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Evaluation of Performance of CNC Turning Centres Alternative Method

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Abstract–CNC Turning Centers are extensively used in aerospace, defence and automobile industries for manufacture of critical and complicated components accurately. The final quality of machined part depended on performance of machine tool in addition to cutting parameters, cutting tool and work material. Therefore periodic evaluation of performance of machine tool is essential for manufacture of precision components. But the standard methods involve highly sophisticated and costly instrumentation. Therefore, A simplified alternative method has been identified based on quality of the machined component. In this study, three similar CNC Turning centers of identical model but varied year of makes from same machine tool manufacturer were selected. These machines are being used at DMRL for various individual applications since from their installations. Two types of work piece materials namely soft material (Aluminium) and hard material (Stainless Steel) were selected for machining operation by the above CNC machine tools for performance evaluation. Subsequently, Machining experiments were conducted on the both cylindrical components of the above materialswith appropriate cutting parameters and cutting tools under similar working conditions. The parameters roundness and surface roughness of the machined components were inspected by high precision measuring instruments. Theinspection data is analysed for evaluation of performance of the machine tool. The result gave significant help for selection of appropriate machine tool for achieving accuracy of the component.

Keywords –CNC Turning Centers, Surface Roughness and Roundness

I. Introduction

The Precision CNC Turning Centers are extensively used in aerospace, defence and automobile industries for manufacture of critical and complicated components accurately. In these machines, the machining operations on the workpiece are execute through preloaded CNC (computer numerical controlled) part programs. The CNC part program consists of machine control commands and numerical data. This alpha numerical data is used to operate and control various mechanisms such as servo motors,slides, hydro pneumatic systems, spindle motors, turret and other machine accessories for machining of components. The periodic checking of performance of the machine tool is essentially needed for precision machining works. This process involves measurement of geometrical and kinematic accuracy machine tool components. The measurement of geometric deviations such as straightness, parallelism, flatness and so on, giving the ability to assess the level of accuracy that is specific machine tools can be used. In practice, several methods are availablefor checking and testing geometric and kinematics accuracy of machine toolsevaluation, but which required high sophisticated and costlier instrumentation. Therefore, A simplified alternative method is essential at the machine shop for regular evaluation of performance of machine tool.

Machine tools dynamic response is a very important feature of any machining process that strongly influences quality of a machined component. Vibration in machining can be originated from many sources. This vibration is influences in surface roughness of the machined component. Similarly run out errors of head stock spindle leads to circular errors. The roundness and cylindricity error of the component is a high valued parameter for identification of performance of turning machines.

II. Experimental Setup

Three variety of CNC Turning CentersA, B and C shown in table 1 are identified for carrying out performance evaluation.

Table 1. General information of CNC Turning Centers

	A	B	C
Make	M/s Batliboi	M/s Batliboi	M/s Batliboi
Model	SPRINT 16 TC	SPRINT 16 TC	SPRINT 16 TC
Year of Installation	2004	2009	2009
Controller	FANUC-0iT	FANUC-0iTD	FANUC-0iTD
Mfgd. Accuracy	Positional : ± 0.005 Repeatability : ± 0.002	Positional : ± 0.005 Repeatability : ± 0.002	Positional : ± 0.005 Repeatability : ± 0.002
Holder	3 Jaw Chuck	3 Jaw Chuck	Collect Chuck

III. Experimentation

Two soft and hard materials of work pieces namely stainless-steel, aluminium rod of size 25 mm diameter and 100 mm long of each three in quantity were selected for experimentation. These specimen were loaded into the available three types of CNC turning Centers machines as per clamping mechanism defined in table 1.

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Machining experiments were carried out with the machining parameters shown in table 2 for stainless steel (SS) material and aluminium (AL) material by the above CNC Machine tool with solid carbide inserted type cutting tool

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IV. Results

Surface Roughness of the machined specimens were inspected by a ultra precision contact type surface roughness tester of Form Talysurf Intra – II model instrument of M/s Taylor Hobson, UK make. The sample figure of surface roughness profile was displayed as figure 1. The results obtained are shown in table 3, 4 and 5.

Table 5. SR Result by Machine Tool C			
STAINLESS STEEL		ALUMINUM	
SS3	VALUE (Ra in µ)	AL3	VALUE (Ra in µ)
R 1	0.2356	R 1	0.2861
R 2	0.2334	R 2	0.25280
R 3	0.2194	R 3	0.2449
AVG	**0.2294**	**AVG**	**1.2612**

Table 3. SR Result by Machine Tool A			
STAINLESS STEEL		ALUMINUM	
SS 1	VALUE (Ra in µ)	AL 1	VALUE (Ra in µ)
R 1	0.2644	R 1	0.3340
R 2	0.1982	R 2	0.2432
R 3	0.1697	R 3	0.1932
AVG	**0.2108**	**AVG**	**0.2570**

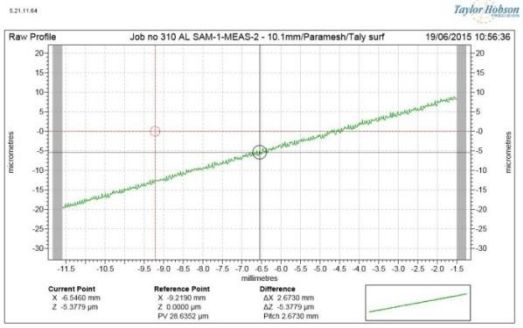

Fig. 1. Surface Roughness of SS1 on Machine Tool A

Table 4. SR Result by Machine Tool B			
STAINLESS STEEL		ALUMINUM	
SS2	VALUE (Ra in µ)	AL2	VALUE (Ra in µ)
R 1	0.4304	R 1	0.4304
R 2	0.4007	R 2	0.4007
R 3	0.2983	R 3	0.2983
AVG	**0.3765**	**AVG**	**0.2118**

Table 2. Parameters for Turning Experiments			
	Cutting Speed mm/min	Feed mm/rev	DOC mm
SS	100	0.4	0.5
Al	180	0.8	1.0

Roundness values of the machine sample of stainless steel and aluminium were evaluated by high precision roundness tester of CNC Talyrond 565 model M/s Taylor Hobson, UK make. The Roudness profile of stainless steel sample machine on Machine Tool A was shown in figure 2. The results obtained are shown in table 6, 7 and 8 below.

Table 6. Roundness Result by Machine Tool A			
STAINLESS STEEL		ALUMINUM	
SS1	VALUE (µ)	AL1	VALUE (µ)
R 1	1.86	R 1	**1.13**
R 2	1.03	R 2	0.67
R 3	0.94	R 3	0.67
AVG	1.27	AVG	0.82

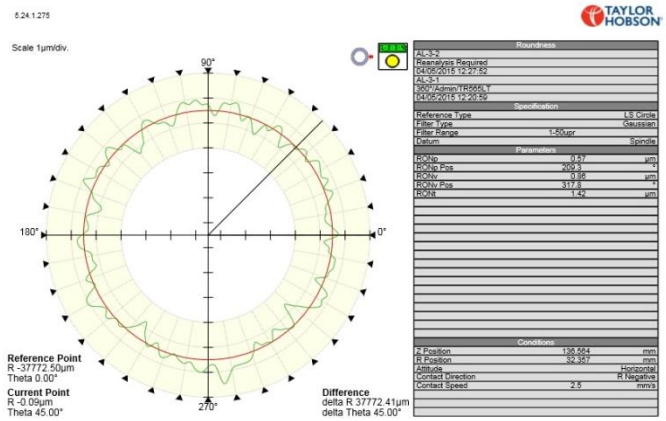

Fig. 2. Roundness Profile of SS1 on Machine Tool A

Table 7. Roundness Result by Machine Tool B			
STAINLESS STEEL		ALUMINUM	
SS2	VALUE (µ)	AL2	VALUE (µ)
R 1	2.84	R 1	1.64
R 2	1.87	R 2	1.47
R 3	1.38	R 3	1.46
AVG	2.03	AVG	1.52

Table 8. Roundness Result by Machine Tool C			
STAINLESS STEEL		ALUMINUM	
SAMPLE 3	VALUE (µ)	SAMPLE 3	VALUE (µ)
READING 1	3.46	READING 1	4.44

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READING 2	2.22	READING 2	1.72
READING 3	1.65	READING 3	1.46
AVG	2.44	AVG	2.54

V. Conclusion:

The periodic checking of performance of the machine tool is essentially needed for precision machining works. The performance of CNC Turning Centers have been evaluated by quality of the machined component. The surface roughness values and roundness of the machined component of selected materials were measured by high precision measuring instruments. These two parameters are found to be a perfect judge for dynamics of machine tool such as geometric and kinematics accuracy of machine tool.Based on the experimental result it is found that the Machine Tool A is having very low valuesof surface roughness and roundness for both stainless steel and aluminium material when compared with other two machines.The Comparison of machines for roughness and roundness were shown in figure 3 and 4 respectively (1, 2, 3 in abscissa depicts machine tool A, B and C). The order of accuracy of machine tool for precision work is found to be A, B and C. This results gave a message that the older machine tool can also give better performance.

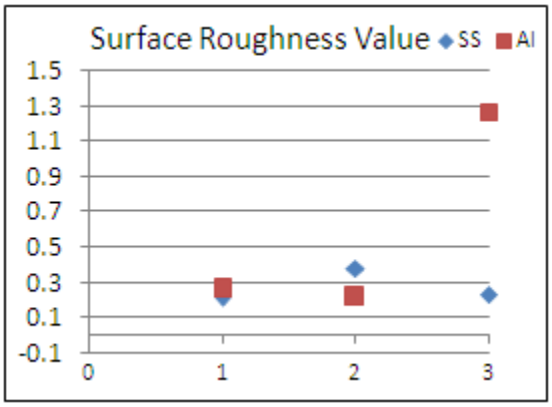

Fig. 3. Roughness Values of Machine Tool A, B and C

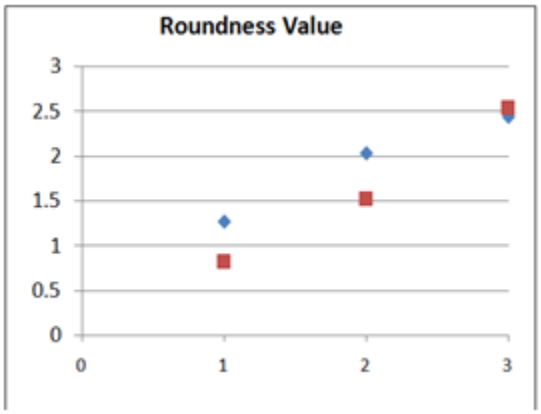

Fig. 4. Roundness Values of Machine Tool A, B and C

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