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Technological project of the existing plants reconstruction of large-panel housing construction: problems and solutions

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Abstract

Increasing the volume of construction and meeting the requirements to reduce the cost of housing contribute to the flourishing of industrial housing. First, industrial housing is cheaper, and its construction is necessary for implementation of the state policy in relation to the needy in improvement of housing conditions of needy disabled citizens, and also their other categories enjoying the privileges provided by the legislation (social housing). Secondly, with the transition to the construction of residential buildings of modernized series, i.e. houses of modern consumer and operational qualities, it is possible to move to meet the needs of a wider range of consumers, namely the more affluent segments of the population, organizations and enterprises of various forms of ownership. Thus, project institutes have developed new standard series of panel buildings, allowing to build housing with increased kitchens, bathrooms, staircases, equipped with freight elevators. In the development of some standard series managed to ensure that modern panel houses have Bay Windows, French balconies, individual architectural solutions, non-standard input groups. Solutions for the development of a series of 25-storey houses, as well as industrial 3-room houses of the manor type for rural areas on the basis of products of large-panel housing (LPH) construction are being worked out. To date, there are 14 enterprises of efficiency and house-building plants in the Republic, of which 8 enterprises are subordinated to the Ministry of construction and architecture of the Republic of Belarus and 6 enterprises are in communal ownership, and all enterprises to a greater or lesser extent require the renewal of technological equipment, reconstruction of industrial buildings and structures. In order to solve this problem, a State comprehensive program for the development of the material and technical base of the construction industry was developed, within the framework of which investment projects for the reconstruction, modernization and technical re-equipment of LPH plants were implemented.

Keywords: reconstructions, LPH

1 The main requirements for the modernization of LPH plants and the sequence of its implementation

The main purpose of the modernization of LPH plants is to improve the consumer quality of housing and reduce its cost by switching to modern flexible structural and technological systems that provide freedom of architectural and planning solutions of apartments and the appearance of buildings, improving operational, especially thermal, characteristics, the use of new energy and resource-saving technologies for the production of efficiency products, expanding their range [3, 4].

In General, the process of modernization of LPH enterprises can be divided into the following stages:

- development of project proposals for modernization of the standard series;
- development of a business plan for modernization;
- inspection of enterprises with the development of technical conclusions on the physical condition of equipment, buildings (shops, warehouses, etc.);
- development of the project of reconstruction of buildings;
- development of the project of technological re-equipment of the plant;

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- tenders for the supply of equipment;
- development of investment justification or project documentation of the "Architectural project" stage";
- opening of financing and obtaining permission to perform construction and installation works on the restoration of buildings and dismantling of equipment; development of project documentation of the "Construction project" stage";
- installation and adjustment of new technological equipment;
- commissioning and output of equipment at full capacity.

At the same time, the main requirements for the modernization of enterprises for the production of precast concrete products and structures include [5]:

- modernization of the main production without stopping the production to fulfill the obligations of enterprises under the contracts;
- increase of productivity of the enterprise without increase in floor spaces;
- reducing the energy intensity of production through the use of modern technological approaches and equipment;
- reduction of metal production through the use of production lines and systems that allow flexible change of the range and size of products;
- the preservation of the old duty crane industry.

2 Brief description of the facility and justification of the decisions taken to modernize the LPH plant without stopping production

On the scale of Vitebsk region large-panel house building plant (branch of the open joint stock company "Construction and installation company N⌀16 Novopolotsk") is the only company with production facilities for the production of series 90 products for industrial housing construction and construction of residential buildings in combination with other structural systems and products LPH. The structure of the branch includes:

- molding work shop, which includes 4 spans;
- concrete-raw material Department (CRMD) tower type;
- reinforcement work shop;
- finished product warehouse;
- rail cement warehouse;
- warehouse of inert aggregates.

In accordance with the program of modernization of the company provided for the transfer of production of LPH in the release of products for houses of a new generation on the basis of modernized 90 series with the raise the production capacity of 84 000 m^2 to 100 000 m^2 of total area of housing per year, or 50 to 89 500 m^3 of reinforced concrete products per year, using modern equipment and technology, without stopping production.

In the project of modernization of production the technological scheme providing increase in production capacity of the enterprise without increase in floor spaces, change of constructive decisions of production cases of the enterprise and additional expenses of specific electric power per unit of production is developed. Also used technological solutions that reduce the complexity of the production of products and reduce the material intensity of production due to modern bench technology, allowing flexibility to solve the problem of production of a wide range of products for LPH. The use of modern methods of control of strength set of molded concrete products will improve the quality while reducing the production cycle of products.

According to the program of modernization of the enterprise and being guided by the requirement not to stop production, repair and construction works on modernization of the main production are divided into start-up complexes.

3 Implementation of the 1st launch complex of the project

The 1st launch complex provided for the construction of a new mortar unit (MU) for the preparation of structural heavy concrete and mortar mixtures (Fig. 1).

The construction of this facility in the 1st start-up complex is due to the need to provide the main production of concrete mixtures at the time of stop for the reconstruction and modernization of CRMD, cement warehouse and inert materials [1, 6]. To ensure the production program for the production of LPH products and the provision of construction sites with mortars and ready-mixed concrete, the construction of MU with a capacity of 90 m^3/h was envisaged.

Figure 1. Domestic MU capacity of 90 m^3/h

After modernization due to the increase in the capacity of the main production and the corresponding increase in the load on the CRMD MU is used to provide commercial concrete and mortar mixes for construction projects.

4 Implementation of the 2nd launch complex of the project

In the 2nd start-up complex, the project provided for the reconstruction of the reinforcement and part of the molding shop by replacing the process equipment on half-spans in order to continue the production of products of the old series.

In the reinforcement shop, due to the constant updating of the technological equipment Park to ensure the production program, after increasing the production capacity, only individual machines were subject to replacement [2]. The project provided for the installation of new, more powerful machines on site to be dismantled, taking into account the requirements for safety, supply of engineering networks and communications. The output to the design capacity of the reinforcement shop is provided to the end of the 2nd start-up complex.

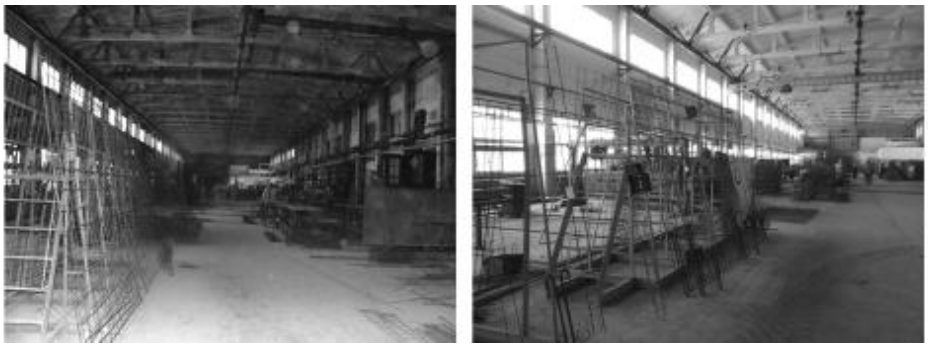

Figure 2. a) General view of the reinforcement shop before modernization; b) General view of the reinforcement shop after modernization

In the 2nd start-up complex in the molding shop, the old technological equipment was dismantled on half of the spans, the existing targeted concrete supply was dismantled and the new technological equipment was installed. This launch complex provided for the supply of all engineering networks and communications to the installed technological equipment and equipment to be installed in the 3rd launch complex, for its subsequent uninterrupted operation.

At the final stage of the 2nd start-up complex, simultaneous operation of the old technological equipment on the half-span and the new one is provided. At the same time in the 2nd start-up complex on the new technological equipment it is planned to produce 30 % of the designed capacity, which is due to the limited working conditions and the need to test the new technology and perform tests when setting up a new series of products for production. The following approaches were used to ensure the simultaneous operation of the old technological equipment on the half-span and new assembled lines:

- in spans additional technological posts on which expendables and accessories of new technological lines and the equipment were placed were arranged;
- in accordance with the new technology, additional areas were provided in the spans for holding the finished products up to the set of their selling strength.

5 Implementation of the 3rd launch complex of the project

In the 3rd start-up complex, the project provided for the reconstruction of the remaining part of the molding shop, storage of aggregates, cement warehouse and CRMD, including the targeted supply of concrete to the spans of the molding shop. In the molding shop, the old technological equipment is dismantled in the remaining half of the spans and the installation of new production lines and equipment. After you connect the mounted equipment to the utility networks used to run production lines and the exit of production at full capacity.

In CRMD dismantle of the old equipment and installation of the modern concrete-mixing and weight-loading equipment is carried out. When upgrading the storage facilities of aggregates, it is planned to equip the existing stock with modern power plants for heating inert aggregates, as well as the construction of a new open warehouse of the stack type for the needs of the new MU.

When upgrading the cement warehouse due to the increase in the capacity of the main production and the construction of a new mortar unit to ensure the regulatory storage of cement, it is planned to build 2 new silos with a capacity of 300 tons.

6 The main technological solutions for the modernization of the molding shop

The molding shop is a 4-span building with dimensions in terms of 79 144 m and height to the bottom of the roof trusses covering 12.1 m. the Width of the 1st span – 24 m, 2nd – 4th – 18 m. The range of products by spans is presented in table 1.

Table 1. The range of products on the spans of the molding shop

Name of the object	**Product name**
Forming span N$\underline{o}$1	Exterior wall panel (ordinary, semi-basement, garret), the elements of the loggias, login items
Forming span N$\underline{o}$2	Internal wall panels and partitions (ordinary, basement, attic), loggia fencing
Forming span N$\underline{o}$3	Plate covering and overlapping the elements of the input
Forming span N$\underline{o}$4	Elevator shafts; stairwells; ventilation units; additional products

To ensure uninterrupted production, the reconstruction and modernization of the molding shop is divided into 2 start-up complexes (2nd and 3rd start-up complexes of the LPH plant modernization project).

7 The main technological solutions for the modernization of the span N$\underline{o}$1 of the molding shop

In the molding span N$\underline{o}$1, before modernization, external wall panels were produced on a conveyor line consisting of 2 parallel branches. Heat treatment of products was carried out in 3 single-tier slotted chambers located outside the body parallel to the conveyor line. In order to gradually move to the production of external wall panels of the upgraded series, it was planned to dismantle one branch of the conveyor line and install a stationary stand 100 m long on the half-span in the "B-B/1" axes (Fig. 3) and specialized technological equipment for stand maintenance (cleaning and lubrication machine (Fig. 6), grout machine (Fig. 8), the machine for the layout of the insulating tarpaulin (Fig. 9)).

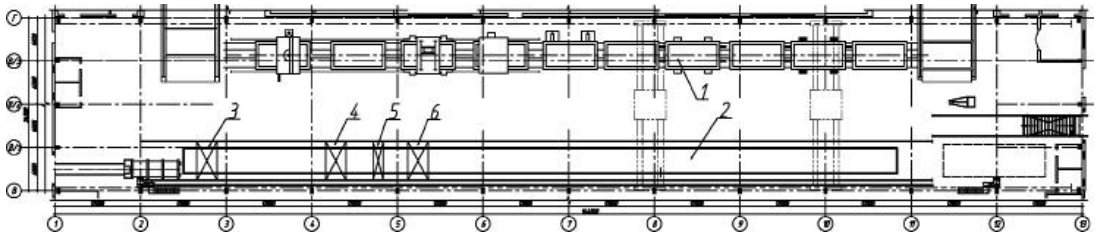

Figure 3. Forming a Plan of span No. 1 (2nd start-up complex)

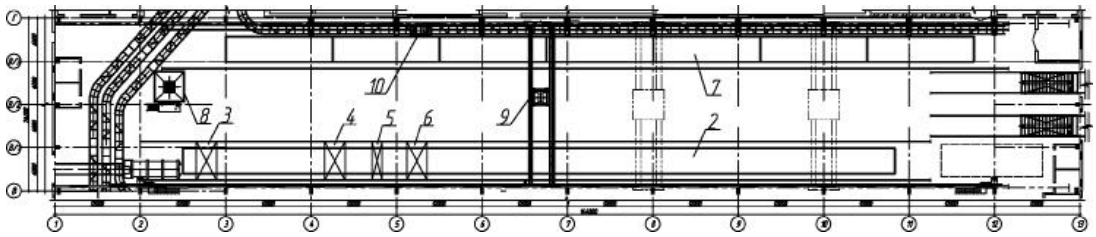

Figure 4. Forming a plan of span No. 1 (3rd launch complex): 1 – conveyor production line of external wall panels; 2, 7 – stand for the production of external wall panels; 3 – machine for cleaning and lubrication of the stand; 4 – trowel machine; 5 – vibrator; 6 – machine for laying insulating tarpaulin; 8 – post washing concrete paver; 9 – bridge concrete paver; 10 – Kubel targeted concrete supply

Production of external wall panels after modernization of molding shop is carried out on bench technology on 2 lines the front side down (Fig. 4). Stand in the axes "B/3-Г " tilted length of 105 m is divided into 7 sections of 15 m. The Second stand in the axes "B- B /1" has stationary length of 100 m. Fastening of separators and meatus formators to the pallet is carried out by means of permanent magnets (Fig.10).

The technology of production of products on long stands allows to refuse a set of the metal forms necessary for each type and size of a product. Stands are easily converted to the desired type of product. Thus, the length of the product can be changed by rearranging the dividers, and the height of the products is changed by moving the longitudinal side of the stand.

The stands are a 2-tier rigid structure. On the upper tier, molding of products is performed, on the lower tier there are heat treatment registers. The opening and closing of the longitudinal sides of the Elevator with a hydraulic drive providing for remote control.

A distinctive feature of the bench technology is that the products are formed in certain areas in accordance with the layout scheme of products, and all technological equipment is moved from post to post.

To seal the lower layer of the concrete mixture on the side surface of the stands, mounted electric vibrators are provided. Remote control of the vibrators from the control panel.

Figure 5. (A) General view of molding span No. 1 before modernization; B) General view of the molding span N$\underline{o}$1 after modernization

Figure 6. Machine for cleaning and lubrication of stands

Figure 7. Concrete paver of bridge type

8 The main technological solutions for the modernization of the span N$\underline{o}$2 of the molding shop

The production of internal wall panels and partitions on the cassette unit and on the conveyor-cassette line was organized in the molding span N$\underline{o}$2. In the 2nd launch complex (Fig. 11) provided for the dismantling of the old physically worn cassette installation and installation in its place 2 modern high-tech cassette units with pneumatic drive.

In the 3rd launch complex (Fig. 12) dismantling of the existing cassette-conveyor line for production of internal wall panels and installation on its place of 2 new cassette installations, the machine for cleaning and greasing of cassette installations (Fig. 14) and concrete paver (Fig. 15).

Production of external wall panels and partitions after modernization is organized in 4 cassette installations (3 cassette installations on 16 compartments (8 + 8) for products in the thickness of 160 mm and 1 cassette installation

Figure 8. Ride-on trowel insulating tarpaulin

Figure 9. Machine for layout

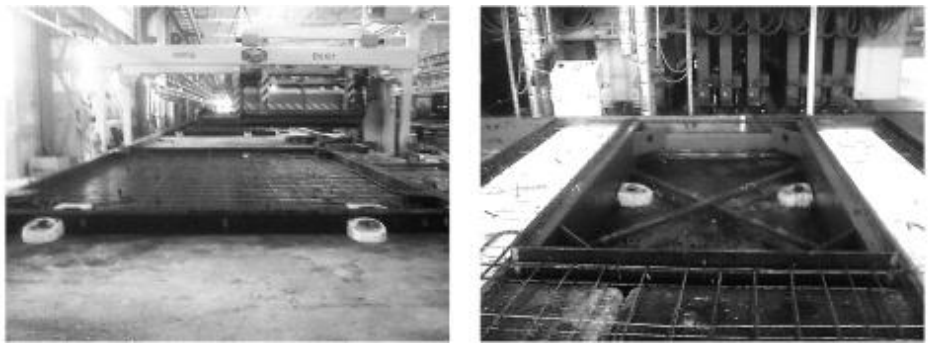

Figure 10. The attachment of dividers and cavities to the stand with magnets

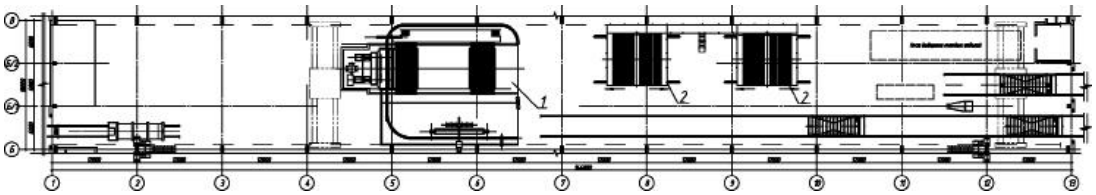

Figure 11. Plan of molding span N$\underline{o}$2 (2nd start-up complex of modernization)

on 16 compartments (10 compartments for panels in the thickness of 80 mm + 6 compartments for panels in the thickness of 60 mm). The organization of production of internal wall panels and partitions in a vertical position (in cassettes) is primarily associated with limited production space in the 2nd molding span and a large volume of products.

The cassette unit consists of 2 parts with a Central side. The design of the cassette provides 2-sided heating of

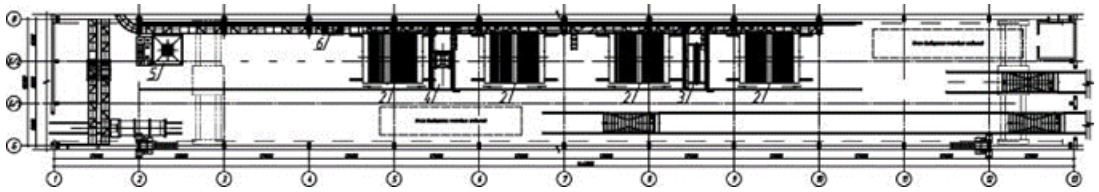

Figure 12. Forming plan of span No. 2 (3rd launch complex modernizations): 1 – line cluster line; 2 – battery; 3 – the machine cleaning and lubricating cassette; 4 – paver; 5 – post washing concrete paver; 6 – Kubel targeted concrete supply)

the product. The travel drive of the cassette compartments is pneumatic. Compaction of concrete mix is carried out by means of a set of hinged vibrators from the vibration control Board.

Figure 13. A) General view of molding span No. 2 prior to modernization B) General view of the molding span N$\underline{o}$2 after modernization

Figure 14. Machine for cleaning and lubrication of cassette units

Figure 15. Portal concrete paver

9 The main technological solutions for the modernization of the span N$\underline{o}$3 of the molding shop

In the molding span N$\underline{o}$3, the production of floor slabs according to the current technology was organized on a conveyor line consisting of 9 posts. Heat treatment of products was carried out in 2 underground slotted chambers of continuous action, located under the molding span.

After dismantling of finishing posts, marking and storage of floor slabs on the released place in axes "A-A/1" (Fig. 16) provides for the installation of the stand with a length of 110 m and specialized technological equipment for maintenance of the stand (machine cleaning and lubrication, rubbing machine, machine for insulating tarpaulin layout).

In the 3rd launch complex (Fig. 17) provides for the dismantling of conveyer lines in the production of floor slabs, installation of the stand with a length of 110 m and a bridge paver.

In the end, the production of coating and floor slabs will be organized by bench technology, on 2 stands with a length of 110 m each, divided into sections. Structurally, the stands are similar to the stands in the molding span N$\underline{o}$1.

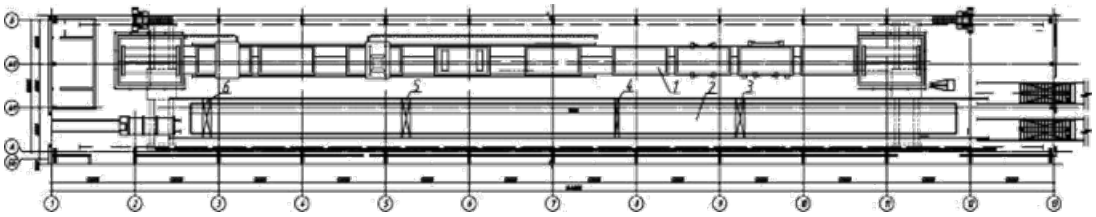

Figure 16. Forming Plan of span No. 3 (2nd start-up complex modernizations)

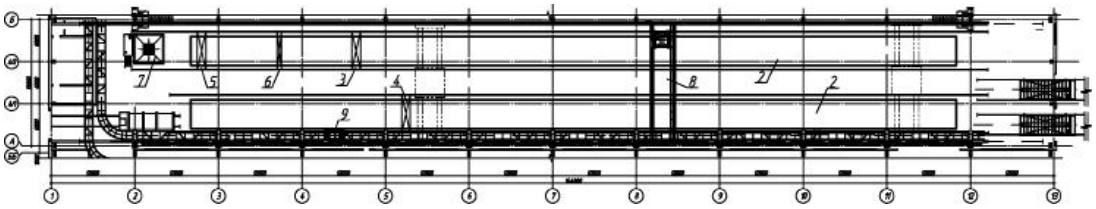

Figure 17. forming a Plan of span No. 3 (3rd launch complex modernizations): 1 – conveyor production line of floor slabs; 2 – stand for production of floor slabs; 3 – machine for cleaning and lubrication of the stand; 4 – ride-on trowel; 5 – vibrating screed; 6 is the machine for pickup insulating tarpaulin; 7 – concrete paver washing station; 8 – pavement concrete paver; 9 – Kubel of address concrete supply

Figure 18. A) General view of molding span No. 3 before modernization; B) General view of the forming passage No. 3 after modernization

10 The main technological solutions for the modernization of the span N$\underline{o}$4 of the molding shop

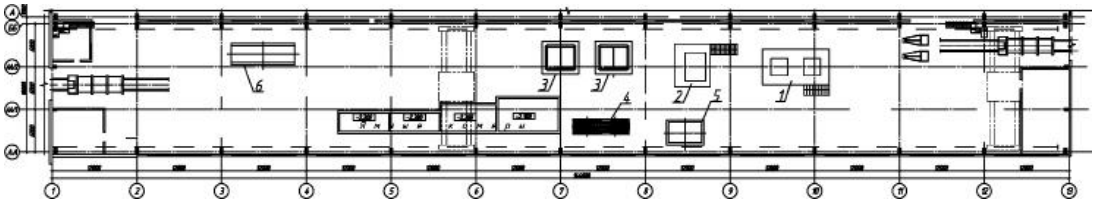

Figure 19. Forming Plan of span No. 4 (2nd start-up complex)

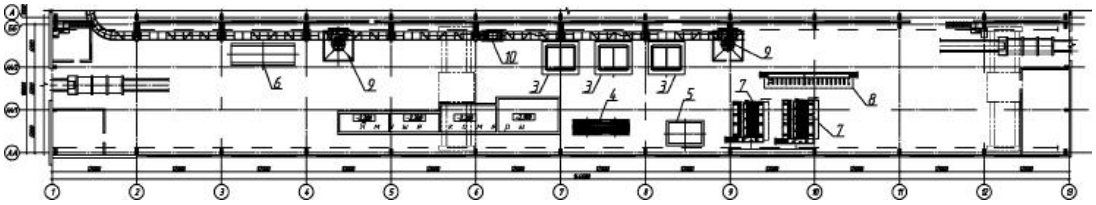

Figure 20. forming Plan of span No. 4 (3rd launch complex): 1– cassette unit for the production of ventilation units (existing); 2 – cassette installation for the production of Elevator shafts (existing); 3 – cassette installation for the production of Elevator shafts (project); 4 –cassette installation for the production of staircases; 5 – conductor for the Assembly of reinforcement cages; 6 – vibratory platform; 7 – cassette installation for the production of ventilation units (project); 8 – post lubrication and storage of punches; 9 – post reception of concrete mixture from Kubel; 10 – Kubel concrete transportation

Figure 21. A) General view of molding span No. 4 before modernization; B) General view of the molding span N$\underline{o}$4 after modernization

Figure 22. Cassette unit for the production of ventilation units

In the molding span No.4 aggregate was placed in-line manufacture of articles of slats in forming a post with

Figure 23. Cassette units for the production of Elevator shafts

Figure 24. Cassette installation for the production of staircases

Figure 25. Post reception of concrete mix from Kubel of address giving

the shaking table and bench production of sanitary cabins and ventilation units in the individual forms. After the modernization provides for the manufacture of products of additional aggregate-flow technology and manufacturer of ventilation units, Elevator shafts and stairways in cluster installations with the flow of the concrete mix according to the scheme of the crane bucket. To do this, after installation of the new system address the filing in the span runs 2 post receiving the concrete mix of shuttles (self-propelled carts which are designed for transportation of concrete mixes) (Fig. 25). Heat treatment of products will take place in 4 pit steaming chambers.

In the 2nd launch complex (see Fig. 19) provided for the dismantling of 2 forms for the manufacture of sanitary cabins, installation in place of dismantled forms 2 cassette units for the production of Elevator shafts and installation of a cassette unit for the production of staircases.

In the 3rd launch complex (Fig. 20) provided for the dismantling of 2 cassette units for the production of ventilation units and one cassette unit for the production of sanitary cabins, the installation of 2 new cassette units for the production of ventilation units and a cassette unit for the production of Elevator shafts. In the span of a device is provided post the cleaning and lubrication of the punches and the positions of the sink molding bucket. Also in the

3rd start-up complex modernization of pit steaming chambers with transition to heat treatment of products "deaf" steam is made.

Cassette installation for the production of staircases (Fig. 24) provides simultaneous production of 4 products.

Cassette unit for the production of Elevator shafts (Fig. 23) equipped with metal sliding sides with hydraulic opening and closing drive. The installation is equipped with a blasting device that provides partial separation of the steamed product from the bottom of the metal mold and the Central liner, followed by removal of the product (Stripping). Heat and humidity treatment of the product is carried out by means thermoresistive located in the outer sides. Seal concrete mixtures in the cluster units is carried out using the kit mounted vibrators from the control vibration.

Cassette unit for the production of ventilation units (Fig. 22) provides simultaneous production of 10 products (5 left + 5 right). Opening (moving) sides of the cassette installation is carried out mechanically by means of an electric drive. Heat and humidity treatment of the product is carried out by means thermoresistive located in the outer sides.

11 Conclusion

Each LPH plant, due to its specific manufacturing and organization of production, requires individual approaches to the development of the modernization program. Presented in the article approaches to the comprehensive modernization of the branch of the open joint stock company "Construction and installation company N$\underline{o}$16 Novopolotsk" - a plant of large-panel housing construction by dividing the modernization process into start-up complexes allowed to carry out technical re-equipment of production without stopping it. After all, stopping the main production of the plant entailed stopping the work of the construction departments of the trust and, consequently, the failure of the program for the introduction of housing. The approaches to the modernization of the LPH plant presented in the article can be useful in the future in the development of projects of reconstruction and modernization of enterprises and the choice of technology for the production of LPH products of modernized standard series.

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