



G00002

- 1 -

IMPROVED PRE-STRESSED CONCRETE FORMATION

Field of the Invention

The invention relates to pre-cast pre-stressed concrete members used in the construction industry, and in particular relates to the methods and apparatus used in the formation of said concrete members.

Background of the Invention

The use of pre-stressed concrete members is a widespread industry practice, in that it uses the inherent properties of concrete in a most efficient manner. Concrete has a particularly high compressive strength but a relatively low tensile strength, and hence by applying a compressive load to a concrete member prior to the application of in-service loads, if said compressive load is greater than the tensile forces the concrete member will be subjected to, then the net result will be a concrete member totally in compression, and thus the concrete member may be designed in an optimal fashion.

One application of a pre-stressed concrete member is the use of pre-cast concrete planks used for floor slabs and the like. A concrete plank may be defined for this application to have a significant width as compared to its length.

In the formation of the concrete planks, typically they are cast on flat horizontal beds in batches and specifically in rows whereby several such planks are formed in series and share pairs of complementary reaction blocks. Thus, the operation will follow a procedure of stringing a plurality of pre-stressing cables between two reaction blocks and placing several sets of plank formwork along this line so as to incorporate the pre-stressing cables within the formwork. Concrete is then poured into the formwork and permitted to cure so as to bond with the pre-stressed cables. On curing, the cables are cut both at the reaction blocks and between each of the individual sets of formwork, which are subsequently stripped away from the freshly cured concrete planks.

In order to best use the capital equipment required for casting pre-stressed concrete planks in the most efficient manner available, it is common to have the reaction blocks spaced by 120 to 150 metres, and therefore be able place a large number of discrete planks between the reaction blocks. The difficulty in this manner of production is the required space to place such beds. Because of the



166166

- 2 -

width of the planks just the floor plan of the formwork alone will need to be up to 600 square metres. Add to this the required area in order to move, install and store formwork pre-stressing cable as well as to deliver the concrete to the formwork, the required floor area is extremely large for the conventional method of forming the pre-stressed concrete planks.

Statement of Invention

It is therefore an object of the invention to maintain the efficiencies of large scale concrete plank production whilst minimising the floor space required.

Hence, the present invention provides a pre-stressed moulding system including a plurality of battery moulds forming a line such that longitudinal axis of the battery moulds are co-linear, and each battery mould is adapted to mould at least one pre-stressed concrete plank. Each pre-stressed concrete plank having an upper surface forming a horizontal plain whilst in use, a reaction frame at each of a first and second opposing end of the line of battery moulds said reaction frames adapted to maintain a required tension in pre-stressing cables passing through each of the battery moulds so as to be formed within the pre-stressed concrete planks wherein the battery moulds are oriented such that the upper surface formed a vertical plain during moulding.

Thus, the invention involves orienting the battery moulds such that the concrete planks are formed in a vertical position, rather than as a flat bed of the prior art. This has the significant advantage of reducing the required floor space by better utilising the space directly above the floor. Whether in a factory environment or in an open space, the clearance above the floor on which the planks are cast is not utilised to its full extent if the plank is formed on the floor. So in addition to the extra floor space being made available, the present invention provides for the formation of planks in series and in parallel. Thus, whereas the prior art requires significant floor space it also requires the reaction blocks to be spaced at a considerable distance. In one embodiment of the present invention, adopting a similar width of floor space the invention can accommodate a plurality of battery moulds placed in parallel, and thus reducing the spacing between reaction blocks by a factor equal to the number of battery moulds in parallel.

In order to cast the pre-stressed concrete planks in a vertical orientation the formwork is required to project upwards for a distance exceeding the width of the plank so as to encase the concrete for pouring.

In an alternative embodiment of the present invention, having reaction blocks of the same size and distance apart as the prior art arrangement will yield a greater output than that of the prior art. For the same reason, because of the ability to add parallel lines for the width of the reaction block where only one horizontal bed was permitted previously.

In a further preferred embodiment of the present invention, linking moulds may be used to join adjacent battery moulds. This has the advantage of being able to select a variety of lengths of pre-cast concrete slabs by using single or multiple battery moulds.

In a still further preferred embodiment of the invention, the battery moulds may be adapted to manually or automatically open and close. In one embodiment of the invention, the battery moulds in parallel may share a rail or a rack-and-pinion arrangement such that the shuttering within the formwork may be individually or in combination open and closed by having the shuttering travelling along the rail or rack. In either alternative the ability to open and close the battery moulds by having the shuttering travel along the rail or rack, may be readily adapted to either a manual system or an automatic system on opening, with the latter possibly involving a motor associated with the shuttering to motivate the shuttering either open or closed.

Description of Preferred Embodiment

It will be convenient to further describe the present invention with respect to the accompanying drawings which illustrate possible arrangements of the invention. Other arrangements of the invention are possible and consequently the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Figure 1 is a plan view of the pre-stressed concrete forming system according to the present invention.

Figure 2 is an elevation view of the pre-stressed concrete forming system of Figure 1.

- 4 -

Figure 3 is a section view A-A of the pre-stressed concrete forming system of Figure 2.

Figures 1 and 2 show the pre-stressed concrete forming system 1 according to the present invention wherein rows of battery moulds 2 are placed in series between reaction frames 3a and 3b. Pre-stressing cables are mounted between reaction frames 3a and 3b so as to pass through the formation space within each battery mould 2 in preparation for pouring concrete into said forming space. On placement of the pre-stressing cables, said cables are then subjected to a high tensile load via stressing jack 4 until the desired pre-stressing force has been applied. Concrete is then poured into each forming space and allowed to cure and, thus, forming the desired pre-stressed concrete plank. The cable is then cut at each reaction frame 3a and 3b and also between each battery mould 2 and then each pre-stressed plank subsequently de-moulded.

Figure 2, in particular, shows a key aspect of the invention in that the battery moulds 2 are oriented such that the pre-stressed plank is formed in a vertical orientation as compared to said planks being formed flat on the ground as is the case with the conventional method. Because of this vertical orientation, the number of pre-stressed planks that can be formed within a specific floor space is markedly increased.

With reference to Figure 1, said plan indicates three parallel lines of battery moulds, each line comprising four sets of battery moulds 2 joined by linking moulds to form long line. Each line of battery mould is capable of forming two rows of pre-stressed concrete planks. Dividers can be placed along the line and partitioned to form the planks of the required length. Thus, for the mentioned configuration, 6 lines of pre-stressed concrete plank can be formed at one time. It would be expected that when using the conventional method of horizontal formation, a maximum of two rows of pre-stressed concrete planks could be formed simultaneously within the same floor plan.

Figure 3 shows a cross-sectional view of the pre-stressed concrete formation system 1, giving a detailed view of three battery moulds 2. It can be seen that the battery mould 2 comprises a central fixed core 7 and flanked by side walls 6a and 6b. The space 8 defined by the fixed central core 7 and side

- 5 -

wall 6a provides the location for the formation of the pre-stressed concrete plank. It is within this space that the pre-stressing cables are passed between reaction frames 3a and 3b and, consequently, concrete poured. To ensure that each side wall 6a and 6b is held in position during the formation process, there is provided a locking bar 13 comprising a pivotal mounting on the central fixed core 7 and a selectively engageable projection on side walls 6a and 6b. To engage, the locking bar 13 is pivoted to engage the projection on the side walls 6a and 6b and a locking nut rotated so as to lock said locking bar 13 in place.

A further important feature of the present invention is the applicability of the apparatus to automation. There is provided in this embodiment a means to automatically move side walls 6a and 6b relative to the central fixed core 7. The movement of the side walls 6a and 6b is necessary so as to prepare the forming space 8 in preparation for casting the concrete and also to de-mould the pre-stressed concrete plank following cure. Because of the vertical orientation, said side walls are necessarily large and difficult to handle. However, because of the system's suitability to automation, this perceived disadvantage is, in fact, a considerable advantage in reducing the typically labour-intensive process of forming said pre-stressed concrete planks.

In this embodiment, the automation system 9 comprises a continuous chain 10 engaging sprockets 11 located on each side wall 6a and 6b. Connected to said sprockets 11 are motors (not shown) within each side wall 6a and 6b so that, individually, each side wall 6a and 6b may be moved away from the central fixed core 7 through a motorised action. Also associated with the automatic system 9 is a series of end stops 12 to ensure the side walls 6a and 6b do not exceed the range defined by continuous chain 10.

In another embodiment of the invention, the opening and closing operation of the side walls 6a and 6b may be by the push arm 10 operated by a hydraulic system. Each push arm can be locked onto the wheel assembly 11 of side wall 6a or 6b, so that the side wall 6a or 6b can be moved away in the same direction from the central core 7, individually or together as a group by the mechanically operated push arm.

- 6 -

Because of the vertical orientation of said battery moulds, and given a typical plank width of 1.0 m to 2.4 m, access to the upper portion of the mould, such as to fit the locking bar 13, is impossible without some means of supporting the operator. Therefore, there is further provided a working platform 14 on each side wall 6a and 6b so as to provide a convenient and safe means to support the operator during the formation process. Conveniently, said working platform 14 is collapsible so as to avoid interference with adjacent battery moulds, when the side walls are moved. It follows that the working platform 14 is for the safety and convenience of workers during mould assembling and concreting work. It can be placed at any level (at mid level as shown in Figure 3 or at the top level) which can allow workers to work efficiently.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A pre-stressed concrete moulding system including a plurality of battery moulds, forming a line such that longitudinal axes of the battery moulds are co-linear and each battery mould is adapted to mould at least one pre-stressed concrete plank, each pre-stressed concrete plank having an upper surface forming a horizontal plane, whilst in use, a reaction frame at each of a first and second opposing end of the line of battery moulds, said reaction frames adapted to maintain a required tension in pre-stressing cables passing through each of the battery moulds so as to be formed within the pre-stressed concrete planks, wherein the battery moulds are oriented such that the upper surface forms a vertical plane during moulding.
2. A pre-stressed concrete moulding system according to claim 1 wherein each battery mould includes disassembling means to selectively separate at least one side wall from the battery mould for removing the pre-stressed concrete plank.
3. A pre-stressed concrete moulding system according to claim 1 wherein adjacent battery moulds are capable of being joined by a linking mould to form a unitary mould assembly adapted to mould a single pre-stressed concrete plank.
4. A pre-stressed concrete moulding system according to claim 3 wherein the mould assembly includes side walls capable of being joined to the side walls of the adjacent battery moulds to form at least one continuous long wall.
5. A pre-stressed concrete moulding system according to claim 2 wherein the disassembling means is mechanically driven.
6. A pre-stressed concrete moulding system according to claims 2 or 3 wherein the disassembling means is automatically controlled.

- 8 -

7. A pre-stressed concrete moulding system according to any one of claims 2 to 6 wherein the battery mould is adapted to simultaneously mould two rows of pre-stressed concrete planks.
8. A pre-stressed concrete moulding system according to any one of the preceding claims wherein the battery moulds include at least one divider for dividing a single pre-stressed concrete plank into at least two pre-stressed concrete planks.
9. A pre-stressed concrete moulding system according to claim 8 wherein the at least one divider is selectively positionable so as to vary the length of the at least two pre-stressed concrete planks
10. A pre-stressed concrete moulding system according to claim 7 wherein the battery mould includes a central fixed core and two side walls, with each plank being moulded between the central core and one of said walls.
11. A pre-stressed concrete moulding system according to claim 10 wherein the side walls are engaged by the disassembling means to disassemble the battery mould.
12. A pre-stressed concrete moulding system according to any one of claims 2 to 11 wherein the disassembling means includes a mechanically driven push arm connected to a wheel assembly, said wheel assembly being mounted to each side wall.
13. A pre-stressed concrete moulding system according to any one of claims 2 to 11 wherein the disassembling means includes a mechanically driven continuous chain and sprockets, adapted to engage the chain, mounted to the at least one side wall.

- 9 -

14. A pre-stressed concrete moulding system according to any one of claims 2 to 11 wherein the disassembling means includes a rack and mechanically driven pinions, adapted to engage the rack, mounted to the at least one side wall.
15. A pre-stressed concrete moulding system according to any one of the preceding claims wherein there is a plurality of parallel lines of battery moulds.
16. A pre-stressed concrete moulding system according to any one of the preceding claims wherein the side walls include locking means for locking the side walls in place prior disassembling the mould.
17. A pre-stressed concrete moulding system according to claim 16 wherein the locking means includes a plurality of screw threaded locking bars adapted to demountably engage an opposing side wall.
18. A pre-stressed concrete moulding system according to claim 16 wherein the locking means includes a plurality of screw threaded locking bars adapted to demountably engage the central fixed core.
19. A pre-stressed concrete moulding system according to any one of claims 13 to 18 wherein each side wall includes a collapsible working platform for supporting operators during the moulding process.
20. A pre-stressed concrete moulding system according to claim 12 wherein on operation of the push arm, the disassembling means is adapted to simultaneously open the side walls on each first side of the battery moulds and close the side walls on each second side of the battery moulds so that the side walls on adjacent parallel battery moulds do not come into contact during said operation.
21. A pre-stressed concrete plank formed by a pre-stressed concrete moulding system, said system including a plurality of battery moulds, forming a line such

- 10 -

that longitudinal axes of the battery moulds are co-linear and each battery mould is adapted to mould the pre-stressed concrete plank, each pre-stressed concrete plank having an upper surface forming a horizontal plane, whilst in use, a reaction frame at each of a first and second opposing end of the line of battery moulds, said reaction frames adapted to maintain a required tension in pre-stressing cables passing through each of the battery moulds so as to be formed within the pre-stressed concrete planks, wherein the battery moulds are oriented such that the upper surface forms a vertical plane during moulding.