ASSURANCE OF MEASUREMENT PROCESS FOR SELECTED PRODUCT QUALITY PARAMETER

ZABEZPEČENIE MERACIEHO PROCESU VYBRANÉHO PARAMETRA KVALITY PRODUKTU

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Abstract

In the existing production process it's necessary to measure one basic parameter – shaft diameter with specified tolerance limits. There are different measurement tools available (slide gauge, micrometer, digital slide gauge, three-dimensional measuring tool, laser measurement system) with its own precision defined by producer. Some of them require the calibration or special environment. The goal is to ensure the conformance of the monitored parameter with the required accuracy within the defined tolerance limits, so their correct settings are very important. Different measurement tools are used in real time revision during the production and different in final inspection performed on randomly selected products.

Key words

measurement tools, precision and accuracy, toleration limits of quality parameter

1 INTRODUCTION

The basic goal of the measurement management system is to ensure the fulfillment of specific metrological requirements. The metrological requirements are derived form requirements for the product. It's necessary to apply these requirements not only on the measurement tools but on the measurement processes as well.

All measuring equipment necessary to satisfy the specified metrological requirements shall be available and identified in the measurement management system [STN EN ISO 10012:2003].

2 EVALUATED PRODUCT: GEAR MAIN SHAFT

As a subject used for assessment of measurement tools eligibility is used gear main shaft. Beside other components, it's a part of screw gear box. The measurement was performed at the manufacturer - SJT Ltd. located in Moldava nad Bodvou, Slovakia. The tools provided and used were the same as in manufacturer's daily work.

As the quality measure was chosen the largest outer diameter of the given component part. The inspected diameter was measured during the production using the slide gauge, micrometer, digital slide gauge and with three-dimensional measurement tool. The results obtained with each tool were afterwards compared with the outcomes measured by laser measurement system.

3 MEASURES AND MEASUREMENT IMPACTS

Measuring equipment shall be used in an environment that is controlled or known to the extend necessary to ensure valid measurement results [Palenčár, Halaj, 1998].

3.1 Slide gauge

Slide gauge (SG) is a length measure with parallel flat measurement planes on the main (steady) and auxiliary (adjustable) measure. The measured object is placed in between and could be as long as the planes distance allows (Figure 1: Slide gaude).

The operating life is not stated, only the precision which is 0.01 mm.

When using the digital slide gauge (DSG) also following additional factors needs to be considered: position of the gauge, the measurement place and human factor. Important is also continuous calibration which is performed by cube shaped zones of different size.

3.2 Micrometer

Measure based (MM) on the micrometer screw is used in engineering either as subtract device on the measurement microscope or on other measurement instrument. The measured dimension is defined by the revolutions count and the slew of micrometric screw.

Micrometers are available in two ranges: 0-25 mm, 25-50 mm. The lifetime is not specified by the producer, the precision is 0.01 mm (Figure 2: Micrometer).

It's important to calibrate the micrometer before the measurement. This is done by the zone-roller.

3.3 Three-dimensional measuring tool

Three-dimensional measuring tool (3D MT) is operated manually even there is a computer software which easies the measurement.

The principle is based on the air pressure in the device. Five sensors are equipped on the adjustable arm fixed in the horizontal position against the working surface. At the end of each sensor is a small pillow which is inflated during the measurement, so the sensors are not wearied. The working surface is made of granite (Figure 3: Three-dimensional measuring tool).

During the measurement is the object placed on the working surface and the user selects, via the software, the desired attribute to measure. Based on the selection, software determines the number of contact points and the sensor needed.

When measuring the outer diameter – four contact points are needed, first is always zero point used as reference for the three others.

Calibration of this device is performed at minimum once a year. It is important for the observance of the stabile measure precision. The precision is not specified by the producer, but based on the experimental investigation was used the precision 0.001 mm.

The clean surface of the measured element is essential for the precision because the dirt may cause the distortion of the measured value. Another considerable factor influencing the measurement is the environment temperature and the air pressure in the device.

The limit for the air pressure is 3-11 bar which important for the device controllability and precision of the measurement. Air pressure is indicated by the offset measure attached to the device [Pavlíčková, 2007].

Figure 1: Slide gaude

Figure 2: Micrometer

Figure 3: Three-dimensional measuring tool

3.4 Laser measurement system

The laser measurement system (LS) consists of camera, laser and a holder. Based on the emitting laser line, the software automatically calculates the desired parameter.

Before the measurement itself, it is essential to ensure its accuracy. That for the first step, before scanning the measured object, is the calibration of camera by the calibration marker. Achieved image is transferred to the computer via EtherCam software and processed by MATLAB program. The result of calibration is represented by calibration matrix which is applied in further images processing. In case of wrong calibration matrix is the measurement impossible (Figure 4: Laser measurement system).

The measurement involves camera scanning of the measured object surface (shaft) with and without the laser line crossing the object. The final light lines are extracted and processed using the image processing technology in MATLAB software and finally the shaft diameter is calculated (Figure 5: Laser measurement process steps).

After assigning the region where the laser line intersects the object, is the measured diameter calculated in Matlab program.

Also this system has is missing the precision specification, after experimental investigation was used the precision of 0.01 mm.

In practical measurement is used the CCD EtherCam camera by Neuricam and the green laser line projector [Pavlíčková, 2007].

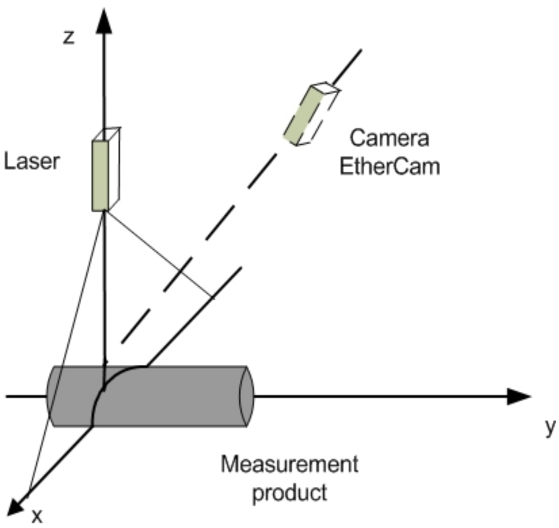

Figure 4: Laser measurement system

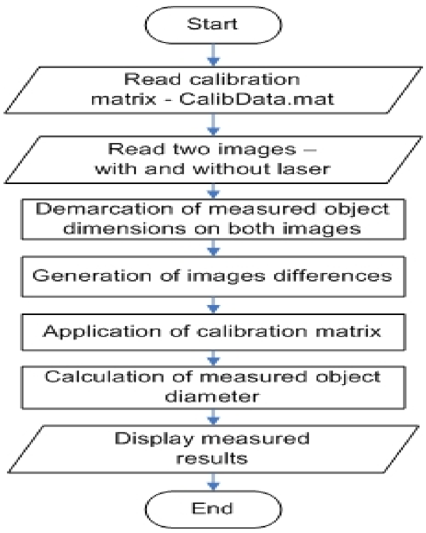

Figure 5: Laser measurement process steps

4. MEASUREMENT REALIZATION

The measurement was realized for the shaft with diameter of *28 n6* using all five measurement tools. With each tool were performed ten measurements.

From the achieved results were calculated parameters (Table 1: Set of data for diameter 28 n6) necessary for the diagram of position characteristics (Figure 6: Variability and tolerance limits for each measurement tool).

In the diagram are the highlighted the toleration limits specified by the producer (UTL = 28.028, LTL = 28.015), target value (T = 28.000) and circles depict the average results of each measurement tool. With x_{max} and x_{min} is shown the minimal and maximal measured value for each tool.

Table 1 shows that the minimal, means no variability for the diameter *28 n6* measurement was achieved by slide gauge (0 mm).

In this case (Figure 6: Variability and tolerance limits for each measurement tool) only the values measured by digital slide gauge are in the tolerance limits. The required diameter was measured by slide gauge. Other measurements are under the lower tolerance limit LTL.

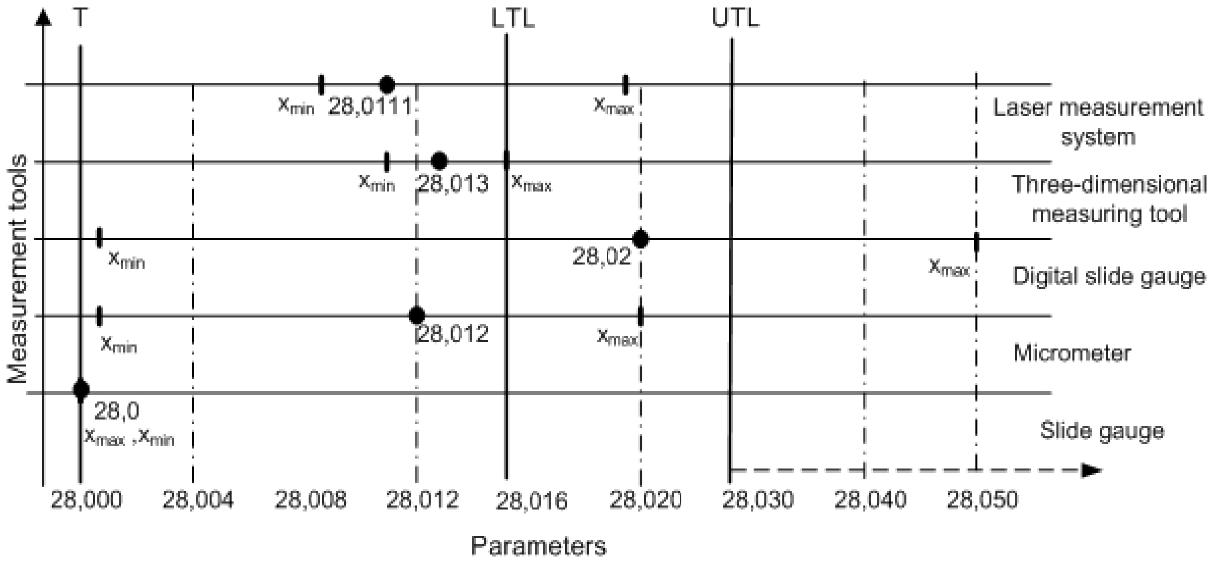

Figure 6: Variability and tolerance limits for each measurement tool

Table 1: Set of data for diameter 28 n6

Minimum	x_{min}	28.000
Maximum	x_{max}	28.050
Lower tolerance limit	*LTL*	28.015
Upper tolerance limit	*UTL*	28.028
Target value	*T*	28.000
Median	*Me*	28.010
Confidence Interval	CI_L	28.008
Confidence Interval	CI_U	28.015
Average SG	x_p *SG*	28.000
Distance SG	*R SG*	0.000
Average MM	x_p *MM*	28.012
Distance MM	*R MM*	0.0100
Average DSG	x_p *DSG*	28.020
Distance DPM	*R DSG*	0.0400

Average 3D MT	x_p *3D MT*	28.013
Distance 3D MT	*R 3D MT*	0.004
Average LS	x_p *LS*	28.0114
Distance LS	*R LS*	0.019

5 CONCLUSION

The measurement process is a part of the control of quality for the products – conformance of the required and really achieved parameters. It shall be designed to prevent incorrect measurement results. The correct identification of differences is important to ensure the prompt detection of deficiencies, and timely corrective actions.

Analysis of the achieved results shows that for the real time revision is advisable to use slide gauge because of its easy and user friendly manipulation. On the other hand, the final inspection using 3D measurement tool may cause problems according to the necessary education for the operation personnel. Here the laser measurement system connected to the computer with the similar software as for the 3D measurement tool can provide objective and precise non contact measurement.

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