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Presentation on

"Review & preliminary design of orbital riveting machine"

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Abstract - Riveting process is conventionally carried out using either a press machine , or manually hammering. This process is not accurate , takes considerable time and effort and so also may result into damage of component. The Portable orbital riveter uses the principle of orbital riveting where in a high speed spinning riveting tool held at an angle in the riveting head is fed into the rivet. This results in cold forming of the rivet head of maximum strength and with comparatively low force (less than 80% force that of conventional method) result into a strong and accurate joint. The angle of the riveting tool held in the riveting head plays a significant role in the reduction in forming force , where as the table motion will determine the accurate positioning of the rivet in to tool profile , resulting into exact shape and size of rivet head formed. Project deals with development of portable orbital form riveting machine with portable drilling machine as power tool and auto-positioning feed table will be designed and modeled using Unigraphix software , Analysis will be done using Ansys work bench 16.0.

***Key Words*:** riveting, rivets, orbital riveting

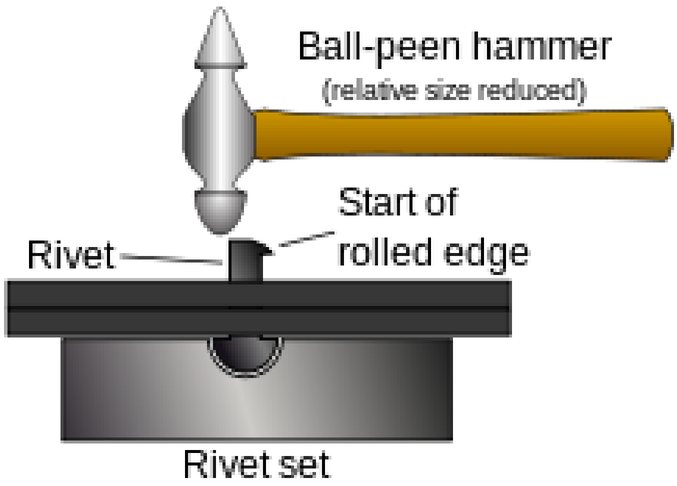
1.INTRODUCTION *(Size 11, Times New roman)*

A rivet is a permanent mechanical fastener. Before being installed, a rivet consists of a smooth cylindrical shaft with a head on one end. The end opposite to the head is called the tail. On installation, the rivet is placed in a punched or drilled hole, and the tail is upset, or bucked (i.e., deformed), so that it expands to about 1.5 times the original shaft diameter, holding the rivet in place.

Fastenings used in traditional wooden boat building, such as copper nails and clinch bolts, work on the same principle as the rivet but were in use long before the term rivet was introduced and, where they are remembered, are usually classified among nails and bolts respectively.

By riveting we mean the upsetting of an rivet to form a head to hold several assembled parts together. The rivet can be in the form of a pin or an eyelet.

Conventional Riveting methods :



Manual installation of a solid rivet

Impact method for solid rivet and semi tubular rivets

Objectives

1. Design Selection of Electric power source for orbital riveting
2. Design of electric screw jack for table feed.
3. Development of mathematical model of system of forces, and validation of strength of critical components of the riveting machine using ANSYS software
4. Experimental validation of maximum and minimum speeds of riveting available from the device under different rivet materials conditions

PROBLEM STATEMENT

The above mentioned processes of riveting are conventional processes used commercially for making riveted joints, the offer advantages such as fast production rate , possibility of automation etc., but some inherent disadvantages in process limit their use,

1. The head formation by the push method uses excessive force that is applied while forming the head, this leads to the deformation of the parts being riveted, hence the use of the process is limited to components that are strong and solid.
2. The push or pull process can be used to make the fixed type of riveted joints, as in either of the processes the force applied for formation of head hence parts are virtually fused together , thereby permitting no relative motion between the mating parts, hence hinged joint is not possible.
3. Due to application of force while head formation the process cannot be applied to riveting of materials like plastics, glass, ceramics, poly -urethane, etc.
4. Due to impact nature of force application the process are excessively noisy.
5. Special shapes like ladder rungs cannot be riveted by these processes.

Current condition

Riveted unions were produced by peening bolt rivets over with a hammer.

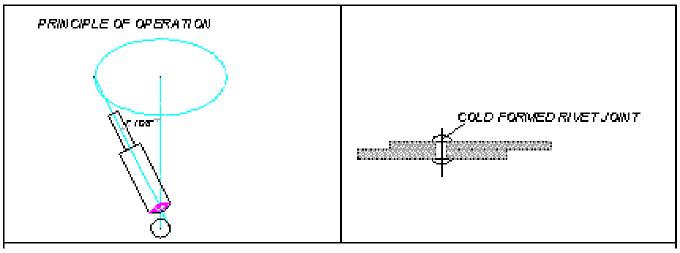
As industrialisation was on the rise, also presses or mechanical hammers for metal working were gaining ground but were soon replaced by specific riveting machines. The great amount of force to be exerted along with high noise levels on the one hand and, on the other hand, the changes in the structure of the rivets and their embrittlement were less and less accepted by users who demanded higher quality standards.

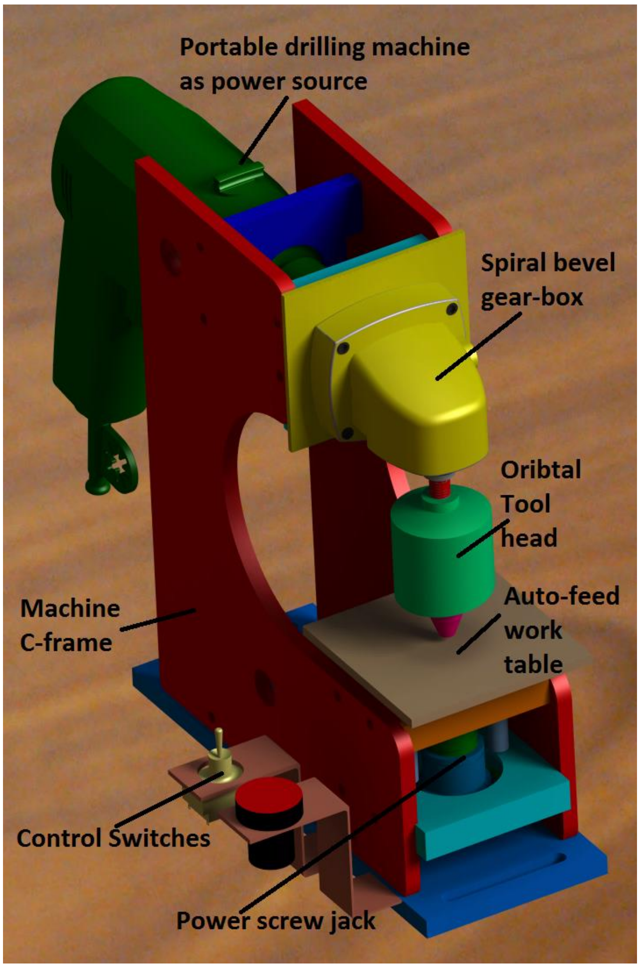
Though the orbital riveting technology did bring some improvements in its wake, the hardenings of the rivet structure and the damage to the closing head surface still remained.

Proposed Condition

ORBITAL RIVETTING

Rivet is set at the joint such that the rivet set angle is from 10 to 80 depending upon the joint to be obtained. It turns around the vertical axis at about 2000 to 3000 rpm and describes a cone whose apex corresponds to the center of gravity of the joint formed. It is the tool which gives the shape.





FEATURES OF OROPOSED ORBITAL RIVETTING MACHINE

- This riveting process allows fixed or hinged assemblies to be made.
- It allows special shapes to be riveted without difficulty. (eg. Square section tubes as ladder rungs)
- Due to orbital riveting principle and specific position of tool (rivet set) on the part to be riveted, the upsetting load required is six times lower than for direct thrust(press).

POSSIBILITIES DUE TO ORBITAL RIVETTING

- Fixed or hinged assembled parts can be done.
- Many types of materials can be riveted eg. Steel, SS, Plastics, aluminium, etc.
- All working positions possible.
- All possibilities of automation.

METHODOLOGY

The experiment for validation of this idea will be conducted as follows:

THEORETICAL WORK

1. Literature review. Study of various configuration of roll forming process by using handbooks, United State Patent documents, Technical papers , etc.

Design and Proposed Development of Machine:

System design as to and theoretical derivation of dimensions of the Rollers section for three stage roll forming of U-section by theoretical method , rollers profile geometry by graphical method .

System Design and theoretical derivation of power required to perform the roll forming operation , determination of gear train dimensions to get desired surface speed during roll forming operation.

System Design and theoretical derivations of critical components of the system as to shaft , bearings , pressure adjustment screw etc.

Design , modelling , drafting and analysis of roller system and critical machine components of roll forming machine by use of Unigraphix NX 8 and Ansys Workbench 16.0

Equipment

Fabrication :Suitable manufacturing methods will be employed to fabricate the components and then assemble the test set –up. Fabrication assembly and testing of machine to experimentally validate the stage wise section profile dimensions by all three methods ie, theoretical , software and experiment Facilities available:-

The following facilities to carry out fabrication work are available at sponsor site

- Centre lathe
- Milling machine
- DRO – Jig Boring machine
- Electrical Arc Welding
- Digital Vernier
- RPM meter
- Depth gage.

DESIGN

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy & efficiency . Hence a careful design approach has to be adopted . The total design work , has been split up into two parts

1) System design

2) Mechanical Design.

EMPIRICAL METHOD TO COMPUTE FORGING LOAD

OPEN DIE FORGING

The load required to forge a flat section in open dies may be estimated by;

P = σ A C ., N

A = Forging projected area ; mm2

σ = mean flow , stress N/mm2

C = Constant (Constraint factor) to allow for in homogeneous deformation

The deformation resistance increases with Δ which is defined as;

Δ = mean thickness of deforming zone / length of deforming zone

= h/2L

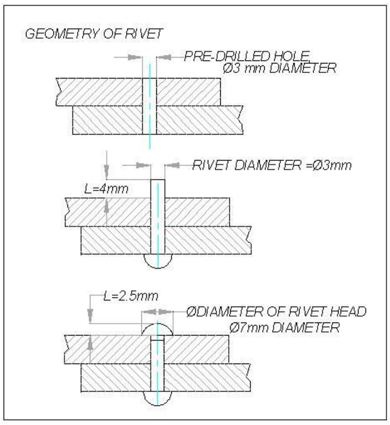
Then C is given as;

C = 0.8 + 0.2 Δ

INPUT DATA

MATERIAL OF RIVET

Designation	Tensile Strength (N/mm2)	0.2%ProofStrength (N/mm2)
5300	215	100



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Δ = mean thickness of deforming zone / length of deforming zone

= h/2L

= 3/2(4) = 0.375

$\Delta = 0.375$

$C = 0.8 + 0.2\ \Delta$

= 0.8 + 0.2 (0.375) = 0.875

C = Constant (Constraint factor) =0.875

σ = mean flow stress = 100 N/mm2

A = Forging projected area ; mm2

= π x D2 /4

= π x 32 /4 =7.06 mm2

$P = \sigma\ A\ C$

= 100 x 7.06 x 0.875

= 617.75 N

Most of the work during orbital forming is focused at the tool's line of contact, not along the entire tool surface. This reduces axial loads by as much as 80%, which has several advantages.

Hence , Peff = 0.2 x 617.75 = 123.5

Peff = 124 N

This is the load that acts in the downward direction while forming the rivet, where as the rivet head diameter is 6mm, hence the torque required at the spindle is given by :

T = Peff x r

= 124 x 3

= 372 N-mm

T = 0.372 N-m

Power required at spindle is given by ,

$P = 2\ \pi\ N\ T\ /60$

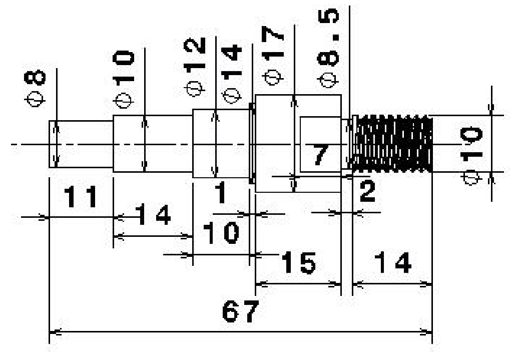
= 2 π x 900 x 0.372 /60 = 70 watt

Considering 100 % overload

Power at spindle = 140 watt

Thus motor of 150 watt will be sufficient for the operation

DESIGN AND ANALYSIS OF SPINDLE OF ORBITAL RIVETTING MACHINE :



MATERIAL SELECTION : - Ref :- PSG (1.10 & 1.12) + (1.17)

DESIGNATION	ULTIMATE TENSILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
EN 24	800	680

ASME CODE FOR DESIGN OF SHAFT

Since the loads on most shafts in connected machinery are not constant , it is necessary to make proper allowance for the harmful effects of load fluctuations

According to ASME code permissible values of shear stress may be calculated form various relation.

fs_{max} = 0.18 fult

= 0.18 x 800

= $144 N/mm^2$

OR

fs_{max} = 0.3 fyt

=0.3 x 680= 204 N/mm^2

considering minimum of the above values

$\Rightarrow fs_{max} = 144\ N/mm^2$

Shaft is provided with notch for locking ; this will reduce its strength. Hence reducing above value of allowable stress by 25

$\Rightarrow$ fs_{max} = 108 N/mm^2

This is the allowable value of shear stress that can be induced in the shaft material for safe operation.

T= 2.84 x10^3 N-mm

Assuming 25% overload.

CHECK FOR TORSIONAL SHEAR FAILURE OF SHAFT.

minimum diameter of the spindle is 8,.5 mm at the M10 x 1.5 pitch threaded section

$\Rightarrow$ d = 16 mm

$Td = \Pi/16 \times fs_{act} \times d^3$

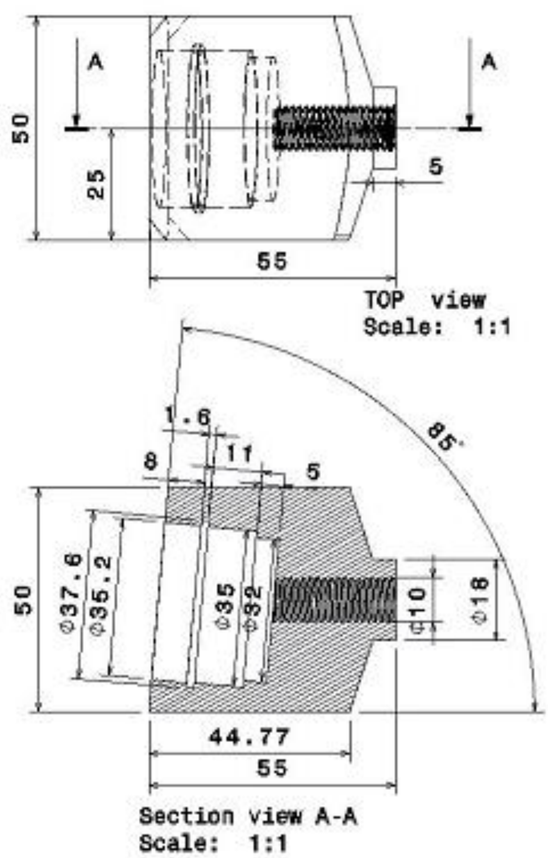
$$\Rightarrow fs_{act} = \frac{16 \times Td}{\Pi \times d^3}$$

$$= \frac{16 \times 2.84 \times 10^3}{\Pi \times (8.5)^3}$$

$\Rightarrow$ fs_{act} =23.54 /mm^2

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

$\Rightarrow$ I/P shaft is safe under torsional load



MATERIAL SELECTION : -Ref :- PSG (1.10 & 1.12) + (1.18)

DESIGNATION	ULTIMATE TENSILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
EN8	520	360

$\Rightarrow$ fs_{max} = uts/fos = 520/2 = 260 N/mm^2

This is the allowable valve of shear stress that can be induced in the shaft material for safe operation.

Assuming 100 % efficiency of transmission

$\Rightarrow$ T design = 2.84 Nm

$Td = \Pi/16 \times fs_{act} \times (D^4 - d^4)/D$

$$\Rightarrow fs_{act} = \frac{16 \times Td}{\Pi \times (D^4 - d^4)/D}$$

Outside diameter of drum boss = 18mm

Inside diameter of drum boss = 10mm

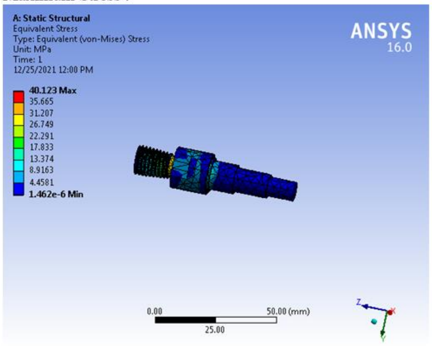
$$= \frac{16 \times 2.84 \times 10^{3} \times 18}{\Pi \times (18^4 - 10^4)}$$

$\Rightarrow fs_{act} = 2.74 N/mm^2$

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

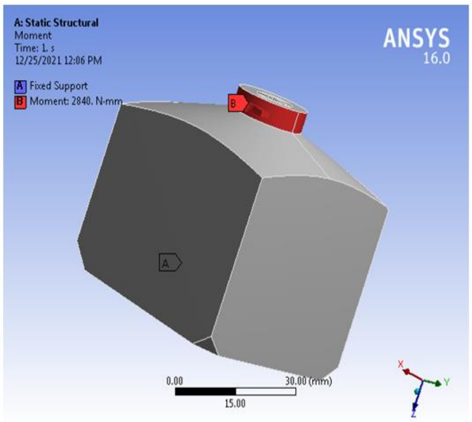
⇒ TOOL HOLDER is safe under torsional load

Maximum Stress :

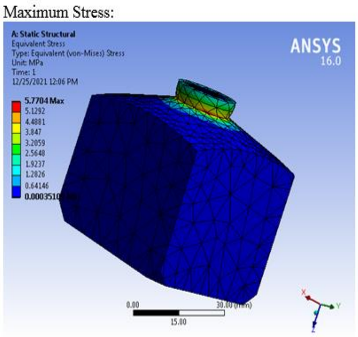


The maximum stress induced is 40.123 Mpa is less than permissible stress hence the part is safe

DESIGN OF TOOL HOLDER



Maximum Stress:



The maximum stress induced is 40.123 Mpa is less than permissible stress hence the part is safe

RESULTS AND DISCUSSION

1. After careful review the shortcomings of the conventional riveting process are observed and the orbital riveting process is found to offer better joint strength , join-ability. Although the portable form of the orbital riveting machine that uses the portable hand drill machine as power source is not been researched

2. The maximum power required for riveting operation was found to be 150 watt

3. The motor selected was in the form of portable drilling machine and the power of the machine is 650 watt at 2900 rpm

4. The design of the spindle is safe by theoretical method and analytical method.

5. The design of the tool holder is safe by theoretical method and analytical method.

6. The design of the tool was done by theoretical method and analytical method.

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