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Analysing Of Cutting Parameters by Turning Operation for Incole Material Using Mini Tab

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ABSTRACT

Thepresent work is an attempt to make use of Taguchi optimization technique and Response Surface Methodology to optimize cutting parameters during high speedturning of Inconel 718 using cemented carbide tool insert to minimize cutting forces thereby stresses on the cutting tool and work piece.

The cutting parameters are cutting speed 40m/min, 50m/min, 60m/min, feed 0.05mm/rev, 0.1mm/rev, 0.15mm/rev and depth of cut 0.2mm, 0.4mm, 0.6mm are considered for optimization. Cutting forces are taken experimentally and static analysis is performed on the cutting tool and work piece assembly by applying the forces to determine displacements, stresses and strains.

Process used in this project is turning process. Modeling is done in Creo 2.0 and analysis is done in ANSYS.

INTRODUCTION

Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, describes a helical tool path by moving more or less linearly while the work piece rotates. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear (in the nonmathematical sense). Usually the term "turning" is reserved for the generation of external surfaces by this cutting action, whereas this same essential cutting action when applied to internal surfaces (that is, holes, of one kind or another) is called "boring". Thus the phrase "turning and boring" categorizes the larger family of (essentially similar) processes. The cutting of faces on the work piece (that is, surfaces perpendicular to its rotating axis), whether with a turning or boring tool, is called "facing", and may be lumped into either category as a subset.

Turning can be done manually, in a traditional form of lathe, which frequently requires continuous supervision by the operator, or by using an automated lathe which does not. Today the most common type of such automation is computer numerical control, better known as CNC. (CNC is also commonly used with many other types of machining besides turning.)

When turning, a piece of relatively rigid material (such as wood, metal, plastic, or stone) is rotated and a cutting tool is traversed along 1, 2, or 3 axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as boring) to produce tubular components to various geometries. Although now quite rare, early lathes could even be used to produce complex geometric figures, even the platonic solids; although since the advent of CNC it has become unusual to use non-computerized tool path control for this purpose.

The turning processes are typically carried out on a lathe, considered to be the oldest machine tools, and can be of four different types such as straight turning, taper turning, profiling or external grooving. Those types of turning processes can produce various shapes of materials such as straight, conical, curved, or grooved work piece. In general, turning uses simple single-point cutting tools. Each group of work piece materials has an optimum set of tools angles which have been developed through the years.
The bits of waste metal from turning operations are known as chips (North America), or swarf (Britain). In some areas they may be known as turnings.

TURNING OPERATIONS

Turning specific operations include:

TURNING

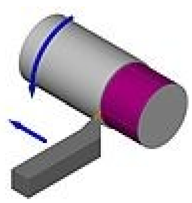


Fig.Turning

This operation is one of the most basic machining processes. That is, the part is rotated while a single point cutting tool is moved parallel to the axis of rotation. Turning can be done on the external surface of the part as well as internally (boring). The starting material is generally a workpiece generated by other processes such as casting, forging, extrusion, or drawing.

Tapered turning

a)From the compound slide b) from taper turning attachment c) using a hydraulic copy attachment d) using a C.N.C. lathe e) using a form tool f) by the offsetting of the tailstock - this method more suited for shallow tapers.

Spherical generation

The proper expression for making or turning a shape is to generate as in to generate a form around a fixed axis of revolution. a) Using hydraulic copy attachment b) C.N.C. (computerized numerically controlled) lathe c) using a form d) using bed.

Hard turning

Hard turning is a turning done on materials with a Rockwell C hardness greater than 45. It is typically performed after the work piece is heat treated.
The process is intended to replace or limit traditional grinding operations. Hard turning, when applied for purely stock removal purposes, competes favorably with rough grinding. However, when it is applied for finishing where form and dimension are critical, grinding is superior. Grinding produces higher dimensional accuracy of roundness and cylindricity. In addition, polished surface finishes of Rz=0.3-0.8z cannot be achieved with hard turning alone. Hard turning is appropriate for parts requiring roundness accuracy of 0.5-12 micrometers, and/or surface roughness of Rz 0.8–7.0 micrometers. It is used for gears, injection pump components, hydraulic components, among other applications.

LITERATURE SURVEY

The paper by B. Satyanarana[1], etal, presented an optimum process parameters (speed, feed and depth of cut) to minimize the cutting force, surface roughness and tool flank wear together in CNC high speed dry turning of Inconel 718 using Taguchi method based Grey relational analysis. The study involved nine experiments based on Taguchi orthogonal array and the result indicates that the optimal process parameters are 60 m/min for speed, 0.05 mm/rev for feed and 0.2 mm for depth of cut from the selected range. Also the significant process parameters have been found out for the above process optimization by performing

ANOVA. Confirmation tests with the optimal levels of cutting parameters are carried out in order to illustrate the effectiveness of the method.

The work done by Karin Kandananond [2], determines the optimal cutting conditions for surface roughness in a turning process. This process is performed in the final assembly department at a manufacturing company that supplies fluid dynamic bearing (FDB) spindle motors for hard disk drives (HDDs). The work pieces used were the sleeves of FDB motors made of ferritic stainless steel, grade AISI 12L14. The optimized settings of key machining factors, depth of cut, spindle speed, and feed rate on the surface roughness of the sleeve were determined using the response surface methodology (RSM). The results indicate that the surface roughness is minimized when the depth of cut is set to the lowest level, while the spindle speed and feed rate are set to the highest levels. Even though the results from this paper are process specific, the methodology deployed can be readily applied to different turning processes.

The paper by NeerajSharma[3], applied extended Taguchi method through a case study in straight turning of mild steel bar using HSS tool for the optimization of process parameters. The study aimed at evaluating the best process environment which could simultaneously satisfy requirements of both quality as well as productivity with special emphasis on reduction of cutting tool flank wear, because reduction in flank wear ensures increase in tool life. The predicted optimal setting ensured minimization of surface roughness. From the present research of ANOVA it is found the Depth of cut is most significant, spindle speed is significant and feed rate is least significant factor effecting surface roughness.

In the paper by Rogov Vladimir Aleksandrovich[4], presents an experimental investigation focused on identifying the effects of cutting conditions and tool construction on the surface roughness and natural frequency in turning of AISI1045 steel. Machining experiments were carried out at the lathe using carbide cutting insert coated with TiC and two forms of cutting tools made of AISI 5140 steel. Three levels for spindle speed, depth of cut, feed rate and tool overhang were chosen as cutting variables. The Taguchi method L_9 orthogonal array was applied to design of experiment. By the help of signal-to-noise ratio and analysis of variance, it was concluded that spindle speed has the significant effect on the surface roughness, while tool overhang is the dominant factor affecting natural frequency for both cutting tools. In addition, the optimum cutting conditions for surface roughness and natural frequency were found at different levels. Finally, confirmation experiments were conducted to verify the effectiveness and efficiency of the Taguchi method in optimizing the cutting parameters for surface roughness and natural frequency.

The work done by J. M. Gadhiya[5], Turning is widely used machining process in today's industrial requirement. In the present research, the effect of CNC lathe machine processing parameters such as speed, feed and depth of cut effect on measured response such as surface roughness. The experiment was designed according to full factorial with three different level of each input parameter. For result interpretation, analysis of variance (ANOVA) was conducted and optimum parameter is selected on the basis of the signal to noise ratio, which confirms the experimental result. The result indicated that cutting speed and Feed play important role in surface roughness.

In the paper by Vikas B. Magdum[6], used for optimization and evaluation of machining parameters for turning on EN8 steel on Lathe machine. This study investigates the use of tool materials and process parameters for machining forces for selected parameter range and estimation of optimum performance characteristics. Develop a methodology for optimization of cutting forces and machining parameters.

The work done by S.B.Salvi [7], focused on hard turning of 20 MnCr5 Steel. The purpose of this paper is to analyze optimum cutting conditions to get lowest surface roughness in turning of 20 MnCr5 Steel. Taguchi method has been used for this. An orthogonal array, the signal to noise ratio and analysis of variance (ANOVA) are employed to investigate the cutting characteristics. The results indicate that feed rate has significant role to play in producing lower surface roughness followed by cutting speed. The cutting insert used is ceramic based TNGA 160404.

The work done by Krishankant[8], reports on an optimization of turning process by the effects of machining parameters applying Taguchi methods to improve the quality of manufactured goods, and engineering development of designs for studying variation. EN24 steel is used as the work
piece material for carrying out the experimentation to optimize the Material Removal Rate. The bars used are of diameter 44mm and length 60mm. In the first run nine experiments are performed and material removal rate (MRR) is calculated. When experiments are repeated in second run adain MRR is calculated. Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of quality characteristic variation due to uncontrollable parameter. The metal removal rate was considered as the quality characteristic with the concept of "the larger-the-better". The S/N ratio for the larger-the-better Where n is the number of measurements in a trial/row, in this case, n=1 and y is the measured value in a run/row. The S/N ratio values are calculated by taking into consideration with the help of software Minitab 15. The MRR values measured from the experiments and their optimum value for maximum material removal rate. Every day scientists are developing new materials and for each new material, we need economical and efficient machining. It is also predicted that Taguchi method is a good method for optimization of various machining parameters as it reduces the number of experiments. From the literature survey, it can be seen that there is no work done on EN24 steel. So in this project the turning of EN24 steel is done in order to optimize the turning process parameters for maximizing the material removal rate.

The work done by YigitKazancoglu[9], investigated the multi-response optimization of the turning process for an optimal parametric combination to yield the minimum cutting forces and surface roughness with the maximum material-removal rate (MRR) using a combination of a Grey relational analysis (GRA) and the Taguchi method. Nine experimental runs based on an orthogonal array of the Taguchi method were performed to derive objective functions to be optimized within the experimental domain. The objective functions were selected in relation to the parameters of the cutting process: cutting force, surface roughness and MRR. The Taguchi approach was followed by the Grey relational analysis to solve the multi-response optimization problem. The significance of the factors on the overall quality characteristics of the cutting process was also evaluated quantitatively using the analysis-of-variance method (ANOVA). Optimal results were verified through additional experiments. This shows that a proper selection of the cutting parameters produces a high material-removal rate with a better surface roughness and a lower cutting force.

In the paper by Kamal Hassan[10], Machining of medium Brass alloy is very difficult. There are a number of parameters like cutting speed, feed and depth of cut etc. which must be given consideration during the machining of medium Brass alloy. This study investigates the effects of process parameters on Material Removal Rate (MRR) in turning of C34000. The single response optimization problems i.e. optimization of MRR is solved by using Taguchi method. The optimization of MRR is done using twenty seven experimental runs based on L'27 orthogonal array of the Taguchi method are performed to derive objective functions to be optimized within the experimental domain When the MRR is optimized alone the MRR comes out to be 8.91. The optimum levels of process parameters for simultaneous optimization of MRR have been identified. Optimal results were verified through confirmation experiments.

ANALYSIS OF TURNING TOOL

BOUNDARY CONDITIONS

The material properties are specified in the below table which are taken from website www.matweb.com

MATERIAL	Density (kg/m^3)	Young's modulus (MPa)	Poisson's ratio
Uncoated cemented carbide (for tool)	11900	534000	0.22
Inconel718 (For work piece)	8220	200000	0.284

STRUCTURAL ANALYSIS OF TURNING TOOL AND WORKPIECE ASSEMBLY

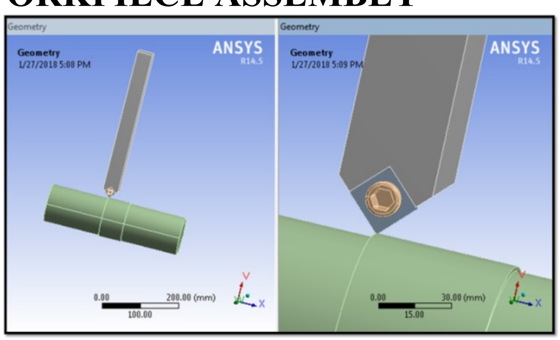


Fig.Imported model of solid beam

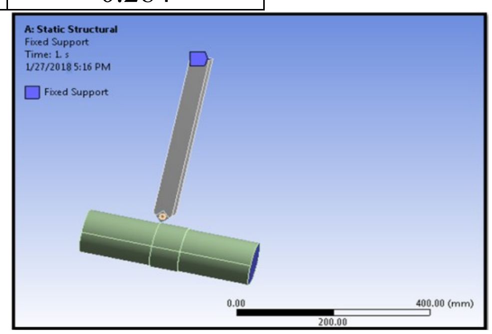
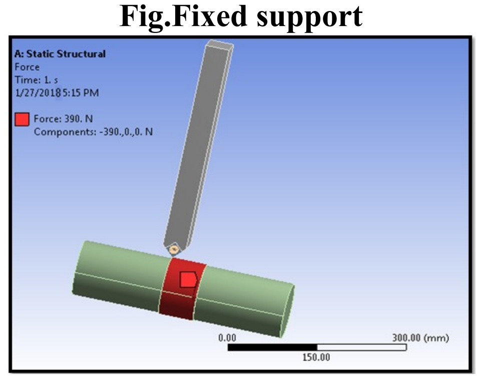


Fig.Fixed support

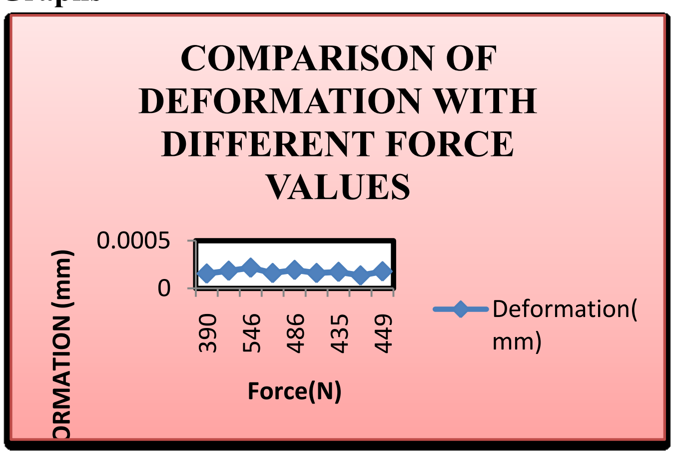


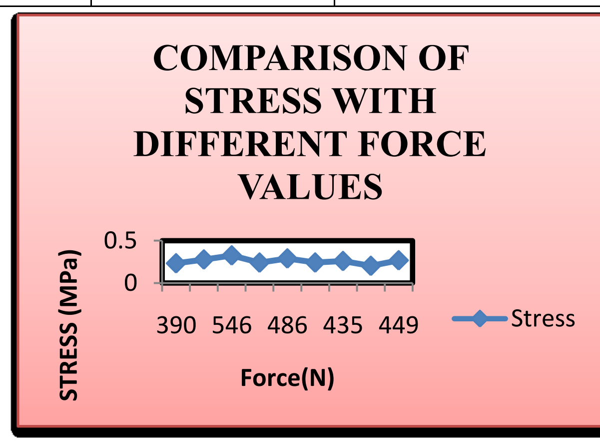
RESULTS TABLE

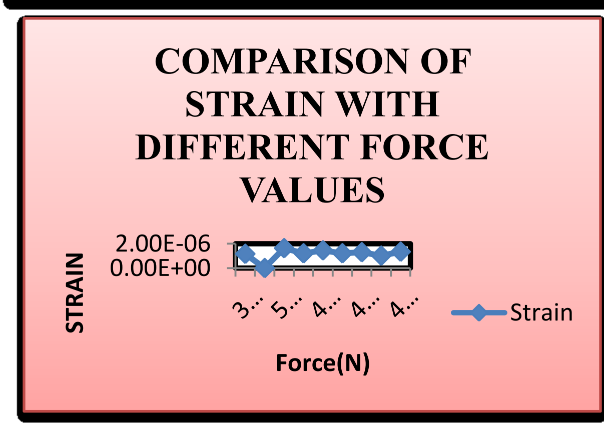
Applied Forces (N)	Deformation (mm)	Strain	Stress (MPa)
390	0.00015466	1.1647e-6	0.23278

465	0.00018441	1.3887e -6	0.27754
546	0.00021653	1.6306e-6	0.32589
404	0.00016022	1.2066e-6	0.24113
486	0.00019274	1.4514e-6	0.29008
405	0.00016061	1.2095e-6	0.24173
435	0.00017251	1.2991e-6	0.25964
340	0.00013484	1.0154e-6	0.20293
449	0.00017806	1.3409e-6	0.26799

Graphs







OPTIMIZATION OF MACHINING PARAMETERS FOR MINIMIZING STRESS USING MINITAB SOFTWARE

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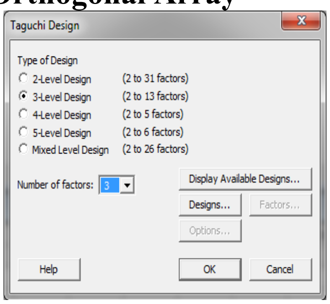
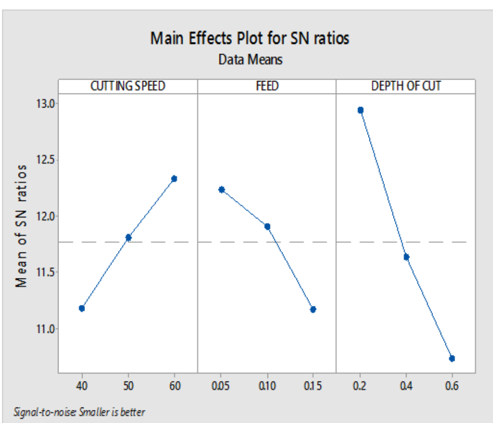
The process parameters and the resultant stress values from analysis by applying forces.

CUTTING SPEED (m/min)	FEED (mm/rev)	DEPTH OF CUT (mm)	STRESS (MPa)
40	0.05	0.2	0.23278
40	0.1	0.4	0.27754
40	0.15	0.6	0.32589
50	0.05	0.4	0.24113
50	0.1	0.6	0.29008
50	0.15	0.2	0.24173
60	0.05	0.6	0.25964
60	0.1	0.2	0.20293
60	0.15	0.4	0.26799

TAGUCHI METHOD

Design of Orthogonal Array





Graph - Effect of parameters on stress for S/N ratio

RESPONSE SURFACE METHODOLOGY

To optimize parameters using Response surface Methodology, first the arrangement of L9 orthogonal array is done in Taguchi Method.

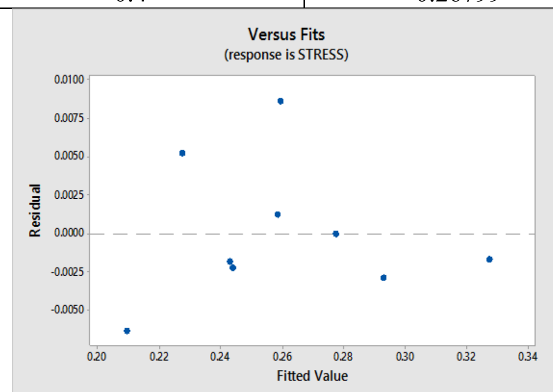


Fig – Residual Vs Fits for Stress

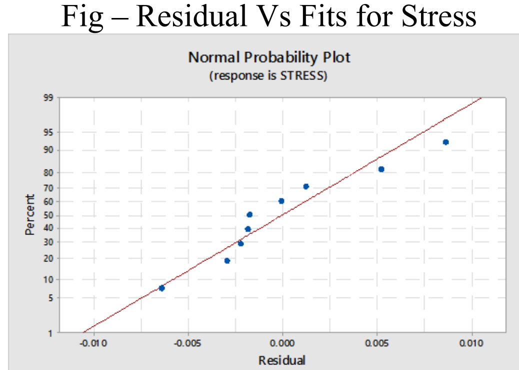


Fig – Normal Plot of Residuals for Stress

CONCLUSION

The cutting parameters considered for optimization are cutting speed 40m/min, 50m/min, 60m/min, feed 0.05mm/rev, 0.1mm/rev, 0.15mm/rev and depth of cut 0.2mm, 0.4mm, 0.6mm. Cutting forces are taken experimentally and static analysis is performed on the cutting tool and work piece assembly by applying the forces to determine displacements, stresses and strains.

By observing the experimental results the following conclusions can be made:

The main parameter that effects the cutting forces is Depth of Cut.

As per Taguchi Method, to minimize stress, the optimal parameters are cutting speed – 60m/min, feed – 0.05mm/rev and depth of cut – 0.2mm.

As per Response Surface Methodology, to minimize stress, the optimal parameters are cutting speed – 60m/min, feed – 0.05mm/rev and depth of cut – 0.2mm.The optimization carried out is good as the R-Sq is 98.41%.

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