio $B/(2 \times t_2)$ and web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ of the rolled H-section steel 1, when the design yield stress F of a steel material is 235 N/mm^2 , as shown in Table 1, in AISC design criteria, the upper limit is specified as 16.5, in BS design criteria, is specified as 16.2, and, in EN design criteria, is specified as 14.0, and EN design criteria in Europe are the severest design criteria. From this, 14.0 is adopted as the flange breadth-thickness ratio $B/(2 \times t_2)$ of the rolled H-section steel in the present embodiment. This value is generalized as $215\sqrt{F}$, using the design yield stress F .

When an allowable stress is designed, the web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ of the rolled H-section steel is not specified in the AISC design criteria and BS design criteria, but is specified as 124.0 in the EN design criteria. From this, in the present embodiment, 71.0 of the web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ specified in AIJ design criteria is adopted. This value is generalized as $1100/\sqrt{F}$, using the design yield stress F .

[0047]

[Table 1]

Breadth-thickness ratio in various allowable stress designs

(When the design yield stress F of a steel material is 235 N/mm^2)

	In the case of allowable stress design				(Reference)
	AIJ *1	AISC *2	BS *3	EN *4	Elastic local buckling theoretical value
Flange breadth-thickness ratio ($B/(2 \times t_2)$)	15.5	16.5	16.2	14.0	18.3
Web breadth-thickness ratio ($(H-2 \times t_2)/(t_1)$)	71.0	-	-	124.0	56.2

*1: AIJ design criteria (Steel structure design criteria: Architectural Institute of Japan)

*2: AISC design criteria (STEEL CONSTRUCTION MANUAL: American Institute of Steel Construction)

5 *3: BS design criteria (BS5950: British Standard)

*4: EN design criteria (EN1993-1-1: European Standard)

[0048]

If flanges and a web that constitute a rolled H-section steel are considered to be
10 a plate element and the elastic local-buckling strength σ_{cr} and specified values in
respective countries are discussed, the elastic local-buckling theoretical value of a plate is
obtained by the following Expression (2).

$$\sigma_{cr} = k \times (\pi^2 \times E) / (12 \times (1 - \nu^2)) \times (t/b)^2 \quad (2)$$

Here, k is the buckling coefficient, E is the Young's modulus, ν is the Poisson's
15 ratio, t is the plate thickness, and b is the plate breadth.

[0049]

In the rolled H-section steel, when it is made ideal that the flanges are
rectangular plates with three-edges simply supported and one edge of freedom (buckling
coefficient $k=0.425$), and a web is a rectangular plate (buckling coefficient $k=4.00$) with
20 edges simply supported, in order for these elements not to cause local buckling up to
yield stress, $\sigma_{cr}=F$ is set, and the above Expression (2) is simplified as follows.

Since $t=t_2$ and $b=B$ are established when (in the case of the flanges) the three-
three edges simply supported and one edge of freedom, $(B/t_2)=281/\sqrt{F}$ is obtained.

From this, 18.3 described in the above Table 1 can be obtained as a theoretical value.

25 Additionally, since $t=t_1$ and $b=H$ are established in the case of the edges simply
supported (in the case of the web), $(H/t_1)=862/\sqrt{F}$ is satisfied. From this, 56.2
described in the above Table 1 can be obtained as a theoretical value.

[0050]

The rolled H-section steel has a cross-sectional shape in which lateral buckling and bending torsion buckling tend to occur. In particular, the flanges are the most

important parts in order to secure the proof stress of a beam. From this, the flange

- 5 breadth-thickness ratio is set a little more severely than the elastic local buckling. In the case of the three-edges simply supported and one edge of freedom (in the case of the flanges), the flange breadth-thickness ratio is 14.0 in an allowable stress design. Thus, the value of X is obtained such that the value of $(B/t_2)=X\sqrt{F}$ becomes 14.0, and is generalized using $(B/t_2)=215/\sqrt{F}$ and the design yield stress F.

10 [0051]

Additionally, in a beam using the rolled H-section steel, it is understood that reduction in a full plastic moment caused by a shear force can be ignored unless the acting shear force exceeds the full plastic shear proof stress of the web. Therefore, the web is formed as follows so that the web breadth-thickness ratio becomes a little gentler

- 15 than the elastic local buckling.

In the case of the edges simply supported (in the case of the web), the web breadth-thickness ratio is 71.0 in an allowable stress design. Thus, the value of Y is obtained such that the value of $(H/t_1)=Y/\sqrt{F}$ becomes 71.0, and is generalized using $(H/t_1)=1100/\sqrt{F}$ and the design yield stress F (N/mm²).

20 [0052]

Accordingly, by specifying the relationship between the length B of the side that is the breadth of the flanges, and the flange thickness t_2 as

$$11.1 < B/(2 \times t_2) \leq 215/\sqrt{F} \quad (3),$$

in countries that specify the flange breadth-thickness ratio $B/(2 \times t_2)$, it is possible to

provide a rolled H-section steel in which dimension setting is also easy, in small-breadth and middle-breadth rolled H-section steels that have performances greater than or equal to required cross-sectional performance, while reducing the weight of steel in a rolled H-section steel with new cross-sectional shape.

5 [0053]

Additionally, in countries that specify the web breadth-thickness ratio $(H-2\times t_2)$, as described above, the relationship between the height (H), the web thickness t_1 and the flange thickness t_2 is defined as

$$56.6 < (H-2\times t_2)/t_1 \leq 1100/\sqrt{F} \quad (4),$$

10 when the design yield stress F (N/mm^2) is $235 \leq F \leq 275$.

[0054]

On the other hand, by making the flange breadth-thickness ratio $B/(2\times t_2)$ and the web breadth-thickness ratio $(H-2\times t_2)/(t_1)$ greater than before, the height H of a cross-section and the dimension B of the side in the rolled H-section steel 1 can be
15 increased. Therefore, even when the web thickness t_1 is equal to or slightly smaller than the flange thickness t_2 , the cross-sectional secondary moment (I) per unit cross-sectional area and a section modulus (Z) for resisting a bending stress can be made higher than a conventional case, to improve rigidity (especially, around a strong axis).

Hence, the web thickness and flange thickness ratio (t_1/t_2) can be made greater
20 than a numerical range shown in JIS G 3192, i.e., the upper limit 0.75 of the web thickness to flange thickness ratio (t_1/t_2).

Accordingly, in the present embodiment, the lower limit of the web thickness to flange thickness ratio (t_1/t_2) is made greater than 0.75.

[0055]

25 In addition, since the efficiency of the cross-sectional secondary moment I and

the section modulus Z to weight degrades if the web thickness t_1 becomes greater than or equal to than the flange thickness t_2 , the web thickness and flange thickness ratio (t_1/t_2) is set to less than 1.0.

Accordingly, in the rolled H-section steel 1 of the present embodiment, as upper
5 and lower values of the web thickness and flange thickness ratio (t_1/t_2),

$0.75 < (t_1/t_2) < 1.0$ is defined (5).

[0056]

In consideration of the above points, various rolled H-section steels 1 of the present embodiment set to various dimensions are shown in Table 3 as Examples A to H
10 of the invention. A cross-sectional dimension, the side-height ratio (B/H), the flange breadth-thickness ratio $B/(2 \times t_2)$, the web breadth-thickness ratio $(H - 2 \times t_2)/(t_1)$, the web thickness to flange thickness ratio (t_1/t_2), and the cross-sectional performance are shown in Table 3. Additionally, in Table 3, various conventional rolled H-section steels 2 in Japan corresponding to the examples A to H of the invention are shown together in Table
15 3 as conventional examples A to H. Additionally, a cross-sectional area ratio, a cross-sectional secondary moment ratio around a strong axis, and a section modulus ratio around a strong axis in the examples A to H of the invention and the conventional examples A to H corresponding thereto are shown in Table 3.

[0057]

20 In addition, on the coordinate axes shown in FIG. 1 in which the flange breadth-thickness ratio has on the horizontal axis and the web breadth-thickness ratio has on the vertical axis, if the travel distance (absolute number) from the conventional example A (to H) to the example A (to H) of the invention is calculated for the respective examples, the results are as follows. In the examples A and B (travel distance > 30 on the
25 coordinate axes in the horizontal axis: flange breadth-thickness ratio and the vertical axis:

web breadth-thickness ratio) of the invention, it is understood that the cross-sectional secondary moment ratios become larger as the travel distances (absolute number) of the examples A and B become larger than those of the examples C to H (travel distance < 25 on the same coordinate axes), i.e., the breadth and height of a H-shaped cross-section

5 increase.

[0058]

Examples	Travel distance from conventional examples to examples of the invention	Cross-sectional secondary moment ratio
A	33.3	1.61
B	31.8	1.39
C	23.6	1.17
D	21.3	1.23
E	18.4	1.18
F	23.1	1.21
G	22.0	1.14
H	19.7	1.14

[0059]

[Table 2-1]

Nominal dimension	Sectional dimension					Side-height ratio	Flange breadth-thickness ratio	Web breadth-thickness ratio	Web thickness to flange thickness ratio
	Height H mm	Side B mm	Web thickness t ₁ mm	Flange breadth t ₂ mm	Curvature radius r mm				
Height × Side						B/H	B/(2×t ₂)	(H-2×t ₂)/t ₁	t ₁ /t ₂
100×50	100	50	5	7	8	0.50	3.6	17.2	0.71
100×100	100	100	6	8	8	1.00	6.3	14.0	0.75
125×60	125	60	6	8	8	0.48	3.8	18.2	0.75
125×125	125	125	6.5	9	8	1.00	6.9	16.5	0.72
150×75	150	75	5	7	8	0.50	5.4	27.2	0.71
150×100	148	100	6	9	8	0.68	5.6	21.7	0.67
150×150	150	150	7	10	8	1.00	7.5	18.6	0.70
175×90	175	90	5	8	8	0.51	5.6	31.8	0.63
175×175	175	175	7.5	11	13	1.00	8.0	20.4	0.68
200×100	198	99	4.5	7	8	0.50	7.1	40.9	0.64
	200	100	5.5	8	8	0.50	6.3	33.5	0.69
200×150	194	150	6	9	8	0.77	8.3	29.3	0.67
200×200	200	200	8	12	13	1.0	8.3	22.0	0.67
	200	204	12	12	13	1.02	8.5	14.7	1.00
250×125	248	124	5	8	8	0.50	7.8	46.4	0.63
	250	125	6	9	8	0.50	6.9	38.7	0.67
250×175	244	175	7	11	13	0.72	8.0	31.7	0.64
250×250	250	250	9	14	13	1.00	8.9	24.7	0.64
	250	255	14	14	13	1.02	9.1	15.9	1.00

[0060]

[Table 2-2]

Nominal dimension	Sectional dimension						Side-height ratio	Flange breadth-thickness ratio	Web breadth-thickness ratio	Web thickness to flange thickness ratio
	Height	Side	Web thickness	Flange breadth	Curvature radius					
Height × Side	H mm	B mm	t ₁ mm	t ₂ mm	r mm		B/H	B/(2×t ₂)	(H-2×t ₂)/t ₁	t ₁ /t ₂
300×150	298	149	5.5	8	13		0.50	9.3	51.3	0.69
	300	150	6.5	9	13		0.50	8.3	43.4	0.72
300×200	294	200	8	12	13		0.68	8.3	33.8	0.67
300×300	294	302	12	12	13		1.03	12.6	22.5	1.00
	300	300	10	15	13		1.00	10.0	27.0	0.67
	300	305	15	15	13		1.02	10.2	18.0	1.00
350×175	346	174	6	9	13		0.50	9.7	54.7	0.67
	350	175	7	11	13		0.50	8.0	46.9	0.64
350×250	340	250	9	14	13		0.74	8.9	34.7	0.64
350×350	344	348	10	16	13		1.01	10.9	31.2	0.63
	350	350	12	19	13		1.00	9.2	26.0	0.63
400×200	396	199	7	11	13		0.50	9.0	53.4	0.64
	400	200	8	13	13		0.50	7.7	46.8	0.62
400×300	390	300	10	16	13		0.77	9.4	35.8	0.63
400×400	388	402	15	15	22		1.04	13.4	23.9	1.00
	394	398	11	18	22		1.01	11.1	32.5	0.61
	400	400	13	21	22		1.00	9.5	27.5	0.62
	400	408	21	21	22		1.02	9.7	17.0	1.00
	414	405	18	28	22		0.98	7.2	19.9	0.64
	428	407	20	35	22		0.95	5.8	17.9	0.57
	458	417	30	50	22		0.91	4.2	11.9	0.60
	498	432	45	70	22		0.87	3.1	8.0	0.64
	446	199	8	12	13		0.45	8.3	52.8	0.67
	450	200	9	14	13		0.44	7.1	46.9	0.64
450×300	440	300	11	18	13		0.68	8.3	36.7	0.61

[0061]

[Table 2-3]

Nominal dimension	Sectional dimension					Side-height ratio	Flange breadth-thickness ratio	Web breadth-thickness ratio	Web thickness to flange thickness ratio
	Height	Side	Web thickness	Flange breadth	Curvature radius				
Height × Side	H mm	B mm	t ₁ mm	t ₂ mm	r mm	B/H	B/(2×t ₂)	(H-2×t ₂)/t ₁	t ₁ /t ₂
500×200	496	199	9	14	13	0.40	7.1	52.0	0.64
	500	200	10	16	13	0.40	6.3	46.8	0.63
	506	201	11	19	13	0.40	5.3	42.5	0.58
500×300	482	300	11	15	13	0.62	10.0	41.1	0.73
	488	300	11	18	13	0.61	8.3	41.1	0.61
600×200	596	199	10	15	13	0.33	6.6	56.6	0.67
	600	200	11	17	13	0.33	5.9	51.5	0.65
	606	201	12	20	13	0.33	5.0	47.2	0.60
	582	300	12	17	13	0.52	8.8	45.7	0.71
600×300	588	300	12	20	13	0.51	7.5	45.7	0.60
	594	302	14	23	13	0.51	6.6	39.1	0.61
	692	300	13	20	18	0.43	7.5	50.2	0.65
700×300	700	300	13	24	18	0.43	6.3	50.2	0.54
	792	300	14	22	18	0.38	6.8	53.4	0.64
800×300	800	300	14	26	18	0.38	5.8	53.4	0.54
	890	299	15	23	18	0.34	6.5	56.3	0.65
900×300	900	300	16	28	18	0.33	5.4	52.8	0.57
	912	302	18	34	18	0.33	4.4	46.9	0.53
B/H is in a range of 0.77 or less						Minimum value	3.6	17.2	0.53
						Maximum value	10.0	56.6	0.75
B/H is in a range exceeding 0.77						Minimum value	3.1	8.0	0.57
						Maximum value	13.4	32.5	1.00

[0062]

[Table 3]

Cross-sectional performance of examples (F235Ns/m²)

	Sectional dimension mm	Side-height ratio	Flange breadth-thickness ratio	Web breadth-thickness ratio	Web thickness and flange thickness ratio	Cross-sectional area	Cross-sectional secondary moment ratio around strong axis	Section modulus around strong axis
	$H \times B \times t_1 \times t_2 \times t_f \times t$	B/H	$B/(2 \times t_2)$	$(H-2 \times t_2)/t_1$	t_1/t_2	A cm ²	I cm ⁴	Z cm ³
Example A of the invention	H-275×120×4.5×8	0.44	12.0	66.3	0.80	23.15	2901	211
Conventional example A	H-200×100×5.5×8	0.50	6.3	33.5	0.69	26.67	1806	181
Example A of the invention/Conventional example A	-	-	-	-	-	0.87	1.61	1.17
Example B of the invention	H-325×150×4.5×5.5	0.46	13.6	69.8	0.82	31.18	5505	339
Conventional example B	H-250×125×6×9	0.50	6.9	38.7	0.67	36.97	3963	317
Example B of the invention/Conventional example B	-	-	-	-	-	0.84	1.39	1.07
Example C of the invention	H-345×175×5×6.5	0.51	13.5	66.4	0.77	40.80	8428	489
Conventional example C	H-300×150×6.5×9	0.50	8.3	43.4	0.72	46.78	7209	481
Example C of the invention/Conventional example C	-	-	-	-	-	0.87	1.17	1.02
Example D of the invention	H-420×200×6×7.5	0.48	13.3	67.5	0.80	55.75	16663	793
Conventional example D	H-350×175×7×11	0.50	8.0	46.9	0.64	62.91	13500	771
Example D of the invention/Conventional example D	-	-	-	-	-	0.89	1.23	1.03
Example E of the invention	H-470×225×7×9	0.48	12.5	64.6	0.78	73.59	27629	1176
Conventional example E	H-400×200×8×13	0.50	7.7	46.8	0.62	83.37	23457	1173
Example E of the invention/Conventional example E	-	-	-	-	-	0.88	1.18	1.00
Example F of the invention	H-540×225×7.5×9.5	0.42	11.8	69.5	0.79	83.28	39883	1477
Conventional example F	H-450×200×9×14	0.44	7.1	46.9	0.64	95.43	32887	1462
Example F of the invention/Conventional example F	-	-	-	-	-	0.87	1.21	1.01
Example G of the invention	H-560×275×8×10	0.49	13.8	67.5	0.80	99.65	53131	1898
Conventional example G	H-500×200×10×16	0.40	6.3	46.8	0.63	112.25	46811	1872
Example G of the invention/Conventional example G	-	-	-	-	-	0.89	1.14	1.01

	Sectional dimension	Side-height ratio	Flange breadth-thickness ratio	Web breadth-thickness ratio	Web thickness and flange thickness ratio	Cross-sectional area	Cross-sectional secondary moment ratio around strong axis	Section modulus around strong axis
	$H \times B \times t_1 \times t_2 (\times r)$ mm	B/H	$B/(2 \times t_2)$	$(H-2 \times t_2)/t_1$	t_1/t_2	A cm^2	I cm^4	Z cm^3
Example H of the invention	H-680×275×9.5×10(×13)	0.40	13.8	69.5	0.95	119.15	86041	2531
Conventional example H	H-600×200×11×17(×13)	0.33	5.9	51.5	0.65	131.71	75557	2519
Example H of the invention/Conventional example H	-	-	-	-	-	0.90	1.14	1.00

[0063]

As in the cross-sectional performance of the present embodiment shown in Table 3, the examples A to H of the invention are rolled H-section steels for a small beam. In all of the examples, the side-height ratio becomes 0.51 or less, the flange
 5 breadth-thickness ratio becomes 11.8 to 13.8, the web breadth-thickness ratio becomes 64.6 to 69.8, and the web thickness and flange thickness ratio becomes 0.77 to 0.95 or less.

Additionally, if the examples A to H of the invention that are rolled H-section steels of the present embodiment in Table 3 and the conventional examples A to H that
 10 are conventional rolled H-section steels corresponding thereto are compared with each other, compared to the conventional examples, in the examples A to H of the invention that are rolled H-section steels of the present embodiment in which the web thickness t_1 and flange thickness t_2 are made small, and the height H and the dimension B of the side that is the flange breadth, it is understood that the cross-sectional area A can be reduced
 15 by 10% to 16%, the cross-sectional secondary moment (I) ratio around a strong axis can exhibit a performance improvement of 14% to 61%, and the section modulus (Z) ratio around a strong axis can exhibit a performance improvement of 17%. In addition, in Tables 2-1 to 2-3, it is understood that the minimum of the side-height ratio (B/H) is 0.33.

[0064]

20 Additionally, as can be seen from FIG. 1, on the graph of the flange breadth-thickness ratio and the web breadth-thickness ratio, it is understood that the rolled H-section steels 1 including the examples A to H of the invention that satisfy respective conditions of the above Expressions (1), (3), and (4) of the present embodiment are rolled H-section steels in a region that can be clearly distinguished from
 25 a region of conventional well-known rolled H-section steels in Japan and other countries

(refer to FIGS. 1, 6, 8, and 10).

Additionally, as can be seen from FIG. 2, on the graph of the side-height ratio (B/H) and the web thickness to flange thickness ratio (t_1/t_2), it is understood that the rolled H-section steels 1 including the examples A to H of the invention that satisfy
 5 conditions of the above Expressions (1), (3), and (4) of the present embodiment are rolled H-section steels in a region that can be clearly distinguished from a region of conventional well-known rolled H-section steels in Japan and other countries (refer to FIGS. 2, 7, 9, and 11).

Additionally, as can be seen from Table 3 and FIGS. 1 and 2, the rolled
 10 H-section steel 1 whose dimensions are set as in the present embodiment exhibits a markedly excellent cross-sectional performance compared to the conventional well-known rolled H-section steel.

[0065]

FIG. 1 and Table 3 show the cross-sectional performance of the examples of the
 15 present embodiment and the conventional examples when the specified design strength F of a steel material is 235 N/mm^2 . Next, similarly to the above embodiment, the cross-sectional performance of the examples of the present embodiment in a case where the specified design strength F of the steel material (N/mm^2) is $235 \leq F \leq 275$ and the concrete specific specified design strength F is 275 N/mm^2 , will be described, in
 20 comparison to the conventional examples.

[0066]

As described above, if the rolled-H-section steel for a small beam is adopted, the rolled H-section steel remains in use within the elastic range. Therefore, the required plastic deformation capacity of a beam member is zero (plastic modulus 1.0), which is
 25 sufficient. Hence, the flange breadth-thickness ratio and the web breadth-thickness ratio

are made greater than the numerical ranges (the upper limit of the flange breadth-thickness ratio is 11.1, and the upper limit of the web breadth-thickness ratio is 63.5) shown in JIS G 3192, JP-A-2002-88974, EN standard, or ASTM standard. The upper limits of the flange breadth-thickness ratio $B/(2 \times t_2)$ and web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ of the rolled H-section steel 1 in the present embodiment, may satisfy the limiting values determined in the Building Standard Law (Notification No. 596 by Ministry of Land, Infrastructure and Transport on May 18, 2007), and satisfy AISC design criteria, BS design criteria, and EN design criteria. That is, when the tensile strength is 400 to 510 N/mm² (the specified design strength F of a steel material is 235 N/mm²), the flange breadth-thickness ratio $B/(2 \times t_2)$ is less than or equal to $215/\sqrt{F}$ (i.e., less than or equal to 14.0), and the web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ is less than or equal to $1100/\sqrt{F}$ (i.e., less than or equal to 71.0). Thus, when the tensile strength is 400 to 510 N/mm² (the specified design strength F of a steel material is $235 \leq F \leq 275$ N/mm²), and the design yield stress is F, the flange breadth-thickness ratio $B/(2 \times t_2)$ may be less than or equal to $215/\sqrt{F}$ (F), and the web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ may be less than or equal to $1100/\sqrt{F}$ (F).

For example, when the design yield stress F is 275 N/mm², the flange breadth-thickness ratio $B/(2 \times t_2)$ may be less than or equal to $215/\sqrt{275}$ (i.e., less than or equal to 12.9), and the web breadth-thickness ratio $(H-2 \times t_2)/(t_1)$ may be less than or equal to $1100/\sqrt{275}$ (i.e., less than or equal to 66.0).

[0067]

The rolled H-section steel and the dimensions of the parts in the present embodiment in which it is required that the design yield stress F (N/mm²) of the steel material as described above satisfies $235 \leq F \leq 275$ N, are set as follows.

[0068]

A rolled H-section steel may be adopted in which the relationship between the height (H) and the length (B) of the side that is the flange breadth in the rolled H-section steel is

$$5 \quad (B/H) \leq 0.77 \quad (6),$$

the tensile strength which is 400 to 510 N/mm², and the relationship between the length B of the side and the flange thickness t₂ is defined as

$$11.1 < B/(2 \times t_2) \leq 215/\sqrt{F} \quad (7).$$

Additionally, depending on the case, a rolled H-section steel may be adopted that satisfies
10 the above conditions, and in which the relationship between the height H and the web thickness t₁, and the flange thickness t₂ is defined as

$$63.6 < ((H - 2 \times t_2)/t_1) \leq 1100/\sqrt{F} \quad (8),$$

(where F is the specified design strength (N/mm²) of the steel material and 235 ≤ F ≤ 275).

Additionally, depending on the case, a rolled H-section steel may be adopted
15 that satisfies the above conditions and in which the relationship between the web thickness t₁ and the flange thickness t₂ is

$$0.75 < (t_1/t_2) < 1.0 \quad (9).$$

[0069]

For example, in a case where the specified design strength F of a steel material
20 is 275 N/mm², under the conditions described above, various rolled H-section steels 1 of the present embodiment set to various dimensions are shown in Table 4 as Examples A to H of the invention. A cross-sectional dimension, the side-height ratio (B/H), the flange breadth-thickness ratio B/(2 × t₂), the web breadth-thickness ratio (H - 2 × t₂)/t₁, the web thickness and flange thickness ratio (t₁/t₂), and the cross-sectional performance are shown

in Table 4. Additionally, in Table 4, various conventional rolled H-section steel 2
corresponding to the examples A to H of the invention are together shown as
conventional examples A to H. Additionally, a cross-sectional ratio, a cross-sectional
secondary moment ratio around a strong axis, and a section modulus ratio around a
5 strong axis in the examples A to H of the invention and the conventional examples A to H
corresponding thereto are shown in Table 4.

[0070]

[Table 4]

Cross-sectional performance of examples (F235Ns/m²)

	Sectional dimension mm	Side-height ratio	Flange breadth-thickness ratio	Web breadth-thickness ratio	Web thickness to flange thickness ratio	Cross-sectional area	Cross-sectional secondary moment ratio around strong axis	Section modulus around strong axis
	H×B×t ₁ ×t ₂ (×t)	B/H	B/(2×t ₂)	(H-2×t ₂)/t ₁	t ₁ /t ₂	A cm ²	I cm ⁴	Z cm ³
Example A of the invention	H-275×120×4.5×5(×8)	0.44	12.0	58.9	0.90	24.47	2979	217
Conventional example A	H-200×100×5.5×8(×8)	0.50	6.3	33.5	0.69	26.67	1806	181
Example A of the invention/Conventional example A	-	-	-	-	-	0.92	1.65	1.20
Example B of the invention	H-310×150×5×6(×8)	0.48	12.5	59.6	0.83	33.45	5381	347
Conventional example B	H-250×125×6×9(×8)	0.50	6.9	38.7	0.67	36.97	3965	317
Example B of the invention/Conventional example B	-	-	-	-	-	0.90	1.36	1.09
Example C of the invention	H-340×175×5.5×7(×13)	0.51	12.5	59.3	0.79	43.88	8753	515
Conventional example C	H-300×150×6.5×9(×13)	0.50	8.3	43.4	0.72	46.78	7209	481
Example C of the invention/Conventional example C	-	-	-	-	-	0.94	1.21	1.07
Example D of the invention	H-400×200×6.5×8(×13)	0.50	12.5	59.1	0.81	58.41	15881	794
Conventional example D	H-350×175×7×11(×13)	0.50	8.0	46.9	0.64	62.91	13500	771
Example D of the invention/Conventional example D	-	-	-	-	-	0.93	1.18	1.03
Example E of the invention	H-470×225×7.5×9(×13)	0.48	12.5	60.3	0.83	75.85	28014	1192
Conventional example E	H-400×200×8×13(×13)	0.50	7.7	46.8	0.62	83.37	23457	1173
Example E of the invention/Conventional example E	-	-	-	-	-	0.91	1.19	1.02
Example F of the invention	H-520×225×8.5×10(×13)	0.43	11.3	58.5	0.85	88.95	39005	1500
Conventional example F	H-450×200×9×14(×13)	0.44	7.1	46.9	0.64	95.43	32887	1462
Example F of the invention/Conventional example F	-	-	-	-	-	0.93	1.19	1.03
Example G of the invention	H-570×250×9×10.5(×13)	0.44	11.9	61.0	0.86	103.36	54572	1915
Conventional example G	H-500×200×10×16(×13)	0.40	6.3	46.8	0.63	112.25	46811	1872
Example G of the invention/Conventional example G	-	-	-	-	-	0.92	1.17	1.02

	Sectional dimension	Side-height ratio	Flange breadth-thickness ratio	Web breadth-thickness ratio	Web thickness to flange thickness ratio	Cross-sectional area	Cross-sectional secondary moment ratio around strong axis	Section modulus around strong axis
	$H \times B \times t_1 \times t_2 (\times r)$ mm	B/H	$B/(2 \times t_2)$	$(H-2 \times t_2)/t_1$	t_1/t_2	A cm^2	I cm^4	Z cm^3
Example H of the invention	H-625×275×10×11.5(×13)	0.44	12.0	60.2	0.87	124.90	78992	2528
Conventional example H	H-600×200×11×17(×13)	0.33	5.9	51.5	0.65	131.71	75557	2519
Example H of the invention/Conventional example H	-	-	-	-	-	0.95	1.05	1.00

[0071]

As in the cross-sectional performance of the examples of the present embodiment shown in Table 4, the examples A to H of the invention are rolled H-section steel for a small beam. In all of the examples, the side-height ratio becomes 0.51 or less, the flange breadth-thickness ratio becomes 11.3 to 12.5, the web breadth-thickness ratio becomes 58.5 to 61.0, and the web thickness and flange thickness ratio becomes 0.79 to 0.90.

[0072]

Additionally, if the examples A to H of the invention that are rolled H-section steel of the present embodiment in Table 4 and the conventional examples A to H that are conventional rolled H-section steel corresponding thereto are compared with each other, compared to the conventional examples, in the examples A to H of the invention that are rolled H-section steel of the present embodiment in which the web thickness t_1 and flange thickness t_2 are made small, and the height H and the dimension B of the side that is the flange breadth, it is understood that the cross-sectional area A can be reduced by 5% to 10%, the cross-sectional secondary moment (I) ratio around a strong axis can exhibit a performance improvement of 5% to 65%, and the section modulus (Z) ratio around a strong axis can exhibit a performance improvement which at least the same as before, and the best achieves improvement of 20%.

[0073]

The rolled H-section steel 1 of the present embodiment can also be applied to a small-breadth beam, a middle-breadth small beam, and a middle-breadth beam in addition to the small-breadth small beam.

Industrial Applicability

[0074]

According to the invention, compared to rolled H-section steel that is standardized in major advanced nations including the U.S., Britain, Europe, and Japan, it is possible to provide a rolled H-section steel that is made to be lightweight for a small
5 beam and does not degrade the cross-sectional performance.

Reference Signs List

[0075]

- 1: Rolled H-section steel of Present Embodiment
- 10 2: Conventional rolled H-section steel
- 3: Web
- 4: Flange

CLAIMS

1. A rolled H-section steel having a web and flanges, wherein:
 the rolled H-section steel satisfies a following Expression (1) when H is a height
 5 of the rolled H-section steel, and B is a breadth of the flanges;
 a tensile strength thereof is 400 to 510 N/mm²; and
 the rolled H-section steel satisfies following Expressions (2) and (3), when a
 plate thickness of the flanges is t₂ and a design yield stress of a steel material of the rolled
 H-section steel is F (N/mm²).

10 $(B/H) \leq 0.77 \quad (1)$

$$11.1 < B/(2 \times t_2) \leq 215/\sqrt{F} \quad (2)$$

$$235 \leq F \leq 275 \quad (3)$$

2. The rolled H-section steel according to Claim 1,
 15 wherein the rolled H-section steel satisfies a following Expression (4) when a
 plate thickness of the web is t₁.

$$63.5 < ((H - 2 \times t_2)/t_1) \leq 1100/\sqrt{F} \quad (4)$$

3. The rolled H-section steel according to Claim 1,
 20 wherein a plate thickness t₁ of the web and the plate thickness t₂ of the flanges
 satisfy a following Expression (5).

$$0.75 < (t_1/t_2) < 1.0 \quad (5)$$