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Modification in Drilling Mechanism with Self Centering Fixture Arrangement

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***Abstract*-The modified drilling machine is used to control depth of drilling. The self-centering fixture reduces cycle time as well as accuracy. In conventional mechanical system lot of time wastage in clamping the job and errors in hole sizes. To overcome above drawbacks it is required to design a hydraulically self centering fixture with limit switch arrangement for depth control so that it will increase productivity as well as accuracy in drilling operation.**

In conventional radial drilling machine, it require more time to clamp the job and hence cycle time increases and manual handle used to adjust depth of cut. In modern concept we use hydraulic pressure to clamp the job by using thruster and depth of drill can be controlled by using limit switch. It will give exact clamping pressure and job is self centered which reduces cycle time and accuracy of hole can be increased by more percentage by using the limit switch.

Key words: Fixture, Depth control, limit switch

INTRODUCTION

The main function of fixture is to locate and hold the work piece .Fixture is a mechanical device which can be replaced as work piece changes. There are number of factors which we have to consider while designing of fixture. Quality of production should also depend on jig and fixture. A fixture consists of set of locators and clamps. Locators are used to determine position and orientation of a job whereas clamp can be used for clamping the job by applying clamping pressure. The main aim of this project is to replace conventional fixture system by hydraulically operated self centered fixture.

Clamping pressure can be exerted by means of hydraulic fluid and work piece can be clamped. By using hydraulic fixture manufacturer get flexibility in clamping pressure as per job specification and material. Work piece location principles are defined in terms of 3-2-1 fixturing which is widely used work piece location method for prismatic parts.

Problem Definitions

Problems Occurring in Existing Fixture are:

- Fixture setup is done manually due to this cycle time is more.
- Overnighting or loosening of screw leads to machining defects.
- Product quality is not obtained as per specification.
- Sometimes rejection rate is observed.
- Manual clamping leads to accidents.
- More hectic to operator to load and unload.

Solution of problem

In order to overcome the above limitations it is proposed to design and develop an auto-feed drill mechanism with following features as per product development needs

- Drilling head with 250 watt power, 2500 rpm (0 to max Speed) with ½” drill chuck
- Auto-feed drill head with 12 V DC motor drive
- Automated sensor based depth control.
- Hydraulic operated self centering fixture for quick clamping and secure location..

Design of Fixture

We require to design self centering fixture for proper clamping of the workpiece so we need to design fork pin, arm, internal and external gear pair which is shown in fig 5

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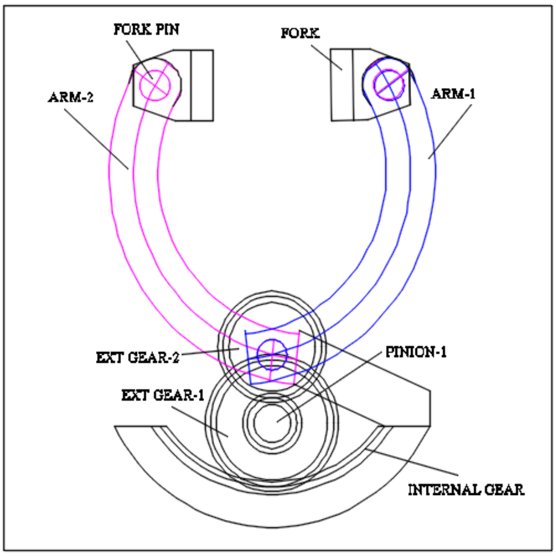

Fig 2 Self Centering Fixtures

Design of Fork Pin

Fork pin connects the fork to arm. The material of fork pin is EN9. We know that, load applied is due to translation of piston rod, i.e. Pt = 57N

Check for direct shear of connecting pin

$$\text{Shear stress} = \frac{\text{Shear force}}{\text{Shear area}}$$

The fork pin supports the fork end and is supported in the lever at other end hence will be subjected to a single shear failure

$$\text{Shear force} = \frac{180}{\Pi/_{4} \times (\mathrm{d})^2}$$

Connecting pin minimum section is 11 mm for mounting in fork eye hole.

$$\text{Shear stress} = \frac{57 \times 4}{\Pi \times (11)^2}$$

$$\text{Shear stress} = 0.06\text{N/mm}^2$$

As $fs_{act} < fs_{all}$

Hence pin safe

Design of Arm Lever

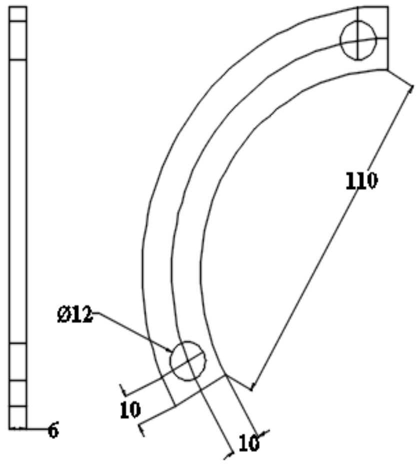

Fig 3 Arm lever of fixture

Material of arm = EN9

Section = 20x 6 mm

The lever is a link that is subjected to direct tensile load in the form of push/pull = 57 N

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The lever is slotted in order to accommodate the slider hence the weakest section is the central part where the slider fits. Section of lever is 20x6 with central hole of 11mm hence;
The cross sectional area at this point is 54 mm^2

Material Selection for Arm

Material Designation	Tensile Strength(N/Mm^2)	Yield Strength(N/Mm^2)
C40 (EN9)	600	380

Check for failure of connecting rod under direct tensile load
Now,
Ft = Load /Area
Ft act = 57/54
=1.05/mm^2
As $Ft_{act} < Ft_{all}$
The link is safe under tensile loading.

Design of spur gear pair, geared motor and screw

Power = 01/15 HP = 50 watt
Speed = 1000 rpm
b = 10 m
Tdesign = 0.48 N.m
Sult pinion = Sult gear = 400 N/mm^2
Service factor (Cs) = 1.5
dp = 20
T = T design = 0.48 N-m
Now;

$$T = \text{Pt} \times \frac{\text{dp}}{2}$$

$$\text{Pt} = 48\text{N}$$

$$\text{Peff} = \frac{(\text{Pt} \times \text{Cs})}{\text{Cv}} = \frac{(32 \times 1.5)}{\text{Cv}}$$

Neglecting effect of C_v as speed is very low

$$\text{Peff} = 48\text{N} \quad \text{(A)}$$

Lewis Strength equation

$$\text{WT} = \text{Sbym}$$

Where;

$$Y = 0.484 - \frac{2.86}{Z}$$

$$\text{Yg} = 0.484 - \frac{2.86}{10} = 0.198$$

$$\text{Syp} = 79.2$$

W_T = (Syp) x b x m
=79.2 x 10m x m
$W_T = 792m^2$ (B)

Equation (A) & (B)
$792m^2 = 48$
m=0.25
Selecting standard module =2 mm
This module e is selected with the view that the proper mesh between sun –planet-and ring gear is done
No. of teeth on sun=10
No. of teeth on planet gear =22
Module = 2mm

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Experimental set up

Fig 4 Experimental set up of drilling machine

Testing of drilling mechanism with self centering fixture to determine

- Reduction in cycle time of fixturing
- Improvement of dimensional accuracy due to implementation of fixture
- Productivity improvement owing to use of developed system
- Analysis of clamping force in self centering fixture at different hydraulic oil pressure

Measurement of clamping force

Fig 5 Clamping force Measurement

The clamping force produced is a function of the solenoid stroke. The clamping force can be measured by using load meter having range 0 to 40 kg

a) Minimum Clamping force: 0.8 kg
b) Maximum clamping force: 5.4 kg
c) This is secure clamping force for diameter up to 80 mm.

Hydraulic Thruster for Clamp
It is combination of two parts namely
a) Solenoid
b) Thruster

Solenoid Specifications:
a) Voltage: 230 V Ac
b) Load: 3 kg
c) Stroke: 20 mm

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Fig.6 Solenoid with Hydraulic Thrusters

Working of solenoid

When electric current is passed to the solenoid , magnetic field is developed which pulls the , ram of the solenoid behind and thus ram which is connected to the brake lever is pulled back to apply the brake.

The solenoid is mounted along with a linear guide ways to apply the pull force to the band.

Thruster specifications

Thruster is a set of piston housed in a hydraulic cylinder. Piston is of diameter 20 mm. This indicates that if solenoid gives input of 1 kg the Thruster delivers an output force of 1.8 Kg.

RESULTS AND DISCUSSION

When 6mm drill can be operated for the depth of 15mm for rectangular job then following results can be obtained:

Table 1Observations for 6mm Drill Size and 15 mm Depth

Sr. No	Size of job mm	Size of drill mm	Conventional machine		Modified machine	
			Clamping time (sec)	Cycle time(sec)	Clamping time (sec)	Cycle time(sec)
01	25	8	38	67	5	33
02	35	8	40	69	6	35
03	40	8	42	70	6	36
04	45	8	42	70	s7	36
05	60	8	44	72	7	37
06	65	8	44	72	7	37
07	80	8	46	74	8	38

Table 2 Comparison of Hole Size and Hole Position

Sr. No	Size of job (mm)	Size of drill (mm)	Conventional machine		Modified machine	
			Final dimension of hole	Position accuracy of hole	Clamping time (sec)	Cycle time(sec)
01	30	8	6.50	+/- 0.7	6.15	+/- 0.4
02	35	8	6.40	+/- 0.7	6.15	+/- 0.4
03	40	8	6.30	+/- 0.7	6.14	+/- 0.3
04	50	8	6.30	+/- 0.7	6.12	+/- 0.3
05	60	8	6.30	+/- 0.7	6.10	+/- 0.3
06	70	8	6.30	+/- 0.7	6.10	+/- 0.3
07	80	8	6.30	+/- 0.7	6.10	+/- 0.3

a) From table above it is clear that the hole size produced by modified machine is more precise wit close tolerance of +/- 0.15 mm as compared to +/-0.5 mm for conventional machine
b) From table above it is clear that the hole position by modified machine is more precise with close tolerance of +/- 0.4 mm as compared to +/-0.8 mm for conventional machine.

- Analysis Result

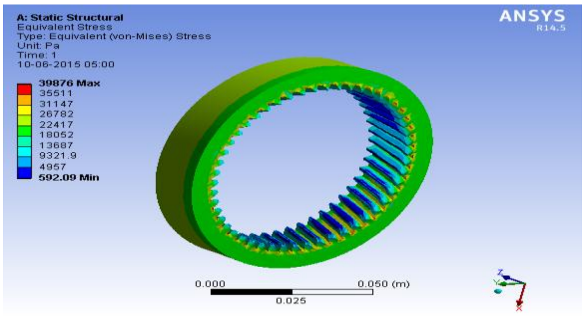

Fig.7 Stress distribution of Internal Gear

The maximum stress for internal gear is 0.3896 N/mm^2 which is shown in fig. m and theoretical stress calculated is 0.01 N/mm^2.so, internal gear is safe for the result.

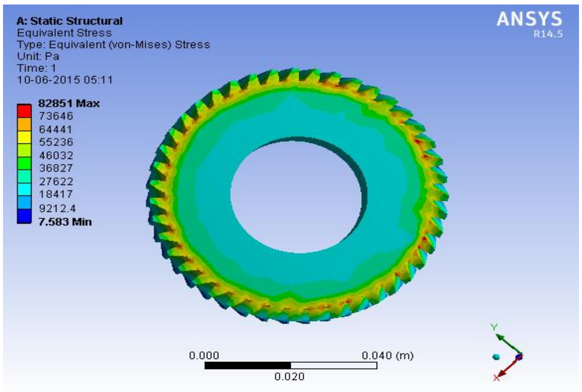

Fig.8 Stress distribution of External Gear

The maximum stress for External gear is 0.8285 N/mm^2 which is shown in fig. m and theoretical stress calculated is 0.02N/mm^2.so, External gear is safe for the result.

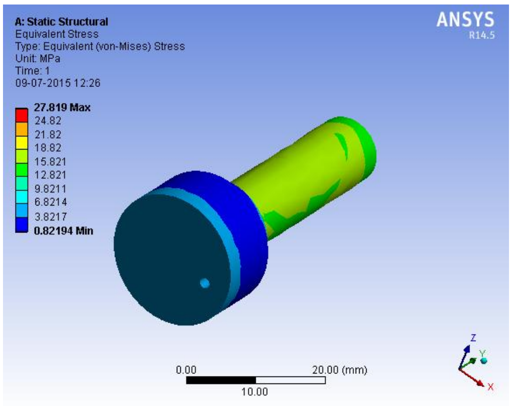

Fig.9 Stress distribution of Piston

The Von-mises stress is 27.81 N/mm^2 which is shown in fig X. The maximum theoretical stress is 16.29 N/mm^2. Hense Piston is safe for above result.

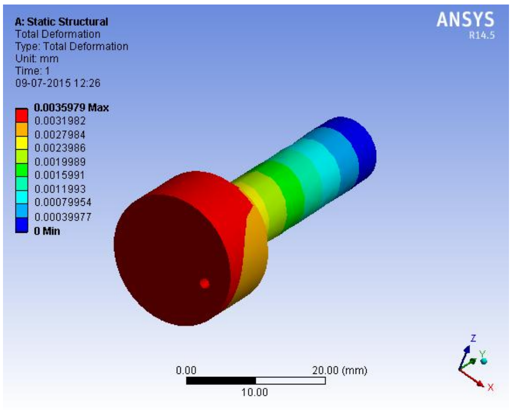

Fig.10 Total Deformation of Piston

The total deformation of piston is 0.0036 mm.which is shown in fig.10

Part Name	Maximum theoretical stress N/mm^2	Von-mises stress N/mm^2	Maximum deformation mm	Result
Piston	16.29	27.81	0.0036	safe

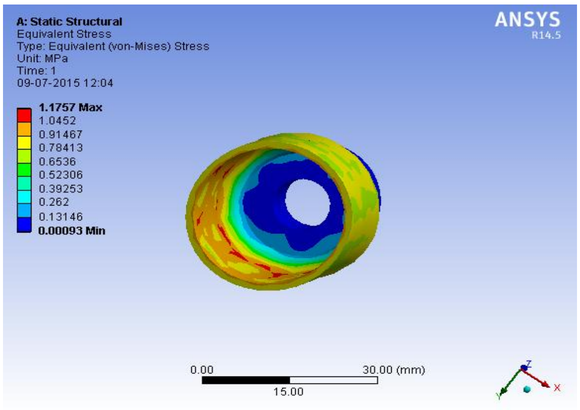

Fig.11 Stress distribution of Cylinder

The Von-mises stress for cylinder is 1.18 N/mm^2 which is shown in fig 11. The maximum theoretical stress is 8.26 N/mm^2. Hense Cylinder is safe for above result.

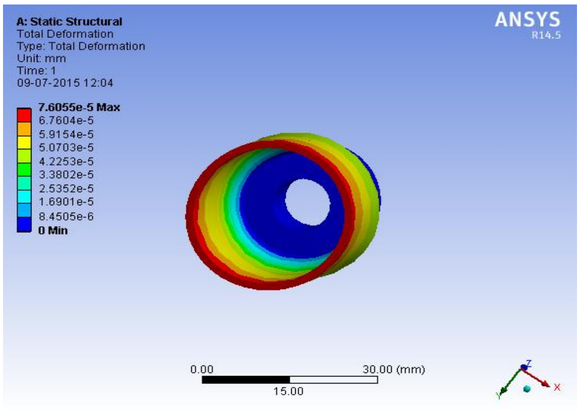

Fig.12 Total deformation of Cylinder

The total deformation of cylinder is 7.6E-5 which is as shown in fig 12

Part Name	Maximum theoretical stress N/mm^2	Von-mises stress N/mm^2	Maximum deformation mm	Result
Hydraulic Cylinder	8.26	1.18	7.6E-5	safe

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CONCLUSION

Graph shows a slight increment in clamping time with increase in job size with maximum clamping time of 46 seconds.

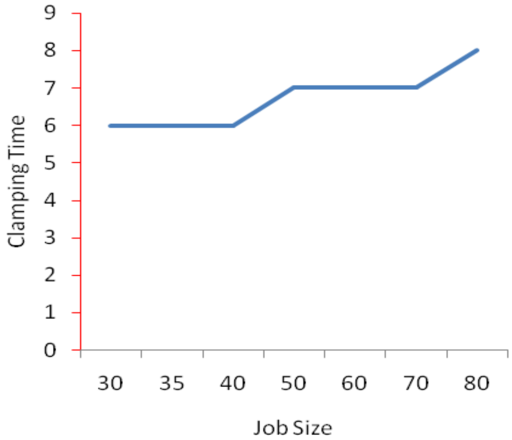

Fig 7 Clamping Time Required Vs Job Size

Graph shows a slight increment in clamping time with increase in job size with maximum clamping time of 8 seconds.

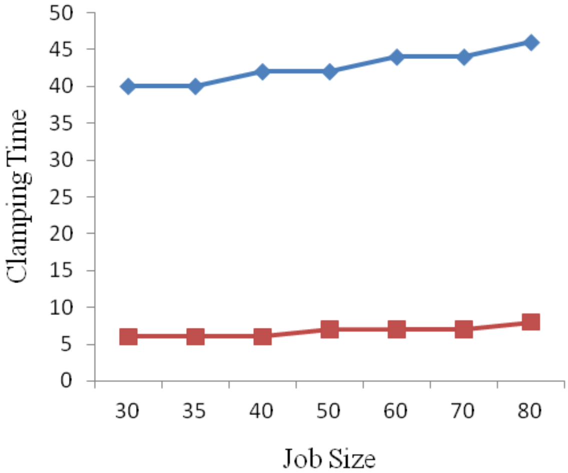

Fig 8 Clamping Time Required for Modified and Conventional Machine

Graph shows that the clamping time with modified fixture system is only 20 % of the clamping time required on conventional machine indicating a very fast clamping action and there by a saving of close to 80% of idle time of machine

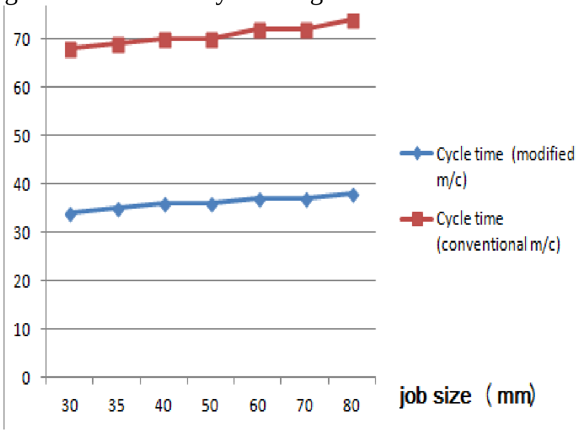

Fig 9 Cycle Time for Modified and Conventional Machine

Graph shows that the cycle time with modified fixture system is only 50 % of the clamping time required on conventional machine indicating a very fast clamping action and there by a saving of close to 50% of production time of machine thus the productivity of the modified machine is close to 2 times that of the conventional machine.

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