Metrological Analysis of Sphericity Geometry to Lathe Conditions at the Mechanical Technology Laboratory of the Department of Mechanical Engineering Politeknik Negeri Pontianak

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Abstract: *This research was conducted on the premise that the age of using lathes in the Mechanical Technology Laboratory of the Department of Mechanical Engineering Pontianak State Polytechnic has been more than 30 years since this Polytechnic was established. It is predicted that the resulting workpiece is not exactly sized by the tolerance limit given to students. This research was conducted by measuring geometry (geometric metrology) on lathes used by the Department of Mechanical Engineering students during machining practice. This study aims primarily to see whether there has been a significant deviation / beyond the allowable tolerance limit on the lathe used by students of the Pontianak State Polytechnic Mechanical Department, this research will later be able to take benefits that have to do with improving the skills of students of the Pontianak State Polytechnic Mechanical Engineering Department. Data obtained based on direct experiments on the object under study, the data obtained are processed with several analytical techniques by the variables studied, namely roundness analysis. The results showed that the tolerance of sphericity deviations in lathes MB 2 = 64 µm, can produce workpieces with tolerance values above 64 µm (IT 10). On lathes MB 2 = 84 µm, it can produce workpieces with tolerance values above 84µm (IT 10). Lathe MB 3 = 50 µm, can produce workpieces with tolerance values above 50 µm (IT 9). While the MB 4 lathe tolerance of the deviation of the roundness is 92 µm, it can produce workpieces with tolerance values above 92 µm (IT 11). While the lathe MB 5 tolerance of the deviation of roundness is 80 µm (IT 10), it can produce workpieces with tolerance values above 80 µm. Because these machines are still used for education, especially the implementation of practicum in machining process courses and production activities, improvements should be made to improve their performance.*

Keywords: Metrology, Geometry of Roundness, Lathe Machine

The Machining Process is one of the practical courses which is one of the basic courses of expertise in the Department of Mechanical Engineering of Pontianak State Polytechnic (Polnep), starting from semester 2 to semester 3, To support the smooth practice of the machining process, the Department of Mechanical Engineering Polnep provides a Mechanical Technology Laboratory complete with qualified facilities and infrastructure. For the skills obtained by students to be by the demands of the curriculum, in this Mechanical Technology Laboratory there are various types of machine tools with sufficient quantities such as lathes, scrap machines, milling machines, grinding machines, and grinding tools. In addition, there are also various types of measuring instruments that function as tools for students when practicing machining processes, for example, calipers, micrometers, and high gauges.

In addition to the existence of adequate facilities and infrastructure, no less important is the role of coordinated cooperation between lecturers, technicians, heads of the Mechanical Technology Laboratory, and students. The competencies that students are expected to obtain are if each student can complete the job sheet correctly and correctly by the time limit and allowable tolerance.

To realize the ha1 mentioned above, one important factor that cannot be ignored is the accuracy and precision of the machine used. Without being supported by standard and precise machine tools (by the provisions of the manufacturer), the expected student competence is difficult to achieve.

The role of lecturers, technicians, and workshop managers is very influential on the smoothness of students' practice to achieve the expected competencies. In addition, the management of the Mechanical Technology Laboratory and the availability of machines that are ready to operate also play a role in realizing the desired things. Of course, to achieve this perfect learning and teaching process, all aspects related to the above must be well-conditioned. One ha1 that has been neglected/forgotten is that the accuracy, precision, and condition of the machine tools used have decreased. This may be due to age factors or inadequate care. If this situation is true, it is appropriate to conduct a metrological study to determine the lathe's condition and ability. If there has been a very large deviation, it is appropriate to find several alternatives until the main objectives that have been set in the machinery process course are still achieved.

Previous research. Eko Yudo, 2019, conducted his research on 3 Geminis lathes that have been used by Bangka Belitung Manufacturing Polytechnic students in teaching and learning activities for 20 years. The research carried out was the geometric testing of lathes on the roundness of the workpiece. The test results showed that the three Geminis lathes had an average deviation of 45.33 μm and the smallest deviation on average of 20 μm could produce workpieces with tolerances above 41 μm. S

Meanwhile, Fajar Aswin, 2017, carried out the process of restoring the initial condition (reconditioning) of the DoAll LT 13 Bu01 lathe by focusing on improvements to the electrical system, geometric accuracy, and engine performance. The direct observation method is applied to solve problems that include cause and effect relationships using analysis of 5 (five) whys (5 whys). The reconditioning phase starts by collecting initial damage data obtained from visual inspection, function testing, and geometric testing on the machine; then proceeds to analyze the damage; and corrective actions against the results of the analysis. Function testing methods, geometric deviation testing, and machine performance testing are carried out to see the achievement of reconditioning goals. Based on the results of the tests carried out, it was obtained that the electrical system function returned to normal, the average geometric deviation value was still within tolerance based on the ISO-1708 standard, and engine performance for spindle rotation values with deviations of 5%, roundness and tapering values of workpiece turning results of 0 and 0.004mm/255mm and spindle vibration in the range of 0.33 – 0.66 mm/s RMS for speeds of 50 – 2500 RPM was still considered normal based on ISO 10816 standards.

Metrology of Spheres Geometry. Metrology of Geometry Sphericity is a measurement aimed at checking the roundness of an object or in other words to find out whether an object is round or not if viewed carefully using measuring instruments (Mukhlis, 2014).

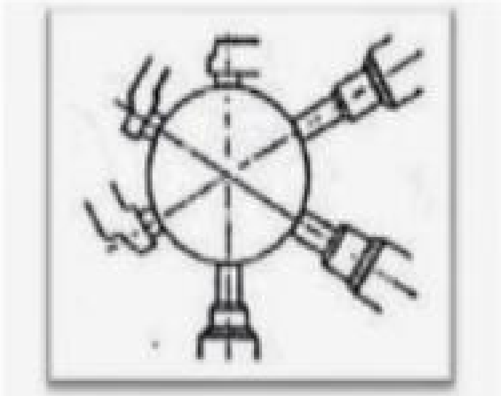

Figure 1. Measuring sphericity using the diameter method (Mukhlis, 2014)

Roundness is a price that can be calculated based on the profile of sphericity relative to its reference circle (Rochim, 2001). Observation of the roundness of the results of the machining process can be done by observing the roundness of the test objects produced by the cutting process on the machine tool, observation of roundness is carried out by changing the cutting parameters (Erizal Hamdi et al, 2015).

METHODS

This roundness test uses a diameter measurement method using an indicator dial at 6 points. The test design is shown in Figure 2 and Figure 3.

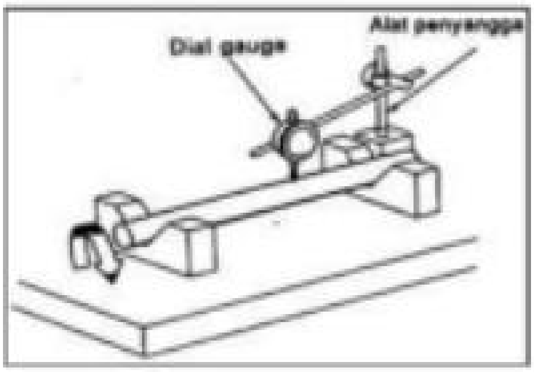

Figure 2. Measuring Sphericity using V-Block (Eko Yudo, 2019)

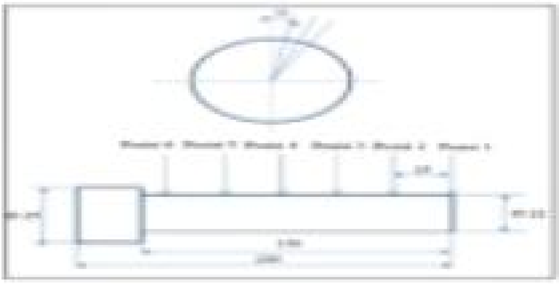

Figure 3 . Measurement Position of lathe test specimens (Eko Yudo, 2019)

Stages of Research. The goal to be achieved in this study is to find out the conditions, work accuracy, and deviations from the lathe in the Polnep Mechanical Engineering laboratory. To provide solutions to these objectives, research was carried out with the flow presented in Figure 4.

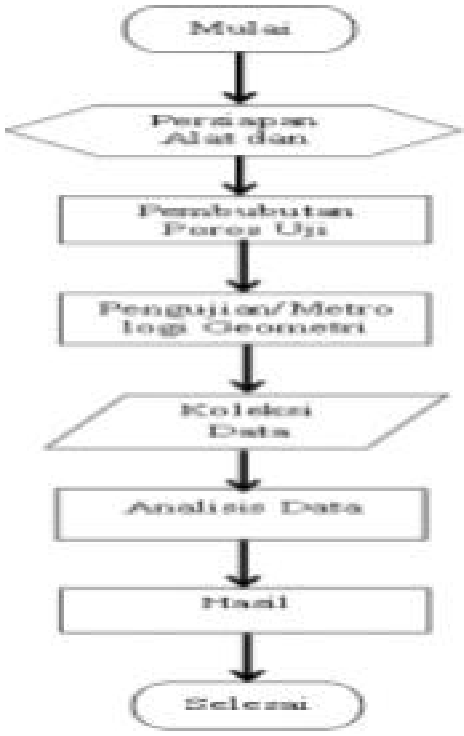

Figure 4. Research flowchart

Data Analysis. Data analysis in this study is by using descriptive quantitative analysis techniques, which are techniques used to describe or convey research results in graphic form.

The roundness parameter can be calculated based on the profile of the roundness relative to the reference circle. The reference circle used to analyze roundness can be done in 4 ways (Taufik Rochim, 2001), namely the minimum outer circle. maximum inner circle, minimum area circle, and smallest squared circle. More details can be seen in Figure 5.

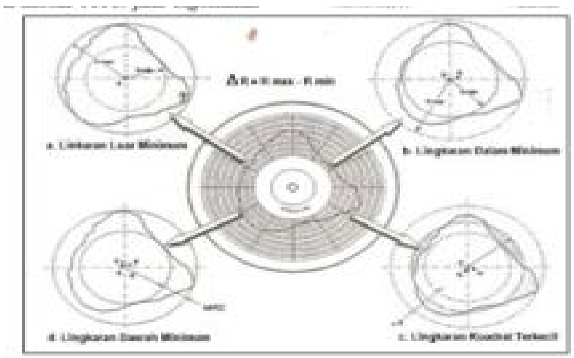

Figure 5. Polar graph of 4 ways of measuring sphericity (Taufik Rochim, 2001)

RESULTS AND DISCUSSION

To obtain the geometry of sphericity from the five tables above, Standard ISO recommends using the Minimum Radial Zone (MRZ), as it corresponds to the meaning of tolerance. MRZ is the difference between the radii of the two circles (ΔR). Each shaft is carried out in 6 measurement positions and each position is taken with measurement data every 10-degree change. From each of these positions, the MRZ value is taken, as shown in Table 1.

Table 1. Unsoundness of the test specimen

POSISI	1	2	3	4	5	6
NO. MESIN BUBUT	KETIDAKBULATAN (µm)					
MB 1	64	51	63	52	58	64
MB 2	66	84	58	68	53	57
MB 3	37	15	36	39	49	50
MB 4	72	92	62	50	59	72
MB 5	44	67	62	69	66	80

From Table 5.6 data, it can be seen that the test specimen at MB 1 in positions 1 and 6 has the largest unrounding value with a value of 64 µm and the smallest value of 51 µm at position 2. The specimen in MB 2 has the largest unsoundness in position 2 with a value of 84 µm and the smallest unsoundness of 53 µm in position 5. The specimen in MB 3 has the largest unsoundness in position 6 with a value of 50 µm and the smallest unsoundness of 15 µm in position 2. Meanwhile, the specimen on MB 4 has the largest unsoundness in position 2 with a value of 92 µm and the smallest unsoundness of 50 µm in position 4. While the test specimen in MB 5 has the largest unsoundness in position 6 with a value of 80 µm and the smallest unsoundness of 44 µm in position 1.

Table 2. Standard tolerances for diameters up to 500 mm

Diameter (mm)	Angka Kualitas IT, International Tolerance; Toleransi yang dinyatakan dalam µm																	
	01	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
≤3	0.3	0.5	0.8	1.2	2	3	4	6	10	14	25	40	60	100	140	250	400	600
>3-6	0.4	0.6	1	1.5	2.5	4	5	8	12	18	30	48	75	120	180	300	480	750
>6-10	0.4	0.6	1	1.5	2.5	4	6	9	15	22	36	58	90	150	220	360	580	900
>10-18	0.5	0.8	1.2	2	3	5	8	11	18	27	43	70	110	180	270	430	700	1100
>18-30	0.6	1	1.5	2.5	4	6	9	13	21	33	52	84	130	210	330	520	840	1300
>30-50	0.6	1	1.5	2.5	4	7	11	16	25	39	62	100	160	250	390	620	1000	1600
>50-80	0.8	1.2	2	3	5	8	13	19	30	46	74	120	190	300	460	740	1200	1900
>80-120	1	1.5	2.5	4	6	10	15	22	35	54	87	140	220	350	540	870	1400	2200
>120-180	1.2	2	3.5	5	8	12	18	25	40	63	100	160	250	400	630	1000	1600	2500
>180-250	2	3	4.5	7	10	14	20	29	46	72	115	185	290	460	720	1150	1850	2900
>250-315	2.5	4	6	8	12	16	23	32	52	81	130	210	320	520	810	1300	2100	3200
>315-400	3	5	7	9	13	18	25	36	57	89	140	230	360	570	890	1400	2300	3600
>400-500	4	6	8	10	15	20	27	40	63	97	155	250	400	630	970	1550	2500	4000

In the ISO system, 18 grades of tolerance are set called standard tolerances, starting from IT 01, IT 0, IT 1 to IT 16. Standard tolerances for diameters up to 500 mm can be seen in Table 5.7. If we insert the innumerity value in table 5.6 into the standard tolerance above, it will be obtained that MB 1 enters IT 9 and IT 10, MB 2 includes IT 9 and IT 10, MB 3 enters the IT tolerance class 6 – IT 9, and MB 4 includes IT 9- IT 11, and IT 8- IT 10 for MB 5.

CONCLUSION

Lathes at the Pontianak State Polytechnic Mechanical Engineering

Laboratory tested have been used for more than 30 years, with the ability of each machine to machine with a tolerance of roundness deviations on lathes MB 2 = 64 µm, can produce workpieces with tolerance values above 64 µm (IT 10). On lathes MB 2 = 84 µm, it can produce workpieces with tolerance values above 84µm (IT 10). Lathe MB 3 = 50 µm, can produce workpieces with tolerance values above 50 µm (IT 9). While the MB 4 lathe tolerance of the deviation of the roundness is 92 µm, it can produce workpieces with tolerance values above 92 µm (IT 11). While the lathe MB 5 tolerance of the deviation of roundness is 80 µm (IT 10), it can produce workpieces with tolerance values above 80 µm.

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