DESIGN AND ANALYSIS OF FIXTURE FOR A BEARING PLATE

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Abstract - In machining fixtures, the deformation that can happen in the work piece due to clamping and cutting forces is essential to be minimized to maintain the machining accuracy. The design of fixtures plays major role in many manufacturing industries, so that it should be done with very much care. This can be achieved by selecting the optimal location of featuring elements such as locators and clamps. The fixture set up for component is done manually. For that more cycle time required for loading and unloading the material. So, there is need to develop system which can help in improving productivity and time. Fixtures reduces operation time and increases productivity and quality of operation.

***Key Words*: *Key Words*:** Design of fixture, Analysis of fixture

1. INTRODUCTION

The project we have undertaken is to design a fixture for a bearing plate component. The main objective of our project is to design a fixture so that machining will be done at a faster rate, as the shape of component is somewhat complicated, so the loading and unloading will be easier.

1.1. FIXTURE:

Fixture are production tools which are used to hold the components. It facilitates easy assembly and will reduce the production cost. The main purpose fixture is to hold the work piece during machining operation or some other industrial process example: chuck

1.2. FUNDAMENTAL DESIGN PRICIPLE OF FIXTURE:

1.2.1. REDUCE IDLE TIME: The first and foremost thing in designing the fixture is to reduce the idle time

1.2.2. LOCATING POINTS: Certain parts may be complicated in its shape and it is not possible to hold the component with normally used holding device, so a special holding device is necessary to hold the complicate shaped components.

1.2.3. FOOL PROOF: Fixture helps to machine the component in its position exactly where necessary.

1.2.4. MATERIAL FOR FIXTURE: Usually fixtures are made of Mild steel, High Carbon Steel, High Speed Steel, etc.

1.3. TYPES OF FIXTURE:

- Vise fixture
- Milling fixture
- Boring fixture
- Facing fixture
- Turning fixture
- Grinding fixture

1.4. MATERIALS USED FOR FIXTURE:

S.NO	PART NAME	MATERIAL
1	Body	CI
2	Stud	MS
3	Bush	Gun Metal
4	Pin	MS
5	Nut	MS

1.5. ADVANTAGE:

- Alignment of a part or work piece
- Maintain or improve part quality
- Increase productivity
- Reduce the cost of production
- Improve overall safety

2. LITERATURE REVIEW:

Nirav.P.Maniar and Dr.P.Vakharia[1] have focused On Design and development of Rotary fixture for CNC with computer aided mass balancing method as a pre-mortem tool. On accomplishing this project they have saved 10 million rupees in installation cost. They have also covered analytical analysis of dynamic machining. Pasquale Franciosa, Salvatore Gerbino and Darek Ceglerek[2] introduces the novel concept of fixture capability measure to determine fixture layout for the best assembly process yield by optimizing position of locators and reference clamps to compensate stochastic product variations and part deformation. Corrado Andrea, Polini Wilma and Moroni Giovanni[3], have done a work to investigate how the geometric errors of a machined surface are related to the main sources of the locator errors and to the form deviations of the work piece. A mathematical framework is presented for an analysis of the relationship among the manufacturing errors, the part form deviations, and the locator errors. Abhishek Das, Pasquale Franciosa and Darek Ceglarek[4] had worked together that aim at fixture layout optimization of single ideal parts. This paper presents a new approach to improve the probability of joining feasibility index by determining an N-2-1 fixture layout optimized for a production batch of non-ideal sheet metal parts. Kiran Valandi, M.Vijaykumar, Kishore Kumar S [5], have Designed, Developed, Fabricated and Analyzed fixture and computed the results. Their dissertation work aims at designing a fixture used for performing machining operations at certain angle (102.5 degree) on the Crank case used in commercial vehicles. N. P. Maniar, D. P. Vakharia[6] have done work where they explains Various areas related to design of fixture are already been very well described by various renowned authors. This section reviews some of the developments in fixture design and proposes directions for future research initiatives. Shailesh.S.Pachbhai, Laukik.P.Raut [7], have worked to make a review on fixture. In their work they have discussed about various methodology used for clamping. They have concluded that there is need to develop system which can help in improving productivity and time. Fixtures reduce operation time and increases productivity and high quality of operation is possible. Heidar Hashemi, Awaluddin Mohamed Shaharoun, Izman S.[8], have done a review of recent approaches for fixture designing guidance. The significant techniques used in this field along with their applications, criteria and assumptions are also considered. The shortcomings of the existing research studies are stated and some issues pertaining to handling the weaknesses of the current research are suggested to be hopefully taken into account in future research.

3. FIXTURE DESIGNING

3.1. COMPONENT FOR WHICH FIXTURE IS TO BE DESIGNED:

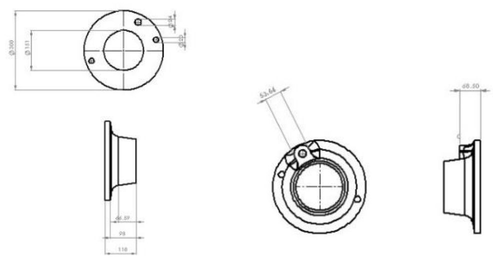

Table 3.1 SPECIFICATION OF THE COMPONENET

Material	Cast iron
Density	7200 Kg/m^3
Expected weight	15077.02 grams
Volume	2094030.83 cubic millimeter
Surface area	230891.47 square millimeter
Tensile strength	151.66 N/mm^2
Compressive strength	572.17 N/mm^2

3.2SELECTION OF FIXTURE MATERIAL

For fixture, one of the important consideration is material selection for fixture. Phosphor Bronze, Die steel, High Speed Steel, Carbon Steel and Mild Steel are the most commonly used materials for fixture.

Since the material to be machined is Cast iron, for cast iron material is enough to use Mild steel for fixture. The strength of Mild steel is enough to withstand the force developed.

3.1.1. REASON FOR SELECTING MILD STEEL

- Cheap
- Easy availability
- Enough strength to withstand the load

3.3. CALCULATION

Drilling is to be carried on the component. The force that develop due to the operation may cause some damage on the fixture. So it is necessary to consider the force developed.

Drilling machine specification is tabulated below,

SPECIFICATION	
Drilling machine Motor power	1.5 hP
Rated speed	1600 rpm
Gear ratio	2:3

Output speed i.e., spindle speed : 1066.66 rpm

$$\text{cutting speed} = \frac{\pi DN}{1000}$$

$= \pi*1066.66*24/1000$

$= 80.4242$ m/min

Feed rate = Feed * rpm

From design data book, refer page 12.22 for drill size of 25mm

Feed= 0.25 to 0.325mm

Taking feed as 0.3mm

Feed rate $= 0.3 * 1066.66$

$= 319.998$ mm/min

Material removal rate = feed rate * cross section area

$= 319.998 * \pi/4 * 24^2$

$= 144763.6847$ mm^3/min

$$\text{cutting time} = \frac{\text{volume}}{\text{MRR}}$$

$= \pi/4 * 24^2 * 20$

$= 0.062$ min

$= 3.75$ seconds

Cutting force required to drill on material = Shear area* Shear stress

For cast iron,

Tensile strength= 414 MPa

Shear strength= 80% of tensile strength

Shear strength= 331 MPa

Cutting force= 141.83 KN

3.4. FIXTURE MODELS

3.4.1. FIXTURE MODEL 1

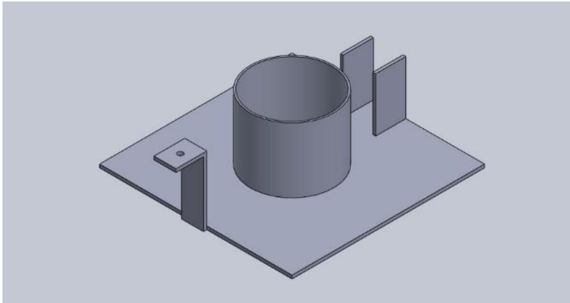

Fig 3.3.1(A) Fixture model 1

Table 3.3.1 SPECIFICATION OF FIXTURE MODEL 1

Mass	7.858 Kg
Volume	994783.08 cubic millimeter

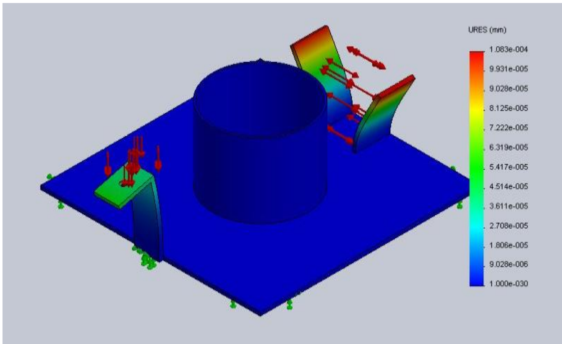

Fig 3.3.1(B) Displacement

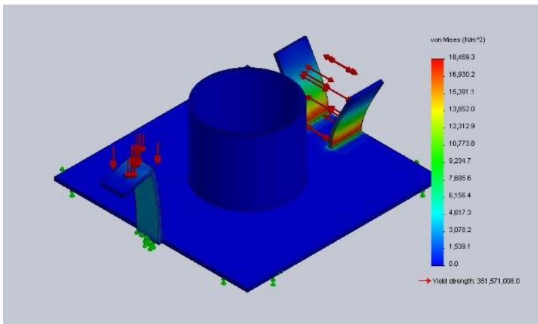

Fig 3.3.1(C) Von mises Stress

3.4.2. FIXTURE MODEL 2

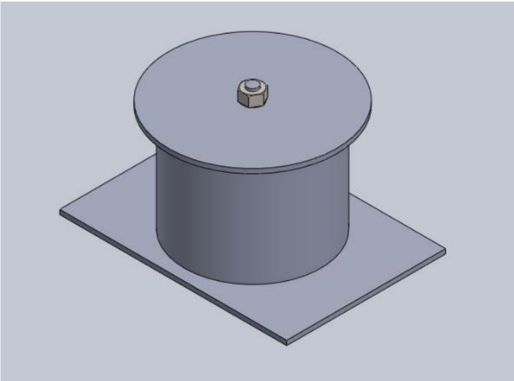

Fig 3.3.2(A) Fixture Model 2

Table 3.3.2 SPECIFICATION OF FIXTURE MODEL 2

Mass	4.203 Kg
Volume	535309.38 cubic millimeter

3.3.3 FIXTURE MODEL 3

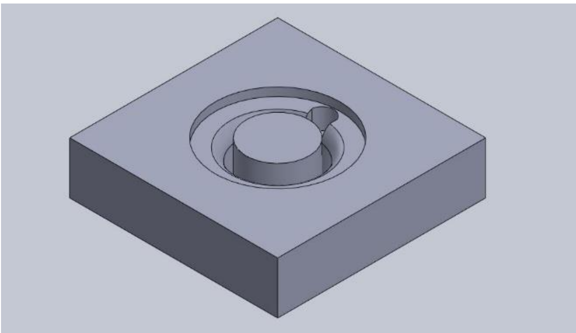

Fig 3.3.3(A) Fixture Model 3

Table 3.3.3 SPECIFICATION OF FIXTURE MODEL 3

Mass	231.271 Kg
volume	29268083.18 cubic mm

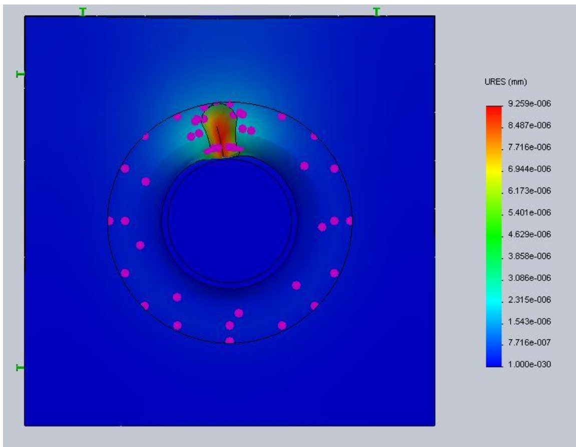

Fig 3.3.3(B) Dispalcement

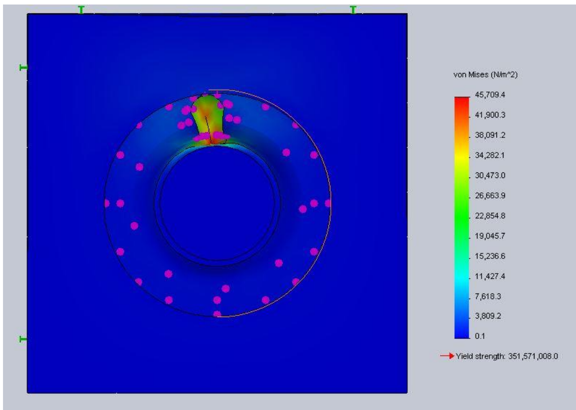

Fig 3.3.3(C) Von Mises Stress

For the bearing plate three fixture has been designed. For the designed component analysis has been done using solid works simulation. All the three of them will do the same work i.e, holding the component. But not all the three is useful as there is some constrains in manufacturing these fixtures. All the 3 fixture is made of mild steel and the dimension and the manufacturing procedure varies. Fixture model 1 and Fixture model 2 are manufactured by simple joining process of welding i.e, welding a hollow cylindrical body over a fixed plate. But the fixture model 3 is done by casting process. The fixture 3 is the most robust of all but it is difficult to do the casted component of the fixture and machine that for a greater accuracy.

4. RESULT AND DISCUSSION

Fixture plate 1 fails when the cutting force exceeds the limiting value as it can be seen from the analyzed results. The fixture cannot withstand if the cutting force is greater than 15KN.

Fixture 3 is heaviest ever design among all. Moreover manufacturing process of fixture 3 is tedious than the other 2. Cost of production of fixture is also high. The strength of this fixture is tremendous, as it can withstand the cutting force of upto 200KN.

Fixture 2 can withstand the stress produced due to the cutting force and also cost of production is acceptable.

5. CONCLUSION:

While considering weight among the three fixtures, fixture 3 is heavier than the other two, as it is casted component and there is no way to reduce its weight. Since the weight is very high and in turn it will make the cost of production to exceed than other two fixture. But while considering the strength fixture 3 will possess more strength than other two. But while considering the ease of production its sure that fixture 3 must not be selected.

Fixture 3 is rejected, on the other two fixture, fixture 2 is having more strength than the fixture 1. So it is good to choose fixture 1 among the three. So fixture 2 is the desired fixture for the component to be machined.

ITEMS	**FIXTURE 1**	**FIXTURE 2**	**FIXTURE3**
WEIGHT	Acceptable	Acceptable	Over weight
COST	LOW	LOW	HIGH
STRENGTH	Low	Required	High
EASE OF PRODUCTION	Easy	Easy	tedious

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