

SHEAR KEY STRUCTURE

Technical Field

[0001]

5 The present invention relates to a shear key structure that is mounted to prevent steel pipes from being rotated relative to each other around an axis when the steel pipes are connected to each other and can suppress loosening or separation caused by an impact, vibration, or the like during the construction of these steel pipes.

 Priority is claimed on Japanese Patent Application No. 2009-242266, filed
10 October 21, 2009, the content of which is incorporated herein by reference.

Background Art

[0002]

 In the past, steel pipes, such as steel pipe piles or columns, have been widely
15 used in civil engineering or building structures.

 When these steel pipes are used in civil engineering or building structures, regular sized columnar bodies (steel pipes) are transported to the site for the convenience of production, transport, and the like and are longitudinally joined to each other at the site, so that a body having a predetermined length is formed. In recent years, a method of
20 connecting upper and lower steel pipes by joint members has been employed as an example of a longitudinally joining method.

[0003]

 In this method, for example, as shown in FIG. 6, joint members 102 and 105 are mounted at the lower end of the upper steel pipe 101 and the upper end of the lower steel
25 pipe 104 by welding in a factory, respectively. Further, the joint members 102 and 105 are connected to each other by load transmitting keys 107 at the site, so that the upper and lower steel pipes 101 and 104 are connected mechanically to each other.

 Furthermore, in order to prevent these upper and lower steel pipes 101 and 104 from being rotated relative to each other around an axis, shear keys (not shown) are generally
30 mounted on a joint 120 between the joint members 102 and 105 so as to extend over both the joint members 102 and 105.

[0004]

 For example, since steel pipe piles are constructed by a driving by pile hammer

method, vibratory pile driver method, rotary drilling method, jacked piling method (press-fitting method), or the like, large vibration or an impact force is applied to the steel pipes or the joint members.

For this reason, bolts or the like, which are used at the joint where the upper and lower steel pipes of the longitudinally joined pile are connected to each other, are apt to be loosened. As result, a load may not be sufficiently transmitted to a joint portion. Further, there is a possibility that shear keys mounted on the peripheral surface (for example, the outer surface) of the joint portion are separated when bolts or nuts fixing the shear keys are loosened.

10 [0005]

In contrast, for example, Patent Document 1 discloses a columnar body including a rotation preventing mechanism that prevents connected joints from being rotated relative to each other around an axis.

Further, for example, Patent Document 2 discloses means for preventing the screws that are provided at a joint of a steel pipe from being loosened.

[0006]

Furthermore, for example, Patent Document 3 discloses a washer where an engaging protrusion is formed to suppress the loosening of screws caused by vibration.

Moreover, for example, Patent Document 4 discloses a technique that mounts an elastic body on a male screw and uses the male screw with the elastic body as a loosening prevention member.

[0007]

Further, for example, a nut (SOLN) (registered trademark of Japanese Sanco Industry Co., Ltd.) with a toothed washer and a disc spring disclosed in Non-patent Document 1; a “Hard Lock Nut” (“hard lock” is a registered trademark of Japanese Hard Lock Industry Co., Ltd.) that is locked by making a wedge provided on the upper surface of a nut disclosed in Non-patent Document 2 bite into a male screw; and the like are put to practical use as the loosening prevention member.

30 Related Art Document
Patent Documents

[0008]

Patent Document 1 Japanese Unexamined Patent Application, First Publication

No. 2000-319874

Patent Document 2 Japanese Unexamined Patent Application, First Publication

No. 2005-48583

Patent Document 3 Japanese Unexamined Patent Application, First Publication

5 No. H7-54827

Patent Document 4 Japanese Patent Publication No. 3041682

Non-patent Documents

[0009]

Non-patent Document 1 <http://www.sunco.co.jp/street/catalog.html#>

10 Non-patent Document 2 <http://www.hardlock.co.jp/en/hl/index.php>

Disclosure of the Invention

Problems to be Solved by the Invention

[0010]

15 However, predetermined clearances are generally formed at a member in consideration of dimensional errors at the time of manufacture or mounting. Accordingly, when a large impact force is applied as in the driving construction, shear keys themselves vibrate.

For this reason, in the mechanism in the related art, the vibration of the shear
20 key is transmitted to a nut or the like that fixes the shear key. As a result, it is not easy to sufficiently prevent the nut or the like from being loosened. Further, if a bolt or the like is tightened in order to make the nut or the like be not easily loosened, there is a problem in that a load is directly applied to the bolt and the bolt is apt to be broken.

[0011]

25 An object of the invention is to provide a shear key structure that can suppress loosening or separation even though pile hammer driving, vibratory driving, and the like are applied during the construction of steel pipes.

Means for Solving the Problems

30 [0012]

In order to achieve the objectives, the invention proposes the following.

According to a first aspect of the invention, there is provided a shear key structure that prevents steel pipes from being rotated relative to each other around an axis

when the plurality of steel pipes are connected in a longitudinal direction of the steel pipes. The shear key structure includes a screw, a key main body, a nut, and an elastic body. The screw is fixed to a joint member connecting the respective steel pipes. The key main body includes a recessed portion, a through-hole into which the screw is
 5 inserted being formed at a bottom portion of the recessed portion. The nut is screwed to the screw and is disposed in the recessed portion. The elastic body is provided in a gap between the outer periphery of the nut and a side wall of the recessed portion.

According to the shear key structure, since the periphery of the nut is elastically supported by the elastic body, it is possible to absorb the oscillation of a shear key and to
 10 suppress the rotation of the nut.

[0013]

According to a second aspect of the invention, in the shear key structure according to the first aspect, the nut may include a toothed washer.

According to the shear key structure, since the nut and the elastic body more
 15 tightly mesh with each other by means of the toothed washer, it is possible to prevent the nut from being rotated.

[0014]

According to a third aspect of the invention, in the shear key structure according to the first aspect, an outer portion of the nut, which corresponds to an opening of the
 20 recessed portion, may be covered with an elastic lid having elasticity and an outer portion of the elastic lid is covered with a lid body. The lid body may include separation-prevention unit that prevents the lid body from being separated from the recessed portion.

According to the shear key structure, since the outer portion of the nut is covered
 25 with the elastic lid having elasticity, the vibration of the nut in the axial direction is absorbed. In addition, since the lid body includes the separation-prevention unit, it is possible to prevent the nut from coming off.

[0015]

According to a fourth aspect of the invention, in the shear key structure
 30 according to the third aspect, the separation-prevention unit may be a stop ring that is fitted to a groove formed on the side wall of the recessed portion.

According to the shear key structure, since the stop ring is fitted to the groove formed on the side wall of the recessed portion, the loosening of the nut is suppressed

and the separation of the nut from the recessed portion is prevented.

[0016]

According to a fifth aspect of the invention, in the shear key structure according to the first aspect, a hollow portion may be formed in the elastic body.

5 According to the shear key structure, since the hollow portion is formed in the elastic body, the elastic body can be locally deformed by resistance at the time of mounting. As a result, it is possible to mount the elastic body with a small force.

[0017]

10 According to a sixth aspect of the invention, in the shear key structure according to any one of the first to fifth aspects, the side wall of the recessed portion may be an inclined surface of which an opening edge is formed toward the outside of the bottom portion, and an inclined portion corresponding to the inclined surface may be formed at the elastic body.

15 According to the shear key structure, the contact between the elastic body and the side wall is reduced when the elastic body is mounted. As a result, it is possible to mount the elastic body with a small force.

Advantageous Effects of Invention

[0018]

20 According to the shear key structure of the invention, an elastic body absorbs an impact force or the like that is applied to a steel pipe by a driving method or the like. Accordingly, the loosening of a nut is suppressed, so that it is possible to prevent a shear key from being separated.

25 Brief Description of Drawings

[0019]

FIG. 1A is a perspective view showing an example of joint members of steel pipes according to an embodiment of the invention, and shows a state where the joint members are not yet connected to each other.

30 FIG. 1B is a perspective view of the joint members, and shows a state where the joint members are connected to each other.

FIG. 2A is a partial sectional view illustrating a procedure for connecting connection portions of the joint members, and shows a state where the joint members are

not yet connected to each other.

FIG. 2B is a partial sectional view illustrating the continuation of the procedure for connecting the connection portions, and shows a state where the joint members are connected to each other.

5 FIG. 2C is a partial sectional view illustrating the continuation of the procedure for connecting the connection portions, and shows a state where the joint members are connected to each other.

FIG. 3A is a view illustrating a first process of a procedure for mounting a shear key structure according to a first embodiment of the invention.

10 FIG. 3B is a view illustrating a second process of the procedure for mounting the shear key structure according to the first embodiment.

FIG. 3C is a view illustrating a third process of the procedure for mounting the shear key structure according to the first embodiment.

15 FIG. 3D is a view illustrating a fourth process of the procedure for mounting the shear key structure according to the first embodiment.

FIG. 3E is a view illustrating a fifth process of the procedure for mounting the shear key structure according to the first embodiment.

FIG. 3F is a view illustrating a sixth process (mounting state) of the procedure for mounting the shear key structure according to the first embodiment.

20 FIG. 4 is a view showing the schematic configuration of a shear key structure according to a second embodiment of the invention.

FIG. 5 is a view showing the schematic configuration of a shear key structure according to a third embodiment of the invention.

25 FIG. 6 is a perspective view showing a state where steel pipes in the related art are connected to each other.

Description of Embodiments

[0020]

30 A first embodiment of the invention will be described below with reference to FIGS. 1A to 3F.

[0021]

FIGS. 1A and 1B show an example of a joint member that longitudinally joins upper and lower steel pipes, and are perspective views of the joint member of which a

part of the entire periphery is cut.

As shown in FIG. 1A, a female box joint member 2 is welded at a welded portion 3 in a factory and mounted to the lower end of an upper steel pipe 1. Further, a male pin joint member 5 is welded at a welded portion 6 in a factory and mounted to the upper end of the lower steel pipe 4.

[0022]

Arc-like load transmitting keys 7, which are appropriately divided over the entire circumference, are mounted on the box joint member 2.

The load transmitting keys 7 are fitted into key grooves 11 formed on the outer periphery of the pin joint member 5, so that the box joint member 2 and the pin joint member 5 are connected to each other by the load transmitting keys 7. Accordingly, the upper and lower steel pipes 1 and 4 are mechanically connected to each other in the longitudinal direction as shown in FIG. 1B.

[0023]

The pin joint member 5 formed in a cylindrical shape includes a fitting portion 13 which is continuously extended from a cylindrical portion 12. The cylindrical portion 12 has substantially the same diameter as the outer diameter of the lower steel pipe 4, and the fitting portion 13 has a diameter smaller than the diameter of the cylindrical portion 12. An engaging recessed portion 14 into which an engaging protruding portion 21 of the box joint member 2 is inserted is formed at the base end portion of the outer periphery of the fitting portion 13. An engaging protruding portion 16 is formed at the tip of the fitting portion 13 over the entire circumference. In addition, the key grooves 11 to which the load transmitting keys 7 are fitted are formed on the outer periphery of the fitting portion 13 over the entire circumference.

[0024]

The box joint member 2 is formed in the shape of a cylinder that has substantially the same outer diameter as the outer diameter of the upper steel pipe 1. The inner periphery of the box joint member 2 forms a portion to which the fitting portion 13 of the pin joint member 5 is fitted, and the engaging protruding portion 21 is fitted to the engaging recessed portion 14 of the pin joint member 5.

[0025]

Further, an engaging recessed portion 22, which is engaged with the engaging protruding portion 16 of the pin joint member 5, is formed on the inner periphery of the

base end portion of the box joint member 2 over the entire circumference. Furthermore, screw holes 23 are formed on the outer periphery at appropriate intervals so as to correspond to the mounting positions of the load transmitting keys 7. The screw holes 23 pass through the box joint member 2 from the outside to the inside thereof.

5 [0026]

As shown in FIG. 1B, dents 20a, which extend over both the box joint member 2 and the pin joint member 5, are formed at one or a plurality of positions at appropriate intervals on a joint 20 when the box joint member 2 and the pin joint member 5 are connected to each other. Shear keys, which prevent the box joint member 2 and the pin joint member 5 from being rotated relative to each other, are mounted in the dents 20a.

[0027]

FIGS. 2A and 2B illustrate a method of connecting the box joint member 2 to the pin joint member 5.

As shown in FIG. 2A, joining screws 8 and the load transmitting keys 7 are mounted on the box joint member 2. For example, a stud bolt with a hexagonal hole is used as the joining screw 8, and the joining screws 8 are screwed and mounted to the screw holes 23 of the box joint member 2 shown in FIG. 1B.

[0028]

Further, the engaging protruding portion 21 of the box joint member 2 is fitted to the engaging recessed portion 14 of the pin joint member 5 and the engaging protruding portion 16 of the pin joint member 5 is fitted to the engaging recessed portion 22 of the box joint member 2 as shown in FIG. 2B, so that the box joint member 2 and the pin joint member 5 are positioned in the longitudinal direction and tips of the load transmitting keys 7 are disposed at the inlets of the key grooves 11 of the pin joint member 5.

25 [0029]

After that, each of the joining screws 8 is rotated in a normal direction as shown in FIG. 2C by a hex wrench 9 from the outside of the screw hole 23 shown in FIGS. 1A and 1B, so that each of the load transmitting keys 7 is moved forward along the axis of the joining screw 8 and enters the key groove 11. When the thickness of the load transmitting key 7 is set to be larger than the depth of the key groove 11 as shown in FIG. 2C, the load transmitting key 7 is disposed so as to extend over both the box joint member 2 and the pin joint member 5. In this way, the box joint member 2 and the pin joint member 5 are connected to each other.

[0030]

After the joining screws 8 are screwed, the depth of each of the joining screws 8 from the outside of the box joint member 2 is measured by a depth gauge or the like and it is confirmed that the load transmitting keys 7 are reliably fitted to the key grooves 11.

5 [0031]

In addition, a shear key structure 10 according to this embodiment is provided in each of the dents 20a that are formed on the joint 20 between the box joint member 2 and the pin joint member 5.

10 In the shear key structure 10, a screw 30 is previously locked to each of the dents formed at the pin joint member 5 so that a tip portion of the screw 30 formed of, for example, a stud bolt with a hexagonal hole protrudes into the dent 20a, and a key main body 31, a nut 35, and the like to be described below are mounted at the tip portion of the screw 30.

[0032]

15 Since the shear key structure 10 is provided in each of the dents 20a so as to extend over both the box joint member 2 and the pin joint member 5, the shear key structure 10 prevents the box joint member 2 and the pin joint member 5, that is, the upper and lower steel pipes 1 and 4, which are connected to each other, from being rotated relative to each other around an axis.

20 [0033]

The details of the shear key structure 10 according to a first embodiment will be described below with reference to FIGS. 3A to 3F. FIGS. 3A to 3F are views illustrating a mounting procedure (first to sixth processes). A plan view of the shear key structure 10 when seen from the tip of the screw 30 is shown on the left side in each of
25 FIGS. 3A to 3F, and a cross-sectional view, which passes through an axis of the screw 30 and is orthogonal to the central axis of the joint member 5, is shown on the right side in each of FIGS. 3A to 3F.

[0034]

30 As shown in FIGS. 3A to 3F, the key main body 31 is formed in the shape of a plate that has a substantially rectangular shape in plan view and a predetermined thickness.

Further, a recessed portion 32, which has a circular shape in plan view, is formed at the key main body 31, and a through-hole 34 is formed at the center of a bottom face

(bottom portion) 33 of the recessed portion 32.

Furthermore, as shown in FIG. 3A, the screw 30 is inserted into the through-hole 34 and the tip portion of the screw 30 protrudes into the recessed portion 32.

[0035]

5 A base end portion of the screw 30 is screwed into the pin joint member 5 as described above. The shear key structure 10 is disposed so that the tip portion of the screw 30 passes through the through-hole 34 and the key main body 31 extends over both the upper and lower joint members 2 and 5 as shown in FIG. 2C.

[0036]

10 Moreover, the recessed portion 32 is formed at a position closer to the pin joint member 5 than the middle of the key main body 31 in a vertical direction so that the screw 30 is inserted into the through-hole 34 while the key main body 31 extends over the joint members 2 and 5. Meanwhile, as long as the screw 30 can be inserted into the through-hole 34 while the key main body 31 extends over the joint members 2 and 5, the
15 position of the recessed portion 32 on the key main body 31 in the vertical direction may be arbitrarily set.

[0037]

The nut 35 is screwed to the tip portion of the screw 30. As shown in FIG. 3B, the planar shape of the recessed portion 32 of the key main body 31 is slightly larger than
20 the planar shape of the nut 35, and the depth of the recessed portion 32 is slightly larger than the thickness of the nut 35 in the direction of a rotation axis of the nut 35.

A base end portion of the nut 35 includes a toothed washer. Further, when a nut, which includes both a toothed washer and a disc spring washer like the above-mentioned "SOLN" (registered trademark), is used, an effect of preventing the nut
25 from being loosened is improved. The nut 35 is screwed to the screw 30 until the washer of the nut 35 comes into contact with the bottom face 33 of the recessed portion 32. Accordingly, the nut 35 is disposed at the position shown in FIG. 3B.

[0038]

30 Next, a solid belt-like elastic body 38, which is made of an elastic material such as rubber and is formed in a columnar shape, is provided in a gap 37 (FIG. 3B) between a side wall 36 of the recessed portion 32 and the outer periphery of the nut 35 so as to be wound around the nut 35. As shown FIG. 3C, the gap 37 is filled with the elastic body 38. Accordingly, when an impact force is applied during construction, the relative

oscillation between the key main body 31 and the nut 35 is absorbed and the rotation of the nut 35 is prevented by a frictional force that is generated between the side wall 36 and the nut 35 by the elastic body 38. Further, the toothed washer of the nut 35 bites into the elastic body 38 and more reliably prevents the rotation of the nut.

5 [0039]

After that, the outer portion of the nut 35, which corresponds to the opening of the recessed portion 32, is covered with an elastic lid 39 that is made of rubber or the like and has elasticity, as shown in FIG. 3D, and the outer portion of the elastic lid 39 is covered with a lid body 40 as shown in FIG. 3E. Further, a C-shaped stop ring 41,
10 which is fixed to the side wall 36 of the recessed portion 32 as shown in FIG. 3F, is fitted on the outside of the lid body 40 as separation-prevention unit for the lid body 40. As shown in FIG. 3F, the stop ring 41 is fitted to a groove 42 that is formed on the side wall 36 near the opening of the recessed portion 32. Accordingly, the stop ring 41 is reliably fixed, so that the separation of the stop ring from the recessed portion 32 is prevented.

15 [0040]

Meanwhile, the elastic lid 39 has elasticity in the axial direction of the nut 35. Accordingly, while the dimensional error of the position of the stop ring 41 to be fitted to the groove 42 is absorbed, a gap between the head surface of the nut 35 and the lower surface of the lid body 40 is always filled with the elastic body and a state where a
20 repulsive force is generated between the head surface of the nut 35 and the lower surface of the lid body 40 is maintained. Therefore, the elastic lid 39 is preferable since the deviation of the nut 35 in the axial direction, which is caused by vibration during the construction, can be prevented.

[0041]

25 Since the outer periphery of the nut 35 is surrounded and supported by the elastic body 38 and the outer portion of the nuts 35 is pressed by the elastic lid 39, the vibration transmitted to the nut 35 is absorbed and the rotation of the nut 35 is prevented even though the key main body 31 oscillates due to an impact or vibration. Moreover, since the outside of the recessed portion 32 is covered, the coming-off of the nut 35 is
30 prevented. For this reason, the shear key structure 10 provided in the dent 20a as shown in FIG. 2C can reliably prevent the upper and lower steel pipes 1 and 4 from being rotated relative to each other without being deviated or separated due to an impact or vibration.

[0042]

Further, since the elastic body and the elastic lid are disposed and held around the nut, a load such as an impact is absorbed by the elastic body and the like and is not directly applied to the screws. Accordingly, it is possible to prevent the screws from
5 being loosened while suppressing the increase of cost without the increase of the size of the screws.

[0043]

Next, a shear key structure 50 according to a second embodiment of the invention will be described with reference to FIG. 4.

10 [0044]

The shear key structure 50 according to this embodiment is different from the shear key structure 10 according to the first embodiment in that an elastic body 51 having an annular hollow structure where a cylinder having a hole 52 at the central portion of the cross-section is formed in an annular shape as the center shaft, is used instead of the
15 elastic body 38, which is formed in the shape of a solid columnar belt, of the shear key structure 10. Since other portions of this embodiment are the same as those of the first embodiment, other portions of this embodiment are denoted by the same reference numerals and the description thereof will be omitted.

[0045]

20 According to this embodiment, since the elastic body 51 has the hollow structure, the elastic body 51 can be locally deformed. If there is a portion to which a large force is applied when the elastic body 51 is mounted, the portion is locally and significantly deformed. Accordingly, it is possible to mount the elastic body 51 in the gap 37 between the nut 35 and the side wall 36 with a small force. As a result, it is possible to
25 improve working efficiency.

[0046]

Next, a shear key structure 60 according to a third embodiment of the invention will be described with reference to FIG. 5.

[0047]

30 The shear key structure 60 according to this embodiment is different from the shear key structure 10 according to the first embodiment in that an opening edge of a recessed portion 32 is positioned outside the edge of a bottom face 33 so that a side wall 36A of a recessed portion 32 is formed of an inclined surface inclined toward the outside

of the bottom face 33 and an annular elastic body 61, which has a cross-section corresponding to the outer periphery of the nut 35 and the inclined surface of the side wall 36A, is used instead of the elastic body 38. Since other portions of this embodiment are the same as those of the first embodiment, they are denoted by the same
5 reference numerals and the description thereof will be omitted.

[0048]

According to this embodiment, when the elastic body 61 is mounted in the gap 37 between the outer periphery of the nut 35 and the side wall 36A, the contact between the elastic body 61 and the side wall 36A is reduced. Accordingly, it is possible to
10 reduce a force that is required to mount the elastic body. As a result, it is possible to efficiently mount the elastic body 61.

[0049]

The first to third preferred embodiments of the invention have been described above, but the invention is not limited to the embodiments. It is apparent for those
15 skilled in the art that the invention may have various modifications and alterations within the range of the scope disclosed in claims, and it is understood that these modifications and alterations are also naturally included in the range of the invention.

[0050]

For example, the structures of the box joint member and the pin joint member
20 are not limited to the structures shown in FIGS. 1A and 1B. Further, in the above-mentioned embodiments, the shear key structures 10, 50, and 60 have been described in the cases where the upper steel pipe 1 and the lower steel pipe 4 are connected to each other by the box joint member 2 and the pin joint member 5. However, the shear key structures may be applied to a case where the recessed portions
25 forming the dents 20a are formed at any one or both of the upper steel pipe 1 and the lower steel pipe 4.

[0051]

Further, cases where the screws 30 are screwed into the pin joint member 5 have been described in the above-mentioned embodiments. However, the screws 30 may be
30 screwed into the box joint member 2.

[0052]

Furthermore, the cases where the dents 20a in which the shear key structures 10, 50, and 60 are provided are formed on the outer surfaces of joint portions have been

described in the above-mentioned embodiments. However, the shear key structures may be applied to a case where the dents 20a are formed on the inner surface of the joint portion.

[0053]

5 Moreover, the connection between steel pipes, which are suitable for steel pipe piles, has been described as an example in the above-mentioned embodiments. However, it goes without saying that the invention may be applied to other members, to which vibration or the like is applied, for example, civil engineering or building structures.

10 [0054]

 Meanwhile, synthetic rubber, such as polybutadiene synthetic rubber, nitrile synthetic rubber, and chloroprene synthetic rubber, other than rubber may be used as the material of each of the elastic bodies 38, 51, and 61 and the elastic lid 39. A porous body having a three-dimensional mesh structure, such as sponge, may be applied as the
15 material of each of the elastic bodies and the elastic lid 39.

[0055]

 Further, the belt-like elastic body 38 having a solid columnar structure, the elastic body 51 having a hollow structure formed in a cylindrical and annular shape, and the annular elastic body 61 having a cross-section corresponding to the shape of a gap in
20 which the annular elastic body is mounted have been used in the above-mentioned embodiments. However, elastic bodies having structures other than these structures or known annular elastic bodies such as O-rings may be used as the above-mentioned elastic bodies.

[0056]

25 Furthermore, the case where the elastic body 51 having the hollow structure where the hole 52 is formed at the central portion of the cross-section is used has been described in the second embodiment. However, a hole (space) of a hollow structure is not formed at the central portion of the cross-section, and may be formed at a predetermined portion on the cross-section, or at a predetermined portion on the elastic
30 body 51 in the circumferential direction (longitudinal direction) of the elastic body 51.

 Moreover, it goes without saying that the structures, the materials, and the like of the first to third embodiments can be arbitrarily combined.

[0057]

Further, the cases where the toothed washer is disposed at the base end portion of the nut 35 have been described in the above-mentioned embodiments. However, whether the toothed washer is formed or not may be arbitrarily set.

[0058]

5 Furthermore, the cases where the outer portion of the nut 35, which corresponds to the opening of the recessed portion 32, is covered with the elastic lid 39 and the outer portion of the elastic lid 39 is covered with the lid body 40 have been described in the above-mentioned embodiments. However, both the elastic lid 39 and the lid body 40 may not be provided, and only the lid body 40 may be provided without the elastic lid 39.

10 [0059]

Moreover, the cases where the stop rings 41 are fitted to the grooves 42 formed on the side walls 36 and 36A of the recessed portions 20 as the separation-prevention unit for the lid body 40 have been described in the above-mentioned embodiments. However, the stop ring 41 is an example of the separation-prevention unit, and other
15 separation-prevention unit may be used. Further, the separation-prevention unit may not be used.

[0060]

Furthermore, the cases where each screw 30 is formed of a stud bolt with a hexagonal hole, the base end portion of each screw is screwed to the pin joint member 5, and each screw 30 is thus fixed have been described in the above-mentioned
20 embodiments. However, for example, the base end portion of the screw may be fixed to the joint member by other means such as press-fitting.

Moreover, a screw, which is screwed by other tools other than a hex wrench, for example, a flat-head screwdriver, a Phillips-head screwdriver, and the like, may be used
25 instead of the stud bolt with a hexagonal hole.

Industrial Applicability

[0061]

According to the shear key structure of the invention, an elastic body can absorb
30 an impact or vibration that is applied to a steel pipe by a driving method or the like, and it is possible to prevent the separation of a shear key by preventing the loosening or separation of a nut.

Reference Signs List

[0062]

- 1: upper steel pipe
- 2: box joint member
- 5 3, 6: welded portion
- 4: lower steel pipe
- 5: pin joint member
- 7: load transmitting key
- 8: joining screw
- 10 9: hex wrench
- 10: shear key structure
- 11: key groove
- 12: cylindrical portion
- 13: fitting portion
- 15 14, 22: engaging recessed portion
- 16, 21: engaging protruding portion
- 20: joint
- 20a: dent
- 23: screw hole
- 20 30: screw
- 31: key main body
- 32: recessed portion
- 33: bottom face
- 34: through-hole
- 25 35: nut
- 36, 36A: side wall
- 37: gap
- 38, 51, 61: elastic body
- 39: elastic lid
- 30 40: lid body
- 41: stop ring
- 42: groove

CLAIMS

1. A shear key structure (10) that prevents steel pipes (1,4) from being rotated relative to each other around an axis when the plurality of steel pipes (1,4) are connected in a longitudinal direction of the steel pipes (1,4), the shear key structure (10) comprising:
 - a screw (30) that is fixed to a joint member connecting the respective steel pipes (1,4);
 - a key main body (31) that includes a recessed portion (32), a through-hole into which the screw (30) is inserted being formed at a bottom portion (33) of the recessed portion (32);
 - a nut (35) that is screwed to the screw (30) and is disposed in the recessed portion (32); and
 - an elastic body (38,51,61) that is provided in a gap (37) between an outer periphery of the nut (35) and a side wall (36, 36A) of the recessed portion (32).
2. The shear key structure (10) according to Claim 1,
wherein the nut (35) includes a toothed washer.
3. The shear key structure (10) according to Claim 1,
wherein an outer portion of the nut (35), which corresponds to an opening of the recessed portion (32), is covered with an elastic lid (39) having elasticity and an outer portion of the elastic lid (39) is covered with a lid body (40), and
the lid body (40) includes a separation-prevention unit that prevents the lid body (40) from being separated from the recessed portion (32).
4. The shear key structure (10) according to Claim 3,
wherein the separation-prevention unit is a stop ring (41) that is fitted to a groove (42) formed on the side wall (36, 36A) of the recessed portion (32).
5. The shear key structure (10) according to Claim 1,
wherein a hollow portion is formed in the elastic body (38,51,61).
6. The shear key structure (10) according to any one of Claims 1 to 5,
wherein the side wall (36, 36A) of the recessed portion (32) is an inclined surface of which an opening edge is formed toward the outside of the bottom portion (33), and
an inclined portion corresponding to the inclined surface is formed at the elastic body (38,51,61).