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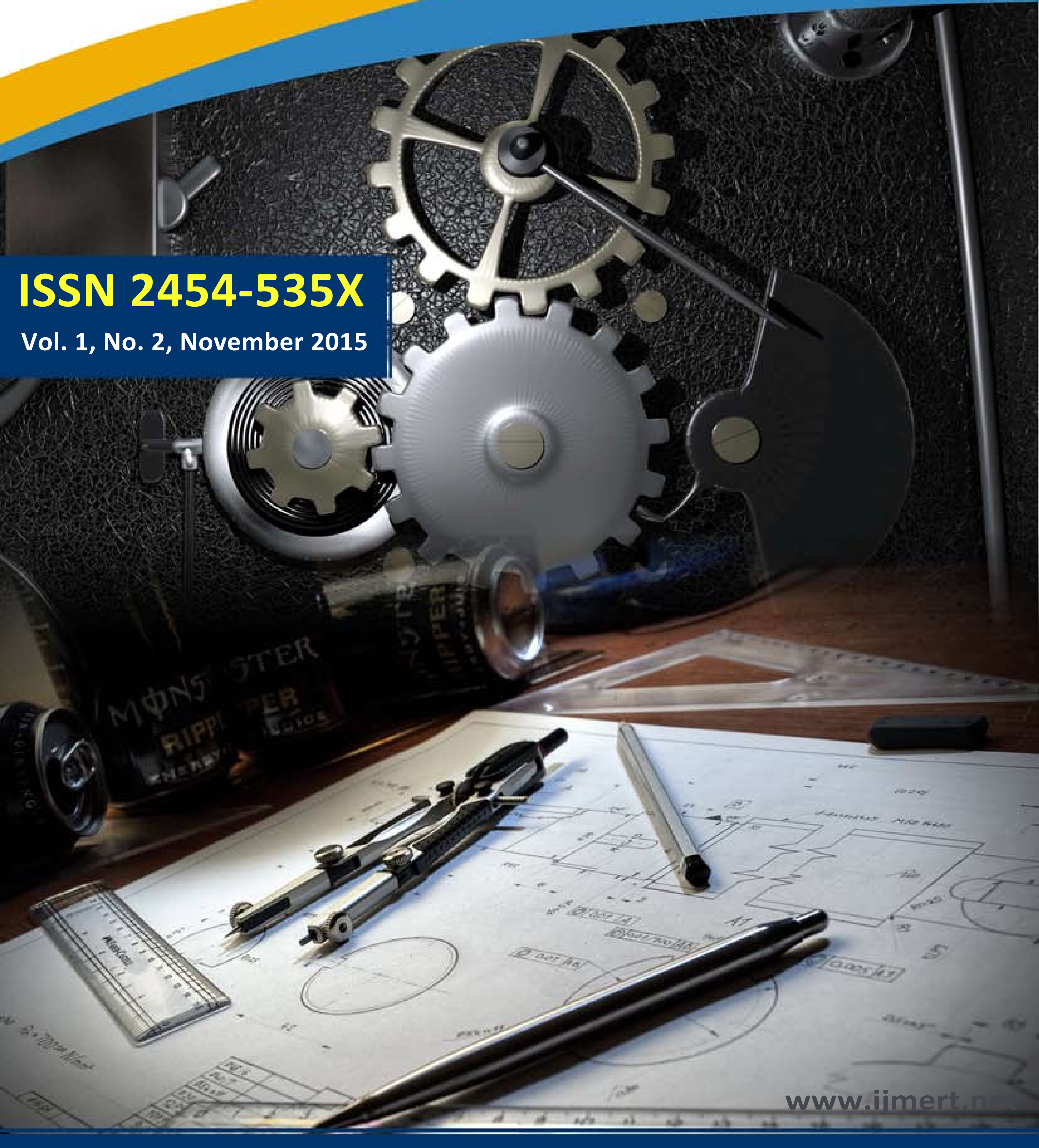

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Research Paper

DESIGN AND FABRICATION OF JIG AND FIXTURE FOR HOLLOW CYLINDRICAL COMPONENT IN DRILLING MACHINE

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Jigs and fixtures are serving as one of the most important facility of mass production system. It is very difficult to indexing and positioning of hollow circular component by index plate with crank and sector mechanism. In this project an attempt has been made for the design and fabrication of jig and fixture for indexing and positioning of hollow cylindrical component in drilling machine at lesser cost. Quality of the performance of a process largely influenced by the quality of jigs and fixtures used for this purpose. The main purpose of a fixture is to locate and in the cases hold a work piece during an operation. A jig differs from a fixture in the sense that it guides the tool to its correct position or towards its correct movement during an operation in addition to locating and supporting the work piece.

Keywords: Casting, Base plate, Indexing shaft, Drill bush, Bearing, Allen bolt, ANSYS, Pro-E Creo parametric 2.0

INTRODUCTION

Jigs and fixtures are the devices which are mainly designed for holding, supporting and locating the work piece and to guide the tools. By using jigs and fixtures the cost of manufacture is reduced extensively. These devices are used to produce a repetitive type of workpieces with zero defects. But these are economical in mass production only. Jigs and fixtures are designed to save production time, to maintain dimensional accuracy, to facilitate quick and interchangeable assembly.

Over the past century, manufacturing has made considerable progress. New machine tools, high-performance cutting tools, and modern manufacturing processes enable today's industries to make parts faster and better than ever before. Although work holding methods have also advanced considerably,

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the basic principles of clamping and locating are still the same.

The first manufactured products were made one at a time. Early artisans started with little more than raw materials and a rough idea of the finished product. They produced each product piece by piece, making each part individually and fitting the parts into the finished product. This process took time. Moreover, the quality and consistency of products varied from one artisan to the next. As they worked, early manufacturing pioneers realized the need for better methods and developed new ideas.

The jigs are usually lighter in construction and direct the tool to the correct position on the work piece. It is rarely clamped on the machine table because it is necessary to move on the table to align the bushes in the jig with machine spindle. Jigs are used on drilling, reaming, tapping, and counter boring operations. The fixtures are heavy in construction and mostly mounted on the machine table. Fixtures are used in turning, milling, grinding, shaping, planning and boring operation.

PROBLEM IDENTIFICATION

In initial condition V-block is used to holding the circular hollow job and it is very difficult to positioning the circular hollow job by making use of V-block. This project aims at to overcome the difficulty of holding and positioning of circular hollow job while drilling external holes on it. In this indexing jig is used for positioning the circular hollow job, by making use of this the work piece can be positioned easily. By making use of the casing locking mechanism the positioning of work can be done and that is motion economic. There are various problems created while designing the indexing shaft and base plate.

The Various Problem Identified are

- Work holding method. Where there are number of work holding methods available for holding circular hollow component, here Allen bolt with C washer were used.
- For positioning the work component, indexing shaft with locking pin was used, where indexing of the component which is to be machined can be achieved.
- The base plate was designed with casing locking mechanism by which the casing can be rotated to next position without any angel deviation.
- Key which is used for arresting the rotation of the shaft should be designed with proper dimension to avoid misalignment.
- The holding of work piece is done by making use of Allen bolt and C washer. This will helps to reduce the length of the indexing shaft. The reduced indexing shaft avoids bending of the shaft.
- The thickness of the base plate should be right enough to have a better rigidity and capacity of absorbing vibrations that are occurs while machining a component.

COMPONENTS USED

Casing

It is a rectangular component having holes on their side surface as shown in a Figure 1. Which is used for inserting the bearing and indexing shaft. Drill bush plate or jig plate is mounted on the casing at the appropriate position.

Base Plate

The base plate is the supporting member on which the casing is mounted with the help of bearing. Base plate is equipped with casing locking mechanism which is used to arrest the

Figure 1: Casting

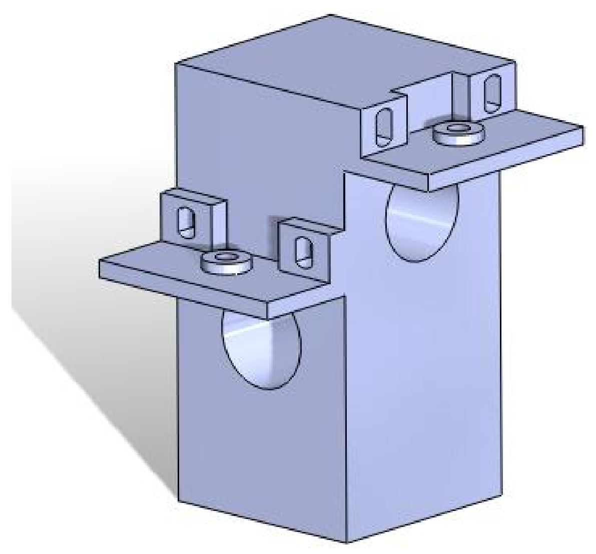
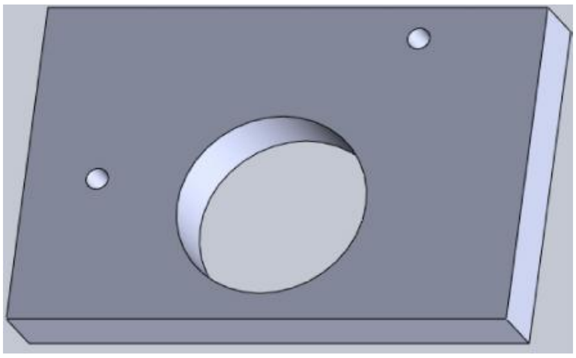


Figure 2: Base Plate



rotation of the casing during machining. The base plate is made up of mild steel and it is mounted on the machine table. The base plate is shown in Figure 2.

Indexing Shaft

It is used for indexing the work piece to drill holes on it which are perpendicular to each other. The machined and unmachined workpieces are mounted on either side of the shaft. The indexing shaft having internal thread, which is used for clamping the work piece by Allen bolt as shown in a Figure 3.

Figure 3: Indexing Shaft

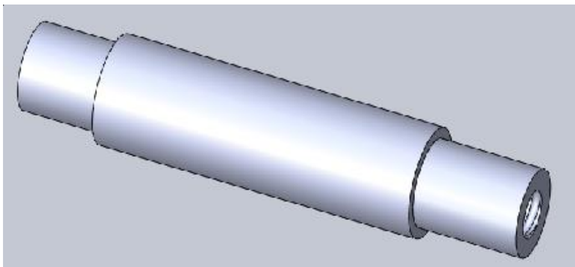
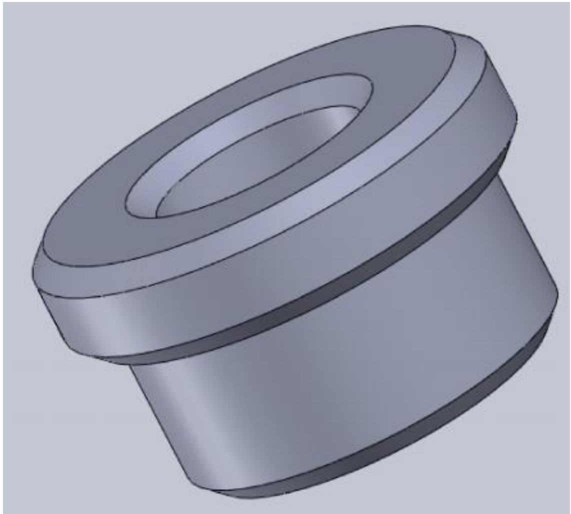


Figure 4: Drill Bush



Drill Bush

It is a tool guiding device which is used for guiding the drill bit while machining. It is usually mounted on the jig plate. The drill bush is inserted into the jig plate by means of press fit or push fit. The inner diameter of the drill bush is a running fit. The drill bush is shown in the Figure.4.

Ball Bearing

Bearing is shown in the Figure 5. This is used for supporting the indexing shaft. It will also reduce the wear between the casing and indexing shaft. Ball bearings are used for lower duty applications and it is made of stainless steel.

Figure 5: Bearing

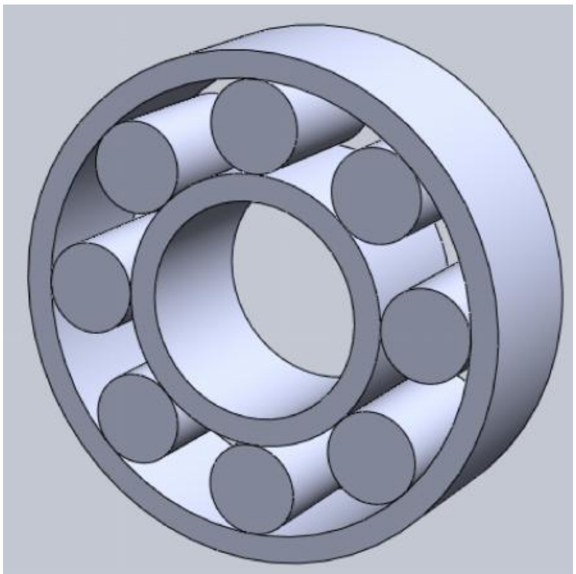
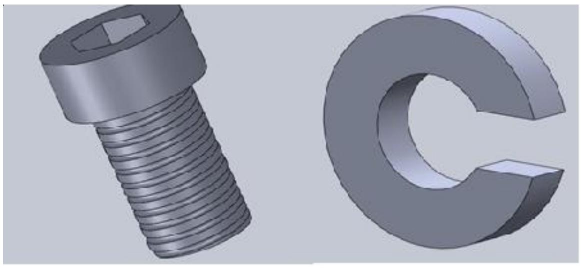


Figure 6: Allen Bolt and C Washer



Allen Bolt and C Washer

Allen bolt and C washer is used for holding the work rigidly during machining. These are commonly used for matting two parts. The Allen and C washer is shown in the Figure 6.

DESIGN CALCULATIONS

Drilling Force Calculation

$F = k^1 \times k_c \times f \times d/2$

where

Specific cutting force, $k_c = 3100\ N/mm^2$

Feed mm/revolution, $f = 0.2032$

Tool diameter, $d = 10$ mm

Coefficient constant, $k^1 = 0.5$

$F = 0.5 \times 3100 \times 0.2032 \times 10/2$

$= 1.5748 \times 10^3$ N

$= 1.5748$ KN

Table 1: Feed Rate Calculation

Drill Diameter (inch)	Recommended Feed, f_r (inch/rev)
Below 1/8”	Up to 0.002
1/8” to 1/4”	0.002 to 0.004
1/4” to 1/2”	0.004 to 0.008
1/2” to 1”	0.008 to 0.012
1” and above	0.012 to 0.020

Specific Cutting Force

The feed rate is based on the diameter of the drill. According to the drill diameter the feed rate is given on the Table 1.

The cutting force is based on the work piece material and the tensile strength of the using material. The specific cutting force for the material is given in the Table 2.

Bending Moment Calculation

Shear force = Total load acting on shaft

$= 1.5748$ KN

Bending moment = Load × distance

$= 1.5748 \times 24 \times 10^{-3}$

$= 0.0377952$ KN-m

$= 37.7952 \times 10^3$ N-mm

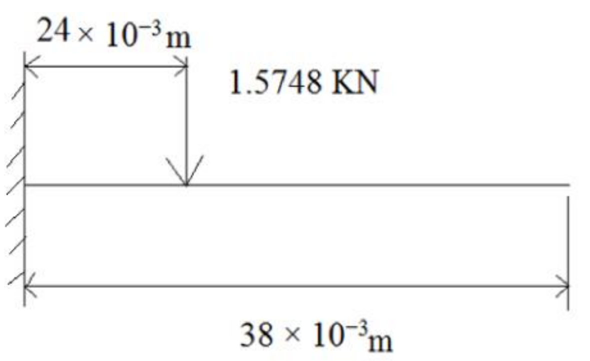
Maximum stress calculation

$M = \delta_{max} \times Z$

Table 2: Specific Cutting Force

Workpiece Material	Tensile Strength(MPa) and Hardness	Specifi c Cutting Force Kc (MPa)				
		0.1(mm/rev)	0.2(mm/rev)	0.3(mm/rev)	0.4(mm/rev)	0.6(mm/rev)
Mild Steel	520	3610	3100	2720	2500	2280
Medium Steel	620	3080	2700	2570	2450	2300
Hard Steel	720	4050	3600	3250	2950	2640
Tool Steel	670	3040	2800	2630	2500	2400
Tool Steel	770	3150	2850	2620	2450	2340
Chrome Manganese Steel	770	3830	3250	2900	2650	2400
Chrome Manganese Steel	630	4510	3900	3240	2900	2630
Chrome Molybdenum Steel	730	4500	3900	3400	3150	2850
Chrome Molybdenum Steel	600	3610	3200	2880	2700	2500
Nickel Chrome Molybdenum Steel	900	3070	2650	2350	2200	1980
Nickel Chrome Molybdenum Steel	352HB	3310	2900	2580	2400	2200
Hard Cast Iron	46HRC	3190	2800	2600	2450	2270
Meehanite Cast Iron	360	2300	1930	1730	1600	1450
Gray Cast Iron	200HB	2110	1800	1600	1400	1330

Figure 7: Load Diagram



where

M = Maximum bending moment

= 37.7952×10^3 N-mm

Z = Section modulus

= $(\pi/32) \times d^3$

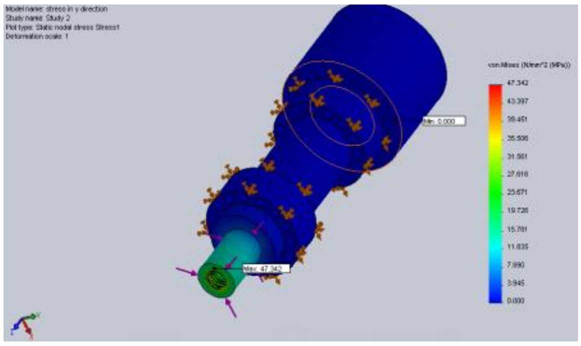
= $(\pi/32) \times (20)^3$

= 785.398 mm^3

δ_{max} = M/Z = $37.7952 \times 10^3/785.398$

= 48.1223 N/mm^2

Figure 8: Maximum Stress



The maximum stress calculated is equal to stress value obtained from the analysis.

Bearing Calculation

Weight of the components = 150 Kgf

By referring the design data book page. no 4.12

Inner diameter of bearing = 40 mm

Weight of the component 150 Kgf less than the given Value static capacity 980 Kgf.

Hence the selected ball bearing is safe to use.

Calculations for Drill Bush

Selection of Drill Bush

- Generally the outer diameter of the drill bush is push fit or press fit.
- The inner diameter of the drill bush is running fit.

By referring the design data book page. no: 5.100

For drill diameter 10 mm

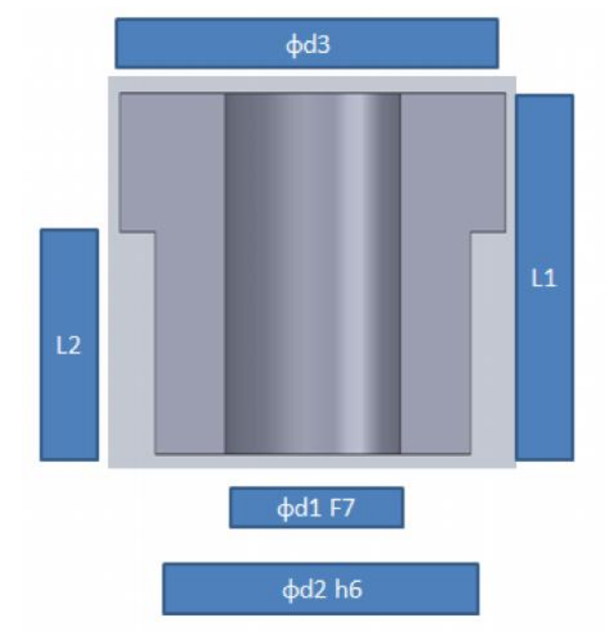
Select d_1 = 10-12 mm

L_1 = 12 mm

L_2 = 8 mm

d_2 = 18 mm

Figure 9: Drill Bush



d_3 = 22 mm

r_1 = 2.5 mm

r_2 = 0.8 mm

To Find Tolerance Value

By referring the design data book page. no: 3.9

d_1 F7 = + 0.034 mm

+ 0.016 mm

d_2 h6 = –0.000 mm

= –0.011 mm

Jig Plate Calculation

The thickness of the jig plate is equal to length of the drill bush L_2.

Hence the thickness of the jig plate = 8 mm

Clearance Between Jig Plate and Work Piece

- For ductile material clearance is half of the drill diameter.
- For brittle material is clearance is equal diameter of the drill.

Clearance = 5 mm.

PROPOSED JIG AND FIXTURE FOR HOLLOW WORK PIECE

The hole is to be made on the work piece by using the indexing mechanism to drill multiple numbers of holes on the surfaced of the work piece. The Figures 10 and 11 shows the view of unfinished and finished work. By using our proposed jig we have created a multiple number of holes. The work is hold in a right positioned by using a Allen screw and C washer. The drill bit is being guided by using the drill bush which is attached along with our

Figure 10: Unfinished Work Piece

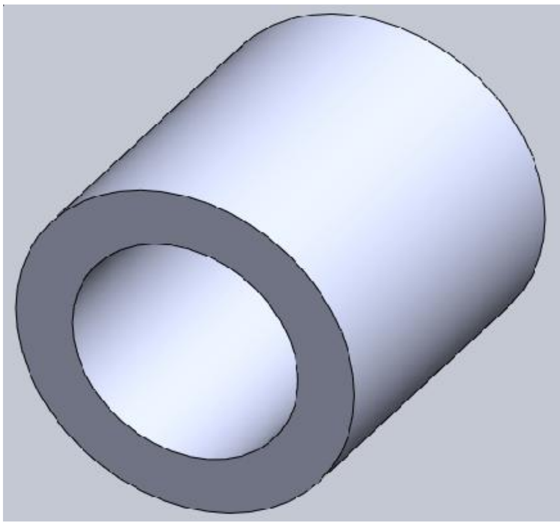
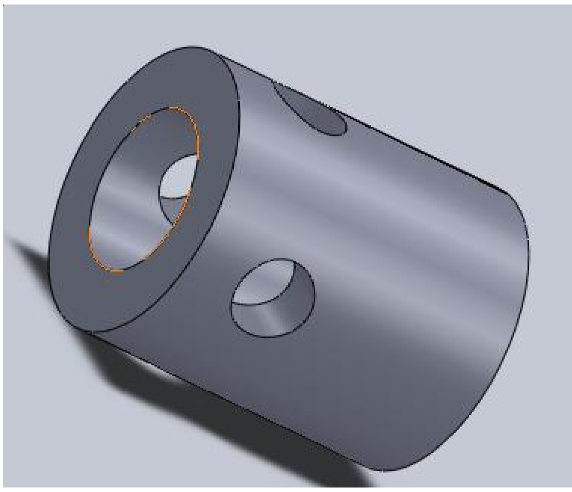


Figure 11: Finished Work Piece



proposed jig. The drill bush size can be varying according to our drill tool diameter. At once in a time we can sattach two work piece on our proposed jig on the either side of the jig which is shown Figure 12. After finishing of one work the jig can be easily rotate with the help of the bearing which is attached to the jig. It is used to reduce the friction on the jig base while rotating the jig for machining.

Figure 12: Proposed Model

CONCLUSION

It is concluded that the project design and fabrication of a jig and fixture for hollow cylindrical component is to overcome the difficulty of holding and positioning of hollow cylindrical component by index plate with crank and sector mechanism while drilling external holes on the component. By making use of this jig and fixture, the holding and indexing of the circular job is made easy. This saves time that leads to the increase in the rate of production and reduce the fatigue of the workers.

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