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Research Article

DESIGN AND FABRICATION OF HYDRAULIC LIFT COVER (HLC) COMPONENT TILTING MACHINE

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ABSTRACT

By using the Karakuri Kaizen concept in Japanese technology helps to reduce the physical strain of a workman in a work place. So I had planned to design and fabricate a mechanism in order to reduce operator fatigue caused during tilting manually the hydraulic lift cover which weighs about 40 kg. I implemented this project in Tractor and Farm equipment TAFE, Chennai. Due to frequent power shutdowns many industries are facing problems to run their manufacturing unit peacefully. As an alternate they are using generators which require fuel to generate power. This adds excess cost for manufacturing the products and demand for fuel is also increasing day by day. So to avoid all these problems with a one-step solution that is dependability of energy resources has to be minimized. For avoiding the usage of energy resources the usage of pneumatics and compressed air has to be reduced. Karakuri kaizen which was first introduced by Japanese is a system which handles materials using natural principles like gravitation force, centrifugal force. It requires only investment cost. I planned to apply this system at machine shop of TAFE ltd, Chennai with the help of my guide Mr. Subramani T (TPM), Mr. Pandit(fabrication). As a first step we started with 2-D drawing and then went on with offline 3-D testing which was done after the design process. A solid works model was made to avoid corrections in the fabrication process so that cost and time can be reduced.

INTRODUCTION

Besides tractors, The Industries and its subsidiaries have diverse business interests in area such as farm machinery, diesel engine, batteries, transmission components, panel instruments, engineering plastics and hydraulic pumps and cylinders. From a small beginnings with just one tractors model in 1961, Industries today is recognized as a high quality mass manufacturer with an extensive product range to meet every farming need, innate engineering strengths, uncompromising on quality and immense reserve of experimental knowledge gained through designing, developing, manufacturing and supporting tractors that are synonymous to reliability and ruggedness. Industries R&D facilities are centres of excellence, renowned for their innovative design and engineering expertise, and have been recognized by the department of scientific and Industrial Research, ministry of science and technology, Government of India.

Extensive research and testing ensures that Industries first overseas plant in turkey went on stream in 2010 and manufacturers a range of tractors for distribution in turkey through AGCO dealer network. With its acquisition of Eicher's tractor business and engines plant in 2015 through a wholly owned subsidiary. Industries presently has four tractor plants in India, an engine's plant and two engineering plastics

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units besides other facilities, employing over 2500 engineers apart from a number of specialists in other disciplines.

METHODOLOGY

Calculation for the Installed HLC Vertical Machining Centre Unit

Design of the shaft material-mild steel (Ms):

- Weight of the component =40 kg = 400 N
- Weight of 1 plate = Total volume × Density of the material.
- Total Volume = (volume of the base plate)+(volume of the length corner on the both sides)+(volume of the base corner on the both sides)=(length × breadth × thickness of the Plate)+ (Length × height from base ofthe plate × thickness × 2) + (Breadth × height from base of the plate × thickness × 2)=(730 × 330 × 6)+(730 × 40 × 6 × 2)+(330 × 40 × 6 × 2)

Total volume=1954200 mm^3

Weight of the component =1954200 × (7.87 × 10^{-3})=15379.589 g

=15.37 kg

=153.7 N

Total load=400+153.7

=553.7 N

Total load P + 554N

To find the diameter of the shaft:

$$Factor\ of\ safety = \frac{Maximum\ shear\ stress}{Allowable\ shear\ stress}$$

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For shock load Factor of safety=10

$10=200/\tau_{allow}$

τ_{allow}= 20 N/mm^2

$$= \frac{\quad}{24}$$

$d^2= 554 \times 4/(20 \times \pi)$

d = 5.93

Standard diameter=10 mm

To find the deflection of the shaft:

Here the plate is considered as a beam

0.758 N/mm

Bending moment $M=Wl^2/24$

$$= \frac{0.758*\left(730^2\right)}{24}$$

=16850.833 N-mm

M=16.85 N-m

$$Deflection\ y = \frac{Wl4}{384\ EI}$$

$$= \frac{0.758*\left(730^4\right)}{384*200*10^3*(\Pi*\left(10^4/64\right)}$$

y=5.7 mm

Analysis of the design:

- Obtained stress analysis for plate 1=0.0407 N/mm^2
- Obtained strain analysis for plate 1= 1.065 × 10^{-7} (Fig. 1-3).

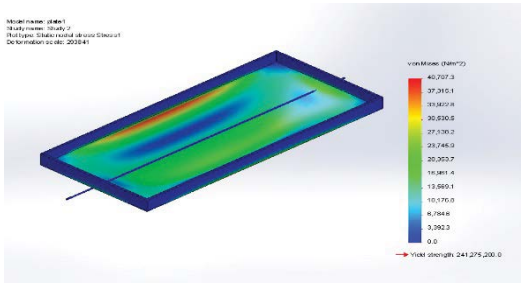

Fig. 1 Stress analysis of plate.

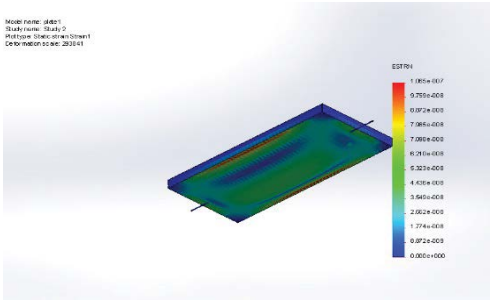

Fig. 2 Strain analysis of plate.

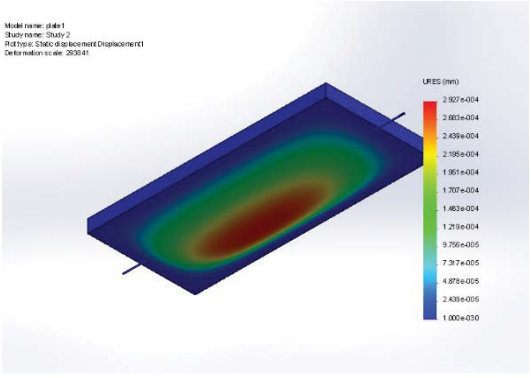

Fig. 3 Displacement analysis of plate.

LITERATURE SURVEY

More than theory Japanese believed in practical application therefore our industry guide Subramani T advised us to go through the video tutorials rather than study theory. But he said to go through the basic principles of physics which are used in this video as a main key concept. And a clue let given by japans consultant Kido san was used as a reference material as it had many practical applications with images as shown below.

Savita Tomar *et al*., Increasingly stringent emissions and fuel economy standards have long remained a source of challenges for research in automobile engine technology development towards the more thermally efficient and less polluting engine. Variable compression ratio (VCR) technology has long been recognized as a method for improving the fuel economy of SI engines. Spark ignition (SI) engines have lower part-load efficiency when compared with the diesel engines. To improve this efficiency operate SI engine with high compression ratio at part load and with low compression ratio at high load.

Design and Fabrication

The fabricator was nearly from that area only. So he was practical in all approaches. He asked for sample design before starting the discussion. The 2-D design is revealed to him. He gave the whole quotation to PED engineer Mr. Rajesh. There are totally 2 equipment in HLC line. Both are used in the inspection area. The process was started after the approval of quotation by the company to avoid future problems (Fig. 4 and 5).

Fabrication Process

The idea behind it is to reduce the physical strain (that is to add a v-plate arrangement of tilting 90 degree and returning). So we made 2 plates of (730 mm × 330 mm). The plate is made of mild steel material.

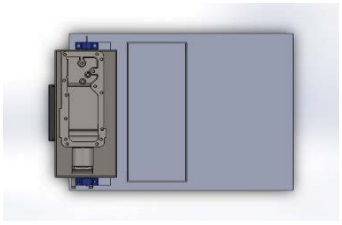

Fig. 4 Assembled top view.

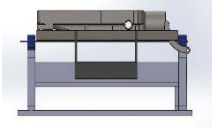

Fig. 5 Assembled side view.

The reason for choosing the Mild Steel (also known as carbon steel) material is because the operator needs to lift a component of 40 kg cast iron hence in order to withstand the load mild steel material is chosen by its material properties also it is easy to tilt by the operator. The mild steel material is weldable , ductile, the generation of heat is less than that of steel machining and have a better tool life also it has high tensile strength and low carbon percentage. It can also tempered with great hardness (Murata, *et al*., 2013).

The sender plate is kept at a inclined position of 10degree where a pedal type lever lock is given as a separate support near the pillow block bearing , when the component releases and comes to the original position the lever gets locked and the operator just needs to unlock the lever when the component is placed on the sender plate. While tilting the sound impact on the receiver plate is huge , hence a 1 × 1 rubber mat is taken because rubber mat gives resistance to vibration , it has hardness also it provides resistance to air diffusion and physiologically inert and with high adhesiveness. When the component tilts the sender plate needs to come to the original position, under the balancing of rotating masses principle for a component is a dynamic balancing when the rotation does not produce any resultant centrifugal force or couple, other than required to support its weight. The counterweight is made of mild steel material welded along with a T-shape joint rod . The stopper is kept at lower position when the sender plate releases the component to the receiver plate a stopper is being kept at the middle of the base where the sender plate hits the stopper such that it doesn't rotate 360 degree (Suematsu, 2001a; Suematsu, 2001b).

Factors Determining the Choice of Material

Hydraulic lift cover

A Tractor Hydraulic Lift System in which the lift system may be controlled by driveline torque, by draft sensed by one of the tractor hitch links or by a position control cam. The mechanism is arranged to permit combinations of position control with draft control and with torque control. Agricultural and general purpose tractors usually are provided with a power liftable hitch for supporting an implement mounted on or attached to the tractor. It is usual to provide mechanism for automatic lifting or lowering of the implement in order to maintain a more or less uniform implement draft or load on the tractor, which is measured by the force or reaction on the top link or lower links of the tractor hitch. Customarily, the force

Table 1. Factors determining the choice of material.

S. No	Description	Quantity
1.	6 mm thickness plate (19 kg)	2
2.	Rubber mat (1 × 1) meters	1
3.	Plummer block	2
4.	Shaft	1
5.	Lever lock	1
6.	Anabond (100 g)	2

Fig. 6 Hydraulic lift cover.

Fig. 7 Before and after the tilting mechanism.

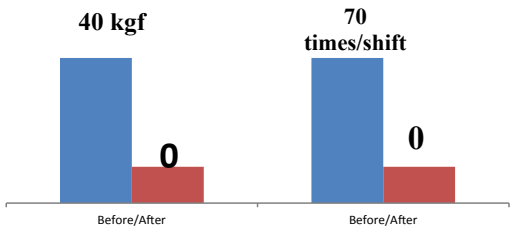

Fig. 8 Before and after the tilting mechanism.

exerted on the tractor links is sensed by displacement of a spring, and forces above or below that selected for operation result in raising or lowering the hitch to bring implement draft within the range selected. It also is usual to provide automatic height control of the hitch, in which the hitch is maintained at an elevation corresponding to the position of a control lever, known as position control Table 1 and (Fig. 6) (Kurokawa, 2001).

RESULTS AND DISCUSSION

1. Worker fatigue is reduced.
2. Employee morale increased.
3. Easy to load and unload the component from the tilting machine (Fig. 7 and 8).

CONCLUSION

The target of this project was to implement Karakuri Kaizen in machine shop. This was achieved before the date given in the master plan (Tamaya, 1976). This project is a great success because it has created a way for people to think and act. Also it has put lots of question in people's mind to generate new ideas. Karakuri Kaizen is a mechanism which can bring change to the whole world. The main advantage of it is that anybody can think and create the concept for a problem. It can be implemented not only in machine shop but even in our house it can be implemented. As the resources are shrinking every day we must save energy by implementing karakuri kaizen where ever possible in our places. You just need to analyze the situation and give an alternate for that which can save energy and reduce stress after implementation. One should also consider the point of safety as it is important than all other things. Everyone should practice (fool –proofing) and 3M's process called Muda (waste), Mura(unevenness) and Muri (overburden). One should know how to identify these things during implementation of any kaizen. This may save cost and may also ensure safety.

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