QFD –Application in Design and Fabrication of Cam Operated Riveting Machine

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Abstract— In many industries various types of machines and equipment have been used for various operations such as riveting, forging, hammering, cutting etc. But different problems such as low power supply, less man power and also heavy laborious work force, safety etc. found during the above said operations This paper relates to operation performance aiming to increase the efficiency with cost consideration using QFD approach and there by building house of quality (HOQ). Hence present paper focus on QFD to increase the productivity.

Key words: QFD, HOQ, Riveting Machine

I. INTRODUCTION

QFD conceptualized in the year 1966 with quality emphasis mainly establishes relation between customer requirements (voice of customer/what's) and production requirements (how's). QFD is a tool /process which can be applied for several fields at any phase of product and services.

II. LITERATURE SURVEY

A. *Evolution of QFD*

Year	Topic	Areas involved
1950	Fitness to standard	Standardization ,SQC.
1960	Fitness to use	Marketresearch,CrossFunctional Involvement .
1970	Fitness to cost	QC.7 QC Steps 7 QC Tools.
1980	Fitness to Latent requirement	QFD , 7 Management Tools.

Table 1: Evolution of QFD

III. QFD METHODOLOGY

By obtaining the components of QFD as shown in Fig 1, relationships are established, compared and analyzed. QFD-approach provides a great opportunity to work on cross-functional teams, employee involvement and participating management by discussing the meaning and importance of the `WHATs, HOWs, WHY's combinations. These strategic issues indicate that starting a QFD activity needs all support from various levels of management.

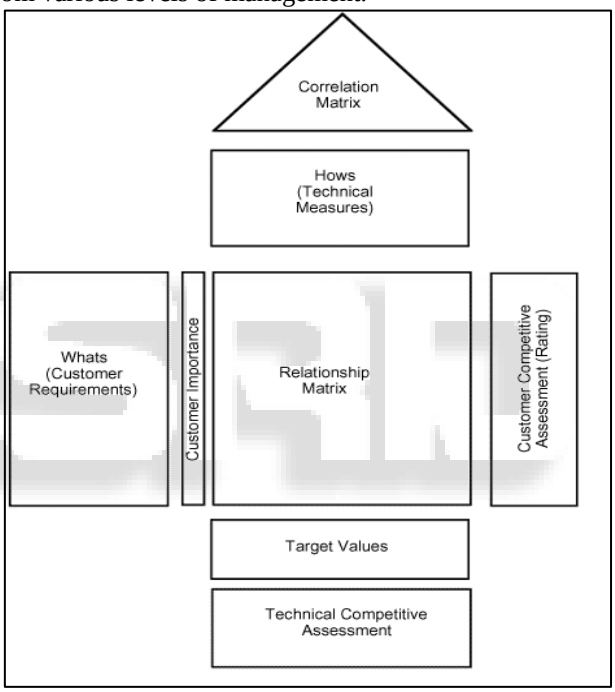


Fig. 1: Components of QFD Mode

IV. IMPORTANT RELATIONS OF HOQ

HOWS → / WHATS ↓	Priority	Squeeze force	Riveting structure	Countersink hole	Shear force
	8	3	3	0	3
Riveting distance					
Number of rivets	7	3	3	0	3
Types of rivets	6	3	0	0	0
Depth of hole		3	0	0	3
Load applied	5	3	0	3	0
Effective power transmission	4	3	1	3	1
Easy dismantling	3	3	0	0	0
Easy modification	1	3	0	0	3
Life /reliability	2	3	1	1	1
	Total	27	8	7	14

No relationship 0 Low correlation 1 Medium correlation 3 High correlation 9

This information analyzed to choose the major dominating values are 27and 14 are opted as dominating and trading factor for future design of riveting machine.

The dominating factors are squeeze force and shear force.

The cam operated riveting machine is a device which can be used for multi-purpose operations, mainly used for riveting. It can also be used for various purposes.

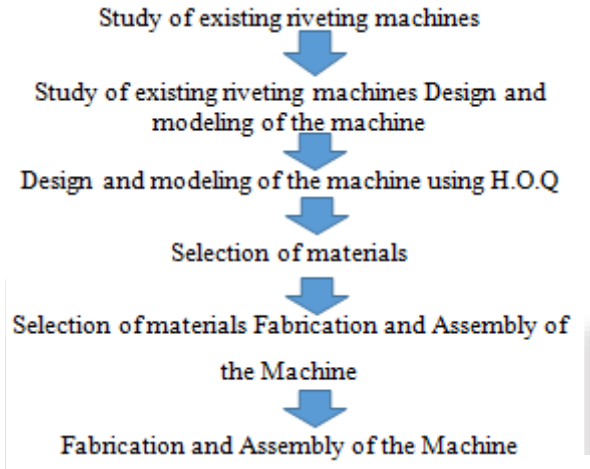
It is found that, from HOQ table, the major dominating values are 27and 14 are opted as dominating and trading factor for future design of riveting machine.

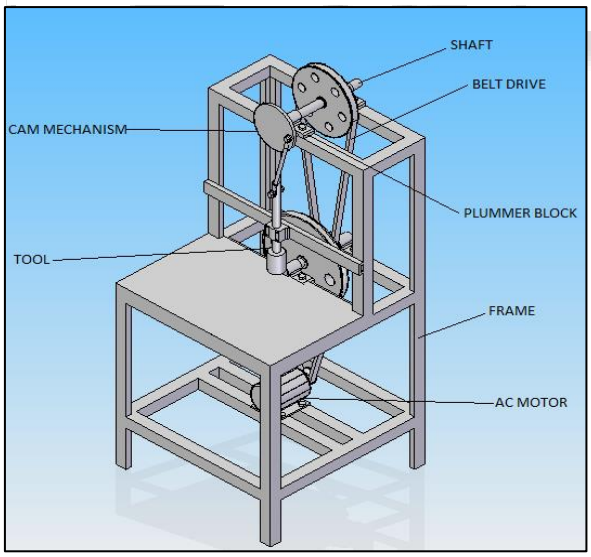
Hence future design must satisfy the above criterion one.\

V. DESIGN OF THE MACHINE

A. CAD design

1) FLOW CHART FOR DESIGN





B. Parts

- AC Motor: provides rotational movement for cam mechanism.
- Belt Drive: These are used for power transmission.
- Frame: It is a structure that supports all other components of the machine.
- Shaft: They act as a supporting structure for rotating elements.
- Plummer Block: It is a pedestal for supporting
- Cam Mechanism: It is used to obtain reciprocating motion of the tool.

C. Operation

An electric motor, which is having 1440 rpm is used to rotate the eccentric mechanism by pulley V-belt arrangement. The eccentric mechanism converts rotary motion into reciprocating motion. The tool which is attached to the eccentric mechanism reciprocates. A rail mechanism is provided for proper movement of the tool. The rivets are kept on the work table below the tool. As the tool applies continuously load on the rivet, under the action of tool riveting operation takes place.

D. Calculation

The feasibility study considered to design the riveting machine among the various power supply options.

Minimum Force Required for Riveting:

Impact loading formula is given by,

$$\sigma = \frac{W}{A}\left(1+\sqrt{\frac{1+2hEA}{WL}}\right)$$

$$240 = \frac{W}{\frac{\pi}{4}*14^2}\left(1+\sqrt{\frac{1+(2*155*69*10^3*\frac{\pi}{4}*14^2)}{W*15}}\right)$$

W=6.21 Newton

Force required for riveting is 6.21N

Using load W =6.21 N, among the three various alternatives scrutinized for the modification of design using feasibility analysis.

1) Rivette Calculations

$d = 6.04\sqrt{t}$

d = 6.04 5 d = 13.5mm.

d =14mm

Length of rivet (L) = total thick ness of the plate + allowance

Length of rivet (L) = 10 + 5

Length of rivet (L) = 15mm

Speed Reduction calculation:

D1 = Diameter of motor shaft

D2 = Diameter of middle shaft

D3 = Diameter of upper shaft

Motor speed, N1 = 1440 rpm (constant)

D1 = Diameter

Speed of middle shaft, N2 =?

D2=speed of middle shaft

i.e. N1D1=N2D2

N2 = N1D1/ D2

$$N2 = \frac{1440*2.54}{30.48}$$

Speed of middle shaft, N2 = 120 rpm

Speed of upper shaft =?

Using N2D2=N3D3

N3 = N2D2/ D3

$$N3 = \frac{120*5.08}{15.24}$$

Speed of upper shaft, N3 = 40rpm

Power Requirement:

$$\text{Power} = \frac{2*\pi*N*T}{60000}$$

$$P = \frac{2*\pi*40*(6.21*7)}{60000}$$

P = 0.1820 kilowatt = P = 0.244 HP

Since 0.244 HP motor is not available, selecting 0.5 HP AC motor.

The final design selected should have P = 0.5 HP

E. Parts specification

V-belt calculation

Based on above power calculation the power that is nearer to obtained value is 0.37 kW. Hence from design data hand book selecting 0.37 kW.

For 0.37 kW, Belts of type A (or) B (or) C can be selected.

Selecting type A

For belt of type A, Top width (w) = 13mm

Thickness (t) = 8mm

Length of belt = 2C + π 2

$D + d +$

$D-d$ 2 $4*C$

Where,

C = Center distance between the pulleys = 425mm

D = Diameter of larger pulley = 304.8 mm

D = Diameter of smaller pulley = 25.4 mm

Length of belt = (2*425) + π 2

(304.8+25.4) + (304.8−25.4) ^2 4∗425

Length of belt = 1414mm

Length of belt = 2C + π 2

$D + d +$

$D-d$ 2 $4*C$

Length of belt = (2*540) + π 2

(152.4+50.8) + (152.4−50.8) ^2 4∗540

Length of belt = 1404 mm

-Length of belt (1) =1414mm

-Length of belt (2) =1404mm

-Motor pulley dia=50mm

-Cam shaft pulley dia=230mm

-Length of shaft=250mm

-Dia of shaft=25mm for effective riveting operation.

VI. COMPARISON

Compared with other riveting machine, modified machine is compact and light in weight. The rate of production is also increased in comparison with existing riveting machine.

VII. CONCLUSION

The cam operated riveting machine incorporated with QFD and HOQ parameters in design leads to increase in productivity, compact and light in weight.

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