AN IMPROVED CONNECTING ARRANGEMENT FOR REINFORCEMENT BARS

TECHNICAL FIELD

[0001] The present disclosure relates to a connecting arrangement for connecting at least two reinforcement bars of adjacent concrete elements so that when adjoined, the connecting arrangement enhances the structural performance of the connected reinforcement bars. Such a connecting arrangement is compact and may be adopted in thinner width structures and improve productivity during construction.

BACKGROUND

[0002] The following discussion of the background is intended to facilitate an understanding of the present disclosure only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or is part of the common general knowledge of the person skilled in the art in any jurisdiction as of the priority date of the invention.

[0003] Concrete is commonly used in the construction industry. However, concrete is a brittle material, which performs well under compression but not when in tension. To enhance the performance of concrete, steel is usually introduced, as a means of reinforcement.

[0004] With the increased emphasis placed on using precast or prefabricated technology in construction due to productivity and efficiency reasons, innovation needs to focus on its connecting means. Steel reinforcement bars are used in concrete construction and frequently need to be joined end to end in order to make up a longer bar length and to transfer forces from one reinforcement bar to another. At the same time, in prefabricated or precast columns, walls or concrete structures, such columns, walls or structures are required to be connected to one another in a side-by-side and/or end-to-end manner . It is thus important to have cost effective, labour-saving connection solutions between such elements.

[0005] There are known systems for connecting precast or prefabricated structures in a side-by-side manner. One solution includes the use of a cylindrical shaped steel sleeve that is filled with grout. The reinforcement bars to be spliced are then inserted into the sleeve to meet at the middle of the sleeve. Finally, the interior of the sleeve is filled with grout.

[0006] Other common connection methods include using mechanical connections, such as bolts, dowels, or embedded connectors, as well as adhesives or grouts. These connections are designed to prevent movement and ensure load transfer between adjacent panels.

[0007] However, such systems are generally cast-in and more rigid and costly to use. Moreover, such connectors are labor intensive and require the installation of one device at each time as such installation requires high precision and may have to be cast-in and therefore have very tight tolerances such that there is low flexibility to accommodate any construction deviation. Further, such systems cannot be deployed in tighter space constraints with thinner width structures, or where the design requires the installation of slabs, columns and walls with very closely spaced reinforcement bars.

[0008] There thus exists a need for an improved connecting arrangement to alleviate one or more of the aforementioned problems.

SUMMARY

[0009] The disclosure was conceptualized to provide a connecting arrangement for reinforcement bars. At least one connector is formed by spinning from a straight bar into a continuous infinity "∞" or lemniscate shape helix. Such a connecting arrangement is compact and provides an enhanced performance of the reinforcement bar connection by providing an effective confinement to the grout infill. Such a connecting arrangement also allows the connector to be adopted in thinner width structures, spaces with tighter constraints or with requirements for closely spaced reinforcement bars and enhances productivity during installation. Moreover, such a connecting arrangement can also be designed to be installed in many different configurations within the precast element or concrete structures based on individual design needs. Since such a connecting arrangement need not be cast-in, the present invention provides a much higher level of flexibility and can accommodate higher construction tolerances.

[0010] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF DRAWINGS

[0011] In order to illustrate the technical solutions to the embodiments of the present disclosure, introduction of the drawings referred to in the description of the embodiment is provided below. The drawings described below are only some examples or embodiments of the present disclosure. A person having ordinary skill in the art, without further creative effort, may apply the present disclosure to other scenarios according to these drawings.

[0012] FIGs. 1A – 1C illustrate various views of a connecting arrangement for reinforcement bars according to some embodiments. FIG. 1A is an isometric view, FIG. 1B is a top view and FIG. 1C is a front side view of the connecting arrangement;

[0013] FIG. 2A is a schematic top and side views of a connecting arrangement having a two-loop configuration according to some embodiments, while FIG. 2B illustrates a schematic top and side views of a connecting arrangement having a three loop configuration according to some embodiments;

[0014] FIG. 3A is a schematic top and side views of a connecting arrangement of a plurality of connectors adjoined in a linear engagement to one another according to some embodiments. FIG. 3B is a schematic top and side views of a connecting arrangement illustrating the connection between the connectors in series and in parallel, according to some embodiments;

[0015] FIG. 4 is a schematic top view of the connecting arrangement in various configurations, illustrating the self-confining force interaction between the connectors according to some embodiments;

[0016] FIG. 5 is a schematic plan and elevation view of the connecting arrangement when two pairs of reinforcement bars are connected, according to some embodiments;

[0017] FIG. 6 is a schematic diagram illustrating how the connecting arrangement

is capable of fitting into smaller width spaces;

[0018] FIGs. 7A – 7C is a schematic side view of the connecting arrangement, illustrating the self-locking function of a bent bar;

[0019] FIG. 8 is a schematic side view of a structural element arrangement comprising two pairs of reinforcement bars connected with the connecting arrangement according to some embodiments;

[0020] FIG. 9 is a schematic side view of an alternative structural element arrangement comprising two pairs of reinforcement bars connected with the connecting arrangement according to some embodiments

[0021] FIG. 10 is a schematic plan and isometric view of a connecting arrangement comprising a pair of L-shaped bars, according to some embodiments; and

[0022] FIG. 11 is a top and elevation view of an alternative connecting arrangement employed to resist shearing forces according to some embodiments.

DESCRIPTION OF EMBODIMENTS

[0023] Reference will now be made in detail to the preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. The preferred embodiments of the invention are not intended to limit the invention in its broadest aspect to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of the embodiments, numerous specific details are set forth in order to provide an understanding of the present embodiments.

[0024] FIGs. 1A – 1C respectively illustrate an isometric view, a top view and a front side view of a connecting arrangement for reinforcement bars according to some embodiments. This connecting arrangement 10 is used primarily in the construction industry to connect adjoining reinforced concrete structures or pre-cast concrete structures. The connecting arrangement 10 comprises a coil 20. The coil 20 may be

shaped in the form of an infinity “∞” or lemniscate shape as more clearly seen in FIG. 1B. The coil 20 has a first end 22 (at the top of the connecting arrangement 10) and terminates at a second end 24 (at a base of the connecting arrangement 10) and may be spun continuously into an infinity “∞” or lemniscate shape and helical structure 28. As seen in FIG. 1B, the coil 20 is spun continuously into an infinity “∞” or lemniscate shape such that two loops 26 are formed. Each loop 26 is sized and adapted to receive one or more reinforcement bars as will be explained later. Each loop 26 may be formed of the same size or of a different size, according to design requirements.

[0025] The inner periphery of the helical structure 28 may be provided with at least one bar 30 extending throughout the length of the helical structure 28. The at least one bar 30 provides the structural strength required for splicing of the two reinforcement bars and structural integrity to the helical structure 28 and helps to maintain the overall shape and form of the helical structure 28. The at least one bar 30 also functions as a force transfer bar that provides the effect of a balanced force transmission during operation. While FIGs 1A to 1C illustrate the use of four bars 30, a skilled person would understand that any numbers of bars may be utilized and selected according to design and load considerations. Optionally and advantageously, the helical structure 28 may further be provided with one or more bent bars 40. The one or more bent bars 40 extend from the top of the helical structure 28 towards a base of the helical structure 28. Unlike the one or more bars 30, the bent bars 40 do not extend across the entire length of the helical structure 28. The bent bars 40 may extend up to a distance before the middle of the helical structure 28, as illustrated in FIGs. 1A and 1C. The bent bars 40 may initially rest on the inner periphery of the helical structure 28 and subsequently form a bend 42 towards a center of each loop 26. The bent bars 40 help in the installation process and allows pre-installation and inspection. More functions of the bent bars 40 will be described later.

[0026] The earlier paragraphs describe a connecting arrangement 10 having a two-loop configuration, as illustrated in FIG. 2A. FIG. 2B illustrates a schematic top and side views of a connecting arrangement having a three-loop configuration according to some embodiments. In this configuration, the coil 20 may be spun continuously to form three loops in a linear fashion and the helical structure 28. Each loop 26 in the three-

loop configuration may be formed of the same size or of a different size, according to design requirements.

[0027] A skilled person when reading this disclosure will understand that the present invention is not limited to a two or three loops connecting system. FIG. 3A is a schematic top and side views of a connecting arrangement of a plurality of connectors adjoined in a linear engagement in a side-by-side manner to one another according to some embodiments. In this example, three pairs of helical structures 28 connected to one another in a side-by-side manner are shown. This simply illustrates one possible configuration and a skilled person will understand that this disclosure is not limited to three pairs of helical structures connected to one another linearly. As will be appreciated, “N” numbers of helical structures may be arranged and connected according to this disclosure, where “N” is any number greater than one, so long as the coil 20 may be shaped continuously into multiple infinity “∞” or lemniscate shape and helical structures.

[0028] FIG. 3B is a schematic top and side views of a connecting arrangement illustrating the connection between the connectors in series and in parallel, according to some embodiments. In this illustration, the helical structures 28 are connected both in series and in parallel configuration.

[0029] FIG. 4 is a schematic top view of the connecting arrangement in various configurations, illustrating the self-confining force interaction between the connectors according to some embodiments. Hence, a skilled person upon reading this disclosure, will understand that arrangements of various kinds in a side-by-side linear manner, whether in series or in parallel, will be covered by the scope of this disclosure, so long as the coil 20 may be shaped continuously into multiple infinity “∞” or lemniscate shape and helical structures. Advantageously, the coils that are shaped continuously into multiple infinity “∞” or lemniscate shape and helical structures provide a self-confining force interaction between the connectors. For instance, when one loop 26 experiences a tensional force, the adjacent loop 26 will help to retain it in, as it is a continuous loop adjoined to each other. This provides additional structural integrity with the benefit that the reinforcement bars contained in each loop, remains rigidly held in place.

[0030] FIG. 5 is a schematic plan and elevation view of the connecting arrangement

when two pairs of reinforcement bars are connected, according to some embodiments. Steel bars (known as reinforcement bars) may be introduced into concrete elements to reinforce the concrete elements or blocks so that they may perform well under both compression and tension. Concrete elements with steel bars introduced are known as reinforced concrete elements. An upper reinforced concrete element comprises a first pair of reinforcement bars 52 and a lower reinforced concrete element comprises a second pair of reinforcement bars 62. The reinforcement bars 52, 62 may be introduced into the upper and lower reinforced concrete elements via any known means. As shown in FIG. 5, the ends of the first and second reinforcement bars 52, 62 that approach each other may optionally be provided with enlarged ends 54, 64. The advantages of the enlarged ends 54, 64, will be described subsequently when used with the one or more bent bars 40.

[0031] When positioned for use according to the present invention, the first and second reinforcement bars 52, 62, are received within the confines of the helical structure 28. The enlarged ends 54, 64 are advantageous as it also enhanced the resistance to prevent the first and second reinforcement bars 52, 62 from slipping away from the connecting arrangement 10.

[0032] FIG. 6 is a schematic diagram illustrating how the connecting arrangement is capable of fitting into smaller width spaces. In the exemplary configuration on the left, a connecting arrangement formed from coils that are shaped and continuously looped into multiple infinity “∞” or lemniscate shape and helical structures is deployed and may be installed in a thinner width structure as compared to two similar sized connectors separately connected. Such separately joined connectors also have to meet the minimum tolerances.

[0033] FIGs. 7A – 7C is a schematic side view of the connecting arrangement, illustrating the self-locking function of the bent bars 40. In these figures, one half of the coil 20 has been removed for brevity. As shown in FIG. 7A, the first reinforcement bar 52 has not been installed within the confines of the helical structure 28. As the first reinforcement bar 52 is inserted through the coil 20 in the direction of the arrow, the enlarged end 54 of the first reinforcement bar 52 bears against the bends 42 of each bent bars 40. This causes the bends 42 of each bent bars 40 to be biased outwards axially in the direction of the arrows shown in FIG. 7B. Once the enlarged end 54 of the

first reinforcement bar 52 is inserted further past the bends 42, the bends 42 are then biased back to their original positions in the direction of the arrow shown in FIG. 7C. In this position shown in FIG. 7C, the first reinforcement bar 52 is “locked” within the helical structure 28. Hence, the self-locking function of the bent bars 40 prevents the reinforcement bars from being accidentally removed . Furthermore, the bent bars advantageously serve as a system to suspend the connecting arrangement and thus facilitates installation on site, as will be described later.

[0034] FIG. 8 is a schematic side view of a structural element arrangement 70 comprising two pairs of reinforcement bars connected with the connecting arrangement according to some embodiments. The structural element arrangement 70 comprises an upper reinforced concrete element 50 and a lower reinforced concrete element 60. The upper reinforced concrete element 50 is provided with a recess forming a trough 56 and sidewalls 57 on the surface of the upper reinforced concrete element 50. This surface of the upper reinforced concrete element 50 is the surface where the pair of first reinforcement bar 52 extends therefrom. Arbitrarily and as shown in FIG. 8, the upper reinforced concrete element 50 is provided with the trough 56 and sidewalls 57. Only either one of the reinforced concrete elements needs to be provided with a recess, for a pre-cast concrete arrangement, so that when in position, an enclosure may be formed in between the reinforced concrete elements 50, 60 for the connecting arrangement 70 to be positioned.

[0035] The upper concrete element 50 may have at least one orifice (not shown) through the sidewalls 57 to allow bonding medium 58 to be introduced. The inner periphery of the helical structure 28 may be provided with at least one bar 30 extending throughout the length of the helical structure 28.

[0036] When positioned for use according to the present invention, the first and second pair of reinforcement bars 52, 62 are received within the confines of the helical structure 28, as seen in FIG. 8. When in use, the upper reinforced concrete element 50 is placed with the trough 56 facing towards the second reinforcement bars 62 to be in connection with. The helical structure 28 is then placed over the upwardly extending second reinforcement bars 62 so that the first reinforcement bars 52 are positioned within the internal confines of the helical structure 28.

[0037] Next, the upper reinforced concrete element 50 is positioned over the lower reinforced concrete element 60, thereby forming an enclosure and so that the first reinforcement bars 52 are positioned within the confines, and in close or abutting relationship with the second reinforcement bars 62.

[0038] When the upper and lower reinforced concrete elements 50, 60 are in position, bonding medium 58 may then be introduced through the orifice into the enclosure. The bonding medium 58 may be introduced, using high-pressure sources or otherwise. When pressure is introduced, a second orifice is preferably provided, as an outlet, so that a buildup of pressure within the enclosure will not be experienced. Having a second outlet allows the enclosure to be completely filled with bonding medium 58. Once the bonding medium 58 sets, the connecting arrangement 70 is complete. Moreover, since the design of the helical structure 28 does not require it to be cast-in, this provides the helical structure 28 the flexibility to move within the pre-formed enclosure. The enlarged ends 54, 64 and the bent bars 40 allow the helical structure 28 to be suspended and slidable along a longitudinal axis of the reinforcement bar 52. Such combination of movements provides the flexibility and a greater margin of tolerance for it to align with the projected field dowels, and hence facilitate installation which reduces the time taken and manpower required for installation of the precast panels.

[0039] FIG. 8 also shows the force diagrams depicting the advantage of the connecting arrangement of the present invention. As seen in FIG. 8, the interaction between the bonding medium 58 and the enlarged ends 54, 64 of the first and second reinforcement bars 52, 62 is such that the bonding medium 58 provides an opposed force to the tensile forces such that the first and second reinforcement bars are maintained in position within the confines of the helical structure 28 when an external tensile force is exerted.

[0040] Further, the enlarged ends 54, 64 of the first and second reinforcement bars 52, 62 direct the forces towards the at least one bar 30, which in turn directs the force back towards the first and second reinforcement bars 52, 62, or more specifically the first and second enlarged ends, so that, again, the externally exerted tensile forces are internally opposed, within the enclosure.

[0041] The helical structure 28 is also advantageous as the internal edges of the helix provide a radial inward compression so that the inward compression further provides a cohesive force to prevent the first and second reinforcement bars 52, 62 from slipping away, when an external tensional force is experienced. Further, and as explained earlier, the coils that are shaped and continuously looped into multiple infinity "∞" or lemniscate shape and helical structures provide a self-confining force interaction between the connectors.

[0042] Hence, when the bonding medium 58 is introduced into the enclosure, the helical structure 28, the one or more bars 30 and the enlarged ends 54, 64 cooperate such that the external tensional force is effectively resisted. The connecting arrangement 70 therefore effectively resists tensional forces. Compressional forces are similarly resisted.

[0043] FIG. 9 illustrates an alternative form of installing the structural element arrangement 70 comprising two pairs of reinforcement bars connected with the connecting arrangement according to some embodiments. The structural element arrangement 70 comprises an upper reinforced concrete element 50 and a lower reinforced concrete element 60. The lower reinforced concrete element 60 is provided with a recess forming a trough 66 and sidewalls 67 on the surface of the lower reinforced concrete element 60. This surface of the lower reinforced concrete element 60 is the surface where the pair of second reinforcement bar 62 extends therefrom. Arbitrarily and as shown in FIG. 9, the lower reinforced concrete element 60 is provided with the trough 66 and sidewalls 67. Only either one of the reinforced concrete elements needs to be provided with a recess, for a pre-cast concrete arrangement, so that when in position, an enclosure may be formed in between the reinforced concrete elements 50, 60 for the connecting arrangement 70 to be positioned.

[0044] The lower concrete element 60 may have at least one orifice (not shown) through the sidewalls 67 to allow bonding medium 68 to be introduced. The inner periphery of the helical structure 28 may be provided with at least one bar 30 extending throughout the length of the helical structure 28.

[0045] When positioned for use according to the present invention, the first and

second pair of reinforcement bars 52, 62 are received within the confines of the helical structure 28, as seen in FIG. 9. When in use, the upper reinforced concrete element 50 is placed with the first reinforcement bars 52 extending downwards. The helical structure 28 is then placed over the downwardly extending first reinforcement bars 52 so that the first reinforcement bars 52 are positioned within the internal confines of the helical structure 28. The one or more bent bars help to retain the first reinforcement bars 52 within the helical structure 28.

[0046] Next, the upper reinforced concrete element 50 is positioned over the lower reinforced concrete element 60, thereby forming an enclosure and so that the first reinforcement bars 52 are positioned within the confines, and in close or abutting relationship with the second reinforcement bars 62. The second installation method illustrated in FIG. 9 advantageously does not require the use of any pressure grouting.

[0047] FIGs. 8 and 9 illustrate two examples of connection between the upper and lower reinforced concrete elements. A skilled person would know from reading the disclosure that other forms and manner of connection between the upper and lower reinforced concrete elements may be reproduced.

[0048] Apart from tensional and compressional forces, adjacent connected structural elements also are subjected to shearing forces. FIG. 9 is a schematic plan and isometric view of a connecting arrangement comprising a pair of L-shaped bars, according to some embodiments. In the example illustrated in FIG.9, a first structural element 80 is connected to an adjacent second structural element 90 via a helical structure 28. To resist shearing forces, a pair of L-shaped bars 82 may be installed between each loop 26 of the helical structure 28 and the first structural element 80. A first end of the L-shaped bar extends from within the helical structure 28 and bends into an L-shaped to terminate within the first structural element 80.

[0049] Similarly, for the second structural element 90, a second pair of L-shaped bars 92 may be installed between each loop 26 of the helical structure 28 and the second structural element 90. A first end of the L-shaped bar extends from within the helical structure 28 and bends into an L-shaped to terminate within the second structural element 90. The interaction of the L-shaped bars 82, 92 with the helical structure 28 and the first and second structural elements 80, 90 provides good resistive

forces against shearing. The gaps and spaces between both elements may be filled with any suitable bonding medium.

[0050] Alternatively, in lieu of L-shaped bars, the connecting arrangement described in FIGs. 8 to 9 may also be adopted to resist shearing forces in the manner illustrated by FIG. 11. Here, instead of a vertical connection, such connection can be seen rotated by 90 degrees such that a horizontal configuration is now seen. This beneficially assist to resist shearing forces between the two structural elements.

[0051] It will now be apparent that a new and improved connecting arrangement for connecting at least two reinforcement bars of adjacent concrete elements has been described in the specification with sufficient particularity as to be understood by one of ordinary skill in the art. Moreover, it will be apparent to those skilled in the art that various modifications, variations, substitution and equivalents exist for features of the apparatus and system which do not materially depart from the scope of the invention.

[0052] It should be further appreciated by the person skilled in the art that variations and combinations of features described above, not being alternatives or substitutes, may be combined to form yet further embodiments falling within the intended scope of the invention.