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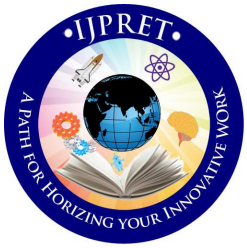

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A PATH FOR HORIZING YOUR INNOVATIVE WORK

DESIGN AND ANALYSIS OF WEIGHT LEVER DRILLING JIG

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Abstract

The manufacturing industry mainly of small scale and medium scale provide wide range of products to fulfil the need of today's market. To face the challenges these industries should increase their production rate with good quality and accuracy. Thus the time required for the production should be decreased to as small as possible. Jadhao gear is the flagship of the Jadhao group of Companies. JG is well known in India & Abroad for high quality Cotton Ginning & Pressing Machinery manufacturing. Auto feeder is important part of ginning machine with increase demand of product and need of company. Ginning machine has many components out of which many are very time & cost consuming. This paper deals with Design of Jig for Weight Lever which includes production time reduction, improved and accurate dimension-ability, reduction in rejection, and cost effectiveness.

INTRODUCTION

Today's business scenario is characterized by increase demand of product, faster response and mass production. To meet the current challenges it has become imperative for companies to increase the production rate. The companies throughout the world are trying to improve their profit without increasing their sale price of their products. This can only be done by minimizing the manufacturing cost of products by increasing productivity and reducing losses during production.

Over the past few centuries there have been large strides in manufacturing processes and use of jigs and fixture in manufacturing is one of them. Jigs and fixtures are production-work holding devices used to manufacture duplicate parts accurately.

Jigs and Fixtures are special purpose tools which are used to facilitate production when work pieces are to be produce on a mass scale. They provide a means of manufacturing interchangeable parts since they establish a relation, with predetermined tolerances, between the work and the cutting tool. Once the Jig or Fixture is properly set up, any number of duplicate parts may be readily produced without additional set up. Hence, jigs and fixtures are used to:

- To reduce the cost of production.
- To increase the production rate.
- To assure higher accuracy of parts.
- To provide for interchangeability.
- To enable heavy and complex-shaped parts to be machined by being held rigidly to a machine.
- To reduce quality control expenses.
- Less skilled labour.
- Saving labour.
- Their use improves the safety at work, thereby lowering the rate of accident.

The present paper deals with one of the manufacturer in Amravati region Jadhao Gears Limited. This industry manufactures ginning machine which separates the seed from cotton. An auto feeder is a sub component of ginning machine which feeds cotton continuously to ginning machine. The ginning machines are produced in the assembly lines of Jadhao gears private limited. While the components required for the ginning machine are manufactured in Jadhao gears.

In present condition, the machining of components is done manually. As the machining has been done manually, the various operations like punching, marking consumes ample amount of time. Moreover the setting and holding of job during machining is difficult and time consuming task. Thus the machining of the components becomes difficult and the production rate remains slow.

OBJECTIVE

The primary objective of this paper is to increase the production by reducing operation time thus reduce cost which leads to enhance quality of the fabrication process of various parts of the Ginning machine.

METHODOLOGY ADAPTED

Design work is executed in five steps and these are as follows:

- First of all we have observed the different manual operations and selected our area of interest for working.
- Then we have selected few components according to their time and labour requirement which can be reduced using some engineering solutions.
- Then all the components are studied in detail. Its application in the assembly and the present method of fabrication is also studied in details.
- Then as per the job specification the design of drilling jig is prepared and design calculation for each element of jig and fixture have done.
- To validate the design calculation and assumption made in the analysis of different designed part will carried out using software ANSYS-WORKBENCH-13.0. Finally the results will obtain and will discuss.
- The comparative fabrication cost and time analysis is done before and after implementing the drilling Jig or fixture.

as per the companies present requirement they need such processes and techniques which can be efficiently used to reduce the cost, improve the quality and reduce the time of operation for its various products. when we had taken the view of various operations in the company, we found some process required few improvements.

We have selected WEIGHT LEVER which is the parts of **Ginning machine** and **Auto**

feeder as our paper as these parts are having very inefficient working processes requires much time and extra labour which is unnecessarily increasing the cost of components. To reduce this time, to eliminate unnecessary movements and reduce cost also to make processes

PROBLEM STATEMENT

These components are having drilling operation which is currently done with manual mode of drilling comprising various processes such as marking, punching, setting of components and drilling.

After detailed study of these components we have come to the conclusion that the providing drilling jig is the best way to increase the production rate. This wills semi automated the process and provide better way to increase the production.

As per market requirement, company produces40 machines per day for six month each year.

Total machines produced per year: 180×40=7200 machines (for six months)

The cost of DR Ginning machine is Rs. 77442/-.

The cost of Auto Feeder machine is Rs. 20528.48/-.

Weight Lever (4/machine) = 28800 per annum

The above mentioned part is having drilling operations at various positions, which require tedious method of operation and consumes lot of time. So we have decided to Design the Jigs & Fixtures for it.

Fig. 4.1 showing Beater cap In Actual Machine

Fig. 4.2 Weight Lever

The Weight Lever is a heavy and rigid component made of cast iron and is about 3kg in weight. This component looks like

two cylindrical shapes arranged at an acute angle. Inner diameters of these two cylinders are 25 mm and 35 mm. It has one shorter leaf like structure on which drilling operation is performed. This component is used in both the DR Ginning machine and Auto Feeder machine. In the cylindrical pace one lever is attached with the help of which we can adjust different positions and control the operation. In Auto Feeder machine this component is used to make the belts tight or slack. Four weight levers are required for each of DR Ginning machine and Auto Feeder machine.

A. Material selection [6]

MATERIAL PROPERTIES REQUIRED ARE AS FOLLOWS:

High yield strength- As slotted element is subjected to very high bending stresses due to the welding distortion. To withstand these high bending stresses the material should have high tensile strength.

Good wear resistant- the partition plates are inserted into the slot of the slotted element again and again. This may cause wear of the inner faces of the slot and consequently results in inaccuracies. So, material selected should have good wear resistance.

High shear resistant- very high magnitude of distortion force acts tangentially which may cause shearing off the slotted element.

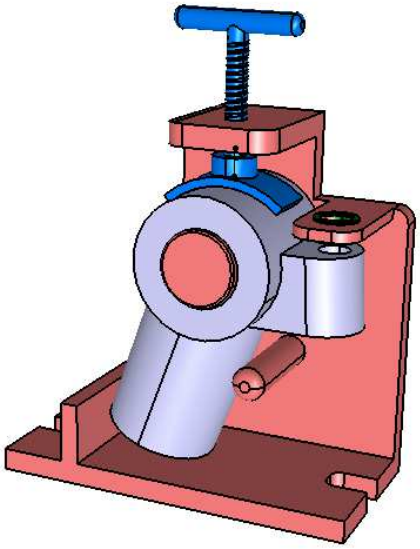

Fig. 5.1 Design of Weight lever jig.

Good machinability- this is very desirable material property because during fabrication of the fixture element very precise machining is required and if machinability is not good then it will cost moreGood welding capability- material selected should have good welding capability to weld with variety of material.

Design OF JIG

A.WEIGHT LEVER

Problem definition

PRESENTLY WEIGHT LEVER REQUIRES THREE OPERATIONS TO BE DONE VIZ. MARKING, PUNCHING

AND DRILLING WHICH REQUIRES TWO WORKERS AND 245 SECONDS FOR THE COMPLETION OF ONE JOB. HERE THE MARKING AND PUNCHING IS BEING DONE BY THE SAME WORKER AND THE OPERATION TIMING AND NO. OF WORKERS REQUIRED ARE AS TABULATED BELOW.

TABLE

TIME REQUIRED BEFORE JIG

Sr. No	Process Name	No. of Workers Required	Time Required
1	Marking + Punching	1	108 + 72 = 180 sec
2	Job setting + Drilling	1	20 + 45 = 65 sec
	Total	2	245 sec

AS IT REQUIRES NUMBER OF WORKERS AND MORE TIME TO BE COMPLETE OPERATION, WE HAVE DECIDED TO DESIGN JIG FOR IT. JIG WILL ELIMINATE THE MARKING, PUNCHING OPERATION AND SETTING OF JOB ALSO. IT WILL DIRECTLY DO THE DRILLING OF 21MM DIA. HOLE ON JOB WITH MUCH ACCURACY.

Proposed Solution

THIS JIG IS MADE FOR MAKING THE SINGLE HOLE ON THE WEIGHT LEVER (WORKPIECE) ON THE DESIRED POSITION FOR WHICH WE HAVE DESIGNED THE ABOVE JIG. THIS JIG CONTAINS THE FOLLOWING PARTS/ ELEMENTS:

1. Body
2. Locator
3. Jig plate
4. Clamp

Body is made up from 20 Mn2 alloy steel material. The two locators and the center rod are welded with the body on desired location. Jig plate and the clamp are fitted as shown in figure. Workpiece has centre hole which is held in the mandrel of jig and locator provides its proper position. After locating the workpiece clamp is operated by hand, this exerts the clamping force to the workpiece

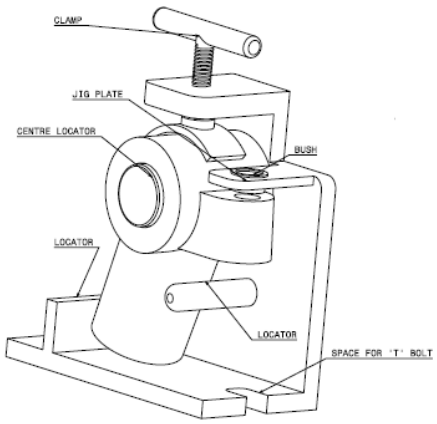

Fig. 5.2 Design of Weight Lever jig showing various components

Material Selection

THE MATERIAL SELECTED FOR THIS ELEMENT IS ALLOY STEEL (20 MN 2).

THIS STEEL IS TOUGH YET DUCTILE AND HAS GOOD WELDABILITY AND MACHINABILITY.

Table-II

Properties of Alloy Steel – 20Mn2

Sr. No.	Properties	values
1	Yield strength	432 N/mm2
2	Tensile strength	588-736 N/mm2
3	Brinell Hardness No.	170-217

Drilling Force formulae:-

Moment due to Forces

$$M = HB \times D^2 \times {}^{f}/_{8}$$

Thrust force due to Cutting Edge :

$$T_1 = (1.7 - 3.5)\frac{M}{D}$$

Thrust Force Due to Chisel Edge :

$$T_2 = (0.1 - 0.2)\ \frac{\pi}{4} \times W^2 \times HB$$

As we have to drill the Hole of 15 mm diameter,

D = 15 mm. f = feed rate = 0.25 mm/ rev & HB = Brinell Hardness No.

Load Distribution during loading

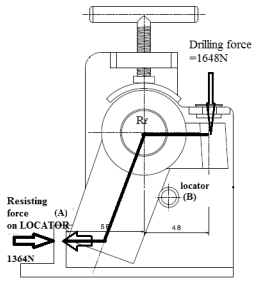

Fig. 5.1 Drill force distribution

PROCESS OF LOADING AND UNLOADING OF JIG

1. Revolve the screw and open the clamp

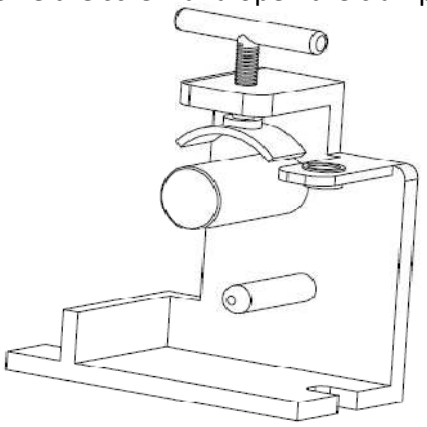

Fig. 6.1Main Body

1) Fixed the hollow cylindrical part of the component over the centre support.

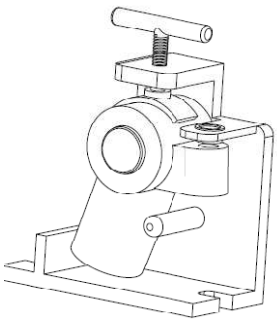

Fig. 6.2 Jig with its Weight lever

1) Now again revolve the screw and fix the component with help of clamp.
2) Through the bushes of the jig plate make the drilling and create the hole in the component.

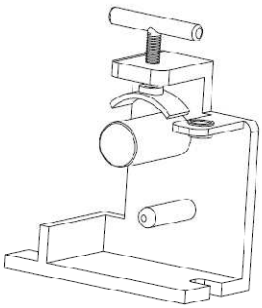

Fig. 6.3 Main Body

TOTAL JIG COST:

Total Cost = Material Cost + Operation Cost

= 616.50 + 2234.00

Total Cost = Rs. 2850.50 /-

VII. ANALYSIS OF FRAME

Apply fixed supports at its Base.

Apply the force of 1700 N at centre of Mandrel also apply the load of 1300 N at locator plate in –X direction.

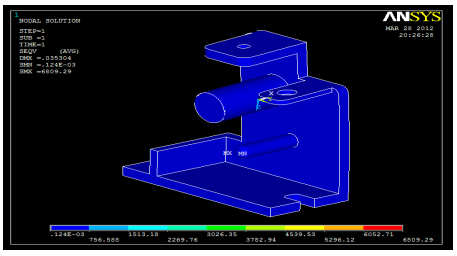

Fig. 7.1 Vole mise Stresses on Frame

Post-processing:-The total deformation and total stresses produced in base is obtained by applying the boundary conditions.

The result for stress is as shown in fig. From the figure, it concludes that the maximum stress is approximately 0.134 × 10-3 which is negligible and within the limit.Similar procedure is adapted for analysis of remaining elements of jig.

ASSEMBLY OF FRAME AND COMPONENT

- Boundary Conditions-
- Fixed the base of Frame.
- Force is applied on the component at the area where drilling is to be done.The uniform pressure of 2 N/mm2 is applied on this area.

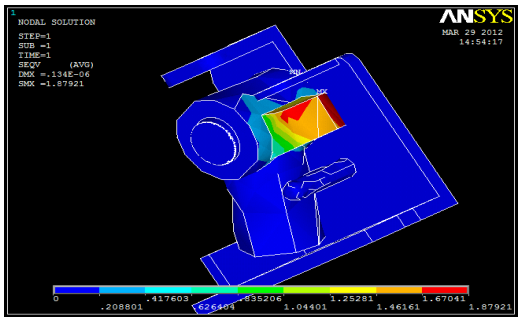

Fig. 7.2 Vole mise Stresses on Assembly

The result for total stresses induced is shown in fig.. From the figure, it concludes that total stresses produced on slotted

element are negligible. That is design is safe.

CLAMPING NUT

- Material type- Alloy Steel 20Mn2.
- Mesh type-Coarse Tetrahedral Mesh Type.
- Boundary Conditions-

- Fixed the base of Nut.
- Force is applied on the component at the area where drilling is to be done. The uniform pressure of 0.85 N/mm2 is applied on this area.

The result for total stresses induced is shown in fig.. From the figure, it concludes that total stresses produced on slotted element are negligible. That is design is safe.

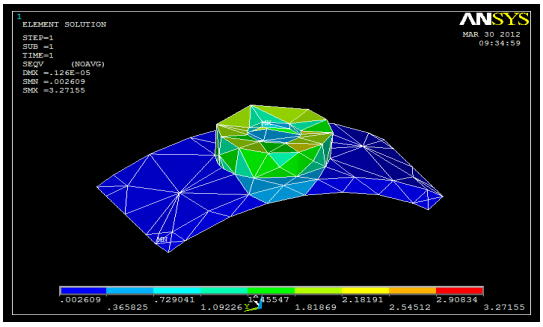

Fig. 7.3 Vole mise Stresses on Clamping Nut

Sr.	Existing Solution	Proposed solution (using JIG)
1	Operation time = 245 sec (Marking + setting + drilling)	Operation time = 60 sec (Drilling + Loading + Unloading)
2	No. of Workers required = 2	No. of Workers required= 1
3	Rate of production =200 jobs/day	Rate of production =820 jobs/day
4	Labour Cost per Weight Lever =Rs.2.4/-	Labour Cost per Weight Lever =Rs.0.30/-
5	Total Operation cost for 28800 Weight Lever =Rs.69120/-	Total Operation cost for 28800 Weight Lever =Rs.8429/-
6		**Cost of Jig = Rs. 2850 /-**

- **Total Saving with Jig= Rs. 57841/- (Per Annum)**
- **Payback Period = 8 days**

RESULT AND DISCUSSION

We can directly compare the labour cost before and after Jig. As the material cost and operation cost will be same we are not taking these costs into account.

CONCLUSION

This paper has provided the solution to the problem faced by the Jadhao Gears regarding drilling and production rate of Ginning Machine components. The industry has been using manual preparatory method for drilling due to which the company is facing problem like low production rate and high labor cost. To overcome this problem

in this project we have proposed some designed of jigs.

Weight Lever before using the jig with 2 workers requires 245 sec per components while after using jig there will be only 1 worker required having operation time 60 sec thus we will save the labour cost of Rs. 57841 /-. Other than this we will save the machine working hours

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