Computer Aided Design of Low Cost Bale Trolley

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Abstract

Material handling systems are commonly used in almost all the industries in all over the world. It is an art and science involving moving, packaging and storing of substances in various forms. This paper contains design of low cost bale trolley used for cotton bale handling. The Bajaj steel industry has manufactured cotton pressing machine 15 BP4818, for that they need to design new trolley according to the size of bale. They have previously designed bale trolley for another press machine (for BP5421) which is not suitable for this new pressing machine (15 BP4818). As more and heavy material was used in previous design which was leading in increasing cost of the bale trolley. Requirement is to improve previous design and to reduce weight according to cotton bale size (which is 175 kg).The Bajaj steel industry is continuously working for higher productivity, cost reduction and quality improvement of the ginning and pressing equipment. As a result of this research can accomplish the requirement of low cost bale trolley for 15 BP 4818 cotton pressing machine. So improve productivity and quality. Since reducing weight and improving design bring significant cost reductions in material handling process.

Keywords- Bale, Trolley, Press, Cost, Weight Reduction Design

I. INTRODUCTION

Bale trolley is one of the most important components of cotton pressing machine. Over all materials that are pressed by pressing machine is ejected on bale trolley by ejector. Bale trolley as the component of material handling plays an important role in the hydraulic pressing machine production. Cotton bales of various densities and weights were used. Square bales came to 500 lb. average and round bales came to a standard of 250 lb. weight From 1940-1960, standard and high-density presses at gins began to be widely used. These bales weighed about 500 lb. and were packaged at of about 24 and 32 lb. /ft³, respectively. Now this bale trolley which is going to design is able to sustain a weight 175kg which is square bale. This paper contains design and analysis of low cost bale trolley used for cotton bale handling. The Bajaj steel industry has manufactured cotton pressing machine 15 BP4818, for that they need to design new trolley according to the size of bale. They have previously designed bale trolley for another press machine (for BP5421) which is not suitable for this new pressing machine (15 BP4818). Therefore we decide to reduce material thickness and weight of the trolley. As more and heavy material was used in previous design which was leading in increasing cost of the bale trolley. Requirement is to improve previous design and to reduce weight according to cotton bale size (which is 175). Bale presses are described primarily by the density of the bale that they produce, such as low density or universal density (gin or compress). Other descriptions include up-packing, down-packing, fixed box, and door-less. Regardless of description, they all packages lint cotton so that it can be handled in trade channels and at textile mills. A material may be handled even 50 times or more before it changes to finished product. It has been estimated that average material handling cost is roughly 10-30% of the total production cost depending upon product to process. By saving in the material handling cost, the cost of production can be reduced considerably. Material handling involves the movement of materials, manually or mechanically in batches or one item at a time within the plant. The Bajaj steel industry is continuously searching for higher productivity, cost reduction and quality improvement of the ginning and pressing equipment. As a result of this research can accomplish the requirement of low cost bale trolley for 15 BP 4818 cotton pressing machine. So ultimate increased in productivity and quality while the cost will decrease. Since reducing weight and improving design bring significant cost reductions in material handling process.

1) Reasons for Making Bale Trolley

Bajaj steel industry had previously designed bale trolley for another press machine (for BP5421) which is not suitable for this new pressing machine (15 BP4818). Therefore we decide to reduce material thickness and weight of the trolley. As more and heavy material was used in previous design which was leading in increasing cost of the bale trolley. Requirement is to improve previous design and to reduce weight according to cotton bale size (which is 175).

II. LITERATURE REVIEW

Dr.Devanand Uttam[1] 2013 "International journal of advanced research in ginnery equipment" In this presented paper study on number of obstacles in the way of accomplishing the adoption of various improved methods of cotton handling and processing

practices, particularly related with packaging. Improvement of the ginnery is possible only if the initial cost of the press and cotton handling system is substantially reduced. Reduction can be achieved by reducing weight of cotton bale handling equipment.
Kaustubh V. Wankhade and Dr. N. A. Wankhade [2] this paper reviews the "Design, modelling and computer simulation as a tool for aiding trolley used by various researchers earlier". This paper shows the results of computer simulations and results obtained by real experimentation compared to get detailed idea about the design ideas. Design and analysis carried out with various CAD software like CREO PARAMETRIC or CATIA and ANSYS.

A. B. Dahake, P. G. Patil, P. M. Padole [3] had done study on "Techno-economic Feasibility of a Mini Cotton Ginnery for developing countries like India". In this paper was found through experimentation that about 55 to 60 percent of the total energy required by the ginnery was consumed by the packaging system and it was also found that cotton of lower moisture content consumed 30 to 50 percent more electrical energy per kg of seed cotton processed than wetter cottons.
Michael G. Kay [4] Fitts Dept. of Industrial and Systems Engineering North Carolina State University January 12/2012 had done study on "Material Handling Equipment". In this paper describe how Material handling involves short-distance movement that usually takes place within the confines of a building such as a plant or a warehouse and between a building and a transportation agency. How It can be used to create "time and place utility" through the handling, storage, and control of material, as distinct from manufacturing (i.e., fabrication and assembly operations), which creates "form utility" by changing the shape, form, and makeup of material.

A.P.Bahale, Dr.S.S.Deshmukh [5]P.G. Student, Department of Mechanical engineering, PRMIT&R, Bandera, India, Had done study on "Improving Material Handling Efficiency in a Ginning Machine manufacturing Company". In this paper they shows Material handling cannot be avoided in logistics, but can certainly be reduced to minimum levels. Material handling system design has a direct influence on the logistics cost. Therefore, they show how to improve the efficiency of material handling system gets more and more people's attention.

Gautam B.Ghegadmal, Late.Prof. Ashok S. Patole, Prof. Vaishali S. Kumbhar, Prof. Vinayak H. Khatawate / International Journal of Engineering Research and Applications (IJERA) [6] Material handling operations should be mechanized and/or automated where feasible to improve operational efficiency, increase responsiveness, and improve consistency and unsafe manual labour. Still there is scope for improvement by preventing frequent breakdowns, occurring due to some design level parameters

Mr.Madhukara Nayak [7] (Assistant Professor) Mechanical Engineering department, Shri Madhwa Vadiraja Institute of Technology and Management, India. Done research work on automated sensor operated trolley which use to reduce human effort and the beauty of all this system is that it uses all of these sensors in the most effective way to help it react. Unmanned operation requires sensor system for target position, sensors for load position, and control and communication equipment on the trolley and remote consoles for control signals.

Sarmad Ali[8];had done study on The Smart Trolley which was designed to function as a mobile self-checkout system providing users the flexibility to Make transactions from it within the retail store. It is designed to be highly efficient and fully synchronized with the retailer's current system.

Mulik shriniwas [9]: has done research work on advance material handling trolley through try wheel mechanism though this article some limitations regarding the strength and built of the structure, it can be considered to be a small step forward, as far as Stair Climbing Vehicles are concerned. During the test run of this project, it was realized that it wouldn't be a bad idea to consider this design for carrying heavy loads up the stairs. This product will be well acclaimed if it can be commercialized to suit the needs. Though the initial cost of the project seemed to be higher but more accurate manufacturing would shorten this.

Md. A. Hossain. Nafis [10] studied a new horizon for the transportation of the loads over the stair. Most of the buildings of the Countries are structurally congested and unavailing of elevator facility so it is difficult and laborious to lift up heavy loads. The stair climbing Trolley can play an important role in those areas to lift loads over a short height, like libraries, hospital, And in construction area. The Trolley, which can move upper level through strain, or run in very rough and rocky surfaces, is Called stair climbing Trolley.

III. IDENTIFIED GAPS IN THE LITERATURE

The literature review indicates that

1) Improvement of cotton ginnery is takes place with improvement in cotton handling system.
2) The period of operation of ginnery is estimated to be a total of 150 days in a Season ranging from October to April.
3) The bales can be pressed with a density of 300 kg/cubic meter for local domestic consumption.
4) The quality of cotton can be better maintained by minimizing the transportation of cotton, and limiting storage time of cotton.
5) A composite ginnery (having all functions of cotton ginning and bale
6) Pressing) should be located in cotton growing areas

IV. PROBLEM DEFINITION

1) The Bajaj steel industry has manufactured cotton pressing machine 15 BP4818, for that they need to design new trolley according to the size of bale.

2) They have previously designed bale trolley for another press machine (for BP5421) which is not suitable for this new pressing machine.
3) Plant needs to reduce material thickness and weight
4) As more and heavy material was used in previous design which is not suitable for this pressing machine lead to increase cost.
5) Requirement is to improve previous design and to reduce weight according to cotton bale size (which is 175 kg).

V. METHODOLOGY

Methodology to be used is as follows for the designing of new bale trolley on the basis of literature survey.
Data and design calculation
Design of low cost Bale trolley

A. Data Collection

1) Details of Trolley

- Length=1485 mm
- Width=950 mm
- Height770 mm
- No. of wheels= 4
- No of shaft=2
- Commercial Bale trolley size is 1485*950*770 mm

2) Details of Motor

- Motor Power= 1 HP
- Motor RPM= 1440 rpm
- It consists of 1HP motor having rpm 1440 which is reduced to 44 rpm by adding gear box.
- There are 4 helical gears are used in gearbox

1) Gear-i (16 teeth)
2) Gear-ii (66 teeth)
3) Gear-iii (12 teeth)
4) Gear-iv (94 teeth)

- Motor 1HP weight is 25 kg which is 7.24% of bale trolley who's price range between 4000-5000
- Total Weight of trolley = 345 kg
- There are 6 Sprockets
  1) 18 teeth
  2) 14 teeth
  3) 18 teeth
  4) 14 teeth
  5) 18 teeth
  6) 14 teeth
- Need to reduce sheet size from 10mm to 5mm which leads to reduce weight.
- Numbers of bends are used instead of welds.
- Limit switch (extended type) needed for sensor to stop and move.
- Material is going to use for bale trolley is MS because it has a reasonable strength and hardness, it is easier to weld than stainless , it is cheaper, light weight.
- Material for Shafts is used Fe 360.
- Proper designing & modeling of bale trolley using a CAD Modeling Software like CREO.
- Analysis of load stresses on Bale trolley by means of ANSYS.

B. Trolley Body

1) Material Used- Mild Steel

Mild steel, also called as plain-carbon steel, is the most common form of steel because its price is relatively low while it Provides material properties that are acceptable for many applications, more so than iron. Low-carbon steel contains approximately 0.05–0.3% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is Cheap and malleable; surface hardness can be increased through carburizing. It is often used when large quantities of steel are needed, for example as structural steel. The density of mild steel is approximately 7850 kg/cm3 and the Young's modulus
Is 210 GPa (30,000,000 psi).

2) Design of Shaft

Material for shaft – Fe 360
Yield Strength (Syt) = 220 N/mm^2
Ultimate tensile strength (Sut) = 360 N/mm^2
Now according to A.S.M.E (American Society of Mechanical Engineers)
Shear stress $\tau = 0.18 * Syt$
$= 0.18 * 220$
$= 39.6$ N/mm^2
$\tau = 0.3 * 360$
$= 0.3 * 360$
$= 108$ N/mm^2
Total Load = 345 kg
= 345 kg
= 345 * 9.81
= 3384.45 N
There are two different sides
So, load on single side = 3384.45/2
= 1692.22 N
RA = 1692.45 N
RB = 1692.45 N
Bending Moment M = RA * 30
=1692.22*30
=50766.6 N-mm
So, Twisting moment
$(Te) = \sqrt{(Km * M)^2 + (Kt * T)^2}$
$= \sqrt{(1.5 * 50766.6)^2 + (1 * 23.54 * 10^3)^2}$
= 79705.32 N-mm
For rotating shaft having gradually applied load,
Km – Combined shock and fatigue factor for bending = 1.5
Kt – Combined shock and fatigue fact for torsion = 1
We know, the torsion equation
$T/J = \tau/r$
Where, T = Twisting moment acting upon the shaft
J = Polar moment of inertia of the shaft about the axis of rotation.
τ = Torsion shear stress and
r = d/2, d is the diameter of the shaft.
So, $Te = \prod/16 * d^3 * 39.6$
d = 21.72 mm
So, get standard diameter of the shaft i. e. 22 mm

C. DC Motor Specification

Power of motor = 1 hp
= 750 watt
Torque = 240 kg-cm
$= 23.54 * 10^3$ N-mm

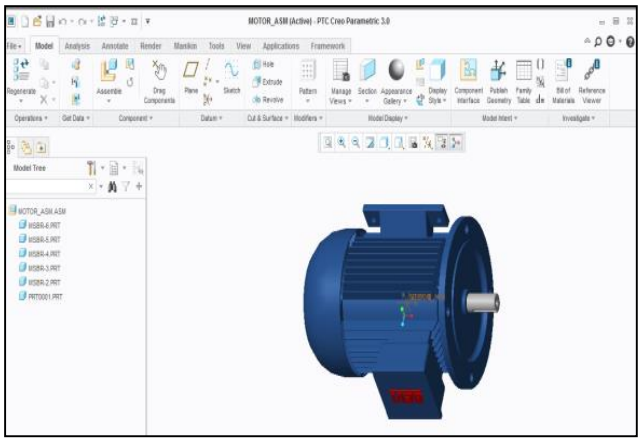

Fig. 1: DC Motor

Frequency = 60 Hz
Now, Power = 2∏*N*4.94/60
745= 2 ∏*N*4.94/60
N = 1440 rpm

D. Load Calculations

Power =1HP
Where, 1HP=745.7W

1) Torque

P=2πNT/60
745.7 =2×3.14×1440×T/60
T=4.94 N.m
Gear 1&2 are meshed together
Torque of gear 1 is =4.94 N.m
T1/T2 =t1/t2
4.94/T2=16/66
T2=20.37 N.m
Gear 2&3 are mounted on similar shaft
Therefore, T2=T3=20.37 N.m
Gear 3&4 are meshed together
T3/T4=t3/t4
20.37/T4=12/94
T4=159.56N.m

2) Speed (N)

N1=1440rpm
N1/N2=t2/t1
1440/N2=66/16
N2=N3=349.09rpm
N3/N4=t4/t3
349.09/N4=94/12
N4=44.5 rpm

3) Gear Ratio

FOR GEAR 1&2 =T2/T1
=66/16
=4.12
FOR GEAR 3&4=T4/T3
=94/12
=7.83
TOTAL
GEAR RATION= T2/T1×T2/T1
= 4.12× 7.83
G.R= 32.25

4) Output Speed

=input rpm/G.R
=1440/32.25
=44.5rpm

VI. DRAWING AND CAD MODELING OF BALE TROLLEY

On the basis of above design calculation the computer aided design (CAD model) of some parts of the Bale trolley and assembly of the bale trolley has been done with the help of Computer Aided Software naming 'CRE-O' by applying top-down approach.

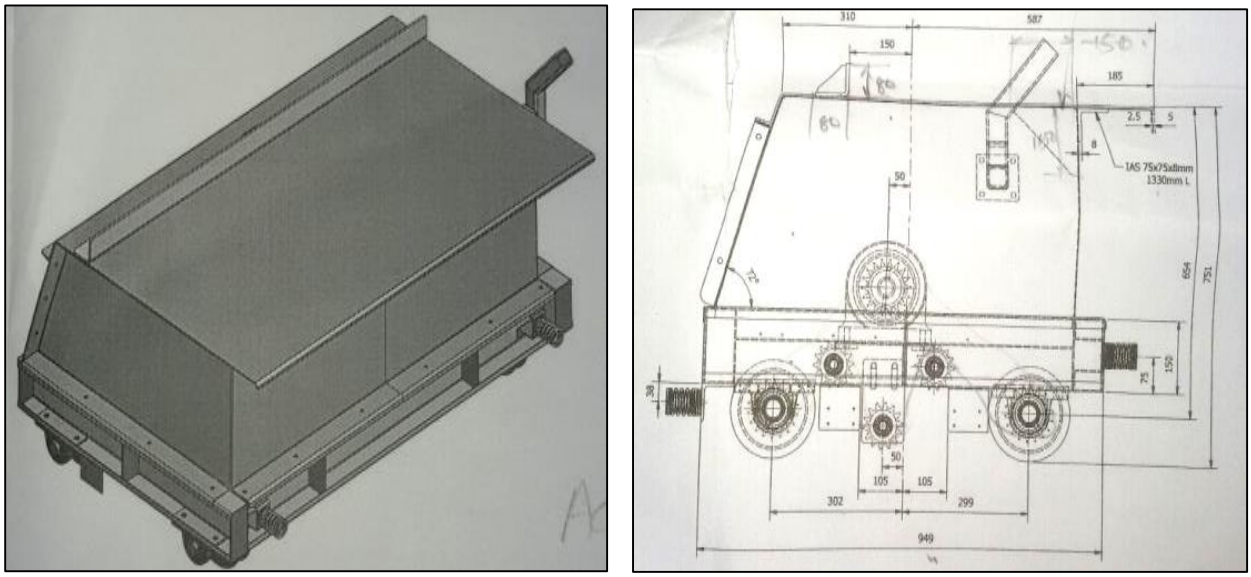

Fig. 2: Rough Design of Low Cost Bale Trolley

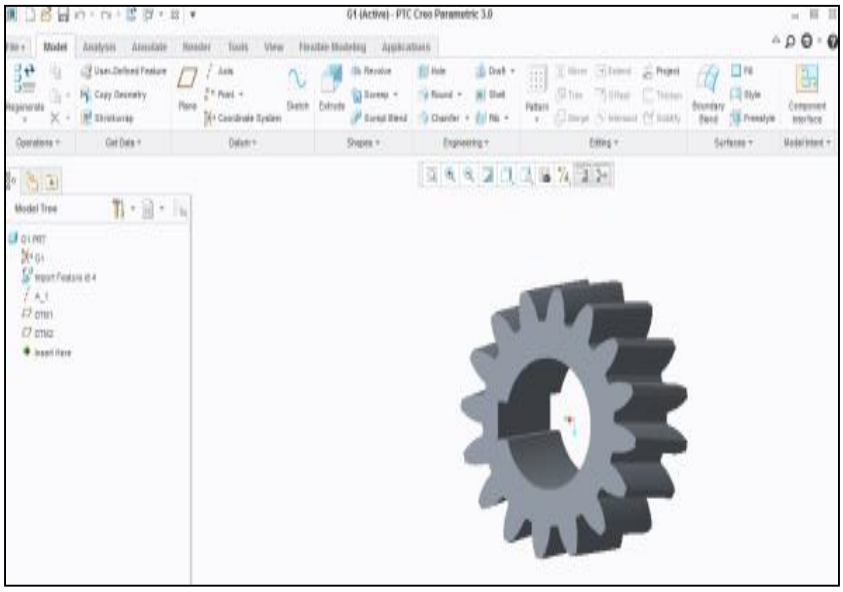

Fig. 3: Gear 1

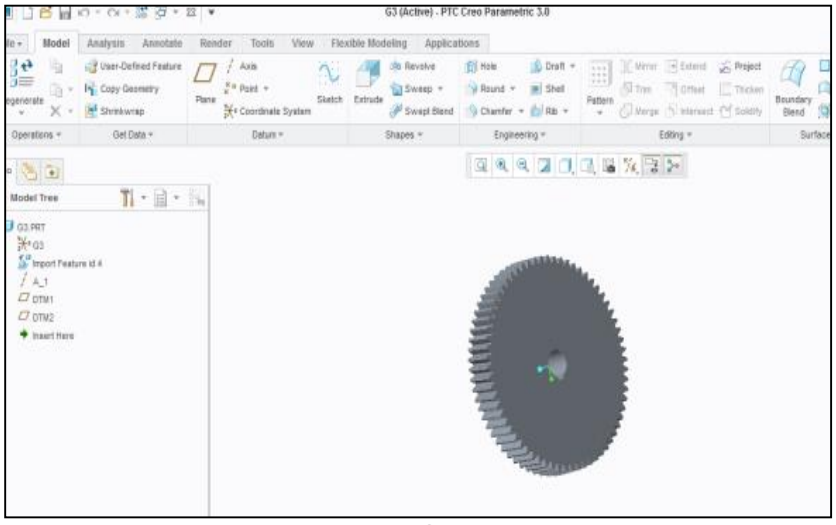

Fig. 4: Gear 2

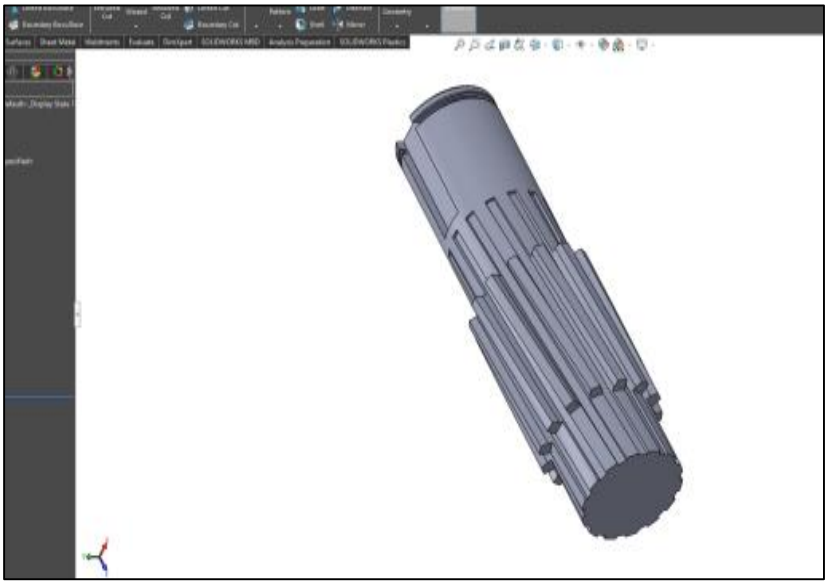

Fig. 5: Gear 3

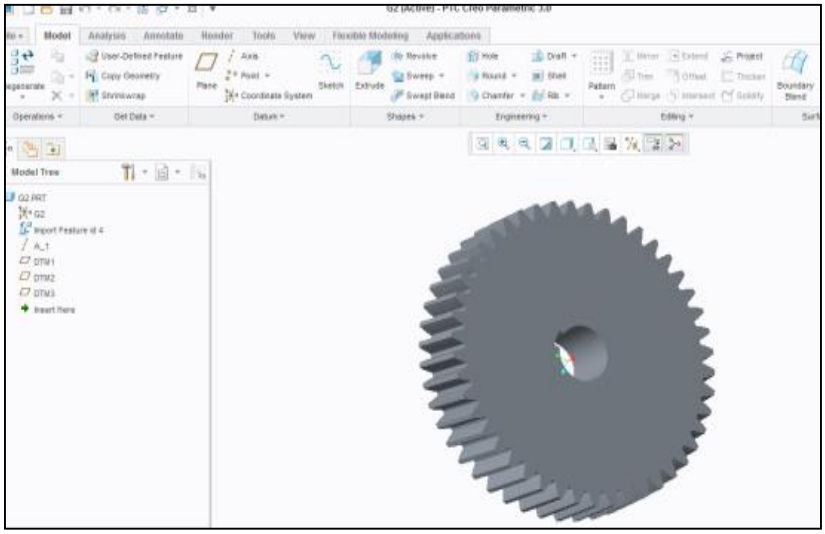

Fig. 6: Gear 4

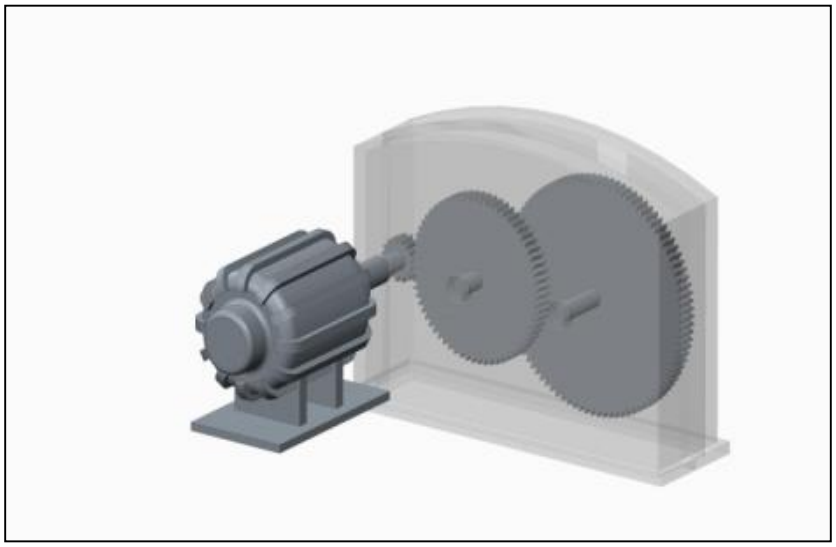

Fig. 7: Gear Box

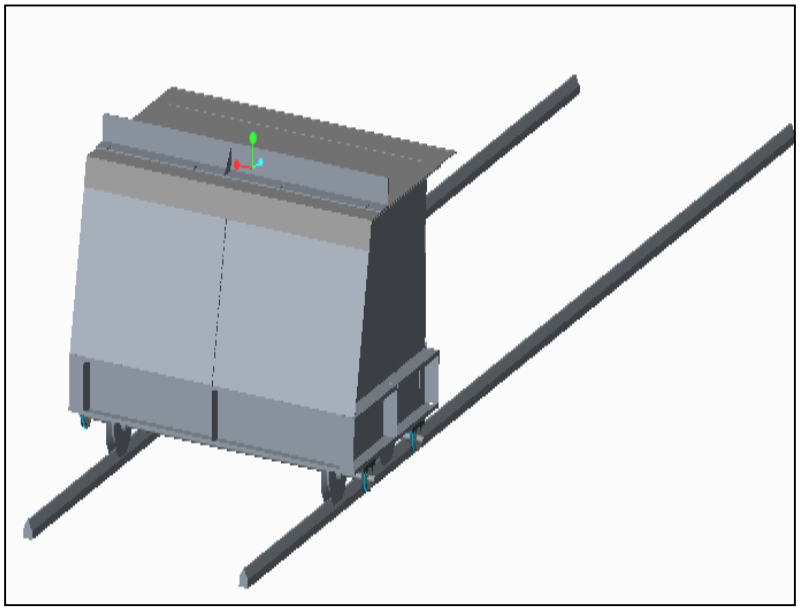

Fig. 8: CAD Model of Components of Plastering Machine

Fig. 9: Bale Trolley

VII. CONCLUSION

By studying all the above literatures and the work done following conclusions are obtained.

1) Bale trolley is one type of unique trolley will be used in bale press machine (ginnery).
2) It helps to save the time and money.
3) Researchers have done tremendous work in the area of trolley design with greater reliability, protection and robust design also design was adequate and costs reduced.
4) The bale trolley is lighter in weight than the conventional bale trolley.
5) Higher quality of bale can be obtained with this process.
6) Due to saving in time, labor cost, raw material, the overall cost of construction is less hence the trolley is economically efficient Than the conventional bale trolley.
7) Get professional quality finishing in less time, reduce project cost, and manufacture Bale trolley in low cost.
8) The trolley solves the issues like shortage of labor, raise in labor cost etc. and wastage of time is reduced more than 60% thereby reduces the cost

VIII. RESULT

Table shows comparative result on different objectives, for a trolley by both existing bale trolley method as well as Automatic low cost bale trolley as follows.

Sr. No.	*Objective*	*Existing method*	*New low cost bale trolley*
1.	*No. of labors required*	*0-1*	*0*
2.	*Time required (hours)*	*The baling press capacity is 24-26 bales/hour*	*capacity is 30-35 bales/hour and bale size is 18.9*18.9*48.9*
3.	*Material*	*More material required compared to new bale trolley machine as there is more utilization of material.*	*Less material required, compared to conventional method as less material wastage is there.*
4.	*Cost*	*Comparatively high cost. (As labors and time required is more)*	*Comparatively low cost. (As no. of labors and time required is less)*

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