International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 02 Issue: 04 | July-2015 www.irjet.net p-ISSN: 2395-0072

Determination of bending strength of machining fixture by using finite element analysis

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Abstract - Machining fixture for conical wedge of post tensioning system of pre-stressed concrete needs to be designed and analyzed which is a project sponsored by a SSI in Udyambag, Belgavi. The component is first machined from round bar stock giving to it the conical shape with a threaded hole (Threading meant for only better grip on tensioning wires). Finally the cone is to be cut in to three equal wedge shaped pieces by slitting saw. The component is required on fairly large scale and the cost of machining needs to be kept to minimum. Thus the need arises for the development of a low cost, and ***efficient machining fixture. The company's main aim is*** *to reduce the cost of the machine without compromising on the quality of the output.*

Key Words : Conical Wedge, Low Cost, Quality, Deflection.

1. INTRODUCTION

1.1 Machine Tools

There are various processes by which a product can be manufactured. Each process, however its own place and can particularly be adapted to a certain specific application. Machining is one such process, which involves removing excess material from the metallic object so as to obtain the required shape and size. Machining process include Turning (using lathe), Drilling, Milling, Grinding, Shaping etc. The process is carried out by means of a machine tool, which is power driven and designed to hold and move a sharp cutting tool against a rigid work material so as to shape the work material to the desired size and finish.

1.2 Lathe Machine

The lathe is the oldest of all machine tools and most basic tool used in industries. A lathe is defined as a machine tool used to remove excess material by forcing a cutting tool against a rotating workpiece. Lathes are also called turning machines, since the workpiece is turned or rotated between two centres .They are primarily used to produced cylindrical, plain and tapered surfaces and also used for knurling and thread cutting on metal parts.

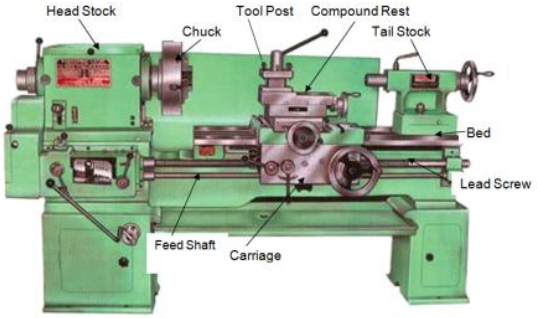


Fig-1:Lathe Machine

1.3 Milling Machine

Milling is a manufacturing process in which the excess material from the workpiece is removed by a rotating multipoint cutting tool is called milling cutter. Figure shows the milling process for producing a flat surface on the workpiece.

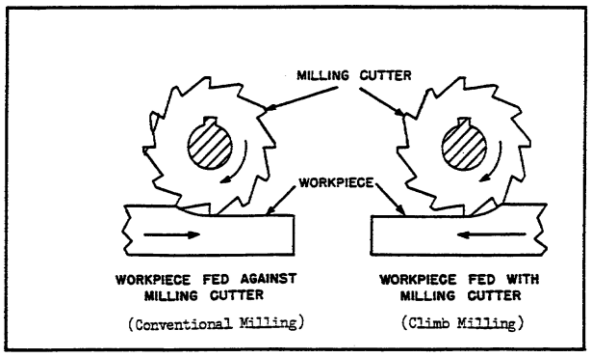


Fig-2:Direction Feed for Milling

In milling, the cutter is held in the spindle of the machine and made to rotate at suitable speeds. The workpiece, which is held rigidity by a suitable device is fed slowly

against the rotating cutter. As the workpiece advances against the rotating cutter , each tooth of the cutter removes metal from the surface of the workpiece to produce the desired shape.

Milling can be used for producing flat, angular or curved surfaces for cutting threads, toothed gears, keyway, slots and a wide variety of operations.

PROPERTIES OF MATERIAL SELECTED

The machining fixture is made up of Standard Structural Steel IS 226-1975.The bolts and washers are structure steel of 8.8 class.

Table -1: Mechanical properties of Structural Steel.

SL.NO	Particulars	Values
1.	Carbon content	0.40
2.	Density	7850 Kg/m^3
3.	Ultimate tensile strength	460 N/mm^2
4.	Young's modulus	2×10^5 N/mm^2
5.	Poisson's ratio	0.3
6.	Coefficient of thermal expansion	12×10^{-6}/°C
7.	Thermal conductivity	43.3 W/m-K
8.	Yield strength	250 N/mm^2

Table -2: Mechanical properties of Steel bolts and washers of 8.8 class.

SL.NO	Particulars	Values
1.	Carbon Content	Medium carbon
2.	Minimum Proof Strength	600 N/mm^2
3.	Minimum Tensile Strength	830 N/mm^2
4.	Minimum Yield	660 N/mm^2

	Strength	

Table -3: Mechanical properties of Steel bearings.

SL.NO	Particulars	Values
1.	Carbon Content	Carbon 0.95-1.10
2.	Young's modulus	203 N/mm^2
3.	Poisson's ratio	0.3
4.	Density	7850

2.OBJECTIVES AND METHODOLOGY

Objectives

- Any error in the design stage can be identified and modified in 2D model.
- Cutting the conical wedge in to 120^0 ×3 number.
- Machine should produce 100-300 numbers components per day.
- Accuracy of component is ± 0.2 mm
- To estimated the stress distribution, maximum and minimum stress acting on the machining fixture.
- Deformation of the fixture under the action of cutting forces needs to be studied.
- Component location and clamping to be analyzed.

Methodology

- Analytical design of machining fixture using specifications.
- Creation of 3D models of machining fixture using SOLID WORKS.
- Importing of 3D models of machining fixture in ANSYS.
- Meshing of 3D models using ANSYS.

- Analysis of machining fixture using static analysis.

3. 2D AND 3D OF MODEL ASSEMBLY

Conical Wedge

Fig-3(a): INTIAL JOB

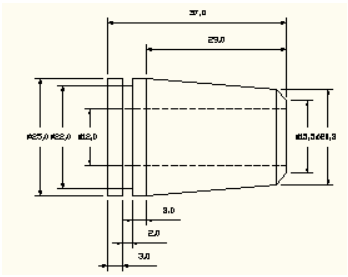


Fig-3(b): 2D drawing

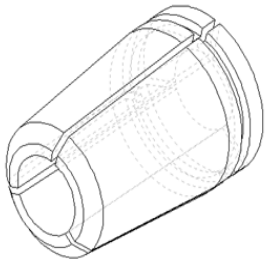


Fig-3(c): FINAL JOB(120^0×3nos) IN CAD

Assemble Drawing

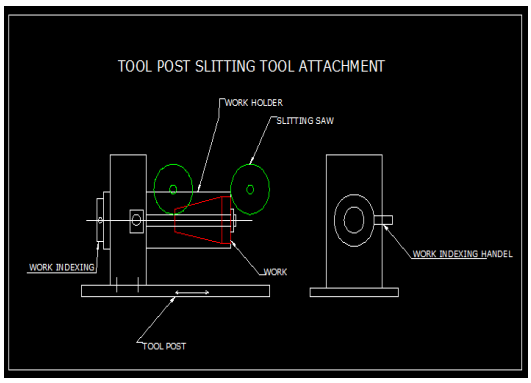


Fig-4:Tool Post Slitting Tool Attachment

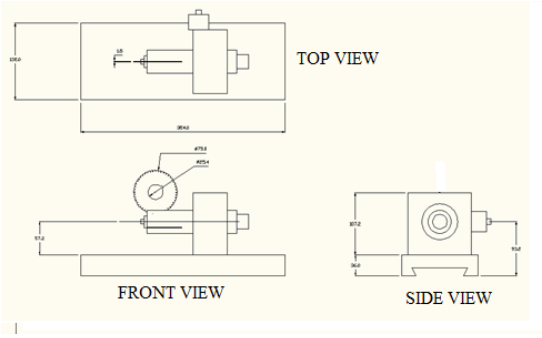


Fig-5:2D Views Of Machining Fixture Assembly

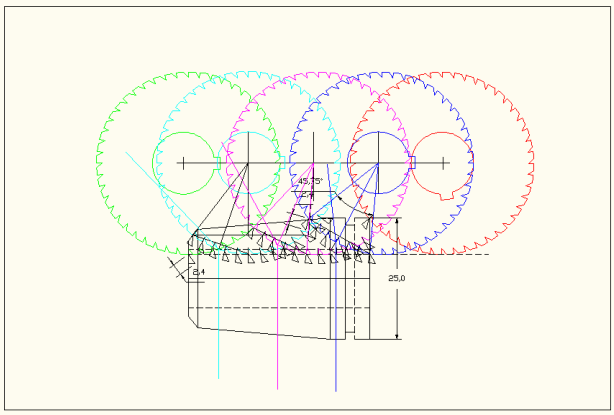


Fig-6: Cutting Tool Engage With Conical Wedge

Assembly Analysis

The Machining fixture assembly consists of cross slide, mandrill, Aero 07-62 bore bearing, Aero 07-68 bore bearing, indexing pin and end cap arrangements. The Mandrill diameter is 40 mm. The whole assembly is made up of structural steel and it is modeled in SOLID WORKS.

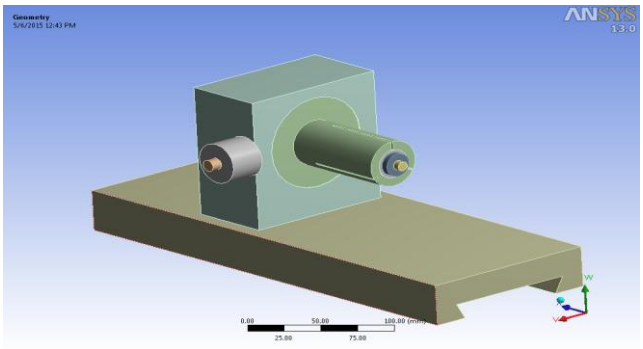


Fig- 7: Shows 3D view of Conical wedge machining fixture.

Mesh Of Machining Fixture.

The meshing of machining fixture using elements SOLID185 element (8node with 3DOF/node) in ANSYS Software. The mesh of machining fixture is free meshing. Meshed view of machining fixture is shown below.

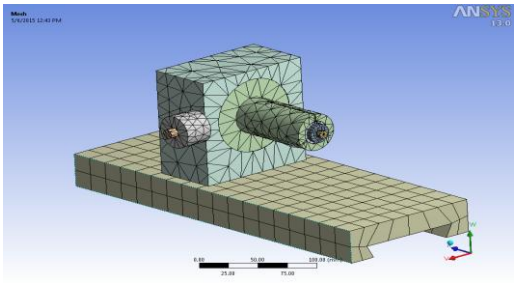


Fig- 8 :Meshed view of Conical wedge machining fixture.

Boundary Conditions

The Machining is constrained in all DOF at the base and force of 250N are applied where mandrill and conical wedge arrangement comes.

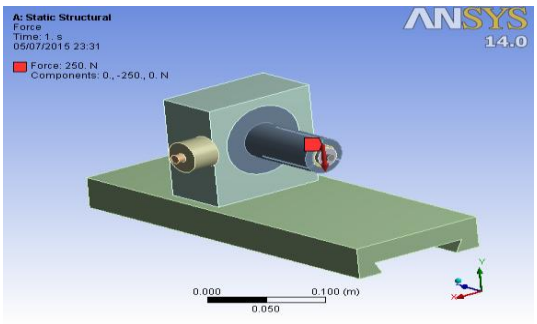


Fig -9: Shows application of 250N load and BC's on conical wedge.

4.RESULTS AND DISCUSSION

Cutting Position-1

A Force of 250N is applied on end of the conical wedge where mandrill arrangement comes and results obtained are shown in below figure.

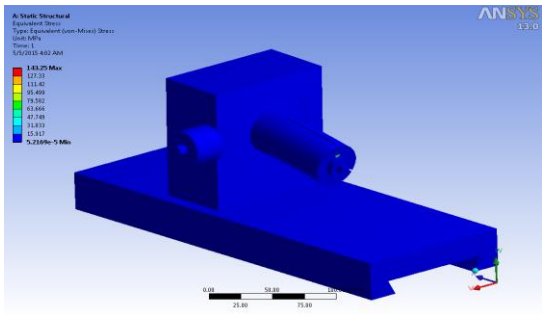


Fig- 10(a): Stress

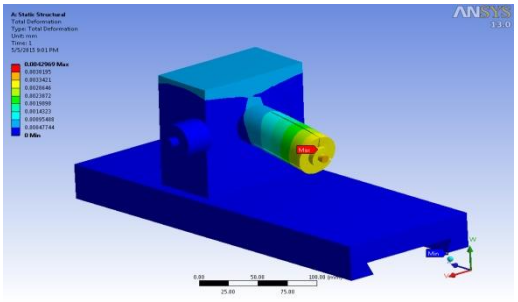
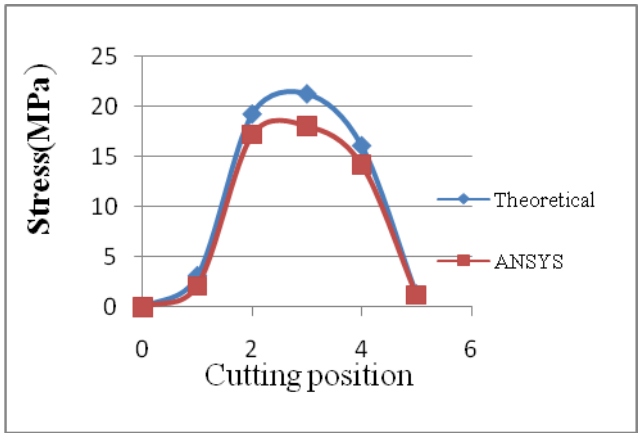


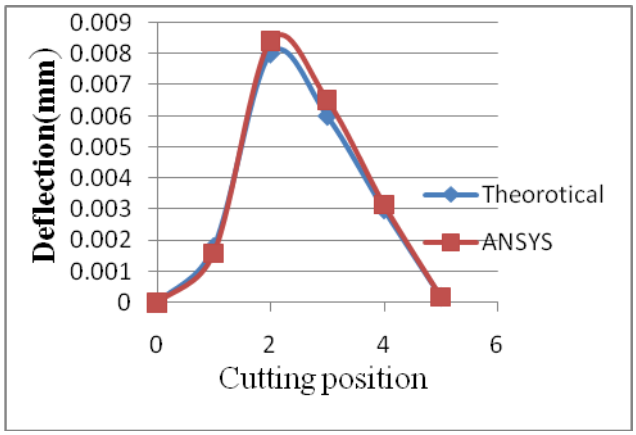
Fig- 10 (b): Deformation

Table-4: Ansys And Theoretical Results

SL No	ANSYS RESULT		THEORETICAL RESULT	
	SRTESS in (MPa)	DEFLECTION in (mm)	SRTESS in (MPa)	DEFLECTION In (mm)
1.	2.15	0.0016	3.1632	0.0018
2.	17.23	0.0084	19.242	0.008
3.	18.11	0.006519	21.26	0.00623
4.	14.23	0.003159	16.10	0.00303
5.	1.22	0.0002	0.1574	0.0002



Graph-1: Stress V/S Cutting position



Graph-2: Deflection V/S Cutting position

EXPERIMENTAL SET UP OF MACHINING FIXTURE ON LATHE MACHINE

Fabrication Of Machining Fixture Assembly

(a)TOP VIEW

(b)SIDE VIEW

The lathe is the oldest of all machine tools and most basic tool used in industries. A lathe is defined as a machine tool used to remove excess material by forcing a cutting tool against a rotating workpiece. Lathes are also called turning machines, since the workpiece is turned or rotated between two centres.

They are primarily used to produced cylindrical, plain and tapered surfaces and also used for knurling and thread cutting on metal parts. In this project, operation on the lathe is different i.e A lathe is defined as a machine tool used to remove excess material by forcing a machining fixture against a rotating slitting saw (cutter). Our main objective of project is cutting of conical wedge into 120^0×3 numbers.

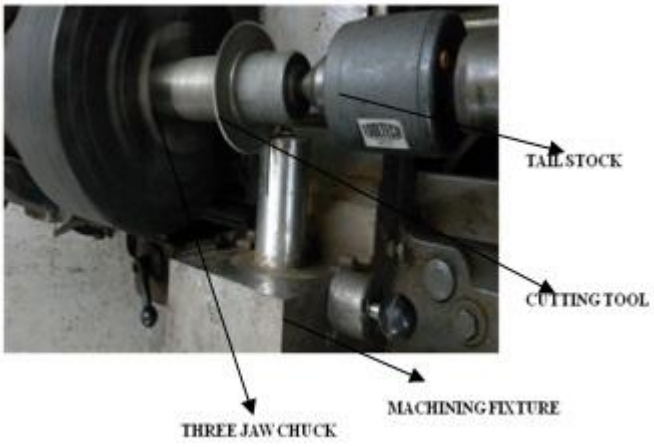


Fig-11: Experimental set up of machining fixture on lathe machine

(a)Before operation

(b)After operation

5. CONCLUSIONS

- Machining fixture can be fixed on lathe machine and milling machine.
- An attempt was made to analyze the conical wedge machining fixture in ANSYS analysis software.
- Static structural analysis is carried out for parts of machining fixture.
- The project work completely designed as per the constraints.
- The Conical wedge machining fixture is cross checked where it does meet the requirement.
- With reference to the assumptions made above the maximum stress induced in the machine in 21.26MPa it is less than the allowable stress of the material.

6. SCOPE FOR THE FURTHER STUDIES

- Optimization of whole machining fixture has to be carried out.
- In order to reduce the weight and cost of the machine by using different material with their material properties as possible. Such that cost should not go higher than the present design.
- An alternative design can be thought, which satisfies the required purpose likewise as existing.
- Dynamic and modal analysis may be carried out for obtaining further information about the behavior of fixture in running condition.

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AUTHOR PROFILE

Rajendra Balappa Chingale obtained his Bachelor's Degree in Mechanical Engineering from Visvesvaraya Technological University. He is presently pursuing Masters Degree in Mechanical Machine Design in Visvesvaraya Technological University.

