with the granular fine powder disposed in between.

In this manner, the rebar 2 is bonded to the inner peripheral surface of the insertion hole 3a of the insertion part 31 of each of two sleeves 3, and the sleeves 3 are connected by the connecting bolt 4, thereby connecting the two rebars 2.

[0036]

As described above, similarly to the previous embodiment, the rebar 2 is bonded to the sleeve 3 with the granular fine powder disposed on the contact surfaces of the rebar 2 and the sleeve 3 in the embodiment. As a result, the granular fine powder increases the friction force between the rebar 2 and the sleeve 3 to enhance the bonding strength of the rebar 2 and the sleeve 3.

[0037]

Note that, in the embodiment described above, the shape and the configuration of the mechanical joint are not particularly limited to those of the embodiment. Any shape and configuration allowing the rebar 2 to be inserted in the insertion holes 1a and 3a formed in the sleeves 1 and 3, can be applied.

[0038]

Further, the granular fine powder can be disposed on the contact surfaces of the rebar 2 and the sleeves 1 and 3 by adhering the granular fine powder on one surface of a

thin sheet of which other surface is adhered to the inner peripheral surface of the insertion holes 1a and 3a, or by melt adhesion in which the granular fine powder is sprayed on the inner peripheral surface of the insertion holes 1a and 3a of the heated sleeves 1 and 3.

[0039]

In the method of forming a bonding structure of a rebar and a bonding attachment according to the embodiment, description is made for the case in which the mechanical joint for connecting rebars is formed. However, it is not limited to the embodiment. Another embodiment of the present invention may be configured as a method of forming a bonding structure of a rebar and a bonding attachment for fastening the rebar to concrete. An example of such embodiment is illustrated in Figs. 10(A) to 10(E).

As illustrated in Figs. 10(A) and 10(B), one end of a rebar 2 is inserted in an insertion hole 5a, having a circular cross section, formed in a bonding attachment 5 having an approximately elliptical cross section. The bonding attachment 5 is bonded to the rebar 2 with a granular fine powder disposed on the inner peripheral surface of the insertion hole 5a on which the bonding attachment 5 and the rebar 2 make contact.

[0040]

A method of forming the bonding structure will be

described referring to Figs. 10(C) to 10(E).

First, the end portion of the rebar 2 is inserted in the insertion hole 5a, having a circular cross section, formed in the bonding attachment 5 having an approximately square cross section. Then, the bonding attachment 5 is pressed from the outer peripheral surface by a dice 51 having an arc shaped groove 51a. In this manner, the bonding attachment 5 is compressed and deforms to have a periphery having an approximately elliptic cross section, and in the same process, the bonding attachment 5 is bonded to the rebar 2.

In the embodiment, the bonding attachment 5 and the rebar 2 are also bonded with the granular fine powder disposed on the contact surfaces of the bonding attachment 5 and the rebar 2 by applying the application liquid mixed with the granular fine powder, before bonding, on the inner peripheral surface of the insertion hole 5a on which the bonding attachment 5 and the rebar 2 make contact.

[0041]

Another bonding structure formed by the method of forming a bonding structure according to the embodiment is illustrated in Figs. 11(A) to 11(E).

As illustrated in Figs. 11(A) and 11(B), a bonding attachment 6 including an insertion hole 6a having a circular cross section includes a portion with an outer

periphery having a hexagonal cross section and a portion with an outer periphery having a circular cross section produced by compressing and deforming the hexagonal cross section. One of both end portions of the rebar 2 is inserted in the insertion hole 6a in the portion having a circular cross section produced by compressing and deforming. In the portion of the insertion hole 6a where the rebar 2 is inserted, the bonding attachment 6 and the rebar 2 is bonded with the granular fine powder disposed in between.

[0042]

A method of forming the bonding structure will be described referring to Figs. 11(C) to 11(E).

First, the end portion of the rebar 2 is inserted in the insertion hole 6a to half the length of the insertion hole 6a having a circular cross section formed in the bonding attachment 6 having a hexagonal cross section. Then, the portion of the bonding attachment 6 in which the rebar 2 is inserted is pressed from the outer peripheral surface by a dice 61 having an arc shaped groove 61a. In this manner, the pressed portion of the bonding attachment 6 is compressed and deforms to have an approximately circular cross section, and the bonding attachment 6 is bonded to the rebar 2 in the deformed portion. A step is formed on the outer periphery surface by the process of

producing the bonding. Thereby, the bonding attachment 6 is now configured with the portion having an original hexagonal cross section and the compressed portion having a circular cross section.

In the embodiment, the bonding attachment 6 and the rebar 2 are also bonded with the granular fine powder disposed on the portion contacting each other by applying the application liquid mixed with the granular fine powder, before bonding, on the bonding attachment 6 or the rebar 2. Further, the bonding attachment 6 can enhance the fixing force on concrete by the step on the outer periphery surface formed in the process of producing the bonding.

[0043]

Another bonding structure formed by the method of forming a bonding structure according to the embodiment is illustrated in Figs. 12(A) to 12(G).

As illustrated in Figs. 12(A) and 12(B), a bonding attachment 7 including an insertion hole 7a having a circular cross section includes a thin sleeve-shaped portion having a circular cross section and a thick portion of which diameter gradually increases from the end of the sleeve-shaped portion. One of ends of the rebar 2 is inserted in the insertion hole 7a of the sleeve-shaped portion. In the portion of the insertion hole 7a where the rebar 2 is inserted, the bonding attachment 7 is bonded to

the rebar 2 with the granular fine powder disposed in between.

[0044]

A method of forming the bonding structure will be described referring to Figs. 12(C) to 12(G).

First, chucks 73 and 74 are attached to the sleeve-shaped bonding attachment 7 with an insertion hole 7a having a circular cross section formed therein. Then, a dice 72 having a column-shaped protrusion which can be inserted in the inner circumference of the thin portion is pressed on to the end portion of the thin portion. Thus, the end portion of the thin portion is stretched to increase the diameter, and then pressed by the flat portion of the dice 72 to expand. Thereby, the thin portion expands toward the end. Then, the rebar 2 is inserted in the insertion hole 7a in the thick portion which is not expanded. The portion of the bonding attachment 7 in which the rebar 2 is inserted is pressed from the outer peripheral surface by a dice 71 having an arc shaped groove 71a. In this manner, the pressed portion of the bonding attachment 7 is compressed and deforms, and the bonding attachment 7 is bonded to the rebar 2.

In the embodiment, the bonding attachment 7 and the rebar 2 are also bonded with the granular fine powder disposed on the portion contacting each other by applying

the application liquid mixed with the granular fine powder, before bonding, on the bonding attachment 7 or the rebar 2. Further, the bonding attachment 7 can enhance the fixing force on concrete by the portion expanding toward the end.

[0045]

Another bonding structure formed by the method of forming a bonding structure according to the embodiment is illustrated in Figs. 13(A) to 13(G).

As illustrated in Figs. 13(A) and 13(B), a bonding attachment 8 including an insertion hole 8a having a circular cross section includes a sleeve-shaped portion having a circular cross section and a portion which expands from the end portion of the sleeve-shaped portion and then is folded inward. One of ends of the rebar 2 is inserted in the insertion hole 8a of the sleeve-shaped portion. At the portion of the insertion hole 8a in which the rebar 2 is inserted, the bonding attachment 8 is bonded to the rebar 2 with the granular fine powder disposed in between.

[0046]

A method of forming the bonding structure will be described referring to Figs. 13(C) to 13(G).

First, chucks 83 and 84 are attached to the sleeve-shaped bonding attachment 8 with an insertion hole 8a having a circular cross section formed therein. The dice 82 is subsequently pressed on to the end surface of the

bonding attachment 8. Thereby, the end surface buckles to expand outward. By further pressing the dice 82, the end surface is folded in a two-fold shape. The rebar 2 is inserted in the insertion hole 88 in the sleeve-shaped portion. The portion of the bonding attachment 8 in which the rebar 2 is inserted is pressed from the outer peripheral surface by a dice 81 having an arc shaped groove 81a. In this manner, the pressed portion of the bonding attachment 8 is compressed and deforms, and the bonding attachment 8 is bonded to the rebar 2.

In the embodiment, the bonding attachment 8 and the rebar 2 are also bonded with the granular fine powder disposed on the portion contacting each other by applying the application liquid mixed with the granular fine powder, before bonding, on the bonding attachment 8 or the rebar 2. Further, the bonding attachment 8 can enhance the fixing force on concrete by the portion expanding toward the end.

[0047]

Further, a bonding structure according to another embodiment formed by the method of forming a bonding structure according to the embodiment is illustrated in Figs. 14(A) to 14(F).

As illustrated in Figs. 14(A) and 14(B), a bonding attachment 9 including an insertion hole 9a including a sleeve-shaped portion in which the insertion hole 9a having

an approximately rectangular cross section with round corners is formed and a portion, in which the insertion hole 9a having a circular cross section is formed, expanding toward the end from the end portion of the sleeve-shaped portion. One end of the rebar 2 is inserted in the sleeve-shaped portion. At the portion of the sleeve-shaped portion in which the rebar 2 is inserted, the bonding attachment 9 is bonded to the rebar 2 with the granular fine powder disposed in between.

[0048]

A method of forming the bonding structure will be described referring to Figs. 14(C) to 14(G).

First, the periphery of the sleeve-shaped portion is pressed from four directions by four trapezoidal dices 91 to form the insertion hole 9a having an approximately rectangular cross section with round corners. Then, the located end portion of the rebar 2 is inserted in the sleeve-shaped portion. The round corner of the insertion hole of the portion of the bonding attachment 9 in which the rebar 2 is inserted is pressed toward the center by the four dices 91 having an arc shaped grooves 91a. In this manner, the pressed portion of the bonding attachment 9 is compressed and deforms, and the bonding attachment 9 is bonded to the rebar 2.

In the embodiment, the bonding attachment 9 and the

rebar 2 are also bonded with the granular fine powder disposed on the portion contacting each other by applying the application liquid mixed with the granular fine powder, before bonding, on the bonding attachment 9 or the rebar 2. Further, the bonding attachment 9 can enhance the fixing force on concrete by the portion expanding toward the end.

[0049]

The entire disclosure of the specification, the drawings, and the abstract included in Japanese Patent Application No. 2003-362703 filed October 23, 2003 is hereby incorporated by reference.

Reference Signs List

[0050]

1 sleeve

1a insertion hole

2 rebar

3 sleeve

3a insertion hole

31 insertion part

32 threaded portion

4 connecting bolt

5 to 9 bonding attachment

10 granular fine powder

CLAIMS

1. A method of forming a bonding structure to bond a bonding attachment to a rebar, the bonding attachment having an insertion hole for inserting the rebar therein, the method comprising:

a step of applying an application liquid including a water-soluble resin emulsion mixed with a granular fine powder with a grain size of 180 to 600 μm on an outer peripheral surface of the rebar and/or an inner peripheral surface of the insertion hole of the bonding attachment;

a step of inserting the rebar in the insertion hole of the bonding attachment; and

a step of bonding the bonding attachment to the rebar by pressing the bonding attachment with the rebar inserted in the insertion hole.

2. The method of forming a bonding structure according to claim 1, wherein the grain size of the granular fine powder is from 180 to 300 μm.

3. The method of forming a bonding structure according to claim 1 or 2, wherein the granular fine powder is silicon carbide based material or aluminum based material.

with the granular fine powder disposed in between.

In this manner, the rebar 2 is bonded to the inner peripheral surface of the insertion hole 3a of the insertion part 31 of each of two sleeves 3, and the sleeves 3 are connected by the connecting bolt 4, thereby connecting the two rebars 2.

[0036]

As described above, similarly to the previous embodiment, the rebar 2 is bonded to the sleeve 3 with the granular fine powder disposed on the contact surfaces of the rebar 2 and the sleeve 3 in the embodiment. As a result, the granular fine powder increases the friction force between the rebar 2 and the sleeve 3 to enhance the bonding strength of the rebar 2 and the sleeve 3.

[0037]

Note that, in the embodiment described above, the shape and the configuration of the mechanical joint are not particularly limited to those of the embodiment. Any shape and configuration allowing the rebar 2 to be inserted in the insertion holes 1a and 3a formed in the sleeves 1 and 3, can be applied.

[0038]

Further, in a reference example, the granular fine powder can be disposed on the contact surfaces of the rebar 2 and the sleeves 1 and 3 by adhering the granular fine powder on one surface of a thin sheet of which other surface is adhered to the inner peripheral surface of the insertion holes 1a and 3a, or by melt adhesion in which the

granular fine powder is sprayed on the inner peripheral surface of the insertion holes 1a and 3a of the heated sleeves 1 and 3.

[0039]

In the method of forming a bonding structure of a rebar and a bonding attachment according to the embodiment, description is made for the case in which the mechanical joint for connecting rebars is formed. However, it is not limited to the embodiment. Another embodiment of the present invention may be configured as a method of forming a bonding structure of a rebar and a bonding attachment for fastening the rebar to concrete. An example of such embodiment is illustrated in Figs. 10(A) to 10(E).

As illustrated in Figs. 10(A) and 10(B), one end of a rebar 2 is inserted in an insertion hole 5a, having a circular cross section, formed in a bonding attachment 5 having an approximately elliptical cross section. The bonding attachment 5 is bonded to the rebar 2 with a granular fine powder disposed on the inner peripheral surface of the insertion hole 5a on which the bonding attachment 5 and the rebar 2 make contact.

[0040]

A method of forming the bonding structure will be described referring to Figs. 10(C) to 10(E).

First, the end portion of the rebar 2 is inserted in the insertion hole 5a, having a circular cross section, formed in the bonding attachment 5 having an approximately square cross section. Then, the bonding attachment 5 is

pressed from the outer peripheral surface by a dice 51 having an arc shaped groove 51a. In this manner, the bonding attachment 5 is compressed and deforms to have a periphery having an approximately elliptic cross section, and in the same process, the bonding attachment 5 is bonded to the rebar 2.

In the embodiment, the bonding attachment 5 and the rebar 2 are also bonded with the granular fine powder disposed on the contact surfaces of the bonding attachment 5 and the rebar 2 by applying the application liquid mixed with the granular fine powder, before bonding, on the inner peripheral surface of the insertion hole 5a on which the bonding attachment 5 and the rebar 2 make contact.

[0041]

Another bonding structure formed by the method of forming a bonding structure according to the embodiment is illustrated in Figs. 11(A) to 11(E).

As illustrated in Figs. 11(A) and 11(B), a bonding attachment 6 including an insertion hole 6a having a circular cross section includes a portion with an outer periphery having a hexagonal cross section and a portion with an outer periphery having a circular cross section produced by compressing and deforming the hexagonal cross section. One of both end portions of the rebar 2 is inserted in the insertion hole 6a in the portion having a circular cross section produced by compressing and deforming. In the portion of the insertion hole 6a where the rebar 2 is inserted, the bonding attachment 6 and the

rebar 2 is bonded with the granular fine powder disposed in between.

[0042]

A method of forming the bonding structure will be described referring to Figs. 11(C) to 11(E).

First, the end portion of the rebar 2 is inserted in the insertion hole 6a to half the length of the insertion hole 6a having a circular cross section formed in the bonding attachment 6 having a hexagonal cross section. Then, the portion of the bonding attachment 6 in which the rebar 2 is inserted is pressed from the outer peripheral surface by a dice 61 having an arc shaped groove 61a. In this manner, the pressed portion of the bonding attachment 6 is compressed and deforms to have an approximately circular cross section, and the bonding attachment 6 is bonded to the rebar 2 in the deformed portion. A step is formed on the outer periphery surface by the process of producing the bonding. Thereby, the bonding attachment 6 is now configured with the portion having an original hexagonal cross section and the compressed portion having a circular cross section.

In the embodiment, the bonding attachment 6 and the rebar 2 are also bonded with the granular fine powder disposed on the portion contacting each other by applying the application liquid mixed with the granular fine powder, before bonding, on the bonding attachment 6 or the rebar 2. Further, the bonding attachment 6 can enhance the fixing force on concrete by the step on the outer periphery surface formed in the process of producing the bonding.

[0043]

Another bonding structure formed by the method of forming a bonding structure according to the embodiment is illustrated in Figs. 12(A) to 12(G).

As illustrated in Figs. 12(A) and 12(B), a bonding attachment 7 including an insertion hole 7a having a circular cross section includes a thin sleeve-shaped portion having a circular cross section and a thick portion of which diameter gradually increases from the end of the sleeve-shaped portion. One of ends of the rebar 2 is inserted in the insertion hole 7a of the sleeve-shaped portion. In the portion of the insertion hole 7a where the rebar 2 is inserted, the bonding attachment 7 is bonded to the rebar 2 with the granular fine powder disposed in between.

[0044]

A method of forming the bonding structure will be described referring to Figs. 12(C) to 12(G).

First, chucks 73 and 74 are attached to the sleeve-shaped bonding attachment 7 with an insertion hole 7a having a circular cross section formed therein. Then, a dice 72 having a column-shaped protrusion which can be inserted in the inner circumference of the thin portion is pressed on to the end portion of the thin portion. Thus, the end portion of the thin portion is stretched to increase the diameter, and then pressed by the flat portion of the dice 72 to expand. Thereby, the thin portion expands toward the end. Then, the rebar 2 is inserted in the

insertion hole 7a in the thick portion which is not expanded. The portion of the bonding attachment 7 in which the rebar 2 is inserted is pressed from the outer peripheral surface by a dice 71 having an arc shaped groove 71a. In this manner, the pressed portion of the bonding attachment 7 is compressed and deforms, and the bonding attachment 7 is bonded to the rebar 2.

In the embodiment, the bonding attachment 7 and the rebar 2 are also bonded with the granular fine powder disposed on the portion contacting each other by applying the application liquid mixed with the granular fine powder, before bonding, on the bonding attachment 7 or the rebar 2. Further, the bonding attachment 7 can enhance the fixing force on concrete by the portion expanding toward the end.

[0045]

Another bonding structure formed by the method of forming a bonding structure according to the embodiment is illustrated in Figs. 13(A) to 13(G).

As illustrated in Figs. 13(A) and 13(B), a bonding attachment 8 including an insertion hole 8a having a circular cross section includes a sleeve-shaped portion having a circular cross section and a portion which expands from the end portion of the sleeve-shaped portion and then is folded inward. One of ends of the rebar 2 is inserted in the insertion hole 8a of the sleeve-shaped portion. At the portion of the insertion hole 8a in which the rebar 2 is inserted, the bonding attachment 8 is bonded to the rebar 2 with the granular fine powder disposed in between.

[0046]

A method of forming the bonding structure will be described referring to Figs. 13(C) to 13(G).

First, chucks 83 and 84 are attached to the sleeve-shaped bonding attachment 8 with an insertion hole 8a having a circular cross section formed therein. The dice 82 is subsequently pressed on to the end surface of the bonding attachment 8. Thereby, the end surface buckles to expand outward. By further pressing the dice 82, the end surface is folded in a two-fold shape. The rebar 2 is inserted in the insertion hole 88 in the sleeve-shaped portion. The portion of the bonding attachment 8 in which the rebar 2 is inserted is pressed from the outer peripheral surface by a dice 81 having an arc shaped groove 81a. In this manner, the pressed portion of the bonding attachment 8 is compressed and deforms, and the bonding attachment 8 is bonded to the rebar 2.

In the embodiment, the bonding attachment 8 and the rebar 2 are also bonded with the granular fine powder disposed on the portion contacting each other by applying the application liquid mixed with the granular fine powder, before bonding, on the bonding attachment 8 or the rebar 2. Further, the bonding attachment 8 can enhance the fixing force on concrete by the portion expanding toward the end.

[0047]

Further, a bonding structure according to another embodiment formed by the method of forming a bonding structure according to the embodiment is illustrated in Figs. 14(A) to 14(F).

As illustrated in Figs. 14(A) and 14(B), a bonding attachment 9 including an insertion hole 9a including a sleeve-shaped portion in which the insertion hole 9a having an approximately rectangular cross section with round corners is formed and a portion, in which the insertion hole 9a having a circular cross section is formed, expanding toward the end from the end portion of the sleeve-shaped portion. One end of the rebar 2 is inserted in the sleeve-shaped portion. At the portion of the sleeve-shaped portion in which the rebar 2 is inserted, the bonding attachment 9 is bonded to the rebar 2 with the granular fine powder disposed in between.

[0048]

A method of forming the bonding structure will be described referring to Figs. 14(C) to 14(G).

First, the periphery of the sleeve-shaped portion is pressed from four directions by four trapezoidal dices 91 to form the insertion hole 9a having an approximately rectangular cross section with round corners. Then, the located end portion of the rebar 2 is inserted in the sleeve-shaped portion. The round corner of the insertion hole of the portion of the bonding attachment 9 in which the rebar 2 is inserted is pressed toward the center by the four dices 91 having an arc shaped grooves 91a. In this manner, the pressed portion of the bonding attachment 9 is compressed and deforms, and the bonding attachment 9 is bonded to the rebar 2.

In the embodiment, the bonding attachment 9 and the rebar 2 are also bonded with the granular fine powder disposed on the portion contacting each other by applying the application liquid mixed with the granular fine powder, before bonding, on the bonding attachment 9 or the rebar 2. Further, the bonding attachment 9 can enhance the fixing force on concrete by the portion expanding toward the end.

Reference Signs List

[0050]

1 sleeve
1a insertion hole
2 rebar
3 sleeve
3a insertion hole
31 insertion part
32 threaded portion
4 connecting bolt
5 to 9 bonding attachment
10 granular fine powder

CLAIMS

1. A method of forming a bonding structure to bond a bonding attachment to a rebar, the bonding attachment having an insertion hole for inserting the rebar therein, the method comprising:

a step applying an application liquid including a water-soluble resin emulsion previously mixed with a granular fine powder with a grain size of 180 to 600 μm on an outer peripheral surface of the rebar and/or an inner peripheral surface of the rebar and/or an inner peripheral surface of the insertion hole of the bonding attachment;

a step of inserting the rebar in the insertion hole of the bonding attachment; and

a step of bonding the bonding attachment to the rebar by pressing the bonding attachment with the rebar inserted in the insertion hole.

2. The method of forming a bonding structure according to claim 1, wherein the grain size of the granular fine powder is from 180 to 300μm.

3. The method of forming a bonding structure according to claim 1 or 2, wherein the granular fine powder is silicon carbide based material or aluminum based material.