

REINFORCING BAR ASSEMBLY AND SHEAR REINFORCEMENT BAR USED FOR REINFORCED CONCRETE STRUCTURE

Field of the Invention

[0001]

The present invention relates to a reinforcing bar assembly and a shear reinforcement bar used for reinforced concrete structures such as columns, beams, walls, ceilings, floors and foundations.

Background of the Invention

[0002]

A reinforced concrete structure includes a concrete and a reinforcing bar assembly embedded in the concrete. As an example, an elongated reinforced concrete structure such as a column and a beam will be described in detail. As disclosed in Patent Document 1 (Japanese Patent Application Publication No. H08-42064), a reinforcing bar assembly includes a plurality of main bars and shear reinforcement bars having annular or helical configurations. The main bars extend linearly in parallel to each other. The shear reinforcement bars are spacedly disposed along a longitudinal direction of the main bars so as to surround the main bars. Concrete surfaces surround entire circumference of the reinforcing bar assembly.

[0003]

A reinforcing bar used as the main bar or the shear reinforcement bar of the reinforcing bar assembly has a base portion having a generally circular cross-sectional configuration and ribs formed in an outer circumference of the base portion to enhance adherability of the reinforcing bar to the concrete.

Summary of the Invention

Problem to be Solved by the Invention

[0004]

Building standards strictly require that the reinforced concrete structure given above should have a covering depth of concrete of a prescribed depth or deeper. The covering depth corresponds to a distance between a concrete surface and a portion of the reinforcing bar assembly closest to the concrete surface.

Taking an elongated reinforced concrete structure such as a column and a beam for example, the shear reinforcement bars are disposed on an outermost side of a reinforcing bar assembly. Therefore, the covering depth of concrete is a distance between an outer circumference of the shear reinforcement bars and the concrete surfaces.

[0005]

Since it is strictly required to secure a covering depth of concrete of a prescribed depth or deeper as mentioned above, there is restriction in reducing a cross-sectional area of the concrete or increasing strength of the reinforced concrete structure by shifting a main bar outward (in a direction away from a central axis of the reinforced concrete structure).

To reduce a cross-sectional area of the concrete or to shift a main bar outward while securing a covering depth of a prescribed depth or deeper, a diameter of the shear reinforcement bar may be reduced. However, this may result in reduction in a cross-sectional area of the shear reinforcement bar, which may hinder the shear reinforcement bar from fulfilling its essential function. If a pitch of the reinforcing bars is reduced and a number of the shear reinforcement bars is increased to compensate for the reduction of the cross-sectional area of the shear reinforcement bars, this may result in an insufficient concrete filling and an increase in the number of parts.

[0006]

The problems mentioned above are about an elongated reinforced concrete structure such as a column and a beam. However, similar problems may occur in reinforced concrete structures in which a diameter of a reinforcing bar may affect a

covering depth of concrete, such as a wall, a ceiling slab, a floor slab or a foundation that extends on a plane.

[0007]

Patent Document 2 (Japanese Patent Application Publication No. 2006-104884) discloses a reinforcing bar having a flattened cross-sectional shape, in which a circumferential length of the cross-section is increased, in order to enhance adherability of the reinforcing bar to concrete. This reinforcing bar is for use in a reinforced concrete structure. However, it is not disclosed exactly how it can be used in a reinforced concrete structure.

Solution to the Problem

[0008]

The present invention was made to solve the problems mentioned above. The present invention provides a reinforcing bar assembly used in a reinforced concrete structure, the reinforcing bar assembly embedded in a concrete, wherein the reinforcing bar assembly includes: a reinforcing bar having a flattened cross-sectional shape; the reinforcing bar having the flattened cross-sectional shape extends along a surface of the concrete; and the reinforcing bar is disposed such that a direction of a short axis of the cross-section of the reinforcing bar is orthogonal to the surface of the concrete.

According to the features mentioned above, a dimension of the reinforcing bar in a direction orthogonal to the concrete surface can be reduced while sufficiently securing a cross-sectional area of the reinforcing bar because the reinforcing bar has the flattened cross-sectional shape and the direction of the short axis of the cross-section of the reinforcing bar is orthogonal to the concrete surface. As a result, a dimension of the concrete in a direction orthogonal to the concrete surface can be reduced or a strength of the reinforced concrete structure as a whole can be enhanced while sufficiently securing a covering depth of concrete.

[0009]

An embodiment of the present invention provides the reinforcing bar assembly used in a reinforced concrete structure extending linearly, the reinforcing bar assembly including: a plurality of main bars parallel to each other and linearly extending in a longitudinal direction of the reinforced concrete structure; and shear reinforcement bars that have annular or helical configurations and that are spacedly disposed along longitudinal directions of the main bars so as to surround the main bars, wherein: the shear reinforcement bars are disposed on an outermost side of the reinforcing bar assembly; the shear reinforcement bars are composed of the reinforcing bars having flattened cross-sectional shapes; and each of the shear reinforcement bars is bent such that a pair of surfaces opposed to each other in the direction of the short axis of the shear reinforcement bar are located inside and outside.

According to the features mentioned above, a cross-sectional area of the concrete can be reduced or a main bar can be shifted outward to enhance a strength of the reinforced concrete structure as a whole while sufficiently securing the covering depth of concrete. Moreover, the shear reinforcement bar can be easily bent.

[0010]

Another embodiment of the present invention provides the reinforcing bar assembly used in a reinforced concrete structure extending linearly, the reinforcing bar assembly including: a plurality of main bars parallel to each other and linearly extending in a longitudinal direction of the reinforced concrete structure; shear reinforcement bars that have annular or helical configurations and that are spacedly disposed along longitudinal directions of the main bars so as to surround the main bars; cylindrical joints that connect the main bars arranged on a straight line; and an additional shear reinforcement bar disposed so as to surround the joints, wherein: the additional shear reinforcement bar is composed of the reinforcing bar having a flattened cross-sectional shape; and the additional shear reinforcement bar is bent

such that a pair of surfaces opposed to each other in the direction of the short axis of the additional shear reinforcement bar are located inside and outside.

According to the features mentioned above, the additional shear reinforcement bar surrounding the joint is located closer to the concrete surface by a distance corresponding to a thickness of the joint. However, the covering depth of concrete can be sufficiently secured without reducing a cross-sectional area of the additional shear reinforcement bar because the additional shear reinforcement bar is composed of the reinforcing bar having the flattened cross-sectional shape and the direction of the short axis of the cross-section of the reinforcing bar is orthogonal to the concrete surface.

[0011]

Another embodiment of the present invention provides the reinforcing bar assembly used in a reinforced concrete structure having a pair of flat concrete surfaces extending in a planar fashion and parallel to each other, the reinforcing bar assembly disposed on a plane parallel to the pair of concrete surfaces, the reinforcing bar assembly including a plurality of first bars and a plurality of second bars orthogonally intersecting with each other, wherein: the first bars and/or the second bars comprise the reinforcing bars having flattened cross-sectional shapes: and directions of the short axes of the first bars and/or the second bars are orthogonal to the concrete surface.

According to the features mentioned above, a thickness of the concrete between the pair of concrete surfaces can be reduced while securing the covering depth of concrete.

[0012]

Still another embodiment of the present invention provides the reinforcing bar assembly used in a reinforced concrete structure having a pair of flat concrete surfaces and an opening extending through the pair of concrete surfaces, the pair of flat concrete surfaces extending in planar fashions and parallel to each other, the reinforcing bar assembly disposed on a plane parallel to the pair of concrete

surfaces, the reinforcing bar assembly including: a plurality of first bars and a plurality of second bars orthogonally intersecting with each other; and a plurality of diagonal bars inclined with respect to the first bars and the second bars and disposed so as to surround the opening, wherein: the diagonal bars are composed of the reinforcing bars having flattened cross-sectional shapes: and directions of the short axes of the diagonal bars are orthogonal to the concrete surfaces.

According to the features mentioned above, a thickness of the concrete between the concrete surfaces may be increased by disposing the diagonal bars. However, the increased thickness can be contained by using the reinforcing bar having the flattened cross-sectional shape as the diagonal bar.

[0013]

Another feature of the present invention is to provide a shear reinforcement bar that is laid across a plurality of main bars extending linearly in parallel to each other or that is disposed so as to surround the main bars, wherein: the shear reinforcement bar has a flattened cross-sectional shape; and the shear reinforcement bar is bent such that a pair of surfaces opposed to each other in a direction of a short axis of the flattened cross-section of the shear reinforcement bar are located inside and outside.

According to the features mentioned above, the shear reinforcement bar can be easily bent.

[0014]

Preferably, the shear reinforcement bar includes a base portion and ribs formed in an outer circumference of the base portion, wherein an outline of a cross-section of the base portion comprises a pair of straight-line portions opposed to each other in the direction of the short axis.

According to the features mentioned above, the shear reinforcement bar can be bent on one plane.

[0015]

More preferably, the ribs include a pair of longitudinal ribs and transverse ribs, the longitudinal ribs extending in a longitudinal direction of the shear reinforcement bar and opposed to each other in a direction of a long axis of the flattened cross section, the transverse ribs formed between the longitudinal ribs and extending in directions intersecting with the longitudinal ribs.

According to the features mentioned above, the shear reinforcement bar can be more easily bent without being interfered by the longitudinal rib.

Advantageous Effects of the Invention

[0016]

According to the present invention, a covering depth of concrete can be sufficiently secured in a reinforced concrete structure.

Brief Description of the Drawings

[0017]

FIG. 1A is a cross-sectional view of a reinforcing bar having a flattened cross-sectional shape used in all of the embodiments of the present invention.

FIG. 1B is a side view of the reinforcing bar.

FIG. 1C is a plan view of the reinforcing bar.

FIG. 2 is a longitudinal sectional view of a reinforced concrete column according to a first embodiment of the present invention in which the reinforcing bars having flattened cross-sectional shapes are used as hoops.

FIG. 3 is a transverse sectional view of the reinforced concrete column.

FIG. 4A is an enlarged cross-sectional view of an essential part of FIG. 2.

FIG. 4B is an enlarged cross-sectional view of an essential part of FIG. 3.

FIG. 5 is a transverse sectional view of a reinforced concrete column according to a second embodiment of the present invention.

FIG. 6 is a transverse sectional view of a reinforced concrete column according to a third embodiment of the present invention.

FIG. 7 is a longitudinal sectional view of a reinforced concrete beam according to a fourth embodiment of the present invention.

FIG. 8 is an enlarged cross-sectional view on arrow A-A of FIG. 7.

FIG. 9 is a longitudinal sectional view of a reinforced concrete wall according to a fifth embodiment of the present invention.

FIG. 10 is a front view of a reinforced concrete wall according to a sixth embodiment of the present invention with the concrete omitted.

FIG. 11 is a longitudinal sectional view of the reinforced concrete wall according to the sixth embodiment of the present invention.

FIG. 12 is a cross-sectional view of a reinforced concrete continuous footing according to a seventh embodiment of the present invention.

FIG. 13 is a cross-sectional view of a reinforced concrete mat foundation according to an eighth embodiment of the present invention.

Description of the Preferred Embodiments

[0018]

Embodiments of the present invention will be described hereinafter with reference to the drawings. FIGS. 1A to 1C show a reinforcing bar 10 used in all of the embodiments. The reinforcing bar 10 is formed by rolling as with ordinary deformed reinforcing bars. The reinforcing bar 10 includes a base portion 11, a pair of longitudinal ribs 12 and transverse ribs 13. The longitudinal ribs 12 are formed in an outer circumference of the base portion 11 and continuously extend in a longitudinal direction of the reinforcing bar 10. The transverse ribs 13 are formed in the outer circumference of the base portion 11 at even intervals in the longitudinal direction of the reinforcing bar 10. The transverse ribs 13 extend in a direction intersecting with the longitudinal ribs 12 (direction orthogonally

intersecting with them as shown in FIGS. 1A to 1C or a direction obliquely intersecting with them.)

[0019]

Unlike ordinary deformed reinforcing bars, the reinforcing bar 10 has a flattened cross-sectional shape. A short axis of the cross-section of the reinforcing bar 10 is indicated by X and a long axis thereof is indicated by Y. In the cross-sectional shape of the reinforcing bar 10, a ratio of a dimension Lx in a direction of the short axis X to a dimension Ly in a direction of the long axis Y is preferably between 1.0 to 1.2 and 1.0 to 3.0. More preferably, the ratio is between 1.0 to 1.5 and 1.0 to 2.5. In this embodiment, the ratio is about 1 to 2. In FIGS. 1A to 1C, the ratio is exaggerated to a certain degree.

[0020]

In the present invention, the reinforcing bar 10 has an oval cross-sectional shape. Specifically, the base portion 11 has a pair of flat surfaces 11a parallel to each other and a pair of arc surfaces 11b connecting the flat surfaces 11a, thus having the oval cross-sectional shape. The pair of flat surfaces 11a are opposed to each other in the direction of the short axis X. The pair of arc surfaces 11b are opposed to each other in the direction of the long axis Y.

The pair of flat surfaces 11a form a pair of straight-line portions in an outline of the cross-section of the base portion 11.

[0021]

The longitudinal ribs 12 are respectively formed in middle portions of the pair of arc surfaces 11b of the base portion 11. The longitudinal ribs 12 are spaced from each other in the Y-axis direction.

The transverse rib 13 has straight-line portions and curved portions. The straight-line portions extend along the flat surfaces 11a of the base portion 11 and have an even height. The curved portions continue from the straight-line portions and extend along the arc surfaces 11b. Ends of the curved portions continue to the longitudinal ribs 12.

[0022]

Various embodiments of a reinforcing bar assembly including the reinforcing bars 10 and a reinforced concrete structure having the reinforced bar assembly embedded therein will be described below. In the embodiments, reinforcement bars using the reinforcing bars 10 are indicated with the reference number 10 with a capital alphabet letter added thereto.

[0023]

FIGS. 2 to 4 show a reinforced concrete column 21 (linearly extending reinforced concrete structure) according to a first embodiment of the present invention. The column 21 includes a concrete 22 having a quadrangular cross-sectional shape and a cage-shaped reinforcing bar assembly 23 extending linearly and embedded in the concrete 22. As is well-known, the column 21 is obtained by casting the concrete 22 into a space inside a formwork (not shown) having a quadrangular cross-sectional shape and surrounding the reinforcing bar assembly 23 in a factory or at a construction site.

[0024]

The reinforcing bar assembly 23 includes four vertical main bars 24 and a multitude of hoops 10A (shear reinforcement bars). The main bars 24 are respectively located at corner portions of a quadrangular planar shape of the reinforcing bar assembly 23 and are parallel to each other. The hoops 10A are arranged at even intervals along a longitudinal direction of the main bars 24.

An ordinary deformed reinforcing bar having longitudinal ribs and transverse ribs may be used as the main bar 24. Alternatively, a reinforcing bar having thread-shaped nodes (threaded reinforcing bar) may be used as the main bar 24.

[0025]

The hoop 10A may be called a welded closed hoop, for example. The hoop 10A may be obtained by bending a straight reinforcing bar 10 having a flattened cross-sectional shape to form a quadrangular planar shape and by welding

opposite ends of the reinforcing bar 10. In FIG. 3, a welded portion is indicated by a reference numeral 10a and bent corners are indicated by a reference numeral 10b. The hoop 10A is horizontally disposed (disposed so as to orthogonally intersect with the main bars 24). The four corners 10b of the hoop 10A are disposed so as to wrap around the main bars 24 contacting outer sides of the main bars 24. Accordingly, the hoop 10A surrounds the four main bars 24 and is located on an outermost side of the reinforcing bar assembly 23. The hoop 10A and the main bars 24 are joined with thin metal wires (not shown).

[0026]

The concrete 22 has a quadrangular cross-sectional shape similar to the planar shape of the reinforcing bar assembly 23. The concrete 22 includes four flat concrete surfaces 22a respectively parallel to sides of the hoops 10A. A distance between outer side surfaces of four side portions of the hoops 10A and the concrete surfaces 22a is a covering depth T of the concrete 22.

[0027]

As shown in FIGS. 4A and 4B, when the hoop 10A is formed, the reinforcing bar 10 is bent such that the pair of flat surfaces 11a, 11a opposed to each other in the direction of the short axis X are located inside and outside, thereby the corners 10b are formed. Since a thickness in a bent direction is reduced in this way, a load required for the bending can be reduced and the reinforcing bar 10 can be easily bent with a reduced radius of curvature. Particularly, since the pair of surfaces 11a, 11a opposed to each other in the direction of the short axis X are flat (an outline of the cross-section of the reinforcing bar 10 includes straight-line portions opposed to each other in the direction of the short axis X) in this embodiment, the reinforcing bar 10 can be bent without being distorted, and the hoop 10A that is disposed on one plane can be obtained.

[0028]

Since the reinforcing bar 10 is bent such that the pair of surfaces 11a, 11a opposed to each other in the direction of the short axis X are located inside and

outside as mentioned above, the direction of the short axis X of the cross-section of each side of the hoop 10A is perpendicular to the concrete surface 22a. This allows the dimension Lx of the hoop 10A in a direction orthogonal to the concrete surface 22a to be reduced compared with when a conventional reinforcing bar of the same cross-sectional area having a generally circular cross-sectional shape is used. This allows the covering depth T of the concrete to be deeper by a depth corresponding to the reduced dimension.

[0029]

From a different point of view, a cross-sectional area of the concrete 22 can be reduced corresponding to the reduced dimension of the hoop 10A while securing a prescribed covering depth.

[0030]

From another point of view, the main bars 24 can be placed outside (in a direction away from a center of the column 21), and a strength of the column 21 can be enhanced. A detailed explanation of this will be given below with reference to FIG. 4B. If a conventional hoop 100 (indicated by imaginary lines in FIG. 4B) made of a reinforcing bar having a circular cross-sectional shape is used, a main bar 104 should be located at a position indicated by an imaginary line to secure a sufficient covering depth T because a dimension in a direction orthogonal to the concrete surface 22a is greater and a radius of curvature of a corner 100b is greater. On the other hand, when the reinforcing bar 10 having a flattened cross-sectional shape is used for the hoop 10A as with the present invention, the dimension in the direction orthogonal to the concrete surface 22a is smaller and the radius of curvature of the corner 10b is smaller. Therefore, when the cross-sectional area and the covering depth T of the concrete 22 are the same, the main bars 24 can be located further outside than the main bars of the conventional hoops.

[0031]

From still another point of view, in order to reduce the cross-sectional area of the concrete 22 while securing the covering depth of concrete or in order to

move the main bars 104 outward in the conventional hoop 100 having the circular cross-sectional shape, a radius of the hoop 100 should be reduced. This may cause a reduction in the cross-sectional area of the hoop 100. In order to compensate for the reduction in the cross-sectional area of the hoop 100, the number of the hoops 100 should be increased and a pitch of the hoops 100 should be reduced. On the other hand, in the present invention, when the cross-sectional area of the concrete 22 is reduced or when the main bars 24 are moved outward, the covering depth of concrete can be secured without reducing the cross-sectional area of the hoops 10A. As a result, the reduction of the pitch of the hoops 10A is not required, thus not causing an insufficient filling of concrete.

[0032]

Other embodiments of the present invention will be described below. In these embodiments, components corresponding to those of the preceding embodiments are indicated by the same reference numerals and detailed explanations thereof will be omitted.

In the column 21 according to a second embodiment shown in FIG. 5, a hoop 10B may be obtained by bending without welding the opposite ends of the reinforcing bar 10 to form hook portions 10c (catching portions) and by hooking the hook portions 10c around one of the main bars 24. As with the first embodiment, the corners 10b and the hook portions 10c of the hoop 10B are bent such that the pair of surfaces 11a, 11a opposed to each other in the direction of the short axis X are located inside and outside.

[0033]

In the column 21 according to a third embodiment shown in FIG. 6, in addition to the main bars 24 located at the corners of the quadrangular planar shape of the reinforcing bar assembly 23, intermediate main bars 25 are disposed in side portions of the quadrangular planar shape. Shear reinforcement bars 10C are laid across the intermediate main bars 25. Specifically, hook portions 10d are formed at opposite end portions of the shear reinforcement bars 10C and the hook portions

10d are hooked around the intermediate main bars 25. As with the hoop 10A, the shear reinforcement bar 10C is composed of the reinforcing bar 10 having a flattened cross-sectional shape. The hook portion 10d is formed by bending the reinforcing bar 10 such that the surfaces opposed to each other in the direction of the short axis X are located inside and outside. Therefore, the sheer reinforcement bar 10C is not protruded outward from the hoop 10A, and does not cause the covering depth of the concrete 22 to be reduced.

[0034]

In a fourth embodiment shown in FIGS. 7 and 8, the present invention is applied to a reinforced concrete beam 31 (reinforced concrete structure) extending horizontally in a linear manner. The beam 31 may be obtained by connecting the reinforcing bar assemblies 33 having basic structures similar to that of the reinforcing bar assembly 23 of the column 21 and embedding the connected reinforcing bar assemblies 33 in a concrete 32 having a quadrangular cross-sectional shape. End portions of two main bars 34 arranged on a straight line are inserted in a joint 35 and thereby connected, and thereby the reinforcing bar assemblies 33 are joined. When the main bars 34 are threaded reinforcing bars, the joints 35 internally threaded in inner circumferences thereof may be used to threadedly connect the end portions of the main bars 34.

[0035]

The hoop 36 surrounding the main bars 34 has a circular cross-sectional shape as with a conventional reinforcing bar. To maintain a strength of the beam 31, it is required to lay a hoop 10D (additional shear reinforcement bar) across the joints 35. Since a radius of the joint 35 is greater than a radius of the main bar 34, the covering depth T of the concrete between the hoop 10D and a concrete surface 32a may be reduced if a reinforcing bar having a generally circular cross-section similar to the hoop 36 is used as the hoop 10D. To avoid such reduction in the covering depth, the reinforcing bar 10 having a flattened cross-section shown in FIG. 1 is used as the hoop 10D in this embodiment. The short axis X of the

reinforcing bar 10 is orthogonal to the concrete surface 32a and the reinforcing bar 10 is bent such that the pair of surfaces 11a, 11a opposed to each other in the direction of the short axis X are located inside and outside as with the foregoing embodiments. Therefore, the reduction in the covering depth T can be avoided.

From another point of view, it is not required to reduce a cross-sectional area of the hoop 10D to secure the covering depth T. Also, it is not required to increase the number of the hoops 10D and to reduce a pitch of the hoops 10D to compensate for the reduction in the cross-sectional area of the hoop 10D. Specifically, the hoops 10D can be disposed at generally the same pitch as the hoops 36.

In the fourth embodiment, the hoop 36 may also be made by the reinforcing bar 10 having a flattened cross-sectional shape.

[0036]

The features of the columns according to the first to the third embodiments can be applied to a beam extending horizontally in a linear manner.

Conversely, the features of the beam according to the fourth embodiment can be applied to a column.

[0037]

In a fifth embodiment shown in FIG. 9, the present invention is applied to a reinforced concrete wall 41 (reinforced concrete structure extending in a planar fashion). The wall 41 includes two reinforcing bar assemblies 43 embedded in a concrete 42. The concrete 42 includes vertical surfaces 42a parallel to each other. The two reinforcing bar assemblies 43 are parallel to the concrete surfaces 42a and are respectively disposed on two planes spaced from each other in a thickness direction of the concrete 42.

[0038]

Each of the reinforcing bar assemblies 43 includes vertical bars 10E (first bars) and horizontal bars 10F (second bars) joined at intersecting portions thereof with thin metal wires.

[0039]

The reinforcing bars 10 having flattened cross-sectional shapes are used as the vertical bars 10E and the horizontal bars 10F. The reinforcing bars 10 are cut into predetermined dimensions and are used in straight configurations thereof without being bent. The reinforcing bars 10 are oriented such that the short axes X of the cross-sections of the reinforcing bars 10 are orthogonal to the concrete surface 42a.

Thereby, the thickness of the wall 42 can be reduced while securing the covering depth T of the concrete and securing enough space for filling concrete between the reinforcing bar assemblies 43. From another point of view, the covering depth T of the concrete can be increased or the space for filling concrete can be increased without changing the thickness of the wall 42.

[0040]

In a sixth embodiment shown in FIGS. 10 and 11, the present invention is applied to the reinforced concrete wall 41 as with the embodiment shown in FIG. 9. An opening 41a for disposing pipes or the like (not shown) therethrough is formed in the wall 41. The vertical bar 10E and the horizontal bar 10F of the reinforcing bar assembly are removed in an area corresponding to the opening 41a. The opening 41a may be an opening of a window or a door.

Left and right additional vertical bars 10E' and upper and lower additional horizontal bars 10F' are disposed surrounding the opening 41a and four diagonal bars 10G are disposed.

[0041]

In this embodiment, not only the vertical bars 10E and the horizontal bars 10F but also the additional vertical bars 10E', the additional horizontal bars 10F' and the diagonal bars 10G are composed of the reinforcing bars 10 having a flattened cross-sectional shape and directions of the short axes X of the reinforcing bars 10 are orthogonal to the concrete surface 42a.

[0042]

Incorporation of the diagonal bars 10G may cause reduction in the covering depth of concrete or the space for filling concrete between the pair of the reinforcing bar assemblies 43. However, by adopting the reinforcing bars 10 having a flattened cross-sectional shape, such reductions can be contained.

[0043]

In a seventh embodiment shown in FIG. 12, the present invention is applied to a reinforced concrete continuous footing 50 (reinforced concrete structure). The continuous footing 50 extends long along walls of a house to support the house. The continuous footing 50 includes a footing portion 50A embedded in the ground GL and a raised portion 50B vertically raised from the footing portion 50A. In this invention, both of the footing portion 50A and the raised portion 50B are regarded as the reinforced concrete structures.

[0044]

In the footing portion 50A, a footing reinforcing bar assembly 52 to be embedded in a concrete 51 having a rectangular cross-sectional shape is disposed on a horizontal plane. The footing reinforcing bar assembly 52 includes two horizontal bars 10J (first bars) parallel to each other and a multitude of horizontal bars 10H (second bars) laid across the horizontal bars 10H and orthogonally intersecting with the horizontal bars 10J. The horizontal bars 10H are disposed at even intervals along the horizontal bars 10J. The footing reinforcing bar assembly 52 has a configuration of a ladder. The horizontal bars 10H, 10J are composed of the reinforcing bars 10 having a flattened cross-sectional shape. The horizontal bars 10H, 10J are disposed such that the short axis X of the cross-section thereof is oriented in a vertical direction, i.e. in a direction orthogonal to upper and lower horizontal surfaces 51a, 51a of the concrete 51.

[0045]

In the raised portion 50B, a raised portion reinforcing bar assembly 54 to be embedded in a concrete 53 having a rectangular cross-sectional shape is

disposed on a vertical plane (plane parallel to left and right vertical surfaces 53a, 53a of the concrete 53). The raised portion reinforcing bar assembly 54 includes two horizontal bars 10K (first bars) parallel to each other and a multitude of vertical bars 10L (second bars) laid across the horizontal bars 10K and disposed at even intervals along the horizontal bars 10K. The raised portion reinforcing bar assembly 54 has a configuration of a ladder. A lower end of the raised portion reinforcing bar assembly 54 is fixed in a generally middle portion of the footing reinforcing bar assembly 52.

[0046]

The horizontal bars 10K and the vertical bars 10L are composed of the reinforcing bars 10 having a flattened cross-sectional shape. The horizontal bars 10K and the vertical bars 10L are disposed such that the short axis X of the cross-section thereof extends in a thickness direction of the concrete 53, i.e. in a direction orthogonal to left and right vertical surfaces 53a, 53a of the concrete 53.

[0047]

The raised portion reinforcing bar assembly 54 of this embodiment includes an intermediate horizontal bar 10M disposed between the two horizontal bars 10K in parallel to the horizontal bars 10K. A cross-sectional area of the intermediate horizontal bar 10M is smaller than a cross-sectional area of the horizontal bar 10K. Therefore, the intermediate horizontal bar 10M may have a circular cross section. Alternatively, the intermediate horizontal bar 10M may be composed of the reinforcing bar 10 having a flattened cross-sectional shape as with the horizontal bar 10K in this embodiment.

[0048]

In an eighth embodiment shown in FIG. 13, the present invention is applied to a reinforced concrete mat foundation 60 (reinforced concrete structure). The mat foundation 60 includes a horizontal slab 60A, an exterior side raised portion 60B extending along external walls of a house and an interior side raised portion 60C extending along interior walls of the house. In this invention, each of

the horizontal slab 60A and the raised portions 60B, 60C is regarded as the reinforced concrete structure.

[0049]

The horizontal slab 60A includes a concrete 61 extending horizontally and a reinforcing bar assembly 62 embedded in the concrete 61 so as to be parallel to upper and lower flat surfaces 61a, 61a of the concrete 61. The reinforcing bar assembly 62 includes a multitude of horizontal bars 10P (first bars) parallel to each other and a multitude of horizontal bars 10Q (second bars) orthogonally intersecting with the horizontal bars 10P. The reinforcing bar assembly 62 has a reticulated configuration. The horizontal bars 10P, 10Q are composed of the reinforcing bars 10 having a flattened cross-sectional shape. The horizontal bars 10P, 10Q are disposed such that the short axis X of the cross-section thereof extends in a vertical direction, i.e. in a direction orthogonal to the upper and lower horizontal surfaces 61a, 61a of the concrete 61.

[0050]

In the exterior side raised portion 60B, a reinforcing bar assembly 64 to be embedded in a concrete 63 having a rectangular cross-sectional shape is disposed on a vertical plane parallel to left and right flat vertical surfaces 63a, 63a of the concrete 63. The reinforcing bar assembly 64 includes a plurality of horizontal bars 10R (first bars) parallel to each other and a multitude of vertical bars 10S (second bars) laid across the horizontal bars 10R and disposed at even intervals along the horizontal bars 10R. The horizontal bars 10R and the vertical bars 10S are composed of the reinforcing bars 10 having flattened cross-sectional shapes. The horizontal bars 10R and the vertical bars 10S are disposed such that the short axes X of the cross-sections thereof extend in a thickness direction of the concrete 63, i.e. in a direction orthogonal to the left and right vertical surfaces 63a, 63a of the concrete 63.

[0051]

The vertical bars 10S are bent at lower end portions located at a portion where the horizontal slab 60A and the exterior side raised portion 60B intersect with each other. Specifically, each of the vertical bars 10S is bent such that the pair of surfaces 11a, 11a opposed to each other in the direction of the short axis of the reinforcing bar 10 having a flattened cross-sectional shape are located inside and outside.

[0052]

The interior side raised portion 60C is made of a concrete 65 having a rectangular cross-sectional shape and a vertical reinforcing bar assembly 66 embedded in the concrete 65. A structure of the interior side raised portion 60C is similar to that of the raised portion 50B shown in FIG. 12. Therefore, the reinforcing bars used in the interior side raised portion 60C are indicated by the same reference numerals as the raised portion 50B and explanations thereof are omitted.

[0053]

The present invention is not limited to the embodiments described above and various modifications can be adopted. For example, the reinforcing bar having the flattened cross-sectional shape may alternatively be a flattened threaded reinforcing bar.

The cross-sectional shape of the reinforcing bar may be oval instead of being flattened.

[0054]

The hoops (shear reinforcement bars) used in the reinforced concrete structures such as columns and beams may be spiral hoops. In this case, loops of the spiral may be spacedly disposed along a longitudinal direction of the reinforced concrete structure.

[0055]

A cross-section of the reinforced concrete column may be polygonal or circular. In the reinforced concrete column having a circular cross-section, the hoops may be bent such that planar shapes thereof are circular.

In the embodiments shown in FIGS. 9 to 13, it is acceptable that only one of the first bar and the second bar is composed of the reinforcing bar having a flattened cross-sectional shape.

In the embodiments shown in FIGS. 10 and 11, only the diagonal bars may have a flattened cross-sectional shape.

The reinforced concrete structures shown in FIGS. 9 to 11 may be applied to a ceiling slab or a floor slab.

Industrial Applicability

[0056]

The present invention can be applied to reinforced concrete structures such as columns, beams, walls, ceilings, floors and foundations.

CLAIMS

[Claim 1] A reinforcing bar assembly used in a reinforced concrete structure having a pair of flat concrete surfaces and an opening extending through the pair of concrete surfaces, the pair of flat concrete surfaces extending in planar fashions and parallel to each other, the reinforcing bar assembly disposed on a plane parallel to the pair of concrete surfaces, the reinforcing bar assembly comprising:

a plurality of first bars and a plurality of second bars orthogonally intersecting with each other; and

a plurality of diagonal bars inclined with respect to the first bars and the second bars and disposed so as to surround the opening, wherein:

the diagonal bars comprise reinforcing bars having flattened cross-sectional shapes; and

directions of the short axes of the cross-sections of the diagonal bars are orthogonal to the concrete surfaces.

[Claim 2] A reinforcing bar assembly used in a reinforced concrete structure extending linearly, the reinforcing bar assembly embedded in a concrete, the reinforcing bar assembly comprising:

a plurality of main bars parallel to each other and linearly extending in a longitudinal direction of the reinforced concrete structure;

shear reinforcement bars that have annular or helical configurations and that are disposed along a concrete surface and spacedly arranged along longitudinal directions of the main bars so as to surround the main bars;

cylindrical joints that connect the main bars arranged on a straight line; and

an additional shear reinforcement bar disposed along the concrete surface so as to surround the joints, wherein:

the additional shear reinforcement bar comprises a reinforcing bar having a flattened cross-sectional shape; and

the additional shear reinforcement bar is bent such that a pair of surfaces opposed to each other in the direction of the short axis of the cross-section of the additional shear reinforcement bar are located inside and outside and the direction of the short axis of the cross-section is orthogonal to the concrete surface.

[Claim 3] A reinforced concrete structure having the reinforcing bar assembly according to claim 1 or 2 embedded in the concrete.

[Claim 4] A reinforcing bar comprising a base portion and ribs formed in an outer circumference of the base portion, wherein the base portion has a flattened cross-sectional shape and an outline of a cross-section of the base portion comprises a pair of straight-line portions opposed to each other in the direction of a short axis of the cross-section;

 wherein the ribs comprise a pair of longitudinal ribs and transverse ribs, the longitudinal ribs extending in a longitudinal direction of the reinforcing bar and opposed to each other in a direction of a long axis of the flattened cross section, the transverse ribs formed between the longitudinal ribs and extending in directions intersecting with the longitudinal ribs.

[Claim 5] A shear reinforcement bar comprising the reinforcing bar according to claim 4, wherein the shear reinforcement bar is laid across a plurality of main bars extending linearly in parallel to each other or is disposed so as to surround the main bars, wherein the shear reinforcement bar is bent such that a pair of surfaces opposed to each other in a direction of a short axis of the cross-section of the shear reinforcement bar are located inside and outside.