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CONCRETE BUILDING FRAME CONSTRUCTION METHOD

DISCLOSURE

Background of the Invention

The present invention relates to the construction of
5 multi-level concrete building structures and, more
particularly, to such a construction method in which a
deck support form assembly for a structural concrete slab
is lowered into position and supported from the level
above for the making of the next lower structural concrete
10 slab.

The vertical frame elements of concrete building
structures generally are made up of columns (which may be
concrete, structural steel, or a composite of both
concrete and steel) connected together via slabs of
15 reinforced concrete. These slabs are the principle
horizontal frame members for the building. It is common
to incorporate rebar and/or post tensioned beams in such
structural concrete slabs. These slabs act not only as
integral parts of building frames of multi-level concrete
20 buildings, but also to define floors/ceiling soffits.

The most common way of constructing the floor
dividing slabs in concrete multi-story buildings, is to
construct formwork at a floor elevation, install rebar
and/or post tensioning tendons, and then fill the formwork

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with concrete which is allowed to cure. It is typical to build the slabs sequentially in a "bottom-up" approach (one above the other). When the slab for a floor is made, the formwork to support the next slab above is installed
5 on top of such concrete slab. If garage levels or other floors are built below grade level, it is common to excavate to the lowest elevation of slab and then proceed with the "bottom-up" slab making approach described above.

Summary of the Invention

10 The present invention relates to a method of constructing the generally horizontal structural slabs from the "top-down", rather than from the bottom-up as now commonly done. More particularly, it includes the steps of providing a generally vertical frame network of columns
15 for interaction with horizontal structural concrete slabs, and making one of the structural slabs with a deck support formwork assembly. (When reference is made herein to "making" a concrete structural slab or "constructing" the same, this terminology is meant to encompass the provision
20 of formwork for such slab, the installation of rebar or the like in such formwork, and the pouring and curing of concrete for the same, but not necessarily the many other steps that have to be accomplished before one can say that the construction procedure with respect to a particular
25 slab is completely finished.)

In keeping with the invention, the deck support formwork assembly, from the level defined by such one slab is lowered into position for the making of the next lower structural concrete slab. This formwork also is supported
30 for the making of such next lower slab, from the level defined by the first slab. Most desirably, such support is from the first structural slab itself. Such structural slab is designed to support the loads to be encountered during the construction of the next lower slab.

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Attachment nuts are provided in the first structural slab to transmit loads to such upper slab.

A major advantage of this approach to the construction of a concrete building is the speed and simplicity of the actual construction. Upper floors, once the structural slabs for the same have been made, can be finished (partitions, windows/curtain walls can be installed, etc.) while the construction of lower slabs is taking place. And, indeed, it is not necessary for the concrete frame construction workmen to have access to such upper floors after the forms are lowered. Other advantages are that buildings can be built to zero lot line without having to fly forms over adjacent buildings. The system is extremely cost efficient because it requires so few workers and because of the speed of erection. Full 8'0" floor-to-ceiling heights can be achieved with 8'6" (or less) floor-to-floor heights.

It should be noted that the broad concept of constructing horizontal slabs in a "top-down" manner has been used in the past in other types of construction which cannot be used in constructing buildings of significant height. Reference is made, for example, to U.S. Patent Nos. 3,194,532; 3,275,719; and 4,029,286. In such arrangements the slab is not a ductile diaphragm. The criteria for these other types of construction are completely different, and it is not obvious how those top down approaches will work in an arrangement in which the slab is a structural ductile diaphragm part of the frame in addition to dividing levels.

Other features and advantages of the invention either will become apparent or will be described in connection with the following, more detailed description of preferred embodiments of the invention.



Brief Description of the Drawing

With reference to the accompanying drawing:

FIGS. 1A-1D provide an overall elevation view schematically illustrating a preferred embodiment of the invention for making structural slabs below grade level;

FIG. 2 is a partial sectional view illustrating more specifically a preferred arrangement of interfacing a form assembly of the invention with a slurry wall;

FIG. 3 is a broken away, somewhat schematic isometric view of the preferred embodiment of FIG. 1, with a showing in phantom of a concrete slab of one level above made with a form assembly as illustrated;

FIG. 4 is an enlarged and partly exploded sectional view, generally showing the area encircled by the line 4-4 in FIG. 1A;

FIGS. 5A and 5B are enlarged plan and end sectional views, respectively, of a washer especially designed for the invention;

FIG. 6 is an enlarged sectional view generally showing the area encircled by the line 6-6 in FIG. 1B, after concrete is poured and set;

FIG. 7A is a plan view of a preferred embodiment of a wheel of the invention used to turn a rod to be described and lower the form assembly;

FIG. 7B is a sectional view of the wheel of FIG. 7A showing the same in engagement with a rod;

FIG. 8 is an enlarged sectional view of a coupler for a pair of axially aligned rods;





FIG. 9 is a nut pulling apparatus of the invention;

FIG. 10A is an elevation view of an alternate hanger arrangement;

FIG. 10B is a plan view of the alternate hanger
5 arrangement of FIG. 10A;

FIG. 11 is an elevation view illustrating a preferred embodiment of the invention in which slabs are made above grade level for a multi-level concrete building structure; and

10 FIG. 12 is an enlarged sectional view similar to that of FIG. 5, showing an alternate arrangement for supporting a threaded rod.

Detailed Description of the Preferred Embodiment(s)

The following relatively detailed description is
15 provided to satisfy the patent statutes. However, it will be appreciated by those skilled in the art that various changes and modifications can be made without departing from the invention. The following description is exemplary, rather than exhaustive.

20 FIG. 1 illustrates not only the major aspects of a preferred embodiment of the apparatus of the invention, generally referred to in both FIG. 1 and FIG. 3 by the reference numeral 11, but also the method of use of the same. Although the specifics for invention will be
25 described in some detail with respect to the construction of structural slabs below grade level, it will be obvious which of these specifics are applicable to the construction of structural slabs above grade level. The apparatus illustrated in FIG. 1 includes a deck form
30 assembly 12 for supporting concrete for a structural slab. Such assembly includes an upper platform 13 against which



concrete for a structural slab to be made is poured. As best illustrated in FIG. 3, such platform includes a raised central portion 13 to define a slab soffit, which portion is defined by a membrane formed, for example, from plywood supported by a frame made up primarily of 2 x 6 joists 14 which, in turn, are supported by steel bar joists 16. Dropheads 17 are formed at each column. The support portion of the assembly 12 also includes a pair of end I-beams 18 which support the remainder of such assembly. Each I-beam 18 (only one of which can be seen in FIG. 2) terminates in a protective pocket 19, the purpose of which will be described in more detail hereinafter.

When the method of the invention is used for making slabs below grade, i.e., below the level of the ground at the location of the building structure, at a location in which significant egress of water is to be expected, e.g., a coast site, a water barrier wall 21 is formed surrounding the site at which such slabs are to be made. Such barrier wall 21 is simply a slurry wall, and in one realization of the invention in the construction of a multi-level underground garage, the wall 21 was a 3-foot thick slurry wall that was 100-feet deep. As illustrated in FIGS. 1 and 2, the decks are dowelled and poured into the slurry wall via a keyway 22.

A generally vertical structural frame network of columns for interaction with the structural slabs is provided. Such network includes a plurality of generally vertical columns 23 which extend upward from a stable base. In one realization of the invention the steel columns were secured to bedrock by the formation of a grid of 5 to 8 foot diameter concrete caissons which served as foundations for the columns. Cages of reinforcing steel were provided in the holes augured for the columns 23. Then tremied concrete was inserted in the holes to displace a polymer driller's mud that had been used within



the holes to prevent the sides of the same from caving in. Enough concrete was poured in the holes to cover the steel columns from bedrock to the elevation of the bottom slabs to be formed.

5 As mentioned earlier, the invention particularly relates to concrete construction in which the slabs act not only to define the floors/ceiling soffits of the various levels, but also act as primary horizontal structural diaphragms. A significant aspect of the method
10 is the making of such horizontal structural slabs in a top-down arrangement with the repetitive use of the same deck form assembly. This is unusual in that a building of this type does not have a permanent structural frame at the location at which the slabs are made (or at any level
15 below the same). It only does so after a slab is poured and cured at such location. In the traditional "bottom-up" approach this is no problem since the structural frame of a building is completed all the way from the foundation to the top as the slabs are made. In
20 contrast, when the horizontal structural slabs are made in a top-down arrangement the completed portion of the frame for the building is the upper part, i.e., that part in which the slabs have already been made. It will be appreciated, though, that the construction of the
25 horizontal slabs at the upper part of the building provides meaningful structural stiffening to the vertical frame columns. In this connection, it should be noted that each completed slab acts as a structural diaphragm that ties the columns together in a rigid framework while
30 the soil beneath the slab is excavated for the construction of the next lower level.

In keeping with the invention, the deck form assembly is lowered from one level to the next lower level to be made, and as each level is constructed the support for the
35 form assembly is provided at the level that has just been defined. Most desirably, the support is provided by the



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slab itself by embedding an attachment to transmit the loads encountered during construction of the next lower slab, to such upper slab. This procedure is best illustrated in FIGS. 1A-1D which show the bays of adjacent slabs being made. (It will be appreciated that such figures are not true-to-life in that a single slab pour will include several bays in one level.) Each deck form assembly 13 is suspended from the level above via threaded rods 26 at each corner.

10 The level above a level to be made provides support for the deck form assembly. With reference, for example, to bay 27 of FIG. 1A in this embodiment, such support takes the form of a shoulder nut 28 which is embedded in the concrete slab for the bay. In this connection, each
15 of the threaded rods 26 mates with the interior threads of the corresponding nut 28. Each rod also has a plastic sleeve 30 extending from the nut through the slab to protect the rod from concrete when it is poured and to define the axial hole through the slab necessary for the
20 rod.

Each of the threaded rods 26 terminates and is threadably connected to the bottom form assembly in an associated pocket 19. FIG. 4 is an enlarged sectional view which illustrates the same in more detail. That is,
25 each threaded rod extends through a flange 29 at the bottom of the pocket and then terminates in an anchor or end nut 31. Such nut is made non-rotatable with respect to the threaded rod end via, for example, the use of locking bolts 32. Thrust straps 34 also can be provided
30 to transmit the thrust applied to the rod 26 to the flange 29 and, hence, to the main end beam 18 of the form assembly. A washer 35 is provided which is heavily greased to permit rotation of the tie rod 26 and, hence, nut 32, with respect to flange 29. A plurality of
35 shoulder nuts 28 to be embedded in the concrete slabs



defining other levels are also provided on the rod as illustrated.

It will be recognized that there often is a significant load on the threaded rods, and in many situations it is desirable to facilitate the turning of the same. Washer 35 is especially designed to cooperate with grease to permit such rotation. FIGS. 5A and 5B are enlarged views of such washer, showing that it has radial grooves 36 on opposite sides of a center plate 37. Each groove on one side defines a channel for the distribution of grease from the rod to the side of the washer associated with such groove. As illustrated, the grooves 36 on one side have a circumferential component in one direction, whereas the grooves on the opposite side of the plate have a circumferential component in the opposite direction. Because of these opposite circumferential directional components, grease will be distributed in both directions of rotation of the threaded rod.

In the below-grade implementation of the invention being described, before the deck form assemblies for a slab are lowered, the volume of material (earth) for the next lower level is excavated. The excavation is to the level, for example, indicated at 33 for bays 27 and 39. The volume excavated includes the additional depth beneath the slab to be formed at that level necessary to accommodate the depth of the deck form assemblies. The deck form assemblies are then lowered.

The deck form assembly can be stripped from the cured concrete slab by various means which will provide the turning torque necessary to rotate the rod to initiate lowering. Two such means are schematically depicted for the bay 39, by the workers 40 and 41 schematically shown respectively applying an impact wrench 42 and a spud wrench with a cheater 43 to the end of two of the rods 26.



Once the deck form assemblies for a concrete slab are stripped from the concrete soffit at one level, they can be lowered into position to form the next lower slab. That is, the length of the threaded rod extending between
5 the form assembly and the nut is increased. Each of the threaded rods 28 is provided with spaced machined areas or notches represented in FIG. 1 at 46, for engagement to adjust the elevation of the deck form at the threaded
10 rods 46 should be such that one is assured to have a machined notch in easy range for use by a worker. FIGS. 7A and 7B illustrate a turning wheel 47 which is particularly designed to engage such a machined notch 46 and rotate the associated threaded rod. The wheel 47
15 includes a center portion 48 adapted to engage a machined notch 46. Such center portion includes a slot 49 which is closable by a rotating latch 51. A weighted gripping wheel 52 circumscribes the center portion and is connected to the same by a plurality of spokes 53. It will be
20 appreciated that turning of the weighted wheel will transmit turning motion of the same to the center portion and, hence, to any threaded rod engaged by the same.

As a slab is made defining a level, the deck form can be lowered (after excavation) for reuse at the next lower
25 level. The steps of excavating and making, a structural slab with the deck form assemblies, are repeated for each suspended slab. This repetition is represented by bays 54 and 56.

The invention is also applicable to the use of a
30 concrete vibrating screed. As is illustrated in bay 56, a screed rail 57 can be provided connecting two adjacent threaded rods 26 as illustrated. It will be appreciated, although not shown, that a similar screed rail connects the other two threaded rods of each form assembly. A
35 carrier 58 for a vibrating screed 59 can travel along the



length of the rails to position the screed at an appropriate location and elevation therefor.

The shoulder nut attachment/threaded rod arrangement is used in the preferred arrangement being described, not only to lower and support the deck form assembly itself, but also to provide the support necessary to transmit the load of the poured and curing concrete slab to the concrete slab above the same. That is, as is best illustrated by the bay 38, the threaded rods 26 extend upward to the concrete slab represented at 44 and support not only the form assembly 12, but the poured concrete for the next lower slab.

In some instances it is desirable to transmit the loads encountered by a deck form assembly and the concrete supported by the same, to more than one higher completed slab. FIG. 8 illustrates a coupler 61 joining axially aligned threaded rods 26 for this purpose. It will be noted from FIG. 1 that the upper threaded rod is connected to the shoulder nut 28 at the upper structural slab, whereas the lower threaded rod is suitably received within the shoulder nut in the lower slab. With this arrangement, the loads on each deck form assembly will be transmitted to the two adjacent upper slabs as long as the threaded connections all are tight.

After the shoulder nuts in a completed slab are no longer being used, they can be pulled from the slab. FIG. 9 illustrates a nut pulling arrangement. It includes a rod 62 which is, in essence, a much shorter version of a threaded rod. Such rod 62 has a center section which is machined to a smaller diameter to thereby create a shoulder. The rod engages the nut in a non-slip manner by being threaded into the same. The pulling apparatus also includes a bearing plate 63 which bears upon the slab from which the nut is to be removed and is a stop for the upper edge of the notch on the rod. It will be appreciated that



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turning of the rod in the appropriate direction will result in the length of the same extending between the bearing plate and the nut being reduced, so that a pulling force is supplied to the nut whenever an effort is made to
5 reduce such length while the bearing plate is on the slab. Once the nuts have been removed, the columns at a particular level defined by a suspended slab can be encased as is common.

It will be recognized that in some situations it is
10 desirable to make use of the lowering aspect of the invention even though it is not desired to apply the load of the concrete to be poured to the slab at the higher level. In many instances the slabs will not be designed to provide such load support and will be incapable by, for
15 example, being too thin, of providing the desired support. Moreover, in some of such situations, it either is impractical or undesirable to use couplers as discussed above to transmit the load to more than one slab. FIGS. 10A and 10B show an alternate arrangement for
20 supporting the threaded rods without use of already formed (constructed) slabs. That is, an articulated support arm, generally referred to by the reference numeral 66, is connected via pins 67 to one of the columns, represented at 23. The arm 66 terminates in a cup 68 configured to
25 interact with a nut 28 for a threaded tie rod 26. It will be appreciated that for each deck form assembly to be supported, there will be four of these support arms 66, one at each of the corners of the deck form assembly. The arm 66 is adapted to be infinitely adjustable relative to
30 the positioning of the cup 68. To this end, it includes a pair of hinged joints 69 and 71 which facilitate positioning adjustment. The freedom provided by the adjustment ability of the cup portion enables use of the arms at many locations where other attachment apparatus
35 might be difficult to use.



It is desirable that the articulating support arms be at a level just above the location desired for the new structural slab. Holes at the four corners of the finished slab allow the threaded rods to pass

5 therethrough. It will be appreciated that the lowering of the form, etc. is essentially the same as that described when the nut 28 is embedded within, or placed on top of, the upper structural slab itself.

As mentioned previously, the invention is
10 particularly applicable to the formation of above-grade levels for concrete multi-story buildings. FIG. 11 is a plan view schematically illustrating such an arrangement, generally referred to by the reference numeral 76. The specific design has twenty above-grade levels (19
15 floor/soffit slabs and one roof slab). The construction includes bays, two of which are shown at 77 and 78 surrounding a core bay 79. The core bay is designed for stairwells, elevators, etc. and includes lightweight bracing represented at 81 to support those core elements
20 which are installed before the structural slabs are formed in accordance with the invention. The building structural frame includes a plurality of vertical columns 82 akin to the columns 23 of the below grade construction described previously. Each of the columns 82 is made up of column
25 sections 83 which are joined as illustrated at 84 in the field in accordance with conventional techniques. Each of such columns can be concrete, structural steel, or a composite of both, for example, concrete encased in a metal tubular shell. Such columns are supported via
30 footings 86 or the like in accordance with conventional techniques depending upon local conditions. Temporary bracing represented by lines 87 is also provided to aid in supporting the columns 82 until the horizontal structural frame slabs are formed in accordance with the invention.
35 In this connection, such horizontal structural frame slabs are represented at 88. The manner in which they are provided above ground is essentially the same as that



described previously in connection with the formation of
below grade slabs. Such slabs may have any desired
configuration, e.g., have a beam-in slab configuration.
The top roof slab is formed by hanging the rods from
5 temporary bracing supporting the columns.

Each structural slab will incorporate the lightweight
bracing for the columns in the core bay. Moreover, the
temporary bracing in the other bays at each particular
level will be removed just before the form assemblies are
10 lowered to the particular level having such bracing.
the schematic arrangement illustrated, four slabs have
been made.

In some situations, the number of levels to be formed
makes it impractical to provide enough shoulder nuts 28 in
15 a protective pocket 19 for all the levels to be made.
This is particularly true in multi-story, above grade
construction projects. In such a situation it is
desirable to be able to provide a split shoulder nut which
can be installed on a threaded rod after the threaded rod
20 is in position, thus eliminating the need to have it
already installed on the rod. FIG. 12 is a sectional view
showing such an arrangement. The nut 91 is made up of two
halves, 92 and 93, bolted together via bolts 94 extending
through mating flanges 96. Although not shown, it will be
25 recognized that there are similar mating flanges 96 and
bolts 94 diametrically opposite those illustrated.

It is also desirable in some situations that a
shoulder nut be utilized that is not embedded in the
concrete. As illustrated in FIG. 12, a shoulder nut 30 is
30 threaded upside down on the threaded rod and bears tightly
against a bearing plate 97. If desired, such shoulder nut
can include an extension (not shown) for facilitating
gripping of the sleeve 30 so that removal of the shoulder
nut will result also in the removal of such sleeve. It
35 will be seen that the load carried by the threaded rod is

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transferred through the upside down nut and bearing plate 97 to the structural slab.

The "top-down" construction of the floor/ceiling structural slabs of the building frame provided by the invention greatly simplifies the construction procedure. It also enables the concrete structure to be completed in a much shorter time. It will be seen that after the next lower slab is made, it is not necessary for the workmen involved in the frame/slab construction to have access to the other, higher levels. Thus, the invention makes it appropriate for a contractor constructing such a building to provide complete access for sub-contractors to each of the floors following, in essence, the construction of the structural slab. That is, as soon as a slab is completed the interior walls, curtain walls, the interior finishing, etc. can be completed. Thus, when the instant invention is utilized, a building can be completely finished in little more time than is required to construct the frame for the same. Even making the frame is simplified in view of the ability to support the horizontal slabs for one level from the next higher level.

As mentioned at the beginning of the detailed description, Applicant is not limited to the specific embodiment described above. Various changes and modifications can be made. As mentioned previously, the specific embodiments are exemplary, rather than exhaustive. The claims, their equivalents and their equivalent language define the scope of protection.





CLAIMS

What is claimed is:

1. In a method of constructing a plurality of generally horizontal structural concrete slabs for a multi-level building structure, the steps comprising:

- (a) providing a generally vertical frame
5 structural column network for interaction with horizontal structural concrete frame slabs;
- (b) making one of said structural slabs out of concrete with a deck form assembly;
- (c) thereafter lowering said deck form assembly
10 from the level defined by said one slab when it is made, to a position for the formation of the next lower structural frame slab; and
- (d) supporting said form for the construction of said next lower slab from the level defined by said one
15 slab.

2. The method of claim 1 wherein said step of supporting said form for said construction of said next lower slab from said level includes supporting said form from said one slab itself.

3. The method of claim 2 wherein said next lower slab is to be made below the grade of the ground at the location of said building structure, further including the step before said steps of lowering and supporting, of
5 excavating the earth to below the level to be defined by said next lower slab.

4. The method of claim 2 wherein said step of supporting said form from said one slab itself includes embedding an attachment in said slab to transmit to said one slab, the loads encountered during the formation of
5 said next lower slab.





5 5. The method of claim 4 wherein said embedded attachment is threaded interiorly thereof, and said step of lowering said bottom support form assembly includes rotating a threaded rod which is attached to said form assembly and threadably engaged within said embedded attachment.

5 6. The method of claim 1 wherein said step of supporting said form for said construction of said next lower slab from said level includes attaching a structural slab form support arm to said column network at said level.

7. The method of claim 6 further including the step of providing a threaded rod between said level and said position.

8. The method of claim 1 wherein said position is the position for said next lower slab in said building structure when such structure is completed.

9. The method of claim 1 wherein a plurality of succeeding structural slabs are formed and the steps labeled (b), (c) and (d) are repeated for each pair of vertically adjacent slabs.

10. In a method of forming a plurality of generally horizontal structural concrete slabs for a multi-level building structure, the steps comprising:

- 5 (a) providing a generally vertical column frame network for interaction with horizontal structural concrete frame slabs;
- (b) constructing one of said slabs out of concrete with multiple deck form assemblies; and
- 10 (c) thereafter supporting said deck form assemblies from the level defined by one slab, for the constructing of the next lower structural frame slab.





11. The method of claim 10 wherein a plurality of succeeding slabs are constructed and the steps labeled (b) and (c) are repeated for each pair of vertically adjacent structural slabs.

12. The method of claim 10 wherein said step of supporting said form for said construction of said next lower slab from said level includes supporting said form from said one slab itself.

13. The method of claim 12 wherein said next lower slab is to be constructed below the grade level of the ground at the location of said building structure further including the step before said step of supporting, of
5 excavating the ground to below the level to be defined by said next lower slab.

14. The method of claim 12 wherein said next lower slab is constructed below the grade at the location of said building structure, further including the step prior to said step of supporting said form assembly, of
5 constructing a barrier against the egress of water into the area at which said next lower slab is to be made.

15. In a method of constructing a plurality of generally horizontal structural concrete slabs for a multi-level building structure, the steps comprising:

- (a) providing a generally vertical structural
5 column frame network for said building structure;
- (b) constructing one of said structural concrete slabs with multiple deck form assemblies;
- (c) thereafter lowering said deck form assemblies from said one slab after it has been
10 constructed into position for the construction of the next lower structural slab.



16. The method of claim 15 wherein a plurality of succeeding slabs are constructed and the steps labeled (b) and (c) are repeated for each pair of vertically adjacent structural slabs.

17. The method of claim 15 wherein said step of lowering said form for said formation of said next lower slab from said level includes supporting said form for said lowering from said one slab itself.

18. The method of claim 17 wherein said next lower slab is made below grade at the location of said building structure, further including the step prior to said step of lowering said form assemblies, of constructing a
5 barrier against the egress of water into the area at which said next lower structural slab is to be formed.

19. The method of claim 17 wherein said next lower slab is to be made below grade at the location of said building structure further including the step before said step of supporting, of excavating the earth to below the
5 level of said next lower slab.



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20. In a method of making a plurality of generally horizontal structural concrete slabs for a multi-level building structure, the steps comprising:

- 5 (a) providing a generally vertical structural column frame network for said building structure;
- (b) constructing a structural concrete slab with deck form assemblies;
- 10 (c) thereafter lowering said deck form assemblies from the first slab after it is constructed, to a position for the formation of the next lower structural slab;
- (d) supporting said decks for the formation of said next lower slab from said first slab, including supporting an attachment with said first slab when it is
15 constructed to transmit to said first slab, the loads expected during the formation of said next lower structural slab;
- (e) said step of lowering including rotating a threaded rod which is attached to said form assembly and
20 threadably engaged within said embedded attachment; and
- (f) repeating the steps labeled (b), (c), (d) and (e) for each pair of vertically adjacent structural concrete slabs to construct a plurality of succeeding structural slabs.

21. The method of claim 20 wherein said next lower slab is to be made below grade at the location of said building structure, further including the step before said steps of lowering and supporting, of excavating the earth
5 to below the level of said next lower slab.

22. The method of claim 20 wherein said next lower slab is made below grade at the location of said building structure, further including the step prior to said step of lowering said form assembly, of constructing a barrier
5 against the egress of water into the area at which said next lower structural slab is to be constructed.



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AMENDED CLAIMS

[received by the International Bureau on 09 December 1994 (09.12.94);
original claims 1-4,6,8-22 amended;
remaining claims unchanged (11 pages)]

1. In a method of constructing a plurality of
generally horizontal structural concrete diaphragm slabs
5 for a multi-level building structure, the steps
comprising:

(a) providing a generally vertical frame
structural column network made up of spaced vertical
columns that are substantially free of one another;

10 (b) structurally connecting spaced vertical
columns together by making out of concrete with a deck
form assembly, a first horizontal structural diaphragm
slab providing said connection;

(c) thereafter lowering said deck form assembly
15 from the level defined by said first slab when it is made,
to a position for the formation of the next lower
structural diaphragm slab connecting said spaced vertical
columns together; and

(d) supporting said form for the construction
20 of said next lower diaphragm slab from the level defined
by said first slab.

2. The method of claim 1 wherein said step of
supporting said form assembly for said construction of
said next lower diaphragm slab from said level includes
25 supporting said form from said first slab itself.

3. The method of claim 2 wherein said next lower
diaphragm slab is to be made below the grade of the ground
at the location of said building structure, further
including the step before said steps of lowering and
30 supporting, of excavating the earth to below the level to
be defined by said next lower diaphragm slab.

4. The method of claim 2 wherein said step of
supporting said form assembly from said first slab itself
includes embedding an attachment in said slab to transmit
35 to said first slab, the loads encountered during the



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formation of said next lower diaphragm slab.

5. The method of claim 4 wherein said embedded attachment is threaded interiorly thereof, and said step of lowering said bottom support form assembly includes
5 rotating a threaded rod which is attached to said form assembly and threadably engaged within said embedded attachment.

6. The method of claim 1 wherein said step of supporting said form assembly for said construction of
10 said next lower diaphragm slab from said level includes attaching a structural slab form support arm to said column network at said level.

7. The method of claim 6 further including the step of providing a threaded rod between said level and said
15 position.

8. The method of claim 1 wherein said position is the position for said next lower diaphragm slab in said building structure when such structure is completed.

9. The method of claim 1 wherein a plurality of
20 succeeding structural diaphragm slabs are formed and the steps labeled (b), (c) and (d) are repeated for each pair of vertically adjacent diaphragm slabs.

10. In a method of forming a plurality of generally horizontal structural concrete diaphragm slabs for a
25 multi-level building structure, the steps comprising:

(a) providing a generally vertical column frame network made up of spaced vertical columns that are substantially free of one another;

(b) structurally connecting spaced vertical
30 columns together by constructing out of concrete with multiple deck form assemblies, a first horizontal structural diaphragm slab providing said connection; and





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(c) thereafter supporting said deck form assemblies from the level defined by said first slab for the construction of the next lower structural diaphragm slab.

5 11. The method of claim 10 wherein a plurality of succeeding diaphragm slabs are constructed and the steps labeled (b) and (c) are repeated for each pair of vertically adjacent structural diaphragm slabs.

10 12. The method of claim 10 wherein said step of supporting said form assemblies for said construction of said next lower diaphragm slab from said level includes supporting said form from said first diaphragm slab itself.

15 13. The method of claim 12 wherein said next lower diaphragm slab is to be constructed below the grade level of the ground at the location of said building structure further including the step before said step of supporting, of excavating the ground to below the level to be defined by said next lower diaphragm slab.

20 14. The method of claim 12 wherein said next lower slab is constructed below the grade at the location of said building structure, further including the step prior to said step of supporting said form assemblies, of constructing a barrier against the egress of water into
25 the area at which said next lower diaphragm slab is to be made.

30 15. In a method of constructing a plurality of generally horizontal structural diaphragm concrete slabs for a multi-level building structure, the steps comprising:

(a) providing for said building structure, a generally vertical structural column frame network made up of a plurality of spaced vertical columns;

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(b) connecting spaced vertical columns together by constructing a first one of said structural diaphragm concrete slabs with multiple deck form assemblies;

(c) thereafter lowering said deck form
5 assemblies from said first slab after it has been constructed into position for the construction of the next lower structural diaphragm slab.

16. The method of claim 15 wherein a plurality of succeeding diaphragm slabs are constructed and the steps
10 labeled (b) and (c) are repeated for each pair of vertically adjacent structural diaphragm slabs.

17. The method of claim 15 wherein said step of lowering said form assemblies for said formation of said next lower slab from said level includes supporting said
15 form assemblies for said lowering from said first slab itself.

18. The method of claim 17 wherein said next lower slab is made below grade at the location of said building structure, further including the step prior to said step
20 of lowering said form assemblies, of constructing a barrier against the egress of water into the area at which said next lower structural diaphragm slab is to be formed.

19. The method of claim 17 wherein said next lower diaphragm slab is to be made below grade at the location
25 of said building structure further including the step before said step of supporting, of excavating the earth to below the level of said next lower slab.

20. In a method of making a plurality of generally horizontal structural concrete diaphragm slabs for a
30 multi-level building structure, the steps comprising:

(a) providing for said building structure, a generally vertical structural column frame network made up of spaced vertical columns;





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(b) structurally connecting spaced vertical columns together by constructing a structural concrete diaphragm slab with deck form assemblies;

(c) thereafter lowering said deck form assemblies from the first slab after it is constructed, to a position for the formation of the next lower structural diaphragm slab;

(d) supporting said deck form assemblies for the formation of said next lower slab from said first slab, including supporting an attachment with said first diaphragm slab when it is constructed to transmit to said first slab, the loads expected during the formation of said next lower structural diaphragm slab;

(e) said step of lowering including rotating a threaded rod which is attached to one of said form assemblies and threadably engaged within said embedded attachment; and

(f) repeating the steps labeled (b), (c), (d) and (e) for each pair of vertically adjacent structural concrete slabs to construct a plurality of succeeding structural diaphragm slabs.

21. The method of claim 20 wherein said next lower diaphragm slab is to be made below grade at the location of said building structure, further including the step before said steps of lowering and supporting, of excavating the earth to below the level of said next lower slab.

22. The method of claim 20 wherein said next lower slab is made below grade at the location of said building structure, further including the step prior to said step of lowering said form assemblies, of constructing a barrier against the egress of water into the area at which said next lower structural diaphragm slab is to be constructed.



23. Apparatus for forming a plurality of generally

horizontal structural slab diaphragms for levels of a multi-level building structure, comprising:

(a) a deck formwork assembly for supporting concrete and defining a desired configuration for the bottom of a structural slab of said building structure;

(b) a support for said deck formwork assembly at the level of said building structure immediately above the structural slab to be formed with said deck formwork assembly;

(c) a suspension rod extending between said deck formwork assembly and said support at said level immediately above the slab to be formed; and

(d) said support being an attachment for said rod embedded in the concrete of the structural slab immediately above the structural slab to be formed.

24. The apparatus of claim 23 further including means for removing said attachment from said structural slab.

25. The apparatus of claim 23 wherein the length of suspension rod extending between said formwork assembly and said support at said level immediately above the slab to be formed is selectively changeable.

26. The apparatus of claim 25 wherein said support is threaded interiorly thereof and said suspension rod is provided with threads which mate with and engage the interior threads of said support whereby rotation of said rod relative to said attachment results in the length change.

27. The apparatus of claim 26 wherein said suspension rod has means defining an engagement surface which is rotatable relative to said deck formwork assembly for said rod length change, and a washer is disposed between said engagement surface and said deck formwork assembly, which washer has a generally flat disk which engages said surface during said relative rotation, and



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channels are provided extending radially of said disk face for distributing lubricant along said face during such relative rotation.

28. The apparatus of claim 27 further including a plurality of portions of said rod along the length of said rod adapted for selective engagement of said rod to provide said rotation.

29. The apparatus of claim 23 wherein said support is a slab form support arm attached at said level immediately above said level to be defined, to a generally vertical column of a support network for said slabs so as to impart load from said deck formwork assembly to said column.

30. The apparatus of claim 29 wherein the length of suspension rod extending between said deck formwork assembly and said support at said level immediately above the slab to be formed is selectively changeable.

31. The apparatus of claim 30 wherein said slab form support arm includes a securance portion for rigidly securing the arm to said column, an elongated upper arm rod extending from said securance portion with an end thereof pivotally secured to said securance portion, a forearm rod pivotally secured to and cantilevered from an opposite end of said upper arm portion, and a hand portion extending from said forearm rod adapted to hold an attachment which interacts with said roll threaded rod to provide said support.

32. The apparatus of claim 23 wherein said support is threaded interiorly thereof and said suspension rod is provided with threads which mate with and engage the interior threads of said attachment whereby rotation of said rod relative to said attachment results in changing the length thereof extending between said formwork assembly and said attachment.



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33. The apparatus of claim 32 wherein said rod is rotatable relative to said support to change the length of said rod extending between said formwork assembly and said support, further including a plurality of portions of said rod along the length of said rod adapted for engaging said rod to provide said rotation.

34. The apparatus of claim 23 further including a coupling for connecting said suspension rod to a similar rod extending from the level above said level immediately above the slab to be formed.

35. The apparatus of claim 23 wherein said rod is exteriorly threaded and further including a wheel which engages said rod for rotating said rod relative to said support to change the length of said rod extending between said formwork assembly and said support.

36. A wheel for rotating a roll threaded rod which extends between a formwork assembly for concrete during the formation of a slab of a multi-level building structure and a support for said roll threaded rod, comprising:

(a) a center portion adapted to engage said roll threaded rod in a generally non-rotating manner relative to said roll threaded rod;

(b) a gripping wheel circumscribing said center portion; and

(c) a plurality of spokes connecting said gripping wheel to said center portion so as to transmit turning motion of said gripping wheel to said center portion.

37. The wheel of claim 36 wherein the length of roll threaded rod extending between said formwork assembly and said support is selectively changeable and wherein said roll threaded rod further includes a plurality of places along its length adapted to be engaged by said center portion of said wheel to provide said rotation.

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38. Apparatus for removing an attachment in a slab of a multi-level building structure embedded in said slab during the construction of such building to provide support through a roll threaded rod for a formwork

5 assembly for another slab of such structure, comprising:

(a) a rod for engaging said attachment in a non-slip manner; and

(b) a bearing plate which is engageable both with said slab and said attachment, the length of said rod
10 extending between said bearing plate and said attachment being reducible whereby a pulling force is applied to said attachment when an effort is made to reduce said length while said bearing plate is engaged with said slab.

39. The apparatus of claim 38 wherein said
15 attachment is threaded interiorly thereof and said rod is provided with threads which mate with and engage the interior threads of said attachment whereby rotation of said roll threaded rod relative to said attachment results in said length reduction.

20 40. In an arrangement for forming generally horizontally suspended slabs for a multi-level building structure, apparatus for attaching a roll threaded rod at one level for a formwork assembly for a slab to be formed, comprising:

25 (a) means for securing the same to said roll threaded rod; and

(b) means for supporting said apparatus at said one level.

41. The apparatus of claim 40 wherein said means for
30 securing said apparatus to said roll threaded rod includes a plurality of threads within the interior of said apparatus matingly engageable with associated threads on the exterior of said roll threaded rod.

42. The apparatus of claim 40 wherein said means for
35 supporting said apparatus includes a shoulder which is



adapted to engage a collar at said level.

43. In an arrangement for forming generally horizontally suspended slabs for a multi-level building structure, a washer facilitating relative rotation between
5 a nut and a part comprising a generally flat disk to be placed between said nut and said part, and channels extending radially of a face of said disk for distributing lubricant along said face during such relative rotation.

44. The apparatus of claim 43 wherein each of said
10 channels is a groove in said face.

45. The apparatus of claim 43 wherein said disk has a pair of opposed faces which individually engage said nut and said part, and channels are provided extending
15 radially of both of said faces for distributing lubricant along the same during such relative rotation.

46. The apparatus of claim 45 wherein each of said channels is a groove within its respective face, which grooves are arcuate in nature and all on one face have a circumferential component in one direction which is the
20 opposite of a direction of a circumferential component of the grooves on the opposed face.

47. In an arrangement for forming generally horizontally suspended slabs for a multi-level building structure, an attachment apparatus comprising:

25 (a) a nut portion which includes interior threads to engage a threaded rod; and

(b) an engagement portion for engaging said nut to prevent the same from moving linearly with respect to said rod.

30 48. Apparatus for forming a plurality of generally horizontally suspended structural slab diaphragms for levels of a multi-level building structure comprising:

(a) a deck formwork assembly for supporting concrete

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and defining a desired configuration thereof for the bottom of a structural slab of said building structure;

(b) a support for said deck formwork assembly, positioned at the level of said building structure
5 immediately above the slab to be formed with said deck formwork assembly;

(c) a suspension rod extending between said deck formwork assembly and said support at said level immediately above said slab;

10 (d) said support being an attachment for said rod embedded in the concrete of the slab defining the floor at said level immediately above the slab to be formed; and

(e) said attachment being threaded interiorly thereof and said rod being provided with threads on the
15 exterior thereof which mate with and engage the interior threads of said attachment whereby rotation of said rod relative to said attachment results in a change of the length of rod extending between said deck formwork assembly and said attachment.

20 49. The apparatus of claim 48 further including a plurality of portions of said rod along the length of said rod adapted to be engaged to provide said rotation of said rod, and a wheel which engages said rod at said portions for said rotation.

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