Design and Fabrication of Paper Bailing Machine

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Abstract - *Industries are facing a lot of problems in storing and handling the scrap. A large amount of space is required to store the scrap. In order to overcome these problems the scraps can be compressed and stored in a brick form. Today, all the modern manufacturing enterprises are trying to develop best optimized reduced weight and cost effective products that meet the intended design functionally and reliably. In this scenario, structural optimization tools like topology and shape optimization with manufacturing simulations are becoming attractive in product design processes. These tools also aid in reducing product development times. In last few years, shape optimization has emerged as the valuable tool to develop new design proposals especially in paper industries. Structural optimization tools have gained paramount importance in industrial applications. In this project, topology optimization has been applied on various components of 5Ton hydraulic paper baling press.*

Key Words: Pascal's principle, Optimization.

1. INTRODUCTION

A baling machine is a device used to compress materials into a bale for storage, transport, or handling. Several types of machines exist for this purpose, as some are designed specifically for one material, while others may be able to handle various materials. Hydraulic scrap baling presses are machinery that find usage to compress different types of scraps into bale forms using hydraulic power. These presses are used in different ways to compress light, thin as well as soft materials. With several kinds of balers available for different materials/applications, these Balers are also used in material recycling facilities. There is also a provision of tying bales manually with help of provided grooves, thus helping in saving much cost of transportation.

Hydraulic scrap bailing presses are designed for:

- Paper scrap
- Plastic scrap
- Cotton waste

All these can be formed into cuboid bales. Further, as the density of bales is high, these are also convenient to store, transport and used in metallurgy. Featuring complex electrical-hydraulic control have two working modes viz. Auto & Inching, these come with pressure adjustable facility that make these Hydraulic scrap baling presses best in performance as well as easy in working and high in productivity. Since high degree of compaction is achieved, it helps in saving expensive storage space as well as allows making transport and handling more easier. These balers are made of steel with hydraulic Ram for compressing the material loaded. Some balers offered are simple and labor-intensive, but suitable for smaller volumes. [5]

2. LITERATURE REVIEW

Agricultural Baler (Arsene Roth) This research relates to an agricultural baler which includes substantially a pickup element, a conveyor which transports a harvested product stream picked up from a field, and a transferring device which conveys the collected product stream in direction toward a bailing chamber. In the known balers the transferring device is composed of several profiled disks Which are fixedly mounted on a cylinder, the baler has sensors Which are formed as pilotable sensing brackets located between the pressing chamber for detecting the harvested product stream over the Width, an evaluating device connected With the sensors, and adjusting means connected With the evaluating device. Basically this kind of device can only be used in making bales in agricultural field. [1]

Baler Machine and Method of Baling (Roman Schmaltz, Robert J. Wolf, and Enrich E. Salzmann) they carried out that that baler machine including a charging chamber for receiving material to be baled. The charging chamber has a charging passage through which material is forced into a baling compression chamber by a compression ram to thereby form a bale in the compression chamber. An ejection ram is provided for forcing the compressed material out of the baling compression chamber through an exit passageway. A movable decompression wall functions as one wall of the baling compression chamber. Such wall is located opposite and spaced from the charging passage through which material is forced from the charging chamber. [2]

Baler machine with a bale transfer conveyor (Wilbur Van Ryswyk) Here cylindrical bale forming machine has a bale transfer unit yieldable maintained in a transport or rest horizontal position located below the bale discharge gate to receive a bale discharged from the machine for transfer to a ground location rearward clear of the discharge gate. The transfer unit is operated in response to the movement of the discharge gate into its open or bale discharge position and is returned to its rest position in response to movement of the discharge gate out of the open position therefore. [3]

2.1 Gaps in the review

- After our initial survey, we found that most of the industries are using the traditional way to store the scraps.
- Due to the excess of paper waste it requires lot of time for filling the waste in the transporting vehicle and it more tedious work .
- These paper baling machines, hydraulic operated machines are costlier which is not affordable for some small scale industries.

2.2 Objective

Structural optimization tools have gained the paramount importance in industrial applications as a result of innovative designs, reduced weight and cost effective products. Especially, in paper, aircraft and automobile industries, topology optimization has become an integral part of the product design process. In this project, topology optimization has been applied on various components of scrap baling press and 5Ton hydraulic press.

3. WORKING

3.1 Working Principle

The Hydraulic presses works on the principle of Pascal's law which state that: The pressure throughout the system remains constant. The pressure exerted onto the confined fluid is transmitted equally in all directions at the same time and acts at 90 degrees to the containing surfaces".

4. CALCULATIONS

4.1 Specifications

- Bale size : Breadth x Height x Length

  =600x600x600

4.2 Design of 5 ton hydraulic cylinder

4.2.1 To find diameter of bore

- Capacity : 5ton

  49.05KN

- Taking working Pressure P : 115 bar

  11.5 N/mm^2

  1667.5 Psi

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

  $\frac{\pi}{4}D^2 = \frac{F}{P}$

  $\frac{\pi}{4}D^2 = \frac{5000x9.81}{11.5}$

  D = 73.69 mm

  D = 80mm

4.2.2 Thickness of cylinder body

- $t = \left(\frac{di}{2}\right)\left\{\left(\frac{S+(1-2\mu)P}{S-(1+\mu)P1}\right)^{1/2} - 1\right\}$

  $t = \left(\frac{80}{2}\right)\left\{\left(\frac{165+(1-2x0.3)20}{165-(1+\mu)20}\right)^{1/2} - 1\right\}$

  t = 3.55

  For safe taking double = 7.5mm

4.2.3 To find outer diameter

- $Do = Di + (2t)$
- $Do = 80 + (2 * 75)$

  Do = 95mm

  The hydraulic cylinder is 95/80 mm is used

4.2.4 Piston rod design

Force

- $F = AP$

  $F = \frac{\pi}{4}d^2 * P$

  $F = \frac{\pi}{4} * 63^2 * 11.5$

  F = 57805.3 N

  Taking $^{Di}/_{d}$ = 1.27

  $^{80}/_{d}$ = 1.27

  D = 62.9mm

  D = 63mm

4.2.5 Volume of cylinders

- Bore side

$Vb = \frac{\pi}{4} D^2 * L$

$Vb = \frac{\pi}{4} 80^2 * 500$

Vb = $2.513 * 10^6 mm^3$

- Ram side

$Vr = \frac{\pi}{4} D^2 * L$

$Vr = \frac{\pi}{4} 63^2 * 500$

Vr =$1.55 * 10^6 mm^3$

4.2.6 Time required for Forward and Return stroke

- T=$\frac{V}{FR}$
- V=Volume
- FR=Flow Rate
- We assume time for each stroke = 30 seconds
- F =$\frac{2.513 X 10^6}{30}$

= 83766.66 $\frac{mm^3}{sec}$

- W.K.T = 1 $\frac{mm^3}{sec}$ = 0.00006 LPM
- FR = 5.026 LPM
- Select Q = 5 LPM gear pump for operation

4.2.7 Time for return

- T = $\frac{1.55 X 10^6}{\left(\frac{5.026}{0.00006}\right)}$

T = 18.5 sec

4.2.8 Motor required H P

- H P = $\frac{Flowrate (LPM) X Pressure (bar)}{442}$

H P = $\frac{5.026 X 115}{442}$

H P = 1.307

4.2.9 Thickness of cylinder end cover

- $F = \pi * Di * tc * \sigma_a$
- tc = Thickness of end cover
- σ_a = Allowable tensile stress for mild steel

= 165 Mpa

F = 57805.3 N

- $tc = 80 * \sqrt{\frac{0.1875X11.5}{165}}$

tc= 9.14 mm

=2 X 9.14

tc= 18.29 mm

$tc \approx$ 20 mm

4.2.10 To check buckling of piston rod

- Rankine formula for induced stress
$\sigma c = \frac{F}{A}\left[1 + \frac{a}{n}\left(\frac{Lc}{k}\right)^2\right]$

Where,

- K= Radius of gyration = $\sqrt{\frac{I}{A}}$
- σc = Compression stress
- Le = Effective length
- a = Rankine constant for mild steel 1/7500
- n = End constant for one end fixed and other end free 0.25
- Le = effective length 2L
- L = 600mm
- Le = 1200 mm
- dp = 63 m
- $A = \frac{\pi}{4} D^2$

$A = \frac{\pi}{4} 63^2$

$A = 3117.2\, mm^2$

- $I = \frac{\pi}{64} D^4$

$I = \frac{\pi}{64} 63^4$

I = 773.27*$10^6 mm^4$

- $K = \sqrt{\frac{I}{A}}$

$K = \sqrt{\frac{773.27 * 10^6}{3117.2}}$

K = 15.75

- E = Young's modulus $207 * 10^3\ N/mm^2$

- $\sigma c = \frac{F}{A}\left[1 + \frac{a}{n}\left(\frac{Lc}{k}\right)^2\right]$

$$320 = \frac{F}{37.2}\left[1 + \frac{\frac{1}{7500}}{0.25}\left(\frac{1200}{15.75}\right)^2\right]$$

F = 243.5 KN

Since the critical load for buckling is 243 KN and load applied is 57.8 KN which is less and hence design is safe.

5. DESIGN

5.1 Base

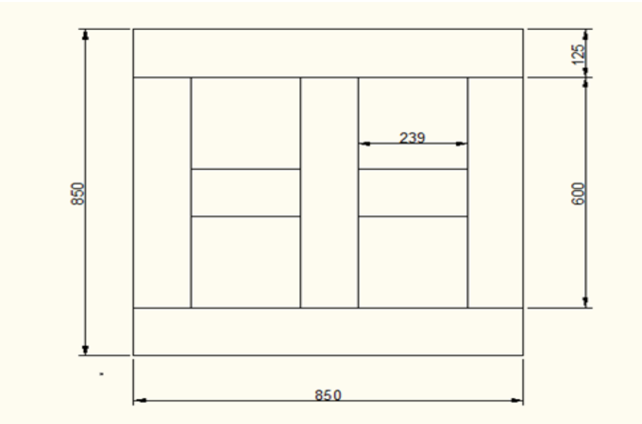


Fig -1: Base

5.2 Structure

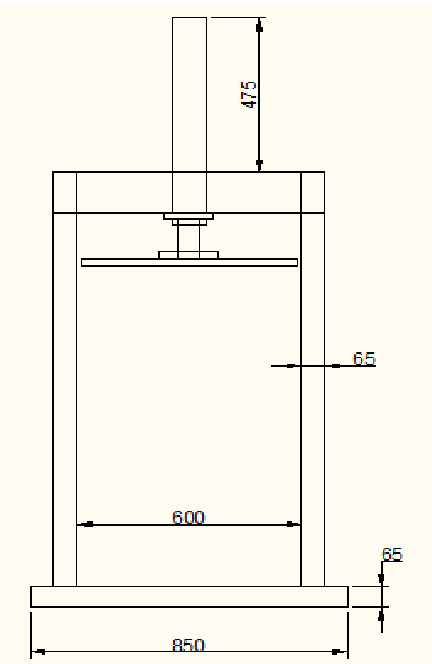


Fig -2: Structure

5.3 Door

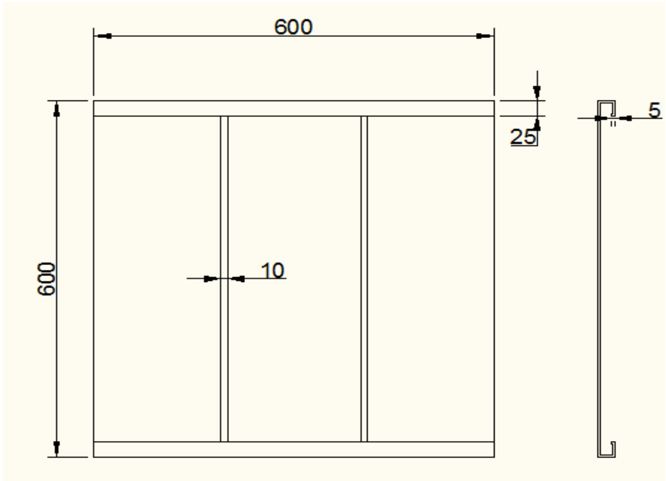


Fig -3: Door

5.4 Side Plate:

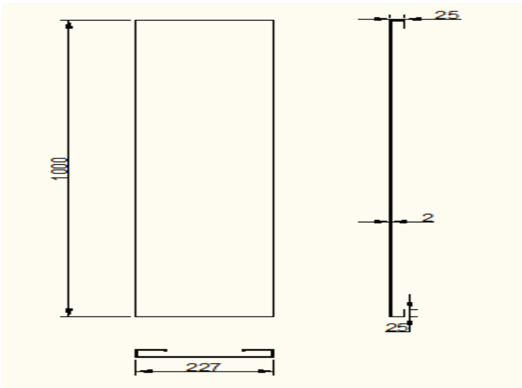


Fig -4: Side plate

5.5 Support Pillar:

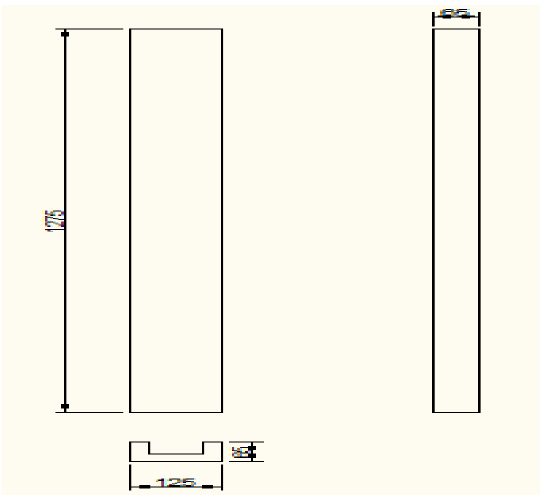


Fig: 5. Support pillar

5.6 Flange:

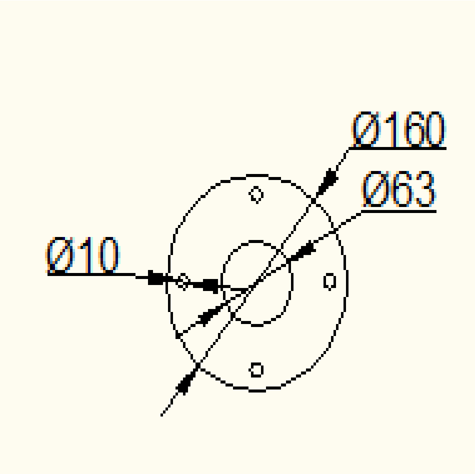


Fig -6: Flange

5.7 Moving Plate:

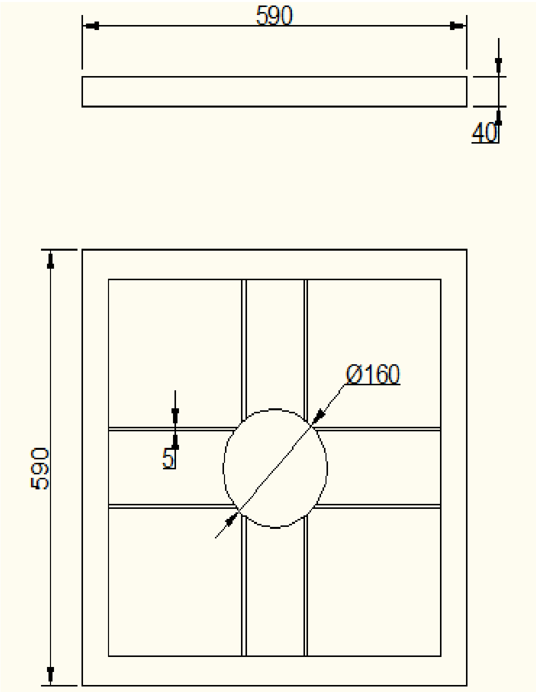


Fig -7: Moving plate

5.8 Cylinder Barrel:

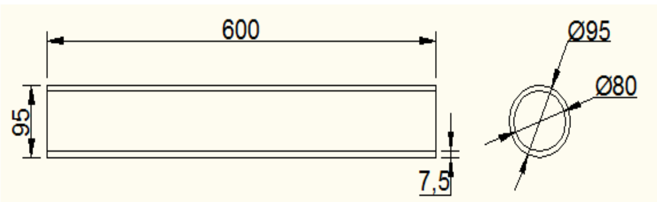
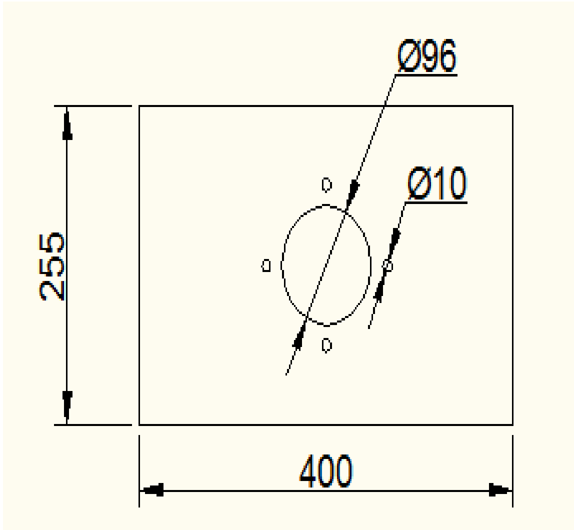


Fig -8: Cylinder barrel

5.9 Cylinder mounting plate:



5.10 3D Model

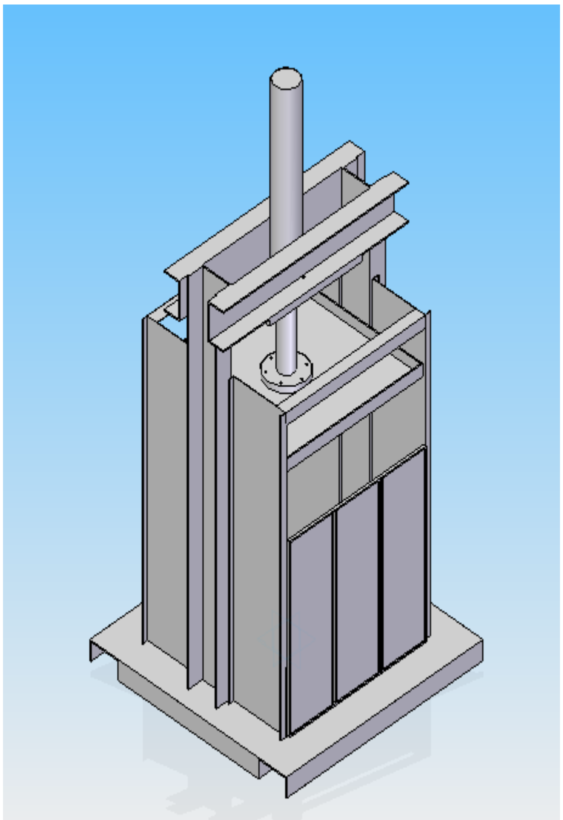


Fig -10: 3D model of paper bailing machine

5.11 Drafting:

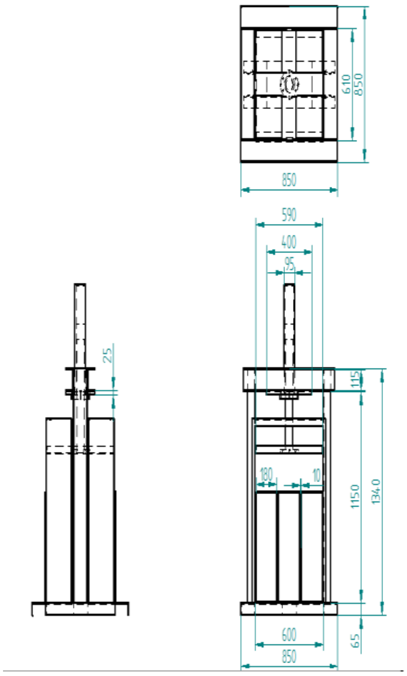


Fig -11: Drafting of paper bailing machine

7. CONCLUSIONS

- The bales formed by this machine helps in easy handling, storage and transportation.
- The maneuverability of the device is quite good and the handling is quite simple.
- Optimization design is compared to the actual part design that is being manufactured for the scrap baling press and hydraulic press.
- It is inferred that under the same loading conditions, constraints and intended design purposes, shape optimization results in better and more reliable design.
- The cost of the machine is low compared to market product; there is 50% reduction in the cost.

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