Design and Optimization of Shearing Machine Using FEA at Daulat Industries, Nagpur

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Abstract— Shearing machines are based on the principle of metal cutting by shearing action of a moving blade in relation to a fixed blade. It is a simple process which involves the cutting of metal sheet by two knives which are posed at an angle relative to each other. This project is based on the requirement of Daulat Industries, Nagpur. Todesign a shearing machine which is capable of cutting 5mm thick stainless steel sheets of 8ft wide and 4 ft. length in size. In this researchwe will develop a CAD model of shearing machine and optimization of machine using FEA.

Key words: Shearing Machine, Design and Optimization of Machine

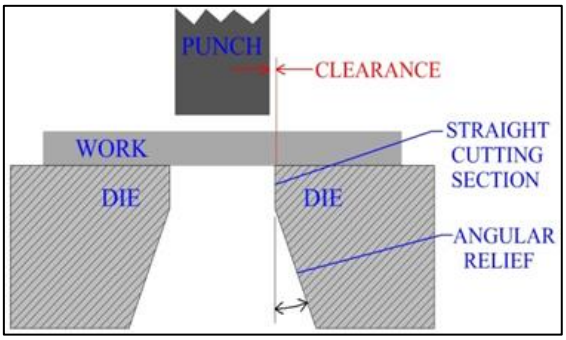


Fig. 1: Simple Diagram of Shearing Machine

I. INTRODUCTION

Shearing is a general name for most sheet metal cutting, but in a specific sense, designates a cut in a straight line across a strip, sheet or bar. This procedure leaves a clean edge on the piece of the metal that is sheared or cut. Shearing machines are used to cut or shear metal sheets in many ways. The particular method chosen depends on several factors such as the size and shape of the parts required and the numbers needed.The moving cutting member of a shearing machine may be actuated by:

1) Hand lever in bench shearing machines
2) Foot treadle in treadle guillotines
3) Electric motor or hydraulic system in power guillotines

It is also known as die cutting. It is a process which cuts stock without the formation of chips or the use of burning or melting the metal. In strict technical terms, the process of shearing involves the use of straight cutting bladesorm of sheet metal or plates, however rods can also be sheared. Shearing type operations include: blanking, piercing, roll slitting, and trimming.

In shearing, a punch is used to push a work piece against the die, which is fixed. Usually the clearance between two is 5 to 40% of the thickness of the material, but dependent on the material.

There are various types of metal cutting operations, each is defined by the relationship of the end tool position to the thickness of the material. These three are: Alligator shear, Bench shear, Guillotine, Power Shear, and Throat less shear.

II. NEED OF DESIGNING THE SHEARING MACHINE

- During a visit to the DAULAT INDSUTRIES, it was revealed that there is a requirement for shearing machine to cut 5mm thick sheets of stainless steel (ss).
- There are various shearing machine available in the market to perform this task. But the general manager at Daulat Industries is insisting to design and fabricate the machine in house.
- After a detailed conversation with the general manger it was decided that the designing and optimizing part of the shearing machine would be executed in this project.
- In this project, the design and optimization of a shearing machine which is capable of cutting 5mm thick stainless steel sheets will be designed and optimized with the help of CAD and FEA software's.
- With this project the company will be benefited from the advancements of computer technologies and thus will be able to reduce cost of procuring a shearing machine.

A. Problems

1) Existing process require high labor cost.
2) Existing process require high process time.
3) Many accidents encountered with existing process.

B. Requirements

1) Process should decrease the labor cost.
2) It should cut minimum 5mm thick plate.
3) To increase workers safety.
4) Process should increase the productivity.

III. RESEARCH METHODOLOGY

In present study, we create the CAD model of shearing machine. Thenanalysis of the design will be performed. If required theoptimization and analysis of optimized design will beperformed after that results will be discussed anddesign will be finalized.

IV. DATA ACCUMULATION

CALCULATIONS:

design of shearing machine to cut 5mm thick and 2.4m length of cut

Shear force = shear stress X Area

Syt = 0.7 X Ultimate stress

Syt = 0.7 X 510 (FOR 5.8 Carbon Steel)

Syt = 357 MPa

Shear strength = 357/2 = 178.5 > 150 MPa {shear strength should be less than half of yield strength}

shear force = 150 X 5 X 2438.4

Shear force = 1828800 N

= Shear force / 9.81 = 1828800/ 9.81 = 186 Ton

2 hydraulics of 100 ton each will be used to provide 186 ton...

CASE 1:

Load of 200 Ton in upward direction acting on horizontal members at bolt location

200000 X 9.81 = 1962 KN ,

there are 10 horizontal members sharing this load and 4 locations at each member,

1962/10X4 = 49.05 KN

RA + RB = -196.2 KN

RA = RB = -98.1 KN

BMX = (98.1 x 1.366) + (49.05 x 0.766) + (49.05 x 0.53)

BMX = -70.436 KN.m = 70436000 N.mm

$$I = \frac{1}{12} \times \{(120 \times 120^3) - (70 \times 20^3)\}$$

$$I = 17233333.33 \ mm4$$

$$\sigma = \frac{M}{I} y$$

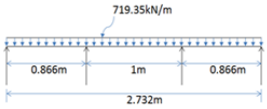
$$\sigma = \frac{70436000}{17233333.33} \times 60$$

$$\sigma = 245.23 MPa$$

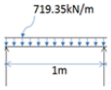
CASE 2: Plate in contact with tool throughout the length, 4 support

F = 200000+ 332 = 200332 X 9.81 = 1965.26 KN

Load intensity = 1965.26/2.732 = 719.35 KN/m



considering only center portion,



RA + RB = 719.35 KN

RA = RB = 359.67 KN

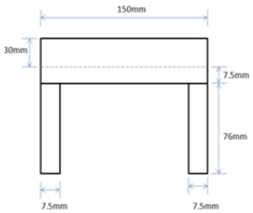
BMA = BMB = 0

BMX = (359.67 X 0.5) - (719.35 X 0.5 X 0.25)

= 89.916 KN.m

= 89916000 N.mm

y = 26.93 mm



$$I = \frac{1}{12} \times \{(150 \times 106^3) - (135 \times 68.5^3)\}$$

$$I = 11271734.84 \ mm4$$

$$\sigma = \frac{M}{I} y$$

$$\sigma = \frac{89916000}{11271734.84} \times 26.93$$

$$\sigma = 214.82 MPa$$

CASE 3: Buckling of vertical member

Downward force (weight) = 5.79 KN

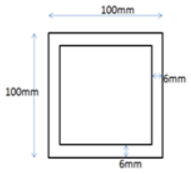
Upward force (200ton) = 1962 KN

1962 - 5.79 = 1956.21 KN (upward)

this load is shared by 12 members, 1956.21 / 12 = 163.017 KN

$$Pcr = \frac{\pi^2 EI}{Le^2}$$

column end condition: Both end fixed,



Le = 0.5 L = 0.5 x 1750 = 875mm

E = 210000 MPa

$$I = \frac{1}{12} \times \{(100^4) - (88^4)\}$$

$$I = 3335872 \ mm4$$

$$Pcr = \frac{\pi^2 \ X \ 210000 \ X \ 3335872}{875^2}$$

Pcr = 9030.5 KN (Pcr > P = STABLE STRUCTURE)

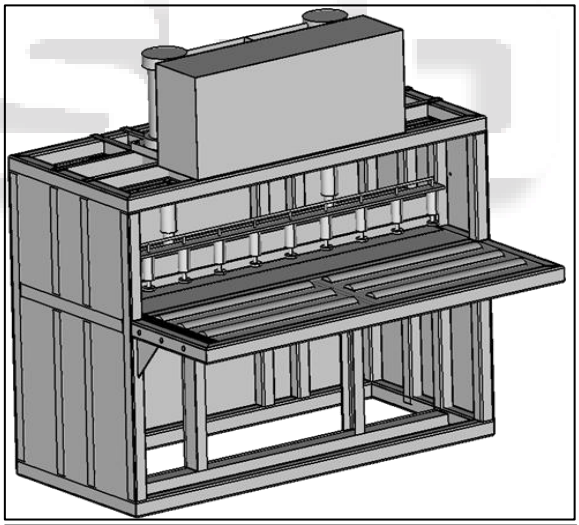
Compressive stress:

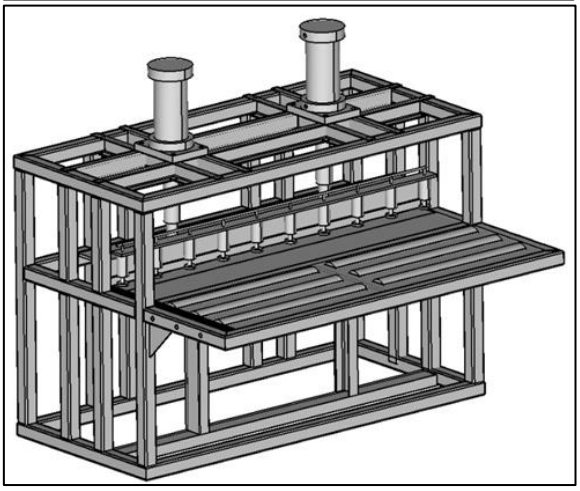
$$\sigma = \frac{F}{A}$$

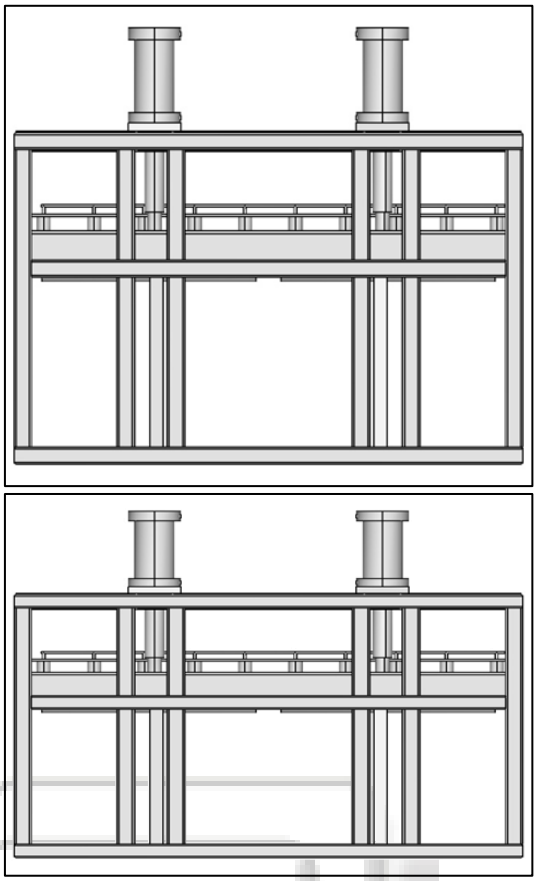
$$\sigma = \frac{163017}{2256}$$

$$\sigma = 72.26 MPa$$

V. CAD MODELING OF SHEARING MACHINE







VI. CONCLUSIONS

In present study, we develop the CAD model of shearing machine. Then perform FEA analysis of shearing machinefor validation and perform hand calculation for loads and structure design of shearing machine after that results will be discussed and design will be finalized. With this project the company DAULAT INDUSTRIES Nagpur, will be benefited from the advancements of computer technologies and thus will be able toreduce the fabrication cost of shearing machinewithout compromising on the performance parameters.

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