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Optimization of Roller Burnishing Process Parameters for High Strength En19 Alloy Steel

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ABSTRACT
The present experimental investigation focuses on effect of various parameters and optimization of burnishing processes on surface finish and surface Harding of EN19 material during burnishing operation. Burnishing is a chip less finishing method which employs a rolling tool pressed against the work piece for achieving plastic deformation of the surface layer. Design of experiments (DOE) methodology was used for the optimization purpose. L'27 orthogonal array (three factors at three levels) was chosen. The parameters considered for the present study were speed, force and feed. By of the Taguchi methodology optimum machining parameters obtained which gives better surface finish and Hardness.

Keywords: Roller burnishing, EN19material, Optimization, Taguchi Methodology, Surface Roughness, Surface Hardness.

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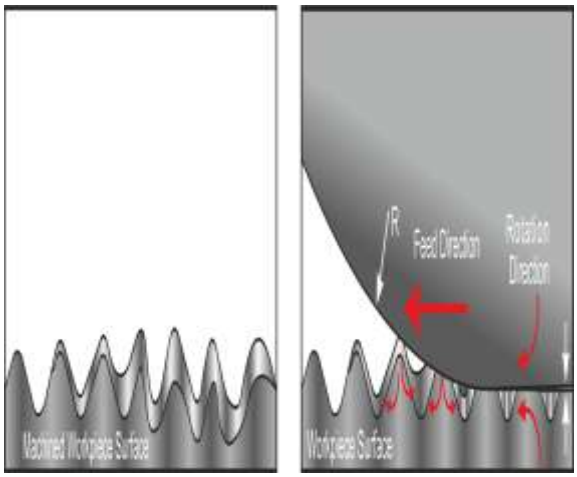
I. INTRODUCTION

Roller Burnishing is a cold working process which produces a fine surface finish by the planetary rotation of hardened rolls over a bored or turned metal surface. Roller Burnishing involves cold working the surface of the workplace to improve surface structure. In the process, tool marks and irregularities are rolled out. The result is a mirror like finish with a tough, work-hardened, wear and corrosion resistant surface.

This method can be carried out using conventional machines, such as lathe machine. On account of its high productivity, it also saves more on production costs than other conventional processes such as super finishing, honing and grinding. The figure 1 shows the actual mechanism of burnishing process of plastic deformation with the movement of burnishing tool over the work piece. By use of the Taguchi methodology the burnishing parameters are analyzed and optimization to achieve considerable surface



The mechanism of burnishing process

II. BENEFITS OF BURNISHING PROCESS

Burnishing process can provide the following benefits especially as following,

a) Polished surface finish
b) Improved metallurgical properties
c) Dimensional Consistency and accuracy
d) No additional machine investment
e) More utilization of machining capabilities
f) No chip accumulation

III. MATERIALS AND METHODS

In this research EN19 steel material material is used because of its high strength.Nowadays, automobile industry has been growing at fast rate which require high tensile strength, and impact for the components. EN19 steel material is suitable for heat treated parts where high tensile and impact are required. For motorsport applications an engine will need to run at speeds beyond the limits of the standard crank. Inevitably this means a steel crank for greater strength and reduced weight. EN19 generally used for axle shafts gears, connecting rods, studs bolts, propeller shaft joint.

EN-19 Steel Specifications:

Level	Speed (RPM)	Force (kg)	Feed rate (mm/rev)
1	2.884	**1.895**	1.835
2	2.629	2.981	2.609
3	**2.061**	2.698	3.130
Delta	0.823	1.086	**1.295**
Rank	3	2	1

Table I Chemical Composition (In Percentages)

c	si	Mn	Cr	mo
0.35-0.45	0.1-0.30	0.50-0.80	0.90-1.40	0.2-0.40

Mechanical Properties

- Hardness = 201 to 255 BHN.
- Yield stress = 465 MPa.
- Max Stress = 700 to 850 MPa.
- Tensile Stress = 550 MPa.
- Elongation % = 16
- Length of each compartment= 40mm.
- Diameter= 30mm.
- Number of trial compartments for process= 27

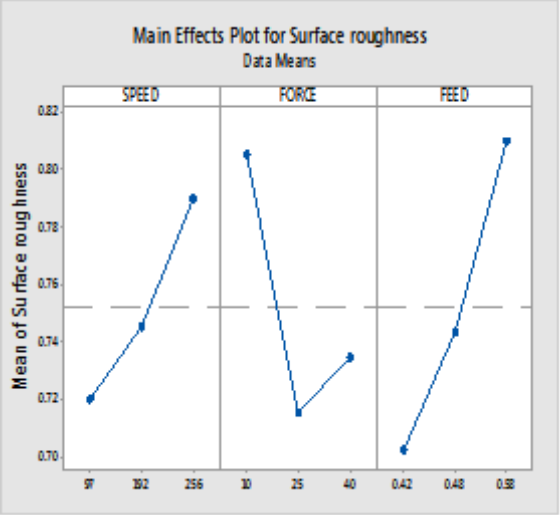
IV. FULL FACTORIAL METHOD DESIGN OF EXPERIMENT:

Table II. Machining Parameters and their levels for Roller Burnishing Processes

Parameters	**Level 1**	**Level 2**	**Level 3**
Speed (rpm)	97	192	256
Feed (mm/rev)	0.58	0.48	0.42
Force(kg)	10	25	40

TAGUCHI ANALYSIS The Experimental Results Are Transferred To A Mean To Mean Ratio With The Criteria Smaller-The-Better Is Used To Determine The Surface Quality And Larger Is Better Is Used To Determine The Surface Hardness By Use Of Minitab-17 Software

MAIN EFFECTS PLOT FOR MEANS OF SURFACE ROUGHNESS

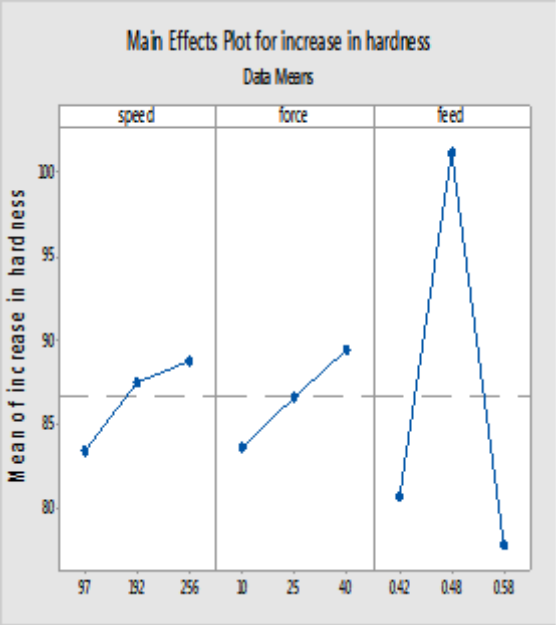


The main effects plot for S/N ratio of surface roughness versus Speed, Feed rate and feed are minitab-17 statistical software is useful to find out optimum parameter value for response variable. Fig.4.2 shows that lower surface roughness will meet at Speed 97rpm, force 10kg and feed 0.42mm/rev. The graph generated by use of minitab- statistical software for surface roughness is shown in fig.4.2. From the fig.4.2, it has been conclude that the optimum combination of each process parameter for lower surface roughness is meeting lower Speed, medium Pressure and low feed.

Exp. no	Speed (RPM)	Force	Feed rate(mm/rev)	Surface roughness	Hardness
1	97	10	0.58	0.81	79
2	97	10	0.48	0.74	97
3	97	10	0.42	0.70	70
4	97	25	0.58	0.79	81
5	97	25	0.48	0.68	98
6	97	25	0.42	0.63	72
7	97	40	0.58	0.78	83
8	97	40	0.48	0.70	98
9	97	40	0.42	0.65	73
10	192	10	0.58	0.85	82
11	192	10	0.48	0.84	99
12	192	10	0.42	0.75	72
13	192	25	0.58	0.80	84
14	192	25	0.48	0.63	103
15	192	25	0.42	0.55	74
16	192	40	0.58	0.78	88
17	192	40	0.48	0.74	106
18	192	40	0.42	0.70	80
19	256	10	0.58	0.85	66
20	256	10	0.48	0.83	100
21	256	10	0.42	0.81	88
22	256	25	0.58	0.83	67
23	256	25	0.48	0.78	105
24	256	25	0.42	0.75	96
25	256	40	0.58	0.80	70
26	256	40	0.48	0.75	105
27	256	40	0.42	0.71	102

The Experiments are performed as per Taguchi methodology with L27 orthogonal array created in Minitab- 17 software. The range of the burnishing parameters used in this experiment shown in Table III

Main Effects Plot for means of surface hardness



higher surface hardness will meet at Speed 256, force 40kg and feed 0.48 mm/rev. From the

Level	Speed (RPM)	Force (kg)	Feed rate(mm/rev)
1	38.36	38.36	38.07
2	38.77	38.65	**40.10**
3	**38.82**	**38.94**	37.77
Delta	0.46	0.58	2.33
Rank	3	2	1

fig.4.3, it has been conclude that the optimum combination of each process parameter for lower surface hardness is meeting at higher Speed, higher force and medium feed

IV. CONCLUSION

Experimental investigation on roller burnishing machining of EN19 has been done using Design of experiment. In this experimentation, the burnishing speed, feed, force these all factors are optimized by using TAGUCHI Methodology.From the mean effect plot the optimum parameter settings for surface roughness at, Speed 97rpm, force 25kg, feed 0.42mm/rev and no of passes is 3.It can also observe that all process parameters are more contribute for surface roughness but feed is the most prominent factor affecting the surface roughness.From the Taguchi methodology, maximum increase in hardness is obtained for 256rpm speed,at40 kg force, 0.48mm/rev roller feed, and no of passes is 3. In this experiment no of passes 3 kepted as constant because during my project literature survey i seen better surface roughness and hardness obtained at 3 passes and also to reduce no of workpiecses

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