International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Design and Analysis of Milling Cutter Tool Using Various Materials of Milling Machine by Ansys

***Sumit Dekhne*[1] *, Dr. Rahul Joshi*[2]*, Dr. Pradeep Kumar Patil* [3]*, Mr. Manoj Sharma*[4]**

[1]Research Scholar, Swami Vivekanand College of Engineering , India
[2&3]Associate Professor, Swami Vivekanand College of Engineering, India
[4]Assistant Professor, Swami Vivekanand College of Engineering, India

ABSTRACT:

The present research was carried out in order to predict the deformation at varied speeds, which was caused by high frequency vibration, as well as the milling cutter's full deformation. Tool vibration was studied in order to estimate tool life and instrument wear. This project highlights a cutter model with instrument inserts for static and dynamic cutting system components. To boost the deformation technique, a new generation of computers was created in collaboration with Ansys. To determine the cutting tool reaction, many designs utilise finite element analysis. The goal of this study is to look at the design and modelling of a face milling cutter with inserts using SolidWorks and FEA using Ansys 14.0. When comparing the two models, it was discovered that tungsten carbide is superior owing to reduced deformation and high strength.

Keywords: Multi Point Cutting Tool, Solidwork, Ansys 14.0, Solid Modelling and Finite Element Analysis.

1.Introduction

Material removal may occur through direct shearing, as in machining, or via abrasion, erosion, or chemical action, as in non-conventional machining techniques. Cutting tools play an important role in machining manufacturing. Two wide heading instruments, a one-point cutting tool, and a multi-point cutting tool may all be investigated. To achieve enhanced surface finishes, multi-point cutting instruments are utilised. Using a one-point cutting tool is one of the most versatile and frequently utilised metal extraction techniques in the industrial industry. Intensive research in the cutting tooling equipment industry has resulted in recent breakthroughs in engineering materials and pressing demands for increased efficiency in global manufacturing. Metal cutting or machining is the process of creating a product by removing undesirable material chips from a metal frame. This is critical since metal extraction directly or indirectly finishes almost all goods in shape and size. The loss of chip content is the method's most significant drawback.

A large amount of heat is generated during machining as well as other operations that cause material deformation. When the carrying device comes into contact with the workpiece, the temperature generated at the bottom of the instrument is referred to as the tool-cutting temperature. Heat is a factor that has a significant impact on the tool's operating efficiency. We realise that a significant portion of the energy received by metal cutting is converted to heat. Elevated cutting temperatures have a significant impact on tool wear, tool life, the integrity of workpiece surfaces, and the chip forming mechanism, all of which contribute to heat deformation of the cutting tool, the most severe source of errors in the machining technique. Cutting is the separation of two portions of a physical item or part of a physical object by the application of actual force.

Figure 1: Milling Cutting Tool

Types of Milling

- **Up Milling (conventional milling)**

The safest way to use a horizontal miller to process a piece of metal is to feed the metal into the cutter while it is rotating. Up-milling is the technique utilised in classroom sessions. To provide extreme tightness, the metal must be held tightly in a large machine vice. When frying, the largest chip size is at the bottom of the slice. The advantages of utilising friction include a gentle operating technique that hardens the cutting edges. They may, however, have a yearning to communicate, and the whole must rise. However, there is a possibility that the tool may clatter and the workpiece will have to draw upward.

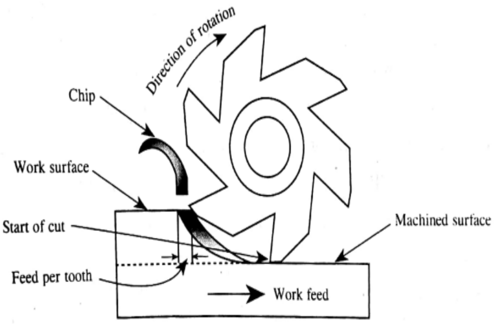


Figure 2: Up Milling

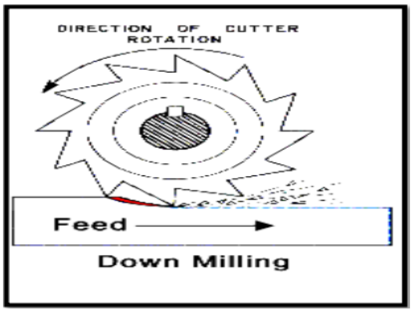


Figure 3: Down Milling

- **Down Milling (climb milling)**

Climbing friction is another name for down friction. The feed movement is the same as the cutting orientation. For example, if the cuts are rotated counter clockwise, the workpiece is supplied to the right during milling. The advantages are that the workpiece is kept in the downstream portions of the cutting force. Warm wrought metals, forges, and casting, on the other hand, are not suitable for treating a piece with a ground scale. The measurement is tough and abrasive, and it may cause extra wear and damage to the cutting teeth.

Milling Cutting Tool

The majority of the cutting point or bottom of a frying tool is made of one. A milling tool has a sharp portion of the cutting proposed as its shank. Used to make a tool for cutting teeth into merchandise. End mouldings: End moulds are tools with teeth curving at one end, as shown on the side, and are used for a variety of jobs like as edges, slots, or channels.

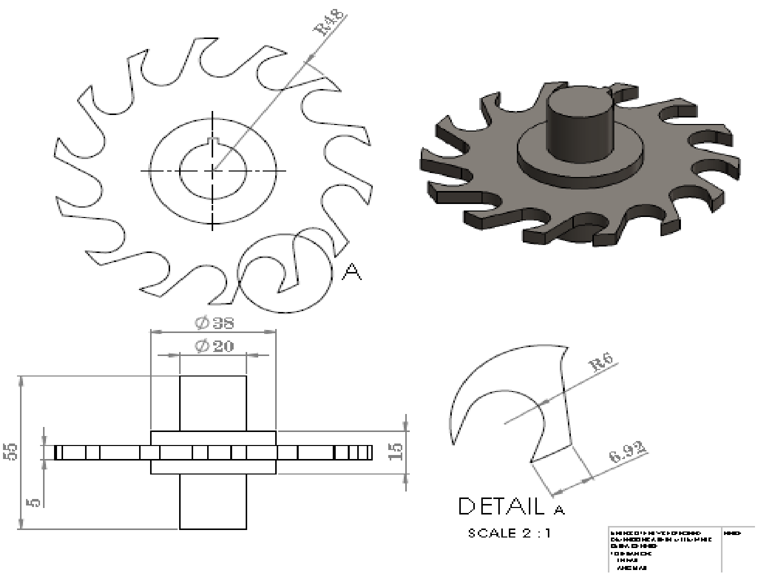


Figure4: Milling Cutting tool designed in Solidwork

Material Properties

The material characteristics of a milling cutting tool are detailed below:

The single factor cutting tool is composed of high speed steel and tungsten carbide, the characteristics of which are given in tables 1 and 2.

Table 1: Material properties of High-speed steel

Density	7980	Kg/ m^3
Young's Modulus	2.1E+05	MPa
Poisson's Ratio	0.3	
Bulk Modulus	1.75698E+11	Pa
Shear Modulus	80457364341	Pa
Tensile Yield Strength	970	MPa
Tensile Ultimate Strength	655	MPa

Table 2: Material properties of Tungsten Carbide

Density	1.53E-05	kg /m^3
Young's Modulus	600000	MPa
Poisson's Ratio	0.31	
Bulk Modulus	5.26316E+11	Pa
Shear Modulus	2.29008E+11	Pa
Tensile Ultimate Strength	344	MPa

Modelling of Milling Cutting Tool

Figure 5, shows the geometrical version of milling cutting tool designed in solid work and imported for analysis in ANSYS.

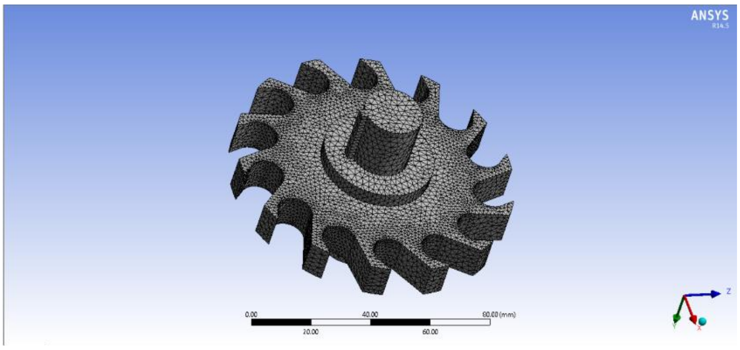


Figure5: Solidwork Model of Cutting Tool Imported in IGES Format in ANSYS for Analysis

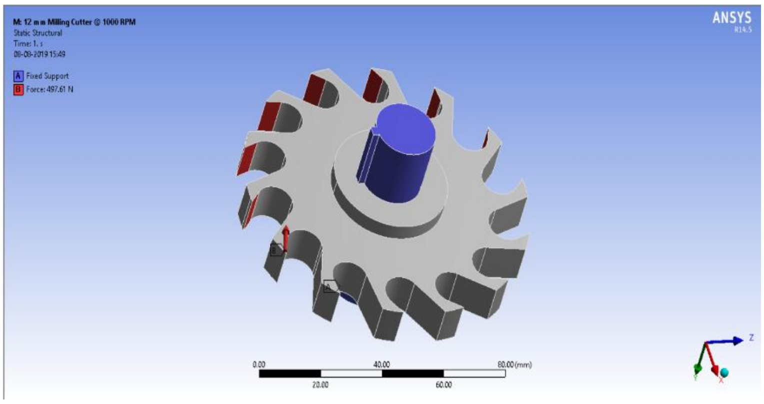


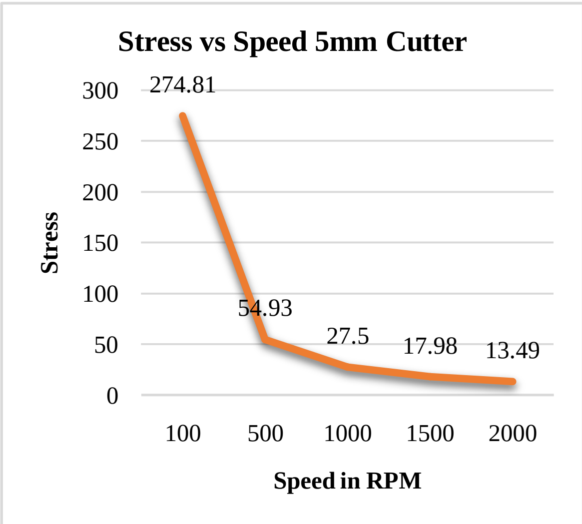
Figure 5: Boundary conditions for milling cutting tool

Results and Discussion

The analysis is run at different speeds to determine the Von-Misses stresses and deformation of the tip in the XYZ direction. Additionally, the product is used to locate stresses and deformations. The table below shows the stresses and deformation at various speeds. Tungsten carbide and high-speed steel are the two materials utilised to create the milling tool. The study is performed here for five distinct spindle speeds ranging from 100 to 2000 rpm. The loads at these rates are computed, as well as the corresponding Stresses operating on the teeth are discovered.

Table 3: Stress and deformation of 5 mm thickness Milling tool

Diameter in mm	Speed in RPM	Stress in MPa	Deformation in mm
96	100	274.81	0.0532
96	500	54.93	0.0106
96	1000	27.5	0.0053
96	1500	17.98	0.0035
96	2000	13.49	0.0026



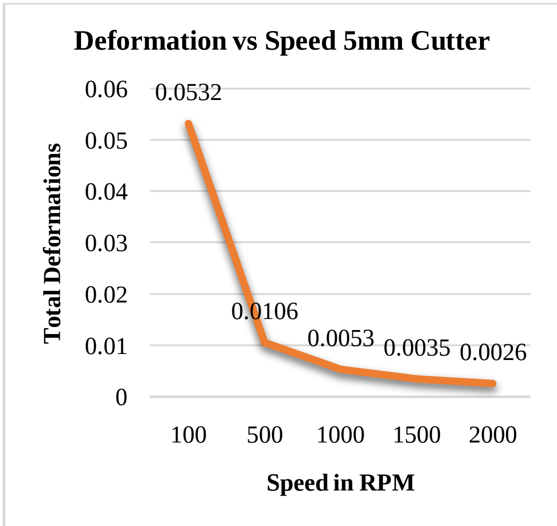


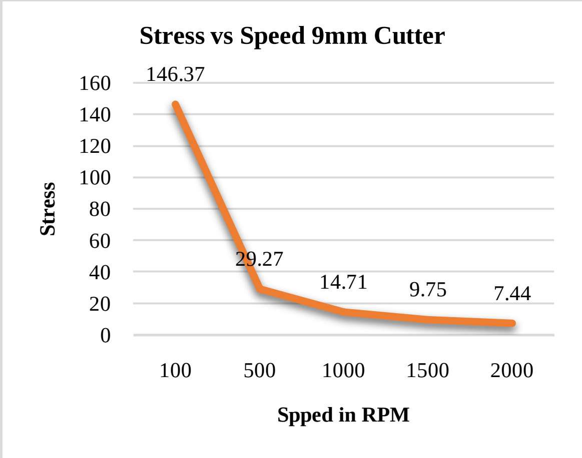
Figure 6: Stress and deformation of 5 mm thick milling cutter tool

Table 4: Stress and deformation of 9 mm thickness Milling tool

Diameter in mm	Speed in RPM	Stress in MPa	Deformation in mm
96	100	146.37	0.029
96	500	29.27	0.0059
96	1000	14.71	0.0029
96	1500	9.75	0.0019
96	2000	7.44	0.0014

Table 5: Stress and deformation of 12 mm thickness Milling tool

Diameter in mm	Speed in RPM	Stress in MPa	Deformation in mm
96	100	109.06	0.022
96	500	21.84	0.004
96	1000	10.92	0.002
96	1500	7.28	0.0014
96	2000	4.55	0.0009



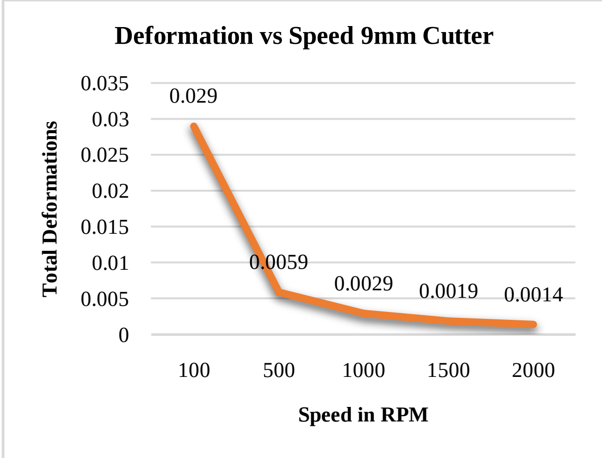
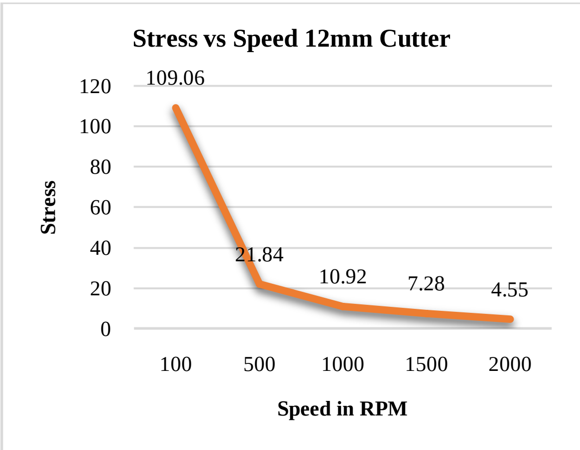


Figure 7: Stress and deformation of 9 mm thick milling cutter tool



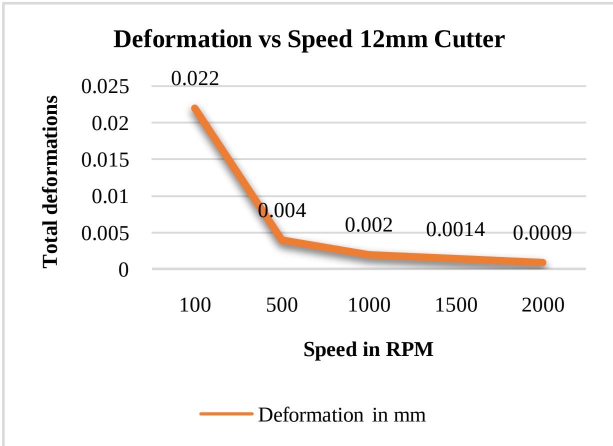


Figure 8: Stress and deformation of 12 mm thick milling cutter tool

Comparison of milling cutter tool of thickness 5mm, 9mm and 12 mm with speed vs stress. Speed Rpm varies from 100 to 2000 RPM.

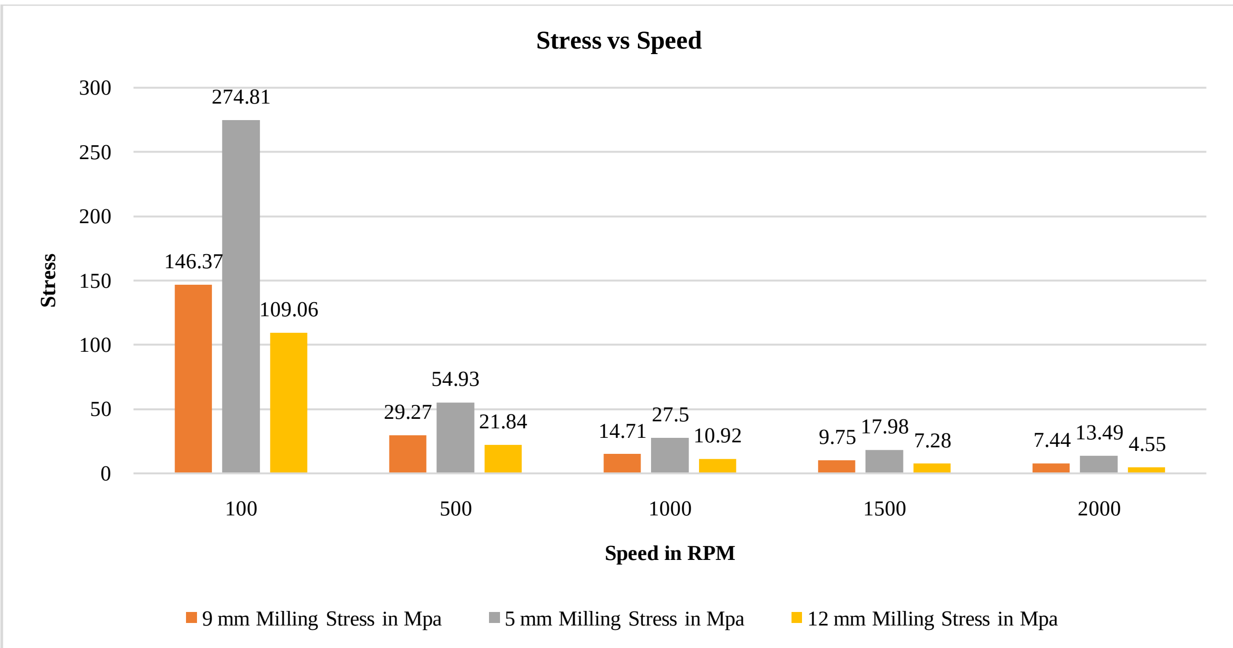


Figure 9: Comparison of graph of 5mm, 9mm and 12mm thickness

- **Milling Cutter tool analysis by using different materials**

  We chose two kinds of materials for the milling cutter tool research. High-speed steel with tungsten carbide. For both materials, an analysis was conducted using a milling cutting tool with a thickness of 5mm. The stress and deformations produced of a 5mm thickness cutting tool are shown in the table.

Table 6: Variations of 5mm thick milling cutter on selected materials

Diameter in mm	Materials	Stress	Total deformation
96	High Speed Steel	274.81	0.0532
96	Tungsten Carbide	274.6	0.0186

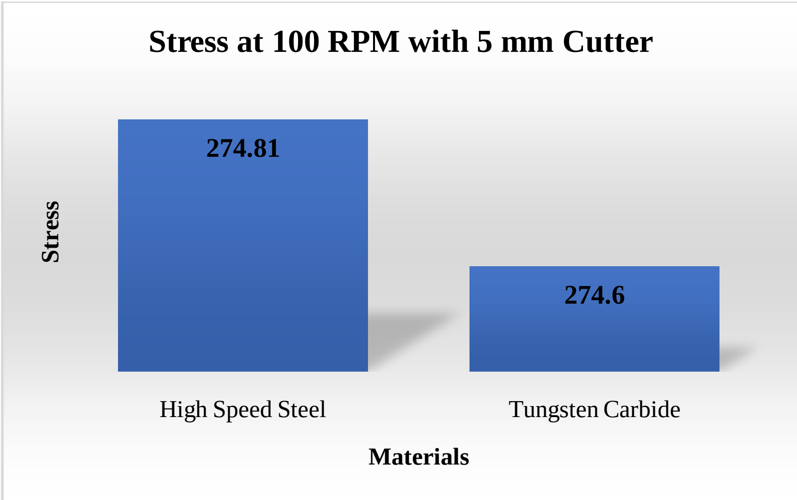


Figure 10: Stress variations with different materials of cutter tool of 5mm thickness

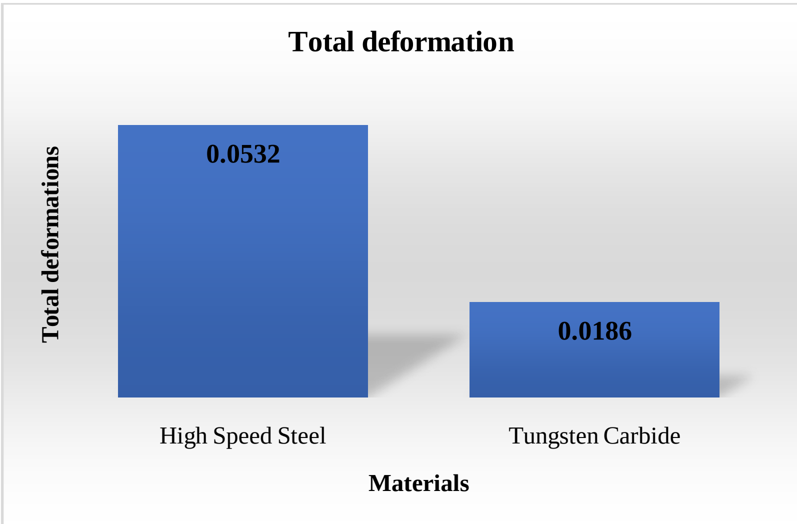


Figure 11: Total deformations with different materials of cutter tool of 5mm thickness

Conclusion

The project work given in this article emphasises that as the speed rises, the stresses produced in the tool diminish, as does the deformation on the upper side with each interval of reduction in speed. It's also one of the leading causes of tool failure. According on the findings of the preceding research, the following conclusions are provided below.

- For the 5 mm thickness tool at 100 RPM speed, the equivalent stress generated in Tungsten Carbide tool material is relatively lower than that caused in High-speed Steel tool material.

- For the 5 mm thickness tool at 100 RPM speed, the total deformation in High speed Steel tool material is relatively greater than that in Tungsten Carbide tool material.
- According to the findings of the preceding research, Tungsten Carbide outperforms High Speed Steel tool material in terms of performance.
- When we compared the output of stress to speed, we discovered that stress reduces as speed rises.
- Thickness rises as thickness changes, but stress and deformations decrease.
- When comparing tool materials, Tungsten carbide steel is the best material when all characteristics are considered.

REFERENCES

1. Yung-Chih Lin, Kung-Da Wu, Wei-Cheng Shih, "Evaluation of the Optimum Machining Stability of a Milling Tool with Different Flutes and Overhangs", Advances in Science and Technology Research Journal, Volume 13, Issue 2, June 2019, pages 56–64.
2. ErryYulianAdesta, Muhammad Riza, Avicena, "Comparative Investigation on tool wear during End milling of AISI H13 steel with different tool path strategies", IOP Conf. Series: Materials Science and Engineering, 343, 2018.
3. Hong-Jun Zhang, Chaoyu Sun, Meng Liua, "Analysis of the optimization of tool geometric parameters for milling of Inconel718", IOP Conf. Series: Materials Science and Engineering, 423, 2018.
4. Meher R. Pratapwar, Neeraj P. Raut, Akash S. Rameshware, "Thermal Analysis of Milling Cutter Using Finite Element Analysis Tool", International Research Journal of Engineering and Technology (IRJET), Volume: 05, Issue: 03, Mar-2018.
5. Ronak Singh Bhatia, Nikhilesh N. Singh, Prabhat Kumar Sinha, "Study and Vibration Analysis of Multipoint Cutting Tools of Milling Machine by Fem and Ansys Benchwork 14.0", International Journal of Engineering Sciences & Research Technology, International Journal of Engineering Sciences & Research Technology, June, 2018.
6. Ali Davoudinejad, Guido Tosello, Paolo Parenti, "3D Finite Element Simulation of Micro End-Milling by Considering the Effect of Tool Run-Out", micromachines, 8, 187,2017.
7. SundiSyahrulAzwan, Muhamad Mohd Razali, Kasim Mohd Shahir, "Tool Wear Analysis on Five-Axis Flank Milling for Curved Shape Part – Full Flute and Ground Shank End Mill", MATEC Web of Conferences 97, 2017.
8. Vikas Patidar, Kamlesh Gangrade, Suman Sharma, "Wear Analysis of Multi Point Milling Cutter using FEA", International Journal of Engineering Trends and Technology (IJETT) – Volume 47 Number 6 May 2017.
9. V. Gnanasekaran, J. Ekanthamoorthy, K. Senthilkumar, "Failure Analysis of Solid Carbide Cutting Tool Used In Milling Operation", International Journal of Chemistry and Sciences, 2016.
10. Virginijagyliene, ValdasEidukynas, "The numerical analysis of cutting forces in high feed face milling assiuming the milling tool geometry", CIRP conference on high performance cutting, Elsevier, 2016.
11. B.R.Dabhi, K.V.Parmar, "A Review Paper On Latest Trend On Face Milling Tool", International Journal of Advance Engineering and Research Development, Volume 2, Issue 1, January -2015.
12. Mulugundam Siva Surya, Sridhar Atla, "Effect of Approach Angle in Face Milling Using Tungsten Carbide Tool", nternational Journal of Recent advances in Mechanical Engineering (IJMECH) Vol.4, No.2, May 2015.
13. S. Arun, M.Palpandi, "Design and Analysis of High Carbon Steel Milling Cutter", International Journal of Engineering Sciences & Research Technology, May, 2014.
14. Vinod Kumar, Eakambaram, Arivazhagan, "FEM Analysis to Optimally Design End Mill cutters for Milling of Ti-6Al-4V", 12th Global Congress on Manufacturing and Management, Elsevier, 2014.