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Ljubiša Balanović
Dejan Tanikić

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APPLICATION OF CONTROL CHARTS IN THE LABORATORY FOR TESTING THE METALLIC MATERIALS

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Abstract

Control charts are methods for collecting, processing, analyzing and displaying data to ensure the product and process quality. Control charts as tools belong to the statistical process control (SPC). The accuracy of the results is ensured by application the control charts for accreditation the tensile testing methods. This paper presents the application of control charts for validation the testing method of steel wires by tension. Control charts show that the analyzed method is under control. The main goal of control charts is to quickly detect errors during testing and prove that the processes are under control.

Keywords: *application, control charts, testing, metal materials*

1. INTRODUCTION

Control charts are the statistical process control (SPC) techniques. The SPC is an online quality control system, defined as a philosophy, strategy and methods for improving systems, outcomes and processes. [1]. The static process monitoring methods have an irreplaceable position in a smart process control [2]. The static methods began to be successfully applied in the twenties of the last century. The use of control charts has grown significantly in recent times. Various forms of control charts have been developed for the process monitoring. The classic parametric control charts represent the presence of normal data, constant mean and variance, and data independence [3,4,5]. In a practical sense and smart manufacturing processes with a complex structure, such prerequisites are often not met. Therefore, an incorrect application of the parametric control charts can lead to the wrong conclusions about the static stability of process. More reliable non-parametric control charts have been designed for these types of processes [6,7]. The non-parametric control charts to overcome the shortcomings of classical parametric control charts have shown a great role in a smart manufacturing process monitoring due to their ability [8,9,10,11].

The control charts are considered as the most important tool for the process quality control. They are presented as graphs where the vertical line represents the order of control and the horizontal value of the parameter that is controlled on the certain size samples. The graph shows the process quality variation in relation to certain control limits. The control limits are given by the standard or calculated depending on the process or method. When the process variation occurs within given limits, that process is said to be in a state of static control. Otherwise, if the process variation is outside the control limits, the process is said to be out of static control.

The control charts are the simplest form of process control providing a detailed insight into the state. Also, they provide enough visibility to conclude whether the process is under control or not. They clearly show where the measured individual quantities are in relation to the tolerance field. This means that the control charts accurately show the range of individual measured quantities [12].

This paper provides an example of control charts for the testing method of tension the metallic materials at room temperature, method B, SRPS EN ISO 6892-1:2020.

2. EXPERIMENTAL

This paper deals with demonstration the application of control charts in the Laboratory for Materials Testing (LIM) on the method: tensile testing of metallic materials at room temperature, method B, SRPS EN ISO 6892-1:2020. The control chart is the primary tool in technique of the static method of process control. The creator of the control charts is Dr. Suhart.

According to Dr. Suharo, a task of control charts is to:

1. maintain the production process in a state of control
2. bring the production process under control
3. with an indication of whether the state of control has been achieved.

A control chart is a diagram that shows exactly where the process being controlled is located. The values of quality characteristic, whose variation is studying, are written on the vertical axis, The tensile strength Rm is written in the work. The control chart is characterized by the central lines (processes) and control limits (lower and upper limits).

This paper presents the 8 tests of steel wires (Table 1).

X-Mean value of tensile strength Rm, upper and lower limits of Rm are given in Table 1.

Nominal tensile strength of a steel wire, test tube Rm=1570 N/mm^2.

Table 1 - Test tube test results

Ord. No.	Measured wire diameter, mm	Tensile strength Rm, N/mm^2	X-Mean value Rm	Lower limit Rm	Upper limit Rm
1	0,9	1700	1677.85	1570	1920
2	0,9	1659	1677.85	1570	1920
3	0,9	1654	1677.85	1570	1920
4	0,9	1627	1677.85	1570	1920
5	0,89	1739	1677.85	1570	1920
6	0,89	1689	1677.85	1570	1920
7	0,91	1677	1677.85	1570	1920

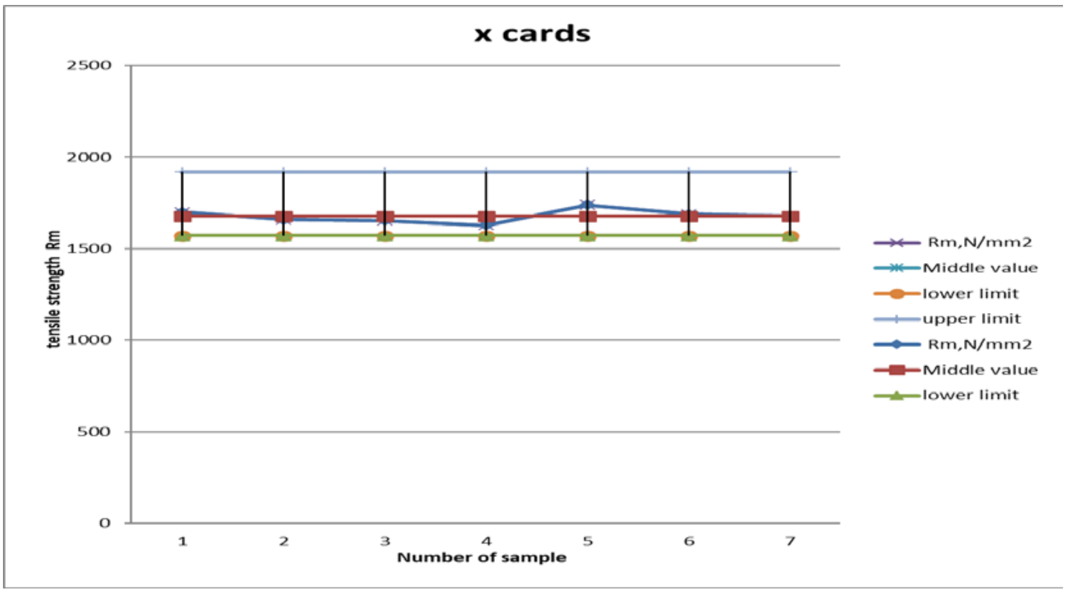

Figure 1 - Control chart

Methods of a control chart: Metallic materials - Tensile testing at room temperature, Method B, Determination of tensile strength (SRPS EN ISO 6892-1 2020) (Figure 1).

Criteria that determine the upper and lower limit values are: Nominal tensile strength Rm and nominal wire diameter d.

Nominal value Rm=1570 N/mm^2 represents the lower limit value.

The upper limit value is equal to the lower limit values, plus the tolerances given in Table 2, and they are taken from the SRPS ISO 3154:2014 Standard.

For this example, the lower limit value is Rm=1570 N/mm^2, and for the upper limit value 350 N/mm^2 (Table 2) is added so that it amounts Rm=1920N/mm^2.

Table 2 - Upper tolerance limits for nominal tensile strength Rm=1570 N/mm^2

Nominal wire diameter, d	**Upper tolerance limits for nominal strength**
mm	N/mm^2
0.8 ≤ d <1	350

Source: [13]

3. RESULTS AND DISCUSSION

The control charts are most commonly used in various laboratories for the process control. The control charts have proven to be an excellent tool to improve the quality of testing the metallic materials, steel wires in the LIM.

In th8s work, the 8 samples were tested (Table 1) according to the method: Metal materials - Tensile testing at room temperature, Method B, Determination of tensile strength (SRPS EN ISO 6892-1 2020) with the following characteristics:

- Nominal wire diameter d value 0.8 ≤ d <1
- Nominal tensile strength Rm=1570 N/mm^2
- Calculated mean values X= 1677.85 N/mm^2
- Lower limit value is the nominal tensile strength and is Rm=1570 N/mm^2
- Upper limit value is Rm=1920N/mm^2

The upper and lower limit values determine whether the process is in control or out of control. From the experimental part of the work, Figure 1 shows that the process is under control. This means that the variation in quality is normal and room temperature tensile testing process, method B, is stable.

Control charts in this work have the role of intermediate checks of operators involved in the process of testing and checking the device on which the test is performed.

4. CONCLUSION

This paper presents the role of control charts in the LIM on the method: tensile testing of metallic materials at room temperature, Method B, SRPS EN ISO 6892-1:2020.

The graphic display of the control charts shows that during the testing process of 8 samples, the tensile strength does not exceed the control limit, the lower and upper limit. The room temperature tensile test method for metallic materials is controlled.

Application of control charts in the laboratory for material testing (steel wire) by tensioning leads to the process improvement and reduction of errors.

The control charts provide the opportunity for laboratory managers to have the objective information about the state of quality of processes, personnel and devices.

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