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(54) **CONCRETE REINFORCER AND METHOD**

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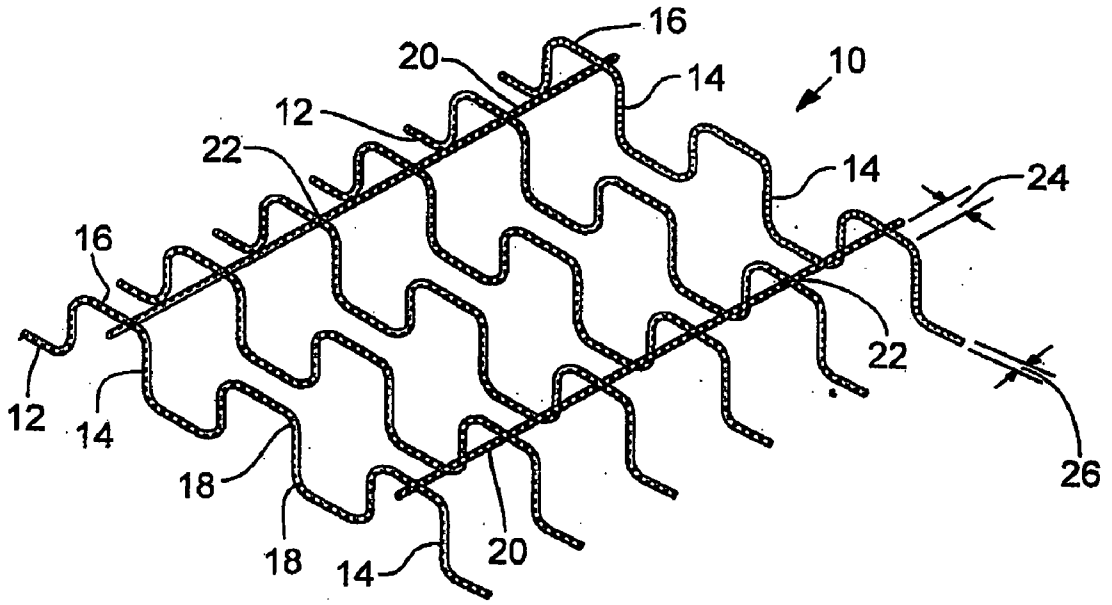
(57) **ABSTRACT**

A concrete reinforcing apparatus including a plurality of shear stirrups, each having a substantially horizontal portion and a substantially vertical portion separated by a bend. Stringers may be rigidly attached to the substantially horizontal portions.



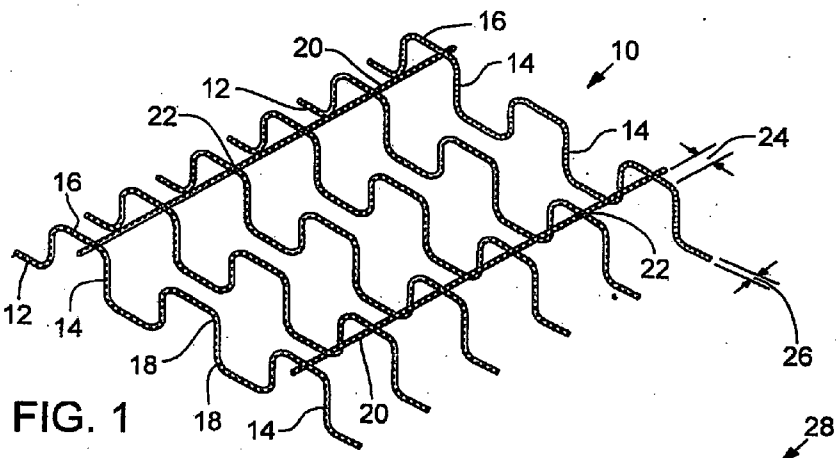


FIG. 1

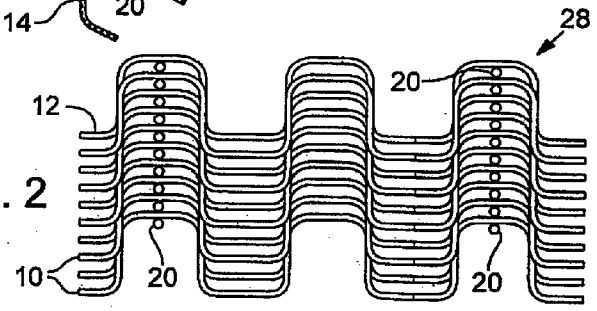


FIG. 2

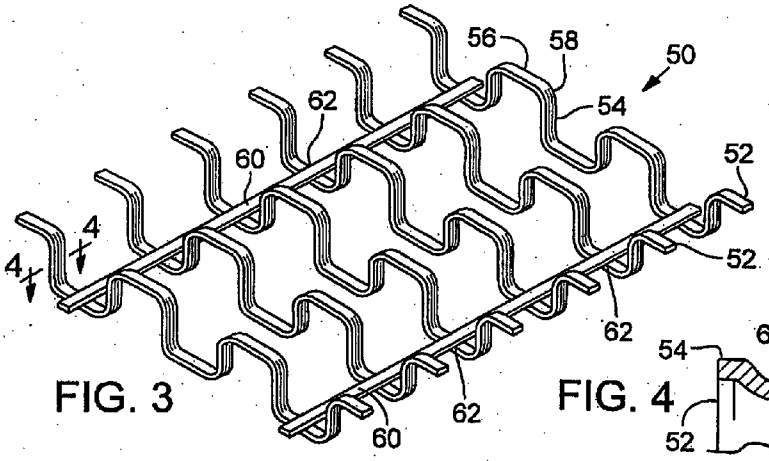


FIG. 3

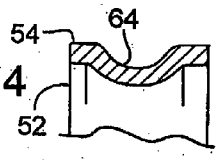


FIG. 4

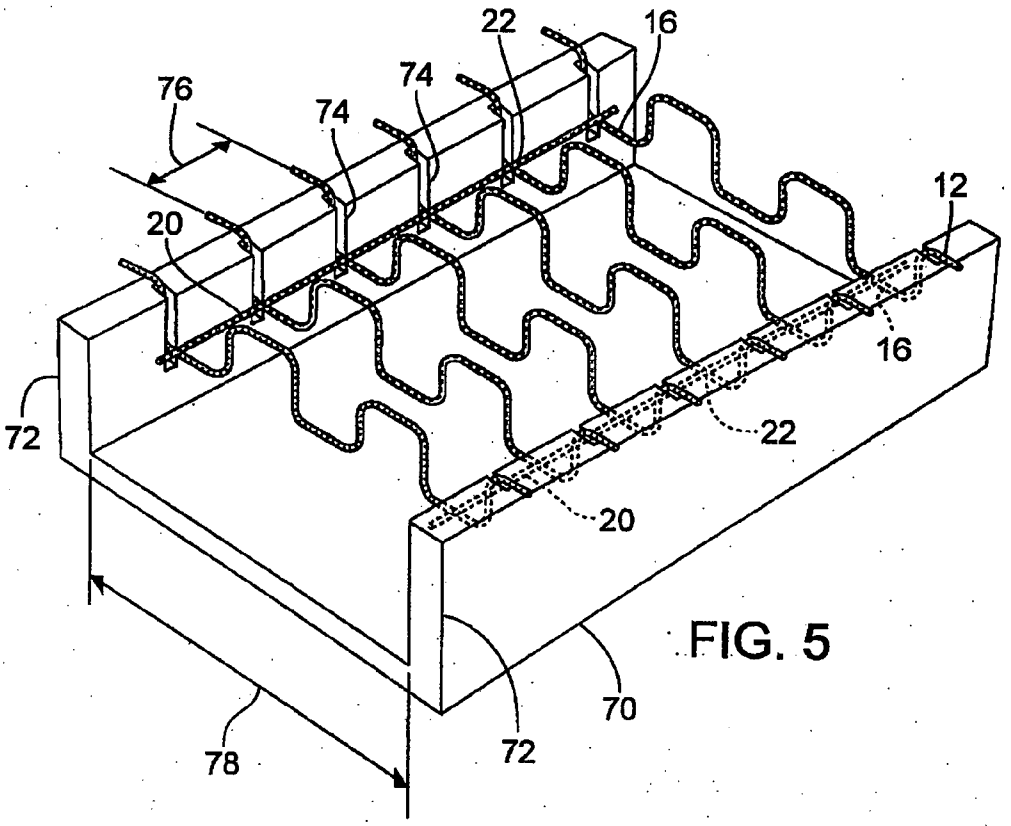


FIG. 5

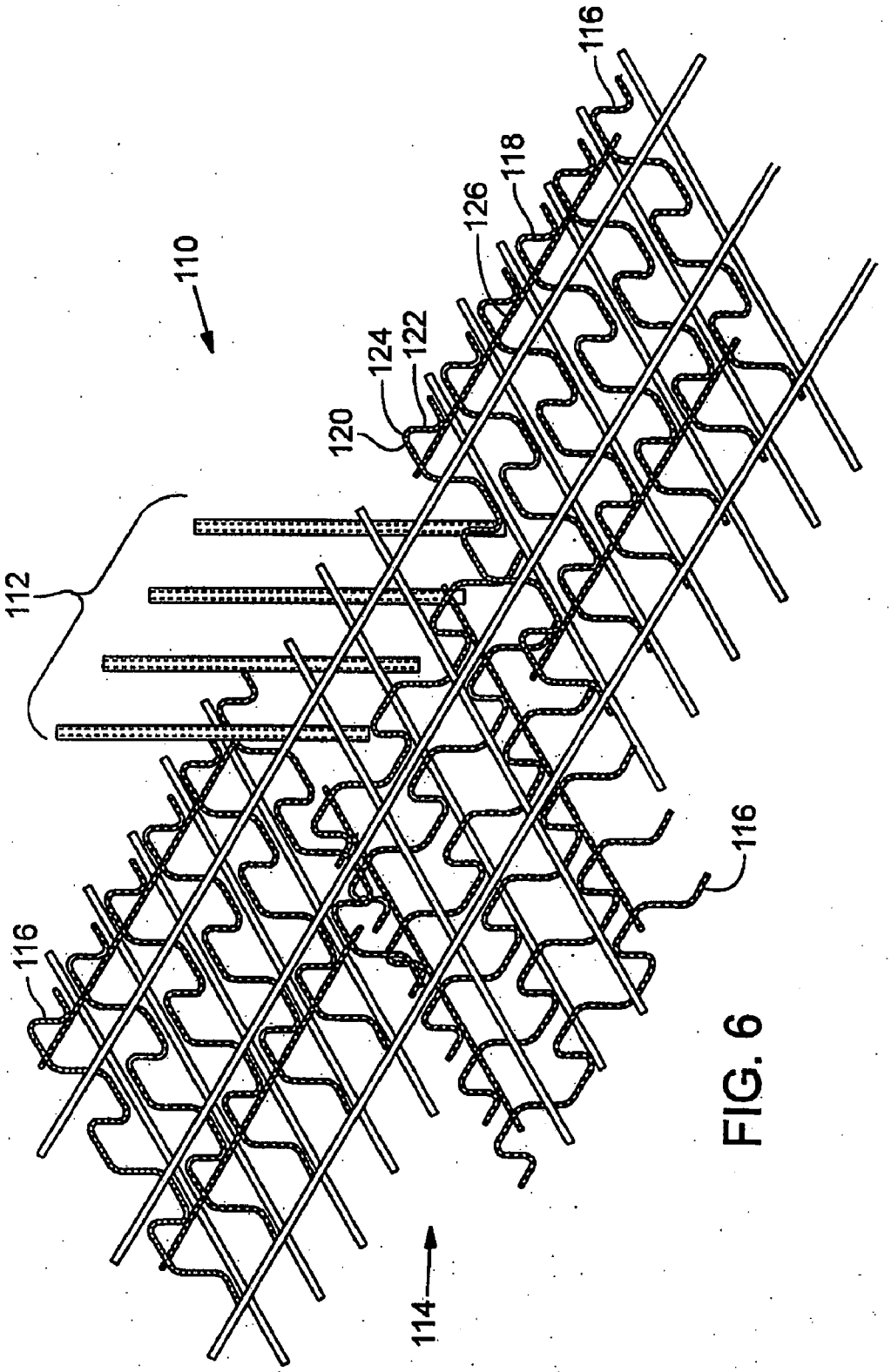


FIG. 6

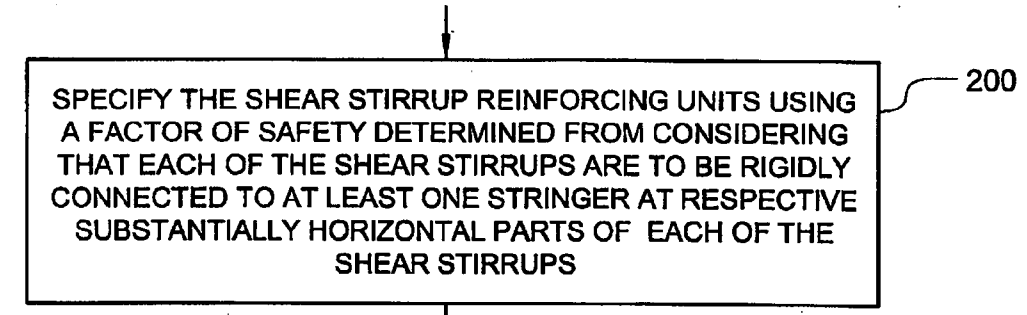


FIG. 7

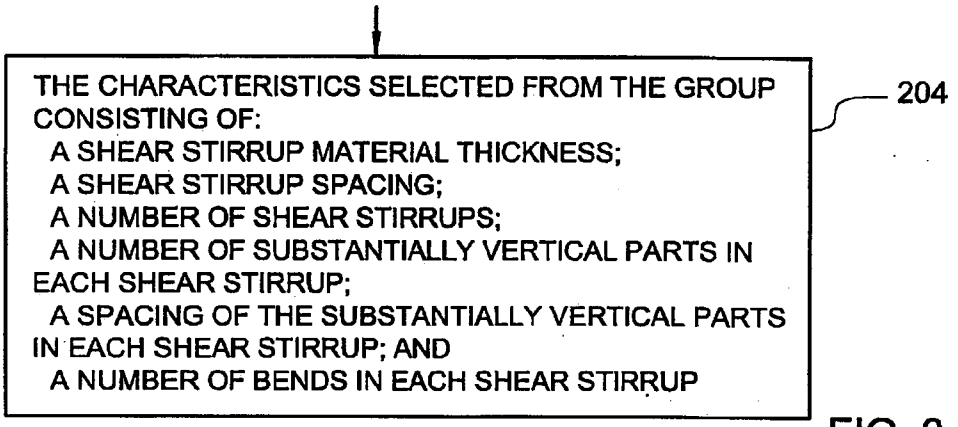


FIG. 8

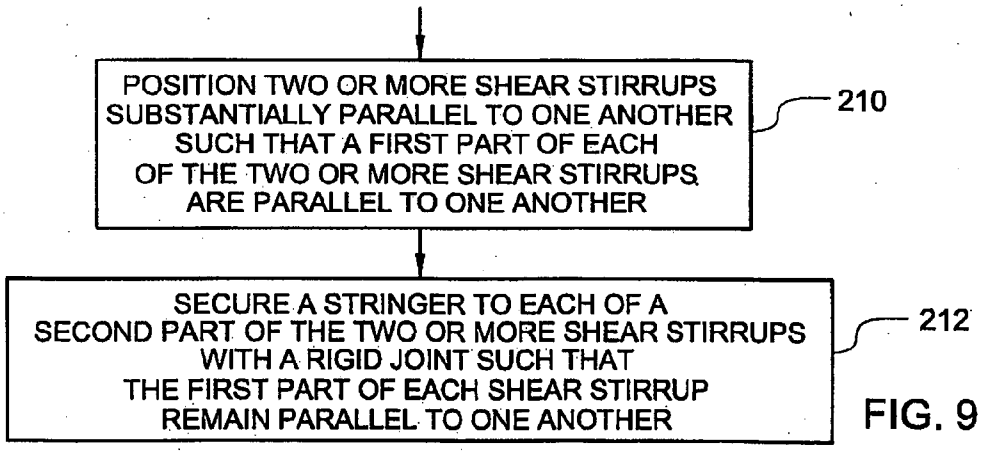


FIG. 9

CONCRETE REINFORCER AND METHOD

TECHNICAL FIELD

[0001] Embodiments of the present invention relate generally to reinforcing concrete, and more particularly to reinforcing concrete slab floors subject to shear stress.

BACKGROUND

[0002] Constructing multi-level structures using concrete slab floors is common, and becoming more common. However, the concrete slabs may experience stress concentrations at certain points of support, particularly at columns.

[0003] There are a number of methods in use to reinforce the concrete slabs against shear failure. They may include making the slab thicker around the column, or flaring the column top by, for example, adding a column capital which includes additional reinforced concrete formed around the column to support a portion of the concrete slab. The additional reinforcing requires additional form work, more concrete, and the end product of the building may have a lower ceiling in the area around the column, and may require the whole building to have a greater distance between floors.

[0004] There are a number of techniques being used wherein the additional form work and additional concrete is avoided by adding metal reinforcing into the slab itself in the area of the slab adjacent to each column. One technique is to use metal reinforcing having a number of bends therein to shape each bar into a square wave-type pattern, sometimes called a shear stirrup, and sometimes referred to as a galloping stirrup. The shear stirrups may be made from concrete reinforcing bars, or rebar. A number of the shear stirrups are placed parallel to one another in a spaced-apart configuration. Several stringers, typically straight pieces of rebar, may be placed perpendicular to the shear stirrups and tie wired in a twist-tie fashion to each of the shear stirrups to form a shear stirrup unit. Typically, at least two spaced-apart parallel stringers are wired at or near corresponding bends of the shear stirrups, and a third or fourth stringer is tied at or near diagonally opposed bends in an attempt to provide three-dimensional stability for the shear stirrup unit.

[0005] Despite the three or four stringers and the tie wires, the shear stirrup units are prone to moving, shifting, or falling over. In particular, busy construction sites will have many electrical cords and pneumatic lines, and the like, pulled around and over the shear stirrup units, which cause the units to shift, tip, and/or collapse. In addition, the tie wires may tend to scratch and/or cut the hands and arms of workers.

[0006] To best resist shear stresses in the slab it is important for the parts of the stirrups intended to be vertical. i.e., the vertical parts of each stirrup, in the final concrete pour and the resultant slab, to be positioned and to stay as close to vertical as possible. However, verticality of the vertical members of the shear stirrup when tie-wired is not guaranteed. Therefore, engineers designing shear stirrup units may allow for an average number of the shear stirrups being off vertical and may compensate when selecting a factor of safety when specifying the shear stirrup unit characteristics to be used in any given application such as: thickness of stirrup; the spacing of each stirrup; the number of bends in a stirrup; the number of verticals; and the like.

[0007] Included among the activities that may go on in and around the metal reinforcing, and form work, in a concrete slab construction, is installation of post-tensioning cables. Post-tensioning cables are steel cables, housed in a sheathing or a duct, to prevent the steel from bonding to the concrete, which are placed in a rough grid configuration within the slab form. After the concrete is poured, and cured, covering the reinforcing work and the post-tensioning cables, the steel cables are tensioned by pulling on, and anchoring, each end. The strands of post-tensioning cables can have a diameter of one-half inch and may be stressed to a force of 33,000 pounds using a hydraulic jack. The post-tensioning strands are typically placed between the vertical elements of the shear stirrups. They are typically maneuvered and moved around on the job site, also tending to knock over the tie-wired shear stirrup units.

[0008] One attempt to avoid the hassle and management and re-management of the shear stirrup units is to use so-called stud rails instead. Stud rails are prefabricated metal studs attached at one end to a spacing bar. The other end of each metal stud has a circular disk attached to it. The metal studs are oriented vertically in the concrete slab to resist shear stresses near columns, and the spacing bars extend from the column. Stud rails, may not tend to sag or collapse like tie-wired reinforcing units may, however, they may still be knocked from a vertical plane during normal construction activity. Stud rails also tend to be expensive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Embodiments of the present invention will be readily understood by the following detailed description in conjunction with the accompanying drawings. To facilitate this description, like reference numerals designate like structural elements. Embodiments of the invention are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings.

[0010] FIG. **1** is a perspective view illustrating one embodiment of the present invention;

[0011] FIG. **2** is a front view illustrating one embodiment of the present invention;

[0012] FIG. **3** is a perspective view illustrating one embodiment of the present invention;

[0013] FIG. **4** is a cross-sectional view taken along the line **4-4** in FIG. **3**;

[0014] FIG. **5** is a perspective view illustrating one embodiment of the present invention;

[0015] FIG. **6** is a perspective view illustrating one embodiment of the present invention;

[0016] FIG. **7** is a flow diagram illustrating a method in accordance with one embodiment of the present invention;

[0017] FIG. **8** is a flow diagram illustrating a method in accordance with one embodiment of the present invention; and

[0018] FIG. **9** is a flow diagram illustrating a method in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS OF THE INVENTION

[0019] Embodiments of the invention may provide a low maintenance reinforcing unit to be used in reinforcing

concrete. Such unit may not need maintenance, repositioning, and repair during the course of a construction project once such a unit is in place, and prior to the concrete pour. Embodiments may provide a greater degree of positional reliability of shear stress-resistant reinforcing members affording structural designers and engineers, and the like, greater confidence to avoid "overdesigning" by specifying more metal be used than is absolutely necessary, and instead allowing them to conserve material. Embodiments also may provide reinforcing units that may be easily stacked and unstacked in a nesting fashion, which may save space and may make the units easy to transport.

[0020] In the following detailed description, reference is made to the accompanying drawings which form a part hereof wherein like numerals designate like parts throughout, and in which is shown by way of illustration embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural or logical changes may be made in alternate embodiments. Therefore, the following detailed description is not to be taken in a limiting sense, and the scope of embodiments in accordance with the present invention is defined by the appended claims and their equivalents.

[0021] The following description may include terms such as inner, outer, under, between, upward, downward, outward, inward, top, bottom, above, below, and the like. Such terms are used for descriptive purposes only and are not to be construed as limiting in the description or in the appended claims. That is, these terms are terms that are relative only to a point of reference and are not meant to be interpreted as limitations but are, instead, included in the following description to facilitate understanding of the various aspects of the invention.

[0022] The phrase "in one embodiment" is used repeatedly. The phrase generally does not refer to the same embodiment; however, it may. The terms "comprising,""having," and "including" are synonymous, unless the context dictates otherwise.

[0023] Embodiments of the invention may use a plurality of shear stirrup straps and may include galloping stirrups, arranged parallel to one another, and may include a straight rebar member fixed to each of the stirrups. Embodiments may include a number of bent rebar shear stirrups which may be shear stirrups, and two spaced-apart stringer elements extending perpendicular to each of the shear stirrups and tack-welded to each stirrup forming a rigid frame which resists, or is prevented from, tipping over.

[0024] FIG. **1** is a perspective view of one embodiment of the present invention. A reinforcing device such as a concrete reinforcing device **10**, which may be referred to as a shear stirrup unit, may include a plurality of elongate members **12**, for example, six shear stirrups. Each elongate member **12** may include one or more first parts **14**, configured to be oriented substantially vertically, and may include one or more second parts **16** configured to be oriented substantially horizontally, separated by bends **18**. Stringers **20** may be rigidly attached to second parts **16**. Each of the first parts **14** may then be kept substantially parallel with one another and may be arranged to be positioned in a substantially vertical orientation if the reinforcing device **10** is put on a horizontal surface such as a concrete slab form, or otherwise appropriately supported. The plurality of elongate members **12** may be made from rebar, and the stringers **20** may also be made from rebar. Stringers **20** may be attached to each of the elongate members **12** by a rigid joint **22**. The rigid joint **22** may be any appropriate rigid joint including, for example, a welded joint or an adhesive joint such, a cemented joint, or a fastener joint, such as a joint made with one or more screws or one or more nuts and one or more bolts. The stringers **20** may be fixed to the second parts **16** of each elongate member **12** at a distance **24** away from the nearest bend **18**, wherein in the distance **24** is greater than or equal to a diameter **26** of the elongate member **12**.

[0025] In one embodiment only one stringer is used. In one embodiment two or more stringers are used. In one embodiment a stringer may be discontinuous. In another embodiment, a stringer may be cut to allow something, for example, one or more post-tensioning cables, to pass through it, and/or to be positioned below it. In one embodiment a stringer may be cut and something may be passed through the opening, and another stringer may be secured in place with a rigid joint. In one embodiment one or more horizontal portions may be cut, for example, to allow something to pass through.

[0026] FIG. **2** is a front view of one embodiment of the present invention. FIG. **2** illustrates how the plurality of elongate members **12** and stringers **20** may be positioned to form similarly configured concrete reinforcing devices **10** or shear stirrup units that may be stacked in a nesting fashion into a stack **28**. A plurality of concrete reinforcing units may be moved as a stack **28** to a convenient location to be used at a job site. The concrete reinforcing devices **10** may be preassembled, and stacked, at a job site, or away from a job site, which may save space, time, or money.

[0027] FIG. **3** is a perspective view of one embodiment of the present invention. A reinforcing device **50** includes a plurality of elongate members **52** or shear stirrups made from a substantially flat material. For example, in one embodiment shear stirrups may be made from punched strips of sheet metal. Each elongate member **52** may include a plurality of first parts **54**, configured to be oriented substantially vertically and may include a plurality of second parts **56** configured to be oriented substantially horizontally. The first parts **54** and the second parts **56** may be separated by bends **58**. Stringers **60** which may also be made from substantially flat metal may be rigidly attached, with a rigid joint **62**, to each of the second parts **56** of the plurality of elongate members **52**, at the second parts **56**. The first parts **54** may be kept substantially parallel with one another and may be arranged to be positioned in a substantially vertical orientation if the unit is put on a horizontal surface such as a concrete slab form, or otherwise appropriately supported. The rigid joint **62** may be any appropriate rigid joint including, for example, a welded joint, an adhesive joint, a cemented joint, or a fastener joint, such as a joint made with one or more screws or one or more nuts and one or more bolts. In one embodiment, the elongate members **52** may define holes therein and the stringers **60** may define holes therein. The holes in the respective parts may be arranged to be lined up, and to receive fasteners such as screws or bolts, to fasten the stringers **60** to the elongate members **52**.

[0028] In one embodiment, a plurality of the reinforcing devices **50** may be configured to be stacked in a nesting fashion.

[0029] FIG. **4** is a cross-sectional view taken along the line **4-4** in FIG. **3**, illustrating that each elongate member **52** may have a portion corresponding with the first part **54** being shaped to provide additional shear strength. For example, elongate members **52** may include a curve **64** shaped into the sheet metal by, for example, a punching operation.

[0030] FIG. **5** is a perspective view of one embodiment of the present invention. A plurality of shear stirrups **12** may be placed in a fixture or jig **70** adapted to hold the plurality of shear stirrups **12** in a desired configuration while one or more stringers **20** may be fixed to a substantially horizontal portion **16** of each shear stirrup **12**. The stringer **20** may be fixed with a rigid joint **22** by, for example, welding. The jig **70** may, for example, include parallel rails **72** defining a plurality of holders **74**, for example, notches therein disposed to receive opposite sides of each of the plurality of shear stirrups **12**. In one embodiment, the rails may be designed to include adjustable holders or multiple holders to use the same jig to construct different reinforcing devices with various distances **76** between shear stirrups. In one embodiment, a spacing **78** between the rails may be adjustable. Using a jig to construct reinforcing units may save time, and materials, and allow for consistent construction.

[0031] FIG. **6** is a perspective view of one embodiment of the present invention. A concrete reinforcing system **110** may include a first group of reinforcing members **112** disposed to reinforce a concrete column, and a second group of reinforcing members **114** disposed to reinforce a substantially concrete slab. The second group **114** may include at least one concrete reinforcing device **116** extending outwardly from the first group of reinforcing members **112** and may include a plurality of shear stirrups **118**. Each shear stirrup **118** may be made from a rigid material and may include at least one substantially horizontal portion **120** and at least one substantially vertical portion **122** separated by a bend **124**. A stringer **126** may rigidly attach the at least one substantially horizontal portion **120** of the plurality of shear stirrups to one another.

[0032] In the embodiment illustrated, three concrete reinforcing devices **116** substantially surround the column location which may be the case for an outside column, i.e., at an outside edge of a building. In the case of an interior column four reinforcing devices **116** may substantially surround the column and may extend outwardly therefrom. A corner column may have two reinforcing devices **116** extending therefrom.

[0033] In one embodiment according to the invention a concrete reinforcing device may be used to reinforce a concrete wall. In one embodiment according to the invention a concrete reinforcing device may be used to reinforce a portion of a concrete slab not near a column.

[0034] FIG. **7** is a flow diagram illustrating a method in accordance with one embodiment of the invention wherein an amount of reinforcing material may be reduced. While in place at a job site, before and/or during a concrete pour embodiments of the invention may include vertical parts of each shear stirrup reinforcing unit which may have a high degree of reliability with regard to remaining at least substantially vertical. This high degree of reliability may afford a designer, such as a structural engineer, greater confidence, and some flexibility, when preparing a specification regarding the characteristics of the shear stirrup units. Whether consciously, or subconsciously, the designer may use what could be called a vertical reliability factor, and elect to use less material for some characteristics, of the concrete reinforcing devices, that may otherwise be prone to be overdesigned in order to compensate for less vertical reliability.

[0035] The method may include:

[0036] specifying the shear stirrup reinforcing units using a factor of safety determined from considering that each of the shear stirrups are to be rigidly connected to at least one stringer at respective substantially horizontal parts of each of the shear stirrups, **200**; and

[0037] based on the factor of safety specifying the characteristics of the shear stirrups, **202**.

[0038] FIG. **8** illustrates one embodiment of the invention wherein the characteristics of the shear stirrup unit may be selected from the group consisting of:

[0039] a shear stirrup material thickness;

[0040] a shear stirrup spacing;

[0041] a number of shear stirrups;

[0042] a number of first parts in each shear stirrup;

[0043] a spacing of the first parts in each shear stirrup; and

[0044] a number of bends in each shear stirrup, **204**.

[0045] Preparing a specification may include providing instructions which may be written in various degrees of formality or may include providing verbal instructions to instruct workers on how reinforcing is to be placed in a concrete form.

[0046] The factor of safety may be an estimate based on a tendency of another shear stirrup reinforcing unit not made according to the present invention to move relative one another, and/or to tip. For example, other shear stirrup reinforcing units that may include shear stirrups not fixed to at least one stringer at respective horizontal portions.

[0047] One embodiment of the invention may include a method of specifying by, for example, preparing a specification, which may include estimating an increased level of strength for the shear stirrup reinforcing unit which includes shear stirrups being rigidly fastened to at least one stringer at respective horizontal portions as compared to another shear stirrup reinforcing unit not including shear stirrups fixed to at least one stringer at respective horizontal portions.

[0048] One embodiment of the invention may include a method which includes requiring the stringers be fastened to the second parts of the shear stirrup unit with a rigid joint which may be of a weld; an adhesive joint such as an epoxy joint; a cemented joint; or a fastener joint such as with screws or nuts and bolts.

[0049] FIG. **9** is a flow diagram illustrating a method in accordance with one embodiment of the invention. The method includes:

[0050] positioning two or more shear stirrups substantially parallel to one another such that a first part of each of the two or more shear stirrups are parallel to one another, **210**;

[0051] securing a stringer to each of a second part of the two or more shear stirrups with a rigid joint such that the first part of each shear stirrup remains oriented parallel to one

another, **212**. Securing may include securing more than one stringer to each of more than one second part of the shear stirrups by, for example, welding, adhering, cementing, fastening. The method may further comprise positioning each of the shear stirrups in a fixture, or a jig, such that each of the first parts are substantially parallel, and welding the at least one stringer to each of the second parts.

[**0052**] In one embodiment the method may further comprise placing a shear stirrup unit made from the positioning and the securing within a concrete slab form such that the first part of each of the shear stirrups are substantially vertical. The shear stirrup unit may be placed adjacent to a column location.

[**0053**] Although certain embodiments have been illustrated and described herein for purposes of description of the preferred embodiment, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent embodiments or implementations calculated to achieve the same purposes may be substituted for the embodiments shown and described. Those with skill in the art will readily appreciate that embodiments in accordance with the present invention may be implemented in a very wide variety of ways. This application is intended to cover any adaptations or variations of the embodiments discussed herein. Therefore, it is manifestly intended that embodiments in accordance with the present invention be limited only by the claims and the equivalents thereof.

What is claimed is:

1. A concrete reinforcing device, comprising:

a plurality of shear stirrups, each shear stirrup made of a rigid material and including at least one substantially horizontal portion and at least one substantially vertical portion separated by a bend; and

a stringer rigidly attached to the at least one substantially horizontal portion of the plurality of shear stirrups.

2. The concrete reinforcing device of claim 1, wherein the stringer is rigidly attached to each of the second parts with a connection selected from the group consisting of: a weld; an adhesive joint; an epoxy joint; a cemented joint; and a fastener joint.

3. The concrete reinforcing device of claim 1, further comprising two stringers, each stringer being rigidly attached to a different one of the at lease one substantially horizontal portions of the plurality of shear stirrups.

4. The concrete reinforcing device of claim 1, wherein at least one of the plurality of shear stirrups and the stringer are made from one selected form the group consisting of:

rebar;

a substantially flat metal;

a substantially flat material;

a stamped metal; and

a substantially flat metal, the substantially vertical portion being reinforced by a structural bend.

5. The concrete reinforcing device of claim 1, wherein the at least one stringer is rigidly attached to the substantially horizontal portion of each shear stirrup at a distance away from the bend, wherein the distance is greater than or equal to a diameter of the shear stirrup.

6. The concrete reinforcing device of claim 1, Wherein the plurality of shear stirrups and the stringer are made from substantially flat metal, and the plurality of shear stirrups and stringer define holes therein arranged to receive one of screws or bolts to rigidly attach the stringer to the plurality of shear stirrups.

7. The concrete reinforcing device of claim 1, wherein the plurality of shear stirrups are placed in a fixture adapted to hold the plurality of shear stirrups in a desired configuration while the stringer is rigidly attached to the at least one substantially horizontal portion of each shear stirrup.

8. The concrete reinforcing device of claim 1, wherein the plurality of shear stirrups and the stringer are positioned such that an additional similarly configured concrete reinforcing device may be stacked thereon in a nesting fashion.

9. A method of reducing the amount of reinforcing material required in specifying shear stirrup reinforcing units made from a plurality of shear stirrups, comprising:

specifying the shear stirrup reinforcing units using a factor of safety determined from considering that each of the shear stirrups are to be rigidly connected to at least one stringer at respective substantially horizontal parts of each of the shear stirrups; and

based on the factor of safety, specifying the characteristics of the shear stirrups.

10. The method of claim 9, wherein specifying the characteristics of the shear stirrups includes specifying a characteristic from the group consisting of:

a shear stirrup material thickness;

a shear stirrup spacing;

a number of shear stirrups;

a number of substantially vertical parts in each shear stirrup;

a spacing of the substantially vertical parts in each shear stirrup; and

a number of bends in each shear stirrup.

11. The method of claim 9, wherein the factor of safety is an estimate based on a tendency of shear stirrup reinforcing units including shear stirrups that are not rigidly attached to at least one stringer at respective substantially horizontal portions of each of the shear stirrups to move with respect to the other shear stirrups in an assembly.

12. The method of claim 9, wherein the specifying includes estimating an increased level of strength for the shear stirrup reinforcing unit including shear stirrups being rigidly connected to at least one stringer at respective substantially horizontal portions as compared to another shear stirrup reinforcing unit including other shear stirrups not being rigidly connected to at least one stringer at respective substantially horizontal portions.

13. The method of claim 9, further comprising: requiring the stringers be rigidly connected with a rigid joint to the substantially horizontal portions of the shear stirrup unit, the rigid joint being one from the group consisting of: a weld; an adhesive joint; a cemented joint; and a fastener.

14. A method of fabricating shear stirrup assemblies, comprising:

positioning two or more shear stirrups substantially parallel to one another such that a substantially vertical

portion of each of the two or more shear stirrups are substantially parallel to one another; and

rigidly attaching a stringer to a substantially horizontal portion of each of the two or more shear stirrups with a rigid joint such that the substantially vertical portions of each shear stirrup remain parallel to one another.

15. The method of claim 14, further comprising:

placing the shear stirrup assembly adjacent a column, and supporting the shear stirrup assembly such that the substantially vertical portions remain substantially vertical.

16. The method of claim 14, wherein rigidly attaching the stringer to the substantially horizontal portions includes welding the stringer to the substantially horizontal portions of the shear stirrups.

17. The method of claim 16, further comprising a bend between the substantially horizontal portion and the substantially vertical portion, the shear stirrups having a diameter, the welding arranged to take place a distance from the bend greater than or equal to the diameter.

18. The method of claim 14, wherein the positioning includes putting a plurality of the shear stirrups in a jig such that each of the vertical portions are substantially parallel, and the rigidly attaching includes welding the at least one stringer to the respective substantially horizontal portions.

19. A concrete reinforcing system, comprising:

a first group of reinforcing members disposed to reinforce a concrete column; and

a second group of reinforcing members disposed to reinforce a concrete slab, the second group including at least one concrete reinforcing device extending outwardly from the first group of reinforcing members and including a plurality of shear stirrups, each shear stirrup being made of a rigid material and including at least one substantially horizontal portion and at least one substantially vertical portion separated by a bend, and a stringer rigidly attached to the at least one substantially horizontal portion of the plurality of shear stirrups.

* * * * *