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Development of the Automated Control System for Concrete Plant with Two Units Concrete Mixing

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Abstract
This paper proposes an approach to the development of the automated control system (ACS) for concrete plant with two concrete mixing, which is a set of hardware maintenance, information, mathematical and software for the management of technological objects. ACS has a layered structure, and may include multiple geographically distributed plants connected into a single technological system integrated into the enterprise management system. The proposed system is scalable and can include management subsystem concrete plants, air traffic control, laboratory, hydrothermal treatment, weight management, warehouse aggregates and cement, concrete targeted distribution, access control subsystems, jobs management personnel.

Keywords: concrete, concrete plant, mnemonic scheme, automated control system (ACS), programmable logic controller (PLC), control, process, twin-shaft mixer.

Introduction

Improving and speeding up the process of construction, lifting it to a new level is possible only with high performance and reliability of the respective production lines. With increasing international requirements for quality of production processes there is a need of its increase and stabilize.

The construction of important objects of civil and industrial construction requires considerable amounts of concrete, which are able to provide a high-performance concrete plants.

Process Control Production of concrete mixtures is currently impossible without the use of modern automated systems developed by using modern controllers and software [1 – 19].

Technological processes of producing concrete mixtures

Alternatives to concrete as a building material, as well as significant changes in the technology of its production is not observed. Despite the abundance of species of concrete, they are obtained by intimately mixing the major components in a concrete mixer to obtain concrete mixture of high homogeneity. In the case of individual use of concrete for the manufacture of small batches of small concrete products and construction yard outbuildings sufficiently small volume mixer.

The preparation includes the preparation of concrete materials, dosing and mixing of the components of the concrete mix. The technological process of preparation of concrete mixes is shown in Fig. 1.

Qualitatively prepared concrete mixture must have a homogeneous, in which a sample taken from any place has the same composition and uniform distribution of all components. To obtain a homogeneous concrete mix is necessary that not only the individual volume of the mixed materials, but also possible, each particle mixture separately made repeated movement in a mixer in the most complicated, often intersecting trajectories.

Automation object

The fundamental factors in choosing the concrete plant are specifications on mixing technology original equipment, as well as the reputation of the manufacturer, the presence of his certificates of quality, providing technical patronage during the operation of the delivered equipment. In recent years, widespread quickly mounted concrete plants.

Quickly mounted concrete plants (Fig. 2) is a plant with skip feeding inert materials.

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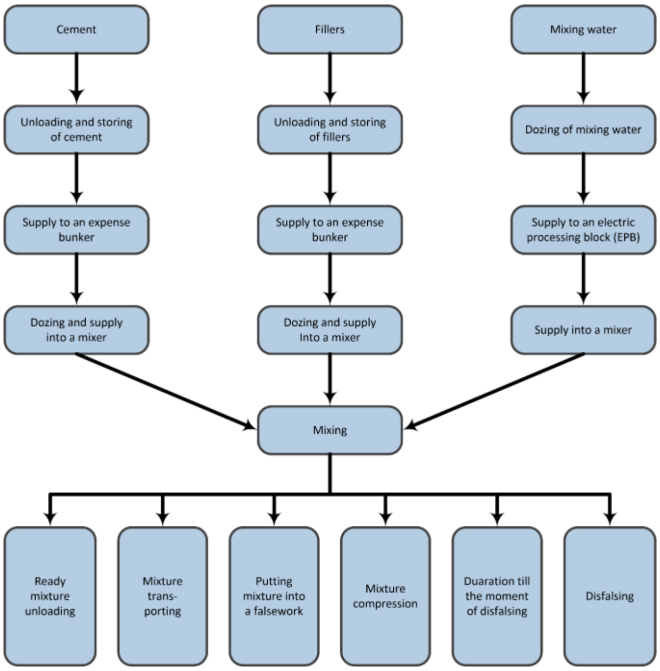

Fig. 1. Process of Concrete Mixes Production

Fig. 2. Quickly mounted concrete plants ELCON QUICK MASTER 120

The key features of plants is their compactness, in connection with the transportation of equipment is one of the container or wagon, deadlines mounting (dismantling), and there is no need to prepare a special foundation, and as a consequence - to minimize the cost of its fill for the installation of the plant. So quickly mounted concrete plants combine the characteristics of both fixed and mobile installations.

Equipment design allows you to quickly perform operations on the installation (dismantling) production and transportation of concrete to another site. Low cost of installation due to the use of innovative design solutions, combined with all the advantages mentioned above, created a steady demand for them around the world.

As an automation object considered quickly mounted concrete plants QUICK MASTER 120, which produces LLC "ELCON" (Turkey).

System approach to the development of a concrete plant automation

In accordance with the methodology of systems engineering work on the creation of a concrete plant automation will divide into stages and steps.

At the first stage we formulate the goal of the system. ACS concrete plant is designed for effective control and management process, from submission of materials from warehouses and ending with the delivery of the concrete mix to consumers. The purpose of control - increased efficiency, rhythm and quality of production, the timely provision of the necessary number of consumers mixtures settings.

In the second stage of the system analysis to delimit the system under study. Specifies that the system should include the management of the following processes: supply of materials from warehouses in capacity over the bunker separating dosing concrete mixture, issuance and delivery of ready-mixed concrete in the molding stations. Molding and other areas that consume the concrete, as well as rail and road transport, delivering the components of concrete warehouses, are not included in the system and can be attributed to the environment. It is assumed that in the operation of the system receives the orders for the concrete mix (with points of consumption), and the components of the concrete mix (warehouse cement and aggregates).

Thus, the external environment influences on the system. The influence of the external environment is neglected.

As a result, the primary structuring elements stand out the process to be automated management, as well as inputs and outputs that connect the system under consideration and the environment.

In the third stage of system analysis pre develop a mathematical model of the system. At this stage, limited to image and verbal description of subsystems and communication function.

Given the natural structure of the process, we conduct its decomposition into sub-processes (Fig. 3).

In accordance with the decomposition process in the sub-decomposed management tasks into subtasks (difficulty level decision makers).

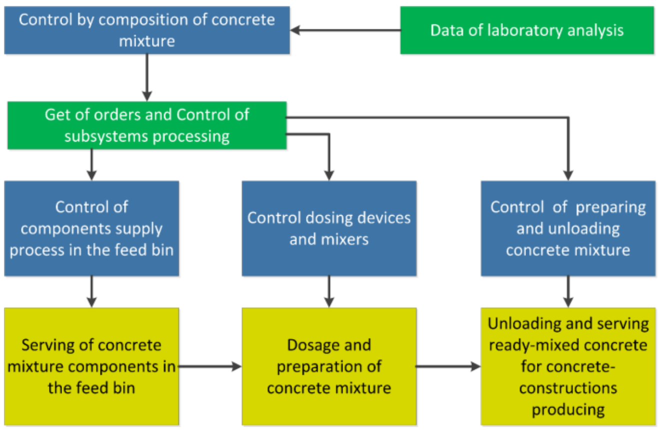

Fig. 3. Control Tasks for Concrete Plant

The overall objective of the control process as a whole is divided into a series of consistently solve simpler problems

(see Fig. 3). First, on the basis of laboratory analysis established percentages of components in concrete mixtures of different brands, taking into account humidity and debris aggregates, cement activity and so on. The results of this task are the initial data for the solution of coordination of subsystems in accordance with the orders for concrete mix, coming from environment. Based on the data queue of orders and results of solving the problem of the control structure, defined job dispensers and mixers, chain selected vehicles, delivering the finished concrete mixture to the consumer, supply bins are determined to be downloaded.
Further, preliminary design is carried out and the choice of the technical means control system (Fig. 4).

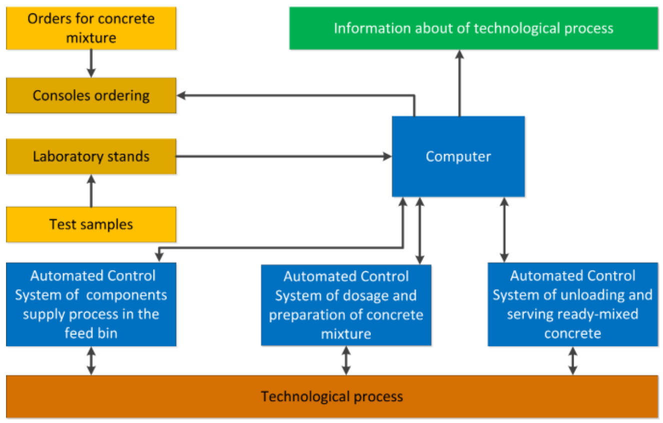

Fig. 4. Model ACS for Concrete Plant

Based on these stages of systems analysis work is distributed among individual performers, compiled schedules for completion of design and research works.
In the future for a number of sub-systems are drawn up more detailed mathematical models. In this transition function, outputs, binding functions are described in the form of mathematical expressions, which allows you to explore a variety of control algorithms by numerical simulation on a computer.
At receipt in the concrete component weighbridge tracking error mass change of material in the hopper of the dispenser because of the transient is large.
After closure of the dosing process and damping of transient weight of each component can be measured with greater accuracy. If it turns out that the components of the vector of percentage deviation is beyond a certain tolerance range, select the type of component and the corresponding dispenser dosing. After the implementation of the selected dosing procedure is repeated until the line is in principle the interactions vector percentage deviations will not be in the predetermined region.

Multilevel structure of the control system concrete plant
Concrete plant control system has three-level structure, and may include multiple geographically distributed plants connected into one technological system integrated into the enterprise management system (Fig. 5).
The complex may consist of the following subsystems:

- concrete plant;
- dispatching service;
- laboratory;
- hydrothermal treatment;
- weight management;
- warehouses of inert materials and cement;
- targeted distribution of concrete, access control systems;
- employment of administrative staff.

The database of each production associated with enterprise management system, and allows you to share information in real time.

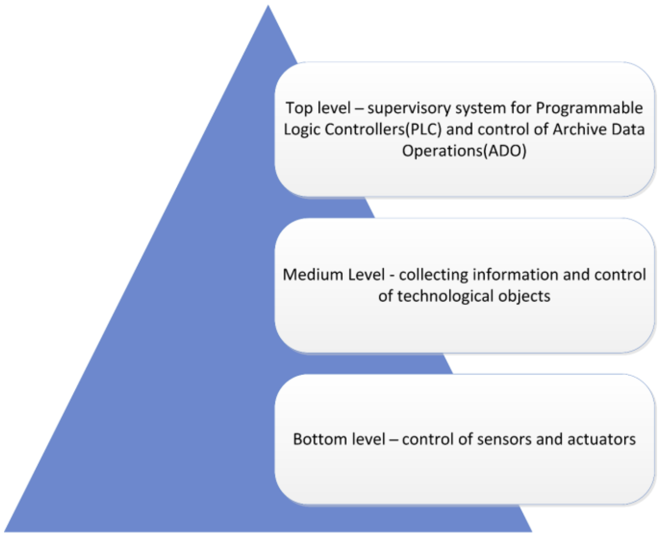

Fig. 5. Three-level management structure concrete plant

Automated Control System for concrete plant
In Fig. 6 shows the control system [14 - 16, 19] concrete plant concrete mixing two nodes. Control the process of mixing and dispensing an order proposed to take place with the help of programmable logic controllers (PLCs).

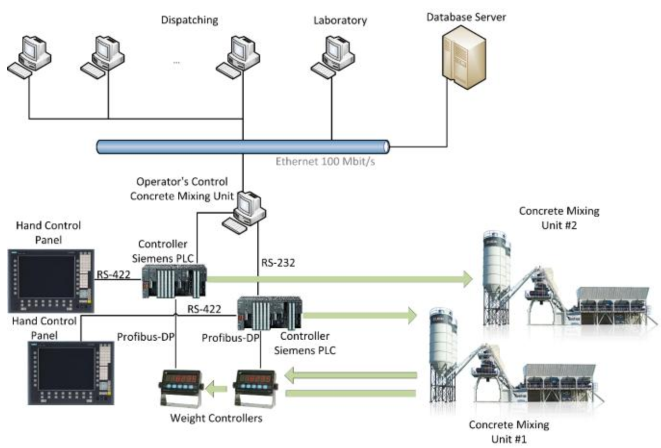

Fig. 6. Control system with two Concrete Mixing Units

The controller performs the following functions:

- process the data received from the sensors and actuators on the basis of which are managed;
- provide a communications interface for visualization of the technological process at the operator's station;
- return the factual information about the order.

All the resulting data with the time of the order are sent to the program flow control vehicles, as well as a statement accompanying documents.
The system allows for different kinds of statistics:

- current - the number of shipped product (m3) from the beginning of the change;
- monthly - for the costs of raw materials, with the transfer to the company's network.

Use the menu bar, you can get more information on each of the sites and to organize work with lists of alarms and process messages. This allows the operator to control the operation of the system, follow the failure of the process equipment and prevent accidents.
All the technological process is displayed on the operator's station, which is divided into two parts, relating to different nodes. Also at the bottom of the screen is a menu bar and alarms.
All operator actions and failures of process equipment are recorded. In addition, it formed a database of results for each order dispensing with the preservation of information about the time of execution of the order and the amount of raw dosing materials.
In case of failure of the operator station provides a backup control channel from the operator panel (console).
The system includes a number of flexible configurable parameters set in the configuration utility. With their help, you can fine tune the different delay times, weight thresholds, and so on dosing parameters:

- to avoid splashing the product implemented regimes of fast and slow discharge. The developed system is able to "learn" and to compensate the error of dosing previous downloads. The system uses several multi-component dispensers;
- use an adaptive algorithm dosing "Coarse / Fine", which allows to achieve high accuracy of dosing;
- provides an introduction to the system of new components and operational correction prescription content of individual components of the moisture content;
- to upload the components to the mixer may vary depending on the season;
- realized heated inert components, which together with the adaptive allows the addition of hot water to bring ready-mixed concrete to the desired temperature;
- flexible distribution of the components of the feed bin, depending on their completion.

Conclusion

The introduction of automated control systems allow for automated processing through the vehicle of the customer - from its registration at the entrance to the exit of the gate with the load [17, 18], improve the quality of the delivered product and to reduce scrap rates due to the increased accuracy of the dosing, and enhance the capacity of batching installations and reducing the overall time of stay of a vehicle in the queue.
By improving the quality and ergonomics of work the operator is expected to increase technological discipline it is also important complete recording of all events occurring in the system, including the actions of the operator.
The accumulation of the results of raw materials and consumable materials enables statistical analysis and "close the loop" circulation of raw materials and finished products at the plant, as well as generate reporting and records of the results of the concrete mixing plants for different time periods.

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