

DESCRIPTION

ANCHORING DEVICE FOR TRANSMITTING SHEARING FORCE WITH
TENSILE RESISTANCE FUNCTION

TECHNICAL FIELD

[0001]

The present invention relates to an anchoring device with tensile resistance function for transmitting a shearing force where a resistance function against a tensile force is provided to an anchoring device that is installed while straddling between a major structure and an additional structure and transmits a shearing force in a direction perpendicular to the direction in which the major structure and the additional structure face each other between both the structures. The major structure and the additional structure are adjacent to each other by being constructed in contact with each other or a similar method, and are movable independently when a horizontal force acts. The major structure and the additional structure are, for example, an existing concrete structure and a newly-built concrete structure constructed in contact with the existing concrete structure, a structure as a main body of a construction and a structure additionally constructed in contact with the main body, or similar structure.

BACKGROUND ART

[0002]

For example, in the case where a newly-built concrete structure (new structure) is constructed in order to compensate the earthquake resistance of an existing concrete structure (old structure), for the purpose of the seismic reinforcement, the newly-built structure (additional structure) is joined to the existing structure (major structure) such that the shearing force during the earthquake is transmitted between the newly-built structure and the existing structure (major structure) (see Patent Documents 1 to 3).

[0003]

On the other hand, for example, in the case where the additional structure (new structure) and the major structure (old structure) behave independently from each other when a horizontal force acts due to a different in flexural rigidity (natural frequency) or similar parameter, the additional structure is forcibly deformed while following (being dragged by) the deformation of the major structure. During the deformation of both these structures, relative rotational deformation might occur between the surfaces facing each other in the respective building frames.

[0004]

Since the deformation of the additional structure by following the deformation of the major structure occurs when bending deformation of the major structure occurs in the direction in which both the structures face each other, the relative rotational deformation between the major structure and the additional structure occurs around the horizontal axis parallel to the plane (in-plane direction of the structure) where both the structures face each other.

[0005]

At this time, a bending moment around the horizontal axis parallel to the surface (boundary surface) where both the structures face each other acts on the joint between the major structure and the additional structure. A tensile force acts on the cross section at one side with respect to the neutral axis of the bending moment while a compressive force acts on the cross section at the other side. The tensile force and the compressive force act while the direction is alternately changed each time the additional structure deforms in a positive or negative direction with respect to the major structure. Therefore, the tensile force and the compressive force act alternately and repeatedly at one side and at the other side of the neutral axis.

[0006]

For example, in the case where the major structure and the additional structure, which have different natural frequencies, are joined together in the respective portions corresponding to the anti-node of vibration, the joint is the portion where the amplitudes of both the structures become largest. Therefore, in the joint, both the structures make a relative movement alternately in the directions close to and away from each other. Accordingly, the tensile force and the compressive force alternately act on the joint.

[0007]

The situation where the tensile force and the compressive force act alternately might occur in a general joint where the major structure and the additional structure are joined together in contact with each other. For example, when the respective superstructures of the major structure and the additional structure cause bending deformation, the respective foundations bear the bending moment to reduce the bending deformation of the superstructures. Accordingly, in the case where the additional structure has a foundation, the tensile force and the compressive force might act on the joint between the foundation of the major structure and the foundation of the additional structure.

[0008]

In contrast to the joint of the structures that are in contact with each other and where the transmission of the bending moment might occur as just described, for example, in the joint that employs the structure where a bending moment is not transmitted between both members like the joint between the foundation of the superstructure and the head of a pile that supports the foundation, it is possible to avoid the action of the tensile force in association with the bending moment on the foundation and the pile head. However, when the foundation bears a horizontal force, the

foundation needs to transmit the horizontal force to the pile head without causing floating from the pile head. Accordingly, the foundation needs to be joined to the pile head in the state where the tensile force the horizontal shearing force can be transmitted at least in the axial direction of the pile (see Patent Document 4).

[0009]

Patent Document 1: Japanese Patent No. 4038472 (paragraphs 0067 and 0080, FIG. 11 and FIG. 12)

Patent Document 2: Japanese Patent No. 4230533 (paragraphs 0081 to 0083, FIG. 6 and FIG. 7)

Patent Document 3: Japanese Patent No. 4628491 (claims 1 to 3, paragraphs 0017 to 0056, FIG. 1, FIG. 3, FIG. 4, and FIG. 8 to FIG. 11)

Patent Document 4: Japanese Unexamined Patent Application Publication No. 2002-070036 (claim 1, paragraphs 0004 to 0006 and 0045 to 0057, FIG. 1 to FIG. 4)

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0010]

In Patent Document 4, in order to avoid an increase in cross section of the pile head due to transmission of a bending moment, the joint between the foundation and the pile head has the structure where relative rotation occurs to some extent. To transmit the pulling upward force that acts on the horizontal force and the foundation during earthquake to the pile, a stress transmission device arranged at the joint is resistant to the shearing force and the tensile force.

[0011]

However, like Patent Document 4, in the case where the foundation and the pile head are joined together in the state where a bending moment is not transmitted, the

foundation and the pile head need to be joined together in the state that allows relative rotational displacement. Therefore, between the member secured to the foundation and the member secured to the pile head, a clearance is ensured in the horizontal direction (in FIG. 1 to FIG. 4, paragraph 0057). Accordingly, a shearing force (horizontal force) is not transmitted in the range of the clearance.

[0012]

Like Patent Document 4, the joint that allows the relative rotational displacement between the structures by formation of the clearance has the structure that does not transmit a bending moment between the structures that can behave independently from each other. Therefore, this joint cannot be applied to the portion between structures that are constructed in contact with each other and are premised on transmission of a bending moment like the portion between the major structure and the additional structure described above. Thus, the structure in Patent Document 4 is only the structure specific for the joint between the foundation and the pile head, and does not have a technique that can be applied (expanded) to a general joint.

[0013]

In view of the above-described background, the present invention proposes an anchoring device with tensile resistance function for transmitting a shearing force in a structure that is applicable to a general joint that transmits a shearing force and a tensile force while transmitting a bending moment like a portion between structures that can behave independently and are adjacent to each other.

SOLUTIONS TO THE PROBLEMS

[0014]

According to the invention in claim 1, an anchoring device with tensile resistance function for transmitting a shearing force has the following constituent

features. The anchoring device is installed while straddling between a major structure and an additional structure adjacently in contact with one another. The major structure and the additional structure are movable independently from each other when a horizontal force acts. The anchoring device is configured to transmit a shearing force between the major structure and the additional structure in a direction perpendicular to a direction in which both the structures face one another. The anchoring device includes: a main anchoring member anchored in a position at a distance from a boundary surface with the additional structure in the major structure; a shear resistant material that is arranged in contact with the boundary surface while straddling between the major structure and the additional structure at the boundary between the major structure and the additional structure, and that bears a shearing force during relative displacement between the major structure and the additional structure; an additional anchoring member anchored on a line passing through the main anchoring member and the shear resistant material in a position at a distance from a boundary surface with the major structure in the additional structure; and a tension member that is bridged between the main anchoring member and the additional anchoring member while passing through the shear resistant material, that is coupled to the main anchoring member and the additional anchoring member, and that bears a tensile force when a distance between the main anchoring member and the additional anchoring member expands. When viewed in an axial direction of the tension member, a portion of the shear resistant material in contact with the boundary surface between the major structure and the additional structure has an area that allows insertion of a plurality of the tension members. When viewed in the axial direction of the tension member, the main anchoring member has a projected area equal to a projected area of the shear resistant material. The main anchoring member is in an state configured to apply a

compressive force to a hardened body in a region sandwiched between the main anchoring member and the shear resistant material in the axial direction of the tension member together with the shear resistant material in pairs.

[0015]

The expression "the major structure and the additional structure behave independently from each other when a horizontal force acts" mainly means that the major structure and the additional structure independently cause bending deformation in the facing direction, and includes the case where a shearing force acts between the major structure and the additional structure and relative deformation (relative

displacement) occurs in the direction perpendicular to the direction in which the major structure and the additional structure face each other. The shearing force that acts between the major structure and the additional structure indicates the force generated during relative deformation (relative displacement) in the direction perpendicular to the direction in which the major structure and the additional structure face each other, and is not limited to the shearing force in the horizontal direction.

[0016]

The tensile force acting between the major structure and the additional structure mainly includes: the tensile force in association with bending moment that acts on the joint when the major structure and the additional structure independently cause bending deformation; and the tensile force when the major structure and the additional structure simply deform in the direction away from each other. The latter tensile force is generated in the case where the major structure and the additional structure that have different natural frequencies are joined together in the respective portion corresponding to the anti-node of vibration.

[0017]

The major structure and the additional structure are mainly a part of reinforced concrete constructions, or may be a part of plain concrete constructions, mortar constructions, or similar construction. For example, the major structure indicates general existing concrete constructions, and the additional structure indicates general additionally (newly) built concrete constructions in contact with the surface of the existing concrete construction. The major structure and the additional structure may be both newly-built constructions. The major structure and the additional structure include both architectural constructions and civil engineering constructions, and correspond to a bridge girder, a pier, a footing, and similar member of a bridge in

addition to a column, a beam, a slab, a foundation, and similar member of a building.

[0018]

The expression "adjacently in contact with one another" is to the effect that any structure and joint can be used in the respective major structure and additional structure insofar as the major structure and the additional structure have a relationship in contact with each other as a result, for example, the major structure and the additional structure are constructed or installed in contact with each other. In the case where the additional structure is a structure similar to the major structure, the joint is, for example, the joint between the slabs, the beams (girders), the columns, the foundations, or similar portion of the old and new structures, or any combination of these portions corresponding to the constructed position of the additional structure or similar parameter, including the joint between the foundation and the pile.

[0019]

In the case where the additional structure functions as seismic (vibration control) reinforcement for the major structure, the additional structure is constructed in the state where the slab, the beam, or similar portion of the additional structure is joined to the surface of any portion of the major structure. Also, any time of construction of the additional structure for the major structure is possible. The time when the additional structure is constructed is the time when the construction of the major structure is completed and the necessity for reinforcing the major structure occurs in the period when the major structure is used or similar time, in addition to the case where the additional structure is constructed immediately after the construction of the major structure like jointing of the major structure and the additional structure.

[0020]

The main anchoring member positioned in the major structure is anchored

(buried) in the major structure while the additional anchoring member positioned in the additional structure is anchored (buried) in the additional structure. The "position at a distance from the boundary surface with the additional structure in the major structure" in which the main anchoring member is anchored is the position getting into the major structure side from the boundary surface between the major structure and the additional structure in the direction in which both the structures face each other. The "position at a distance from the boundary surface with the major structure in the additional structure" in which the additional anchoring member is anchored is the position getting into the additional structure side from the boundary surface between the major structure and the additional structure. Since "the additional anchoring member is anchored on the line passing through the main anchoring member and the shear resistant material," the shear resistant material is positioned in the middle portion on the straight line connecting between the main anchoring member and the additional anchoring member.

[0021]

The shear resistant material is arranged while straddling between the major structure and the additional structure at the boundary between the major structure and the additional structure. Accordingly, during relative displacement between the major structure and the additional structure, the shear resistant material bears the shearing force in the direction of the relative displacement. The direction of the relative displacement includes all the directions perpendicular to the direction in which both the structures face each other, and is not limited to the horizontal direction. The expression "arranged while straddling" means the state having the portion anchored or buried at the respective sides of the major structure and the additional structure and anchored to both sides. When the additional structure causes relative displacement parallel to the boundary surface with respect to the major structure, the anchoring

portion (which may be a main body portion described later) in the major structure receives the reactive force from the major structure. This provides shearing resistance so as to prevent shearing deformation of the additional structure with respect to the major structure.

[0022]

For details, as illustrated in FIG. 1, the shear resistant material 3 has the axial direction (the axial direction of an "insertion hole 3a" described later) oriented to the direction in which the major structure 7 and the additional structure 8 face each other, and includes two portions of an anchoring portion 31 and a main body portion 32. The anchoring portion 31 is anchored to any one structure of a major structure 7 and an additional structure 8. The main body portion 32 is continuous with the anchoring portion 31 and is anchored to the other structure. The anchoring portion 31 fits into a groove 7b formed from the front side of the structure (concrete) on its side.

[0023]

The anchoring portion 31 is, as illustrated in FIG. 1, formed (protrudes) in the position biased to the peripheral area of the main body portion 32 continuously or intermittently in the circumferential direction. The anchoring portion 31 is formed in a ring shape as a whole. To distribute a load in the entire anchoring portion 31 when any portion of the anchoring portion 31 bears a shearing force, the anchoring portion 31 is continuously formed. The expression "intermittently formed" means that the depth of the anchoring portion 31 changes in the circumferential direction like the case where the anchoring portion 31 is formed in a wave shape.

[0024]

The anchoring portion 31 and the main body portion 32 are anchored to the structure on their own sides. During earthquake or similar situation, when relative

displacement (shearing deformation) in the direction parallel to the contact surfaces (boundary surfaces) of both one structure (the major structure 7) and the other structure (the additional structure 8) occurs while the contact surfaces are parallel to each other, the shear resistant material 3 transmits the shearing force between both the structures (the additional structure 7 and the major structure 8).

[0025]

In the case of FIG. 1 where the boundary surface between the major structure 7 and the additional structure 8 is the vertical surface, the shearing force in the vertical direction can be also transmitted in the following case. The shear resistant material 3 has the shape (three-dimensional shape) having similar lengths (projected area) in two directions (the horizontal direction and the vertical direction) and has the shape without orientation in the direction perpendicular to the axial direction, for example, a spherical shape like the main anchoring member 2 illustrated in FIG. 1 when the shear resistant material 3 is viewed in the direction (the direction in FIG. 1 or similar direction) perpendicular to the axial direction. Here, when one structure (the major structure 7) and the other structure (the additional structure 8) behave independently from each other and a bending moment acts on the joint (the boundary surface between the major structure 7 and the additional structure 8), in the case where the shear resistant material 3 provides the function that causes relative rotational deformation around the horizontal axis between the facing surfaces of both the structures 7 and 8, the surface of the main body portion 32 on the additional anchoring member 4 side is formed in a three-dimensional convex shape such as a spherical shape and a curved shape not to hinder the relative rotational deformation of both the structures 7 and 8 like the surface of the main anchoring member 2 on the shear resistant material 3 side illustrated in FIG. 1.

[0026]

The "shape not to hinder the relative rotational deformation of both the structures" means the shape where the structure 8 at the main body portion 32 side can cause rotational deformation relative to the structure 7 at the anchoring portion 31 side along the surface of the main body portion 32 in a convex shape while the anchoring portion 31 of the shear resistant material 3 is anchored to the structure 7 on its side. The "rotational deformation along the surface of the main body portion 32" means that, for example, the other structure (the additional structure 8) rotates to cause sliding along the surface of the main body portion 32 with respect to the one structure (the major structure 7) when viewed in the horizontal direction parallel to the contact surface between the one structure (the major structure 7) and the other structure (the additional structure 8).

[0027]

As described above, the shear resistant material 3 is anchored in the one structure (the major structure 7) in the anchoring portion 31, and is buried in the other structure (the additional structure 8) in the main body portion 32. Accordingly, the shearing force, which is received from the other structure 8, in the direction perpendicular to the axis of a tension member 5 described later is transmitted to the one structure 7. In contrast, the shearing force received from the one structure 7 is transmitted to the other structure 8. As described above, the anchoring portion 31 gets into (fits into) the groove 7b formed from the surface (boundary surface) on the other structure 8 side in the one structure 7 and is anchored to the one structure 7 by filling the inside of the groove 7b with a filler such as mortar and adhesive.

[0028]

FIG. 1 illustrates the state where the anchoring portion 31 of the shear resistant

material 3 fits into the major structure 7 to be anchored while the main body portion 32 is buried in the additional structure 8. In some cases, the anchoring portion 31 fits into the additional structure 8 in FIG. 1 to be anchored while the main body portion 32 is buried in the major structure 7. In either case, in the region sandwiched between: the main anchoring member 2 anchored in the major structure 7; and the shear resistant material 3 arranged at the boundary between the major structure 7 and the additional structure 8, a shearing force might be transmitted from the anchoring portion 31 or the main body portion 32 in the shear resistant material 3, which bears the shearing force. Hereinafter, the region sandwiched between the main anchoring member 2 and the shear resistant material 3 is referred to also as a "hardened body 6" for convenience.

[0029]

The transmission of the shearing force from the shear resistant material 3 to the "hardened body 6" as the region sandwiched between the main anchoring member 2 and the shear resistant material 3 is caused by anchoring (burying) any of the anchoring portion 31 and the main body portion 32 in the "hardened body 6." The "hardened body 6" is formed by filling with a filler after the main anchoring member 2 and the shear resistant material 3 are arranged in the major structure 7 in the case where the major structure 7 is an existing construction. In the case where the major structure 7 is a newly-built construction, the "hardened body 6" is concrete (reinforced concrete), mortar, or similar material constituting a building frame when the major structure 7 is constructed. Regardless of the existing or newly-built construction, the hardened body 6 is concrete, mortar, adhesive, or similar material. The hardened body 6 mainly indicates the cement-based material that causes compressive strength by hardening, and also includes organic adhesive.

[0030]

As illustrated in FIG. 1, in the case where the anchoring portion 31 of the shear resistant material 3 faces the major structure 7 side, and in the case where the anchoring portion 31 is formed within the position within the cross section of the hardened body 6 and buried inside the hardened body 6, a shearing force is transmitted to the hardened body 6 from the anchoring portion 31. In the case where the anchoring portion 31 is formed to be positioned out of the range of the cross section of the hardened body 6, the anchoring portion 31 is not buried in the hardened body 6 and fits into the groove 7b. Accordingly, a shearing force is not transmitted directly to the hardened body 6 from the anchoring portion 31, but is transmitted indirectly. In the case where the anchoring portion 31 faces the additional structure 8 side, at least a part of the main body portion 32 is buried in the hardened body 6. Accordingly, a shearing force is transmitted to the hardened body 6 from the buried portion.

[0031]

In the case where at least a part of the anchoring portion 31 or the main body portion 32 of the shear resistant material 3 is buried in the hardened body 6, the shear resistant material 3 bears the shearing force in association with relative displacement of the additional structure 8 with respect to the major structure 7. When a shearing force is transmitted to the major structure 7 from the shear resistant material 3, a part of the shearing force is also transmitted to the hardened body 6. As illustrated in FIG. 1, in the situation where the outer peripheral surface of the anchoring portion 31 in the shear resistant material 3 is in contact with the building frame of the major structure 7 and the inner peripheral surface of the anchoring portion 31 is in contact with the hardened body 6, a shearing force is transmitted to the building frame of the major structure 7 from the outer peripheral surface of the anchoring portion 31 and a shearing force is transmitted to the hardened body 6 from the inner peripheral surface.

[0032]

In the center portion or similar portion when the shear resistant material 3 is viewed in the axial direction, the insertion hole 3a for inserting the tension member 5 is formed. The tension member 5 passes through the main body portion 32 in the axial direction, and is anchored to both the structure 7 and 8. This insertion hole 3a allows insertion of the tension member 5 that causes a shearing force to act on the shear resistant material 3 during relative displacement of the additional structure 8 with respect to the major structure 7 while causing a tensile force, which is caused by a bending moment acting between the major structure 7 and the additional structure 8, to act between the major structure 7 and the additional structure 8. Also when relative displacement is caused in the direction in which the major structure 7 and the additional structure 8 face each other, a tensile force and a compressive force alternately and directly act between the major structure 7 and the additional structure 8.

[0033]

The tension member 5 is coupled to the additional anchoring member 4 in the additional structure 8, and is coupled to the main anchoring member 2 in the major structure 7. Accordingly, for example, when the additional structure 8 causes bending deformation with respect to the major structure 7, the tension member 5 bears the tensile force caused by the bending moment acting from the additional anchoring member 4 or bears the above-described direct tensile force so as to transmit the tensile force to the main anchoring member 2. When the major structure 7 causes bending deformation with respect to the additional structure 8, a tensile force is transmitted to the additional anchoring member 4 through the tension member 5 from the main anchoring member 2. The condition where a tensile force is transmitted to the main anchoring member 2 from the additional anchoring member 4 and the condition where a tensile force is transmitted

to the additional anchoring member 4 from the main anchoring member 2 occur alternately.

[0034]

The tension member 5 is arranged in the state inserted through the insertion hole 3a of the shear resistant material 3 and in the state straddling between the major structure 7 and the additional structure 8. The main anchoring member 2 and the additional anchoring member 4, which are anchored to the major structure 7 and the additional structure 8, are coupled to both the end portions of the tension member 5. Accordingly, the tension member 5 functions to transmit the shearing force received from the additional structure 8 (the major structure 7) to the major structure 7 (the additional structure 8) together with the shear resistant material 3 in the acting direction of the shearing force. Additionally, the tension member 5 compensates the shearing-force transmitting ability of the shear resistant material 3 and also provides a restoring function after the relative rotational deformation between the major structure 7 and the additional structure 8.

[0035]

The tension member 5 is maintained in the state anchored to the respective major structure 7 and additional structure 8 on both sides sandwiching the shear resistant material 3. Accordingly, the tension member 5 causes bending deformation or causes bending deformation and extensional deformation within the elastic range, so as to follow relative rotational deformation between the major structure 7 and the additional structure 8 while bearing bending moment in the acting direction of the bending moment. The tension member 5 causes bending deformation within the elastic range, so as to follow relative rotational deformation of both the structures 7 and 8 and function as a spring for restoring the deformation after the rotational deformation

ends. The main anchoring member 2 and the additional anchoring member 4 as both the end portions of the tension member 5 in the axial direction are maintained in the state anchored to the respective major structure 7 and additional structure 8.

Accordingly, the tension member 5 also functions to reduce (restrict) the separation between the major structure 7 and the additional structure 8 in the case where the deformation of the tension member 5 occurs in association with the extensional deformation.

[0036]

The tension member 5 mainly employs a bar-like steel material such as reinforcing steel, a bolt (anchor bolt), and bar steel, and also employs fiber-reinforced plastic. In the case where the tension member 5 employs a bolt or threaded reinforcing steel, a nut 33 for clamping the tension member 5 to the shear resistant material 3 might be attached to the tension member 5. While in FIG. 1 the nut 33 is arranged only at the additional anchoring member 4 side of the shear resistant material 3, the nut 33 might be arranged on both sides sandwiching the shear resistant material 3. In the case where a nut is coupled to the end portion of the tension member 5 in the axial direction, the nut 41 functions to ensure an anchoring effect (pulling out resistance) in both the structures 7 and 8 together with the additional anchoring member 4. In the case where the nut 33 is coupled to the position in contact with the shear resistant material 3, the nut 33 functions to join (restrict) the tension member 5 to the shear resistant material 3 such that the position of the tension member 5 with respect to the shear resistant material 3 is not changed. The insertion hole 3a of the main body portion 32 is formed in the center portion or similar portion of the main body portion 32, but is not necessarily formed in one portion in the center of the main body portion 32. A plurality of the insertion holes 3a might be formed.

[0037]

When the tension member 5 functions as a resistance element with respect to the shearing force in the direction perpendicular to the axis of the tension member 5, the resistance force corresponding to the projected area of the tension member 5 in the acting direction of the shearing force is added to the shearing resistance of the anchoring portion 32. In the case where the tension member 5 is expected to function as the resistance element with respect to the shearing force, the diameter (thickness) and the length corresponding to the shearing resistance to be expected are provided.

[0038]

The tension member 5 may be integrated with the main body portion 32 of the shear resistant material 3 by being threadably mounted on the insertion hole 3a formed in the shear resistant material 3 or by being simply inserted through the insertion hole 3a and filling the inside of the insertion hole 3a with adhesive, mortar or similar material. However, to transmit most of the tensile force borne by the tension member 5 to the main anchoring member 2 when the additional structure 8 causes relative displacement with respect to the major structure 7, it is preferred to ensure a certain amount of clearance between the inner peripheral surface of the insertion hole 3a and the surface of the tension member 5 in the state where the tension member 5 is inserted through the inside of the insertion hole 3a of the shear resistant material 3 (the main body portion 32). This is because, while the tensile force borne by the tension member 5 is likely to be transmitted to the shear resistant material 3 in the case where the tension member 5 is threadably mounted on the shear resistant material 3, the tensile force of the tension member 5 becomes more likely to be transmitted to the main anchoring member 2 by simply inserting the tension member 5 through the shear resistant material 3.

[0039]

The tension member 5 passes through the shear resistant material 3 to be bridged between the main anchoring member 2 and the additional anchoring member 4. Accordingly, a tensile force acts on the additional anchoring member 4 and the main anchoring member 2 through the tension member 5 when the bending moment around the horizontal axis parallel to the boundary surface between the additional structure 8 and the major structure 7 acts between the additional structure 8 and the major structure 7, or when relative displacement occurs in the direction in which the additional structure 8 and the major structure 7 face each other between both the structures without being associated with a bending moment. The tension member 5 bears a tensile force when the distance between the main anchoring member 2 and the additional anchoring member 4 expands.

[0040]

In the major structure 7, insofar as the shear resistant material 3 is maintained in contact with the boundary surface between the major structure 7 and the additional structure 8 when a tensile force is transmitted to the main anchoring member 2 from the tension member 5, as illustrated by the arrows in FIG. 1, a compressive force acts on the hardened body 6 such as concrete that is present between the main anchoring member 2 and the shear resistant material 3. The hardened body 6 bears the compressive force while the reactive force of the compressive force acts on the main anchoring member 2 and the shear resistant material 4.

[0041]

At this time, a pair of the main anchoring member 2 and the shear resistant material 3 provides the hardened body 6 with the compressive force in the axial direction of the hardened body 6. Accordingly, it is appropriate that the main anchoring member 2 and the shear resistant material 3 have similar projected areas with

respect to the plane perpendicular to the axial direction of the hardened body 6 when viewed in the axial direction of the hardened body 6. In the drawing, in the entire shear resistant material 3, the anchoring portion 31 is formed in a ring shape at the inner peripheral side with respect to the outer periphery of the main body portion 32. The inner peripheral surface of the anchoring portion 31 corresponds to the outer peripheral surface of the hardened body 6. Accordingly, the projected area of the range including the anchoring portion 31 that can cause the compressive force to act on the hardened body 6 from the shear resistant material 3 is equal to the projected area of the main anchoring member 2. The portion of the main body portion 32 at the outer peripheral side of the anchoring portion 31 provides a compressive force to the building frame of the major structure 7 that is present at the outer peripheral side of the hardened body 6.

[0042]

The hardened body 6 between the main anchoring member 2 and the shear resistant material 3 bears a compressive force and resists against a compressive force. Accordingly, the main anchoring member 2 is maintained in the state anchored in the major structure 7 (in the hardened body 6), and the shear resistant material 3 is maintained in the state arranged at the boundary between the major structure 7 and the additional structure 8.

[0043]

In the case where the major structure 7 is an existing construction, the main anchoring member 2 is installed on the far-side (bottom side) of drilling 7a formed by coring of existing concrete using a core drill or similar tool and anchored in the hardened body 6 by filling a filler in the drilling 7a and hardening. Since the hardened body 6 is formed of concrete, mortar, adhesive, and similar material, the hardened body 6 is integrated with the building frame of the existing construction by hardening within

the drilling 7a. In the case where the major structure 7 is a newly-built construction, it is only necessary to arrange the main anchoring member 2 in the position at a distance from the boundary surface with the additional structure 8 in the major structure 7.

Since the inner peripheral surface of the drilling 7a after coring is the boundary surface with the hardened body 6, chipping (giving unevenness) is performed as necessary on the inner peripheral surface of the drilling 7a so as to ensure attachment between the major structure 7 and the hardened body 6.

[0044]

Regardless of whether the major structure 7 is the existing construction or the newly-built construction, when the main anchoring member 2 is installed or before the main anchoring member 2 is installed, the tension member 5 is coupled to the main anchoring member 2, the shear resistant material 3 is coupled to the middle portion of the tension member 5 in the axial direction, and the main anchoring member 2, the shear resistant material 3, and the tension member 5 are buried in the hardened body 6. The section of the tension member 5 projecting from the major structure 7 and the additional anchoring member 4 are buried in the building frame of the additional structure 8 when the additional structure 8 is constructed.

[0045]

When the tensile force from the additional anchoring member 4 is transmitted to the main anchoring member 2, in the case where the tension member 5 is coupled to the shear resistant material 3 by being threadably mounted or similar method, a part of the tensile force generated in the tension member 5 is transmitted to the shear resistant material 3. Accordingly, the tensile force acting on the main anchoring member 2 is reduced and the compressive force borne by the hardened body 6 is reduced correspondingly. In this case, a part of the tensile force that is transmitted to the shear

resistant material 3 and to be borne by the shear resistant material 3 is borne by the major structure 7 due to the attachment force (through the attachment force) with the major structure 7 or with the hardened body 6 in the anchoring portion 31 anchored in the major structure 7.

[0046]

In the case where the tension member 5 is not coupled to the shear resistant material 3, as described above, the tension member 5 is in the state where the shear resistant material 3 is simply inserted. Accordingly, most of the tensile force from the tension member 5 is transmitted to the main anchoring member 2 and transmitted to the hardened body 6 from the main anchoring member 2 as a compressive force. The state where "the tension member 5 is not coupled to the shear resistant material 3" corresponds to the case where the tension member 5 is inserted through the insertion hole 3a of the shear resistant material 3 while having a clearance, a filler is not filled with the clearance, and the nut 33 is not threadably mounted on the tension member 5.

[0047]

When a compressive force is transmitted to the hardened body 6 from the main anchoring member 2 as the reactive force of a tensile force, the entire surface of the main anchoring member 2 receives the reactive force from the hardened body 6 as a bearing pressure. Accordingly, the main anchoring member 2 becomes the state where the entire main anchoring member 2 bears the bending moment in direction perpendicular to the axis (the coupling portion with the tension member) around the axis. The shape of the main anchoring member 2 may have a flat plate shape or a curved shape. However, in the case where the main anchoring member 2 is assumed to be deformed by bearing the bending moment due to the bearing pressure, it is possible to provide the main anchoring member 2 with stability and safety with respect to the

bending deformation by forming the surface of the main anchoring member 2 on the shear resistant material 3 side in a curved surface shape as illustrated in FIG. 1 or similar drawing (in claim 2).

[0048]

For example, as illustrated in FIG. 1, FIG. 2, and FIG. 4 to FIG. 6, formation of the main anchoring member 2 in a curved surface shape is formation of the surface on the shear resistant material 3 side of the main anchoring member 2 in a curved surface shape such as a spherical surface, an elliptic curved surface, and a conical curved surface that is convex toward the shear resistant material 3 side. However, if the main anchoring member 2 has a flat plate shape, it is possible to resist to the bending moment due to the bearing pressure by forming a protrusion (rib) or similar member in at least any one of the surface on the major structure 7 side and the surface on the additional structure 8 side in the main anchoring member 2. Accordingly, the main anchoring member 2 need not necessarily have a curved shape, and may have a flat plate shape.

[0049]

When the tensile force from the additional anchoring member 4 anchored in the additional structure 8 is transmitted to the tension member 5 or the main anchoring member 2, the additional anchoring member 4 receives the reactive force of the tensile force from the additional structure 8, similarly to the main anchoring member 2. Accordingly, the surface on the shear resistant material 3 side of the additional anchoring member 4 or the surface on the opposite side might be formed in a convex curved surface shape or a protrusion might be formed in the additional anchoring member 4. Corresponding to the width, the depth, and similar parameter of the additional structure 8, and the section (distance) in the axial direction of the tension member 5 buried in the additional structure 8, a plurality of the additional anchoring

members 4 might be arranged in the axial direction of the tension member 5 in the additional structure 8 so as to be coupled to the tension member 5.

[0050]

As described above, in the case where at least a part of the anchoring portion 31 or the main body portion 32 of the shear resistant material 3 is buried in the hardened body 6 as the region sandwiched between the main anchoring member 2 and the shear resistant material 3, a part of shearing force is also transmitted to the hardened body 6 when the shear resistant material 3 bears the shearing force. At this time, the hardened body 6 bears the shearing force in the direction perpendicular to the axis. To reliably prevent breaking due to bearing this shearing force, as illustrated in FIG. 6, it is appropriate to arrange confining steel 9 "in the region sandwiched between the main anchoring member and the shear resistant material in the major structure" within the hardened body 6 (claim 3). The confining steel 9 confines that region from the periphery, for example, in a helical shape (spiral shape), a ring shape (hoop shape), or similar shape. The confining steel 9 confines the portion in its inside from the peripheral portion within the hardened body 6 to increase the shear capacity of the hardened body 6 so as to ensure safety for shear failure.

EFFECTS OF THE INVENTION

[0051]

Between the major structure and the additional structure that are adjacently in contact with each other and can behave independently from each other when a horizontal force acts, the main anchoring member is anchored in the position at a distance from the boundary surface with the additional structure in the major structure while the additional anchoring member is anchored in the position at a distance from the boundary surface with the major structure in the additional structure. The tension

member, which can bear a tensile force, is bridged between the main anchoring member and the additional anchoring member. This allows a tensile force to act on the main anchoring member through the tension member when the distance between the main anchoring member and the additional anchoring member expands.

[0052]

When a tensile force is transmitted to the main anchoring member, the hardened body such as concrete present between the shear resistant material, which is arranged while straddling the boundary between the major structure and the additional structure, and the main anchoring member bears a compressive force to maintain the main anchoring member in the anchored state. This allows maintaining the main anchoring member in the state anchored in the major structure. The shear resistant material straddles the boundary between the major structure and the additional structure to bear the shearing force between the major structure and the additional structure. Eventually, the anchoring device can transmit a shearing force and a tensile force between the major structure and the additional structure in any of the joint where the tensile force in association with bending moment acts and the joint where a tensile force and a compressive force directly and alternately act between the major structure and the additional structure adjacent to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053]

FIG. 1 is a vertical cross-sectional view illustrating the state where a main anchoring member is buried in a major structure, an additional anchoring member is buried in an additional structure, and a tension member is bridged between the main anchoring member and the additional anchoring member while passing through the shear resistant material arranged at the boundary between the major structure and the

additional structure.

FIG. 2 is a perspective view illustrating the joint between a wall or a beam of an existing construction and a beam of a newly-built construction as the example of the major structure and the additional structure where an anchoring device illustrated in FIG. 1 is buried.

FIG. 3 is a perspective view illustrating the state where the anchoring device illustrated in FIG. 1 is installed between a foundation (footing) of an existing construction as the major structure and a foundation of a newly-built construction of the additional structure.

FIG. 4 is an enlarged perspective view of the anchoring device illustrated in FIG. 3 in the case where the main anchoring member is formed in a half spherical shape.

FIG. 5 is an enlarged perspective view of the anchoring device illustrated in FIG. 3 in the case where the main anchoring member is formed in a conical shape.

FIG. 6 is a perspective view illustrating the state where a shear reinforcement bar, which reinforces a hardened body, in a spiral pattern is arranged between the main anchoring member and the shear resistant material of the anchoring device illustrated in FIG. 5.

FIG. 7A is an elevation illustrating a concrete example of an anchoring device formed in a shape different from that of the anchoring device illustrated in FIG. 1 or similar drawing.

FIG. 7B is a vertical cross-sectional view illustrating a drilling into which the anchoring device illustrated in FIG. 7A fits.

FIG. 8A is an elevation illustrating another concrete example of an anchoring device formed in a shape different from that of the anchoring device illustrated in FIG. 1 or similar drawing.

FIG. 8B is a vertical cross-sectional view illustrating a drilling into which the anchoring device illustrated in FIG. 8A fits.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0054]

Hereinafter, a description will be given of best modes for carrying out the invention with respect to the drawings.

[0055]

FIG. 1 illustrates the configuration example and the installation example of an anchoring device 1 with tensile resistance function for transmitting a shearing force (hereinafter referred to as the anchoring device) that is installed while straddling between a major structure 7 and an additional structure 8 that are adjacent to each other by being constructed, installed, or similar method in contact with each other and can behave independently from each other when a horizontal force acts and that transmits a shearing force between the major structure 7 and the additional structure 8 in the direction perpendicular to the direction in which both these structures 7 and 8 face each other. Any joint between the major structure 7 and the additional structure 8 is possible insofar as the major structure 7 and the additional structure 8 are in contact with each other. The major structure 7 and the additional structure 8 may be newly-built constructions or existing constructions.

[0056]

The anchoring device 1 includes: a main anchoring member 2, a shear resistant material 3, an additional anchoring member 4, and a tension member 5. The main anchoring member 2 is anchored (buried) in the position at a distance from the boundary surface with the additional structure 8 in the major structure 7. The shear resistant material 3 is arranged while straddling between the major structure 7 and the

additional structure 8 at the boundary between the major structure 7 and the additional structure 8. The additional anchoring member 4 is anchored (buried) in the position at a distance from the boundary surface with the major structure 7 in the additional structure 8. The tension member 5 is bridged between the main anchoring member 2 and the additional anchoring member 4. The additional anchoring member 4 is anchored on the line passing through the main anchoring member 2 and the shear resistant material 3. The tension member 5 passes through the shear resistant material 3 so as to be bridged between the main anchoring member 2 and the additional anchoring member 4, and bears the tensile force when the distance between the main anchoring member 2 and the additional anchoring member 4 attempts to expand.

[0057]

FIG. 1 and FIG. 2 illustrate the installation examples of the anchoring device 1 on the major structure 7 and the additional structure 8 in the case where the major structure 7 is a building frame such as a beam and a wall in an existing reinforced concrete construction while the additional structure 8 is a building frame such as a beam in a newly-built reinforced concrete construction. In the case where the major structure 7 is the existing construction, a drilling 7a for disposing the main anchoring member 2 and the shear resistant material 3 from the front side is formed in the building frame of the concrete of the major structure 7. After the main anchoring member 2 and the shear resistant material 3 are arranged in the drilling 7a, the inside of the drilling 7a is filled with a filler made of cement-based material or other materials such as concrete, mortar, and adhesive. The filler is hardened inside the drilling 7a so as to be a hardened body 6. The hardened body 6 also indicates a part (such as concrete) of the building frame in the newly-built construction.

[0058]

In the case where the major structure 7 is an existing construction, the anchoring device 1 is inserted into the drilling 7a, for example, in the state where the tension member 5 is coupled to the main anchoring member 2 and where the shear resistant material 3 is temporarily joined to the tension member 5 to be biased to the additional anchoring member 4. In the state where the main anchoring member 2 is arranged in the deep side of the drilling 7a, a filler that becomes the hardened body 6 is filled from the vicinity of the boundary surface between the major structure 7 and the additional structure 8. Since an insertion hole 3a, which causes the insertion of the tension member 5, is formed in the shear resistant material 3, ensuring the void (clearance) in the peripheral area of the tension member 5 while the tension member 5 is inserted through the insertion hole 3a allows filling the filler through the insertion hole 3a. Accordingly, the shear resistant material 3 might be arranged on the boundary surface between the major structure 7 and the additional structure 8 in the state where the distance with the main anchoring member 2 is preliminarily adjusted to the distance in the installation state.

[0059]

The tension member 5 is bridged between the main anchoring member 2 and the additional anchoring member 4. The tensile force from the additional anchoring member 4 anchored in the additional structure 8 is transmitted to the tension member 5, and is further transmitted to the main anchoring member 2. Accordingly, the tension member 5 is coupled in a state where the tensile force can be transmitted, basically by being threadably mounted on both the main anchoring member 2 and the additional anchoring member 4 or by being inserted through these members and filling of the filler or similar method. In FIG. 1, the tension member 5 is coupled by being threadably mounted on the main anchoring member 2 and the additional anchoring member 4.

[0060]

In the drawing, the shear resistant material 3 side of the main anchoring member 2 is formed in a convex curved shape (spherical shape) in order to prevent the deformation when the main anchoring member 2 transmits the tensile force from the tension member 5 to the hardened body 6 as the compressive force. In association with this configuration, in the center of the main anchoring member 2 when the main anchoring member 2 is viewed in the axial direction, an inserting portion 21, which has an insertion hole 2a for causing insertion of the tension member 5, is formed in a cylindrical shape so as to have an additional section for threadably mounting the tension member 5. On the inner peripheral surface of the insertion hole 2a, a female screw is threaded. On this female screw, a male screw of the tension member 5 is threadably mounted.

[0061]

In the drawing, the additional anchoring member 4 in a plate (flat plate) shape is coupled to the tension member 5 with nuts 41 and 41 clamped on both sides in the thickness direction. Similarly to the main anchoring member 2, a cylindrical portion may be formed to directly couple the additional anchoring member 4 by threadably mounting this member. Similarly to the main anchoring member 2, the additional anchoring member 4 may be formed in a curved surface shape convex toward the shear resistant material 3 side or toward the opposite side or in a curved surface shape convex toward both sides. In the additional structure 8, a plurality of the additional anchoring members 4 may be arranged in the axial direction of the tension member 5 so as to be coupled to the tension member 5.

[0062]

The shear resistant material 3 includes the anchoring portion 31, which is

anchored to any one structure of the major structure 7 and the additional structure 8, and the main body portion 32, which is anchored (buried) in the other structure. The anchoring portion 31 is anchored to the one structure while the main body portion 32 is anchored (buried) in the other structure. Accordingly, when the one structure moves relative to the other structure while being maintained to be parallel to each other, the shear resistant material 3 transmits a shearing force in the direction perpendicular to the axis of the tension member 5 to the other structure. In the drawing, the anchoring portion 31 fits into the groove 7b formed in the major structure 7 so as to be anchored while the main body portion 32 is buried in the additional structure 8. The anchoring portion 31 may be anchored to the additional structure 8 while the main body portion 32 is buried in the major structure 7. The groove 7b may be a part of the drilling 7a as illustrated in FIG. 1 or may be formed separately from the drilling 7a.

[0063]

In FIG. 1, the anchoring portion 31 of the shear resistant material 3 is disposed to protrude toward the major structure 7 side in the axial direction from the inner side biased to the center side (the insertion hole 3a side) with respect to the outer periphery (edge) in the main body portion 32. The anchoring portion 31 may be disposed to protrude from the outer periphery (edge) of the main body portion 32. As illustrated in FIG. 1, in the case where the anchoring portion 31 is disposed to protrude at the inner side with respect to the outer periphery of the main body portion 32, when the anchoring portion 31 fits into the groove 7b of the major structure 7, the portion at outer periphery side with respect to the anchoring portion 31 in the main body portion 32 is brought into contact (close contact) with the boundary surface with the additional structure 8 in the major structure 7 so as to lock the major structure 7 side.

[0064]

Accordingly, the portion of the main body portion 32 at the outer periphery side with respect to the anchoring portion 31 can transmit a tensile force to the building frame of the major structure 7 when the tensile force acts from the major structure 7 side to the additional structure 8 side through the tension member 5, so as to resist to the tensile force. As a result, the shear resistant material 3 functions to project from the main body portion 32 to the additional structure 8 side in response to the tensile force acting from the major structure 7 side to the additional structure 8 side, so as to cause the additional structure 8 to behave integrally with the major structure 7 via the tension member 5 and the additional anchoring member 4, which are buried in the additional structure 8. The portion at the outer periphery side with respect to the anchoring portion 31 also becomes the resistance element against the bending moment that acts on the boundary surface between the major structure 7 and the additional structure 8 when the additional structure 8 causes rotational deformation with respect to the major structure 7 around the horizontal axis in the direction perpendicular to the facing direction.

[0065]

In the shear resistant material 3, the surface on the major structure 7 side in the portion at the inner peripheral side of the annular anchoring portion 31 including the anchoring portion 31 is in contact with the hardened body 6 in the drilling 7a. The area of this contact surface with the hardened body 6 applies a compressive force in the axial direction of the tension member 5 to the hardened body 6 together with the main anchoring member 2 in pairs. The main anchoring member 2 is maintained in the state anchored in the hardened body 6 by the resistance of the hardened body 6 in the drilling 7a to the compressive force received from the shear resistant material 3 and the main anchoring member 2.

[0066]

In the shear resistant material 3, one or more of the insertion holes 3a, which cause insertion of the tension member 5, are formed in the center portion or similar portion within the surface parallel to the boundary surface between the major structure 7 and the additional structure 8. The tension member 5 is inserted through this insertion hole 3a while having a clearance or threadably mounted on this insertion hole 3a as illustrated in FIG. 1. In the case where a plurality of the insertion holes 3a are formed, a plurality of the tension members 5 are used. Then, one of the tension members 5 is inserted through each insertion hole 3a. In the case where the tension member 5 is threadably mounted, a female screw is threaded on the inner peripheral surface of the insertion hole 3a. As illustrated in FIG. 1, in the case where the tension member 5 is threadably mounted on the insertion hole 3a, the tension member 5 becomes the state integrally coupled to the shear resistant material 3 by clamping a nut 33 threadably mounted on the male screw of the tension member 5.

[0067]

In the case where the tension member 5 is inserted through the insertion hole 3a, the clearance may be left or the clearance may be filled with a filler. In the case where the clearance is left and the nut 33 is not threadably mounted on the tension member 5, the tension member 5 and the shear resistant material 3 are relatively movable in the axial direction of the tension member 5 under the situation where the additional structure 8 is separated from the major structure 7 (boundary crack). In this case, only the tension member 5 is assumed to expand in association with the deformation of the additional structure 8 while the shear resistant material 3 is anchored to the major structure 7. Insofar as the shear resistant material 3 remains in the major structure 7, the state where a compressive force is applied to the hardened body 6 from

the main anchoring member 2 and the shear resistant material 3 is maintained. In the case where the clearance is filled with the filler and in the case where the tension member 5 is threadably mounted, the tensile force of the tension member 5 is transmitted to the shear resistant material 3 and the tensile force is dispersed and borne by the shear resistant material 3 and the main anchoring member 2.

[0068]

In the case where the tensile force generated in the tension member 5 is dispersed and borne by the shear resistant material 3 and the main anchoring member 2, the tensile force from the shear resistant material 3 is transmitted to the building frame of the major structure 7 and the hardened body 6 by the attachment force in the outer peripheral surface and the inner peripheral surface of the anchoring portion 31 of the shear resistant material 3.

[0069]

The tensile force transmitted from the tension member 5 to the main anchoring member 2 is transmitted to the hardened body 6, which is filled in the drilling 7a portion from the surface on the shear resistant material 3 side at the front side of the main anchoring member 2, and is transmitted to the hardened body 6 in the drilling 7a from the front side of the main anchoring member 2 as a compressive force. Since the compressive force transmitted to the hardened body 6 is borne by the surface on the main anchoring member 2 side of the shear resistant material 3, as described above, the hardened body 6 in the drilling 7a receives the compressive force in the axial direction from the main anchoring member 2 and the shear resistant material 3.

[0070]

When a compressive force acts from the main anchoring member 2 to the hardened body 6, the main anchoring member 2 receives a bearing pressure (contact

pressure) as the reactive force of the compressive force in the axial direction of the tension member 5. Accordingly, to ensure stability for this bearing pressure, the main anchoring member 2 is formed in the curved surface shape convex toward the shear resistant material 3 side in the drawing. Forming the main anchoring member 2 in the curved surface shape increases the projected area in the direction to the shearing force borne by the shear resistant material 3. Thus, the main anchoring member 2 also has ability to resist to the shearing force in the same direction as that of the shearing force borne by the shear resistant material 3. As described above, the pair of the main anchoring member 2 and the shear resistant material 3 applies a compressive force to the hardened body 6. Thus, the surface on the main anchoring member 2 side of the shear resistant material 3 may be formed in a convex curved surface shape.

[0071]

The hardened body 6 in the drilling 7a receives the compressive force in the axial direction when the tensile force is transmitted to the main anchoring member 2 from the tension member 5, and additionally receives the shearing force borne by the shear resistant material 3. Accordingly, for the purpose of reinforcement for the shearing force, in FIG. 6, a confining steel 9 in a spiral shape is arranged at the vicinity of the outer periphery side with respect to the axis within the hardened body 6 so as to confine the deformation of the hardened body 6. The confining steel 9 may have a ring shape (hoop shape). In this case, a plurality of pieces of the confining steel 9 is arranged at intervals in the axial direction within the hardened body 6.

[0072]

FIG. 2 illustrates a specific arrangement example of the anchoring devices 1 illustrated in FIG. 1 at the joint (boundary surface) between the major structure 7 and the additional structure 8. Here, the drawing illustrates the interface of both the structures

7 and 8 and the arrangement state (distance) of the anchoring devices 1 when the boundary surface is viewed in the longitudinal direction in the case where the major structure 7 is a building frame such as a beam and a wall of an existing construction and the additional structure 8 is a building frame such as a beam of a newly-built construction as described above.

[0073]

In the example of FIG. 2, the major structure 7 and the additional structure 8 are both the building frames in shapes having the boundary surfaces continuous with each other. Accordingly, the anchoring devices 1 are arranged at intervals in the horizontal direction along the boundary surface. Here, in addition to the anchoring device 1, a connecting steel 10 straddling between both the structures 7 and 8 is arranged and is anchored to both the structures so as to compensate the function of the anchoring device 1 and to improve the integrity between the major structure 7 and the additional structure 8. Within the beam of the additional structure 8, a main bar 11 and a shear reinforcement bar 12 are arranged.

[0074]

FIG. 3 illustrates the arrangement example where the anchoring device 1 is installed while straddling between both the structures 7 and 8 to transmit a shearing force and a tensile force between the major structure 7 and the additional structure 8 in the case where the major structure 7 is a foundation (footing) of an existing construction and the additional structure 8 is a foundation (footing) of a newly-built construction. In this example, the major structure 7 and the additional structure 8 have shapes having ranges in the horizontal direction and the height direction (vertical direction). Accordingly, a respective plurality of the anchoring devices 1 are arranged in the horizontal direction and the height direction.

[0075]

In the example of FIG. 3, the distance (depth) between the major structure 7 and the additional structure 8 is large when viewed in the axial direction (bridging direction) of the tension member 5. Accordingly, the anchorage length (buried section) of the tension member 5 in the additional structure 8 becomes large corresponding to the distance according to the example in FIG. 2. In this example, when viewed in the axial direction of the tension member 5, there is no substantial difference between the distance of the major structure 7 and the distance of the additional structure 8. However, the buried section in the additional structure 8 is longer than the buried section in the major structure 7 of the tension member 5.

[0076]

In FIG. 3, the reason why the anchorage length in the major structure 7 can be small relative to the anchorage length in the additional structure 8 of the tension member 5 is as follows. The tensile force transmitted to the main anchoring member 2 through the tension member 5 from the additional structure 8 is borne by the hardened body 6 in the major structure 7 as the compressive force. Thus, a large buried section in the major structure 7 need not necessarily be ensured. On the other hand, in the additional structure 8, a large buried section in the additional structure 8 is ensured such that the tensile force from the additional structure 8 can be transmitted to the major structure 7 through the attachment force of the whole length of the tension member 5.

[0077]

FIG. 4 to FIG. 6 illustrate the detailed examples of the anchoring device 1 illustrated in FIG. 3. FIG. 4 illustrates the case where the main anchoring member 2 is formed in a three-dimensional shape similarly to the main anchoring member 2 of the anchoring device 1 illustrated in FIG. 1 and FIG. 2. FIG. 5 illustrates the case where

the main anchoring member 2 is formed in a shape with a conical curved surface. FIG. 6 illustrates the case where, as described above, the confining steel 9 in a spiral shape whose axis is oriented to the axial direction of the tension member 5 is arranged in the hardened body 6 within the drilling 7a. The confining steel 9 is arranged biased to the most peripheral passage from the material axis within the hardened body 6 such that the confining effect acts on the entire hardened body 6.

[0078]

In the arrangement examples of the anchoring devices 1 illustrated in FIG. 1 to FIG. 6, the case where the axial direction of the tension member 5 is oriented to the horizontal direction has been described. However, in the arrangement, the axial direction of the tension member 5 may be oriented to the vertical direction or oriented to the direction inclined to both the horizontal direction and the vertical direction.

[0079]

FIGS. 7A and 7B and FIGS. 8A and 8B illustrate: the concrete examples of the anchoring devices 1 formed in the shapes different from those of the anchoring devices 1 illustrated in FIG. 1 and similar drawing, and the formation examples of the drillings 7a corresponding to the anchoring devices 1. FIG. 7A and FIG. 8A illustrate the examples in the case where, in particular, the cross-sectional area passing through the axis of the main body portion 32 of the shear resistant material 3, that is, the projected area (cross-sectional area) when viewed in the direction (the in-plane direction of the boundary surface between the major structure 7 and the additional structure 8) perpendicular to the axial direction of the main body portion 32 is increased so as to increase the shearing resistance of the main body portion 32.

[0080]

In particular, in FIG. 7A and FIG. 8A, the main body portion 32 is formed in a

shape with two steps in the axial direction of the tension member 5. FIG. 7A illustrates the case where the cross-sectional area of the two-step portion of the main body portion 32 is increased to ensure a large cross-sectional area when viewed in the direction perpendicular to the axial direction so as to increase the rigidity of the main body portion 32 and the shearing resistance in the additional structure 8. FIG. 8A illustrates the case where the area in the axial direction of the portion at the main anchoring member 2 side in the two-step portion of the main body portion 32 is increased to ensure a large cross-sectional area when viewed in the direction perpendicular to the axial direction so as to increase the distance between the inner peripheral surfaces of the anchoring portion 31 and increase the shearing resistance of the main body portion 32 in the major structure 7.

[0081]

In both FIG. 7A and FIG. 8A, while the surface of the main anchoring member 2 is formed in a hyperboloidal shape, the inserting portion 21 on which the tension member 5 is threadably mounted is formed along the whole length of the main anchoring member 2 in the axial direction. FIG. 7B and FIG. 8B illustrate the drillings 7b into which the respective anchoring devices 1 in FIG. 7A and FIG. 8A are inserted.

DESCRIPTION OF REFERENCE SIGNS

[0082]

- 1 anchoring device for transmitting shearing force
- 2 main anchoring member
- 21 inserting portion
- 2a insertion hole
- 3 shear resistant material
- 31 anchoring portion

32	main body portion
3a	insertion hole
33	nut
4	additional anchoring member
41	nut
5	tension member
6	hardened body
7	major structure
7a	drilling
7b	groove
8	additional structure
9	confining steel
10	connecting steel
11	main bar
12	shear reinforcement bar

CLAIMS

1. (Amended) An anchoring device with tensile resistance function for transmitting a shearing force, the anchoring device being installed while straddling between a major structure and an additional structure adjacently in contact with one another, the major structure and the additional structure being movable independently from each other when a horizontal force acts, the anchoring device being configured to transmit a shearing force between the major structure and the additional structure in a direction perpendicular to a direction in which both the structures face one another, the anchoring device comprising:

a main anchoring member anchored in a position at a distance from a boundary surface with the additional structure in the major structure;

a shear resistant material arranged in contact with the boundary surface while straddling between the major structure and the additional structure at the boundary between the major structure and the additional structure, the shear resistant material bearing a shearing force during relative displacement between the major structure and the additional structure;

an additional anchoring member anchored on a line passing through the main anchoring member and the shear resistant material in a position at a distance from a boundary surface with the major structure in the additional structure; and

a tension member bridged between the main anchoring member and the additional anchoring member while passing through the shear resistant material, the tension member being coupled to the main anchoring member and the additional anchoring member, the tension member bearing a tensile force when a distance between the main anchoring member and the additional anchoring member expands, wherein

when viewed in an axial direction of the tension member, a portion of the shear

resistant material in contact with the boundary surface between the major structure and the additional structure has an area that allows insertion of a plurality of the tension members,

when viewed in the axial direction of the tension member, the main anchoring member has a projected area equal to a projected area of the shear resistant material, and

the main anchoring member is in an state configured to apply a compressive force to a hardened body in a region sandwiched between the main anchoring member and the shear resistant material in the axial direction of the tension member together with the shear resistant material in pairs.

2. The anchoring device with tensile resistance function for transmitting the shearing force according to claim 1, wherein

the surface on the shear resistant material side of the main anchoring member forms a curved surface.

3. The anchoring device with tensile resistance function for transmitting the shearing force according to claim 1 or claim 2, wherein

confining steel is arranged in a region sandwiched between the main anchoring member and the shear resistant material in the major structure, the confining steel being configured to confine the region from a periphery of the region.