

BAR-PODS FOR REINFORCED CONCRETE FORMWORK AND SCAFFOLD

Field of Invention

5 [0001] This invention relates to bar-pods (being assemblies of bar-chairs) which are useful to independently support a single layer or multiple layers of reinforcement bars (referred to as 'rebar') at a desired level in a reinforced concrete ('RC') structure, including but not limited to thick RC slabs. These bar-pods are also useful as supports for falsework for RC or scaffolds for working platforms in the construction industry.

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Background

[0002] Conventionally, bar-chairs are used to support a single layer or multiple layers of rebars at a designed level in a RC slab. Bar-chairs can be made of plastic, timber, steel or other materials. Typically, a bar-chair made from steel rebar is used to support single or 15 multiple layers of main rebars in a RC slab. The most common method of fabricating a bar-chair is to bend a straight rebar into a vertical inverted 'U' shape with horizontal arms projecting in opposite directions from the ends of the legs of the 'U' as seen in Figure 1A.

[0003] Bar-chairs have been used in RC construction for decades now. Although a bar-chair may not contribute to the strength and stability of the permanent structure, it is an important part of the formwork for the RC structure. The common arrangement of bar-chairs is to have lines of single bar-chairs, with the rows spaced uniformly in the perpendicular direction. Bracing against sway and buckling is installed in the vertical planes connecting the rows. 25

[0004] Nevertheless, there are some serious and dangerous problems associated with bar-chairs. Firstly, a standard bar-chair is asymmetric, with the arms pointing in opposite directions as in Figure 1A. As a result, there is an inherent tendency towards instability. In situations when there is an imminent failure, such instability accelerates and 30 exacerbates collapse of the bar-chairs and rebars above them.

[0005] Secondly, when the horizontal arms of a bar-chair are longer than the spacing of the bar-chairs, it becomes impractical and uneconomical to accommodate them or install the bar-chairs within the formwork.

5 **[0006]** Thirdly, when horizontal movement or horizontal force is exerted on tall bar-chairs in the direction perpendicular to the bar-chair rows, the bar-chairs tend to sway laterally and overturn. The larger the ratio of the bar-chair's leg's height to the length of its end arms, the greater the tendency to sway or overturn.

10 **[0007]** Fourthly, under vertical forces, the load-bearing capacity of the vertical legs would be reduced considerably for high (L/r) ratios, leading to buckling failure. In the preceding, L is the unbraced length of the bar-chair leg, and r is the radius of gyration of the cross-section area which is one-fourth of the diameter of the bar. For instance, a 2 m tall 32mm diameter rebar would buckle under a stress of about 30 MPa, which is a small
15 fraction of the yield strength of the steel.

[0008] Fifthly, as the tall bar-chair is much more unstable than the short bar-chair due to sway and buckling, it requires a considerable amount of bracing against both adverse behaviours to prevent its total collapse.

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[0009] Sixthly, special design and quality workmanship are crucially required to overcome the risks of sway and buckling. Further, the implementation of such design and installation procedures and also the relevant safe work procedures (SWP) are quite tedious, time consuming and labour intensive, leading to possibilities for serious error.

25 While these problems are well known and adequately managed for permanent structures, they are often overlooked or de-emphasized in the case of formwork and other temporary structures, resulting in collapse.

[0010] It can thus be seen that there exists a need to provide a simple, practical and cost-effective solution to eliminate or mitigate the disadvantages and hazards associated with
30 current practice of single bar-chairs. The present invention provides a method of combining three or four bar-chairs in an integrated manner to form a 'bar-pod'. In essence, the bar-pod is a stand-alone structure, strong and stable in itself and by itself,

which overcomes almost all the shortcomings of the single bar-chair. These bar-pods can also be used as scaffolds to support other temporary structures at a worksite.

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Summary

[0011] The following presents a simplified summary to provide a basic understanding of the present invention. This summary is not an extensive overview of the invention, and is not intended to identify key features of the invention. Rather, it is to present some of the innovative concepts of this invention in a generalised form as a prelude to the detailed description that is to follow. For example, the concepts and procedures presented are not exclusive to the use of a steel rebar as the only material for the bar-chairs, but may apply with equal validity to any other doubly symmetric cross-sectional configuration such as a circular or rectangular pipe or other straight prismatic member, and to any other structural material such as aluminium, plastic and timber.

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[0012] The present invention seeks to provide stand-alone bar-pods which are strong and stable. These bar-pods are combinations of three or four bar-chairs. When the bar-pod is a combination of three bar-chairs to form a triangle in plan view, it is termed as a 'tri-pod'. When the bar-pod is a combination of four bar-chairs to form a square or rectangle, it is termed as a 'quad-pod'.

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[0013] In one embodiment, the present invention provides a bar-pod made up of three or four or more bar-chairs. Each of the bar-chairs of the bar-pod is fabricated by bending a straight bar into a substantially vertical inverted 'U' shape with two ends of the legs of the inverted 'U' bent again to form base support arms. Unlike in a conventional bar-chair, the terminal arms of the bar-chair with this preferred aspect are not bent in opposite directions perpendicular to the plane of the 'U', but folded inwards to lie in the plane of the 'U' as in Figure 1B, and hence do not introduce any asymmetry.

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[0014] Preferably, to develop integral stability, the legs of the bar-chairs constituting the bar-pod are connected by means of one or more sets of connectors, such as straps, clamps, hinges, U-bolts, or swivel clamps to form the triangular or square (or rectangular) shape of the bar-pod.

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[0015] Preferably, two sets of connectors of the bar-pod are positioned with one set near the top of the legs and the other set near the bottom of the bar-chair legs.

5 **[0016]** Preferably, welded straps may be used to connect the legs permanently. Hinges may be used to connect the three or four bar-chairs in a foldable fashion for convenience of transport, to be opened up to the triangular or rectangular shape at the assembly location and the closure made with a pair of pre-welded detachable hinges or a pair of U-bolts. U-bolts or swivel clamps are also useful for on-site assemblies or to fix broken
10 welded connections.

[0017] Preferably, these connectors are pre-designed and properly installed, being required for the integrity of the bar-pod. Simply wrapping of a few loops of binding wire around pairs of bar-chair legs is not considered sufficient to achieve the integral
15 behaviour envisaged for the bar-pod in the invention.

[0018] The bar-pod may be prepared in one of the following ways: (i) Fully fabricated at an off-site or on-site workshop; (ii) Fabricated in a foldable fashion in a workshop for transport to a convenient spot in the site, where the folded shape may be opened out to a
20 triangle or square (or rectangle), and the closure made by welding or suitable reconnectable connectors; or (iii) All the components are assembled within the formwork and connected to form the bar-pod by welding or suitable connectors.

[0019] Preferably, the bar-pod may be separated by a maximum distance equal to the
25 bar-chair span, and the space between adjacent bar-pods may be bridged by rebar links termed 'Pod-links' (PL) with short bent arms which may be slid into short pipe sockets (PS) welded or otherwise attached to the bar-chair legs. These links (PL) serve to support the first layer of main rebars on the bar-pods, while at the same time inter-connecting the bar-pods into a robust system..

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[0020] Preferably, suitable precautions must be taken to ensure that top connectors or other rebar supports not welded to the bar-chair legs remain in position and do not slide

down accidentally before or during the concreting process and violate the integrity of the bar-pods.

5 [0021] For the quad-pod, two sets of diagonal link pairs may be pre-fabricated from straight rebars with two short bent arms to be slotted at the fabrication location into rings or pipes sockets (PS) previously welded to the bar-chair legs, with one horizontal pair near the top and the other horizontal pair near the bottom. This is to minimise the potential danger due to plan distortion of the square (or the rectangle) into a diamond or parallelogram shape, or alternatively to retain a specific parallelogram shape required to
10 suit a site configuration.

Brief Description of the Drawings

[0022] In order that the present invention may be fully understood and readily put into
15 practical effect, there shall now be described by way of non-limitative examples or embodiments of the present invention, with reference to the accompanying drawings. For ease of reference, common reference by double capital letters will be used throughout all the figures when referring to the same or similar features common to the figures. In the drawings:

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[0023] Figure 1A shows stages of fabricating a conventional bar-chair from a rebar, whilst Figure 1B shows stages of fabricating a bar-chair for configuring a bar-pod according to an embodiment of the present invention;

25 [0024] Figures 2A, 2B and 2C show views of three bar-chairs assembled into a tri-pod according to an embodiment of the present invention;

[0025] Figures 3A, 3B and 3C show views of four bar-chairs assembled into a quad-pod according to an embodiment of the present invention; and

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[0026] Figures 4A to 4E illustrate the use of various types of connectors according to other embodiments of the present invention whilst Figure 4F illustrates the use of a pipe section for engaging with a bent end of link bars to provide stability of the bar-pods.

[0027] Figures 5A and 5B illustrate how bar-pods or chain of bar-chairs can be connected by means of pod-links PL to form continuous support of various shapes in plan.

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Detailed Description

[0028] One or more specific and alternative embodiments of the present invention will now be described with reference to the attached drawings. It shall be apparent to one skilled in the art, however, that this invention may be practised without such specific details. Some of the details may not be described at length so as not to obscure the invention.

[0029] Figure 1A shows stages of fabrication of a conventional bar-chair (BC). As shown in Figure 1A, the method of fabricating the bar-chair (BC) is to bend a straight rebar into a substantially vertical inverted 'U' shape with horizontal arms projecting in opposite directions from the ends of the two legs of the 'U'.

[0030] Figure 1B shows stages of fabrication of a bar-chair (BD) for configuring the bar-pod of the present invention. As shown in Figure 1B, the bar-chair (BD) of the bar-pod is fabricated by bending a straight rebar into a substantially vertical inverted 'U' shape, with the two ends of the inverted 'U' further bent to form base support arms. Unlike in a conventional bar-chair, the terminal arms of the bar-chair (BD) with this preferred aspect are not bent in opposite directions perpendicular to the plane of the 'U', but are folded inwards to lie within the plane of the 'U'.

[0031] Figure 2A shows a top (plan) view of a tri-pod (TP) comprising three bar-chairs (BD). The three bar-chairs (BD) form a triangular shape in plan view and are connected by means of connectors (CC) (straps, hinges, swivel clamps, U-bolts, metal plates with bolts and nuts, and so on).

[0032] Figure 2B is a front perspective view of the tri-pod (TP). In Figure 2B, the three bar-chairs (BD) are connected by means of two sets of connectors (CC) to form the

triangular shape of the tri-pod (TP). One set of connectors (CC) is positioned near a top of the legs of the bar-chairs (BD) and the other set is positioned near a bottom of the legs.

- 5 **[0033]** Figure 2C shows the tri-pod (TP) in a folded manner, as one alternative to complete the fabrication of the tri-pod. If the tri-pod (TP) is fabricated off-site, one pair of detachable hinges (DH) for one corner of the tri-pod (TP) may be released and bar-chair legs at one corner X of the tri-pod may be left unconnected. The tri-pod may now be folded like an accordion as shown in Figure 2C for efficient and economical transportation, and then the two free edges X and X' at corner X may be re-joined at site to produce the third corner at X.

- [0034]** Figure 3A shows a top (plan) view of the quad-pod (QP) comprising four bar-chairs (BD). The four bar-chairs (BD) form a square (or rectangular) shape in plan view and are connected by means of connectors (CC). To retain the square (or rectangular) shape of the quad-pod (QP) during erection and concrete casting, two sets of diagonal links (DL) are provided linking opposite corners T-V and U-W, with one set at a top and the other set at a bottom.

- 20 **[0035]** Figure 3B is a front perspective view of the quad-pod (QP). In Figure 3B, the four bar-chairs (BD) are connected by means of two sets of connectors (CC) to form the square (or rectangular) shape of the quad-pod. One set of connectors (CC) is positioned near a top of the legs of the bar-chairs (BD) and the other set is positioned near a bottom of the legs. Two sets of horizontal diagonal links (DL) are provided linking corners T-V and U-W, with one set at a top and the other set at a bottom.

- [0036]** Figure 3C shows the quad-pod (QP) in a folded manner, as one alternative to complete the fabrication of the quad-pod. If the quad-pod (QP) is fabricated off-site, one pair of detachable hinges (DH) for one corner of the quad-pod (QP) may be released and bar-chair legs at one corner T of the quad-pod may be left unconnected. The quad-pod may now be folded like an accordion as shown in Figure 3C for efficient and economical transportation, and then the two edges T and T' at corner T may be re-joined at site to

produce the fourth corner at T. The horizontal diagonal links (DL) are then installed to provide rigidity and stability.

5 **[0037]** Figures 4A to 4E show a plurality of ways in which adjoining bar-chairs (BD) may be connected using the connectors (CC). These allow flexibility to use the connectors (CC) in a convenient manner. The connectors (CC), with one set near a top of the bar-chair legs and the other set near their bottom, are components of the bar-pods TP and QP, and must be chosen and installed properly. Simple wrapping of a few loops of binding wire around pairs of bar-chair legs is not sufficient to achieve the integral
10 behaviour envisaged for the bar-pods of the present invention.

[0038] Figure 4A shows a flat metal strap (MS) welded to two adjacent legs of two bar-chairs BD. This is suitable when (i) the bar-pod TP or QP is fully fabricated in an off-site fabrication shop, or (ii) if individual bar-chairs BD are transported to the site and the bar-
15 pod TP or QP is fully assembled in an on-site welding shop.

[0039] Figure 4B shows a metal hinge (MH) welded to two adjacent legs of two bar-chairs BD. This is suitable when the bar-pod TP or QP is partially assembled in an off-site fabrication shop or on-site welding shop, and transported in a folded form to the
20 formwork site.

[0040] Figure 4C shows a detachable metal hinge (DH) with each half welded to one of two adjacent legs of two bar-chairs BD. This is suitable when the bar-pod TP or QP is partially assembled and transported to the formwork site in a folded fashion and the
25 closing connection has to be completed at the formwork site. At the formwork site, the two halves of the detachable hinge DH are slid over each other to complete the assembly of the tri-pod TP or quad-pod QP.

[0041] Alternatively, the closing of the bar-pod TP or QP at the formwork site may be
30 effected by U-bolts (UB), or swivel clamps (SC), as seen in Figures 4D and 4E. Figure 4D shows a U- bolt, which may be tightened around two adjacent legs from two bar-chairs BD. Figure 4E shows a swivel clamp of the type commonly used to connect tubes in other temporary structures.

[0042] Care must be taken to avoid accidental separation of the detachable hinge DH, as for example by wire binding through holes in the two halves of the detachable hinge.

5 **[0043]** The bar-chair legs may shift to a certain extent during the formwork erection or concrete casting process, or the nuts may loosen during the concrete vibration process. Steps must be taken to ensure that the top connectors UB and SC do not accidentally become slack and slide down the bar-chair legs, destroying the integrity of the bar-pods.

10 **[0044]** Figure 4F shows a length of pipe PS, for example 10 cm long, welded to the leg of a bar-chair BD at any desired position, to receive a bent arm of either a diagonal link bar DL for stabilising the shape of a square or rectangle, or pod link PL for spanning the gaps between adjacent bar-pods TP or QP. In another embodiment, a ring is provided instead of a pipe section. In another embodiment, both ends of the link bars DL are bent.

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[0045] Figure 5A shows one example of the use of pod links PL for bridging the gaps between tri-pods and/or quad-pods to enable the support of rebars above. Figure 5B shows one example of use of bar-chairs in a zig-zag pattern connected by pod links PL to form various desired shapes in plan.

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[0046] While the quad-pod links DL are necessary to retain the square or rectangular shape of the quad-pod, the pod links PL between two tri-pods or quad-pods will be necessary to maintain the relative position of the pods as well as to serve as supports for the upper rebar arrangements.

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[0047] While for the quad-pod the length of the diagonal links DL will be fixed, in the case of pod links PL between tri-pods TP and/or quad-pods QP the exact length of the links PL may not remain as calculated, but may vary due to site adjustments and cumulative tolerances in erection. Hence to span gaps between bar-pods, preferably one end of the pod link PL may be bent and slotted into the pipe socket PS and the other end permitted to slide longitudinally and fixed in position to an adjacent bar-chair leg by a strap, clamp, or U-bolt.

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[0048] In the present invention, the bar-pods TP and QP made from rebar bar-chairs BD offers many advantages, including but not limited to the following: Firstly, since the bar-chairs BD of the bar-pods TP and QP are fabricated from commonly available rebars, preparation is easy, fast and economical, and no fresh vendors or specially skilled
5 workers are required.

[0049] Secondly, as the bar-pods TP and QP can be made as wide as needed, the risk of over-turning under the influence of horizontal forces is practically eliminated.

10 **[0050]** Thirdly, as there are six or eight legs in each bar-pod, the bar-pod TP or QP provides multiple load paths for applied vertical loads, and reduces the buckling tendencies of the bar-chair legs. If intermediate bracing is required against buckling, bracing in one or more horizontal planes may be attached using the methods for connecting the links DL or PL.

15 **[0051]** Fourthly, because of plan symmetry of the bar-pods TP and QP, there is no twisting or warping under vertical or horizontal forces.

[0052] Fifthly, the bar-pods TP and QP can be moved around in the formwork site
20 without disturbing the general layout, so that uneven shapes of plan and special support arrangements can be easily met. Projections within the formwork such as pile heads, utility vents, etc. may be circumvented easily. In general, it is recommended that a boundary of the casting area be first aligned with the bar-pods TP and/or QP and then the interior of the formwork is suitably filled with sufficient number and arrangement of
25 more bar-pods TP and/or QP.

[0053] Sixthly, as the gaps between adjacent bar-pods TP and QP can be easily spanned with the links PL from the corners of adjacent bar-pods to provide temporary supports for the first layer of the upper rebars, the bar-pod arrangement becomes independent of
30 the main rebar directions.

[0054] Seventhly, the bar sizes for the bar-chairs BD, as well as the bar-pod TP or QP sizes and spacing may be optimised to utilise any excess capacity of the bar-chair legs.

To take advantage of this versatility of the present invention, integrated design of all components of bar-pods becomes possible, and must conform to standard structural analysis practices, as well as to applicable codes of practice.

5 **[0055]** Eighthly, with proper management of bar-pod TP or QP fabrication, the connectors FS, MH, etc. and links DL or PL are easy and fast to install on-site, thus saving a lot of formwork preparation time.

10 **[0056]** Ninthly, the various embodiments described earlier for assembling the bar-pods TP, QP provide considerable flexibility in the fabrication and erection of the formwork to suit different requirements and contingency conditions.

15 **[0057]** Last but not the least, the main advantage of the bar-pods TP and QP is the fact that when properly designed and installed, each bar-pod TP or QP is a stand-alone, stable, and strong structure, capable of supporting the top layer of reinforcement bars and any other construction loads even without additional sway bracing.

20 **[0058]** Whilst there has been described and illustrated in the foregoing preferred embodiments of the present invention, it will be understood by those skilled in the field concerned that many changes, variations or modifications in details of method or combination may be made without departing from the scope of the present invention as defined in the following claims.

25 **[0059]** For example, whilst rebars are used in the above description, circular, rectangular or prismatic bars, or plain solid bars or hollow pipes can also be used to make the above bar-chairs BD, link members DL, tri-pods TP or quad-pods QP.

30 **[0060]** In another embodiment of the invention, the fabrication and assembly of the bar-pods described for supporting reinforcement in RC slabs is also used for supporting formwork for casting concrete and even work platforms for scaffolds, with the same advantages as claimed for formwork structure.

[0061] In another embodiment of the invention, the concept of folding a series of three or four connected bar-chairs BD to create the tri-pod TP and quad-pod QP, is also extended to form a long chain of bar-chairs, zig-zag shaped in plan, of desired length and width, in a self-stabilised mode, with the longitudinal gaps between consecutive ends
5 being bridged by links such as PL, as in Figure 5B to form a support system for formwork or scaffold platform.

CLAIMS:

1. A bar-pod for supporting a single layer or multiple layers of reinforcement bars (or rebar) at a pre-determined level in a reinforced concrete member, the bar-pod comprising a combination of three bar-chairs to form a tri-pod (TP) of a triangle shape in plan view, wherein each of the three bar-chairs is formed into a substantially vertical inverted U-shape having substantially vertical legs and terminal feet folded inwardly so as to lie within a plane defined by the substantially vertical inverted U-shape;

wherein two adjacent bar-chairs are coupled to each other by at least one set of connecting means, with the connecting means comprising a metal strap, a metal hinge, a detachable metal hinge, a ring, a pipe socket, U-bolt, or swivel clamp, where the metal strap, metal hinge, components of the detachable metal hinge, ring or pipe socket are welded to the substantially vertical legs.

2. A bar-pod for supporting a single layer or multiple layers of reinforcement bars (or rebar) at a pre-determined level in a reinforced concrete member, the bar-pod comprising a combination of four bar-chairs to form a quad-pod (QP) of a square, rectangle or quadrilateral shape in plan view, wherein each of the four bar-chairs is formed into a substantially vertical inverted U-shape having substantially vertical legs and terminal feet folded inwardly so as to lay within a plane defined by the vertical inverted U-shape;

wherein two adjacent bar-chairs are coupled to each other by at least one set of connecting means, with the connecting means comprising a metal strap, a metal hinge, a detachable metal hinge, a ring, a pipe socket, U-bolt, or swivel clamp, where the metal strap, metal hinge, components of the detachable metal hinge, ring or pipe socket are welded to the substantially vertical legs.

3. The bar-pod according to claim 1 or 2 comprises two sets of connecting means, wherein one set of connecting means is positioned near a top-portion of legs of the bar-chairs while another set of connecting means is positioned near a bottom-portion of the

legs.

4. The bar-pod according to any one of claims 1-3, wherein a set of connecting means on the substantially vertical leg at an open edge of a series of three or four connected bar-chairs is re-connectable so that the bar-chairs are foldable when not in use and, when in use, open edges of the bar-chairs are closed up and the connecting means are re-connected to form the tri-pod or quad-pod.
5. The bar-pod according to claim 3 when dependent on claim 2, further comprises two sets of diagonal links (DL) for connecting diagonally opposite corners, one set near a top and another set near a bottom of the quad-Pod.
6. The bar-pod according to any one of claims 1-5, further comprising one or more pod links (PL) to spatially connect adjacent bar-pods to form a system.
7. The bar-pod according to any one of claims 1-6, further comprising a brace link (BL) at an intermediate level between a top and a bottom of the bar-chair to connect the substantially vertical legs of each bar chair in order to increase a leg buckling load capacity.
8. The bar-pod according to any one of claims 5-7, wherein the diagonal link, pod link or brace link has a short bent arm at each of two ends, for slotting into rings or pipe sockets welded to the substantially vertical legs of the bar chairs.
9. The bar-pod according to any one of claims 1-8, wherein the bar-chair is made of a reinforcement bar (or rebar), solid bar or hollow prismatic bar.
10. The bar-pod according to any one of claims 1-9, wherein the bar-chair is made of steel, aluminum or plastic.
11. A process for forming a stand-alone support structure, the process comprising the steps of:

forming a bar-chair by bending a straight bar into a substantially vertical inverted U-shaped bar, wherein both ends of said substantially vertical inverted U-shaped bar are folded inwardly so as to lie in a plane of said substantially vertical inverted U-shaped bar;

combining three or more bar-chairs to form a bar-pod; and

coupling the legs of two adjacent bar-chairs with one or more sets of connecting means, with each connecting means comprising a metal strap, a metal hinge, a detachable metal hinge, a ring or a pipe socket welded to each leg of the adjacent bar-chairs, or a U-bolt or a swivel clamp.

12. The process according to claim 11, wherein the coupling steps include connecting a top portion of adjacent bar-chairs and connecting a bottom portion of the adjacent bar-chairs with two or more connecting means.

13. The process according to claim 12, wherein the step of combining three bar-chairs comprises a tri-pod with a triangle shape in plan view.

14. The process according to claim 12, wherein the step of combining four bar-chairs comprises a quad-pod with a square or rectangle or quadrilateral shape in plan view.

15. The process according to claim 14, further comprises a step of connecting diagonally opposite corners using two sets of diagonal link bars (DL), one set disposed near a top and another set disposed near a bottom of the quad-pod.

16. The process according to claim 15, wherein the diagonal link bar further has a short bent arm at each of two ends, for slotting into rings or pipe sockets welded to legs of the bar-chairs.

17. The process according to claim 11, further comprises connecting legs of a bar chair with a brace link at an intermediate level of the legs in order to increase a leg buckling load capacity.
18. The process according to claim 11, further comprises connecting spatially spaced bar pods with pod links (PL) to form a system.
19. The process according to claims 17 to 18, wherein each brace link or pod link bar further has a bent end at each of two ends for slotting into rings or pipe sockets welded to the legs of the bar-chairs.
20. The process according to claim 11, wherein the process steps are performed on-site or off-site such that the stand-alone support structure is formed in complete bar-pod form, in foldable accordion form with only an end closure to be effected at site, or fully assembled at a work site.
21. The process according to claim 20, wherein when the stand-alone support structure is formed in foldable accordion form to be closed on itself by using a pair of U-bolts, or swivel clamp or pre-welded detachable hinges in the coupling step.
22. The process according to claim 20, wherein when the stand-alone quad-pods are fully fabricated in closed form in foldable accordion form, the stand-alone quad-pods are opened at site and stabilized with diagonal links.
23. The process according to claim 11, wherein the straight bar used in the forming step is made of steel, aluminum or plastic.