Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444
Volume 4, Issue 5, May-2017

DESIGN AND MANUFACTURING OF ORBITAL RIVETING MACHINE (ORM)

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Abstract— Riveting is a process of joining two sheet metals by means of a rivet with different types of riveting method. Orbital riveting is a relatively new technology in which parts are product by specific movements of tools at 40 to spindle axis. Special incremental motion obtain smaller contact area so lower the forming load, less friction and it reduce impact load at 60%. Orbital riveting provide number of advantages such as high production rate, easy to operate. By providing the pneumatic mechanism for worktable, it imparts more life to tool.

Keywords- Orbital , Design , Development , Cost , High Production, Analysis

1. INTRODUCTION

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

An unconventional fastening technique cuts the cost of many material forming and assembly applications.

Most engineers tend to rely on traditional fastening methods to join parts, but a lesser known technique, orbital forming, often provides better results at lower costs. Orbital forming, as the name implies, is a cold-forming process that uses an "orbiting" tool. Sometimes called spinning, radial riveting, or spin riveting, orbital forming is most often used to head, swage, crown, flare, or form a column or projection of material in fastening and assembly operations.

The process is somewhat similar to impact and compression forming, where the tool applies a compressive axial load to plastically deform the part. The difference is that in orbital forming, the tool rotates at a fixed angle typically 3 to 6° and applies both axial and radial forces to progressively move malleable material into a desired, predetermined shape. Unlike impact or compression forming, where the process is complete in a single pass. 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%.

HISTORY

1 Conventional riveting process

The conventional riveting process is also referred to as Impact riveting, usually done by manual or machine operation. The manual process is of hammering the rivet to form the head, this process is crude and is performed by the rivet forming head set in the form of a punch which is hammered on the rivet to form the head.

The Machine process is categorized in two types:

2 Push or hammer riveting

In this process usually a pneumatic hammer is used where the riveting head or punch is mounted on machine which is moved to and fro by pneumatic power.

The rivet is solid in this case. The rivet is positioned in the hole between the mating parts and then the rivet portion projecting out of the joint is formed by the impact of the rivet head. This process requires considerable force, only fixed joints can be formed. There is a chance of the work-piece to be damaged due to impact. This process is used for joining solid steel elements and finds less application for hollow components.

3 Pull riveting

In this process a scissor riveting machine operated either manually or by power (electric /Pneumatic) is used. In this process is hollow and the pull force is applied on the nail projecting out of the rivet. The nail is gripped in the gripper head of the machine and is pulled to form the rivet head. This process is relatively fast. This process is used in production of sheet metal bodies, cabins etc.

2.1 Problem definition

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, and 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.

Solution

Orbital Riveting is a unique process characterized by a variety of rivet head shapes and by very low force requirements.

Other features of orbital riveting are:

- Precise forming of the rivet head material
- No impact force
- Fast and quiet
- Capable of manufacturing moving rotatable joints

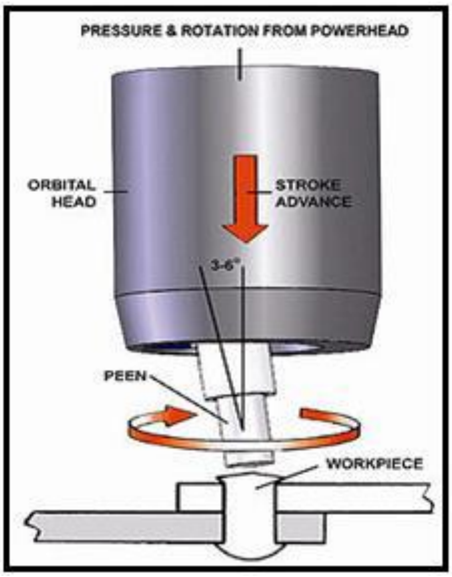


FIGURE 1 ORBITAL FORMING

2. AIM AND OBJECTIVE

An unconventional fastening technique cuts the cost of many material forming and assembly applications. Most engineers tend to rely on traditional fastening methods to join parts, but a lesser-known technique, orbital forming, often provides better results at lower costs. Orbital forming, as the name implies, is a cold-forming process that uses an "orbiting" tool. Sometimes called spinning, radial riveting, or spin riveting, orbital forming is most often used to head, swage, crown, flare, or form a column or projection of material in fastening and assembly operations.

The process is somewhat similar to impact and compression forming, where the tool applies a compressive axial load to plastically deform the part. The difference is that in orbital forming, the tool rotates at a fixed angle — typically 3 to 6° — and applies both axial and radial forces to progressively move malleable material into a desired, predetermined shape. Unlike impact or compression forming, where the process is complete in a single pass, orbital forming requires several tool revolutions and typically takes 1.5 to 3 sec to complete. 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. Fasteners and mating parts see less stress.

Orbital forming produces a smooth surface finish and, in some applications, eliminates cracks caused by impact riveting.

3.CONSTRUCTION

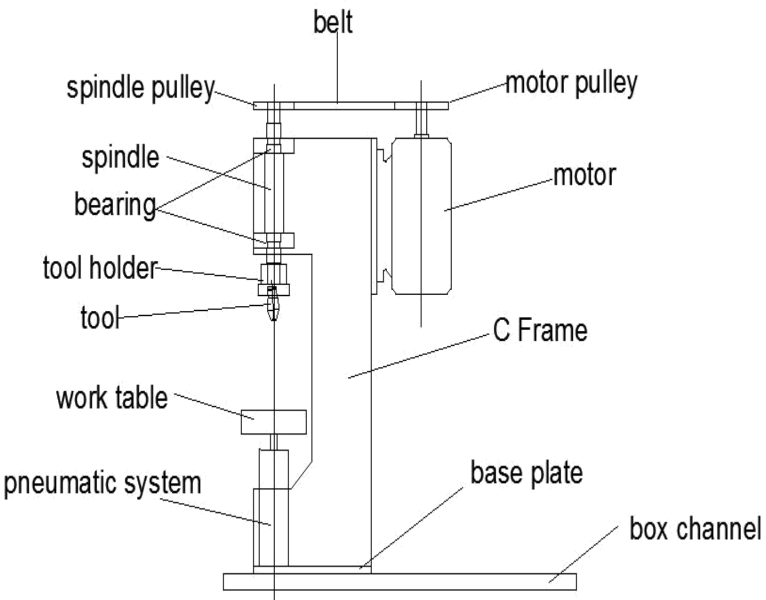


Fig 2:- Orbital riveting machine

4 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.

In mechanical design the components are listed down and stored on the basis of their procurement, design in two categories namely,

- Designed Parts
- Parts to be purchased

4.1 EMPIRICAL METHOD TO COMPUTE FORGING LOAD
OPEN DIE FORGING

The load required to forge a flat section in open dies may be estimated by;
$P = \sigma A C$, 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;
$C = 0.8 + 0.2\ \Delta$
Δ = mean thickness of deforming zone / length of deforming zone
= h/2L
= 3/2(4) = 0.375
$\Delta = 0.375$
Now,
$C = 0.8 + 0.2\ \Delta$
= 0.8 + 0.2 (0.375) = 0.875
C = Constant (Constraint factor) =0.875
σ = mean flow stress = 100 N/mm^2
A = Forging projected area; mm^2
= π x D2 /4
= π x 32 /4 = 7.06 mm^2
$P = \sigma A C$

= 100 x 7.06 x 0.875 = 617.75 N

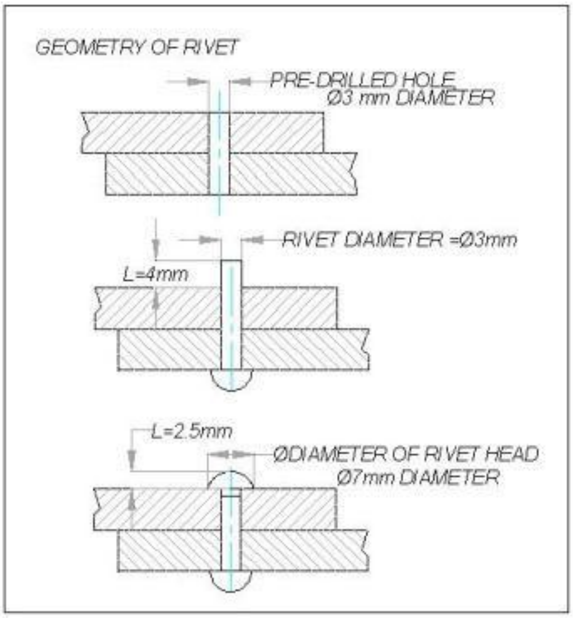


Fig 4:- Rivet Geometry

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 N

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-m42

Power required at spindle is given by,

P = (2 π N T) /60

= (2 π x 900 x 0.372)/60 = 70 watt

Now, Considering 100 % overload

So, Power at spindle = 140 watt

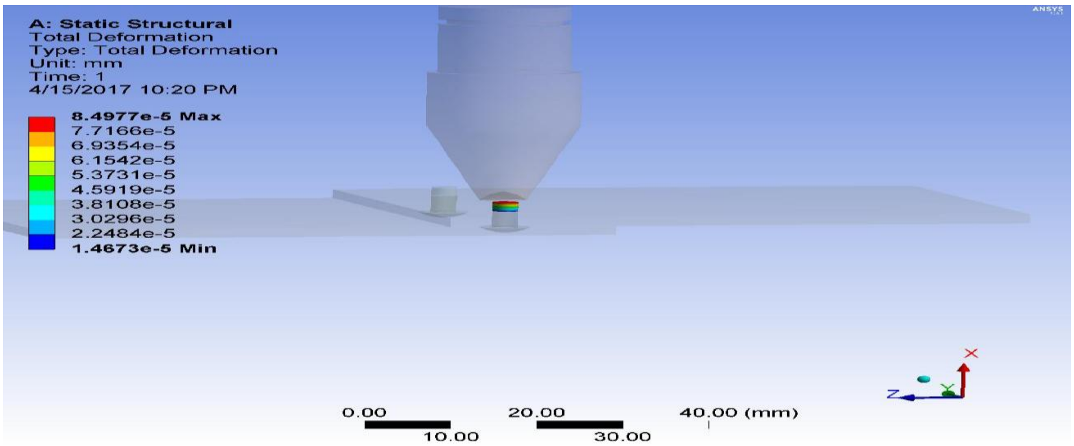
Considering 60 % transmission efficiency of belt drive

Power at motor shaft = 140 + (140 x 0.4) = 196 watt

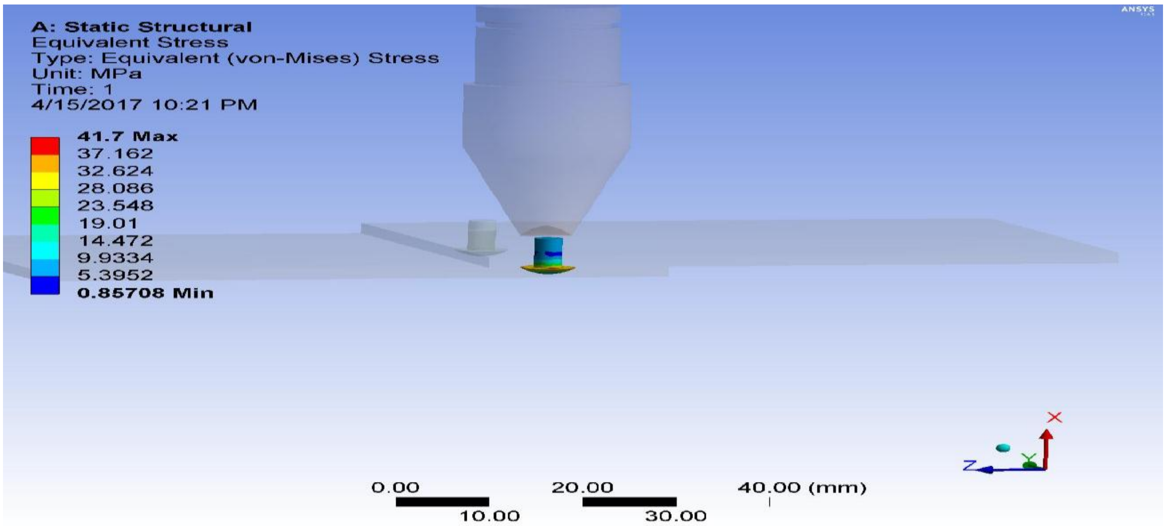
5 ANALYSIS OF ORBITAL RIVETING MACHINE

The analysis of this machine is done with the help of Analysis software and the results were obtained for total deformation, Von-Misses Equivalent Stress is illustrated below:

Total Deformation



Equivalent Stress



ORBITAL RIVETING MACHINE

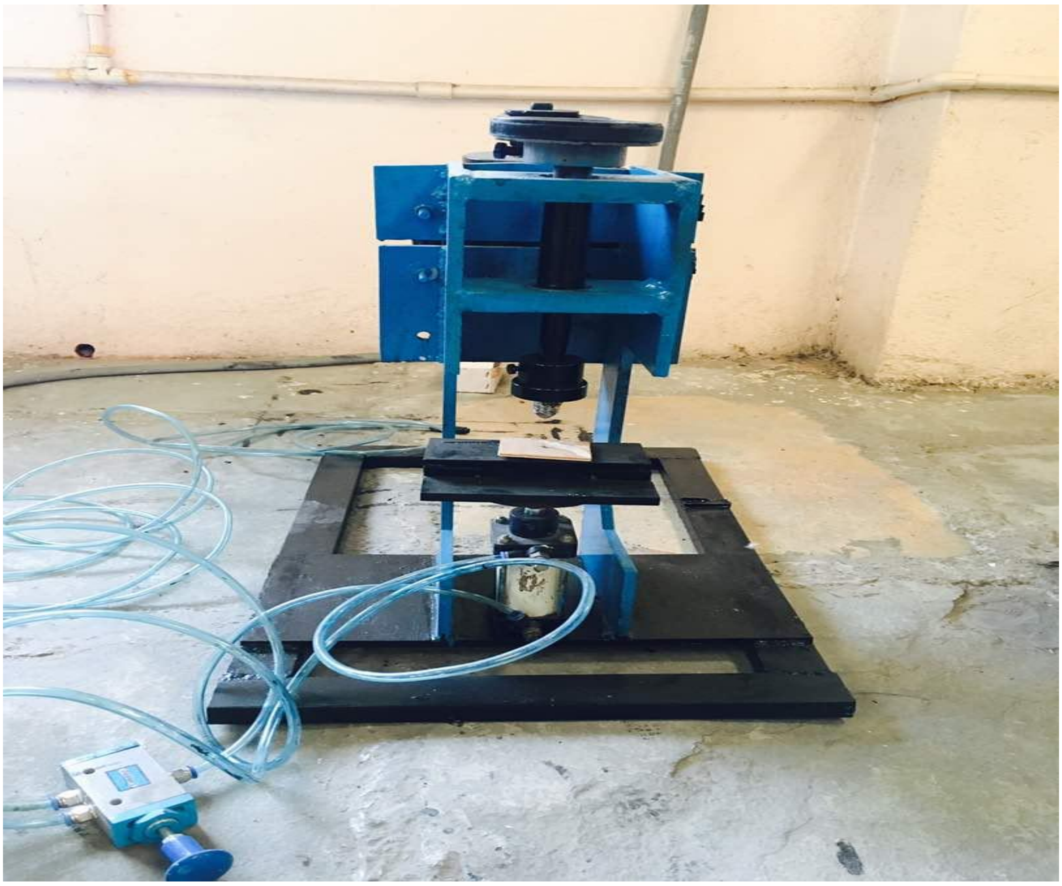


Fig :- Final Model of Orbital Riveting Machine

6 Comparative Study of Manual Riveting & Orbital Riveting Machine

Sr. No.	Characteristic	Manual Riveting / Impact Riveting	Orbital Riveting Machine
1.	Definition	A hammer is used to form a rivet.	3-6 degree offset spindle is used to form the rivet.
2.	Force required	More forces	Less force
3.	Noise pollution	Noise operation	Less noisy operation
4.	Accuracy	Less accuracy	Accuracy is more
5.	Production rate	Production rate is less	Production rate is high
6.	Vibration	Vibration created is too more	Less vibration is created
7.	Time required to form a rivet	More time	Less time
8.	Cost per unit	More	Less
9.	Operation	Difficult operation	Easy operation
11.	Effort required for per unit formation of rivet	More effort is Required	less effort is Required
12.	Material wastage	More material wastage during manual operation of riveting	less material wastage during ORM operation of riveting
13.	Finishing	Due to manually riveting a rough surface finish is obtained	In the actual ORM , the excellent finishing is obtained
14.	Safety and clean	Operation is not safety & clean. Because while manually hammering there is chances of accident	Operation is safe, clean & no effect on rivet
15.	Forces & stress acted on rivet	Due to uneven forces acted on rivet a different stress will acted on rivet	A particular amount of force is acted on whole rivet circumference so less stress is acted on rivet.

CONCLUSION

- Quiet, non-impact process of cold forming.
- Contact area between tool and work piece is smaller which results in lower impact stress and friction.
- It can be used to replace loose fasteners.
- This machine gives many advantages as personal safety and operational safety because of simple in design and construction and also easy to handle and any one can operate.

- It reduced the cost of machining operation, cost of the assembly operation and cycle time.

FURTHER SCOPE

- The machine can be made automated by using a pneumatic cylinder instead of the handle arrangement.
- Variable sizes of rivets can be accommodated by merely changing the rivet set.
- The Tool holder can be modified for quick change of rivet set.
- The job holder arrangement can be changed to accommodate various shapes and sizes of the work-pieces

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