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Effect of internal roller burnishing on surface roughness and surface hardness of mild steel

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Roller burnishing is a cold working surface treatment process to generate a uniform and work-hardened surface. This study presents two internal roller burnishing tools to perform roller burnishing process on mild steel under different speeds. Burnishing speed impact on surface roughness and surface hardness has been examined.

Keywords: Roller burnishing, Surface hardness, Surface roughness

Introduction

Under contact aspects between machine elements, provided energy (> 50%) lost by friction results from relative movements between elements[1,2]. Roughness (< 0.1 µm) is required for minimizing friction losses, easy mould release, good corrosion resistance and high fatigue strength. Conventional machining leave inherent irregularities on surface causing additional cost of finishing operations[3,4]. Use of burnishing improves surface characteristics by plastic deformation of surface layers[5]. Cold working finishing process is reported[6] to produce good surface finish and residual compressive stresses at metallic surface layers. Burnishing distinguishes itself from chip-forming finishing process (grinding, honing, lapping and super finishing), which induce residual tensile stresses at machines surface layers[7]. Burnishing requires less time and skill to obtain a high quality surface finish[8]. Fatigue life, bearing properties and lubrication of a part depends upon appropriate surface finish[9].

Present work examines effect of internal roller burnishing on surface roughness and surface hardness of mild steel by varying the speed.

Materials and Methods

Commercial mild steel (MS) bars (diam, 32 mm) were prepared on all geared head stock lathe by piece cutting to required dimensions from bar, turning outside diameter, drilling and boring. Work pieces (length, 50 mm) were cut by hacksaw machine using water emulsion as lubricant. Then, facing was done and work pieces were turned to 30 mm outer diameter on lathe machine. For internal roller burnishing, work pieces were center drilled and then drilled to internal diameters using drill bits of required size on lathe machine. Finally, boring was accomplished to improve strength and also to provide required stock allowances for burnishing. Two internal roller-burnishing tools were used (Figs 1 and 2).

Machines and Equipment

Proposed work is internal roller burnishing for MS work pieces using burnishing tool (diam, 11 & 13 mm). Surface roughness (SR) values of all 12 work pieces were taken before burnishing using Stylus probe instrument, Surf Test and surface hardness was estimated using Rockwell hardness tester.

Burnishing Operation

Burnishing was done on radial drilling machine with following specifications: I) number of spindle speeds, 8; ii) range of spindle speeds, 62-1980 rpm; range of power feeds, 0.08-0.04 mm/rev; power of main motor, 2 HP; and drilling capacity in M.S, 38 mm. Burnishing was performed with varying speed, under continuous lubrication of water emulsion type oil, and proper stock allowance (0.020 mm) was maintained. Drill tool

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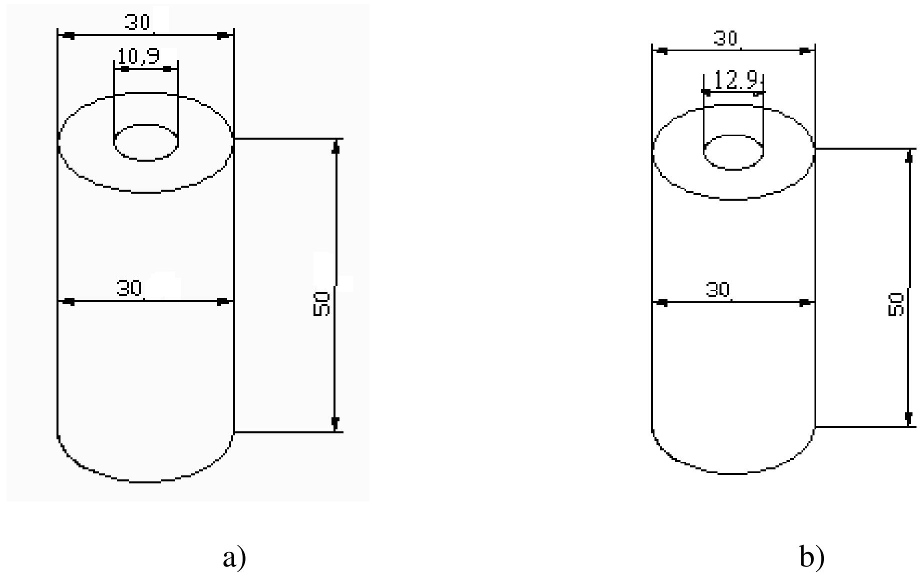

Fig. 1—Work piece: a) internal diameter (11 mm); b) internal diameter (13 mm)

Fig. 2—Internal roller burnishing tool

Table 1—Comparison of surface finish values before and after burnishing for MS work piece

Burnishing speed m/min	Surface finish before burnishing (Ra) µm		Surface finish after burnishing (Ra) µm		Improvement in surface finish %	
	diam, 11	diam, 13	diam, 11	diam, 13	diam, 11	diam, 13
18	6.83	13.25	2.96	1.72	56.66	87.2
25	6.1	11.88	1.94	1.41	68.29	88.13
40	7.43	11.79	1.51	1.39	79.67	88.2
62	7.74	10.05	1.36	1.08	82.42	89.25
97	6.75	7.5	1.33	1.05	80.3	86.7

Table 2—Surface hardness values for burnishing tool

Speed rpm	Before burnishing avg R_c		After burnishing avg R_c		Increase in hardness %	
	diam, 11	diam, 13	diam, 11	diam, 13	diam, 11	diam, 13
18	97.667	105.667	88.667	93.667	9.21	11.35
25	98.667	93.33	84	81.667	14.9	12.49
40	141.33	104.33	107	98	24.29	21.4
62	124.67	138.667	92.667	98	25.66	29.32
97	123.4	132.8	94.4	97	23.5	27.2

dynamometer was used to determine thrust and torque. Hardness values of all work pieces were determined using Rockwell hardness testing machine before and after burnishing.

Results and Discussion

Relationship existing between SR parameter (Ra) and speed for normal burnishing is reported[10]. In internal burnishing process, surface finish and SR of MS material increases with increase of burnishing speed, due to repeated deformation of surface irregularities with increased burnishing speed. Surface finish and surface hardness increases with burnishing speed up to an optimum value (62 m/min), and then decrease (Tables 1 and 2). Optimum value was due to severe work-hardening of surface with increased speed of burnishing, leading to flaking effect of surface layer. Thus burnishing gives positive results of increase in SR and surface finish up to optimum value of burnishing speed, beyond which there are negative results of decrease in surface finish and SR. In present work, concentration was on determination of optimum burnishing speed for internal burnishing of MS material.

Conclusions

Internal roller burnishing process has been performed using a radial drilling machine on MS work pieces. Variation of surface finish and SR were observed by varying burnishing speed, keeping burnishing interference and burnishing feed as constant. Optimum increase in surface finish and SR was at 62 m/min. If speed is different than optimum value, increase in surface finish and SR is less. Same study can be extended to other metals, non-metals and composite materials to explore possibility of burnishing use.

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