*Kamal Ahmed, et. al. International Journal of Engineering Research and Applications*
*www.ijera.com*
*ISSN: 2248-9622, Vol. 14, Issue 5, May, 2024, pp: 83-86*

RESEARCH ARTICLE OPEN ACCESS

# Experimental and Numerical Evaluation of Cutting Force In Pneumatic Sheet Cutting Machine

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**ABSTRACT**
The cutting process is involved in almost every industrial process. So here we propose a pneumatic-based cutting machine that uses pneumatic strength for the instant cutting of small sheets and pipes. Manual cutting machines require a lot of human effort and also are not suitable for mass-cutting processes with precision.

The pneumatic cutting machine ensures the exact cutting speed each time to get a consistent cutting result without any breaks. The machine consists of a fabricated pneumatic cylinder with a linking joint attached. This joint is assembled with a cutter blade. These parts are fitted together in position using a metallic frame. We use pipes and valves to connect the pneumatic cylinder with a compressor through a valve arrangement controlled by an electronic circuit. The circuit has 2 push buttons. One button allows for a single cut when pushed and the other allows for automatic cutting at 1-second intervals and continues operation as long as the button is not pressed again to stop the machine. Thus we develop the pneumatic cutting machine to automate the industrial cutting process.

***Keywords* – pneumatic machine, sheet cutting machine, automated, industry, shearing machine**

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Date of Submission: 06-05-2024 Date of acceptance: 17-05-2024

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## I.INTRODUCTION

The shearing machine and bending machine is the most important in the sheet metal industry. This machine should be used for straight-cutting machines with wide applications. hence we tried to develop the Pneumatic Shearing and Bending Machine. In the shearing operation, as the punch moves upon the metal, the pressure exerted by the punch causes the plastic deformation of the sheet/plate. Since the clearance between the punch and the die is very small, the plastic deformation takes place in a localized area and the metal is adjacent to the cutting edges. Hence, we are introducing a pneumatic sheet metal cutting machine which will reduce manufacturing costs and minimize industrial labor problems which is the biggest headache for humans. The main objective of our project is to perform job-holding operations effectively with less human effort by using a machine with the pneumatic power

### 1.1Research Objectives

- To cater to the issue of competition in the mechanical industry the need for automation is assessed by all the industry.
- To identify the key policy avenues considered appropriate to meet the challenge of the sustainable manufacturing and packaging industry in the future.
- To provide alternatives for industries aiming to reduce human effort and improve material handling systems by implementing automation.

## II. METHODOLOGY

Fabrication is an important industry that involves cutting, manipulating and assembling cast iron materials to produce desired structures. And while different fabrication companies use a variety of techniques, most rely on three basic processes: cutting, bending and assembling.

2.1 **Design Procedure**

- Definition of problem
- Synthesis
- Analysis of forces
- Selection of material
- Determination of mode of failure
- Selection of factor of safety
- Determination of dimensions
- Modification of dimensions
- Preparation of drawings
- Preparation of design report

## III. LITERATURE REVIEW

T. Z. Quazi et. al. [1] studied the influence of punch-die clearance in blanking process. Their investigation showed that by decreasing clearance the required blanking force increased. They found that 10 percent is the optimum clearance is required for optimizing blanking force.

Viraj N. Suryawanshi et. al. [2] Develop a pneumatic punching machine to decrease punching cost on metallic sheet.

K. K. Alaneme et. al. [3] They found the reasons behind the failure of dies in a punching machine. They found out that die failure occurs due to improper heat treatment thus decrease the fatigue resistance and toughness of die material.

Sudeep Kelaginamane et. al. [4] designed a programmable logic controlled pneumatic punching machine. The machine reduced the production time and increased productivity from 60 items per hour to 420 items per hour.

## III. MODELING IN SOLID WORKS

Part modelling and assembling is carried out using Solid works. It is one of the world's most advanced and highly integrated CAD/CAM/CAE products. Solid works delivers a great value to enterprises of all sizes by covering the entire range of product development. It increases the design process by simplifying complicated product designs.

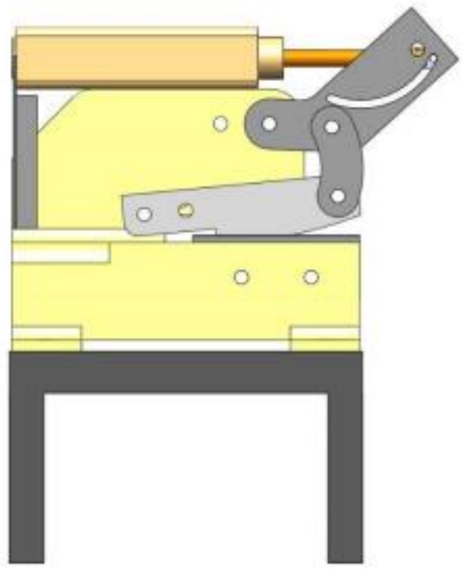

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Fig.1 CAD model Of Machine

## IV.THEORETICAL ANALYSIS

The theoretical analysis performed asserts on the forces necessary to cut the sheet, different forces Calculations The design calculations, to obtain the optimum force for cutting is performed considering the parameters from literature reviews and practical application of the research-

• The maximum width (L) of the sheet, which the machine can cut in one cycle is taken as 120 mm, based on practicality and length of the blade used.

• The strength of aluminium sheet (Tmax) is found to be 180 N/mm$^2$.

• The maximum thickness of the sheet, which the machine can cut is taken as 2.5 mm, based on scope defined.

• The factor of safety for the calculations is assumed to be 1.2.

• The mass of the cutting mechanism is taken to be 2.5 Kg, based on individual weights of the components used.

• The area of the bore was calculated to be 962.1127 mm$^2$ , based on the blade designed on Inventor.

The Figures 1 represent locations, the piston rod occupies in a single stroke, based on which the location of the blade changes.

**4.1. Cutting Force**

$FC = L \times t^3 \times T_{max}$ Where

FC – force to cut the sheet L – width of sheet = 120 mm, t3 – thickness of the sheet = 2.5 mm $T_{max}$ - strength of GI sheet = 180 N/mm$^2$,

FC = 120 × 2.5 × 180 = **54000N**

**4.2. Stripping Force**

FS = 0.2 × FC . Where. FS – force to strip the sheet

FC – force to cut the sheet

FS = 54000 N FS = 0.2 × 54000 = **10800 N**

**4.3. Static Force**

FST = M x g ,where

FST – static force M – total mass= 2.5 Kg,

g-Gravitational moment of acceleration=9.81 m/sec$^2$

FST = 2.5 x 9.81 = **24.525 N**

**4.4. Total Force** FT = FC + FS + FST ,

Where, FT – total force to shear the sheet

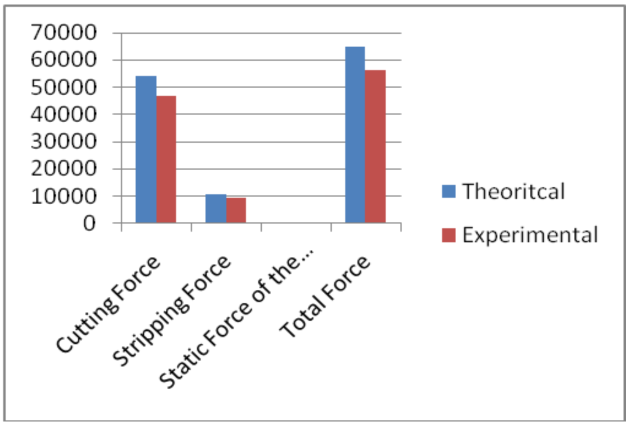
= 54000 + 10800 + 24.525 = **64824.525 N**

## V.FABRICATION AND EXPERIMENTAL

Fig.2 Prototype model Of Machine

| Description | Theoretical values | Experimental values |
|---|---|---|
| Cutting Force | 54000 N | 46980 N |
| Stripping Force | 10800 N | 9396 N |
| Static Force | 24.525 N | 20.1 N |
| Total | 64824.52 N | 56396 N |
| Force | | |

## VI.RESULTS




## VII. CONCLUSION

- The results of the theoretical are in good accordance with that of experimentation. The defects like shrinkage, and cracks, are eliminated from the sheet.
- The UTM Testing of the plates taken shows that there were no major defects in the plate. The result obtained from this experiment shows that forces are one of the essential factors in producing good quality.
- From the experimental results, it is concluded that among all the forces static force is negligible and theoretical are in good accordance with that of experimentation.

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