

CONSTRUCTION METHOD OF AN ELEVATED CONCRETE SLAB
USING PRECAST CONCRETE PANELS AND
TEMPORARY ELEVATED SUPPORTING MEANS

Field of the Invention

The present invention relates generally to the field of concrete slab construction and particularly to the field of concrete slab construction using precast concrete panels to ease and accelerate the construction.

Background of the Invention

Two typical techniques are utilized in the prior art for the construction of concrete slab. The first technique may be called "a complete cast-in-place technique" and the second technique may be called "a partial cast-in-place technique". The present invention may be considered as "a new partial cast-in-place technique".

By the complete cast-in-place technique, all works are performed on site starting from, for example, the formulation of concrete slab formworks covering open areas between supporting members, the laying out of concrete slab reinforcing bars and the pouring of wet concrete mixture over the top surfaces of formworks to form a complete concrete slab.

On the other hand, by the partial cast-in-place technique, partial works are performed on site starting from, for example, the installation of precast concrete panels on the top of panel supporting members covering open areas between supporting members, the laying out of concrete slab reinforcing bars and the pouring of wet concrete mixture over the top surfaces of precast concrete

panels to form a complete concrete slab which is a composite of in-situ concrete and precast concrete panels.

Precast concrete panels can be fabricated as required elsewhere prior to the beginning of concrete slab construction at the construction site. These precast concrete panels are designed such that after installed on panel supporting members they can be used as horizontal parts of concrete slab formworks by themselves, without any use of shoring members arising from the ground or the lower floor below them. They are also designed such that after the laying out of concrete slab reinforcing bars and the pouring of wet concrete mixture over them, they can be used as a part of permanent concrete slab being constructed.

Notice that precast concrete panels introduced into the partial cast-in-place technique play an important role in easing and accelerating the construction of concrete slab. With precast concrete panels, the formulation for most parts of concrete slab formworks, which has to deal with the installation of shoring members on the ground or on the lower floor, is not necessary. Thus, most difficulties of concrete slab construction due to inability properties of ground or of lower floor to support shoring members adequately are eliminated and the construction is made to become a lot easier and, of course, a lot faster. In addition, some necessary works on ground or on lower floor may be performed simultaneously, without any obstruction of shoring members during the construction and curing periods of concrete slab on the upper floor, results in the acceleration of the construction as a whole drastically.

However, the construction method for an elevated concrete slab using precast concrete panels in the prior art still has some disadvantages in itself. These disadvantages result from the necessity of having at least a number of supporting members for precast concrete panels to be placed on, to avoid the direct support of precast concrete panels by a large number of shoring members. In the prior art, these panel supporting members may be a number of reinforced concrete beams constructed on top of supporting piles or supporting columns, or may be other adequate types of permanent supporting members. These permanent supporting members are constructed before the installation of precast concrete panels at the construction site. To construct permanent supporting members, the formulation of elevated concrete formworks, supported by supporting shoring members installed on ground or on lower floor, must be performed between the supporting piles or the supporting columns.

Hence, all difficulties due to inability properties of ground or of lower floor to support shoring members adequately cannot be avoided in this case. In addition, a relatively long period of time must be allowed for the construction of these permanent supporting members before the installation of precast concrete panels can be performed.

Summary of the Invention

It is an object of the present invention to provide a method for the construction of an elevated reinforced concrete slab such that the construction of permanent structures of an elevated reinforced concrete slab on the

supporting vertical members at the construction site can be performed completely above ground or above lower floor without any use of shoring members.

It is another object of the present invention to provide a method for the construction of an elevated reinforced concrete slab which is easier, faster, better quality and also less expensive than any existing conventional method.

It is yet another object of the present invention to provide a method for the construction of an elevated reinforced concrete slab which is applicable where the existing conventional methods are not applicable effectively, efficiently and economically.

According to the present invention, the method provided for the construction of an elevated reinforced concrete slab comprises the steps of installing supporting vertical members on ground or on lower floor; installing temporary elevated supporting means with access hole forming sets around the heads of supporting vertical members; installing precast reinforced concrete panels on temporary elevated supporting means with a predetermined width of spacing gaps; installing spacing gap formworks to close the spacing gaps directly at the outer perimeters of temporary elevated supporting means and at the bottom surfaces of precast reinforced concrete panels, as well as installing side formworks directly at the open sides of precast reinforced concrete panels; laying out concrete reinforcing bars around the heads of supporting vertical members, along the spacing gaps between precast reinforced concrete panels, throughout the upper surface surrounded by the side formworks and on the areas in the vicinities of

supporting vertical member heads; pouring of concrete slab mixture over the laid out reinforcing bars; removing all removable components, including temporary elevated supporting means, after the reinforced concrete slab has gained enough strength and finishing the surface of reinforced concrete slab.

The supporting vertical members according to the present invention can be a number of reinforced concrete piles which are vertically driven or fabricated deep down into the ground or can be a number of reinforced concrete columns which are constructed or installed on top of reinforced concrete piles or on top of lower reinforced concrete columns. The shapes, the sizes and the positions of these supporting vertical members are chosen and designed in corresponding to other members involving in the construction method of the present invention.

The temporary elevated supporting means with access hole forming sets utilized in this invention are provided by the present invention. These temporary elevated supporting means with access hole forming sets are designed in a manner that they are easy to be installed around the heads of supporting vertical members and all removable components are easy to be removed and also are reusable. Their structures are designed to be strong enough to support precast reinforced concrete panels and other temporary loads which occur during the construction of concrete slab. Their shapes and sizes as well as other included facilities are chosen and designed in corresponding to other members involving in the construction method of the present invention. In addition, the included access hole forming sets are designed to form

access holes from top surface of concrete slab to bottom surface of this temporary elevated supporting means such that the lowering of temporary elevated supporting means during the removal process can be performed conveniently from the top surface of concrete slab.

The precast reinforced concrete panels utilized in this invention are provided by the present invention, these precast reinforced concrete panels are designed such that they can be utilized as most part of concrete slab formworks without any use of shoring members arising from the ground or the lower floor, and also as parts of permanent structures of an elevated reinforced concrete slab being constructed. Their shapes and sizes as well as other included facilities are chosen and designed in corresponding to other members involving in the construction method of the present invention.

The spacing gap formworks utilized in this invention are provided by the present invention. These spacing gap formworks are designed in a manner that they are easy to be installed directly at the outer perimeters of temporary elevated supporting means and at the bottom surfaces of precast reinforced concrete panels, to close spacing gaps between precast reinforced concrete panels and between temporary elevated supporting means, without any use of shoring members arising from the ground or the lower floor. Their shapes and sizes as well as other included facilities are chosen and designed in corresponding to other members involving in the construction method of the present invention. In addition, they are designed to be removed conveniently and to be reusable.

The structural designs of reinforcing bars utilized in this invention are also provided by the present invention. These structural designs are given in a manner that, incorporating with structural designs of reinforcing bars of precast reinforced concrete panels and of supporting vertical members, all loads applied on the elevated concrete slab can be transferred onto supporting vertical members effectively and, in addition, the supporting vertical members are held in place firmly to be able to support all transferred loads effectively as well. These structural designs comprise the head cover reinforcing bars installing around supporting vertical members heads, the beam like reinforcing bars installing along spacing gaps between precast reinforced concrete panels and crossing over the top of supporting vertical members, the plane like reinforcing bars installing throughout the upper surface surrounded by the side formworks, and the cap like reinforcing bars installing over the top areas in the vicinities of supporting vertical member heads.

The method for the construction of an elevated reinforced concrete slab provided by the present invention as described above has at least three remarkable useful characteristics, among other useful characteristics, as follows:

The first characteristic is to support temporary loads on supporting vertical members. Temporary loads which occur during concrete slab construction are supported on vertical supporting members with temporary elevated supporting means, instead of on ground or on lower floor with shoring members.

The second characteristic is to place precast reinforced concrete panels on the temporary elevated supporting means. Precast reinforced concrete panels which are utilized as most parts of concrete slab formworks and as parts of permanent structures of concrete slab are placed on temporary elevated supporting means immediately following the installation of the temporary elevated supporting means on the vertical supporting members, instead of waiting for a relatively long period of time to be placed on permanent supporting members being constructed on the supporting vertical members.

The third characteristic is to install spacing gap formworks directly to the temporary elevated supporting means and the precast reinforced concrete panels. Spacing gap formworks which are utilized to close the spacing gaps between precast reinforced concrete panels and between temporary elevated supporting means are installed directly to the temporary elevated supporting means and the precast reinforced concrete panels instead of being supported by shoring members arising from the ground or the lower floor.

Thereby after the step of setting vertical supporting members on ground or on lower floor, the construction of permanent structures of an elevated reinforced concrete slab on the vertical supporting members at the construction site can be performed completely above ground or above lower floor without any use of shoring members. This results in the construction method for an elevated reinforced concrete slab which is easier, faster, better quality and also less expensive than any existing conventional method.

In addition, since the present invention allows for most works to be carried out above ground, including the lowering of temporary elevated supporting means from the top surface of concrete slab, thus the workability of important works is not effected by ground or by lower floor conditions after the installation of supporting vertical members. This excellent advantage makes it possible for the present invention to be applicable where the existing conventional methods are not applicable effectively, efficiently and economically.

An example, where the construction method of the present invention can be applied effectively, efficiently and economically is the construction of an elevated reinforced concrete slab covering the area with soft topping surface such as mud or water.

Brief Description of the Drawings

The present invention will become more fully understood from the detailed description given herein below and the accompanying drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention, and wherein;

Fig. 1 illustrates supporting vertical members set on the ground according to an embodiment of the present invention.

Fig. 2 illustrates a temporary elevated supporting means with an access hole forming set according to an embodiment of the present invention.

Fig. 3 is a perspective view of a precast reinforced concrete panel according to an embodiment of the present invention.

Fig. 4 illustrates a bottom plan view and a side view of a spacing gap formwork according to an embodiment of the present invention.

Fig. 5 is a cross sectional side view of supporting piles driven into the ground and cut off to a desired level according to an embodiment of the present invention.

Fig. 6 is a cross sectional side view of temporary elevated supporting means of Fig. 2 installed around supporting pile heads according to an embodiment of the present invention.

Fig. 7 is a cross sectional side view of precast reinforced concrete panels of Fig. 3 placed on temporary elevated supporting means according to an embodiment of the present invention.

Fig. 8 is a plan view of Fig. 7 illustrating spacing gaps between precast reinforced concrete panels according to an embodiment of the present invention.

Fig. 9 is a plan view illustrating spacing gap formworks of Fig. 4 installed to close spacing gaps between precast reinforced concrete panels and between temporary elevated supporting means according to an embodiment of the present invention.

Fig. 10 is a cross sectional side view illustrating head cover reinforcing bars installed inside hollow cores and covering around the top of supporting pile heads according to an embodiment of the present invention.

Fig. 11 is a cross sectional side view illustrating reinforcing bars installed along spacing gaps, throughout

top surfaces of precast reinforced concrete panels, and over supporting pile heads according to an embodiment of the present invention.

Fig. 12 is a plan view of Fig. 11 illustrating reinforcing bars installed as a beam like along spacing gaps, as a plane like throughout top surfaces of precast reinforced concrete panels, and as a cap like over supporting pile heads according to an embodiment of the present invention.

Fig. 13 is a cross sectional side view illustrating access hole forming sets of Fig. 2 installed over hanging frame of temporary elevated supporting means according to an embodiment of the present invention.

Fig. 14 is a cross sectional side view illustrating wet concrete mixture poured above reinforcing bars but lower than top ends of access hole forming sets to form an in-situ concrete according to an embodiment of the present invention.

Fig. 15 is a cross sectional side view illustrating access holes formed through an in-situ concrete after the removal of removable components of access hole forming sets according to an embodiment of the present invention.

Fig. 16 is a cross sectional side view illustrating the piles supported elevated concrete slab obtained after the removal of temporary elevated supporting means through the access holes according to an embodiment of the present invention.

Description of the preferred embodiments

Preferred embodiments of the present invention will be explained below with reference to the accompanying drawings.

Fig. 1 illustrates supporting piles 1 which are chosen to be supporting vertical members. These supporting piles are the annular cross sectional shape reinforced concrete piles with inner diameter 2 and outer diameter 3, driven vertically into the ground 4 and cut off or set at a given horizontal level above ground 5.

Fig. 2 illustrates a temporary elevated supporting means 6 with an access hole forming set 7 to be used with the supporting pile 1. This temporary elevated supporting means 6 comprises a removable supporting collar 8 installed tightly at a given position around the supporting pile 1, a removable supporting bracket 9 fitting around the supporting pile 1 and sitting on the removable supporting collar 8 and a bracket hanging set 10 hanging on top of supporting pile 1 and holding the bottom of removable supporting collar 8. In addition, Fig. 2 also illustrated an access hole forming set 7 standing on top of the bracket hanging set 10.

The removable supporting collar 8 comprises two semi-annular cross sectional pieces incorporating to be an annular cross sectional shape collar 8 by means of bolts and nuts 11 with an inner diameter is approximately the same as of the outer diameter 3 of the supporting pile 1 with an appropriate width such that, incorporating with a friction rubber band 12 sandwiching in between inner surface of the removable supporting collar 8 and the outer surface of the supporting pile 1, this removable supporting

collar 8 can be installed tightly around the supporting pile 1 and can support the removable support bracket 9 with an appropriate safety factor. In addition, this removable supporting collar 8 includes four collar access holes 13 for the bracket hanging set 7 to be installed through them.

Referring to Fig. 2, the removable supporting bracket 9 comprises two semi-annular cross sectional pieces 14, 15 incorporating to be an annular cross section shape bracket 9 by means of bolts and nuts 16 with an inner diameter 17 is slightly larger than the outer diameter 3 of the supporting pile 1 to fit around the supporting pile 1 comfortably, with a higher shoulder 18 with an outer diameter 19 is large enough to place on precast reinforced concrete panels 20 appropriately, with a number of supporting holes 21 around its outer perimeter 22 to support spacing gap formworks, with a lower annular shape shoulder 23 around its inner perimeter 24 for being set lower than the top of supporting pile head 25 in order to form a part of an in-situ concrete 26 around the head of the supporting pile 1 to keep the supporting pile head firmly in place after the completion of concrete slab construction. In addition, this removable supporting bracket 9 includes four bracket access holes 27 through which the bracket hanging set 10 are installed.

The bracket hanging set 10, illustrated in Fig. 2, comprises a hanging frame 28 with four hanging nuts 29 and four removable hanging bolts 30. The hanging frame 28 is placed over and covering around the top of the supporting pile head 25. The four removable hanging bolts 30 are bolted into the four hanging nuts 29, from bottom of the supporting collar 8 through the four collar access holes 13

and the four bracket access holes 27, to hold the supporting bracket 9 in place and hang both removable supporting collar 8 and removable supporting bracket 9 on top of supporting pile 1 such that all temporary loads which occur during the construction are to be supported on top of supporting pile 1.

The access hole forming set 7, also illustrated in Fig. 2, comprises four concrete access hole forming sheath pipes 31 and a removable set of four inserting bars 32 with four handle bars 33. This access hole forming set 7 is installed on top of the bracket hanging set 10 by fitting the four concrete access hole forming sheath pipes 31 vertically around the end of the four removable hanging bolts 30 and standing on the four hanging nuts 29 and then inserting a removable set of four inserting bars 32 with four handle bars 33 into the four concrete access hole forming sheath pipes 31.

Notice that the four hanging nuts 29 with the four removable hanging bolts 30 of the bracket hanging set 10 and the four concrete access hole forming sheath pipes 31 with the removable set of four inserting bars 32 with four handle bars 33 of the access hole forming set 7 are formed along the same vertical line. If the height 35 of the four concrete access hole forming sheath pipes 31 is set higher than the top surface 34 of an in-situ concrete 26, then upon the removal of the four removable hanging bolt 30 and the removal of the removable set of four inserting bars 32 with four handle bar 33, four complete access holes 36 are formed from the top surface 34 of an in-situ concrete 26 to the bottom surface 37 of the removable supporting collar 8. These four complete access holes 36 are formed through the

four concrete access hole sheath pipes 31, the hanging frame 10 with the four hanging nuts 29 which are left inside an in-situ concrete 26, after the removal of the four hanging bolts 30, the four bracket access holes 27, and the four collar access hole 13. Thus, the removable supporting bracket 9 can be lowered conveniently from the top surface 34 of the in-situ concrete 26 through the four complete access holes 36 after the in-situ concrete 26 has gained enough strength.

Fig. 2 also illustrates the positions of precast reinforced concrete panels 20 placed on top of the temporary elevated supporting means 6. The precast reinforced concrete panels 20 with the cut off corners 38 are placed on the higher shoulder 18, in a manner that the width of spacing gaps 39 between the two adjacent precast reinforced concrete panels 20 is substantially the same as of the outer diameter 3 of the supporting pile 1, and the cut off corners 38 are limited approximately at the inner perimeter 40 of the higher shoulder 18 of the removable supporting bracket 9, to provide the spaces for the head cover reinforcing bars to be placed inside.

Fig.3 is a perspective view of the precast reinforced concrete panel 20 rectangular in shape with the cut off corners 38 being used in this embodiment. By the present invention, the cross over widened-U-shape reinforcing bars 51 are embeded inside the precast reinforced concrete panel 20 and let their two ends protrude horizontally out of the two opposite sides 52,52 of the precast reinforced concrete panel 20 as the protruding L-shape reinforcing bars 53,53 by a length of approximately the same as of the width of spacing gaps 39 of Fig.2 or substantially the same as of

the outer diameter 3 of the supporting pile 1 of Fig.1. After the installation of the precast reinforced concrete panels 20 on the removable supporting brackets 9 with the width of the spacing gaps 39, two overlapping protruding L-shape reinforcing bars 53, 53 of two adjacent precast reinforced concrete panels 20 form spacing gap U-shape reinforcing bars in between the spacing gaps. The beam like reinforcing bars will later be installed conveniently within the spacing gap U-shape reinforcing bars.

Also by the present invention, the inverted-U-shape reinforcing bars 54 in Fig. 3 are embedded inside the precast reinforced concrete panel 20 and let their top ends arise vertically above the upper surface 55 of the precast reinforced concrete panel 20 as the protruding inverted-U-shape reinforcing bars 56 by a predetermined height. The plane-like and the cap-like reinforcing bars will later be placed conveniently over the protruding inverted-U-shape reinforcing bars 56.

In addition, Fig.3 illustrates eight formwork anchored bars with nuts 57 anchored into the precast reinforced concrete panel 20 on the bottom sides at the given positions near the sides 52, 52 of the precast reinforced concrete panel 20. The spacing gap formworks will later be installed conveniently to the anchored bars with nuts 57, to close the spacing gap between the precast reinforced concrete panels 20 and between the outer perimeters 22 of the removable brackets 9 of Fig.2.

Fig.4 illustrates a set of spacing gap formwork being used in this embodiment. A set of spacing gap formwork 60 comprises two pieces of bracket side fitting formworks 61,61' with a number of fitting bars 66, one piece of

central area closing formwork 62, and two pieces of supporting pipes 63 each with two adjustable plates 64 and two bolts 65. Each one of the two bracket side fitting formworks 61,61' includes a formwork 61 with a number of fitting bars 66, for fitting into the supporting holes 21 at the outer perimeter 22 of the removable supporting bracket 9 and an integrated plate 61' for attaching along bottom sides of the precast reinforced concrete panels 20 and being supported underneath by the central area closing formwork 62.

The central area closing formwork 62 has the width less than the distance between two opposite formwork anchored bars with nuts 57 of two adjacent precast reinforced concrete panels 20 but wide enough to overlap with the bottom sides of the precast reinforced concrete panels 20, and also has the length long enough to overlap and to support the bottom sides of the two integrated thin plates 61' of the two bracket side fitting formworks 61,61'. Each one of the two supporting pipes 63 has the length long enough to support the central area closing formwork 62 on bottom sides of the two adjacent precast reinforced panels 20 forming the spacing gap through its adjustable plates 64. Each one of the adjustable plates 64 of the supporting pipe 63 has a through hole for the bolt 65 to be bolted into the formwork anchored bar with nut 57 which anchored into the precast reinforced concrete panel 20 on the bottom sides at the given position near the sides 52,52. The two adjustable plates 64 are movable such that they can be adjusted to bolt the two bolts 65 into the formwork anchored bars with nuts 57 of the precast reinforced concrete 20 conveniently.

The installation procedure of the spacing gap formwork 60 comprises the step of installing first the bracket side fitting formworks 61,61', and then the step of installing the central area closing formwork 62 with the two ends support underneath the two integrated plates 61' of the bracket side fitting formworks 61,61' simultaneously with the step of installing the two supporting pipes 63 underneath the central area closing formwork 62 by bolting the two bolts 65 into the anchored bars with nuts 57 of the precast reinforced concrete panels 20.

Fig.5 to Fig.16 illustrate typical steps for the construction method of elevated reinforced concrete slab using precast reinforced concrete panels and temporary supporting brackets, according to an embodiment of the present invention;

Fig.5 illustrates the beginning step of the construction. In this figure, the supporting piles 1 with the inner diameter 2 and the outer diameter 3 are shown to be driven deep down into the ground at the given positions 71,72,73, and are cut at the given pile cut off level 5 above the ground. The installation procedure for the supporting piles 1 is the same as of a conventional procedure.

Fig.6 illustrates the second step of the construction. In this figure, the temporary elevated supporting means 6 provided by an embodiment of the present invention, as shown in Fig.2, are shown to be installed around the top of the supporting piles 1, in a manner that the level of the top surface 74 of the removable supporting brackets 9 is substantially the same as the pile cut off level 5. The installation procedure for the temporary elevated

supporting means 6 begins with the installation of the removable supporting collars 8 followed by the installation of the removable supporting brackets 9 and then the installation of the bracket hanging set 10.

Fig.7 and Fig.8 illustrate the third step of the construction. In this figure, the precast reinforced concrete panels 20 provided by an embodiment of the present invention, as shown in Fig.3, are shown to be installed on the top surface 74 of the removable supporting brackets 9, in a manner that the width 39 of the spacing gaps 82 between the two adjacent precast reinforced concrete panels 20 is substantially the same as of the outer diameter 3 of the supporting piles 1, and the cut off corners 38 are limited approximately at the inner perimeters 40 of the higher shoulder 18 of the removable supporting brackets 9 as explained in the description of Fig.2.

Notice that after the installation, two protruding L-shape reinforcing bars 53,53 of two adjacent precast reinforced concrete panels 20 form spacing gap U-shape reinforcing bars 81 in between the spacing gaps 82 of two adjacent reinforced concrete panels 20 as explained in the description of Fig.3.

Fig.9 illustrates the possible fourth step of the construction. In this figure, the spacing gap formworks 60 provided by an embodiment of the present invention, as shown in Fig.4, are shown to be installed along the outer perimeter 22 and along the sides at the bottom surfaces of the precast reinforced concrete panels 20, to close the spacing gaps 82 between two adjacent precast reinforced concrete panels 20 and between the outer perimeters 22 of two adjacent removable supporting brackets 9. The

installation procedure of the spacing gap formworks 60 has been explained in detail in the description of Fig.4. Notice that the installation of the spacing gap formworks 60 can be performed at any convenient step of the construction, after the installation of the precast reinforced concrete panels, before the step of pouring concrete mixture on the reinforcing structures of the concrete slab.

Fig.10 illustrates the possible fifth step of the construction. In this figure, the head cover reinforcing bars 86 provided by an embodiment of the present invention, are shown to be installed inside hollow cores 87 and covering around the top of pile heads 1. A circular plate 88 is attached at the bottom part of the cylindrical structure 89 of each one of the head cover reinforcing bars 86, plugged inside the hollow core, to limit the quantity of concrete mixture inside the hollow core 87 of the supporting pile 1 at the bottom of the cylindrical structure 89 of the head cover reinforcing bar.

Fig.11 and Fig.12 illustrate the possible sixth step of the construction. In this figure, the beam like reinforcing bars 91, the plane like reinforcing bars 92 and the cap like reinforcing bars 93 provided by an embodiment of the present invention, are shown to be installed along the spacing gaps 82 between the precast reinforced concrete panels 20, throughout an elevated plane and on the area over the top of supporting pile heads 25, respectively. The beam like reinforcing bars 91 are placed within the spacing gap U-shape reinforcing bars 81 and cross over the top of supporting pile heads 25. The plane like reinforcing bars 92 are placed over the protruding inverted-U-shape

reinforcing bars 56 of the precast reinforced concrete panels 20. In addition, the cap like reinforcing bars 93 are placed by adding more reinforcing bars to the plane like reinforcing bars 92 on the area over the top of supporting pile heads 25 to ensure the transferring of all loads onto the top of supporting pile head 25.

Fig.13 illustrates the possible seventh step of the construction. In this figure, the access hole forming sets 7 are shown to be installed on top of the bracket hanging set 10 of the temporary elevated supporting means 6. The installation is made by fitting the four concrete access hole forming sheath pipes 31 vertically around the end of the four removable hanging bolts 30 and standing on the four hanging nuts 29 of the bracket hanging set 10 of the temporary elevated supporting means 6 and then inserting a removable set of four inserting bars 32 with four handle bars 33 into the four concrete access hole forming sheath pipes 31, as explained in the description for the access hole forming set 7 in Fig.2. The installation of the access hole forming set 7 can be also performed at any convenient step of construction after the installation of the elevated temporary elevated supporting means 6, before the step of pouring concrete mixture on the reinforcing structures of the concrete slab.

Fig. 14 illustrates the possible sixth step of the construction. In this figure, the concrete mixture of an in-situ concrete 101 is shown to be poured on the reinforcing structures 102 of the concrete slab. The top level 103 of the concrete mixture of an in-situ concrete 101 is kept at a predetermined level which is lower than the top ends 104 of the concrete access hole forming sheath

pipes 31, in order that the access hole through an in-situ concrete 101 can be obtained after the removal of the removable set of four inserting bars 32 with four handle bars 33 and also the removal of the removable hanging bolts 30.

Fig.15 illustrates the possible seventh step of the construction. In this figure, the removable set of four inserting bars 32 with four handle bars 33 and also the removable hanging bolts 30 of Fig.14 are shown to be removed out of their places, and the access holes 106 from the top surface 107 of the in-situ concrete 101 to the bottom surface 108 of the removable supporting collar 8 are formulated. The lowering of the removable supporting brackets 6 can be performed conveniently from the top surface 107 of the in-situ concrete through the access hole 106.

Fig. 16 illustrates the complete elevated reinforced concrete slab supported by the supporting piles 1. After all removable components including the temporary elevated supporting means have been removed, all protruding concrete access hole sheath pipes have been removed or cut off and all access holes have been grouted with an appropriate material. The precast reinforced concrete panels 20 become most of the bottom parts of the concrete slab structures. The supporting pile heads 25 are kept in place firmly by the bottom part 26 of the in-situ concrete 101.

According to the description of the preferred embodiment explained above, it is evidently clear that the construction of permanent structures of the elevated reinforced concrete slab on the supporting vertical members at the construction site can be performed completely above

ground or above lower floor without any use of shoring members, as the first aspect of the present invention.

The utilization of the temporary elevated supporting means with access hole forming sets, the precast reinforced concrete panels and the spacing gap formworks, which are provided by the present invention, allow most of the construction works to be performed conveniently and also independently from the ground conditions or the lower floor conditions results in the construction method which is clearly seen to be easier, faster, better quality and also less expensive than any conventional method, as the second aspect of the present invention.

In addition, the description of the preferred embodiment has demonstrated clearly that after the installation of the supporting piles, all construction works related to the permanent structures of the elevated reinforced concrete slab including the lowering of the temporary elevated supporting means are allowed to be carried out above ground or above lower floor. This makes it possible for the construction method of the present invention to be effective, efficient and economical, for example the construction of an elevated reinforced concrete slab over a very soft topping surface area which has its border adjacent to a hard topping surface area, where as the conventional method cannot be applied effectively, efficiently and economically.

Many different embodiment of the present invention may be constructed without departing from the spirit and scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in this specification. To the

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contrary, the present invention is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the claims. The following claims are to be accorded the broadest interpretation, so as to encompass all such modifications and equivalent structures and functions.

Claims

1. A construction method for an elevated reinforced concrete slab including the steps of

- installing supporting vertical members on the ground or lower floor,
- installing temporary elevated supporting means around the heads of said supporting vertical members,
- installing precast reinforced concrete panels on said temporary elevated supporting means with the predetermined spacing gaps,
- installing spacing gap formworks to close the spacing gaps between said temporary elevated supporting means and between said precast reinforced concrete panels, directly at the outer perimeters of said temporary elevated supporting means and at the bottom surfaces of said precast reinforced concrete panels, as well as installing side formworks directly at the open sides of said precast reinforced concrete panels,
- laying out concrete reinforcing bars around the heads of said supporting vertical members, along said predetermined spacing gaps between said precast reinforced concrete panels, throughout the upper surface surrounded by said side formworks, and on the areas above the heads of said supporting vertical members,
- pouring concrete over said concrete reinforcing bars to form reinforced concrete slab, and
- removing all removable components, including said temporary elevated supporting means, after said reinforced concrete slab has cured or attained adequate strength;

characterized in that

said supporting vertical members are installed permanently at the corner positions of said precast

reinforced concrete panels such that the adjacent corners of said precast reinforced concrete panels can be placed on said temporary elevated supporting means with said predetermined spacing gaps, and

said precast reinforced concrete panels include protruding bars such that incorporating with said concrete reinforcing bars said precast reinforced concrete panels can be utilized as parts of permanent structure of said elevated reinforced concrete slab, and said permanent structure of said elevated reinforced concrete slab can transfer all loads directly onto said supporting vertical members without using any additional supporting beams, after the removal of said temporary elevated supporting means.

2. A construction method for an elevated reinforced concrete slab according to claim 1 including further the step of

installing access hole forming sets on said temporary elevated supporting means to form access holes through said reinforced concrete slab;

characterized in that

said access hole forming sets incorporating with said temporary elevated supporting means can form access holes from the top surface of said reinforced concrete slab to the bottom surfaces of said temporary elevated supporting means, and

lowering of said temporary elevated supporting means during the removal process can be performed conveniently from the top surface of said reinforced concrete slab through said access holes.

3. A construction method for an elevated reinforced concrete slab according to claim 2 wherein each one of said supporting vertical members is a

supporting pile with an annular cross sectional shape being driven vertically into the ground and being cut off or being set at a given horizontal level above the ground.

4. A construction method for an elevated reinforced concrete slab according to claim 3 wherein each one of said temporary elevated supporting means includes

a removable supporting collar with collar access holes installed at a given position around the head of said supporting pile,

a removable supporting bracket with bracket access holes fitting around the head of said supporting pile and sitting on top of said removable supporting collar, and

a bracket hanging set hanging on top of said supporting pile and holding said removable supporting collar and said removable supporting bracket through said collar access holes and said bracket access holes.

5. A construction method for an elevated reinforced concrete slab according to claim 4 wherein said removable supporting collar comprises of two semi-annular cross sectional pieces incorporating to be an annular cross sectional shape collar by means of bolts and nuts with a number of collar access holes, with an inner diameter of substantially the same as of the outer diameter of said supporting pile, and with an appropriate width such that, incorporating with said friction rubber band sandwiching in between the inner surface of said removable supporting collar and the outer surface of said supporting pile, said removable supporting collar can be installed tightly around said

supporting pile to support said removable supporting bracket with an appropriate safety factor.

6. A construction method for an elevated reinforced concrete slab according to claim 5 wherein said removable supporting bracket comprises of two semi-annular cross sectional pieces incorporating to be an annular cross sectional shape bracket by means of bolts and nuts with a number of bracket access holes corresponding to a number of collar access holes and with an inner diameter is slightly larger than the outer diameter of said supporting pile to fit around said supporting pile comfortably, with an outer diameter is large enough for said precast reinforced concrete panels to be placed on appropriately, with a number of supporting holes around its outer perimeter to support said spacing gap formworks, with a lower annular shape shoulder around its inner perimeter where said bracket access holes are located and to be set lower than the top of said supporting pile in order to form a part of said reinforced concrete slab around the head of said supporting pile to keep said supporting pile firmly in place.

7. A construction method for an elevated reinforced concrete slab according to claim 6 wherein said bracket hanging set comprises of a hanging frame with a number of hanging nuts and a number of removable hanging bolts both corresponding to a number of said bracket access holes, where said hanging frame is placed over and covering around the top of said supporting pile and said removable hanging bolts are bolted into said hanging nuts from the bottom of said supporting collar through said collar access holes and said bracket access holes to hold said removable supporting bracket in place

and hang said removable supporting collar and said removable supporting bracket on top of said supporting pile such that temporary and permanent loads which occur during the construction are to be supported on top of said supporting pile.

8. A construction method for an elevated reinforced concrete slab according to anyone of claim 1 to claim 7 wherein each one of said precast reinforced concrete panels is triangular or parallelogram in shape with cut off corners, comprising

a number of protruding inverted U-shape reinforcing bars arising from the top surface of each one of said precast reinforced concrete panels,

a number of protruding L-shape reinforcing bars projecting out along the sides of each one of said precast reinforced concrete panels, and

a number of anchored bars with nuts on the bottom surface near the sides of each one of said precast reinforced concrete panels.

9. A construction method for an elevated reinforced concrete slab according to claim 8 wherein each one of said spacing gap formworks comprises at least

two identical pieces of bracket side fitting formworks each one with a number of fitting bars for fitting into said supporting holes around the outer perimeter of said removable supporting bracket to close each bracket side area of said spacing gaps,

one piece of central area closing formwork for closing the remaining area of each one of said spacing gaps, and

two pieces of supporting pipes with bolts to support said central area closing plate as well as said

bracket side fitting formworks by means of tightening said bolts into said anchored bars with nuts on the bottom surfaces near the sides of said precast reinforced concrete panels.

10. A construction method for an elevated reinforced concrete slab according to claim 8 or claim 9 wherein said concrete reinforcing bars comprise

a number of cage like reinforcing bars each one with a circular plate at the bottom end plugging inside the hollow core and covering around the head of said supporting pile within said lower annular shape shoulder of said removable supporting bracket to limit the quantity of said concrete inside said hollow core and to keep the head of said supporting pile firmly in place,

a number of reinforcing bars placed over said protruding L-shape reinforcing bars of said precast reinforced concrete panels along said predetermined spacing gaps between said precast reinforced concrete panels and across the heads of a plurality of said supporting piles to form the beam like structure along the straight lines connecting the heads of a plurality of said supporting piles,

a number of reinforcing bars placed over said protruding inverted U-shape reinforcing bars of said precast reinforced concrete panels throughout the plane of composite formworks covering a plurality of said removable supporting brackets, said precast reinforced concrete panels and said spacing gap formworks, to form the plane like structure on said plane of composite formworks, and

a number of additional reinforcing bars added to said plane like structure to form the cap like structure

on the areas over the heads of a plurality of said supporting piles.

11. A construction method for an elevated reinforced concrete slab according to anyone of claim 7 to claim 10 wherein each one of said access hole forming sets comprises

a number of concrete access hole forming sheath pipes corresponding to a number of said removable hanging bolts fitting vertically around the emerging ends of said removable hanging bolts and standing on said hanging nuts with the top ends set higher than the predetermined level of said reinforced concrete slab, and

a number of removable inserting bars corresponding to a number of said concrete access hole forming sheath pipes inserted into said concrete access hole forming sheath pipes.

12. A construction method for an elevated reinforced concrete slab according to claim 11 wherein the pouring of said concrete to form reinforced concrete slab over said concrete reinforcing bars installed on said plane of composite formworks is made up to the predetermined level of said reinforced concrete slab which is lower than the top ends of said concrete access hole forming sheath pipes of said access hole forming sets.

13. A construction method for an elevated reinforced concrete slab according to claim 12 wherein said removable hanging bolts of said bracket hanging sets and said removable inserting bars of said access hole forming sets are removed to form access holes through said concrete access hole forming sheath pipes,

through said bracket access holes and also through said collar access holes.

14. A construction method for an elevated reinforced concrete slab according to claim 13 wherein a plurality of said removable supporting brackets can be lowered by means of removing tools from the top surface of said reinforced concrete slab after its curing period through said access holes.

15. The temporary elevated supporting means as being used in the construction method for an elevated reinforced concrete slab according to anyone of claim 4 to claim 7.

16. The precast reinforced concrete panels as being used in the construction method for an elevated reinforced concrete slab according to claim 8.

17. The spacing gap formworks as being used in the construction method for an elevated reinforced concrete slab according to claim 9.

18. The concrete reinforcing bars as being used in the construction method for an elevated reinforced concrete slab according to claim 10.

19. The access hole forming sets as being used in the construction method for an elevated reinforced concrete slab according to claim 11.