

PRE-FABRICATED STAIRCASE PRODUCTION LINE

5 **Field of the Invention**

The present invention relates to the technical field of production of concrete pre-fabricated members, in particular to a layout structure of a concrete pre-fabricated staircase production line.

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Background of the Invention

In traditional building construction, reinforced bars are generally bound and concrete is poured at the construction site for a building. The above construction method suffers the defects, such as long construction period, hardly controlled quality, heavy pollution, or the like. Recently, the building construction method has been gradually developing towards use of pre-fabricated members, wherein concrete pre-fabricated members with reinforced bars are directly manufactured at factories according to the actual construction requirements and then delivered to the construction site, so that the pre-fabricated members can be directly combined together to complete the construction of the building. The construction method with pre-fabricated members can not only overcome the defects associated with the above traditional construction method, but further present the following advantages. For example, it requires little footprint, and is easy to design. In addition, it can also drive the surrounding factories to establish a whole industrial chain.

The production layout of the concrete pre-fabricated 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 adapt to the local situations well.

Summary of the Invention

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The present invention provides a pre-fabricated staircase production line, which can effectively increase the production efficiency, save the factory footprint, and simplify the equipment involved. In this manner, the technical defects existing in the prior arts, such as large footprint and poor curing of the pre-fabricated members, can
10 be overcome, thus achieving the technical advantages of utilizing the space sufficiently, increasing the production efficiency and efficacy, or the like.

In order to eliminate the above technical defects, the present invention proposes a pre-fabricated staircase production line, including a reinforced bar storing area, a
15 reinforced bar binding area, a production area, a post treatment area, and a product storage area. The production area, the post treatment area and the product storage area are connected with each other in sequence along a lengthwise direction, and a material conveying system is provided between adjacent areas. The production area includes a right staircase mold storage region and a left staircase mold storage region, so that
20 reinforced bars and concrete can be used to form a pre-fabricated staircase in a staircase mold, wherein a passageway is provided between the right and left staircase mold storage regions. The post treatment area is used for performing post treatment on the pre-fabricated staircase already formed. The product storage area also includes two storage parts that are symmetrically arranged at a right side and a left side
25 respectively, with a passageway being arranged between the two storage parts, for storage of the pre-fabricated staircase after post treatment. The material conveying system is used for conveying the pre-fabricated staircase and production material among these areas.

Preferably, the post treatment area includes a repairing region arranged at a left side and a decorating region at a right side, for repairing and decorating the pre-fabricated staircase released from the mold respectively. A passageway in communication with those of the production area and the product storage area is provided between the repairing region and the decorating region.

Preferably, the reinforced bar storing area and the reinforced bar binding area are arranged at a front portion of the production area in a side-by-side manner, and a passageway in communication with that of the production area is provided between the reinforced bar storing area and the reinforced bar binding area. The reinforced bar storing area is used for storing the reinforced bars necessary for manufacturing the pre-fabricated staircase. The reinforced bar binding area is used for binding the reinforced bars stored in the reinforced bar storing area into a reinforcement cage, and the reinforcement cage as formed is conveyed through the material conveying system to the staircase mold arranged in the production area.

Preferably, each staircase mold storage region is provided therein with a staircase mold station, and a vibrator used for compacting the concrete in the staircase mold in a homogenous and dense manner. The staircase mold station is provided at its bottom with a steam curing pipeline, which performs heating maintenance on the pre-fabricated staircase as formed according to predetermined temperature and humidity conditions. The pre-fabricated staircase completed in the production area is conveyed to the post treatment area through the material conveying system.

Preferably, the production area is provided therein with a boiler room, which is in communication with the steam curing pipeline arranged at the bottom of each staircase mold station.

Preferably, the product storage area is further provided with a loading station at

its rear portion, for loading the pre-fabricated staircase as formed for delivery.

Preferably, the production area, the post treatment area, and the product storage area occupy $30\pm5\%$, $10\pm5\%$, and $50\pm5\%$ of a total area of the pre-fabricated staircase production line, respectively, and the reinforced bar storing area and the reinforced bar binding area occupy $10\pm5\%$ of the total area.

Preferably, the production line has a length of 60-100 m, and a width of 23-25 m.

10 Preferably, the product storage area is provided therein with a water curing apparatus and a drainage system.

Preferably, the material conveying system is an overhang conveying system, which includes: a first movement mechanism that can be movable along a lengthwise direction of the pre-fabricated staircase production line; a second movement mechanism that is connected with the first movement mechanism and can be movable along a widthwise direction of the pre-fabricated staircase 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.

Compared with the prior arts, the pre-fabricated staircase production line of the present invention has the following technical advantages. According to the pre-fabricated staircase production line of the present invention, the production line is optimized based on the production process of the pre-fabricated staircase and the requirements of the engineering project. In this manner, the distance between adjacent areas is minimized, so that ineffective transportation can be reduced. In addition, the mold storage area and the product storage area can be used for storage and curing, so

that pre-fabricated members can be formed in a continuous manner according to the production process. Therefore, a continuous production can be realized, the production efficiency can be increased, the construction period can be shortened, and the footprint of the manufactory can be reduced.

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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 art will be briefly introduced in the following. Obviously, the drawings introduced as follows are provided to elaborate some of embodiments of the present invention only. For one skilled in the art, other drawings can be also obtained without any creative labor based on these drawings.

15 Fig. 1 schematically shows a pre-fabricated staircase production line according to an embodiment of the present invention; and

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

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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 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.

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As shown in Fig. 1, the pre-fabricated staircase production line according to the present invention is arranged in a rectangular region, and includes, along its

lengthwise direction, a reinforced bar storing area 1, a reinforced bar binding area 2, a production area 3, a post treatment area 6, a product storage area 4, and a loading area 5. Between adjacent areas there is provided with a material conveying system.

5 The reinforced bar storing area 1 and the reinforced bar binding area 2 are arranged at a front portion of the production area 3 in a parallel manner. A passageway in communication with a central passageway of the production area 3 is arranged between the reinforced bar storing area 1 and the reinforced bar binding area 2.

10 The reinforced bar storing area 1 is used for storing the reinforced bars necessary for manufacturing a pre-fabricated staircase.

 The reinforced bar binding area 2 is used for binding the reinforced bars stored in the reinforced bar storing area 1 into a reinforcement cage. The reinforcement cage as
15 formed is conveyed through the material conveying system to a staircase mold arranged in the production area 3.

 The production area 3 includes two staircase mold storage regions 31, a right one and a left one, where reinforced bars and concrete can be used to form the
20 pre-fabricated staircase in the staircase mold. There is provided with a passageway for operators and material between the right and left staircase mold storage regions 31. The passageway is so wide that the production requirement and the safety can be both ensured.

25 The post treatment area 6 is used for performing post treatment on the already-formed pre-fabricated staircase.

 The post treatment area 6 includes a repairing region 61 and a decorating region 62, which are arranged at the right side and the left side respectively, for repairing and

decorating the pre-fabricated staircase released from the mold respectively. A passageway in communication with those of the production area 3 and the product storage area 4 is provided between the repairing region 61 and the decorating region 62.

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The product storage area 4 also includes two regions that are arranged at the right side and the left side respectively. A passageway is also arranged in advance between said two regions for storage of the pre-fabricated staircase after post treatment.

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The loading area 5 is arranged at a rear portion of the product storage area 4, for delivery of the already-formed pre-fabricated staircase.

In the present embodiment, the material conveying system is an overhang conveying system.

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In the following the function of each area will be explained with reference to a specific implementing process.

20 The reinforced bar storing area 1 is used for storing the reinforced bars necessary for manufacturing the pre-fabricated staircase. The reinforced bars stored here can be customized in advance according to some related parameters, such as length, shape or the like. Preliminary binding may be unnecessary.

25 The reinforced bar binding area 2 is used for binding the reinforced bars stored in the reinforced bar storing area 1 into a reinforcement cage. The reinforcement cage as formed is conveyed through the overhang conveying system to a mold arranged in the staircase mold storage region 31, where the final steps, such as binding the reinforced bars, mounting accessories, embedding inserts, or the like, are performed.

The reinforcement cage necessary for the production of the pre-fabricated staircase is relatively large in volume, thus it is generally not suitable for transport means, such as a roller bed or a forklift. In the present embodiment, the reinforcement cage as formed in advance is put in the staircase mold through hoisting. According to
5 the present embodiment, the reinforced bar storing area 1 and the reinforced bar binding area 2 are arranged at the front portion of the production area 3, thus reducing the movement distance of the overhang conveying system. In the meantime, since there is a passageway formed between the reinforced bar storing area 1 and the reinforced bar binding area 2, the ground operators can easily access and operate the
10 overhang conveying system. The whole layout is reasonable, thus reducing inefficient transportation, achieving sufficient utilization of the production space, and increasing the production efficiency.

The pre-fabricated staircase mold is very large in volume, and generally speaking,
15 it will be fixed in the staircase mold storage region 31 in advance, thus forming a plurality of staircase mold stations. In the present embodiment, each staircase mold station is provided with a vibrator, which is used to compact the concrete in the staircase mold in a homogenous and dense manner. Under normal weather condition, the pre-fabricated staircase, after pouring and vibrating steps, can reach the hoisting
20 strength after a certain time of settlement. However, if the temperature is relatively low, the solidification of the pre-fabricated staircase will turn slow. Therefore, to meet the requirement of production, it is necessary to perform thermal curing. Accordingly, in a preferred embodiment, the mold station is provided at its bottom with a steam curing pipeline, which is in communication with a boiler room 32 that is arranged in
25 the production area 3 for generating steam, and thus can perform thermal curing on the pre-fabricated staircase as formed according to predetermined temperature and humidity conditions. When the mold has a fixed position, the cost associated with steam curing through the pipeline would be lower than that associated with a steam curing room.

After the pre-fabricated staircase in the production area 3 reaches the hoisting strength, the mold is removed, and the pre-fabricated staircase is conveyed to the post treatment area 6 through the overhang conveying system. According to the actual
5 producing conditions, the pre-fabricated member may be damaged when being released from the mold, or need further decorations. For this purpose, the pre-fabricated member released from the mold can be repaired and decorated in the post treatment area 6. The decoration includes sticking bricks on the pre-fabricated member released, or mosaicking the pre-fabricated member. The pre-fabricated
10 staircase after being repaired or decorated is conveyed to the production storage area 4 through the material conveying system.

For facilitating the water curing, in a preferred embodiment, the production storage area 4 is configured as having a structure which is concave in the peripheral
15 region while convex in the central region. In addition, there is a draining system, such as a drainage channel, surrounding the production storage area 4. Moreover, in the production storage area 4 there is further provided with a water curing system, with which water curing to the already-formed pre-fabricated staircase can be performed. Water from the water curing system can be collected by the drainage channel for
20 future use.

The curing of the pre-fabricated staircase is the most time-consuming step in the whole process for the production of the pre-fabricated staircase. Traditionally, the curing method includes steam curing, natural curing, and water curing. When the
25 pre-fabricated staircase reaches the design strength, the water curing is generally cheap in cost. In the present embodiment, in order for further saving water, the production storage area 4 as a whole is configured as having a structure which is concave in the peripheral region while convex in the central region. In addition, water wasted by the water curing system can be collected by the drainage channel for

secondary use. Therefore, the production cost is reduced.

5 The production area 3, the post treatment area 6, and the production storage area 4 occupy the total area of the pre-fabricated staircase production line in percentages of 30±5%, 10±5%, and 50±5%, respectively. And the reinforced bar storing area 1 and reinforced bar binding area 2 each occupy the total area in a percentage of 10±5%. With the above reasonable percentages of area, these areas and related process steps can cooperate with each other smoothly, so as to achieve a high efficient operation.

10 The pre-fabricated staircase production line has a length of 60-100 m, and a width of 23-25 m. Preferably, the pre-fabricated staircase production line has a length of 85 m, and a width of 23 m.

15 The overhang conveying system includes: a first movement mechanism that can be movable along the lengthwise direction of the pre-fabricated staircase production line; a second movement mechanism that is connected with the first movement mechanism and can be movable along the widthwise direction of the pre-fabricated staircase production line; an overhang mechanism that is connected with the second movement mechanism and can be movable along a vertical direction; and a controller
20 for controlling the first movement mechanism, the second movement mechanism, and the overhang mechanism.

25 According to the pre-fabricated staircase production line of the present invention, the production line is optimized based on the production process of the pre-fabricated staircase, 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, by means of the overhang conveying system which connects these areas, the

pre-fabricated members and the work-pieces can be conveyed between these areas with a high efficiency. Moreover, one single overhang conveying system can be used for the production of two sets of pre-fabricated staircase, thus maximizing the production efficacy.

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In the following the operation procedure of the pre-fabricated staircase production line according to the present invention will be illustrated with reference to Fig. 2.

10 In a step of cleaning the mold, the staircase mold or the like is cleaned, mainly for removing concrete from the surfaces of the mold.

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

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In a step of binding reinforced bars and mounting accessories, reinforced bars are bound in the staircase mold, and accessories necessary for the building, such as electric lines, inserts or the like, are mounted therein in advance. For a large-sized reinforcement cage, a preliminary binding can be performed in the reinforced bar
20 binding area 2, and then the reinforcement cage is delivered to the staircase mold for further binding reinforced bars.

In a step of assembling the mold, the staircase mold is mounted and fixed.

25 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 staircase mold is in a good condition, or the like.

In a step of pouring concrete, after inspections concerning whether the reinforced

bars are bounded correctly, the accessories are mounted correctly, the mold is in a good condition, or the like, are performed, concrete is poured in the staircase mold already with reinforced bars therein, during which a vibrator is used to homogeneously compact the concrete in the staircase mold.

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In a step of natural/steam curing, the pre-fabricated staircase after the pouring and vibrating steps is cured via natural curing or steam curing, so that the concrete is set to reach the hoisting strength. If necessary, steam curing should be performed on the pre-fabricated members. A steam curing pipeline is arranged at a bottom of each staircase mold station, for curing the pre-fabricated staircase as formed based on predetermined temperature and humidity conditions.

In a 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 staircase mold is opened after the concrete in the staircase mold reaches the hoisting strength, so that the pre-fabricated staircase is removed from the mold. Then, the pre-fabricated staircase completed in the production line 3 is delivered to the post treatment area 6 through the material conveying system.

In a step of detecting and repairing, the pre-fabricated staircase removed from the mold is detected. The product necessary for repair is repaired in the repairing region 61. Qualified product is conveyed to the production storage area 4 for storage and water curing, or to the decorating region 62 for decorating treatment.

In a step of laying non-slip bricks or blind track bricks, for the pre-fabricated staircase that should be laid with outer non-slip bricks or blind track bricks, it will be

laid with non-slip bricks or blind track bricks in the decorating region 62, and then the non-slip bricks or blind track bricks will be protected by wood plates or rubber plates.

In a step of water curing, water curing is performed on specific pre-fabricated staircases in the production storage area 4 so that they can reach the design strength.

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.

In a step of delivery, qualified pre-fabricated staircase can be loaded at the loading station 5, and delivered to the customer.

In a specific application scenario according to an embodiment of the present invention, the quantity and type of the pre-fabricated staircases in one and the same construction site are counted, so that the quantify 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 staircases of a specific type, one mold is sufficient. Thus one mold will be used in the production line for production of this 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 staircase products can be arranged according to the sequence of mounting these products at the construction site, thus meeting the mounting requirement during construction.

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 can be used for production in a high efficiency.

5 The pre-fabricated staircase production line of the present invention 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
10 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
15 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,
20 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.

CLAIMS

1. A pre-fabricated staircase production line, including a reinforced bar storing area (1), a reinforced bar binding area (2), a production area (3), a post treatment area
5 (6), and a product storage area (4),

characterized in that the production area (3), the post treatment area (6) and the product storage area (4) are connected with each other in sequence along a lengthwise direction, a material conveying system being provided between adjacent areas;

the production area (3) includes a right staircase mold storage region (31) and a
10 left staircase mold storage region (31), so that reinforced bars and concrete can be used to form a pre-fabricated staircase in a staircase mold, wherein a passageway is provided between the right and left staircase mold storage regions (31);

the post treatment area (6) is used for performing post treatment on the pre-fabricated staircase already formed;

15 the product storage area (4) also includes two storage parts that are symmetrically arranged at a right side and a left side respectively, with a passageway being arranged between said two storage parts, for storage of the pre-fabricated staircase after post treatment; and

the material conveying system is used for conveying the pre-fabricated staircase
20 and production material between these areas.

2. The pre-fabricated staircase production line according to claim 1, characterized in that the post treatment area (6) includes a repairing region (61) arranged at a left side and a decorating region (62) at a right side, for repairing and
25 decorating the pre-fabricated staircase released from the mold respectively; and

a passageway in communication with those of the production area (3) and the product storage area (4) is provided between the repairing region (61) and the decorating region (62).

3. The pre-fabricated staircase production line according to claim 1, characterized in that the reinforced bar storing area (1) and the reinforced bar binding area (2) are arranged at a front portion of the production area (3) in a side-by-side manner, and a passageway in communication with that of the production area (3) is provided between the reinforced bar storing area (1) and the reinforced bar binding area (2);

the reinforced bar storing area (1) is used for storing the reinforced bars necessary for manufacturing the pre-fabricated staircase; and

the reinforced bar binding area (2) is used for binding the reinforced bars stored in the reinforced bar storing area (1) into a reinforcement cage, and the reinforcement cage as formed is conveyed through the material conveying system to the staircase mold arranged in the production area (3).

4. The pre-fabricated staircase production line according to claim 1, characterized in that each staircase mold storage region (31) is provided therein with a staircase mold station, and a vibrator used for compacting the concrete in the staircase mold in a homogenous and dense manner;

the staircase mold station is provided at its bottom with a steam curing pipeline, which performs thermal curing on the pre-fabricated staircase as formed according to predetermined temperature and humidity conditions; and

the pre-fabricated staircase completed in the production area (3) is conveyed to the post treatment area (6) through the material conveying system.

5. The pre-fabricated staircase production line according to claim 4, characterized in that the production area (3) is provided therein with a boiler room (32), which is in communication with the steam curing pipeline arranged at the bottom of each staircase mold station.

6. The pre-fabricated staircase production line according to claim 1,

characterized in that the product storage area (4) is further provided with a loading station (5) at its rear portion, for loading the pre-fabricated staircase as formed for delivery.

5 7. The pre-fabricated staircase production line according to any one of claims 1 to 6, characterized in that the production area (10), the post treatment area (6), and the product storage area (4) occupy $30\pm5\%$, $10\pm5\%$, and $50\pm5\%$ of a total area of the pre-fabricated staircase production line, respectively, and the reinforced bar storing area (1) and the reinforced bar binding area (2) occupy $10\pm5\%$ of the total area.

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

15 9. The pre-fabricated staircase production line according to any one of claims 1 to 6, characterized in that the product storage area (4) is provided therein with a water curing apparatus and a drainage system.

20 10. The pre-fabricated staircase production line according to any one of claims 1 to 6, characterized in that the material conveying system is an overhang conveying system, which includes:

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

25 a second movement mechanism that is connected with the first movement mechanism and can be movable along a widthwise direction of the pre-fabricated staircase 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.