"ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF CONTRIBUTION OF BURNISHED PARAMETERS ON ROUGHNESS AND MICRO HARDNESS OF AA6340''

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Abstract - *Now a day, every material is work satisfactorily under any conditions with high efficiency of performance due their highly improved properties. Among all properties the surface finish has their maximum valuation. The considerable attention is made towards quality of the surface finish.*
The surface finish not only plays important role in aesthetic look but it majorly affect the performance parameters of the material like load carrying capacity, fatigue life , surface hardness , wear and corrosion resistance.

Key Words: Roughness,micro-hardness,micro-stucture

1. INTRODUCTION

The surface roughness is the parameter which directly gives surface quality of material in the form of micro irregularities. The surface finish is obtained by conventional machining operations like turning, milling and grinding. The conventional operations have greater surface roughness which has limited surface finish.

Machining operations are used to produce a desired shape and size by removing excess stock from a blank in the form of chips. The work piece is subjected to intense mechanical stress and localized heating by tools having one more shaped cutting edges. Each cutting edge leaves its own mark on the mechanical surface. Also the work piece and tool together with the machine on which they are mounted form a vibratory system liable to random, forced or induced vibration. Due to these reons, the surface of the machined component is more or less damaged. Surface finish and surface integrity are the terms used to denote the degree of such damage. The above term describes the geometrical and micro structural quality of machined surface

In the present scenario of manufacturing good surface finish and dimensional accuracy plays an important role. A good surface finish is essential in many applications, e.g. in the moulds and dies, bioengineering, semiconductor and optical industries. In the injection molding process, the surfaces finish required is Ra= 0.1µm or less. Surface finish is important not only as an indication of expert workmanship, but it has effects on the life and function of the component. Finishing processes such as grinding, polishing, lapping and honing are commonly employed to improve surface finish. It also improves exterior quality of surface.

1.1 Sub Heading 1

1.1 Importance of the Problem

The main importance of this work is getting required surface quality and improvement in the properties of materials. To obtain these properties the theory behind the surface has to take in to consideration.

1.1.1 Parameters that affect surface finish

1. Roughness: Roughness consist of the finer irregularities in the surface texture, usually including those irregularities which results from the inherent action of the production process. They include transverse feed marks and other irregularities within the limit of roughness width cutoff.
2. Waviness: The widely spaced component of surface texture and generally of wider space than the roughness width cutoff, waviness may results from such factors as machine or work deflection, vibration, heat treatment etc. It consists of all surface irregularities whose spacing is greater than the roughness sampling length (about 1mm).
3. Lay: The direction of predominant surface pattern, ordinarily determined by the production method used. The lay depends upon the orientation of the work piece and the cutting tool on the machine as well as the nature of the relative motion between the two.
4. Flaws: Irregularities which occurs at one place or at relatively infrequent or widely varying intervals in the surface. Flaws could be due to inherent defects, such as

inclusions, cracks, blow-holes, etc. in the work piece that get exposed on machining, or they could arise from the machining process.

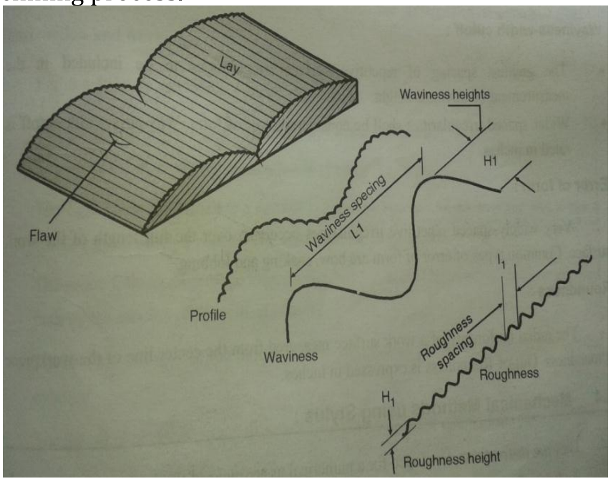


Fig. 1.1: Elements of surface texture

Based on surface properties the service life and surface quality of any component varies thus it is require to improve these properties by various operations, burnishing is one of the suitable method of surface enhancement. Depending on type of tool used for operation the concept of ball burnishing invented.

Ball Burnishing is a polishing and work hardening of a metallic surface. This process will Smooth and harden the surface, creating a finish which will last longer than one that hasn't been burnished. Burnishing is a chip less cold-work process, which consists of plastic deformation the surface layer of the work piece through the indentation of a tool, accompanied by other simple motions that ensure machining along the desired area the pressure generated by the indenter must exceed the yield point of the work piece's material and flattens asperities from previous machining process. This cause also strain hardening of the surface layer and induces compressive stresses into it. Finally, the result is a smooth hardened surface, with some improved mechanical properties.

1.2 Current Status

The improved surface properties show many operational improved life of engineering components. Thus to improve surface finish and surface hardness the surface conditions of any material will have to take in to consideration. The failure of any material originates from surface crack and internal parts gets fail due to application of triaxial stresses in material.

The residual compressive stresses and amount of cold working enhances the surface finish and fatigue strength. Ball burnishing process provides high magnitude, deep, mechanically stable compressive stresses, cold working and is performed on conventional or CNC machine tools.

1.2.1 Effect of machining parameters on surface finish

Surface finish is influenced by several machining parameters including cutting tool geometry, work piece geometry, machine tool rigidity, work piece material, cutting condition and tool material.

1. Tool Geometry: It is known that larger the rake angle, smaller are the cutting forces. And when cutting forces are small, deflection and waviness heights are small. Relief angle should be sufficient to prevent rubbing against the machined surface. The additional cutting forces due to rubbing action causes harmful deflection. The major and minor edges should be joined by a nose of sufficiently large radius to reduce the sharpness of tool.

2. **Work Piece Geometry:** Long slender work pieces have low stiffness against both static and dynamic forces. As a result waviness effects are more pronounced. On the other hand, if work piece is stiff or is rigidly clamped on the machine, waviness height is small.

3. **Machine Tool Geometry and Accuracy:** The machine tool the surface finish mainly through the extent of its rigidity, freedom from alignment errors and accuracy of motions.

4. **Work Piece Material:** Chemical composition, hardness microstructure and metallurgical consistency are known from experience to affect surface finish. Very low hardness and ductility are not conductive to good finish because of the tendency of the tool to dig in to a material having such properties. High hardness, strength and low ductility results in good surface finish.

5. **Cutting Condition:** Cutting speed generally tends to improve surface finish. At low cutting speeds, the cutting forces are high and tendency of work material to form a built up edge is also stronger. Due to increase in temperature and decrease in frictional stress at the rake face at higher cutting speeds, cutting forces and tendency towards built up edge formation weakens. Both these effect are beneficial for surface finish. Feed and depth of cut have large effect on surface finish. Depth of cut changes cutting forces and therefore deflections. Increase in depth of cut tends to increase waviness height.

6. **Tool Material:** A tool made up of tough material can give better rake and relief angle. HSS is the better tool material in this regard than cemented carbide and oxides. In general smaller the friction between the tool and work material better is the surface finish produced on the work piece.

1.3 Scope of Investigation

There are many method used for surface enhancement that can provide required surface roughness, surface hardness and residual compressive stresses on the surface of materials. All surface treatment processes gives improvement in the surface properties. But ball burnishing is the process which can give better surface finish and Micro hardness. This process is cold working process and does not remove the material in the form of chips and particles. Ball burnishing is method of surface enhancement which can provide mechanically stable deep compression for improving surface characteristics. The operation of ball burnishing process is non similar to machining operation where the chip formation not occurs. The alternative surface treatment processes for burnishing require high capital investment as well as human safety is also a part of consideration in working environment. Lower investment and better adaptability in the existing machine shop environment is the key of success of ball burnishing as compared with other surface enhancement techniques.

1.4 Thesis Layout

The main objective of the present research work was to design Burnishing tool and investigate contribution of burnishing parameters on AA6340 alloy for improving surface finish and micro hardness.

1. Purpose

The main purpose of current study is to design ball burnishing tool and investigate surface roughness, micro hardness and effect on microstructure by ball burnishing surface treatment method.

2. Design/methodology/approach

The cylindrical specimen is prepared which is circular in cross section were performed through ball burnishing process. The burnishing parameters are investigated by DOE. The surface roughness for specimens were investigated by Suitable Surface recorder. The micro hardness for specimens were investigated by suitable hardness tester.

3. Findings

Ball burnishing process may increase surface finish, surface hardness and effect on microstructure of AA6340 Aluminum alloy material.

4. Limitation

This project dose gives amount of stresses induced due application of burnishing Process. This project also does not represent any simulating results for surface enhancement.

5. Practical Importance

The ball burnishing surface treatment can significantly improve surface finish, surface hardness and induces amount of residual compressive stresses in aluminum alloy, which provide satisfactory applications in the service life of component at a given environmental condition. Ball burnishing process for AA6340 has been not reported in literature. Application of this method can increase the reliability of components.

OBJECTIVE OF PROJECT

The main purpose of this project work is to Design such a tool which is suitable for burnishing process and also to investigate surface roughness and Micro hardness of AA6340 aluminum alloys with various burnishing parameters. It is expected that this work will be useful in the application of ball burnishing to improve surface finish, surface hardness and effect of microstructure under various conditions of burnishing parameters. It is also expected that the due ball burnishing process the chances of failure of material during loading conditions can be reduced.

3.1 Objectives of Project

1. To study ball burnishing technique used for surface finish improvement and investigation of Roughness and Micro hardness of a specimen.
2. To Design a tool which is suitable for burnishing operation.
3. To study the effect of burnishing parameters on surface roughness, hardness and Microstructure of AA6340 Alloy.
4. To determine percentage contribution of process parameters for surface roughness and Micro hardness
5. To select maximum contribution best parameters for obtaining desired surface quality.
6. To study implementation of DOE for determining optimal process parameters.

4.7 Work Material

The experimental work is carried out to investigate the effect of process parameter of ball burnishing on surface roughness, hardness and fatigue life of AA6340 alloy work material. This is most widely used alloy in wide variety of general applications in small scale industry as well as large industries. The main focus of selection of this material is the alternative for steel which has maximum chances of corrosion and having high density. The aluminum alloy is widely used in aerospace and space shuttle with high quality and good service life.

The composition and mechanical properties of work material are given in Table 4.1 and Table 4.2 respectively.

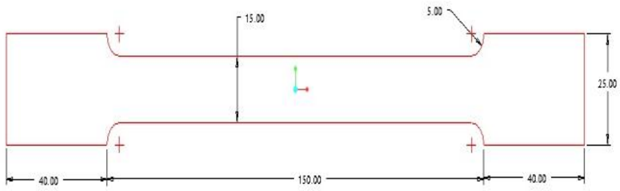
4.8 Specimen Preparation

For this project work AA6340 Aluminum alloy is taken in solid circular bar or rod form as per requirement of machining process. Using general conditions of turning, the required surface roughness texture was achieved.

The material is cut in to number of pieces as per requirement of conduction of burnishing process and further for obtaining result for surface roughness and Micro

hardness. For the fulfillment of Design of experiment 18 pieces are made, among that 2 pieces are used for comparing low level and high level of input conditions while remaining 16 pieces are used for experimental design. The specimen is prepared on Conventional lathe machine.
Fig. 4.14 and Fig. 4.15 show the preparation of specimen for conduction of experiments.

Fig. 4.14: 2D sketch of specimen



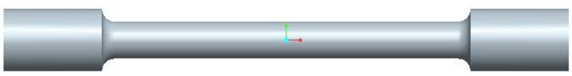


Fig. 4.15: solid layout of Specimen

4.9 Experiment Process Setup

Fig. 4.16: Experiment setup on PL lathe machine

The experimentation is carried out on PL Lathe machine which has variable speed, and feed. The specimen is fixed to jaw of lathe machine and as per parameters obtained from experimental matrix each specimen is burnished. The fig. 4.16 shows Setup for experimentation on PL lathe machine.

4.9.1 Role of ball burnishing tool

Ball burnishing process is carried out on turned component having desired roughness. In this method, machined surfaces are burnished by a ball burnishing tool.
Since all machined surfaces consist of a series of peaks and valleys of irregular height and spacing, the plastic deformation created by ball burnishing is a displacement of the material in the peaks which cold flows under pressure into the valleys. The result is a mirror-like finish with a tough, work hardened, wear and corrosion resistant surface.

4.9.2 Requirement for ball burnishing process

Ball burnishing process can be carried out on machined surfaces with a amount of roughness, for carry out ball burnishing process successfully certain controlled conditions for material are applied. These requirements are material should be ductile in nature, it should have controlled hardness, it should be dimensionally controlled and suitable surface should be prepared.

4.9.3 Parameter under investigation for their effect on roughness, hardness and microstructure

The effect of following parameters on roughness and fatigue life are to be considered

1. Feed rate (A)
2. Speed (B)
3. Depth (C)
4. Number of tool passes (D)

4.9.4 Parameter to be measured

Surface Roughness (Ra), Micro Hardness (Hv) & Microstructure

4.9.5 Experiment procedure

The design of experiments is to be done using full factorial design [2^k] design methodology, based on design of experiment matrix 16 number of samples are prepared and the burnishing is carried out on each sample as per burnishing parameters obtained by DOE matrix. The burnishing is carried out on PL lathe machine with feed, speed, depth and numbers of tool passes are considered as input burnishing parameters.

The Next chapter describes Analytical study and Design of Experiment for ball burnishing operation on conventional PL lathe machine.

3. CONCLUSIONS

Ball burnishing operation is successfully carried out on AA6340 alloy material which implies surface enhancement of the material. The mechanical properties of the selected material gets improved. The following conclusion is made for the successful results.

1. Full factorial design is successful in Surface Roughness and Micro hardness of the AA6340 alloy. In the experiment the independent variables are feed rate, speed, depth of penetration and number of burnishing tool passes while the dependent variables (output variables) are surface roughness (Ra) *and* Micro hardness respectively. Roughness and hardness experiment on AA6340 alloy is successful by varying burnishing parameters (feed rate, speed, depth and number of passes) and output variables are Ra and Hv. Based on the extensive experimental investigations, statistical analysis using ANOVA and the regression method the following observations were made:
    a. Performing ball burnishing operation on AA6340 with burnishing parameters is successful.
    b. The below table 7.1 shows percentage contribution of burnishing parameters on Roughness and micro hardness.

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