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Experimental Investigations for Effect of Various Parameters on Burnishing Process

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Abstract:
Surface finish is a critical factor in creating a durable metal component. Manufacturers strive to produce metal surfaces free of scratches, nicks and gouges, since such defects make components vulnerable to damaging cracks. A smooth surface alone is insufficient, however, to protect the component against the wear and tear of regular usage. Machining process such as milling & turning produce a surface with inherent irregularities. Finishing process such as grinding, lapping, honing, and polishing. Commonly seeing employed to improve the surface finish.

Unlike the above mentioned traditional methods that depend on the chip removal, hard Roller burnishing is a cost effective surface enhancement process in which a smooth hard tool (using sufficient pressure) is rubbed on the metal surface. This process flattens the roughness peaks by causing plastic flow of the metal. A process of finishing by surface plastic deformation can meet this requirement. It not only improves surface finish but also imposes favorable compressive residual stresses and raises hardness in functional surfaces, which can lead to long fatigue life.

Steel in the form of bars, cables, tendons etc. as a reinforcing material in cement concrete is extremely popular and widely accepted construction material all over the world. One of the major drawback with it , is its vulnerability to the environmental attacks and subsequent electro chemical destruction leading to corrosion which in turn reduces strength and serviceability of concrete structures.

Engineers and scientists are in constant search of an alternative material which will be corrosion resistant, withstand extreme environmental conditions, light weight, stronger and fatigue resistant, easy to handle as compared to steel. In this project we will analyze the surface finish and surface hardness of Composite material, E-Glass Epoxy, by external roller burnishing process under different speeds, passes and depth of cuts. Hardness of metal is correlated with the depth of indentation and not with the area of indentation as is done in the brinell and Vickers hardness methods. Harder the material, depth of indentation is less for a given load vice versa Non-destructive testing methods used by modern industry.

Employing highly penetrating x-rays, gamma rays, and other forms of radiation that do not damage the part itself, radiography provides a permanent visible film record of internal conditions. The evidence from millions of film records, or radiographs has enabled industry to assure product reliability To meet the Growing and changing demands of industry, research and development in the field of radiography are continually producing new sources of radiation such as neutron generators and radioactive isotopes; lighter more powerful, more portable x-ray equipment as well as multimillion-volt x-ray machines designed to produce highly penetrating radiation; new and improved x-ray films and automatic film process; and improved or specialized radiographic techniques.

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These factors, plus the activities of many dedicated people, extend radiography's usefulness to industry.

I. INTRODUCTION:

In a manufacturing plant a product may be shaped, turned milled or drilled and left in that condition as being satisfactory for use. Finishing is becoming increasingly important in the production of machine and instrument components, and increasing attention is being paid to surface finish quality. A good surface finish has a positive and lasting effect on the functioning of machine parts, affecting wear resistance, load carrying capacity, tool life, and fatigue.

Poor surface finish may increase wear, invalidate tolerances, and increase the power requirements of the mechanism. However, if a better finish is desired for looks, accuracy, wearing qualities or for any other reasons, one of the micro finishes, that include lapping, honing, polishing, buffing super finishing and burnishing may be employed. It is very difficult to lay down specific rules regarding the choice of any of these methods because of many variables involved the most important being the particular piece to be machined.

Conventional machining processes such as milling, turning and drilling inevitably produce irregular surfaces, and thus post-processing is required to reduce surface roughness, involving grinding, lapping, polishing, honing, and so on. Unlike the above mentioned traditional methods, which depend on the chip removal, the burnishing process is a cold working process, which easily produces a smooth and work hardened surface by plastic deformation of surface irregularities and can also increase the fatigue strength and wear resistance of a work piece, owing to the residual compressive stress and the work hardening of the material on the surface. In this finishing process the top layer of the material is cold forms instead to remove chips.

II. BURNISHING:

Burnishing is considered as a cold-working finishing process, differing from other cold-working, surface treatment processes such as shot peening and sand blasting, etc. [1]In that it produces a good surface finish and also induces residual compressive stresses at the metallic surface layers. Accordingly, burnishing distinguishes itself from chip-forming finishing processes such as grinding, honing, lapping and super-finishing which induce residual tensile stresses at the machined surface layers. Also, [2]burnishing is economically desirable, because it is a simple and cheap process, requiring less time and skill to obtain a high-quality surface finish[3].

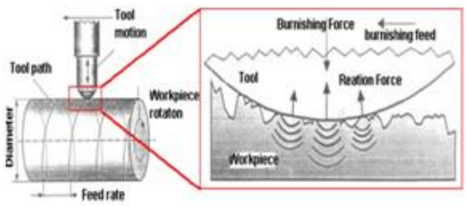

Fig 3.1: representing feed rate and burnishing force.

2.1 Roller Burnishing:

Roller burnishing is a super-finishing process .[4]It is a cold working process by which improvement in surface finish ,dimensional accurate and work hardening can be affected without removing metal .It is a finishing operation and is normally done on parts which are turned, bored, reamed or ground. Any ductile or malleable material with hardness less than 40 HRC can be successfully burnished[5].

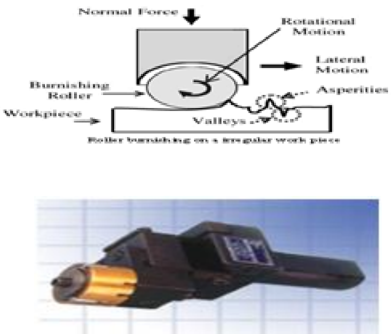

Fig 3.3:Micro view of Roller burnishing process and tool

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Roller burnishing is a cold working process which produces a fine surface finish by the planetary rotation of hardened rollers over bored or turned metal surface .since all machined surfaces consists of a series of peaks and valleys of irregular height and spacing, the plastic deformation created by roller burnishing is a displacement of the material in the peaks which cold flours under pressure into the valleys. The result is a mirror like finish with a tough, work-hardened, wear and corrosion resistant, wear and corrosion resistant surface lapping and horning is eliminated.

2.2 Ball Burnishing

Fig 3.4: ball burnishing tool

Ball burnishing is one of the finishing process which results in a plastic deformation on the work piece surface by using steel balls to improve surface roughness and surface hardness

2.3 Rockwell Hardness Test:

In this method hardness of metal is correlated with the depth of indentation and not with the area of indentation as is done in the Brinell and Vickers hardness methods. Harder the material, depth of indentation is less for a given load and vice versa. Hence, the hardness is inversely proportional to the depth of indentation. The dial is calibrain an inverse fashion so that the hardness number becomes directly proportional to the hardness of the material.

In this test, two types of indenters are used:

1. Hard steel balls of 1/16", 1/8", 1/4" and 1/2" diameters.
2. Brale indenter made of diamond in the form of a cone with included angle of 120°.

The tip of the indenter is accurately ground to a radius of 0.2 mm.

Table 5.1 various combinations of ball indenters and loads

Indenter	Major load		
	60	90	150
Cone	A	D	C
1/6" – ball	F	B	G
1/8" - ball	H	E	K
1/4" – ball	L	M	P
1/2" - ball	R	S	V

Loads are applied in two stages. First a constant minor load of 10 kg is applied and then major load is applied. The major loads are 60,100, or 150 kg. These various combinations of indenters and loads are indicated by letters such as A, B, C. etc. 'A' letter indicates 60 kg load and Brale indenter, B letter indicates 100 kg load and 1/16" diameter indenter, C letter indicates 150 kg load and Brale indenter and so on.

III. EQUIPMENT USED IN EXPERIMENTAL WORK:

This is a 6 all geared heavy duty lathe.

Fig 6.1: Lathe TLC 360B

The lathe used is of model TLC 360B and specifications are:

Length of the bed	-------	1800mm
Height of center	-------	510 mm
Admit between centers	-------	1000 mm
Swing over bed	-------	360 mm
Swing over cross slide	-------	230 mm
Hole through spindle	-------	38 mm
No. of spindle speeds	-------	9
Metric threads	-------	0.25-9
Inch (Thread per Inch)	-------	72-4 ¾
Power of motor	-------	2.2 h.p

Surface Roughness Test SJ-201P

The surface roughness was calculated using this tester.

The specifications are:

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Drive speed measuring ------ 0.01"/s(0.25mm/s)
Evaluation length ------ 1.49"(12.5mm)
Detecting method: ------ Differential inductance
Material of stylus: ------ Diamond
Radius of skid curvature: ------ 1.57" (40mm)
Stylus tip radius: ------ 200μin (5μm)
Measuring force: ------ 4mN
Roughness parameter: ------ Ra, R_y, and Rz
Sampling length (L): ------- 0 .01", 0.03", 0.1" (0.25mm, 0.8mm, 2.5mm)
Cut-off (Lc): ------ 0 .01", 0 .03", 0.1" (0.25mm, 0.8mm, 2.5mm
Power supply: ------ Via AC adapter/built-in rechargeable battery

3.1 Burnishing Tool Used

This is the single roller special burnishing tool. The rollers are made with hard material (Carbide).the can be replaced if in case rollers fail by wear or breakage.

Fig 6.2: H-type External single Roller burnishing tool

3.2 EXPERIMENTAL VALUES

The units of the parameters used are:
Roughness in micro meters (μm)
Feed in mm per revolution (constant 0.032mm/rev)
Speed in meters per minute
Burnishing force in kgf
Hardness in HRC
Depth of cut in mm

3.3 TEMPERATURE EFFECT

Apart from all the above , I had taken sample piece at 0.1 depth of cut and speed is 35.34m/min , and we have increased the temperature of the piece to 300 degrees centigrade respectively by placing in electrical furnace. Before heating, I have taken the values of hardness, and after heating I came to know that the hardness value does not change.

Even after burnishing after the heating process, the hardness increases but not decreases.

IV. EXPERIMENTAL ANALYSI

4.1 Variation of Surface Roughness with Speed at Different Depth of Cuts:

The units of the parameters used are:
Roughness in 10^{-8} meters
Feed in mm per revolution
Speed in m/min, Feed 0.032 mm/rev
Burnishing force in kgf
Hardness in HRC

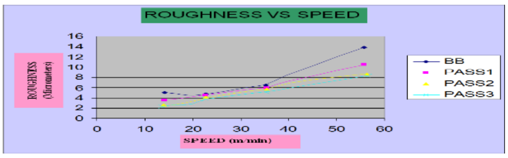

Fig 8.1 variation of surface roughness with Speed at 0.1 depth of cut

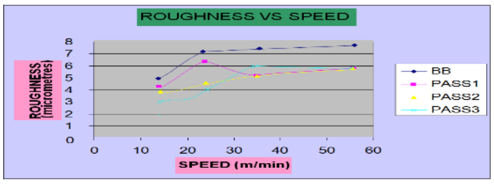

Fig8.2 Variation of Surface Roughness with Speed at 0.2 Depth of cut

4.2 Variation of Surface Roughness with Depth of Cut at Different Speeds:

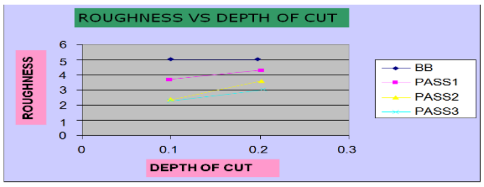

Fig 8.3Variation of Surface Roughness with Depth of cut at Speed 14.13 m/min

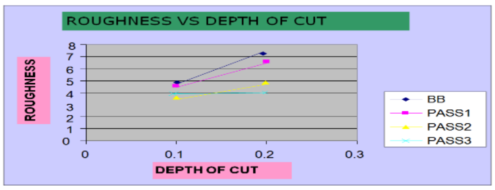

Fig 8.4 Variation of Surface Roughness with Depth of cut at Speed 22.77m/min

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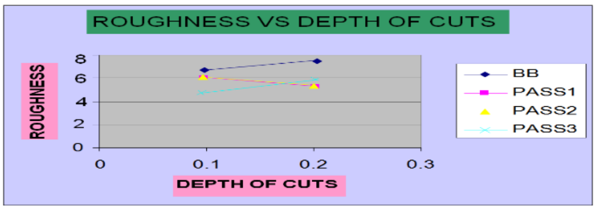

Fig 8.5 Variation of Surface Roughness with Depth of cut at Speed 35.34m/min

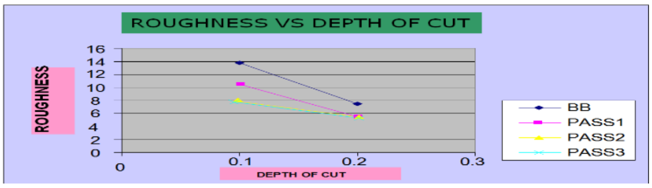

Fig 8.6 Variation of Surface Roughness with Depth of cut at Speed 55.76 m/min

4.3.Variation of Surface Hardness with Speed at Different Depth of Cuts

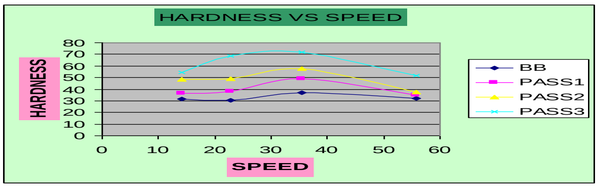

Fig 8.7 Variation of Surface Hardness with Speed at 0.1 Depth of cut

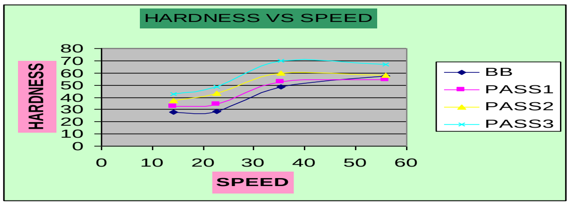

Fig 8.8 Variation of Surface Hardness with Speed at 0.2 Depth of cut

4.4 Variation of Surface Hardness with Depth of Cuts at Different Speeds

Fig 8.9 Variation of Surface Hardness with Depth of cut at Speed 14.13 m/min

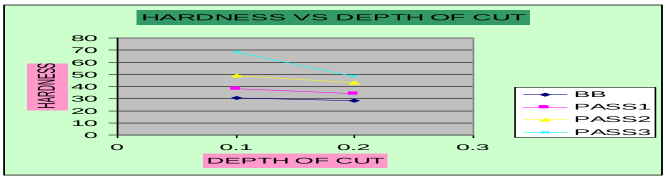

Fig 8.10 Variation of Surface Hardness with Depth of cut at Speed 22.77 m/min

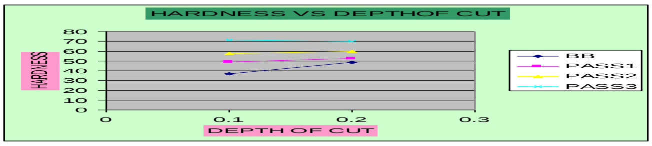

Fig 8.11 Variation of Surface Hardness with Depth of cut at Speed 35.34 m/min

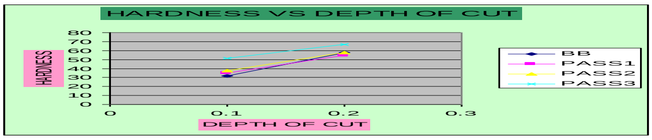

Fig 8.12 Variation of Surface Hardness with Depth of cut at Speed 55.76 m/min

4.6 RESULTS

From the experimental results we can observe the following results:

1) It was observed that the surface roughness and surface hardness varies with burnishing speed, feed, burnishing force, and number of passes.
2) Increase in burnishing speed up to about 35.34 m/min leads to a decrease in mean roughness. With a further increase in burnishing speed mean roughness gradually increases.
3) At low burnishing speeds also, due to repeated burnishing, causing flaking of surface, the roughness is high. At high speeds there is insufficient burnishing and roughness is high. Hence there is an optimum burnishing speed.
4) As the number of passes increases, due to repeated burnishing better surface finish will be obtained. But when the number exceeds the optimum value, severe work hardening causes flaking effect, which increases surface roughness.

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5) It is better to select low speeds because the deforming action of the burnishing tool is greater and metal flow is regular at low speed.
6) The highest surface micro hardness was obtained with the combination of a high number of passes and high depth of penetration used in this work. It is observed that the increase of the number of passes increases the surface micro hardness at high speed as against low speed as a result of the increasing impact between the burnishing tool and work piece surface.
7) The increase in burnishing depth of penetration causes an increase in the amount of surface deformation as the tool passes along the surface of the work piece. This will lead to an increase in the work hardening of the surface layers, which have been affected by plastic deformation, so that surface micro hardness will increase via the increase in burnishing depth of penetration.
8) It has been proved that, the hardness of the material does not decrease even at elevated temperatures and on burnishing the heated material hardness increases.
9) So, hardness is increased (on the surface of the required pipe) after the burnishing process.
10) The technique used ellipsoidal with offset technique.
11) By using Ellipsoidal technique we got the two walls of the pipe in the film.
12) Finally we concluded there is no objectionable indication is appeared on the film. So, the object is does not have any defect.

V. CONCLUSION

The results of the burnishing process are quite complicated, and many factors affect its results. How to find the optimal burnishing conditions and how to control the results are very important for industry. From this project, the following conclusions may be drawn:

- It is better to select low speeds because the deforming action of the burnishing tool is greater and metal flow is regular at low speed.
- The recommended spindle speeds that result in high surface micro hardness and good surface finish are in the range from 90 to 225 rpm.
- No change in surface hardness even at elevated temperatures.
- From the experimental analysis the optimum burnishing speed, number of passes and depth of cuts were finalized which will be useful as guideline while external burnishing of composite materials.

FUTURE SCOPE

- The scope of composite materials is very high in future. Because of stupendous exhibition of properties, Composite materials definitely replace the common material such as steel,cast-iron etc.
- Even now the composite materials are being implemented in defense,space, launch pads, high temperature areas,army, navy,and military depending upon the properties to be exhibited.
- Burnishing process improves some properties of the composite materials which is very advantageous in future.The study can be further extended by considering different type of material models.
- Further study can be done by refining 3D finite element modeling, which reduces computer running time and increases the calculation accuracy.

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