Design and Development of Rotary Type Vegetable Cleaner

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Abstract— Root vegetables from field must be cleaned prior to weighing and grading. Soil and other foreign materials must be removed especially for medium and heavy textured soils in which a pre-harvest irrigation is used to loosen the soil prior to hand harvesting washing of fruits and vegetables is vital steps in any processing operation, which give attractive and chemical free fruits. At present washing of fruits and root vegetables is carried out manually which is very tedious and time consuming and expensive process. As we know that time and human power are the important concern now a days in every field so there is a requirement of design and develop a vegetable cleaner machine which will reduce the required human effort and make their task easy. Main objective of this study which is to be design and develop a vegetable cleaning machine, using CAD software. The project involves the detailed study and getting the information from the sources available about the machine. On the basis of data accumulated CAD model will be developed and after that finite element analysis will be performed.

Key words: Cleaning Process, Vegetable Cleaning, CAD

I. INTRODUCTION

Root vegetables like potato, carrot, raddish, beet root and similar vegetables need to be cleaned before transporting from field to market. Washing of vegetables before selling it into the market, is an important primary process, which reduces the surface microbial load, while removing the fields soil, dust and even residual pesticides, thus leading to the value addition of the product at the farm level. Contamination of vegetables is generally due to unsanitary cultivation and marketing practices. The microorganisms and pesticides involved with the food if remained unsanitized, can be critical from a public health point of view, because they can lead to health hazard. At present there is no primary processing equipment like vegetable washers available in the market for small farmers and traders. Since washing of root vegetables before selling is a consumer's requirement, an appropriate washer must be designed to reduce time and labor in cleaning the root crop before subjecting it to sorting, grading and eventually selling in the market. Manual washing of root vegetables is a back breaking job for everyone who does the work. Normally many Indian farmers follow a traditional method of cleaning the carrots, radish, beet root in which the roots are washed manually by hands and feet. There is need to design a rotary type vegetable cleaner which is every farmer in India can afford.

Fig. : Images of root vegetables

II. DESIGN CALCULATIONS

A. *Barrel dimensions*

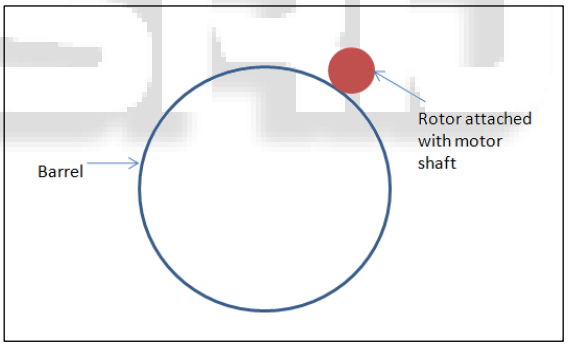
Cleaning in 1 hour:
Total weight / total time = 2750 kg / 4 hours
= 687.5 ≈ 690 kg / hour
[4 min washing with 28 revolution per minute of barrel for single charge]
Charge loading and unloading time approx = 6 min
Total time required for single charge = 6 + 4 = 10 min
Hence,
60 /10 = 6 charge in 1 hour
Weight of single charge = 690/6 = 115 kg
Volume of single charge = 115/1080 = 0.107 m3
Total barrel should be filled 1/6 for better cleaning
Considering the length of barrel = 1.47 m

$$\frac{\pi}{4} \times d^2 \times l = 0.107 \times 6$$

$$\frac{\pi}{4} \times d^2 \times 1.47 = 0.107 \times 6$$

$$d = 0.75 \text{ m}$$

B. *Speed of motor roller*



N_1 = 28 rpm barrel speed
N_2 = roller rpm
D_1 = 750 mm barrel diameter
D_2 = 200 mm roller diameter

$$N1D1 = N2D2$$

$$N2 = \frac{28 \times 750}{200} = 105 \text{ RPM}$$

Roller is directly attached to motor shaft.

C. *Torque calculation*

Considering total weight to be rotated is 150 Kg

$$150 \times 9.81 = 1471.5 \text{ N}$$

$$T = F \times r$$

$$T = 1471.5 \times 0.1 = 147.15 \text{ N.m}$$

D. *Power calculation*

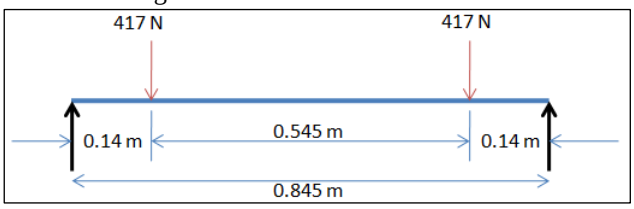
$$P = \frac{2\pi NT}{60}$$

$$P = \frac{2 \times \pi \times 105 \times 147.15}{60} = 1618 \text{ watt}$$

E. Frame Calculations

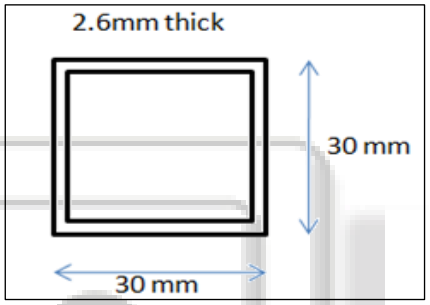
1) There are 2 horizontal members carrying total load at 4 points:

Total load = charge + barrel + others
Total load = 115 kg + 35 Kg + 20 Kg
= 170Kg / 4 = 42.5 Kg
Force = mass x acceleration
Force = 42.5 Kg x 9.81 m/sec2 = 417 N



Ra + Rb = 834 N
Rb x 0.845 - 417 x 0.705 - 417 x 0.14 =0
Ra = Rb = 417 N
Maximum bending moment at center of span

$$B.M = 417 \times 0.4225 - 417 \times 0.2825$$
$$B.M = 58.38\ N.m = 58380\ N.mm$$



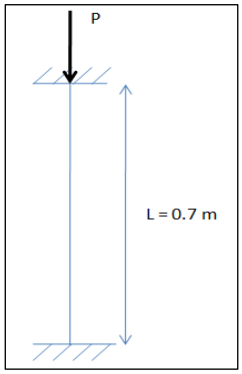
Y = 30/2 = 15 mm

$$I = \frac{BD^3 - bd^3}{12} = \frac{30^4 - 24.8^4}{12}$$
$$I = 35977.15\ mm4$$
$$\sigma = \frac{M}{I}.Y$$
$$\sigma = \frac{58380 \times 15}{35977.15} = 24.34\ MPa$$

Material used for the frame is SS304 which has yield stress between 215 to 250 mpa, and the stresses developed in frame for total load is very less than yield stress, Hence structure is safe.

2) There are 4 vertical members carrying total load:

Total load = charge + barrel + motor + frame + others
Total load = 115 kg + 35 Kg + 5kg + 30kg + 20 Kg
= 205 Kg / 4 = 51.25 Kg
Force = mass x acceleration
P = 51.25 Kg x 9.81 m/sec2 = 502.76 N



Both ends are fixed,

$$le = 0.5l = 0.5 \times 700 = 350mm$$
$$Pcr = \frac{\pi^2 EI}{le^2}$$

Where,
Pcr = crippling load
E = 210000 mpa
I = 35977.15 mm4
Le = 350 mm

$$Pcr = \frac{\pi^2 \times 210000 \times 35977.15}{350^2} = 608091.95\ N$$

For safe operation, Pcr > Pactual.
Compression of the member:

$$\sigma comp = \frac{F}{A}$$

F = 502.76 N
A = bxd-bxd = (30x30) - (24.8x24.8) = 284.96 mm2

$$\sigma comp = \frac{502.76}{284.96} = 1.76MPa$$

III. CAD MODELING OF VEGETABLE CLEANER

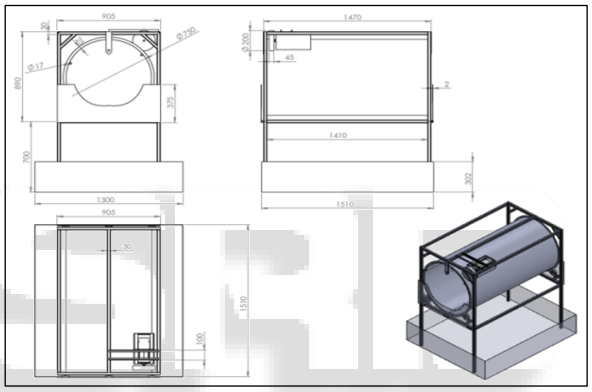


Fig. : Detailing drawing of vegetable cleaner

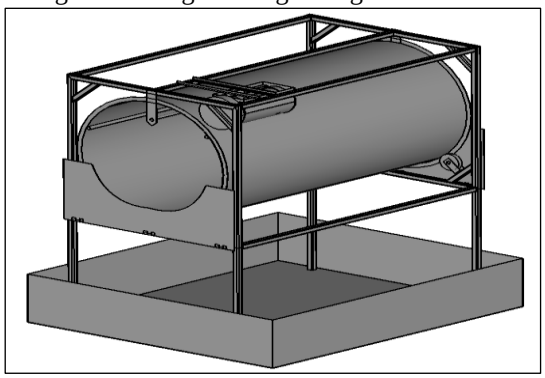


Fig. : CAD model of vegetable cleaner

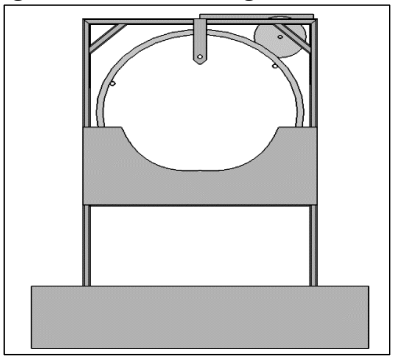


Fig. : Front view of CAD model of vegetable cleaner

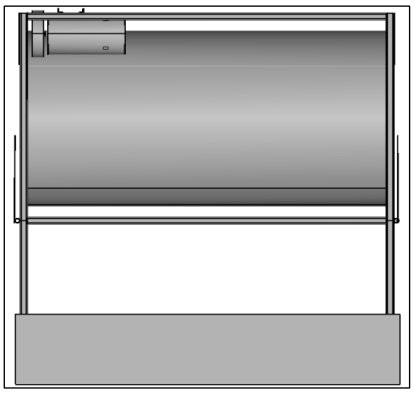


Fig. : Side view of CAD model of vegetable cleaner

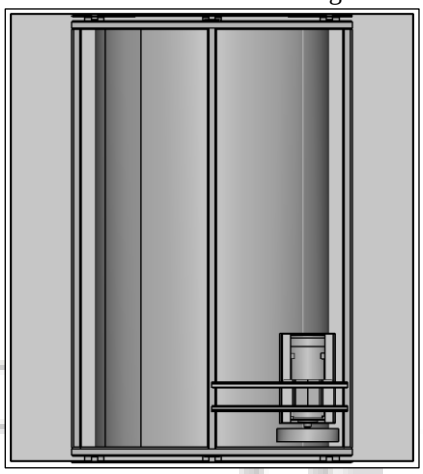


Fig. : Top view of CAD model of vegetable cleaner

IV. RESULTS

Results from the design calculations:
Capacity = 690 kg/hour
6 charges of 115 kg each can be cleaned in 1 hour
Barrel:
Length = 1.47 m
Diameter = 0.75 m

PART	FREAM BENDING	FRAME BUCKLING	FRAME COMPRATION
CROSS SECTION (mm)	30 X 30 X 2.6	30 X 30 X 2.6	30 X 30 X 2.6
MATERIAL	SS304 (215 MPa)	SS304 (215 MPa)	SS304 (215 MPa)
RESULTS	24.34 < 215 MPa Safe	6891.95 > 502.76 N Safe	1.76 < 215 MPa Safe

V. CONCLUSION

Design calculations and development of a vegetable cleaner machine, using CAD Software Techniques is done. The project involves the detailed study of machine and getting the information from the sources available about vegetable cleaner machine. In present study, design and development of the CAD model of vegetable cleaner machine made as per the company requirement. Then finite element analysis of vegetable cleaner machine for validation will be performed in further studies, after that results will be discussed and design will be finalized.

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