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# Productivity Enhancement through Design and Development of Milling Fixture

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***Abstract*— Fixture are work holding devices used to manufacture duplicate parts. Mass production aim at high productivity to reduce unit cost and interchangeability to facilitate easy assembly. Fixture is used for locating and holding the work piece during machining operation. Fixture does not have provision to guide the cutting tool. Fixture is designed for a particular work. Fixtures have various applications according to their purpose. Fixture reduces the operation time and increase productivity and high quality product can be produced. Fixtures can reduce non productive time during manufacturing process. Aim of this project is to design and development of a milling fixture which is used for chamfering purpose CAD model prepared using AUTOCAD and AUTO DESK INVENTOR. Machining operation performed with fixture and without fixture. Observed that setting can be reduced by using milling fixture which can increase productivity.***

***Index Terms*—Fixture. Cad, Auto Desk Inventor, Productivity.**

## I. INTRODUCTION

Mass production always pointing towards increasing quality and productivity. Generally fixtures always increase repeatability avoiding marking; punching and checking in individual workpieces.Fixtures are used to hold and locate the work piece and also make a correct relationship between cutters.

Aim of a fixture is to increase the productivity in manufacturing. Fixture is a production tool that locates hold and support the work securely so the required machining operations can be performed. Set blocks and feeler or thickness gauges are used with fixtures to reference the cutter to the work piece. Fixture mainly consist locating element and clamp. Locating element accurately maintains dimensional and positional relationship between the work piece and cutting tool. Locator is the device which is used for that purpose. Clamping devices are used to securely hold the position of the part against the locator throughout the machining cycle.

Various solid modeling packages are available in order is to easy model the fixtures. Auto Desk inventor is a basic level software package available. 2D and 3D design of the milling fixture make easy understand for various functions of each components of a fixture.

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Fixture basically increases productivity in manufacturing process by reducing setting time avoid individual marking and checking of each work piece. Percentage of increasing productivity can be analyzed be measuring time taken for machining work piece with and with out fixture.

## II. METHODOLOGY

Methodology is the most important element to be considered to make sure the fluent of the project and get expected result.

In other words methodology can be described as a frame work. Where it contains elements of work based on objectives and scope of the project. A good frame work can get overall view of the project and get the data easily. This includes literature survey 2D and 3D modeling of Milling fixture and development of milling fixture.

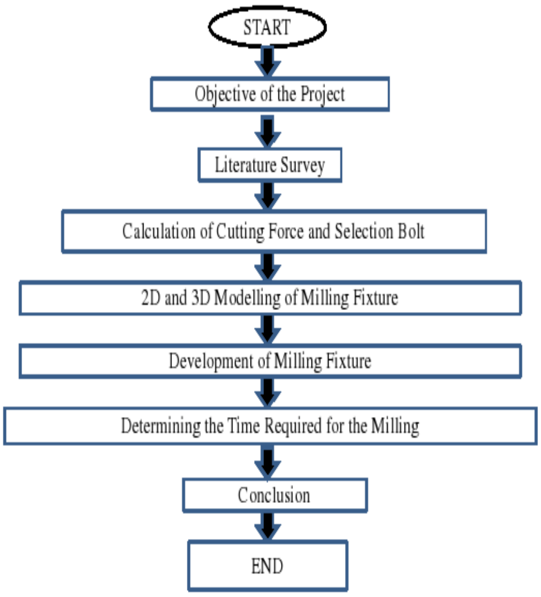


**Fig: 1 Block diagram of Methodology**

## III. LITERATURE REVIEW

### *A. Main Parts of Fixture*

Fixture base: Fixture base hold the entire part of the fixture.

Locating element: Locating element is used to locate the work piece correct relationship with cutting tool.

Clamping element: Clamps are used to hold the work piece against locating surface and prevent all disturbing forces.

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Fool proofing element: Fool proofing element prevent work being loaded wrongly in the fixture.

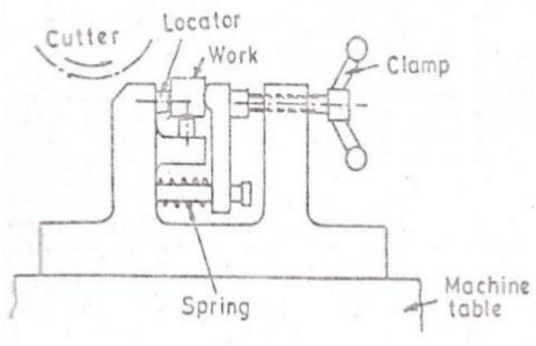


**Fig: 2 Part of Milling Fixture**

### *B. Principles of Location*

1. Location has to meet dimensional requirements of the work piece stated on the component drawing.
2. Location should be done on the most accurate surface of the work piece
3. Location should prevent linear and rotary motion of the work piece along and around the three major axes X ,Y and Z
4. Location should facilitate easy and quick loading of the work piece in the fixture.
5. Redundant or duplicate location should be avoided
6. The location should positively prevent wrong loading of the piece in a fixture by fool proofing.

### *C. Principles of clamping*

1. Clamp should be position to direct the clamping force on strong part of the work piece.
2. Clamping system does not obstruct the path of loading and unloading the work piece.
3. Clamp should not obstruct the path of cutting tool.
4. Clamping system should be capable of holding the work piece securely against the force developed during operation.
5. Clamping force does not bend or damage the work piece with excessive pressure.
6. Clamp can be tightened or loosened manually without using spanner.
7. Clamps are operated from front of operator
8. Consider operator fatigue.
9. Simple clamps are always preferred than complicated clamps
10. When cam or wedge clamp are used the designed in such a way that clamp should tightened due to vibration.

### *D. 3-2-1 Principle*

An unrestricted object is free to move in any of twelve possible direction as shown in figure .An object is free to revolve around or move parallel to any axis in either direction.

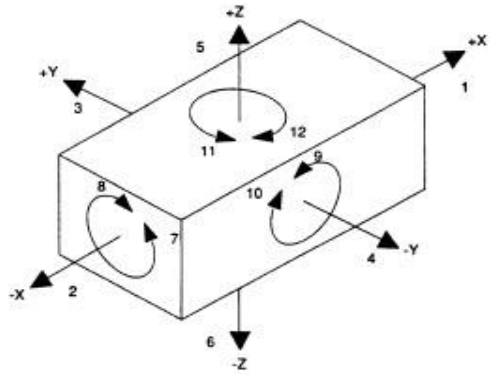


**Fig: 3 Twelve degree of freedom**

To accurately locate a part in a fixture movement must be restricted. This is done locators and clamp. By placing the part on a three –pin base, five direction of movement (9, 10, 8, 7 and 6) are restricted.

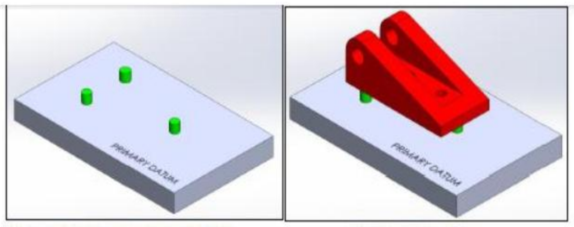


**Fig: 4 Primary Locations**

To restrict the movement of the part around the z-z-axis and in direction (11 and 12) and direction along three two more pin are located as shown in figure

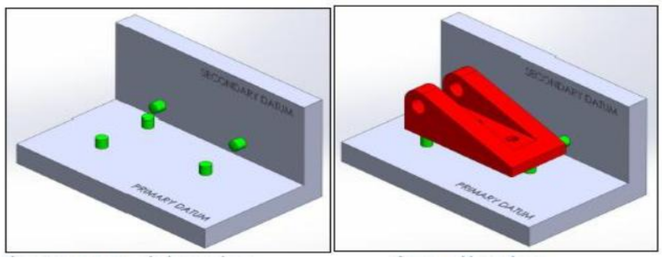


**Fig: 5 Secondary Locations**

To restrict direction two a single pin locator is used as shown below

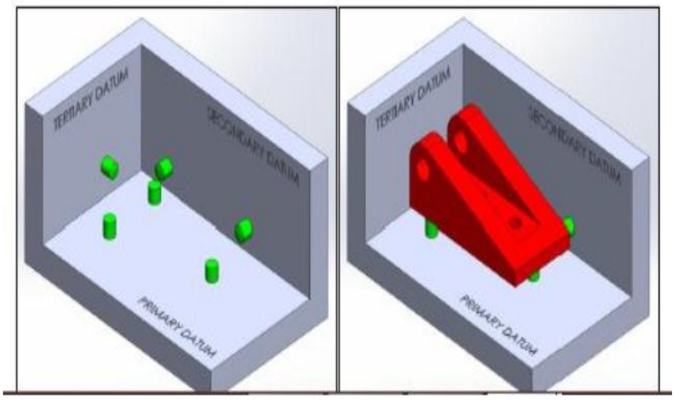


**Fig: 6 Tertiary Locations**

The remaining five one and four are restricted by a clamping device.

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### *E. Types of locator*

*1*. Flat Locator: Flat locators are used for location of flat machined surfaces of the component.

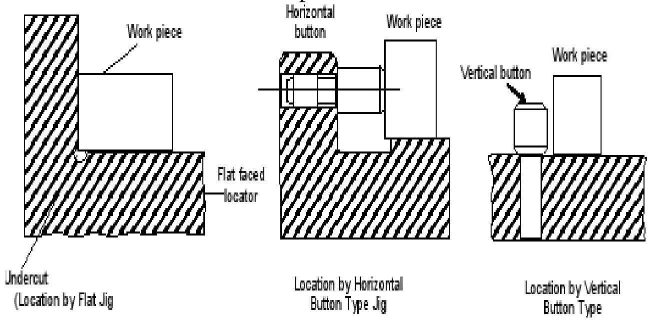


**Fig: 7 Flat locator**

2. Cylindrical Locators: A cylindrical locator is is used for locating components having drilled hole.

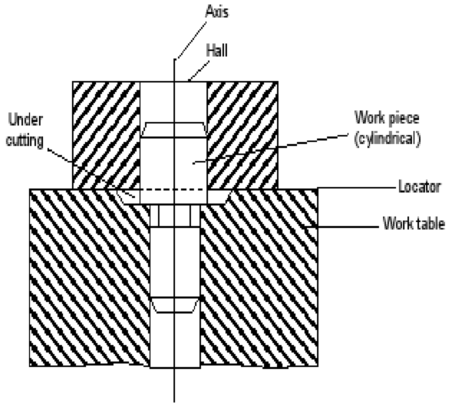


**Fig: 8 Cylindrical locator**

3. Conical Locator: This is used for locating the work pieces having cylindrical hole in the work piece. The work piece is found located by supporting it over the conical locator inserted into the drilled hole of the work piece. A conical locator is considered as superior as it has a capacity.

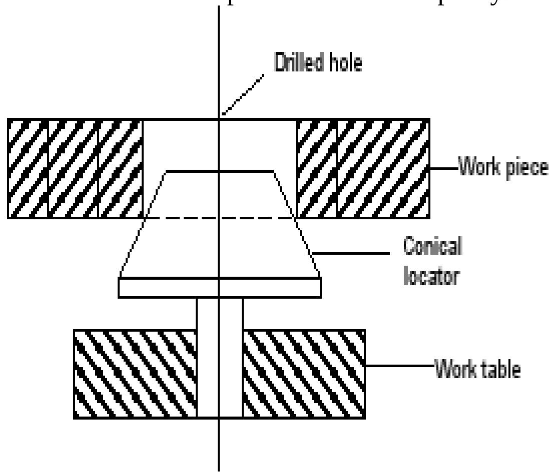


**Fig: 9 Conical locator**

4. Jack Pin Locator: Jack pin locator is used for supporting rough work pieces from the button. Height of the jack pin is adjustable to accommodate the work pieces having variation in their surface texture. So this is a suitable method to accommodate the components which are rough and un-machined.

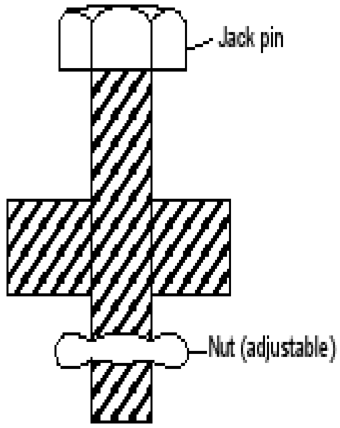


**Fig: 10 Jack pin locator**

5. V Locators: This is quick and effective method of locating the work piece with desired level of accuracy. This is used for locating the circular and semi-circular type of work pieces.

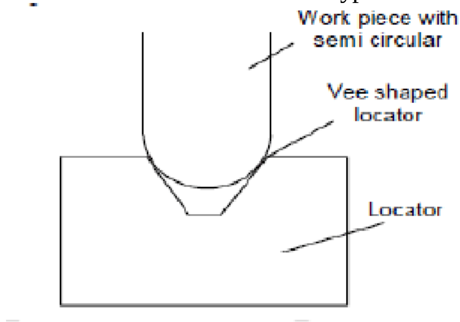


**Fig: 11 V locator**

### *F. Types of Clamps*

1. Strap Clamp: They are made of rectangular plate and act like lever. The clamp is tightened by rotating a hexagonal nut on a clamping screw.

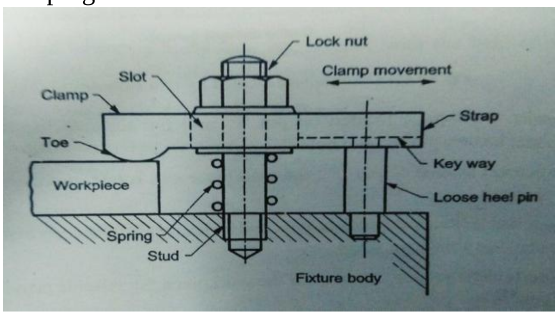


**Fig: 12 Strap Clamp**

2. Screw Clamp: It is also known as clamp screw. This clamping applies pressure directly on the side faces of the work piece. The clamping pressure largely depends on the work piece. it varies from one work piece to other. It is more time consuming and more efforts are required.

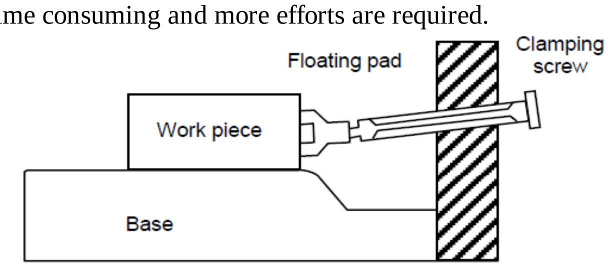


**Fig: 13 Screw Clamp**

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3. Latch clamps are used to clamp the work piece, the clamping system is normally locked with the help of a latch provided. To unload the work piece the tail end of the latch is pushed that causes the leaf to swung open, so releasing the work piece. Here time consumed in loading and unloading is very less as no screw is tightened but clamping pressure is not so high as in other clamping devices

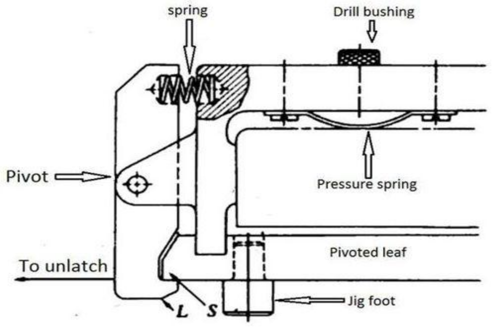


**Fig: 14 Latch Clamp**

4. Equalizing Clamps: It is recommended to apply equal pressure on the two faces of the work. The pressure applied can be varied by tightened or loosening the screw provided for the purpose.

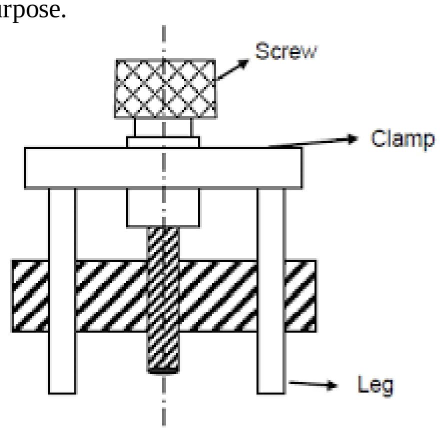


**Fig: 15 Equalizing Clamp**

### *G. Fixture Design process*

1. Set up Planning: Determine work piece orientation, Positions .Determine machining datum feature and locating surface.

2. Fixture planning: Determine locating position. Determine clamping surface. Determine clamping positions

3. Unit design: Generate a unit design.

4. Validation: Trail manufacturing based on modifications.

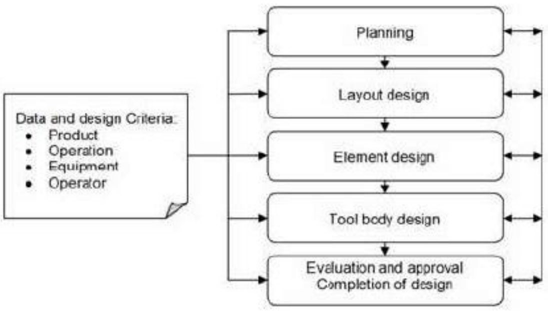


**Fig: 16 Fixture Planning Systems**

### *H. Fixture design consideration*

(a) Study of work piece and finished component size and geometry.

(b) Type and capacity of the machine, its extent of automation.

(c) Provision of locating devices in the machine.

(d) Available clamping arrangements in the machine.

(e) Available indexing devices, their accuracy.

(f) Evaluation of variability in the performance results of the machine.

(g) Rigidity and of the machine tool under consideration.

(h) Study of ejecting devices, safety devices, etc.

(i) Required level of the accuracy in the work and quality to be produced.

### I. *Material Used in Fixture*

a) High speed steel**:**
- These are used mainly for cutting tools such as drill, reamer and high milling cutters.
- These can be oil or air hardened to 66 RC. 18% tungsten to 22% tungsten. HSS also contains 4.3% chromium, 1.6% vanadium and less quantities of carbon, molybdenum.

b) Die Steel :
- These are used mostly for dies for hot or cold working. Cold die steels are used for press tools
- Cold die steels are used for press tools.
- Hot die steels are used for extrusion, forging and die-casting dies which are subjected to high temperature due to hot working.

c) Carbon Steel :
- These can be used for standard cutting tools.
- This steels can used for drill bushes, locators and other parts which are subjected to wear and need to be hardened.

d) Collet steels :
- These are spring steels which contain 1% carbon, 0.5% manganese and less quantity of silicon, collet steels can be oil/ water hardened to 47 RC

e) Non- shrinking tool steels **:**
- These steels are used widely for fine, intricate press tools.
- This is also called as high carbon 1 to 2 % of carbon or high chromium (4 to 12 %) steel.
- These steels distort little during heat treatment.

f) Nickel chrome steel **:**
- Used mainly for gears these steels contains 3 to 4% nickel, 0.6 to 1.1% chromium and less quantities of carbon, silicon and manganese.
- These can be case hardened to 61 to 63 RC. Alloy steels En 36 falls under this category.

g) High tensile steels:
- Used for mainly fasteners such as high tensile screws, these contain 0.4 to 0.6% manganese.
- These can be oil hardened to 45 to 50 RC steels En 9

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is high tensile steel.

h) Mild Steel **:**

- Used for most of the parts in fixtures, mild steels contain less than 0.3% carbon and 0.1 to 0.8% manganese steels.
- Generally all the parts which require no hardening are made of mild steel because it is the cheapest material available among steel

i)Cast Iron **:**

- Used for add shapes to some machining and laborious fabrication, CI usage require a pattern for casting.
- It can withstand vibration well and very suitable base bodies of milling fixtures.
- Self-lubricating properties of cast iron make it suitable for machine slide and guide way.

J) Phosphor Bronze:

- When screw operated clamps are worn out the screw as well as the nuts need to be replaced.
- Generally screw are longer and costlier then nuts.. So nuts are made of phosphor bronze which has high tensile strength.

## IV.IMPLEMENTATION WORK

Component Drawing (2D Sketch)

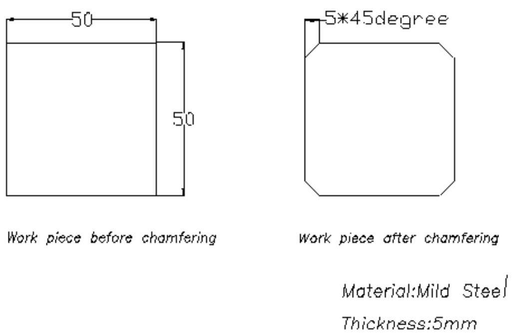



**Fig: 17 Component Drawing**

Component Drawing (3D Modeling)

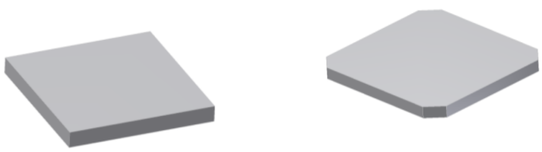


**Fig: 18 Components Drawing (3D Model)**

- Calculation of cutting force

Selection of clamping method: A strap clamp is selected.

Clamping Force: $\frac{4.5Kfd}{Cs}$

Assume feed (f) =75mm/Minute

For low carbon steel k=5

Depth of cut=5mm

Width of cut=4mm

Cs Cutting Speed=75mm/Minute

Cutting Force= $\frac{4.5x5x75x4x5}{75}$

=450N

M10 bolt selected.

- CAD 2D Sketch

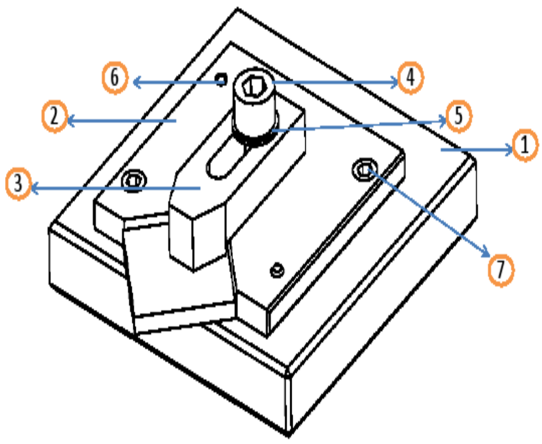


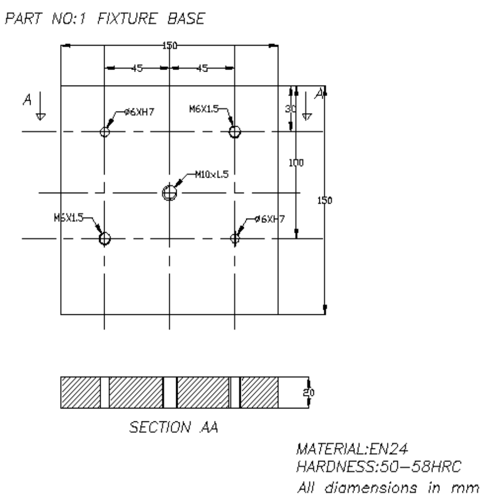

**Fig: 19 CAD 2D Sketch**

**Table 1: Bill of Material**

Bill Of Material

| SL NO | PART NO | MATERIAL | HARDNESS | QUANTITY |
|---|---|---|---|---|
| 1 | FIXTURE BASE | EN24 | 50-58HRC | 1 |
| 2 | V LOCATOR | EN24 | 50-56HRC | 1 |
| 3 | STRAP CLAMP | EN24 | 48-50HRC | 1 |
| 4 | M10 BOLT | STANDARD | | 2 |
| 5 | WASHER | STANDARD | | 1 |
| 6 | DOWEL PIN | STANDARD | | 1 |
| 7 | M6 BOLT | STANDARD | | 1 |

- ***Part Drawing***



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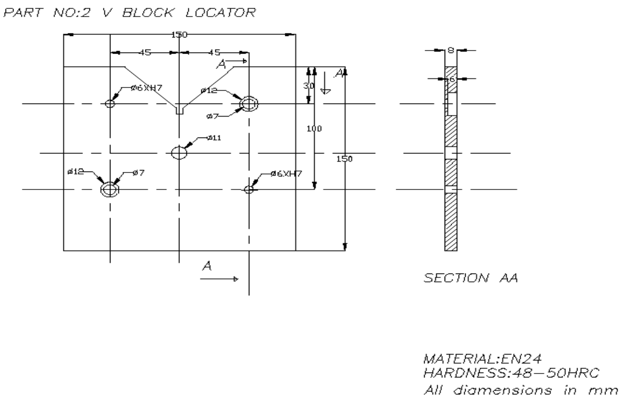


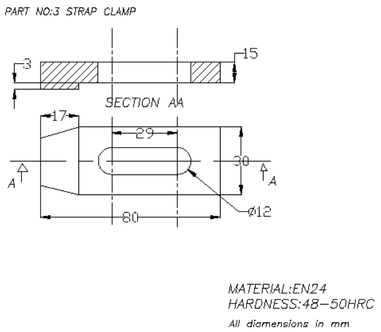


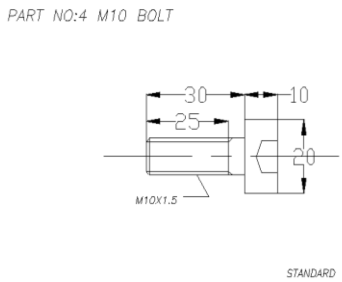


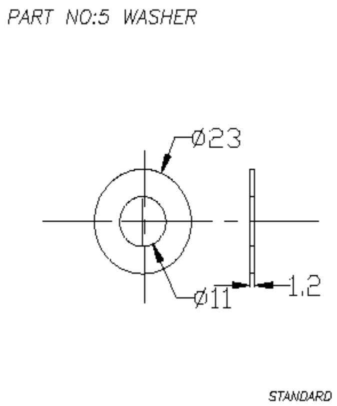


➢ ***Solid modeling of Milling Fixture.***

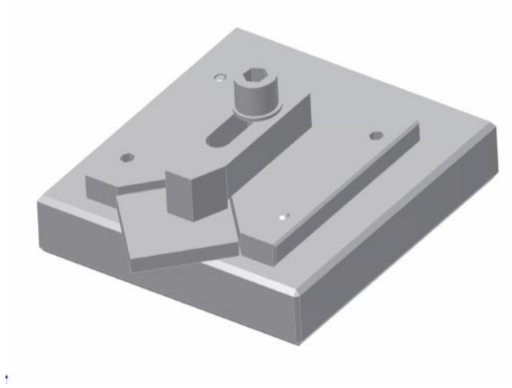

**Fig: 20 Solid Modeling of Fixture**

➢ ***Exploded view***

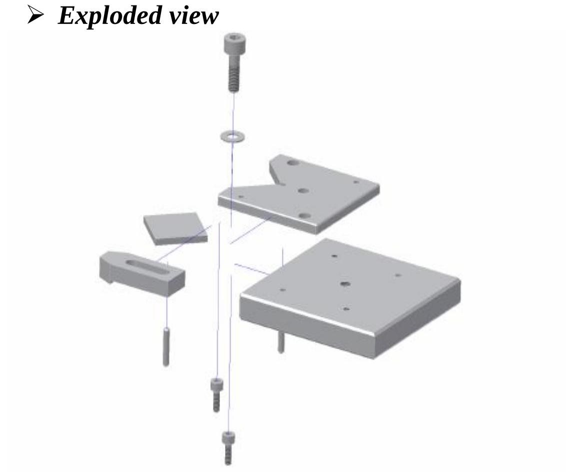

**Fig: 21 Exploded View**

➢ ***Fabrication of Milling Fixture***

Machining Operations

**Table 2: Machining Operations**

| SL NO | PART NO | MACHINING OPERATIONS |
|---|---|---|
| 1 | FIXTURE BASE | SHAPING ,GRINDING ,DRILLING,TAPPING,REAMING |
| 2 | V LOCATOR | SHAPING,GRINDING,DRILLING,COUNTER BORING,REAMING |
| 3 | STRAP CLAMP | SHAPING,DRILLING,GRINDING |
| 4 | M10 BOLT | STANDARD |
| 5 | WASHER | STANDARD |
| 6 | DOWEL PIN | STANDARD |
| 7 | M6 BOLT | STANDARD |

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- ***Milling fixture for chamfering***

***Work piece clamped on machine table without fixture***

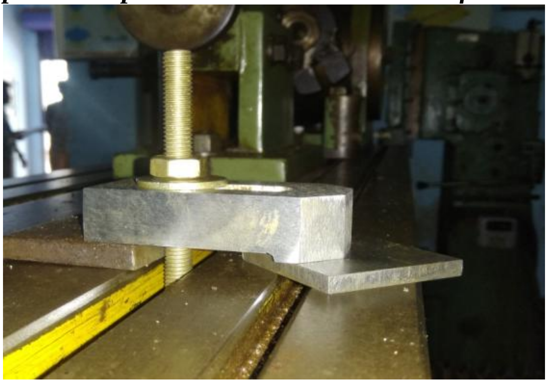

**Fig: 22 Work piece clamped on machine table without fixture**

***Work piece clamped on machine table with fixture***

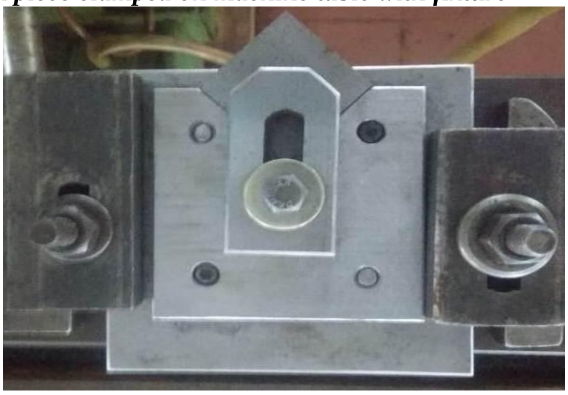

**Fig: 23 Work piece clamped on machine table with fixture**

***Milling fixture for chamfering***

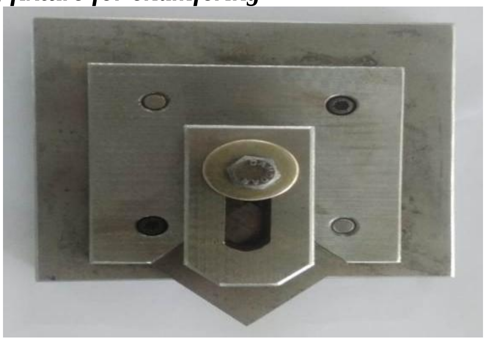

**Fig: 24 Milling Fixture for chamfering**

***Work Piece after chamfering using Milling Fixture***

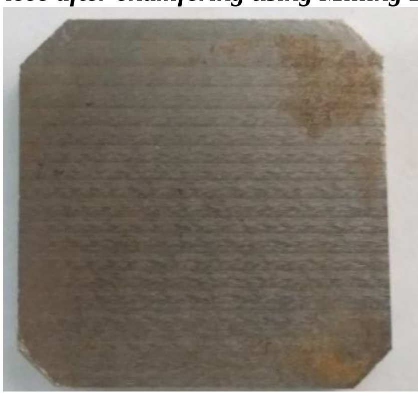

**Fig: 25 Work Piece after chamfering using Milling Fixture**

- ***Measuring Productivity***

Without using fixture

Setting time=4Minute

Machining Time=30Sec

Total Time= (240X4) + (30X4) =18 Minute

With Milling fixture

Setting Time=30 sec

Machining Time=30 sec

Total Time= (30x4) + (30x4) =4 Minutes

Time saving=18 Minute-4Minutes=14Minutes

## V. CONCLUSION

Productivity can be increased by using milling fixture. Setting time can be reduced Work setting time using fixture is 30seconds .This can reduce a time of 14 Minutes thereby increasing productivity.

## VI. FUTURE WORK

Analysis can be conducted over solid modeling in order to find out optimized sizes of different parts. Cutting force and clamping force can be taken in to consideration during analysis. Static analysis can be carried out to find out maximum deformation of work piece.

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## REFERENCES

[1] Amaral N Rencis JJ, Rong Y. Development of a finite element analysis tool for fixture design integrity verification and optimization. The international journal of advanced manufacturing technology 2005:25(5-6):409-19.

[2] Nandakumar K and Prabhakaran V (2014)."Design and Fabrication Testing of Multipurpose Jig and Fixtures" IOSR Journal of Mechanical and Civil Engineering.

[3] Shailesh S. Pachbhai, LaukikP.Raut, ―A Review on Design of Fixtures,‖ International Journal of Engineering Research and General Science, Volume 2, Issue 2, Feb-Mar 2014.

[4] Shrikant.V.Peshatwar, L.P Raut, ―Design and development of Fixture for eccentric shaft: A Review,‖ International Journal of Engineering Research and Applications, Vol. 3, Issue 1, February 2013.

[5] V. R. Basha, J. J. Salunke, ―An Advance Exploration on Fixture Design,‖ International journal of engineering research and application, Volume 5, Issue 6 (Part-3), June 2015.

[6] R. D. Makwana, N. D. Gosvani, ―A study on fixture design for complex part,‖ International journal of

futuristic trends in engineering and technology, Volume 1 (01), 2014.

[7] Kiran Valandi, M. Vijaykumar, Kishor Kumar S., ―Development, fortification and analysis of fixture,‖ International journal of innovative research in science, Volume 3, Issue 4, April 2014.

[8] A Review on Design of a Fixture for a Rear Cover: Sathyapal Vaghela Abishek Singh-2006.

[9] Vallapuzha Subramanian, De Meter EdwardC, Choudhuri Shabbir, et al. An investigation into the use of spatial coordinates for the genetic algorithm based solution of the fixture layout optimization problem. International Journal of Machine Tools and Manufacture 2002;42(2):265–75.

[10] Peng GL, Wang GD, Chen YH. A pragmatic system to support interactive modular fixture configuration design in desktop virtual environment. In: The 2008 IEEE/ASME international conference on advanced intelligent mechatronics. Xi'an (China); 2008. p. 19–24.