

PRE-FABRICATED EXTERNAL WALL 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 pre-fabricated external wall production line.

10 **Background of the Invention**

For the production of pre-fabricated members, the important key points are the production form and the production process, the latter mainly including two kinds, i.e., the fixed-station process and the flow-line process. The flow-line process is characterized in that a bench formwork (i.e., a working platform) is transferred to a station corresponding to each process step, according to the process sequence, by means of a transfer system of the production line. The operator of each station and the specific operation performed there are relatively unchanged. For example, operations such as placing reinforced bars, pouring concrete, vibrating or the like are performed at fixed stations by relatively fixed operators and equipment. With this process, the labor intensity can be lowered, the production efficiency can be increased, and the labor cost can be reduced. Therefore, as far as domestic manufacturers for the production of external wall board is concerned, the flow-line process is widely adopted currently.

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However, the mold for pre-fabricated external wall and the finished external wall are generally large in size, and also relatively heavy. If the process in which a working platform moves along the production line is adopted, on the one hand, hoisting the mold and the pre-fabricated member is difficult, and on the other hand, multiple hoisting will increase the possibility of damaging the pre-fabricated member. The

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pre-fabricated external wall production lines based on fixed-stations generally used in the prior arts are introduced from Europe, although with modifications. However, such pre-fabricated external wall production lines, introduced or modified, cannot adapt to the local situations well.

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Summary of the Invention

Aiming to eliminate the above defects, the present invention proposes a pre-fabricated external wall production line, which can standardize the manufacturing process of the pre-fabricated external wall, fit for the actual engineering conditions, sufficiently utilize the production space, increase the production efficiency, and maximum the production efficacy.

In order to solve the above technical problem, the present invention proposes a pre-fabricated external wall production line, including, along its lengthwise direction, a production area, a post treatment area and a storing/curing area in sequence, a material conveying system being provided between these areas. The production area includes two external wall mold storage regions, which are symmetric to each other along a central line of the production area, a central passageway being provided between the two external wall mold storage regions. The storing/curing area consists of two portions, which are symmetric to each other along the central line of the production area, between which there is also provided with a passageway. The production area is provided therein with an external wall mold, by means of which reinforced bars and concrete can be used to form a pre-fabricated external wall in the external wall mold. The post treatment area is used for performing post treatment on the pre-fabricated external wall already formed. The storing/curing area is used for storing the pre-fabricated external wall after being post treated. The material conveying system is used for conveying the pre-fabricated external wall and production material between these areas.

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In an embodiment, the production area comprises a reinforced bar storing region and a reinforced bar binding region that are arranged in parallel at a front portion of the production area. A passageway in communication with the central passageway of the production area is arranged between the reinforced bar storing region and the reinforced bar binding region. The reinforced bar storing region is used for storing reinforced bars that are necessary for production of the pre-fabricated external wall. The reinforced bar binding region is used for binding the reinforced bars stored in the reinforced bar storing region into a reinforcement cage, which is, after being formed, conveyed by the material conveying system to the mold in the external wall mold storage region.

In an embodiment, the external wall mold storage region is provided therein with a boiler room, a plurality of external wall mold stations, and a vibrator arranged at each of the external wall mold stations for vibrating and compacting concrete in the external wall mold. A steam curing pipeline is arranged at a bottom of the mold stations, for curing the pre-fabricated external wall as formed based on predetermined temperature and humidity conditions. The boiler room is in communication with the steam curing pipeline for supplying steam into the steam curing pipeline, and the pre-fabricated external wall formed in the production area is conveyed to the post treatment area through the material conveying system.

In an embodiment, the post treatment area includes an overturning region and a repairing/cleaning region, wherein an overturning frame is arranged in the overturning region to overturn the pre-fabricated external wall to a certain angle, and the repairing/cleaning region is used to perform cleaning and local repairing operations on the pre-fabricated external wall already-formed.

In an embodiment, the storing/curing area is configured to have a structure which is concave in a peripheral region while convex in a central region, and a drainage channel surrounds the storing/curing area. The storing/curing area is further provided

with a watering curing system for performing watering curing on the pre-fabricated external wall already formed, wherein water from the watering curing system is collected by the drainage channel for secondary use.

5 In an embodiment, the storing/curing area is further provided with a loading station at its rear portion for loading the pre-fabricated external wall as formed for delivery.

10 In an embodiment, the production area, the post treatment area, and the storing/curing area occupy a total area of the pre-fabricated external wall production line in percentages of $40\pm5\%$, $10\pm5\%$, and $50\pm5\%$, respectively.

15 In an embodiment, the loading station occupies $10\pm5\%$ of a total area of the pre-fabricated external wall production line.

20 In an embodiment, 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 external wall 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 external wall 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.

25 In an embodiment, the pre-fabricated external wall production line has a length of 60-100 m, and a width of 23-25 m.

30 According to the pre-fabricated external wall production line of the present invention, compared with the prior arts, the production line is optimized based on the

production process of the pre-fabricated external wall, 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 material conveying system which connects these areas, the pre-fabricated members and the products can be conveyed between these areas with a high efficiency. Moreover, one single material conveying system can be used for two sets of pre-fabricated external wall, thus maximizing the production efficacy.

Brief Description of the Drawings

Fig. 1 schematically shows a pre-fabricated external wall production line according to the present invention; and

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

Detailed Description of the Embodiments

To enable the purpose, the technical solution and the advantages of the present invention clearly understood, the present invention will be described in further detail with reference to the accompanying drawings and embodiments. The embodiments are provided to elaborate the present invention, with no intention of limiting the scope of the present invention.

As shown in Fig. 1, the pre-fabricated external wall production line according to the present invention includes, along its lengthwise direction, a production area 10, a post treatment area 20 and a storing/curing area 30 in sequence. Between adjacent areas there is provided with a material conveying system. The production area 10

includes two storage regions 11 for external wall mold, which are symmetric to each other along the middle line of the production area 10. There is provided with a central passageway for operators and material between the two storage regions 11 for external wall mold. The central passageway is so wide that the production requirement and the safety can be both ensured. The storing/curing area 30 consists of two storage portions arranged side by side, between which there is also provided with a passageway for operators and material.

The production area 10 is provided with an external wall mold therein. By means of which, reinforced bars and concrete can be used to form a pre-fabricated external wall in the external wall mold. The post treatment area 20 is used for performing post treatments on the already-formed pre-fabricated external wall. The storing/curing area 30 is used for storing the pre-fabricated external wall after post treatments. And the material conveying system is used to convey the pre-fabricated external wall and other production material between these areas.

According to the pre-fabricated external wall production line of the present invention, the production line is optimized based on the production process of the pre-fabricated external wall, 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 material conveying system which connects these areas, the pre-fabricated members and the products can be conveyed between these areas with a high efficiency. Moreover, one single material conveying system can be used for two sets of pre-fabricated external wall, thus maximizing the production efficacy.

In this embodiment, as shown in Fig. 1, the production area 10 further comprises a reinforced bar storing region 12 and a reinforced bar binding region 13 that are

arranged at the front portion thereof in a parallel manner. Similarly, a passageway in communication with the central passageway of the production area 10 is also arranged between the reinforced bar storing region 12 and the reinforced bar binding region 13.

5 The reinforced bar storing region 12 is used for storing the reinforced bars necessary for manufacturing the pre-fabricated external wall. 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.

10 The reinforced bar binding region 13 is used for binding the reinforced bars stored in the reinforced bar storing region 12 into a reinforcement cage. The reinforcement cage as formed is conveyed through the material conveying system to the mold arranged in the mold storage regions 11, where the final steps such as binding the reinforced bars, mounting accessories, embedding inserts, or the like, are
15 performed.

The reinforcement cage necessary for the production of the pre-fabricated external wall is relatively large in volume, thus it is generally not suitable for transportation means, such as a roller bed or a forklift. In the present embodiment, the
20 reinforcement cage as formed in advance is put in the external wall mold through hoisting. According to the present embodiment, the reinforced bar storing region 12 and the reinforced bar binding region 13 are arranged at the front portion of the production area 10, thus reducing the movement distance of the material conveying system. In the meantime, since there is a passageway formed between the reinforced
25 bar storing region 12 and the reinforced bar binding region 13, the ground operators can easily access the material conveying system. The whole layout is reasonable, thus reducing inefficient transportation, achieving sufficient utilization of the production space, and increasing the production efficiency.

30 The pre-fabricated external wall mold is very large in volume, and generally

speaking, it will be fixed in the external wall mold storage region 11 in advance, thus forming a plurality of external wall mold stations. In the present embodiment, each external wall mold station is provided with a vibrator, which is used to compact the concrete in the external wall mold in a homogenous and dense manner. Under normal weather condition, the pre-fabricated external wall, after pouring and vibrating steps, can reach the hoisting strength after a certain time of settlement. However, if the temperature is relatively low, the solidification of the pre-fabricated external wall will turn slow. Therefore, to meet the requirement of production, it is necessary to perform thermal curing. Accordingly, in the present embodiment, the mold station is provided at this bottom with a steam curing pipeline, which can perform thermal curing on the pre-fabricated external wall as formed according to predetermined temperature and humidity conditions. The external wall mold storage region 11 is provided with a boiler room 14, which is in communication with the steam curing pipeline, so as to supply steam to the steam curing pipeline. Generally, one single boiler room 14 in the whole production area 10 is sufficient to meet the requirement of production. When the mold has a fixed position, the cost associated with the cladding-type steam curing through the pipeline would be lower than that associated with a steam curing room.

After the pre-fabricated external wall in the production area 10 reaches the hoisting strength, the mold is removed, and the pre-fabricated external wall is conveyed to the post treatment area 20 for further cleaning and repairing operations through the material conveying system. The post treatment area 20 includes an overturning region 21 and a repairing/cleaning region 22.

The repairing/cleaning region 22 is used to perform cleaning operation for the already-formed pre-fabricated external wall, and repairing operation for local defects of the pre-fabricated external wall. In addition, in the repairing/cleaning region 22 a surface brushing operation can be further performed. After the pre-fabricated external wall is mounted on a building, a layer of concrete will be generally applied on one of side surfaces thereof. For achieving good bonding with the concrete cast in situ later,

part of concrete surface of the pre-fabricated external wall 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 rough surface. Of course, the rough surface can be obtained through other tools with a similar function. The overturning region 21 is provided with an overturning frame, which is used to overturn the external wall mold to a certain angle, so that the external wall mold can be hoisted and loaded later, and then conveyed to the storing/curing area 30 for storage and water curing.

For facilitating the water curing, in a preferred embodiment, the storing/curing area 30 is configured as having a structure which is concave in the peripheral region while convex in the central region. In addition, there is a drainage channel surrounding the storing/curing area 30. Moreover, in the storing/curing area 30 there is further provided with a water curing system, with which the water curing operation to the already-formed pre-fabricated external wall can be performed. Water from the water curing system can be collected by the drainage channel for future use.

The curing of the pre-fabricated external wall is the most time-consuming step in the whole process for the production of the pre-fabricated external wall. Traditionally, the curing includes steam curing, natural curing, and water curing. When the pre-fabricated external wall reaches the design strength, the water curing is generally cheap in cost. In the present embodiment, in order for further saving water, the storing/curing area 30 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.

Further, the storing/curing area 30 is provided with a loading station 40, where the already-formed pre-fabricated external wall can be loaded for delivery.

The production area 10, the post treatment area 20, the storing/curing area 30,

and the loading station 40 occupy the total area of the pre-fabricated external wall production line in percentages of $40\pm5\%$, $10\pm5\%$, $50\pm5\%$, and $10\pm5\%$, respectively, and preferably 40%, 10%, 40%, and 10%, respectively. 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.

In the present embodiment, the material conveying system adopts an overhang conveying system, which includes: a first movement mechanism that can be movable along the lengthwise direction of the pre-fabricated external wall 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 external wall 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.

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

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

In a step of cleaning the mold, the mold is cleaned by labor or a suitable machine, mainly for removing concrete from the surfaces of the mold.

In a step of coating release agent and/or retarder, release agent and/or retarder is coated on the mold according to the requirement on the pre-fabricated external wall.

The release agent is coated for future demolding operation, and the retarder is coated

for extending the setting time of the pre-fabricated external wall so as to form a region having a rough surface.

In a step of binding reinforced bars and mounting pre-fabricated accessories, reinforced bars are bound in the external wall mold, and pre-fabricated accessories, such as window frames, panels, lines or the like, are mounted therein. For a large-sized reinforcement cage, a preliminary binding can be performed first, and then the reinforcement cage is conveyed to the external wall mold for further binding of reinforced bars.

In a step of assembling the mold, the baffle plates around the external wall mold are mounted and fixed. At this stage, a checking station can be provided here for checking whether the mold is mounted in a secured and stable manner. If a reversed check is necessary, the mold can be hoisted to the overturning frame, where it is overturned for a certain angle for further check.

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.

In a step of concrete pouring and vibrating, concrete is poured in the external wall mold already mounted, and then vibrated by the vibrator so as to be homogeneously compacted.

In a step of natural/steam curing, the pre-fabricated external wall after the concrete pouring and vibrating step is cured via natural curing or steam curing, so that the concrete is set to reach the hoisting strength.

In a step of mold dismantlement, the side plates and window frames are removed from the external wall mold after the concrete in the external wall mold reaches the

hoisting strength. Then, the pre-fabricated external wall mold is cleaned by water, so as to facilitate the removal of the pre-fabricated external wall from the mold.

5 In a step of hoisting and overturning, the pre-fabricated external wall is hoisted from the mold to the overturning device, which overturns the pre-fabricated external wall to a certain angle, so as to facilitate the following hoisting and transportation.

10 In a step of detecting and repairing, the pre-fabricated external wall removed from the mold is detected. If it is necessary to repair, the product is conveyed to the repairing/cleaning region 22. Qualified product is conveyed to the storing/curing area 30 for storage and water curing.

15 In a step of water curing, water curing is performed on specific pre-fabricated external walls so that they can reach the design strength.

In a step of laying decoration material, for the pre-fabricated members that should be laid with external wall decoration material, the external wall decoration material is laid on the pre-fabricated members.

20 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.

25 In a step of delivery, qualified pre-fabricated external wall can be loaded at the loading station 40, and then 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 external walls 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 30

which a level is built in 6 days, there are 6 pre-fabricated external walls of a specific type, one mold will 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 external walls 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.

A standard production line has a basic width of 23-25 m, and a length of about 60-100 m. Along the lengthwise direction of the production line, the front part thereof is used for production of pre-fabricated members and occupies about 40-50% of the total area of the production line, the remaining being used as storage area. Generally speaking, the storage area can accommodate one to two layers of stock. One layer stock means the pre-fabricated members that are sufficient for construction of one level of building in a construction period.

In the meantime, for each mold production station, it should be taken into consideration that the mold should be quickly detachable, and small elements, such as window cover, or the like, should be temporarily stored during production. The production process is formulated according to that for pre-fabricated members. The steam curing of the pre-fabricated external wall is achieved through a steam pipeline arranged in advance, which is in communication with every mold. Under a weather condition that needs steam curing, each mold should be covered and conserved. After the production area there is provided with a product overturning frame, by means of which, the product coming from the mold, which is horizontally oriented, can be rotated to have an angle suitable for vertical hoisting. The angle is generally in a range of 80-88 degrees.

A temporary repair area is arranged in a central position of the production line, for repairing the defect portions of the product. In the storage 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. A storage rack is provided in the storage area for vertically stored components, so that safety of the stored components can be sufficiently guaranteed. For the product in which the pre-fabricated external wall thereof has a decoration surface, a station for
5 laying external wall decoration can be provided in the storage area. Otherwise, external wall decoration can be directly laid at the storage location of each product. If a procedure of mounting aluminum window panel is necessary according to the requirement on the pre-fabricated external wall, a space for mounting window panel should be left in advance when the product is stored in the storage area. For a
10 production line solely for production of the pre-fabricated external wall, 40 to 60 products, which are usually produced within one day, can be produced in one working hour. In this connection, 18-25 operators are involved, thus requiring less human resource.

15 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 each aspect. The distance between different units 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
20 can maximize the production efficiency.

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,
25 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 external wall production line, including, along its lengthwise direction, a production area (10), a post treatment area (20) and a storing/curing area
5 (30) in sequence, a material conveying system being provided between these areas,

wherein the production area (10) includes two external wall mold storage regions (11), which are symmetric to each other along a central line of the production area (10), a central passageway being provided between the two external wall mold storage regions (11);

10 the storing/curing area (30) consists of two portions, which are symmetric to each other along the central line of the production area (10), between which there is also provided with a passageway;

the production area (10) is provided therein with an external wall mold, by means of which reinforced bars and concrete can be used to form a pre-fabricated
15 external wall in the external wall mold;

the post treatment area (20) is used for performing post treatment on the pre-fabricated external wall already formed;

the storing/curing area (30) is used for storing the pre-fabricated external wall after being post treated; and

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

2. The pre-fabricated external wall production line according to claim 1, characterized in that the production area (10) comprises a reinforced bar storing
25 region (12) and a reinforced bar binding region (13) that are arranged in parallel at a front portion of the production area (10),

wherein a passageway in communication with the central passageway of the production area (10) is arranged between the reinforced bar storing region (12) and the reinforced bar binding region (13);

30 the reinforced bar storing region (12) is used for storing reinforced bars that are

necessary for production of the pre-fabricated external wall; and

the reinforced bar binding region (13) is used for binding the reinforced bars stored in the reinforced bar storing region (12) into a reinforcement cage, which is, after being formed, conveyed by the material conveying system to the mold in the external wall mold storage region (11).

3. The pre-fabricated external wall production line according to claim 1, characterized in that the external wall mold storage region (11) is provided therein with a boiler room (14), a plurality of external wall mold stations, and a vibrator arranged at each of the external wall mold stations for vibrating and compacting concrete in the external wall mold,

wherein a steam curing pipeline is arranged at a bottom of the mold stations, for curing the pre-fabricated external wall as formed based on predetermined temperature and humidity conditions, the boiler room (14) being in communication with the steam curing pipeline for supplying steam into the steam curing pipeline, and the pre-fabricated external wall formed in the production area (10) is conveyed to the post treatment area (20) through the material conveying system.

4. The pre-fabricated external wall production line according to claim 1, characterized in that the post treatment area (20) includes an overturning region (21) and a repairing/cleaning region (22), wherein an overturning frame is arranged in the overturning region (21) to overturn the pre-fabricated external wall to a certain angle, and the repairing/cleaning region (22) is used to perform cleaning and local repairing operations on the pre-fabricated external wall already-formed.

5. The pre-fabricated external wall production line according to claim 1, characterized in that the storing/curing area (30) is configured to have a structure which is concave in a peripheral region while convex in a central region, and a drainage channel surrounds the storing/curing area (30), and

the storing/curing area (30) is further provided with a water curing system for

performing water curing on the pre-fabricated external wall already formed, wherein water from the water curing system is collected by the drainage channel for secondary use.

5 6. The pre-fabricated external wall production line according to claim 1, characterized in that the storing/curing area (30) is further provided with a loading station (40) at its rear portion for loading the pre-fabricated external wall as formed for delivery.

10 7. The pre-fabricated external wall production line according to any one of claims 1 to 6, characterized in that the production area (10), the post treatment area (20), and the storing/curing area (30) occupy a total area of the pre-fabricated external wall production line in percentages of $40\pm5\%$, $10\pm5\%$, and $50\pm5\%$, respectively.

15 8. The pre-fabricated external wall production line according to claim 6, characterized in that the loading station (40) occupies the total area of the pre-fabricated external wall production line in a percentage of $10\pm5\%$.

20 9. The pre-fabricated external wall 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 external wall 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 external wall production line;

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

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

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

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