DEVICE FOR CONNECTING BARS END-TO-END

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ABSTRACT

A device for connecting bars end-to-end includes a hollow body having an internal cavity with at least one bar insertion opening and a longitudinal axis extending through the at least one insertion opening, and a plurality of radially adjustable clamping elements. The device further includes at least one locking element movably arranged inside the hollow body. The internal cavity of the hollow body has at least one slope inclined relative to the longitudinal axis of the hollow body. The at least one locking element has an inclined face that matches the profile of the at least one slope and a gripping face with at least one protrusion.
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CROSS-REFERENCE TO RELATED U.S. APPLICATIONS

[0001] Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

NAMES OF PARTIES TO A JOINT RESEARCH AGREEMENT

[0003] Not applicable.

REFERENCE TO AN APPENDIX SUBMITTED ON COMPACT DISC

[0004] Not applicable.

BACKGROUND OF THE INVENTION

[0005] 1. Field of the Invention

[0006] The present invention relates to a device for connecting two bars in an end-to-end relationship. The device has a particular application in coupling the ends of reinforcing bars used in structural concrete.

[0007] 2. Description of Related Art


[0009] In the art of joining two bars end-to-end in order to extend their continuity, it is known to use a tubular sleeve that receives the end portion of each bar, the sleeve having radially-oriented elements that are forced into the material of the bars in order to lock them. According to one device as disclosed in U.S. Patent No. 5,046,878 issued to Young on Sep. 10, 1991, the radially oriented elements are provided as screws and racks that are arranged longitudinally along the sleeve.

[0010] The prior art systems have drawbacks. First of all, the pneumatic and electric tools that are commonly available on the market are of limited capacity, which means that it is not possible to increase the size or strength of the screws beyond a certain limit. The connection of larger or stronger bars is therefore not possible. Secondly, the effort generated by torquing the screws serves to press the racks into the sleeve as much as to press them into the bars. Less than half of the tightening effort is thus available to actually clamp the bars. Finally, its performance under a tensile load is very difficult to maintain and to control. Indeed, the effectiveness of the fitting of the sleeve onto the bar end wholly depends on the torque applied on the screws, which is the torque at which the screw heads shear off.

[0011] These screws have their neck reduced so that the shearing occurs outside their threaded area. The precision of this diameter reduction, as well as the radius at the bottom of the reduction, are difficult to achieve. The stress riser at the reduction may vary from 1 to 4, depending on the radius at the bottom of the reduction, which on top of being difficult to produce accurately, is also difficult to measure and control. This variation in stress riser affects directly the torque at which the screws shear off, and consequently the performance of the system.

[0012] Moreover, the screws are calculated to shear off under a purely torsion effort. In practice however, it cannot be guaranteed that the pneumatic or electric wrench or screwdriver is perfectly aligned on the axis of the screw. Because this tool is manually held, a certain angle between its axis and that of the screw is unavoidable. Such an angle adds a flexural effort to the torsion effect, thereby reducing the torque necessary to shear off the screws, and hence reducing the system performance.

[0013] Also known are prior art devices disclosed in U.S. Patent No. 5,909,980 and U.S. Patent No. 6,202,282 that work essentially in the same way as the previously referenced device. These prior art systems replace the gripping effect of the racks by the friction effect of the bar against the internal surface of the sleeve. Because friction is not as efficient as gripping in transmitting effort, it compensates by using a longer length and a larger number of screws. Being so closely related to the other prior art cited, these other prior art systems do not bring any particular additional benefit, while still suffering from the same disadvantage and the additional drawback of bulkiness.

[0014] Also known is a device as disclosed in U.S. Patent Publication No. 2004/0238558 that also works essentially in the same way as the previously cited prior art systems. This particular prior art system provides two rows of screws and uses an internal thread rather than racks to produce the gripping effect inside the sleeve. Being closely related to the other prior art cited, this prior art system does not bring any additional benefits, while still suffering from the same disadvantages and the additional drawback that the angle between the two rows of screws requires extra free space for installation.

BRIEF SUMMARY OF THE INVENTION

[0015] Compared to many of the existing systems to connect two bars end-to-end, such as threading or forging the bar ends, the device of the present invention presents the advantage of not needing any preparation of the bar end. This means that it is not necessary to either transport the bars to a workshop where their ends can be prepared, or transport to the location of the bars the machinery needed to prepare their ends. This system was indeed developed with the aim of enabling a site assembly, with only a pneumatic or electric wrench needed to torque the screws. A site assembly is a great benefit in some industries such as the construction or the oil industry. It is also a great benefit in large countries where transport of bars is an issue, due to long distances.

[0016] It is an object of the present invention to provide a device for connecting bars in an end-to-end relationship that upholds the benefit of site assembly, in addition to new benefits in terms of increased reliability, improved safety to the structure, and better tensile and load bearing performance.

[0017] The present invention also provides an additional benefit compared to the prior art systems. The improved size of the device improves safety for the installer and the individuals working around the device at the work or construction site.

[0018] The present invention is a device for connecting bars end-to-end comprising a hollow casing or body whose internal cavity presents slopes, or surfaces that are at a certain angle relative to the axis of the bars to be connected.

[0019] According to the present invention, the device further comprises at least one locking element movably arranged inside the hollow body. The internal cavity of the
body comprises at least one slope, that is inclined relative to the longitudinal axis of the body. The locking element also has an inclined face that matches the profile of at least one slope of the internal cavity and a gripping face with at least one protrusion. With this structure, the device according to the present invention achieves a self-locking effect in which the clamping and gripping force of the device increases with increased loading of the bars to be connected. As a result, the device according to the invention achieves a higher load bearing performance on an improved safety and reliability level. Moreover, thanks to a reduced bulkiness of the device, improved safety is provided to the installer and the people working around the device on an industrial or construction site.

[0020] In the preferred embodiment, the hollow body has at least two insertion openings and its internal cavity has at least two slopes. The slopes are inclined relative to the longitudinal axis of the hollow body, these inclinations being in opposite directions. As a result, a plurality of bars can be reliably connected in a self-locking manner. If part of the device is to be welded to a steel structure, it can be adapted to receive one bar only. Then, the hollow body has only one insertion opening, and its internal cavity has only one slope.

[0021] The shape of the slopes and inclined faces is not particularly limited in the present invention, as long as cooperating slopes and inclined faces match each other.

[0022] The slopes may be flat or curved.

[0023] In order to achieve an optimum gripping force and an easy and reliable operation of the device, it is preferred that the gripping surface is generally parallel to the longitudinal axis of the hollow body. The material of the gripping surface is chosen and its teeth are shaped to suitably bite into the material of the bars to be connected.

[0024] According to a further development of the present invention, the cross-sectional area of the internal cavity of the hollow body is not regular but rather increases from a minimum at the extremity towards a maximum at the middle and then decreases back to a minimum at the other extremity. Alternatively, the cross-sectional area of the internal cavity may also decrease from a maximum at the extremity towards a minimum at the middle and then increase back to a maximum at the other extremity. This allows an easy manufacture and a stable construction of a hollow body having slopes in its internal cavity.

[0025] The shape and type of the radially-adjustable clamping elements are not specifically restricted in the present invention. In many cases, these will be screws which may have pointed or flat ends, depending on the material of the bars to be connected. They may have standard necks or neck reductions designed to shear under a certain torque.

[0026] There may be provided one or more rows of screws.

[0027] In order to achieve a proper and easy positioning of the bars/bar ends to be connected, it is preferred that stop means are provided in the internal cavity of the body.

[0028] In order to increase the variability of the device, the locking elements are of different radial thickness in order to accommodate bars of different sizes.

[0029] The locking elements may in the present invention act as “passive” locking elements which develop a “self-locking effect” only after an increase load has been brought on the bars to be connected. However, in order to reduce possible slip or deformation, the device according to the present invention further comprises a pushing means for pushing the locking elements from outside of the hollow body. In this way, the locking elements may be prestressed and/or it can be avoided during fastening the radially-adjustable clamping elements that the at least one locking element(s) slides away.

[0030] According to a further development of the present invention, at least one internal phase of the body comprises ribs or grooves. This will improve the bond and anchoring of the device when used in concrete or the like.

[0031] Further, in order to increase the durability of the device according to the present invention, a corrosion-protection or binding substance is poured or injected inside the body.

[0032] According to a further aspect, the present invention provides a method of connecting bars end-to-end using the device as described above. Further details on the method of connecting bar ends according to the present invention will be apparent from the following detailed description.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0033] FIG. 1 shows a perspective view of a device for connecting bar ends according to a first embodiment of the present invention.

[0034] FIG. 2 shows a cross-sectional view of the embodiment shown in FIG. 1.

[0035] FIG. 3 shows a cross-sectional view of a variant of the first embodiment where a corrosion-protection or binding substance has been injected inside the body.

[0036] FIG. 4 shows a perspective view of a device for connecting bar ends according to a second embodiment of the present invention.

[0037] FIG. 5 shows a perspective view of a device for connecting bar ends according to a third embodiment of the present invention.

[0038] FIG. 6 shows a cross-sectional view of the device for connecting bar ends according to a third embodiment of the present invention.

[0039] FIG. 7a to 7f show perspective views of various locking elements.

[0040] FIG. 8 shows a cross-sectional view of a device for connecting bars end-to-end according to a fourth embodiment of the present invention adapted to connect bars of different diameters.

[0041] FIG. 9 shows a cross-sectional view of a device for connecting bars end-to-end according to a fifth embodiment of the present invention provided with a pushing means.

[0042] FIG. 10 shows a cross-sectional view of a device for connecting bars end-to-end according to a sixth embodiment of the present invention, also provided with a pushing means.

[0043] FIG. 11 shows a cross-sectional view of a device for connecting bars end-to-end according to a seventh embodiment of the present invention adapted to receive mainly compressive forces.

[0044] FIG. 12 shows a cross-sectional view of a device for connecting bars end-to-end according to a seventh
embodiment of the present invention adapted to receive both tensile and compressive forces.

DETAILED DESCRIPTION OF THE INVENTION

[0045] Preferred embodiments of the invention are discussed in the following with reference to the enclosed drawings.

[0046] A device 1 for connecting the ends 2' of a bar according to a first embodiment of the present invention is schematically shown in a perspective view in FIG. 1 as well as in a cross-sectional view in FIG. 2. The device is adapted for connecting rebars and the like end-to-end as they are used in construction, for instance, in reinforced concrete structures. The device 1 comprises a hollow body 10 having an internal cavity 12 which, in the present embodiment, comprises two insertion openings 14 through which a longitudinal axis extends. The direction of extension of the longitudinal axis coincides with the direction of extension of the bars 2 to be connected (FIG. 2).

[0047] Furthermore, the device 1 comprises a plurality of clamping screws 16 which are fitted into threaded holes formed in the hollow body 10. The screws may have a reduced neck so as to produce a defined failure. As can be seen in FIG. 2, the screws 16 are adapted to press on the bars 2 inserted into the hollow body 10.

[0048] Further, the device 1 comprises two locking elements 18 which are movably arranged inside the internal cavity 12 of the hollow body 10. Specifically, the internal cavity 12 of the body 10 comprises two slopes 12' which are inclined relative to the longitudinal axis of the body 10, and the locking elements 18 each comprise an inclined face 18' which matches the profile of the corresponding slope 12' and is in contact therewith. In addition, each locking element 18 has a gripping face 18'' having a plurality of rack teeth. The gripping face 18'' is adapted to grip and fix the respective bar 2 together with the screws 16. Therefore, it is preferred that the gripping faces 18'' are generally parallel to the longitudinal axis of the bars 2 and body 10.

[0049] As can be seen in FIG. 2, the device 1 further comprises stop means 20, for example in the form of stop or separation walls. As shown in FIG. 6, this stop or separation wall 20 may also fully separate the internal cavity 12 in two parts.

[0050] For applications where the connection needs to grip or bond with an external surrounding material, for example in concrete construction, ribs or grooves 24 may be provided on the external surface of the body 10.

[0051] The connection is achieved by inserting the ends 2' of bars 2 until they hit the wall 20. The screws 16 are then tightened either until a given torque, or until their heads shear off, thereby forcing the ends 2' of bars 2 against the gripping face 18'' of the locking elements 18, and locking themselves into the material surface of the bars 2.

[0052] The bars 2 are then put in use and sustain a tensile load. This tensile load tends to pull both bars apart, along with the locking elements 18 thanks to the gripping achieved on their gripping faces 18''. When the locking elements 18 move apart by sliding over the slopes 12', they force their grip 18'' further into the material of the bars 2. Thus, the resistance of the device increases with the load applied on the bars.

[0053] FIG. 3 relates to a second embodiment for applications where it is necessary to fill up the cavity 12 with a corrosion-protection or binding substance, end caps 26 may be provided to close the spaces at each extremity of the connection, and a hole 28 may be provided in the body 10, through which the substance may be poured or injected.

[0054] FIGS. 4 and 5 show that the external shape of the hollow body 10 may be widely varied within the present invention. Further, the device 1 may comprise one row or also plural rows of screws 16, as shown in FIG. 5.

[0055] Also the shape of the locking elements 18 is not specifically limited in the present invention. Various examples of suitable locking elements 18 are shown in FIGS. 7A to 7G. For instance, the inclined face 18'' may be flat or curved just like the gripping face 18''. Of course, further designs are possible.

[0056] FIG. 8 shows an embodiment which is adapted to connecting bars 2 having different diameters. For this purpose, the locking elements 18 have a different radial thickness. Specifically, in FIG. 8, the locking element 18 on the left hand side is adapted to grip a bar 2 having a smaller diameter and, therefore, itself has a smaller radial thickness than the locking element 18 on the right hand side.

[0057] FIGS. 9 and 10 show a sixth and seventh embodiment, respectively, with additional pushing means 22 for pushing the locking elements 18 against the ends 2 of bars 2 prior to the tightening of screws 16. This feature is illustrated in FIG. 9 with a cam 23 that is rotated around its axis. In FIG. 10 the pushing means 22 comprises a central screw 25 that pushes on the rear faces of the locking elements 18.

[0058] FIG. 11 schematically shows an eighth embodiment of the present invention for cases where the connection must withstand not tensile, but mainly compression efforts. In this embodiment, the slopes 12' are diverging towards the insertion openings 14.

[0059] Under a compression effort, the locking elements 18 are moving towards the center of the body, thereby securing the clamping of the bars 2.

[0060] FIG. 12 schematically shows an ninth embodiment of the present invention for the cases where the connection must withstand alternate cyclic tensile and compression efforts. In this embodiment, a total of four locking elements 18a, 18b are provided, namely two locking elements 18a, 18b per bar 2. Further, the locking elements 18a, 18b of each bar have their respective slopes 18'' inclined in opposite directions. Thus, under a tensile effort, the locking elements 18a are moving towards the extremities of the body, thereby securing the clamping of the bars. Under a compression effort, the locking elements 18b are moving towards the center of the body, thereby securing the clamping of the bars.

[0061] The connection of the bars 2 is achieved by inserting the device over the end 2' of a first bar 2, said bar end 2 being received by the cavity 12 between the locking element 18 and the screws 16. A second bar 2 is then inserted into the other side of the device 1. The device can now be oriented in the radial direction deemed most suitable either for access purpose or for space optimization. The pushing means 22 may then be used to reduce the clearance between the bars 2 and the device 1. The screws 16 are finally torqued so that they press the bar 2 against the locking elements 18 and themselves penetrate into the surface of the bars 2.

[0062] When the bars 2 are pulled by application of a tensile load, the initial resistance comes from the gripping effect between the screws 16 and the locking elements 18. As the load increases, the locking elements 18 move along
the slopes 12' of the body 10, and further lock the bar ends 2' inside the cavity, thereby greatly improving the tensile performance: the stronger the pull on the bars, the stronger the lock.

I claim:
1. A device for connecting bars end-to-end, said device comprising:
   a hollow body having an internal cavity with at least one bar insertion opening and a longitudinal axis extending through said at least one insertion opening, said internal cavity having at least one slope inclined relative to a longitudinal axis of said hollow body;
   a plurality of radially-adjustable clamping elements mounted on said hollow body; and
   at least one locking element movably arranged inside said hollow body, said at least one locking element having an inclined face matching said at least one slope of said internal cavity and a gripping face having at least one protrusion.
2. The device according to claim 1, wherein said internal cavity of said hollow body has at least two slopes inclined relative to the longitudinal axis of said hollow body, said at least two slopes being inclined in opposite directions.
3. The device according to claim 1, wherein said gripping face is generally parallel to the longitudinal axis of said hollow body.
4. The device according to claim 1, wherein said internal cavity of said hollow body has a cross-section area increasing from a minimum at one end of said internal cavity to a maximum at a middle of said internal cavity and decreasing from said maximum at said middle of said internal cavity to a minimum at an opposite end of said internal cavity.
5. The device according to claim 1, wherein said internal cavity of said hollow body has a cross-section area decreasing from a maximum at one end of said internal cavity to a minimum at a middle of said internal cavity and increasing from said minimum at said middle of said internal cavity to a maximum at an opposite end of said internal cavity.
6. The device according to claim 1, wherein said radially-adjustable clamping elements have a designated preferential location of failure.
7. The device according to claim 1, further comprising: stop means provided in said internal cavity of said hollow body.
8. The device according to claim 2, wherein said at least one locking element has a radial thicknesses to accommodate bars of different sizes.
9. The device according to claim 1, further comprising: pushing means for pushing said at least one locking element from outside of said hollow body.
10. The device according to claim 1, wherein said at least one locking element having an end chamfered in order to reduce maximum height thereof.
11. The device according to claim 1, wherein said hollow body has at least one external face being comprised of ribs or grooves.
12. The device according to claim 1, further comprising: a corrosion-protection substance poured or injected inside said hollow body.
13. The device according to claim 1, further comprising: a binding substance poured or injected inside said hollow body.
14. A method of connecting bars end-to-end, said method comprising:
   inserting bars into a device comprised of a hollow body having an internal cavity with at least one bar insertion opening and a longitudinal axis extending through said at least one insertion opening, said internal cavity having at least one slope inclined relative to a longitudinal axis of said hollow body; a plurality of radially-adjustable clamping elements mounted on said hollow body; at least one locking element movably arranged inside said hollow body, said at least one locking element having an inclined face matching said at least one slope of said internal cavity and a gripping face having at least one protrusion; and stop means provided in said internal cavity of said hollow body, said bars being inserted until contacting said stop means; and tightening said radially-adjustable clamping elements until ends of said bars are forced against said gripping face, said radially-adjustable clamping elements being locked into a surface material of said bars, said at least one locking element being further forced against said bars when said bars are subjected to a tensile load.