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Research Article

Design of Drilling Jig for Rod Guide

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Abstract

This project deals with design of jig for drilling component (Rod Guide). The jig is to be designed to increase accuracy, reduce number of part rejected and thereby increase productivity. This paper includes definition of jig, elements of jig, and design procedure of jig. The scope of project is to design a new jig for component named Rod Guide having 3 holes of dia. 2mm at 58 degrees. The current jig of Rod Guide operates manually, there is no proper clamping and locating system provided. Clamping and unclamping of job becomes a time consuming process, thus there is a loss of productivity. Hence in order to eliminate these drawbacks we have to design a new jig. The jig is designed on the basis of space availability. For mass production and interchangeability of drilling components jigs are preferred instead of Fixture because in addition to clamping and locating jig guides the tool.

Keywords: *Bush, Clamping, Design, Jig ,Productivity, Rod Guide.*

1. Introduction

The demand for manufactured products is increasing day by day. The most common goal of any company is to produce high quality products with minimum manufacturing cost within shortest time. The common way to achieve this aim is mass production of component and mass production is achieved economically by using jig and fixtures. Mass production ensures reduction in unit cost by high productivity and interchangeability for ease of assembly.(FazlinaMansor *et al*,2010). Jigs are tools used for production of same and interchangeable parts accurately.Jig is defined as a work holding device that holds, locates and supports the workpiece and guides the tool for particular operation.(Joshi P.H. *et al*, 2010). The advantages of using jigs in production include elimination of individual making, positioning and frequent inspection, and reduction in cost, production increase, high accuracy and interchangeability of parts. Today Frequently used type of jig is drilling jig and it is used in drilling, boring, reaming, tapping and similar operations (LaxmiKumari *et al*,2015).

2. Elements of Jig

Locating Elements

Locating elements includes pin, pad and recesses which locate the job on jig. It may be fixed or adjustable. They are usually made up of hardened steel.

Clamp

A clamp is nothing but force-actuating mechanism of a jig. The clamp exerts a pressure on workpiece and hold securely in correct position of tool. Most commonly used clamping devices are Screw clamp, C clamp, Toggle clamp, Strap clamp etc.

Jig Body

Jig body is the main structural element of jig. The body is formed either by welding different parts or join them by nut and bolt. It maintains relationship between locators, clamps, bushes and the machine tool on which job is to be processed.

Bushes

These are tool guiding elements usually made up of hardened steel or mild steel, cast iron. They must be interchangeable, precise and wear resistant. A bush is held in hole of jig through which drill is to be passed. The bushes are classified as fixed bushes, Renewable bushes and slip bushes.

3. Design considerations

The following points are considered while designing a jig:

a) Jig must be strong enough that deflection in the jig should be as less as possible.
b) The frame of jig should be Rigid to absorb vibrations during operations.

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c) The clamping and unclamping should be quick and require less amount of effort.
d) The chip removal should be easy.
e) There should be proper provision of fool proofing and poka yoke if required.
f) The clamping surface area should be as small as possible.
g) All the parts of jig should be easily available.
h) The jig should be designed such that there are maximum operations performed in single clamping of workpiece.
i) There is no movement of workpiece after clamping.

4. Design Calculations

The standard formulae (Charles ChikwenduOkpala, Ezeanyim OkechukwuC *et al*, 2015) for forces acting on operation of jig are,

$$Torque \quad Mt = K \times A \times f \times 0.8 \times d \times 1.8 \qquad (1)$$

$$Thrust \quad T = 2 \times K \times B \times f \wedge 0.8 \times d \times 0.8 + K \times E \times d \times 2 \qquad (2)$$

Where, d is the diameter of the drill.
A, B, E, and K are constants.

$$\text{Drilling force} = 1.16 \times k \times d \times (100 \times S) \wedge 0.85 \qquad (3)$$

Where, k = material factor
s = feed in mm/rev
d = the diameter of the drill in millimeter (mm)

$$\text{Clamping Force } P = F \times L \div \{2\mu R\,(\frac{A}{B} + 1)\} \qquad (4)$$

Where, F= force on Handle, μ= coefficient of Friction
A,B,R,L= dimensions of Toggle clamp

Table 1 Force Analysis

Parameter	Value
Torque (Mt)	**520.24 N mm**
Thrust (T)	**626.62 N**
Drilling force	**386.77 N**
Clamping force	**426.82N**

5. Workpiece Description

The workpiece for which jig is to be designed is a component named Rod Guide made up of mild steel have to drill 3 holes of dia. 2mm at 58 degrees equally spaced. The Rod Guide is shown in fig.1

Figure 1 Rod Guide

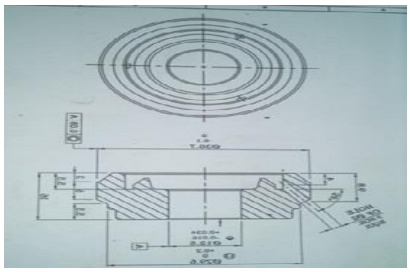

Figure 2 CAD diagram of Rod Guide

6. Basic Design Steps

1. Selection of method of locating the part: Identify the requirement of standard components for locating purpose. Pins, pads, and recesses used to locate the workpiece on the jig. Since the Rod Guide have central bore hence the shaft of drive is used as locator and workpiece is mounted on support. The locator of jig is as shown in fig.3

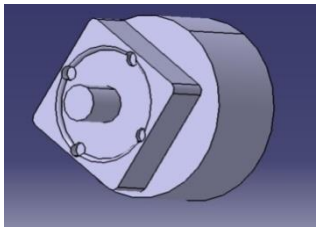

Figure 3 Locator

2. Make a proper choice of clamp: Clamps hold the workpiece which is engaged with locators during operation. The timing required for loading and unloading must be as small as possible. Strap clamp,swing washer, nut, pneumatic clamp, toggle clamp are used for clamp a part. Out of these Toggle clamp provides quick clamping method and suitable for rod guide. Hence toggle clamp is used as a clamp. The toggle clamp is shown on fig. 4

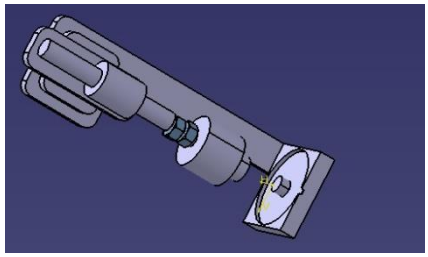

Figure 4 Toggle Clamp

3. Select any supports required: Base plate is supporting device for all clamping and locating devices. The base plate in the design is developed according to the dimensions of the work piece, so that during the machining and non-machining operations the structure remains stable.

4. Design the jig bushes required: Bushings are used to guide drills into proper position on the work piece. Headless renewable bush of mild steel is used.

5. Design the jig body: A jig body is frame of jig. Different parts are assembled in such a way to make a frame of jig and support all the clamping and locating devices. The jig body is shown in fig. 5

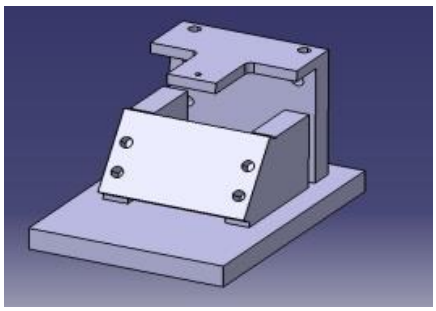

Figure 5 Jig body

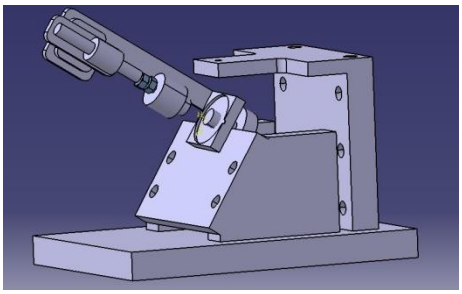

Figure 6 Jig Assembly

7. Result

Table 2 Result

	No. of parts produced per day	Rejection per day	Cost of rejection per part (Rs)/day	Total Rejection Cost(Rs)/day
Before	1000	50	.5	25
After	1000	6	.5	3
Total cost saved				22

Conclusion

Today's manufacturing industry aims increase in production with greater accuracy. This can be achieved by reducing manual fatigue by using jig and fixtures. Jig provides fool proofing arrangement that means operator doesn't require any skill to operate it. There are various pro's that are related with use of jig, it involves- better accuracy, cycle time reduction, interchangeability, reduce quality control cost etc.

This paper titled 'Design of jig for Rod Guide' explains that the design of jig depends on criteria that the clamping force must be greater than thrust required. The new jig designed for rod guide is box jig type and provides proper clamping and locating elements to it. After implementation of this jig, number of parts rejected were reduced from 50 to 6 over 1000 parts per day. The new jig ensures safety of operator as it provides proper clamp and locator to workpiece. The jig rotates with the help of pneumatic drive and it reduces cycle time from 22 seconds to 16 seconds. This results in increase in productivity by 28%. The jig also reduces cost required for quality control and maintenance cost of jig.

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