DESIGN AND DEVELOPMENT OF DE-COBBING AND SEPERARATING MACHINE

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ABSTRACT:
India produces around 24 million tons of corn every year. Product developed from corn needs to process it and peeling techniques used conventionally are not very efficient to avoid wastage of corn. The farmers are cultivating corn on small scale and it is difficult for them to peel it with advanced technology. With implementation of the technology in corn peeling we can reduce the wastage of corn which results in profit to the farmer. Authors have proposed the peeling machine of corn from point of view of small agriculture farms in India. The details of design calculation and CAD design of the machines is presented in this paper in detail. The design is validated and the results are found suitable to carry out the peeling of corn.

KEYWORDS: Corn Sheller Machine, Agriculture sector, Electric Motor, etc.

INTRODUCTION:

India one Corn products are very popular amongst all ages of people in India. The conventional methods of corn peeling are not so efficient and the implementation of machine for this task will help in production enhancements. Sheller machine also reduces the requirement of labours needed for peeling of corns. The corn production is growing since last decade in India.

Corn is produced in more than 165 countries across the world. It means the production of corn is popular amongst most of the countries of world. It is one of the popular crops across Asia hence cultivated in all Asian countries. The machines for peeling the corn are available in market. The problems associated are size and weight of those machines with low production rate as well. It also damages seeds of corn hence there is need for improvement.

We have developed the machine for efficient peeling process of corn. This machine is suitable for the Indian farmers from point of view of cost and the performance.

OBJECTIVES OF WORK:

- Selecting an appropriate design for new machines.
- Making design analysis for speed, vibration, weight, stability, production rate etc.
- Establishing selective manufacturer for fabrication of working machine.
- Providing coating of Polyvinyl Chloride (PVC) on parts.
- Final testing and evaluation.

SYSTEM DESIGN IN CAD:

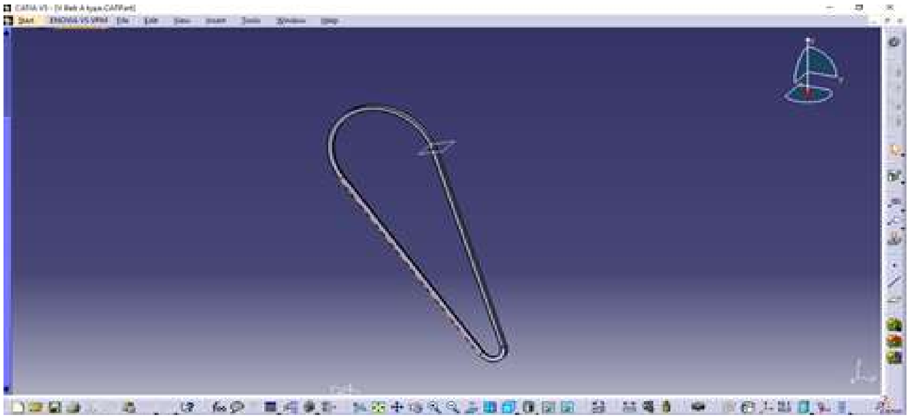

Fig.1: V-Belt Design in CAD

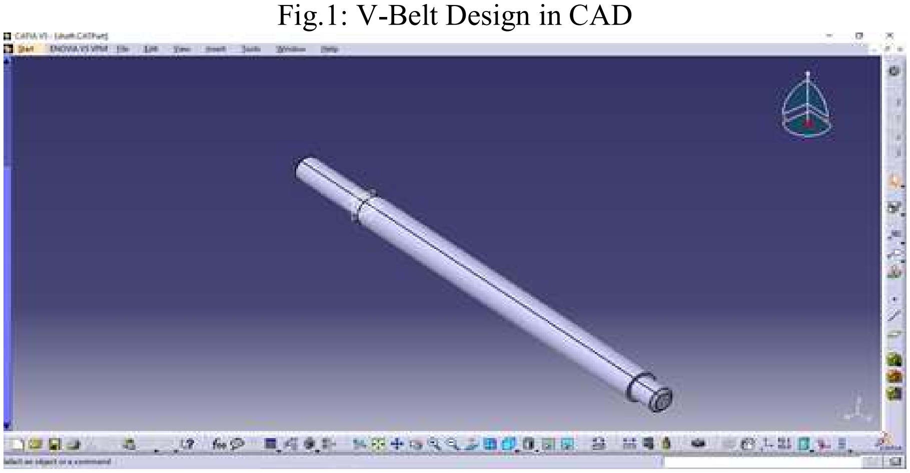

Fig.2: Shaft Design in CAD

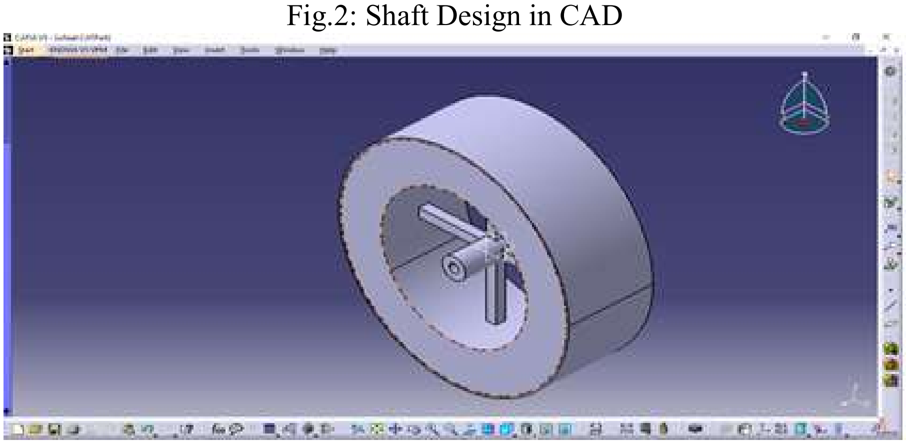

Fig.3: Wheel and Tire Design in CAD

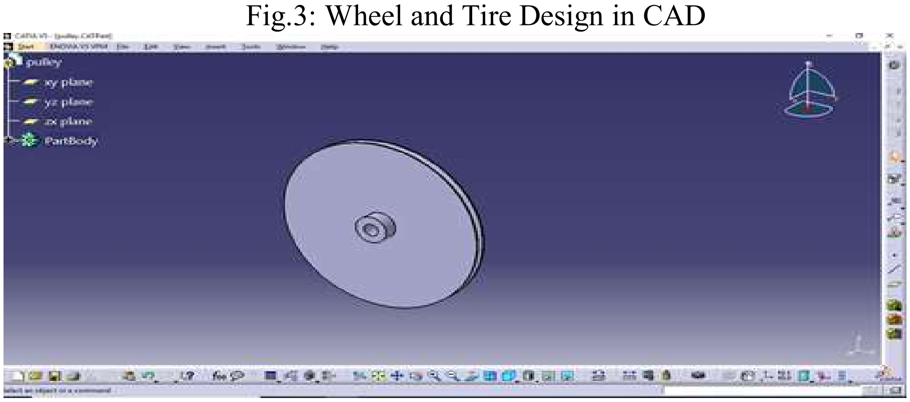

Fig.4: Pulley Design in CAD

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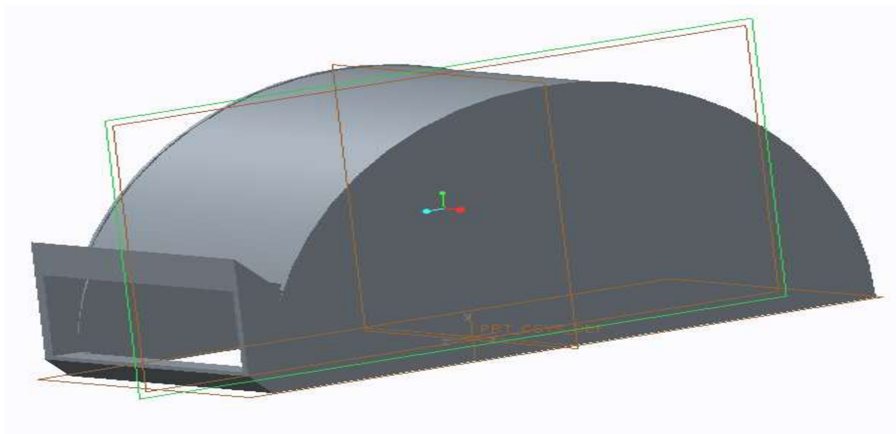

Fig.5: Upper Casing Design in CAD

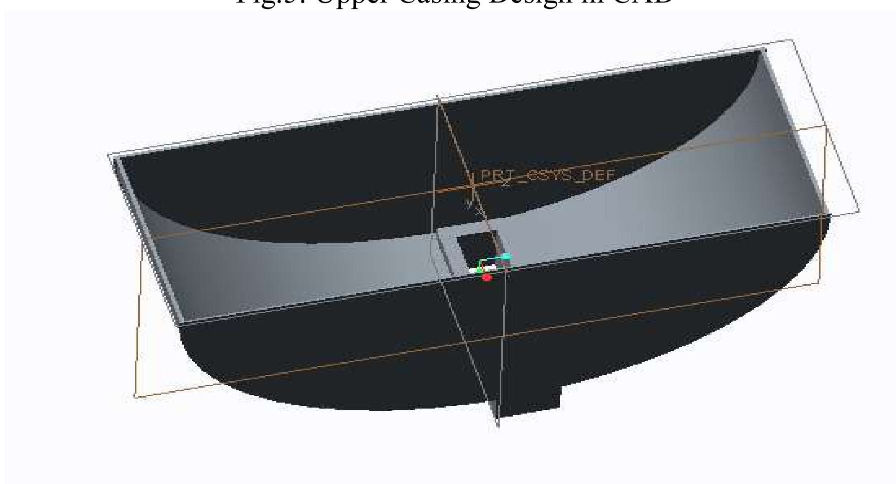

Fig.6: Lower Casing Design in CAD

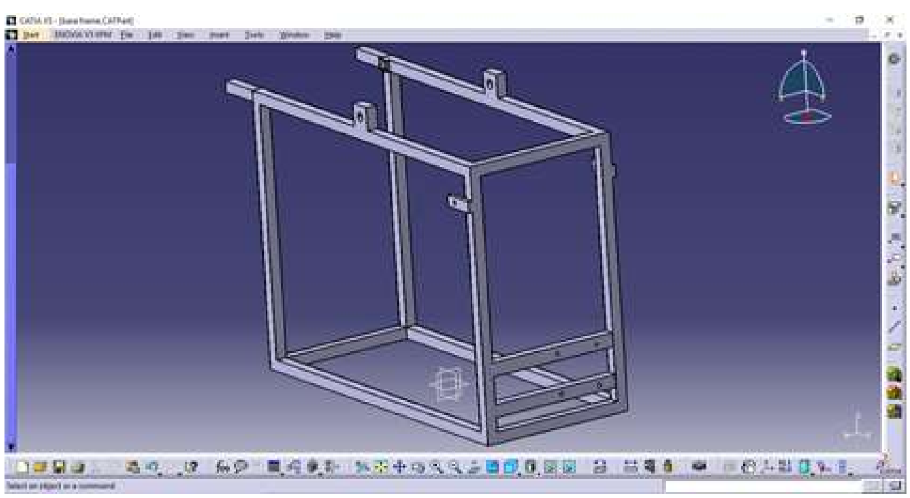

Fig.7: Frame Design in CAD

DESIGN AND CALCULATION:

Manual power required:

Our aim is to shell the corn without crushing and cracking corn seed. The length required to without failure corn……..

1] The standard length of shelled corn $L_1=1.48\times10^{-2}$ m.`

2] The standard length of unshelled corn $L_2=20\times10^{-2}$ m.

3] Kick's constant= K_k=1.2

4] Crushing strength required to crush the corn = F_c= 200 N/m

Power required for shelling the corn:

Power [P]= Kk×Fc×ln[$\frac{L2}{L1}$]

= 1.2×200×ln[$\frac{20\times10^{\wedge}-2}{20\times10^{\wedge}-2}$]

= 624.85 W

P = 625 W or **P= 0.625 KW**

But ,

P = $\frac{2\pi\times N\times T}{60}$

Speed required for shelled the corn is between 300 rpm to 450 rpm by this speed taking the mean value is 3750 rpm, above the 450 rpm the corns seed are crush badly.

N=375rpm

625= $\frac{2\times\pi\times375\times T}{60}$

T=15.9235 N.m

Design of V-belt:

Power range -0.5 to 3.5 taking 0.625 KW

Minimum pitch diameter of pulley [D] = 75 mm

Top width [b] = 13 mm

Thickness [t] = 8 mm

Take centre distance between driving and driven pulley is [C] = 500 mm

Assume, Belt speed V-speed range between 18 m/s to 25 m/s

Velocity of V-belt:

V_b= 21.5 m/s

21.5 =$\frac{\pi\times d\times1440}{60\times1000}$

d=0.285 m

Taking angle of pulley 2Φ=38º

Area =$\frac{1}{2}$× (top width + bottom width) × height

= $\frac{1}{2}$× (13+6) × 8

=312 mm²

Maximum permissible tension

Material cast iron , carbon steel casting or steel cast iron FG200(flake graphite 200n/mm^2)

But , Sut= 730N/mm², Brinell hardness no.150

$T_{allowable}$ = 0.3 × Sut(without key)

$T_{allowable}$ =0.75×0.3×Syt or 0.75×0.18×Sut

Effect of keyway of a shaft strength,

E= 1 - 0.2 × ($\frac{w}{d}$)-($\frac{1.1\times h\times k)}{d}$)

Tension on belt:

T_{max}= σ×A

= 1.53×312

=477.36 N

Centrifugal tension:

T_c=T_{max}/3

= 477.36/3
= 159.12 N

Pitch line velocity of belt:
$T_c = m \times (V_b)^2$
$V_b = 21.5$ m/s
angle of contact
$\Theta = \pi - 2\alpha$
$= 180 - 38$
$\Theta = 2.47$ rad

Tension ratio:
$T_{vt}/T_{vs} = \mu \times \Theta / e^2$
For v belt,, $\alpha = 2\Phi$

Belt tension on the tight side due to friction effect:
$T_{vt} = T_{max} - Tc$
$= 477.36 - 159.12$
$= 318.24$ N

Belt tension on slack side:
$T_{vt}/T_{vc} = 4.56$
$T_{vc} = -69.78$ N

Design of shaft:
Power is 5.3 KW and speed is N = 375 rpm
Wheel weight of tyre (Tata Nano vehicle /car)
Material = 40c8 plain carbon steel
C = 0.4% and Mn = 8%
Syt = -460 N/mm² and Sut = 700 N/mm²
Reference Mechanical properties of steel used for shaft (mechanical design data book)[14]
$\tau_{max} = 0.5 \times Syt/fos = 0.5 \times 460/3 = 76.67$ N/mm²
Design of solid shaft
$P = 2\pi \times n \times T / 60 \times 1000 \times 1000$
$5.3 = 2\pi \times 375 \times T / 650 \times 1000 \times 1000$
$T = 136.1093 \times 10^3$
Forces on pulley Tvt +Tvs =Fp
318.24+69.78
Fp =388.02 N
Reactin on the shaft is
Ra = -47.95 N
Bending moment at point
Mc = Ra×400
= 19182N
Mb =Rc×200
= -77604
Diameter of shaft using A.S.M.E code
$TE = \sqrt{(K_b \times M)^2 + (K_t \times T)^2}$
$Te = \sqrt{(1.5 \times 77604)^2 + (1.0 \times 136109.3075)^2}$
Te =179098.05 Nm
$\tau_{max} = 16Te/\pi D^3$
D = 22.82 mm

Take D=25 mm by using standard dimension

Design of key:
Rectangular key
Width of key, W=d/4 and height of key, h=2/3×w
W=25/4 = 6.25 mm
h=2/3×6.25 =4.16 mm
Material of key 30C8 $\tau = 56 N/mm^2$ $\sigma = 112 n/mm^2$[9]

Direct stress:
$\tau_d = 2T/d_w l$

Crushing stress:
$\sigma = 4T/d_h l$
$\tau = 2 \times 127.32/25 \times 4 \times l$
l = 0.045 m
$\sigma = 4 \times 127.32/25 \times 7 \times l$ & l = 0.025m

ANALYSIS OF LOAD ON SHAFT BY USING ANSYS SOFTWARE:

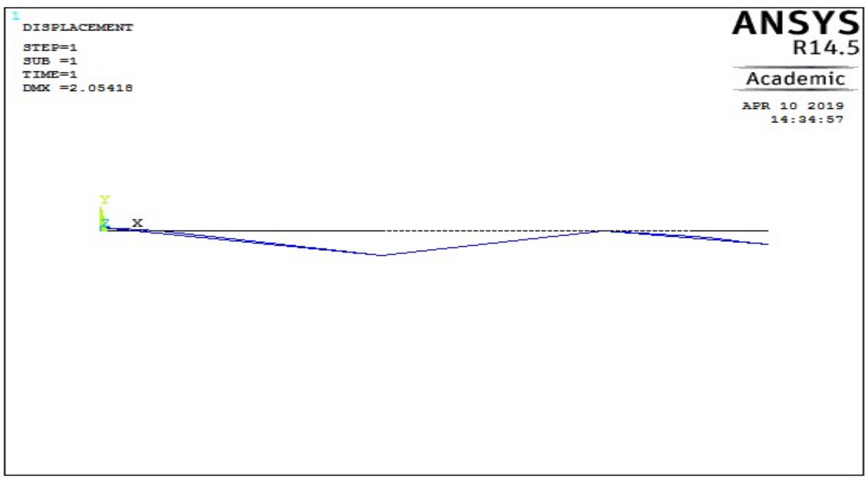

Fig.8: Displacement of shaft

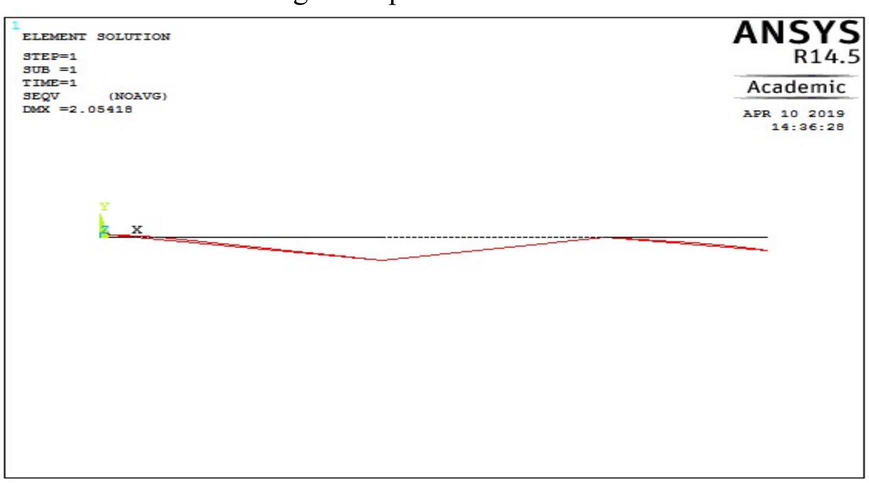

Fig.9: Element solution

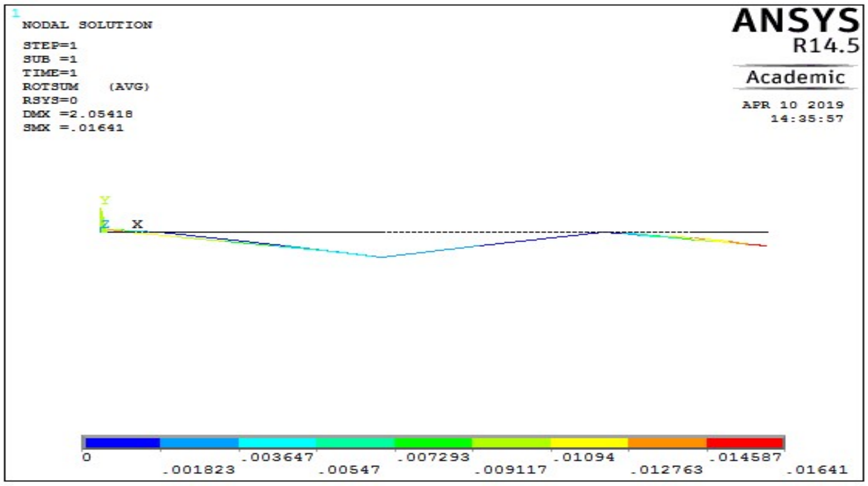

Fig.10: Nodal solution of shaft

Table 1: Nodal Solution of Shaft

Nodal solution	DMX	SMX
1	2.05418	0.01641

Bearing design:

Rolling contact ball bearing having,
Bore diameter = 25 mm
Bearing series no=63
Outside diameter = 52 mm
Width = 15 mm
Bearing series
Bearing no= 6305
6 – single rod deep groove ball bearing
3 – medium series of bearing load
05 – bore diameter in mm
Loads on bearing
Static load = 11.60 KN
Dynamic load = 22.50 KN
Service factor ks =2 or moderate shock load no = 27.5 Values of service factor
Radial load factor , x= 1 and axial load factor = 0,
Fr =534.075 N Fa = 0,andKa = 2
Equivalent dynamic load
Pe = (x.v. Fr +y.fa)×Ka
Pe = 1×1×534.075×2
=1068.15N
Rating life of bearing
$L10 = (Cr/Pe)^n$
$=(22500/1068.15)^3$
Rating life of bearing L10 = 9346.53
$L10 = L10h \times 60 \times 375/10^6$
L10h = 415401.730 hrs
Rating life of bearing in hours is 415401.73 hrs.

Wheel specification:
Wheel diameter = 320 mm
P195/55R1685H
Where , P-These tyre for passenger vehicle(metric size load and speed rating)
195-width of tyre (mm)
55-height of the sidewall
R- Radial tire
16-this tire fits 16 in (410 mm) wheel
98.1-load index (kg)
H- speed index

Casing:
Upper casing:
Upper casing radius = radius of wheel + corn diameter
=160+100
R=260 mm

Lower casing:
Lower casing =260+40 = 300 mm
Width of casing = 200 mm
Standard lenth of corn is = 6 inch .=153.60 mm

Design of spring:
Helical tension spring -full twisted spring.
Grade Vw it is used when the spring are subjected to fluctuating load
Diameter = 1.5 mm strength = 1670 N/mm²
Shear stress on spring is τ = 400N/mm²
Calculate spring index (C),
Ks= (1+0.5/C) =- (1+0.5/54)= 1.1
$\tau = Ks \times 8Fc/\pi d^2$
$400 = 1.1 \times 8 \times 500 \times 5/\pi \times d^2$
wire diameter is ,
d= 6mm
main coil diameter
D =c×d = 5×1.5 = 30 mm
no.of turns = 11
free length
Tmax = F/K =98.1/48 = 2.04 mm
Free length = solid length + maximum deflection + clearance
= 5.4 + 2.04 (0.15×2.04)
FL= 93.55 mm

Pulley specification:
Motor power = 0.625 KW
Motor driving pulley (D_1) = 75 mm
Motor driven pulley (D_2) = 300 mm
Motor speed (N_1) = 1440 rpm
Required speed (N_2) = 375 rpm

$$\frac{N1}{N2} = \frac{D2}{D1}$$

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$$\frac{1440}{375} = \frac{D2}{75}$$

D2 =300 mm.

Belt power required at,

$V_B = \frac{\pi \times 300 \times 375}{60 \times 1000}$

V_B= 5.98 m/s

Power to drive pulley

P=(Tvt-Tvs)× V_B

=248.505.89

P = 1463.88 W

P = 1.46 KW

By this power range motor require to drive the unit

Hp = 0.75×(1.46)

Hp = 1.095

The standard selection of motor is 1.5Hp.

The operation are completed very quick the time is required to 1corn/maize for the shelling is maximum 3 to 5 sec and there is about 80 to 100gm.Shelling 1kg of corn is 30sec.

Fig.11: Actual Working Model

Table 2: Observation table of parameter of corn Sheller machine

Sr. No	Parameter	Observation
1	Broken grain (%)	1-3
2	Un-threshed grain (%)	0.85
3	Threshing efficiency (%)	97-99.15
4	Cleaning efficiency (%)	95-97
5	Grain output capacity, q/h	4.5-5.6
7	Labor requirement, man-h/ha Labor requirement, man-h/ha	1-2

EXPERIMENTAL VALIDATION:

The experimental validation is as below:
Time required for maize shelling = 2-4 sec
Time required for an bag ,
Bag having about 50 kg weight ,one corn having about 8-10 seed /gram means that 8000/kg,
One maize having 400to 450 seed on each,
i.e., 8000/450
= 20 corn/kg, hence for 50kg, 50*8000
=4,00,000 seed for 50kg bag
Means about 1000 to 1200 corn for 50 kg,
Each corn required 2 -4 sec for shelling ,
Time require for 50 kg is,
1000*3 to 1200*3
3000 sec to 3600 sec means 50 kg seed shelling in 1 hour.
Approximately in 1 gram 9 to 10 seed. 1maize having 45 grams seed
For 250 grams seed 250/45 = 6 maize
Each maize having 2 sec to remove
6 maize * 2 sec = T
T = 12 sec …for 250 gram maize seeds
500 g = 24 sec ; 1 kg = 48 sec .
1 bag having average 55 kg maize
55 kg * 48 sec = 2840 sec
2840 sec = 44 min ≈ 45 min

Table 3: Selling capacity with the use of developed machine

Trail	Mass Of Grains (Kg)	Time Taken(S)	Rate Of Shelling Expression (Kg /Hr)	Rate Of Shelling
1	0.250	12	$\frac{0.250 \times 3600}{12}$	75
2	0.500	22	$\frac{0.500 \times 3600}{22}$	81.81
3	0.750	32	$\frac{0.750 \times 3600}{32}$	84.37
4	1.000	45	$\frac{1.000 \times 3600}{45}$	80

Table 4: Shelling capacity with the use of hand

Trail	Mass Of Grains (Kg)	Time Taken(S)	Rate Of Shelling Expression (Kg /Hr)	Rate Of Shelling
1	0.250	460.01	$\frac{0.250 \times 3600}{460.01}$	1.95
2	0.500	860.6	$\frac{0.500 \times 3600}{860.62}$	2.09
3	0.750	901.5	$\frac{0.750 \times 3600}{901.5}$	2.99
4	1.00	1002	$\frac{1 \times 3600}{1002}$	3.591

Table 5: Shelling efficiency

Trail	Mass Of Shelled Grain(Kg)	Mass Of Unshelled Grain(Kg)	Total Mass Of Grain (Kg)	Shelling Efficiency	Shelling Efficiency (%)
1	0.250	0.0131	0.2631	$\frac{0.250}{0.2631} \times 100$	95.02
2	0.500	0.0363	0.5363	$\frac{0.500}{0.5363} \times 100$	93.23
3	0.750	0.0695	0.8195	$\frac{0.750}{0.8195} \times 100$	92.49
4	1.000	0.0950	1.0950	$\frac{1.000}{1.0950} \times 100$	91.32

Table 6: Grain damage with the use of developed maize Sheller

Trail	Mass Of Shelled Grains (Kg)	Mass Of Damage Grains(Kg)	% Of Damage Grains
1	0.250	0.021	0.084
2	0.500	0.067	0.134
3	0.750	0.081	0.104
4	1.000	0.0951	0.095

ADVANTAGES OF PVC COATING:

We have decided to provide coating of Polyvinyl Chloride on various parts of the developed machine. PVC coating will be useful to enhance the life of parts and reduce the wear and tear of mechanical parts. It also helps in avoiding corrosion of parts due to environmental effects. It is a hard material with good mechanical strength than other types of coatings. The better tensile strength of material helps in improving overall mechanical properties to of the machine.

CONCLUSION:

Using of machines has made it possible to automate many processes. We have designed, developed, evaluated and analyzed the maize shelling machine. The main perspective of developing this machine is to fulfill the need of Indian farmers at low cost with effective utilization of resources. The machine is very effective from point of view of reduction in damage of grains. It makes cost saving through reduction in wastage of grain. Better productivity is achieved with this machine. Using this machine is very easy and no special skills are required to operate it. This machine is very useful for the farmer having small lands. It needs only one worked to operate this machine hence it again results in saving of cost of expenses on workers.

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