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Development and Design of Fixture for Face Milling Operation on Tool Shank

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ABSTRACT: Design of fixture is a very crucial step in the process of production. It plays a vital role at the set up planning of desired product. In existing fixture one work piece is mounted for performing face milling operation to have face angle. The aim of the project is to design and analysis of fixture which holds more than one tool shank (work piece) to carry out process which leads to increase in productivity and require minimum possible time to perform operation.

KEYWORDS: Tool Shank, Fixture, Wedge, Locator, Pin, Face Angle, Face milling.

I. INTRODUCTION

While manufacturing product a fixture plays an important role. It holds the work piece on which operations are to be performed. In order to manufacture precise product fixture should be designed properly. A fixture should be correctly fixed on machine upon which work is to be done. Though largely used on milling machine, fixtures are also designed to hold the work for various operations on most of the standard machine tools.

The fixture is a special tool for holding a work piece in proper position during manufacturing operation for supporting and clamping the work piece, device is provided frequent checking, positioning, individual marking and non-uniform quality is eliminated by fixture. This increase productivity and decrease operational time. In fixture locators also plays an important role to locate work in proper way and clamping exerts a clamping force on work piece, so that work piece pressure get matched to locators.

II. LITERATURE SURVEY

Shivaji Mengawade, Vaibhav Bankar, Pratik P Chaphale, "A Review on Design and Analysis of Work Holding Fixture" It reduces or sometimes eliminates the efforts of marking, measuring and setting of work piece on a machine and maintains the accuracy of performance. The work piece and tool are relatively located at their exact positions before the operation automatically within negligible time. So it reduces product cycle time. Variability of dimension in mass production is very low so manufacturing processes supported by use of jigs and fixtures maintain a consistent quality. Due to low variability in dimension assembly operation becomes easy, low rejection due to less defective production is observed. It reduces the production cycle time so increases production capacity.

Shailesh S.Pachbhai, Laukik P.Raut, "A Review on Design of Fixtures" The efficiency and reliability of the fixture design has enhanced by the system and the result of the fixture design has made more reasonable. To reduce cycle time required for loading and unloading of part, this approach is useful. If modern CAE, CAD are used in designing the systems then significant improvement can be assured. To fulfill the multifunctional and high performance fixturing requirements optimum design approach can be used to provide comprehensive analyses and determine an overall

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optimal design. Fixture layout and dynamic clamping forces optimization method based on optimal fixture layout could minimize the deformation and uniform the deformation most effectively .

III. PROBLEM STATEMENT

To produce angle on a tool shank a properly designed fixture should require. Fixture should be designed by considering productivity, time, ease of loading and unloading, accuracy etc. So, the aim is to develop and design the fixture for face milling operation on tool shank which interns increases accuracy of angle, ease of loading and unloading and increases productivity.

IV. OBJECTIVE

The aim of this project is to reduce the problem occurs during the manufacturing of tool shank. The aim can be achieved by objective further.

- Reduce operator fatigue.
- Reduce labour time.
- Machining time decreases.
- To save energy.
- Efficiency of process will increase.
- Improve occupational health.
- Improve accuracy by properly designing fixture.
- To increases Productivity.
- To effective use of man, machine, material (3M)

V. MEANING AND PRINCIPLE OF LOCATION

The location refers to the establishment of a desired relationship between the work piece and the jigs or fixture correctness of location directly influences the accuracy of the finished product. The jigs and fixtures are desired so that all undesirable movements of the work piece can be restricted. Determination of the locating points and clamping of the work piece serve to restrict movements of the component in any direction, while setting it in a particular pre-decided position relative to the jig. Before deciding the locating points it is advisable to find out the all possible degrees of freedom of the work piece. Then some of the degrees of freedom or all of them are restrained by making suitable arrangements. These arrangements are called locators.

The principle of location is being discussed here with the help of a most popular example. It can more along any of these axes or any of its movement can be released to these three axes. At the same time the body can also rotate about these axes too. So total degree of freedom of the body along which it can move is six. For processing the body it is required to restrain all the degree of freedom (DOF) by arranging suitable locating points and then clamping it in a fixed and required position. The basic principle used to locate the points is desirable below. Six points location of a rectangular block. It is made to rest on several points on the jig body. Provide a rest to work piece on three points on the bottom x-y surface. This will stop the movement along z-axis, rotation with respect to x-axis and y-axis. Supporting it on the three points is considered as better support then one point or two points. Rest the work piece on two points of side surface (x-z), this will fix the movement of work piece along y-axis and rotation with respect to z-axis. Provide a support at one point of the adjacent surface (y-z) that will fix other remaining free movements. This principle of location of fixing points on the work piece is also named as 3-2-1 principle of fixture design as numbers of points selected at different faces of the work piece are 3, 2 and 1 respectively.

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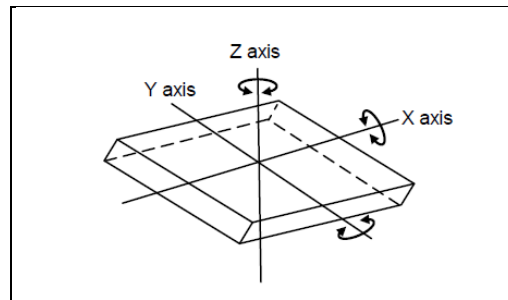


Fig.1: 3-2-1 Principle

VI. MATERIAL SELECTION PROCESS

Alumec is a high strength aluminum alloy supplied in the form of hot rolled, heat treated plate. It undergoes a special cold stretching operation for maximum stress relieving. Thanks to its high and good stability, Alumec has become widely used in the tooling industry.

- **Excellent Machinability** High cutting speeds, reduced machining times, lower tooling costs, quicker delivery times.
- **Low Weight** The low weight, which is approximately 1/3 of the weight of steel, allows easier and more convenient tool handling. Low inertia makes it possible to speed up closing and opening of moulds.
- **High Thermal Conductivity** Cycle times are reduced and less complicated cooling systems may be used
- **Good Stability** A special stress relieving operation guarantees minimal deformation during and after machining.
- **Good Corrosive Resistance** Good resistance against all commonly used plastic materials.
- **Suitable for surface treatments** Alumec can be anodized, hard chromium or nickel plated for increased hardness, wear resistance and corrosion resistance.

VII. ELEMENTS OF FIXTURE

A. Locator

A locator is usually a fixed component of a fixture. It is used to establish and maintain the position of a part in the fixture by constraining the movement of the part. For work pieces of greater variability in shapes and surface conditions, a locator can also be adjustable.

B. Clamp

A clamp is a force-actuating mechanism of a fixture. The forces exerted by the clamps hold a part securely in the fixture against all other external forces.

C. Support

A support is a fixed or adjustable element of a fixture. When severe part displacement/deflection is expected under the action of imposed clamping and processing forces, supports are added and placed below the work piece so as to prevent or constrain deformation. Supports in excess of what is required for the determination of the location of the part should be compatible with the locators and clamps.

D. Fixture Body

Fixture body, or tool body, is the major structural element of a fixture. It maintains the spatial relationship between the fixture elements mentioned above, viz., locators, clamps, supports, and the machine tool on which the part is to be processed.

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VIII. REQUIREMENT OF A FIXTURE

In order to maintain the work piece stability during a machining process, an operational fixture has to satisfy several requirements to fully perform its functions as a work holding device. The following constraints must be observed while designing a variable fixture:

A. Deterministic Location

A work piece is said to be kinematically restrained when it cannot move without losing contact with at least one locator. The work piece is constrained by a set of appropriately placed locators so that it is presentable for the machining operation. Locating errors due to locators and locating surfaces of the work piece should be minimized so as to accurately and uniquely position the work piece within the machine coordinate frame.

B. Total Constraint

A work piece should be fully constrained at all times to prevent any movement. Clamps should provide locking forces to hold the work piece in place once it is located. A totally restrained part should be able to remain in static equilibrium to withstand all possible processing forces or disturbance.

C. Constrained Deflection

Work piece deformation is unavoidable due to its elastic/plastic nature, and the external forces impacted by the clamping actuation and machining operations. Deformation has to be limited to an acceptable magnitude in order to achieve the tolerance specifications.

D. Geometric Constraint

Geometric constraint guarantees that all fixture elements have an access to the datum surface. They also assure that the fixture components do not interfere with cutting tools during a machining operation. In addition to these requirements, a fixture design should have desirable characteristics such as quick loading and unloading, minimum number of components, accessibility, design for multiple cutting operations, portability, low cost, etc.

IX. ANGLE FOR TOOL SHANK

Generally, there is each and every component is made up with different geometry, based on its application working condition forces acting on it and stresses developed in it. There are various holes, slots, curvatures, angles etc. on the tool shank similarly there is an angle on the tool shank as shown in the fig.2 (b) and this angle is known as the face angle (θ).

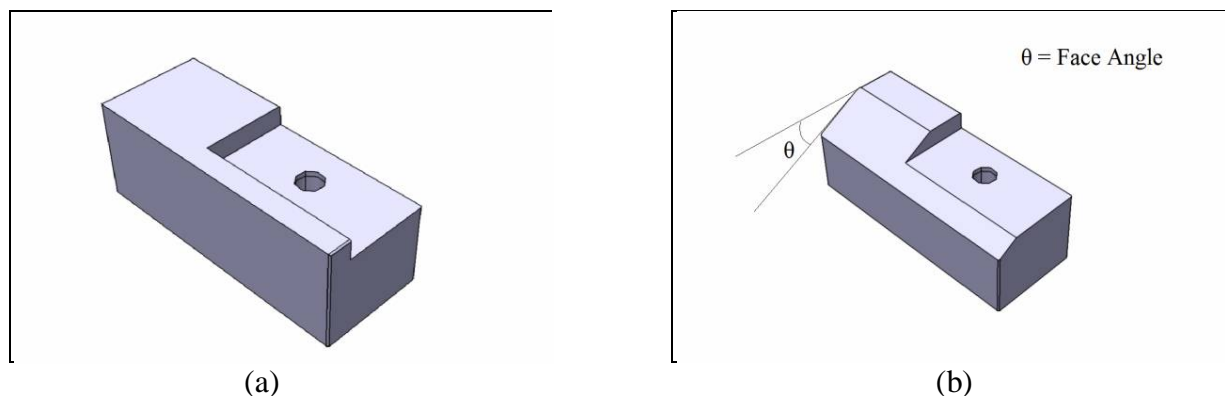


Fig. 2 Tool Shank (a) Before operation (b) After operation

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X. CONSTRUCTION AND WORKING OF FIXTURE

A. Fixture Body

It is circular in shape. It is four slotted which is angled at each slot to provide proper mounting of the tool shank. Each slot is provided at angle of 90° . The fixture body is to be mounted on machine spindle. The round section of the body is the part which is to be hold in the machine spindle.

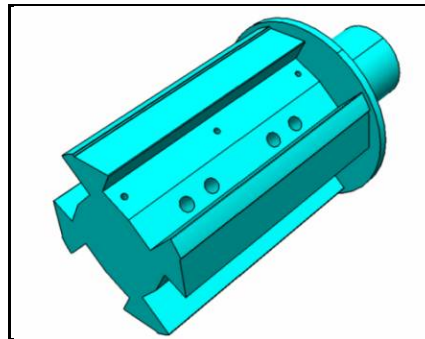


Fig.3: Fixture Body

B. Wedge

Wedge is square part which angled at the surface and a hole at middle to fix it on fixture body with help of double handed screw. It is used to hold the tool cartridge on fixture body. It works on the principle that when the wedge is screwed the clamping forces are increases as because of the angled face at the surface.

It should rigidly hold the work piece. Clamping device should be capable to unaffected by the vibration generated during an operation.

C. Locating pin

The main function of the locating pin is to properly locate the tool shank on the fixture body. It is circular in shape. Once the pin is located on the fixture body it does not need to dislocate that pin.

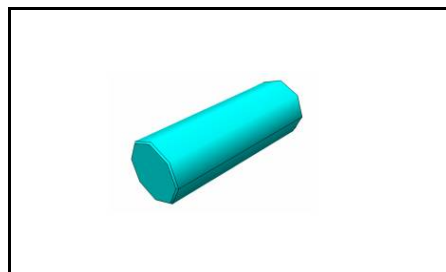


Fig.4: Locating Pin

D. Double handed screw

Double handed screw is used to fit wedge on fixture body. It is left handed thread at one end and right handed screw at other end. This because of the proper mounting of the wedge.

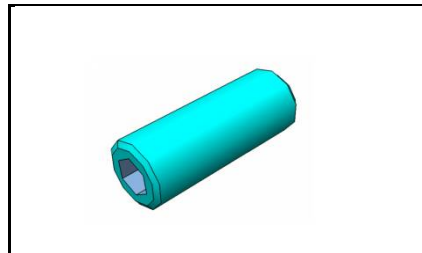


Fig.5: Double Handed Screw

E. Fixture Exploded View And Assembly

The below figure shows the schematic diagram of fixture as shown in figure there are different parts of the fixture are shown in figure. The complete assembly consist of wedge, screw, locating pin. Locating pin screwed half part in fixture body and remaining part out of body for support. Wedge is fixing in slot with help of double thread screw.

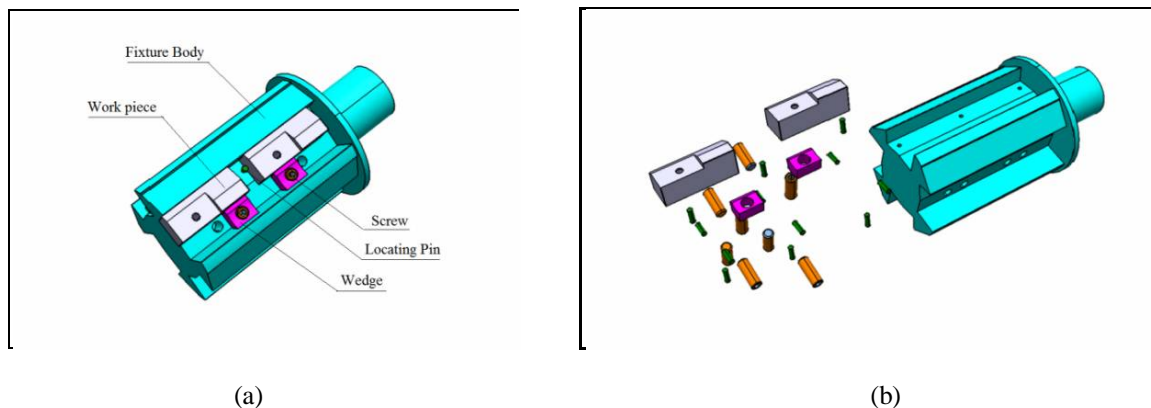


Fig. 6 Assembly and Exploded view of fixture (a) Assembly (b) Exploded view.

XI. SOLUTION AND RESULTS

Fixture is designed with multi-attachment provision which can probably hold eight work pieces that is advantage over old fixture which is single slotted and having arrangement for one work pieces. Multi attachment fixture is a four slot circular fixture which has to mount on same hydraulic collar arrangement. Efficient solution is the main step which is achieved by reducing the process time, eliminating the operator fatigue, and proper mounting of the tool shank on the fixture body. Fixture is designed by considering the machining forces as well as the movements of the tool during machining processes. Material selection is also an important part while designing the fixture that is why the Alumec which is having high wear resistance and strength is used. So, it can handle all the forces acting along the process. As well as for locating the work piece locators are used which properly locate the work piece and wedge applies required clamping forces on the work piece. Thus, all the aspects are taken into consideration and the solution is obtained.

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	Quantity of Work pieces produces per hours	Increase in productivity
Old Fixture	17	$P = \frac{48 - 17}{48}$
New developed Fixture	48	$P = 64.58\%$

Table 1: Result

Time required for producing 8 tool shanks in old fixture is 28 minute and for developed fixture is 10 minute. So lesser time is required with developed fixture productivity increase by 64.58%.

XII. CONCLUSION

From this design we can conclude that there is increase in production rate as well as it require less machining time. Operator fatigue for loading and unloading is minimising due to number of work piece mounted on fixture body. There is no requirement to load and unload work piece after a single operation. Accuracy of angle is improved.

XIII. FUTURE SCOPE

With the designed fixture we can implement it by considering the weight which is reduced by reducing unnecessary material. Improve clamping by using combine clamp and magnetic clamp.

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