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Design of a Semiautomatic Cattle Feeding Machine for Dairy Sector

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Abstract - *Feeding operations in dairy farms are of strategic importance of the economy of the farm. In addition to being strictly related to the productivity of the cattle's, feeding represents one of the greater costs for owner of the farms, considering that more than 25% of labor time is dedicated to this operation. There is a high labour requirement in dairy industry because of no use of technology into it. These labours costs very much to the dairy farm owner because the need of the labour in a dairy farm is only for 3 hours in the morning and 3 hours in the evening but they have to pay them for the whole day So, in order to reduce the quantity of labors and expenditure of owner automatic cattle feeding machine has been designed .*

Key Words: Reduction gears, Bevel gears, Dairy Farm, Cattle feeds, feed thrower , Solid works .

1.INTRODUCTION

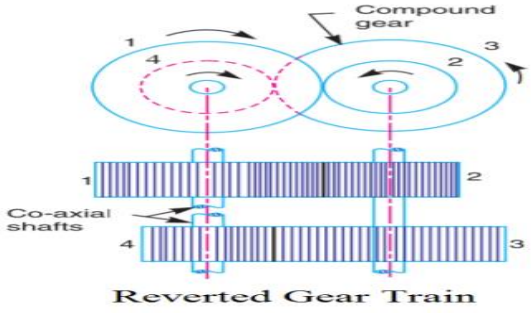
Introduction - There is a high labour requirement in dairy industry because of no use of technology into it. These labours costs very much to the dairy farm owner because the need of labours in dairy farm is for few hours, but they have to pay them for whole day. So, to reduce the unnecessary expenditure over labours, to reduce the number of labours and for saving the time of a dairy farm owner to feeding the cattles, it is necessary to make the automatic cattle feeding machine. Dairy farmers are increasingly evolving toward automation of their farms. Automatic concentrate dispensers and automatic milking systems (AMS) have been utilized for years, and several manufacturers have introduced automatic cattle feeding systems (AFS) during the past decade. The main advantage of AFS is the possibility to supply a total mixed ration (TMR) with a high frequency and a low labor requirement, while farms that feed with conventional feeding systems (CFS) commonly supply TMR only once or twice a day and require more labor with a rigid work schedule. AFS allows for increasing the frequency of feed distribution . Furthermore, a higher frequency reduces the permanence time of feed on the manager with reduced possibility of contamination and of anomalous fermentations. The paper reports about the design of automatic cattle feeding machine and different components used in making of this automatic cattle feeding machine.

1. Dairy Farm Visit

For getting more and in detailed information about dairy sector two group members actually visited the dairy farm. This dairy is in Ulkanagri, Aurangabad. In this dairy they study many things like distance between cattle feeder tray which is 4ft, the height of tray which is 2ft. They discussed on many questions with farm manager. From this discussion they know that the cost of one labor is 400 rs per day and there are 15 cows in the dairy farm which was taken care by 3 labors. They also understand the problems regarding dairy farm. The problem is that this farm require more labors because of no use of technology which costs very much to the owner which is unaffordable. If we implement this automatic cattle feeder machine in farm then one labor will be removed. So the 33% cost i.e. about 12000 rs per month of one lab our will be reduced. The estimate cost of our machine is up to 25000 rs. which is very less as compared to the cost which is very less as compared to the cost which we have to pay the labor.

2. Reverted Gear Train

When the axes of the first gear (i.e. first driver) and the last gear (i.e. last driven or follower) are co-axial, then the gear train is known as reverted gear train.



Reverted Gear Train

$$\text{Speed ratio} = \frac{\text{Product of number of teeth on drivens}}{\text{Product of number of teeth on drivers}}$$

$$\frac{N_1}{N_4} = \frac{T_2 \times T_4}{T_1 \times T_3}$$

equations we can determine the number of teeth on each gear for the given center distance, speed ratio and module only when the number of teeth on one gear is chosen arbitrarily. The reverted gear trains are used in Automotive

transmissions, Lathe back gears, Industrial speed reducers, In clocks (where the minute and hour hand shafts are co axial).

2. Bevel Gear Train-

Bevel gears are gears where the axes of the two shafts intersect and the tooth bearing faces of the gears themselves are conically shaped. Bevel gears are most often mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well.

Figure 1 Bevel Gears.

When referring to bevel gears, we need to consider that it will be equivalent to the number of teeth of the driving gear divided by the number of teeth of the driven gear (RT= Z1 / Z2). Bevel gears are used in differential drives, which can transmit power to two axles spinning at different speeds, such as those on a cornering automobile. Bevel gears are used as the main mechanism for a hand drill.

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Basic Idea of Project – The basic idea of our project is to bring automization in feeding of cattle in the dairy farm industry and to reduce the labour requirement using cattle feeder machine.

Calculation-

1. Now, consider every cattle gets a space of 4 ft. i.e. 1.2 m for their fodder.

2. So, we consider or set the time required by the machine to fill that 1.2 m space with fodder as 8 seconds.

3. Therefore, velocity = 1.2 m / 8 sec = 0.15 m/sec

4. Traction Force = $F_{(tyre)} + F_{(aero)} + F_{(acc)} + F_{(slope)}$

a. Considering, slope angle = 0 degree since, F(slope) is directly proportional to sine angle alpha Therefore, $F_{(slope)} \sim 0$ N.

b. F(tyre) = $C_{(rr)} \times mg$ Where, $C_{(rr)}$ = coefficient of rolling resistance.

Generally , $C_{(rr)}$ ranges from 0.005 to 0.010 Considering the maximum value , we get

$$F^{(tyre)} = 0.010 \times (150 + 50) \times 9.81$$

$$= 19.62 \text{ N} \sim 20 \text{ N}$$

c. $F_{(aero)} = ½ \times (\text{Density of air}) \times C_d \times A_{ref} \times (V_{rel})^2$

Where , C_d = coefficient of drag. C_d ranges from 0.28 (good aerodynamics) to 0.80 (bad aerodynamics). As we have not designed considering aerodynamics due to very low moving velocity i.e. 0.15 m/s, therefore considering $C_d = 0.8$

Density of air = 1.2 kg/m^3 at 27 degree Celsius

$$V_{rel} = V_{(vehicle)} + V_{(wind)} = 7 \text{m/s}$$

Therefore,

$$F_{(aero)} = ½ \times 1.2 \times 0.8 \times (0.5 \times 0.6) \times 49$$

$$\sim 7 \text{ N}$$

d. $F_{(acc)} = m \times a$

Considering vehicle at rest position at the start so, u = 0 m/s , $V_{req.}$ = 0.15 m/s .Therefore,

$$v = u + at$$

$$0.15 = 0 + a \times 1$$

$$a = 0.15 \text{ m/s}^2$$

$$F_{(acc)} = 200 \times 0.15$$

$$= 30 \text{ N}$$

Therefore, F(total) = 30 + 20 + 7

$$= 57 \text{ N}$$

$$\text{Torque} = F \times 0.1$$

$$= 57 \times 0.1$$

$$= 5.7 \text{ Nm}$$

Considering the diameter(d) of the tyre for the ground prototype to be 20 cm. therefore,

$$\text{Circumference of tyre} = Pi \times d$$

$$= 3.14 \times 0.2$$

$$= 0.628 \text{ m}$$

Now, number of rotations = linear speed/circumference of the tyre $= 0.15/0.628$

$$= 0.2388 \text{ rev/sec}$$

$$= 14.333 \text{ rpm}$$

$$\sim 15 \text{ rpm .}$$

Result Table -

Weight of machine	200kg
Volume of container	0.27 m^3
Velocity	0.15 m/s
$F_{(tyre)}$	20 N
$F_{(aero)}$	7 N
$F_{(acc)}$	30 N
$F_{(slope)}$	0 N
Traction Force	57 N
Torque	5.7 N
Diameter of Wheel	20 cm
Circumference of Tyre	0.628 m
Number of Rotation	15 pm

SOLIDWORKS 3D DESIGN

3D model of cattle feed system is made using solidworks CAD tool. Pre-calculations for this model are already given in this report .Model has actual scale as the physical machine in real life. It is made in such a way that according customers need we can adjust the parameters (given further in explanation) within 2 to 3 minutes and manufacture the machine.

Cattle feed machine is being assembled using following parts and sub-assemblies :

1.Base Trolly:

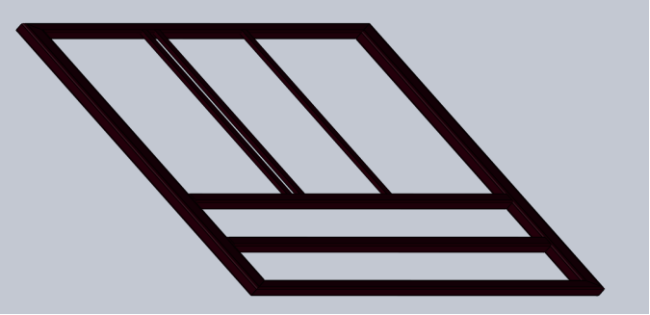


Figure 2 CAD of Base trolly

Base trolly is the basic structure of a machine assembly. All parts are assembled on the base trolly and integrated according the calculations .Trolly base can be resized in accordance with distance between castles.

Pipes used to manufacture the base trolly will be square pip with dimensions 30*30*5 which has strength required to sustain all the loads and forces exerted by the components of machine. Trolly is made up off Steel .

2.Feed Storage

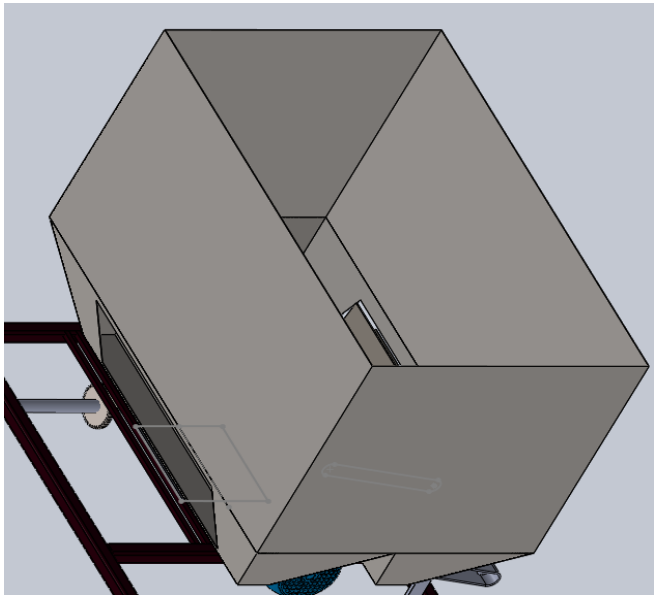


Figure 3 Feed storage showing cuts for thrower and rotating parts.

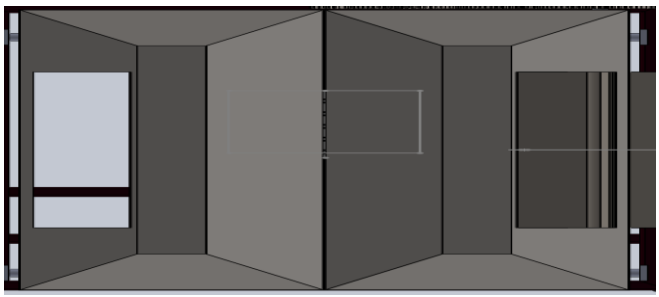


Figure 4 Feed Storage Showing storage space and slope given to pass feed to thrower.

Feed storage is designed using metallic sheet available in market. As name suggest it stores the feed and pass the feed to the thrower. The volume calculations are mentioned in this report earlier.

3.Thrower

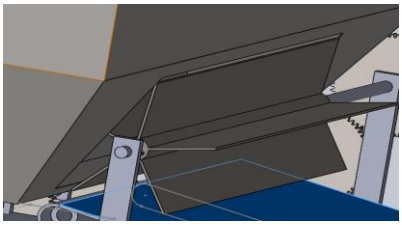


Figure 5 Thrower and position of thrower

Thrower is installed at the lower end of storage to collect the feed from storage and pass it to the conveyer assembly. Thrower part is analyzed using ANSYS software to get optimum functionality of the system.

3. **Wheel Assembly:**

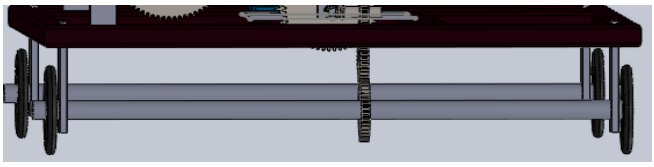


Figure 6 Wheel assembly attached to base trolly.

Wheel assembly can be made using simple wheels or caster wheels .While designing the wheel assembly Hight adjustment of trolly taken into consideration. For adjusting the Hight of trolly we can use the adjustments given in wheel support. Rear wheel axel is driving axel connected with motor using drive assembly and front wheels provide path to the machine.

4. **Motor**

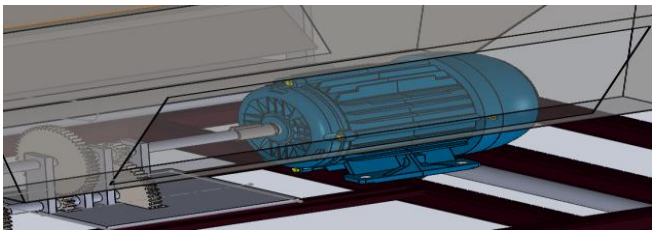


Figure 7 Motor assembled on the base and in v place given in storge part.

1.5 HP motor used to move the machine in liners direction as well as to rotate thrower and conveyer to throw the feed .This motor can be rotate both in clockwise direction and anticlockwise direction. In above picture shows the motor attached to the reduction gear assembly to reduce the 750 RPM given by the motor to about 100 RPM.

6. Reduction Gear assembly:

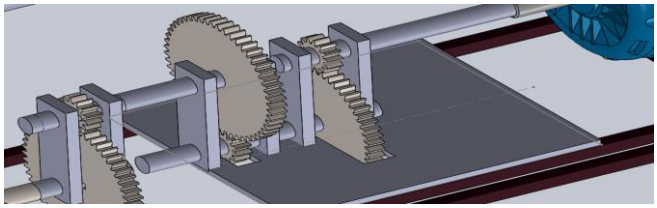


Figure 8 Reduction gear connected to motor and wheel drive assembly

Inverted reduction gears are used to reduce the higher RPM given by the motor to lower rpm for the drive train assembly and thrower rotation system .Generalized gears are used available in market for this assembly so maintenance and manufacturing will be easy.

Bigger ger has 53 teeth while smaller has 14 teeth with module 2. Same gears are used to overcome the c2c changing problem with perfect meshing of gears so there will be no sliding between gears.

7. Drive train Assembly

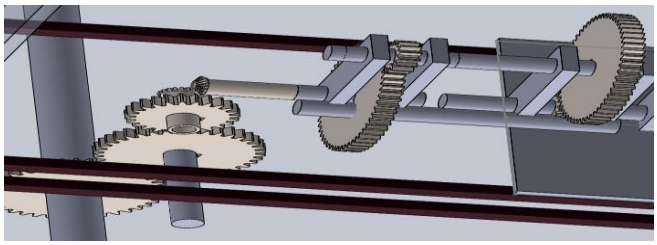


Figure 9 wheels are connected to output of main reduction box with the help of drive train assembly'

Wheels are connected to output shaft of reduction gear box . Bewel gear is used to transmit the rotating output to 90 degree required for wheel rotation. Further reduction is done by using simple gears within plane to get calculated rpm for the wheels. Adjustable idlers are used to get required C2C between rear axel and reduction output shaft .If we change the hight of the wheel assembly we can simply change the position(adjustable supports are hidden to show proper working in above image) supports of the idler according to it .

8. Conveyer Assembly:

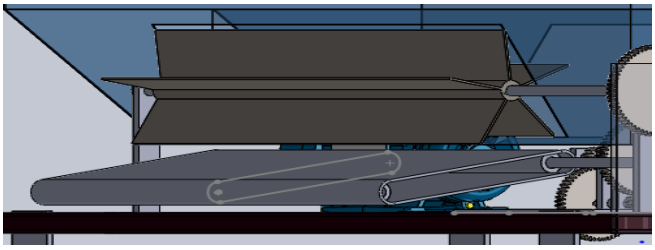


Figure 10 Conveyer position according with trolly and thrower.

As shown in above image conveyer belt is attached below the thrower to carry feed to cattle taken from the thrower .Angle of this assembly can be changed with respect to user requirement using adjustable supports .(hidden in this picture).

10. Thrower Rotation System:

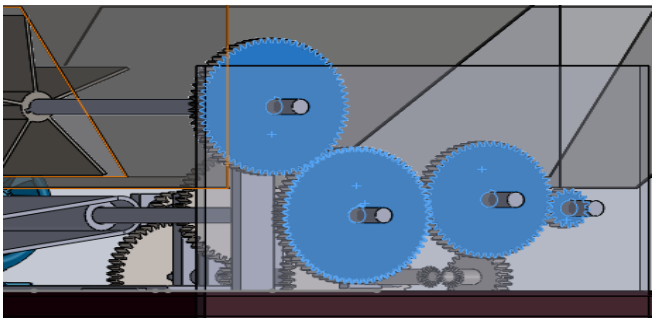
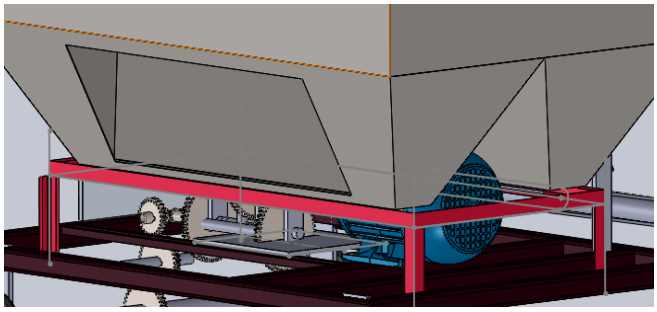


Figure 11 Gear mechanism to rotate thrower and conveyer using output rpm from reduction assembly.

Gear are placed at the one end of the trolly using common support (transparent in this picture). Required gear ratio is calculated before working on cad model. Common support and idlers used in this gear train are designed in such a way that if we adjust the height of the storage using storage support member then we can adjust the idlers and C2C within no time.

11. Storage Support Member:



The red part shown in above figure is used to adjust the height of feed storage .Also this part holds the storage tightly. This part can either be bolted to trolly and Feed storage or can be directly welded as this made by the standard angle bars available in market.

The Cattle Feed Machine:

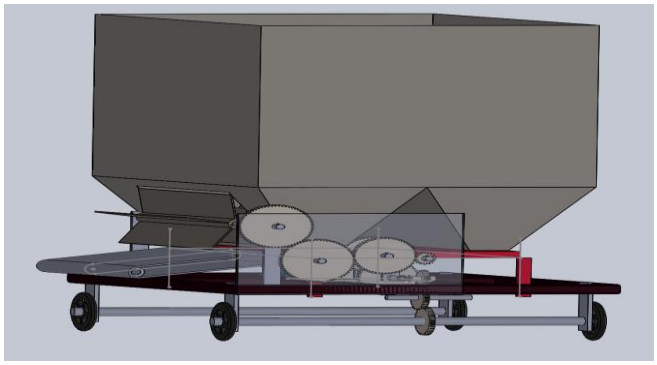


Figure 12 CAD model of Cattle feed Machine.

Above image is the assembled model of feed machine using parts and sub-assemblies discussed above. This machine can move back and forth using the motor and at the same time feed will be delivered to the cattle in proper amount.

All support parts used in this assembly to be manufactured using laser cut parts to get low cost .And Adjustability ports in supports can be manufactured accurately with laser cutting . Gears used are standard gears available in markets .

VARIOUS VIEWS OF ASSEMBLY:

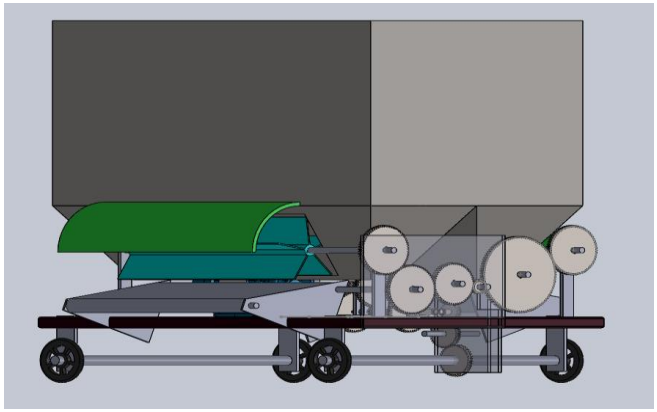


Figure 13 Isometric View of assembly with all views .Green part is cover for safety purpose.

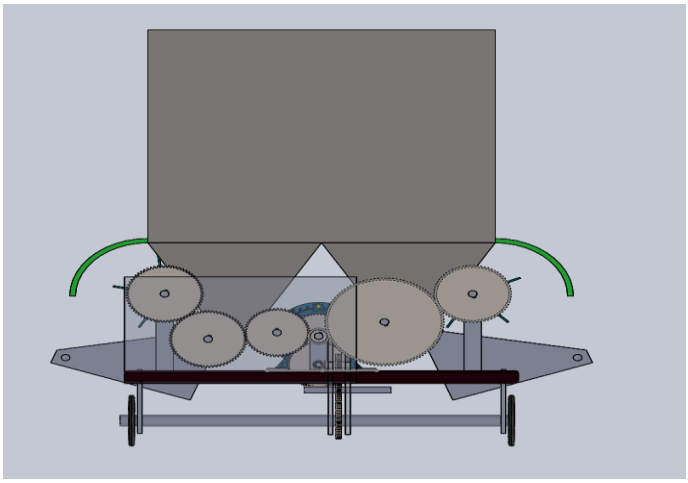


Figure 14 Right Hand Side View.

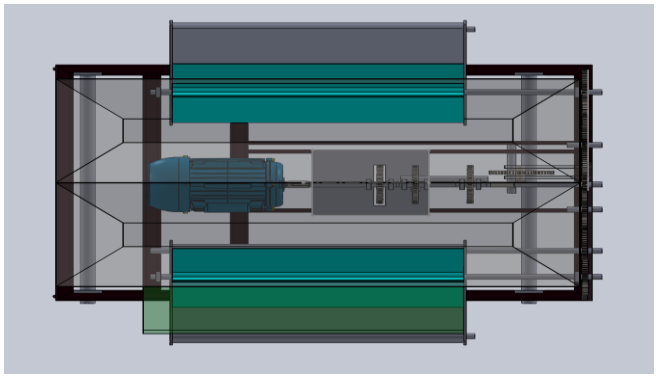


Figure 15 Top View

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