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Design and development of ginning clutch fixture

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Abstract

Fixtures are an important aspect of machining processes and one of the decisive factors in the efficiency of the process and the quality of the finished product. The solution to an industrial challenge of design and fabrication of a ginning clutch fixture built on a VMC machine is presented in this work. Geometry, strength, static and dynamic forces, and fixture loading are all factors in the design process. The fixture's design was modelled and examined using SolidWorks software, and necessary changes were made. The fixture was made utilising the gas cutting and welding method after the redesigned design was assessed successfully.

Keywords: Fixture, VMC machine, SolidWorks.

1. Introduction

Fixtures are workholding devices that keep the job in position while it is being machined. Fixtures are not the same as jigs in that they both steer the tool and hold the workpiece in place. Any machining operation requires fixtures to maintain the job in place during the machining process and get the desired outcomes. They are primarily classified according to the type of machining they perform. Consider milling fixtures, drilling fixtures, lathe work, and so on .The three primary components of fixture design to keep in mind while creating the fixture are:

1. Locators: A locator is a fixed component of a fixture that has no actuation ability. It's utilized to put the workpiece in the right place at the right time. At least six locators are found in a typical fixture.
2. Clamps: A clamp is a force-actuating mechanism that is statically positioned on a fixture. It's utilized to apply a force that keeps the workpiece in place in the face of all forces acting on it. At least two clamps are used in a standard fixture.
1. Supports: Support is a fixed or adjustable fixture part. When severe part displacement/deflection is expected, supports are added and placed below the workpiece to prevent or constrain distortion.

The fixture can be designed using various methods for different types of components. For each different type of component manufactured in different industries, a different type of fixture has to be designed. But even though the design of fixtures for different compositions can be different but the overall research methodology was the same.

From the various research papers we studied, we found out that the methodology to design and develop a fixture was as follows:

A) Data collection

The design planning of a fixture is based on the data collected of the component manufactured in the industry and which has to increase in case of productivity.

The data which is mainly required is

i. A drafting sheet of the component which has all the dimensions with proper accuracy.

ii. The data of the machine on which the component is manufactured including the dimension of the machine, the power on which the machine works, etc.

iii. The data of the tool used while machining the component like its materials and other data like the cutting speed and various forces required to manufacture the component.

B) Design process

At this step, the design process should clearly state the problem to be solved and achieved as needed. The design process also included the analysis that involves the product such as the clamping position, the load distribution, the material selection, and more analysis and information from the design. The designing of the fixture can be done using various designing software available like SolidWorks, CATIA, AutoCAD,

C) Fabrication

Fabrication is another crucial step of any product development selecting proper processes for manufacturing is very important and directly affects the quality of product manufactured.

2. Design Methodology.

A) Design overview

The first step in fixture design is to study the part drawing. The manufacturer provided the part drawing (see Fig. 1), and Mild Steel Plate AISI 1020 was selected for the fixture due to its low cost, ease of availability, high strength, and ease of machining.

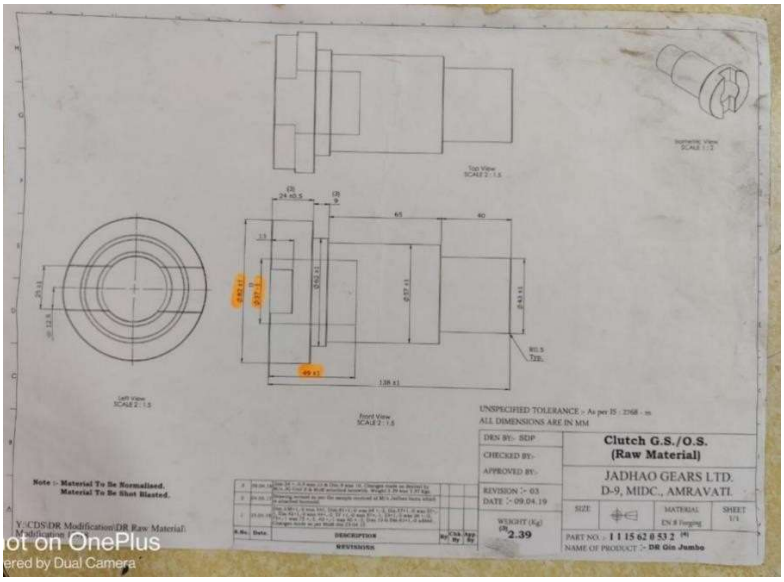

Fig.1 Drafting sheet

B) Designing parameters

a) Design of the base plate
Dimension of machine bed:520×1000
Baseplate length:515mm
Breath:200mm

b) Design of top plate
Top plate length = workpiece diameter +clearance between jobs +Clearance on both side
= (60×4) +(30× 3) +35×2
=240+90+70
= 400 mm
Breath:200mm

c) Design of pillars
Height of job= 138mm
Length of pillars = 140 mm
Breath of pillar =140 mm
Using square plate for pillar.

d) Design of middle plate
Length of plate = diameter of the hole + clearance between holes + clearance on both sides
= 20×4 + 68×3 + 30×2
= 80+204+60
= 344 mm
Breath:140mm

3. Design of the fixture

A. Design of the fixture holding the ginning clutch.

While designing our fixture there were various restrictions and parameters which were supposed to be kept in mind for failure less designed. After creating and plotting our basic ideas of our fixture which were supposed to hold four components at a time. Thereafter mentioning our idea we discussed the weight criteria for the fixture and which was supposed to contain an ideal weight, which should be easily handled and at the same time should not have its own motion attached to it.

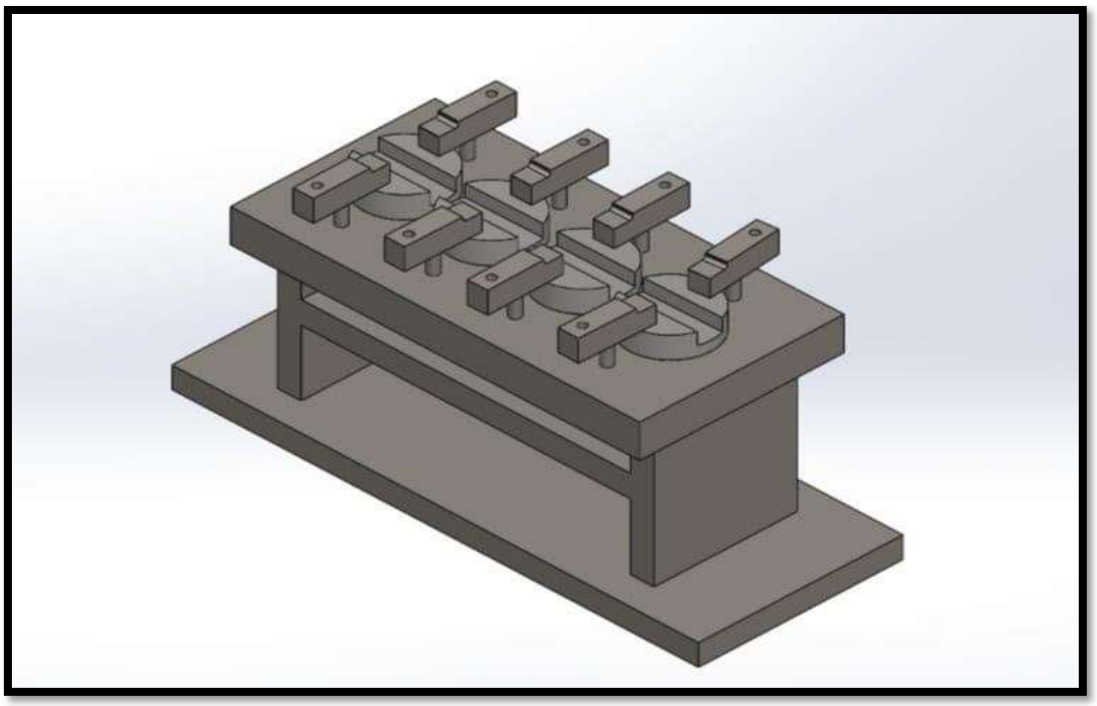

Fig.2 Fixture Design

B. design of the fixture without holding the ginning clutch

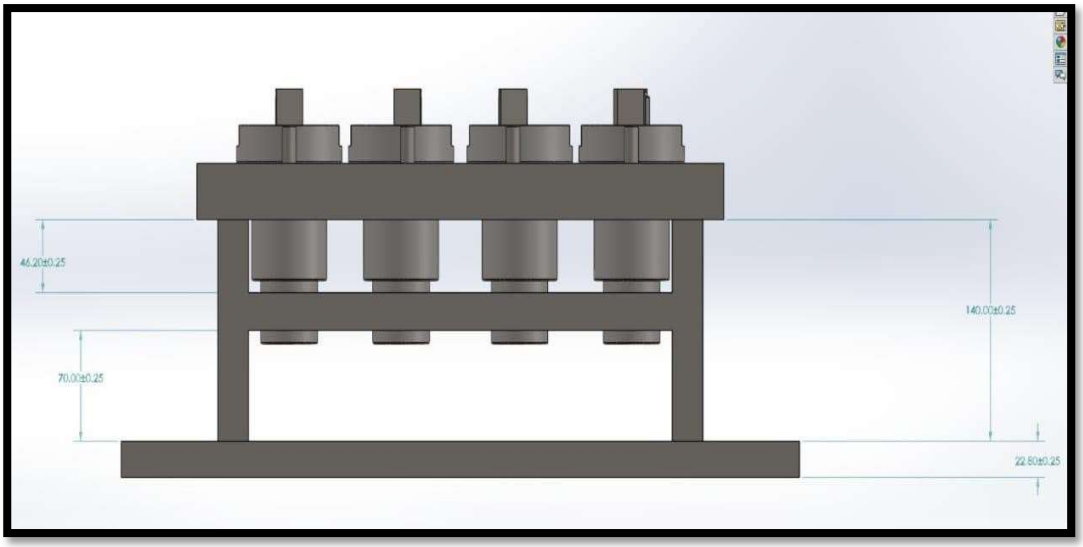

Fig.3 Front View of Fixture.

C) Force calculation

The force analysis was done on the following formula and information:

- Spindle speed (n): 2500 rpm
- Tool radius (r): 2500 rpm
- Spindle power(p): 1HP

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$$cutting\ force = \frac{63025 \times P}{n \times r}$$

$$= \frac{63025 \times 1}{2500 \times 0.5} = 50.42 \text{ lbs}$$

$$= 224.27 \text{ N}$$

CLAMPING FORCE =CUTTING FORCE × FACTOR OF SAFETY

$$= 224.27 \times 2$$

$$= 448.56 \text{ N}$$

4. Results and Discussion

SolidWorks software was used to do an analysis of the changed fixture design. We did a modal analysis and a force analysis. To verify that resonance does not arise during machining operations, a modal analysis was performed. During machining, it may create huge vibrations. The result obtained from modal analysis show as that rpm corresponding to natural frequency of fixture is much more than that of operating conditions, making the design safe for fabrication.

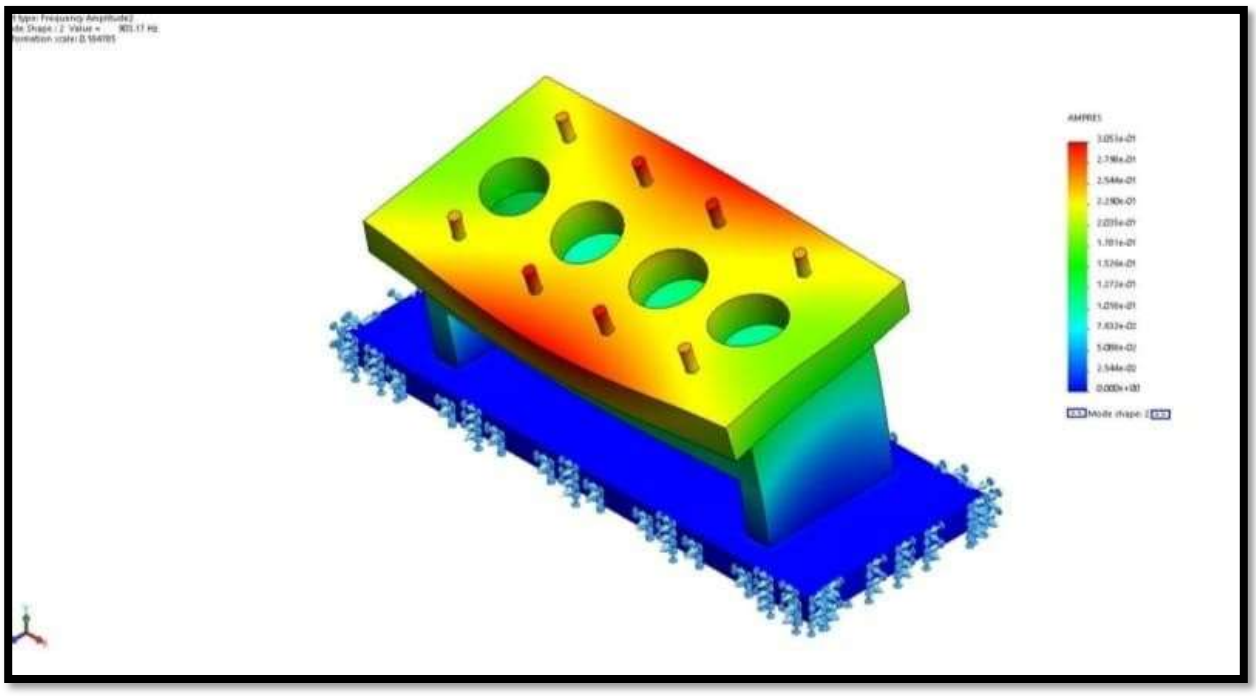

Fig.4 Modal analysis of fixture.

ISSN No.: 2455-6130

Special Issue: 2, 2022, pp. 109-115

Table-1. Modal analysis results

Frequency Number	Rad/sec	Hertz	Seconds
1	2986.3	475.28	0.002104
2	5674.8	903.17	0.0011072
3	5780.1	919.93	0.001087
4	6260.8	996.44	0.0010036
5	8342.4	1327.7	0.00075316

Plastic deformation of the fixture is regarded as a mode of failure since a change in the fixture's dimension would render it ineffective for production use. As a result, the Von Mises Stresses were calculated to quantify the yield stress on the fixture caused by the cutter's cutting operation.

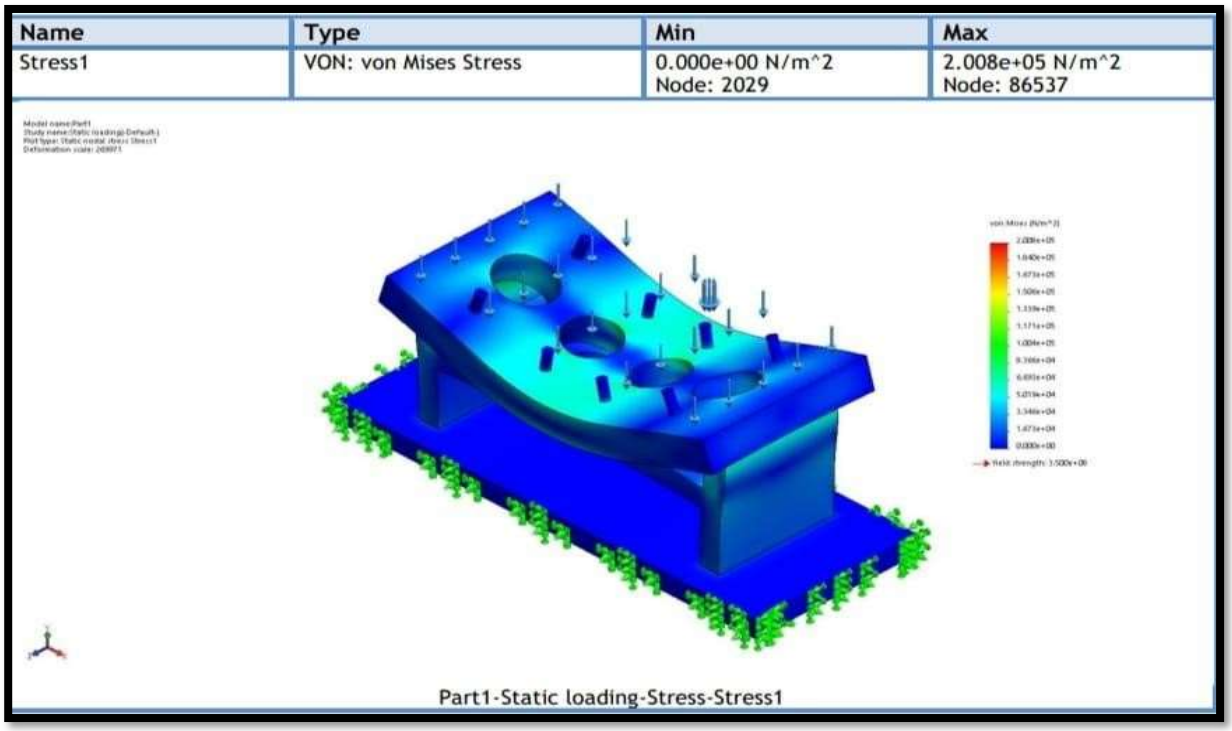

Fig.5.Stress analysis of fixture.

5. Conclusions

Fixture design is an integral part of the manufacturing process. The demand for a ginning clutch fixture was met in this project by employing design ideas such as the stress and modal analysis, and so on. Solidworks was used to design and analyse a modular fixture. Fixture design proposed was found to be safe and be manufactured.

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