Analysis of quality of construction products by example of LLC "RTITS"

K V Zhegera, N A Petuhova, A V Gargala
Quality management and construction technology, Penza State University of Architecture and Construction, 28, Titov St., Penza 440028, Russia
E-mail: jegera@yandex.ru

Abstract. The article provides information about the need for quality management in enterprises. Theoretical and methodological approaches to the study of quality improvement problems in the foreign and Russian economy are considered. The results of the application of statistical evaluation of the quality of construction products are presented by the example of well rings made by LLC "RTITS". The reproducibility index, quality indicator of the technological process $I_k$ was calculated, taking into account the stability of the technological process and the finished product quality. Constructed function desirability. The authors performed the analysis of results obtained and developed recommendations for quality assurance in the production of well rings

1. Introduction

In a market economy, the problem of quality is the most important factor in raising the standard of living, economic, social and environmental security. The quality of products defines its competitiveness and the competitiveness of the company producing these products [1-3].

For the continuous improvement of the company, it is necessary to constantly maintain and improve the quality of its processes. Improving the quality of the process occurs through targeted changes in the characteristics of the process and products. At present, it is considered expedient to use statistical methods of regulation, which make it possible to promptly detect technical process discord and prevent the release of defective products.

Quality management at enterprises is carried out with the aim of continuous improvement of products and services provided. It is also aimed at bringing goods into compliance with national and international standards. Fundamentals of quality management regulate the most important points that can meet the needs of consumers and ensure an adequate level of security. Improving the quality of goods is the basis for the prosperity of not only the company, but also the state as a whole. No state can benefit from the low quality of its products.

Theoretical and methodological approaches to the study of the problems of quality improvement in foreign, Russian and domestic economics are given much attention. In this regard, the concept of quality has a serious scientific basis. The theoretical foundations of this category were laid in the works of W. Schuhart, E. Deming, J. Juran, F. Crosby, A. Feigenbaum, K. Ishikawa, G. Taguchi, F. Kotler and many others [4-7]. In particular, F. Crosby defines quality as "compliance with the requirements", Deming U. believes that "the quality of a product or service can only be determined by the client".
Among Russian scientists whose works attract particular attention, one can highlight the publications of V.G. Versan, M.I. Gelvanovsky, V.V. Okrepilov, B.Yu. Ogvozdin, V.A. Lapidus, V.A. Kachalova, S.D. Ilyenkova, R.A. Fatkhutdinova, M. Kuzmina and other authors, which appeared after the year 2000 [8-14].

Thus, Fatkhutdinov R. A. believes that "quality must be aimed at meeting the requirements of the consumer, not the manufacturer". Kuzmina M. considers quality as a combination of properties and characteristics of products and processes that determine the degree of their suitability for intended use.

Issues of quality and competitiveness are to some extent covered in the scientific works of domestic scientists: T.K. Koychueva, M.B. Balbakova, V.I. Kumskova, Sh.M. Musakojeva, A.A. Migranyan, T.G. Ablytipov, A. Baltabaeva and others [15-18].

Consider the application of statistical methods of quality control of products on the example of a construction company LLC "RTITS".

LLC "RTITS" is a young but rather large and developed enterprise. Company is implements the Concession Agreement with the Federal Road Agency (Rosavtodor) through the Platon system, is a regular participant of Russian and international exhibitions, where successes and achievements were marked with diplomas and other awards. As the object of study selected concrete rings [19].

The solution to the problem of process stability can be the use of the quality index of the technological process $I_k$, which takes into account the stability of the technological process and the quality of the finished product.

### 2. Methods

The stability of the technological process is usually assessed using control charts of Shewhart, and reproducibility according to Cp and Cpk [20]. For calculations using formula 1-3:

$$ C_p = \frac{UCL - LCL}{6\sigma}, $$

$$ C_{pk} = \frac{\overline{X} - LCL}{3\sigma}, $$

$$ C_{pl} = \frac{UCL - \overline{X}}{3\sigma}, $$

where $UCL$ – is the upper limit of the tolerance field;

$LCL$ – the lower limit of the tolerance field;

$C_p$ – process capability index;

$C_{pk}$ – critical index of the process capability.

If $C_p = 1$, the process is reproducible, but attention needs to be paid to production; if $C_p < 1$ - the process is not reproducible; if $C_p > 1.33$ – process is reproducible.

The proposed indicator $I_k$ is calculated using the following formula:

$$ I_k = \frac{C_p - 1}{1 - Q}, $$

where $Q$ - an assessment of the level of product quality.

The value of the quality level $Q$ in the ideal case will be equal to 1, but in practice this is impossible. The numerator of the formula $(C_p - 1)$ can be greater than zero, only in the case of a satisfactory process. Therefore, if the value of $I_k$ becomes negative, then this means $C_p < 1$ and the result of the production cycle is the release of defective products. Thus, for a satisfactory process, the value of the index $I_k$ should vary in the range $0 < I_k < \infty$ (the upper limit is an ideal case, since this is possible only with $Q = 1$).
3. Test results

We calculate the quality index on the example of well rings, LLC "RTITS". To analyze the collected statistical data on the index of compressive strength. This indicator is selected for analysis, as it is the most important characteristic reflecting the quality of reinforced concrete rings. Statistical data on the strength indicators are presented in Table 1.

| sample number | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
|---------------|----|----|----|----|----|----|----|----|----|----|
| $R_{st}$, kgs/cm$^2$ | 207 | 210 | 208 | 205 | 202 | 201 | 203 | 207 | 209 | 212 |

To construct a histogram, it is necessary to distribute the values by intervals (Table 2).

| Partial spacing length $h=2$ | Sum frequency partial spacing $n_i$ |
|-------------------------------|------------------------------------|
| [201-203) | 3 |
| [203-205) | 1 |
| [205-207) | 2 |
| [207-209) | 2 |
| [209-211) | 1 |
| [211-213] | 1 |

Figure 1 shows the histogram of the frequency distribution, based on the results of Table 2.

![Figure 1. Distribution histogram.](image)

An analysis of Figure 1 showed that the resulting histogram has two vertices. Such a histogram is obtained in cases when several distributions are combined, in which the mean values differ slightly.

Find the index of reproducibility, using the formula 1.

$$C_r = \frac{250 - 200}{6 \cdot 3,6} = \frac{50}{21,6} = 2,3$$
Since the result is greater than 1, the production process for well rings can be considered reproducible.

One of the likely ways to assess the quality of a package of characteristics and properties for analyzing the results obtained is to use the generalized desirability function of Harrington [21], which is widely used in psychophysiological and environmental studies [22]. The basis for building a generalized function is the idea of converting the obtained values of property indicators (in various units of measurement, including those with qualitative, aesthetic, psychological and personal characteristics) into a dimensionless scale of desirability.

The purpose of the scale of desirability is to establish the correspondence between the obtained values of the indicators of properties and the experimenter's estimates of the desirability of an indicator for the function of an organ, a system, and the whole human body. Standard desirability grades are not strictly required.

Normalized estimates of quality indicators will be obtained using the desirability function (3), which is shown in Figure 2.

![Desirability function](image)

**Figure 2.** Desirability function.

The value of the normalized assessment of the quality index of well rings is $Q = 0.64$.

Based on the results and formula 4 obtained, the product quality index was:

$$I_k = \frac{2,3 - 1}{1 - 0,64} = 3,6.$$

4. Summary

It has been established that the quality index of construction products tested by LLC "RTITS" is positive. From this we can conclude that the quality of products meets the requirements of GOST [19].

Thus, at the moment the process of production of reinforced concrete rings is reproducible. In order to support it in such a state, it is necessary to conduct a systematic control.

In addition, the company is recommended to introduce a quality management system and pay attention to the process of corrective and preventive actions at the enterprise.

Another embrace of quality assurance and improving the competitiveness of products is its certification.

The use of certification in the conditions of market relations provides the following benefits:
ensuring the confidence of domestic and foreign consumers in product quality
providing the consumer with the necessary objective information on product quality
contributes to longer success and protection in competition with manufacturers of non-certified products
helps to increase the organizational and technical level of production
stimulating the acceleration of scientific and technological progress.

It has been established that the quality of reinforced concrete rings can rightly be attributed to the most important criteria of the LLC «RTITS» business. It is the improvement of the quality of reinforced concrete rings that determines the degree of competitiveness of an enterprise under market conditions, the pace of scientific and technical progress, the increase in production efficiency, and the saving of all types of resources used in an enterprise.

It is revealed that an important element in the quality management system, as well as the final quality assessment of manufactured reinforced concrete rings, is carried out with the help of certification, which means testing the products, issuing a certificate of conformity, marking the products (conformity mark) and monitoring the state of subsequent production using control tests.

Thus, the use of certification as an instrument for improving the quality of reinforced concrete rings produced by LLC «RTITS» is an important factor in market conditions, as it ensures the expansion of market segments, the company’s prosperity and profit growth.

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