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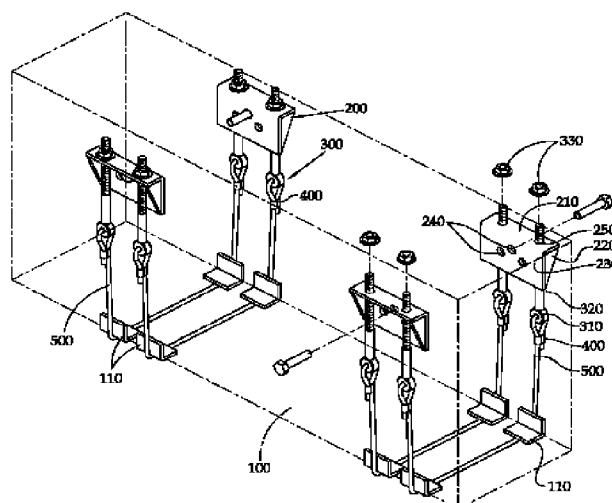
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[Continued on next page]

(54) Title: SHEAR STRENGTH REINFORCING SYSTEM FOR STRUCTURE USING EYE BOLT AND WIRE ROPE



(57) Abstract: Provided is a structure shear reinforcing system for shear reinforcement of a concrete structure such as a beam. Wire ropes constrained by eyebolts are disposed to surround a reinforced structure in a shear reinforcement direction (longitudinal or transverse direction) and are fixed to fixing members mounted to a side surface of the structure or a slab, and the wire rope are constrained by pressure welding members so as not to be released from the eyebolts, so that the wire ropes can be tightened to surround the structure in the shear reinforcement direction. Therefore, the effective and economic shear reinforcement of the structure is possible.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## Description

### SHEAR STRENGTH REINFORCING SYSTEM FOR STRUCTURE USING EYE BOLT AND WIRE ROPE

#### Technical Field

- [1] The present invention relates to a structure shear reinforcing system using eyebolts and wire ropes, and more particularly, to a structure shear reinforcing method used for shear reinforcement of a reinforced concrete structure such as a bridge girder and an inner structural beam that are bending members.

#### Background Art

- [2] Until recently, a study on shear reinforcement of a reinforced concrete beam mainly includes a carbon fiber reinforcing method or a steel reinforcing method mostly using epoxy as an adhesive. An example of an existing carbon fiber reinforcing method is shown in FIG. 1.
- [3] For shear reinforcement of a structure (reinforced concrete T-beam), a lower surface or a side surface of the structure is surface treated, notches are sequentially formed at predetermined intervals, a primer is coated on the surface of the structure in order to uniform a surface of an adhesion part of a fiber-reinforced sheet, and in this state, the notches are filled with adhesives such as an epoxy based resin to form shear keys 10.
- [4] In addition to improving an adhesion between the structure and the fiber-reinforced sheet when bending reinforcement of the structure, the shear keys 10 resists against in-plane shear strength exerted between the structure and the fiber-reinforced sheet such that the integrity of the structure with the fiber-reinforced sheet can be improved. In addition, the shear keys 10 formed when shear reinforcement of the structure can guarantee enough adhesive strength even when adhesion lengths cannot be guaranteed due to geometric limitations of the structure members such that a shear reinforcement effect can be improved.
- [5] After forming the shear keys, the fiber-reinforced sheet (plate) 20 is adhered to the shear keys to be attached to the lower surface or the side surface of the structure by using the epoxy in order to integrate the fiber-reinforced sheet (plate) with the structure, thereby completing the structure shear reinforcing method using the shear keys and the fiber-reinforced sheet (plate).
- [6] However, a failure type of the beam reinforced with the carbon fiber or the like follows a failure mechanism by interface delamination between the reinforcements and the concretes.
- [7] In the entire side surface reinforcement within shear span, delamination occurs at end portions, so that brittle fracture generally occurs in a state where the entire adhered

surface cannot reach maximum shear stress. Therefore, in the existing shear reinforcing methods of the beam using the epoxy, maximum internal force of the structure may increase. However, there is a problem in that the brittle fracture can occur beyond a maximum load.

- [8] In addition, there is a basic problem in that most of related studies and constructions are performed without adequate verification on changes in ambient air conditions including temperature and humidity during reinforcement and on environmental factors such as freezing and thawing in addition to temperature and humidity after curing.

## **Disclosure of Invention**

### **Technical Problem**

- [9] The present invention provides a structure shear reinforcing method using wire ropes capable of reducing suspicion about brittle properties and durability that are problems of an existing shear reinforcing method using epoxy.
- [10] The present invention also provides a structure shear reinforcing method capable of, in addition to having structural advantages, requiring a very short construction period, being environmentally friendly without generating dirt under construction and harmful materials during fire, and being widely applied to structure shear reinforcement using other materials besides a concrete structure.

### **Technical Solution**

- [11] According to an aspect of the present invention, firstly, there is provided a shear reinforcing method of a reinforced structure 100 outside a cross section of concrete through mechanical fixing of wire ropes 500.
- [12] Tightening forces of the wire ropes are controlled by using a torque wrench, and simultaneously the wire ropes 500 are fixed to fixing members 200 by tightening nuts 330 to exert tension to the reinforced structure 100, so that shear internal force of the structure increases due to external constraint by the wire ropes.
- [13] Secondly, for the shear reinforcement for mechanically tightening the reinforced structure 100, the wire ropes 500 and eyebolts 300 to which the wire ropes are connected, are used.
- [14] The wire ropes 500 are thin and lightweight unlike prestressed concrete (PC) steel wires (or prestressed (PS) steel wires) and have a tensile stress larger than that of a connecting bolt and a PC steel wire, so that a worker can easily use the wire ropes to surround the reinforced structure and generate the tension.
- [15] Thirdly, when the wire ropes 500 are used, in order to easily joint both end portions of the wire rope, an optimal end portion constraint member (pressure welding member) is provided.

- [16] The end portion constraint member allows the end portion of the wire rope to be inserted into a ring-shaped head in a U shape and constrains a folded portion of the wire rope by using the pressure welding member 400. Therefore, when the tension is generated at the wire rope, the end portion of the wire rope can be prevented from being released.
- [17] Fourthly, various embodiments of the eyebolts and wire ropes according to an installation status of a reinforced structure which needs the shear reinforcement are provided.

### **Advantageous Effects**

- [18] According to an experimental result of the shear reinforcing system according to the present invention, in a shear reinforcing method used for a concrete structure using post tension of wire ropes, maximum shear internal force of all of structures (beams) markedly increase. Particularly, in the shear reinforcing system according to a second embodiment, a structure is failed at more than bending internal force although an external shear reinforcement cross section is not large.
- [19] When an initial diagonal tension crack occurs at a belly portion of the beam, according to a result of evaluating ductility ratio which defines a ratio of a displacement at a maximum load with respect to a displacement, the beam reinforced according to the present invention has an excellent energy absorbing ability after the initial diagonal tension crack, so that apprehensions of brittle fracture in the shear reinforcement of the beam can be removed.
- [20] Although maximum shear strength of the beam is reached by an applied load, wire ropes do not surrender when the shear reinforced beam according to the present invention is failed. Therefore, in terms of the reduction in materials, constructability, economical efficiency, and environmentally friendly, the structure shear reinforcing system according to the present invention has an excellent shear reinforcement effect. In addition, a worker can easily perform a shear reinforcement operation of the structure by using the wire ropes and fixing members without an additional skill, and a space occupied by the eyebolts and the wire ropes is small. Therefore, when covering layers are formed, a covering thickness can be minimized, and an external appearance can be simple due to the covering layers. In addition, subsidiary materials which are lightweight and can be easily processed and manufactured, are used for construction instead of high cost materials. Therefore, there is a technical advantage of high constructability and economical efficiency.

### **Brief Description of the Drawings**

- [21] FIG. 1 shows an existing shear reinforcing method.
- [22] FIGS. 2 to 6 show a first embodiment and a cross-section of a structure shear re-

inforcing system according to the present invention.

[23] FIGS. 7 and 8 show a second embodiment of a structure shear reinforcing system according to the present invention.

[24] FIG. 9 shows a third embodiment of a structure shear reinforcing system according to the present invention.

[25] <Reference Numerals>

[26] 100: reinforced structure 200: fixing member

[27] 300: eyebolt 310: ring-shaped head

[28] 320: bolt portion 330: tightening nut

[29] 400: pressure welding member 500: wire rope

[30] 600: covering layer 700: slab (bottom plate)

### **Best Mode for Carrying Out the Invention**

[31] The present invention will now be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. The invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the concept of the invention to those skilled in the art.

[32] <First Embodiment>

[33] The first embodiment applies a shear reinforcing system according to the present invention to a reinforced concrete structure which is a beam having a rectangular cross section that is a bending member as a reinforced structure. The reinforcing system for shear reinforcement of the reinforced structure includes: fixing members 200 which protrude from and are fixed to both upper side surfaces of the reinforced structure 100 and are provided with fixing penetrating holes; eyebolts 300 each of which including a bolt portions which extend from a ring-shaped head and is inserted into the fixing penetrating hole to be disposed in a direction of the side surface of the reinforced structure, and a tightening nut used to fix the eyebolt to the fixing member; and wire ropes 500 which surround the reinforced structure 100 by tension due to the tightening nut in a shear reinforcement direction and of which both ends are connected to the ring-shaped head of the eyebolt 300 by a pressure welding member 400.

[34] The reinforced structure 100 is referred to a reinforced concrete beam (hereinafter, referred to as "beam") having a rectangular cross-section that is a bending member according to the present invention. However, the reinforced structure may apply to a reinforced concrete structure into which a steel frame is inserted, a simple steel frame structure, a simple concrete structure, a bricked structure, and a pillar structure, without limitation to materials, shapes, and cross-sections such as a circle or a polygon and

may further apply to a concrete structure such as a beam, a girder, and a structural wall which are exerted with a bending moment.

- [35] At both lower edge portions of the beam, wire rope supporting members 110 may be disposed such that the wire ropes that surround the beam do not directly contact the beam.
- [36] The wire rope supporting members 110 may be L-shaped bent members. More specifically, when the wire rope supporting members 110 are used for the beam having the rectangular cross section, a steel plate may be bent to have the shape of L so as to be disposed at the edge portions.
- [37] The bent members are disposed to contact the edge portions of the beam, and furthermore, the bent members may be fixed to the lower edge portions of the beam by using fixing holes including anchor bolts, or an adhesive such as epoxy may be partially used to the bent members and the beam edge portions in order to temporarily fix the bent members to the edge portions of the beam.
- [38] The fixing members 200 protrude from and are fixed to both the upper side surfaces of the beam and are provided with the fixing penetrating holes.
- [39] As shown in FIG. 2, the fixing member 200 includes a horizontal member 210 protruding in a horizontal direction, wing members 220 extending downward from both sides of the horizontal member 210, and a vertical member 230 supporting the wing members 220. The horizontal member 210 is provided with one or more fixing penetrating holes 250 into which the bolt portions of the eyebolts can be inserted. The vertical member 230 is provided with anchor holes 240 used for the anchor bolts in order to fix the fixing member to the side surface of the beam.
- [40] Accordingly, the fixing members 200 can be fixed to both the upper side surfaces of the beam.
- [41] In a state where an end portion of the wire rope 500 is connected to a fixing member 200 as described above, the wire rope 500 is in contact with a surface of the wire rope supporting member 100 disposed at the lower edge portions of the beam, and the other end portion of the wire rope 500 is connected to another fixing member 200 so as to exert tightening force and surround the entire lower portion of the beam.
- [42] Namely, a means for surrounding the lower portion of the beam and exerting the tightening force to the beam for shear reinforcement is the wire rope 500. The wire rope is manufactured by twisting very thin wires, has a diameter of about 5mm, and is lightweight. Therefore, there is an advantage in that a worker can easily carry and install the wire ropes.
- [43] In addition, since a surface of the wire rope is formed by the twisted wires, due to frictional force generated at the surface of the wire rope supporting member 110, a slip does not occur from the bent member when tension is exerted. Therefore, stable

tightening force can be exerted on the beam in a shear reinforcement direction to constrain the beam.

- [44] Here, the wire rope is disposed in the shear reinforcement direction that is perpendicular to an axis direction of the beam, and intervals between the wire ropes are determined to adequately guarantee intervals that have to be restricted for the shear reinforcement. In FIG. 3, two wire ropes 500 are provided to a fixing member 200. However, one or three or more wire ropes can be provided. This is possible by controlling the number of fixing penetrating holes 250 formed at the fixing member 200, and the number of needed fixing penetrating holes can be controlled according to a diameter of the wire rope.
- [45] The eyebolt 300 has a function of constraining both end portions of the wire rope 500 to the fixing member 200 so as to tighten the wire rope 500 to surround the lower portion of the beam 100, and the pressure welding member 400 according to the present invention has a function of binding the wire rope 500 so as not to loose the wire rope 500 from the eyebolt 300.
- [46] The eyebolt 300 includes the ring-shaped head 310 and the bolt portion 320. An end portion of the wire rope 500 penetrates through the ring-shaped head 310 and is folded to be constrained to the ring-shaped head 310.
- [47] The end portion of the wire rope 400 is stranded through the head 310 in a U shape such that the end portion of the wire rope and the wire rope form a folded portion.
- [48] The pressure welding member 400 according to the present invention is used as a means having a function of constraining the folded portion to connect the wire rope 500 to the eyebolt 300.
- [49] When the pressure welding member is used and tightening force due to the wire rope 500 gradually increases, a situation where connection between the wire rope 500 and the eyebolt 300 is released may occur although the beam or the wire rope can resist against stress due to a working load. The situation causes an ineffectiveness of the beam shear reinforcement, so that the situation has to be prevented by any means.
- [50] Therefore, according to the present invention, the folded portion is surrounded and pressed by a portable press so that the end portion of the wire rope is pressure welded to the wire rope, and the situation can be prevented.
- [51] When the pressure welding member including a material having a good ductility such as aluminum and copper is pressed to the wire rope by the press, the wire rope penetrate to an inner surface of the pressure welding member, so that a strong tightening ability can be achieved due to frictional force between the wire rope and the pressure welding member.
- [52] Accordingly, the pressure welding member 400 is manufactured as a section including two holes through which the wire rope penetrate, the end portion of the wire

rope penetrates the one hole, passes the head of the eyebolt in a U shape, and penetrates the other hole to extend, and in this state, the press presses the pressure welding member. Therefore, the end portion of the wire rope can be simply connected to the eyebolt.

[53] The bolt portion of the eyebolt to which the wire rope constrained by the pressure welding member 400 is connected is inserted into the fixing penetrating hole of the fixing member 200 as shown in FIG. 2. Thereafter, a protruding end portion of the bolt portion is tightened with a tightening nut 330 by using a washer or the like so as to fix the eyebolt to the fixing member 200.

[54] The tightening nut 330 is tightened by a portable torque wrench, and consequently the beam is tightened by the wire rope in the shear reinforcement direction, so that the shear reinforcement of the beam is possible.

[55] FIG. 3 shows a state where a number of the shear reinforcing systems according to the first embodiment are disposed at predetermined intervals to exert final constraint force.

[56] FIG. 4 is a cross-sectional view showing a state where a covering layer 600 such as mortar is formed with a predetermined thickness in order to bury the fixing members 200, the eyebolts 300, the pressure welding members 400, and the wire ropes 500.

[57] The covering layer 600 is formed to prevent an external appearance of the beam from being complicated by the wire ropes attached to the surface of the beam such that the external appearance of the beam can be improved and a decrease in durability such as corrosion of the exposed wire rope can be prevented. The covering layer can be selectively formed at the side surface or the lower surface of the beam.

[58] When the covering layer 600 is not formed, the tightening nut is tightened at different times such that an effectiveness of needed shear reinforcement can be repeatedly achieved.

[59] Furthermore, the fixing members 200 can be connected and integrated with each other.

[60] Namely, as shown in FIG. 5, a connecting member 260 for connecting the two fixing members 200 is integrated with the two fixing members 200 and is disposed on a top surface of the beam. Consequently, the anchor bolts used to fix the fixing members to the side surfaces of the beam are not needed, and a more stable supporting ability of the fixing member 200 can be guaranteed.

[61] In addition, for the shear reinforcement of the beam, as shown in FIG. 6, the fixing member 200 is disposed at a left edge belly portion of the beam, and the wire rope 500 constrained to the fixing member 200 by the pressure welding member 400 surrounds the belly portion in a horizontal (transverse) direction and constrains the beam in the transverse direction by using the wire rope supporting member 110, so that the shear

reinforcement of the beam can be achieved.

[62] Namely, the shear reinforcing method shown in FIGS. 3 to 5 is a method of the shear reinforcement by surrounding the beam in a direction from up to down (longitudinal direction). On the other hand, the shear reinforcing method shown in FIG. 6 is a method of the shear reinforcement by surrounding the beam in a direction from left to right (transverse direction).

[63] Here, although not shown in the figure, the fixing member for the shear reinforcement in the transverse direction shown in FIG. 6 can be integrated with the connecting member. Furthermore, a combination method of reinforcing the beam in both longitudinal and transverse directions can be used for the beam shear reinforcement.

[64] <Second Embodiment>

[65] The second embodiment applies a reinforced concrete structure manufactured as a beam to the shear reinforcing system according to the present invention, and more particularly, applies the beam 100 having an opening portion C at a belly portion to the shear reinforcing system according to the present invention.

[66] The shear reinforcing system for shear reinforcement of a reinforced structure 100 having the opening portion C penetrating the reinforced structure 100 according to the second embodiment includes: fixing members 200 which protrude from and are fixed to both upper and lower side surfaces or left and right side surfaces of the reinforced structure 100 and are provided with fixing penetrating holes; eyebolts 300 each of which including a bolt portion which extends from a ring-shaped head and is inserted into the fixing penetrating hole to be disposed in a direction of the side surface of the reinforced structure, and a tightening nut used to fix the eyebolt to the fixing member; and wire ropes 500 which pass through the opening portion C and surround the reinforced structure 100 by tension due to the tightening nut in a shear reinforcement direction and of which both ends are connected to the ring-shaped head of the eyebolt 300 by a pressure welding member 400.

[67] The reinforced structure 100 may apply the beam in the first embodiment, and in general, the beam having an opening portion may have a high height.

[68] The beam is provided with the opening portion C as shown in FIGS. 7 and 8. The opening portion C may cause a shear crack and a bending crack with a very high possibility.

[69] Namely, when a load applies to the beam along a surface of the opening portion, there is a problem in that the shear crack occurs in advance of a failure caused from the bending along the surface of the opening portion. Therefore, in a case where the opening portion is formed at the beam, the shear reinforcing system according to the present invention can be applied most effectively.

- [70] First, the fixing members 200a and 200b near the opening portion as shown in FIG. 7 are mounted on both upper portions and both lower portions.
- [71] The fixing members 200 are mounted on the upper side surfaces above the opening portion C and lower side surfaces of the beam.
- [72] Here, since the fixing members 200a and 200b are provided with the fixing penetrating holes, the wire ropes 500 constrained to the eyebolts 300 by the pressure welding members 400 can be used as in the first embodiment, and the wire ropes 500 are disposed to surround an upper inner surface and a lower inner surface of the opening portion C.
- [73] Namely, the wire ropes are disposed to surround the top and bottom surfaces of the inner opening portion.
- [74] Here, both end portions of the wire rope 500 are constrained to the ring-shaped head 310 of the eyebolt 300 by the pressure welding member 400, and the bolt portion of the eyebolt is fixed to the fixing member by the tightening nut 330, so that the wire rope 500 can surround the beam having the opening portion C as in the first embodiment.
- [75] The shear reinforcing system according to the second embodiment is applied to the beam having the opening portion C. Therefore, the shear reinforcement of the beam without the opening portion may use the shear reinforcing system according to the first embodiment, and the shear reinforcement of the beam having the opening portion may use the shear reinforcing system according to the second embodiment.
- [76] The first and second embodiments can be separated or combined to apply to the beam.
- [77] Furthermore, when the wire rope supporting members 110 are disposed at the upper and lower surfaces of the opening portion, more effective shear reinforcement is possible. Although not shown in the figure, the fixing members 200 according to the second embodiment can be connected by the connecting member 260 and integrated.
- [78] FIG. 8 shows a case where the wire ropes 500 are disposed at the beam having the opening portion C in a horizontal (transverse) direction.
- [79] The fixing members 200 are fixed to left and right upper portions of the beam 100, and the wire ropes 500 extend in the transverse direction to surround the beam in the transverse direction by using the wire rope supporting members 110. For the part where the opening portion is formed, the fixing member 200 is fixed to a belly portion to be aligned with the opening portion of the beam to surround the left and right side surfaces of the opening portion, so that the shear reinforcement of the opening portion is possible.
- [80] Namely, the method of installing the wire rope disposed in the transverse direction in the first embodiment as shown in FIG. 6 is applied to the beam having the opening portion.

[81] <Third Embodiment>

[82] The third embodiment applies a reinforced concrete structure manufactured as the beam to the shear reinforcing system according to the present invention. The shear reinforcing system may be applied to a case where a top surface of the beam 100 is disposed to be in contact with a slab or a bottom plate 700 and so an operation of tightening the tightening nut 330 to the eyebolt is not easy. The shear reinforcing system for shear reinforcement of a reinforced structure integrated with a lower surface of the slab or the bottom plate 700 includes: fixing penetrating holes 710 formed to penetrate the slab; eyebolts 300 each of which including a bolt portion which extends from a ring-shaped head and is inserted into the fixing penetrating hole such that the ring-shaped head snags on the lower surface of the slab, and a tightening nut used to fix the eyebolt to the slab; and wire ropes 500 which surround the reinforced structure by tension due to the tightening nut in a shear reinforcement direction and of which both ends are connected to the ring-shaped head of the eyebolt 300 by a pressure welding member 400.

[83] According to the third embodiment, since the top surface of the beam is in contact with the lower surface of the slab or the bottom plate 700 as shown in FIG. 9, the operation of tightening the eyebolt 300 fixed to the fixing member 200 with the tightening nut 330 at the fixing member is interfered by the slab or the bottom plate 700.

[84] Therefore, in the third embodiment, a fixing position of the eyebolt 300 is on an upper surface of the slab 700.

[85] Namely, the fixing penetrating hole 710 is formed at the slab 700 neighboring the beam by using a drill in consideration of a diameter of the bolt portion of the eyebolt.

[86] The fixing penetrating hole 710 is formed on the upper surface of the slab 700 at predetermined intervals along a direction of a length of the beam in consideration of intervals of the wire ropes.

[87] The bolt portion 320 of the eyebolt 300 penetrates above the upper surface of the slab 700 and is inserted into the fixing penetrating hole 710. The ring-shaped head 310 of the eyebolt is then in contact with the lower surface of the slab.

[88] The protruding bolt portion 320 is tightened with the tightening nut 330 on the upper surface of the slab by using a washer or a fixing plate as a medium such that the eyebolt 300 is mounted to the slab 700.

[89] The both ends of the wire rope is constrained to the ring-shaped head 310 of the eyebolt contacting the lower surface of the slab by the pressure welding member 400 as in the first and second embodiments, and the wire rope 500 is disposed to surround the beam.

[90] In addition, wire rope supporting members 110 may be disposed at lower edge

portions of the beam, so that the wire ropes can be safely installed.

### **Industrial Applicability**

[91] The present invention can be applied to a means for shear reinforcement of a structural beam and a building girder which are used for all of structures.

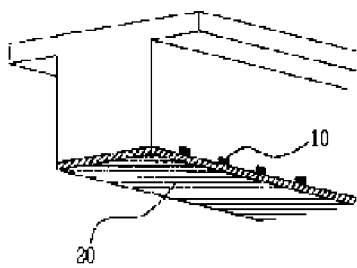
[92] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the appended claims.

## Claims

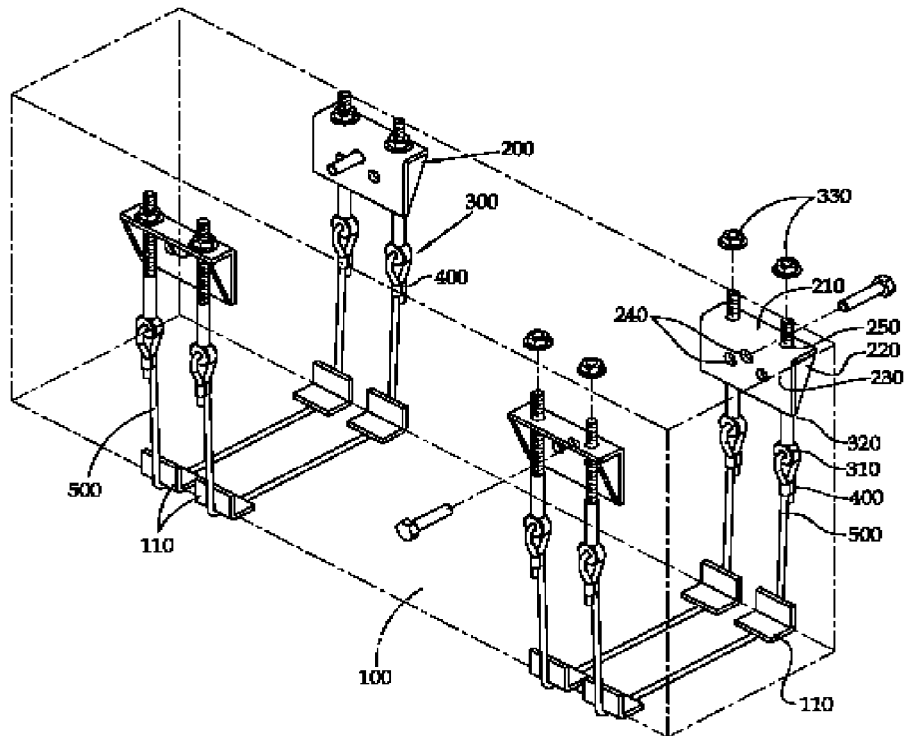
- [1] A structure shear reinforcing system using eyebolts and wire ropes for shear reinforcement of a reinforced structure, comprising:  
fixing members which protrude from and are fixed to both upper side surfaces of the reinforced structure and are provided with fixing penetrating holes;  
eyebolts each of which including a bolt portion which extends from a ring-shaped head and is inserted into the fixing penetrating hole to be disposed in a direction of the side surface of the reinforced structure, and a tightening nut used to fix the eyebolt to the fixing member; and  
wire ropes which surround the reinforced structure in a shear reinforcement direction by tension due to the tightening nut and of which both ends are connected to the ring-shaped head by a pressure welding member.
- [2] A structure shear reinforcing system using eyebolts and wire ropes for shear reinforcement of a reinforced structure having an opening portion C penetrating the reinforced structure, comprising:  
fixing members which protrude from and are fixed to both upper and lower side surfaces or left and right side surfaces of the reinforced structure and are provided with fixing penetrating holes;  
eyebolts each of which including a bolt portion which extends from a ring-shaped head and is inserted into the fixing penetrating hole to be disposed in a direction of the side surface of the reinforced structure, and a tightening nut used to fix the eyebolt to the fixing member; and  
wire ropes which pass through the opening portion C and surround the reinforced structure by tension due to the tightening nut in a shear reinforcement direction and of which both ends are connected to the ring-shaped head of the eyebolt by a pressure welding member.
- [3] A structure shear reinforcing system using eyebolts and wire ropes for shear reinforcement of a reinforced structure integrated with a lower surface of a slab or a bottom plate, comprising:  
fixing penetrating holes formed to penetrate the slab;  
eyebolts each of which including a bolt portion which extends from a ring-shaped head and is inserted into the fixing penetrating hole such that the ring-shaped head snags on the lower surface of the slab, and a tightening nut used to fix the eyebolt to the slab; and  
wire ropes which surround the reinforced structure by tension due to the tightening nut in a shear reinforcement direction and of which both ends are connected to the ring-shaped head of the eyebolt by a pressure welding member.

- [4] The structure shear reinforcing system of claim 1 or 2, wherein the fixing member is integrated with a connecting member disposed at a top surface of the reinforced structure.
- [5] The structure shear reinforcing system of claim 1 or 2, wherein the shear reinforcement direction is a longitudinal direction from up to down or a transverse direction from left to right of the reinforced structure.
- [6] The structure shear reinforcing system of any one of claims 1 to 3, wherein the pressure welding member is formed by enclosing a folded portion formed by an end portion of the wire rope which penetrates the ring-shaped head and is folded in a U shape and pressing the folded portion.
- [7] The structure shear reinforcing system of any one of claims 1 to 3, wherein the wire rope is in contact with wire rope supporting member which is provided to a bent portion of the reinforced structure and surrounds the reinforced structure.
- [8] The structure shear reinforcing system of any one of claims 1 to 3, wherein the reinforced structure is provided with a covering layer including mortar in order to bury the fixing members, the eyebolts, the pressure welding members, and the wire ropes besides the opening portion.

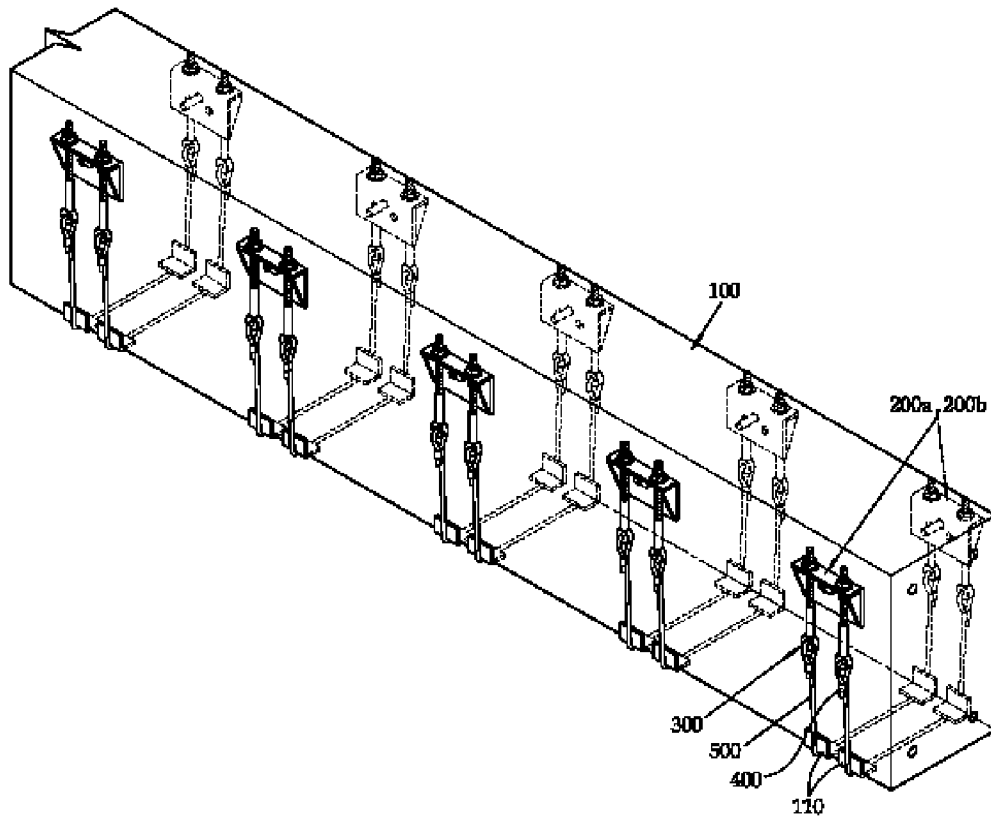
[Fig. 1]



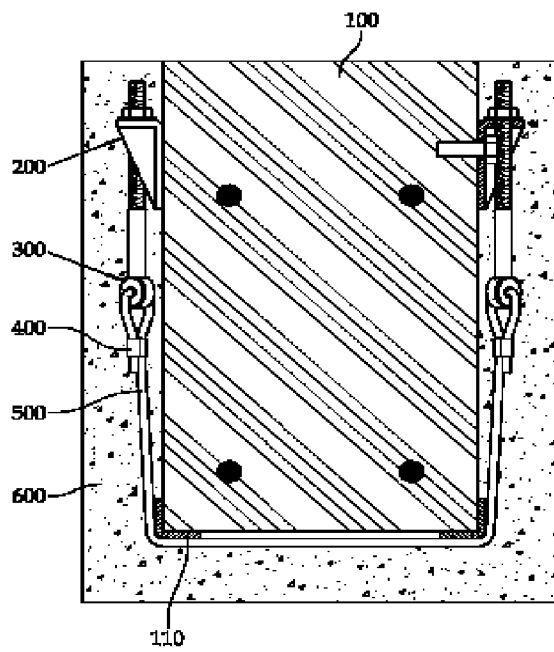
[Fig. 2]



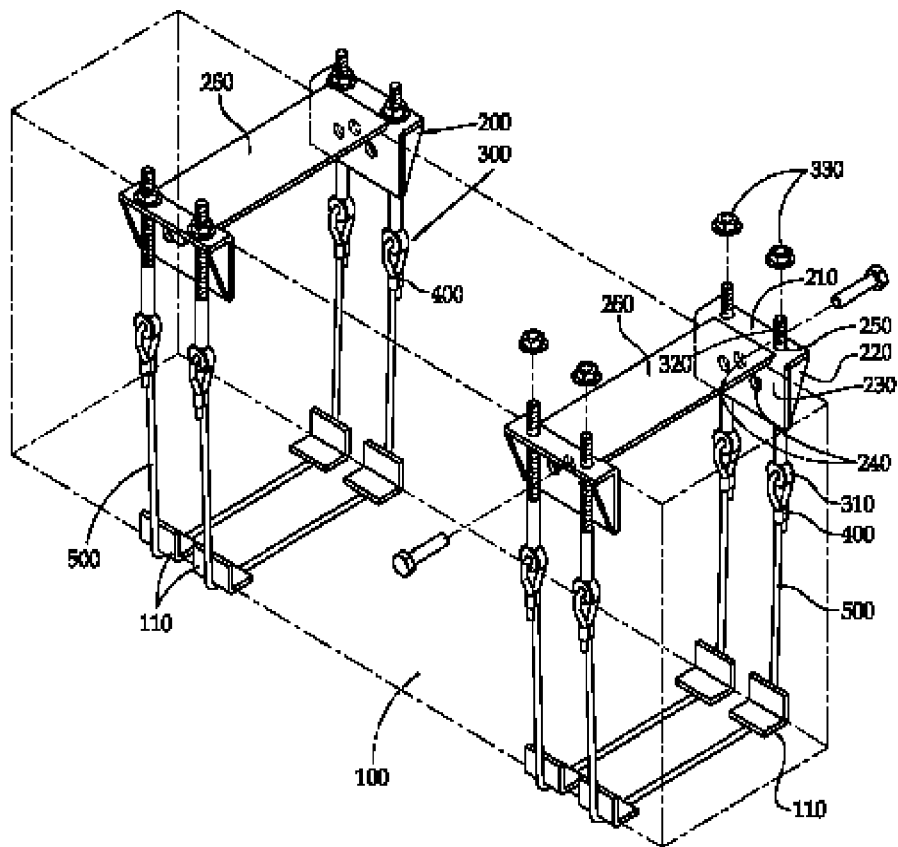
[Fig. 3]



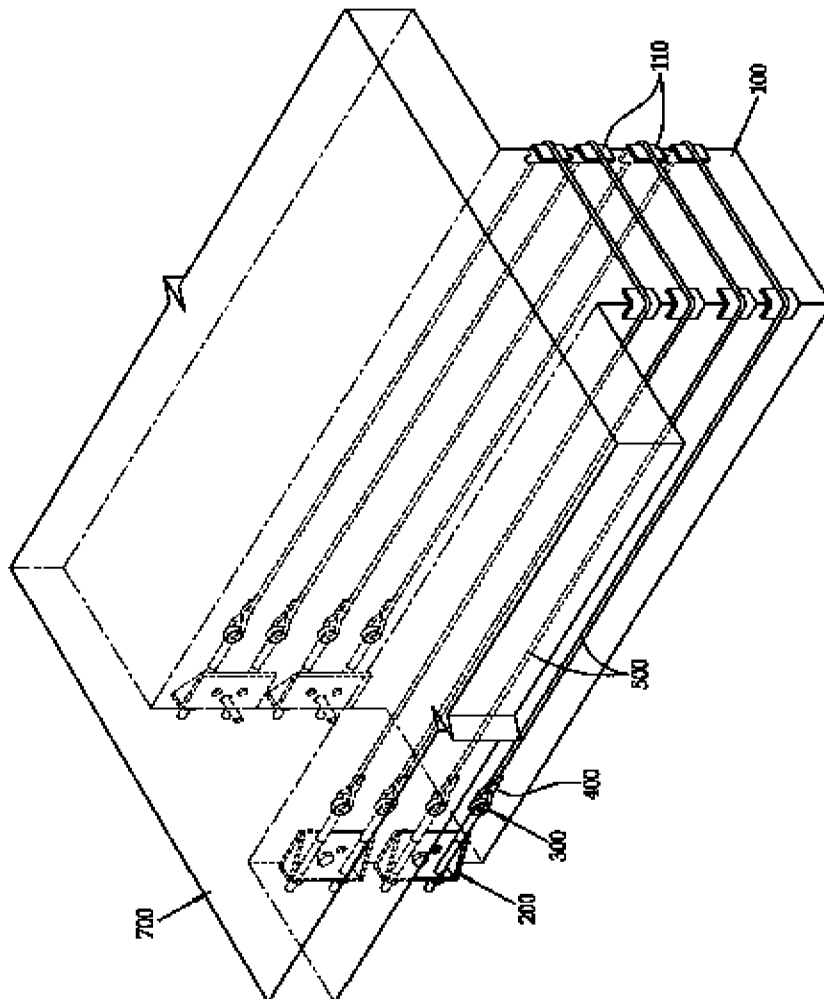
[Fig. 4]



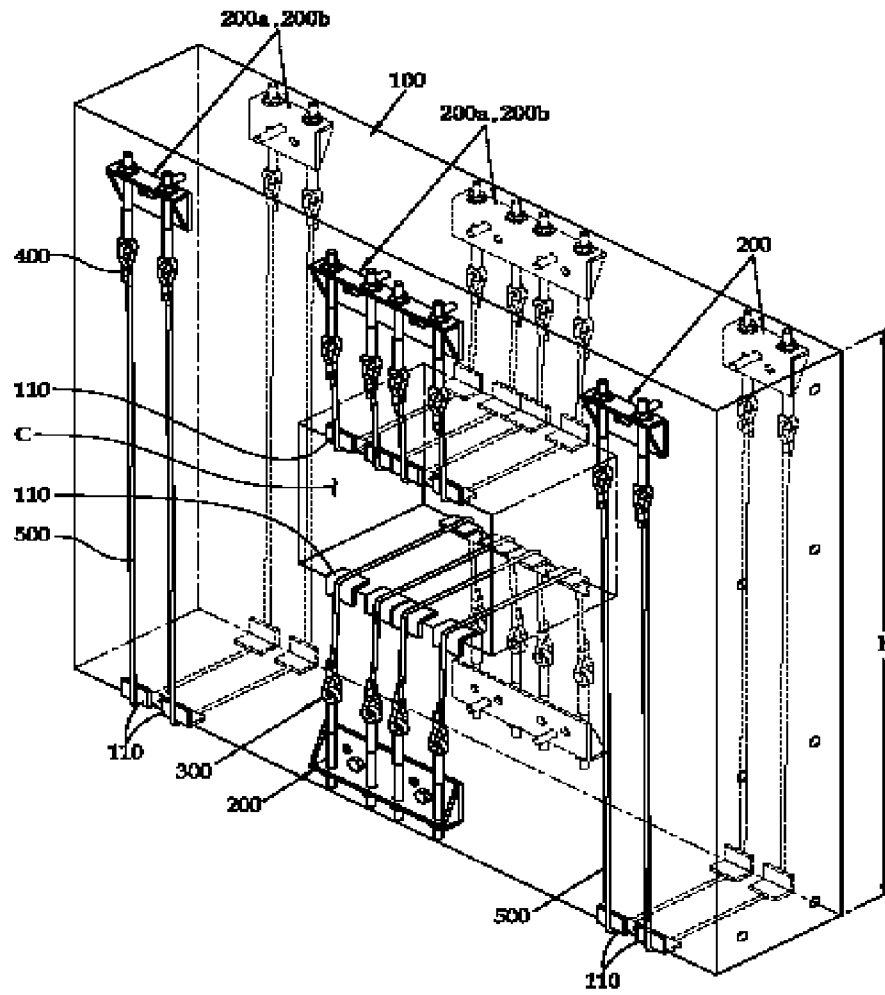
[Fig. 5]



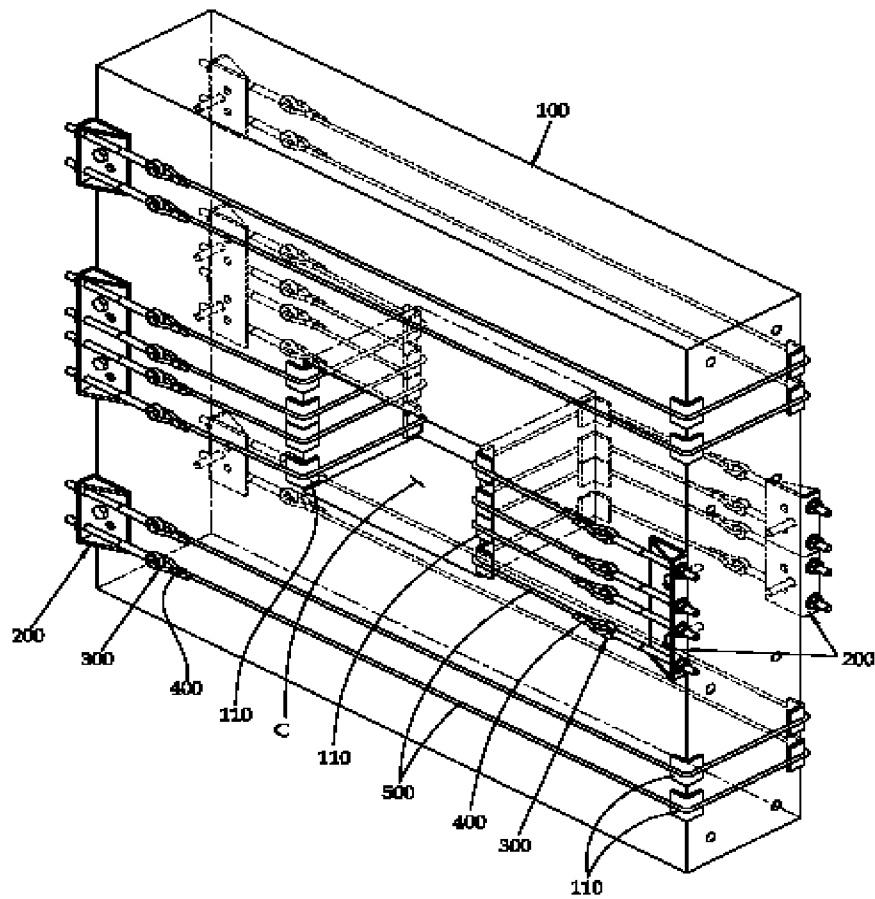
[Fig. 6]



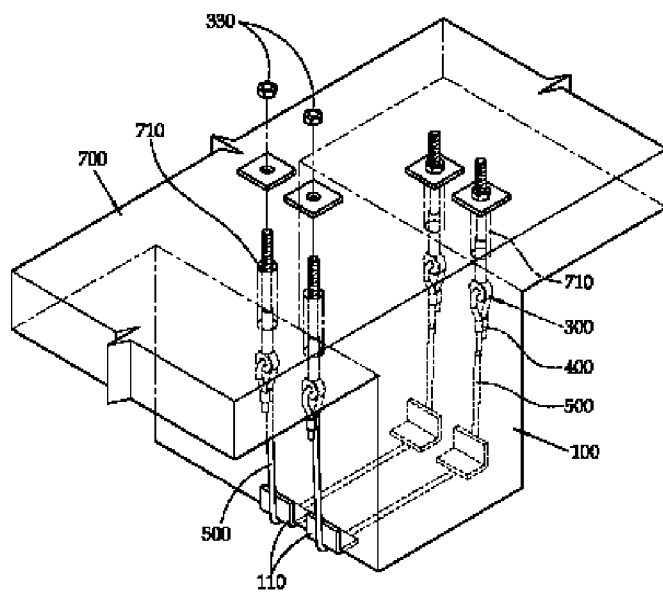
[Fig. 7]



[Fig. 8]



[Fig. 9]



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/KR2006/004219**A. CLASSIFICATION OF SUBJECT MATTER****E04G 23/02(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC8: E04G23/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

KR, JP: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) &amp; keywords: "shear", "reinforce", "tension"

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------|-----------------------|
| A         | US 6 718 723 B1 (AL-TUHAMI ABUZEID AL-TUHAMI) 13 APRIL 2004<br>See figs. 1, 4, 10. | 1-3                   |
| A         | US 5 896 716 A (MAHARAJ K. JALLA) 27 APRIL 1999<br>See figs. 2, 5.                 | 1-3                   |
| A         | JP 64-062558 A (OBA YASHI CORPORATION) 09 MARCH 1989<br>See figs. 1-4.             | 1-3                   |
| A         | KR 10-0375937 B1 (KIM, YANG JUNG) 28 FEBRUARY 2003<br>See fig. 1.                  | 1-3                   |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

16 JANUARY 2007 (16.01.2007)

Date of mailing of the international search report

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

PCT/KR2006/004219

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| US6718723B1                               | 13.04.2004          | NONE                       |                     |
| US5896716A                                | 27.04.1999          | NONE                       |                     |
| JP64-062558A                              | 09.03.1989          | NONE                       |                     |
| KR10-0375937B1                            | 28.02.2003          | NONE                       |                     |