

ANALYZING THE VIBRATION EFFECT OF CUTTING TOOL ON SURFACE ROUGHNESS OF TURNING WORK PIECE IN LATHE MACHINE

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ABSTRACT

Tool condition observation systems are an essential unit in small milling applications. A tool's slenderness needs high-precision observation systems for on-line measurements. In most cases, tool health is indirectly calculable by process and analyzing the cutting method parameters. Tool wear may be an essential development that influences the standard of the machined part. Vibration signals from metal cutting processes are investigated for varied functions, together with in-process tool wear monitoring. Reducing the machining energy consumption (MEC) of machine tools for turning operations is important to market manufacturing production. During this study, the link between vibration and gear wear is investigated throughout high-speed dry turning by victimization applied math parameters. It's aimed to show how tool wear and therefore the work piece surface roughness changes with tool vibration signals. For this purpose, a series of experiments were conducted in a lathe machine. Modal analysis of each traditional and wear tool are going to be performed for locating Natural frequency of cutting tools in ANSYS 19 code. Experimental testing of tool wear is going to be performed using FFT instrument. Afterward the comparative analysis is going to be dispensed between the experimental and analysis results and afterward the result & conclusion are going to be drawn.

Keyword –Cutting tool. Modal analysis, FFT.

I. INTRODUCTION

In turning operations, vibration is a frequent problem, which affects the result of machining, in particular, the tool wear. Vibration can be defined as an object being repeatedly displaced at a very high frequency. In turning process, three types of mechanical vibrations are present. They are free, forced and self-excited vibrations. They occur due to lack of dynamic stiffness/rigidity of the machine tool system comprising tool, tool holder, work piece and machine tool. Machining vibrations, also called as chatter, correspond to the relative movement between the work piece and the cutting tool. These vibrations affect typical machining processes, such as turning, milling and drilling. Relative vibration amplitude between the work piece and cutting tool influences the tool life. Cutting tool and tool holder shank are subjected to dynamic excitation due to the deformation of the work material during the cutting operation. The dynamic relative motion between the cutting tool and work piece will affect the quality of the machining, in particular, the surface finish. Furthermore, the tool life is correlated with the amount of vibration. In turning, the presence of tool vibration is a major factor which leads to poor surface finish, cutting tool damage, increase in tool wear and unacceptable noise. With the production and productivity increasing in modern society, the manufacturing energy consumption is increased with intensifying the energy crisis and global warming [1]. According to

International Energy Agency [2], manufacturing is responsible for nearly 1/3 of the global energy consumption and 36% of carbon dioxide emissions [3]. Increasing energy price and requirements to improve energy efficiency are the severe challenges faced by modern manufacturing enterprises. Increase in manufacturing production is characterized by technological development, which is driven by increased competitiveness. Machining processes must therefore also undergo changes in order to meet market requirements in order to guarantee the expected quality, reduce production costs, and increase productivity.

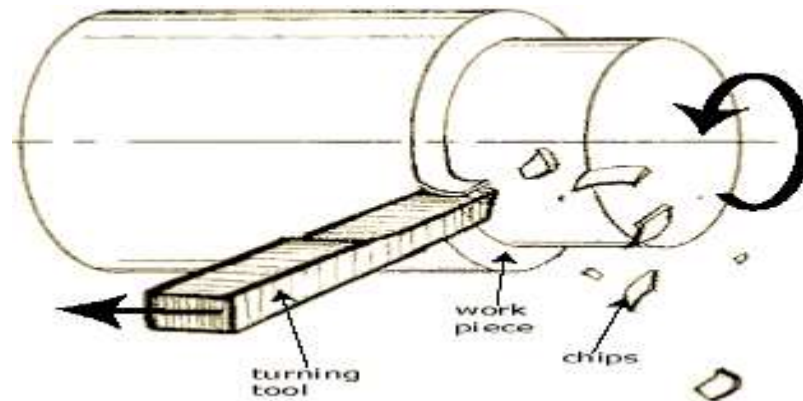


Fig. 1: Turning Process

Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. The processes that have this common theme, controlled material removal, are today collectively known as subtractive manufacturing, in distinction from processes of controlled material addition, which are known as additive manufacturing. Machining is a part of the manufacture of many metal products, but it can also be used on materials such as wood, plastic, ceramic, and composites. A room, building, or company where machining is done is called a machine shop. Much of modern-day machining is carried out by computer numerical control (CNC), in which computers are used to control the movement and operation of the mills, lathes, and other cutting machines.

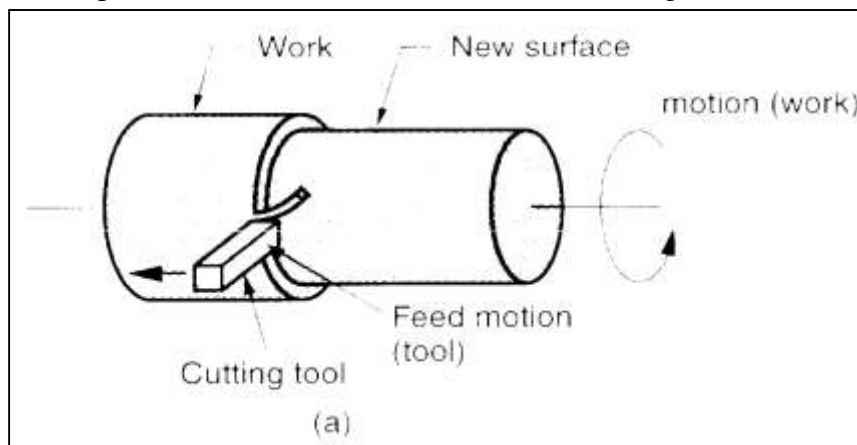


Fig. Cutting tool use for turning operation

II. LITERATURE REVIEW

Hu Luo et al. [1] In this paper Reducing the machining vitality utilization (MEC) of machine instruments for turning activities is noteworthy to advance maintainable assembling. It has been endorsed that choosing ideal cutting (turning) boundaries is a viable way to deal with lessen the cutting vitality utilization (CEC)

inside the MEC. In any case, the probability for this way to deal with decrease the non-cutting vitality utilization (NCEC) has not gotten adequate considerations. Particularly, the vitality devoured for axle pivot change (SRCE) was dismissed. Consequently, this article targets building up an incorporated MEC model with NCEC and SRCE considered. At that point, Simulated Annealing (SA) is utilized to locate the ideal axle pivot speed (SRS) and feed rate which bring about the base MEC.

Rogério Pontes Araújo et al. [2] One of the significant difficulties in machining is controlling the temperature in the cutting area. Slicing liquids can be utilized to drag out instrument life due to their cooling and greasing up capacities. The properties of the cutting liquid and the way wherein it is applied will change to forestall issues brought about by warm bends inside the parts. Temperature control during machining makes it conceivable to meet the resilience's for shape, size, and finish required in the parts' determinations. Among the different cooling strategies utilized in machining, the most striking are nanofluids, cryogenic frameworks, and refrigerated packed air. This examination presents a fume pressure refrigeration framework to cool the cutting liquid in the fluid state. This technique is beneficial because of its diminished expense and simplicity of-use when contrasted with cryogenic frameworks.

Shuang Yia et al. [3] This paper explored tentatively the machining of Ti-6Al-4V with another graphene based cutting liquid. Three distinct sorts of graphene oxide (GO) nanofluids with different GO focuses were applied in a progression of cutting analyses. Apparatus wear, cutting power and the vibration in turning titanium composite with the new nanofluids just as traditional coolant were broke down. The working instrument and diverse cutting impacts brought about by the variety of GO fixation and coolant pressure were examined. The outcomes show that the cutting power was decreased by 50.83 % when GO nanofluids were utilized. The vibration in the turning Ti-6Al-4 V with GO nanofluids was fundamentally lower than that in utilizing base fluids. Graphene oxide suspended liquids brought about lower cutting power in examination with traditional coolant. The cutting power diminished. The surface component creation with various sorts of coolant condition: (a) CC coolant; (b) 0.1 wt.% GO coolant; (c) 0.3 wt.% GO coolant; (d) 0.5 wt.% GO coolant. with the expansion in GO focus. Under a similar cutting condition, the decrease could be up to 50.83 % when GO nanofluids were utilized.

Hakan Arslan et al. [4] In this examination, the connection among vibration and instrument wear is explored during rapid dry turning by utilizing factual boundaries. It is meant to show how device wear and the work piece surface harshness changes with instrument vibration signals. For this reason, a progression of analyses were led in a CNC machine. An indexable CBN device and a 16MnCr5 apparatus steel that was solidified to 63 HRC were both utilized as material twins in the examinations. The vibration was estimated distinctly in the machining bearing utilizing an increasing speed sensor amassed on a machinery analyzer since this heading has more prevailing signs than the other two headings. Likewise, device wear and work piece surface harshness are estimated at various cutting time stretches where the cutting velocity, spiral profundity of cut, and feed rate are kept consistent. The vibration signals are assessed utilizing measurable examination. The factual boundaries in this examination are the Root Mean Square (RMS), Crest Factor, and Kurtosis values. At the point when the flank wear builds, the Kurtosis worth and RMS additionally increment, yet the Crest factor displayed sporadic varieties. It is inferred that these measurable boundaries can be utilized so as to acquire data about apparatus wear and work piece surface harshness. In this examination, the flank wear and the surface harshness were explored under rapid turning conditions. The connection between cutting time from one perspective and flank wear and surface unpleasantness on the other was examined. In addition, the measurable boundaries, for example, the KV, CF, and, RMS were acquired from vibration information and the impact of the flank wear and surface harshness on these boundaries was examined.

JUAN C. JÁUREGUI [5] Tool condition checking frameworks are basic in miniaturized scale processing applications. An instrument's slimness requires high-accuracy checking frameworks for online estimations. By and large, apparatus wellbeing is in a roundabout way evaluated by preparing and breaking down the cutting procedure boundaries. In that sense, the principle challenge lies in the best possible determination of the procedure boundaries and their handling strategies, with the goal that a strong and exact appraisal of the apparatus' wellbeing is acquired. This paper proposes a recurrence and time-recurrence based examination of cutting power and vibration signals for evaluating the instrument state of a rapid miniaturized scale processing process. Estimations acquired from various cutting conditions were used in the examination. The outcomes show varieties in the predominant frequencies, which result from device wear. Moreover, note that the examination results acquired from the two procedure signals give more solid outcomes and improve the detecting transmission capacity. This paper presents a system for the discovery of hardware wear dependent on recurrence and time-recurrence examination of the cutting power and vibration signals. In the first place, tests were done on a small scale processing focus utilizing distinctive cutting conditions, and the comparing cutting power and vibration signals were estimated at the same time. Second, utilizing FFT and CWT methods, the deliberate signs were investigated to distinguish any varieties in recurrence and sufficiency just as the nearness of nonlinearity during the cutting procedure.

PROBLEM STATEMENT

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. Turning operation using a single point cutting tool has been one of the oldest and popular methods of metal cutting. It has even replaced grinding in several applications with reduced lead time without affecting the surface quality. In turning, it is important to find out the appropriate parameters to obtain the high cutting performance. In this connection, two important aspects which are widely studied in turning operations are vibration amplitude and surface roughness of the work-piece. Present manufacturing industries are facing difficulties due to vibrations and poor surface qualities.

OBJECTIVES

- Understand the effect of cutting tool wears on Surface roughness of work piece
- Modelling of exist cutting tool in CATIA V5 software.
- Modal and Harmonic analysis of cutting tool by using ANSYS 19 software.
- To manufacturing of turning work piece samples on both normal and wear tool of lathe machine.
- To measure vibration of cutting tools during the turning process are recorded using accelerometer of FFT analyzer.
- To measure Surface roughness of work piece samples.
- Experimental testing and correlating results.

METHODOLOGY

Step 1: - Started the work of this project with literature survey. I gathered many research papers which are relevant to this topic.

Step2: - After that the components which are required for our project are decided.

Step 3: - After deciding the components, the 3D Model and drafting will be done with the help of CATIA software.

Step 4: - The Analysis of the components will be done with the help of ANSYS using FEA.

Step 5: - The Experimental Testing will be carried out.

Step 6: - Comparative analysis between the experimental & analysis result & then the result & conclusion will be drawn.

MINITAB SOFTWARE

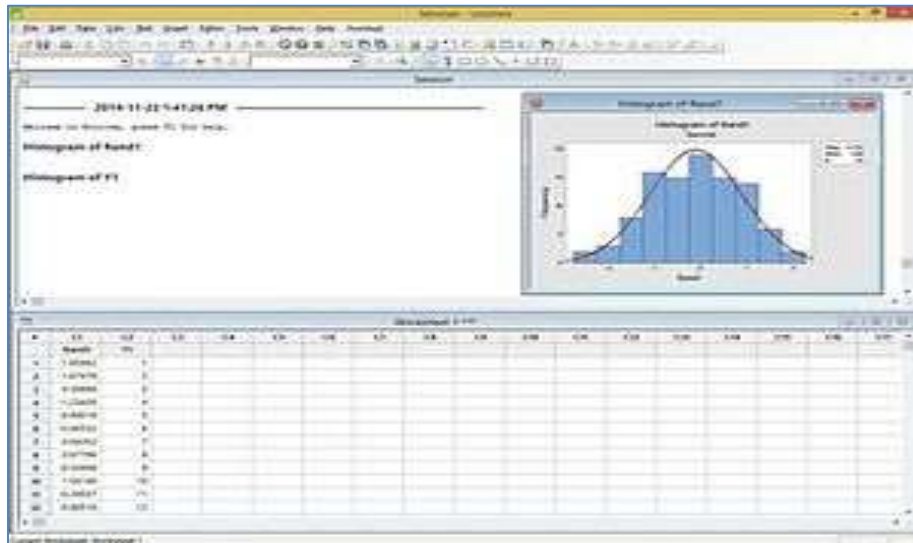


Fig. 4.1 Basic Minitab

LATHE MACHINE



Medium Duty Lathe Machine

EXPERIMENTAL PROCEDURE

The following Procedure were carried –

- The specimens are turned on lathe machine.
- The Speed, Feed & Depth of Cut Required for Turning operation were first decided.
- We decided 3 speed, feed & depth of cut values.
- After that the Orthogonal Array was formed with the help of MINITAB Software.
- According to that Orthogonal Array, nine Turning Operations were carried out on CNC machine.
- The Surface Hardness testing was carried out for all the specimens.

- Then all the values of Surface roughness were put down in MINITAB software & Analyzed as the TAGUCHI design.
- After getting the graph, the optimum Solution was drawn.

FEA ANALYSIS OF WHEEL HUB IN ANSYS

Material Selection – HSS STEEL

Table 1 Material properties

Properties of Outline Row 3: HSS STEEL			
	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	8150	kg m ⁻³
4	Isotropic Elasticity		
5	Derive from	Young's Modulus and Po...	
6	Young's Modulus	2E+11	Pa
7	Poisson's Ratio	0.28	
8	Bulk Modulus	1.5152E+11	Pa
9	Shear Modulus	7.8125E+10	Pa

MESH

ANSYS Meshing may be a general-purpose, intelligent, automated high-performance product. It produces the foremost appropriate mesh for accurate, efficient Multiphysics solutions. A mesh compatible for a selected analysis are often generated with one click for all parts during a model. Full controls over the choices want to generate the mesh are available for the expert user who wants to fine-tune it. the facility of multiprocessing is automatically wont to reduce the time you've got to attend for mesh generation.

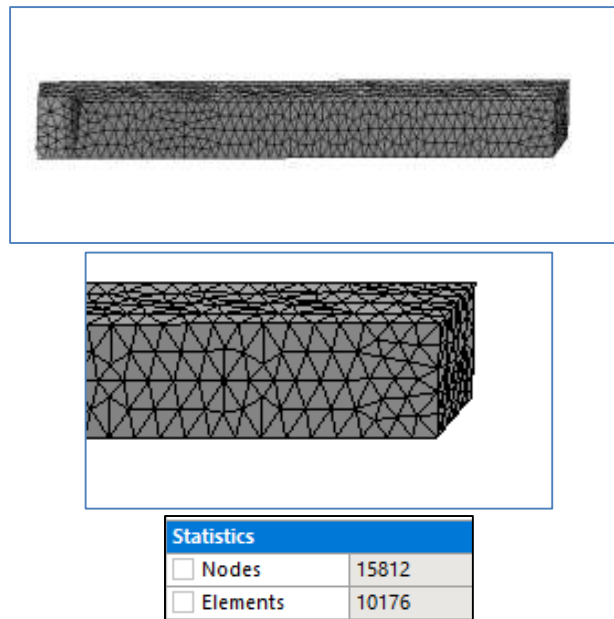


Fig.6 Meshing of Cutting tool

After meshing of cutting tool nodes are 15812 and elements 10176.

BOUNDARY CONDITION

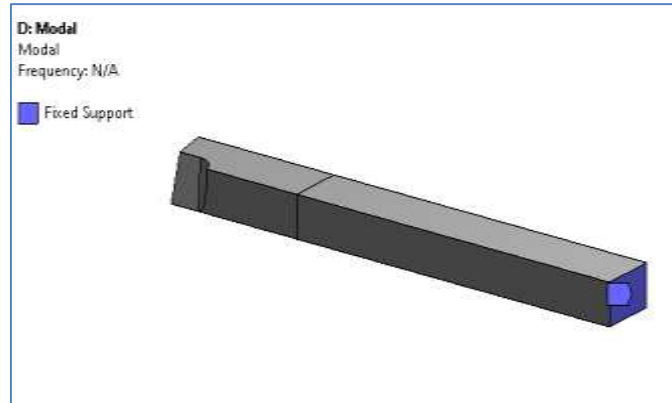


Fig. 7:Details of boundary conditions for Cutting tool

MODE SHAPES RESULTS MODE SHAPE 1

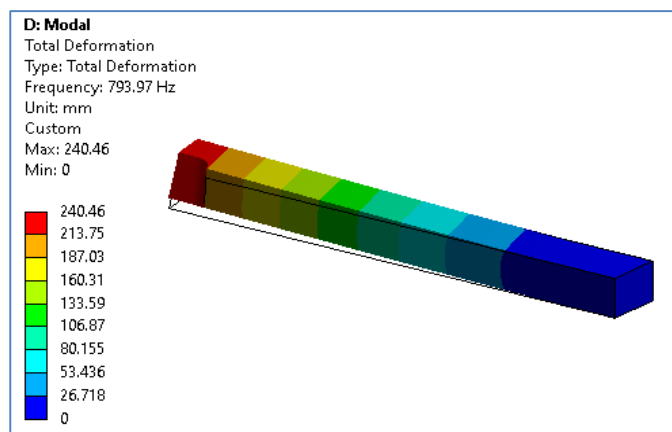


Fig. Natural frequency of lathe cutting tool at mode shape 793.97 Hz

MODE SHAPE 2

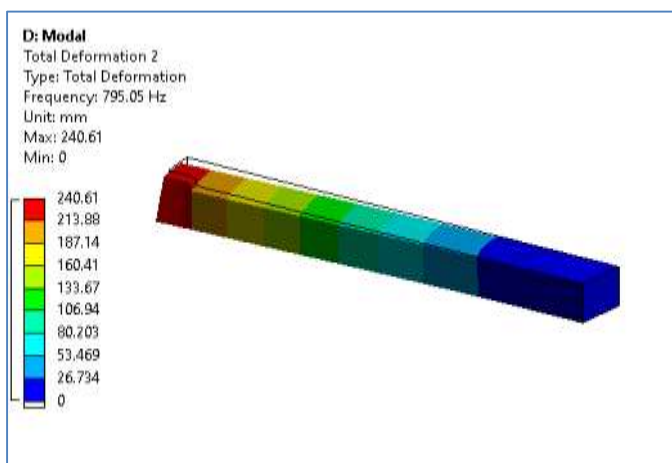


Fig. Natural frequency of lathe cutting tool at mode shape 2 was 795.05 Hz

MODE SHAPE 3

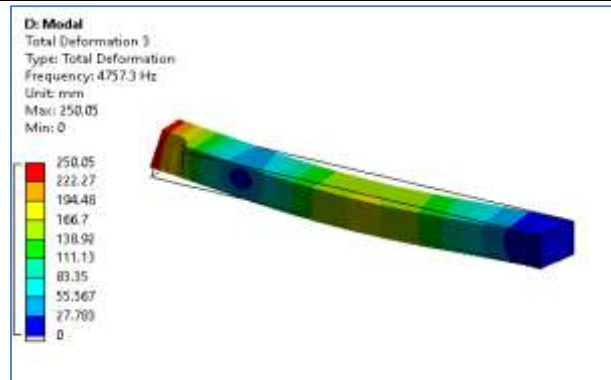


Fig. Natural frequency of lathe cutting tool at mode shape 3 was 4757.3 Hz

MODE SHAPE 4

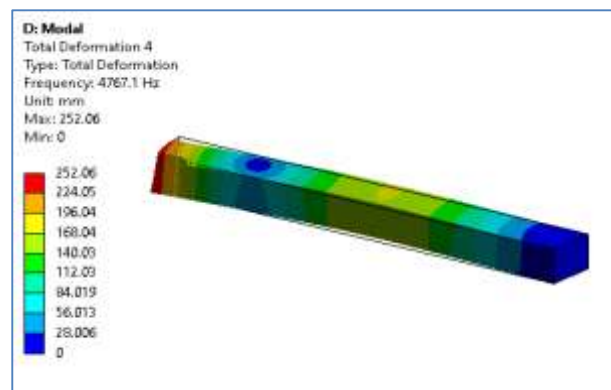


Fig. 13. Natural frequency of lathe cutting tool at mode shape 4 was 4767.1 Hz

MODE SHAPE 5

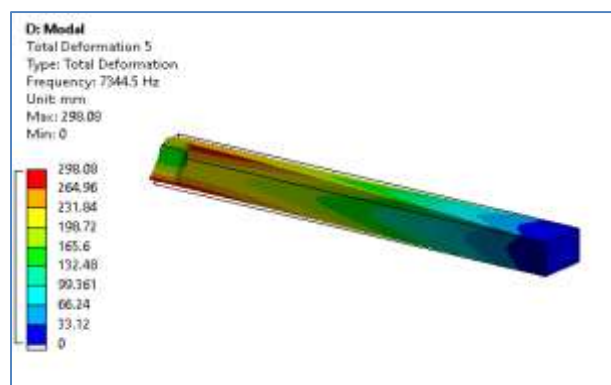
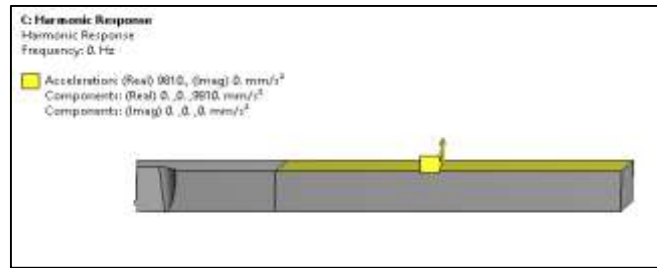


Fig. Natural frequency of lathe cutting tool at mode shape 5 was 7344.5 Hz

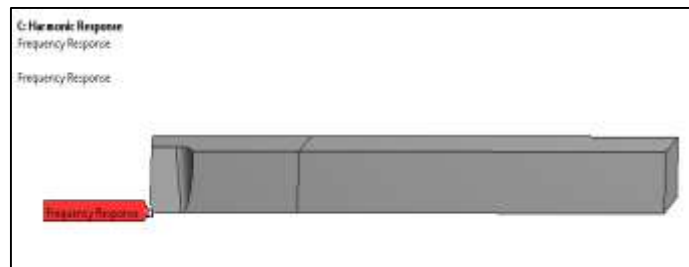
Tabular Data		
	Mode	☒ Frequency [Hz]
1	1.	793.97
2	2.	795.05
3	3.	4757.3
4	4.	4767.1
5	5.	7344.5

HARMONIC ANALYSIS OF CUTTING TOOL

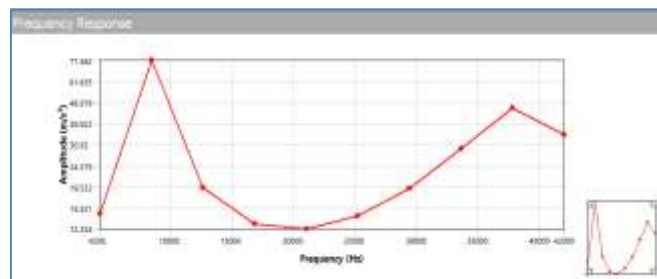
HARMONIC RESPONSE



FREQUENCY RESPONSE IS CALCULATED AT TIP TO DETERMINE PEAK ACCELERATION



GRAPH



Frequency Vs Amplitude

Maximum acceleration is observed around 77 m/s²

FFT ANALYSIS

FFT is one main property in any sequence being used in general. To find this property of FFT for any given sequence, many transforms are being used. The major issues to be noticed in finding this property are the time and memory management. Two different algorithms are written for calculating FFT and Autocorrelation of any given sequence. Comparison is done between the two algorithms with respect to the memory and time managements and the better one is pointed. Comparison is between the two algorithms written, considering the time and memory as the only main constraints. Time taken by the two transforms in finding the fundamental frequency is taken. At the same time the memory consumed while using the two algorithms is also checked. Based on these aspects it is decided which algorithm is to be used for better results

DEWE-43 UNIVERSAL DATA ACQUISITION INSTRUMENT

When connected to the high-speed USB 2.0 interface of any computer the DEWE-43 becomes a powerful measurement instrument for analog, digital, counter and CAN-bus data capture. Eight simultaneous analog

inputs sample data at up to 204.8 kS/s and in combination with DEWETRON Modular Smart Interface modules (MSI) a wide range of sensors are supported Voltage Acceleration Pressure Force Temperature Sound Position RPM Torque Frequency Velocity And more The included DEWESoft application software adds powerful measurement and analysis capability, turning the DEWE-43 into a dedicated recorder, scope or FFT analyzer.

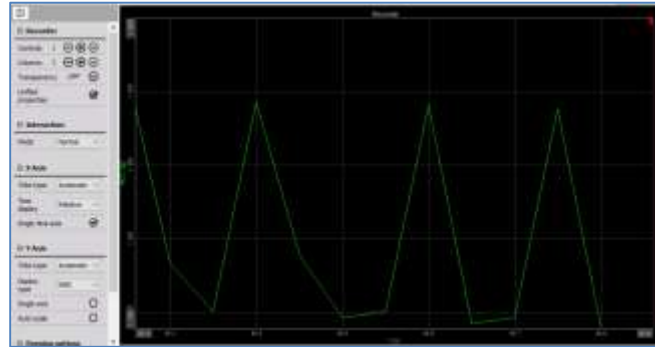


Fig. FFT result for dry testing

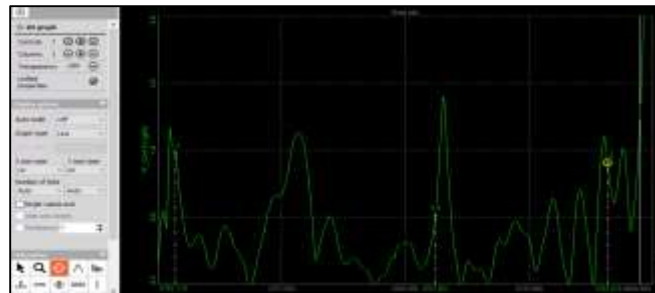


Fig. FFT plot of natural frequency

MODE SHAPE	FEA	EXPERIMENTAL
1	793.97	761.71
2	795.05	761.71
3	4757.3	4707.03
4	4767.1	4707.03
5	7344.5	7324.0

Chart. Comparison between FEA and experimental result

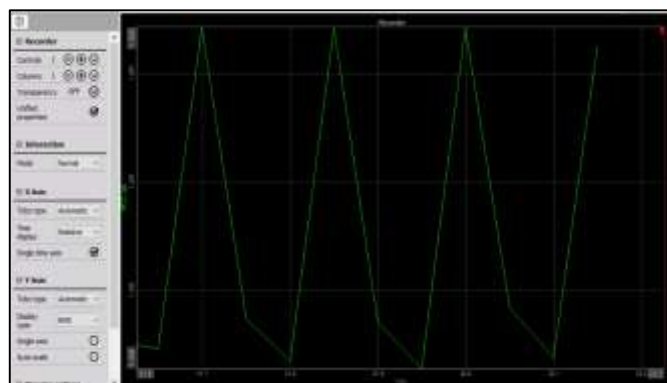
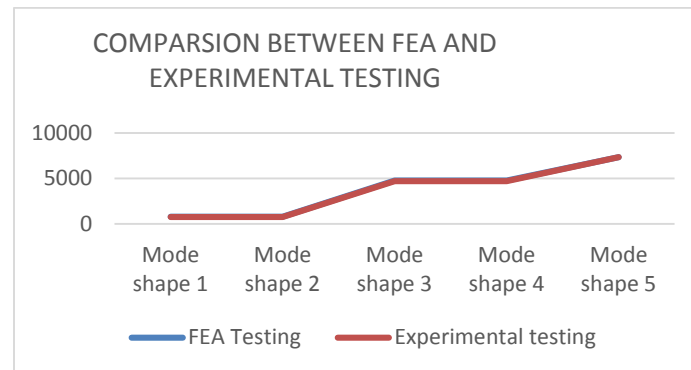


Fig. Experimental result of turning FFT

CONCLUSION

The optimize the Surface roughness of the turning process.

- The optimization result for MS is:
- Speed = 424RPM, Feed = 0.10 Depth of Cut = 2.0
- From FEA modal analysis it concludes that natural frequency of lathe cutting tool at mode shape is maximum that is 7344 Hz.
- Harmonic analysis of lathe cutting tool conclude that Maximum acceleration is observed around 77 m/s^2



Graph. FEA and Experimental natural frequency graph

REFERENCES

1. Hu Luokeya, Tang Renzhong "Optimisation of cutting parameters for improving energy efficiency in machining process" Robotics and Computer Integrated Manufacturing 59 (2019) 406–416
2. "Rogério Pontes Araújo , Tiago L Rolim "Analysis of the surface roughness and cutting tool wear using a vapor compression assisted cooling system to cool the cutting fluid in turning operation Journal of Manufacturing Processes 44 (2019) 38–46
3. Shuang Yia, JinjinLia, "Investigation of machining Ti-6Al-4V with graphene oxide nanofluids: Tool wear, cutting forces and cutting vibration" Journal of Manufacturing Processes 49 (2020) 35–49
4. Hakan Arslan and Ali Osman Er Tool Condition Monitoring in Turning Using Statistical Parameters of Vibration Signal International Journal of Acoustics and Vibration, Vol. 21, No. 4, 2016 (pp. 371_378) <https://doi.org/10.20855/ijav.2016.21.4432>
5. JUAN C. JÁUREGUI " Frequency and Time-Frequency Analysis of Cutting Force and Vibration Signals for Tool Condition Monitoring " 2169-3536 2018 IEEE. March 9, 2018. Digital Object Identifier 10.1109/ACCESS.2018.2797003
6. Farhana Dilwar, Rifat AhasanSiddique, "Analyzing the Effect of Overhang Length on Vibration Amplitude and Surface Roughness in Turning AISI 304" InternationalJournalofScientific&EngineeringResearch, Volume9, Issue6, June-2018 IISSN 2229-5518
7. Balla Srinivasa Prasad †, M. Prakash Babu "Correlation between vibration amplitude and tool wear in turning: Numerical and experimental analysis" Engineering Science and Technology, an International Journal xxx (2016)
8. Sadaf Zahoor1 & Nadeem Ahmad Mufti Int J Adv Manuf Technol "Effect of machine tool's spindle forced vibrations on surface roughness, dimensional accuracy, and tool wear in vertical milling of AISI P20" (2017) 89:3671–3679 DOI 10.1007/s00170-016-9346-1