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Statistical Analysis As An Instrument For Improving The Quality Of Products From Cellular Concrete

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Abstract. Using statistical methods results of acceptance testing of products from autoclave cellular concrete of the enterprises of the Belgorod region were analyzed according to the measured compressive strength and density. It was found that when these indicators conform the regulations, their oscillations reach the frontiers of normal statistical distribution. It is shown that statistical methods can serve as a tool to control the quality of products and for finding problems in the production process with identifying the most important of them. The most expected causes of quality deterioration were identified. Recommendations for enterprise to bring the investigated process under the stable conditions were given.

Thus it was shown that it is not always correct to judge the stability of manufacturing prosess only by output of quality products with a minimum level of defects. As an important tool for adjustment of production activities may be the use of statistical methods of quality management that can improve the efficiency of industrial enterprises.

Introduction.

Production of building materials is a promising of area industry in with a high level of competition. Basic success factors in the competition are the level of technical capacity, management efficiency, quality of produced items and services. However, there is a number of points that are not so obvious for the manufacturers that have a significant impact on the economic efficiency of production.

It often happens that competing enterprises manufacturing products of comparable quality in similar conditions have different inputs, and hence are not be able to achieve an equivalent effect of its implementation.

Nowadays established market relations force Russian entrepreneurs to implement the quality assurance system at the enterprise in order to be able to detect cases of nonconformance at all stages of the product life cycle. Statistical methods have an mportant role in this problem [1, 2].

The introduction of statistical methods in activity of any plant is usually carried out in order to:

- stabilize the production process by monitoring and eliminating special causes of product quality fluctuations;
- reduce costs on alteration and eliminating of discards;
- reduce costs associated with a degradation of products grade;
- reduce the cost of raw materials overruns;
- increase the demand for its products due to lower production costs by adjustment of activity;
- improve the image of the company.

Thus, statistical methods – is a tool for finding problems and to allocation the most important from their mass.

Main Part.

As an example, we have analyzed the results of acceptance testing of one of the enterprises of the Belgorod region that produce blocks of aerated autoclaved concrete according to State Standard (GOST) 31360-2007.

At the enterprises the level of product quality is determined by carrying out acceptance tests for compliance with regulatory requirements. For the studied production one of the main indicators of the quality of finished products is the compressive strength, which is calculated on the basis of indicators of variations in accordance with State Standard (GOST) 18105-2010. That is why this parameter was determined in the first place. To do this, we have made data retrieval from the log book in march 2014 and studied 3 production lots in period from 8th till 10th march that include 22 production series of concrete with strength class B3.5, and density mark D500.

For a preliminary assessment of homogeneity and the type of distribution of the experimental data we have plotted a histogram of values of the compressive strength, the form of which ("distribution with a peak at the edge") have selected the incompleteness of the data. Therefore, for a more precise analysis the range was expanded by the addition of another production lot of specimens tested on March 11, consisting of 9 production series. On the basis of the expanded sample data we have plotted a new histogram which analysis showed that it represents a comber-type distribution. This type usually indicates errors of measurement or data processing, but considering the fact that examined factory is automatized and calculations were performed using computer technology, that minimizes the occurrence of errors due to the influence of the human factor, there is a need to identify a specific reason by constructing Shewhart charts.

For the analysis of compressive strength Average and Range Shewhart control charts of selected samples shown in Fig. 1 and 2 were plotted.

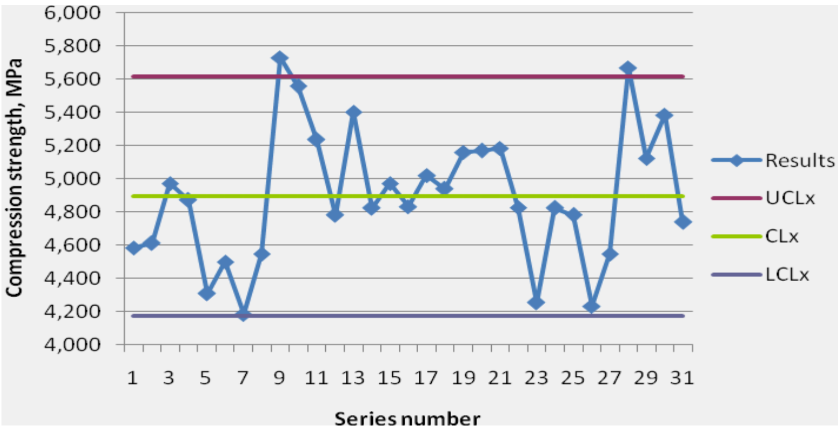

Fig. 1 – Average control chart ($\overline{X}$ – chart)

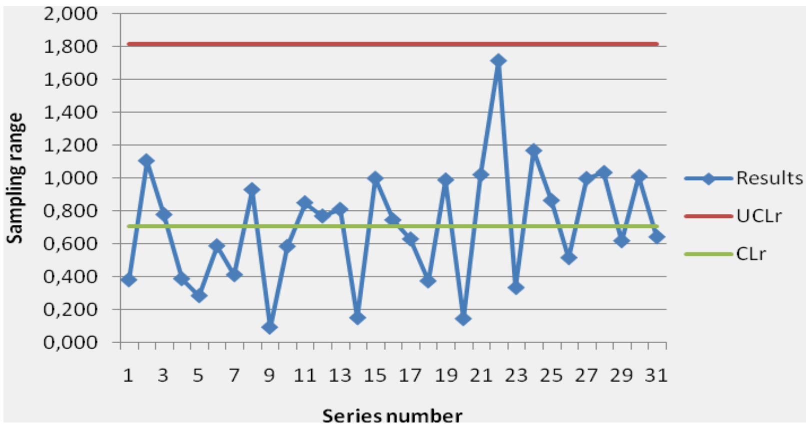

Fig. 2 – Range control chart (R – chart)

Analyzing control charts in accordance with the requirements of State Standard (GOST R) 50779.44-2001, it can be concluded that the process is in state B, i.e. it is stable by the spread, but not stable by the position of the arithmetic mean. This type indicates the presence of a specific reasons, which may be incorrect setup of the program for calculation the strength indicators, the error in the calculation of variation performance, as well as violations of the technological process.

After more detailed analysis of control charts in accordance with the requirements of State Standard (GOST R) 50779.42-99 it was found that on R–chart there is no point outside the control limits, that indicates a stable stray field, but at the same time on $\overline{X}$ –chart in terms of compressive strength two points (number 9 and number 28) are outside the control limits and based on that it can be argued that the process is not stable.

Study of the average control chart for special reasons by using a set of eight criteria for interpreting the course of the process has identified the following discrepancies: output of points number 9 and number 28, as well as a series of 3 consecutive points, two of which number 5 and number 7 are in Zone A . This once again indicates that there are specific reasons.

To determine the influence of the compressive strength indicator, functioning as unstable, on the quality of finished products its relations with density of finished products were analyzed. The choice of this parameter is explained by the application area of autoclaved aerated concrete as a structural heat-insulating wall materials, and by the increased sensitivity of this parameter to the conditions of the microclimate of the production area, mechanical impact on the forming solid mass and other factors. Noted relations were examined by plotting scattering diagram shown in Fig. 3, and the degree of parameters interference was determined by calculating the variation index.

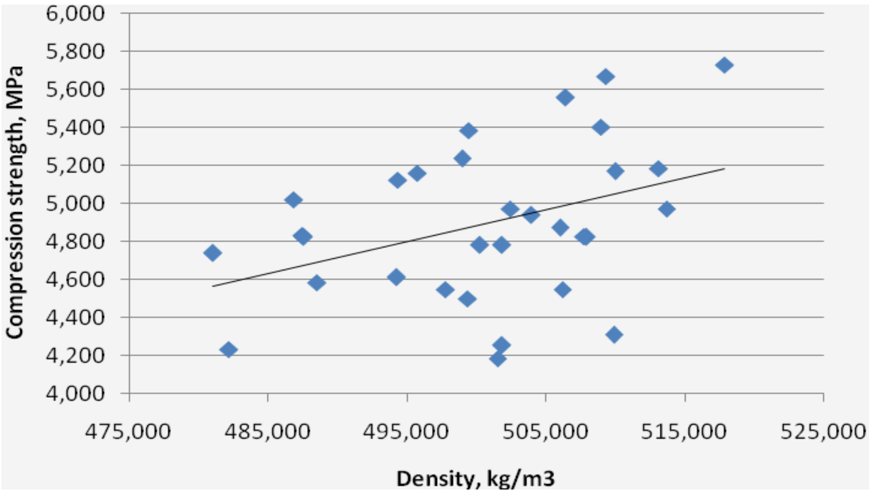

Fig.3 – Scattering diagram

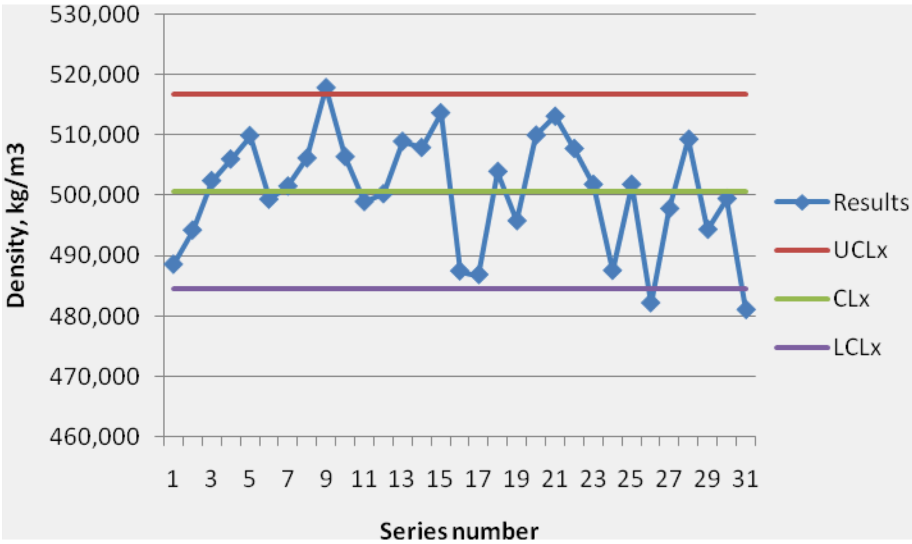

Fig. 4 – Average control chart ($\overline{X}$ – chart)

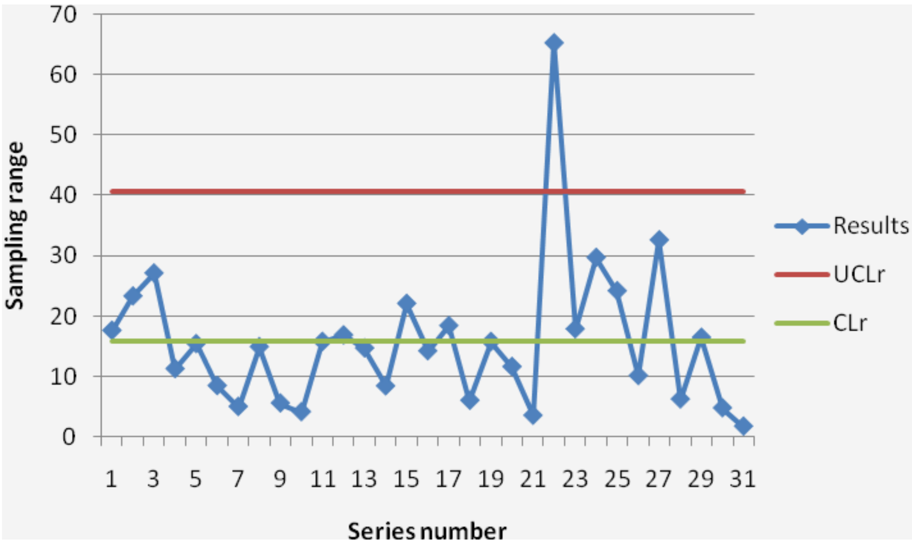

Fig. 5 – Range control chart (R – chart)

The scattering diagram shows a straight line of correlation, indicating that with an increase in strength values the density will also increase. Calculated correlation coefficient for examined totality was 0.38, which indicates a weak interference of these indicators. This make it possible to refer to secondary factors that mainly affect the density of products and have only an indirect influence on the strength. Examples of such factors include, mentioned earlier, the microclimate of the production area, the temperature of the aerating mass etc. [3, 4].

In this regard, there was a need for further analysis of density index using Average and Range Shewhart charts.

After examining of control charts in accordance with the requirements of State Standard (GOST R) 50779.44-2001, it can be concluded that the process is in state C, i.e. it is stable by the spread, but not stable by the position of the arithmetic mean. On both charts there are points that go outside the control limits, it indicates that the manufacturing process requires immediate adjustments. Identified criteria on Average and Range charts for strength and density parameters indicate a presence of non-random causes. These reasons may also include: calculation errors when adjusting the composition of the concrete, the unstable quality of the raw materials, incorrect operation of dosing equipment, inadequate competence of the manufacturing personnel.

Summary.

To find out the exact reasons the company is recommended to conduct a more detailed analysis of all the above areas. Bringing the studied process in a stable state will reduce the costs of eliminating of discard and cost of raw materials overruns.

That is why it is not always correct to judge the stability of manufacturing only by production of quality products with a minimum level of discard. Therefore, the use of statistical methods of quality management can become an important tool for adjustment of production process and can improve the efficiency of industrial enterprises.

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