E-ISSN 2581 – 7957
P-ISSN 2277 – 3916
CVR Journal of Science and Technology, Volume 23, December 2022
DOI: 10.32377/cvrjst2324

Modelling and Fabrication of Hexagonal Turret on Engine Lathe

K. L.N. Murthy
Asst. Professor, Sreyas Institute of Engineering and Technology/Mechanical Engg. Department, Hyderabad, India
Email: klnmurthy1986@gmail.com

Abstract: **The aim of this paper is developed from two different lathe machines, i.e. Centre Lathe and Turret Lathe and the main aim of this work is to Model and develop a tool post that can hold six cutting tools, and replace square tool post in center lathe machine. The different tools like a parting tool, turning tool (right hand turning tool or left-hand turning tool), forming tool, thread cutting tool, chamfering tool and knurling tool are enclosed in the turret where it mainly help in reducing the time which is required to change the tool and help in increasing of productivity of the lathe machine. The Modelling and analysis work of this turret is done in SolidWorks 2018. Material used for metal prototype is mild steel and Fabrication process is done by using the milling machine, radial drilling machine and lathe machine.**

Index Terms: lathe, Machining, Turret, tools.

I. Introduction

A lathe is a machine tool that rotates a work piece about an axis of rotation to perform various operations such as cutting, sanding, knurling, drilling facing, and turning, with tools that are applied to the work piece to create an object with symmetry about that axis[1]. The first machine tool developed was around 1300 B.C., earlier was a tree lathe which was a device for rotating and machining a workpiece. The workpiece kept between two adjacent trees and a rope would round the work with its one end attached to a flexible branch of trees and the other end is pulled by a man to rotate the job. Lathes are manufactured in a variety of types and sizes, from very small bench lathes used for precision work to huge lathes used for turning large steel shafts [2]. However, these lathes have been classified into several types in later stages such as Center lathe, capstan Lathe, Turret Lathe, Automatic Lathe, etc.

The main advantage of using lathe machine is that it can be used for various machining operations such as Step and Taper turning, knurling, various forms of treads, Boring, drilling etc., with and without using special cutting tool attachments on it. Metal cutting or machining is the process of producing work piece by removing unwanted material from a block of metal, in the form of chips [3]. For any machining operation the life of a tool is important since considerable time is lost whenever a tool is replaced or reset. Cutting tools lose its sharpness as usage continues and their effectiveness decreases over time. At some point during the life-span of the tool, it is necessary to replace, index or re-sharpen and reset the tool. Tool life is a measure of the length of time a tool will cut effectively. The life of cutting tool depends upon many factors, such as the microstructure of the material being cut, metal removal rate, the rigidity of the setup and effects of cutting fluid (David and Agapiou, 2000; Krar, 1995) [4]. The correct choice of cutting velocity can enhance tool life but at the same time, the tool should be used to its maximum capacity.

Design of Hexagonal Turret:

The modelling of turret is made in Solid Works 2018 which is a solid modelling computer-aided design (CAD) and computer-aided engineering (CAE). To minimize the modeling time, preprocessor software that helps to create the geometry required for FEA, such as Solid works could be used [5]. Solid modelling is the only Computer Aided Design (CAD) approach that completely and unambiguously represents the 3D geometry of parts and assemblies. It is therefore, the only type of design tool capable of fully supporting today's widely diverse range of engineering applications, from analysis to manufacture and thus enables concurrent engineering. [6]

Fabrication:

The fabrication of Hexagonal turret is made in different steps

Step 1:

Initially the dimensions of the actual square tool post are taken to get the maximum diameter of the tool post that can be fixed on lathe. Then a rough sketch is drawn to prepare a 3D model using SOLIDWORKS 2018.

Step 2: -

3D modelling and drafting

By using Solid Works and the rough sketch prepared earlier, 2D top view of the turret is drawn and developed into 3D by using Solid Works features like extrude, extrude cut, polar array and chamfer. Then the 3d view and cut section is done my using drawing feature (drafting) as shown in the figure.[7][8]

Step 3: -

TABLE I.
Analysis of the Turret Under Static Conditions

MESH: FINE Entity	Size
Nodes	3985
Elements	15896

Received on 20-09-2021, Revised on 19-08-2022, Accepted on 29-08-2022.

E-ISSN 2581 – 7957
P-ISSN 2277 – 3916

DOI: 10.32377/cvrjst2324

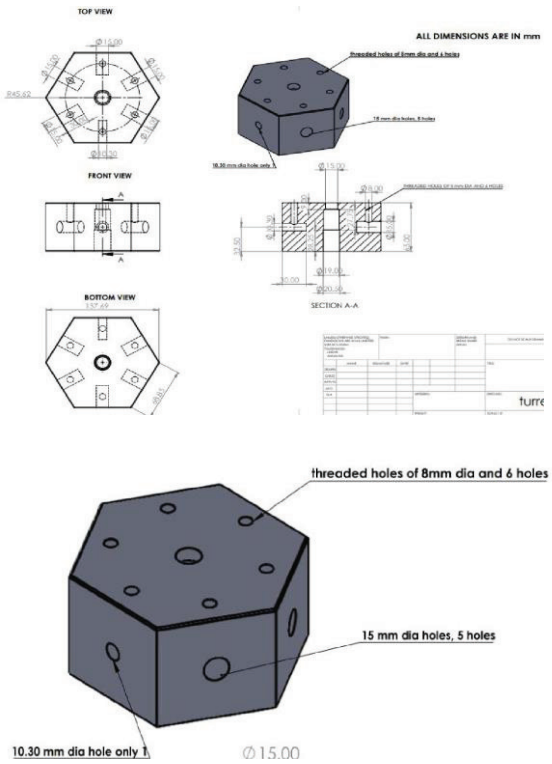


Figure 1. Modelling of turret

The above figure 1 shows modelling of turret using solidworks2018. Meshing was done and the mesh size was kept fine to understand the deformation that takes place at a very small area when the load is applied on the turret. It was fixed and supported at the center stepped holes, and a load of 500N was applied inside the side hole. The material had to withstand the force applied.[9] The result is given below

Result:-

Element Type:

TABLE II.
ELEMENT TYPE

Connectivity	Statistics
TE4	15896 (100.00%)

Element Quality:

T ABLE. III.
ELEMENT QUALITIES

Criterion	Good	Poor
Stretch	15893 (99.98%)	3 (0.02%)
Aspect Ratio	14648 (92.15%)	1241 (7.81%)

Criterion	Bad	Worst	Avg
Stretch	0 (0.00%)	0.270	0.624
Aspect Ratio	7 (0.04%)	5.958	1.916

Material Properties:

TABLE IV.
PROPERTIES OF THE MATERIALS

Material	Mild Steel
Young's modulus	$2e^{+011}$ N-m^2
Poisson's ratio	0.266
Density	7860 kg-m^3
Coefficient of thermal expansion	$1.17e^{-005}$ Kdeg
Yield strength	$2.5e^{+008}$ N-m^2

Static Case Boundary Conditions:

the below figure 2 shows the various boundary conditions of the turret.

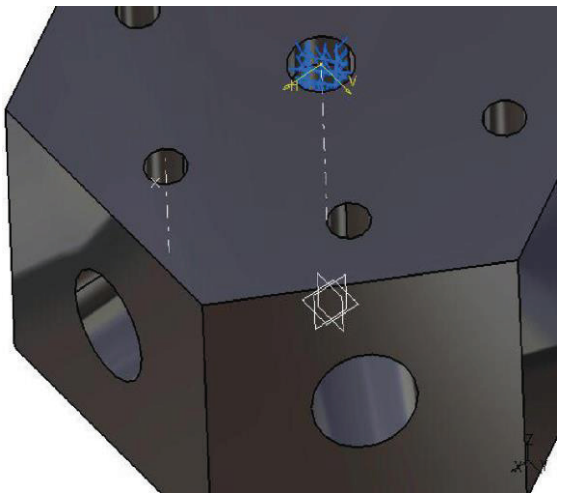


Figure 2. Boundary conditions

Structure Computation:

TABLE V.
STRUCTURE COMPUTATION OF TURRET

Number of nodes	3985
Number of elements	15896
Number of D.O.F.	11955
Number of Contact relations	0
Number of Kinematic relations	0
Linear tetrahedron	15896

Load Computation:

TABLE VI.
APPLIED LOAD RESULTANT

Fx	$-1.000e^{+003}$ N
Fy	$-6.725e^{-021}$ N
Fz	$5.551e^{014}$ N
Mx	$-3.23E^{+001}$ Nm
My	$3.123e^{+001}$ Nm
Mz	$1.435e^{-001}$ Nm

E-ISSN 2581 – 7957
P-ISSN 2277 – 3916

DOI: 10.32377/cvrjst2324

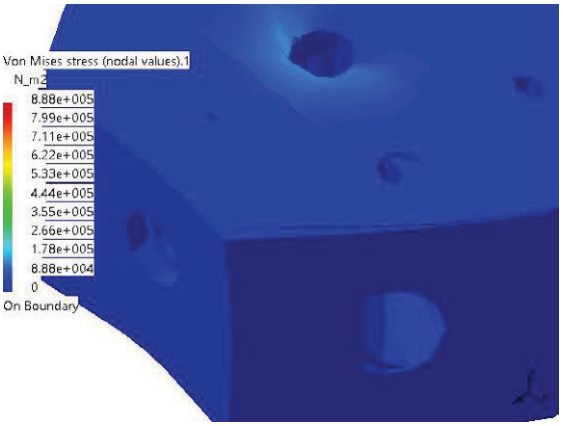


Figure 3. Static case solution vonmises stress

The above figure 3 shows vonmises stress, deformation and the area where the vonmises stress is high. The above chart in the figure shows the maximum stress that can be produced when applying 500N of load is 8, 88000 N/m2. The ultimate strength of the mild steel is 350MPa or 350000000 N/m2 on comparing the stress developed and ultimate strength we can say that the design is very safe.[10]

Fabrication of Foam Prototype:

As the design is found out to be safe a foam prototype shown in figure 4&5 is made with the help of a 3d model designed in SOLIDWORKS 2018. Machinery like wood cutting band saw and jigsaw are used in making this prototype.

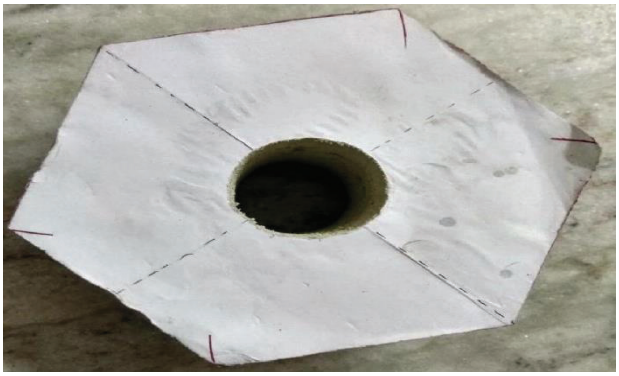


Figure 4 & 5. Prototype of turret made with foam

Step 5:-

Fabrication of Metal Prototype

A Mild steel block is cut with the help of metal cutting band saw according to requirement.[10]
Then the mild steel workpiece is fixed in the lathe chuck, turning and facing operations are performed to remove irregularities if any shown in figure 6.
Dimensions are marked for further operations i.e. milling and drilling.
Milling operation is carried out such that the circular block is shaped into hexagon. To fix the bolts six holes of 8mm diameter are drilled on top portion, five holes of 15mm diameter and one hole of 10.3mm diameter are drilled on each face of the turret for placing the cutting tools. [10][11]
Final output of the tool holder after machining and grinding operations are sown in figure 7,8,9&10 placed at different orientations.

Figure 6. The above figure shows the cutting process of a mild steel block

Figure 7. the above figure shows the block after the turning, facing and boring of MS block in lathe machine

E-ISSN 2581 – 7957
P-ISSN 2277 – 3916

DOI: 10.32377/cvrjst2324

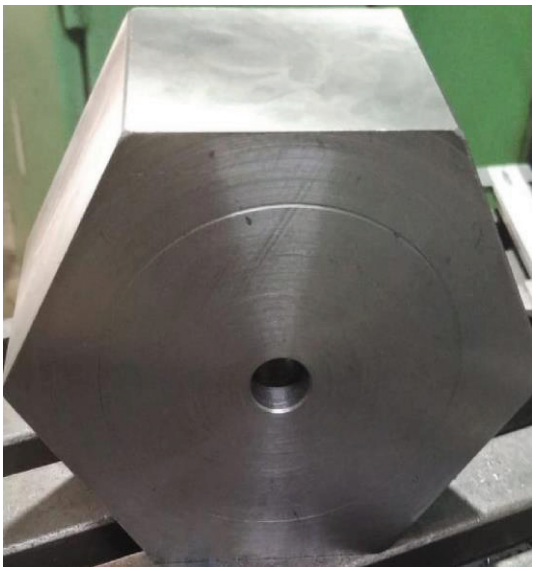
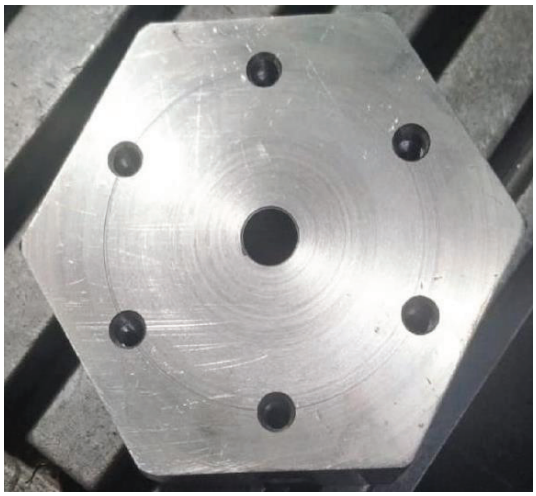


Figure 8. the above figure shows the result after milling.



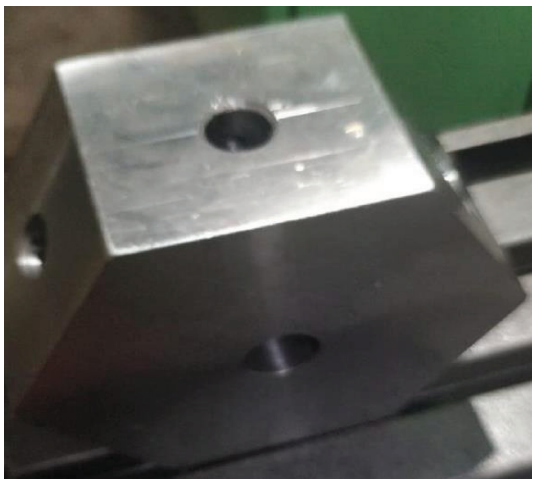


Figure 9 &10. the above figure shows the end product after drilling and tapping operation

II. EXPERIMENTATION

This is the final stage where the testing of the tool post is done by replacing the square tool post with hexagonal tool post. Testing of the turret is conducted inorder to withstand the cutting forces and vibrations. Different machining operations such as turning, forming and drilling are conducted and shown in figures 11,12,13 & 14

Figure 11. the above figure show the simple turning operation of a rod of 28mm diameter

Figure 12 & 13. Forming Operation

CVR Journal of Science and Technology, Volume 23, December 2022
DOI: 10.32377/cvrjst2324

Figure 14. turret holding four single point cutting tools, one drill bit of 8mm, one forming tool

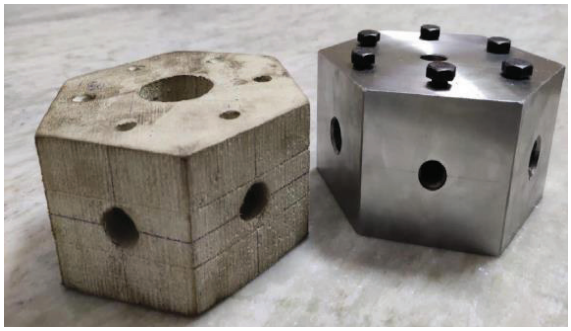


Figure 15. the above figure shows the comparison between foam and metal prototype

The above figure 15 shows the final comparison between the foam prototype and metal prototype.

III. CONCLUSIONS

The Hexagonal turret is manufactured and implemented successfully on center lathe machines with six similar and different types of cutting tools and various operations such as turning, facing, taper turning, knurling, thread cutting, and boring operations are performed.

This tool post reduced the time taken for changing of tool (The average time required for replacing the old cutting tool with new and well-grounded is approximately 2 min). Different operations mentioned above are performed on replacing the square tool post with hexagonal tool post.

REFERENCES

[1] https://en.wikipedia.org/wiki/Lathe#cite_note-1
[2] Analysis of Single Point Cutting Tool Using ANSYS ISSN: 2321-8169 Volume: 4 Issue: 5 Page 331 – 338
[3] Finite element analysis of single point cutting tool, Volume: 04 Issue: 09 | Sep -2017, e-ISSN: 2395-0056
[4] Stress Analysis on Spur Gears Using ANSYS Workbench 16.0, Volume 7–Issue 08,208-213, 2018, ISSN:-2319–7560
[5] A study on Types of Lathe Machine and Operations: Review, Volume 8 Issue 4 (2020) 286-291, ISSN 2347 – 3258
[6] The Concept of Solid Modelling in The Plastic Injection Molding Process – Review, ISSN: 2278-0181, Vol. 2 Issue 4, April – 2013
[7] *"Design Data Book for Machine Elements,"* PSG Tech. Publication.
[8] *"Design Data for Machine Elements,"* by B. D. Shiwalkar, 2005, Central Techno Publications, Nagpur.
[9] *"Introduction to Finite Elements in Engineering,"* by Tirupati R. Chandrupatla and Ashok D. Belegundu, 2002. Prentice Hall of India Pvt. Ltd. New Delhi.
[10] *"A Text Book of Machine Design,"*, by R. S. Khurmi & J. K. Gupta, 1997, S. Chand & Company Ltd., New Delhi.
[11] *"Manufacturing Technology (Volume – II) Metal Cutting & Machine Tools,"* by P. N. Roy, 2008. Tata McGraw Hill Publications, New Delhi.