ISSN 2347 - 3983

Volume 9. No. 3, March 2021

International Journal of Emerging Trends in Engineering Research

Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter27932021.pdf

https://doi.org/10.30534/ijeter/2021/27932021

Design and Manufacturing Analysis of Multi-purpose Vertical baler/trash Compactor Machine

Zelalem Weyuma

Lecturer, Assosa University, Assosa, Ethiopia, zobeti12@gmail.com

ABSTRACT

Humans have always had an impact on their surroundings. Solid waste is one of our biggest effects on nature. Unlike other animals, humans create too much waste for nature to keep up. With the continually rising of the earth's population, the situation is going to get harder and harder to slow it down, or fix it. With garbage pollutioncomes; from the burning of garbage we are destroying the atmosphere just as fast as we are just leaving the garbage on the ground. When you burn garbage it gives off extremely poisonous gases into the atmosphere. If a person breathes this air it can hurt their lungs and if untreated can result in cancers or even death. Even if we burry our garbage not all of it will decompose, as there are some material needs centuries to decompose. By polluting the ground it can seep into our farming soil and even into our ground water, which can cause dramatic consequences.

Compacting trashes is considered a great solution for the problem of throwing garbage as it was examined in well developed countries and solved the problem of thrown garbage in the streets or burning extra garbage which is the same problem that each developing country is facing, and in result it also reduce the pollution amount due to the smoke of burning garbage and the diseases caused because of the uncovered garbage in streets where people walk through and others live nearby.

Key words: Garbage, waste, pollution, burning, Atmosphere, Compacting.

Table 1 **Nomenclature**

Symbol	Description	Symbol	Description
A_p	Area of piston	L_s	Piston stroke length
A_{pipe}	Pipe line area	L_e	Effective length
A_{pr}	Annular piston area	M	Maximum bending moment
C	Half the length of beam	N	Factor of safety
D_R	Piston rod diameter	P	Working pressure
D_p	Piston diameter	P_2	Hydraulic pressure
D_{pipe}	Pipe line diameter	P_H	Hydraulic pump power
E	Modulus of elasticity	Q_1	Required flow rate delivered from the pump
F	Force	SF	Safety of factor
F_b	Force per beam	S_u	Ultimate tensile strength
F_c	Compression force	T	Thickness of rectangular beam
I	Moment of inertia	T_s	Advance stroke time
L	Beam length	V_1	Piston advance stroke speed
L	Maximum permissible stroke	V_2	Piston return speed
V	Volume	Φ	Area ratio
W	Distributed	H	Total

	load		efficiency
η_{vol}	Volumetric efficiency of the hydraulic jack	λ_g	Design slenderness ratio
σ_c	Cylinder rod strength	σ_a	Allowable stress
Λ	Cylinder ratio		

1. INTRODUCTION

Solid waste management is an essential service in any society. Before introducing the process, however, let us start with a discussion of the material being managed solid waste.

Solid waste refers to the range of garbage materials arising from animal and human activities that are discarded as unwanted and useless. Solid waste is generated from industrial, residential, and commercial activities in a given area, and may be handled in a variety of ways. As such, landfills are typically classified as sanitary, municipal, construction and demolition, or industrial waste sites.

Waste can be categorized based on material, such as plastic, paper, glass, metal, and organic waste. Categorization may also be based on hazard potential, including radioactive, flammable, infectious, toxic, or non-toxic wastes. Categories may also pertain to the origin of the waste, whether industrial, domestic, commercial, institutional, or construction and demolition.

Regardless of the origin, content, or hazard potential, solid waste must be managed systematically to ensure environmental best practices. As solid waste management is a critical aspect of environmental hygiene, it must be incorporated into environmental planning.

1.1 Problem Statement

Lack of municipal solid waste management and disposal is leading to significant environmental problems.This includes soil, air water, and aesthetic pollution. Such environmental problems are associated with human health disorder, due to the increase in greenhouse gas emissions.

Dry waste disposal problems are observed in many factories as being seen in the factory it takes a lot of space to store and it is not attractive for the working environment as it makes an environmental pollution, and reduces the willingness of the workers to perform their work properly. In addition, it is becoming an obstacle for the sake of movement due to bad placement of wastes on the walkway and some garden areas.

1.1.1 Proposed Solution

As for the problem of handling of solid waste management and since the population in our country keeps on increasing year by year, the garbage keeps accumulating and the volumes of garbage increased. This accumulation doesn't happen only in landfills but also in the streets everywhere we go. This problem should be dealt with to help solve the problem or at least stop it from growing as the population increases. One of the solutions to this problem is to try decreasing the volume of solid waste material, this could be done by compacting the solid waste and luckily a reasonable volume of waste can be compressed as most of the its components has good compressibility.

We thought about designing a machine that can compress the solid waste as a whole. This machinecan be used in a lot of places and applications. The machine could be used in hospitals, hotels, metal product manufacturers, warehouses, grocery stores, or any commercial entity that generates/recycles materials like used clothing, cardboard, cartons, coconut fibre, and plastic bottles, UBC (used beverage containers), shrink wrap, soft packaging, fabric scrap, tyre/tires, wood shavings, and stores to decrease the volume of waste produced so this will decrease their costs. This machine will be user friendly as anyone could deal with it, it can be used in residential areas or compounds. The machine will operate once the garbage enters and will be safe for use. Finally this proposed solution would help to solve the problem of solid waste acclimation and will decrease the costs of solid waste disposal. Also it will be safe for use and user friendly so any one could deal with it.

2. LITERATURE REVIEW

Agricultural Baler (Arsene Roth) This research relates to an agricultural baler that 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. [5]

(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 walls, function as one of the wall in the baling compression chamber. Such wall is located opposite and spaced from the charging passage through which material is forced from the charging chamber. [6]

Baler machine with a bale transfer conveyor (*Wilbur Van Ryswyk*) Here cylindrical bale forming machine has a bale transfer unit yield-able 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.

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. [7]

*("BALING PRESS", Orion Thomas Quinn, Sr., Los Angeles, Calif., assignor, by mesne assignments, to Apex Steel Corporation, Ltd., Los Angeles, Calif., a Corporation off Nevada).*This invention pertains to a baling press adapted to compress Waste paper, cotton waste, rags, cork chips, metal cuttings, scrap metal and various other materials into consolidated or compressed bales which are then strapped or bound in the usual manner. The invention is specifically directed to improvements in baling presses, among such improvements being simple and efficient means for opening and closing the upper portion of the charging box so as to permit the charging box to be readily filled and the pressed material readily removed from the press. [8]

*("Improvement in Waste Handling System", Varun Chandratre, Pratik Rathod)*Large Square of baling is currently recognized in industry of wasted paper in a proper form so as during transportation the waste material is decreased and quantity of transportation will increase. Baling machine is used to bale collecting and storing at an industry (Jash Packaging Co.) Factors to be effect of this method are large square of bale production and handling logistics were quantified. Performance material capacities of machines used in this system to be determined based on field measurements. It means to increase system efficiency or reduce transportation cost and waste paper material were discussed. [8]

3. DESIGN ANALYSIS: MATERIAL AND METHOD

3.1 Working Principle

The hydraulic press depends on Pascal's principle: the pressure throughout a closed system is constant. At one end of the system is a piston with a small cross-sectional area driven by a lever to increase the force. Small-diameter tubing leads to the other end of the system. Pascal's law: Pressure on a confined fluid is transmitted undiminished and acts with equal force on equal areas and at 90 degrees to the container wall. A fluid, such as oil, is displaced when either piston is pushed inward. The small piston, for a given distance of movement, displaces a smaller amount of volume than the large piston, which is proportional to the ratio of areas of the heads of the pistons. Therefore, the small piston must be moved a large distance to get the large piston to move significantly. The distance the large piston will move is the distance that the small piston is moved divided by the ratio of the areas of the heads of the pistons. This is how energy, in the form of work in this case, is conserved and the Law of Conservation of Energy is satisfied. Work is force times distance, and since the force is increased on the larger piston, the distance the force is applied over must be decreased.

3.2 Design of Hydraulically Operated Multi-purpose Vertical Baler Machine

Strength analysis of hydraulically operated multi-purpose vertical baler machine Performance of a machine and parts of machines are determined by the satisfying the following points:

1. Strength (life and durability)
2. Operating temperature

3. Cost of manufacture or materials, machining and assembly
4. Smoothness in operation

3.3 Material Selection

The selection of a proper material for the design purpose is a very crucial issues. The best material is one which serves the desired objective at the minimum cost. The following factors should be considered while selecting the material.The most important characteristics to be considered when selecting a material of construction are:

1. Mechanical properties
   (a) Strength-tensile strength
   (b) Stiffness-elastic modulus (Young's modulus)
   (c) Toughness-fracture resistance
   (d) Hardness-wear resistance
   (e) Fatigue resistance
   (f) Creep resistance
2. The effect of high and low temperatures on the mechanical properties
3. Corrosion resistance
4. Any special properties required; such as, thermal conductivity, electrical resistance, magnetic properties
5. Ease of fabrication-forming, welding, casting
6. Availability in standard sizes-plates, sections, tubes
7. Cost

3.4 Design of Piston

Piston head is circular in shape connected to the piston rod found inside a cylinder.

$$p = \frac{F}{A} \text{or} A = \frac{F}{P} \quad or \quad \frac{\pi D^2}{4} = \frac{F}{P} D = \sqrt{\frac{4F}{\pi P}}$$

$$D_i = \sqrt{\frac{4 \times 392.4KN}{\pi 18N/mm^2}}$$

$$D_i = 177mm$$

We need to take a standard of 180mm diameter

3.5 Design of Hydraulic Cylinders

Diameter of the cylinder almost equal to the diameter of the piston, but no hard fit, some have clearance;

Then; $D_i = D_{piston} + clearance$
=180(2×0.5)
=181mm

Then find thickness of cylinder by using ductile material, closed ends: **Clavarino's equation** is used

$$t = \frac{D_I}{2}\left[\sqrt{\frac{\sigma_{all} + (1-2\mu)P}{\sigma_{all} - (1+2\mu)P}} - 1\right]$$

$$t = \frac{181}{2}\left[\sqrt{\frac{143.3 + (1-2(0.3))18N/mm2}{143.3 - (1+2(0.3))18N/mm2}} - 1\right]$$

$$t = 13.18 \approx 13mm$$

But we can use double t=26mm;

Then; the thickness of the cylinder implies that the ratio of the thickness to internal diameter of the cylinder given by;

$$\frac{t}{D_i} = \frac{26mm}{180} = 0.143$$

This means 0.143> 1/15 then the cylinder is thick cylinder,

Then find outer diameter of the cylinder;

$D_O = D_i + 2t$

=181+ (2×26)

=233mm

3.6 Design Piston Rod

Force analysis of piston rod

$$F = P \times A$$

Then calculate A,

$A = \frac{\pi \times 125^2}{4}$ =12,271.8mm^2

$$F = 18N/mm^2 \times 12{,}265mm^2$$

$$F = 220{,}780.8N$$

Find length of piston rod

Assume, L=4D =4x180 =720mm

3.7 To Check Buckling of Piston Rod

Rankine formulas for induced stress

$$\sigma_c = \frac{F}{A}\left[1 + \frac{a}{n}\left(\frac{L_e}{K}\right)^2\right]$$

Area of the piston;

$$A = \frac{\pi {d_p}^2}{4} = \frac{\pi \times 125^2}{4} = 12{,}265.6mm^2$$

Calculate moment of inertia of the piston

$$I = \frac{\pi {d_p}^4}{64} = \frac{\pi \times 125^4}{64} = 11.98 \times 10^6 mm^4$$

$$K = \sqrt{\frac{I}{A}} = \sqrt{\frac{11.98 \times 10^6 mm^4}{12{,}265.6 mm^2}} = 31.25mm$$

$$\sigma_c = \frac{F}{A}\left[1 + \frac{a}{n}\left(\frac{L_e}{K}\right)^2\right]$$

$$\frac{320N}{mm^2} = \frac{F}{12{,}265.6mm^2}\left[1 + \frac{\frac{1}{7500}}{0.25}\left(\frac{1230mm}{31.25mm}\right)^2\right]$$

$$F = 1840.6KN$$

Since the critical load for buckling is 1840.6KN and load applied is 392.4 KN which is less and hence design is safe.

3.8 Extension Fluid Pressure

The Pressure generated inside the hydraulic cylinder is given as

Fluid pressure, $F1 = \frac{F1}{A1}$

$$A_1 = \frac{\pi {d_1}^2}{4} = \frac{\pi \times 180mm^2}{4} = 25.4 \times 10^3 mm^2$$

$$P1 = \frac{F1}{A1} = \frac{392.4\text{KN}}{25.4 \times 10^3 mm^2} = 15.43N/mm2$$

3.9 Volume of Cylinder

Table 2 Volume of Cylinder

BORE SIDE	RAM SIDE
$V_b = \frac{\pi D^2}{4} L$	$V_r = \frac{\pi D^2}{4} L$
$V_b = \frac{\pi 180^2 mm}{4} \times 720mm$	$V_r = \frac{\pi 125^2 mm}{4} \times 720\,mm$
$\boldsymbol{V_b = 16.9 \times 10^6 mm^3}$	$\boldsymbol{V_r = 8.2 \times 10^6 mm^3}$

3.10 Cylinder Volume Capacity

Volume displacement of a hydraulic cylinder can be calculated as

Volume, $q = (A_1 - A_2)mm^2 \times L(mm^2)$

Where, q = Volume displacement, A1 = Extension piston area, A2 = Piston rod area

L = Stroke is 720mm

$$A_1 = \frac{\pi {d_1}^2}{4} = \frac{\pi \times 180mm^2}{4} = 25.4 \times 10^3 mm^2$$

$$A_2 = \frac{\pi {d_2}^2}{4} = \frac{\pi \times 125mm^2}{4} = 12.26 \times 10^3 mm^2$$

Therefore, q = (25.4×10^3-12.26×10^3) $mm^2 \times$ 720mm = 9,460,800mm^3=0.0094608m^3

3.11 Cylinder Flow Rate

Stroke is 720, then, 1440mm is for cylinder extends and retracts.

Total Flow rate is given by, = $Q = \frac{A_1 \times L}{T}$

Therefore, $Q = \frac{0.0254m^2 \times 1.44m}{30} = 0.001292 \frac{m^3}{s}$

But, 1mm3/sec=0.00006LPM

Then FR is;

FR=731.5LPM

To calculate time for return

$$T = \frac{V_r}{FR} = \frac{0.0082m^3}{0.001292m^3/sec}$$

$$T = 6.45\,sec \approx 7sec$$

3.12 Cylinder Velocity

For travel time of 30sec for a distance of 720mm,

Cylinder Velocity is given as = $\frac{Q(\frac{m3}{s})}{(A_1 - A_2)(sq-m)}$

Where, Q = total flow rate is $0.001292 \frac{m^3}{s}$

A1 = Extension piston area is $25.4 \times 10^3 mm^2$≡0.0254m^2

A2 = Piston rod area is $12.26 \times 10^3 mm^2 \equiv 0.01226m^2$,

V = cylinder velocity

Therefore, = $V = \frac{0.001292}{0.0254-0.01226} = 0.0983m/s$

3.13 Extended Velocity of the Hydraulic Cylinder

Forward velocity is given by $V_1 = \frac{Q}{A_1}$

Where, V1 = forward velocity,

Q = total flow rate is $0.001292\frac{m^3}{s}$

A1 = Extension piston area is $25.4 \times 10^3 mm^2$≡$0.0254m^2$

Therefore, $V_1 = \frac{0.00192}{0.0254} = 0.0756 m/s$

3.14 Extension Force of the Hydraulic Cylinder

Force during extension is given by

$F_1 = P_1 \times A_1$

Where, F1 = Force in extending piston,

A1 = Extension piston area is $25.4 \times 10^3 mm^2$≡$0.0254m^2$

P1 = Extension fluid pressure is $15.43\frac{N}{mm^2}$

Therefore, $F_1 = 15.43\frac{N}{mm^2} \times 25.4 \times 10^3 mm^2$=3,919,220N≡3919KN

3.15 Retraction Force of the Hydraulic Cylinder

Force during retraction is given by

$$F_2 = P_1 \times (A_1 - A_2)$$

Therefore, = $F_2 = 15.43\frac{N}{mm^2} \times (25.4 \times 10^3 mm^2 - 12.26 \times 10^3 mm^2)$ =202.7×10^3N=202.7KN

3.16 Retraction Fluid Pressure of Hydraulic Cylinder

Hydraulic pressure during the retracting stroke is

Fluid pressure, $P_2 = \frac{F_2}{(A1-A2)}$

Therefore, = $P_2 = \frac{202.7KN}{(25.4-12.26)10^3} = 15.43 N/mm2$

3.17 Extension Hydraulic Cylinder Power

Cylinder KW power during the extending stroke

Power = $F_1 \times V_1$.

Therefore, = Power = $F_1 \times V_1$=296.2×10^3W

3.18 Retraction Hydraulic Cylinder Power

Cylinder KW power during the extending stroke

Power = $F_2 \times V_2$

Where, F2 = Force in retracting piston is 202.7KN

V2 = return velocity is 0.0983m/s,

P_e = extension cylinder power.

Therefore, = Power = $F_2 \times V_2$=202.7KN×0.0983m/s=19.9×10^3W

3.19 Hydraulic Oil Pump-Displacement

Pump displacement needed for m3/s of output flow is

$$q_d = \frac{Q(m^3/sec)}{N(rps)}$$

In most catalogs Gear and Vane pumps are rated at 1,800RPM (30RPS) while Piston pumps are rated at 1200RPM, (Tutle, 2012) so 1800RPM (30rps) was chosen for the pump

Where, Q = total flow rate is $0.001292\frac{m^3}{s}$

N = pump speed is 30rps,

q_d = pump displacement

Therefore, $\boldsymbol{q_d = \frac{Q(m^3/sec)}{N(rps)} = \frac{0.001292}{30} = 00004}$ cubic meter per revolution

3.20 Hydraulic Oil Pumps-Horsepower Required

Horsepower required by hydraulic pumps. Formula for calculating horsepower required by a hydraulic pump

Can be expressed as

P_w = QP

Where, P_w = pump rating in watt (W),

Q = required pump capacity is $0.001292\frac{m^3}{s}$,

P1 = required pressure $15.43\frac{N}{mm^2}$≡$15.43\times 10^6 \frac{N}{m^2}$

1hp=746watt

Therefore, P_w= $0.001292\times 15.43\times 10^6$ = 19974.3watt = 26.75hp

3.21 Efficiency

Note that the equation above can be used for a 100% efficient pump - which in the practical life is never true. An overall efficiency of μ ≤ 93% ≤ μ is common. (Tutle, 2012).

The equation can be modified to

P_w = QP / (μ / 100)

Where, μ = overall efficiency (%) and 93% overall efficiency was chosen for the design.

Therefore, P_w = $0.001292\times 15.43\times 10^6$ / (0.93)

=21,477.42watt=28.8hp

3.22 Motor Power Selection

Hydraulic pump rating =21,477.2W

Since the machine designed for Small and medium scale enterprise, a single phase electric motor is desirable to power the pump. Assuming power transmission of 95%, power rating of electric motor is therefore 28.8/0.95 =30.3HP (30HP was selected)

3.23 Hydraulic Hose Design: Pressure Lines

Good practice demands for a maximum velocity of 4.6m/s in a pressure line up to 18Mpa.

Therefore, A=Q/V

Where, Q = Total flow rate is $0.001292\frac{m^3}{s}$,

V = maximum velocity in a pressure line up 500Psi is 4.6m/s

Therefore, A= $\frac{0.001292}{4.6}$ =2.81× $10^{-4}m^2$=280.87mm^2

Where, A = Area of the pressure hose is 280.87mm^2,

$$280.87mm^2 = \frac{\pi D^2}{4}$$

$$D = \sqrt{\frac{4 \times 280.87mm^2}{\pi}}$$

$$D = 18.9 \approx 19mm$$

Therefore, a minimum of 19mm internal diameter hose is needed for the pressure lines.

3.24 Suction/Return Lines

For the pump suction and return lines, the maximum velocity by practice is 1.2m/s for pressure up to 18Mpa.

The diameter of the pipe is given by,

$$D = \sqrt{\frac{4 \times Q}{\pi V}}$$

Where, Q = Total flow rate is, $0.001292\frac{m^3}{s}$

Therefore, $D = \sqrt{\frac{4\times 0.001292}{\pi \times 1.2}} = 0.037m^2 = 37mm$

A minimum of 37mm internal diameter pipe is therefore used for the suction and return pipes.

3.25 Hydraulic Reservoir Design

The major consideration in designing the reservoir is the volume. The minimum volume of the reservoir should equal volume of the whole fluid in the system, plus volume in the reservoir that will allow for sludge and dirt.

$$volume\ of\ fluid\ in\ cylinder = \frac{\pi D^2}{4}L$$

Where, D = maximum bore diameter is 180mm,

L = Stroke of cylinder is 720mm

V_b = volume of fluid in cylinder is V_b $= 16.9 \times 10^6 mm^3 = 0.0169m^3$

Length of each of the pressure hose = 0.7m,

Diameter of hoses = 0.019m,

Volume of the three hose $= 3 \times \frac{\pi \times 0.019^2}{4} \times 0.7 = 0.000595m^3$

Diameter of each of the suction and return hose = 37mm = 0.037m

Volume of both hoses $= 2 \times \frac{\pi \times 0.037^2}{4} \times 0.7 = 0.001504m^3$

Total volume of the fluid in the system = 0.0169 + 0.000595 + 0.001504 = $0.019m^3$

Often over sizing the reservoir will allow more fluid dwell time to allow cooling through the process of thermal radiation. Giving 40% allowance for other joints and space in the reservoir:

$\frac{40}{100} \times 0.019m^3 = 0.0076m^3$

Total volume of reservoir = $0.0076m^3 + 0.019m^3 = 0.0266m^3$

We can choose mild steel sheet metal have 2 mm thick, the tank must be 3 times the volume of oil in piston.

H=400mm, L=500mm, W=350mm

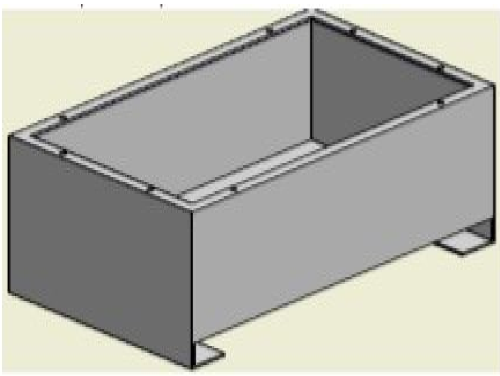

Figure 1: Reservoir

3.26 Design of Piston Seal

Selectfromtable

Elastomeric SEAL Piston seal

Select 180 because, choose standard diameter of piston diameter of piston 180mm

d=159mm

3.27 Design Frame

Where;-F=Force =392.4KN

Number of beams =4

l=beam length=0.88mm

$$M_{max} = moment\ of\ inertia$$

I=moment of inertia

W=distributed load

$$F = \frac{F}{NO.beams}$$

$$F = \frac{392.4KN \times 1000}{4}$$

$$F = \frac{392400N}{4\ Beam} = \frac{98100N}{beam}$$

$$l = 0.88m$$

Find distributed load on the plate

$$W = \frac{F}{l} = \frac{98100N/beam}{0.88m} = 111{,}477.27N/m$$

$$W = 111{,}477.27N/m$$

Then find M_{max}

$$M_{max} = \frac{wl^2}{8}$$

$$M_{max} = \frac{111{,}477.27N/m \times 0.88^2}{8}$$

$$M_{max} = 10790.1Nm$$

$$\sigma = \frac{M_{max} \times c}{I}$$

$$\sigma \leq \frac{s_{ut}}{n}$$

Where; $\sigma = bending\ stress$

Substitute on above equation,

$$\frac{430mpa}{3} \geq \frac{10790.1Nm \times 1000 \times 30}{I}$$

By factorization

$$(60^4 - (60 - 2t)^4) \geq \frac{10790.1Nm \times 1000 \times 30 \times 12 \times 3}{430mpa}$$

Solve the equation for t;

$$t \geq 6.4mm$$

Therefor t≈7mm

3.28 Design Compress Plate

Rectangular plate with all edges fixed and a uniformly distributed load over the surface of the plate.

$$s = \frac{0.5W}{t^2(\frac{L}{l} + 0.623\frac{l^5}{L^5})}$$

$$430mpa = \frac{0.5 \times 392.4KN}{t^2(\frac{980mm}{780mm} + 0.623\frac{780mm^5}{980mm^5})}$$

t=16mm,

but we take it doubled , so t= 36mm

3.29 Design Base Plate

$$430mpa = \frac{0.5 \times 392.4KN}{t^2(\frac{1000mm}{800mm} + 0.623\frac{800mm^5}{1000mm^5})}$$

t=18≈20mm

3.30 Design Right and Left Side Plate

l=0.8m ;L=1.6m

$$430mpa = \frac{0.5 \times 392.4KN}{t^2(\frac{1600mm}{800mm} + 0.623\frac{800mm^5}{1600mm^5})}$$

3.31 Design of Closing Lower Door

Clearance: 3mm for both left and right edge

Material: Mild steel

σ_m = 430MPa ; W = 392.4kN ; L =1.10m ; F.s = 3 ; E = 210MPa

$$430mpa = \frac{0.5 \times 392.4KN}{t^2(\frac{1100mm}{1000mm} + 0.623\frac{1000mm^5}{1100mm^5})}$$

t =18mm ≈ 20mm

The same thickness of upper door, L=1m and l = 50mm

4. RESULT AND DISCUSSION

Table 3 Result and Discussion

Part Name	Result	Part Name	Result
Piston head diameter	180mm	Velocity of extraction	V_{ext} = 0.022m/s
Piston rod diameter small	D_p110mm	Criteria force of piston	F_{cr} = 2156.6KN
Piston rod large diameter	D_p = 125mm	Acting force on base plate	F=787.5KN
Piston rod length	L=720mm	Thickness of base plate	t =23mm
Internal diameter of cylinder	D_i=181mm	Acting force on top plate	F=789.3KN
Outer diameter of cylinder	D_o = 225mm	Velocity of extraction	V_{ext} = 0.022m/s
Thickness of cylinder	t = 22mm	Criteria force of piston	F_{cr} = 2156.6KN
Capacity of machine	F=441.5KN	Acting force on base plate	F=787.5KN
Area of piston head	A=12,271.8mm2	Thickness of base plate	t =23mm
Force of piston rod	F=220.78KN	Acting force on top plate	F=789.3KN
Velocity of retraction	V_{ret} = 0.043 m/s	Thickness of top plate	t =21mm
Thickness of left and right side plate	t=21 mm	Thickness closing (door)	t=23mm
Thickness of back plate	t=20 mm	Force acting on plate	F= 787.5KN

4.1 Cost Analysis

Table 4 Cost Analysis

No.	Component of the machine	Material	Dimension all in mm	Quantity	Unit price in birr	Total price in birr
1.	Hydraulic jack		F=392.4 KN P=18Mpa	2	3500	7000
2.	Pump			1	2000	2000
3.	Motor		30HP	1	14050	14050
4.	Compressing plate	Mild steel	980mm *780mm ,t=36mm	1	1152	1152

5.	Top plate	Mild steel	1000mm *800mm, t=21mm	1	1260	1260
6.	Base plate	Mild steel	1000mm *800mm, t=23mm	1	2016	2016
7.	Right and left side plate	Mild steel	1600mm *800mm, t=21mm	2	1843	3686
8.	Back side plate	Mild steel	1600mm *800mm, t=20mm	1	2016	2016
9.	Closing lower door	Mild steel	1100mm *1000mm,t= 23mm	1	1387	1387
10.	Reservoir	Mild steel	H*L*W= 400*500 *350	1	256	256
11.	Directional control valve		4/3 (Four-way three position directional control valve)	1	960	960
12.	Flange			2	320	640
13.	Pressure gauge			1	200	200
14.	Total					36,623

Total cost of the machine

Cost of designed component = 11,773 birr

Cost of selected component = 24,850 birr

Cost of machining = 10,000 birr

Cost of welding = 2500 birr

Labour cost of machining = 3000 birr

Total costing = 52,123 birr

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The project is mainly deals about solid waste management. Finally, this baling machine will help minimize the surface area carried by the wastes, and help for an easy carrying purpose of those different types of wastes transportation would be no problem for the removal of those wastes from the factory. This machine works with a hydraulic pressing mechanism to squeeze those wastes to a bale size.

The wastes that it can squeeze are:

- Card board
- Metal scrap and cans
- Plastic wastes
- Wood wastes

5.2 Recommendation

Every design should be considered for the proper working of the machine and for the prolonged life of the machine. The manufacturing process written in it would also minimize the time required to finish the job. And all the parts that need to be purchased should be bought and the assembly process may proceed, otherwise the safety of the machine will not be guaranteed and can't be used for the purpose we need or if we do it might cause damage on the machine and unfortunately on the health of the operator.

REFERENCES

1. Dr. H. K. Amarnath, Vaibhav Deshpande, Abhishek Kulkarni, Mahesh Patil OmkarRavan and Sagar Chougule, "Design and Fabrication of Paper Bailing Machine", India, June 2017.
2. Arsene Roth, "Agricultural Baler", "The Chartered Institute of Purchasing and Supply", Vol no. 1, February 1997.
3. Roman Schmaltz, Robert J. Wolf, and Enrich E. Salzmann, "Baler Machine and Method of Baling", the Pennsylvania State University, University Park, USA, Vol. C201, April 1993.
4. Dr. H. K. Amarnath, Vaibhav Deshpande, Abhishek Kulkarni, Mahesh Patil Omkar Ravan and Sagar Chougule, "Design and Fabrication of Paper Bailing Machine", India, June 2017.
5. International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 6 Issue III, March 2018 Availableatwww.ijraset.co.
6. Harari, E; Universal manual trash compactor. US8001887 B2. August 23, 2011. [Visited February 2014].

7. Imperato, J; Portable Trash Compactor. US7000532 B2. February 21, 2006. [Visited February 2014].
8. Iacobucci, E; Waste compactor. US7089852 B2. August 15, 2006. [visited February 2014].
9. Poss, J; Satwicz, J; Richmond, B; Taylor, M; “Solar powered compaction apparatus:, US7124680 B2. October 24, 2006. [visited February 2014].
10. Sammons, D.A; Sammons, E.W; Hydraulic trash compactor. US6959643 B1. November 1, 2005. [visited February 2014].
11. Dr. R.K. Bansal, A Text Book of Strength of Materials. 4th edition, LAXMI publications, New Delhi, India, 2009.