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DESIGN AND DEVELOPMENT OF MODIFIED JIG FOR ANGULAR DRILLING ON CYLINDRICAL PART

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Abstract - *This paper gives the detailed information about drilling jig and also identified the flagrant advantages that are associated with the use of modified jigs in manufacturing. Now a day, development is with large scale of production as well as with good quality of products is shoot up in market, so everyone is developing new design of jig and fixture for saving the production time. In case of drilling machine to reduce production timing with fine accuracy jigs are used, because drilling machine is most vital and commonly used for producing hole on any machine part with optimum surface quality as well as at less cost. The main objective of using jigs in an industry is to achieve the mass production or interchangeable part concept. The basic elements in the design of indexing type of drill jig are component model, location, orientation and clamping. The scope of this paper is to design a drilling jig for linear as well as circular indexing for a circular component having angular hole up to 360° on its periphery this type of design is validated and verified. The modeling is done with the help of Solidworks design tool.*

***Key Words*: Drilling Jig, Angular Drilling, linear indexing, Solidworks.**

1. INTRODUCTION

Now a day, manufacturing plays a vital role in developing as well as developed countries and the respective manufacturing industry are developing day by day with latest ideas for different components some of them are challenging task in manufacturing point of view. Also, the factors like time, accuracy, repeatability and obtained the quality of product as per customer's demand plays a crucial role in manufacturing. Anybody who worked to drill on periphery of circular component is familiar with the upcoming difficulties like as slipping of drill, going the drill bit off side. So making hole on cylindrical periphery of the workpiece being always a challenging task. For single hole to be drilled there is no problem, but the number of holes are to be drilled at equal distance on cylindrical periphery is critical task because the tolerance is very high and mistake are not allowed in mass production. Generally, the vertical drilling machines are commonly used in any machine shop so, there are a lot of chance to make a mistake from starting to end of the process (i.e. marking, dividing as well as finding the center of cylindrical workpiece) because the operation performed on drilling is manually. So our project is concerned about the design, development and fabrication of drilling jig for making an angular hole on solid as well as hollow periphery of cylindrical workpiece to reduce the mistake while angular drilling on vertical drilling machine.

2. PURPOSE OF DRILLING JIG:

The basic purpose of developing drilling jigs for mass production in machine shop are given below-

A. Easily guide the cutting tool while drilling.
B. Comfortable the angular drilling for unskilled labor.
C. To eliminate the marking, positioning and alignment error.
D. Reduction of overall manufacturing cost and save the production time.

3. LITERATURE REVIEW

1. Prof. M. M. Patil et. al [1], concluded that the design of drilling jig is very cheap to adopted for drilling operation on periphery of hollow cylindrical component. For saving the unnecessary cost in automation they have used manual indexing mechanism and that method is very easy as well as most superior for work and unskilled labor can operate easily with precision.

2. D P Kute et. al found that [2] the design of jig and fixture is used to drill five equidistance concentric holes on coupling hub and they pointed out the difficulty which comes during making a concentric hole at equidistance on the coupling hub and they have used regular pentagonal structure block for indexing and they made indexing jig with cheap cost.

3. Nagarajan et. al [3] suggested that the importance of jig and fixture for holding hollow cylindrical component. They have explained how difficult is the indexing and positioning of hollow circular component by indexing plate with crank and sector mechanism. The author has an attempt to made the design and fabrication of jig and fixture for indexing as

well as positioning of the hollow cylindrical component for drilling machine at economical cost.

4. Raghavendra H et. al performed analysis in [4] on drilling jigs and fixture find out stresses acting on jigs under working condition as well as they did modeling by using solid edge design tool and performed drilling operation on different materials.

4. PROBLEM IDENTIFICATIONS

A. At initial condition author made economical design (1) but, the drilling angle can set between 0^0 to 60^0 on both side during setup.
B. Author made a precious design (4) but, only able to make an angular hole on hollow circular workpiece and it's very difficult for holding the solid workpiece for angular drilling.
C. At initial condition (5) author made the design of drilling jig for drilling on circular workpiece with fix position so, able to drill at same position on each workpiece and position of drill cannot be change.

5. METHODOLOGY

In this paper we are trying to make the design safer and precious. The following methodology we have adopted as per above difficulty-

A. In our design we have used special purpose clamping arrangement it help to clamp the solid as well as hollow circular shaft and here is one back supporting member through which the workpiece will pass, so it works as a fixed beam and finally improve the drilling load carry capacity of workpiece as shown in fig. 3 and fig. 4
B. In modified drilling jig design, we can drill a hole upto 360^0 as shown in fig. 7
C. We have provided one circular indexing mechanisms as well as one linear. It will help to drill a hole at a particular angle with a particular distance as shown in fig. 7
D. We have provided one locking arrangement beside the clamping arrangement, it will help to lock the pin for set a particular angle as shown in fig. 5 and fig. 7

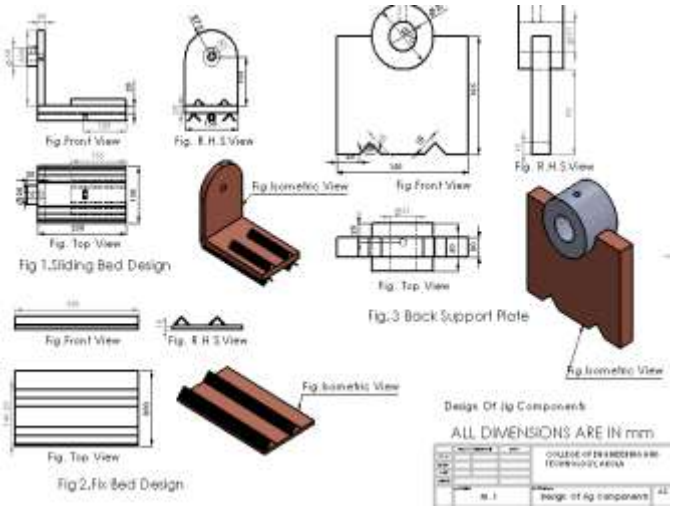
5.1 DESIGN CONSIDERATION:

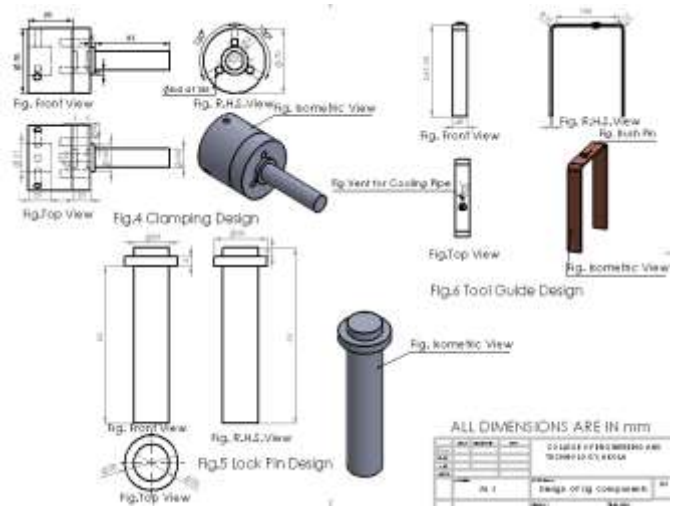
The following points are to be taken into consideration while designing a drilling jig-

A. The clamping is done as quick as possible and required less amount of effort and easy to remove after drilling operation.
B. Part must be easily replaceable if failure occurred.
C. The movement of work piece must be restricted while drilling.
D. The design must be robust as well as possess enough rigidity to prevent vibration.

5.2 DESIGN OF MODIFIED DRILLING JIG COMPONENTS

All the below components are performing important function during machining and its design made by using SOLIDWORKS software.





5.3 CALCULATIONS FOR DESIGN ANALYSIS

The standard formula for the various forces associated with the operation of jigs are explained below-
***Drill Bit size is 8mm**
We know that,

I) $\frac{\text{Thrust}}{\text{Drilling Force}} = 1.16 \times K \times d \times (100 \times S)0.85$ ----------(1)

Where,
K-Material Factor
d- Diameter of Cutting tool (mm)
S- Feed rate (mm/Rev)

So,
K for M. S is 1.5, Diameter of drill bit is 8mm,
S as per drill bit size is taken as 0.169 mm/rev
Put all the value in equation 1,

$\frac{\text{Thrust}}{\text{Drilling Force}} = 1.16 \times 1.5 \times 8 \times (100 \times 0.169)0.85$
=153.93 Kgf ≈ 1509.53 N

II) Force acting on each of the lips,

$KS = \frac{PZ}{A}$ ----------(2)

Where,
K_S- Cutting force
PZ- Force acting on each of the lips
A-Area of cutting hole
So,
KS= (K×S) (K is material factor)
= (1.5×0.169)
= 0.2535 Kgf ≈ 2.48N

Then,
$A = \frac{\pi \times d^2}{4}$ (We know d is 8mm)
= 50.26mm^2
Put all the value in eqn 2,
Then, we will get force acting on each of the lips,

$0.2535 = \frac{Pz}{50.26}$

$P_z = 0.2535 \times 50.26$
= 12.73 Kgf ≈ 124.83 N

III) Torque (M)= $\frac{PZ \times d}{20}$

$M = \frac{124.83 \times 50.26}{20}$

= 49.93 N-mm

IV) Thrust (T)= 0.195 HB × S0.8 × d0.8 + 0.002 HB × d2
----------(3)

Where,
HB- Brinell Hardness & for MS HB is 130
d- Diam. Of cutting tool
S- Feed Rate
Put all the value in eqn 3,

T= 0.195 × 130 × 0.169(0.8) × 8(0.8) + 0.002×130× 82
T = 50.57N

V) Clamping Force (Q)= M × FOS
= 49.93 × 3
= 149.73N ≈ 150N

VI) Spindle Speed (N) = $\frac{\text{Cutting speed} \times 12}{\pi \times \text{Diam. Of drill bit}}$

$\frac{= 100 \times 12}{\pi \times 0.319}$ = 1198 rpm

where,
Standard Cutting Speed for MS 100
Diam of drill bit is in inch.

VII) $\frac{\text{Thrust}}{\text{Drilling Force}}$ = 1509.53 -----(According to eqn 1)
----------(4)

But, we know that,
Thrust =50.57 N

Put the value in equation 4
We will get,

$\frac{50.57}{\text{Drilling Force}} = 1509.53$

Drilling Force= 0.033N

From above calculation we can say that drilling force is negligible.

VIII) Machining Timing (TC)= $\frac{Id \times I}{N \times F_R}$

Where,
Id- Depth of hole (10mm), N-Spindle Speed (1198 rpm),
I-No of holes (1), F_R- Feed/Rev (0.169)

TC= $\frac{10 \times 1}{1198 \times 0.169}$
TC= 0.049 min/ Workpice.
TC=2.96 Sec/ Workpiece.

5.4 CAD MODEL OF MODIFIED DRILLING JIG

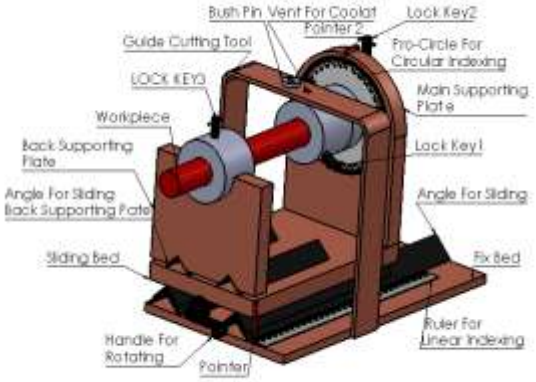


FIG.7 DESIGN OF MODIFIED DRILLING JIG WITH COMPONENT DETAILS

5.5 FABRICATION MODEL OF MODIFIED DRILLING JIG

6. CONCLUSION

In this paper, we have made the design of drilling jig for angular drilling on hollow as well as solid cylindrical component. After performing trial on drilling machine, we concluded that the making use of this drilling jig the holding and indexing of the cylindrical component is made easy this will give high accuracy as well as less consumption of time for setup the angle during drilling operation as compared to conventional drilling process and according to our calculation clamping force is more as the drilling force so our design is safe for use and the design of drilling jig components is made by using Solidworks design tool, So we suggested that, this type of drilling jig can be used for road side workshop as well as small scale industry where mass production is done.

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