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JOINT CONSTRUCTION OF COLUMN MEMBER STEEL PIPES

FIELD OF THE INVENTION

The present invention relates to a joint construction of column member steel pipes used as columns for steel-framed structures, for example.

BACKGROUND OF THE INVENTION

As for a column member steel pipe used as a column, there has heretofore been provided an arrangement, as found, for example, in Japanese Patent Laid-Open No. 2001-303661 in which a thick-walled column obtained by hot forming is employed as a column for a panel zone.

That is, for example, a long-sized quadrangular steel pipe having a predetermined wall thickness is produced by cold forming, while a short-sized quadrangular steep pipe having a greater wall thickness than that of the long-sized quadrangular steel pipe and a sufficient length to form a beam connector is produced by heating in a furnace, followed by hot forming. And, the short-sized quadrangular steel pipe is internally formed with a bevel. The long-sized and short-sized quadrangular steel pipes thus obtained are joined as by arc welding, thereby providing a quadrangular steel pipe column.

As another prior art example, a long-sized quadrangular steel pipe of predetermined wall thickness is produced by cold forming, while a short-sized quadrangular steel pipe having a greater wall thickness than that of the long-sized quadrangular steel pipe and a sufficient length to form a beam member connector is produced by cold forming. The long-sized and short-sized quadrangular steep pipes thus obtained are joined as by arc

welding, thereby providing a quadrangular steel pipe column.

According to the thus-obtained thick-walled quadrangular steel pipe column, for example, as compared with a through diaphragm system or inner diaphragm system, the number of man-hours for assembly can be reduced and the weld length can be reduced; thus, the whole can be simplified and economical, with weld strains hardly occurring. Further, the beam member connector is capable of securing a sufficient strength because of the predetermined increased wall thickness of the short-sized quadrangular steel pipe and allows the weld joining of beam members without any trouble. Furthermore, the quadrangular steel pipe column is obtained in the form of a pipe joint and can be finished into the state of having no internal ribs or patches, and an arrangement adapted to have concrete or the like filled therein can be easily employed; other various merits are also expectable.

However, according to the quadrangular steel pipe column employing the thick-walled short-sized quadrangular steel pipe described above, forming a welding bevel in the interior of the thick-walled short-sized quadrangular steel pipe takes much time in the manufacture thereof, increasing the cost. Furthermore, the inner side (patch side) welding is performed with the patch applied over a region extending from the bevel in the thick-walled short-sized quadrangular steel pipe to the inner surface of the long-sized quadrangular steel pipe of predetermined thickness, such welding resulting in too much amount of welding, hampering fast welding, sometimes requiring a deformed (specially processed) patch.

SUMMARY OF THE INVENTION

Accordingly, an object of the invention is to provide a joint construction of column member steel pipes that is capable of retaining various merits of a type employing thick-walled short-sized steel pipes, in which a welding bevel can be formed in a shortened production time at a low cost and a joining operation by welding can be more smoothly effected.

To achieve the object described above, a joint construction of column member steel pipes according to a first aspect of the invention comprises a long-sized steel pipe of a predetermined wall thickness and a short-sized steel pipe of a greater wall thickness than that of the long-sized steel pipe, wherein these long-sized and short-sized steel pipes are formed by hot forming so that they are the same in outer peripheral shape, and these two steel pipes are joined by welding from outside in a state that an end surface of the long-sized steel pipe is opposed to an end surface of the short-sized steel pipe that is not beveled.

In the arrangement according to the first aspect described above, the long-sized and short-sized steel pipes are linearly positioned with their outer peripheral shapes conforming to each other, and with their end surfaces opposed to each other, and then joined to each other at their opposed end surfaces by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing thick-walled short-sized steel pipes. In this case, since the outer peripheral shapes are the same, the joining operation by welding can be effected more smoothly, efficiently and suitably all the time, with no step portion (linear misalignment) formed, and transmission of stress can be effected more suitably. Further, since the thick-walled short-sized steel pipe is not beveled, it can be

formed in a reduced production time and at a lower cost.

In a first embodiment according to the first aspect of the invention, a joint construction of column member steel pipes is characterized in that the long-sized and short-sized steel pipes are quadrangular steel pipes, and these long-sized and short-sized quadrangular steel pipes are formed by hot forming to have a same external width and a same outer curved surface at each corner portion.

In this first embodiment according to the first aspect of the invention, the long-sized and short-sized quadrangular steel pipes are linearly positioned with their outer peripheral shapes conforming to each other, and with their end surfaces opposed to each other, and then joined at their opposed end surfaces by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing thick-walled short-sized quadrangular steel pipes. In this case, since the opposed outer curved surfaces are of the same shape and there is no step portion (linear misalignment) formed, the joining operation by welding between the corner portions can be effected more smoothly, efficiently, and suitably all the time.

In a second embodiment according to the first aspect of the invention, a joint construction of column member steel pipes is characterized in that the long-sized and short-sized steel pipes are round steel pipes, and these long-sized and short-sized round steel pipes are formed by hot forming so that they are the same in outer diameter.

In this second embodiment according to the first aspect of the invention, the long-sized and short-sized round steel pipes are concentrically and linearly positioned, and their opposed

end surfaces are joined by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing the thick-walled short-sized round steel pipes.

To achieve the object described above, a joint construction of column member steel pipes according to a second aspect of the invention comprises a long-sized steep pipe of a predetermined wall thickness and a short-sized steel pipe of a greater wall thickness than that of the long-sized steel pipe, wherein the long-sized steel pipe is cold-formed, while the short-sized steel pipe is hot-formed to have a same outer peripheral shape as that of the long-sized steel pipe, and an end surface of the long-sized steel pipe is opposed to an end surface of the short-sized steel pipe that is not beveled, and in this state the two steel pipes are joined by welding from outside.

In the arrangement according to the second aspect of the invention, the long-sized steel pipe which is cold-formed and the short-sized steel pipe which is hot-formed are linearly positioned with their outer peripheral shapes conforming to each other, with their end surfaces opposed to each other, and subsequently the opposed end surfaces are joined by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing the thick-walled short-sized steel pipe. In this case, since the outer peripheral shapes are the same, the weld-joining operation can be effected more smoothly, efficiently and suitably all the time, with no step portion (linear misalignment) formed, and transmission of stress can be effected more suitably. Since the thick-walled short-sized

steel pipe is not beveled, it can be formed in a reduced production time at a lower cost. And the long-sized steel pipes can be formed by cold forming at a lower cost.

In a first embodiment according to the second aspect of the invention, a joint construction of column member steel pipes is characterized in that the long-sized and short-sized steel pipes are quadrangular steel pipes, and the long-sized quadrangular steel pipe is cold-formed, while the short-sized quadrangular steel pipe is formed by hot forming to have a same external width and a same outer curved surface at each corner portion as those of the long-sized quadrangular steel pipe.

In the first embodiment according to the second aspect of the invention, the long-sized quadrangular steel pipe cold-formed and the short-sized quadrangular steel pipe hot-formed are linearly positioned with their outer peripheral shapes conforming to each other and with their end surfaces opposed to each other, and then joined at their opposed end surfaces by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing the thick-walled short-sized quadrangular steel pipe. In this case, since the opposed outer curved surfaces are the same and no step portion (linear misalignment) is formed, the joining operation by welding between the corner portions can be effected more smoothly, efficiently and suitably all the time.

In a second embodiment according to the second aspect of the invention, a joint construction of column member steel pipes is characterized in that the long-sized and short-sized steel pipes are round steel pipes, and the long-sized round steel pipe is cold-formed, while the short-sized round steel pipe is formed

by hot forming to have a same outer diameter as the long-sized round steel pipe.

In this second embodiment according to the second aspect of the invention, the long-sized round steel pipe that is cold-formed and the short-sized round steel pipe that is hot-formed are concentrically and linearly positioned, and then are joined at their opposed end surfaces by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing the thick-walled short-sized round steel pipe.

To achieve the object described above, a joint construction of column member steel pipes according to a third aspect of the invention comprises a long-sized steep pipe of a predetermined wall thickness and a short-sized steel pipe of a greater wall thickness than that of the long-sized steel pipe, wherein these long-sized and short-sized steel pipes are cold-formed to have a same outer peripheral shape, and an end surface of the long-sized steel pipe is opposed to an end surface of the short-sized steel pipe that is not beveled, and in this state the two steel pipes are joined by welding from outside.

In the arrangement according to the third aspect of the invention described above, the cold-formed long-sized and short-sized steel pipes are linearly positioned with their outer peripheral shapes conforming to each other and with their end surfaces opposed to each other, and then joined at their opposed end surfaces by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing the thick-walled short-sized steel pipe. In this case, since the outer peripheral shapes are the same and no step portion (linear

misalignment) is formed, the weld joining operation can be effected more smoothly, efficiently and suitably all the time, and transmission of stress can be effected more suitably. And since the thick-walled short-sized steel pipe is not beveled, it can be formed in a reduced production time at a lower cost. Further, both long-sized and short-sized steel pipes can be formed by cold forming at a lower cost.

In a first embodiment according to the third aspect of the invention, a joint construction of column member steel pipes is characterized in that the long-sized and short-sized steel pipes are quadrangular steel pipes, and these long-sized and short-sized quadrangular steel pipes are cold-formed to have a same external width and a same outer curved surface at each corner portion.

In this first embodiment according to the third aspect of the invention, the cold-formed long-sized and short-sized quadrangular steel pipes are linearly positioned with their outer peripheral shapes conforming to each other, with their end surfaces opposed to each other which are then joined to each other by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing thick-walled short-sized quadrangular steel pipes. In this case, since the opposed outer curved surfaces are the same and there is no step portion (linear misalignment) formed, the joining operation by welding between the corner portions can be effected more smoothly, efficiently and suitably all the time.

In a second embodiment according to the third aspect of the invention, a joint construction of column member steel pipes is characterized in that the long-sized and short-sized steel

pipes are round steel pipes, and these long-sized and short-sized round steel pipes are cold-formed to have a same outer diameter.

In this second embodiment according to the third aspect of the invention, the cold-formed long-sized and short-sized round steel pipes are concentrically and linearly positioned and then joined at their opposed end surface by welding from outside over the entire periphery, thereby constituting a column member steel pipe retaining the various merits of the type employing the thick-walled short-sized round steel pipe.

In preferred embodiments according to the first through third aspects of the invention, the joint construction of column member steel pipes are characterized in that the short-sized steel pipe has a length forming a panel zone.

In these preferred embodiments according to the first through third aspects of the invention, the long-sized and short-sized steel pipes are linearly positioned with their outer peripheral shapes conforming to each other, and in this state the opposed end surfaces are joined by welding from outside over the entire periphery, thereby constituting a column member steel pipe with the short-sized steel pipe used as a panel zone. Thus, the various merits of the type employing the thick-walled short-sized steel pipe can be retained.

In other preferred embodiments according to the first through third aspects of the invention, a joint construction of column member steel pipes is characterized in that a patch positioned inside the long-sized steel pipe is abutted against an end surface of the short-sized steel pipe and in this state the two steel pipes are joined by welding from outside.

In these other preferred embodiments according to the first

through third aspects of the invention, the weld joining operation can be suitably effected using the patch, and by abutting the patch against a flat end surface of the short-sized steel pipe, welding can be rapidly effected in a reduced weld amount. Further, the patch does not require special processing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partly cutaway perspective view of a quadrangular steel pipe column in a joint construction of column member steel pipes before subjected to weld joining, according to a first embodiment of the invention;

FIG. 2 is a sectional front elevation of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 3 is a partly cutaway perspective view of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 4 is a sectional front elevation of flat plate portions of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 5 is a sectional front elevation of a corner portion of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 6 is an enlarged sectional front elevation of an essential portion of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 7 is a cross-sectional plan of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 8 is a diagram explaining hot forming or the like of a quadrangular steel pipe for the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 9 is a partly cutaway perspective view of a round steel pipe column in a joint construction of column member steel pipes before subjected to weld joining, according to a second embodiment of the invention;

FIG. 10 is a sectional front elevation of the round steel pipe column in the joint construction of column member steel pipes;

FIG. 11 is an enlarged sectional front elevation of an essential portion of the round steel pipe column in the joint construction of column member steel pipes;

FIG. 12 is a cross-sectional plan of the round steel pipe column in the joint construction of column member steel pipes;

FIG. 13 is a partly cutaway perspective view of a quadrangular steel pipe column in a joint construction of column member steel pipes before subjected to weld joining, according to a third embodiment of the invention;

FIG. 14 is a sectional front elevation of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 15 is an enlarged sectional front elevation of an essential portion of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 16 is a cross-sectional plan of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 17 is a diagram explaining forming or the like of a quadrangular steel pipe for the quadrangular steel pipe column

in the joint construction of column member steel pipes;

FIG. 18 is a partly cutaway perspective view of a round steel pipe column in a joint construction of column member steel pipes before subjected to weld joining, according to a fourth embodiment of the invention;

FIG. 19 is an enlarged sectional front elevation of an essential portion of the round steel pipe column in the joint construction of column member steel pipes;

FIG. 20 is a cross-sectional plan of the round steel pipe column in the joint construction of column member steel pipes;

FIG. 21 is a partly cutaway perspective view of a quadrangular steel pipe column in a joint construction of column member steel pipes before subjected to weld joining, according to a fifth embodiment of the invention;

FIG. 22 is a sectional front elevation of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 23 is an enlarged sectional front elevation of an essential portion of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 24 is a cross-sectional plan of the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 25 is a diagram explaining cold forming or the like of a quadrangular steel pipe for the quadrangular steel pipe column in the joint construction of column member steel pipes;

FIG. 26 is a partly cutaway perspective view of a round steel pipe column in a joint construction of column member steel pipes before subjected to weld joining, according to a sixth embodiment of the invention;

FIG. 27 is an enlarged sectional front elevation of an essential portion of the round steel pipe column in the joint construction of column member steel pipes; and

FIG. 28 is a cross-sectional plan of the round steel pipe column in the joint construction of column member steel pipes.

PREFERRED EMBODIMENTS

A first embodiment of the invention, employing a quadrangular steel pipe, will now be described with reference to FIGS. 1 through 8.

As shown in FIG. 1, the arrangement comprises long-sized quadrangular steel pipes (an example of long-sized steel pipe) 1 having a predetermined wall thickness t , and a short-sized quadrangular steel pipe (an example of short-sized steel pipe) 2 of length (height) L having a wall thickness T greater than the wall thickness t of the long-sized quadrangular steel pipes 1 and forming a panel zone. The predetermined wall thickness t is determined as by the external width W of a quadrangular steel pipe column employed according to the scale of a steel structure. For example, when the external width W is 500 mm, the wall thickness t is 25 mm. Further, the wall thickness t of the long-sized quadrangular steel pipe 1 and the wall thickness T of the short-sized quadrangular steel pipe 2 are so related to each other that $2t \doteq T$, for example.

And the long-sized and short-sized quadrangular steel pipes 1 and 2 are hot-formed so that they are the same in the outer peripheral shape, i.e., the external width W and the radius of curvature R (for example, a radius of curvature of $0.5 T - 1.5 T$) of the outer curved surfaces 1a and 2a at the corner portions 1A and 2A.

In this case, the hot forming is performed in that as shown, for example, in FIG. 8, a half-formed long-sized quadrangular steel pipe 11 and a half-formed short-sized quadrangular steel pipe 12 of length L forming a panel zone are heated by a heating means (a furnace or the like) 15 and formed by forming means (forming roll devices or the like) 16 and 17. Such hot forming for the outer peripheral shape provides a long-sized quadrangular steel pipe 1 and short-sized quadrangular steel pipe 2 that are the same in the external width W and radius of curvature R.

Of the thus-produced long-sized and short-sized quadrangular steel pipes 1 and 2, the long-sized quadrangular steel pipe 1 is cut at the outer portion of end thereof by a processing means (cutting device or the like) 18; thus the end is formed with a bevel (end surface) 1b of predetermined angle ($35^{\circ} - 45^{\circ}$). And, a quadrangular ring-like patch 3 is fitted in the end of the long-sized quadrangular steel pipe 1, and then, as shown in FIG. 6, fixed thereto by a weld 4.

The long-sized and short-sized quadrangular steel pipes 1 and 2 formed in the manner described above are linearly positioned with their outer peripheral shapes conforming to each other, and then the outer end surface 3b of the patch 3 positioned inside the long-sized quadrangular steel pipe 1 is abutted against the flat end surface 2b of the short-sized quadrangular steel pipe 2. That is, the bevel (end surface) 1b of the long-sized quadrangular steel pipe 1 is opposed to the flat end surface (end surface) 2b of the short-sized quadrangular steel pipe 2, which is not beveled.

And as shown in FIGS. 2 through 6, the bevel 1b and the flat end surface 2b opposed thereto are tack-welded from outside,

and then joined by a weld (arc weld or the like) 5 along the entire periphery from outside, whereby the long-sized and short-sized quadrangular steel pipes 1 and 2 are joined by the weld 5 from outside, thereby providing a quadrangular steel pipe column (an example of column member steel pipe) 6 using the short-sized quadrangular steel pipe 2 as a panel zone.

A predetermined number of quadrangular steel pipe columns 6 constructed in the manner described above are conveyed to a building site or the like, and beam flanges or beam members 7 are joined by welds 8 to the outer surface of the short-sized quadrangular steel pipe 2 of length L forming a panel zone. In addition, the quadrangular steel pipe columns 6, as shown in phantom lines in FIG. 2, are stacked and adjoining ones are joined by welds 5, whereby they are constructed to have a predetermined length (height).

A second embodiment of the invention, employing a round steel pipe, will now be described with reference to FIGS. 9 through 12.

That is, as shown in FIG. 9, the arrangement comprises long-sized round steel pipes (an example of long-sized steel pipe) 21 having a predetermined wall thickness t , and a short-sized round steel pipe (an example of short-sized steel pipe) 22 of length (height) L having a wall thickness T greater than the wall thickness t of the long-sized round steel pipes 21 and forming a panel zone. These long-sized and short-sized round steel pipes 21 and 22 are hot-formed so that they are the same in the outer diameter D. And, each long-sized round steel pipe 21 is cut at the outer portion of its end; thus, the end is formed with a bevel 21b of predetermined angle (35° - 45°). Further, a ring-like patch 23 is fitted in the end of the

long-sized round steel pipe 21, and then fixed thereto by a weld 24. In addition, the end of the short-sized round steel pipe 22 is not beveled but is left as a flat end surface 22b.

The long-sized and short-sized round steel pipes 21 and 22 formed in the manner described above are concentrically and linearly positioned, and then the outer end surface 23b of the patch 23 positioned inside the long-sized round steel pipe 21 is abutted against the flat end surface 22b of the short-sized round steel pipe 22. That is, the bevel (end surface) 21b of the long-sized round steel pipe 21 is opposed to the flat end surface 22b of the short-sized round steel pipe 22, which is not beveled.

And as shown in FIGS. 10 through 12, the bevel 21b and the flat end surface 22b opposed thereto are tack-welded from outside, and then joined by a weld (arc weld or the like) 25 along the entire periphery from outside, whereby the long-sized and short-sized round steel pipes 21 and 22 are joined by the weld 25 from outside, thus providing a round steel pipe column (an example of column member steel pipe) 26 using the short-sized round steel pipe 22 as a panel zone. In this case, the joining by the weld 25 can be suitably effected by utilizing the patch 23.

A third embodiment of the invention, employing a quadrangular steel pipe, will now be described with reference to FIGS. 13 through 17.

As shown in FIG. 13, the arrangement comprises long-sized quadrangular steel pipes (an example of long-sized steel pipe) 31 having a predetermined wall thickness t , and a short-sized quadrangular steel pipe (an example of short-sized steel pipe) 32 of length (height) L having a wall thickness T greater than

the wall thickness t of the long-sized quadrangular steel pipes 31 and forming a panel zone. The predetermined wall thickness t is determined as by the external width W of a quadrangular steel pipe column employed according to the scale of a steel structure. For example, when the external width W is 500 mm, the wall thickness t is 25 mm. Further, the wall thickness t of the long-sized quadrangular steel pipe 31 and the wall thickness T of the short-sized quadrangular steel pipe 32 are so related to each other that $2t \doteq T$, for example.

And, the long-sized quadrangular steel pipe 31 is cold-formed, while the short-sized quadrangular steel pipe 32 is hot-formed; thus, the long-sized and short-sized quadrangular steel pipes 31 and 32 are formed by the shaping effected by the hot forming of the short-sized quadrangular steel pipe 32 so that they are the same in the outer peripheral shape, i.e., the external width W and the radius of curvature R (for example, a radius of curvature of $0.5 T - 1.5 T$) of the outer curved surfaces 31a and 32a at the corner portions 31A and 32A.

At this point, the cold-formed long-sized quadrangular steel pipes 31, as shown, for example, in FIG. 17, are each cut at the outer portion of the end thereof by a processing means (cutting device or the like) 47; thus, long-sized quadrangular steel pipes 31 are obtained whose end is formed with a bevel (end surface) 31b of predetermined angle ($35^\circ - 45^\circ$). Further, the hot forming of the short-sized quadrangular steel pipe 32 is effected in that a half-formed short-sized quadrangular steel pipe 41 of length L forming a panel zone is heated by a heating means (a furnace or the like) 45 and is formed by a forming means (a forming roll device or the like) 46. Such hot forming for the outer peripheral shape provides a short-sized

quadrangular steel pipe 32 so formed that it is the same in the outer external width W and the radius of curvature R as the long-sized quadrangular steel pipe 31.

Of the long-sized and short-sized quadrangular steel pipes 31 and 32 produced in this manner, the long-sized quadrangular steel pipe 31 has a quadrangular ring-like patch 33 fitted in the end thereof, the patch being fixed thereto by a weld 34, as shown in FIG. 15. In addition, the end of the short-sized quadrangular steel pipe 32 is not beveled for welding but is left as a flat end surface (end surface) 32b.

The long-sized and short-sized quadrangular steel pipes 31 and 32 formed in the manner described above are linearly positioned with their outer peripheral shapes conforming to each other, and then the outer end surface 33b of the patch 33 positioned inside the long-sized quadrangular steel pipe 31 is abutted against the flat end surface 32b of the short-sized quadrangular steel pipe 32.

And as shown in FIGS. 14 and 15, in the same manner as in the first embodiment described above, joining by a weld (arc weld or the like) 35 along the entire periphery from outside provides a quadrangular steel pipe column (an example of column member steel pipe) 36 using the short-sized quadrangular steel pipe 32 as a panel zone. Further, beam flanges or beam members 37 are joined by welds 38 to the outer surface of the short-sized quadrangular steel pipe 32 of length L forming a panel zone.

A fourth embodiment of the invention, employing a round steel pipe, will now be described with reference to FIGS. 18 through 20.

That is, as shown in FIG. 18, the arrangement comprises long-sized round steel pipes (an example of long-sized steel

pipe) 51 having a predetermined wall thickness t , and a short-sized round steel pipe (an example of short-sized steel pipe) 52 of length (height) L having a wall thickness T greater than the wall thickness t of the long-sized round steel pipes 51 and forming a panel zone.

And, the long-sized round steel pipe 51 is cold-formed, while the short-sized round steel pipe 52 is hot-formed; thus, the long-sized and short-sized round steel pipe 51 and 52 are formed by the shaping effected by the hot forming of the short-sized round steel pipe 52 so that they are the same in the outer peripheral shape, i.e., the outer diameter D . Further, the long-sized round steel pipe 51 is cut at the outer portion of the end thereof; thus, the end is formed with a bevel 51b of predetermined angle ($35^\circ - 45^\circ$). Further, a ring-like patch 53 is fitted in the end of the long-sized round steel pipe 51 and then fixed thereto by a weld 54. In addition, the end of the short-sized round steel pipe 52 is not beveled but is left as a flat end surface 52b.

The long-sized and short-sized round steel pipes 51 and 52 formed in the manner described above are concentrically and linearly positioned, and then the outer end surface 53b of the patch 53 positioned inside the long-sized round steel pipe 51 is abutted against the flat end surface 52b of the short-sized round steel pipe 52. That is, the bevel (end surface) 51b of the long-sized round steel pipe 51 is opposed to the flat end surface 52b of the short-sized round steel pipe 52, which is not beveled.

And as shown in FIGS. 19 and 20, in the same manner as in the second embodiment described above, joining by a weld (arc weld or the like) 55 along the entire periphery from outside

provides a round steel pipe column (an example of column member steel pipe) 56 using the short-sized round steel pipe 52 as a panel zone. At this time, the joining by the weld 55 can be suitably effected by using the patch 53.

A fifth embodiment of the invention, employing a quadrangular steel pipe, will now be described with reference to FIGS. 21 through 25.

As shown in FIG. 21, the arrangement comprises long-sized quadrangular steel pipes (an example of long-sized steel pipe) 61 having a predetermined wall thickness t , and a short-sized quadrangular steel pipe (an example of short-sized steel pipe) 62 of length (height) L having a wall thickness T greater than the wall thickness t of the long-sized quadrangular steel pipes 61 and forming a panel zone. The predetermined wall thickness t is determined as by the external width W of a quadrangular steel pipe column employed according to the scale of a steel structure. For example, when the external width W is 500 mm, the wall thickness t is 25 mm. Further, the wall thickness t of the long-sized quadrangular steel pipe 61 and the wall thickness T of the short-sized quadrangular steel pipe 62 are so related to each other that $2t \doteq T$, for example.

And, the long-sized and short-sized quadrangular steel pipes 61 and 62 are cold-formed so that they are the same in the outer peripheral shape, i.e., the external width W and the radius of curvature R (for example, a radius of curvature of $0.5 T - 1.5 T$) of the outer curved surfaces 61a and 62a at the corner portions 61A and 62A.

In this case, the cold forming of the long-sized and short-sized quadrangular steel pipes 61 and 62 is performed, for example, in the manner shown in FIG. 25. That is, for the

cold forming of the long-sized quadrangular steel pipe 61, first, a flat plate blank, i.e., a thin steel plate 71 of predetermined wall thickness t , length and width, corresponding to the long-sized quadrangular steel pipe 61 is prepared. This thin steel plate 71 is conveyed to a beveling machine 72, where it is beveled. Subsequently, the thin steel plate 71 is conveyed to a pressing machine 73, where it is pressed. And it is conveyed to a welding machine 74, where tack welding, inner surface welding, outer surface welding, etc., are effected with the bevels abutted against each other under external pressure, whereby the long-sized quadrangular steel pipe 61 can be cold-formed to have the predetermined external size W and the predetermined radius of curvature R of the outer curved surface 61a at each corner portion 61A.

The long-sized quadrangular steel pipe 61 cold-formed in this manner is conveyed to a processing means (a cutting device or the like) 75, where the outer portion of the end thereof is cut; thus, a long-sized quadrangular steel pipe 61 having a bevel of predetermined angle ($35^{\circ} - 45^{\circ}$) (end surface) 61b cut in the end thereof is obtained.

Further, the cold forming of the short-sized quadrangular steel pipe 62 is effected first by preparing a flat plate blank, i.e., a thick steel plate 76 having a thickness T greater than the wall thickness t of the long-sized quadrangular steel pipe 61 and having a length L and width forming a panel zone, conveying this thick steel plate 76 to a beveling machine 77, where it is formed with a bevel. Subsequently, the thick steel plate 76 is conveyed to a pressing machine 78, where it is pressed. And it is conveyed to a welding machine 79, where tack welding, inner surface welding, outer surface welding, etc., are

effected with the bevels abutted against each other under external pressure, whereby the short-sized quadrangular steel pipe 62 can be cold-formed to have the predetermined external size W and the predetermined radius of curvature R of the outer curved surface 62a at each corner portion 62A.

At this point, the long-sized and short-sized quadrangular steel pipes 61 and 62 are cold-formed so that they are the same in the external size W and the radius of curvature R.

Of the thus-produced long-sized and short-sized quadrangular steel pipes 61 and 62, the long-sized quadrangular steel pipe 61 has a quadrangular ring-like patch 63 fitted in the end thereof and fixed thereto by a weld 64. In addition, the end of the short-sized quadrangular steel pipe 62 is not beveled for welding but is left as a flat end surface (end surface) 62b.

The long-sized and short-sized quadrangular steel pipes 61 and 62 formed in the manner described above are linearly positioned with their outer peripheral shapes conforming to each other, and then the outer end surface 63b of the patch 63 positioned inside the long-sized quadrangular steel pipe 61 is abutted against the flat end surface 62b of the short-sized quadrangular steel pipe 62. That is, the bevel (end surface) 61b of the long-sized quadrangular steel pipe 61 is opposed to the flat end surface 62b of the short-sized quadrangular steel pipe 62, which is not beveled.

And as shown in FIGS. 22 and 23, in the same manner as in the first embodiment described above, joining by a weld (arc weld or the like) 65 along the entire periphery from outside provides a quadrangular steel pipe column (an example of column member steel pipe) 66 using the short-sized quadrangular steel pipe 62 as a panel zone. Further, beam flanges or beam members

67 are joined by welds 68 to the outer surface of the short-sized quadrangular steel pipe 62 of length L forming the zone panel.

A sixth embodiment of the invention, employing a round steel pipe, will now be described with reference to FIGS. 26 through 28.

That is, as shown in FIG. 26, the arrangement comprises long-sized round steel pipes (an example of long-sized steel pipe) 81 having a predetermined wall thickness t , and a short-sized round steel pipe (an example of short-sized steel pipe) 82 of length (height) L having a wall thickness T greater than the wall thickness t of the long-sized round steel pipes 81 and forming a panel zone.

And, the long-sized and short-sized quadrangular steel pipes 81 and 82 are cold-formed so that they are the same in the outer peripheral shape, i.e., the outer diameter D . Further, the long-sized round steel pipe 81 is cut at the outer portion of the end thereof; thus, the end is formed with a bevel 81b of predetermined angle ($35^{\circ} - 45^{\circ}$). Further, a ring-like patch 83 is fitted in the end of the long-sized round steel pipe 81, and then fixed thereto by a weld 84. In addition, the end of the short-sized round steel pipe 82 is not beveled but is left as a flat end surface 82b.

The long-sized and short-sized round steel pipes 81 and 82 formed in the manner described above are concentrically and linearly positioned, and then the outer end surface 83b of the patch 83 positioned inside the long-sized round steel pipe 81 is abutted against the flat end surface 82b of the short-sized round steel pipe 82. That is, the bevel (end surface) 81b of the long-sized round steel pipe 81 is opposed to the flat end surface 82b of the short-sized round steel pipe 82, which is

not beveled.

And as shown in FIGS. 27 and 28, in the same manner as in the first embodiment described above, joining by a weld (arc weld or the like) 85 along the entire periphery from outside provides a round steel pipe column (an example of column member steel pipe) 86 using the short-sized round steel pipe 82 as a panel zone. In this case, the joining by the weld 85 can be suitably effected by utilizing the patch 83.

As in the first through sixth embodiments described above, the ends of the short-sized quadrangular steel pipes 2, 32, and 62 and short-sized round steel pipes 22, 52, and 82 are not beveled for welding but are left as flat end surfaces (end surfaces) 2b, 32b, 62b, 22b, 52b, and 82b; thus, the short-sized quadrangular steel pipes 2, 32, and 62 and short-sized round steel pipes 22, 52, and 82 can be formed in a reduced production time and at low cost. Further, since the long-sized quadrangular steel pipes 1, 31, and 61 and the long-sized round steel pipes 21, 51, and 81 can have their bevels 1b, 31b, 61b, 21b, 51b, and 81b machined from outside, the bevels can be formed in a reduced production time and at low cost. In this case, the joining by welds 5, 35, 65, 25, 55, and 85 can be suitably effected by using patches 3, 33, 63, 23, 53, and 83.

As in the first, third, and fifth embodiments described above, the joining between the long-sized quadrangular steel pipes 1, 31, and 61 and the short-sized quadrangular steel pipes 2, 32, and 62 by the welds 5, 35, and 65 between the corner portions 1A, 2A, 31A, 32A, 61A, and 62A is effected more smoothly and efficiently, suitably all the time because the radii of curvature, R, of the opposed outer curved surfaces 1a, 2a, 31a, 32a, and 61a, 62a are the same, with no step portion (linear

misalignment) formed.

As in the first, third, and fifth embodiments described above, according to the quadrangular steel pipe columns 6, 36, and 66 employing the thick-walled short-sized quadrangular steel pipes 2, 32, and 62, in the case of the long-sized quadrangular steel pipes 1, 31, and 61 and the short-sized quadrangular steel pipes 2, 32, and 62, stress transmission can be effected more suitably because the radii of curvature, R , of the opposed ends are the same, with no step portion (linear misalignment) formed.

As in the first, third, and fifth embodiments described above, the panel zone can secure a sufficient strength by means of the predetermined increased wall thickness T of the short-sized quadrangular steel pipes 2, 32, and 62, and the joining of the beam flanges or beam members 7, 37, and 67 by the welds 8, 38, and 68 can be effected without any trouble. Further, the quadrangular steel pipe columns 6, 36, and 66 are obtained in the pipe joint type, which can be finished so that there is no contained rib or the like. Therefore, an arrangement having concrete or the like filled therein can be easily employed.

At this time, if a predetermined spacing (50 - 300 mm) l is given between the flat end surfaces 2b, 32b, and 62b of the short-sized quadrangular steel pipes 2, 32, and 62 and the upper and lower surfaces 7b, 37b, and 67b of the beam flanges or beam members 7, 37, and 67, then there is obtained the effect that a hinge action is produced in the vicinity of the upper and lower ends of the short-sized quadrangular steel pipes 2, 32, and 62 of length L forming a panel zone.

That is, when the panel zone portion where the column and the beam are joined is to be controlled to prevent them from

yielding under earthquake force or is to be allowed to yield, it is necessary to design on the safety side considering the balance of the entire building. In this case, in the method of joining the panel zone portion where stress concentration occurs to the column where the influence of stress is relatively low, the use of this joint construction that is easy to form is featured by the formation of a plastic hinge in the vicinity of the panel zone by earthquake force and by the smooth transmission of earthquake force from the panel zone portion to the column.

In the first, third, and fifth embodiments described above, the quadrangular steel pipes 1, 2, 31, 32, 61, and 62 that are square in cross section are employed as quadrangular steel pipes; however, a quadrangular steel pipe that is rectangular in cross section may also be employed. Further, other various steel pipes of polygonal shape, such as regular pentagon or regular hexagon may likewise be used.

In the first through sixth embodiments described above, the short-sized quadrangular steel pipes 2, 32, and 62 and short-sized round steel pipes 22, 52, and 82 have a length L forming a panel zone; however, the length of the short-sized quadrangular steel pipes 2, 32, and 62 and short-sized round steel pipes 22, 52, and 82 is optionally set according to other service places than the panel zone.

In the first through sixth embodiments described above, the long-sized quadrangular steel pipes 1, 31, and 61 and the short-sized quadrangular steel pipes 2, 32, and 62 and the long-sized round steel pipes 21, 51, and 81 and the short-sized round steel pipes 22, 52, and 82 are joined by the welds 5, 35, 65, 25, 55, and 85, thereby constituting the quadrangular steel

pipe columns 6, 36, and 66 and the round steel pipe columns 26, 56, and 86, with the short-sized quadrangular steel pipes 2, 32, and 62 and the short-sized round steel pipes 22, 52, and 82 used as panel zones and these quadrangular steel pipe columns 6, 36, and 66 and the round steel pipe columns 26, 56, and 86 are conveyed to a building site or the like, where the beam flanges or beam members 7, 37, and 67 are joined to the outer surfaces of the short-sized quadrangular steel pipes 2, 32, and 62 and the short-sized round steel pipes 22, 52, and 82 by the welds 8, 38, and 68; however, the long-sized quadrangular steel pipes 1, 31, and 61 and the short-sized quadrangular steel pipes 2, 32, and 62 and the long-sized round steel pipes 21, 51, and 81 and the short-sized round steel pipes 22, 52, and 82 may be conveyed to a building site or the like, where they are joined respectively by the welds 5, 35, 65, 25, 55, and 85, thereby constituting the quadrangular steel pipe columns 6, 36, and 66 and the round steel pipe columns 26, 56, and 86, with the short-sized quadrangular steel pipes 2, 32, and 62 and the short-sized round steel pipes 22, 52, and 82 used as panel zones.

Further, after the beam flanges or beam members 7, 37, and 67 have been joined to the outer surfaces of the short-sized quadrangular steel pipes 2, 32, and 62 and the short-sized round steel pipes 22, 52, and 82 by the welds 8, 38, and 68, the assemblies may be conveyed to a building site or the like. Further, connecting plates used for connecting the beam flanges or beam members 7, 37, and 67 may be attached to the outer surfaces of the short-sized quadrangular steel pipes 2, 32, and 62 and the short-sized round steel pipes 22, 52, and 82.

In the first, third, and fifth embodiments described above, included among the quadrangular steel pipes 1, 2, 31, 32, 61,

and 62 are, for example, one-seam quadrangular steel pipes formed by rolling, two-seam quadrangular steel pipes each formed by butt-welding a pair of press-formed channel section members abutted against each other, two-seam quadrangular steel pipes each formed by welding a pair of rolled channel section members, two-seam quadrangular steel pipes each formed by welding a pair of rolled angle steel members abutted against each other, four-sided boxes, and seamless steel pipes, each being a ready-made quadrangular steel pipe.

In the first through sixth embodiments described above, the welding is by an electroslag welding machine or electrogas arc welding machine, which allows high quality welding to be effected in a short time. In addition, other welding systems, including laser, may be used.

In the first through sixth embodiments described above, the quadrangular and round short-sized steel pipes are of higher material quality than the quadrangular and round long-sized steel pipes, whereby the value of yield point (unit; Newton/mm²) can be selected so that when it is [235] for the long-sized steel pipe, it is [325] for the short-sized steel pipe and when it is [325] for the long-size steel pipe, it is [355] for the short-sized steel pipe. In addition, the short-sized and long-sized steel pipes may be of the same quality.

WHAT IS CLAIMED IS:

1. A joint construction of column member steel pipes, comprising a long-sized steep pipe of a predetermined wall thickness and a short-sized steel pipe of a greater wall thickness than that of the long-sized steel pipes, characterized in that

the long-sized and short-sized steel pipes are formed by hot forming to have a same outer peripheral shape, and the long-sized and short-sized steel pipes are jointed by welding from outside in a state that an end surface of the long-sized steel pipe is opposed to an end surface of the short-sized steel pipe having no beveled portion.

2. The joint construction of column member steel pipes as set forth in Claim 1, wherein the long-sized and short-sized steel pipes are quadrangular steel pipes, and these long-sized and short-sized quadrangular steel pipes are formed by hot forming to have a same external width and a same outer curved surface at each corner portion.

3. The joint construction of column member steel pipes as set forth in Claim 1, wherein the long-sized and short-sized steel pipes are round steel pipes, and these long-sized and short-sized round steel pipes are formed by hot forming to have a same outer diameter.

4. The joint construction of column member steel pipes as set forth in Claim 1, wherein the short-sized steel pipe has a length forming a panel zone.

5. The joint construction of column member steel pipes as set forth in Claim 1, wherein the long-sized and short-sized steel pipes are joined by welding from outside in a state that a patch metal positioned inside the long-sized steel pipe is

abutted against an end surface of the short-sized steel pipe.

6. A joint construction of column member steel pipes, comprising long-sized steep pipes of a predetermined wall thickness and a short-sized steel pipe of a greater wall thickness than that of the long-sized steel pipes, characterized in that

the long-sized steel pipes are formed by cold forming, while the short-sized steel pipes are formed by hot forming to have a same outer peripheral shape as that of the long-sized steel pipes, and the long-sized and short-sized steel pipes are joined by welding from outside in a state that an end surface of the long-sized steel pipe is opposed to an end surface of the short-sized steel pipe having no beveled portion.

7. The joint construction of column member steel pipes as set forth in Claim 6, wherein the long-sized and short-sized steel pipes are quadrangular steel pipes, and the long-sized quadrangular steel pipe is formed by cold forming, while the short-sized quadrangular steel pipe is formed by hot forming to have a same external width and a same outer curved shape at each corner portions as those of the long-sized quadrangular steel pipe.

8. The joint construction of column member steel pipes as set forth in Claim 6, wherein the long-sized and short-sized steel pipes are round steel pipes, and the long-sized round steel pipe is cold-formed, while the short-sized round steel pipe is formed by hot forming to have a same outer diameter as that of the long-sized round steel pipe.

9. The joint construction of column member steel pipes as set forth in Claim 6, wherein the short-sized steel pipe has a length forming a panel zone.

10. The joint construction of column member steel pipes as set forth in Claim 6, wherein a patch positioned inside the long-sized steel pipe is abutted against an end surface of the short-sized steel pipe, and in this state the two steel pipes are joined by welding from outside.

11. A joint construction of column member steel pipes, comprising a long-sized steel pipe of a predetermined wall thickness and a short-sized steel pipe of a greater wall thickness than that of the long-sized steel pipes, characterized in that

the long-sized and short-sized steel pipes are formed by cold forming to have a same outer peripheral shape, and the long-sized and short-sized steel pipes are jointed by welding from outside in a state that an end surface of the long-sized steel pipe is opposed to an end surface of the short-sized steel pipe having no beveled portion.

12. The joint construction of column member steel pipes as set forth in Claim 11, wherein the long-sized and short-sized steel pipes are quadrangular steel pipes, and these long-sized and short-sized quadrangular steel pipes are cold-formed to have a same external width and a same outer curved surface at each corner portion.

13. The joint construction of column member steel pipes as set forth in Claim 11, wherein the long-sized and short-sized steel pipes are round steel pipes, and the long-sized and short-sized round steel pipes are cold-formed to have a same outer diameter.

14. The joint construction of column member steel pipes as set forth in Claim 11, wherein the short-sized steel pipe has a length forming a panel zone.

15. The joint construction of column member steel pipes as set forth in Claim 11, wherein a patch positioned inside the long-sized steel pipe is abutted against an end surface of the short-sized steel pipe, and in this state the two steel pipes are joined by welding from outside.