

**A JOINT LOCATED BETWEEN PRECAST REINFORCEMENT CONCRETE
STRUCTURES AND REINFORCEMENT ARRANGING METHOD FOR
REINFORCEMENT CONCRETE STRUCTURE**

5 **Field of the Invention:**

[0001] The present invention relates to technology to connect concrete structures, in particular to connecting technology for quickly assembling a variety of prefabricated or precast elements at a construction site.

10 **Background of the Invention:**

[0002] In a conventional reinforced concrete structure, a wall, or column includes longitudinal reinforcement bars (e.g., metal reinforcement bars), and open braces and closed ties, in which the braces and the ties are perpendicular to the longitudinal reinforcement bars and are spaced at an interval to form a column shape. The purpose of the braces and ties is
15 mainly to provide lateral restraint to the longitudinal reinforcement bars. Common shapes of the column structures are square and rectangular.

[0003] For circular tie columns, the closed ties form a circular shape. As an alternative, continuous helical spiral reinforcement bars can be used to replace the circular closed ties. For the circular tie columns, reports indicate that continuous helical spiral reinforcement bars
20 have improved strength and ductility, as compared to circular closed ties.

[0004] For reinforced concrete walls, longitudinal reinforcement bars typically are restrained by using braces and closed ties, but no spiral reinforcement is used for strengthening or connecting prefabricated elements. Conventional precast reinforced concrete structures adopt a reinforcement design similar to a cast in situ concrete structure, in
25 which the longitudinal reinforcements are enclosed by braces and closed ties.

[0005] In practical applications for joining two prefabricated vertical elements, details of conventional connection include:

1. distributing and arranging exposed reinforcements at an end of a prefabricated wall;
2. adding reinforcement anchors within ties at a construction site so as to transfer tension force
30 across prefabricated elements;
3. fabricating site formworks for closing up; and
4. casting with concrete or grout.

[0006] The disadvantage of the above system is that the site formwork and fixing reinforcements are required, thereby slowing down construction time. Therefore, there is a

need in the art for improved techniques to join concrete structures. Especially, such improved techniques can be used during building construction so that building site formworks are omitted and thus construction time is speeded up.

5 **Summary of the Invention:**

[0007] The present invention is to provide a joint located between precast reinforced concrete structures, which includes a first precast reinforced concrete structure selected from a wall, a module, a column, a beam, a floor, or a balcony. The joint includes one or more first reinforcing connectors partially embedded along a side surface of the first precast reinforced concrete structure such that first reinforcing connectors at least extend outward from the side surface of the first precast reinforced concrete structure, so as to form periodically protruding portions. Each of the periodically protruding portions extending outward forms an aperture with the side surface of the first precast reinforced concrete structure, and the aperture is configured to receive a joining component. A second precast reinforced concrete structure is further provided, which is disposed adjacent to the first precast reinforced concrete structure and has a configuration similar to that of the first precast reinforced concrete structure. A rotatable spiral component interlocks the apertures of the first reinforcing connector and the aperture of the second reinforcing connector; the connection is completed by filling grout, so as to omit formwork at a construction site.

[0008] In an embodiment, the one or more first reinforcing connectors and the one or more first reinforcing connectors are substantially a spiral shape, in which each of the reinforcing connectors in the spiral shape may include one or more reinforcing bars joined to the connector.

[0009] In an embodiment, the joint further includes cast-in-situ concrete or grout to fill into a space between the first precast reinforced concrete structure and the second precast reinforced concrete structure.

[0010] In an embodiment, the one or more first reinforcing connectors and the one or more second reinforcing connectors have a repeating W-shape, in which each of the reinforcing connectors in the W-shape may include one or more reinforcements joined to the connector.

[0011] In an embodiment, the one or more first reinforcing connectors and the one or more second reinforcing connectors respectively include a plurality of periodic protruding portions in a sinusoidal shape or other shapes, in which each of the periodic protruding portions in the sinusoidal shape or other shapes may include one or more reinforcements joined to the connector.

[0012] In an embodiment, the pitch of the spiral joining component is approximately equal to or the same as a distance between the adjacent apertures.

[0013] In an embodiment, the joint further includes:

at least one third precast reinforced concrete structure that is a structure selected from a wall,
5 a module, a column, a beam, a floor, or a balcony, in which the third precast reinforced concrete structure includes:

one or more third reinforcing connectors configured as being partially embedded along a side
surface of the third precast reinforced concrete structure such that periodic protruding
structures at least extend outward. Each of protruding portions extending outward forms a
10 plurality of apertures with the side surface of the third precast reinforced concrete structure,
and each of the apertures is configured to receive a connecting component. A rotatable spiral
joining component interlocks the apertures of the first reinforcing connector, the apertures of
the second reinforcing connector, and the apertures of the third reinforcing connectors.

[0014] A second aspect of the present invention is to provide a reinforcement arranging
15 method for precast reinforced concrete structures, which includes welding one or more
longitudinal reinforcements to the outer or inner circumference of one or more spiral
reinforcements to form a spiral reinforcement module, which is placed in a structural wall,
floor or other structure.

[0015] A third aspect of the present invention is to provide a joint located between precast
20 reinforcement concrete structures, which includes:

a first precast reinforced concrete structure that is a structure selected from a wall, a module,
a column, a beam, a floor, or a balcony, wherein the structure uses the reinforcement formed
by the method described as the second aspect of the present invention; and

a second precast reinforced concrete structure that is a structure selected from a wall, a module,
25 a column, a beam, a floor, or a balcony, wherein the structure uses the reinforcement formed
by the method described as the second aspect of the present invention;

wherein a spiral reinforcement assembly is placed in the first precast reinforced concrete
structure firstly, the spiral reinforcement assembly placed in the first precast reinforcement
concrete structure is rotated to enter a spiral reinforcement assembly in the second precast
30 reinforced concrete structure after hoisting into position, and a spiral connecting assembly
overlaps the spiral reinforcement assemblies in the first and second precast reinforcement
concrete structures.

[0016] In an embodiment, the longitudinal reinforcement is connected to the outer
circumference of the one or more spiral reinforcements by welding or other approaches.

[0017] In an embodiment, the longitudinal reinforcement is connected to the inner circumference of the one or more spiral reinforcements by welding or other approaches.

[0018] In the above embodiments, if a plurality of the spiral reinforcements are used, all the centers thereof overlap, and the pitches and diameters are the same.

5 [0019] In an embodiment, a spiral reinforcement of the spiral connecting assembly has a diameter less than diameters of the spiral reinforcing assemblies of the first and second precast reinforced concrete structures but has the same pitch, such that the connecting assembly is able to rotate and move in the spiral reinforcing assemblies.

10 [0020] In an embodiment, the longitudinal reinforcements and the spiral reinforcements can be replaced with other metal, carbon fiber, or other suitable structural material strips.

Brief Description of the Drawings:

[0021] FIG. 1A is a top view of a joint according to an embodiment of the present invention;

15 [0022] FIG. 1B is a perspective view of a joint according to an embodiment of the present invention;

[0023] FIG. 1C has left and right parts, in which the left part shows an enlarged schematic diagram of a pitch and a radius of a spiral reinforcement according to an embodiment of the present invention; and the right part shows a side schematic diagram of a joint according to an embodiment of the present invention;

20 [0024] FIG. 2 shows top views (drawings at upper left, lower left and lower right) and a section view (a drawing at upper right) of a joint according to various embodiments of the present invention;

25 [0025] FIG. 3A has upper, lower left, and the lower right parts, in which the upper part shows a top view of using a spiral reinforcement combination to connect with a reinforced wall; the lower left part shows a stereoscopic view of a spiral reinforcement combination for connecting a precast wall in the present invention; and the lower right part shows a cross section view of connecting to a precast wall through a spiral reinforcement combination of the present invention;

30 [0026] Fig. 3B has upper and lower parts, in which the upper part shows a side view of a single spiral reinforcing connector; and the lower part shows side and stereogram views of a double spiral reinforcement connector;

[0027] Fig. 3C has upper and lower parts, in which the upper part a top view of a main spiral reinforcement and a connecting spiral reinforcement according to an embodiment of

the present invention; and the lower part shows start and final positions when using a spiral reinforcement combination to connect walls;

[0028] Fig. 4 has upper and lower parts, in which the upper part shows start and final positions of a connecting spiral reinforcement in two precast slabs when connecting the two precast slabs according to an embodiment of the present invention; and the lower part shows a plan view of a set of precast slabs connected by connecting spiral reinforcements;

[0029] FIG. 5 shows a spiral reinforcement inserted from a top side between W-shaped reinforcements of two walls by a rotational motion according to another embodiment of the present invention;

[0030] FIG. 6 is an isometric view of the two walls of FIG. 5 with the spiral reinforcements inserted therebetween;

[0031] FIG. 7 is a top or cross section view of the two walls of FIG. 5 with the spiral reinforcements inserted therebetween;

[0032] FIG. 8 is an enlarged view of the two walls of FIG. 5 with the spiral reinforcements inserted therebetween;

[0033] FIG. 9 is a top view of connecting four walls by the same manner as the embodiment shown in FIG. 5;

[0034] FIG. 10 shows connecting two precast walls by three spiral reinforcements according to an embodiment of the present invention;

[0035] FIG. 11 shows an enlarged schematic diagram of a pitch and a radius of the spiral reinforcement in the embodiment of FIG. 10;

[0036] FIG. 12 shows a pattern of the three spiral reinforcements present in a staggered style in the embodiment of FIG. 10; and

[0037] FIG. 13 shows connecting four precast walls by five spiral reinforcements according to an embodiment of the present invention.

Detailed Description:

[0038] FIGS. 1A, 1B, and 1C show schematic diagrams of the connection of two precast walls. FIG. 1A is a top view of the precast walls A and B; and FIG. 1B is a perspective view of the precast walls A and B. The two precast walls may be individual precast panels or side walls of two adjacent precast structure modules. Alternatively, other precast structures may be used, such as assemblies, columns, beams, floors, balconies, or the likes. Spiral reinforcing connectors 1 and 2 are respectively cast into ends of two precast concrete structures and have the same height as the precast concrete structures. Although a spiral shape is depicted in the

illustration, it is noted that any connector with a periodic repeating structure that is available to one skilled in the art is applicable, such as W shape, sinusoid shape, or the like. The spiral reinforcing connectors or other connectors having repeating structures extend from the precast walls and form a continuous aperture at the sides of the concrete structures. The geometry of the spiral is defined by its diameter, pitch and rotational direction.

[0039] As shown in FIG. 1A, the spiral reinforcing connectors 1 and 2 are partially extending from ends of the two precast walls 6. Longitudinal reinforcements 7 (e.g., rebar) can be disposed in the spiral reinforcing connectors 1 and 2 if it is required to enhance strength on the structure(s), but such disposition is not absolutely necessary. At the construction site, the two precast walls A and B are placed with their ends corresponding to each other. The ends are designed as being corresponding according to the needs of the connection therebetween, such that when placing them together, a gap having as a spacing 3 of approximately 20 mm is just formed on an external surface between the ends. Another space 5 is formed between the ends of the two precast walls, and its space size corresponds to the dimensional requirement of a third spiral connector 4 to be inserted from a top side of the ends of the precast walls. The diameter of the third spiral connector 4 can be optionally less than the spiral reinforcing connectors 1 and 2 partially cast in the precast walls, such that the third spiral connector 4 can be inserted into a space formed between the precast walls.

[0040] The spiral connector 4 has a spin direction and a pitch which are the same as those of the spiral reinforcing connectors 1 and 2 (however, it is possible to make the spiral reinforcing connectors 1 and 2 have larger pitches such that the spiral reinforcing connectors 1 and 2 may have greater spacings when spirally connecting to each other). Note that any spiral-type of the spiral connector 4 can be used as long as it can rotationally pass through the spiral reinforcing connectors 1 and 2. Due to the chosen spin direction and pitch, the spiral connector 4 can rotate downward into the void without blocking other reinforcements.

[0041] After the gap 3 between the two precast walls are selectively sealed by means of using seam filling strips or other approaches, the connection of the structures is completed through concreting or grouting the space 5. Note that such concreting or grouting does not involve any formwork, thereby speeding up the construction.

[0042] The connection shown in FIG. 1 can also be applied to precast reinforced concrete structures which are joined at an angle. Further, the connection of FIG. 1 can also be applied to connections joining more than two structures, such as integrating a plurality of wall elements. The spiral reinforcements are partially exposed from the ends of the wall elements, and the concreting approach is performed such that the spiral reinforcements exposed to the

walls will not hinder the insertion of the subsequent spiral connecting reinforcement. At the construction site, the last spiral connector is inserted into the space formed by the structures by downward rotation. When the spiral connector is inserted to the end, the void 5 is filled by concreting or grouting, and the connection of the structures is completed.

5 [0043] The advantages of the connection of FIG. 1 are that it enables a vertical joining between two precast walls and other concrete structures without using any formwork. Only a small gap having a spacing 3 needs to be sealed prior to grouting work. Further, the interlocking spiral reinforcements provide confinement to concrete when the concrete joint is under compression and extra strength to the joint.

10 [0044] As shown in FIG. 2, a periodic reinforcement cast in the precast element is formed through bending a continuous reinforcement into a W shape. The steel bars bent into the W shape 1 are cast into the precast wall elements A and B, in which the steel bars run along the length of the wall and optionally have heights the same as those of the walls. Some parts of the W-shaped steel bars protrude from the precast wall elements, and the exposed steel bars
15 form spaces 4 with the concrete surface at intervals. The W-shaped steel bars may form a longitudinal reinforcement in the wall elements through welding, so as to enhance anchorage. After placing the wall elements A and B at the construction site, a void space 6 is formed, and the W-shaped steel bars protrude into the space 6. A spiral connector 3 is inserted into the void space 6 from the top of the walls by a downward rotational motion. The W-shaped steel
20 bars are bent and placed such that the sweeping path of the spiral connector 3 will go through the spaces 4 between the W-shaped steel bars and the concrete surface. After the spiral connector 3 is reaches the bottom of the joint, the void space is filled by concreting or grouting and the connection is completed.

[0045] FIG. 2 depicts various applications of the connection joint, in which components
25 can be connected with different angles or T-junctions. It can be clearly found that this connection mode can easily connect two or more components, and the advantage thereof is that there is no need for any site formwork. The only necessary condition is to seal the small gap of the space 3 before grouting.

[0046] Referring to FIGS. 3A and 3B, a number of longitudinal reinforcements 2 are
30 welded to the periphery of a spiral reinforcement 1 to form a spiral reinforcement assembly 3. As depicted in the illustration, the spiral reinforcement assembly 3 includes four longitudinal reinforcements. The spiral reinforcement assembly 3 is cast into a precast wall at a correspondingly suitable location according to structural requirements. Generally, in view of the structural calculations, ends of columns may require more spiral reinforcement

assemblies, and spacing between the spiral reinforcement assemblies disposed in the middle part of the wall can be larger. The longitudinal reinforcements 2 of the spiral reinforcement assembly 3 will be the main reinforcements of the precast wall. They are restrained by the spiral reinforcements through welding, and therefore additional braces or ties for restraining the longitudinal reinforcements 2 are not necessary. During the production of the precast wall elements, by using a removable mold, filling materials, or other suitable means when pouring, the void 4 of the spiral reinforcement assembly 3 remains empty and is not filled with any concrete, as shown in section 1-1 of FIG. 3C.

[0047] Referring to FIG. 3B, there are two types of spiral reinforcement connectors used as connecting precast components. The first type includes a single spiral reinforcement connector, which is achieved by welding a longitudinal reinforcement 6 to the inside of a spiral reinforcement 5. The second type includes a double spiral reinforcing connector, in which the longitudinal reinforcement 10 is disposed in two spiral reinforcements 8 and 9 which are separated from each other by a rotation angle of 180° and the longitudinal reinforcement 10 is welded to the inside of them. As shown in section 2-2 of FIG. 3C, a diameter of the spiral reinforcement 5 is designed as being smaller than that of the spiral reinforcement assembly 3, while the spiral reinforcement 5 has the same pitch as that of the spiral reinforcement assembly 3. Therefore, before hoisting into position, the spiral reinforcing connector can be rotated to the bottom of the main spiral aperture 4 in the upper precast wall by an approach as shown in the left drawing of FIG. 3C, such that the spiral reinforcing connector is completely hidden in the aperture 4. When hoisting into position, the upper precast wall, its aperture 4 is aligned with an aperture 4 of the lower precast wall which has the same reinforcement configuration. A worker can insert a tool 8 into the aperture 4 of the upper precast wall or use other approach to advance the spiral reinforcing connector 5 in downward rotation such that the spiral reinforcing connector moves halfway into the main spiral reinforcement assembly of the lower precast wall, and then grouting or concreting the aperture 4. After the grout or concrete is solidified, the longitudinal reinforcement 6 laps with the longitudinal reinforcement 2 of the upper and lower precast walls and by overlapping of the spiral reinforcement 1 and the spiral reinforcement 5, an effective structural mechanism is formed to transfer internal force in the longitudinal reinforcements 2 of the upper and lower precast walls. The spiral reinforcing connector 5 further passes through the joint between the upper and lower precast walls, which can enhance shear strength capacity of the joint.

[0048] As shown in the connection of FIGS. 3A to 3C, the advantage is that no formwork is required. The spiral reinforcement assembly already provides lateral restraint to the

longitudinal reinforcements, and therefore open ties, which require intensive labor handling, can be reduced or avoided. Production of the spiral reinforcing assembly can be automated in a factory, especially through using welding robots. Conventionally, the horizontal joint of walls or columns is weak in shear because only the vertical reinforcement passes through it.

5 In the present disclosure, by the spiral reinforcement extending across the joint, shear capacity of the joint is enhanced, making it suitable for application in seismic zones.

[0049] FIG. 4 depicts joining two precast slabs, which is substantially similar to that of the two precast walls placed horizontally to form a slab but with some modifications. Precast slab A and precast slab B are placed to be adjacent with a small spacing 1, such as a distance of approximately 20 mm. A connecting spiral assembly includes a spiral reinforcement 3 with longitudinal reinforcements 2 welded thereto. The design is similar to that of FIG. 3C, and a single spiral or double spiral connector design is also available. As shown in FIG. 4, void spaces 4 are formed in edges of the precast slabs by suitable spacings 7. Each of the void spaces 4 is designed to be large enough to receive the spiral connecting assembly. One

10 of the precast slabs has a deeper void space, with a depth sufficient for temporarily accommodating the connecting spiral assembly.

[0050] A wire 5 or other fastening assembly is securely tied to an end of the connecting spiral with another end extending out of the small gap between the precast slabs. After positioning the precast slabs, the void spaces 4 of the precast slab A and the precast slab B can match and face each other. The spiral connector is moved into the opposite precast slab by pulling the wire 5 or other approaches. In the final position, the connecting spiral is embedded in both the precast slabs with approximately equal depths 6. After positioning the connecting spiral assembly, the gap and the void spaces are fully filled with grout to complete a structural connection. With the completed connection, the longitudinal reinforcement bars

20 of the spiral connecting assembly can transmit forces and bending moments across the joint, while the spiral reinforcement can transmit shears force across the joint. The connection shown in FIG. 4 does not require any formwork, as long as an interval of the small gap needs to be sealed before grouting.

[0051] Referring to FIGS. 5-9 which depict further aspects of the present invention, in which the present embodiment includes a precast wall A and a precast wall B to be joined side by side. Internal faces of the precast walls face each other. In a precasting process, recesses 1 are formed on the internal face, as shown in the perspective view of FIG. 6 and the aerial view of FIG. 7, and each recess 1 is set by a suitable interval in accordance with a structural design requirement. The recesses 1 may be formed as semi-circular or other section

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shapes and extend vertically along the height of the precast wall. Each of the recesses in the precast wall A corresponds to and faces similar recesses in precast wall B, thereby forming a continuous channel along the height of the wall.

[0052] As shown in FIG. 5, reinforcing steel bars bent to a W shape are cast into the precast walls with portions of the bent reinforcements protruding precast into the continuous channel. The W-shaped reinforcements are securely anchored into the precast concrete through embedding therein. Additionally, the W-shaped reinforcements can further be welded to the longitudinal reinforcement bars 3 inside the precast walls. The W-shaped reinforcements and the internal face of the precast walls for anchorage. The part of the W-shaped steel bar and the internal face of the wall forms triangular voids 4. The geometry of the W-shaped reinforcement is defined by its depth and the pitch.

[0053] After the precast walls are correctly set at the construction site, the spiral reinforcement with the same height as the precast walls is inserted into recess 2 from the top of the wall in a rotational motion, as shown in FIGS. 5 and 8. The pitch of the spiral reinforcement is identical to the pitch of the W-shaped reinforcements. The diameter of the spiral shape is designed such that the spiral reinforcement can enter into the triangular voids 2 formed between the protruding W-shaped reinforcement and the internal faces of the precast walls. The W-shaped reinforcements of the precast walls A and B are cast in a staggered manner, such that as the spiral reinforcement advances downward, the spiral reinforcement will pass through all the triangular voids 2 of the two walls. As a result, the spiral reinforcement interlocks with the W-shaped bars, although they may not be in contact with one another.

[0054] After the spiral reinforcement bar advances to the bottom of the walls, concreting or grouting the through holes 3 is performed and all apertures are fully filled. After the concrete or grout hardens, internal forces in the structure can be transmitted from the spiral reinforcement to the W-shaped reinforcements through the hardened concrete or grout. As such, the two precast walls A and B can collectively bear the load of the structure, and their structural performance is equivalent to that of a cast-in-situ reinforcement concrete wall having the same thickness as the total thickness of the two walls.

[0055] The provided connection method of the present disclosure can also be used to join more than two walls. As shown in an embodiment of FIG. 9, in the present embodiment, there are four walls A, B, C and D. The precast walls A and B are side by side, and the precast walls C and D are side by side. The precast walls are parts of a full wall, which can be connected together by the method described in the earlier section or otherwise by other means.

At the junction of the four precast walls, the structural force can be transmitted by using the spiral reinforcement connector.

[0056] It is note that the recesses, which are depicted as being circular, may be selected from any shape that is able to formed in the ends of the precast walls for grouting. The reinforcements bent into the W shapes and cast into the ends of the walls are manufactured in the factory. Portions of the W-shaped reinforcements protrude outward into the recesses. The W-shaped reinforcement on each wall has an identical pitch or has a pitch that corresponds to a multiple or fraction of the pitch of the W-shaped reinforcement of the facing wall, such that the apertures of each W-shaped reinforcement can be connected.

[0057] At the construction site, the four precast walls are placed together such that a continuous channel is formed which runs along the height of the wall. A spiral reinforcement with the same pitch as that of the W-shaped reinforcement is inserted into the continuous channel by a downward rotational motion. Triangular voids/apertures formed at the precast walls by the W-shaped reinforcements match the path of the spiral pitch of the spiral reinforcement. Therefore, the spiral reinforcement can smoothly advance to the bottom of the wall. As a result, the spiral reinforcement interlocks the four W-shaped reinforcements of the four precast walls although they may not be in contact with one another.

[0058] Concreting or grouting is poured into the continuous channel to fill up all spaces. Structural forces can be transmitted between the spiral reinforcement and the W-shaped reinforcements, thereby allowing the four precast wall structures to effectively connect with each other.

[0059] Turning to FIG. 10, a connection by using three spiral structures of the present invention is depicted. In the precasting process, recesses 1 are formed on an internal face of a concrete wall at suitable intervals according to structural design requirements. The recesses 1 may be semi-circular or other shapes and extend vertically along the height of the precast wall. A precast wall A faces a precast wall B which has recesses similar to those of the precast wall A, so as to form a continuous channel extending along the height of the wall. The W-shaped reinforcements are replaced by two spiral reinforcements 6. The two spiral reinforcements 6 have the same height and are respectively cast into precast walls, in which each of the spirals has a portion protruding from the precast wall to form apertures in the continuous channel. The spiral reinforcements are securely anchored into the precast walls by being embedded in the precast concrete. A connecting spiral reinforcement 7 inter-engages the two spiral reinforcements 6.

[0060] As shown in FIG. 11, properties of a spiral reinforcement are defined by its pitch and diameter. After the precast walls are placed at the correct position at the construction site, a third spiral reinforcement/spiral connector 7 having the same height as the walls is inserted into a recess from the top of the walls by a rotational motion. The spiral reinforcements cast
5 into the respective walls have the same pitch as that of the third spiral reinforcement or have the pitch corresponding to a multiple of the pitch of the third spiral reinforcement.

[0061] In accordance with the above design, the third spiral reinforcement 7 will not be obstructed by the first and second spiral reinforcements and thus can be advanced to the bottom of the walls through the channel. As shown in FIG. 12, the connecting spiral
10 reinforcement and the two spiral reinforcements interlock with each other, although they may not be in contact with one another.

[0062] FIG. 13 shows that the above connection can be used to join more than two structures, such as four walls. Walls A and B are placed side by side, and walls C and D are positioned in the same manner. Ends of the four walls A, B, C, and D are placed together.
15 At the junction of the four precast walls, they collectively form recesses 8 which may be circular or other appropriate shapes. Four sets of spiral reinforcements are cast into the ends of the walls A, B, C, and D in the factory. Portions of the spiral reinforcements 9 protrude into the recesses. At the construction site, the four walls are placed together such that a continuous channel is formed along the height of the wall. A spiral reinforcement 11 having
20 the pitch the same as the spiral reinforcements is inserted into the continuous channel from the top with a downward rotational motion. The spiral reinforcement 9 cast into the ends of the walls is displaced by $\frac{1}{4}$ pitch from the adjacent spiral reinforcements so that when the spiral connector 11 advances downwards, it will interlock with the four spiral reinforcements 9 without obstruction. As a result, the spiral connector 11 interlocks the four spiral
25 reinforcements 9, although they may not be in contact with one another.

[0063] Concreting or grouting the continuous channel is performed such that all spaces are filled. Structural forces can be transmitted between the spiral reinforcements, thereby allowing the four precast walls to structurally connect to each other.

[0064] The longitudinal reinforcement and spiral reinforcement described above can be
30 replaced by other suitable structural material strips, such as metal or carbon fibers.

[0065] The present disclosure is not limited to the specific systems, devices and methods as described above, because there are able to be varied. The terms used in the specification are only for the purpose of describing a specific statement or an embodiment, rather than for limiting the scope.

[0066] In the above detailed description, reference is made to the attached drawings that serve as a part of the present disclosure. In the drawings, unless the context otherwise indicates, similar symbols typically identify similar components, the embodiment of the illustration described in the detailed description, drawings, and claims does not mean a restrictive purpose. Without departing from the spirit or scope of the present disclosure, other embodiments may be used and changes may be made. It will be easy to understand that, as generally described herein and illustrated in the accompanying drawings, aspects of the present disclosure may be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly considered in the present disclosure.

[0067] The present disclosure of the particular embodiments described in the present application is not limited and is intended to illustrate for various aspects. For one skilled in the art, many clear modifications and changes can be made without departing from the spirit and scope of the present disclosure. Within the scope of the present disclosure, the functionally equivalent methods and devices, in addition to those listed herein, are clear to one skilled in the art from the foregoing descriptions. Such modification and change intention will fall within the scope of the appended claims. This disclosure is limited only by the terms of the appended claims and the full scope that is equivalent to the rights granted by such claims. It will be understood that the present disclosure is not limited to specific methods, reagents, compounds, compositions or biological systems, which can be changed certainly. It will also be understood that the terms used herein are intended only for the purpose of describing a particular embodiment, but not intend to become restrictive.

[0068] Various of the above-disclosed and other features and functions, or alternatives thereof, may be incorporated into many other different systems or applications. One skilled in the art can correspondingly make various substitutions, modifications, changes, or improvements therein that are currently unforeseeable or unpredictable, in which each intention would be encompassed by the disclosed embodiments.

Claims:

1. A joint between precast reinforced concrete structures, comprising

a first precast reinforced concrete structure selected from a wall, a module, a
column, a beam, a floor, or a balcony, the first precast concrete structure including:

one or more first reinforcing connectors partially embedded along a side of the first
precast reinforced concrete structure, each first reinforcing connector having a periodic
structure of projections such that at least alternating projections extend outward from the
precast reinforced concrete structure side, each outward projection forming an aperture with
the side of the concrete structure, the aperture being configured to receive a joining element;

a second precast reinforced concrete structure selected from a wall, a module, a
column, a beam, a floor, or a balcony, the second precast concrete structure including:

one or more second reinforcing connectors partially embedded along a side of the
second precast reinforced concrete structure, each second reinforcing connector having a
periodic structure of projections such that at least alternating projections extend outward
from the second precast reinforced concrete structure side, each outward projection forming
an aperture with the side of the concrete structure, the aperture being configured to receive a
joining element;; and a rotatable spiral joining component interlocking the apertures of the
first reinforcing connector and the apertures of the second reinforcing connector.

2. The joint between precast reinforced concrete structures of claim 1, wherein the one or
more first reinforcing connectors and the one or more first reinforcing connectors have a
substantially spiral shape.

3. The joint between precast reinforced concrete structures of claim 1, further comprising
cast-in-situ concrete or grout embedding the first and second connectors and filling a space
between the first precast reinforcement concrete structure and the second precast reinforced
concrete structure.

4. The joint between precast reinforced concrete structures of claim 1, wherein the one or
more first reinforcing connectors and the one or more second reinforcing connectors have a
repeating W-shape.

5. The joint between precast reinforced concrete structures of claim 1, wherein one or more of the first reinforcing connectors and one or more of the second reinforcing connectors respectively comprise a plurality of sinusoidal shaped periodic projections.

5 6. The joint between precast reinforced concrete structures of claim 2, wherein each of the spiral-shaped reinforcing connectors includes one or more reinforcements joined to the connector.

10 7. The joint between precast reinforced concrete structures of claim 4, wherein each of the W-shaped reinforcing connectors includes one or more reinforcements joined to the connector.

15 8. The joint between precast reinforced concrete structures of claim 5, wherein each of the sinusoidal-shaped reinforcing connectors includes one or more reinforcements joined to the connector.

20 9. The joint between precast reinforced concrete structures of claim 1, wherein the pitch of the spiral joining component is approximately equal to a distance between the adjacent apertures.

10. The joint between precast reinforced concrete structures of claim 1, further comprising:
a third precast reinforced concrete structure selected from a wall, a module, a column, a beam, a floor, or a balcony, the third precast reinforced concrete structure including:

25 one or more third reinforcing connectors partially embedded in a side of the third precast reinforced concrete structure, each third reinforcing connector having a periodic structure of projections such that at least alternating projections extend outward from the third precast reinforced concrete structure side, each outward projection forming an aperture with the side of the third precast reinforced concrete
30 structure, the aperture being configured to receive a joining element; and
a rotatable spiral joining component interlocking the apertures of the first reinforcing connector, the apertures of the second reinforcing connector, and the apertures of the third reinforcing connector.

11. A reinforcement arranging method for precast reinforced concrete structures, comprising:

welding one or more longitudinal reinforcements to outer or inner circumference of one or more spiral reinforcements to form a spiral reinforcement module;

5 placing the reinforcement module in a structural wall, floor or other concrete structures.

12. The method of claim 11, wherein the longitudinal reinforcement is connected to the outer circumference of the one or more spiral reinforcements by welding or other
10 approaches.

13. The method of claim 11, wherein the longitudinal reinforcement is connected to the inner circumference of the one or more spiral reinforcements by welding or other
15 approaches.

14. The method of claim 12 or 13, wherein when using a plurality of the spiral reinforcements, all the centers thereof overlap, and the pitches and diameters are the same.

15. The method of claim 11, wherein the longitudinal reinforcements and the spiral reinforcements are selected from metal, carbon fiber, or other structural material strips.
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16. A joint between precast reinforced concrete structures, comprising:

a first precast reinforced concrete structure selected from a wall, a module, a column, a beam, a floor, or a balcony, wherein the structure applies the reinforcement arranged by the method of any one of claims 11 to 15; and
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a second precast reinforced concrete structure selected from a wall, a module, a column, a beam, a floor, or a balcony, wherein the structure applies the reinforcement arranged by the method of any one of claims 11 to 15;

wherein a spiral reinforcement assembly is placed in the first precast reinforced concrete structure firstly, the spiral reinforcement assembly placed in the first precast reinforced concrete structure is rotated to enter a spiral reinforcement assembly in the second precast reinforced concrete structure after hoisting into position adjacent the first precast reinforced concrete structure, and a spiral connecting assembly overlaps the spiral reinforcement assemblies in the first and second precast reinforced concrete structures.
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17. The joint of claim 16, wherein a spiral reinforcement of the spiral connecting assembly has a diameter less than diameters of the spiral reinforcement assemblies of the first and second precast reinforced concrete structures and has the same pitch, such that the
5 connecting assembly is able to rotate and move in the spiral reinforcement assemblies.