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Design and Manufacturing of Fixturefor Compressor Die Cast Body

Denish R. Vaghani[1], Jayesh V. Savaj[2], Vishal J. Rana[3], Shubham A. Vaghani[4], Krunal R. Virani[5]

[1,2,3,4,5] *Mechanical, Tapi Diploma Engineering College*

Abstract: During the Shodhyatra, we were gone to industries, where industry will planto start the machining on die cast compressor body on VMC machine butindustry has no fixture for this job. So, we are decided to make the fixture for compressor die cast body. Industry providesan un-machined componentto us. First of all, we have made 2D and 3D drawing with its dimensions in Pro-E software. The fixture design is based on the operation to be performed on the component. The number of operations performed on component is drilling, inside machining and cutting. Then after we were design the two fixtures for two positions in Pro-E software according to 3-2-1 principle and also make prototype for same.The details of the fixture such as its components, design considerations, procedure to fix a job and bill of materials have been specified.

Keywords- Fixture; Design; Compressor; Body; Vertical; Machining; Center; Pro-E, Prototype

I. INTRODUCTION

A fixture is a device for locating, holding and supporting a work piece during a manufacturing operation. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations. Fixtures must correctly locate a work piece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the devices must clamp and secure the work piece in that location for the particular processing operation. Fixtures are normally designed for a definite operation to process a specific work piece and are designed and manufactured individually. **[1]**

A cycle time is a time which involves the loading and unloading of the component, machining operations, tool changing and miscellaneous activities during the processing of the work piece. Compressor die cast body is mainly used in diamond industries.

II. DESIGN OF COMPRESSOR DIE CAST BODY

The model of compressor die cast body machined or un-machined had been design using solid modeling software "PRO-E". The design is prepare using the dimensions, specified in machining drawing provided by industry.

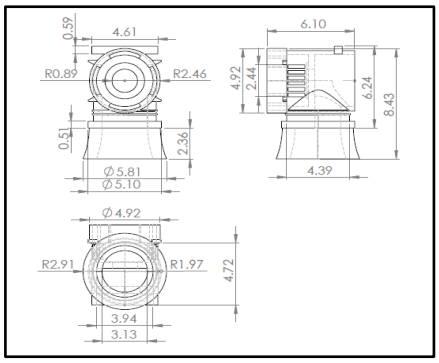

Fig. 1 2D drawing of Un-machined Component

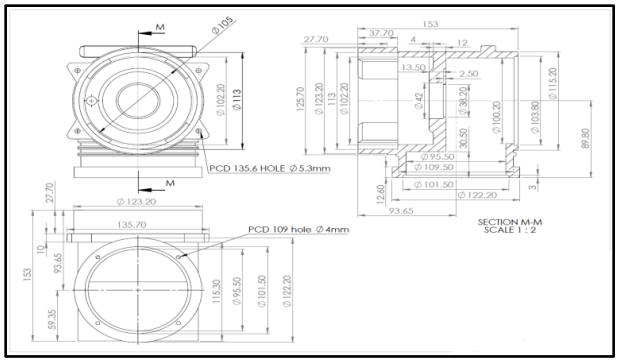

Fig. 2 2D drawing of Machined Component

III. FIXTURE DESIGN

For designing a fixture, various factors are to beconsidered as given below: -

- Component size and shape
- Locating elements
- Type and capacity of the machine
- Loading and unloading arrangement
- Clamping arrangement
- Clearance between parts
- Ejecting devices, table fixing arrangement, and the indexing device

3.1 (3-2-1) Principle of Fixture Design [2]

- For designing a fixture, a major time is spent in deciding how to locate the work piece in the fixture. It is known that any free body has 12 degrees of freedom, six translational and six rotational along X, Y and Z axis. In order to locate the work piece in the fixture, 9 degrees of freedom excluding three translational (-X, -Y and -Z) are to be fixed.

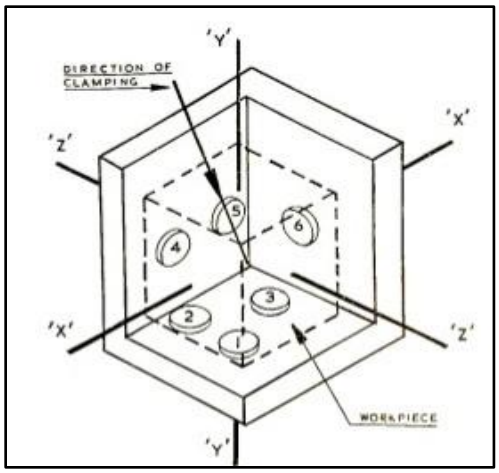

Fig. 3 (3-2-1) Principle of fixture design

- The work piece is rested on three non-collinear points of the bottom surface (XY), by which +Z, CROT-X, ACROT-X, CROT-Y and ACROT-Y degrees of freedom are fixed.
- The +Y and ACROT-Z degrees of freedom are fixed by resting the work piece at two points of the side surface (XZ).
- The +X and CROT-Z degrees of freedom are fixed by resting the work piece at one point of the adjacent surface (YZ). Hence the 9 degrees of freedom has been fixed.

The following figures show the 3D model of the fixture design. The suitable material of the fixture is mild steelbut during the prototype, we select the material of wood. The components, assembly, bill of materials and tools used during the machining have been explained below:

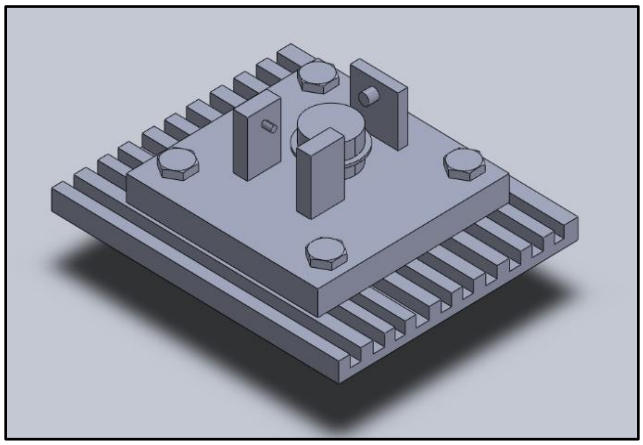

Fig. 4 3D Model of Fixture-1

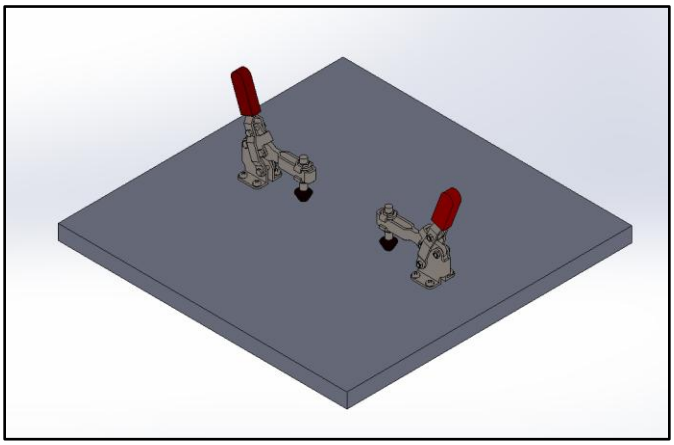

Fig. 5 3D Model of Fixture-2

3.2 Components of the Fixture-1

3.2.1 Base plate:

The base plate is the supporting component of the fixture providing stadiness to the job. Base plate is fixed on vmc table. support plate is welded on base plate.

3.2.2 Stand of Job:

It is a main part of this fixture. Component is fixed on stand. Stand of job is fixed on base plate. Job stand diameter is smaller than component inner diameter so component is rest on stand and after support plate is catches the job with bolt tightly.

3.2.3 Support Plate with Bolt:

It is a plate which provides to support a component tightly. Three support plates are used in this fixture. Three flexible bolts in support plate for tight the component. Support plate is fixed on base plate.

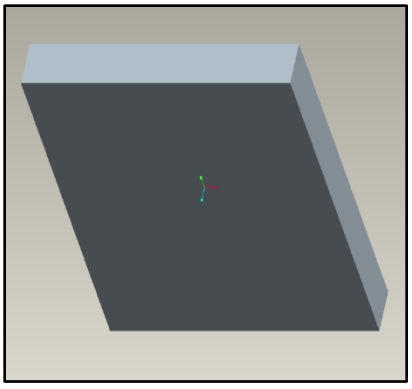

Fig. 6 Base Plate

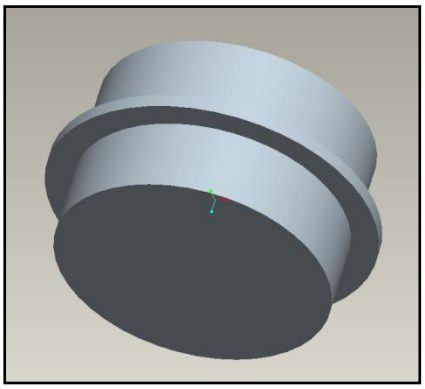

Fig. 7 Stand of Job

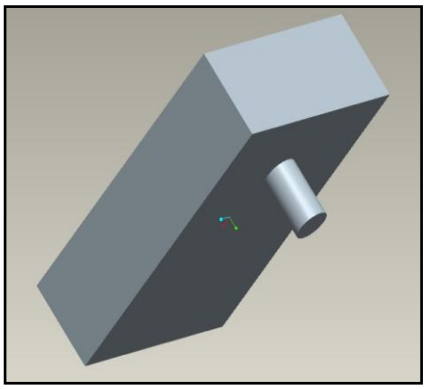

Fig. 8 Support Plate with Bolt

3.2.4 Fasteners:

The fasteners consist of bolts and nuts of size M10.

Fig. 9 Bolt

Fig. 10 Nut

3.3 Components of the Fixture-2

3.3.1 Base plate:

The base plate is the supporting component of the fixture providing stadiness to the job. Base plate is fixed on vmc table. Toggle clamp fixed on base plate at certain distance with the help of screw.

3.3.2 Toggle clamp:

The clamp can be used for both light- and heavy-duty applications. It is commonly used to hold workpieces in woodworking tasks, such as sawing and drilling. There are different types of toggle clamps available, some of which push down on a workpiece, while others push forwards.

3.3.3Screw:

A screw is a mechanism that converts rotational motion to linear motion, and a torque (rotational force) to a linear force. It is one of the six classical simple machines. The most common form consists of a cylindrical shaft with helical grooves or ridges called threads around the outside.

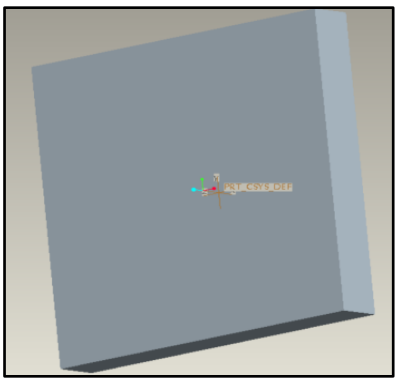

Fig. 11 Base Plate

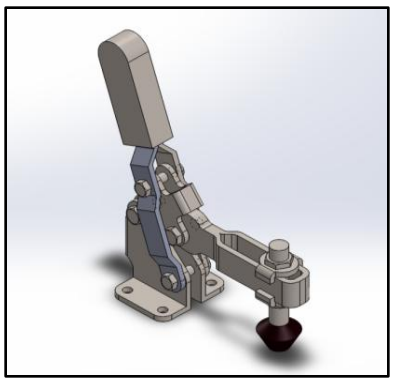

Fig. 12 Toggle Clamp

Fig. 13 Screw

3.4 Procedure to Fix a Job on Fixture 1:

First of all, mount the job on stand. Then, fix the support platefrom side of job for proper mounting of the job by fasteners.

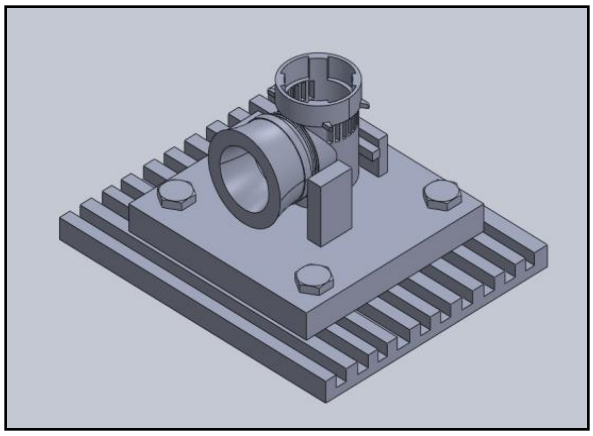

Fig. 14 Fixture 1 with Component

3.5 Procedure to Fix a Job on Fixture 2:

First of all, mount a job vertically on base plate.Then after fixtwo toggle clamps on the work piece. Toggle clamp is fixed with screw on base plate.

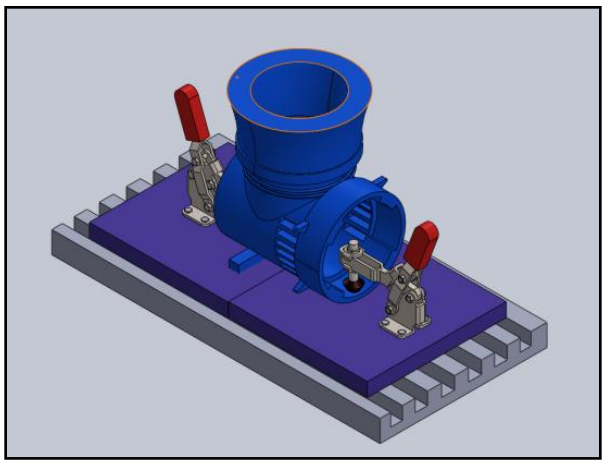

Fig. 15 Fixture 2 with Component

3.6 Material Considerations:

The material used for all the components of the fixture is Mild steel as it is of considerable strength which is sufficient for the machining operations. Also, the work piece is of die cast aluminum, hence mild steel is the best option. Moreover, Mild steel has also been selected considering the costing.

3.7 Bill of Materials:

The bill of materials is a tabular representation of the components used in assembly and the quantities of the corresponding components.

Table 1 Bill of Materials for Fixture 1

SR NO	COMPONENTS	MATERIAL	QTY.
1	Base plate	Mild Steel	1
2	Stand of Job	Mild Steel	1
3	Support Plate 1	Mild Steel	1
4	Support Plate 2	Mild Steel	2
5	M10Bolt	Std. High Tensile Steel	3
6	M10Nut	Std. High Tensile Steel	3

Table 2 Bill of Materials for Fixture 2

SR NO.	COMPONENT	MATERIAL	QTY.
1	Base Plate	Mild steel	1
2	Toggle Clamp	Stainless steel, carbon, rubber	2
3	Screw (M3 size)	Stainless steel	8

IV. PROTOTYPE (WOODEN MATERIAL)

Fig. 16 Component in Fixture-1

Fig. 17 Component in Fixture-2

V. MACHINING OPERATIONS WITH SPECIFIED TOOLS

4.1 Tools:[3]

The following tools have been used during themachining operations of component.

For Machining of Job in Fixture 1:

- Drill tool: - For drilling operation of diameter 5.3 mm
- Milling cutter: - For cutting purpose in full length of last part of the body.
- Surface Grinder: - For internal machining operation.

For Machining of Job in Fixture 1:

- Drill tool: - For drilling operation of diameter 4 mm

4.2 Machining Operations in Fixture-1:

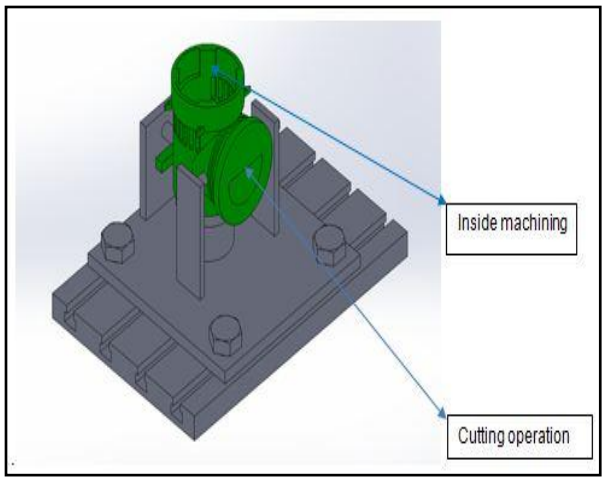

Fig. 18 In-side Machining & Cutting

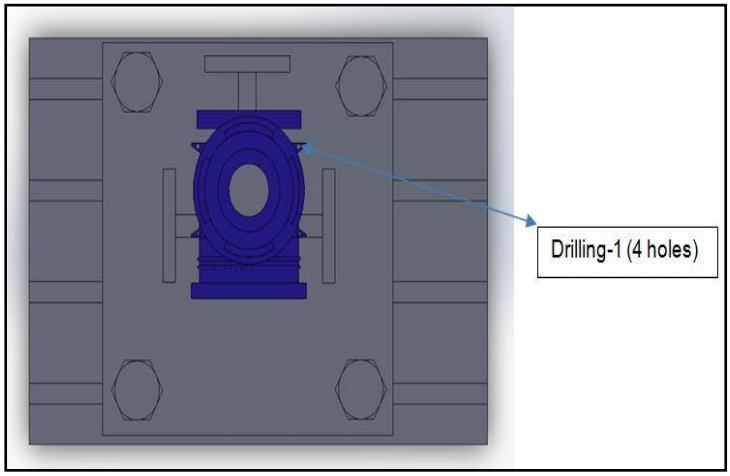

Fig. 19 Drilling-1

4.2 Machining Operations in Fixture-2:

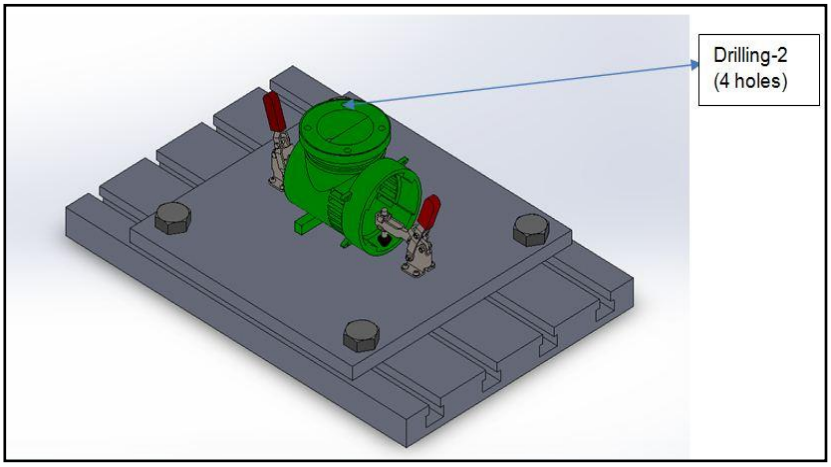

Fig. 20 Drilling-2

VI. CONCLUSION

- The fixture has been designed such that all the operations can be done in two fixtures.
- The fixture in manufacturing industries is very useful that reduces the worker fatigue and provides higher degree of freedom of operator safety by reducing.
- The total cycle time for all the machining operations in both fixtures is 7 minutes and 55 seconds.

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[2] Harin N. Prajapati, Krishnan R., Vishal J. Rana, "Design of a Machine Fixture for a Shifting Fork for Minimum Cycle Time for Machining Operations in Vertical Machining Center", IJAREST

[3] Workshop technology by B.S. Raghuvanshi