Design and Fabrication of Angular Drilling Jig

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***Abstract*- Design of tool is a process to develop and design tools, techniques and methods which improves productivity and efficiency in manufacturing products. The main objective is to reduce manufacturing cost, to maintain quality and increasing production by cutting time between machining operations. The target of the mass production is to increase the productivity and increase the accuracy. This is done by reducing the set up cost and manual fatigue. Thus mass production can be achieved by the use of jigs. Thus angular post jig increases productivity by eliminating individual positioning, marking and frequent checking. The main advantage of the jigs is interchangeability. The need of selective assembly is eliminated. Also it reduces the continuous requirement for tool alignment for drilling holes, locating, clamping and guiding of the tool by the jig itself. The element of tool used whose main work is to guide tool into the correct position. So that the skilled labour requirement is not necessary.**

1. INTRODUCTION

Mass production aims at high productivity to reduce unit cost and interchangeability to facilitate easy assembly. This necessitates production devices to increase the rate of manufacture and inspection device to speed-up inspection procedure.

Jigs are special purpose tools which are used to facilitate production like machining, assembling and inspection operations.

Jigs are used on drilling, reaming, tapping, milling and tapping. There are many advantages for using jigs in production. This reduces operation time and increase productivity.

1.1 PURPOSE

The sole purpose of this project is to understand the fundamental knowledge of the angular post jig fabricating process and its operating system for various purposes like positioning as the locating, clamping and guiding of the tool is done by the jig itself. Bushing which is a tool guiding tool is used. So it reduces the presence of skilled laborer.

The responsibility of maintain the accuracy of the hole is now shifted from the operator and given to the jig. May it be a drill jig or a drill fixture the necessity of a clamping device is inevitable Generally work piece is held by a fixture and the fixture is arranged in such a way that the loading and unloading of the job is quick. As we all know a fixture is a production tool which is mainly used to locate, hold and support the workpiece firmly to the table. Set blocks and feeler are sometimes used to provide reference of the cutter to the workpiece. The main concern is the fastening of the fixture.

1.2 ELEMENTS IN JIGS

The most-common jigs are drill and boring jigs. These tools are fundamentally the same. The difference lies in the size, type, and placement of the drill bushings. Boring jigs usually have larger bushings. These bushings may also have internal oil grooves to keep the boring bar lubricated. Often, boring jigs use more than one bushing to support the boring bar throughout the machining cycle. The two type of jigs, they are open and closed. Open jigs carry out operations on only one, or sometimes two, sides of a work-piece. Closed jigs, on the other hand, operate on two or more sides of work-piece.

1.2 OBJECTIVES

- To design a angular post jig to make a hole of diameter 8mm on to the component.
- The holes is made of high accuracy and with zero defects

2. IMPORTANCE OF JIGS

Jigs are very important in manufacturing industry. These tools needed to make sure that manufacturing

process in production line going smooth and easier to operator doing their job. Jig helps operator to holding part which will be processing or in operation. In production rate, using jigs increased the productivity because it will minimize the production time.

2.1 ADVANTAGES

(i) Jigs eliminate individual marking, positioning and frequent checking. This reduces operation time and increases productivity.

(ii) Interchangeability Jigs facilitate uniform quality in manufacture. There is no need for selective assembly.

(iii) Skill reduction Jigs simplify locating and clamping of the work-pieces.

2.2 DISADVANTAGES

In industry, using jigs is very important in operation. Nowadays, tools are more important than workman skill. This will make the industrial lacking skillful man in workplace.

3. MATERIALS AND METHODS

3.1 MATERIALS USED

Jigs are made from a variety of materials, some of which can be hardened to resist wear. The materials often used in jigs are steel, iron, nylon, fiber and bronze.

3.1.1 HIGH SPEED STEELS (HSS)

These contain 18% (or 22%) tungsten for toughness and cutting strength, 4.3% chromium for better hardenability and wear resistance and 1% vanadium for retention of hardness at high temperature (red hardness) and impact resistance. HSS can be air or oil hardened to RC 64-65 and are suitable for cutting tools such as drills, reamers and cutters.

3.1.2 CARBON STEELS

These contain 0.85-1.18% carbon and can be oil hardened to RC 62-63. These can be used for tools for cutting softer materials like woodwork, agriculture, and also for hand tools such as files, chisels and razors.

3.1.3 Typical compositions of carbon

(i) Mild (low carbon) steel:

Approximately 0.05% to 0.26% carbon content with up to 0.4% manganese content (e.g. AISI 1018 steel). Less strong but cheap and easy to shape; surface hardness can be increased through carburizing.

(ii) Medium carbon steel:

Approximately 0.29% to 0.54% carbon content with 0.60 to 1.65% manganese content Balances ductility and strength and has good wear resistance which used for large parts, forging and automotive components.

3.2 CLAMPING

There are different types of clamps which help in clamping of the job at the required position. Clamps hold the work piece firmly. This helps in better engagement of job during the operation. The clamping should be such that it will sustain the forces during the operation. At the same time if clamping is so tight that it damages the work piece then it must be avoided. The timing required for clamping and unclamping of the device should be as less as possible. These clamping must also restrict vibrations and chatter during the cutting operation.

3.3 DRILL BUSHINGS:

Precision tools that guide cutting tools such as drill and reamers into precise locations in a work piece.Drill bushes ensuring the drill bits enters the work piece straight and with defined accuracy. Drill bushes also prevent drill wondering, chatter and drill breakage.

4. DESIGN CONSIDERATIONS

4.1 RULES FOR DESIGNING JIG

The points that are taken into consideration for designing a product are as following:

a) Jig must be so strong that the deflection in the jig should be as less as possible.

b) Another important design consideration is the clamping which should be fast enough and require less amount of effort.

c) Arrangement of clamps should be such that they are easily available. They should also have the arrangement for easy removal as well.

d) Is swinging of clamp system is provided for removal of work piece the clamp should swing as far as possible for unclamping the device.

e) There should also be provision for easy removal of chip. This will prevent the

interference of the chip with the operation on the work piece i.e. cutting operation.
l) Minimum cost should be incurred during the fabrication of the project and the design should be as simple as possible. In such a way it will help even a lay man to operate the device.

4.2METHODOLOGY ADOPTED

The specification of heavy duty high torque drilling machine is being fabricated is listed in Table 3

Table 3 Specifications of the drilling machine

The drilling machine is called bench drilling machine which rests on a magnetic

The height of the table is set by adjusting the height adjuster lever. When drilling the table should be moved quite close to the drill bit so that the distance from the drill bit to the material is small.

The material selected was of mild steel.

During drilling operation a lot of force acts

Materials generally used are:

- High speed Steel: Cutting tools like drills. Strength -2700 MPa.
- Die steels: Used for press tools, contain 1% carbon, 0.5 to 1% tungsten and fewer quantities of silicon and manganese,Carbon steels: Used for standard cutting tools. Strength-700 MPa.

Sl.No	Part name	Material
1	Jig body	Mild steel
2	Stud	Mild steel
3	Drill bush	Hardened bush
4	Pin	Mild steel
5	Nut	Mild steel

Table 2 Material requirement of different parts

- heat treatment. Used widely for fine, intricate press tools. Strength-750 MPa.
- High tensile steels: Used for fasteners like high tensile screws
- Mild steel: Used in most part of Jigs and Fixtures, Cheapest material, Contains less than 0.3% carbon.

Considering the material given and its properties Mild Steel is used for the fabrication of the device.

5. DESIGN CALCULATION

5.1 DIMENSION OF THE JOB

1. Outer diameter of the job = 75mm
2. Length of the job = 42mm
3. Required diameter of the drill = 8mm

Specifications	Value
Drill diameter	12mm
power input	1150W
No load speed	280/640rpm
Weight	4.8kg

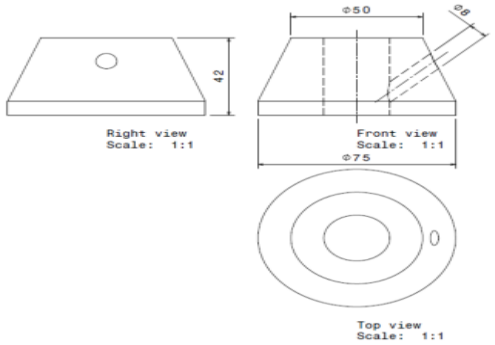


Fig.3 Dimension of the job

5.2 SELECTION OF BUSH

Press fit is preferred, therefore select fixed bush with hole range diameter 8 mm.

Generally the outside diameter of the bush will be push fit or press fit and inner hole will be running fit.

Select bush of fixed type DDB; 5.100

The diameter to be drill the work piece is = 8mm

As per design norms bush sizes (long) are

L1 = 20 mm

L2 = 16mm

D3 = 20mm

In our project bush dimensions are

L1 = 32mm

L2 = 20mm

D3 = 25mm

5.3 SELECTION OF JIG BODY

Thickness of frame (t) = 20mm

Base length = 3 x length of work piece = 3x42 = 126mm

But in our project our base length is designed = 102mm

Working height (h2) – 2 x outer diameter of work piece = 2x 75 = 150mm

But in our project working height = 107mm

Total height of jig (ht) = 2t + h2 + bush head = (2 x 20) + 150 +12 = 202mm
But in our project Total height = 159mm

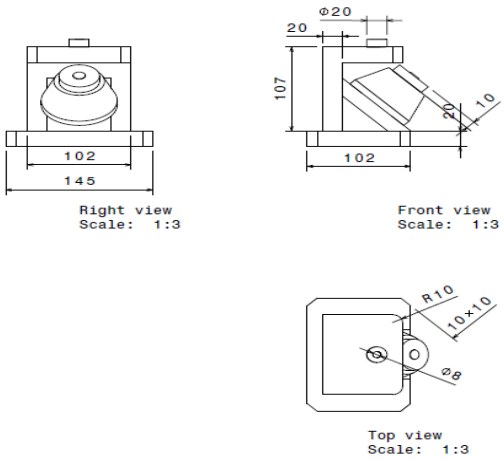
5.4 DESIGN FOR SCREW ROD
Size of the screw (Bolt) = M24
Pitch = 3mm (from5.42)
For coarse thread dc = 0.84 x d = 0.84 x 24
Dc = 20.14 mm
Stress area = 353 mm^2
Initial tension in bold p1 = 280 x d
= 2860x 24
= 68460 N
But this p1 = $(\pi/4)$ x dc^2 x ft
= 214.885n/mm^2
ft= 214.885n/mm^2
As the pin is double shear
P1 = 2 x $(\pi/4)$ x dc^2 x ft
ft = 68640/(2 x $(\pi/4)$ x 20.14^2)
= 107.730 N/mm^2
Shear stress as the pin is double shear
Fs = p/(π x dc x b x n)
Shear stress = Load / area
= 68640/ (π x 20.14 x 1.5 x 10)
= 72.133N/mm^2
107.730>72.133
Therefore our design is safe

5.5 SELECTION OF LOCATING PIN
For side location, pin locater is to be fabricated to the work piece. Locater diameter is 24.5mm that is equal to inner diameter work piece.
Locater height = 80mm

5.6 DIMENSION OF THE JIG COMPONENTS
1. Base plate of the jig = 102 x 145 mm
2. Thickness of the plates= 20 mm
3. Vertical jig plate length & width = 107 x 150mm
4. Top jig plate length & width = 79 x 65mm
5. Angular post plate = 117 x 63mm
6. Locater diameter = 24.5mm


Fig.4 Design of a angular post jig

6. PROCESS IMPLEMENTED IN PROJECT



6.1 SHAPING (PLANING)
Planing is a manufacturing process of material removal in which the work piece reciprocates against a stationary cutting tool producing a plane or sculpted surface. Planing is analogous to shaping. The main difference between these two processes is that in shaping the tool reciprocates across the stationary workpiece. Planing motion is the opposite of shaping. Both planing and shaping are rapidly being replaced by milling.
The mechanism used for this process is known as a planer. The size of the planer is determined by the largest workpiece that can be machined on it. The cutting tools are usually carbide tipped or made of high speed steel and resemble those used in facing and turning.

6.1.1 Process characteristics
1. Uses single-point cutting tool

2. Involves a reciprocating motion between the tool and work piece
3. Produces plane or sculpted surfaces
4. Leaves parallel feed marks

6.2 GRINDING

Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool.

A wide variety of machines are used for grinding:

- Hand-cranked knife-sharpening stones (grindstones)
- Handheld power tools such as angle grinders and die grinders
- Various kinds of expensive industrial machine tools called grinding machines
- Bench grinders often found in residential garages and basements

Grinding is a subset of cutting, as grinding is a true metal-cutting process

6.3 DRILLING

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips (swarf) from the hole as it is drilled.

The higher the length-to-diameter ratio of the drill bit, the greater the tendency to walk. The tendency to walk is also pre-empted in various other ways, which include:

- Establishing a centring mark or feature before drilling, such as by:
- Casting, moulding, or forging a mark into the work piece
- Center punching
- Spot drilling (i.e., center drilling)
- Spot facing
- Constraining the position of the drill bit using a drill jig with drill bushings

Surface finish produced by drilling may range from 32 to 500 micro inches. Finish cuts will generate surfaces near 32 micro inches, and roughing will be near 500 microinches.

Cutting fluid is commonly used to cool the drill bit, increase tool life, speeds, feeds, surface finish, and aid in ejecting chips. There are a variety of drill styles that each serve a different purpose. The sub land drill is capable of drilling more than one diameter. The spade drill is used to drill larger hole sizes. The index able drill is useful in managing chips.

6.4 MILLING

Milling is the machining process of using rotary cutters to remove material from a workpiece by advancing (or *feeding*) in a direction at an angle with the axis of the tool. It covers a wide variety of different operations and machines, on scales from small individual parts to large, heavy-duty gang milling operations. It is one of the most commonly used processes in industry and machine shops today for machining parts to precise sizes and shapes.

6.5 TURNING

.Usually the term "turning" is reserved for the generation of*external* surfaces by this cutting action, whereas this same essential cutting action when applied to *internal* surfaces (that is, holes, of one kind or another) is called "boring".

Turning can be done manually, in a traditional form of lathe. Today the most common type of such automation is computer numerical control, better known as CNC

6.6 HARDENING

Hardening process is used to increase the hardness of the material.

The five hardening processes are:

- The Hall–Petch method, or grain boundary strengthening, is to obtain small grains.. The plastic straining generate new dislocations. As the dislocation density increases, further dislocation movement becomes more difficult .
- Martensitic transformation, more commonly known It is important to quench with a high cooling rate so that the carbon does not have time to form precipitates of carbides.

6.7 NICKEL PLATING

Nickel electroplating is a technique of electroplating a thin layer of nickel onto a metal object. The nickel layer be decorative, provide corrosion resistance, wear resistance, or used to build up worn or undersized parts for salvage purposes

7. CONCLUSION AND FUTURE SCOPE

This report deals with the design and fabrication of drill jig and the detailed drawing of the component and assembles. The project carried out by us made an impressing task in drilling works. It is very useful industries for mass production of identical parts.

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