

HIGH-SPEED COUPLER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Korean Patent
5 Application No. 10-2020-0099117, filed on August 7, 2020,
the disclosure of which is incorporated herein by reference
in its entirety.

BACKGROUND

10 1. Technical Field

[0002] The present disclosure relates to a high-speed
coupler, and more particularly, to a high-speed coupler
that is applied to a drilling agitator during construction
of the composite ground with deep soil-cement mixing (DCM)
15 and that can maintain wear of a bushing to an insignificant
degree together with an improvement in rotational speed of
a rod according to the reduction in rotational load of the
rod in the process of drilling excavation sites.

20 2. Related Art

[0003] A drilling agitator is typically used to create the
foundations of buildings through underground or ground
excavation. In particular, the ground excavation is
performed using a drill bit coupled to the lower end of a

rotor corresponding to the rod of the drilling agitator. The ground may be drilled (tunneled) and excavated by rotating the drill bit along with the rotation of the rotor as the rod.

5 **[0004]** However, most existing couplers, which are applied to the rotor (rod), have a rotational clearance between a bushing and the rotor (rod) due to a drilling capacity for the ground during the rotation of the couplers. The rotational clearance often causes wear and damage due to
10 severe friction between components around the rotor (rod).

[0005] As illustrated in FIGS. 1 to 4, an existing coupler may be configured such that a main shaft 1 corresponding to a rotor (rod) having a cover 2 is inserted into a housing 3, a base 4 and a plate 6 are formed to support the housing 3,
15 the plate 6 is coupled, at the bottom thereof, to a bed or support shaft of a drilling agitator, a bearing 7 is inserted into the inner diameter of the housing (3) to flexibly rotate the main shaft 1 inserted into the housing 3, a packing 10 and a packing gland 11 are formed together
20 with an O-ring 8 for airtightness of the bearing 7 and a packing gland guide 9 around the O-ring, stud bolts 12 are fastened to both ends of the housing 3, and gaskets 14 and 15 are installed at the center of the cover 2.

[0006] The existing coupler configured as described above
25 has a structure in which a bushing 16 is separated from the

rotor (rod) as illustrated in FIG. 4. Hence, the bushing 16 serving to guide the rotor (rod) may be significantly worn, which in turn leads to frequent replacement of the bushing.

5 [0007] In addition, the bushing increasingly becomes worn as the amount of rotation of the rotor (rod) increases, resulting in an increase in the distance from the rotor. In this case, consequently, the damage or bending of the rotor frequently occurs due to the decrease in shear force
10 on the rotor (rod), and the threshold of the amount of rotation of the rotor (rod), namely, the threshold of the rotational speed thereof may not reach more than 30 RPM.

[0008] Meanwhile, Korean Patent No. 10-1263944 (registered on April 30, 2013) discloses a coupler applied to drilling
15 equipment required for excavation of the ground.

[0009] [Patent Document 0001] Korean Patent No. 10-1263944 (registered on April 30, 2013)

SUMMARY

20 [0010] Various embodiments are directed to a high-speed coupler that is applied to a drilling agitator during construction of the composite ground with deep soil-cement mixing (DCM) and that can reduce wear of a bushing together with a reduction in rotational load of a rotor (rod).

25 [0011] In an embodiment, there is provided a high-speed

coupler that includes a coupling member coupled, at the bottom thereof, to a bed or support shaft of a drilling agitator, a housing integrally formed on the top of the coupling member, a rotor (rod) being rotatably inserted and
5 installed into the housing, and coverings coupled to or decoupled from both ends of the housing.

[0012] The high-speed coupler may further include a bushing integrated on and spaced at a predetermined distance from an outer peripheral surface of the rotor (rod) rotatably
10 inserted and installed into the housing.

[0013] The bushing may be inserted and engaged between the housing and the coverings coupled to both ends of the housing.

[0014] The bushing may have friction dispersion holes formed
15 along a periphery thereof at regular intervals and penetrating from an inner diameter to an outer diameter thereof, the friction dispersion holes being configured to absorb and disperse friction shock generated during the rotation of the rotor (rod).

20 **[0015]** The high-speed coupler may further include a dual bushing interposed between the housing and the rotor (rod) rotatably inserted and installed into the housing.

[0016] The dual bushing may include a gap from an inner bushing positioned therein, and reinforcement tips
25 integrated at both ends of the inner bushing. The high-

speed coupler may further include a first friction shock reducing unit composed of a tapered roller bearing formed into the gap to reduce a load and friction shock generated during the rotation of the rotor (rod).

5 **[0017]** The dual bushing may include a gap from an inner bushing positioned therein, and reinforcement tips integrated at both ends of the inner bushing. The high-speed coupler may further include a second friction shock reducing unit composed of a banded ball bearing formed into
10 the gap to reduce a load and friction shock generated during the rotation of the rotor (rod).

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a front view illustrating a cover 2 on one
15 side of an existing coupler.

[0019] FIG. 2 is a top view illustrating a housing 3 of the existing coupler.

[0020] FIG. 3 is a longitudinal cross-sectional view illustrating a main shaft 1, the cover 2, the housing 3, a
20 base 4, and a plate 6 in order to help understanding an internal structure of the existing coupler.

[0021] FIG. 4 is a cutaway cross-sectional view of a bushing 16, when viewed from the top, interposed and installed between the housing 3 and the main shaft 1 of the existing
25 coupler of FIGS. 1 to 3.

[0022] FIG. 5 is a front view illustrating any portion of a housing 120 of a high-speed coupler according to a first embodiment of the present disclosure.

5 [0023] FIG. 6 is a top view illustrating a first housing 121 positioned at the upper portion of the housing 120 of the high-speed coupler according to the first embodiment of the present disclosure.

[0024] FIG. 7 is a cross-sectional view, illustrating the high-speed coupler, taken along line A-A of FIG. 6.

10 [0025] FIG. 8 is a cross-sectional view, illustrating the high-speed coupler, taken along line B-B of FIG. 7.

[0026] FIG. 9 is a longitudinal cross-sectional view of the high-speed coupler including a rotor 130 inserted and installed into the housing 120 thereof, in order to help
15 understanding an internal structure of the high-speed coupler according to the first embodiment of the present disclosure.

[0027] FIG. 10 is a longitudinal cross-sectional view and a side view illustrating the rotor 130 of FIG. 9 for helping
20 understanding an internal structure thereof.

[0028] FIG. 11 is a detailed longitudinal cross-sectional view of one 123 of coverings 123 and 124 coupled to both ends of the housing 120 of FIG. 9.

[0029] FIG. 12 is a detailed conceptual longitudinal cross-sectional view of an exemplary bushing 125 interposed and
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installed between the housing 120 and the rotor 130.

[0030] FIG. 13 is a detailed conceptual longitudinal cross-sectional view of another exemplary bushing 126 interposed and installed between the housing 120 and the rotor 130.

5 [0031] FIG. 14 is a detailed enlarged view of portion "A" of another exemplary bushing 126 illustrated in FIG. 13.

[0032] FIG. 15 is a longitudinal cross-sectional view of a first friction shock reducing unit 127, which may be applied and installed into a gap G formed between another
10 exemplary bushing 126 of FIG. 14 and an inner bushing 126a thereof, in order to help understanding an internal structure of the first friction shock reducing unit 127.

[0033] FIG. 16 is a longitudinal cross-sectional view of a second friction shock reducing unit 128, which may be
15 applied and installed into the gap G formed between another exemplary bushing 126 of FIG. 14 and the inner bushing 126a thereof, in order to help understanding an internal structure of the second friction shock reducing unit 128.

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DETAILED DESCRIPTION

[0034] It is noted that the accompanying drawings in the present disclosure are exaggerated for clarity and convenience of description. The following embodiments do not limit the scope of the present disclosure, and are only
25 examples of components described in the claims of the

present disclosure. In addition, the scope of the present disclosure should be interpreted based on the technical spirit throughout the specification of the present disclosure.

5 **[0035]** The present disclosure relates to a high-speed coupler. Korean Patent No. 10-1666141, assigned to the applicant of the present disclosure, discloses that an auger machine 1 is built next to a bed, which is a frame structure 2 vertically installed on a deep soil-cement
10 mixing (DCM) industrial carrier, wherein the bed configured to firmly support the auger machine 1 is applicable, mutatis mutandis, to the present disclosure. In addition, the above patent document discloses a support shaft 300 configured to support auger shafts 120 at the center
15 thereof in order to stably rotate the auger shafts 120, wherein the support shaft 300 is also applicable, mutatis mutandis, to the present disclosure. Although the DCM industrial carrier herein refers to a marine DCM industrial carrier, a land DCM industrial carrier is of course
20 applicable, mutatis mutandis, to the present disclosure.

[0036] Hereinafter, the present disclosure will be described in detail with reference to the accompanying drawings.

[0037] As illustrated in FIGS. 5 to 9, the high-speed coupler according to the present disclosure may include a
25 coupling member 100, a housing 120 integrally formed on the

top of the coupling member, and coverings 123 and 124 detachably formed at both ends of the housing.

[0038] The coupling member 100 may include a plate 111 coupled, at the bottom thereof, to a bed or support shaft
5 of a drilling agitator, and a base 112 protruding upward from the plate 111. The base 112 may be integrated with the plate 111 as well as the housing 120 while supporting the housing 120.

[0039] The housing 120 may include a second housing 122
10 integrated with the base 112 and a first housing 121 coupled to the upper portion of the second housing 122. The first housing 121 and the second housing 122 may each have a semicircular shape, and may be combined with each other to form a cylindrical structure for insertion and
15 installation of a rotor 130 as illustrated in FIG. 9.

[0040] As illustrated in FIG. 9, the respective coverings 123 and 124 may be fastened to both ends of the housing 120 with fasteners 121a according to the combination of the first and second housings 121 and 122. The fasteners 121a
20 may be, for example, bolts.

[0041] The rotor 130 as a rod, which is rotatably inserted and installed into the housing 120, may have a plurality of through-holes formed therein to partition the inside of the rotor 130. For example, as illustrated in FIGS. 9 and 10,
25 the rotor 130 may include a first through-hole 131 formed

at the center thereof, a second through-hole 132 formed at one side thereof, namely, at the upper portion thereof in the drawing and spaced apart from the first through-hole by a predetermined distance, and a third through-hole 133
5 formed at the other side thereof, namely, at the lower portion thereof in the drawing and spaced apart from the first through-hole by a predetermined distance.

[0042] The first to third through-holes 131 to 133 of the rotor 130 may function as supply/movement passages for
10 inputs including slurry, high-pressure water (water jet), and high-pressure air. The inputs may be selectively supplied through the through-holes to excavation sites during the construction of the composite ground with deep soil-cement mixing (DCM).

[0043] Meanwhile, since the coverings 123 and 124 may have the same configuration, only the configuration of the covering 123 will be described as an example. The covering 123 may have a plurality of first and second bearing grooves 123a and 123b formed along the inner diameter
15 thereof at a predetermined distance as illustrated in FIGS. 9 and 11. The covering 123 may have fastening holes 123c formed above the first and second bearing grooves 123a and 123b.
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[0044] Of course, the above-mentioned first and second bearing grooves 123a and 123b and fastening holes 123c may
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be formed in the same manner in the covering 124. The fastening holes 123c are holes required for insertion and fastening of the above-mentioned fasteners 121a, and the coverings 123 and 124 may be firmly coupled to both ends of the housing 120 through the insertion and fastening of the fasteners 121a.

[0045] The plurality of first and second bearing grooves 123a and 123b are grooves, for example, required for insertion and installation of respective ball bearings.

The insertion and installation of the ball bearings provides a flexible rotational force for the rod, namely, the rotor 130, rotated toward any excavation site, thereby helping to improve the rotational speed of the rotor 130 by reducing the rotational friction thereof.

[0046] Meanwhile, an exemplary bushing 125 applied to the high-speed coupler of the present disclosure, as illustrated in FIGS. 9 and 12, is integrated with the outer diameter of the rotor 130 and is engaged, namely, latched between the housing 120 and the coverings 123 and 124 coupled to both ends of the housing 120. Therefore, in spite of an increase in the amount of rotation of the rotor 130, which is the rod rotated toward the excavation site, the bushing 125 can be slightly worn.

[0047] Furthermore, the bushing 125 may have friction dispersion holes 125a formed along the peripheral length

thereof at a predetermined distance and penetrating from the inner diameter to the outer diameter thereof. In particular, each of the friction dispersion holes 125a has a large-small hole structure in which it has a larger diameter at the inner diameter of the bushing 125 than at the outer diameter of the bushing 125.

[0048] In other words, the friction dispersion hole 125a is a large-small hole formed to have a diameter that gradually decreases from the inner diameter toward the outer diameter of the bushing 125.

[0049] The friction dispersion holes 125a can disperse frictional resistance generated during the rotation of the rotor (rod) 130. To this end, the friction dispersion holes 125a may each have a large-small hole structure in which the diameter thereof decreases from the inner diameter toward the outer diameter of the bushing 125, thereby increasing the dispersion of frictional resistance and thus reducing the rotational load of the rotor 130.

[0050] Since the bushing 125 is integrated with the outer peripheral surface of the rotor 130, the bushing 125 serving to guide the rotor (rod) can be slightly worn. In addition, since there is no rotational clearance between the bushing 125 and the rotor (rod) 130 despite the increase in the amount of rotation of the rotor 130, it is possible to prevent the rotor 130 from being bent or

damaged due to the decrease in the shear force that may be applied thereto. Furthermore, the threshold of the amount of rotation of the rotor (rod) 130 can reach a value of 50 to 60 RPM, which is much higher than the threshold of 30 RPM that may be implemented in a rotor applied to an existing coupler.

[0051] Meanwhile, another exemplary bushing 126 applied to the high-speed coupler of the present disclosure, as illustrated in FIGS. 13 and 14, may be configured as a dual bushing, which is coupled to the fasteners 121a coupled to both ends of the housing 120 and includes an inner bushing 126a therein.

[0052] This another exemplary bushing 126 may further include a gap G, as illustrated in FIG. 14, from the inner bushing 126a, and reinforcement tips 126b integrated at both ends of the inner bushing 126a.

[0053] Moreover, a first friction shock reducing unit 127 as an example may be inserted into the gap G as illustrated in FIG. 15. On the other hand, as illustrated in FIG. 16, a second friction shock reducing unit 128 may be further inserted into the gap G according to the conditions of design and the environment for use.

[0054] The first friction shock reducing unit 127 may be composed of a tapered roller bearing 127A inserted into the gap G as illustrated in FIG. 15. The tapered roller

bearing 127A has a structure that is suitable for maximum reduction of loads generated during the rotation of the rotor (rod) 130.

[0055] That is, the loads may include all of a radial load, an axial load, a composite load, and other loads considered in the process of rotating the rotor (rod) 130, and these loads can be reduced to the maximum through the tapered roller bearing 127A during the rotation of the rotor (rod) 130.

[0056] The tapered roller bearing 127A may include a spherical bearing 127c installed at the center of the gap G and roller bearings 127a and 127b installed on the left and right sides of the spherical bearing. The roller bearings 127a and 127b may have curved contact surfaces 127a1 and 127b1 formed on the respective portions thereof in contact with the left and right sides of the spherical bearing 127c, and the curved contact surfaces 127a1 and 127b1 are suitable to surround and enclose portions of the left and right sides of the spherical bearing 127c.

[0057] As such, the tapered roller bearing 127A including the spherical bearing 127c, the roller bearings 127a and 127b, and the curved contact surfaces 127a1 and 127b1 may be suitable to actively cope with various loads (radial load, axial load, composite load, and other loads) generated during the rotation of the rotor 130, thereby

reducing the loads to the maximum. Consequently, the bushing 126 can be slightly worn, the rotational speed of the rotor 130 can be increased, and the shear force of the rotor 130 can be strengthened.

5 **[0058]** On the other hand, as illustrated in FIG. 16, the second friction shock reducing unit 128 may be further inserted into the gap G according to the conditions of design and the environment for use.

10 **[0059]** The second friction shock reducing unit 128 may be composed of a banded ball bearing 128A inserted into the gap G as illustrated in FIG. 16. The banded ball bearing 128A also has a structure that is suitable for maximum reduction of loads generated during the rotation of the rotor (rod) 130.

15 **[0060]** That is, the loads may include all of a radial load, an axial load, a composite load, and other loads considered in the process of rotating the rotor (rod) 130, and these loads can be reduced to the maximum through the banded ball bearing 128A during the rotation of the rotor (rod) 130.

20 **[0061]** The banded ball bearing 128A may include a band 128c inserted and installed into the gap G and a zigzag leaf spring 128a formed inside the band 128c. The banded ball bearing 128A may further include ball bearings 128b rotatably installed at regular intervals in the
25 longitudinal direction of the leaf spring 128a. The band

128c may have a hollow 128c1 therein, which is suitable to install the zigzag leaf spring 128a and to make it easy to absorb the friction shock transmitted to the ball bearings 128b while enabling the rotation of the ball bearings 128b.

5 **[0062]** As such, the banded ball bearing 128A including the leaf spring 128a, the ball bearings 128b, and the band 128c in the form of the hollow 128c1 may be suitable to actively cope with various loads (radial load, axial load, composite load, and other loads) generated during the rotation of the
10 rotor 130, thereby reducing the loads by absorbing the loads to the maximum. Consequently, the bushing 126 can be slightly worn, the rotational speed of the rotor 130 can be increased, and the shear force of the rotor 130 can be strengthened.

15 **[0063]** Hereinafter, the operation and relationship of the present disclosure will be described below.

[0064] The high-speed coupler of the present disclosure is a device applied to the drilling agitator, and rotates together in the excavation process with the drill bit in
20 the state in which the rotor (rod) 130 is inserted into the housing 120. When the rotor 130 rotates, the inputs including slurry, high-pressure air, and high-pressure water may be selectively supplied to excavation sites through the first, second, and third through-holes 131, 132,
25 and 133 formed to partition the inside of the rotor 130.

[0065] During the rotation of the rotor 130, the bearings installed in the plurality of first and second bearing grooves 123a and 123b formed in the inner diameters of the coverings 123 and 124 coupled to both ends of the housing 120 may provide flexibility for the rotational motion of the rotor 130, thereby reducing the rotational frictional resistance of the rotor 130.

[0066] The exemplary bushing 125 integrated with the outer periphery of the rotor 130 may be interposed to be engaged, namely, latched between the housing 120 and the coverings 123 and 124, and may be rotated simultaneously with the rotor 130. Thus, the bushing 125 may have a structure in which there is no rotational clearance from the rotor 130, and may function to reinforce the portion around the outer periphery of the rotor 130. Therefore, it is possible to strength the shear force of the rotor 130 during the rotation thereof and to prevent the damage or bending of the rotor 130, and the bushing 125 can be slightly worn because there is no clearance therearound.

[0067] Of course, the exemplary bushing 125 applied to the high-speed coupler of the present disclosure has the plurality of friction dispersion holes 125a formed along the periphery thereof at regular intervals and penetrating from the inner diameter to the outer diameter thereof. Therefore, during the rotation of the rotor 130, the

friction dispersion holes 125a can disperse and absorb the friction shock transmitted toward the bushing 125.

[0068] In order to maximize the absorption of such friction shock, each of the friction dispersion holes 125a may have
5 a large-small hole structure in which the diameter thereof becomes larger from the inner diameter to the outer diameter of the bushing 125. That is, the absorption of the friction shock can be maximized in a manner that the friction shock is absorbed into the large portion of the
10 friction dispersion hole 125a at the inner diameter of the bushing and discharged through the small portion of the friction dispersion hole 125a at the outer diameter of the bushing.

[0069] Another exemplary bushing 126 applied to the high-
15 speed coupler of the present disclosure is configured as the dual bushing which includes the inner bushing 126a therein. The reinforcement tips 126b are integrated at both ends of the inner bushing 126a, and the gap G is further formed between the bushing 126 and the inner bushing
20 126a.

[0070] The first friction shock reducing unit 127 is composed of the tapered roller bearing 127A inserted into the gap G formed between the dual bushing 126 and the inner bushing 126a. The spherical bearing 127c and the roller
25 bearings 127a and 127b having the curved contact surfaces

127a1 and 127b1 on the left and right sides thereof, which are included in the tapered roller bearing 127A, may be operated to be actively deformed against various loads (radial load, axial load, composite load, and other loads)

5 generated during the rotation of the rotor (rod) 130.

[0071] Thus, the loads can be reduced through the tapered roller bearing 127A, which can lead to the slight wear of the bushing 126. In addition, the rotational speed of the rotor 130 can be increased, and the shear force of the
10 rotor 130 can be strengthened.

[0072] The second friction shock reducing unit 128 may be inserted into the gap G according to the conditions of design and the environment for use. The second friction shock reducing unit 128 may be composed of the banded ball
15 bearing 128A.

[0073] The banded ball bearing 128A can reduce various loads (radial load, axial load, composite load, and other loads) generated during the rotation of the rotor (rod) 130 by absorbing the friction shock due to the loads.

20 **[0074]** That is, the leaf spring 128a formed in the band 128c is in a zigzag form so as to be suitable for absorption of friction shock. The ball bearings 128b, which are rotatably installed at regular intervals along the length of the leaf spring 128a, can reduce the rotational
25 frictional resistance of the rotor 130 by rotating through

contact with the rotor 130 rotating during the absorption of the friction shock by the leaf spring 128a, or can also reduce the rotational frictional resistance of the rotor 130 in a non-contact state with the rotor 130 by absorbing
5 some of the friction shock through the hollow 128c1.

[0075] Thus, the loads can be reduced to the maximum, resulting in the insignificant progress of wear of the bushing 126. In addition, the rotational speed of the rotor 130 can be increased, and the shear force of the
10 rotor 130 can be strengthened.

[0076] As apparent from the above description, according to the present disclosure, it is possible to reduce the rotational load and friction shock applied to the rotor (rod) during the excavation work of excavation sites using
15 the drilling agitator in the process of constructing the composite ground with deep soil-cement mixing (DCM).

[0077] In addition, according to the present disclosure, it is possible to increase the rotational speed of the rotor (rod) of the high-speed coupler applied to the drilling
20 agitator and to reduce the damage or bending of the rotor by strengthening the shear force for the rotational motion of the rotor (rod).

[0078] Furthermore, according to the present disclosure, the wear of the bushing can be maintained to an insignificant
25 degree despite the increase in rotational speed of the

rotor (rod). Therefore, it is possible to extend the service life of the bushing peripheral components including the bushing and thus to increase the time to replace them.

[0079] Moreover, according to the present disclosure, the
5 rotational speed of the rotor (rod) can be significantly improved, thereby enabling the excavation progress of excavation sites to be rapidly performed. Consequently, it is possible to shorten the period of excavation construction and thus to achieve the reduction in time and
10 cost required for construction together with the rapid construction of products to be constructed.

[0080] While various embodiments have been described above, it will be understood to those skilled in the art that the embodiments described are by way of example only.
15 Accordingly, the disclosure described herein should not be limited based on the described embodiments.

WHAT IS CLAIMED IS:

1. A high-speed coupler comprising:

a coupling member coupled, at the bottom thereof, to a
5 bed or support shaft of a drilling agitator;

a housing integrally formed on the top of the coupling member, a rotor (rod) being rotatably inserted and installed into the housing; and

coverings coupled to or decoupled from both ends of
10 the housing.

2. The high-speed coupler according to claim 1, further comprising a bushing integrated on and spaced at a predetermined distance from an outer peripheral surface of
15 the rotor (rod) rotatably inserted and installed into the housing.

3. The high-speed coupler according to claim 2, wherein the bushing is inserted and engaged between the
20 housing and the coverings coupled to both ends of the housing.

4. The high-speed coupler according to claim 3, wherein the bushing has friction dispersion holes formed

along a periphery thereof at regular intervals and penetrating from an inner diameter to an outer diameter thereof, the friction dispersion holes being configured to absorb and disperse friction shock generated during the
5 rotation of the rotor (rod).

5. The high-speed coupler according to claim 1, further comprising a dual bushing interposed between the housing and the rotor (rod) rotatably inserted and
10 installed into the housing.

6. The high-speed coupler according to claim 5, wherein:

the dual bushing comprises a gap from an inner bushing
15 positioned therein, and reinforcement tips integrated at both ends of the inner bushing; and

the high-speed coupler further comprises a first friction shock reducing unit composed of a tapered roller bearing formed into the gap to reduce a load and friction
20 shock generated during the rotation of the rotor (rod).

7. The high-speed coupler according to claim 5, wherein:

the dual bushing comprises a gap from an inner bushing

positioned therein, and reinforcement tips integrated at both ends of the inner bushing; and

the high-speed coupler further comprises a second friction shock reducing unit composed of a banded ball bearing formed into the gap to reduce a load and friction shock generated during the rotation of the rotor (rod).