

LAYOUT STRUCTURE FOR PRE-FABRICATED FLOOR PLATE PRODUCTION LINE

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Field of the Invention

The present invention relates to the technical field of building construction, in particular to a layout structure of a pre-fabricated floor plate production line.

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Background of the Invention

In traditional building construction, a building is generally built through casting concrete in-situ. The above construction method suffers various defects, such as long construction period, hardly controlled quality, intensive labor consumption, or the like. Moreover, it also brings about a large amount of construction rubbish and generates heavy noise pollution, causing great disturbance on daily life of surrounding residents.

Therefore, recently governments start to promote the housing industrialization. Specifically, methods such as standard design, factory production, pre-fabricated construction, integrated decoration and information management, are promoted, so that the development and design, component production, construction, management or the like during the whole procedure of building a house can be linked together to form a complete industrial chain system. In this manner, the production efficiency and quality of building can be effectively increased, the construction period can be shortened, the labor cost and the whole lifetime cost of the building can be lowered, and the generation and emission of building rubbish can be reduced, so that energy saving and emission reduction can be realized in the house building field.

30 This requires a construction system with pre-fabricated members. The main trend

for the future of domestic building industry is increasing the percentage of pre-fabricated members and assembly, which brings an opportunity and also a challenge for domestic building companies.

5 The production layout of the concrete pre-fabricated concrete member manufactory is an important part for the production of pre-fabricated concrete members. Currently, the concrete pre-fabricated member manufactories generally adopt a flow-line production technology introduced from Europe but with modifications. However, such pre-fabricated members, introduced or modified, cannot
10 adapt to local situations well.

Summary of the Invention

 The present invention provides a pre-fabricated floor plate production line, which
15 can standardize the manufacturing process of the pre-fabricated floor plate, fit for the actual engineering conditions, sufficiently utilize the production space, increase the production efficiency, and maximize the production efficacy.

 In order to eliminate the above technical defects, the present invention proposes a
20 pre-fabricated floor plate production line, which includes, along its lengthwise direction, a production area, a curing area, a post treatment area and a storing area in sequence, with an overhang conveying system being arranged above these areas. The production area is provided therein with a floor plate mold, so that reinforced bars and concrete can be used to form a pre-fabricated floor plate in the floor plate mold. The
25 curing area is provided therein with a steam curing room, so that a pre-fabricated floor plate as formed can be cured via steam, and then removed from the mold after the curing is completed. The post treatment area is used for performing post treatment on the pre-fabricated floor plate already formed. The storing area is used for storage of the pre-fabricated floor plate after being post treated. The overhang conveying system
30 is used to convey the floor plate mold and/or the pre-fabricated floor plate between

these areas.

It can be seen from the above technical solution that the pre-fabricated floor plate production line according to the present invention has the following advantageous technical effect. According to the layout structure of the above technical solution, the production line is optimized based on the production process of the pre-fabricated floor plate, the requirement of the engineering project, and the practical conditions of the engineering project. In this manner, the distance between adjacent areas is minimized, so that ineffective transportation can be reduced. Therefore, the production space is sufficiently utilized, and the production efficiency is increased. In addition, the overhang conveying system is used to connect the areas with each other, thus achieving efficient transportation of the molds and products between these areas, which facilitates to maximize the production efficiency.

Brief Description of the Drawings

To enable the technical solution of the present invention clearly understood, the accompanying drawings that are used to illustrate the embodiments and the prior arts will be briefly introduced in the following. Obviously, the drawings introduced as follows are provided directing to some of embodiments of the present invention only. For one skilled in the art, other drawings can be also obtained from these drawings without any creative labor.

Fig. 1 schematically shows the layout structure of a pre-fabricated floor plate production line according to an embodiment of the present invention; and

Fig. 2 is the flow chart of a process of the pre-fabricated floor plate production line according to the embodiment of the present invention.

Detailed Description of the Embodiments

To enable the technical solution of the present invention clearly understood to

one skilled in the art, the present invention will be described in further detail with reference to the accompanying drawings and embodiments. Obviously, the embodiments elaborated here are only part of embodiments of the present invention, rather than all the embodiments thereof. Other embodiments obtained from the
5 embodiments described in the present invention by one skilled in the art without any creative labor are all intended to be included within the scope of the present invention.

10 In the description, the claims and the above drawings, the terms of "first", "second", "third" and so on are used to indicate different objects, rather than defining any specific sequence. In addition, the terms "include", "has" and their variants are intended to cover all the objects involved non-exclusively. For example, a process, a method, a system, a product or an apparatus including a series of steps or units is not limited to include these steps or units as listed only, but can optionally include other steps or units that are inherent to the process, method, system, product or apparatus.

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Detailed description will be provided as follows through specific embodiments.

Reference is made to Fig. 1, which shows the layout structure of a pre-fabricated floor plate production line according to an embodiment of the present invention. The
20 pre-fabricated floor plate is a pre-fabricated concrete member for building, and can be used to achieve standard construction, so that the production efficiency and quality of the building can be effectively increased, and the construction period can be shortened.

25 As the layout structure of Fig. 1 shows, the pre-fabricated floor plate production line is arranged in a rectangular region, and includes, along its lengthwise direction, a production area, a curing area, a post treatment area, and a storing area in sequence. A loading area may be arranged behind the storing area. Above these areas is there provided with an overhang conveying system, and a passageway can be provided
30 between two adjacent areas. Among others, the production area 10 is provided with a floor plate mold therein, so that reinforced bars and concrete can be used to form a pre-fabricated floor plate in the floor plate mold. The curing area 20 is provided with

a steam curing room therein, so that the pre-fabricated floor plate as formed can be cured via steam, and then removed from the mold after the curing is completed. The post treatment area 30 is used for performing post treatment on the already-formed pre-fabricated floor plate. The storing area 40 is used for storage of the pre-fabricated floor plate after being post treated. The overhang conveying system is used to convey the floor plate mold and/or the pre-fabricated floor plate between these areas. The loading area 50 is used for delivery of the products. Delivery trucks can be stopped at the loading area, and the completely-formed pre-fabricated floor plates can be loaded on the trucks through the overhang conveying system.

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According to an embodiment, the production area 10 is further divided into two half-areas, such as a right one and a left one, divided along a widthwise direction of the production line. One of the two half-areas includes, along the direction of the production line, a reinforced bar storing region 11 and a reinforced bar binding region 12, and the other half-area includes, along the direction of the production line, a concrete processing region 13 and a surface brushing region 14.

The reinforced bar storing region 11 is used for storing the reinforced bars necessary for manufacturing the pre-fabricated floor plate. The reinforced bars stored here can be customized in advance according to some prescribed parameters, such as length, shape or the like. Preliminary binding may be unnecessary.

The reinforced bar binding region 12, in which the floor plate mold is arranged, is used for performing binding operations of the reinforced bars in the floor plate mold. Subsequently, the floor plate mold together with the reinforced bars therein is conveyed to the concrete processing region. The floor plate mold is a mold for manufacturing the pre-fabricated floor plate, and generally made from metal according to some parameters of the floor plate necessary for the building, such as the size, the thickness and the shape thereof. In this area, operators can bind the reinforced bars according to the required structure and then put them in the floor plate

mold. Part of the reinforced bars can be exposed outside for connection with other parts of the building. The floor plate mold with reinforced bars therein can be transferred as a whole from the reinforced bar binding region 12 to the concrete processing region 13 through the overhang conveying system 50.

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The concrete processing region 13 is provided with a vibrating table and a concrete pouring device, so that concrete can be poured into the floor plate mold and vibration can be applied thereon. Then, the floor plate mold is conveyed to the surface brushing region. The floor plate mold with reinforced bars therein can be disposed on the vibrating table directly, and then concrete can be poured into the floor plate mold through the concrete pouring device. During or after the pouring procedure, the vibration is applied through the vibrating table according to the required vibration intensity and time frame, ensuring that there are no defects, such as bubbles, existing in the concrete.

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The surface brushing region 14, also called as the scratching area, is used to roughen the surface of the concrete. After the pre-fabricated floor plate is mounted on the building, a layer of concrete will be generally applied thereon. For achieving good bonding with the concrete cast later, part of concrete surface of the pre-fabricated floor plate should be roughened. This can be realized through brushing the concrete surface by operators with a broom, a wood float or the like to form a roughened surface. Of course, the roughened surface can be obtained through other tools with a similar function.

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In an embodiment, the curing area 20 can be provided with one or more steam curing rooms, for performing steam curing on the pre-fabricated floor plate as formed according to predetermined temperature and humidity conditions. The steam curing aims to enable the concrete to have a certain temperature and humidity, so that the concrete can reach a required strength in a prescribed time, such as the strength at least necessary for mold removal, or the strength which can allow hoisting. The mold

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removal means a procedure of opening the floor plate mold and taking out the pre-fabricated floor plate already cured in the mold. Multiple steam curing rooms can be disposed along the width direction of the production line side by side. The steam curing room can be configured as a closeable space, which can be opened to receive the floor plate mold and the pre-fabricated floor plate, and also completely closed to perform steam curing operations on the floor plate mold and the pre-fabricated floor plate disposed therein. In addition, it should be noted that it is unnecessary to perform the curing operations of the curing area 20 in the steam curing room. If natural conditions are favorable, the pre-fabricated floor plate can be also applied with natural curing under the natural conditions.

Optionally, the pre-fabricated floor plate production line can further include a boiler 15 arranged in the production area 10. The boiler 15 can be arranged between the reinforced bar binding region 12 and the reinforced bar storing region 11, for example. The boiler 15 is used to generate steam, which can be supplied to the steam curing room through pipes, for steam curing or other uses.

In an embodiment, the post treatment area 30 includes a washing region 31 and a repairing region 32. The washing region 31 is used to wash the pre-fabricated floor plate already formed, while the repairing region 32 is used to repair the pre-fabricated floor plate already formed to eliminate possible local defects thereof. The washing region 31 and the repairing region 32 can be arranged along the width direction of the production line side by side, with a passageway arranged therebetween.

In an embodiment, the storing area 40 can be also used to provide water curing for the pre-fabricated floor plate stored therein if necessary, so that the pre-fabricated floor plate can be completely cured with a strength that can reach the requirement of related standards.

In an embodiment, the production area, the curing area, the post treatment area,

the storing area and the loading area occupy the total area of the pre-fabricated floor plate production line in percentages of $30\pm5\%$, $20\pm5\%$, $10\pm5\%$, $30\pm5\%$, and $10\pm5\%$, respectively, preferably 30%, 20%, 10%, 30%, and 10%, respectively. With the above reasonable percentages of area, these areas and related process steps can cooperate
5 with each other smoothly, so as to achieve a high efficient operation.

In an embodiment, the overhang conveying system includes: a first movement mechanism that can be movable along the lengthwise direction of the pre-fabricated floor plate production line; a second movement mechanism that is connected with the
10 first movement mechanism and can be movable along the widthwise direction of the pre-fabricated floor plate production line; an overhang mechanism that is connected with the second movement mechanism and can be movable along a vertical direction; and a controller for controlling the first movement mechanism, the second movement mechanism, and the overhang mechanism, wherein the controller may include a
15 control keypad, the buttons of which can be pressed by operators to control the overhang mechanism.

In an embodiment, the pre-fabricated floor plate production line has a length of 60-100m, and a width of 23-25m. Preferably, the pre-fabricated floor plate production
20 line has a length of 85 m, and a width of 23 m.

It should be noted that unlike other production lines for pre-fabricated concrete members, such as the external wall, staircase or the like, in the pre-fabricated floor plate production line the floor plate mold is movable, and can be transferred from a
25 production step to a next production step as required by the production process. After the mold is removed so that the pre-fabricated floor plate as formed is taken out, the empty mold will be transferred to the production area again for next use.

Fig. 2 is the flow chart of a process for the production of the pre-fabricated floor
30 plate based on the layout structure as shown in Fig. 1. The process includes the

following steps.

In a step of cleaning the mold, the floor plate mold or the like is cleaned.

5 In a step of coating release agent, release agent is coated on the inner surfaces of the floor plate mold so as to facilitate the removal of the mold or release from the mold.

10 In a step of mounting accessories, binding reinforced bars, and assembling mold, reinforced bars are disposed in the floor plate mold and bound together, and accessories necessary for the building, such as electric lines, pipelines, inserts or the like, are mounted therein in advance. Then, the floor plate mold is fixed.

15 In a step of check before concrete pouring, inspections are performed to confirm whether the reinforced bars are bounded correctly, whether the accessories are mounted correctly, whether the mold is in a good condition, or the like.

20 In a step of pouring concrete, concrete is poured in the floor plate mold under vibration.

In a step of roughening surfaces, at least one surface of the concrete is roughened.

25 In a step of curing, the concreted is cured via natural curing or steam curing, so that the concrete is solidified.

30 In an optional step of brick pressing, strengthen checking or other inspections are performed on a small concrete sample also obtained by the same process for the pre-fabricated floor plate.

In a step of mold removal, the floor plate mold is removed so that the pre-fabricated floor plate as formed can be taken out from the mold.

5 In a step of hoisting to the storing area, the pre-fabricated floor plate is hoisted to the storing area for storage after being post treated.

In a step of inspecting the pre-fabricated floor plate, the pre-fabricated floor plate is detected to find any possible defects. If necessary, repairing operation is performed.

10 In a step of water curing, water curing is performed on specific pre-fabricated floor plates.

In a step of inspection before delivery, quality inspection is performed again before delivery. If any defect is found, a repair operation may be necessary.

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In a step of delivery, qualified pre-fabricated floor plate can be loaded at the loading area, and then delivered to the customer.

20 It should be noted that when concrete is poured, the concrete should be poured into the floor plate mold homogenously, with excessive concrete removed, and then the vibrating table is activated. The time point for applying vibration can be selected by the operator according to different conditions.

25 In a specific application scenario according to an embodiment of the present invention, the quantity and type of the pre-fabricated floor plates in one and the same construction site are counted, so that the quantity of each type of the mold necessary for a construction period (i.e., the time for constructing a standard level of an assembled building) is calculated. For example, if in a construction period, in which a level is built in 6 days, there are 6 pre-fabricated floor plates of a specific type, one
30 mold is sufficient and thus can be used in the production line for production of this

product. If in a construction period, in which a level is built in 6 days, there are 11 pre-fabricated floor plates of this specific type, two molds will be used in the production line for production of this product. The quantity of the mold should be decimally rounded in line with the construction period.

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A standard pre-fabricated floor plate production line has a basic width in a range of 23-25m, and a length in a range of about 60-100m. The front part of the production line along its lengthwise direction is used for the production of the pre-fabricated floor plate, in which the production area and the curing area occupy the total area of the production line in a percentage of about 40%-50%, while the remaining part of the production line is mainly used for storage. Generally speaking, the storing area is able to store stock which can meet the requirement for one to two levels of a building. Stock which can meet the requirement for one level means the pre-fabricated members that are necessary for construction of one level of a building in a construction period.

The front part of the production line along the lengthwise direction thereof is used for receiving the floor plate mold for the production of the pre-fabricated floor plate and the steam curing room(s). Generally speaking, when the total number of the molds is taken into consideration, two to four rows of molds can be arranged along the lengthwise direction, with a passageway for operators and materials being left between two adjacent molds. The passageway should be wide enough so that the production requirement and safety can be sufficiently guaranteed. The repairing region is arranged behind the steam curing room in the production line, for performing repairs on the defects of the product.

In the storing area, products that should be loaded in the same batch should be put in the same position as much as possible according to the delivery request, so as to facilitate the loading and delivery. The pre-fabricated floor plate products can be arranged according to the sequence of mounting these products at the construction site,

thus meeting the mounting requirement during construction.

In an application scenario, for a production line solely for the production of the pre-fabricated floor plate, 40 to 60 products, which are usually produced within one day, can be produced in one working hour. Only 12 to 16 operators are necessary, thus requiring less human resource. The average unit labor output is more than 2 tons of plates each day.

One of key points in designing a manufactory for pre-fabricated concrete members is the layout of equipment in the factory. Therefore, the positions of a variety of equipment in the factory and the connections among the equipment should be suitably determined, so that all the material resource can be utilized for production in a high efficiency. The above layout structure of the production line can bring about the following advantages. The production line is optimized as a whole according to a systematic principle. It will not require excellence in all aspects. The distance between different equipment is minimized, thus reducing inefficient transportation and also the transportation cost. Moreover, the area and the space are efficiently utilized, so that cost can be saved. Further, the site layout can maximize the production efficiency.

In the above embodiments, the description provided therein is directed to different aspects of the present invention. For some aspects that are not introduced in one embodiment, reference can be made to other embodiments.

The foregoing description is merely illustrative of preferred embodiments of the present invention, and is not intended to limit the present invention. Various changes and modifications may be made by those skilled in the art. Any modifications, equivalent substitutions, improvements, and the like within the spirit and principles of the present invention are intended to be included within the scope of the present invention.

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CLAIMS

1. A pre-fabricated floor plate production line, including, along its lengthwise direction, a production area, a curing area, a post treatment area and a storing area in
5 sequence, with an overhang conveying system being arranged thereabove,

characterized in that the production area is provided with a floor plate mold therein, so that reinforced bars and concrete can be used to form a pre-fabricated floor plate in the floor plate mold;

the curing area is provided with a steam curing room therein, so that a
10 pre-fabricated floor plate as formed can be cured via steam, and then removed from the mold after the curing is completed;

the post treatment area is used for performing post treatment on the pre-fabricated floor plate already formed;

the storing area is used for storage of the pre-fabricated floor plate after being
15 post treated; and

the overhang conveying system is used to convey the floor plate mold and/or the pre-fabricated floor plate between these areas.

2. The pre-fabricated floor plate production line according to claim 1,
20 characterized in that the production area is divided into two half-areas, one of said two half-areas including a reinforced bar storing region and a reinforced bar binding region, while the other including a concrete processing region and a surface brushing region,

wherein the reinforced bar storing region is used for storing reinforced bars
25 necessary for manufacturing the pre-fabricated floor plate;

the reinforced bar binding region, in which the floor plate mold is arranged, is used for performing binding operations of the reinforced bars in the floor plate mold, and then the floor plate mold together with the reinforced bars therein is conveyed to the concrete processing region;

30 the concrete processing region is provided with a vibrating table and a concrete

pouring device, so that concrete can be poured into the floor plate mold and vibration can be applied thereon, and then the floor plate mold is conveyed to the surface brushing region; and

the surface brushing region is used to roughen surfaces of the concrete.

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3. The pre-fabricated floor plate production line according to claim 1, characterized in that the curing area is provided with one or more steam curing rooms, for performing steam curing on the pre-fabricated floor plate as formed according to predetermined temperature and humidity conditions.

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4. The pre-fabricated floor plate production line according to claim 1, characterized in that the post treatment area includes a washing region and a repairing region, wherein the washing region is used to wash the pre-fabricated floor plate already formed, while the repairing region is used to repair the pre-fabricated floor plate already formed to eliminate local defects thereof.

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5. The pre-fabricated floor plate production line according to claim 1, characterized in that the storing area is also used to provide water curing for the pre-fabricated floor plate stored therein when necessary.

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6. The pre-fabricated floor plate production line according to claim 1, characterized in that a loading area is arranged behind the storing area for loading and delivery.

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7. The pre-fabricated floor plate production line according to claim 6, characterized in that the production area, the curing area, the post treatment area, the storing area and the loading area occupy a total area of the pre-fabricated floor plate production line in percentages of $30\pm5\%$, $20\pm5\%$, $10\pm5\%$, $30\pm5\%$ and $10\pm5\%$, respectively.

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8. The pre-fabricated floor plate production line according to claim 1, characterized in that the pre-fabricated floor plate production line further includes a boiler arranged in the production area.

5 9. The pre-fabricated floor plate production line according to claims 1 to 6, characterized in that the overhang conveying system includes:

 a first movement mechanism that can be movable along a lengthwise direction of the pre-fabricated floor plate production line;

 a second movement mechanism that is connected with the first movement
10 mechanism and can be movable along a widthwise direction of the pre-fabricated floor plate production line;

 an overhang mechanism that is connected with the second movement mechanism and can be movable along a vertical direction; and

 a controller for controlling the first movement mechanism, the second movement
15 mechanism, and the overhang mechanism.

10. The pre-fabricated floor plate production line according to any one of claims 1 to 6, characterized in that the pre-fabricated floor plate production line has a length of 60-100 m, and a width of 23-25 m.

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