

[Document Type] Specification

[Title of the Invention] BEAM-TO-COLUMN CONNECTION

[Technical Field of the Invention]

[0001]

The present invention relates to a beam-to-column connection in a joining location between a column member and a beam member.

Priority is claimed on Japanese Patent Application No. 2016-037377, filed on February 29, 2016, the content of which is incorporated herein by reference.

[Related Art]

[0002]

In the related art, in order to provide a beam-to-column connection in which a structure of a joining location of a column member and a beam member is drastically simplified and which excels in workability and economic efficiency, beam-to-column connections disclosed in Patent Documents 1 to 3 have been proposed.

[0003]

In the beam-to-column connection disclosed in Patent Document 1, a steel frame beam is welded in a strong axis direction of a steel H-shape constituting a column having a steel framed structure or a steel framed reinforced concrete structure. The beam-to-column connection disclosed in Patent Document 1 is characterized in that the column is constituted of a steel H-shape in which a sheet thickness of a web and a sheet thickness of a flange have a predetermined relationship, and reinforcements such as stiffener plates or a doubler plates are not provided.

[0004]

In Patent Document 2, in a beam-to-column connection having a column with a reinforced concrete structure and a beam with a steel framed structure, a welding wire

gauze or a reinforcing lattice used as a shearing reinforcing bar. In the beam-to-column connection disclosed in Patent Document 2, the welding wire gauze is provided to be accommodated within a range of a section blocked by a web of the steel beam, and transverse reinforcements and vertical reinforcements of the welding wire gauze are combined in a lattice shape.

[0005]

In Patent Document 3, in a beam-to-column connection having concrete encased steel columns and a steel beam, reinforcing bars lapped together within a range of a section blocked by a web of the steel beam extending in a predetermined direction is provided. In the beam-to-column connection disclosed in Patent Document 3, the reinforcing bars lapped together are disposed within a range blocked along the web of the steel beam extending in the predetermined direction and are put into an orthogonal reinforcing rod through-hole of the web of the steel beam within the blocked range.

[Prior Art Document]

[Patent Document]

[0006]

[Patent Document 1] Japanese Unexamined Patent Application, First Publication No. 2001-214514

[Patent Document 2] Japanese Unexamined Patent Application, First Publication No. 2005-180100

[Patent Document 3] Japanese Unexamined Patent Application, First Publication No. 2006-144474

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0007]

Here, a beam-to-column connection disclosed in Patent Document 1 is characterized in that reinforcements such as stiffener plates or a doubler plates are not provided in a column constituted of a steel H-shape. However, site welding of reinforcing bars provided inside a concrete column is not made unnecessary. That is, in the beam-to-column connection disclosed in Patent Document 1, since no reinforcements such as stiffener plates or a doubler plates are provided in the column, a construction period of factory fabrication can be shortened. However, since site welding of reinforcing bars is not made unnecessary, a construction period of site work cannot be shortened.

[0008]

In contrast, in beam-to-column connections disclosed in Patent Documents 2 and 3, a construction period of site work is shortened by making site welding of reinforcing bars provided inside a concrete column unnecessary in a lap portion.

[0009]

Therefore, in the beam-to-column connection disclosed in Patent Document 2, site welding is made unnecessary by combining transverse reinforcements and vertical reinforcements of welding wire gauzes in a lattice shape. Then, in the beam-to-column connection disclosed in Patent Document 2, falling of concrete which will become a column is prevented by an off-plane restraining force of the lattice-shaped welding wire gauzes. However, a plurality of welding wire gauzes are divided and provided within a range of a section blocked by a web of a steel beam. In this case, in the beam-to-column connection disclosed in Patent Document 2, since the plurality of welding wire gauzes are divided individually, the concrete column cannot be integrally reinforced over the whole circumference.

[0010]

In addition, in the beam-to-column connection disclosed in Patent Document 3 as well, site welding is made unnecessary by putting the lap portion into a reinforcing rod through-hole of the web of the steel beam. Then, in the beam-to-column connection disclosed in Patent Document 3 as well, the reinforcing bars lapped together are provided in a divided manner within the range of the section blocked by the web of the steel beam extending in a predetermined direction. In this case, in the beam-to-column connection disclosed in Patent Document 3, in both or any one of the reinforcing bars lapped together, since the other end side via an outer circumference of a corresponding column main reinforcement is disposed along the web of the steel beam disposed at a right angle to the steel beam, the reinforcing bars are divided in the web of the steel beam. Therefore, the concrete column cannot be integrally reinforced over the whole circumference. In addition, in the beam-to-column connection disclosed in Patent Document 3, since the lap portion put into the reinforcing rod through-hole of the steel beam is likely to spread in an off-plane direction on a side surface of the concrete column, it is not possible to sufficiently prevent concrete which will become a column from falling in the reinforcing bars lapped together.

[0011]

The present invention has been devised in consideration of the foregoing problems described above, and an object thereof is to provide a beam-to-column connection in which concrete is prevented from falling and rotational rigidity of a steel frame beam is enhanced while realizing simple and prompt construction in a joining location of a column member and a beam member.

[Means for Solving the Problem]

[0012]

The gist of the present invention is as follows.

[0013]

(1) According to a first aspect of the present invention, there is provided a beam-to-column connection including a concrete column, a steel frame beam that is joined to the concrete column, and a plurality of reinforcing bars that are provided in a surface layer region of the concrete column in a joining location of the concrete column and the steel frame beam. A continuous portion which extends over the surface layer region of the concrete column from a corner portion to a corner portion, a pair of elongated portions which are bent from both ends of the continuous portion and extends along the surface layer region of the concrete column, and a protrusion portion which is bent from one of or both the pair of elongated portions and protrudes toward an inside of the concrete column are formed in each of the reinforcing bars in an integrally continuous manner. The entirety of the continuous portions respectively formed in the plurality of reinforcing bars forms a hoop over a whole circumference of the surface layer region of the concrete column.

[0014]

(2) In the beam-to-column connection according to (1), the protrusion portion may be bent from both the pair of elongated portions and may protrude toward the inside of the concrete column.

[0015]

(3) In the beam-to-column connection according to (1) or (2), the continuous portion of each of the reinforcing bars may be inserted through a penetration hole penetrating the steel frame beam in a sheet thickness direction.

[0016]

(4) In the beam-to-column connection according to any one of (1) to (3), a protrusion length of the protrusion portion of each of the reinforcing bars may be a

length of ten times or greater than the diameter of each of the reinforcing bars and a length of half or smaller than the length of the continuous portion.

[0017]

(5) In the beam-to-column connection according to any one of (1) to (4), in the plurality of reinforcing bars, four reinforcing bars may be provided in a partially overlapping manner such that the entirety of the continuous portions of the four reinforcing bars forms a hoop over the whole circumference of the surface layer region of the concrete column.

[0018]

(6) In the beam-to-column connection according to any one of (1) to (5), the steel frame beam and the concrete column may be subjected to semi-rigid joining or pin joining.

[0019]

(7) In the beam-to-column connection according to any one of (1) to (6), in the steel frame beam, a face bearing plate which covers an inner measurement portion formed by an upper flange, a lower flange, and a web of the steel frame beam may be provided along a side surface of the concrete column.

[0020]

(8) In the beam-to-column connection according to any one of (1) to (7), the concrete column may be a steel framed reinforced concrete column internally having a steel frame column.

[Effects of the Invention]

[0021]

According to the configurations of (1) to (8), since the entirety of the continuous portions of the plurality of reinforcing bars forms a hoop over the whole

circumference of the surface layer region of the concrete column in the joining locations of the concrete column and the steel frame beams, the whole circumference of the concrete column can be integrally reinforced. Moreover, since each of the reinforcing bars extends in an integrally continuous manner without being divided in the continuous portion, each of the reinforcing bars is unlikely to spread in an off-plane direction on the side surface of the concrete column. Therefore, it is possible to exhibit a restraining force of hoop tension caused by a combination of the plurality of reinforcing bars, so that the concrete column in the joining locations of the steel frame column and the steel frame beams can be reliably reinforced. In addition, since there is no need to provide a welding portion in the reinforcing bar by flare welding or the like and there is no need to provide a mechanical joint, each of the reinforcing bars can be simply and promptly provided. Moreover, since the protrusion portion which extends while protruding toward the inside of the concrete column is formed in each of the reinforcing bars, the continuous portion and the protrusion portion of each of the reinforcing bars are coupled by the elongated portion, so that the protrusion portion of each of the reinforcing bars can exhibit a resistance force inside the concrete column. Therefore, it is possible to enhance a restraining force of hoop tension caused by a combination of the plurality of reinforcing bars.

[0022]

Particularly, according to the configuration of (6), since the steel frame beams are subjected to semi-rigid joining or pin joining with respect to the concrete column, compared to a case where all of steel frame beams are subjected to rigid-joining with respect to the concrete column, it is possible to shorten a construction period and to suppress a cost rise in quality control by reducing welding work for end portions of the steel frame beams. In addition, in a case where the steel frame beams are subjected to

semi-rigid joining or pin joining with respect to a concrete column, the steel frame beams are likely to make a rotational movement in a height direction with respect to the concrete column. However, since a restraining force of hoop tension acts due to a combination of the plurality of reinforcing bars, concrete of the concrete column can be prevented from falling.

[0023]

Particularly, according to the configuration of (7), since the face bearing plate of each of the steel frame beams is provided along the side surface of the concrete column, falling of concrete caused by action of a rotational force can be suppressed. In addition, since a pressing force acts from the concrete column to the steel frame beams and falling of concrete is suppressed, rotational rigidity of the steel frame beams can also be enhanced. Moreover, the concrete column can be simply and promptly established by utilizing the face bearing plate of each of the steel frame beams as a formwork when concrete is placed.

[Brief Description of the Drawings]

[0024]

FIG. 1 is a perspective view showing a state where concrete is removed from a beam-to-column connection according to an embodiment of the present invention.

FIG. 2 is a plan view showing joining locations of a concrete column and steel frame beams in the beam-to-column connection according to the embodiment of the present invention.

FIG. 3 is a front view showing the joining location of the concrete column and the steel frame beam in the beam-to-column connection according to the embodiment of the present invention.

FIG. 4A is a plan view showing protrusion portions respectively extending

from both elongated portions in the beam-to-column connection according to the embodiment of the present invention.

FIG. 4B is a plan view showing the protrusion portion extending from one elongated portion in the beam-to-column connection according to the embodiment of the present invention.

FIG. 5A is an exploded view showing reinforcing bars formed into a substantial C-shape in the beam-to-column connection according to the embodiment of the present invention.

FIG. 5B is a plan view showing the reinforcing bars formed into a substantial C-shape in the beam-to-column connection according to the embodiment of the present invention.

FIG. 6A is an exploded view showing reinforcing bars formed into a substantial L-shape in the beam-to-column connection according to the embodiment of the present invention.

FIG. 6B is a plan view showing the reinforcing bars formed into a substantial L-shape in the beam-to-column connection according to the embodiment of the present invention.

FIG. 7A is an enlarged view showing a continuous portion continuously extending in a reinforcing bar of the beam-to-column connection according to the embodiment of the present invention.

FIG. 7B is an enlarged view showing flare welding of a beam-to-column connection in the related art.

FIG. 7C is an enlarged view showing a mechanical joint of the beam-to-column connection in the related art.

FIG. 8A is a plan view showing a state where the protrusion portion of the

reinforcing bar is inserted through a penetration hole by a rotational movement in the beam-to-column connection according to the embodiment of the present invention.

FIG. 8B is a plan view showing a state where the elongated portion of the reinforcing bar is inserted through the penetration hole by a rotational movement in the beam-to-column connection according to the embodiment of the present invention.

FIG. 8C is a plan view showing a state where the continuous portion of the reinforcing bar is inserted through the penetration hole by a rotational movement in the beam-to-column connection according to the embodiment of the present invention.

FIG. 9A is a plan view showing four steel frame beams joined to a steel frame column in the beam-to-column connection according to the embodiment of the present invention.

FIG. 9B is a front view of the beam-to-column connection shown in FIG. 9A.

FIG. 10A is a plan view showing a state where a first reinforcing bar is rotationally moved in the beam-to-column connection according to the embodiment of the present invention.

FIG. 10B is a front view showing a state where the first reinforcing bar is rotationally moved in the beam-to-column connection according to the embodiment of the present invention.

FIG. 11A is a plan view showing a state where a second reinforcing bar is rotationally moved in the beam-to-column connection according to the embodiment of the present invention.

FIG. 11B is a front view showing a state where the second reinforcing bar is rotationally moved in the beam-to-column connection according to the embodiment of the present invention.

FIG. 12A is a plan view showing a state where a third reinforcing bar is

rotationally moved in the beam-to-column connection according to the embodiment of the present invention.

FIG. 12B is a front view showing a state where the third reinforcing bar is rotationally moved in the beam-to-column connection according to the embodiment of the present invention.

FIG. 13A is a plan view showing a state where a fourth reinforcing bar is rotationally moved in the beam-to-column connection according to the embodiment of the present invention.

FIG. 13B is a front view showing a state where the fourth reinforcing bar is rotationally moved in the beam-to-column connection according to the embodiment of the present invention.

FIG. 14A is a plan view showing a state where the reinforcing bar is rotationally moved while being widened in the beam-to-column connection according to the embodiment of the present invention.

FIG. 14B is a front view showing a state where the reinforcing bar is rotationally moved while being widened in the beam-to-column connection according to the embodiment of the present invention.

FIG. 15 is a plan view showing the reinforcing bars in a state where positions are held by a plurality of main reinforcements in the beam-to-column connection according to the embodiment of the present invention.

FIG. 16 is a plan view showing the joining locations of the concrete column and the steel frame beams in the beam-to-column connection according to the embodiment of the present invention.

FIG. 17 is a perspective view showing face bearing plates provided in the steel frame beams in the beam-to-column connection according to the embodiment of the

present invention.

FIG. 18 is a side view showing the face bearing plates provided in the steel frame beam in the beam-to-column connection according to the embodiment of the present invention.

FIG. 19 is a plan view showing a restraining force of hoop tension caused by a combination of a plurality of reinforcing bars in the beam-to-column connection according to the embodiment of the present invention.

FIG. 20A is a plan view showing a state where hoop tension is reliably generated by a combination of the plurality of reinforcing bars in the beam-to-column connection according to the embodiment of the present invention.

FIG. 20B is a plan view showing a state where sufficient hoop tension is not generated in a beam-to-column connection in the related art.

FIG. 21A is a plan view showing a state where two steel frame beams are joined to the steel frame column in the beam-to-column connection according to the embodiment of the present invention.

FIG. 21B is a plan view showing a state where three steel frame beams are joined to the steel frame column in the beam-to-column connection according to the embodiment of the present invention.

[Embodiment of the Invention]

[0025]

Hereinafter, a beam-to-column connection 1 according to an embodiment of the present invention (hereinafter, will be simply referred to as a beam-to-column connection 1) will be described in detail with reference to the drawings.

[0026]

As shown in FIG. 1, for example, the beam-to-column connection 1 is

introduced to a joining location of a column member and a steel frame beam in buildings having a staircase structure or the like, such as housing, schools, offices, and hospital facilities.

[0027]

As shown in FIG. 2, the beam-to-column connection 1 includes a concrete column 3 that is formed by placing concrete, a steel frame beam 2 that is joined to the concrete column 3, and a plurality of reinforcing bars 4 that are provided in a surface layer region of the concrete column 3 in a joining location of the concrete column 3 and the steel frame beam 2. In more detail, in the beam-to-column connection 1, for example, a plurality of steel frame beams 2 extending in the width direction X and the depth direction Y are joined to the concrete column 3 extending in a height direction Z (vertical direction). In this specification, “a surface layer region of the concrete column 3” denotes a region from a side surface 31 of the concrete column 3 to a depth position of “50% of a separation distance between the side surface 31 and a central axis” in a cross section perpendicular to an axial center direction of the concrete column 3.

[0028]

In the beam-to-column connection according to the present embodiment, as shown in FIG. 2, mainly, the concrete column 3 is a steel framed reinforced concrete column having a configuration in which a steel frame column 5 is provided in an inside 30 of the concrete column 3. However, the concrete column 3 may be a reinforced concrete column in which the steel frame column 5 is not provided in the inside 30 of the concrete column 3.

[0029]

The concrete column 3 is formed into a substantially rectangular shape or the

like in a cross section. The side surfaces 31 are disposed on all sides in a cross-sectional direction, and corner portions 32 are disposed in four corners of the surface layer region. In the concrete column 3, the reinforcing bar 4 such as a reinforcing rod extending in a width direction X and a depth direction Y, and a main reinforcement 6 such as a reinforcing rod extending in the height direction Z are provided in the inside 30 of the concrete column 3.

[0030]

The concrete column 3 is provided such that the main reinforcement 6 extends in the height direction Z in the inside 30 of the concrete column 3 in the vicinity of each of the corner portions 32 disposed in four corners. The main reinforcement 6 may also be provided at a position separated from each of the corner portions 32 in the vicinity of each of side surfaces 31 disposed on all sides.

[0031]

For example, a steel H-shape having a substantial H-shape or the like in a cross section is used as the steel frame column 5, in which a first flange 51 and a second flange 52 making a pair on both sides in the width direction X are disposed, and a steel frame column web 53 is built from the first flange 51 to the second flange 52. The steel frame column 5 is disposed in the substantial middle in the inside 30 of the concrete column 3 in the cross-sectional direction and is provided to extend in the height direction Z.

[0032]

The steel frame beams 2 are provided to extend in one direction or a plurality of directions in a plan view in the joining location with respect to the concrete column 3. The steel frame beams 2 may be provided to extend in only one direction of the width direction X and the depth direction Y. Furthermore, the steel frame beams 2

may be provided to extend in a plurality of directions in both the width direction X and the depth direction Y. In addition, the steel frame beams 2 may be provided on both sides of the concrete column 3 in the width direction X or the depth direction Y. Furthermore, the steel frame beams 2 may be provided on only one side of the concrete column 3.

[0033]

The steel frame beams 2 extend in a plurality of directions and are provided on both sides of the concrete column 3 in both the width direction X and the depth direction Y, so that four steel frame beams 2 are joined to one concrete column 3. The steel frame beams 2 extend in only one direction and are provided on both sides of the concrete column 3, or extend in a plurality of directions and are provided on one side or both sides of the concrete column 3, so that two or three steel frame beams 2 are joined to one concrete column 3.

[0034]

In the steel frame beams 2, for example, end portions of the steel frame beams 2 extending in the width direction X are subjected to welding joining in the first flange 51 and the second flange 52 of the steel frame column 5, thereby being subjected to rigid-joining with respect to the concrete column 3. On the other hand, in the steel frame beam 2, for example, the end portions of the steel frame beams 2 extending in the depth direction Y are subjected to bolt joining with respect to each of connection steel sheets 24 attached to both surfaces of the steel frame column web 53 of the steel frame column 5 by performing welding or the like, thereby being subjected to semi-rigid joining or pin joining with respect to the concrete column 3.

[0035]

In the steel frame beams 2, it is preferable that a part or all of the steel frame

beams 2 extending in one direction or a plurality of directions are subjected to semi-rigid joining or pin joining with respect to the concrete column 3 in the joining location with respect to the concrete column 3. In the steel frame beams 2, in four steel frame beams 2 extending in a plurality of directions, for example, only two steel frame beams 2 extending in one direction may be subjected to semi-rigid joining or pin joining with respect to the concrete column 3. In addition, in the steel frame beams 2, all of the four steel frame beams 2 extending in a plurality of directions may be subjected to semi-rigid joining or pin joining with respect to the concrete column 3.

[0036]

Here, semi-rigid joining indicates a form of joining in which a rotational movement of the steel frame beam 2 with respect to the concrete column 3 is restrained to a certain degree and indicates that bending stress which can be transferred between the concrete column 3 and the steel frame beam 2 is small. In addition, pin joining indicates a form of joining in which a rotational movement of the steel frame beam 2 with respect to the concrete column 3 is not restrained and indicates that bending stress which can be transferred between the concrete column 3 and the steel frame beam 2 is none or extremely small. Then, the definitions of semi-rigid joining, pin joining, and rigid-joining particularly conform to the Europe Design Standard (Eurocode 3 Part 1-8).

[0037]

As shown in FIG. 3, for example, a steel H-shape having a substantial H-shape or the like in a cross section is used as the steel frame beam 2, in which an upper flange 21 and a lower flange 22 making a pair in the height direction Z are disposed, and a web 23 is built from the upper flange 21 to the lower flange 22. As shown in FIG. 1, in the steel frame beam 2, particularly, a penetration hole 20 penetrating the web 23 of the steel frame beam 2 in a sheet thickness direction is formed. In a case where the steel

frame beam 2 is subjected to semi-rigid joining or pin joining with respect to the concrete column 3, the web 23 of the steel frame beam 2 is subjected to bolt joining with respect to the connection steel sheet 24 attached to the steel frame column web 53 of the steel frame column 5.

[0038]

In the main reinforcement 6, as shown in FIG. 3, a plurality of reinforcing rods or the like are provided to extend in the height direction Z and the plurality of main reinforcements 6 are restrained by a tie hoop 61. As the tie hoop 61, for example, a deformed reinforcing rod or the like is used and is provided to surround the plurality of main reinforcements 6 over the whole circumference. As necessary, the tie hoops 61 are provided in a plurality of stages above and below the steel frame beam 2 in the height direction Z.

[0039]

The reinforcing bars 4 are provided in the surface layer region of the concrete column 3 around the steel frame column 5. The reinforcing bars 4 are provided to extend in the width direction X and the depth direction Y and restrain the plurality of main reinforcements 6. For example, the reinforcing bars 4 are provided over two stages in the height direction Z between the upper flange 21 and the lower flange 22 of the steel frame beam 2. The reinforcing bars 4 are provided in a partially overlapping manner in each stage in the height direction Z in a state where a plurality of adjacent reinforcing bars 4 abut onto or are separated from each other.

[0040]

As shown in FIG. 4A and FIG. 4B, as each of the reinforcing bars 4, a deformed reinforcing rod, a deformed steel bar, or the like formed to have an open shape with a substantial C-shape is used. In each of the reinforcing bars 4, a

continuous portion 41 which extends in the width direction X or the depth direction Y over the surface layer region of the concrete column 3 from a corner portion 32 to a corner portion 32, a pair of elongated portions 42 which is bent at a substantially right angle from both ends of the continuous portion 41 and extends, and a protrusion portion 43 which is bent at a substantially right angle from one end of the elongated portion 42 and protrudes toward the inside of the concrete column 3 are formed integrally and continuously.

[0041]

Each of the reinforcing bars 4 is continuously provided along the inner side of the side surface 31 of the concrete column 3 from the corner portions 32 to the corner portions 32 adjacent to each other in the concrete column 3, and the continuous portion 41 extends therein with a predetermined length B. In addition, each of the reinforcing bars 4 is continuously provided along the inner side of the side surface 31 from the corner portion 32 of the concrete column 3, and the elongated portion 42 extends therein with a predetermined length D which is a size of half or smaller than the length B of the continuous portion 41. Moreover, each of the reinforcing bars 4 is continuously provided toward the inside 30 from the side surface 31 of the concrete column 3, and the protrusion portion 43 extends therein with a predetermined protrusion length L.

[0042]

In each of the reinforcing bars 4, for example, a diameter d of the reinforcing bar 4 ranges approximately from 6 mm to 10 mm. In each of the reinforcing bars 4, mainly, the protrusion length L of the protrusion portion 43 protruding toward the inside 30 of the concrete column 3 is a length of ten times or greater than the diameter d of the reinforcing bar 4 and half or smaller than the length B of the continuous portion 41. In each of the reinforcing bars 4, for example, the protrusion length L of the protrusion

portion 43 ranges approximately from 60 mm to 100 mm.

[0043]

In each of the reinforcing bars 4, the protrusion portion 43 which is continuously provided from any one of or both the pair of elongated portions 42 and extends while protruding toward the inside 30 of the concrete column 3 is formed. As shown in FIG. 4A, in each of the reinforcing bars 4, a pair of protrusion portions 43 which extends while protruding from both the pair of elongated portions 42 may be formed. Furthermore, as shown in FIG. 4B, the protrusion portion 43 which extends while protruding from only one of the pair of elongated portions 42 may be formed.

[0044]

As shown in FIG. 5A, FIG. 5B, FIG. 6A, and FIG. 6B, in each of the reinforcing bars 4, each of the continuous portions 41 of the plurality of reinforcing bars 4 is disposed to surround the side surface 31 of the concrete column 3 over the whole circumference in the cross-sectional direction by the plurality of reinforcing bars 4. That is, the continuous portions 41 of the plurality of reinforcing bars 4 in the entirety thereof are disposed to form a hoop over the whole circumference of the surface layer region of the concrete column 3. In the plurality of reinforcing bars 4, the continuous portions 41 are respectively disposed on the side surfaces 31 on all sides of the concrete column 3, so that the plurality of reinforcing bars 4 are integrally provided over the whole circumference of the concrete column 3.

[0045]

As shown in FIG. 5A, as the plurality of reinforcing bars 4, mainly, four reinforcing bars 4 are used in a combination. In this case, as shown in FIG. 5B, in the plurality of reinforcing bars 4, the continuous portion 41 is formed in one location in each of the reinforcing bars 4, and the continuous portion 41 formed in each of the

reinforcing bars 4 is disposed in a hoop shape over the whole circumference of the surface layer region of the concrete column 3. The plurality of reinforcing bars 4 are provided in a state where four reinforcing bars 4 abut onto or are separated from each other, and the continuous portion 41 of each of the reinforcing bars 4 and the elongated portion 42 partially overlap each other in the height direction Z.

[0046]

As shown in FIG. 6A, as the plurality of reinforcing bars 4, two reinforcing bars 4 formed to have an open shape with a substantial L-shape may be used in a combination. In this case, in the plurality of reinforcing bars 4, the continuous portions 41 are formed in two locations in each of the reinforcing bars 4, bent portions 40 bent at a substantially right angle are formed between the continuous portions 41 in two locations, and the pair of elongated portions 42 is continuously formed from both ends of the continuous portions 41 formed in two locations. As shown in FIG. 6B, the plurality of reinforcing bars 4 are provided in a state where two reinforcing bars 4 abut onto or separated from each other, and the continuous portion 41 of each of the reinforcing bars 4 and the elongated portion 42 partially overlap each other in the height direction Z. The plurality of reinforcing bars 4 may be used by combining one open-shaped reinforcing bar 4 in which the bent portions 40 are formed in two locations among the continuous portions 41 formed in three locations, and the reinforcing bar 4 having a substantial C-shape as shown in FIG. 4A.

[0047]

Since the continuous portion 41 continuously extends from the corner portion 32 to the corner portion 32 in the surface layer region of the concrete column 3, each of the reinforcing bars 4 is formed without being divided at the continuous portion 41 as shown in FIG. 7A. Particularly, each of the reinforcing bars 4 is formed without being

divided at the continuous portion 41, so that the continuous portion 41 continuously extends without being joined by flare welding as shown in FIG. 7B or by a mechanical joint such as a coupler 90 as shown in FIG. 7C.

[0048]

For example, as shown in FIG. 8A, each of the reinforcing bars 4 is rotationally moved with respect to the steel frame beam 2, so that the continuous portion 41 is inserted through the penetration hole 20 penetrating each of the webs 23 of the plurality of steel frame beams 2 and is attached to each of the steel frame beams 2. In each of the reinforcing bars 4, the protrusion portion 43 is inserted through the penetration hole 20 as in FIG. 8A. Then, the elongated portion 42 is inserted through the penetration hole 20 as in FIG. 8B, and the continuous portion 41 is inserted through the penetration hole 20 as in FIG. 8C. In a state where each of the reinforcing bars 4 is attached to each of the steel frame beams 2, the steel frame beams 2 are carried to a construction site or the like. However, as shown in FIG. 9A, FIG. 9B, FIG. 10A, FIG. 10B, FIG. 11A, FIG. 11B, FIG. 12A, FIG. 12B, FIG. 13A, and FIG. 13B, each of the reinforcing bars 4 may be attached to each of the steel frame beams 2 at a construction site.

[0049]

In the beam-to-column connection 1, as shown in FIG. 9A to FIG. 15, the plurality of reinforcing bars 4 is provided in the joining locations of the concrete column 3 and the steel frame beams 2. The beam-to-column connection 1 is provided such that the elongated portion 42 and the protrusion portion 43 of the reinforcing bar 4 do not interfere with the web 23 of the steel frame beam 2, and the continuous portion 41 of the reinforcing bar 4 is inserted through the penetration hole 20 of the web 23 of the steel frame beam 2.

[0050]

In the beam-to-column connection 1, first, as shown in FIG. 9A and FIG. 9B, in a stage before concrete for the concrete column 3 is placed, the steel frame beams 2 are installed to extend in one direction or a plurality of directions. In this case, in the steel frame beams 2, for example, two steel frame beams 2 extending in the width direction X are subjected to rigid-joining with respect to the steel frame column 5 of the concrete column 3, and two steel frame beams 2 extending in the depth direction Y are subjected to semi-rigid joining or pin joining with respect to the steel frame column 5 of the concrete column 3 by the connection steel sheet 24.

[0051]

Next, in the beam-to-column connection 1, as shown in FIG. 10A and FIG. 10B, for example, first reinforcing bars 4 are provided over two stages in the height direction Z in the joining locations in which the steel frame beams 2 extending in the width direction X are installed. In this case, the first reinforcing bars 4 are rotationally moved in the height direction Z while having the continuous portion 41 inserted through the penetration hole 20 of the web 23 of the steel frame beam 2 as a rotational axis.

[0052]

Next, in the beam-to-column connection 1, as shown in FIG. 11A and FIG. 11B, second reinforcing bars 4 are provided over two stages in the height direction Z on a side opposite to the first reinforcing bars 4. In this case, the second reinforcing bars 4 are also rotationally moved in the height direction Z while having the continuous portion 41 as the rotational axis.

[0053]

Next, in the beam-to-column connection 1 as shown in FIG. 12A and FIG. 12B, in a state of partially overlapping the first and second reinforcing bars 4, third reinforcing bars 4 are provided over two stages in the height direction Z in the joining

locations in which the steel frame beams 2 extending in the depth direction Y are installed. In this case, the third reinforcing bars 4 are also rotationally moved in the height direction Z while having the continuous portion 41 as a rotational axis.

[0054]

Next, in the beam-to-column connection 1, as shown in FIG. 13A and FIG. 13B, in a state of partially overlapping the first and second reinforcing bars 4, fourth reinforcing bars 4 are provided over two stages in the height direction Z on a side opposite to the third reinforcing bars 4. In this case, the fourth reinforcing bars 4 are also rotationally moved in the height direction Z while having the continuous portion 41 as a the rotational axis.

[0055]

Lastly, the beam-to-column connection 1, in a state where the plurality of reinforcing bars 4 are temporarily tacked with an annealed wire or the like and their positions are held so as not to make a rotational movement, concrete for the concrete column 3 is placed. In the beam-to-column connection 1, as shown in FIG. 14A and FIG. 14B, in a case where the main reinforcement 6 is provided in the concrete column 3 in advance, the reinforcing bars 4 are rotationally moved in the height direction Z so as not to interfere with the main reinforcement 6 by causing each of the reinforcing bars 4 to spread and to be deformed.

[0056]

In the beam-to-column connection 1, as shown in FIG. 15, the main reinforcement 6 may be provided in the vicinity of each of the corner portions 32 of the concrete column 3. Furthermore, the main reinforcement 6 may be provided at a position separated from each of the corner portions 32 of the concrete column 3. In this case, in the beam-to-column connection 1, even if the plurality of reinforcing bars 4

are not temporarily tacked with an annealed wire or the like, the reinforcing bars 4 are respectively locked in the main reinforcement 6 in the corner portion 32 of the concrete column 3 and the main reinforcement 6 at the position separated from the corner portions 32, so that the plurality of reinforcing bars 4 are in a state where positions are held.

[0057]

In addition, in the beam-to-column connection 1, instead of providing the steel frame column 5 in the inside 30 of the concrete column 3, as shown in FIG. 16, the reinforced concrete column may be provided as the concrete column 3. In this case, in the beam-to-column connection 1, for example, the end portion of the steel frame beam 2 extending in the depth direction Y is subjected to bolt joining with respect to the connection steel sheet 24 of the web 23 of the steel frame beam 2 extending in the width direction X, thereby being subjected to semi-rigid joining or pin joining with respect to the concrete column 3.

[0058]

In the beam-to-column connection 1, as shown in FIG. 17, as necessary, a face bearing plate 25 which covers an inner measurement portion 26 formed by the upper flange 21, the lower flange 22, and the web 23 of the steel frame beam 2 may be provided in each of the steel frame beams 2. In the beam-to-column connection 1, as shown in FIG. 18, the face bearing plate 25 of each of the steel frame beams 2 is provided along the side surface 31 of the concrete column 3 and is disposed in a boundary with respect to the inside 30 of the concrete column 3, or in the inside 30 of the concrete column 3.

[0059]

In the beam-to-column connection 1, as shown in FIG. 19, the continuous

portions 41 respectively formed in the plurality of reinforcing bars 4 are disposed to surround the side surface 31 of the concrete column 3 over the whole circumference in the cross-sectional direction. In this case, in the beam-to-column connection 1, since the plurality of reinforcing bars 4 are integrally provided over the whole circumference of the side surface 31 of the concrete column 3 without being divided, the whole circumference of the concrete column 3 can be integrally reinforced.

[0060]

In the beam-to-column connection 1, since the steel frame beams 2 are subjected to semi-rigid joining or pin joining with respect to the concrete column 3, the steel frame beams 2 are likely to make a rotational movement in the height direction Z with respect to the concrete column 3. In this case, in the beam-to-column connection 1, since the whole circumference of the concrete column 3 is integrally reinforced by the plurality of reinforcing bars 4 and a restraining force F of hoop tension acts due to a combination of the plurality of reinforcing bars 4, concrete of the concrete column 3 can be prevented from falling.

[0061]

In addition, in the beam-to-column connection 1, since the protrusion portion 43 which extends while protruding toward the inside 30 of the concrete column 3 is formed in each of the reinforcing bars 4, the protrusion portion 43 of each of the reinforcing bars 4 exhibits a resistance force R in the inside 30 of the concrete column 3. In this case, in the beam-to-column connection 1, since the protrusion portion 43 of each of the reinforcing bars 4 exhibits the resistance force R, and the continuous portion 41 and the protrusion portion 43 are coupled by the elongated portion 42, it is possible to enhance the restraining force F of hoop tension in the continuous portion 41 of the reinforcing bar 4.

[0062]

Particularly, in the beam-to-column connection 1, since a part or all of the steel frame beams 2 are subjected to semi-rigid joining or pin joining with respect to the concrete column 3, compared to a case where all of the steel frame beams 2 are subjected to rigid-joining with respect to the concrete column 3, it is possible to reduce welding work for the end portions of the steel frame beams 2. In this case, in the beam-to-column connection 1, it is possible to shorten a construction period and to suppress a cost rise in quality control by reducing welding work for the end portions of the steel frame beams 2.

[0063]

In addition, in the beam-to-column connection 1, as shown in FIG. 7A, each of the reinforcing bars 4 continuously extends without being divided at the continuous portion 41. In this case, in the beam-to-column connection 1, since there is no need to provide a welding portion W by flare welding or the like as shown in FIG. 7B, and there is no need to provide a wet-type or dry-type mechanical joint as shown in FIG. 7C, the plurality of reinforcing bars 4 can be simply and promptly provided.

[0064]

In addition, as shown in FIG. 20A, in the beam-to-column connection 1, since each of the reinforcing bars 4 continuously extends without being divided at the continuous portion 41, each of the reinforcing bars 4 is unlikely to spread in an off-plane direction of the side surface 31 of the concrete column 3. In this case, in the beam-to-column connection 1, since each of the reinforcing bars 4 is unlikely to spread in the off-plane direction, and hoop tension is reliably generated by a combination of the plurality of reinforcing bars 4, the restraining force F of hoop tension can be reliably enhanced. In contrast, in a beam-to-column connection 9 in the related art, as shown

in FIG. 20B, since lap portions 91 lapped together are likely to spread in the off-plane direction, sufficient hoop tension is not generated in shearing reinforcing bars. In addition, in the beam-to-column connection 9 in the related art, the lap portions 91 are put into a reinforcing rod through-hole of a steel beam. However, generally, a clearance is provided in the reinforcing rod through-hole, and the lap portions 91 is likely to escape from the reinforcing rod through-hole due to the clearance. Therefore, sufficient hoop tension is still not generated in the shearing reinforcing bar. Therefore, in the beam-to-column connection 9 in the related art, falling of concrete cannot be sufficiently prevented.

[0065]

In the beam-to-column connection 1, as shown in FIG. 18, since the steel frame beams 2 are subjected to semi-rigid joining or pin joining with respect to the concrete column 3, a rotational force M acts on the concrete column 3 from the steel frame beams 2. In this case, in the beam-to-column connection 1, since the face bearing plate 25 of each of the steel frame beams 2 is provided along the side surface 31 of the concrete column 3, it is possible to suppress falling of concrete caused by action of the rotational force M . In addition, in the beam-to-column connection 1, since a pressing force P acts from the concrete column 3 to the upper flange 21 and the lower flange 22 of the steel frame beam 2 in the height direction Z , and falling of concrete is suppressed, rotational rigidity of the steel frame beam 2 can also be enhanced. Moreover, in the beam-to-column connection 1, since the face bearing plate 25 of each of the steel frame beams 2 is utilized as a formwork when concrete for the concrete column 3 is placed, the concrete column 3 can be simply and promptly established.

[0066]

In the beam-to-column connection 1, as shown in FIG. 19, one reinforcing bar

4 is attached to one steel frame beam 2. Then, in the beam-to-column connection 1, in a case where four steel frame beams 2 are joined to one concrete column 3, four reinforcing bars 4 formed into a substantial C-shape are used as shown in FIG. 5A and FIG. 5B. In addition, in the beam-to-column connection 1, as shown in FIG. 21A, in a case where two steel frame beams 2 are joined, four reinforcing bars 4 having a substantial C-shape may be used. Furthermore, as shown in FIG. 6A and FIG. 6B, two reinforcing bars 4 having a substantial L-shape may be used. Moreover, as shown in FIG. 21B, in the beam-to-column connection 1, in a case where three steel frame beams 2 are joined, four reinforcing bars 4 having a substantial C-shape may be used. Furthermore, two reinforcing bars 4 having a substantial C-shape and one reinforcing bar 4 having a substantial L-shape may be used in a combination.

[0067]

Hereinabove, examples of the embodiment of the present invention have been described in detail. However, those in the above-described embodiment are merely specified examples for realizing the present invention, and the technical scope of the present invention should not be restrictively interpreted by the examples.

[Industrial Applicability]

[0068]

According to the present invention, it is possible to provide a beam-to-column connection in which concrete is prevented from falling and rotational rigidity of a steel frame beam is enhanced while realizing simple and prompt construction in a joining location of a column member and a steel frame beam.

[Brief Description of the Reference Symbols]

[0069]

1 beam-to-column connection

2	steel frame beam
20	penetration hole
21	upper flange
22	lower flange
23	web
24	connection steel sheet
25	face bearing plate
26	inner measurement portion
3	concrete column
30	inside
31	side surface
32	corner portion
4	reinforcing bar
40	bent portion
41	continuous portion
42	elongated portion
43	protrusion portion
5	steel frame column
51	first flange
52	second flange
53	steel frame column web
6	main reinforcement
61	tie hoop
9	beam-to-column connection in related art
X	width direction

Y depth direction

Z height direction

What is claimed is:

1. A beam-to-column connection comprising:
a concrete column;
a steel frame beam that is joined to the concrete column; and
a plurality of reinforcing bars that are provided in a surface layer region of the concrete column in a joining location of the concrete column and the steel frame beam,
wherein a continuous portion which extends over the surface layer region of the concrete column from a corner portion to a corner portion, a pair of elongated portions which is bent from both ends of the continuous portion and extends along the surface layer region of the concrete column, and a protrusion portion which is bent from one of or both the pair of elongated portions and protrudes toward an inside of the concrete column are formed in each of the reinforcing bars in an integrally continuous manner, and
wherein the entirety of the continuous portions respectively formed in the plurality of reinforcing bars forms a hoop over a whole circumference of the surface layer region of the concrete column.
2. The beam-to-column connection according to Claim 1,
wherein the protrusion portion is bent from both the pair of elongated portions and protrudes toward the inside of the concrete column.
3. The beam-to-column connection according to Claim 1 or 2,
wherein the continuous portion of each of the reinforcing bars is inserted through a penetration hole penetrating the steel frame beam in a sheet thickness

direction.

4. The beam-to-column connection according to any one of Claims 1 to 3, wherein a protrusion length of the protrusion portion of each of the reinforcing bars is a length of ten times or greater than a diameter of each of the reinforcing bars and a length of half or smaller than a length of the continuous portion.

5. The beam-to-column connection according to any one of Claims 1 to 4, wherein in the plurality of reinforcing bars, four reinforcing bars are provided in a partially overlapping manner such that the entirety of the continuous portions of the four reinforcing bars forms a hoop over the whole circumference of the surface layer region of the concrete column.

6. The beam-to-column connection according to any one of Claims 1 to 5, wherein the steel frame beam and the concrete column are subjected to semi-rigid joining or pin joining.

7. The beam-to-column connection according to any one of Claims 1 to 6, wherein in the steel frame beam, a face bearing plate which covers an inner measurement portion formed by an upper flange, a lower flange, and a web of the steel frame beam is provided along a side surface of the concrete column.

8. The beam-to-column connection according to any one of Claims 1 to 7, wherein the concrete column is a steel framed reinforced concrete column internally having a steel frame column.